

**DETAIL DESIGN
FOR
LABORATORY BUILDING
OF
DESALINATION RESEARCH PROJECT
IN
THE KINGDOM OF SAUDI ARABIA**

VOLUME 5 of 6 VOLUMES

AUGUST, 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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DETAIL DESIGN FOR
LABORATORY BUILDING OF
DESALINATION RESEARCH PROJECT
IN THE KINGDOM OF SAUDI ARABIA

VOLUME 5 OF 6 VOLUMES'

TEST PLANTS

GENERAL DESCRIPTION
CIVIL AND BUILDING WORK
ANCILLARY FACILITIES

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AUGUST 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

国際協力事業団	
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GENERAL DESCRIPTION

GENERAL DESCRIPTION

GENERAL

1. SCOPE OF WORK

As the major processes of both test plants are of the fabricated type (mounted on the skid), the scope of works regarding test plants consist of following items.

- (1) Foundation of test plants, water tanks and the like.
- (2) Ancillary facilities for the operation of test plants, and
- (3) Fire fighting facilities around the boiler.

Detailed drawings of the major processes of test plants and their technical specifications are attached as "Attachment I~II" which should be referred to for the fabrication of foundations and connection of ancillary facilities.

The Bill of Quantities for the installation and test are excluded from this document

Those BQ will be provided separately together with other documents such as "Manuals of installation" and "Manuals of test".

2. GENERAL ITEMS

- (1) In accordance with the instructions of Customer Engineers, Contractor of the plant construction takes responsibility for the execution of ancillary facilities.
- (2) Work scope of Contractor is as follows.
 - The materials listed on the Bill of Quantity (BQ) and those which are not mentioned in the BQ but required for the execution of the works.
 - Designing and detail drawing based on the specifications.
 - Piping works and electric wiring works.
 - Commissioning and inspection.

(3) The works will be carried out in accordance with the specifications and those which are not clear will be discussed with Customer Engineer.

(4) Inspection & Commissioning

- After the completion of the piping works, water will be fed with a specified flow rate and the pressure 1.5 times larger than the working pressure to make sure of the absence of leakage and the favourable functions in the presence of Customer Engineer.

- For the electric wiring works, prior to the initial operation of plant, inspection and tests are carried out. The inspection items are as follows.

- a) Insulation resistance test
- b) Conductor resist test
- c) Sequence check

3. OUTLINE OF TEST PLANTS

3.1 MSF Test Plant

- (1) Type: Cross tube type multistage distillation
- (2) Capacity: 20 m³/d
- (3) No. of stage: Heat recovery section; 4 stages
Heat rejection section; 2 stages
- (4) Performance ratio: 2.5
- (5) Boiler system:
 - Type; Once through, water tube type
 - Equivalent evaporation; 1,000 kg/h
 - Max. steam press.; 10 kg/cm²
 - Oil consumption; 68.7 l/h (Bunker C)
 - Oil heater; Electric system
 - Capacity of fuel tank; 10 m³
 - Material of fuel tank; Carbon steel
 - Capacity of boiler feed water tank; 3 m³
 - Material of boiler feed water tank; Carbon steel, resin coating

3.2 RO Test Plant

- (1) Type of modules: Spiral wound and hollow fiber
- (2) Capacity: Two trains of 20 m³/d, for spiral wound and hollow fiber
- (3) Filter: Pressured dual media layer filter
- (4) Tanks:
 - Seawater tank: Type; Vertical, cylindrical
Capacity; 3 m³
Material; Polyethylene
 - Filtered seawater tank: Type; Vertical, cylindrical
Capacity; 15 m³
Material; Polyethylene
 - Feed tanks (x 2): Type; Vertical, cylindrical
Capacity; 1.5 m³
Material; Polyethylene
 - Permeate tank (x 2): Type; Vertical, cylindrical
Capacity; 1 m³
Material; Polyethylene

ATTACHMENT I
(MSF TEST PLANT)

1. List of Equipment for MSF Test Plant

2. Drawings

DWG. NO.	Drawing List Title
SAJ 304-S0001	MSF 20T/D EVAPORATOR SKID PLOT PLAN
SAJ 304-S0002	MSF 20T/D WATER TANK
SAJ 304-S0011	PRODUCT TRANSFER TANK
SAJ 304-S0003	MSF 20T/D OIL TANK
SAJ 304-S0004	BOILER OUTLINE
SAJ 304-S0005	MSF 20T/D BOILER HOUSE
SAJ 304-S0006	MSF 20T/D AIR COMPRESSER UNIT
SAJ 304-S0007	MSF 20T/D DECARBONATOR
SAJ 304-S0008	MSF 20T/D DEAERATOR
SAJ 304-S0009	MSF 20T/D MSF CONTROL PANEL OUTLINE

{ List of Equipment for MSF Test Plant

Item No.	Equipment Name	Specification	Q'ty
1	<p>Evaporator</p> <p>Type</p> <p>Capacity</p> <p>No. of stage</p> <p>Operating system</p> <p>Scale control system</p> <p>Performance ratio</p> <p>Material</p>	<p>Cross tube type multi stage distillation</p> <p>20 m³/D [in operation under pH control rated output]</p> <p>Heat recovery section: 4 stages</p> <p>Heat rejection section: 2 stages</p> <p>Brine recirculation system [also operative as once-through system]</p> <p>pH control system [also operative as chemical injection system]</p> <p>2.5 [rated output, pH control operation]</p> <p>Plate & partition : 90/10 Cu-Ni</p> <p>Tube 16 mmϕ x 1t : 90/10 Cu-Ni</p> <p>Tube sheet : 90/10 Cu-Ni</p> <p>Internal parts : 90/10 Cu-Ni</p> <p>Demister : SUS 316</p> <p>Connection pipe between water-box : 90/10 Cu-Ni</p> <p>Pipe for brine loopseal : 90/10 Cu-Ni</p> <p>Pipe for distillate loopseal : 90/10 Cu-Ni</p>	1 set
2	<p>Brine Heater</p> <p>Type</p> <p>Material</p>	<p>Shell & tube</p> <p>Shell : Carbon steel</p> <p>Tube 16 mmϕ x 0.5t : Titanium</p> <p>Tube sheet : 90/10 Cu-Ni</p> <p>Water box [with Anode] : 90/10 Cu-Ni</p>	1 set

Item No.	Equipment Name	Specification	Q'ty
3	Vacuum System		1 set
3-1	Ejector		1 set
	Type	Two stage jet steam ejectors	
	Material	Mixing chamber : SUS 304 Nozzle : SUS 304 Diffuser : SUS 304	
3-2	Ejector Condenser		1 set
	Type	Shell & Tube	
	Material	Shell : SUS 316 Tube 16 mm ϕ x0.4t : Titanium Tube sheet : Titanium Water-box : C.S. + Neoprene rubber lining [3t] Tube support : SUS 316	
4	Deaerator and Decarbonator		
4-1	Deaerator		1 set
	Type	Vertical cylinder	
	Performance	DO concentration : 20 ppb or less	
	Capacity	8 m ³ /h	
	Material	Shell : C.S. + Neoprene rubber lining [3t] Internal parts : SUS 316, FRP	
4-2	Decarbonator		1 set
	Type	Spray tray type	
	Performance	Decarbonation efficiency : 80% or more	
	Capacity	8 m ³ /h	
	Material	Shell : C.S. + Neoprene rubber lining [3t] Internal parts : SUS 316	

Item No.	Equipment Name	Specification	Q'ty
5.	Pump & Motor		
5-1	Brine recirc. pump		2 sets
	Type	Horizontal centrifugal	[1 set is
	Capacity)	Surplus 10% or more determined by MFR	spare of
	Head)		warehouse]
	NPSH	0.5 m [NPSHav – NPSHreq]	
	Material	Casing, impeller : SCS 14	
		Shaft : SUS 316	
5-2	Make-up pump		2 sets
	Type	Horizontal centrifugal	[1 set is
	Capacity)	Surplus 10% or more determined by MFR	spare of
	Head)		warehouse]
	NPSH	0.5 m [NPSHav – NPSHreq]	
	Material	Casing, impeller : SCS 14	
		Shaft : SUS 316	
5-3	Distillate pump		2 sets
	Type	Horizontal centrifugal	[1 set is
	Capacity)	Surplus 10% or more determined by MFR	spare of
	Head)		warehouse]
	NPSH	0.5 m [NPSHav – NPSHreq]	
	Material	Casing, impeller : SCS 13	
		Shaft : SUS 304	
5-4	Acid injection pump		2 sets
	Type	Controlled volume, diaphragm	[1 set is
	Capacity)	10 m ltr/min.	spare of
	Head)	70 mAq	warehouse]
	Material	Diaphragm : Teflon	
		Body : SCS 14	

Item No.	Equipment Name	Specification	Q'ty
5-5	Anti-scale chemical injection pump Type Capacity Head Material	Controlled volume, diaphragm 10 m ltr/min 70 mAq Mf'R St'd	2 sets [1 set is spare of warehouse]
5-6	Anti-foam injection pump Type Capacity Head Material	Controlled volume, diaphragm 5 m ltr/min. 70 mAq Mf'R St'd	2 sets [1 set is spare of warehouse]
5-7	Sodium bisulfite injection pump Type Capacity Head Material	Controlled volume, diaphragm 5 m ltr/min 70 mAq Mf'R St'd	2 sets [1 set is spare of warehouse]
5-8	Acid cleaning pump Type Capacity Head Material	Centrifugal 30 ltr/min 20 mAq Mf'R St'd. [liquid end nonmetallic]	1 set
5-9	Motor for recirc. brine pump	TEFC, insulation class JIS B AC 220V x 3 ϕ x 60 Hz, 2p, 5.5 kW	2 sets [1 set is spare of warehouse]
5-10	Motor for make-up pump	TEFC, insulation class JIS B AC 220V x 3 ϕ x 60 Hz, 2p, 5.5 kW	2 sets [1 set is spare of warehouse]

Item No.	Equipment Name	Specification	Q'ty
5-11	Motor for distillate pump	TEFC, insulation class JIS B AC 220V x 3 ϕ x 60 Hz, 2p, 3.7 kW	2 sets [1 set is spare of warehouse]
5-12	Motor for acid injection pump	Insulation class JIS B	"
5-13	Motor for anti-scale chemical injection pump	Insulation class JIS B	"
5-14	Motor for anti-foam injection pump	Insulation class JIS B	"
5-15	Motor for sodium bisulfite injection pump	Insulation class JIS B	"
5-16	Motor for acid cleaning pump	Insulation class JIS B	1 set
6	Electric Instrumentation		
6-1	Motor control panel	Indoor type, self-standing Size: 700 [W]x 2,000 [H]x 400 [D] Power supply: AC 220V x 3 ϕ x 60 Hz AC 110V x 1 ϕ x 60 Hz [for control] Breaker : NFB Start method : Direct online Spare parts Overcurrent circuit : 3 elements Earth : Earth trip Stop lamp : Supply instrument panel Control switch : Supply on central panel & local	1 set

Item No.	Equipment Name	Specification	Q'ty
6-2	Instrument panel Recorder Adjuster Annunciator Push button Lamp	Indoor type, self-standing Size: 1400(W) x 2000(H) x 1200(D) Power supply: AC 110V x 1 ϕ x 60 Hz Design condition: temperature : 40°C relative humidity : 60% Same as 6-4	1 set
6-3	Electric instrumentation work materials	Wiring materials shall be provided for use in the test plant site: between the plant and instrument panel, motor control panel.	1 set
6-4	Panel instruments 6 point type recorder 2 pen type recorder 3 pen type recorder Indicator Indicator Ratio bias setter 2 point process alarm 1 point process alarm Annunciator	The instruments complying with the requirements shown in "Table of Instrument" shall be provided 1 – 5V resistance thermometer input 1 set 1 – 5V DC input 4 sets 1 – 5V DC input 2 sets 1 – 5V DC input 7 sets 1 – 5V DC input 1 set 1 – 5V DC input 2 sets 1 – 5V DC input 3 sets (Upper or lower set point) 1 – 5V DC input 4 sets (Upper or lower alarm) Abnormal on light, test push button, acknowledge push button, reset push button, push button lamp, R/V converter trans., distributor	1 set

Item No.	Equipment Name	Specification	Q'ty
6-5	Local transmitters	The transmitters complying with the requirements shown in "Table of Instrument" shall be provided.	1 set
	Differential pressure transmitter	4 – 20 mA DC output	5 sets
	Pressure transmitter		3 sets
	Pneumatic level controller	0.2 – 1.0 kg/cm ² , displacement type	3 sets
	Level transmitter	4 – 20 mA DC output	2 sets
	Conductivity meter	4 – 20 mA DC output, direct mounted	2 sets
	pH meter	4 – 20 mA DC output	2 sets
	Orifice plate	Flange tap or ring tap, SUS 316	5 sets
	Thermal resistance	Pt 100, 3 wire type	7 sets
	Local pressure gauge	Dial type 100 ϕ , bourdon tube	17 sets
	Local thermometer	Glass type, attached thermowell	17 sets
	Level gauge	Glass type	5 sets
	Level gauge	Float type	1 set
	Differential pressure transmitter	4 – 20 mA DC output	3 sets
	Dissolved oxygen meter	Range 0 – 0.2/1/5/20 ppm	2 sets

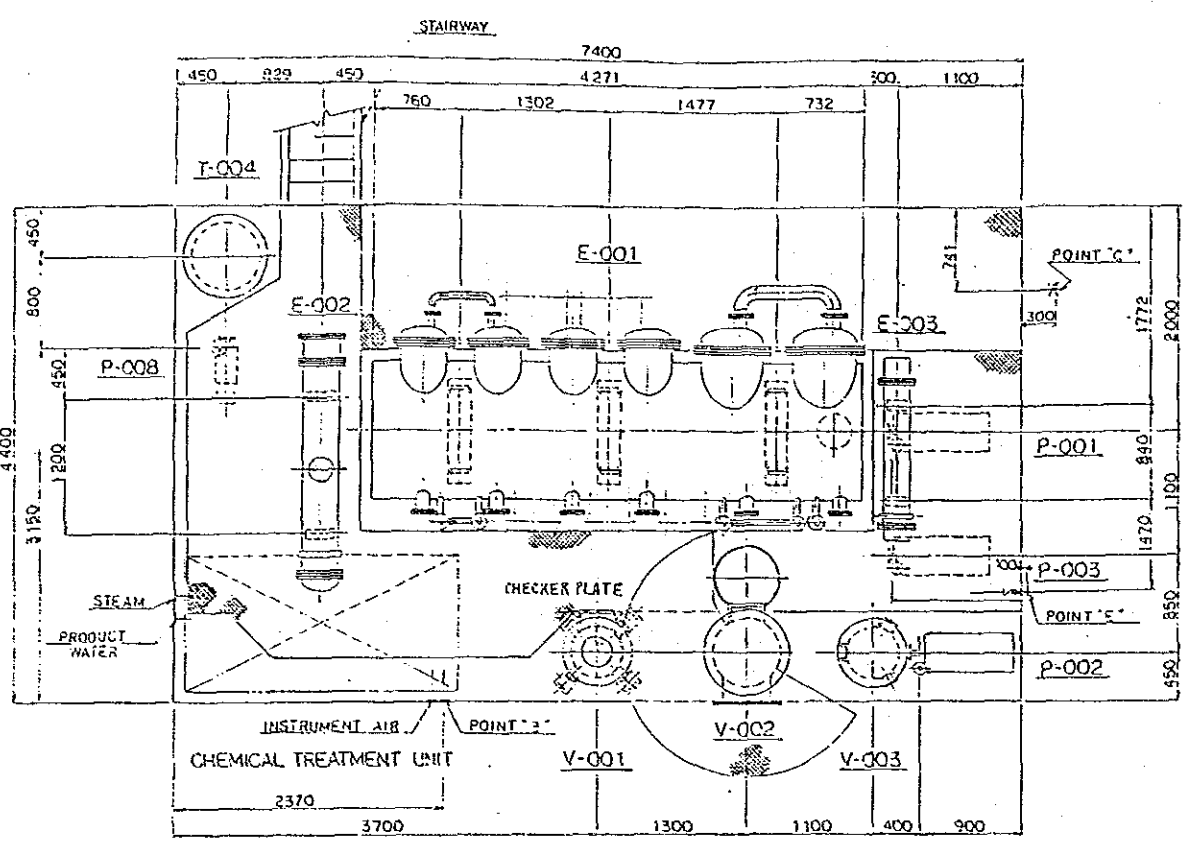
Item No.	Equipment Name	Specification	Q'ty
6-6	Control valve Flow C/V for desuperheater Pressure C/V for B/H steam Temperature C/V for brine Level C/V for brine 3-way valve for distillate online and distillate damp Flow C/V for seawater Level C/V for deaerator ON-OFF valve for ejector steam Flow C/V for brine Level C/V for B/H condensate	Globe valve, serial control, attached positioner, SCPH/SUS 316 Ball valve, SCS 14/SUS 316 Butterfly valve, serial control, attached positioner, FC20+ rubber lining/SUS 316 Globe valve, serial control, attached positioner, SCS 14/SUS 316 Globe valve, ON-OFF control, electromagnetic valve, SCPH Globe valve, serial control, attached positioner, SCS 14/SUS 316 Globe valve, serial control, attached positioner, SCPH/SUS 316	1 set each 1 set 1 set 1 set 1 set 1 set 1 set

Item No.	Equipment Name	Specification	Q'ty
6-6 (cont'd)	Flow C/V for make-up	Globe valve, serial control, attached positioner, SCS 14/SUS 316	1 set
	Level C/V for flash tank	Globe valve, serial control, attached positioner, SCS 14/SUS 316	1 set
	Level C/V for decarbonator	Globe valve, serial control, attached positioner, SCS 14/SUS 316	1 set
	Pressure C/V for acid injection		1 set
	Pressure C/V for chemical dosing		4 sets
7	Piping	<p>* Intra-skid piping shall be provided for MSF test plant.</p> <p>* Assembled products or sub-assemblies shall be provided as the interconnecting piping among the boiler, feedwater tank, fuel tank and MSF test plant skid.</p>	
	Material	Seawater & brine line : Cu-Ni, FRP, Rubber lining Distillate line : SUS Vent line : SUS Others : Mf'R St'd.	
8	Tanks and Mixers		
8-1	Sulfuric acid tank	Capacity : 100 ltr. Material : SUS 316	1 set

Item No.	Equipment Name	Specification	Q'ty
8-2	Anti-scale chemical tank	Capacity : 100 ltr. Material : SUS 316	1 set
8-3	Anti-foam chemical tank	Capacity : 25 ltr. Material : SUS 316	1 set
8-4	Sodium bisulfite tank	Capacity : 25 ltr. Material : SUS 316	1 set
8-5	Flash tank	Capacity : 150 ltr. Material : SUS 304	1 set
8-6	Acid cleaning tank	Capacity : 300 ltr. Material : Polyethylene	1 set
8-7	Sulfuric acid mixer	Material : FRP	1 set
8-8	Anti-scale chemical mixer	Material : SUS 316	1 set
8-9	Anti-foam chemical mixer	Material : SUS 316 Manual type	1 set
8-10	Sodium bisulfite mixer	Material : SUS 316 manual type	1 set
8-11	Seawater strainer	Material : BC3, SGP + Rubber lining	1 set
8-12	Frames, platforms and baseplates	* Appropriate frames, platforms and base- plates shall be provided to facilitate operation. * A lifting device shall be installed to take out the brine heater and evaporator tube bundle.	1 set
8-13	Ball cleaning system	The tube of brine heater and the recovery section shall be cleaned with sponge balls during operation.	1 set

Item No.	Equipment Name	Specification	Q'ty
9	Boiler system	Indoor type	
9-1	Boiler		1 set
	Type	Once-through, water tube type	
	Equivalent evaporation	1,000 kg/h	
	Max. steam press.	10 kg/cm ²	
	Efficiency	85% or more	
	Oil consumption	68.7 ltr/h [A heavy oil bunker C]	
	Oil heater	Electric system	1 set
	Insulation		1 set
9-2	Fuel tank	Capacity : 10 m ³ Material : CS	1 set
	Oil heater	Electric system	1 set
	Insulation		1 set
9-3	Boiler feed tank	Capacity : 3 m ³ Material : CS, resine coating	1 set
9-4	Boiler feed water pump		1 set
	Type	Horizontal centrifugal	
	Capacity	1.3 m ³ /h	
	Head	Surplus 10% or more determined by MFR	
	NPSH	0.5 m [NPSH _{av} – NPSH _{req}]	
	Material	MFR St'd.	
9-5	Accessories	Chemical injection system, etc.	1 set
10	Spare parts	For one year	1 set

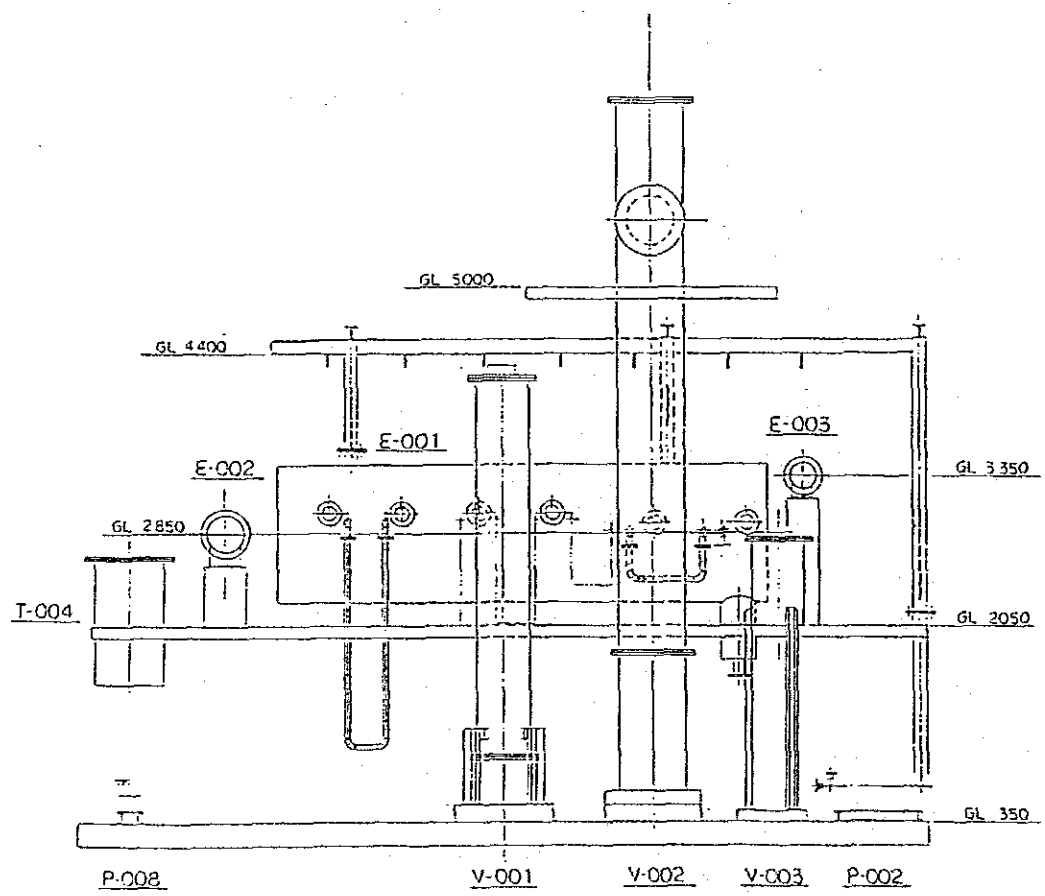
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2	REVISED	
3		
4		



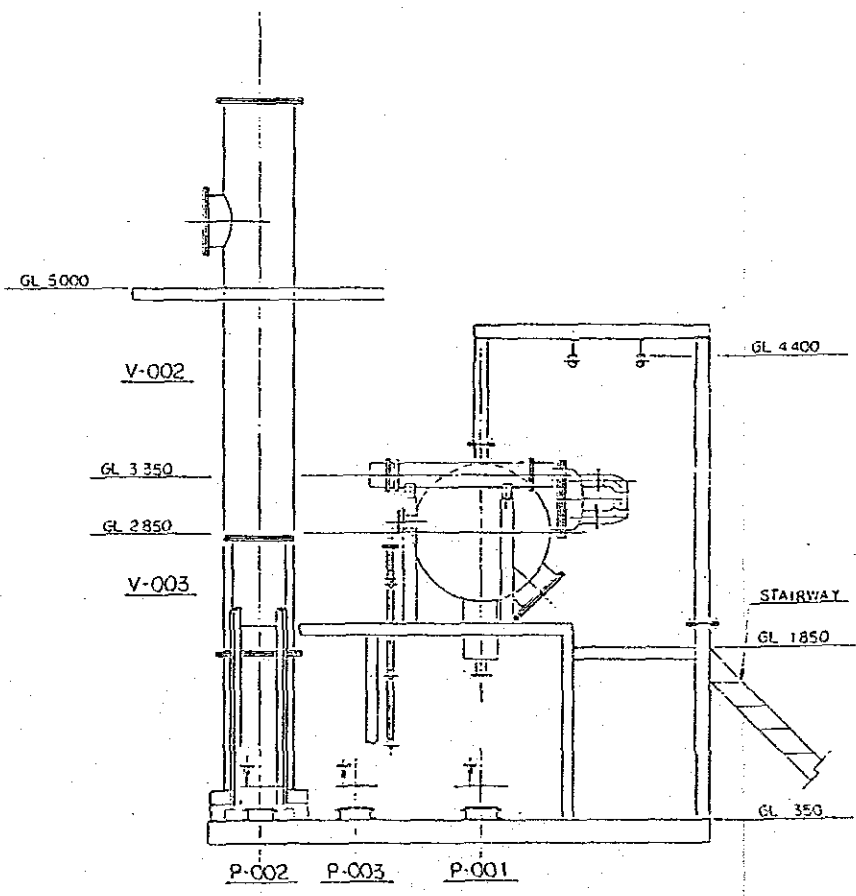
PLAN

CONNECTION POINTS OF UTILITIES BETWEEN CUSTOMER(S/W.C.S.)

