JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF INDUSTRY AND TRADE
PETROCHEMIA PLOCK S.A. (PPSA)
REPUBLIC OF POLAND

STUDY ON MODERNIZATION AND ENVIRONMENTAL POLLUTION CONTROL IN MAZOVIAN OIL REFINERY AND PETROCHEMICAL WORKS IN PLOCK, THE REPUBLIC OF POLAND

(ANNEXES)

JANUARY, 1995

UNICO International Corporation
IDEMITSU Engineering Co., Ltd.

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List of Annexes

ANNEX 1

RETROFITTING WORK
ITEMS & SPECIFICATION FOR NO.1 CRUDE OIL DISTILLATION UNIT OF PETROCHEMIA PLOCK

ANNEX 1 RETROFITTING WORK ITEMS & SPECIFICATION FOR NO.1 CRUDE OIL DISTILLATION UNIT OF PETROCHEMIA PLOCK

NOTE: This is prepared for the feasibility study only based on the discussion between PPSA and JICA Study team.

Retrofitting Item List
for NO.1 Crude Oil Distillation Unit
of PPSA

1. Rearrangement of Heat Exchangers

The purpose is to recover the heat from the products for saving energy.

Refer to Figures 4.8-1 and 4.8-2 as a proposed re-arrangement of Heat Exchangers.

The following factors are taken into consideration of this plan ;

(1)The number of products are reduced.
Since the quality of the some products increase, pumps and heat exchangers shall be replaced or newly installed.

(2)Stabilizer and Splitter are to be constructed.
Refer to Figure 4.8-1 as Flow Diagram.

(3)New product specifications are applied.

2. Installation of Air Preheater

This is to recover the heat from the Flue gas of Pc-1 and Pc-2 then to heat up the combustion air.

Refer to Figure 4.8-3 as a proposed flow scheme.

The existing Heaters are used as it is and connected each other by a flue gas duct. A Steam Air Heater and a Jung Strom will be installed.

3. O2 Control in Flue Gas from Pc-1 and Pc-2

This is to control the Oxygen content in the Flue Gas in order to reduce excess air to the Heaters.

Dampers of each Heater will be driven by GO Motor.

4. Replacement to DCS

All the instrument will be replaced with electric ones from pneumatic ones.

5. Reducing Offensive Odor Substances in sewage

This is to reduce offensive odor from the drip funnel in NO.1 Unit.

The following 3 plans were discussed with PPSA during the second site visit.

(1)Seal of drip funnels

(2)Construction of a waste water stripping unit for NO.1 CDU

(3)Construcdtion of a waste water unit for NO.1 and NO.2 CDU

Seal of drip funnels was selectred by PPSA because this is a simple measure and less cost effective.

6. The treatment of Od-8 and Zb-3 emissions

PPSA requested the treatment of Od-8 and Zb-3 emissions because these 2 emissions contain 90 % of H2S in NO.1 CDU.

Study team recommended an amine treating unit because the unit planned in NO.2 CDU, using NaOH solution to absorb H2S, cannot be applied for NO.1 CDU.

7. Installation of Coalescers for the prodtcts of A12, A13 and A14 for CDU.

In order to prevent corrosion and deterioration of performance of catalysts in reactors downstream, new coalescers will be installed in CDU.

1. Rearrangement of Heat exchangers (1/5)

Item	Main works	NOTE
1.1 Stabilizer Unit & Splitter Unit	(1) Manufacturing of towers, vessels, heat exchangers, and pumps. (2) Piping (3) Electrical & Instrument (4) Painting & Insulation	Refer to Equipmet list. DCS System shall be applied.
1.2 Rearrangement of Heat exchangers	The following 6 Heat exchangers will be newly manufactured and installed ; (1) Ex-3(W-4 Reboiler) No. 1 (2) Ex-4(W-5 Reboiler) 1 (3) Ex-5(W-5 Feed Exchanger) 1 (4) Ex-6(R13 Product cooler) 1 (5) Ex-7(W-4 Overhead Condenser) 1 (6) Ex-8(W-5 Overhead Condenser) 1	(1) Including Civil, , Foundation, Piping, Insulation and Painting around newly installed heat exchangers. (2) Refer to Equipment list.
1.3 Piping work around the existing Heat exchangers	(1) Wm 2, Wm 5 a. To connect Shell Side Inlet to Tube Side Outlet of Wm 16.1, Wm 17.1, Wm 18.1 and Wm 19.1. b. To connect Shell Side Outlet to run down pipe line to tank. c. To connect Tube Side Inlet to Outlet Pipe of Eh-2. d. To connect Tube Side Outlet to Tube Side Inlet of Wm 10 and Wm 14.	

Item	Main works	NOTE
	(2) Wm 3.3 a. To connect Shell Side Inlet to Discharge line of P 490. b. To connect Shell Side Outlet to Shell Side Inlet of Ch 3. c. To connect Tube Side Inlet to Tube Side Outlet of Wm 4.6. d. To connect Tube Side Outlet to Tube Side Outlet of Pd 1.2. (3) Wm 14 a. To connect Shell Side Inlet to Shell Side Outlet of Wm 11. b. To connect Shell Side Outlet to Shell Side Inlet of Ch 6. c. To connect Tube Side Inlet to Tube Side Outlet of Wm 2. d. To connect Tube Side Outlet to Tube Side Inlet of Wm 12. (4) Wm 6,8 a. To connect Shell Side Inlet to Discharge Line of P 590. b. To connect Shell Side Outlet to Shell Side Inlet of Ch 4. (No change for Tube Side of Wm 6,8) (5) Wm 4.4 a. To connect Shell Side Inlet to Shell Side Outlet of Wm 15. b. To connect Shell Side Outlet to Reflux line going to #17 tray of W-7. (No change for Tube Side of Wm 4.4)	

Item	Main works	NOTE
1.4 Other Piping works	(1) To connect Suction line of P 10 to Inlet line of ex-A14 Side Cut Stripper. (2) To connect Outlet line of ex-A14 Side Cut Stripper to Suction line of P 490.	
1.5 Other works	(1) Isolation of ex-A12 Side Cut Stripper. (2) Revamping of #27 tray of W-7 (Acuumlator tray.) (3) Isolation of Box Collers (4) Replacement of draw-off trays to valve trays W-1 : #12 W-2 : #45, #43, #29, #25, #19, #17, #11, #9 W-7 : #20, #14, #10	Instllation of blind plates after purging combustible gas and liquid. Instllation of blind plates after purging combustible gas and liquid. Connecting pipe shall be removed at the place where tray is replaced. As for A13 Fractions, no replacement is required because of its increased volume.
	(6) Extension of the steel structure for new condensers Sc-30 and Sc-31. (7) Replacement of the overhead pipe line of W-2 including the replacement of W-2 top nozzle.	Size of the new sturucure: 10 m(hight) × 6 m (length)× 9 m (width) New pipe line size : 30 inches

Item	Main works	NOTE
1.6 Replacement of Pumps	(1) The following pumps shall be replaced due to the yield change. P19,20(to P190 A,B) P32,33(to P320 A,B) P47,48(to P470 A,B) P49,50(to P490 A,B) P51,52(to P510 A,B) P53,54(to P530 A,B) P37,38(to P370 A,B) P26,27(to P260 A,B) P39,40(to P390 A,B) P41,42(to P410 A,B) P43 (to P430) (2) The following pump shall be removed due to the reduction of number of products. P46	The following criteria were adopted: When the ratio is 0.6 to 1.1, the existing pump will be used after the modernization.
1.7 Replacement or installation of new Heat Exchangers	The following heat exchangers shall be replaced or newly installed: Sc-30 (Newly installed) 31 (Newly installed) Ch-1 (Replaced) Ch-30 (Newly installed) Ch-40 (Newly installed) Ch-41 (Newly installed) Ch-60 (Newly installed) Ch-70 (Newly installed)	 Parallel with Sc-3 Parallel with Ch-5 Parallel with Ch-3 Parallel with Ch-4 Parallel with Ch-4 Parallel with Ch-6 Parallel with Ch-7
1.8 Replacement of Od-2	Due to the increase of the quanity of W-2 overhead gas and liquid, Od-2 is replaced to new one.	Refer to equipment list.

Product Name	Pump No.	Flow rate (Table 3.1-6) ①	Corrected flow rate ①×1.14	Flow rate (Table 4.6-3) ②	Ratio ②/ ①	NOTE
Crude Oil	P1,2	270	308	308	1.0	1. 1.14 is the correction factor by flow rate(308/270).
D. Crude	P3,4	270	308	308	1.0	
W-1 Botm	P5,6,7	407.4	464.5	486.2	1.05	
W-2 Botm	P8,9	144	164.2	154.3	0.94	
W-1 Ref.	P15,16	55	62.7	50	0.80	
Od-1 Botm	P17,18	22	25	25.1	1.00	
Od-2 Botm	P19,20	26	29.6	122.9	4.15	Replace.(P190 A,B)
1st Ref.	P32,33	65	74.1	86	1.16	Replace.(P320 A,B)
2nd Ref.	P34,35	63	71.8	75	1.05	
3rd Ref.	P36	58.5	66.7	64	0.96	
A12	P46	12	13.7	——	——	Remove.
A13⇨A12	P47,48	18	20.5	9.7	0.47	Replace.(P470 A,B)
A14⇨P11	P49,50	16	18.2	36	2.0	Replace.(P490 A,B)
A15⇨A13	P51,52	22	25.1	65.7	2.62	Replace.(P510 A,B)
A16⇨A14	P53,54	17	19.4	28.0	1.44	Replace.(P530 A,B)
W-7 1st	P10,11	61	69.5	61	1.00	
W-7 2nd	P37,38	24	27.4	24	0.88	Replace.(P370 A,B)
P11⇨P10	P26,27	118.5	135.1	97	0.72	Replace.(P260 A,B)
P13	P39,40	15	17.1	26	1.52	Replace.(P390 A,B)
P14	P41,42	30	34.2	9.9	0.29	Replace.(P410 A,B)
VR	P43	10	11.4	10.0	0.88	Replace.(P430)
	P12,13,14	53	60.4	60.4	1.00	

2. Installation of Air Preheater (1/1)

Item	Main works	NOTE
2.1 Steam Preheater & Jung Strom	(1) Manufacturing and installation of an Steam Preheater & a Jung Strom. (2) Piping (3) Electrical & Instrument	Refer to Equipmet list. Shut down sequence below is required; Imput • FDF Stop • IDF Stop • Jung Strom Stop Output • FDF Stop • IDF Stop • Jung Strom Operation (By air motor) • Fuel Oil & Gas Stop
	(4) Painting & Insulation (5) Civil	
2.2 Installation of Ducts	(1)Flue Gas Duct (2)Combustion Air Duct	Refer to Figure 4.8-3.
2.3 Replacement to Low Nox/Low O2 Burners	(1) 16 Sets for Pc-1 and 8 Sets for Pc-2 of the existing burners shall be replaced to Low NOX/Low O2 Burners.	
2.4 I.D.F./ F.D.F. Installation	(1) Manufacturing and installation of an IDF and FDF. (2) Piping (3) Electrical & Instrument (4) Painting & Insulation (5) Civil	Refer to Equipment list. As for IDF, Suction Duct shall be installed.
2.5 Stack	(1) Manufacturing and installation of an Stack. (2) Electrical (3) Painting & Insulation (4) Civil	30 m height and Concrete lining

3. O2 Control in Flue Gas from Pc-1 and Pc-2 (1/1)

Item	Main works	NOTE
3.1 Oxygen Analyzer	(1) Procurement and installation of 2 Oxgen Analyzers. (2) Piping Including a 4 inch takeoff nozzle with flange for Oxygen analyzer. (3) Electrical & Instrument Including electric power supply and signal tubing work. (4) Painting & Insulation (5) Civil	• Specification (1)Zirconium Type (2)Explosionproof Type (3)Duct Insertion Type (4)Range 0～15% O2 in flue gas
3.2 Installation of GO Motors	(1) Procurement and installation of 2 GO Motors. Including Supply Air piping, I/P Converter installation and related signal tubing works.	• Specification (1)Damper shall be driven by GO Motor directly.
3.3 Installation of Furnace Pressure gauge	(1) Procurement and installation of 2 Furnace Pressure Gauges	• Specification (1) + 5 ～ − 20 mmH2O (2)Imput to DCS.
3.4 Revamping of Damper	(1) Damper shall be driven by both GO Motor and Manuaul. (2) Maintenance platform shall be installed. (3) Mechanical Stopper shall be installed to prevent Damper closure.	
3.5 Piping Works	(1) Electrical & Instrument (2) Painting & Insulation (3) Civil	

4. Replacement to DCS (1/2)

4.1 Principle

(1) The area of replacing to DCS
All the existing pneumatic instruments will be replaced to DCS.
(Refer to Attachment 1 for the existing Instrument List)

(2) Replacement of transmitter
The existing transmitters will be replaced to electrical transmitters.
(Refer to Case 2 of Table 4.8-6)

(3) Control room
The existing control room will be used.
The existing instrument panels will be replaced with flat panels.

