Often times insufficient supply of demineralized water happens in Malaya. On this regard JICA team recommends that an additional demineralizer shall be installed and also RO Units for primary water treatment.

(f) Instrumentation of Demineralizer

As a result of our investigation, the instrumentation for all monitoring of the control system for an automatic operation were out of order.

Therefore, JICA Team recommends that the conductivity meters and recorders should be replaced to newest model in order to operate the demineralizers by conductivity control of the effluent.

Gardner (Graver) Anion Outlet	3 sets electrodes
& Mixed Bed Polisher Outlet	2 sets electrodes with recorder
Snyder (Permutit) Anion Outlet	2 sets electrodes
& Mixed Bed Polisher Outlet	2 sets electrodes
Malaya (Permutit) Anion Outlet	2 sets electrodes
& Mixed Bed Polisher Outlet	2 sets electrodes with recorder

and all the flow meters, recorders and counters should be replaced/repaired in order to know water production of demineralizers of Gardner/Snyder and Malaya Thermal Station.

The control system for automatic operation should also be repaired or replaced in order to prevent operation failure of demineralizer at Gardner/Snyder Thermal Station.

(g) Maintenance (Overhauling)

The demineralizers of Gardner/Snyder and Malaya Thermal Station have been operating with no overhauling for few years.

Therefore, JICA team recommends that overhauling of all demineralizers should be performed as soon as possible according to the attached manual.

(h) Laguna Lake Water

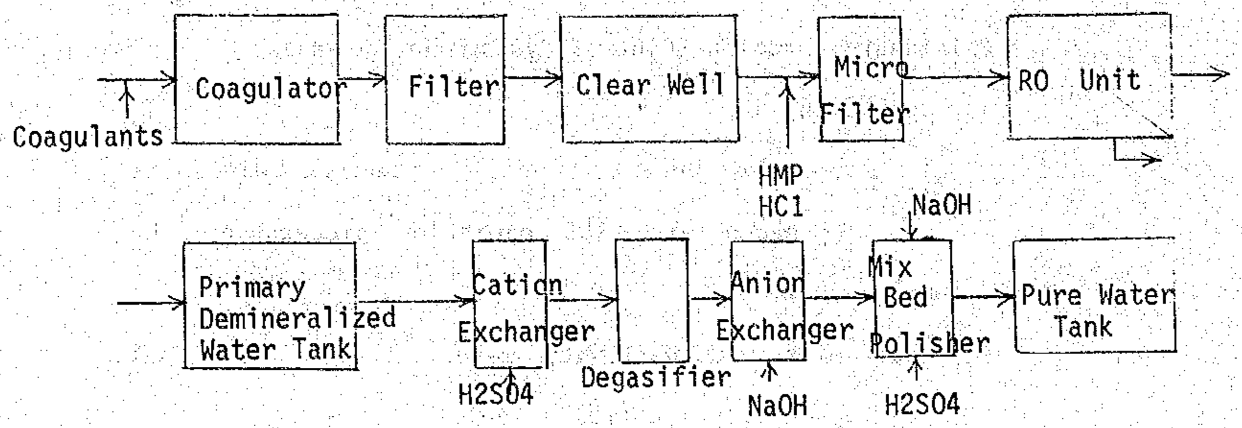
Recently, the deep well water quality is getting bad and it is sometimes insufficient to supply the demineralizer because of deep well pumps failure (Malaya Thermal Station).

Therefore, Laguna lake water might be used for it in the near future. However, when Laguna lake water is used for demineralizers, the following problems will occur.

Laguna lake water has higher turbidity, higher organic matters and higher salt content than deep well water.

In such a case, the following system is most recommended:

Water Treatment System



(i) Waste Water Treatment

In near future, facilities for anti water pollution must be installed such as neutralizing equipment for regeneration waste and etc.

d. <u>Maintenance Manual (Annual Inspection or Overhauling)</u>

(a) Rotating Equipment (Motor, Pump, Blower)

Inspection and Overhauling should be performed in accordance with each manual submitted by manufacturer.

Check Items:

i.	Gland Packing	Replace it.
ii.	Bearing	Replace it if abnormal sound or vibration occurs during operation. Grease up.
iii.	Shaft & Impeller	Repair it if shaft is bended or impeller is damaged.

After overhauling

Megger — To be more than 1 mega ohm

Adjust the centering of motor and pump coupling.

(b) Instrumentation (Control System for Automatic Operation)

Make sure open/close of air actuating valves are in accordance with the operation process of the programmer.

(c) Instruments (Conductivity meter, flow meter, tank level gage, flow control valve)

Perform the calibration of each instruments attached on the control panel in accordance with the manual issued by manufacturer.

Calibration	Adjust 0 (zero) point.
	Adjust Span (Slope) point.
P.I.D.	Adjust PID operation while operation.

(d) Valve

Disassemble all valves and check the following items.

Diaphragm, Valve Sheet,	
O-Ring	Replace it if damaged.

(e) Ion Exchanger (Cation, Anion Exchanger & Mixed Bed Polisher)

Carry out the following items.

Back Wash	Specified flow rate	30 min.
Settling	-	10 min.
Drain Water	From bottom	20 min.

Open Manhole of ion exchanger top.

Take the resin sample to analyze resin exchange capacity.

Note:

$$\text{Cation Resin Capacity Drop\%} = \frac{\text{Neutral Salt Decomposed Capacity (meq/ml)}}{\text{1.9 meq/ml (new resin)}} \times 100$$

Anion Resin Capacity Drop%

$$= \frac{\dfrac{\text{(Neutral Salt Decomposed Capacity (meq/ml)+Total Exchange Capacity(meq/ml)}}{2}}{\text{1.0 meq/ml (new resin)}} \times 100$$

Measure the resin volume.

Calculate new make-up resin volume.

Old resin (m^3) x Resin Capacity Drop %/100

= Make Up (m^3)

Inspect inside of ion exchanger.

Distributor - - - Clean up & Adjust horizontal level if decline

Bolts & Nuts - - - Tighten if loosen

Surface of Rubber lined

- - - Repair if damaged

Sight Glass - - - Clean Up

Take out old deteriorated resin. [=Make up resin volume (m^3)]

Supply new resin, [make up resin volume (m^3)].

Note: The distance between resin surface and distributor should be kept within 300-700mm after resin make up.

Close the manhole of ion exchanger top.

Back Wash 30 min.

(f) Start up After Overhauling

Regenerate the demineralizer and set the flow rate to specification by manually adjusting the handle of the automatic valve.