POINT	NAME OF UTILITIES	CONDITION OF UTILITY	CONNECTION FLANGES	LEVEL (mm)
A				
B	SULFURIC ACID	98wt %	UIS 10 ⁶ -25 ⁴ GL+500	
C	SEWAGE FROM STAKE FACILITY	2.3% CH ₂ O	UIS 10 ⁶ -100 ⁴ GL+885	
D				
E	SERVICE WATER	2 ⁴ % CH ₂ O	UIS 10 ⁶ -25 ⁴ GL+500	
F				



ELEVATION



ELEVATION

E-001	EVAPORATOR
E-002	BRINE HEATER
V-001	DECARBONATOR
V-002	DEAERATOR
V-003	FLASH TANK
P-001	BRINE RECIRCULATION PUMP
P-002	DISTILLATE PUMP
P-003	MAKE UP PUMP
P-008	ACID CLEANING PUMP

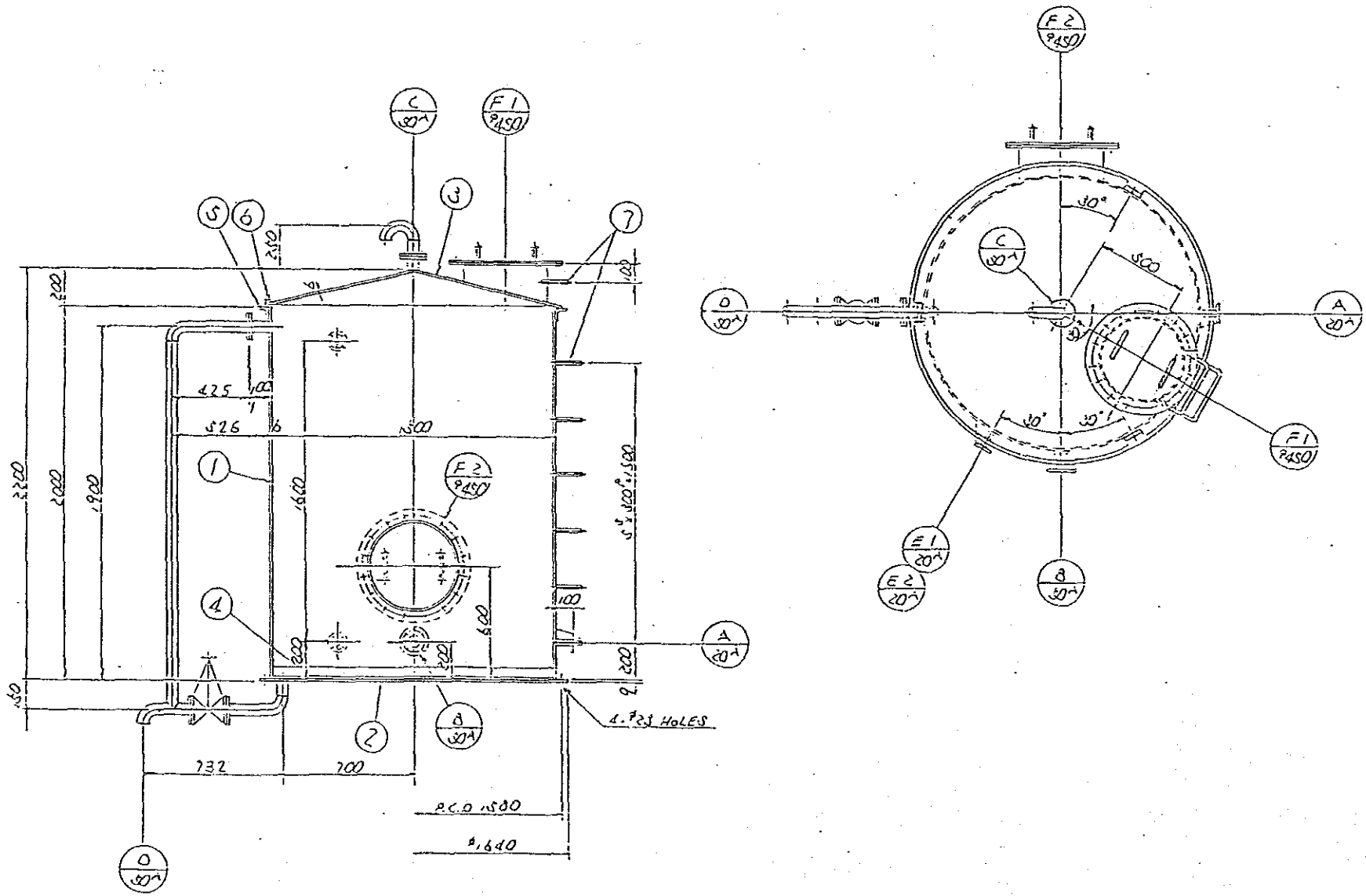
PROJECT: JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION

TITLE: MSF-20 T/D EVAPORATOR SKID PLOT PLAN

DATE: SEP. 21 '87 SCALE: —

DRAWING NO.: SAJ 304-S0001

JAPAN INTERNATIONAL COOPERATION AGENCY



NOZZLE AND CONNECTIONS				
MARK	SIZE	RATING	SERVICE	REMARKS
A	20"	11510 ^A 50.55	WATER INLET	
B	20"	11510 ^C 50.55	WATER OUTLET	
C	20"	11510 ^K 50.55	AIR VENT	
D	20"	11510 ^X 50.55	OVER FLOW AND DRAIN	
E1	20"	11510 [*] 50.55	LEVEL GAUGE CONN	
E2	2450		MAN HOLE	

DESIGN DATA			
FLUID MATERIAL	FRESH WATER		
CAPACITY	3M ³		
NO. REQ'D	1		
DESIGN PRESSURE	ATOMS		
DESIGN TEMPERATURE	40 °C		
HYDRO'IC TEST PRESSURE	FULL OF WATER		
PNEUM'IC TEST PRESSURE	-		
INTERNAL SURFACE TREAT.	EPOXY COATING		
WEIGHT	EMPTY	OPERATION	FULL OF WATER
	1100 KG	4200 KG	4200 KG

NO.	NAME	MATERIAL	QTY.	REMARKS
1	TREAD BAR	SS 41	7	
2	LIFTING LUG	-	2	
3	TOP ANGLE	-	1	L57x6
4	BOTTOM ANGLE	-	1	L57x6
5	ROOF PLATE	-	1	
6	BOTTOM PLATE	-	1	
7	SIDE PLATE	SS 41	1	

PROJECT: JAPAN-SAUDI ARABIA RESEARCH
PROJECT OF SEA WATER DESALINATION

TITLE: MSF-20 T/D
WATER TANK

DATE: SEP. 21 '87 SCALE: —

DRAWING NO.: SAJ 304-S 0002

JAPAN INTERNATIONAL COOPERATION AGENCY

NO.	DESCRIPTION	REV'D	CHEK'D	APPRO

REVISIONS				
NO.	DESCRIPTION	REV'D	CHEK'D	APPR'D
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DESIGN DATA	
FLUID	DISTILLATE
QUANTITY	2.7 m ³ /HR
OPERATING PRESS.	ATMOS.
INLET TEMP.	37.9 °C
OUTLET TEMP.	37.9 °C
DESIGN PRESSURE	1.0 kg/cm ²
DESIGN TEMP.	40.0 °C
HYDRO'C TEST PRESS.	FULL OF WATER
RADIOGRAPHIC EXAM.	NO

WEIGHT	EMPTY	OPERATION	FULL OF WATER
	100 kg	217 kg	280 kg

OUTSIDE PAINTING
 SURFACE TREATMENT --- SPC SP-10
 PRIME COAT --- CYANAMID HELGON OD. 70% (NIPPON PAINT)
 TOP COAT --- CR PAINT FINISH COAT 25% (NIPPON PAINT)

PART NO.	NAME	MATERIAL	Q'TY	REMARKS
6	GASKET	ASBESTOS	1	
5	BOLT & NUT	CARBON STEEL SS 41	16	M24
4	BOTTOM PLATE	DO.	1	EPOXY COATING
3	TOP PLATE	DO.	1	DO.
2	SHELL FLANGE	CARBON STEEL SS 41	1	DO.
1	SHELL	CARBON STEEL STPY 41	1	EPOXY COATING

NOZZLE AND CONNECTION				
MARK	SIZE/RATING	SERVICE	MATERIAL	
			NOZZLE	FLANGE
A	40 ^A JIS 10K 50 FF	DISTILLATE INLET	CARBON STEEL STPG38	CARBON STEEL SS 41
B	65 ^A	DISTILLATE INLET	↑	↑
C	50 ^A	DISTILLATE OUTLET	↑	↑
D	20 ^A	VENT	↑	↑
E	50 ^A	OVER FLOW	↑	↑
F	20 ^A	DRAIN	↑	↑
G	2 50 ^A JIS 10K 50 FF	LEVEL CONTROLLER	CARBON STEEL STPG38	CARBON STEEL SS 41

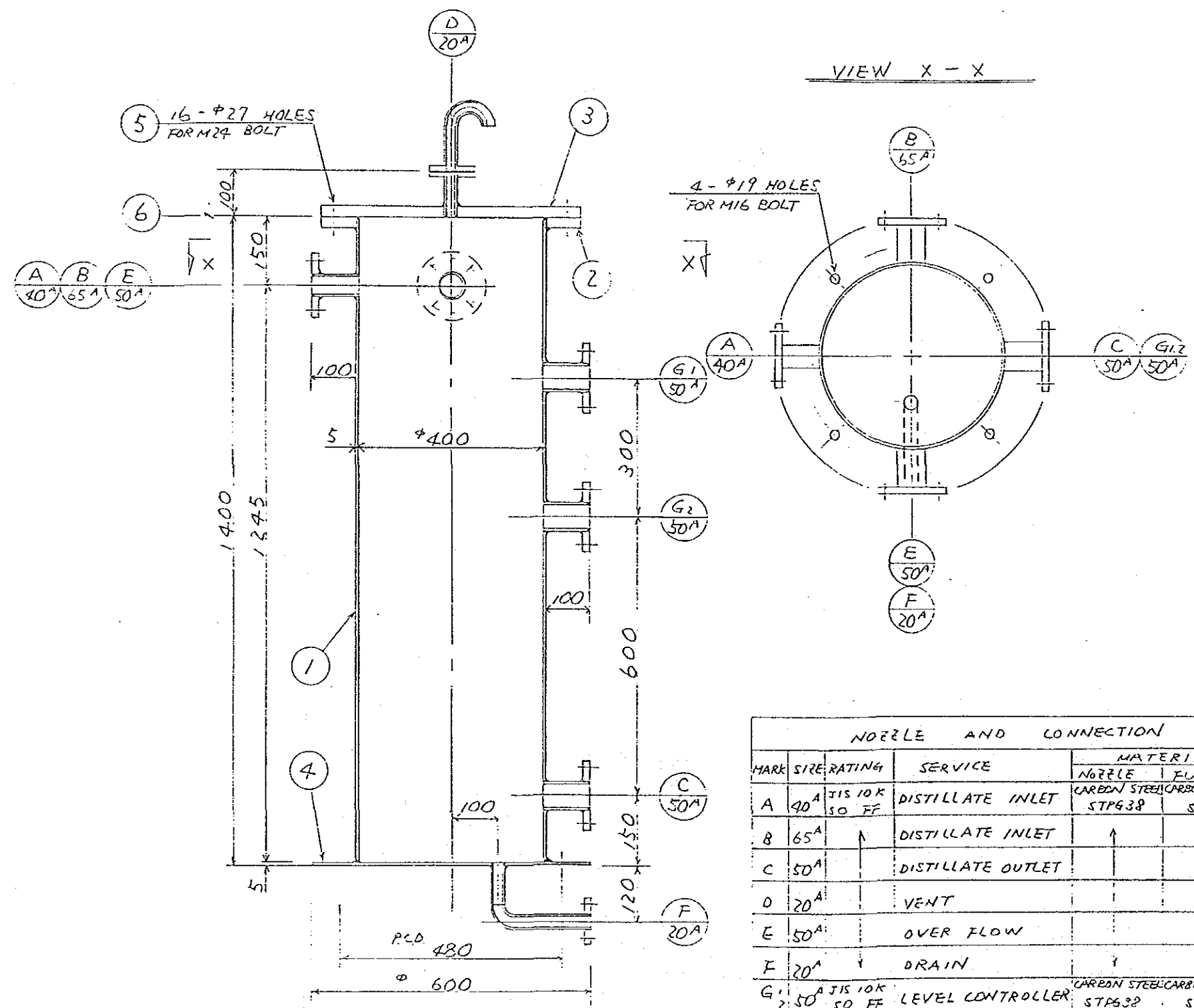
PROJECT: JAPAN-SAUDI ARABIA RESEARCH
 PROJECT OF SEA WATER DESALINATION

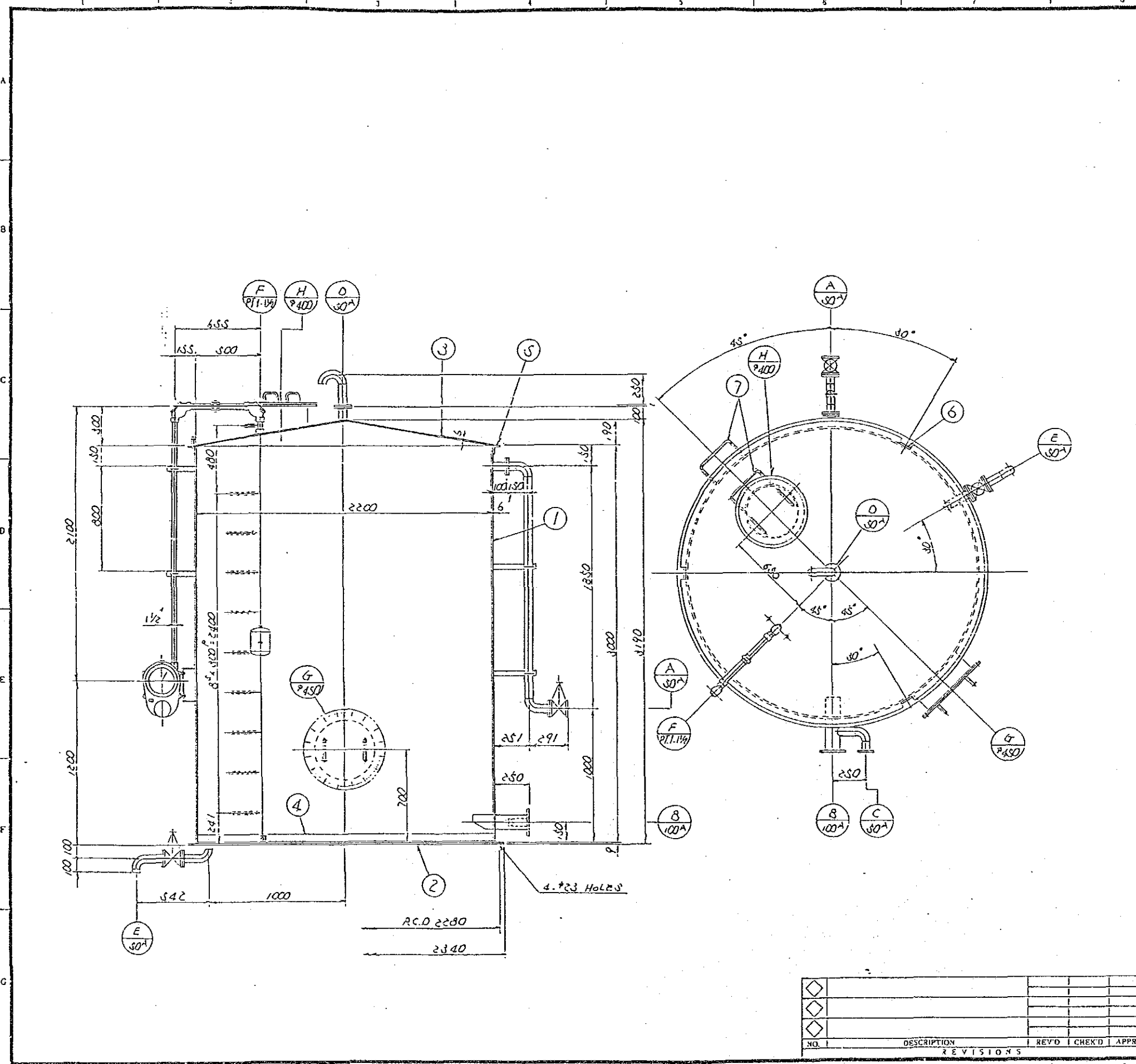
TITLE: PRODUCT TRANSFER TANK

DATE: SEP. '87 SCALE: 1/10

DRAWING NO.: S&J 304-50011

JAPAN INTERNATIONAL COOPERATION AGENCY





NOZZLE AND CONNECTIONS				
MAKE	SIZE	RATING	SERVICE	REMARKS
A	50A	119 10A 50 2F	OIL INLET	
B	100A	119 3X 50 2F	HEATER CONN.	
C	50A	119 10X 50 2F	OIL OUTLET	
D	50A	119 10C 50 2F	AIR VENT	
E	50A	119 10K 50 2F	DRAIN	
F	PT. 1/2"		ROSS FOR LEVEL GAUGE	
G	φ450		MAN HOLE	
H	φ400		MAN HOLE	

DESIGN DATA	
FLUID MATERIAL	C HEAVY OIL
CAPACITY	10 M ³
NO. REQ'D	1
DESIGN PRESSURE	ATMOS
DESIGN TEMPERATURE	40 °C
HYDRO'G TEST PRESSURE	FULL OF WATER
PNEUM'G TEST PRESSURE	—

WEIGHT	EMPTY	OPERATION	FULL OF WATER
	2400 kg	13000 kg	13000 kg

NO.	DESCRIPTION	REV'D	CHEK'D	APPR'D
7	TREAD BAR	SS 41	1	0
b	LIFTING LUG	-	3	
5	TOP ANGLE	"	1	L59 x b
4	BOTTOM ANGLE	"	1	L59 x b
3	ROOF PLATE	"	1	
2	BOTTOM PLATE	"	1	
1	SIDE PLATE	SS 41	1	

PROJECT: JAPAN-SAUDI ARABIA RESEARCH
PROJECT OF SEA WATER DESALINATION

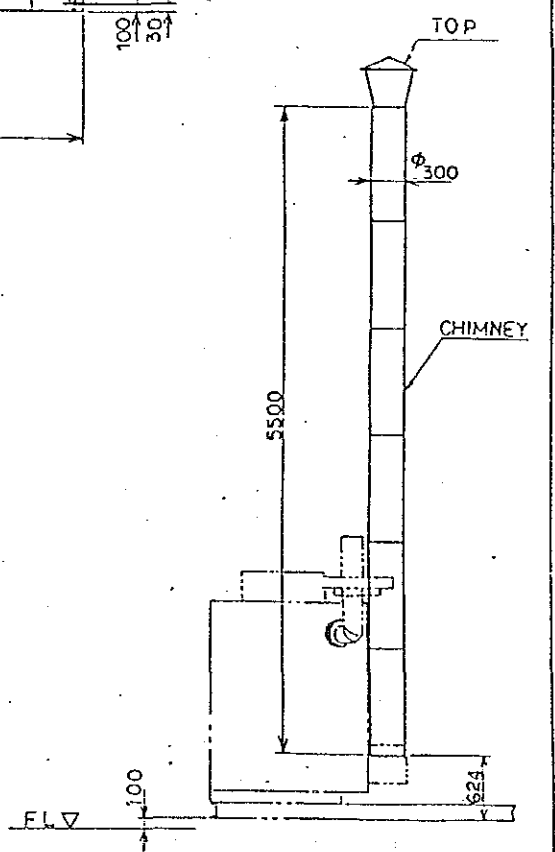
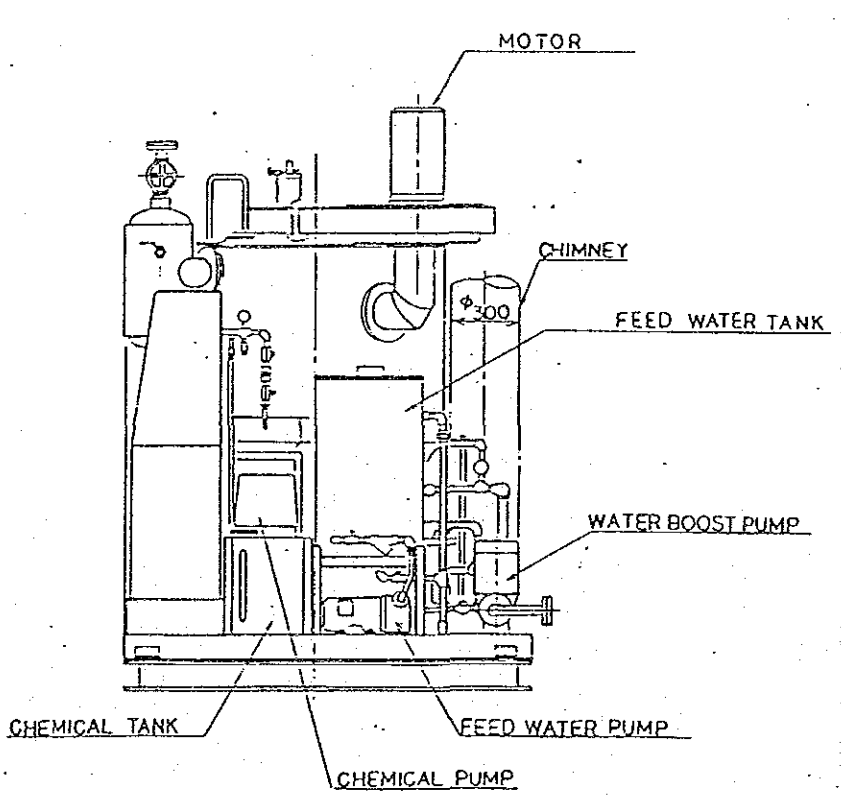
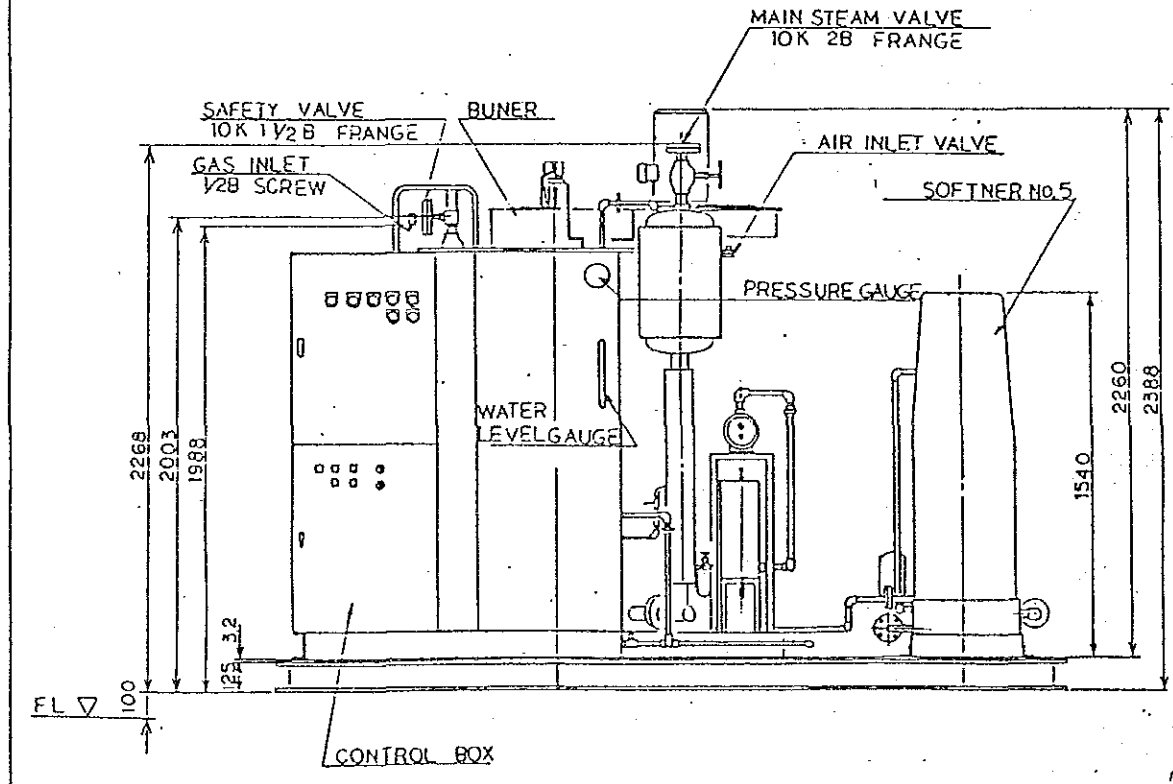
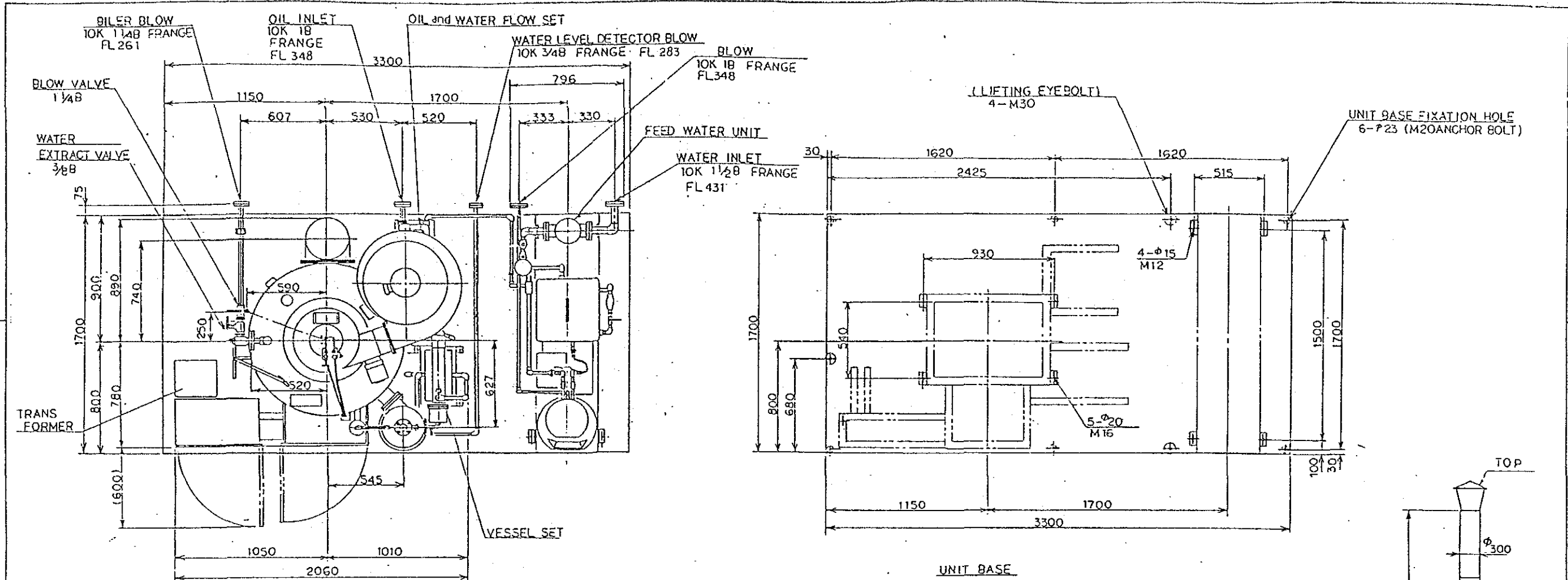
TITLE: MSF-20 T/D
OIL TANK

DATE: SEP. 21 '87 SCALE: —

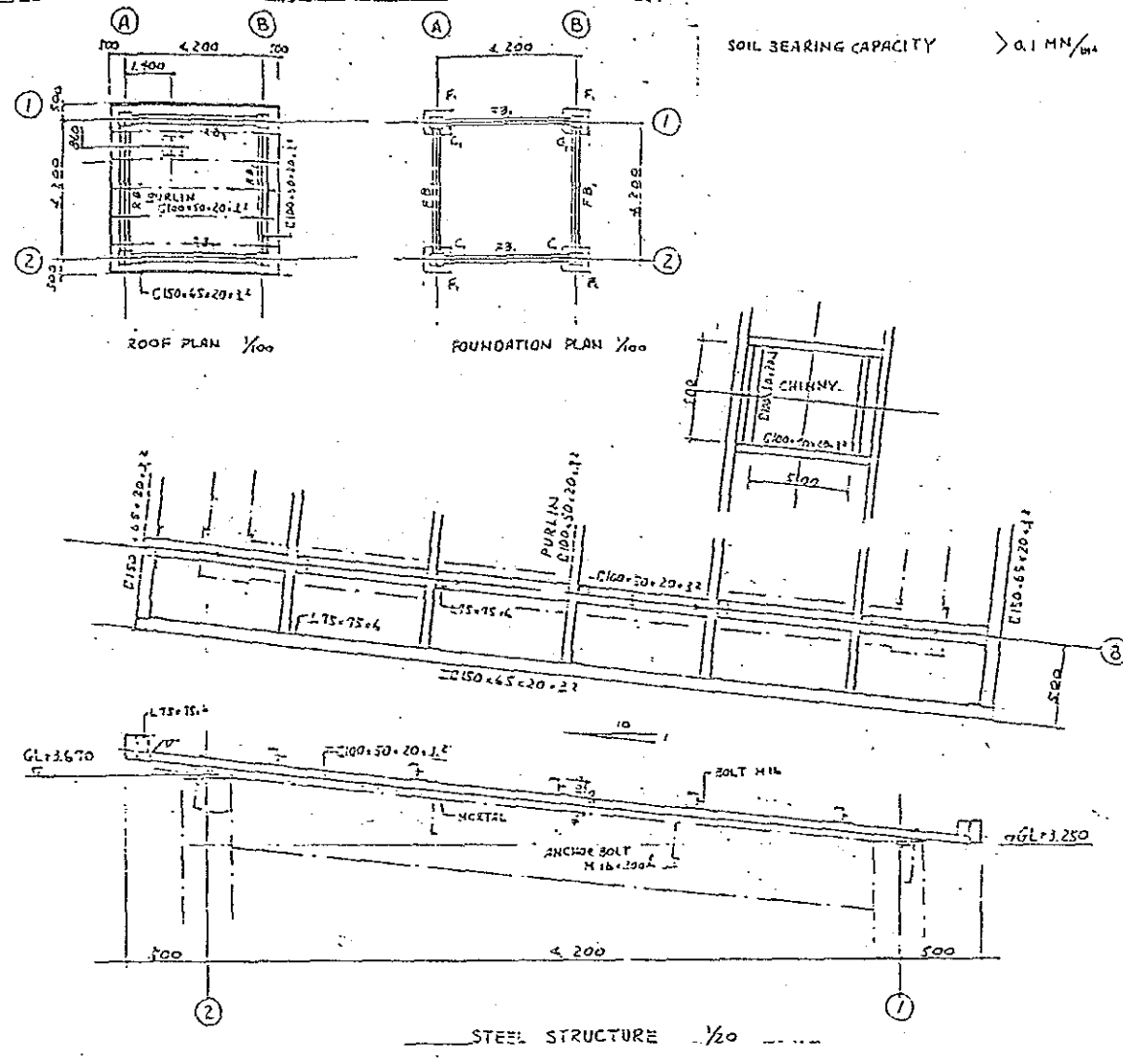
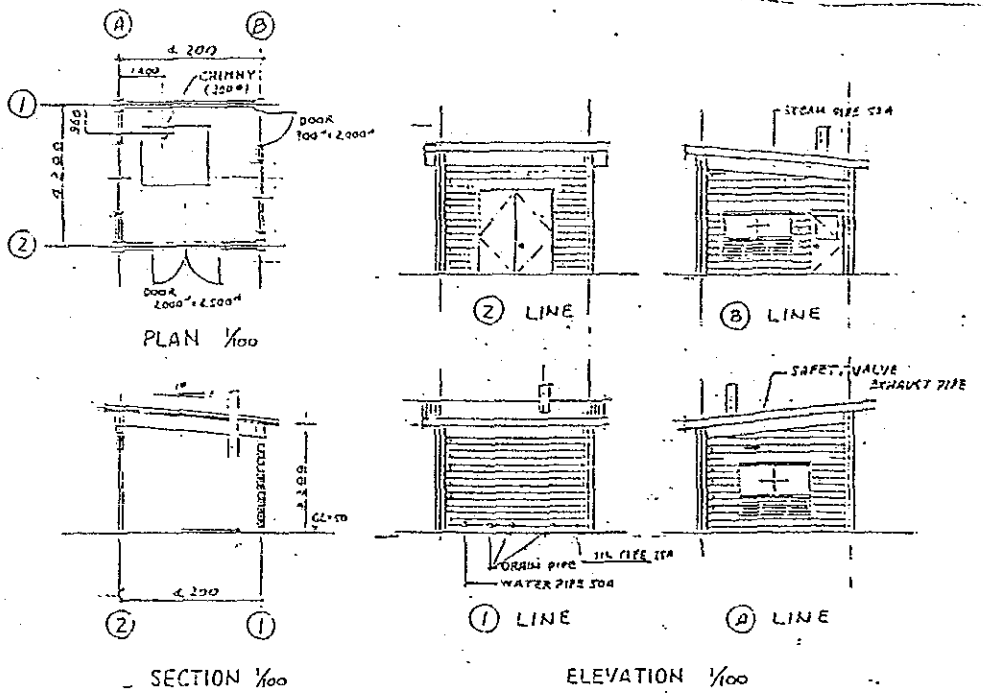
DRAWING NO.: SAJ 304-S0003