(4) The capacity and space of Sub-station
There is enough capacity and space of the existing Sub-station.
(No-revamping work is required for power supply to DCS and there is enough space for Un-interrupted Power Supply - UPS)

4.2 Retrofitting works

Item	Main works	NOTE
(1)Control Room / Sub-Station		
1) DCS	(1) Procurement and installation of DCS	
2) UPS	(1) Procurement and installation of UPS	
3) Sub-Station	(1) Connection to UPS (2) Connection to DCS	
4) Modification of Control Room	(1) Changing to Free access floor. (2) Installation of Distribution Panels and Joint Boxes.	Refer to Figure 1.
5) Lighting and Partition of Control Room	(1) To be clarified by PPSA.	
(2) Site Works	(1) Installation of electric transmitter.	From pneumatic to electric transmitter
	(2) Modification of signal tube.	Refer to Figure 2.
	(3) Installtion of I/P Converter.	Including stanchion. Refer to Figure 3.
	(4) Cable Duct Installation	Pipe rack

Item	Main works	NOTE
	(5) Cable Placing a. Transmitter ~ Site Joint Box b. Site Join Box~ Control room Joint Box c.Control room ~ DCS Joint Box (6) Site Joint Box Installation	

4.3 Control Loops for new Stabilizer and Splitter

(1)Temperature	10
(2)Flow	10
(3)Pressure	6
(4)Level	6
Total	32

Figure 1 Conceptual scheme

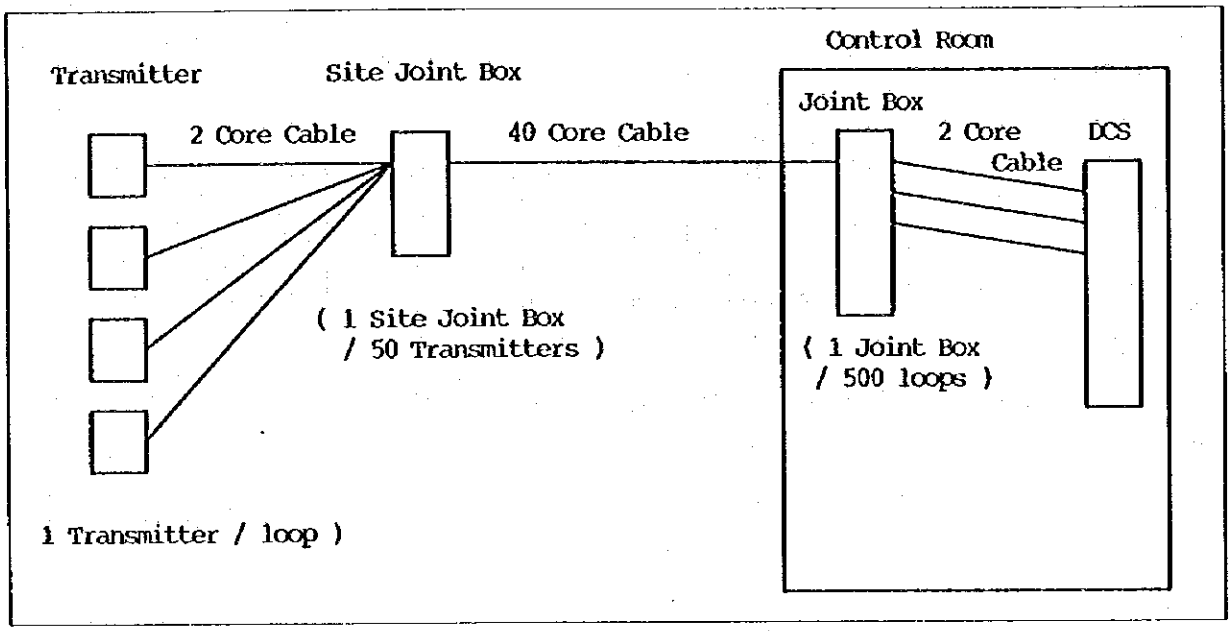


Figure 2 Modification of lead piping

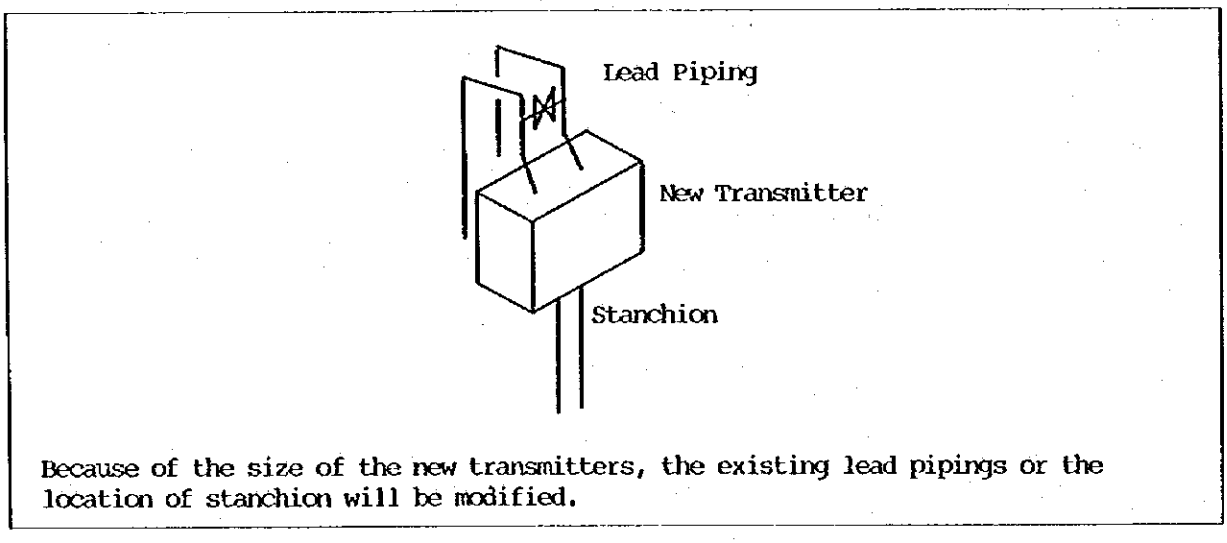
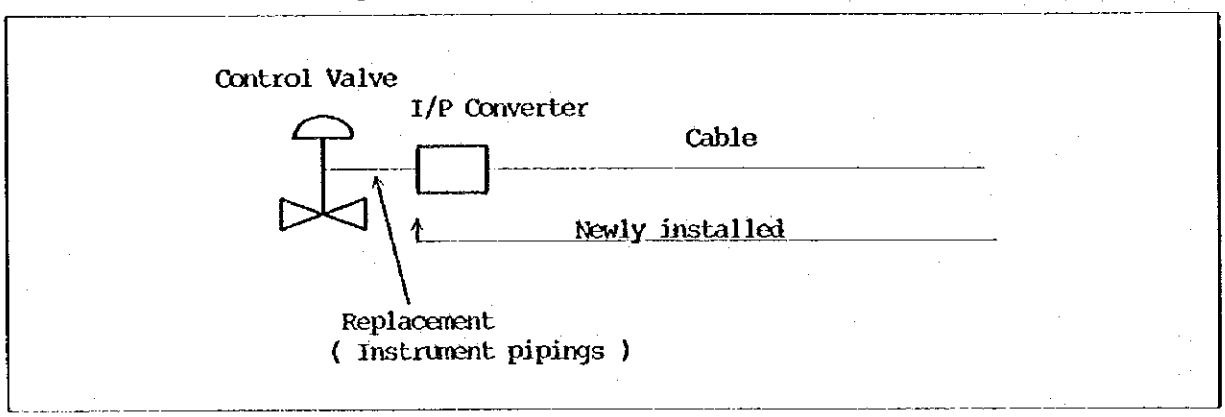


Figure 3 Modification around control valves



5. Reducing offensive odor substances in sewage (1/1)

Item	Main works	NOTE
5.1 Sealing of drip funnels	(1) Installation of short pipes as illustrated in Figure 4.6-2.	8 drip funnels shall be sealed by short pipes as illustrated in Figure 4.6-2.

6. The treatment of Od-8 and Zb-3 Emissions (1/1)

Item	Main works	NOTE
6.1 Gas compression section	(1) Installation of gas compression section in Figure 4.8-4 in Report.	
	Suction drum 1 Discharge drum (with SV) 1 Cooler 1 Compressor 2	Refer to Equipment List. Shut down sequence is required when
	O2 Analyzer 1 (with shut down sequence)	• Pressure of the Suction becomes below 0.0 kg/cm2. • O2 content in the gas of Suction Drum becomes over 2.0 vol %.
		Spill back line with a control valve is required for maintaining suction pressure of the Compressor.
	(2)Zb-3 shall be sealed by N2 to prevent air from entering into the gas.	Zb-3 will be conrolled under the positive pressure.
	(3)A safety valve shall be installed at Zb-3.	
6.2 Amine Treating Unit	(1) Amine Treating Unit	
	Feed Gas flow rate 140 nm3/h (240 kg/h)	
6.3 H2S rich gas transfer line	(1) H2S rich gas transfer line to the existing Clause Unit	
	Distance 3 km	• Steam trace & Insulation • Free drain

7 Installation of Coalescers for Products (1/1)

Item	Main works			NOTE
7.1 Installation of Coalescers	(1) CDU			(1) Refer to Equipment List.
		Estimated flow (t/h)	Design flow(t/h)	
	A12	9.7	15	(2) Process coalescer will be used with strainer.
	A13	65.7	80	
	A14	28.0	35	(3) 2 Strainers for 1 Coalescer shall be required.
				(4) Pressure gauge to measure the differential pressure is required.

EQUIPMENT LIST

(HEAT EXCHANGER)

MAZOVIAN REFINERY

NO.	EQUIPMENT ITEM NUMBER	SERVICE	TYPE	DUTY	SURFACE AREA	TUBE SIDE			SHELL SIDE			MEMO
						MATERIAL	DES PRES	DES TEMP	MATERIAL	DES PRES	DES TEMP	
				GJ/h	㎡		MPa	℃		MPa	℃	
1.	Re-arrangement of Heat Exchanger (Including Stabilizer & Splitter Unit)											
	Ex-3	W4 REBOILER	BEU	13.0	230×1	C.S.	—	275	C.S.	—	190	1 100φ×3 500L
	Ex-4	W5 REBOILER	BEU	6.3	150×1	C.S.	—	190	C.S.	—	150	900φ×3 500L
	Ex-5	W4 FEED EXCHANGER	BEU	4.0	90×1	C.S.	—	150	C.S.	—	120	550φ×6 000L
	Ex-6	R13 PRODUCT COOLER	BEU	2.5	45×1	C.S.	—	60	C.S.	—	120	500φ×3 500L
	Ex-7	W4 O/H CONDENSER	BEU	8.4	170×1	C.S.	—	60	C.S.	—	120	750φ×6 000L
	Ex-8	W5 O/H CONDENSER	BEU	10.5	210×1	C.S.	—	60	C.S.	—	120	850φ×6 000L
	Sc-30	W-2 O/H CONDENSER			245/205	C.S						SAME SPEC. AS Sc-3
	Sc-31	W-2 O/H CONDENSER			245/205	C.S						SAME SPEC. AS Sc-3
	Ch-30	P11 COOLER			136	C.S						SAME SPEC. AS Ch-3
	Ch-40	A13 COOLER			136	C.S						SAME SPEC. AS Ch-4
	CH-41	A13 COLER			136	C.S						SAME SPEC. AS Ch-4

EQUIPMENT LIST

(HEAT EXCHANGER)

MAZOVIAN REFINERY

No.	EQUIPMENT ITEM NUMBER	SERVICE	TYPE	DUTY	SURFACE AREA	TUBE SIDE			SHELL SIDE			MEMO
						MATERIAL	DES PRES	DES TEMP	MATERIAL	DES PRES	DES TEMP	
				GJ/h	m²		MPa	℃		MPa	℃	
	Ch-60	P12 COOLER			136	C.S			C.S			SAME SPEC. AS Ch-6
	Ch-70	P13 COOLER			136	C.S			C.S			SAME SPEC. AS Ch-7
2	Installation of Air Preheater											
								STEAM		AIR		
		STEAM AIR HEATER	FIN		2,200	C.S		In :300	C.S	In :-20		18.0 ata Steam
								Out:230		Out:120		
								AIR		FLUE GAS		
		JUNG SIROM	19 - HR-650		1,105	C.S		In :120		In :400		
								Out:200		Out:240		
3	Installation of Amine Treating Unit											
	EX-600	Gas Cooler	BEU		100	C.S						

EQUIPMENT LIST

(COLUMN & DRUM)

MAZOVIAN REFINERY

No.	EQUIPMENT ITEM NUMBER	SERVICE	No. REQ'D	DIMENSION I.D.mm×T.L.mm	SHELL MATERIAL	DES PRES MPa	DES TEMP °C	MEMO	Estimated Wall Thickness (mm)
1	Stabilizer & Splitter Unit								
	W4	STABILIZER	1	TOP 1 250× 16,000	C.S.	1.38 &FV	190	40 VALVE TRAYS	14
				BTM 1 900× 17,000					
	Od-201	STABILIZER O/H RECIEVER	1	1 500 × 3 500	C.S.	1.38&FV	120	HORIZONTAL , WITH WATER BOOT	14
				BOOT 300× 450					
	W5	SPLITTER	1	1 700 × 22,000	C.S.	0.45& FV	150	24 VALVE TRAYS	14
	Od-202	SPLITTER O/H RECEIVER	1	1 500 × 4 000	C.S.	0.45& FV	120	HORIZONTAL , WITH WATER BOOT	14
				BOOT 400× 600					
2	Amine Treating Unit								
	W600	Suction Drum	1	1 000 × 2 000	C.S	5.0 & FV			10
	W601	Discharge Drum	1	1 000 × 2 000	C.S	10.0 &FV			10
3	Replacement of vessel								
	Od-2	W-2 O/H RECEIVER	1	4 500 × 14 500	C.S	10.0 &FV		2 Level controlers with level gauges and 1 pressure controller with pressure gauge	

EQUIPMENT LIST

(PUMP & BLOWER)

MAZOVIAN REFINERY

No.	EQUIPMENT ITEM NUMBER	SERVICE	No. REQ'D	TYPE	FLUID	CASING MATERIAL	CAPACITY m³/h	DENSITY kg/m³	TEMP °C	DIFF.PRES MPa	HEAD m	For Feasibility Study Only Head (m)	Motor Rating JEM1188 (kw)	Motor Rating NEMA MG1 HP(kw)
1	Stabilizer & Splitter Unit													
	P201 A,B	W4 O/H PUMP	2	CENTRIF.	HC		39.7	538	38			10	1.5	2(1.5)
	P202 A,B	W5 O/H PUMP	2	CENTRIF.	HC		33.8	606	47			10	1.5	2(1.5)
	P203 A,B	W5 BOTTOM PUMP	2	CENTRIF.	HC		22.1	615	116			10	1.1	1.5(1.1)
2	Re-arrangement of Heat Exchangers													
	P510 A,B	A13 PRODUCT PUMP	2	CENTRIF.	HC		95.3	690	183			10	3.7	5(3.7)
	P490 A,B	P11 PRODUCT PUMP	2	CENTRIF.	HC		48.5	742	261			10	2.2	3(2.2)
	P190 A,B		2	CENTRIF.	HC		185	742						
	P320 A,B		2	CENTRIF.	HC		130							
	P470 A,B		2	CENTRIF.	HC		12	770	63					

EQUIPMENT LIST

(PUMP & BLOWER)

MAZOVIAN REFINERY

No.	EQUIPMENT ITEM NUMBER	SERVICE	No. REQ'D	TYPE	FLUID	CASING MATERIAL	CAPACITY m^3/h	DENSITY kg/m^3	TEMP °C	DIFF.PRES MPa	HEAD m	For Feasibility Study Only Head (m)	Motor Rating JEM1188 (kw)	Motor Rating NEMA MGI HP(kw)
	P530 A,B		2	CENTRIF.	HC	C.S	42	834						
	P370 A,B		2	CENTRIF.	HC	C.S	36							
	P260 A,B		2	CENTRIF.	HC	C.S	144.5	863						
	P390 A,B		2	CENTRIF.	HC	C.S	39	912						
	P410 A,B		2	CENTRIF.	HC	C.S	15	929						
	P430		1	CENTRIF.	HC	C.S	15	933						
	P46	REMOVAL												