(g) Service Run

Make sure that conductivity and SiO_2 are less than specified. At anion exchanger outlet.

Put in service and set the service flow rate as specified.

Make sure that the capacity of demineralizer per cycle are of good quality of de-ionized water.

NOTE: The expected capacity after make up of new resin are as follows:

$$A = \frac{B \times C}{C} + \frac{E \times F}{D} \times G - H$$

A = Expected capacity after make up of new resin (m^3)

B = Break through capacity (g as $CaCO_3$/l-R)

C = Make up new resin volume (liter)

D = Total cation or anion inlet total anion (ppm as $CaCO_3$)

E = Break through capacity (g as $CaCO_3$/l-R)

F = Old resin volume (liter)

G = Resin Capacity Drop (%/100)

H = Required water for regeneration (Introduction & Displacement)

5) Condensate Polishing Plant

a. Specification of Condensate Polishing Plant

(a) Condensate Polisher

	Condensate Polisher	Size	Capacity
Gardner - 1	3 units	6'-0"ϕ x 4'-6"H	1400 gpm x 2
		(1828mm x 1371mm)	(318 m^3/H)
Snyder - 1	3 units	"	"
Snyder - 2	4 units	"	1400 gpm x 3

(Design Pressure 355 psi 25 kg/cm^2)

(b) Regeneration Equipment (2 sets)

Resin Separation & Cation Regeneration Tank

4'-0"ϕ x 10'-0"H (1219mm x 3048mm) 1.166m^2

Anion Regeneration Tank

3'-0"ϕ x 12'-0"H (914mm x 3657mm) 0.6557m^2

Resin Storage Tank

4'-0"ϕ x 10'-0"H (1219mm x 3048mm) 1.166m^2

(c) Resin Volume

Cation Exchange Resin

Amberlite-200C 56 ft^3 (1586 liter) x 12

Anion Exchange Resin

Amberlite IRA-900 2B ft^3 (793 liter) x 12

(d) Regenerants

Sulfuric Acid - - - - - - - - - - 415 lb/cycle

(66°Be H_2SO_4) 188 kg

118 g/L-R

Flow rate/time (66BeH_2SO_4)- - 1.4 gpm - 20 minutes

Caustic Soda - - - - - - - - - -	211 lb/cycle
(100% NaOH)	95.9 kg
	120 g/L-R
Flow rate/time (50% NaOH) - -	0.55 gpm - 60 minutes
Ammonia Hydroxide - - - - - - - -	224 lb/cycle
(28% NH_4OH)	101.8 kg/cycle
Flow rate/time (28% NH_4OH)- -	0.6 gpm - 180 minutes

(e) Effluent Quality

Total Silica	Less than 20 ppb as SiO_2
Total Dissolved Solid	Less than 50 ppb as $CaCO_3$
Iron	Less than 10 ppb as Fe
Copper	Less than 2 ppb as Cu
pH	9.2 - 9.4

Malaya No. 1 Unit also has four (4) condensate polishers and a regeneration equipment with same specification as that of Gardner/Snyder Power Plant.

b. Result of Survey

(a) Instrument of Condensate Polishing Plant

The instrumentation which is attached on the control panels of condensate polishing plant is as follows:

i. <u>Gardner - 2 (Condensate Polishers)</u>

Instruments for Monitoring	
Conductivity Meter & Recorder (Leads & Northrup) (After-cation column resins have been exhausted)	X
Flow Meter & Recorder (Foxboro)	X
Differential Pressure Indicator (Foxboro)	X
Sodium Analyzer (Orion) (Common line only) --- Additional	O
Control System for Automatic Operation	
Stepping Programmer (Manual Operation)	X
Alarm Unit	
Alarm Unit	X

ii. <u>Snyder - 1 (Condensate Polishers)</u>

Instruments for Monitoring	
Conductivity Meter & Recorder (Leeds & Northup) (After-cation column resins have been exhausted)	X
Flow Meter & Recorder (Foxboro)	X
Differential Pressure Indicator (Foxboro)	X
Sodium Analyzer (Orion) (Common line only)	O
Control System for Automatic Operation	
Stepping Programmer (Manual Operation)	X
Alarm Units	X

iii. <u>Snyder - 2 (Condensate Polishers)</u>

Instruments for Monitoring

Conductivity Meter & Recorder (Leeds (& Northup) (After cation column resins have been exhausted)	X
Flow Meter & Recorder	X
Differential Pressure Indicator (Foxboro)	X
Sodium Analyzer (Orion) (Common line only)	O

Control System for Automatic Operation

Stepping Programmer (Manual Operations)	X
Alarm Units	X

iv. <u>Malaya (Condensate Polisher)</u>

Instruments for Monitoring

Conductivity Meter & Recorder (Leeds & Northup) (After cation column resins have been exhausted)	X
Flow Meter & Recorder	
Differential Pressure Indicator (Foxboro)	X
Sodium Analyzer (Orion) (Common line only)	O

Control System for Automatic Operation

Stepping Programmer (Manual Operations)	X
Alarm Units	X

v. <u>Snyder - 1 (Regeneration Equipment)</u>

-- Constructed by Cochrane

Instruments for Monitoring

Conductivity Meter & Recorder	X
(H_2SO_4, NaOH, NH_4OH) (Leeds & Northrup)	
Tank Level Gauge	X

Control System for Automatic Operation

Stepping Programmer (Resin Transfer & Regeneration) (Manual Operation)	X
Alarm Units	X

vi. <u>Snyder - 2 (Regeneration Equipment)</u>

-- Constructed by Atom

Instruments for Monitoring

Conductivity Meter & Recorder (H_2SO_4, NaOH, NH_4OH)	O
Tank Level Gauge	O

Control System for Automatic Operation

Diode Matrics Circuit Unit (Resin Transfer & Regeneration)	O
Alarm Units	O

vii. <u>Malaya (Regeneration Equipment)</u>

-- Constructed by Cochrane

Instruments for Monitoring

Conductivity Meter & Recorder (H_2SO_4, NaOH, NH_4OH)	X
Tank Level Gauge	X

Control System for Automatic Operation	
Stepping Programmer (Manual Operation)	X
Alarm Units	X

Note:

*At Gardner/Snyder Thermal Station, before, the exhausted resin of G-2, S-1 and S-2 condensate polisher were regenerated by only one (1) regeneration equipment (Snyder - 1), however, another regeneration equipment at (Snyder - 2) has been constructed by Atom. Since February, 1982, and both regeneration equipments can now be used for the regenerations of G-2, S-1 and S-2 exhausted resin.