JAPAN INTERNATIONAL COOPERATION AGENCY

NO.	DESCRIPTION	REV'D	CHEK'D	APPR'D

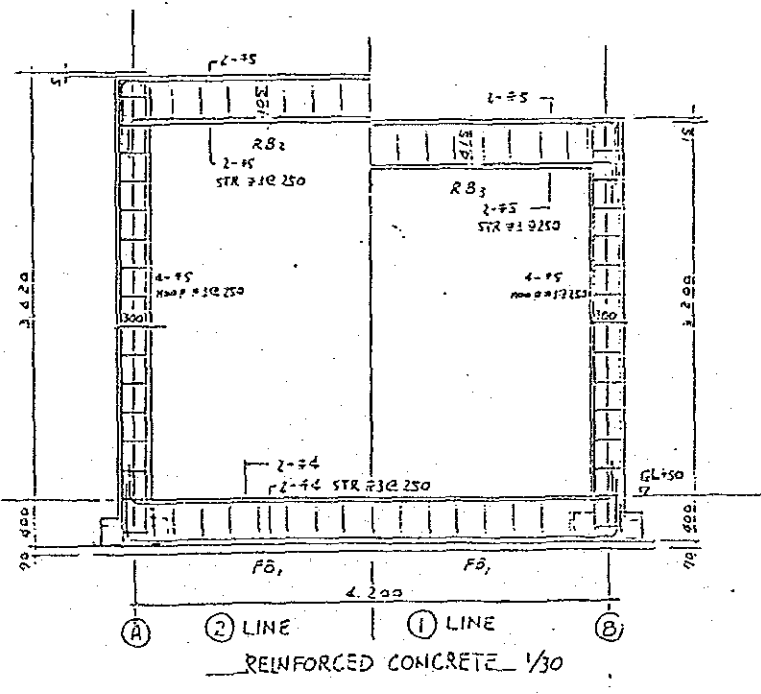
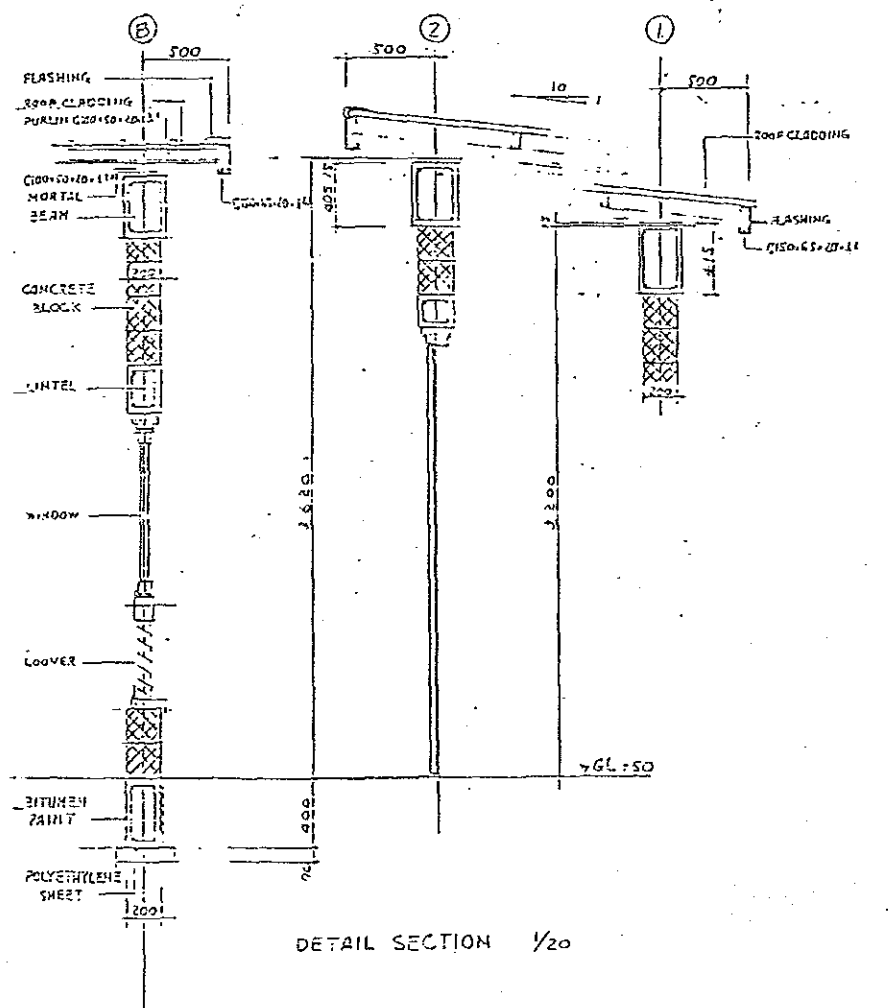


PROJECT: JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION	
TITLE: MSF-20 T/D BOILER OUTLINE	
DATE: SEP. 21 '87	SCALE: —
DRAWING NO.: SAJ 304-S 0004	
JAPAN INTERNATIONAL COOPERATION AGENCY	

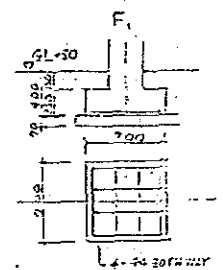


SOIL BEARING CAPACITY > 0.1 MN/m²

NO.	REVISIONS	BY	DATE



C	RB ₁	RB ₂	RB ₃	FB ₁
STR #1 @ 250	STR #1 @ 250	STR #1 @ 250	STR #1 @ 250	STR #1 @ 250
STR #2 @ 250	STR #2 @ 250	STR #2 @ 250	STR #2 @ 250	STR #2 @ 250
STR #3 @ 250	STR #3 @ 250	STR #3 @ 250	STR #3 @ 250	STR #3 @ 250



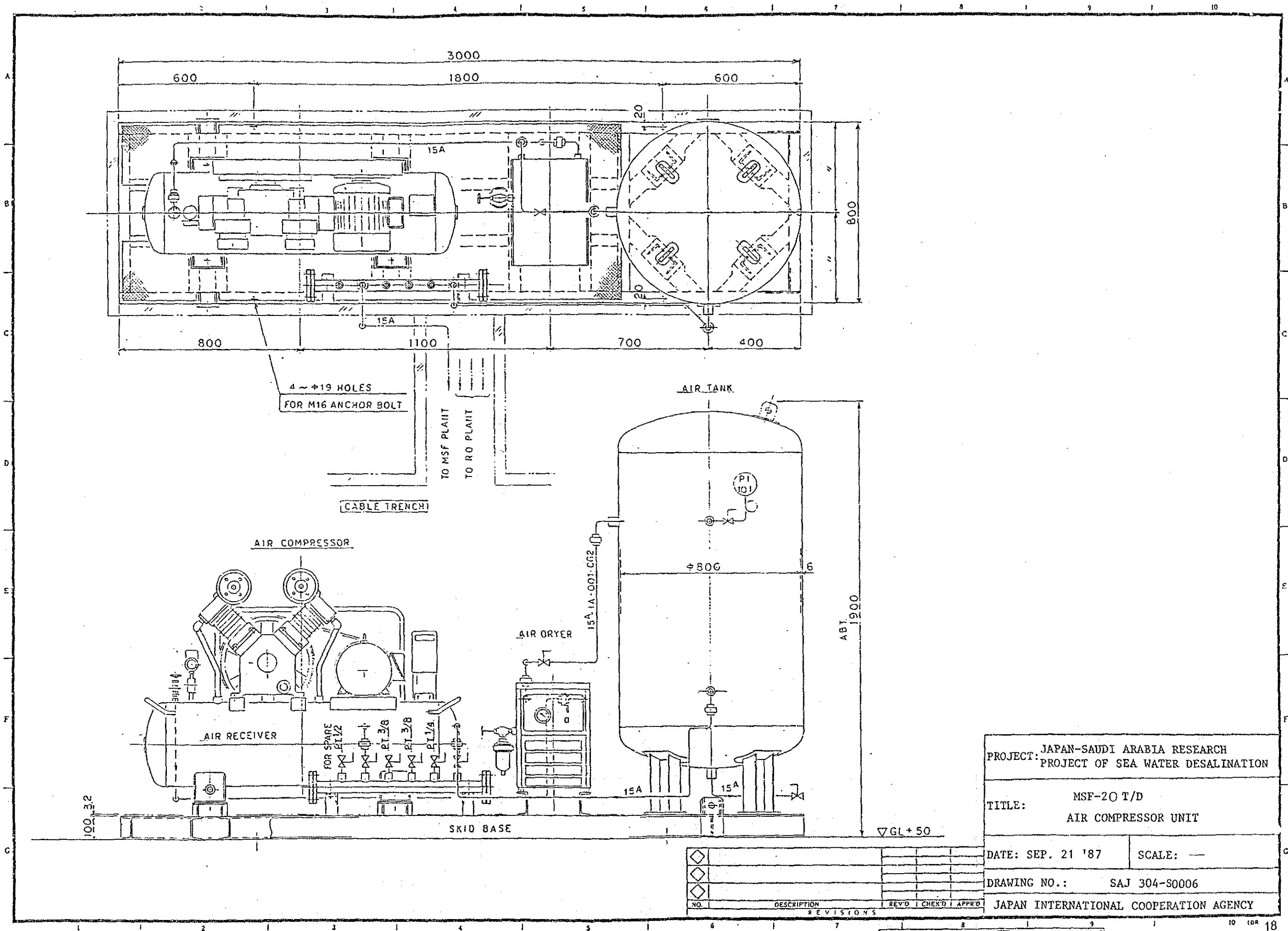
PROJECT: JAPAN-SAUDI ARABIA RESEARCH
PROJECT OF SEA WATER DESALINATION

TITLE: MSF-20 T/D
BOILER HOUSE

DATE: SEP. 21 '87 SCALE: —

DRAWING NO.: SAJ 304-S0005

JAPAN INTERNATIONAL COOPERATION AGENCY



PROJECT: JAPAN-SAUDI ARABIA RESEARCH
PROJECT OF SEA WATER DESALINATION

TITLE: MSF-20 T/D
AIR COMPRESSOR UNIT

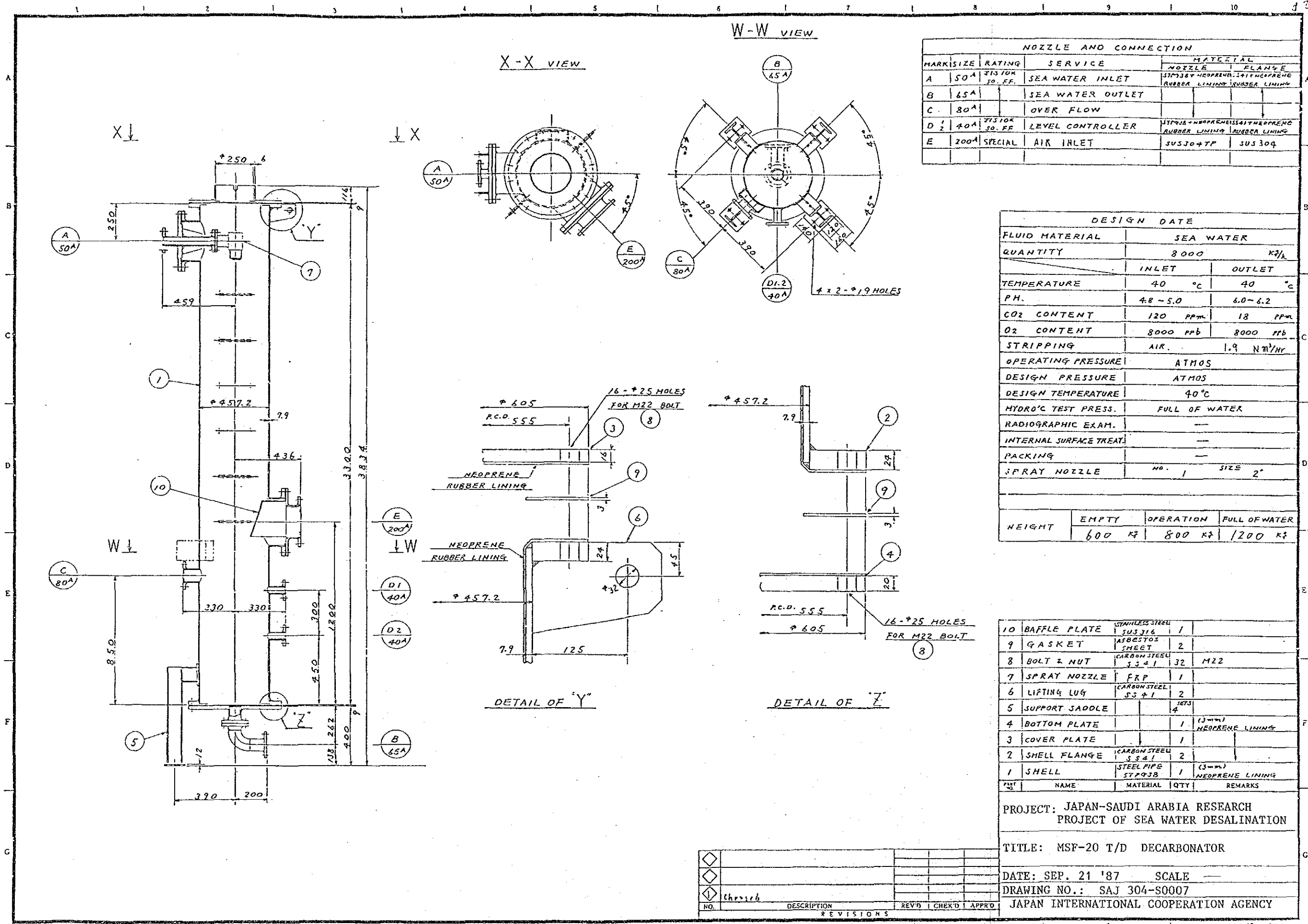
DATE: SEP. 21 '87 SCALE: —

DRAWING NO.: SAJ 304-S0006

JAPAN INTERNATIONAL COOPERATION AGENCY

NO.	DESCRIPTION	REV'D	CHEK'D	APPR'D

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NOZZLE AND CONNECTION					
MARK	SIZE	RATING	SERVICE	MATERIAL	
				NOZZLE	FLANGE
A	50A	7310K 30. FF.	SEA WATER INLET	SUS316 RUBBER LINING	SUS316 RUBBER LINING
B	65A		SEA WATER OUTLET		
C	80A		OVER FLOW		
D	40A	7310K 30. FF.	LEVEL CONTROLLER	SUS316 RUBBER LINING	SUS316 RUBBER LINING
E	200A	SPECIAL	AIR INLET	SUS304TP	SUS304

DESIGN DATA			
FLUID MATERIAL	SEA WATER		
QUANTITY	8000 K ³ /h		
	INLET	OUTLET	
TEMPERATURE	40 °C	40 °C	
P.H.	4.8 - 5.0	6.0 - 6.2	
CO ₂ CONTENT	120 PPM	18 PPM	
O ₂ CONTENT	8000 PPB	8000 PPB	
STRIPPING	AIR	1.9 NM ³ /HR	
OPERATING PRESSURE	ATMOS		
DESIGN PRESSURE	ATMOS		
DESIGN TEMPERATURE	40 °C		
HYDRO-C TEST PRESS.	FULL OF WATER		
RADIOGRAPHIC EXAM.	---		
INTERNAL SURFACE TREAT.	---		
PACKING	---		
SPRAY NOZZLE	NO. 1	SIZE 2"	
HEIGHT	EMPTY	OPERATION	FULL OF WATER
	600 K ³	800 K ³	1200 K ³

10	BAFFLE PLATE	STAINLESS STEEL SUS316	1	
9	GASKET	ASBESTOS SHEET	2	
8	BOLT & NUT	CARBON STEEL S.S. 4.1	32	M22
7	SPRAY NOZZLE	FRP	1	
6	LIFTING LUG	CARBON STEEL S.S. 4.1	2	
5	SUPPORT SADDLE		4	(SETS)
4	BOTTOM PLATE		1	(3mm) NEOPRENE LINING
3	COVER PLATE		1	
2	SHELL FLANGE	CARBON STEEL S.S. 4.1	2	
1	SHELL	STEEL PIPE STPQ3B	1	(3mm) NEOPRENE LINING
NO.	NAME	MATERIAL	QTY	REMARKS

PROJECT: JAPAN-SAUDI ARABIA RESEARCH
PROJECT OF SEA WATER DESALINATION

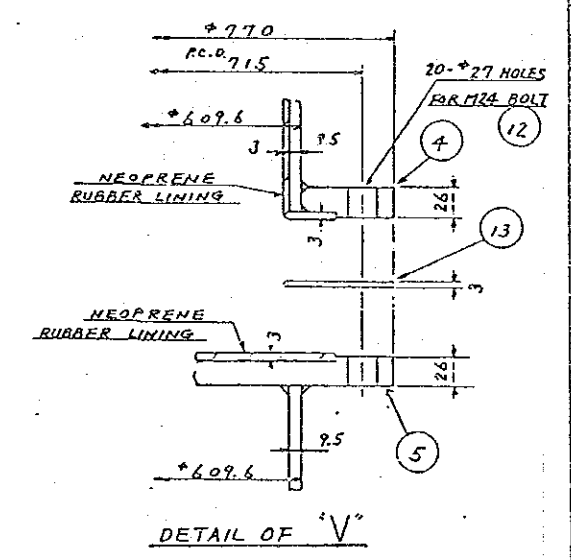
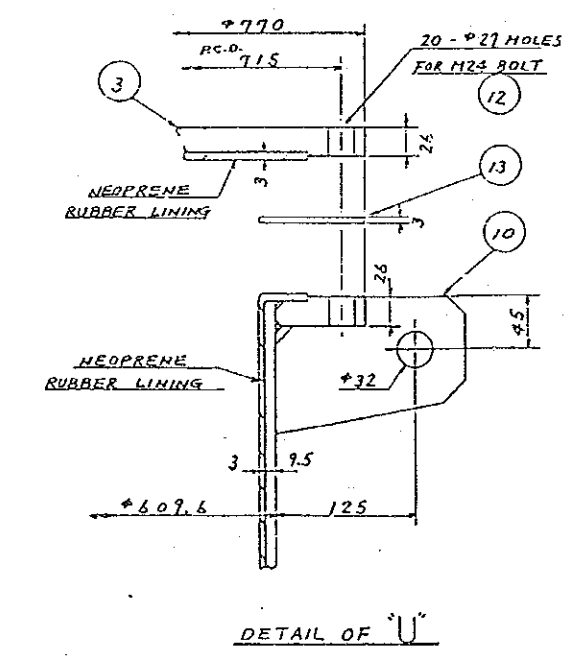
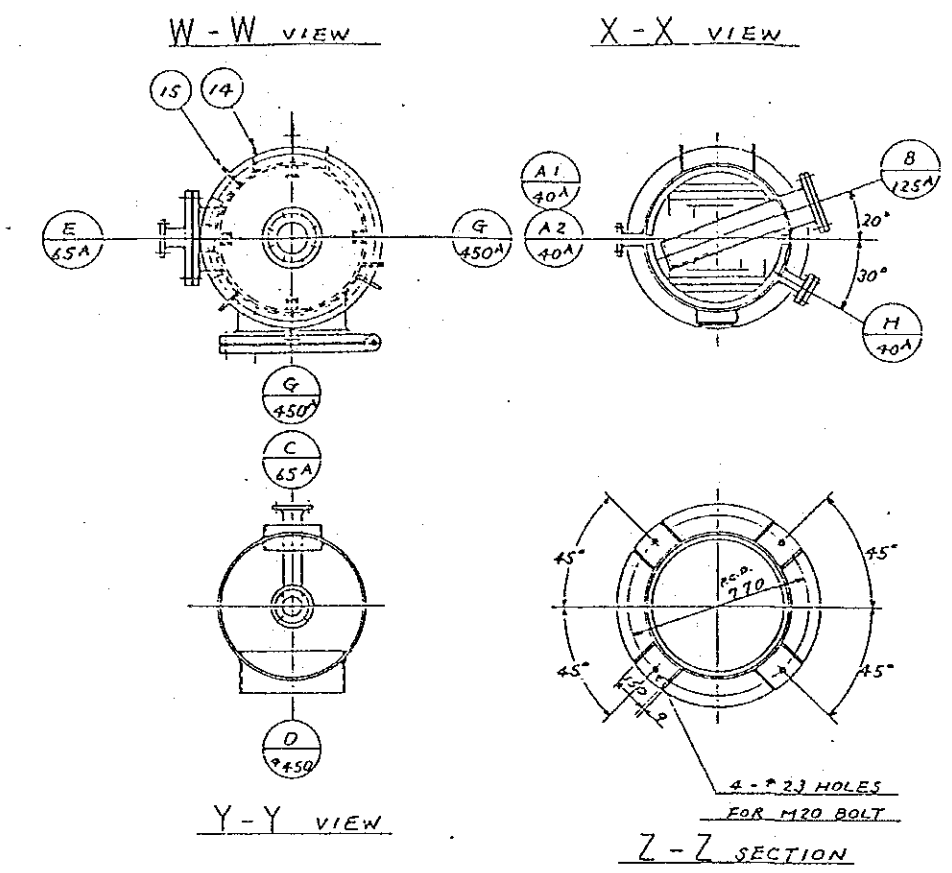
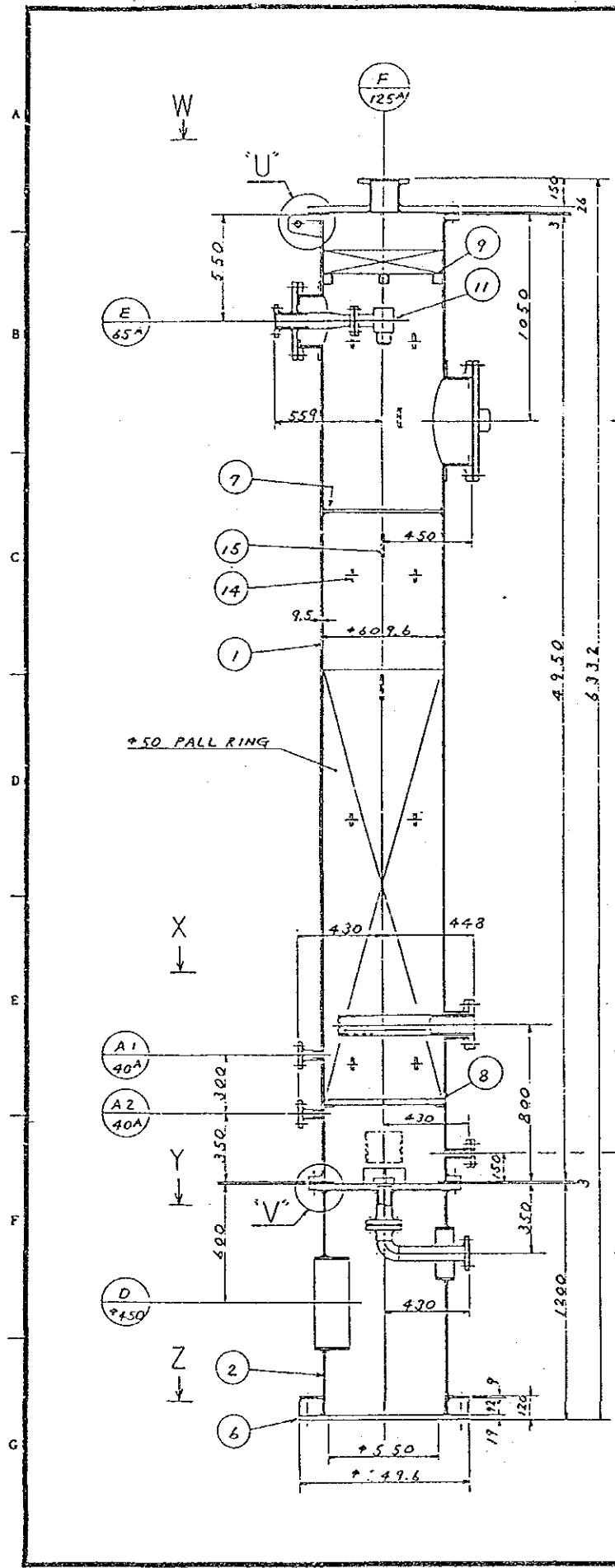
TITLE: MSF-20 T/D DECARBONATOR

DATE: SEP. 21 '87 SCALE: ---

DRAWING NO.: SAJ 304-S0007

JAPAN INTERNATIONAL COOPERATION AGENCY

NO.	DESCRIPTION	REV'D	CHEK'D	APPRO
1	Chrosch			



NOZZLE AND CONNECTION			
MARK/SIZE	RATING	SERVICE	MATERIAL
A 1	40A	LEVEL CONTROLLER	NOZZLE: STPG 38 + NEOPRENE SS41 + NEOPRENE RUBBER LINING. FLANGE: IR RUBBER LINING
B	125A	VAPOR INLET	SUS 316 TP / SUS 316
C	65A	SEA WATER OUTLET	STPG 38 + NEOPRENE SS41 + NEOPRENE RUBBER LINING / RUBBER LINING
D	450	PEEP HOLE	SS 41
E	65A	SEA WATER INLET	STPG 38 + NEOPRENE SS41 + NEOPRENE RUBBER LINING / RUBBER LINING
F	125A	VENT OUTLET	
G	450A	MAN HOLE	SS41 + NEOPRENE SS41 + NEOPRENE RUBBER LINING / RUBBER LINING
H	40A	TEMP. GAUGE	STPG 38 + NEOPRENE SS41 + NEOPRENE RUBBER LINING / RUBBER LINING