EQUIPMENT LIST

(PUMP & BLOWER)

MAZOVIAN REFINERY

No.	EQUIPMENT ITEM NUMBER	SERVICE	No. REQ'D	TYPE	FLUID	CASING MATERIAL	CAPACITY n m³/h	DENSITY kg/m³	TEMP °C	DIFF.PRES MPa	HEAD m	For Feasibility Study Only Head (m)	Motor Rating JEM1188 (kw)	Motor Rating NEMA MGI HP(kw)
4	INSTALLATION OF AIR PREHEATER													
		MOTOR FOR JUNG STROM	1		AIR/FLUE GAS								2.2	
		SOOT BLOWER AT JUNG STRM	1										0.2	
		FORCED DRAFT FAN	1	CENTRIF.	AIR	C.S	200,000	1.19	-20			0.55	500	
		INDUCED DRAFT FAN	1	CENTRIF.	FLUE GAS	C.S	350,000	0.71	240			0.33	400	
		GO MOTOR	2	AIR DRIVEN										
5	Amine Treating Unit													
	C600 A,B	Sour Gas Compressor	2		HC		210		40 ~45	1.0			7.5	(7.5)

EQUIPMENT LIST

(COALESCER & STRAINER)

MAZOVIAN REFINERY

No.	EQUIPMENT ITEM NUMBER	SERVICE	No. REQ'D	DIMENSION I.D.mm×T.L.mm	SHELL MATERIAL	DES PRES MPa	DES TEMP °C	DES FLOW t/h	MEMO	Estimated Wall Thickness (mm)
1	CDU									
	ST-1 A,B	A12 STRAINER	2		C.S			15.0	SWITCHOVER TYPE	
	CO-1	A12 COALESCER	1		C.S			15.0	PROCESS COALESCER	
	ST-2 A,B	A13 STRAINER	2		C.S.			80.0	SWITCHOVER TYPE	
	CO-2	A13 COALESCER	1		C.S			80.0	PROCESS COALESCER	
	ST-3 A,B	A14 STRAINER	2		C.S			35.0	SWITCHOVER TYPE	
	CO-3	A14 COALESCER	1		C.S.			35.0	PROCESS COALESCER	

INSTRUMENT NUMBER LIST (TEMPERARURE)

(Instruments of new Stabilizer and Splitter Section are not included.)

NO	Number	Service	Note
1	TR-6923	Wm-4.2 Shell Side Outlet	
2	TIC-3120	Pd-1.2 Tube Side Inlet	
3	TIC-3121	Pd-1.1 Tube Side Inlet	
4	TI-3211	Pd-2 Tube Side Outlet	
5	TI-3220	CH-3.1 Tube Side Outlet	
6	TI-3415	Eh-2 Crude Oil Outlet	
7	TI-3315	Eh-1 Crude Oil Outlet	
8	TIC-4491	Wm-9 Tube Side Outlet	
9	TIC-6321	Wm-14 Tube Side Outlet	
10	TI-4490	Wm-10 Tube Side Outlet	
11	TI-487	Wm-5 Tube Side Inlet	
12	TIC-6222	Wm-15 Shell Side Outlet	
13	TR-6420	Wm-16.1 Tube Side Outlet	
14	TRC-6430	Wm-17.1 Tube Side Outlet	
15	TRC-6322	Wm-16.2/Wm-17.2 Shell Side Outlet	
16	TR-6323	Wm-18.2/Wm-19.2 Shell Side Outlet	
17	TR-6460	Wm-16.1/Wm17.1 Tube Side Outlet	
18	TR-6440	Wm-18.1 Tube Side Outlet	
19	TR-6450	Wm-19.1 Tube Side Outlet	
20	TR-6470	Wm-18.1/Wm19.1 Tube Side Outlet	
21	TI-4211	W-1 Overhead Gas	
22	TRC-4212	W-1 Overhead Gas	
23	TRC-4230	W-1 Overhead Reflux	With Oriffice
24	TR-4231	W-1 Overhead Reflux	
25	TR-4232	W-1 Feed	
26	TI-4405	W-2 Overhead Gas	

(Instruments of new Stabilizer and Splitter Section is not included.)

NO	Number	Service	Note
27	TRCA-4404	W-2 Top Reflux	
28	TR-4401	W-2 Top Reflux	
29	TR-4440	A_{L2} Draw off	
30	TR-4450	A_{L3} Draw off	
31	TR-4460	A_{L4} Draw off	
32	TR-4470	A_{L5} Draw off	
33	TR-4480	A_{L6} Draw off	
34	TR-4417	W-2 Side Reflux (Upper)	
35	TR-4420	W-2 Side Reflux (Middle)	
36	TR-4423	W-2 Side Reflux (Lower)	
37	TIC-6321	Wm-14 Tube Side Outlet	
38	TR-4427	W-2 Bottoms	
39	TI-4443	W-3 Draw Off (A_{L2})	
40	TI-4453	W-3 Draw Off (A_{L3})	
41	TI-4463	W-3 Draw Off (A_{L4})	
42	TI-4473	W-3 Draw Off (A_{L5})	
43	TI-4483	W-3 Draw Off (A_{L6})	
44	TRC-4140	Pc-1 Coil Outlet	
45	TR-4170	Pc-1 Coil Outlet	
46	TR-4171	Pc-1 Coil Outlet	
47	TR-4172	Pc-1 Coil Outlet	
48	TR-4173	Pc-1 Coil Outlet	
49	TR-4174	Pc-1 Coil Outlet	
50	TR-4175	Pc-1 Coil Outlet	
51	TR-4130	Pc-1 Convection Section	
52	TR-4131	Pc-1 Convection Section	
53	TR-4132	Pc-1 Convection Section	

INSTRUMENT NUMBER LIST (TEMPERARURE)
(Instruments of new Stabilizer and Splitter Section is not included.)

NO	Number	Service	Note
54	TR-4133	Pc-1 Convection Section	
55	TR-4134	Pc-1 Convection Section	
56	TR-4135	Pc-1 Convection Section	
57	TR-4113	Pc-1 Convection (Steam Coil Outlet)	
58	TR-4120	Pc-1 Wall (Top)	
59	TR-4121	Pc-1 Wall (Top)	
60	TR-4122	Pc-1 Wall (Top)	
61	TR-4123	Pc-1 Wall (Top)	
62	TR-4124	Pc-1 Wall (Top)	
63	TR-4125	Pc-1 Wall (Top)	
64	TR-4150	Pc-1 Wall (Middle)	
65	TR-4151	Pc-1 Wall (Middle)	
66	TR-4152	Pc-1 Wall (Middle)	
67	TR-4153	Pc-1 Wall (Middle)	
68	TR-4154	Pc-1 Wall (Middle)	
69	TR-4155	Pc-1 Wall (Middle)	
70	TRC-4141	Pc-1 Fuel Gas	
71	TR-4117	Fuel Oil	
72	TI-6211	W-7 Overhead Gas	
73	TI-6212	W-7 Overhead Gas	
74	TRC-6231	W-7 Side Reflux (Upper) Draw Off	
75	TR-6240	W-7 $P_{1,2}$ Draw Off	
76	TR-6250	W-7 $P_{1,3}$ Draw Off	
77	TR-6260	W-7 $P_{1,4}$ Draw Off	
78	TR-6219	W-7 Side Reflux (Middle) Return	
79	TR-6218	W-7 Side Reflux (Middle) Draw Off	
80	TR-6270	W-7 Vacuum Residue Draw Off	

INSTRUMENT NUMBER LIST (TEMPERARURE)

(Instruments of new Stabilizer and Splitter Section is not included.)

NO	Number	Service	Note
81	TI-6244	W-8 P_1, Draw Off	
82	TI-6254	W-8 P_1, Draw Off	
83	TI-6264	W-8 P_1, Draw Off	
84	TR-6113	Pc-2 Convection (Steam Coil Outlet)	
85	TR-6114	Pc-2 Atmospheric Residue Feed	
86	TR-6164	Pc-2 Convection	
87	TR-6160	Pc-2 Atmospheric Residue Outlet	
83	TR-6165	Pc-2 Atmospheric Residue Outlet	
84	TRC-6140	Pc-2 Atmospheric Residue Outlet	
85	TRC-6112	Pc-2 Fuel Oil (Pc-2 Temp. Control)	
86	TR-6117	Pc-2 Fuel Oil	
88	TI-6882	ChS-2.1 Vacuum Residue Outlet	
89	TI-6883	ChS-2.2 Vacuum Residue Outlet	
90	TR-6880	ChS-1.1 Vacuum Residue Outlet	
91	TR-6881	ChS-1.2 Vacuum Residue Outlet	
92	TI-2140	Cooling Water	
93	TR-2150	Sc-10 Cooling Water Outlet	
94	TI-4320	Sc-5d,g Liquid	
95	TI-4321	Sc-4d,g Liquid	
96	TI-4340	Sc-3d,g Liquid	
97	TI-4311	Sc-2d,g Liquid	
98	TI-4310	Sc-1d,g Liquid	
99	TI-4412	Ch-12 Shell Side Inlet	
100	TI-4416	Ch-12 Shell Side Outlet	
101	TI-4413	Ch-10 Shell Side Inlet	
102	TI-4419	Ch-10 Shell Side Outlet	
103	TI-4414	Ch-11 Shell Side Inlet	

INSTRUMENT NUMBER LIST (TEMPERARURE)
(Instruments of new Stabilizer and Splitter Section is not included.)

NO	Number	Service	Note
104	TI-4422	Ch-11 Shell Side Outlet	
105	TI-4425	Ch-9A Shell Side Outlet	
106	TI-4435	Ch-13 Shell Side Outlet	
107	TI-682	Ch-13 Shell Side Inlet	
108	TI-4488	Ch-5 Shell Side Outlet	
109	TI-4487	Ch-5 Shell Side Outlet	
110	TI-6257	Ch-7 Shell Side Outlet	
111	TI-6266	Ch-8 Shell Side Outlet	
112	TI-685	Ch-14 Shell Side Outlet	
113	TI-4146	Z-11	
114	TI-4147	Z-12	

INSTRUMENT NUMBER LIST (PRESSURE)

(Instruments of new Stabilizer and Splitter Section are not included.)

NO	Number	Service	Note
1	PR-3112	P1/P2 Discharge	
2	PIC-3116		
3	PIC-3117		
4	PI-3123	Pd.1.2 Tube Side Outlet	
5	PRC-3210	P-59/P-60 Discharge	
6	PIC-3513	Zb-1	
7	PRCA-3512	Eh-2	
8	PDC-3411	Emulsion Valve for Eh-2	
9	PDC-3311	Emulsion Valve for Eh-1	
10	PIA-3316	Eh-1 Outlet	
11	PIA-4013	Wm-2 Tube Side Inlet	
12	PIA-4014	Wm-5 Tube Side Inlet	
13	PRA-4403	W-2 Top	
14	PIC-4410	Pc-1 Recycle	
15	PI-4142	Pc-1 Convection Section	
16	PR-4118	Pc-1 Convection Section Steam Inlet	
17	PD-4101	Pc-1 Draft	
18	PD-4102	Pc-1 Draft	
19	PD-4103	Pc-1 Draft	
20	PD-4104	Pc-1 Draft	
21	PD-4105	Pc-1 Draft	
22	PD-4106	Pc-1 Draft	
23	PIC-4312	Od-1	
24	PIC-4322	Od-2	
25	PIC-5320	Od-3	
26	PaR-6213	W-7 Top	
27	PaR-6220	W-7 Flash Zone	

INSTRUMENT NUMBER LIST (PRESSURE)

(Instruments of new Stabilizer and Splitter Section is not included.)

NO	Number	Service	Note
28	PR-6118	Pc-2 Preheat Steam Outlet	
29	PI-6101		
30	PI-6102		
31	PIC-6490	Vacuum Residue to ChS-2.1/2.2	
32	PIC-6810	Steam to Ejector	
33	PI-2130	Cooling Water Sc-10 Inlet	
34	PI-2137	Cooling Water Sc-10 Outlet	
35	PIC-2131	Cooling Water Ch-10,11,12	
36	PI-2140	Steam Header	
37	PI-2145	Steam Header	
38	PRA-2215	Steam Header	
39	PIA-4014	Wm-5 Tube Side Inlet	
40	PRA-4403	W-2 Top	
41	PIC-4410	Pc-1 Recycle	
42	PI-4142	Pc-1 Convection Section	
43	PR-4118	Pc-1 Convection Section Steam Inlet	
44	PD-4101	Pc-1 Draft	
45	PD-4102	Pc-1 Draft	
46	PD-4103	Pc-1 Draft	
47	PD-4104	Pc-1 Draft	
48	PD-4105	Pc-1 Draft	
49	PD-4106	Pc-1 Draft	
50	PIC-4312	Od-1	
51	PIC-4322	Od-2	
52	PIC-5320	Od-3	
53	PaR-6213	W-7 Top	
54	PaR-6220	W-7 Flash Zone	

INSTRUMENT NUMBER LIST (FLOW) 1 of 3

(Instruments of new Stabilizer and Splitter Section are not included.)

NO	Number	Service	Note
1	FRC-3113	P-1/P-2 Discharge (Crude Oil)	
2	FR-3115	Crude Oil to Wm-1.1	
3	FR-3122	Pd-1.2 Tube Side Outlet	
4	FRC-2326	P-83/P-84 Discharge	
5	FR-2420	P-3/P-4 Discharge	
6	FRC-3216	Water to Eh-1	
7	FRC-3217	Water to Eh-2	
8	FRC-4011	Wm-2 Tube Side Inlet	
9	FRC-4012	Wm-5 Tube Side Inlet	
10	FRC-4220	Bottom Recycle to W-1	
11	FR-4015	W-2 Upper Reflux	Confirm FR-4415 in P&ID A-40. (Maybe same Flow Meter)
12	FR-4418	W-2 Middle Reflux	
13	FR-4421	W-2 Lower Reflux	
14	FRC-4430	W-2 Stripping Steam	
15	FRC-4431	W-3 Stripping Steam to Atmosphere	
16	FRC-4441	W-3 Stripping Steam	
17	FRC-4451	W-3 Stripping Steam	
18	FRC-4461	W-3 Stripping Steam	
19	FRC-4471	W-3 Stripping Steam	
20	FRC-4481	W-3 Stripping Steam	
21	FRC-4112	Steam to Pc-1	
22	FR-2610	Od-1 Off Gas	
23	FRC-6224	W-7 Upper Reflux	
24	FRC-6225	W-7 Top Reflux	
25	FRC-6272	Stripping Steam to W-7	
26	FRC-6231	W-8 Stripping Steam to Atmosphere	
27	FRC-6242	Stripping Steam to W-8	

INSTRUMENT NUMBER LIST (FLOW)

(Instruments of new Stabilizer and Splitter Section are not included.)