LEGEND:

Out of Order	X
Working but necessary to calibrate	△
Available	O

(b) Water Quality of Condensate Polisher Inlet & Outlet (Ammonex)

The water quality of condensate polisher inlet and outlet are as follows:

Condensate Polisher (Ammonex) Sodium & Conductivity

Item		Date	Aug. 12	13	16	17	18	19	20
S-1	Na (ppb)	Ammonex Inlet	6	5	5.5	4	6	4	6.5
		Ammonex Outlet	3	3	3	2	3.5	3.5	3
	Cation Pass Conductivity(micro. S/cm)	Ammonex Inlet	0.82	0.99 (13)	0.88	0.34	0.56(15.3)	0.65	0.90
		Ammonex Outlet		A 0.50(9.8) B 0.62(0.58)			B 0.88(18.5) C 0.65(19.3)		
S-2	Na (ppb)	Ammonex Inlet	5	5	5	4	5	5	5
		Ammonex Outlet	3	3	3	3	4	3.5	3
	Cation Pass conductivity (Micro. S/cm)	Ammonex Inlet	0.4	0.33(12.5)	0.42	0.31	0.37(8.8)	0.36	0.40
		Ammonex Outlet		A 0.43(10.2) B 0.43(10.2) C 0.39(6.2)			B 0.50(9.7) C 0.50(9.7) D 0.70(8.8)		
	Temperature ('C)						47-51		

NOTE: ( ) Conductivity -- Direct

Condensate Polisher (Ammonex) Sodium & Conductivity

Malaya Thermal Plant

Item		August 24	August 26	September 1	
M-1	Ammonex Inlet Cation pass Conduct.(Micro S/cm)	0.51(3.2)		0.50 (3.5)	
	Ammonex Outlet Cation Pass Conduct.(Micro S/cm)	A 0.41(0.38) B 0.66(0.51) C 0.33(0.23) D 0.50(0.33)	A 0.44(0.36) B 0.60(0.49) C 0.30(0.88) D 0.47(0.43)	A 0.53 (0.44) B 0.74 (1.77) C 0.75 (1.73) D 0.75 (0.63)	
	Deaerator Na (ppb)	2.5	1.5	2.0	
	Temperature ('C)	42	42	42	

NOTE: ( ) Conductivity -- Direct

In Japan, condensate polishing plant (Ammonex type) operates on the following water quality.

Effluent	*Conductivity	Less than 0.1 - 0.15 micro S/cm
	Sodium	Less than 2.3 ppb as Na
	Silica	Less than 0.02 ppm as SiO_2

Ammonex of Gardner/Snyder and Malaya are being operated with high conductivity of the effluents. Also, results of sodium analysis indicate higher values than the required specification.

(c) Ion Exchange Resin Volume Balance

There are no nozzles for taking out excess resin in resin separation in the cation regeneration tank so that adjustment of resin volume cannot be performed. The sight glass which is for confirmation of resin separation level during separation at the cation regeneration tank are too small and resin separation level cannot be confirmed sometimes. As a result, resin volume of all vessels deviated from the recommended specifications.

(d) Caustic Soda Quality

The result of caustic soda analysis which is used in Gardner Thermal Station for ammonex is as follows:

August 18, 1982   1.435% as NaCl/100/NaOH

Note: NaCl Content which is contained in 100% NaOH for ammonex must be less than 0.1%. Refer to attached analysis method for NaCl contained in NaOH (JIS-K1204).

Table 5C-27.

* Direct conductivity in H/OH - form less than 0.10 micro S/cm

Cation pass conductivity in NH_4/OH - form less than 0.15 micro S/cm

(e) Resin Capacity Drop

Data taken on ion exchange capacity of resin being for ammonex.

	Total decomposing capacity (meq/ml)	Total exchange Capacity(meq/ml)	Capacity drop (%)
Amberlite (IRA-900 (R-11)	0.61	0.87	26

Note: Basic of Calculation (Catalog value) for capacity drop

IRA-900   1.0 meq/ml-R

and use an average of 0.61 & 0.87

Table 5C-28 OPERATION PROCESS OF CONDENSATE POLISHING PLANT (AMMONEX) 1/3

	Process	Flow Rate (gpm)	Time(min)	Remarks	m^3/H / m^3
Ammonex	Service	1400			318 /
	Rinse				
	Rinse Recycle	1000			227 /
Ion Removal in Ammonex	Drain to Scrub				
	Air Scrub	285 (scfm)			
	Black Wash	113			25.6 /
	Drain				
	Air Mix	285 /scfm)			
	Fill	145			33.9 /
	Rinse	145			33.9 /
Resin Transfer	Vent		2		
	Transfer Exhausted Resin	45 (scfm)	30		
	Pressurize Resin Storage Tank	45 (scfm)			
	Fill Condensate Polisher	145			33.9 / 7.3
Iron Removal in Cation Tank	Drain Scrub				
	Air Scrub	126 (scfm)	1		
	Rinse Down	65	2		14.7 / 0.5
	Cation Tank Rinse	110			24.9 / 1.7
	Resin Separation	45	10		10.2 / 7.5
	Forced Settle	65	4		14.7 / 1.0
	Resin Transfer (Anion Resin)	75	10		17.0 / 2.8
	Cation Back Wash	100	10		22.7 / 3.8