DESIGN DATA			
FLUID MATERIAL	SEA WATER		
QUANTITY	8000 K2/H		
	INLET	OUTLET	
TEMPERATURE	40 °C	40 °C	
PH.	8.0 - 8.2	8.0 - 8.2	
CO2 CONTENT	18 PPM	18 PPM	
O2 CONTENT	8000 PPB	20 PPB	
OPERATING PRESSURE	- 0.74	K2/cm2 G	
DESIGN PRESSURE	1.1	K2/cm2 G	
DESIGN TEMPERATURE	40	°C	
HYDRO'IC TEST PRESS.	1.65	K2/cm2 G	
RADIOGRAPHIC EXAM.			
INTERNAL SURFACE TREAT.	NEOPRENE RUBBER LINING (3mm)		
PACKING	450 PALL RING		
SPRAY NOZZLE	NO. 1	SIZE 2"	
WEIGHT	EMPTY	OPERATION	FULL OF WATER
	1,700 K2	1,850 K2	3,100 K2

NO.	NAME	MATERIAL	QTY	REMARKS
15	SUPPORT OF	CARBON STEEL SS 41	2	
14	SUPPORT OF LUGGER	CARBON STEEL SS 41	8	
13	GASKET	ASBESTOS SHEET	2	
12	BOLT & NUT	CARBON STEEL SS 41	40	M24
11	NOZZLE	FRP	1	2"
10	LIFTING LUG	CARBON STEEL SS 41	2	
9	SUPPORT PLATE	STAINLESS STEEL SUS 304	4	
8	"	FRP	1	
7	SUPPORT PLATE	CARBON STEEL SS 41	1	
6	BASE PLATE		1	
5	BOTTOM PLATE		1	
4	FLANGE		2	(3mm) NEOPRENE LINING
3	COVER PLATE	CARBON STEEL SS 41	1	(3mm) NEOPRENE LINING
2	SKIRT	STEEL PIPE STPG 38	1	600A
1	SHELL	STEEL PIPE STPG 38	1	600A

PROJECT: JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION

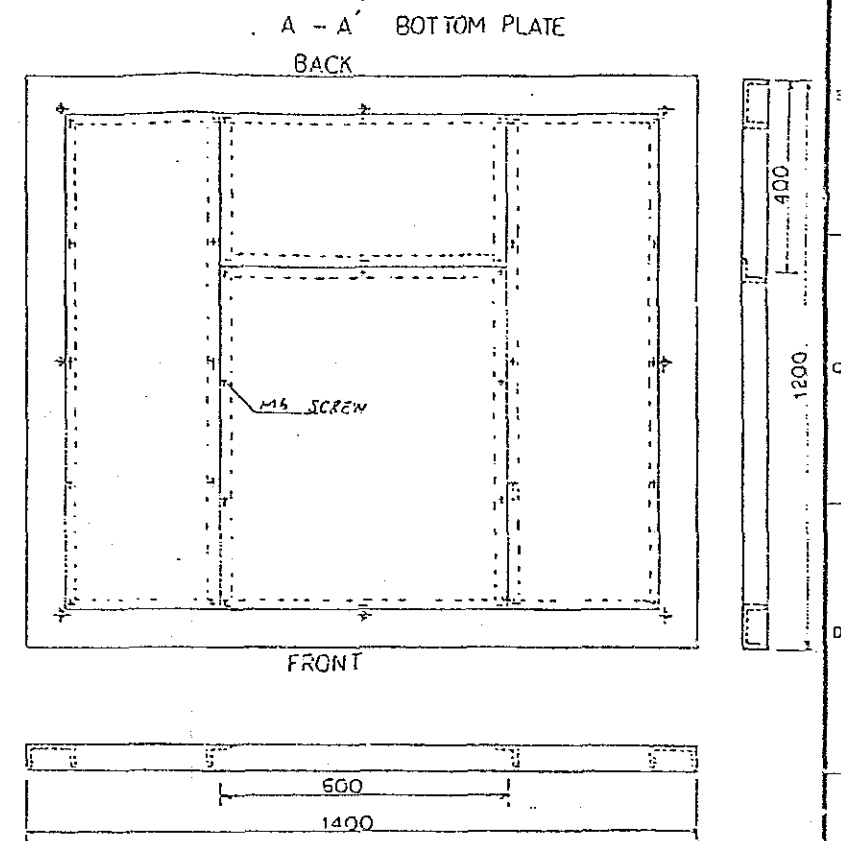
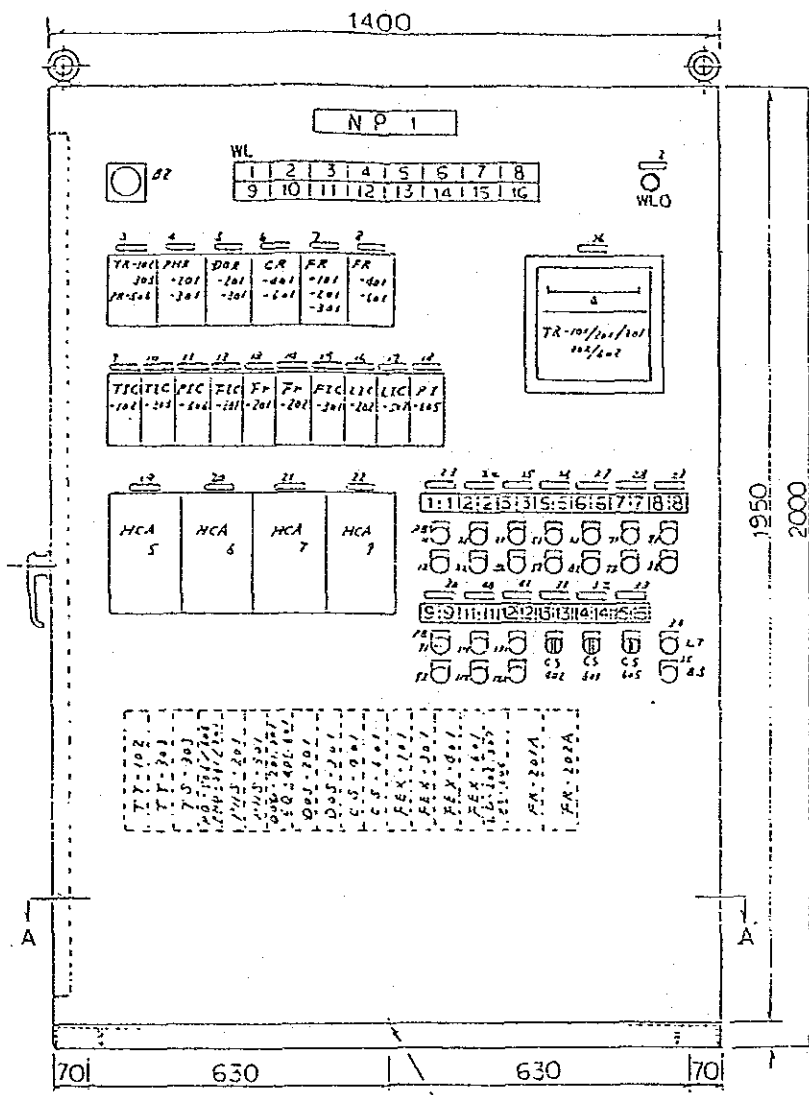
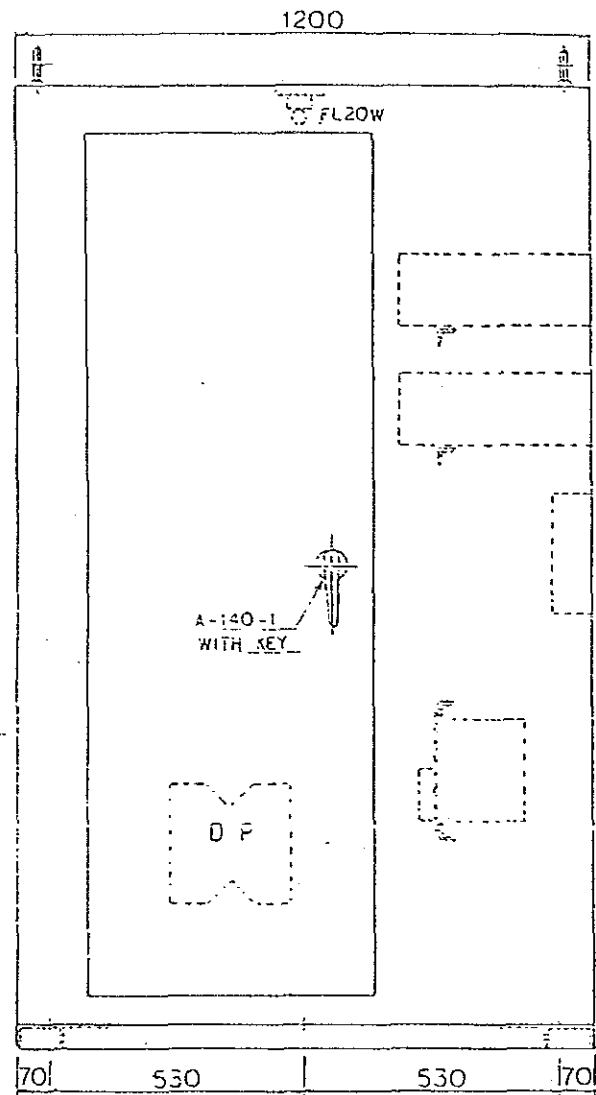
TITLE: MSF-20 T/D DEAERATOR

DATE: SEP. 21 '87 SCALE: —

DRAWING NO.: SAJ 304-S0008

JAPAN INTERNATIONAL COOPERATION AGENCY

NO.	DESCRIPTION	REV'D	CHEK'D	APPR'D
1	changed nozzle orientation.	9/27/87		



SPECIFICATION
 1) SELF STANDING
 2) MATERIAL
 OUTSIDE, DOOR : SPC 2.3^E
 DEVICE ATTACHED PLATE : SPC 3.2^E
 3) PAINTING COLOR : OUTSIDE, MUN. 2.5G 3/2
 : INSIDE, MUN. 2.5G 3/2
 4) Q'TY : 1 SET

PROJECT: JAPAN-SAUDI ARABIA RESEARCH
 PROJECT OF SEA WATER DESALINATION

TITLE: MSF-20 T/D
 MSF CONTROL PANEL OUTLINE

DATE: SEP. 21 '87 SCALE: —

DRAWING NO.: SAJ 304-S 0009

JAPAN INTERNATIONAL COOPERATION AGENCY

NO.	DESCRIPTION	REV'D	CHECK'D	APPRO'D

ATTACHMENT II

(RO TEST PLANT)

1. List of Equipment for RO Test Plant

2. Drawings

DWG. NO.	Drawing List Title
SAJ 304-R4001	PLOT PLAN OF MSF & RO TEST PLANT
SAJ 304-R4003	PLOT PLAN OF INDOOR AND SIDE VIEW
SAJ 304-R4007	ARRANGEMENT OF TANKS
SAJ 304-R4101	PRETREATMENT EQUIPMENT SKID
SAJ 304-R4111	SPIRAL WOUND TYPE RO EQUIPMENT SKID ASSEMBLY
SAJ 304-R4112	HOLLOW FIBER TYPE RO EQUIPMENT SKID ASSEMBLY
SAJ 304-4131	CHEMICAL FEEDER SKID ASSEMBLY
SAJ 304-RE131(1/2)	CONTROL PANEL
SAJ 304-RE131(2/2)	MOTOR CONTROL PANEL
SAJ 304-RKED0016	KURITA'S FOULING INDEX MONITOR ASSEMBLY

1 List of Equipment for RO Test Plant

1. Sea Water Pretreatment Equipment Section-100

Item	Equipment Name	Specification	Q'ty
T-101	Seawater intake tank Material Capacity Accessories	Vertical, cylindrical, and closed type Polyethylene 3 m ³ Level indicator, overflow pipe, drain valve, ladder, manholes, anchor bolts, etc.	1 set
T-102	Filtered sea water tank Capacity	Same as T-101 15 m ³	1 set
F-101AB	Filter Material Media Accessories	Pressured dual media layer filter Steel inside of filter lining with rubber sheet Gravel-Sand-Anthracite Manhole, nozzles, piping, sight glass, etc.	2 sets
P-101	Sea water pump Material Motor Accessories	Volute centrifugal pump SCS14/SUS316 Outside, 220V x 3 ϕ x 60 Hz x 3.7 kW, TEFC, insulation class JIS E Common bed, coupling etc.	1 set
P-102	Back washing pump Motor	Pumps type and material is same as P-101. Outside, 220V x 3 ϕ x 60 Hz x 1.5 kW, TEFC, insulation class JIS E	1 set
P-103	Back washing air blower Material Motor Accessories	Roots blower, three blade helical Cast iron Outside 220V x 3 ϕ x 60Hz x 1.5 kW, TEFC, insulation class JIS E Common bed, V belt/pulley, silent cleaner, relief valve etc.	1 set
P-105	Waste pump Material Motor	Volute centrifugal pump SCS-14/SUS-316 Outside, 220V x 3 ϕ x 60 Hz x 1.5 kW, TEFC, insulation class JIS E	1 set

Item	Equipment Name	Specification	Q'ty
UV- 101	UV sterilizer Capacity Material Accessories	Ultra violet ray type 7.5 m ³ /h Hard glass, SUS 316 Setting bed, controller, etc.	1 set
FI- 101 - 103	Flow indicator Material	Rotor-meter type For sea water feed, back washing, back washing air SUS 316 or plastic	3 sets
PI- 101 - 106	Pressure indicator Material Piping & valve Material Valve Automatic valve	Bourdon tube type SUS 316, plastic Class JIS 10K type Plastic pipe & fitting JIS 10K type gate, ball valve plastic made JIS 10K air torque cylinder type diaphragm Valve (PVC) Steam pressure regulating valve (PVC) Heated steam automatic shut down valve (TASV) Cast iron line with rubber made sample valve, etc. Strainer, Steam trap, etc.	8 sets 1 set
	Indicator board Material	Pressure & flow indicators setting Steel	1 set
	Skid Accessories	Shape steel made Anchor bolt, others Note: Instruments such as LSA-101, 102, 103 AB etc. are listed in Section 700.	1 set
P-401	Air compressor Discharge pressure Motor Accessories	Oilless baby compressor 7 kg/cm ² , automatic pressure control Outside, 220V x 3 ϕ x 60Hz x 4P x 3.7 kW, TEFC, insulation Class JIS E Bed, V belt/pulley, air receiver, safety valve, etc.	1 set

2. Fouling Index Automatic Indicating Recorder

Item	Equipment Name	Specification	Q'ty
FIR-101	FI meter Sampling & measuring part Controlling part Power source	Automatic sampling, measuring, indicating and recorder for filtered seawater fouling index Automatic operation Digital printer, sequence controller 110V x 1 ϕ x 60Hz x 0.5 kW	1 set

3. Chemical Feeder Section-500

Item	Equipment Name	Specification	Q'ty
T-501	Sodium hypochlorite solution tank (NaHClO) Material Accessories	Square type 200 ℓ capacity Plastic Level indicator, etc.	1 set
T-502	Ferric chloride solution tank (FeCl ₃)	Same as T-501	1 set
T-503	Sulfuric acid solution tank (H ₂ SO ₄)	Same as T-501	1 set
T-504	Sodium bisulfite solution tank	Same as T-501	1 set
P-501AB	Sodium hypochlorite injection pump Accessories Motor	Constant flow injection diaphragm pump Pump bed, pump cover, etc. 220V x 3φ x 60Hz x 0.03 kW, Tropical insulation treated	2 sets
P-502	Ferric chloride injection pump	Same as P-501	1 set
503AB	Sulphuric acid	Same as P-501. Note: P-503B pump operation (ON-OFF) is controlled by PHRA-301.	2 sets
504ABC	Sodium bisulfate injection pump	Same as P-501. Note: 1) P-504C pump operation is controlled by ORPA-201 and timer program. 2) P-504AB pumps inject 40 ppm SBS for normal operation, P-504C inject 500 ppm SBS for shock treatment.	3 sets

Item	Equipment Name	Specification	Q'ty
FIR-101	Piping & valve	Pump suction valve (non-return with strainer) Pump delivery valve (non-return with siphon protector) Braid hose, hose band, etc.	1 set
	Mixing bar Material	For chemical tank PVC	4 sets
	Skid Accessories	Shape steel made Anchor bolts, others Note: 5 tanks (one is S/P tank) and 8 pumps shall be installed and mounted on the same skid.	1 set

4. Spiral wound type Reverse Osmosis Equipment Section-200

Item	Equipment Name	Specification	Q'ty
T-201	Feed tank Material Capacity Accessories	Vertical, cylindrical, closed type Polyethylene 1.5 m ³ Level indicator, nozzles, overflow pipe, drain valve, manhole, bolt-tap, anchor bolt, etc.	1 set
T-202	Permeate tank Capacity Accessories	Vertical, cylindrical, closed type and polyethylene make. 1.0 m ³ Level indicator, nozzles, overflow pipe, drain valve, anchor bolt, etc.	1 set
P-201	Feed water supply pump Material Motor Accessories	Centrifugal pump SCS-14 Outside, 220V x 3 ϕ x 60Hz x 1.5kW, TEFC, insulation class E Common bed, coupling, etc.	1 set
P-202	Booster pump Material Motor Accessories	Centrifugal pump SCS-14 220V x 3 ϕ x 60Hz x 3.7 kW Common bed, coupling, etc.	1 set
P-203	High pressure pump Material Motor Accessories	Variable flow 20 - 100%, triplex plunger pump SCS-14/SUS-316 Plunger: Ceramic coating 220V x 3 ϕ x 60Hz x 300 - 1,375 rpm x 15 kW, VS motor, TEFC, insulation class E Common bed, driving system, relief valve, accumulator, etc.	1 set
HE-201	Feed preheater Capacity Design pressure Material	Plate type heat exchanger 45,000 Kcal/h 5 kg/cm ² Heating surface; titanium or equivalent equal	1 set

Item	Equipment Name	Specification	Q'ty
HE-202	Feed heater Capacity Material Design pressure	Plate type Steam supply : max. 90 kg/hr : saturated steam of 8 kg/cm ² /g Supply water temperature is to be automatic- controlled up to max. 50°C Titanium or equivalent equal 5 kg/cm ²	1 set
UV-201	UV sterilizer Capacity Material Design pressure Accessories	Ultra violet ray type 3.5 m ³ /hr Hard glass, SUS 316 5 kg/cm ² Setting bed, controller, etc.	1 set
F-201AB	Safety filter Capacity Material Design pressure	Cartridge filter type 3.5 m ³ /h x 20 micron Filter element: polypropylene Housing: Polycarbonate 5 kg/cm ²	2 sets
RO-201 ABC	RO membrane module RO membrane element RO vessel Accessories	Spiral wound type 8"φ x 6 elements FRP made 2 elements x 3 vessels Max. applied pressure x temperature 70 kg/cm ² x 50°C RO element/Vessel parts	1 set
FI- 201 - 202	Flow indicator for permeate, brine Material	Rotor meter type panel mounted Taper tube-hard glass Other: SUS 316 or plastic	2 sets
PI- 201 - 206	Pressure indicator Material	Bourdon tube type panel mounted D model SUS 316/plastic case Note: PI-204, 205 are vibro-isolating type	6 sets

Item	Equipment Name	Specification	Q'ty
TI- 201 - 204	Thermometer	Local mounted scale 0 - 100°C with protecting tube, SUS 316 made	4 sets
PSA-201	Pressure switch	Bellows or bourdon tube type	1 set
	Material	SUS 316	1 set
	Setting pressure	0 - 3 kg/cm ²	1 set
	Indicator board	Steel plate is stainless steel. Mount pressure, flow indicators, pressure switch and name plate, etc.	1 set
	Piping & valve	High pressure side; Stainless steel pipe SUS-316 TP, high pressure rubber hose, victaulic coupling, flange and fitting, valve Valve: 600 lbs. type stainless steel made Low pressure side; Plastic pipe, rubber, plastic hose, JIS 10K flange and fitting, Valve: JIS 10K plastic made ball, globe, gate valve, etc. Sampling valve: Stainless steel, plastic made Automatic control valve, Diaphragm valve, drain trap, etc.	1 set
	Skid	Shape steel made	1 set
	Accessories	Anchor bolt, others Note: Instrument such as TC-201, TR-201, CRPA-201, CR-201, LSA-201, TA-201, etc. are listed in SECT-700.	
	Special parts	Setting parts for other foreign spiral wound RO module Note: Other module (RO element) is U.S.A. UOP Fluid System model TFC-1501 PA	1 set

5. Hollow fiber type Reverse Osmosis Equipment Section-300

Item	Equipment Name	Specification	Q'ty
T-301	Feed tank Material Capacity Accessories	Vertical, cylindrical closed type Polyethylene 1.5 m ³ Level indicator, nozzles, overflow pipe, drain valve, manhole, ladder, ball-tap, anchor bolt, etc.	1 set
T-302	Permeate tank	Same as T-202 Note: Without ball-tap	1 set
P-301	Feed water supply pump Material Motor Accessories	Centrifugal pump SCS-14 Outside 220V x 3 ϕ x 60Hz x 1.5 kW, TEFC, insulation class E Common bed, coupling, etc.	1 set
P-302	Booster pump Material Motor Accessories	Centrifugal pump SCS-14 220V x 3 ϕ x 60Hz x 3.7 kW Common bed, coupling, etc.	1 set
P-303	High pressure pump Material Motor Accessories	Variable flow 20 – 100%, triplex plunger pump SCS-14/SUS-316 Plunger: Ceramic coating 220V x 3 ϕ x 60Hz x 300 – 1,375 rpm x 15 kW, VS motor, TEFC, insulation class E Common bed, driving system, relief valve, accumulator, etc.	1 set
HE-301	Feed preheater	Same with HE-201	1 set
HE-302	Feed heater	Same with HE-202	1 set

Item	Equipment Name	Specification	Q'ty
UV-301	UV Sterilizer Capacity Material Design pressure Accessories	Ultra violet ray type 3.5 m ³ /hr Hard glass and stainless steel 5 kg/cm ² Setting bed, controller, etc.	1 set
F-301AB	Safety Filter Capacity Material Design pressure	Cartridge filter type 3.5 m ³ /h x 10 micron meter Filter element: Polypropylene Housing: Polycarbonate 5 kg/cm ²	2 sets
RO-301AB	RO membrane module	RO membrane module: Hollow fiber type 2 elements (8"φ) x 1 module 1 element(8"φ) x 1 module Max. applied pressure x temperature 65 kg/cm ² x 50°C	1 set
FI- 301 - 302	Flow indicator Material	Rotor meter type panel mounted For permeate, brine Taper tube: Hard glass Other: Stainless steel or plastic	2 sets
PI- 301 - 306	Pressure indicator Material	Bourdon tube type panel mounted model D Stainless steel/plastic case Note: PI-304 – 305 are vibro-isolating type	6 sets
TI- 301 - 304	Thermometer	Local mounted scale 0 – 100°C with protecting tube SUS-316 made	4 sets
PSA-301	Pressure switch Material Setting pressure Indicator board	Bellows or bourdon tube type Stainless steel 0 – 3 kg/cm ² Steel plate or stainless steel. Mounted pressure, flow indicators, pressure switch and name plate, etc.	2 sets 1 set

Item	Equipment Name	Specification	Q'ty
PSA-301 (Cont'd.)	Piping & Valve	<p>High pressure side; SUS-316 TP, high pressure rubber hose, victaulic coupling, flange and fitting Valve: 600 lbs. type stainless steel made</p> <p>Low pressure side; Plastic pipe, rubber and plastic hose, JIS 10K flange and fitting Valve: JIS 10K type plastic made ball, glove, gate valve, etc. Automatic control valve (CV), diaphragm valve, drain trap, etc.</p>	1 set
	Skid Size Accessories	<p>Shape steel made Approx. 3,000 L x 2,000 W mm Anchor bolt, others Note: Instruments such as TC-301, TR-301, PHRA-301, CR-301, LSA-301, TA-301 are listed in SECT. 700.</p>	1 set
	Special parts	<p>Setting parts for other foreign hollow fiber type RO module. Note: Other module is U.S.A. DuPont Permasep B-10 model 6840-060 x 1 module.</p>	1 set

6. Cleaning Equipment for RO Membrane Module Section-600

Item	Equipment Name	Specification	Q'ty
T-601	Cleaning tank	Portable cylindrical, vertical, closed type	1 set
	Capacity	500 ℓ	
	Material	Polyethylene	
	Accessories	Level indicator, nozzles, manholes, etc.	
	Piping & Valve	Portable type	1 set
	Material	Plastic hose, JIS 10K type, valve plastic made	

7. Electrical Equipment and Instrumentation Section-700

Item	Equipment Name	Specification	Q'ty
MCP-701	Motor control panel Size	Self-supporting indoor use type Approx. 3,000W x 2,350H x 800D mm Attached apparatus Main molded case circuit breaker, distribution molded case circuit breaker, pilot lamp, magnetic contactor, thermal relay, VS controller, VS operator, VS system module etc., pilot lamp (running), annunciator lamp for operation switch, (changeover switch, push button switch), auxiliary relay, auxiliary timer, floatless switch, flicker relay, off delay relay, annunciator relay, buzzer, power control switch, hour meter for transformer 220/110V, panel inner lighting, name plate, terminal plate, inner wiring material. Attached instrument Feed pH recorder with alarm, temperature recorder, conductivity recorder,	1 set
MVP-701	Solenoid valve panel	Self-supporting indoor use type (attached in MCP-701 panel) Back washing automatic valve for filter (F-101A) Operating control panel Attached apparatus Solenoid valve, annunciator lamp, pilot lamp for valve (open-close), changeover switch (auto-manu), auxiliary relay, timer relay, off delay relay, etc.	1 set
TR- 201 - 301	Instrument Temperature recorder	2-pen recorder (range 0 – 110°C)	1 set

Item	Equipment Name	Specification	Q'ty
TC- 201 - 301	Temperature controller	Temperature indicating-controlling instrument using air pressure	2 sets
ORPA-201	Oxidation reduction potential with alarm	Electrode type with alarm (range: -700 – 700mV) Sensor, electrode holder, Special cable	1 set 1 each 1 set
PHIA-301	pH recorder with alarm	Glass electrode type recorder with alarm (range 0 – 14 pH) Electrode, electrode holder Special cable	1 set 1 each 1 set
CR- 201 - 301	Conductivity recorder	2-pen conductivity recorder (range: 0 – 1,000 μ S/cm) Electrode Special cable	1 set 2 sets 1 set
LSA-101 -201 -301 -103AB	Level switch	Conductivity type level switch	6 sets
TA- 201 - 301	Temperature switch		1 set