NO	Number	Service	Note
28	FRC-6252	Stripping Steam to W-8	
29	FRC-6262	Stripping Steam to W-8	
30	FRC-6141	Fuel Oil to Pc-2	
31	FR-6278	Steam to Ejector (North)	
32	FR-6276	Steam to Ejector (Middle)	
33	FR-6275	Steam to Ejector (South)	
34	FRC-6280	Cooling Water to Ejector Condenser	
35	FR-6282	Cooling Water to Sc-1/Sc-2	
36	FR-6283	Cooling Water to Ch-10/Ch-11/Ch-12	
37	FRC-4402	W-2 Top Reflux ($A_{\ell 1}$)	
38	FRC-4352	$A_{\ell 1}$ to NO.2 UNIT	
39	FR-6279	Od-8 Concensate to Z-8	
40	FRC-6267	P-42/P-43 Discharge ($P_{\ell 4}$)	
41	FRC-6410	P-12/P-13 Discharge (Vacuum Residue)	
42	FRC-6480	P-13/P-14 Discharge (Vacuum Residue)	
43	FRC-4429	Atmospheric Residue to Pc-2	
44	FRC-4474	Atmospheric Residue to Chs-1.2/1.2	
45	FRC-4110	W-1 Bottoms Oil to Pc-1(P-7/8/9 Dis)	
46	FRC-6235	Ch-9A Outlet ($P_{\ell 1}$ Rundown)	
47	FRC-4486	Ch-5 Outlet ($A_{\ell 6}$ Rundown)	
48	FRC-6247	Ch-6 Outlet ($P_{\ell 2}$ Rundown)	
49	FRC-6257	Ch-7 Outlet ($P_{\ell 3}$ Rundown)	
50	FRC-4446	P-46/47 Discharge ($A_{\ell 2}$ Rundown)	
51	FRC-4456	P-47/48 Discharge ($A_{\ell 3}$ Rundown)	
52	FRC-4466	P-49/50 Discharge ($A_{\ell 4}$ Rundown)	
53	FRC-4476	P-51/52 Discharge ($A_{\ell 5}$ Rundown)	
54	FRC-6111	P-98/99 Dis. (Fuel Oil for Pc-2)	

INSTRUMENT NUMBER LIST (FLOW)

(Instruments of new Stabilizer and Splitter Section are not included.)

NO	Number	Service	Note
55	FRC-4111	P-96/97 Dis. (Fuel Oil for Pc-1)	
56	FR-2260	Steam to Collector	
57	FR-2210	Steam to 1.7 MPa Header	
58	FRC-2901	Steam to Collector	
59	FRC-2902	Instrument Air	
60	FR-2320	Steam to Collector	
61	FRC-2310	Steam to Collector	
62	FRC-2203	Maintenance Nytrogen	
63	FRC-7140	P-94/95 Discharge (A.D. Rundown	

INSTRUMENT NUMBER LIST (LEVEL)

(Instruments of new Stabilizer and Splitter Section are not included.)

NO	Number	Service	Note
1	LI-3213	Z-8 (Ejector Steam Condensate)	
2	LIA-3218	Ot-1	
3	LICA-3514	Zb-1	
4	LICA-3410	Eh-2 Water	
5	LICA-3310	Eh-1 Water	
6	LICA-4240	W-1 Bottom	
7	LICA-4428	W-2 Bottom	
8	LICA-4442	W-3 (A_{L2})	
9	LICA-4452	W-3 (A_{L3})	
10	LICA-4462	W-3 (A_{L4})	
11	LICA-4472	W-3 (A_{L5})	
12	LICA-4482	W-3 (A_{L6})	
13	LICA-4313	Od-1	
14	LICA-4323	Od-2	
15	LICA-4314	Od-1 (Water)	
16	LICA-4324	Od-2 (Water)	
17	LAH-5321	Od-3	
18	LICA-6271	W-7 Bottom	
19	LCA-6241	W-8 (P_{L1})	
20	LCA-6251	W-8 (P_{L2})	
21	LCA-6261	W-8 (P_{L3})	
22	LIC-6233	Zb-2	
23	LAH-6279	Z-15	
24	LI-6274	Od-8	
25	LICA-6273	Od-8	
26	LICA-4144	Z-11	
27	LICA-4145	Z-12	

INSTRUMENT NUMBER LIST (LEVEL)

(Instruments of new Stabilizer and Splitter Section are not included.)

NO	Number	Service	Note
28	LIA-3010	Zm-1	
29	LIA-3011	Zm-2	
30	LIA-3012	Zm-3	
31	LIA-3219	Zb-3	
32	LIC-7130	Zb-4.2	
33	LIC-72304	Zb-4.2	
34	LICA-2020	E-41	
35	LIA-3205	Z-6	

PLANT COST ESTIMATION

(Unit : US$)

		Equipment & Material		Field work	EPS-MH and expense	Sub total	Import duty	VAT	Total
		Foreign	Local						
1	Rearrangement of heat exchanger								
1)	1-1 Tower and vessel w/internal	-	377,340	139,470	50,440	567,250	-	124,795	
	1-2 Heat exchanger	-	392,306	42,100	85,370	519,776	-	113,354	
	1-3 Pump and driver	-	223,300	27,230	9,010	259,540	-	57,099	
	1-4 Transportation at site	-	-	4,100	-	4,100	-	900	
	Sub-Total	-	-	-	-	1,350,666	-	296,148	1,646,814
2)	Piping, electrical, instrument and misc. work	-	-	1,762,640	250,550	2,013,190	-	442,907	2,456,097
3)	Isolation and Tray replacement	-	-	257,010	38,550	295,560	-	65,023	360,583
	Total of 1	-	992,946	2,232,550	433,920	3,659,416	-	804,078	4,463,494
	Installation of heater for w4 and w5	-	481,950	265,302	48,348	795,600	-	175,032	970,632
	Reduction of heat exchanger Ex-3 & Ex-4 and related work	-	57,200	270,063	10,380	337,643	-	74,281	411,924
	Actual investment cost (New heater installation and Heat exchanger (ex-3 & 4) and related work reduction)	-	424,750	-4,761	37,968	457,957	-	100,751	558,708
2	Installation of air preheater								
	2-1) Steam air heater	-	264,000	21,500	39,500	325,000	-	71,500	396,500
	Jungstrom	306,250	-	107,000	45,750	459,000	150,063	33,605	642,668
	2-2) Forced and induced draft fan	-	224,000	18,000	33,600	275,600	-	60,632	336,232
	2-3) Fuel gas duct	-	-	174,500	13,800	188,300	-	41,426	229,726
	2-4) Low NOx/O_2 burner	-	168,000	21,800	16,800	206,600	-	45,452	252,052
	2-5) Stack	-	-	55,780	3,480	59,260	-	13,037	72,297
	2-6) Electric and instrument work	-	-	180,600	24,160	204,760	-	45,047	249,807
	2-7) Piping work	-	-	129,000	12,900	141,900	-	31,218	173,118
	Total of 2	306,250	656,000	708,180	189,990	1,860,420	150,063	341,917	2,352,400

Note: 1. Field work for 2-1) to 2-5) is including foundation, steel structure, erection, insulating, painting and misc. work.
2. Cost of Jungstrom is applied to be supplied by Japanese vendor.

(Unit : US$)

		Equipment & Material		Field work	EPS-MH and expense	Sub total	Import duty	VAT	Total
		Foreign	Local						
3	O_2 control in flue gas from Pc-1 and Pc-2								
	3-1) Oxygen analyzer	-	60,000	7,600	-	67,600	-	14,872	82,472
	3-2) G.O. motor	15,400	-	9,000	-	24,400	7,546	1,980	33,926
	3-3) Pressure gauge	-	5,000	3,000	-	8,000	-	1,760	9,760
	3-4) Dumper	-	-	20,000	-	20,000	-	4,400	24,400
	3-5) Miscellaneous	-	-	12,000	-	12,000	-	2,640	14,640
	EPS-MH and expenses for 3-1) to 3-5)	-	-	-	19,800	19,800	-	4,356	24,156
	Total of 3	15,400	65,000	51,600	19,800	151,800	7,546	30,008	189,354
4	Replacement to D.C.S								
	4-1) DCS w/back-up power system	633,000		-	-	633,000	310,170	-	943,170
	4-2) Field instrument	-	606,500	-	-	606,500	-	133,430	739,930
	4-3) Cable, wire and other material	-	187,700	-	-	187,700	-	41,294	228,994
	4-4) Installation and instrument work	-	-	242,800	-	242,800	-	53,416	296,216
	EPS-MH and expense	-	-	-	214,080	214,080	-	47,098	261,178
	Total of 4	633,000	794,200	242,800	214,080	1,884,080	310,170	275,238	2,469,488

Note: 1. DCS w/back-up power system will be supplied by European vendor.
2. Cost of modification of existing control room is included in 4-4) above.

		Equipment & Material		Field work	EPS-MH and expense	Sub total	Import duty	VAT	Total
		Foreign	Local						
5	Reducing offensive odor substance in sewages	-	6,400	10,000	-	16,400	-	3,608	20,008
6	Installation of coalescer	338,000		84,600	12,700	435,800	165,865	22,790	624,455

Note: Coalescer w/filter will be supplied by Japanese vendor

REFERENCE

60,000 BPSD CRUDE UNIT (INCL. VACUUM UNIT)

	(Unit : US$)
1. Professional services (Home, local & field office M.H)(162,000 Hrs)	5,680,000
2. Direct & indirect material	39,800,000
3. Direct labor & construction	10,460,000
4. Transportation (15,000 F/T)	2,000,000
5. Home and field office exp.	3,220,000
6. Contingency and OH & PR (15%)	9,180,000
Total	70,340,000

Note : SCOPE OF WORKS AND FACILITIES

(1) The crude unit includes all the process facilities and services inside Battery Limit of:

a) Design and engineering
b) Civil works
c) Equipment and materials
d) Transportation
e) Erection and installation
f) Precommissioning and commissioning work

(2) Soil improvement and piling work is excluded.

(3) Import duty and VAT is excluded

(4) Utility services facilities and storages are not included in the estimate. As for the electric supply, up to secondary electric substation is included

(5) No building is included, other than control room and electric substation.

ANNEX 2

Reference Documents for Cost Estimation of Modernization of Power Plant

ANNEX 2 REFERENCE DOCUMENTS FOR COST ESTIMATION OF MODERNIZATION OF POWER PLANT

A.2.1 Retrofitting Item List for Power Plant in PPSA

1. Replacement of Economizer

   A staggered, not a checker arrangement is used in the economizers of boilers burning heavy fuel oil. The present economizer will be replaced with a checker arrangement economizer.

2. Replacement of Jungstrom

   The present Jungstrom will be replaced with the most up-to-date model in order to reduce combustion air leak to flue gas at Jungstrom by under 5%.

3. Replacement of Burners

   All burners will be replaced with low NOx burners from conventional type.

4. Replacement of Burner Guns for Bias Combustion

   Burners are mounted on three stages. The burner guns on upper stage will be replaced with guns having 80% capacity. The burner guns on lower stage will be replaced with guns having 120% capacity. (These capacity data shall be used for cost estimation only.)

5. Installation of Flue Gas Recirculation System

   This is to reduce NOx formation in combustion chamber. Refer to Figure.1 as a proposed flow scheme.

6. Installation of Soot Blower

Soot blowers will be installed up fand down stream of each superheater and at the heat transfer element of Jungstrom for boilers. As for the type of soot blowers, refracting type for high temperature zones and fixed position rotating type for Jungstrom. Refer to Figure 2 as positions of soot blowers to be installed.

7. Installation of New Steam Air Heaters at Down Stream of Existing Ones

Existing steam air heater is possible to heat combustion air from ambient temperature to 50°C by using 7.5 ata steam. New steam air heaters using 18 ata steam will be installed at downstream of existing steam air heaters.

1. Replacement of Econimizer

Item	Main works	Note
1.1 Piping work around economizer	(1) To remove & repair of side wall	Refer to Fig.6.2-1 in the Final Draft Report.
	(2) To rearrange of economizer tubes tube size 19 mm ϕ tube material carbon steel	Refer to Fig.1
	(3) Painting & insulation	

2. Replacement of Jungstrom

Item	Main works	Note
2.1 Jungstrom	(1) Manufacturing & installation of Jungstroms	Refer to Fig.6.2-1 in the Final Draft Report.
	(2) Piping	
	(3) Electrical & Instruments	
	(4) Painting & insulation	
	(5) Civil	
2.2 Piping work around Jungstrom	(1) To connect flue gas duct and combustion air duct	
	(2) To connect utility piping	

3. Replacement of Burner

Item	Main works	Note
3.1 Replacement to low NO_x Burners	(1) Manufacturing of burner assemblies including air register dampers (2) To rearrange of burner assemblies (3) Refractory lining	Refer to Fig.5.2-1 in the Final Draft Report.

4. Replacement of burner guns for bias combustion

Item	Main works	Note
4.1 Burner tips	(1) Manufacturing of burner tips number 12 material (2) To mount burner tips on existing burner guns	Refer to Fig.5.2-2 in the Draft Final Report.

5. Installation of Flue Gas Recirculation System ⇦ Cancel

Item	Main works	Note
5.1 Blower	(1) Manufacturing and installation of flue gas circulation blowers quantity 2 flue gas temperature 400 ℃ flue gas pressure mmAq head mmAq flow rate m³/min (2) Electrical & Instrument (3) Painting & Insulation (4) Civil	This system is canceled by the following reasons. ① There is no access for this system in the boiler site. ② The other measures is available for reduction of NOx .
5.2 Installation of ducts	(1) Flue gas duct (2) Mixing device (3) Insulation	Refer to Fig.2.(delete)

6. Installation of Soot Blowers

Item	Main works	Note
6.1 Soot Blowers	(1) Manufacturing and installation of soot blowers quantity 7 refracting type 5 fixed position-rotating type 2	Refer to Fig.6.2-1 in the Interim report.
	(2) Rearrangement of water screen tube wall for refracting type soot blowers	Refer to Fig.3.
	(3) Electric & Instruments	
	(4) Painting & Insulation	

7. Installation of new steam air heater

Item	Main works	Note
7.1 steam air heater	(1) Manufacturing and installation of steam air heater	Refer to Fig.4.
	(2) Piping a. To connect inlet line of 18 ata steam. b. To connect recovery line of condensate.	