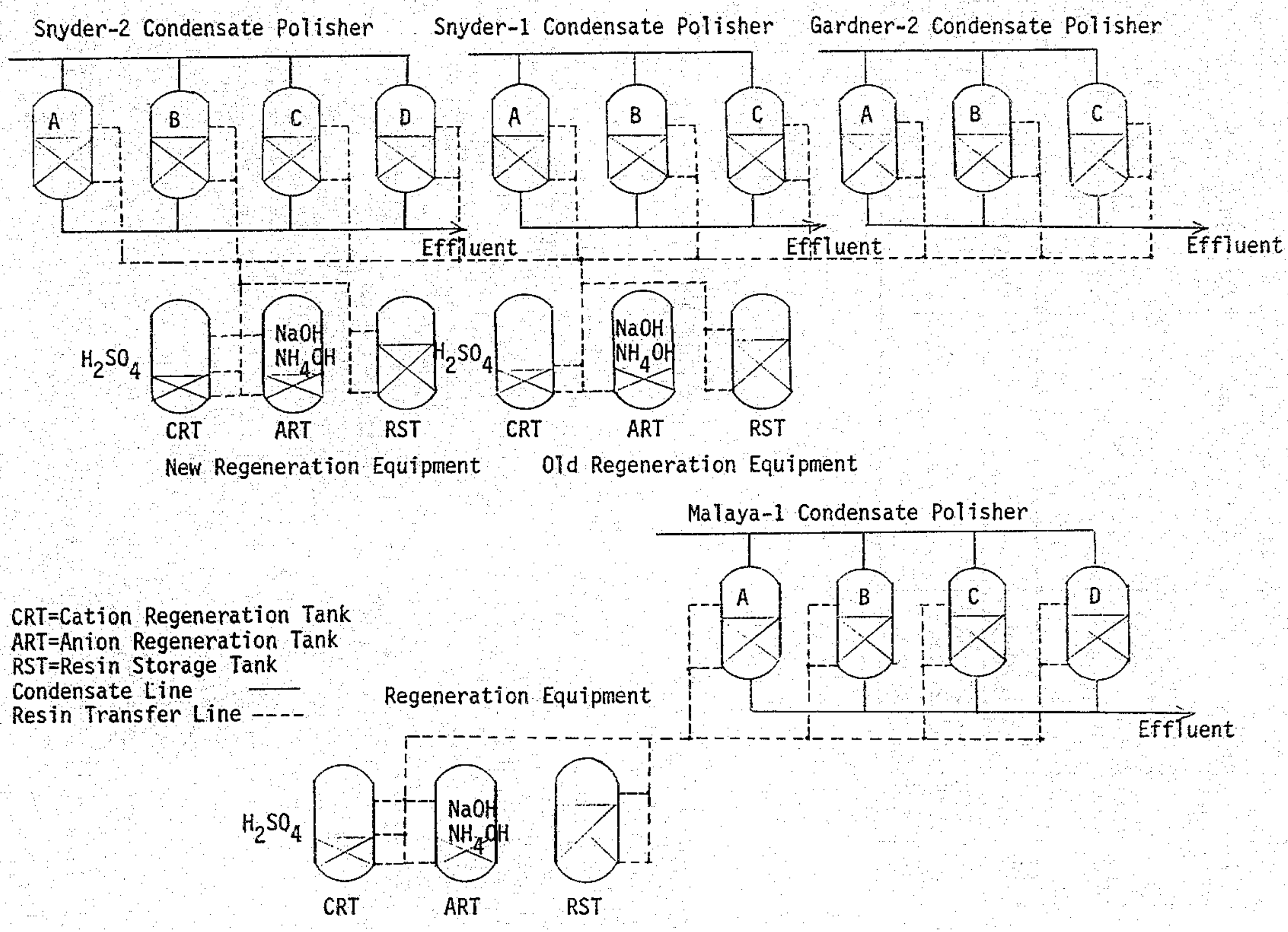
Table 5C-28 (2/3)

	Process	Flow Rate (gpm)	Time(min)	Remarks	m^3/H / m^3
Anion Tank	Anion Drain Scrub				
	Anion Air Scrub	70 (scfm)	5		
	Anion Fill	48			10.9 / 1.0
	Force Settle	35	4		7.9 / 0.5
	Anion Back Wash	25	10		5.6 / 1.0
Regeneration	Cation Acid Draw Anion Caustic Draw	(4%) 59.9 + 1.4(H2SO4) (4%) 9.5 + 0.55(NaOH)	(20)	66'Be H_2SO_4 415 50% Na OH	13.6 / 1.2
	Anion Caustic Draw	(4%) 9.5 + 0.55 (NaOH) Temp 110-120°F	60	50% NaOH 211 lbs	2.1 / 4.5
	Cation Rinse Anion Caustic Draw	59.9	40		9.0 / 12.8
	Cation Rinse Caustic Displace	9.5	13		2.1 / 0.5
	Cation Rinse Anion Rinse	37	60		/ 8.4
Anion Resin Ammonia Draw	Cation Drain				
	Cation Ari Scrub	126 (scfm)	5		
	Cation Fill	110			20.9 / 1.0
	Forced Settle	65	4		14.7 / 1.0
	Cation Back Wash	100	10		22.7 / 2.8
Anion Resin Transfer to Cation Tank	Anion Drain				
	Anion Scrub	70 (scfm)	5		
	Anion Fill	60			13.6 / 1.0
	Forced Settle	35	4		7.9 / 0.5
	Anion Back Wash	25	10		5.7 / 1.0
	Anion Receive Ammonia	(0.5%) 29.7 +0.6(NH_3)	180	NH_3 224 lbs	6.7 / 20
	Anion Rinse	35	45		7.9 / 5.9
	Transfer Anion Resin	29	10		6.6 / 1.1

Table 5C-28 (3/3)

	Process	Flow Rate (gpm)	Time(min)	Remarks	m^3/H / m^3
Conductivity Check in Cation Tank	Cation Drain				
	Air Mix	126 (scfm)	5		
	Cation Fill	110			24.9 / 1.0
	Conductivity Check	65	20 (5)		14.7 / 8.79
RST	Resin Transfer to Storage Tank	110	15		24.9 / 6.7
	Storage Tank Fill	120			27.2 / 1.0

Fig. 5C-12 SCHEMATIC DIAGRAM OF CONDENSATE POLISHING PLANT

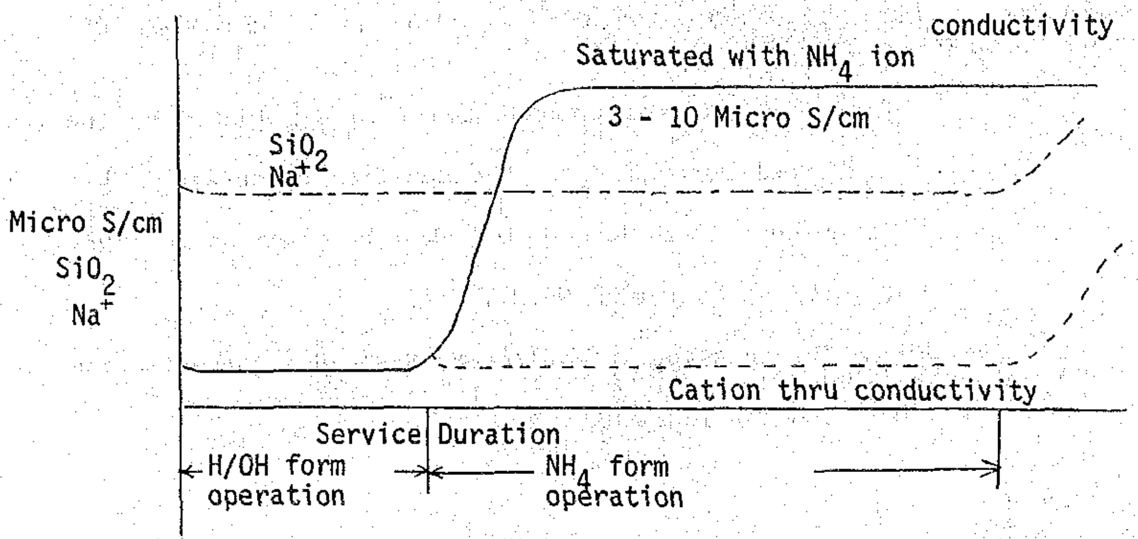


Note: CRT=Cation Regeneration Tank
ART=Anion Regeneration Tank
RST=Resin Storage Tank
Condensate Line ——
Resin Transfer Line ----