8. Piping and Wiring Materials

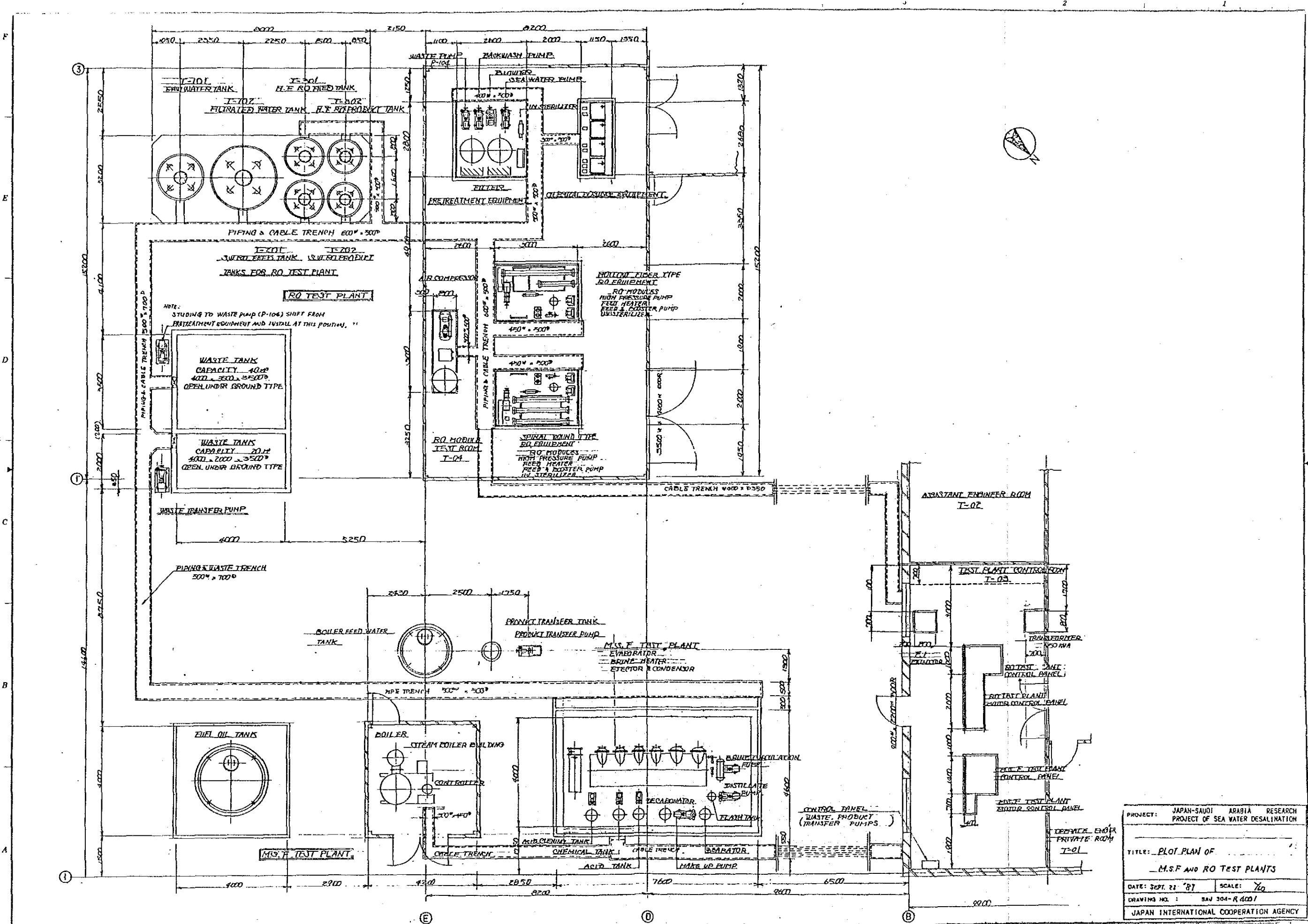
Item	Equipment Name	Specification	Q'ty
	Scope of Supply for piping and wiring materials inside of battery limit shown in flow sheet and plot plan of this test plant.		
	Piping material	Sea water intake pipe Waste, steam and concentrate discharge pipe, sea water, filtered water, product concentrate, etc.	1 set
	Material	Pipes between each equipment and tank. Chemical injection pipe 10 - 80 mm ϕ plastic pipe (pvc) and fitting JIS 10K class plastic flange. 15 - 25 mm ϕ SGP & SUS-316 pipe & fitting, JIS 10K class 8 mm ϕ plastic braid hose, vinyl hose, hose hand, pipe fitting, etc.	
	Valve	JIS 10K class, BC or FC, PVC Globe, ball, check valves, Sampling valve, etc.	1 set
	Other	Drain trap, strainer, etc.	1 set
	Wiring material	Wiring material between control panel and electrical equipment and instruments.	1 set
	Pneumatic pipe air set		
	Power cable	CV cable type	
	Control cable	CVV cable type	
	Instrument cable	CVV cable type and special type	
	Wiring pipe	Steel pipe for wiring	
	Flexible wiring pipe	Flexible wiring pipe covered with vinyl	
	Supporting material, etc.	Hard vinyl pipe & fitting	

9. Apparatus and tool for Operation and Maintenance

Item	Equipment Name	Specification	Q'ty
	Apparatus	Portable measuring instruments and mess cylinder, sampling bottle, etc. for daily operation and maintenance.	1 set
	Portable fouling index meter	Pressure water vessel, FI filter, baby compressor, etc.	1 set
		Portable pH meter	1 set
		Portable conductivity meter	1 set
		Portable dissolved oxygen meter	1 set
		Portable residual chlorine meter	1 set
		Thermometer 0 – 100°C	2 sets
		Mess-cylinder, bottle, filter paper, etc.	1 set
	Tools	Tools for daily operation and maintenance	1 set
	Ordinary tool	Spanner, pench, hammer, driver, metal saw etc. and tool box.	
		Waste cloth, fitting material for piping, glue, seal gasket, maintenance paint, etc.	
		Buckets	
	Special tool	Special tool for overhaul and fabrication of pump and RO module.	
	Spare parts and reagent	For one year operation	1 set

10. Chemical for Operation and Maintenance

Item	Equipment Name	Specification	Q'ty
	Chemicals for one year operation and maintenance	Note: Not include chemicals (Sulfuric acid, sodium hypochlorite)	1 set
	Ferric chloride	34% conc. FeCl ₃ drum can	800 kg
	Sodium bisulfite	95% more conc. S.B.S. vinyl bag	2,400 kg
	Sodium hexametaphosphate	98% more conc. S.H.M.P. vinyl bag	200 kg
	Citric acid	98% citric acid vinyl bag	120 kg
	Ammonia	25% ammonia 20ℓ plastic bottle	60 ℓ
	Formaline	34% Formaldehyde 20 ℓ plastic bottle	100 kg
	Membrane treatment agent		1 set



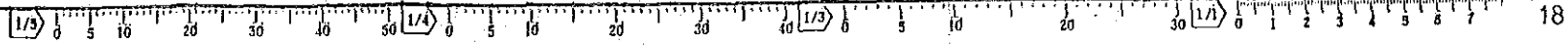
PROJECT: JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION

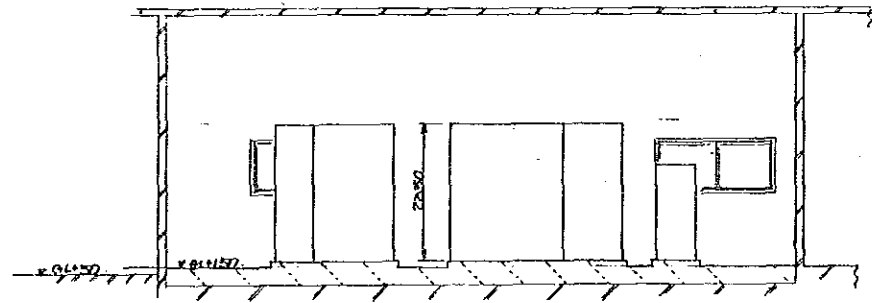
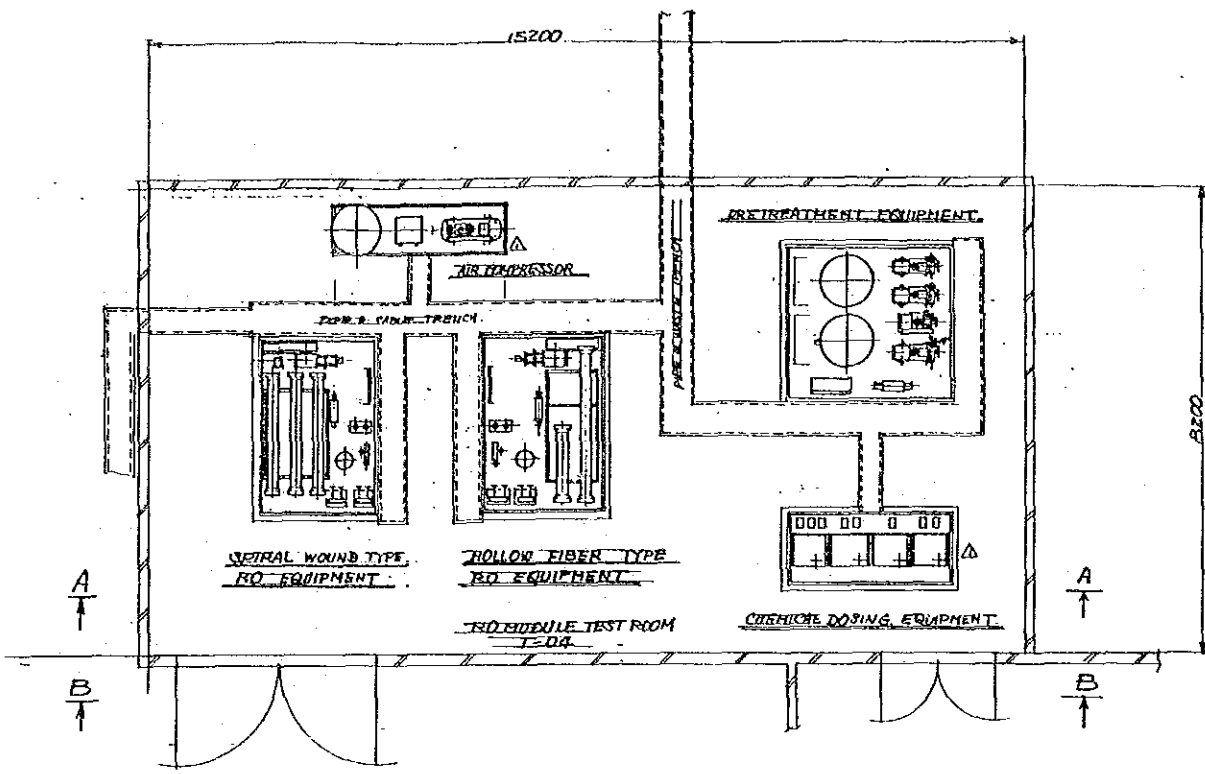
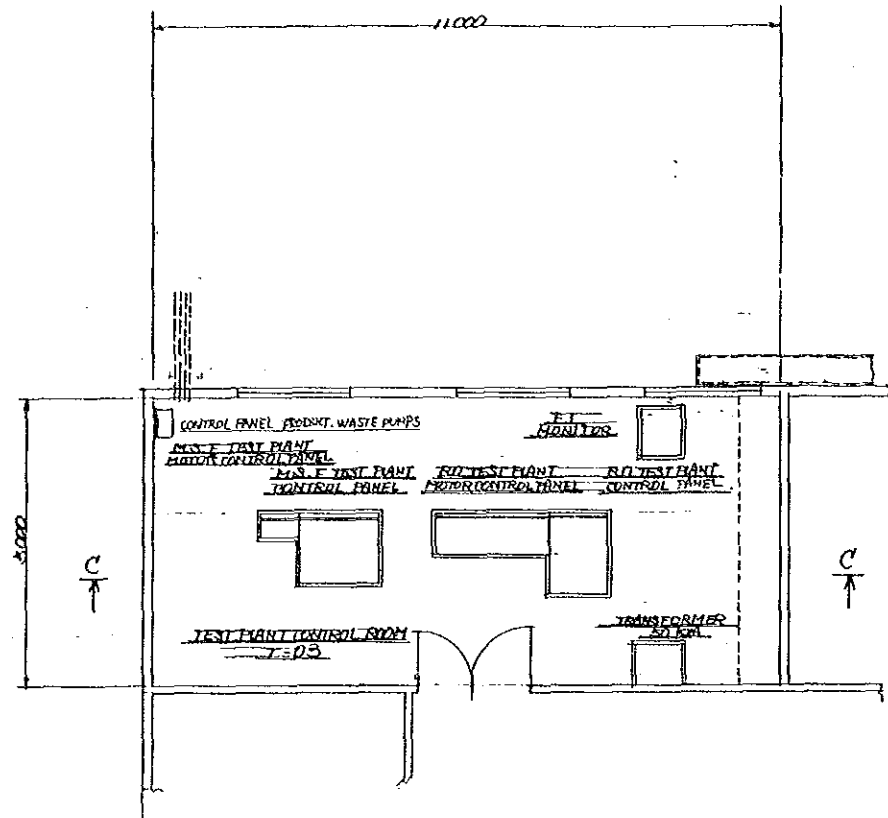
TITLE: PLOT PLAN OF M.S.F. AND RO TEST PLANTS

DATE: SEPT. 21 '87 SCALE: 1/60

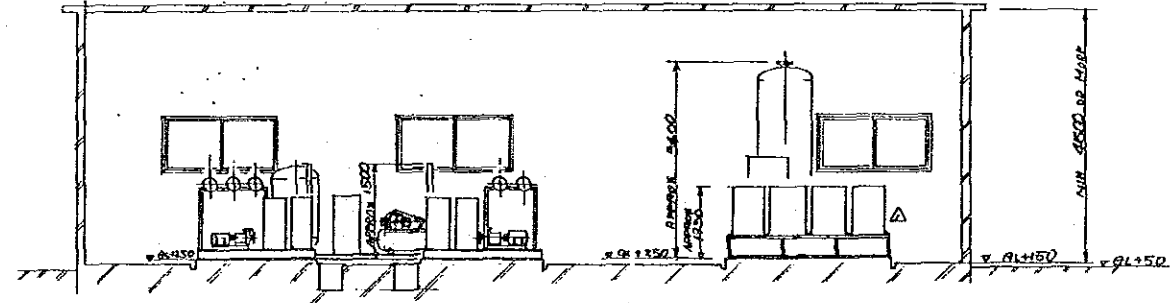
DRAWING NO.: SAU 304-R 4001

JAPAN INTERNATIONAL COOPERATION AGENCY

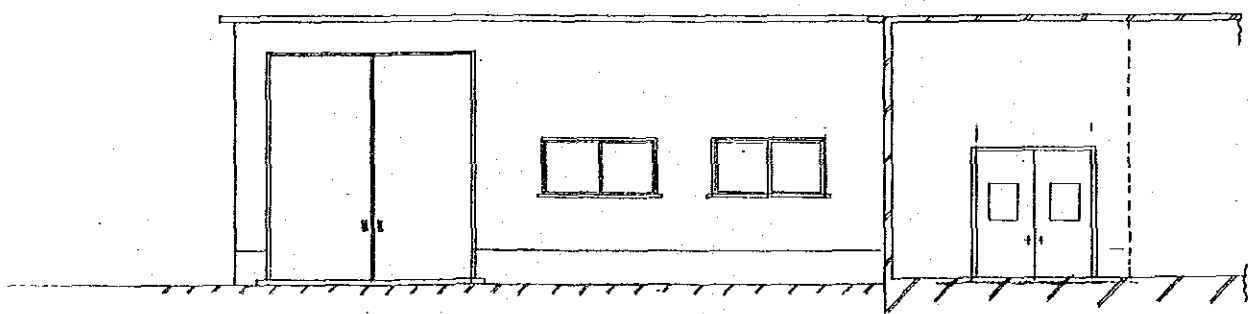




C-C VIEW



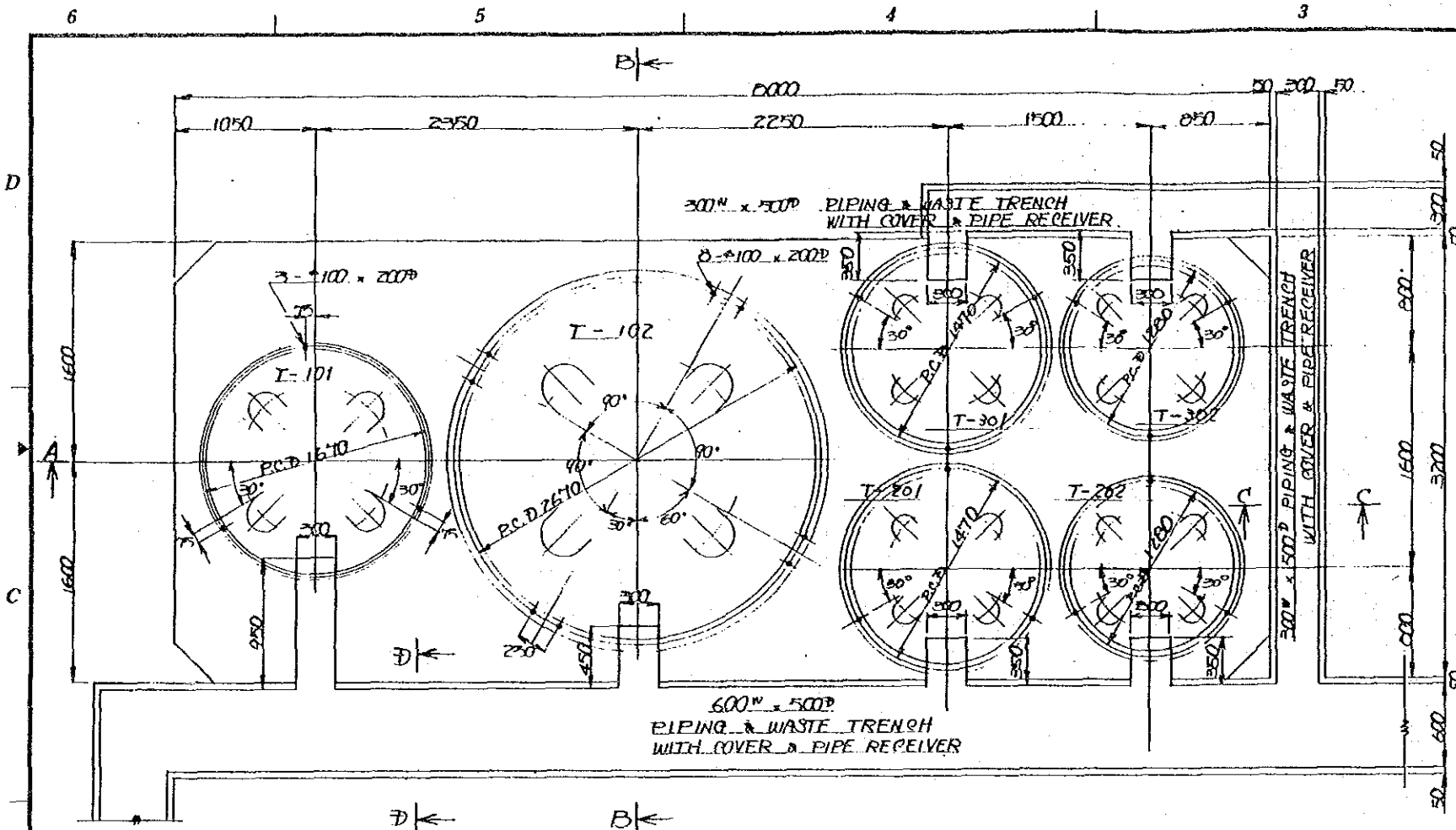
A-A VIEW



B-B VIEW

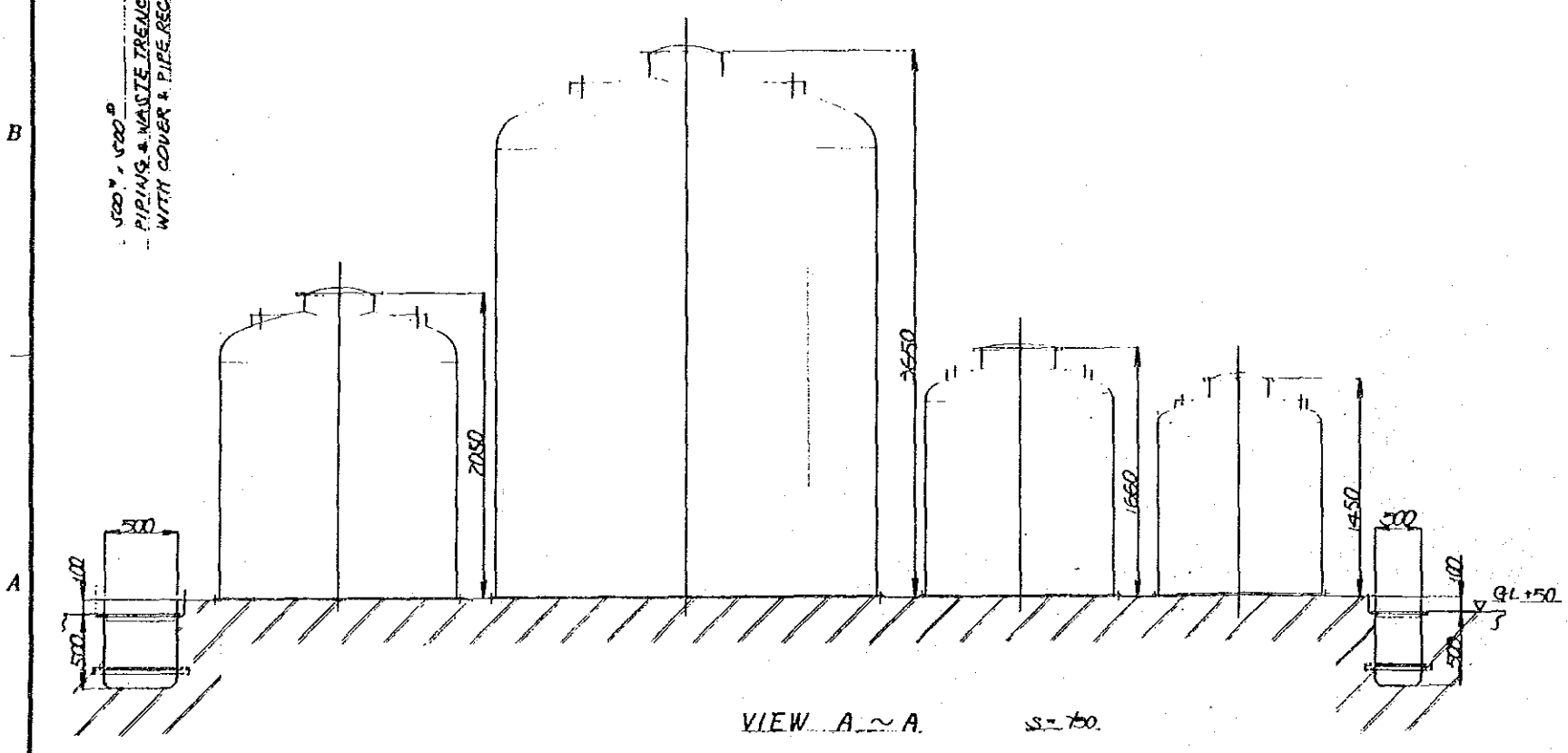
REVISOR: ON OCT. 3, 1984
 AUG. 5, 1987

PROJECT: JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION	
REVERSE OSMOSIS TEST PLANT	
TITLE: PLOT PLAN OF INDOOR AND SIDE VIEW	
DATE: SEPT. 27, '87	SCALE: 1/60
DRAWING NO.: SAJ 304-R-4003	
JAPAN INTERNATIONAL COOPERATION AGENCY	

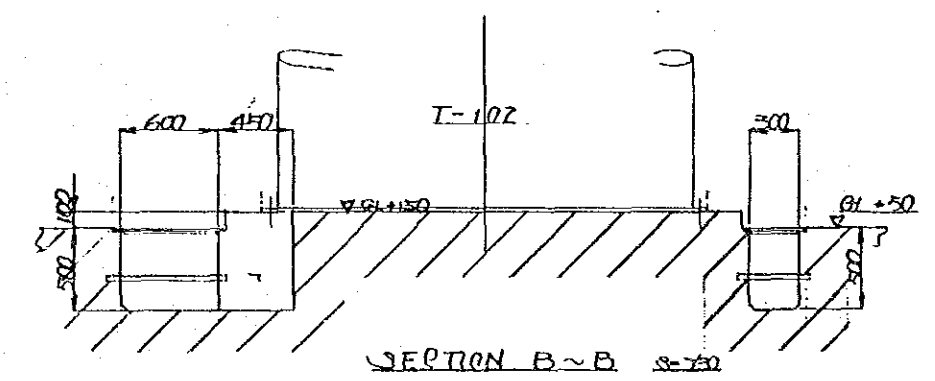


LOADING DATA OF TANKS.				
ITEM	TANK NAME	DIMENSION	WEIGHT AT EMPTY APPROX.	WEIGHT AT EMPTY APPROX. TONS
T-101	RAW SEA WATER TANK	1620 ^{mm} x 2050 ^{mm}	250 kg	3.34 TONS
T-102	FILTRATED SEA WATER TANK	2580 ^{mm} x 3050 ^{mm}	860	16.2
T-201	SW/RO FEED TANK	1276 ^{mm} x 1660 ^{mm}	70	1.62
T-301	HF/RO FEED TANK	1276 ^{mm} x 1660 ^{mm}	70	1.62
T-202	SW/RO PRODUCT TANK	1108 ^{mm} x 1450 ^{mm}	50	1.05
T-302	HF/RO PRODUCT TANK	1108 ^{mm} x 1450 ^{mm}	50	1.05

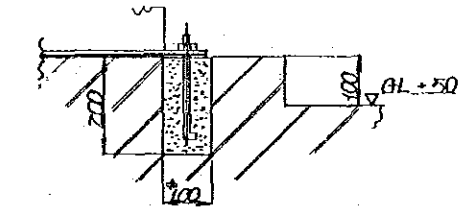
FOUNDATION OF TANKS S=750



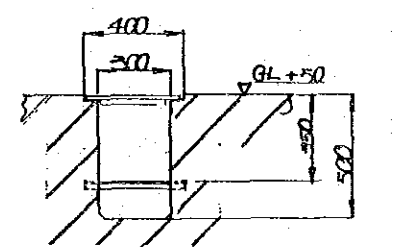
VIEW A-A S=750



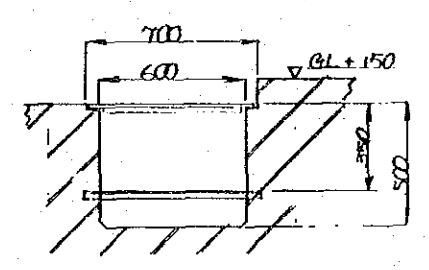
SECTION B-B S=750



DETAIL OF ANCHORE HOLE S=750



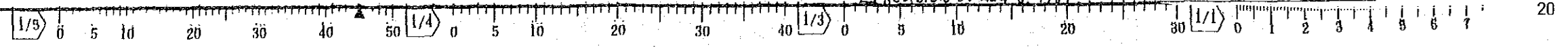
SECTION C-C S=750



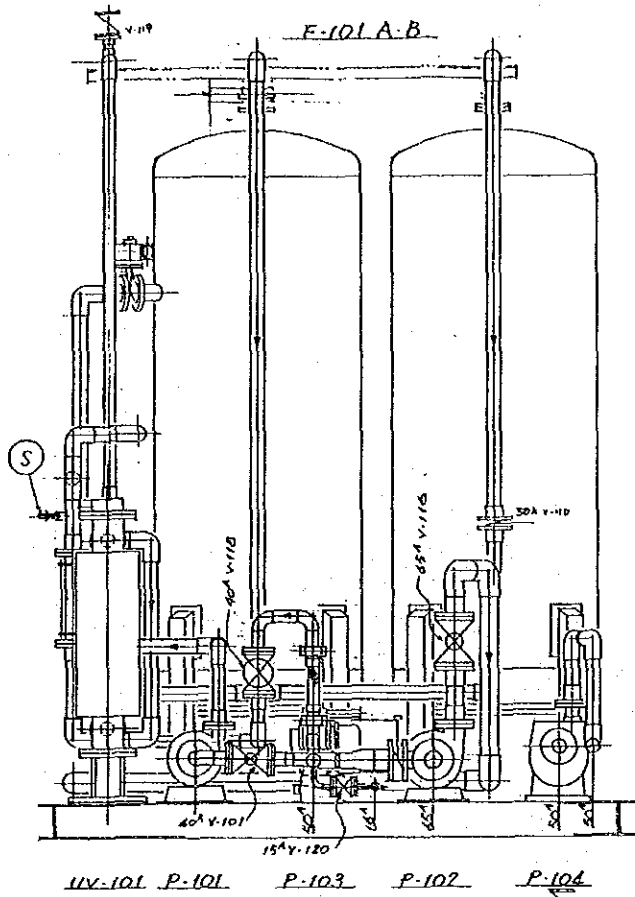
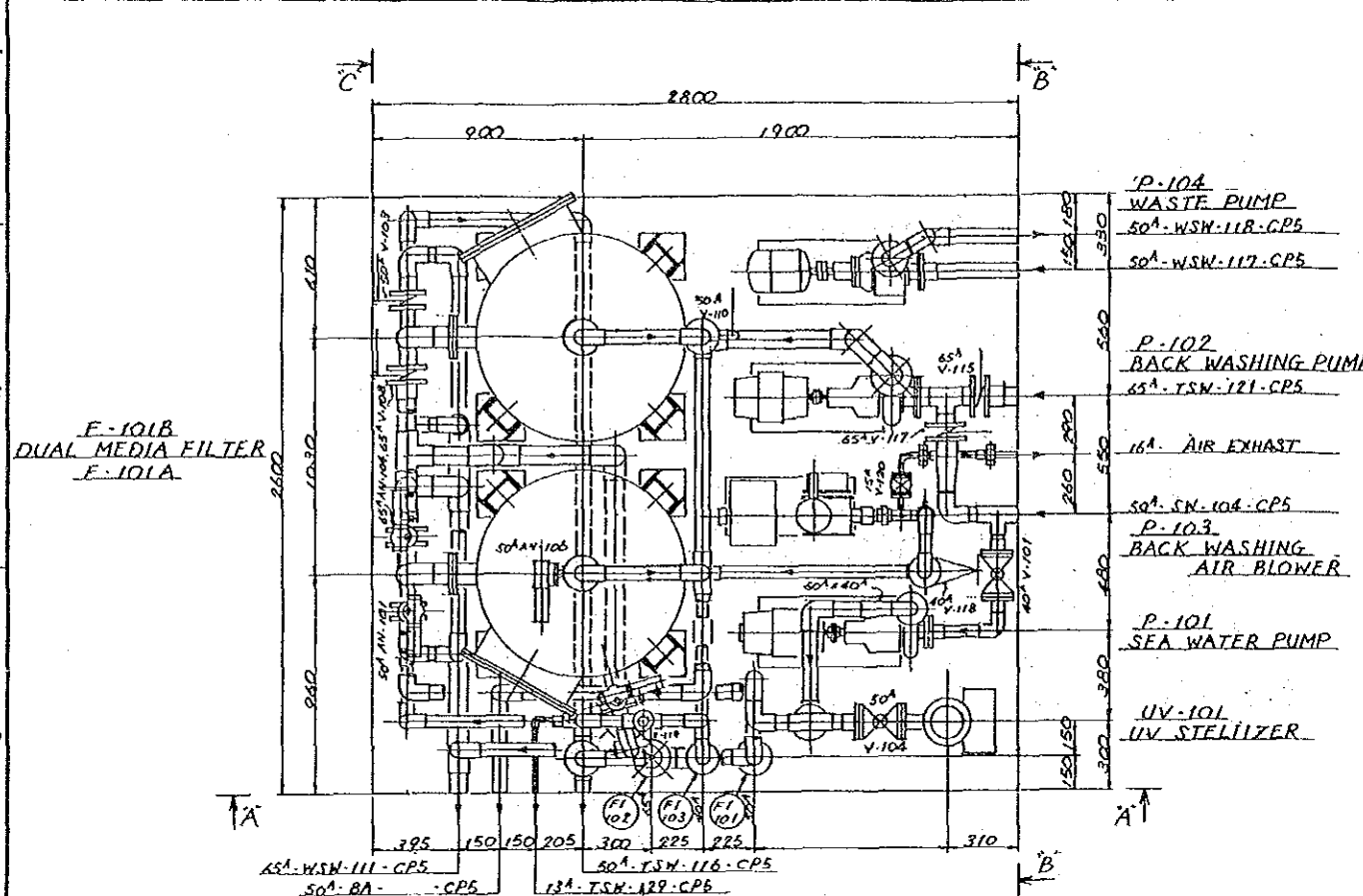
SECTION D-D S=750