8. Adoption of countercurrent regeneration

Item	Main works	Note
8.1 Piping work	(1) Manufacturing of internals of ion-exchangege resin towers (5 sets) a. Inlet nozzle with flange for water stream b. Distributor for water stream c. Outlet nozzle with flange for regenerant stream d. Collector for regenerant stream e. Inlet nozzle with flange for regenerant stream (2) To mount an outlet nozzle on each ion-exchange tower for collector of regenerant stream a. Nozzle size 207 mm-ID b. Hard rubber lining and curing (3) Assembling of internals in ion-exchange resin tower (4) To connect water line & regenerant line line size mmφ line length m material	Refer to Fig.5.

9. Adoption of series regenerant feed

Item	Main works	Note
9.1 Piping work	(1) To connect regenerant line from collector outlet of downstream cation (anion) tower to distributor inlet of upstream cation(anion) tower. line size mmφ line length m material SUS 316	

10. Elimination of dead ends of pipe

Item	Main works	Note
10.1 Piping work	(1) To eliminate common piping. a.Between adsorber and cation tower b.Between cation tower and anion tower c.Between anion tower and decarbonator d.cation tower and anion tower e.anion tower and silica polisher (2) To connect new piping for each train instead of common piping. line size mmφ line length m material Hard rubber lining	

Figure 1 DETAIL DRAWING OF ECONOMIZER IN NO.2 BOILER OF PPSA

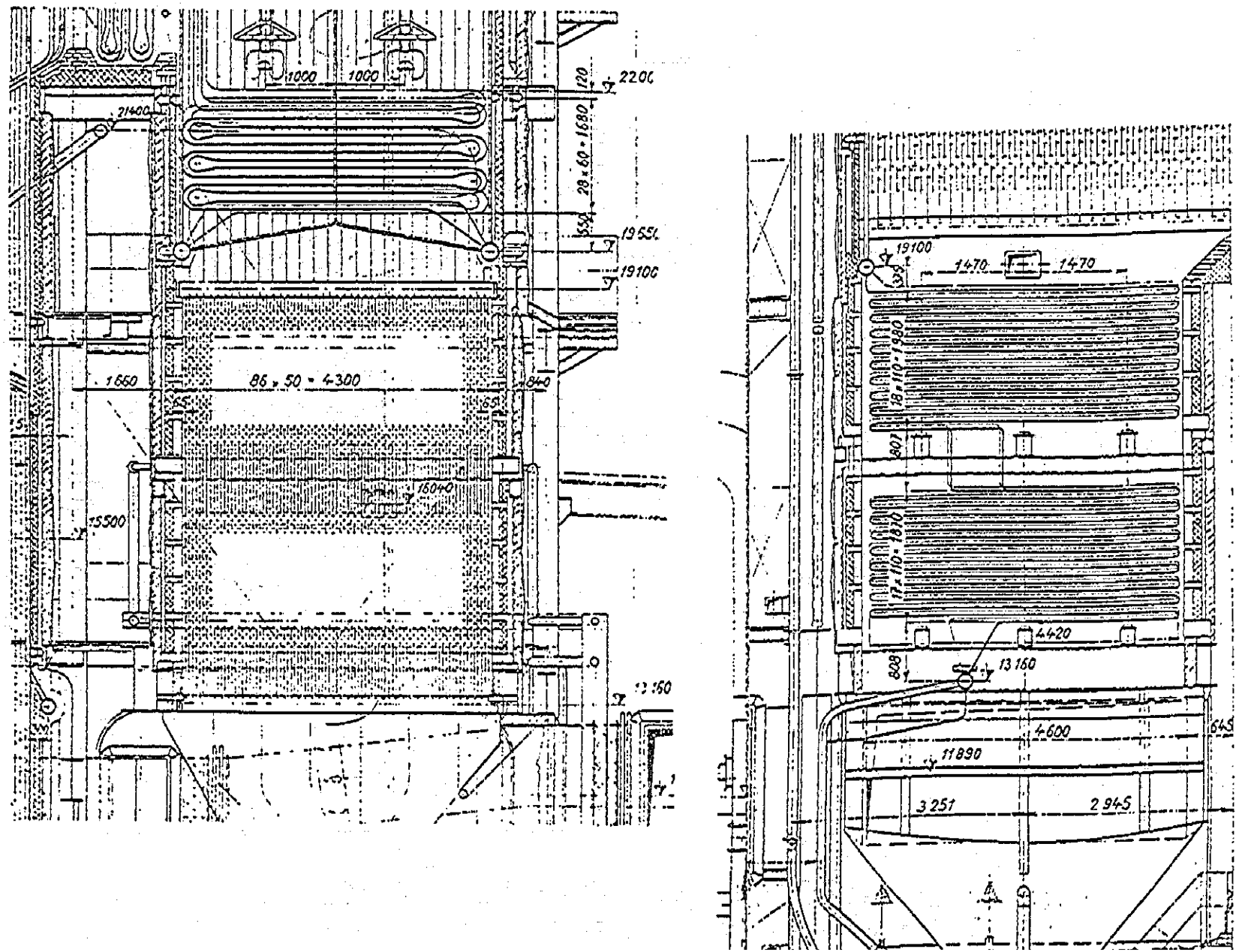


Figure 2 SIMPLIFIED FLOW SCHEME OF FLUE GAS RECIRCULATION SYSTEM

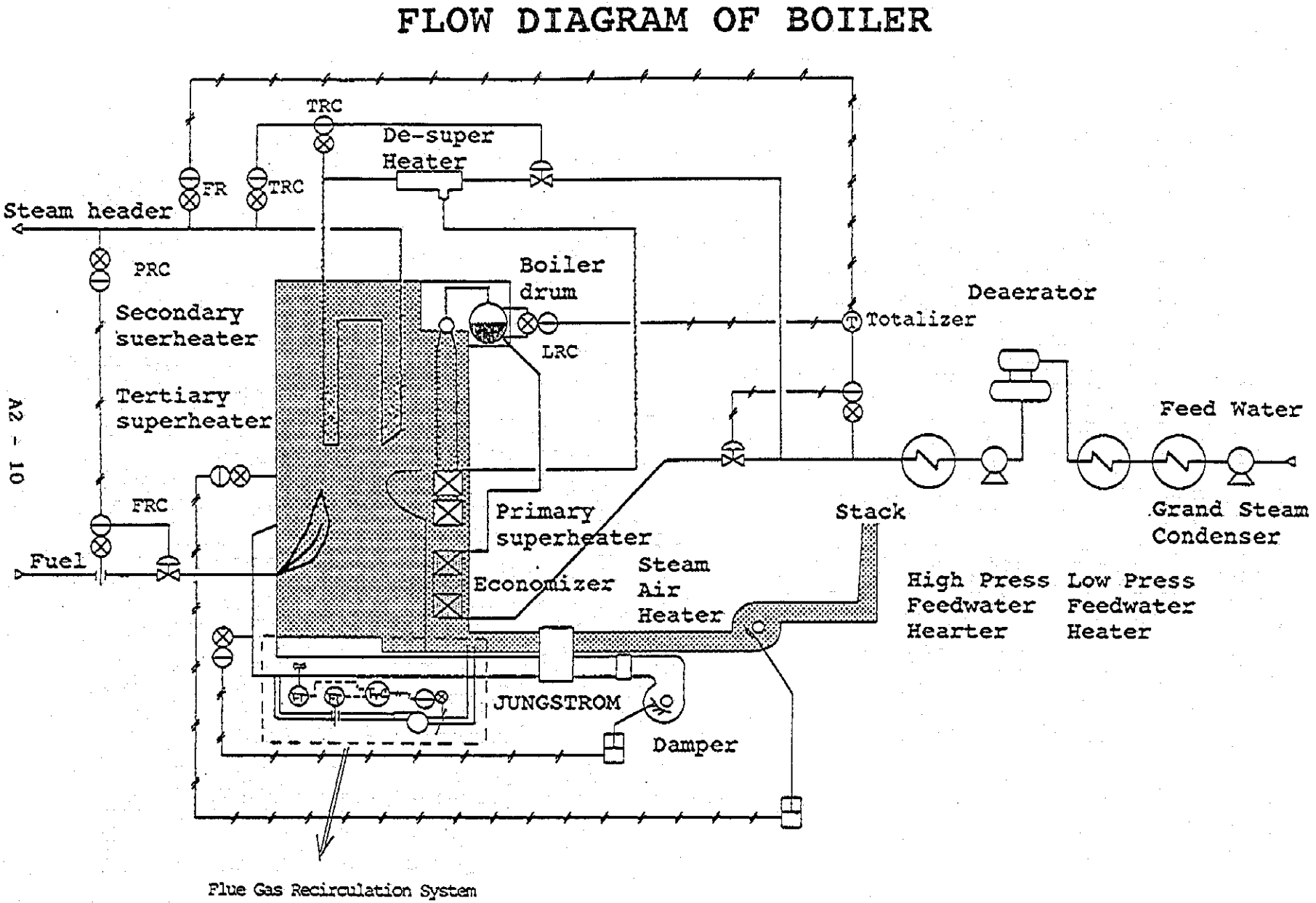


Figure 3 GENERAL DRAWING OF REARRANGEMENT OF WATER SCREEN TUBES

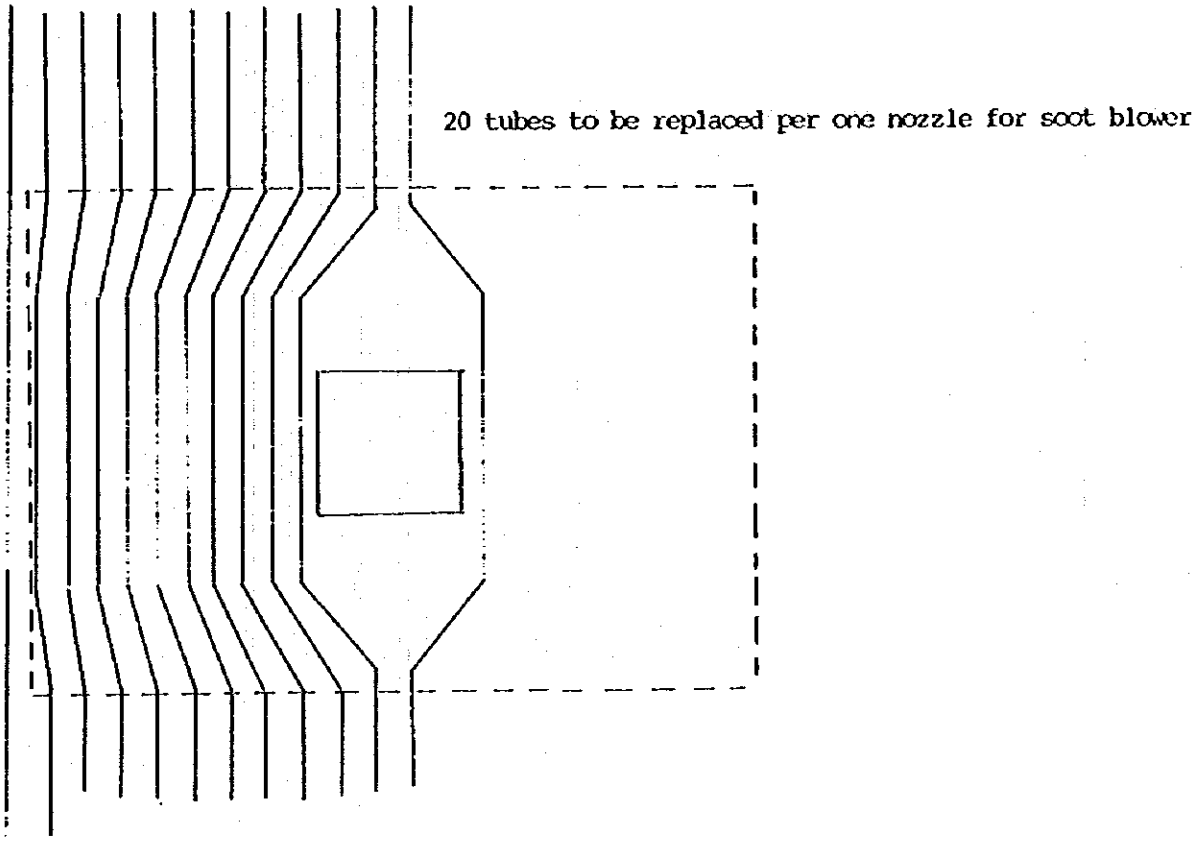
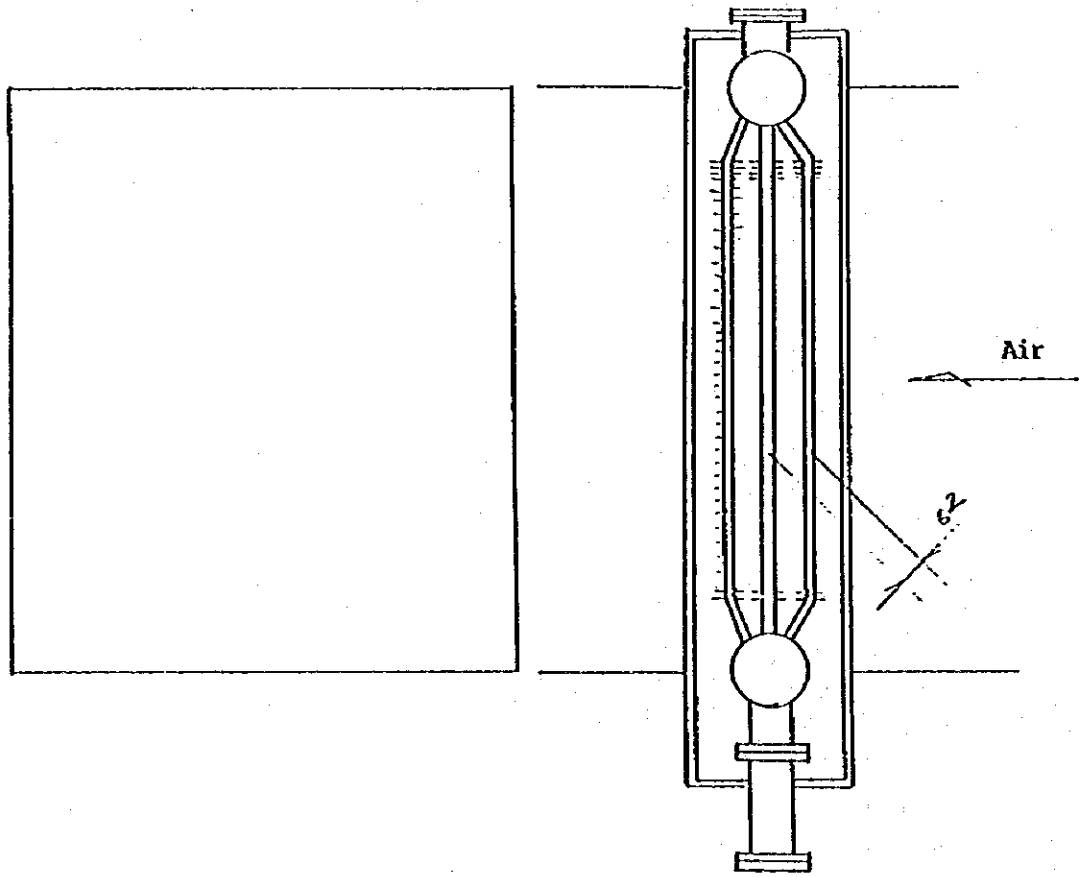
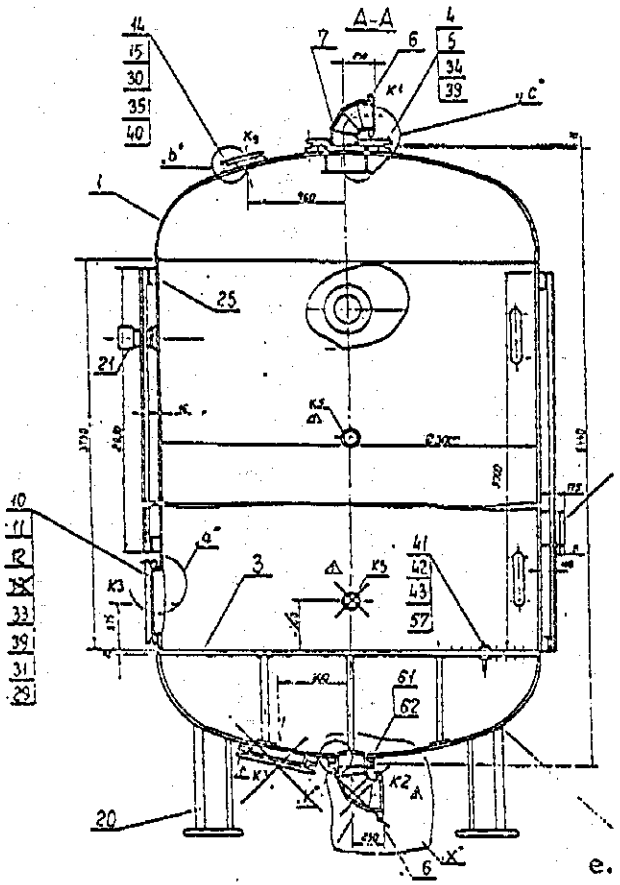