c. Recommendations

(a) Treated Water Quality in Ammonex are as follows:

Typical Curve of Ammonex



* Cation thru conductivity	Less than 0.15 micro S/cm
* Silica	Less than 0.02 ppm as SiO_2
* Sodium	Less than 2.3 ppb as Na^+

That is to say, service duration of ammonex should be determined by Na^+, SiO_2 and conductivity (or cation pass conductivity). However, at G-2, S-1, S-2 and M-1 service duration of ammonex is determined by Na^+ values only, (when Na value reaches higher than 10 ppb as Na^+ at ammonex outlet, this resin is exhausted and regenerated). In comparison with the above values, ammonex of G-2, S-1, S-2 and M-1 are operated at higher conductivity and Na.

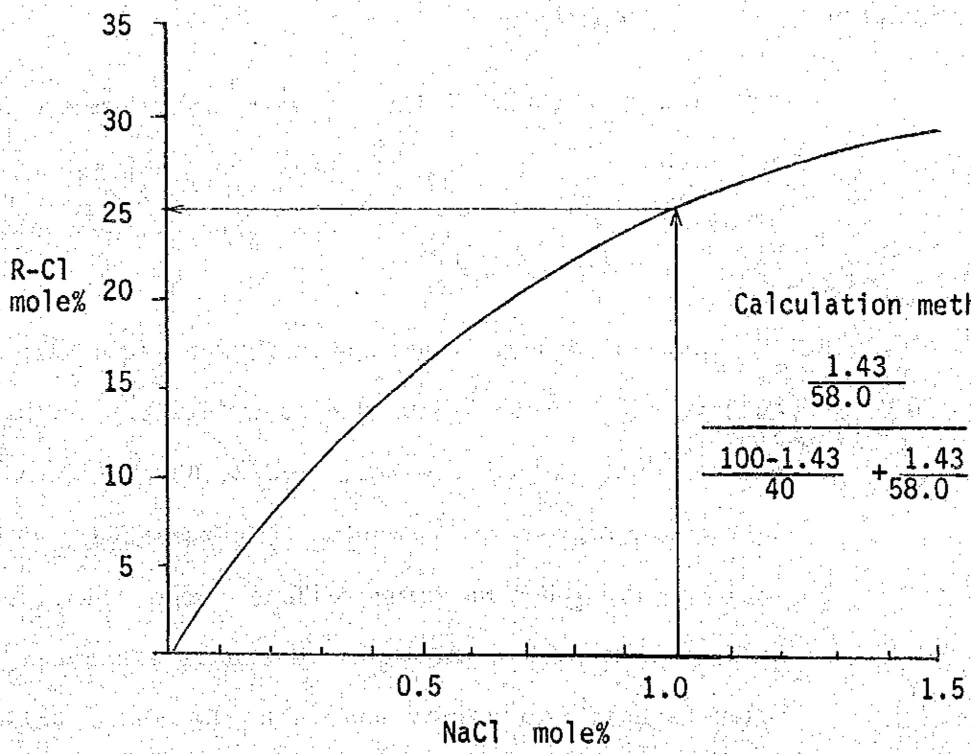
When cation pass conductivity becomes 0.5 micro S/cm, it will contain about 50 ppb as $CaCO_3$ of H^+Cl^-.

<u>Relation of Conductivity and HCl Concentration</u>

Conductivity (micro S/cm)	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
Conductivity (HCl ppb as $CaCO_3$)	8.8	22.5	35	46.8	58	68.6	78.3	88.5	97.3	105

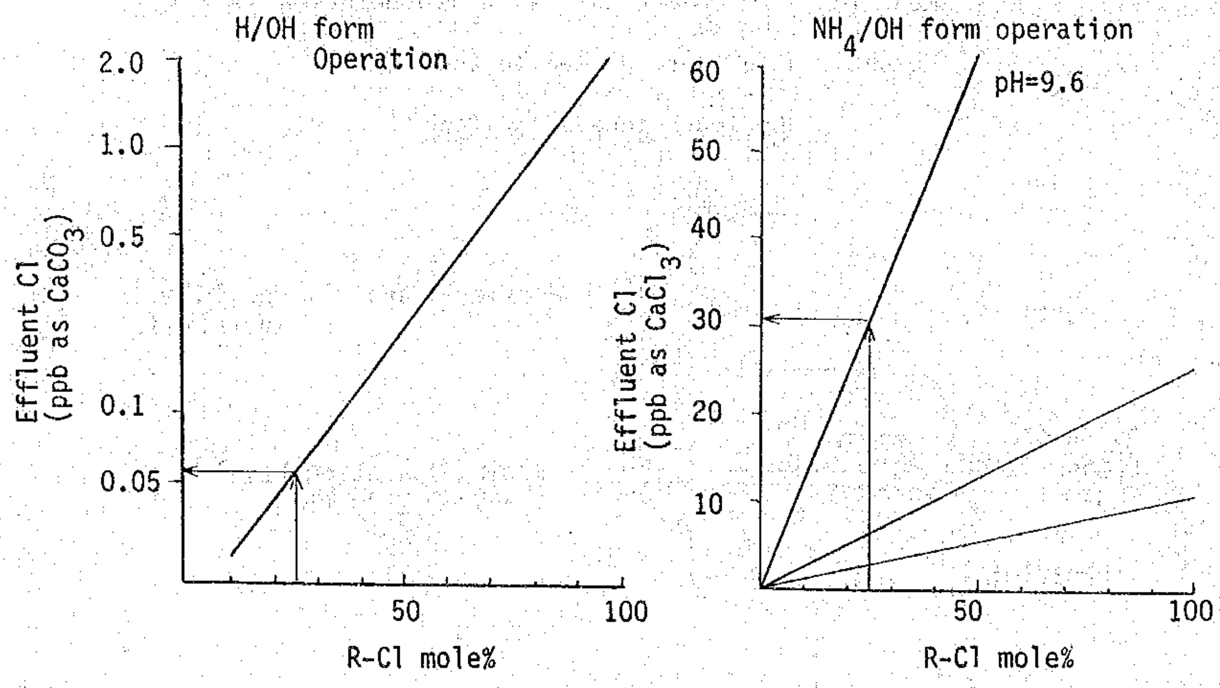
High Cl leak from ammonex could be attributed to the high NaCl percentage in the caustic regenerant. This is evident from the sample taken last August 18, 1982 (1.435% as NaCl/100% NaOH).