PROJECT:	JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION
TITLE:	REVERSE OSMOSIS TEST PLANT ARRANGEMENT OF TANKS (FOUNDATION)
DATE:	SEPT. 22. '87
SCALE:	1/50, 1/100, 1/200
DRAWING NO.:	SAJ 304-R 4007
JAPAN INTERNATIONAL COOPERATION AGENCY	

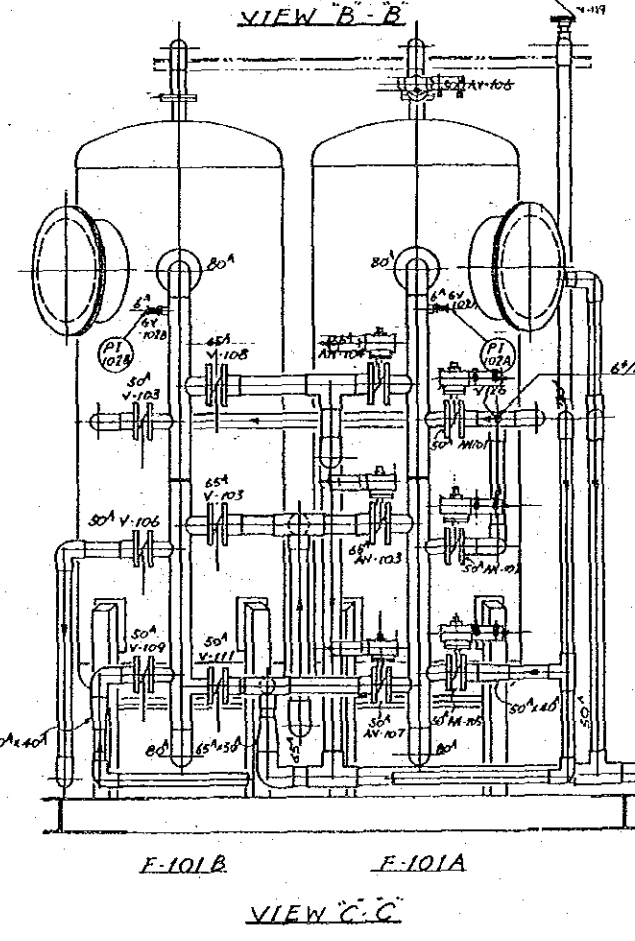
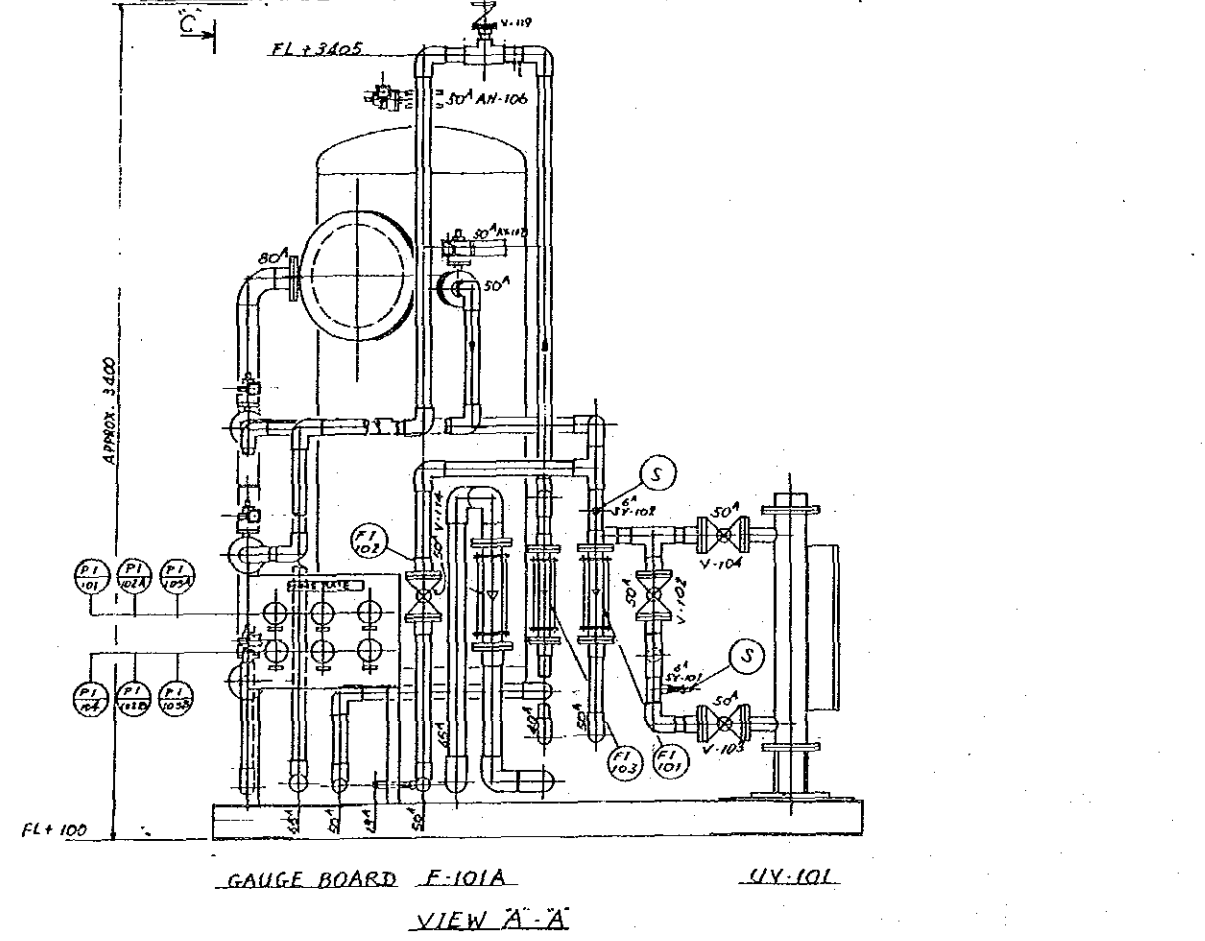
REVISION ON AUG 6 1987



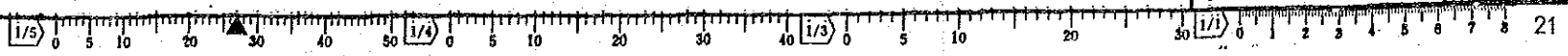
No.	REVISIONS	BY	CHKD	APPRD	DATE
1					9/27/87



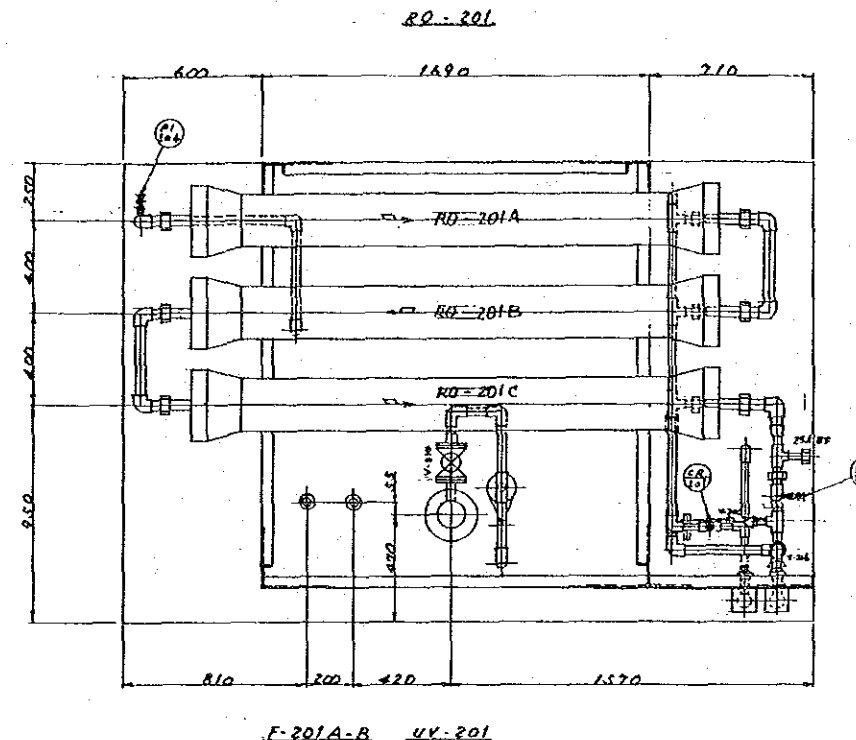
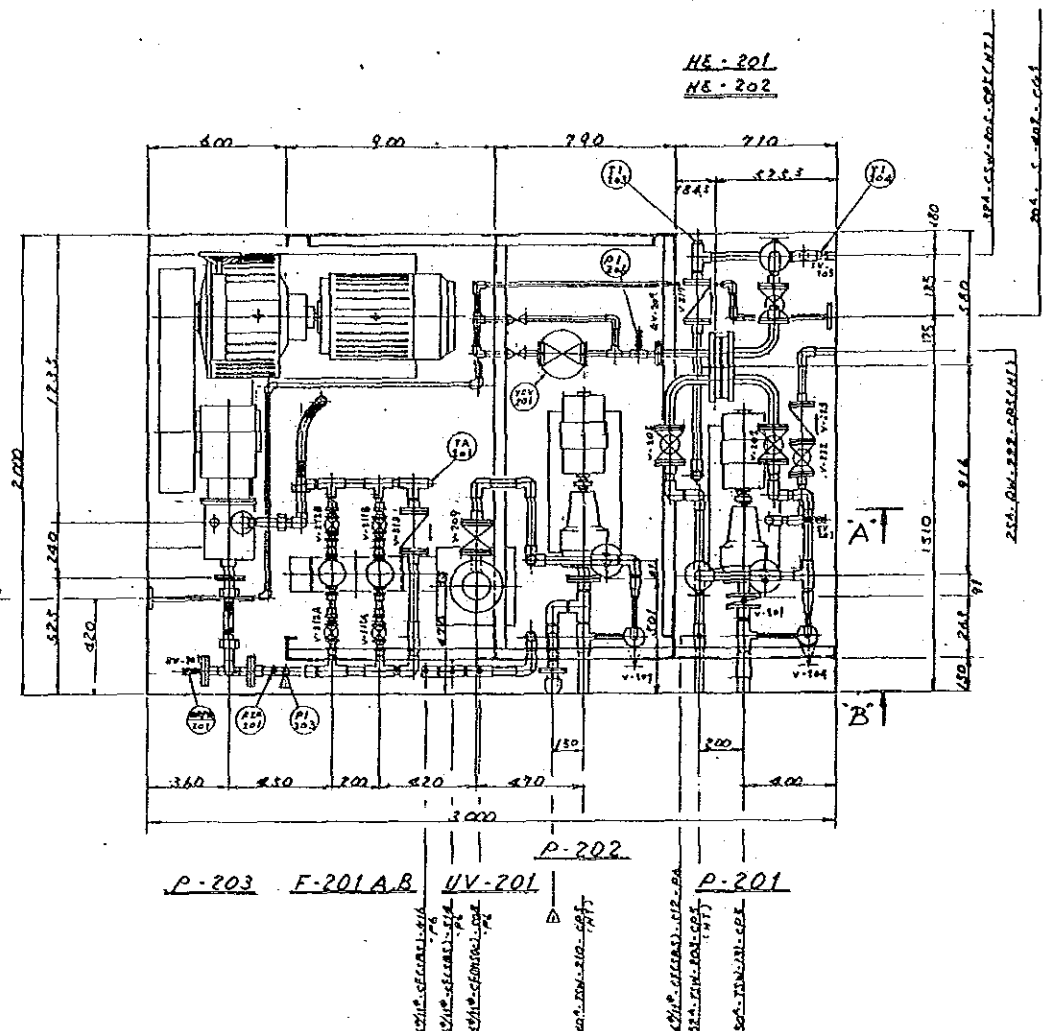
PARTICULARS	
TREATED SEA WATER CAPACITY	168 M ³ /DAY
FOULING INDEX (CETIS)	LESS THAN 4.0
STERILIZATION	CHLORINATION WITH F ₂ O ₂ OR ULTRA VIOLET RAY
COAGULATION	LINE COAGULATION WITH F ₂ O ₂
FILTRATION	TWO EQUAL MEDIA FILTERS SERIAL ARRAY
FILTERS	F-101 A, B 900" x 2800" 2 SETS
SEAWATER PUMP	P-101 3.7" 1 SET
BACK WASHING PUMP	P-102 2.2" 1 SET
BACK WASHING AIR BLOWER	P-103 1.5" 1 SET
WASTE PUMP	P-104 1.5" 1 SET
ULTRA VIOLET RAY STERILIZER	UV-101
EQUIPMENT OXID DIMENSION 2800" x 1600" x 3400"	
WEIGHT OPERATION APPROX. 6.7 TONS	



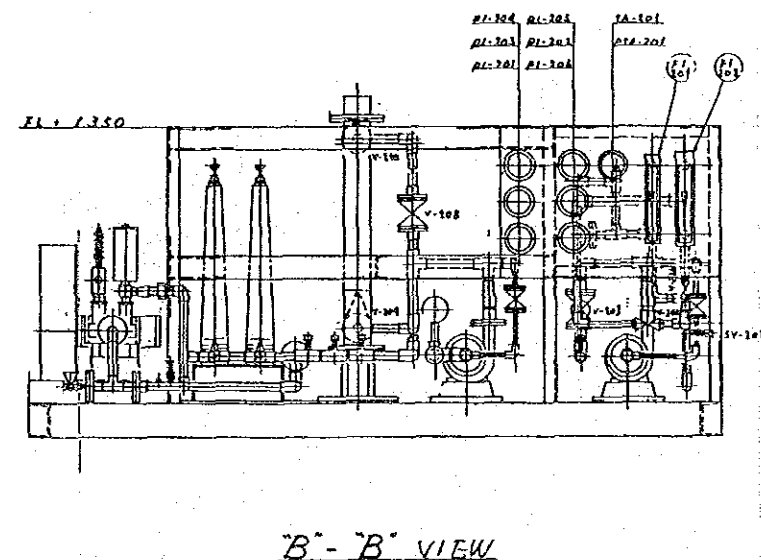
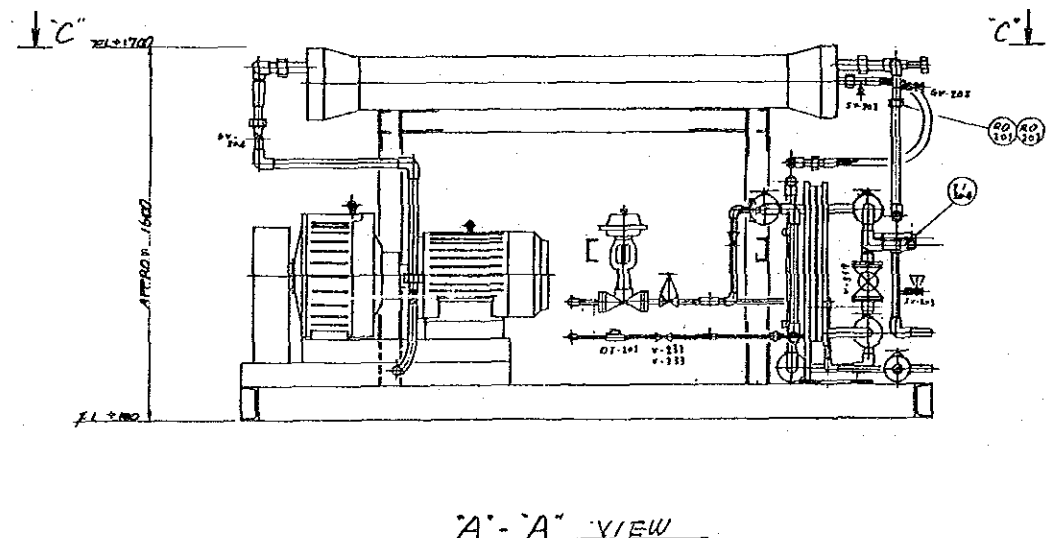
PROJECT:	JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION
TITLE:	REVERSE OSMOSIS TEST PLANT PRETREATMENT EQUIPMENT SKID ASSEMBLY SECTION-100
DATE:	SEPT 27 '87
DRAWING NO.:	SAJ 304-R4101
JAPAN INTERNATIONAL COOPERATION AGENCY	



No.	REVISIONS	BY	CHKD	APRD	DATE
1					1/1/85

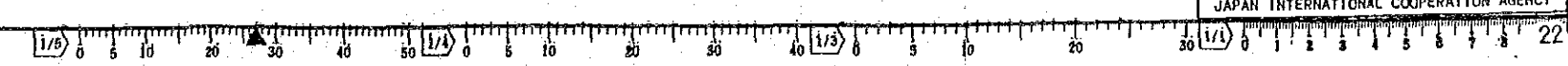


PARTICULARS	
PRODUCT CAPACITY	20 m ³ /DAY
PRODUCT SALINITY	LESS THAN 500 PPM TDS
OPERATION CONDITION	
APPLIED PRESSURE	55-70 PSI/CM ²
FEED TEMPERATURE	25-30 °C
RECOVERY RATIO	25-30 %
RO MODULE	SERIAL WOUND 8" DIA. ELEMENT (TYPICAL UP-120) MOUNTED 2 ELEMENT X 3 VESSEL
DECHLORINATION	WITH NaHSO ₃ (SBS)
STERILIZATION	ULTRA VIOLET RAY SHOCK TREATMENT WITH NaHSO ₃
FEED HEATING	WITH HEAT EXCHANGER WITH STEAM
RO MODULE	RO-201A, B, C 2200' 3 SETS
STERILIZER	UV 201 1 SET
HEATER	HE-201, 202 PLATE TYPE 1 SET
SAFETY FRIER	F-201, A, B CARTRIDGE TYPE 2 SETS
FEED PUMP	P-201 7.7 HP 1 SET
BOOSTER PUMP	P-202 3.7 HP 1 SET
HIGH PRESSURE PUMP	P-203 15 HP 1 SET
EQUIPMENT SKID DIMENSION	3000 x 2000 x 1600 mm APPROX
WEIGHT OPERATION	APPROX 2.5 TONS

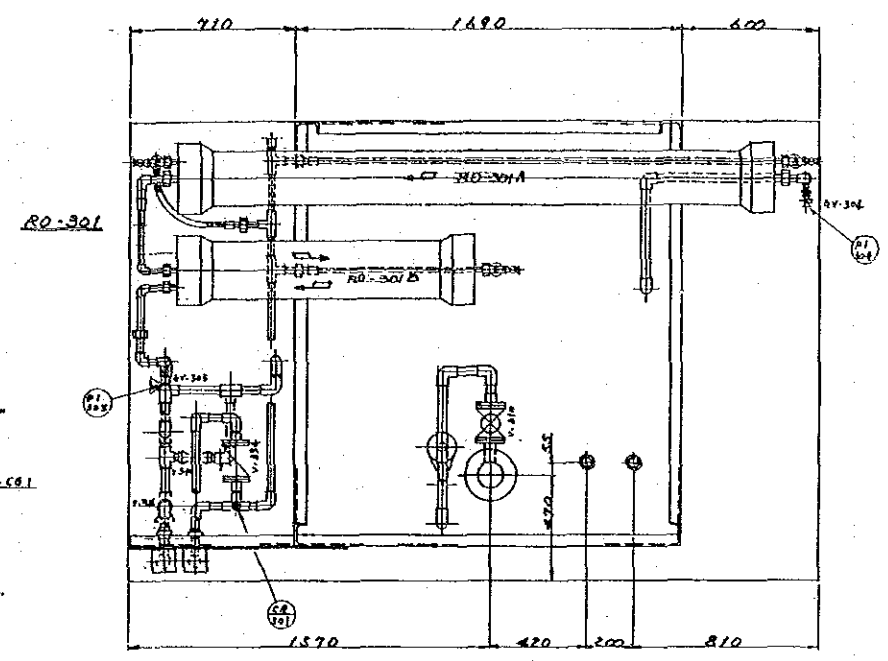
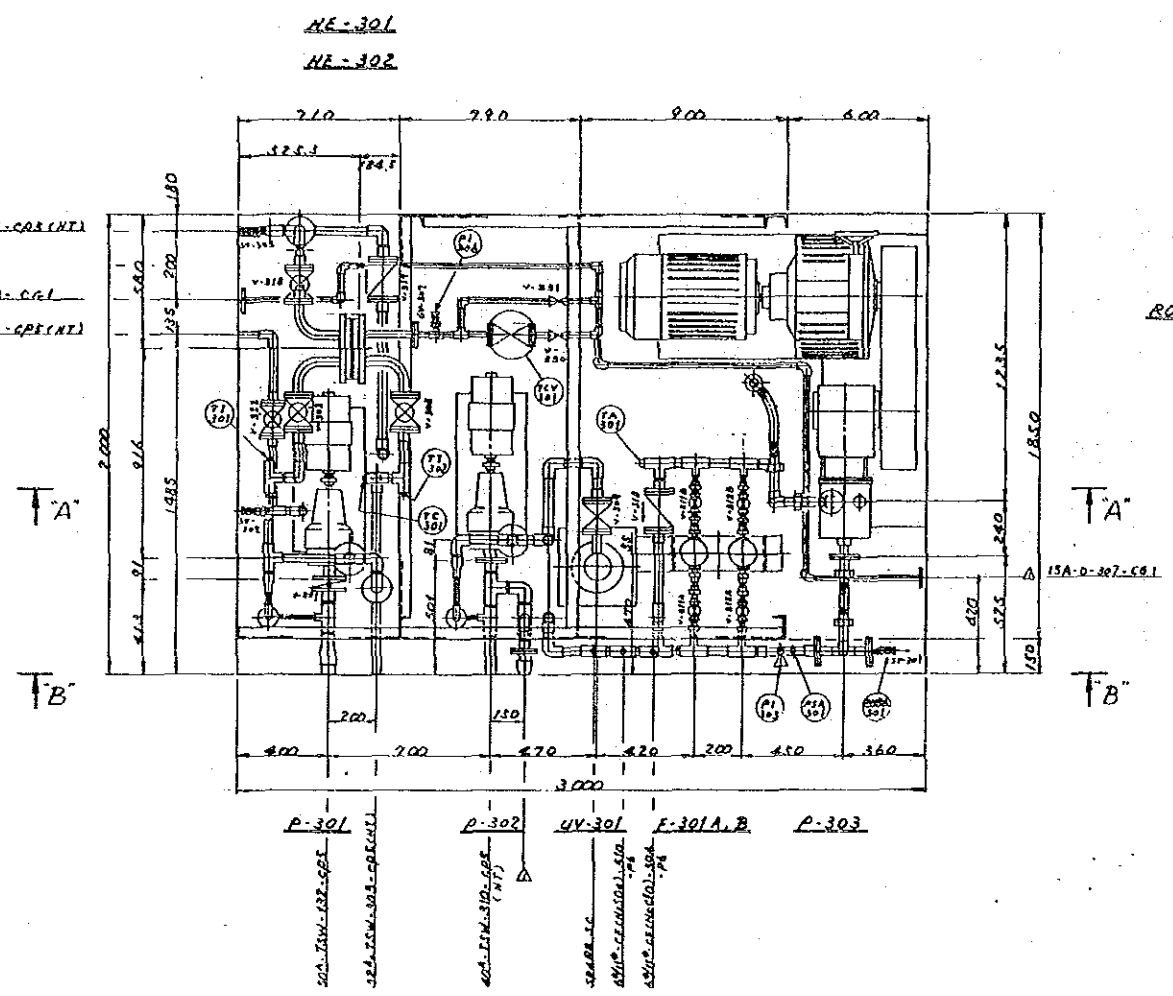


REVISOR ON JAN. 20 1985

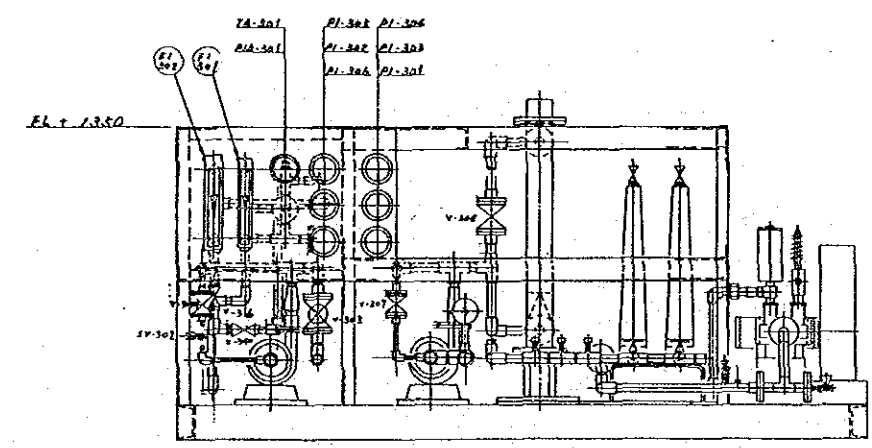
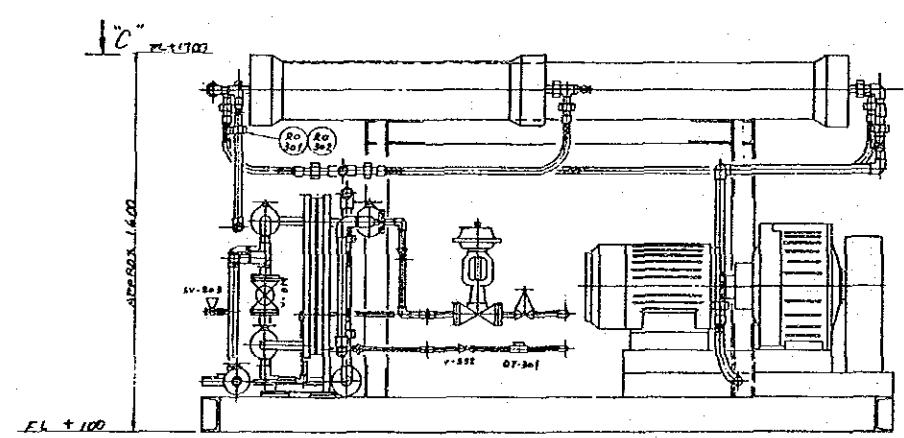
PROJECT:	JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION
TITLE:	REVERSE OSMOSIS TEST PLANT SKID ASSEMBLY SECTION-200
DATE:	SEPT 22 '87
SCALE:	1/5
DRAWING NO.:	SAJ 304-R 411
JAPAN INTERNATIONAL COOPERATION AGENCY	