Figure 4 GENERAL DRAWING OF A NEW STEAM-AIR HEATER

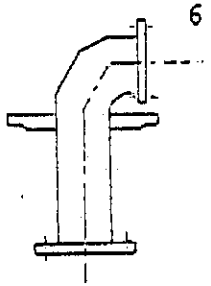


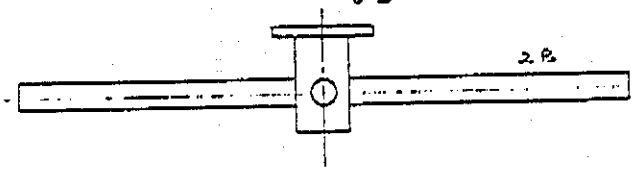
tube 15.9 mmϕ × 2 mm thickness

Figure 5 GENERAL DRAWING OF INTERNALS IN ION-EXCHANGE RESIN TOWER



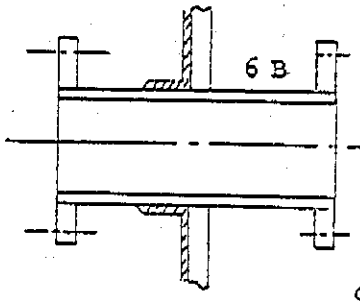
a. Inlet nozzle with flange for water stream

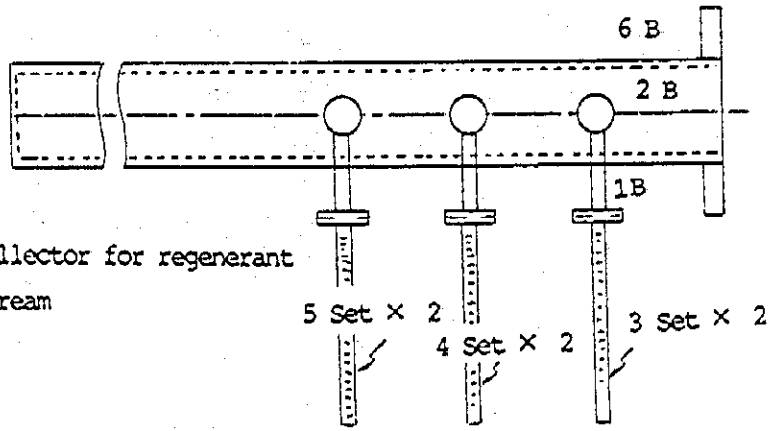




b. Distributor for water stream

c. Outlet nozzle with flange for regenerant stream

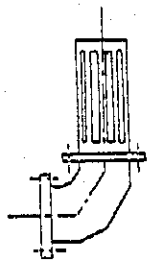




d. Collector for regenerant stream

Total 33 set × 2

e. Inlet nozzle with flange for regenerant stream



A.2.2 Installation of New Boiler Plant in PPSA

1. Design Basis

(1) Quality of Steam

The main specification of generated steam are as follows.

Design Capacity	320 t/h
Design Steam Temperature	540°C
Design Steam Pressure	139 ata

(2) Quality of Fuel

The main specification of fuel are as follows.

Fuel	Vacuum Residue Oil
Pour Point	45°C
Specific Gravity	
Heating Value	40,000 KJ/kg
Composition	
Sulfur	3 wt %
Nitrogen	wt %
Residual Carbon (Conradson Carbon)	wt %
Vanadium	220 wt ppm
Nickel	wt ppm
Viscosity	cSt @ 100°C

(3) Performance

- Boiler Efficiency more than 94%
- Continuous Operation more than 1 year
- Emission of Air Pollutants

NOx	160 vol ppm @ 4% O_2 and Rated Load
Dust	less than 150 mg/Nm^3

2. Special Requirements

(1) Draft Control System

Forced draft system will be required to use as draft control system in combustion chamber.

(2) Combustion Control System

Air-fuel ratio control system will be required to use as combustion control system.

(3) Instrumentation

It is possible to control the Unit in advanced and effective ways by using DCS(Distributed Control System).

(4) Analyzer

It is possible to use the following analyzers.

- Flue Gas System
  * O_2 analyzer in combustion flue gas
  * NOx monitor in combustion flue gas
- Boiler Water Control System
  * pH monitor of boiler water
  * Electric conductivity monitor of boiler water
  * Dissolved oxygen monitor in boiler water
  * Residual hydrazine monitor in boiler water

(5) Battery Limits

The battery limits of construction works are as follows.

- It is included to tie-in with the existing flue gas duct.
- It is included to tie-in with the existing boiler feed water line.
- It is included to tie-in with the existing steam heater.
- It is included to tie-in with the existing cooling water heater.
- It is included to tie-in with the existing fuel oil heater.

- it is included to tie-in with the existing control panels of electric power units.
- It is included to mount keyboards and displays, but construction of control house is out of scope.

(6) spare Parts

Spare parts for two years operation will be required with vendor's recommendation.

A.2.3 Installation of New Boiler Feed Water Treatment Facilities in PPSA

1. Design Basis

(1) Capacity

The main specification of raw water are as follows.

Design Capacity 300 m^3/h (Product Base)

(2) Quality of Raw water

pH	9.8 - 10.6
SS(mg/l)	26.9
COD(mg-O_2/l)	49.5
Ca(mg-$CaCO_3$/l)	206.3
Mg(mg-$CaCO_3$/l)	49.5
Na(mg-$CaCO_3$/l)	202.5
K (mg-$CaCO_3$/l)	8.3
Total Cation	466.6
HCO_3(mg-$CaCO_3$/l)	3.0
SO_4 (mg-$CaCO_3$/l)	114.8
Cl (mg-$CaCO_3$/l)	244.5
NO_3 (mg-$CaCO_3$/l)	1.5
CO_3 (mg-$CaCO_3$/l)	87.0
SiO_2(mg-$CaCO_3$/l)	15.8
Total Anion	466.6

(3) Quality of Raw water

pH	8.5 - 9.8	
Hardness(mg-$CaCO_3$/l)	0	
Total Iron(mg-Fe/l)	0.20	under
Total Copper(mg-Cu/l)	0.01	under
Soln O_2 (mg-O/l)	0.007	under
N_2H_4(mg-N_2H_4/l)	0.01	under
Electric Conductivity (μS/cm)	0.3	under

[Ion-Exchange Method Case]

(1) Requirement for chemical consumption

HCl consumption <0.40 kg/m^3 -pure water

NaOH consumption <0.50 kg/m^3 -pure water

(2) Requirement for raw water consumption

raw water consumption <1.10 m^3/m^3 -pure water

(3) Analyzer

It is possible to use the following analyzers.

- pH meter
  * pH control of HCl injection line
  * pH monitor of back wash water recovery line
- Silica meter
  * Silica monitor of Anion tower outlet
  * Silica monitor of M/B tower outlet
- Electric conductivity meter
  * Electric conductivity monitor of M/B tower outlet
  * Electric conductivity monitor of filter outlet
  * Electric conductivity monitor of Anion tower outlet

(4) Buttery limits

- It is included to tie-in with the existing raw water line
- It is included to tie-in with the existing pure water line
- It is included to install pressurized flotation separator and sludge removal system.

- It is included to mount keyboards and displays, but construction of control house is out of scope.

(5) Spare Parts

Spare parts for two years operation will be required with vendor's recommendation.

[R.O. Method case]

(1) Requirement for chemical consumption

to be provided recommendation.

(2) Requirement for raw water consumption

to be provided recommendation.

(3) Analyzer

to be provided recommendation.

(4) Buttery limits

- It is included to tie-in with the existing raw water line
- It is included to tie-in with the existing pure water line
- It is included to install pressurized flotation separator and sludge removal system.
- It is included to mount keyboards and displays, but construction of control house is out of scope.

(5) Spare Parts

Spare parts for two years operation will be required with vendor's recommendation.

A.2.4 Installation of New Condensing Turbine Generator System

1. Design Basis

(1) Capacity

Generated Electricity	65,000 kw

(2) Driving Steam

The specification of driving steam are as follows.

Design Steam Temperature	540°C
Design Steam Pressure	139 ata

(3) Extraction Steam

The specification of extraction steam are as follows.

Design temperature of 45 ata steam	°C
Design pressure of 45 at steam	ata
Design temperature of 18 ata steam	°C
Design pressure of 18 ata steam	ata
Design temperature of 1.2 ata steam	°C
Design pressure of 1.2 ata steam	ata

(4) Specification of electricity generated

Voltage	10.5 kV
Frequency	50 + 0.5 Hz
Power Factor	

(5) Performance

- Generating Efficiency	more than %
- Continuous Operation	more than 1 Year

2. Special Requirements

(1) Reducing valve of Steam Header

Reducing valve from 45 ata steam header to 35 ata steam header will be installed.

(2) Instrumentation

It well be required to use control system in advanced and effective ways by using DCS (Distributed Control System). And it is possible to meet the demand for process control by applying the software of DCS.

(3) Battery Limits

The battery limits of construction works are as follows.

- It is included to tie-in with the existing cooling water heater.
- It is included to tie-in with the existing bus duct.
- It is included to tie-in with the existing steam heater.
- It is included to mount keyboards and displays, but construction of control house is out of scope.
- It is included to tie-in with the bus bar and construction of substation for new condensing turbine.

(4) Spare Parts

Spare parts for two years operation will be required with vender's recommendation.

PLANT COST ESTIMATION

(Unit : US$)

		Equipment & Material		Field work	EPS-MH and expenses	Sub total	Import duty	VAT	Total
		Foreign	Local						
B-1	Modification of 3 boilers								
	1) Economizer	-	528,000	432,000	67,200	1,027,200	-	225,984	1,253,184
	2) Jungstrom	1,800,000	42,360	9,000	55,540	1,906,900	882,000	23,518	2,812,418
	3) Low NOx burner	-	1,710,000	1,350	51,340	1,762,690	-	387,792	2,150,482
	4) Installation of duct	-	75,600	81,400	15,750	172,750	-	38,005	210,755
	5) Soot blower	173,100	-	10,800	5,520	189,420	84,819	3,590	277,829
	6) Heat recovery from continuous blow water	-	incl. Field work	56,560	8,480	65,040	-	14,309	79,349
	7) Steam recovery from dealrator vent	-	-	56,000	8,400	64,400	-	14,168	78,568
	Total of B-1	1,973,100	2,355,960	647,110	212,230	5,188,400	966,819	707,366	6,862,585
	Alternative plan - Exchange of burner tip	-	180,000	incl. in material cost		180,000	-	39,600	219,600
B-2	3 sets of 320 T/M Boiler								
	- Boiler w/auxiliaries	-	25,440,000	6,360,000	2,403,000	34,203,000	-	7,524,660	41,727,660
	- Demolishing of existing boilers	-	-	318,000	-	318,000	-	69,960	387,960
	Total of B-2		25,440,000	6,678,000	2,403,000	34,521,000	-	7,594,620	42,115,620

Note : Jungstrom and soot blower will be supplied European vendor.

		Equipment & Material		Field work	EPS-MH and expenses	Sub total	Import duty	VAT	Total
		Foreign	Local						
G-1	Condensing Turbine Generator								
	1) Turbine generator W/auxiliaries	8,000,000	5,500,000	4,044,000	1,454,000	18,998,000	3,920,000	2,419,560	25,337,560
	2) Cooling water line	-	-	2,228,680	222,868	2,451,548	-	539,341	2,990,889
	Total of G-1	8,000,000	5,500,000	6,272,680	1,676,868	21,449,548	3,920,000	958,901	26,328,449

Note : 1. Condensing turbine will be supplied by foreign vendor and auxiliary equipment and materials will be supplied by local vendor.
2. Control system by DCS is included.

		Equipment & Material		Field work	EPS-MH and expenses	Sub total	Import duty	VAT	Total
		Foreign	Local						
W-1	Boiler feed water facilities								
	1) Modification of regeneration vessels	-	-	66,000	32,500	98,500	-	21,670	120,170
	2) Modification of piping	-	-	240,200	36,030	276,230	-	60,771	337,001
	3) Feed water recovery system	66,000	28,800	42,560	20,600	157,960	32,340	20,231	210,531
	Total of W-1	66,000	28,800	348,760	89,130	532,690	32,340	102,672	667,702

Note : "Funda-filter" will be supplied by Japanese vendor.