The relation of NaCl/NaOH, R-Cl, HCl concentration are shown below:



Calculation method of mole%

$$\frac{\frac{1.43}{58.0}}{\frac{100-1.43}{40}+\frac{1.43}{58.0}} \times 100 = 1.0$$



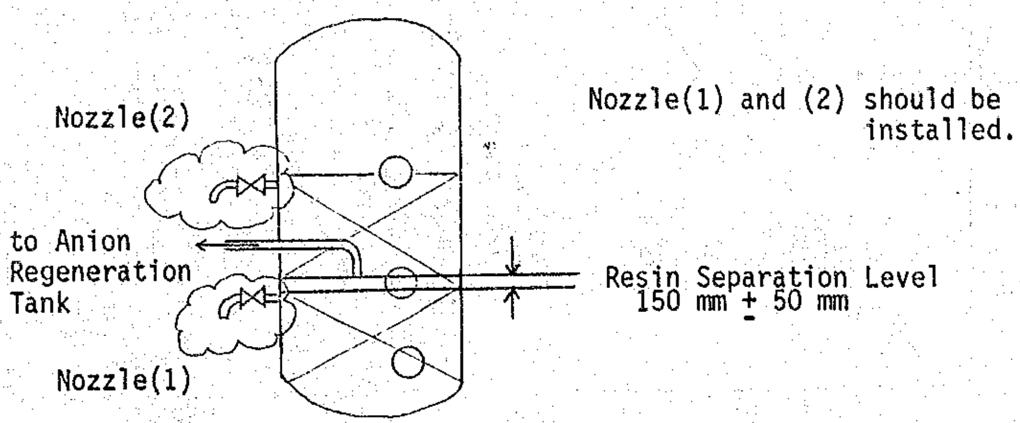
Therefore, Cl content from ammonex depends on NaCl/NaOH and also of condensate pH value in resin layer. During the survey, it was confirmed that conduc tivity of condensate polisher at S-1 become 0.19 micro S/cm in H/OH form operation. However, in H/OH form operation, there is no leakage of Cl.

Furthermore, Na^+ is also found leaking high from ammonex effluent. It is caused by high mixed percentage of cation resin in anion resin layer after the transfer from cation regeneration tank to anion regeneration tank.

in Japan, resin separation level is strictly kept within 150 mm ± 50 mm under the center of outtake nozzle in cation regeneration tank after resin separation. Refer to figure shown in next page.

If the resin separation is not well done, adjustment of resin level in cation regeneration tank must be undertaken as specified in the figure.

<u>Cation Regeneration Tank</u>



In ammonex, permissible values of R-Na, R-Cl and $R\text{-}SO_4$ after regeneration are shown below:

R-Na	Less than 0.3%
R-Cl	Less than 2%
$R\text{-}SO_4$	Less than 20%

In order to get higher water quality, the following items should be observed. (JICA team recommendation)

i. Perform strictly adjustment of resin separation more strictly.

ii. Change caustic soda quality as specified (less than 0.1/NaOH/100% NaOH)

iii. Control condensate pH as specified (pH 9.3).

iv. Operate condensate polisher in H/OH form (especially during boiler turbine start-up or during condenser leakage.)

(b) Caustic Introduction & Displacement Temperature

The maximum operating temperature of anion exchange resin in R-OH form is 60°C but in case of NAPOCOR, it is between 110-120°F (43-48°C). In Japan, heating temperature is controlled in 53 ± 3°C in order to remove effectively SiO_2 adsorped in resin layer.

(c) Resin Traps of Condensate Polisher Outlet

The resin traps at each condensate polisher (ammonex) outlet must be installed in order to trap effluent resin caused by damaged collectors.

Attached Figure 5C-13 is one of resin trap drawing which is used for condensate polisher in Japan.

(d) Instrumentation

As a result of our investigation, the instruments of all for monitoring and the control system for automatic operation are out of order. Therefore, JICA team recommends that the conductivity meters and recorders should be replaced to newest model in order to operate the condensate polisher by conductivity control of the effluent.

Gardner - 2 Condensate Polisher Outlet; 3 sets electrodes with recorder

Snyder - 1 Condensate Polisher Outlet; 3 sets electrodes with recorder

Snyder - 2 Condensate Polisher Outlet; 4 sets electrodes with recorder

Malaya - 1 Condensate Polisher Outlet; 4 sets electrodes with recorder

All of the flow meters, recorders and counters should be replaced/repaired in order to determine correctly the service duration of condensate polishers irregardless of flow variation at Gardner/Snyder and Malaya Thermal Stations.

The control system for automatic operation should also be repaired/replaced in order to prevent operation failure of condensate polishing plant at Gardner/Snyder Thermal Station. This is with the exception of the regenerating equipment of Snyder-2.

(e) Crud Removal

In Japan, two (2) methods of procedures are employed for the iron removal in an exhausted resin of condensate polisher. These are as follows:

	Down Flow (ABRO)	Up Flow (Back Wash)
Procedure	(1) Air Scrubbing (2) Down Flow	(1) Air Scrubbing (2) Back Wash (LV - 9m/H)
Demerit	Under collector clog with crud and difficult to remove crud completely.	Much water is needed
Effect of crud removal	Small	Big
No. of times repeated	20 - 30	3 - 5
Normal Operation (small deposited)	Effective	-
Start Up of Plant (Much deposited)	-	Effective

During unit start-up, much crude is deposited in the resin layer so that it must be removed completely. It is better to repeat air scrubbing and back wash until turbidity of waste water becomes less than 1.0 ppm. JICA team recommends up flow method for crud removal.

(f) H/OH Type Operations

The following table is a comparison of H/OH type and NH_4/OH type in ammonex operation (Condensate polisher).