NO.	REVISIONS	BY	CHKD	APRD	DATE
A					12-87

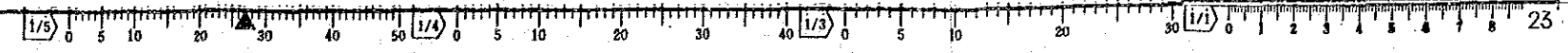


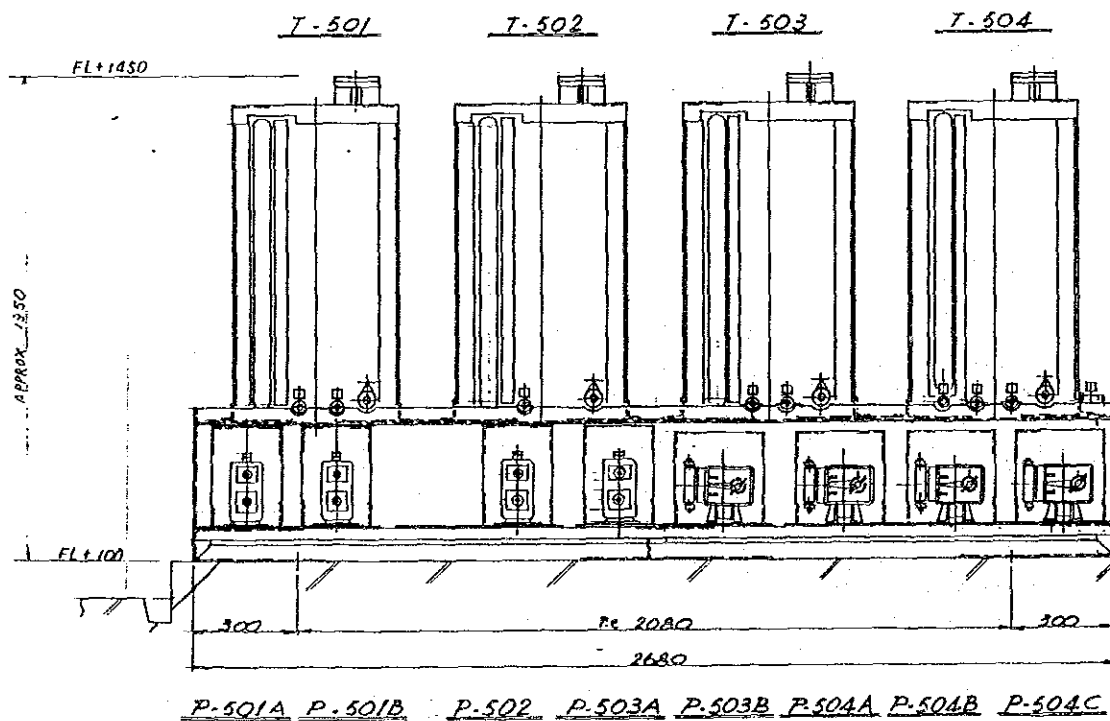
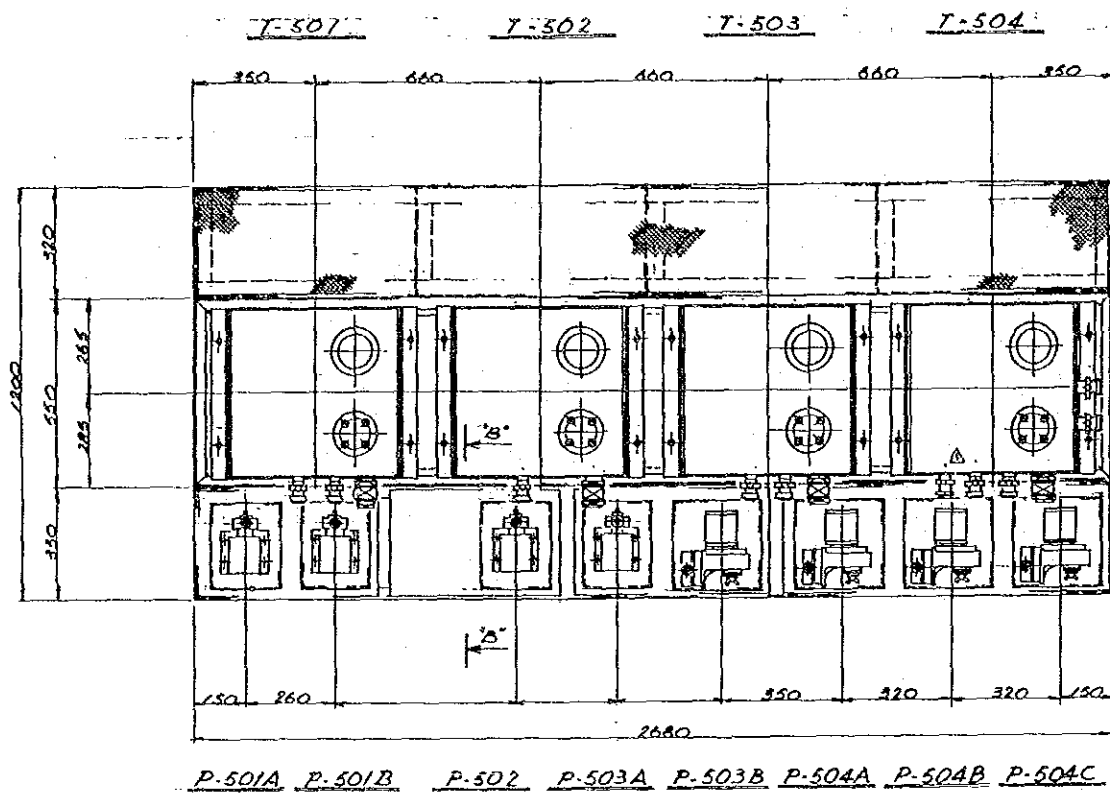
PARTICULARS	
PRODUCT CAPACITY	20 TPD
PRODUCT SALINITY	LESS THAN 500 PPM TDS
OPERATION CONDITION	
APPLIED PRESSURE	36.285 MPa
FEED TEMPERATURE	27.230 °C
RECOVERY RATIO	25.240 %
RO MODULE	HOLLOW FIBER (TOKYO JINBUSHI, HR0255 F)
PH ADJUSTING	WITH H-304
STERILIZATION	ULTRA VIOLET RAY OR CHLORINATION WITH NaClO
FEED HEATING	WITH HEAT EXCHANGER BY STEAM
RO MODULE	RO-301A,B 0.81x1.200 1 SET 0.81x1.200 1 SET
STERILIZER	UV-301 1 SET
HEATER	HE-301, 20L PLATE TYPE 1 SET
SAFETY FILTER	F-301A,B 0.81x1.200 2 SETS
FEED PUMP	P-301 2.2 KW 1 SET
BOOSTER PUMP	P-302 5.7 KW 1 SET
HIGH PRESSURE PUMP	P-303 15 KW 1 SET
EQUIPMENT SKID DIMENSION 5000 x 2000 x 1800	
WEIGHT OPERATION APPROX. 2.5 TONS	



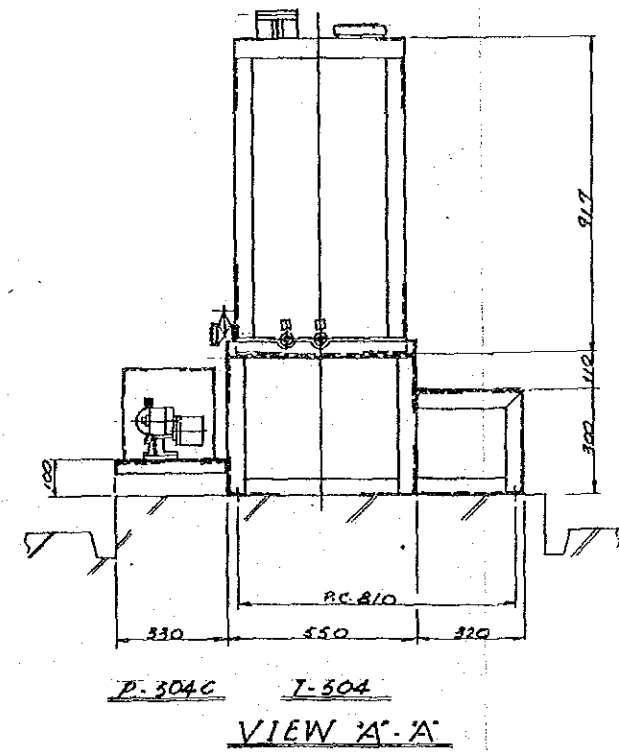
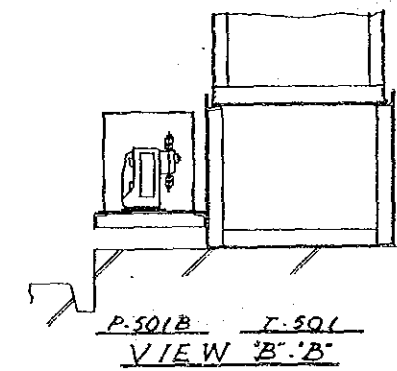
REVISOR: [Signature]
DATE: 12-87
REVISED ON JAN. 20 1985

PROJECT:	JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION
TITLE:	REVERSE OSMOSIS TEST PLANT HOLLOW FIBER TYPE RO EQUIPMENT SKID ASSEMBLY SECTION-300
DATE:	SEPT. 22, 87
SCALE:	1/5
DRAWING NO.:	SAJ 304-R4112
JAPAN INTERNATIONAL COOPERATION AGENCY	





ITEM NO.	NAME	SPECIFICATION	REMARK
T-501	SODIUM HYPOCHLORIDE (NCS) TANK	CAPACITY 200 LIT MATERIAL PVC	MINION FEEDER #B-05 DWG. NO. T-24400
T-502	FERRIC CHLORIDE TANK (FeCl ₃)	CAPACITY 200 LIT MATERIAL PVC	T-24402
T-503	SULFURIC ACID TANK (H ₂ SO ₄)	CAPACITY 200 LIT MATERIAL PVC	T-24400
T-504	SODIUM BISULFATE (NAHSO ₃) TANK	CAPACITY 200 LIT MATERIAL PVC	T-24401
P-501A	NaClO DOSING PUMP	TYPE PD-31P CAPACITY 30% @ 11.7 M ³ /H	PA-303460
P-501B	NaClO DOSING PUMP	TYPE PD-11P CAPACITY 10% @ 11.7 M ³ /H	PA-303459
P-502	FeCl ₃ DOSING PUMP	TYPE PD-31P CAPACITY 30% @ 11.7 M ³ /H	PA-303460
P-503A	H ₂ SO ₄ DOSING PUMP	TYPE PD-11P CAPACITY 10% @ 11.7 M ³ /H	PA-303459
P-503B	H ₂ SO ₄ DOSING PUMP	TYPE CSD-31P CAPACITY 30% @ 11.7 M ³ /H	T-
P-504A	JSB (NO.1 STAGE) DOSING PUMP	TYPE CSD-31P CAPACITY 30% @ 11.7 M ³ /H	T-
P-504B	JSB (NO.2 STAGE) DOSING PUMP	TYPE CSD-31P CAPACITY 30% @ 11.7 M ³ /H	T-
P-504C	JSB (SHOCKING, ETC.) DOSING PUMP	TYPE CSD-22 CAPACITY 30% @ 11.7 M ³ /H	T-11506
EQUIPMENT SKID SIZE		2680" x 1200" x APPROX 1350"	
OPERATION WEIGHT		APPROX 1.5 TONS	



PROJECT: JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION

REVERSE OSMOSIS TEST PLANT

TITLE: CHEMICAL FEEDER SKID ASSEMBLY

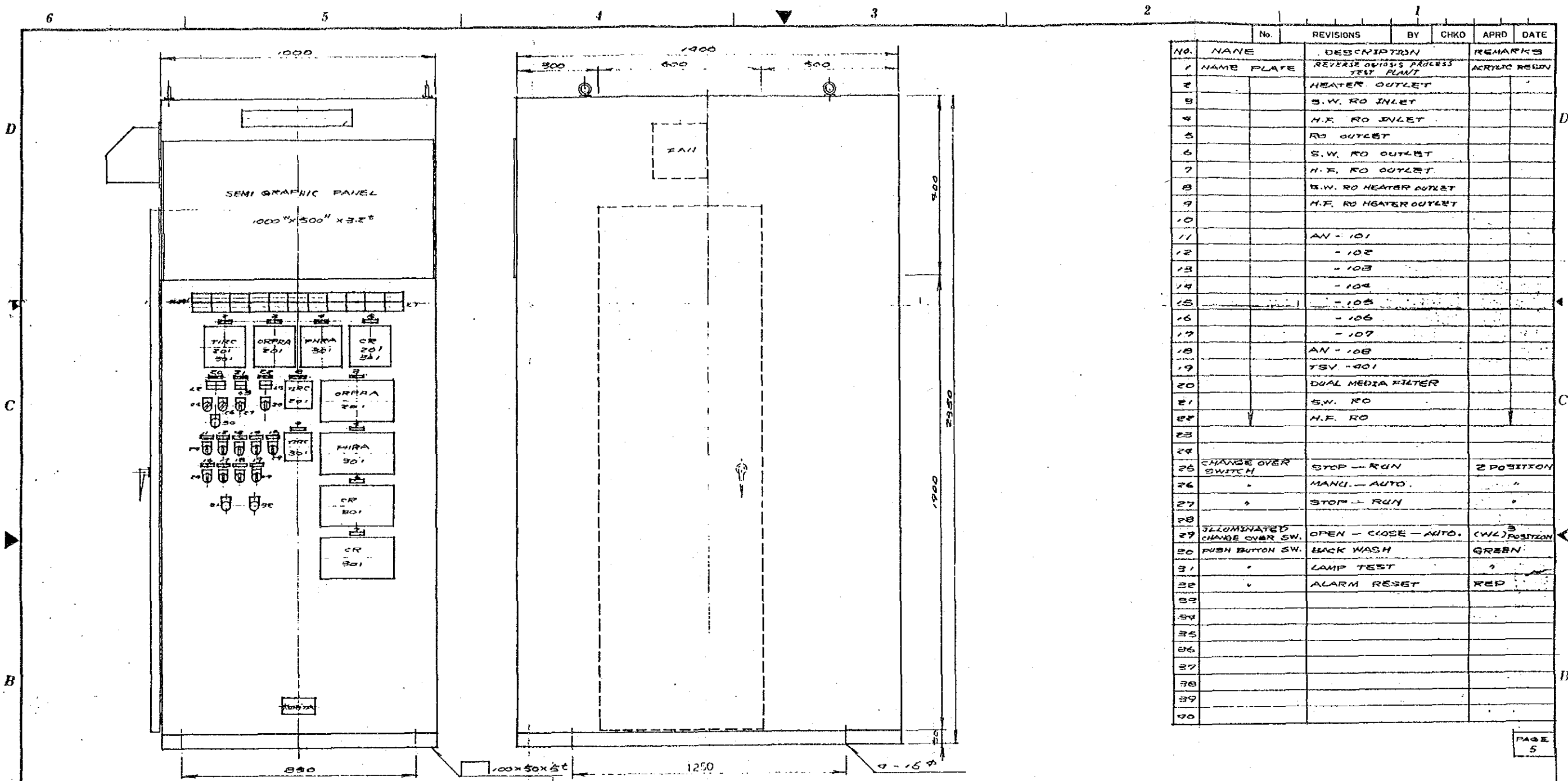
SECTION- 500

DATE: SEPT 22 '87 SCALE: 1/10

DRAWING NO.: SAJ 304-R 4131

JAPAN INTERNATIONAL COOPERATION AGENCY

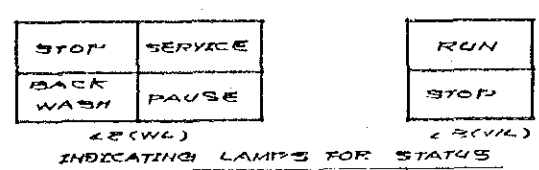
REVISED ON JAN. 20 1985



No.	NAME	DESCRIPTION	REMARKS
1	NAME PLATE	REVERSE OSMOSIS PROCESS TEST PLANT	ACRYLIC RESIN
2		HEATER OUTLET	
3		S.W. RO INLET	
4		H.F. RO INLET	
5		RO OUTLET	
6		S.W. RO OUTLET	
7		H.F. RO OUTLET	
8		S.W. RO HEATER OUTLET	
9		H.F. RO HEATER OUTLET	
10			
11		AV - 101	
12		- 102	
13		- 103	
14		- 104	
15		- 105	
16		- 106	
17		- 107	
18		AV - 108	
19		TSV - 401	
20		DUAL MEDIA FILTER	
21		S.W. RO	
22		H.F. RO	
23			
24			
25	CHANGE OVER SWITCH	STOP - RUN	2 POSITION
26		MANU. - AUTO.	
27		STOP - RUN	
28			
29	ILLUMINATED CHANGE OVER SW.	OPEN - CLOSE - AUTO.	(CWL) POSITION
30	PUSH BUTTON SW.	BACK WASH	GREEN
31		LAMP TEST	
32		ALARM RESET	RED
33			
34			
35			
36			
37			
38			
39			
40			

PAGE 5

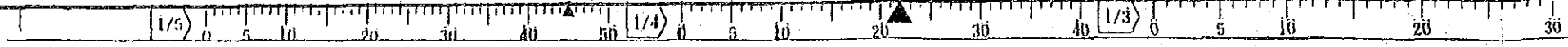
EARTH LEAKAGE	FILTER MOTOR TRIP	H.F. RO MOTOR TRIP	SEAWATER TANK LEVEL HIGH	TREATED SEA-WATER TANK LEVEL HIGH	S.W. RO FEED TANK LEVEL HIGH	H.F. RO FEED TANK LEVEL HIGH	S.W. RO FEED TEMP. HIGH	H.F. RO FEED PRESSURE LOW	S.W. RO ORP HIGH	(SPARE)
INSTRUMENT AIR PRESSURE LOW	S.W. RO MOTOR TRIP	UTILITY MOTOR TRIP	SEAWATER TANK LEVEL LOW	TREATED SEA-WATER TANK LEVEL LOW	S.W. RO FEED TANK LEVEL LOW	H.F. RO FEED TANK LEVEL LOW	H.F. RO FEED TEMP. HIGH	H.F. RO FEED PRESSURE HIGH	H.F. RO PH HIGH	(SPARE)

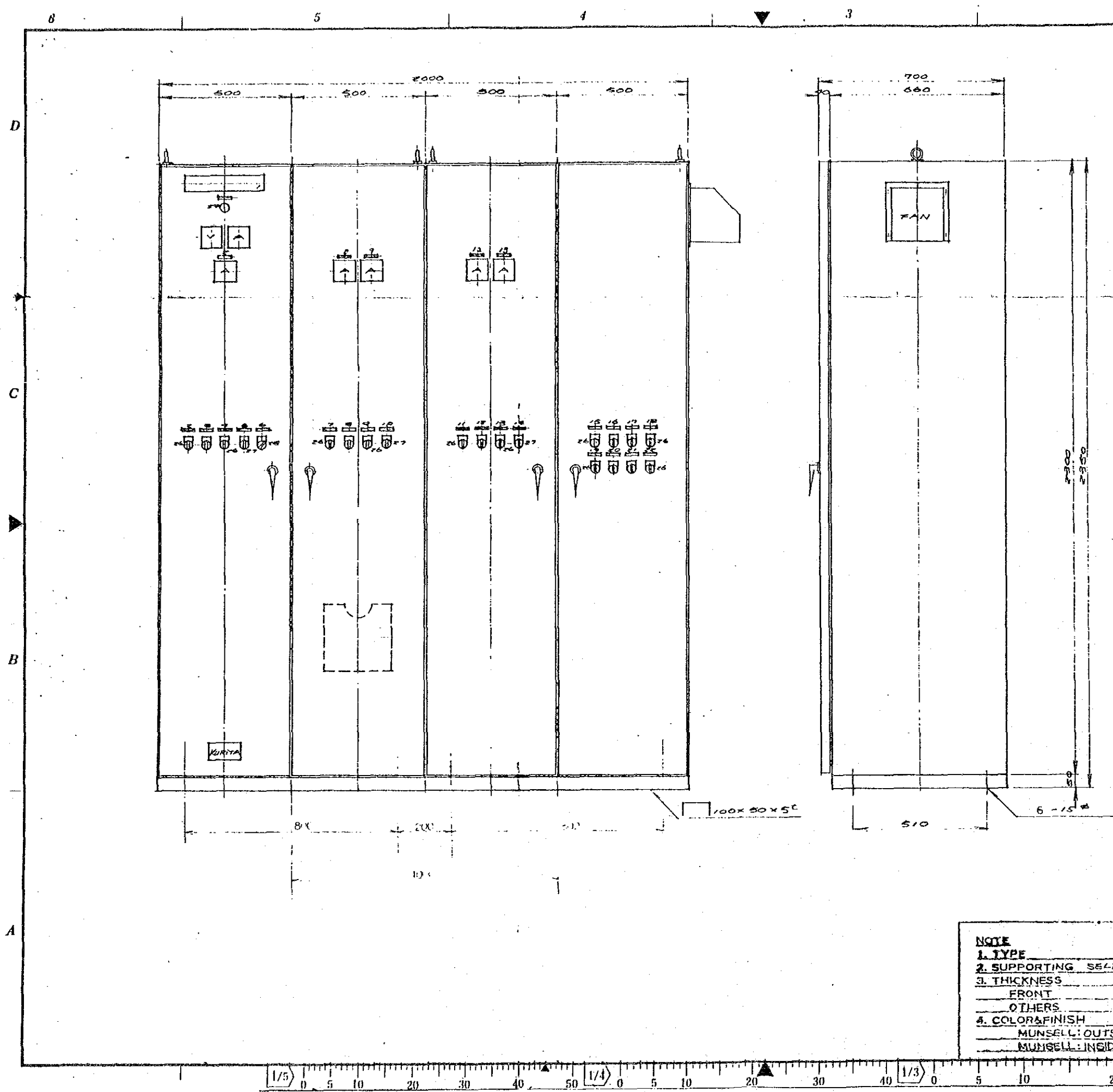


(CWL) INDICATING LAMPS FOR ALARM

NOTE
 1. TYPE 1/4 DECK
 2. SUPPORTING SELF STANDING
 3. THICKNESS
 FRONT 3.2
 OTHERS 2.3
 4. COLOR & FINISH
 MUNSELL: OUTSIDE 4Y 7/1
 MUNSELL: INSIDE

PROJECT: JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION
 TITLE: REVERSE OSMOSIS TEST PLANT CONTROL PANEL
 DATE: SEPT. 22 '87 SCALE: 1/10
 DRAWING NO.: SAJ 304-RE131 (1/1)
 JAPAN INTERNATIONAL COOPERATION AGENCY

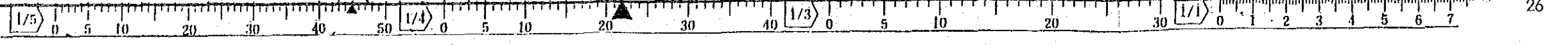




No.	REVISIONS	BY	CHKD	APRD	DATE
1	NAME PLATE	MOTOR CONTROL PANEL	ACRYLIC RESIN		
2		SEAWATER PUMP			
3		BACK WASHING PUMP			
4		BACK WASHING AIR BLOWER			
5		UV STERILIZER			
6		WASTE PUMP			
7		S.W. RO FEED PUMP			
8		S.W. RO BOOSTER PUMP			
9		S.W. RO HIGH PRESSURE PUMP			
10		S.W. RO UV STERILIZER			
11		H.F. RO FEED PUMP			
12		H.F. RO BOOSTER PUMP			
13		H.F. RO HIGH PRESSURE PUMP			
14		H.F. RO UV STERILIZER			
15		CHLORINE DOSING PUMP - A			
16		" - B			
17		COAGULANT DOSING PUMP			
18		ACID DOSING PUMP - A			
19		" - B			
20		DEOXYDANT DOSING PUMP			
21		" - B			
22		" - C			
23					
24					
25					
26	ILLUMINATED CHANGE OVER S.W.	RUN - STOP - AUTO.	RED POSITION		
27	DO	ON - OFF - AUTO.	DO		
28	DO	STOP - RUN	DO POSITION		
29	INDICATING LAMP		W.L.		
30					
31					
32					
33					
34					
35					

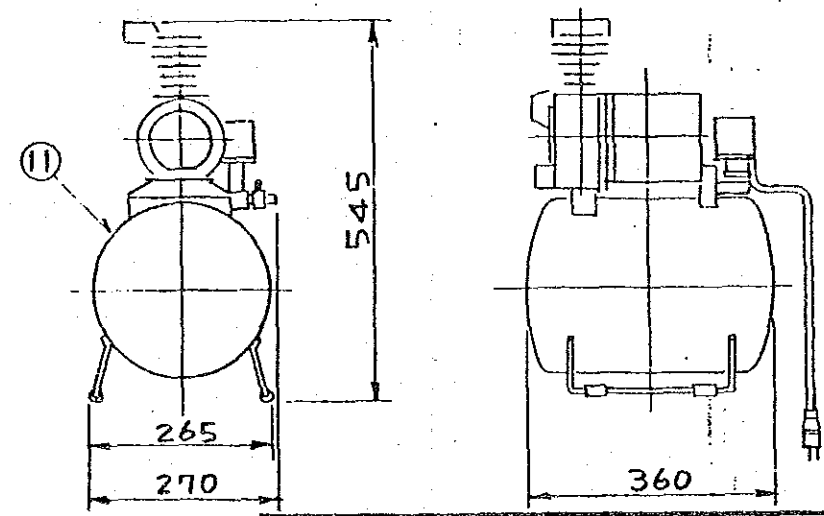
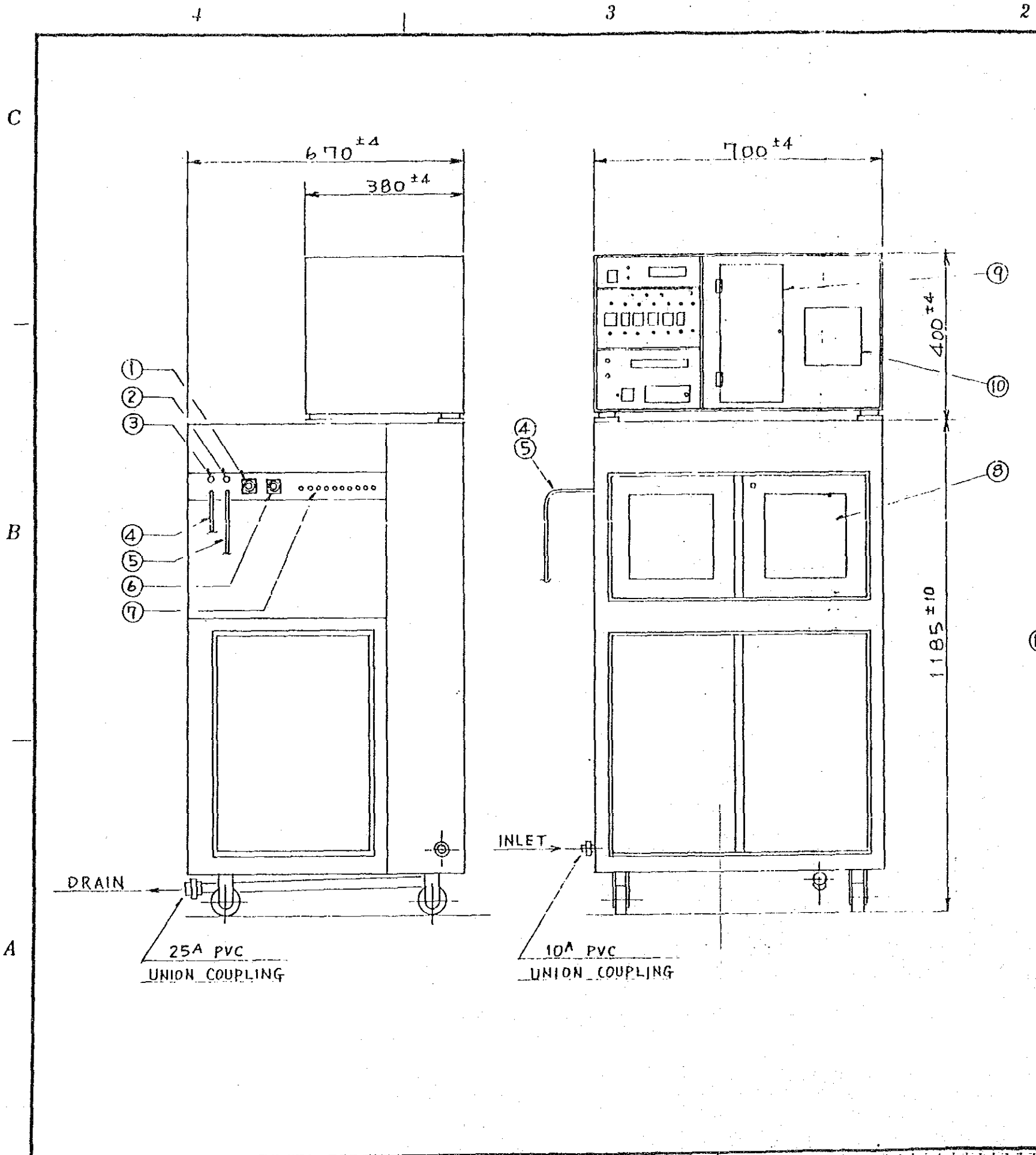
NOTE
 1. TYPE IN DOOR
 2. SUPPORTING SELF STANDING
 3. THICKNESS
 FRONT 3.2C
 OTHERS 2.2C
 4. COLOR & FINISH
 MUNSELL: OUTSIDE 5Y 7/1
 MUNSELL: INSIDE "