REFERENCE

DEMINERALIZED WATER FACILITIES

(Unit : U.S.$)

Description	Ion exchange	R.O. System
1. Equipment & material (Foreign supply)	7,070,000	5,225,000
2. Equipment & material (Local supply)	5,215,000	2,457,000
3. Engineering work	780,000	600,000
4. Field work	5,550,000	3,852,000
5. Supervising	375,000	375,000
6. Transportation	250,000	175,000
7. Civil work	400,000	400,000
8. Misc. expenses	1,669,000	1,255,000
Total	21,309,000	14,339,000

Cost breakdown of R.O. system of Demineralized water facilities

(1) Equipment and material (Foreign supply)

Coagulator	1 set	700,000
Gravity filtrator	3 sets	450,000
Safety filter	3 sets	90,000
R.O. Unit	1 set	2,300,000
Field instrument	1 set	35,000
Control panel w/control instrument	1 lot	1,300,000
Ion exchange resin	1 lot	350,000
Total	U.S.$	5,225,000

(2) Equipment and material (Local supply)

Towers and vessels	1 lot	637,000
Piping material	1 lot	1,120,000
Rotating equipment	1 lot	350,000
Electrical and instrument material	1 lot	350,000
Total	U.S.$	2,457,000

ANNEX 3

Reverse Osmosis Membrane Method

ANNEX 3 REVERSE OSMOSIS MEMBRANE METHOD

3.1 Application as Boiler Feed Water Treating Unit

Flush method has come into wide use as the technology of fresh waterization from sea water at first. In recent years, the osmosis membrane method has spread widely. At the time of 1980, the application examples has reached 930 units in the world. And also there are many examples of reverse osmosis membrane method as boiler feed water treating units in Japan. Table A.3.1 are listed Japanese examples of big plants more than 1,000 m^3/h.

Table 3.1 THE EXAMPLES OF REVERSE OSMOSIS METHOD AS BOILER FEED WATER TREATMENT UNIT IN JAPAN

Year	Plant owner	Location	Plant Capacity	Unit No. of CapacityUnit	
1971	Sumitomo Metal Industry Co.	Kashima	13,600 m^3/h	1,360 m^3/h	10
1973	Kashima Co-operative Generation Co.	Kashima	9,600 m^3/h	2,400 m^3/h	4
1974	Kashima Petro.	Kashima	5,300 m^3/h	2,650 m^3/h	2
1974	Kanegafuchi Chemical Co.	Kashima	1,000 m^3/h	1,000 m^3/h	1
1975	Hokuriku Electric Co.	Fukui	3,500 m^3/h	1,750 m^3/h	2
1980	Kansai Electric Co.	Himeji	1,200 m^3/h	1,200 m^3/h	1

Source: T. Ishihara, Zosui Gizyutsu, 15 (2), 39-44 (1989)

3.2 Outline of Reverse Osmosis Membrane Method

The demineralizer using reverse osmosis membrane has the following three sections, pre-treating section, demineralizing section and post-treating section. Figure A.3.1 shows the typical flow scheme of reverse osmosis membrane method. It is required the same of pre-treating and post-treating section in the ion exchange resin method.

Science, in the case of river water treating, raw water contains much organic materials and micro-organismains much organic materials, osmosis membranes are fouled and plugged by these pollutants most of the time.

Especially, in the existence of much suspended materials such as waterweeds and water micro-organisms, it is difficult to remove these suspended materials by means of precipitator. Therefore, flotation methods are adopted in many cases.

Demineralized water is treated according to the purpose of use. In the purpose of supping boiler feed water, silica polisher using ion exchange resins are adopted in post-treating section.

3.3 Comparison with Reverse Osmosis Membrane Method and Iron Exchange Resin Method

In this item, merits and demerits of reverse osmosis membrane method are summarized as follows in order to compare with ion exchange resin method.

[Merits of Reverse Osmosis Membrane Method]

(1) No dairy regeneration operation using strong acid and strong alkali

In reverse osmosis membranes are washed several times per year and only silica polisher requires regeneration operation.

(2) Easy operation and easy maintenance

(3) Continuous operation

(4) Small amount of waste water during regeneration operation

(5) Possibility of removal of organic materials, micro-organisms and colloidal silica.

(6) High cost performance

Higher mineral concentration in raw water, more profitable than ion exchange resin method.

[De-merits of Reverse Osmosis Membrane Method]

(1) Much raw water consumption

The brine which is enriched 4 times of mineral concentration in raw water is generated after production of demineraled water.

(2) Membrane washing

Membrane washing is required approximately every 4 months. Therefore, some waste water containing citric acid and ammonia is discharge.

(3) Expensive membrane

(4) Much electric consumption

Here, construction cost based on raw water quality shown in Table 6.1-2 and capacity of 300 m^3/h are listed in the following Table A.3-2 for reference.

Table 3-2 CONSTRUCTION COSTS OF BOILER FEED WATER TREATING UNITS

Boiler feed water treating unit	Estimated construction cost
Iron exchange resin method	21 million US$
Reverse osmosis membrane method	14 million US$

Chemical consumptions per 1 m^3 of demineralized water are shown in Table A.3-3.

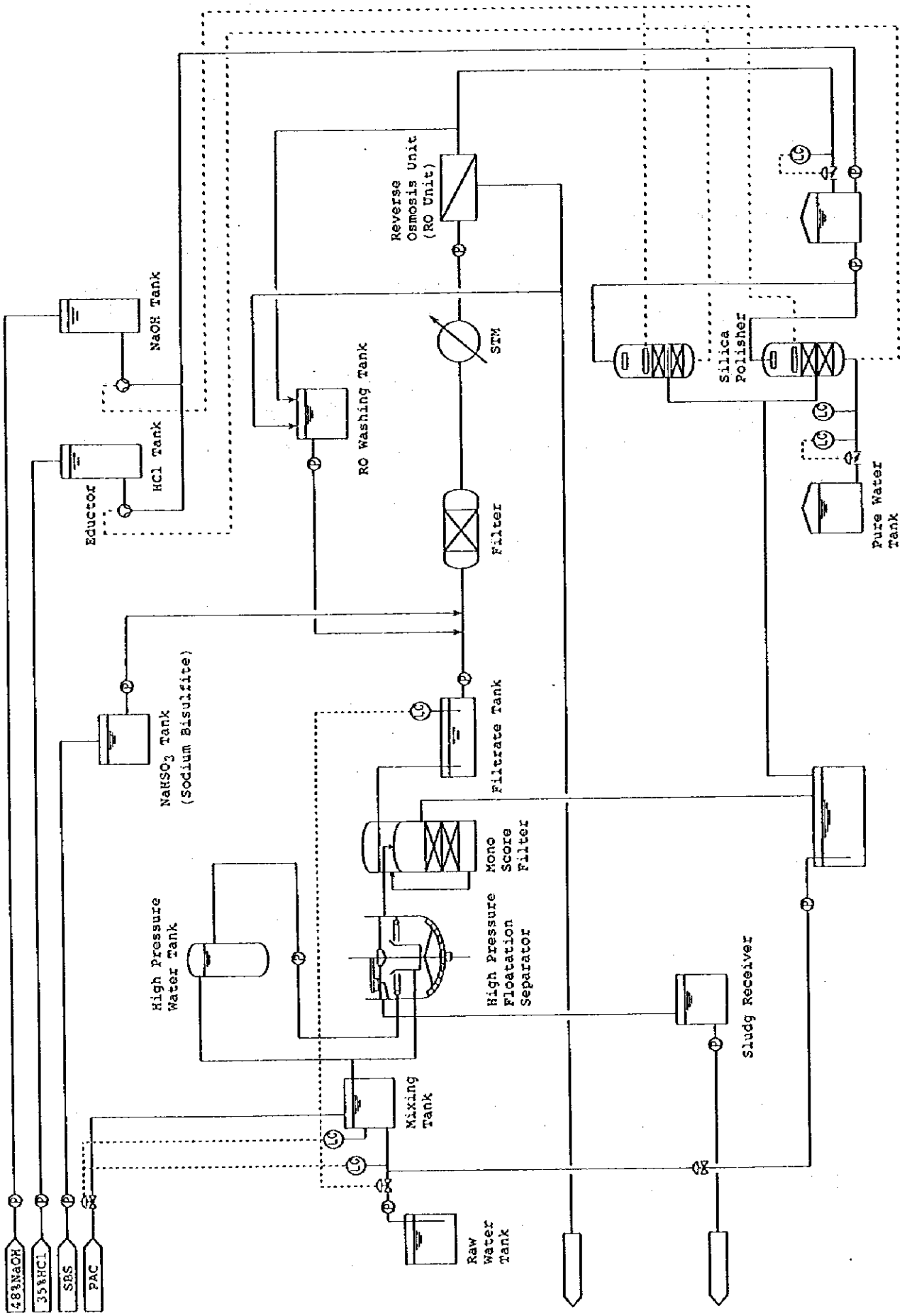
Table 3-3 CHEMICAL CONSUMPTION OF BOILER FEED WATER TREATING UNITS

Chemicals	Reverse Osmosis Method	Ion Exchange Method
HCl @ 100%	0.06 kg/m^3 -P.W.	0.40 kg/M^3 -P.W.
NaOH @ 100%	0.10 kg/m^3 -P.W.	0.50 kg/M^3 -P.W.
Na_2SO_3 @ 100%	0.30 kg/m^3 -P.W.	
Citric Acid	0.80 kg/m1000 m^3 -P.W.	
NH_3	0.80 kg/m1000 m^3 -P.W.	

Consequently, it is presumed that reverse osmosis membrane method is superior to ion exchange resin method from the economical viewpoint in the case of newly installation of boiler feed water treating unit, if the quality of raw water is severe such as P.P.S.A..

However, when the new plant is actually constructed, actual sample of raw water is taken for test in order to certificate whether the pre-treating system constructed is suitable and reliable.

Figure A.3-1 SIMPLIFIED FLOW DIAGRAM OF REVERSE OSMOSIS DEMINERALIZER



ANNEX 4

PRICE OF CRUDE OIL AND PRODUCTS

Annex 4 PRICE OF CRUDE OIL AND PRODUCTS

4.1 Price of Crude Oil and Products

The feed to No.1 Crude Distillation Unit has been agreed to be Ural Crude Oil to be supplied from Russia through a pipeline. As the basis for the establishment of the price of the crude oil, PPSA presented the prices of different crudes used by PPSA in the year 1993 as indicated in table A4-1.

Table A4-1 PURCHASE PRICE OF CRUDE BY PPSA

	Ural	Brent Blenol	Flotte	Wytch Farm
FOB Price (US$/ton)	15.79	17.89	16.92	17.31
Transportation (US$/bbl)	Nil	0.70	0.70	0.70
CIF Price (US$/bbl)	15.79	18.59	17.62	18.01
Border Tax (6% FOB)	0.947	1.073	1.015	1.039
Fee to Foreign Trade Agency	0.205	0.617	0.584	0.597
(Percentage on FOB)	(1.30)	(3.45)	(3.45)	(3.45)
Local Transportation (US$/bbl)	0.206	0.201	0.202	0.197
(Zl/ton)	(24.81)	(24.81)	(24.81)	(24.81)
Total Supplied Price (US$/ton)	17.15	20.48	19.42	19.84
Conversion Rate (bbl/ton)	7.314	7.511	7.447	7.629

Source : PPSA

In principle, the prices will be used for the Study with the consideration and modification as mentioned below;

(1) It is reported that the price of Ural crude oil supplied from Russia to Poland does not necessarily reflect the international free market price since the trade relation between two countries has a long history, and it is

possible that the price is still skewed. It is required to study if the price of Ural crude oil presented is at the level of international price.

(2) Other crude oils which are purchased in the international market can be considered to represent the international prices. Among these oils, price of Brent Blenol (North Sea) will be used as the basis of determining the Ural crude oil price since the price trend of this crude oil is most available in international publication.

(3) The prices of different crude oils, of course, depend on various characteristics and properties of oils. However, major determinant factors will be API gravity and content of sulfur of the oil. Brent Blenol has API 38° and 0.4 wt% sulfur content. On the other hand, the Ural has API 32.3° and sulfur content of 1.39 wt%. This implied that price of Ural crude oil is far below the that of Brent Blenol.

(4) Where prices are commonly reported in the international market, crude oils similar in terms of API gravity and sulfur content to Ural are USSR Export Blend and Dubai Fete. Former has API 32.5° and sulfur content of 1.38 wt% and the later has API 32° and higher sulfur content of 1.8 wt% sulfur. Since USSR Export Blend is very close to Ural in the API gravity and sulfur content, it is assumed that the price of Ural will be equal to the price of USSR Export Blend. Further, to confirm the relevancy of the price relations by API gravity and sulfur content, it will be studied how is the relation of the prices between USSR Export Blend and Dubai Fete. Since the two have similar API gravity, but, Dubai Fete has higher sulfur content, the price of USSR Export Blend shall be higher than Dubai Fete in the international market.

(5) The price relation among Brent Blenol, USSR Export Blend and Dubai Fete for the last 13 months are enumerated in Table A4-2.