When ammonex are operated in H/OH type, there will be shortage of regenerant water at Malaya Thermal Station because of frequent regeneration of exhausted resin.

In H/OH type operation, water consumption will be about 5 times and chemicals consumption will be 6 times in comparison with in Nh_4/OH type operation.

When an additional regeneration equipment is installed for G-2, JICA team recommends that condensate polishers of G-2 should also be replaced because of vessel deterioration.

Comparison of H/OH & NH_4OH Type Operation

	Gardner/Snyder TPP Condensate Polisher		Malaya TPP Condensate Polisher	
	NH_4/OH type operation	H/OH for operation	NH_4/OH type operation	H/OH type operation
Number of Polisher	2 (G-2) 2 (S-1) 3 (S-2)	each has 1 stand by unit	3 (M-1)	1 stand by
Regeneration Times/Month	7	42 (7 x 30/5)	3	18 (3 x 30/5)
Service Duration (days)	30	5	30	5
Expected Capacity (m^3/cycle)	228960	*37407	228960	*37407
Consumption of 66'Be H_2SO_4 (kg/month)	1316 (188 x 7)	7896 (188 x 42)	564 (188 x 3)	3384 (188 x 18)
Consumption of 100% NaOH (kg/month)	671.3 (95.9 x 7)	4027.8 (95.9 x 42)	287.7 (95.9 x 3)	1726.2 (188 x 18)
Consumption of 28% NH_4OH (kg/month)	712.6 (101.8 x 7)	-	305.4 (110.8 x 3)	-
Regeneration Water Consumption (m^3/day)	700 (110 x 7)	3528 (84 x 42)	330 (110 x 3)	1512 (84 x 18)
Regeneration Water Consumption (m^3/day)	26	118	11	50

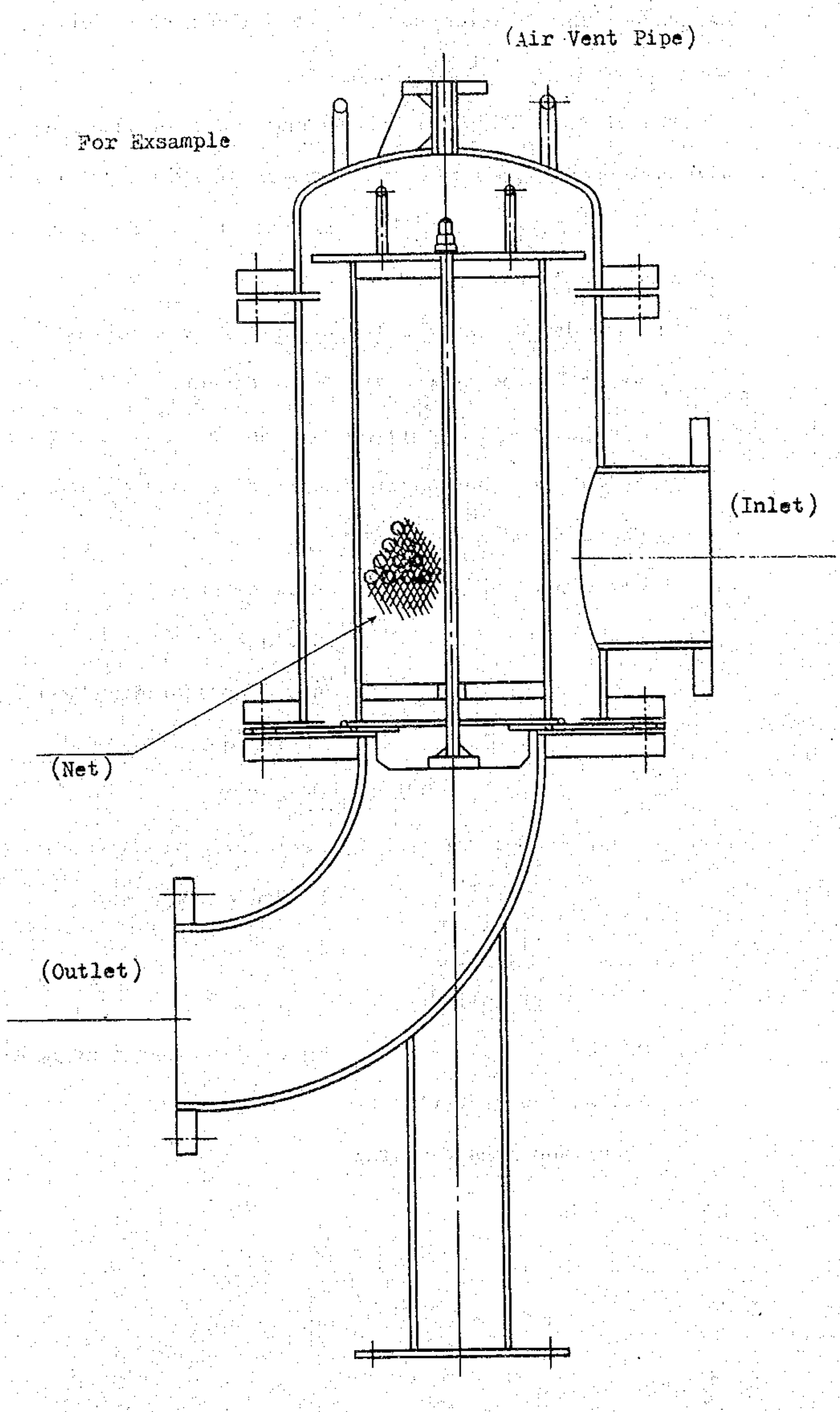
* Expected Capacity in H/OH type Operation

Example: $$5 \text{ days} = \frac{50 \text{ g as } CaCO_3 \text{ x } 1586 \text{ liter}}{} + (318 \, m^3/H \text{ x } 24H)$$

** 2.12 ppm as $CaCO_3$

** Condensate pH 9.3 -- NH_4^+

Fig. 5C-13 RESIN STRAINER (RESIN TRAP)
FOR CONDENSATER POLISHER



d. Maintenance (Overhauling)

The condensate polishing plants of Gardner/Snyder and Malaya Thermal Station has not been overhauled for years of operation.

Therefore, JICA team recommends that overhauling of all condensate polishing plants should be performed as soon as possible according to the following item d. (Maintenance Manual)

Maintenance Manual (Annual Inspection or Overhauling)

(a) Rotating Equipment (Motor, Pump, Blower)

Inspection and overhauling should be performed in accordance to the manual submitted by manufacturers.