PROJECT: JAPAN-SAUDI ARABIA RESEARCH
 PROJECT OF SEA WATER DESALINATION
 TITLE: REVERSE OSMOSIS TEST PLANT
 MOTOR CONTROL PANEL
 DATE: SEPT. 22, '87 SCALE: 1/10
 DRAWING NO.: SAJ 304-RE/31 (3/2)
 JAPAN INTERNATIONAL COOPERATION AGENCY



MARK	REVISIONS	DATE	DES	BY	APPROBY

NO	NAME
1	CONNECTOR FOR SEQUENCER
2	FUSE FOR AIR COMPRESSOR
3	MAIN FUSE
4	POWER CABLE 3M
5	AIR COMPRESSOR CABLE 3M
6	POWER CONNECTOR FOR SEQUENCER
7	PILOT LAMP FOR SOLENOID VALVE
8	FILTER SECTION
9	PRINTER SECTION
10	SPARE SPACE
11	AIR COMPRESSOR



PROJECT: JAPAN-SAUDI ARABIA RESEARCH PROJECT OF SEA WATER DESALINATION

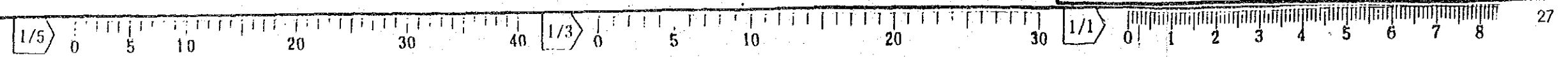
REVERSE OSMOSIS TEST PLANT

TITLE: KURITA'S FOULING INDEX MONITOR ASSEMBLY

DATE: SEPT. 22 '87 SCALE: 1/10

DRAWING NO. : SAJ 304-RKED 0016

JAPAN INTERNATIONAL COOPERATION AGENCY



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CIVIL AND BUILDING WORKS
FOR
TEST PLANT

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TABLE OF CONTENTS

<u>CHAPTER</u>	<u>TITLE</u>	<u>PAGE</u>
1.	GENERAL	1
	1.1 Scope	1
	1.2 Codes and Standards	1
2.	EARTH WORK	2
	2.1 Excavation	2
	2.2 Backfilling	3
	2.3 Disposal of Soil	3
	2.4 Crush Stone	3
	2.5 Soil Bearing Capacity	3
3.	CONCRETE WORK	4
	3.1 Materials	4
	3.2 Concrete	5
	3.3 Performance and Tests	6
	3.4 Coating of Concrete Surfaces	6
4.	BLOCK WORK	7
	4.1 Applicable Publications	7
	4.2 Products	7
	4.3 Execution	9
5.	FINISH WORK	11
	5.1 Applicable Publications	11
	5.2 In-situ Finishes	11
	5.3 Lathin	15

CHAPTER	TITLE	PAGE
6.	DOOR AND WINDOW WORK	16
	6.1 Applicable Publications	16
	6.2 Products	17
	6.3 Execution	21
7.	GLAZING WORK	24
	7.1 Applicable Publications	24
	7.2 Products	24
	7.3 Execution	24
8.	PAINTING WORK	26
	8.1 Applicable Publications	26
	8.2 Materials	26
	8.3 Execution	27

CHAPTER 1

GENERAL

1.1 Scope

This specification covers the requirements of civil and building works for the Test Plant.

1.2 Codes and Standards

Unless otherwise specified, this specification and the following standards shall be applied for the work.

- (1) British Standards (BS)
- (2) American National Standards (ANSI, ASTM, ACI etc.)

CHAPTER 2

EARTH WORK

2.1 Excavation

Excavation shall include the excavation of all materials of whatever nature encountered as required to complete the work. The equipment and construction methods used shall be to the approval of the Engineer.

Excavation shall be carried out to the lines, levels, dimensions and depths indicated on the drawings or as directed by the Engineer. If during the course of excavation any condition is encountered which might indicate a lower bearing capacity than that assumed the foundation of the building shall be placed at a deeper level providing the minimum bearing pressure used for calculation. Foundation pits shall be excavated to permit the placing of the full widths and lengths of foundations shown in the drawings with full horizontal beds.

All excavation shall be inspected and approved by the Engineer prior to placing of any kind of overlaying material (concrete, bedding-material, etc...)

All excavation shall be made in open cuts and tunneling shall not be permitted except by written permission of the Engineer. All excavations shall be carried out in such a manner as to create a minimum of inconvenience and interference with pedestrian and vehicular traffic and with access to buildings or other properties.

Care shall be taken to avoid disturbing the bottom of the excavation. In case the foundation material is unsuitable, the Engineer may require the Contractor to excavate to a greater depth and to backfill to grade with approved material. The backfill or disturbed strata shall be compacted properly to the satisfaction of the Engineer and in accordance with these Specifications.

Special care shall be taken not to destroy cables, pipes, and the like laid under the ground. When encountered underground objects during excavation work, following excavation shall be directed by the Engineer.

2.2 Backfilling

Backfilling shall be performed using only approved backfilling materials in layers not exceeding 30 cm, and each layer shall be compacted to a density of not less than 90 %.

Backfilling may be placed by machine and compaction must be carried out with approved mechanical equipment.

No backfilling shall be carried out until all debris and other objectionable materials have been removed from the excavation and until the Engineer has inspected and approved.

2.3 Disposal of Soil

Excess soil shall be stockpiled at locations designated by the Engineer.

2.4 Crush Stone

Crush stone under foundation shall be laid in accordance with Chapter 11, 11.4 Base.

2.5 Soil Bearing Capacity

More than 1 kg/cm² of soil bearing capacities shall be confirmed at the expected foundation on bottom.

CHAPTER 3

CONCRETE WORK

The Contractor shall comply with the recommendations of CP 110, unless otherwise specified or directed.

3.1 Materials

All materials used in the works shall comply in all respects with the latest edition of the relevant British Standard Specifications except for any deviations specifically described or authorized by the Engineer.

(1) Cement

Cement shall comply with B.S. 12 and B.S. 4027. Other cements not be used provided that a fully detailed application is made, in writing, by the Contractor in support of his request. Approval, when given, shall be in writing.

All cement used below groundlevel shall be "sulphate resisting portland cement".

(2) Aggregates

Fine and coarse aggregates shall comply with B.S. 882 except that other aggregates may be used if approved by the Engineer.

The nominal maximum size of coarse aggregate shall be 20 mm.

Before commencing work the Contractor shall submit for approval the source of aggregate that it is intended to use together with details of the methods that may be required to ensure compliance with B.S. 882 in respect of grading and impurities. The salt content of exposed or sulphate resisting cement concretes expressed as the percentage of sodium chloride on the dry weight of aggregates shall not exceed 0.1% in accordance with C.P. 110.

For other concretes the total salt in a mix (sodium chloride from aggregate plus calcium chloride from any additive) shall not exceed 2.0% of the weight of cement.

(3) Water

Water shall comply with the requirements of the Appendix of B.S. 3148 and shall be clean and uncontaminated. Water shall be obtained from a Public Utility supply or from a source approved by the Engineer

(4) Admixtures

Admixtures shall not be used without approval of the Engineer. Any approved admixtures are to be used strictly in accordance with the manufacturer's instructions.

(5) Reinforcement

Bars for reinforcement shall be hot rolled high yield steel complying with B.S. 4449 (characteristic strength: 410 N/mm²).

Mesh for reinforcement shall comply with B.S. 4482.

3.2 Concrete

3.2.1 Mix design

The grade of concrete to be used in the works shall be as follows :

	Grading	Characteristic compressive strength at 28 days N/mm ²
Concrete for super structure	Grade 25 in accordance with C.P. 110. The minimum cement content to be 325 kg/m ³ . The maximum water/cement ratio to be 0.45.	25
Foundation, slab-on-grade, etc.	Grade 20 in accordance with C.P. 110.	20

3.2.2 Formwork and surface finish

Forms shall be so designed and constructed that the concrete can be properly placed and thoroughly compacted and that the hardened concrete whilst still supported by the forms shall conform accurately to the required shape, position and level, subject to the tolerances and standards of finish specified.

The quality of finish shall be :

- rough formwork for all parts which are not visible.
- smooth formwork for all parts which are visible.

3.3 Performance and Tests

All tests and checks on site shall be carried out in the presence of, or as directed by, the Engineer. The Contractor shall be responsible for carrying out all tests required by the Specifications, or called for by the Engineer and shall arrange for copies of test results to be supplied direct to the Engineer immediately they are available.

3.4 Coating of Concrete Surfaces

The Contractor shall cover the concrete surfaces in contact with soil and for groundwater with a protective coating.

All concrete surfaces shall be prepared to achieve a surface which ensures good bond.

All holes, cracks, defective joints and other defects shall be made good.

All dirt, grease, laitance, loosely adhering flakes shall be removed and repaired properly.

The concrete shall be thoroughly dry before application of the coating is started.

The coating shall be a thixotropic filled coal tar paint, obtained from a reputable manufacturer and applied in accordance with the Engineer's instructions.

The coating shall be applied in two layers, have a total uniform dry thickness of minimum 200 microns.

CHAPTER 4

BLOCK WORK

4.1 Applicable Publications

Following Standards are applicable :

4.1.1 SSA (Saudi Arabian Standards Organisation)

145 Concrete (cement) hollow blocks for buildings

4.1.2 BS (British Standards)

Codes of Practice (CP)

121 Pt. 1 Brick and block masonry

122 Pt. 2 Walls and partitions of blocks and slabs

4.2 Products

4.2.1 Basic Materials

(1) Sand

See chapter 3 : Concrete Work

The sand for mortar shall be graded in accordance with the following tables and the various sizes of particles shall be uniformly distributed.

(1.1) For Natural Sand

Sieve size mm	Percent passing by weight	
	min.	max.
4.76	100	
2.36	95	
1.18	70	100
0.60	40	75
0.30	10	35
0.15	2	15
0.075	0	0

(1.2) For Manufactured Sand

Sieve size mm	Percent passing by weight	
	min.	max.
4.76	100	
2.36	95	
1.18	70	100
0.60	40	75
0.30	20	40
0.15	10	25
0.075	0	10

(2) Cement

See chapter 3 : Concrete Work

Cement shall be "Sulphate Resisting Cement" used for mortar and concrete blocks.

(3) Water

Only clean and fresh water shall be used for mixing the mortar.

(4) Additives

Additives, where used, shall be proprietary products used in the proportions and manner recommended by the manufacturer. The additives shall in no way adversely affect the mortar strength or contain chemicals which may be harmful to other building materials. To add gypsum to cement is strictly forbidden.

4.2.2 Mortar and Grout

Materials for mortar, sand, binding agent and water, shall be mixed by volume or by weight for at least 3 minutes with the minimum amount of water to produce a correctly mixed workable consistency in a mechanical batch mixer.

Mortar shall be as strong, but no stronger than the materials it bonds together.

Mortars shall be mixed in batches which can be used within a period before the setting process commences. Once a mix begins to go off it shall be discarded, no ingredients may be added to it once the setting process has begun.

(1) Cement Based Mortar

Cement based mortar shall consist of cement and clean sharp sand mixed by volume in approved gauge boxes.

Mortar mixes shall be ;

Proportions by volume : Cement : Sand

1 : 3

4.2.3 Concrete Blocks

Concrete blocks shall comply with SSA 145 and shall be of regular standard to the required sizes, dimensions, crushing strengths, face textures and be uniform texture throughout the volume of unit.

Blocks shall be obtained from an approved manufacturer.

Block dimensions : 190 x 190 x 390 mm

Solid concrete blocks are used around door and window openings in blockwork walls, other blocks are hollow core concrete blocks.

4.3 Execution

4.3.1 General Requirements for Blockwork

(1) Workmanship

The permissible variation of walls shall not exceed 15 mm above and below the plumb and horizontal lines and the specified dimensions.

(2) Materials and Source

Hollow and solid concrete blocks shall be obtained from one source of manufacturer and no section of the work shall be constructed with a mixture of units from differing sources.

Samples of blocks shall be submitted to the Engineer.

Blocks shall be properly stacked on level and hard standings and be adequately protected from inclement weather.

4.3.2 Laying

Concrete blocks shall be laid horizontally along their length with prepared or faced sides exposed. Blocks shall be laid upright bedded on one of the long "thin" - sides.

All beds of mortar shall be level and straight and vertical joints formed so as to present a uniform pattern of bond. Exposed joint width shall be 10 mm.

Concrete blocks erected when the ambient air has a temperature of more than 42°C in the shade and a relative humidity of less than 50% shall be protected from direct exposure to wind and sun for 48 hours after construction. The absorption rates of masonry units shall be adjusted by previously wetting to ensure a good solid bond with the mortar.

4.3.3 Bonding

All masonry for half blocks thick walls or single thickness block work shall be laid in stretcher bond.

4.3.4 Built-in items

Anchors, ties, pipe sleeves, flashings, lintels and the like required to be built into the work shall be correctly inserted and executed as the work proceeds.

Walls or partitions abutting concrete columns or walls shall be securely anchored and tied with metal anchors or ties at not more than 400 mm vertical centres.

Wall ties cast in with concrete shall be bent down after the removal of formwork and securely jointed into the mortar beds of walling.

4.3.5 Chases, Holes and the like

Chases, holes, sinkings and mortices for other trades shall be correctly located and formed to the sizes as required by the relevant trades.

4.3.6 Jointing and Pointing

Jointing is the forming of joints as work proceeds.

Pointing is the finishing of joints after the wall is complete. For pointing, masonry joints shall be raked out to a depth of 20 mm and left clean and ready for pointing. Pointing shall be carried out to the required colour, texture and finish.

Pointing shall be carried out from the top of the wall downwards.

The raked joints shall be well-brushed to remove dust and loose material and shall be lightly wetted with a brush.

CHAPTER 5

FINISH WORK

5.1 Applicable Publications

5.1.1 1400 Ceramic Tiles (Floor Tiles)

5.1.2 BS (British Standards)

Code of Practice (CP)

204 In situ floor finishes

5.2 In-situ Finishes

5.2.1 Ordinary Cement Screeds and Floors

These shall consist of cement, natural aggregates, water and , where specified, colouring agents and/or additives.

(1) Cement

See chapter 3 : Concrete Work

(2) Aggregates

Aggregates shall comply with BS 882, Pt. 2, 1199 and 1201 Pt. 2.

(3) Sand

Sand shall consist of natural sand, crushed stone sand or crushed gravle sands or a combination of these. They shall be hard, durable, clean and free from adherent coatings.

The sand shall not contain harmful materials such as iron pyrites, salts, coal or other organic impurities in such a form or in sufficient quantity to adversely affect the hardening, the strength, the durability of the appearance of the final product or any materials in contact with it.

Sand less than 0.02 mm shall be limited to 3 % by weight. The aggregates 0-3 mm shall not exceed 75 % by weight.

(4) Water

See chapter 3 : Concrete Work

5.2.2 Ordinary cement based rendering

With a mixture consisting of only cement and sand a plasticiser is necessary.

Proportions by volume : Cement : Sand
1 : 3 to 8

For materials : see 6.2.1

5.2.3 Execution

(1) Ordinary Cement Screeds and Floors

The screed shall be laid on set and hardened concrete.

The surface of the base concrete should be brushed to remove all laitance and loose aggregate and , at the same time, to roughen the surface to improve the bond. The hardened base should be thoroughly cleaned, wetted, preferably overnight, the surplus water removed, and a grout of cement and water brushed into the surface, keeping just ahead of the application of the screed.

The aggregates and cement shall be accurately batched by weight and the ratio of cement to aggregate shall not be greater than 1:3 nor less than 1:4,5.

The material for screeding shall be mixed in a mechanical mixer.

Each batch shall contain the minimum amount of water consistent with a mixture of adequate workability. Mixing shall continue until the mixture is of uniform colour and consistency.

Screed battens carefully levelled and trued should be fixed at the correct height for the required thickness of screed. The mix should be spread on the base with adequate surcharge, levelled with a screed board and thoroughly compacted. The wearing surface shall be trowelled smooth.

In hot or dry weather care has to be taken by the contractor to ensure that Portland cement mixes do not stiffen or dry out to an extent that prevents full compaction. After compaction the surface shall be covered with plastic sheeting, wet jute or curing compound to prevent rapid drying.

(2) Concrete screed for roofs

Screeds shall have a maximum allowable density of 2,000 Kg/m³ and be of grade 20 concrete in accordance with B.S. C.P. 110.

Screeds shall be laid in partitions not exceeding 20 m² with expansion joints 15 mm formed through softwood 12 mm thick. Roof screeds shall be laid with slopes of 2 % to falls. Minimum thickness at falls shall be 30 mm. The completed screed shall be smooth, dry and free from defects and shall be subject of roofing subcontractors approval.

(3) Cement based rendering

All plant and tools shall be kept clean and free from the residue of previous mixes.

Where the temperature exceeds 42 deg C, precautions shall be taken to protect the surface of plaster from direct sunshine both during application and for at least 48 hours after finishing.

Suitability of backing to receive plasterworks shall be checked. Bonding agent, if required, shall be applied.

Projections and concrete fins on in-situ concrete work shall be hacked off before plastering commences.

All efflorescence, laitence, dirt and other loose material shall be removed by thoroughly dry brushing.

All traces of mould oil, paint, grease, dirt and other materials incompatible with plasterwork shall be removed by scrubbing with water containing detergent.

Any organic growths shall be treated with fungicide and brushed off.

Hollow block partitions shall be thoroughly dampened immediately before coating to ensure good bonding.

Any piping, conduit, fixing clips or other metallic objects which will be covered by the plasterwork, shall be covered with metal lathing to avoid cracks.

Types of render for undercoats and finishing coats are listed in following table :

A. cement and Sand 1:3

B. cement and Sand 1:5

Types of Background	Types of finish	First and subsequent undercoats	Final coat
Dense, strong, smooth e.g. dense clay or concrete blocks and struct. concrete	Wood float	A	B
Metal lathings	Wood float	A	B

The type of finish used for rendering is smooth and scrapped.

Smooth rendering shall be obtained by using a wood float.

Scrapped finish shall be obtained by using a fine saw blade on smooth finished rendering and applied during early stage of hardening process.

5.3 Lithin

5.3.1 Material

(1) Lithin

Materials shall be manufactured in factory.

(2) Water

Clean water shall be used for mixing of materials.

5.3.2 Mixing

Mixing ratio and coverage shall be applied in strict accordance with manufacturer's instruction and with relevant standards.

5.3.3 Execution

(1) Preparation of surfaces

Surface to receive Lithin spray shall be clean and free of efflorescence or any other foreign materials and free of voids in excess of 5 mm in diameter.

Nails or wires that are exposed on the surface shall be removed, or painted after cutting off. Tie-rods shall be cut back 2~3 cm from face and filled and leveled with appropriate materials.

(2) Spray Gun

Orifice of spray gun and air pressure shall be by manufacturer specification.

CHAPTER 6

DOOR AND WINDOW WORK

6.1 Applicable Publications

6.1.1 SSA (Saudi Arabian Standards Organization)

- 79 Aluminium products Part 1 : Sheets, strips, plates, bars and structural sections
- 107 Tensile testing of steel
- 207 Bend test for structural steel Part 1 : Steel products, except sheets, strips less than 3 mm thickness
- 208 Bend test for steel Part 2 : Sheets and strips less than 3 mm thickness. A :
Simple bend test
- 209 Bend test for steel Part 2 : Sheets and strips less than 3 mm thickness. B :
Reverse bend test.

6.1.2 BS (British Standards)

(BS) British Standards and (DD) Special Issues

- 1161 Aluminium and aluminium alloy sections
- 1470 Wrought aluminium and aluminium alloys for general engineering purposes, plate sheet and strip
- 1471 Wrought aluminium and aluminium alloys for general engineering purposes, drawn tube
- 1474 Wrought aluminium and aluminium alloys for general engineering purposes
- 1615 Anodic oxydation coatings on aluminium
- 1227 Hinges
- 1245 Metal door frames (steel)
- 1331 Builder's hardware for housing
- DD4 Recommendations for the grading of windows.
 - > Resistance to wind loads, air infiltration and water penetration, and notes on window security.

(CP) Code of Practice

- 118 The structural use of aluminium.

6.2 Products

6.2.1 Basic Materials

All metals shall be free from defects impairing strength or durability of the end product, and shall be of adequate commercial quality for each intended purpose. Fastenings which are exposed shall be of the same material, colour and finish as the metal to which they are applied.

Individual metals shall be uniform in colour, sound and free from surface, flaws, segregation, laminations and other defects which are detrimental to subsequent processing and ultimate use. Sheetting shall be uniform in thickness and free of camber.

(1) Steel

Steel for metalwork shall be SSA 107, 207, 208, 209 and BS 1448, 2994.

(2) Aluminium

Aluminium shall comply with SSA 79 and 80 and B.S. 1161, 1470, 1471 and 1474. Section and profiles shall generally be extruded and be of thicknesses appropriate to the use and design of the member.

6.2.2 Finishes

(1) Finishes for aluminium

Aluminium for window frames shall be anodized, grade AA25 ; (minimum thickness of coating 0.025 mm)

(2) Finishes for steel

Steel where used shall be rustproofed.

6.2.3 Fixing Devices

Fixings shall be as recommended by the manufacturer to give adequate support to the units in regard to their position, size and weight.

The fixings shall be capable of withstanding the design wind load and any operating forces on the doors, windows and gates.

Materials used for anchors, fastenings, fixings and the like should be corrosion-resistant and to the actual requirements.

6.2.4 Steel doors and frames

(1) Steel frames

Frames for doors shall be rigid, straight, square and uniform. They shall consist of two jambs, a head and, where applicable further transoms and mullions, each piece being of continuous length. Sills where required shall be fitted flush with the base of the frame.

Door frames shall be braced with an adjustable base tie to hold the frame rigid during transit and erection. Where applicable, base ties may be designed to suit the thickness of the floor for subsequent casing in.

Individual sections shall be pressed or extruded and may be solid, hollow or open channel. Rebates shall be formed within the frame and shall be minimally larger than the door leaf thickness to ensure that a close fit is obtained. Where compressible seals are used then the depth of the rebate shall be sufficient to allow for the seal and maintain it in a compressed state when the door is closed. Internal door frame rebates shall be a minimum of 13 mm deep and external door frames 19 mm deep.

Joints shall be mitred and ground to a flush close fit. They shall be reinforced and welded or be of a mechanical interlocking type with adjustable screws, bolts or cramps to permanently align abutting edges inconspicuously. Joints shall be of a strength to maintain the structural properties of the members connected. Where transoms or mullions are used the joints shall be straight and the rebates match the rebates of the adjoining frame member. After welding all welds shall be cleaned and ground smooth. Work shall be coordinated with hardware suppliers for templates and sizes of all applicable hardware and screws.

The tolerance for location of all applicable hardware and screws shall be ± 1.5 mm.

(2) Preparation for Hardware

Frames shall be cut, drilled and tapped ready to receive all necessary hardware. All hollow frames shall be strengthened and reinforced with solid plates where frames are to receive hinges, door closers, bolts, and striker plates.

Frames for single doors shall be fitted with an adjustable lock strike plate. Door frames shall be provided with continuous grooves to receive weather stripping or continuous seal. Grooves shall be designed to allow for easy replacement. Hinges shall be countersunk screwed to the frames and reinforcing plates.

The outer surface of the hinge leaf fitted to the frame shall not project above the surface of the rebate. Frames to support doors of less than 30 kg shall have two hinges and for doors above 30 kg there shall be three hinges.

However, all doors of more than 2.25 m in height shall have three hinges, irrespective of weight.

Where applicable glazing beads shall be matching in depth to the door frame rebate.

Beads may be solid or hollow, square-shaped or moulded and be securely fixed to the frame with clips or countersunk screws at 150 mm (min.) centres.

(3) Fixing Devices for Steel Frames

Ties for fixing shall be a minimum size of 25 x 3 x 250 mm long with one end welded to the back of the frame. The free end is flat for fixing with anchor bolts or fishtailed for fixing in preformed pockets.

Frames up to 2.25 m high shall have 3 anchors per frame each side.

Frames over 2.25 m high shall have an additional anchor for every 1 m or part thereof. Anchors shall be spaced out equally between the top and bottom anchors which shall be 150 mm from the top and bottom edges of the frame.

6.2.5 Aluminium Windows

(1) Performance requirements

The whole of the fabricated, assembled and erected work shall withstand safely and with sufficient factor of safety, the produced stresses due to followings :

1. Thermal expansion and contractions. Thermal movements shall be calculated on the basis of ambient air temperature variation range of 0° to 45°C.
2. Windload having a pressure of 1.5 KN/m² acting inward and outward and with a safety factor of 1.2.

The resulting deflection under heavy exposure to external forces or temperature variations shall not exceed 1/300 of span length.

(2) Construction

The dimensions and thickness of windows shall be in proportion to the static requirements of the windows. The profiles of members shall be as required and adequate to receive a good solid fixing, take the weight and fixing of the glazing, withstand wind load, suction pressures and the like without distorting or damaging the unit in any way.

(3) Frames

Frames shall be rigid, straight, square and uniform, and manufactured in accordance with the design details or manufacturer's standard.

Individual sections shall be of continuous length and shall be extruded into rebated and grooved profiles to receive seals.

Casements shall be defined as a part of a window which opens on hinges or pivots, and be of profiles adequately dimensioned to receive glazing.

Joints in frames shall be made by mechanical means (examples are cleating and screwing). Joints shall be flush.

Joint sealing materials shall not harm adjacent materials or finishes.

Tolerances for overall dimensions in height and width, ± 2 mm.

(4) Metal Glazing beads

Glazing beads and other members shall be adequately rigid and fixed at a sufficient number of points to withstand design wind load. Windows shall be such that glazing or re-glazing on site is possible from outside without the need to remove the frame from the structure of the building.

Glazing beads, gaskets, glass adaptors and glazing compounds shall be of materials that do not react with the framing material.

(5) Weatherstripping

Weatherstripping shall be made from materials known not to react with the framing material and such that any shrinkage, warping or adherence to sliding or closing surfaces shall not impair the performance of the window.

All openable windows are to be fully weatherstripped to prevent draughts.

Weatherstripping shall be in hollow or solid neoprene sections or brush pile as appropriate. Cellular foam weatherstrips will not be accepted and all materials used shall be in positions not exposed to direct ultra-violet light. The frames and extrusions are to be designed to allow replacement of weatherstrips without dismantling the frame or casement. Frames are to be provided with integral drainage to prevent build-up of water within the sections.