Table A4-2 OIL & GAS JOURNAL WORLD CRUDE PRICES ($/bbl)

	United Kingdom-Brent 38°	U.S.S.R.-Export blend 32°	Saudi light 34°	Dubai Fateh 32°
92/12/18	18.40	17.15	16.75	16.10
92/12/25	18.30	16.60	17.20	16.55
93/01/01	17.90	16.30	16.80	16.15
93/01/08	17.35	15.50	16.35	15.65
93/01/15	17.20	15.35	16.35	14.95
93/01/22	17.05	15.25	15.47	14.80
93/01/29	18.55	16.85	16.20	15.40
93/02/05	18.55	16.85	16.70	15.95
93/02/12	18.45	16.65	17.00	16.05
93/02/19	18.20	16.20	16.55	15.60
93/02/26	18.90	17.30	17.10	16.30
93/03/05	19.25	17.50	17.55	16.80
93/03/12	18.75	17.00	17.55	16.55
93/03/19	18.70	16.90	17.30	16.15
93/03/26	18.50	16.65	17.05	15.90
93/04/02	18.85	16.95	17.50	16.30
93/04/09	18.60	16.75	17.60	16.55
93/04/16	18.50	16.70	17.50	16.45
93/04/23	18.55	16.80	17.10	16.10
93/04/30	18.80	16.95	17.10	16.10
93/05/07	19.00	17.25	17.35	16.30
93/05/14	18.40	16.50	17.15	16.25
93/05/21	18.05	16.15	16.43	15.55
93/05/28	18.35	16.40	16.55	15.50
93/06/04	18.20	16.25	16.85	16.05
93/06/11	17.55	15.70	16.80	16.10
93/06/18	17.20	15.40	16.23	15.45
93/06/25	17.25	15.50	16.03	15.25
93/07/02	16.85	15.10	15.83	15.15
93/07/09	16.50	14.70	15.30	14.45
93/07/16	16.50	14.60	15.13	14.20
93/07/23	16.80	15.15	14.95	13.95
93/07/30	16.70	15.50	15.10	14.10
93/08/06	16.30	14.65	15.03	14.30
93/08/13	16.90	15.25	14.95	14.30
93/08/20	16.65	14.90	15.60	15.15
93/08/27	17.15	15.25	15.05	14.70
93/09/03	16.30	14.60	15.33	14.65
93/09/10	15.40	13.65	14.70	14.15
93/09/17	15.55	13.80	14.38	13.85
93/09/24	16.00	14.20	14.68	14.15
93/10/01	17.15	15.65	15.05	14.55
93/10/08	16.90	15.50	15.50	14.90
93/10/15	16.70	15.35	15.78	15.10
93/10/22	16.50	15.15	15.53	14.85
93/10/29	15.55	14.30	15.10	14.40
93/11/05	15.70	14.45	14.90	14.30
93/11/12	14.95	13.75	14.65	14.05
93/11/19	15.30	14.05	14.68	13.95
93/11/26	14.30	13.00	14.30	13.50
93/12/03	13.90	12.90	12.95	12.45
93/12/10	13.80	13.00	12.50	12.15
93/12/17	13.70	12.75	12.55	12.30
93/12/24	13.50	12.55	12.55	12.20
93/12/31	13.15	12.35	12.40	12.00
94/01/07	14.65	14.00	13.20	12.70
94/01/14	14.10	13.60	13.48	13.05
94/01/21	14.25	13.85	13.75	13.35
94/01/28	14.70	14.25	14.10	13.60
94/02/04	14.90	14.40	14.13	13.60
94/02/11	13.80	13.20	13.63	13.10
94/02/18	13.05	12.45	13.03	12.45
94/02/25	13.30	12.70	13.05	12.45
94/03/04	13.45	12.90	13.43	12.75
94/03/11	13.75	13.30	12.73	12.00
94/03/18	14.05	13.65	12.98	12.25
94/03/25	14.65	14.30	13.00	12.10
94/04/01	13.10	12.60	12.58	11.75
94/04/08	14.35	13.75	13.63	13.05
94/04/15	15.15	14.55	14.03	13.60
94/04/22	16.00	15.45	14.48	14.10
94/04/29	15.40	14.50	14.93	14.55
94/05/06	16.40	15.50	14.85	14.30
94/-5/20	16.70	15.90	15.33	14.75
94/05/27	16.20	15.50	15.55	15.05
94/06/03	16.05	15.45	16.10	15.40

(6) By using regression analysis of the relations, following formulas can be obtained

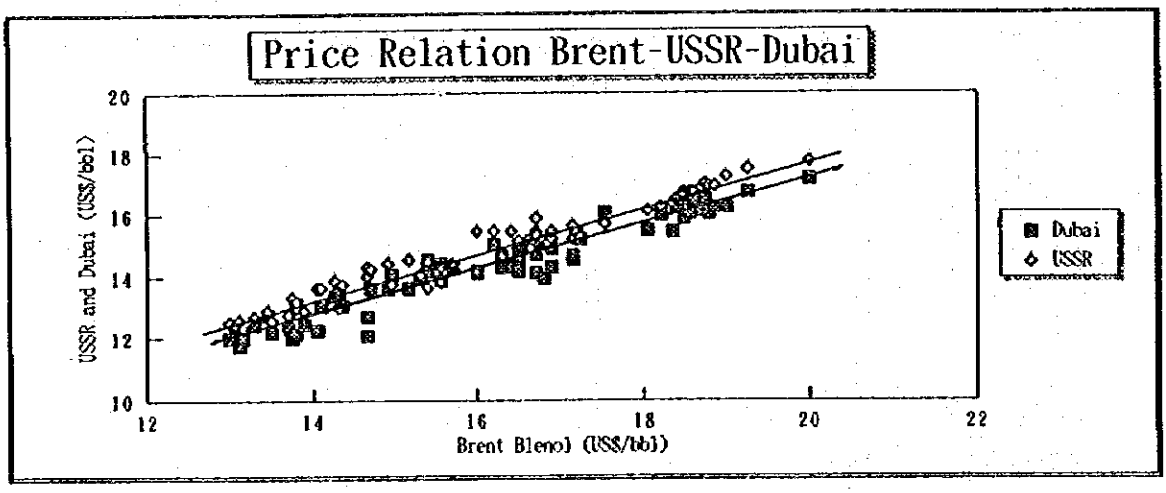
$P_{USSR} = 2.734 + 0.751 \times P_{BRENT}$
(0.324) (0.023)
No. of Freedom = 62
$R^2 = 0.947$

$P_{DUBAI} = 2.382 + 0.742 \times P_{BRENT}$
(0.403) (0.028)
No. of Freedom = 62
$R^2 = 0.919$

Where,
P_{USSR} = Price of USSR Export Blend, P_{DUBAI} = Price of Dubai Fete and P_{BRENT} = Price of Brent Blenol

Those relations are depicted in Figure A4-1, where actual price data and estimated prices of are depicted.

Figure A4-1



(6) From the above equation, the best estimated price of USSR Export Blend when the price of Brent Blenol is at US$ 17.89/bbl has been calculated as 16.17 $/bbl on FOB (or border) price and this will be used as the FOB price of Ural Crude Oil. Further, it has been confirmed in the

figure that the price of Dubai Fete is lower than the price of USSR Export Blend since its has higher sulfur content although both have similar API gravity.

Estimate of the price of Ural Crude to be used for the study is obtained as follows using the same formula as Table A4-2.

Price of Ural	FOB	16.17 $/bbl
	Border Tax	0.970 $/bbl
	Fee to FTA	0.210 $/bbl
	Local Transport	0.206 $/bbl
	Total Cost	17.56 $/bbl
		128.4 $/ton

4.2 Price of the Products

(1) As for the price of the Ural crude oil, it has been estimated to be 16.17 $/bbl based on the price of 17.89 US$/bbl of Brent Blenol Crude Oil Price. Now, based on the price of Brent Crude Oil, the prices of the intermediate products to be applicable for the study will be estimated. Due to the fact that the refinery industry will be fully liberalized from the year 1998, international prices prevailing in the European market will be used as the base for the study.

(2) In the international market, the prices of fractions of the refinery will be more or less linked to the price of crude oil in general. Such are naphtha, kerosene and gas oil. On the other hand, prices of fuel oils which are rather residue of the refining mainly depend on the seasonal demand of fuel oils. Therefore, the prices of the intermediates (naphtha, kerosene and gas oil) are calculated by using the analyzing the price data in relation with the price of crude (this time the price of Brent Blenol) in the Rotteldom market.

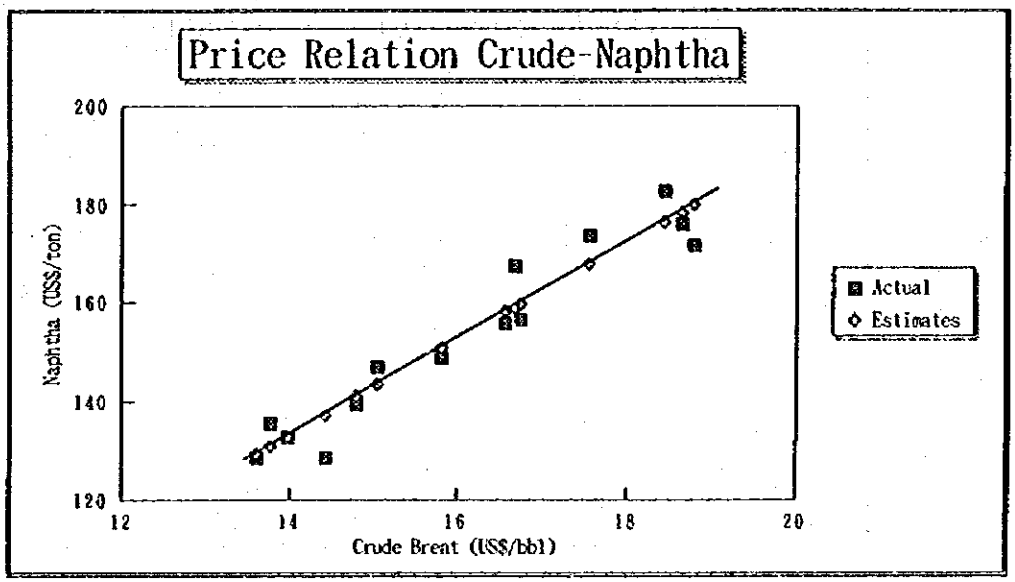
(3) Prices of the international market in the European countries are well represented by the spot prices of the products at Rotteldom, where transaction of petroleum is active. The prices of the naphtha, kerosine, gas oil and fuel oils in relative to the price of Brent crude oil are shown Table A4-3 attached herein.

Table A4-3

	Crude Brent	Naphtha	Kerosin	Gas Oil	Fuel 1%	Fuel 3%
	$/bbl	$/ton	$/ton	$/ton	$/ton	$/ton
	12					
93/12	13.61	128.68	167.37	145.13	68.00	52.81
94/02	13.76	135.70	160.39	141.57	86.52	77.33
94/03	13.98	132.63	156.16	139.99	82.22	76.56
94/01	14.43	128.42	164.03	143.40	76.68	59.78
94/04	14.80	139.45	163.02	148.74	78.32	73.11
93/11	15.06	146.75	185.94	163.74	73.84	60.87
93/09	15.81	148.84	178.91	161.80	81.32	60.29
93/10	16.56	155.97	192.30	170.00	83.66	62.31
93/07	16.67	167.50	174.25	161.75	91.00	56.00
93/08	16.75	156.45	176.59	159.82	84.07	59.87
93/06	17.55	173.90	179.78	166.15	88.35	58.88
93/05	18.45	182.60	189.32	175.54	96.15	70.51
93/04	18.66	175.95	191.44	178.88	101.50	77.99
93/03	18.80	171.84	193.20	175.90	95.42	76.56
	19					

(4) The relation between the price of naphtha and the Brent Blenol is analyzed by the regression and the result is depicted in the Figure A4-2.

Figure A4-2



The regression formula is;

Price of Naphtha = -3.744 + 9.77 x Price of Brent
(5.431) (0.817)

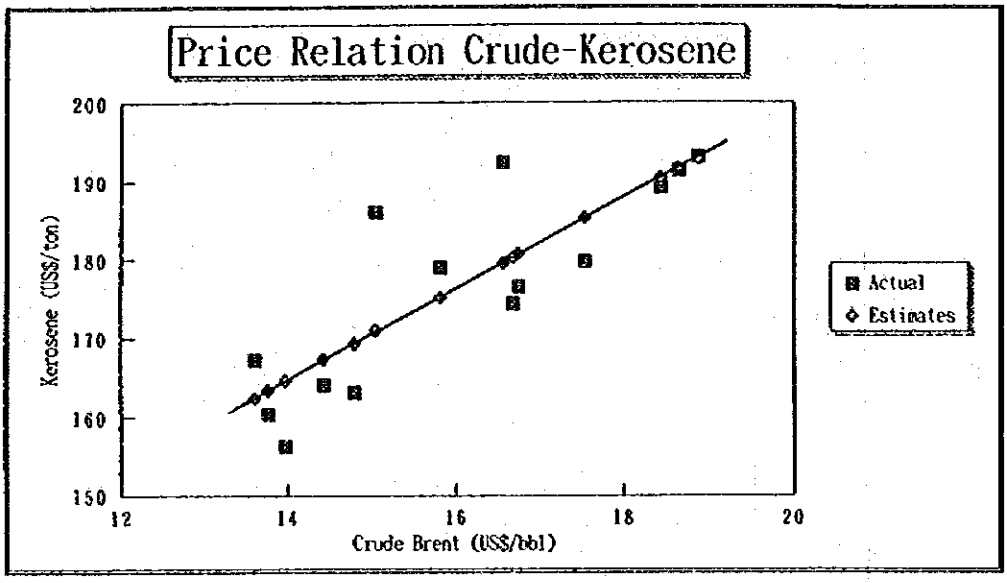
No. of Freedom = 12

R^2 = 0.923

The price of naphtha at the price of Brent 18.89 is estimated to be 171 US$/ton.

(5) The relation between the price of kerosene and the Brent Blenol is analyzed by the regression and the result is depicted in the Figure A4-3.

Figure A4-3



The regression formula is ;

Price of Kerosene = 83.74 + 5.78 x Price of Brent
(7.312) (1.1)

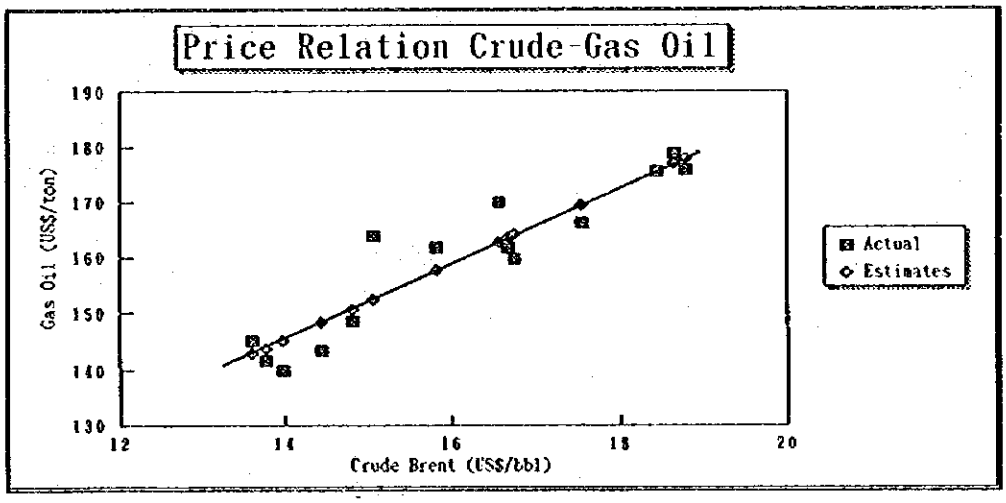
No. of Freedom = 12

R^2 = 0.697

The price of kerosene at the price of Brent 17.89 is estimated to be 187 US$/ton.

(6) The relation between the price of gas oil and the Brent Blenol is analyzed by the regression and the result is depicted in the Figure A4-4.

Figure A4-4



The regression formula is ;

Price of Gas Oil = 50.19 + 6.80 x Price of Brent
(5.024) (0.752)

No. of Freedom = 12

R^2 = 0.872

The price of kerosene at the price of Brent 17.89 is estimated to be 171 US$/ton.