Check Items

i.	Gland packing	Replace it
ii.	Bearing	Replace it if abnormal sound or vibration occurs during operation Grease up.
iii.	Shaft & Impeller	Replace it if shaft is bended or impeller is damaged.

After Overhauling

iv.	Megger	To be more than 1 mega ohom
v.	Adjust the centering of motor and pump coupling.	

(b) Sequence Test of Control System for Automatic Operation

Make sure open/close of air actuating valves are in accordance with the operating sequence chart of programmer.

(c) Instruments:

(Conductivity Meter, Flow Meter, Differential Pressure Indicator, Tank Level Gauge, Flow Control Valve, Recorder, etc.)

Perform the calibration of these instruments attached on the control panel in accordance with the manual issued by manufacturers.

Calibration	Adjust 0 (zero) point
	Adjust span (slope) point
P.I.D. (or gain)	Adjust PID operation (or gain) while operation

(d) Valve

Disassemble all valves and check the following items.

Diagram	Replace it if damaged
Valve sheet	Replace it if damaged
O-Ring	Replace it if damaged

(e) Tank

(Condensate Polisher, Cation Regeneration Tank, Anion Regeneration Tank and Resin Storage Tank)

Perform tank inspection after each resin have been transferred to the next tank.

Check Item	
i. Sight glass	Clean up or replace it if damaged
ii. Collectors	Clean up by air blowing or replace it if damaged
iii. Distributors	Clean up holes or replace it if damaged and adjust horizontal level if declined.
iv. Bolts & Nuts	Tighten it if loosened.
v. Rubber-lined Internal Surface	Repair it if damaged.

(f) Adjustment of Resin Level

Carry out the adjustment of resin separation level in the cation regeneration tank in accordance with the following procedure. Refer to figure at next page.

Transfer the resins from condensate polisher to cation regeneration tank.

Perform the crud removal process and then resin separation.

Check the resin level in the cation regeneration tank.

*** Separation Level ***

If this level is higher than specified, take out some cation exchange resin from nozzle (1) while back washing.

If this level is lower than specified, put the additional cation exchange resin through manhole.

For Reference

Regeneration Procedure of the After-Cation-Column Resin

The after-cation-column resin has to be regenerated with HCl solution in every NH_4/OH form operation cycle.

The procedure for regeneration is as follows:

Regenerant

35% HCl solution 2.1 liter/liter-resin

Dilute 2.1 liter of 35% HCl to 10 liters of 7% HCl with demineralized water

Procedure:

Put one liter of cation exchange resin into column.

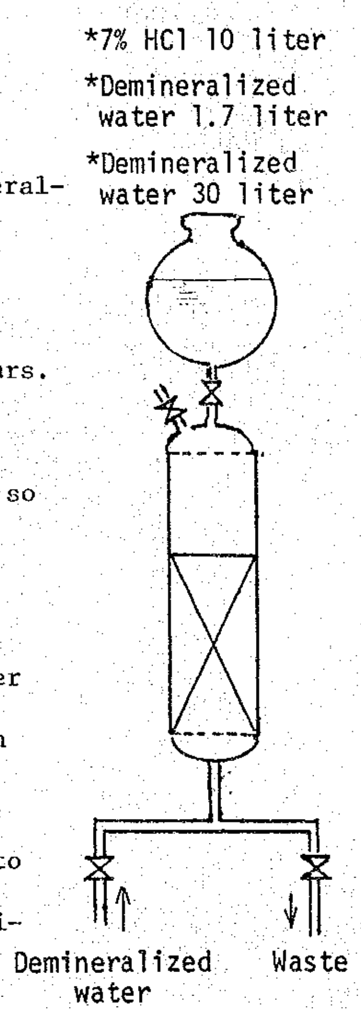
Carry out back wash process with demineralized water. 10 minutes (backwash)

Flow 10 liters of 7% HCl solution into column so as to finish within 2 hours. 120 minutes (acid introduction)

Flow 1.7 liters of demineralized water so as to finish within 20 minutes. 20 minutes (displacement)

Rinse the resin with demineralized water of 30 liters so as to finish within one hour. 60 minutes (rinse)

Make sure that waste water is changed to green color with methyl orange indicator at the end of rinse.



Take out the resin which has been regenerat-
ed and charge it into after-cation-
column of condensate polisher outlet.

*** Anion Resin Level ***

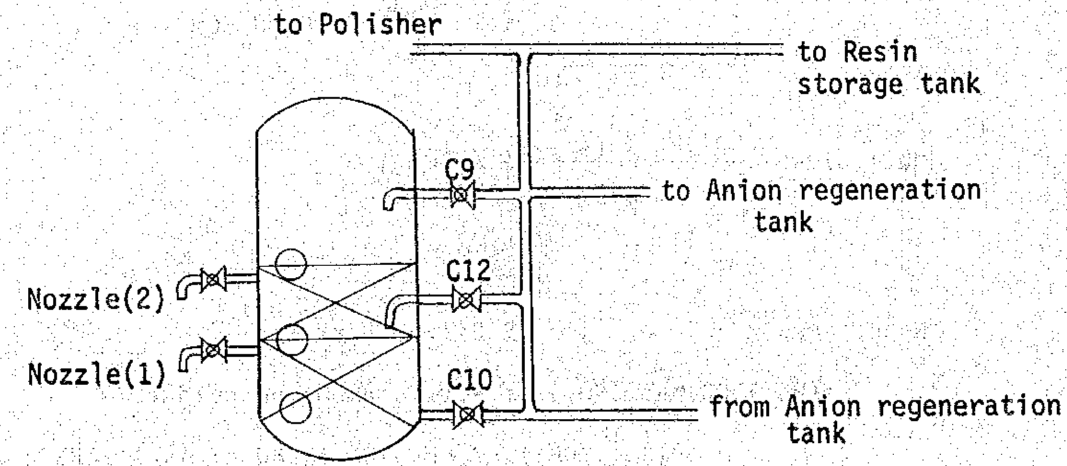
If anion exchange resin level is higher than specified, take out some of anion exchange resin from nozzle #(2) while back washing.

If anion exchange resin is lower than specified, put the new anion exchange resin through manhole.

(g) Regeneration

Perform regeneration by using twice the volume of regenerants (H_2SO_4 & NaOH) after addition of new resin.

Carry out the adjustment of resin level and perform regeneration by using twice the volume of regenerants in all resins of the condensate polishing plants during overhauling.



Cation Regeneration Tank

Note: As NAPOCOR plants do not have nozzle (1) and nozzle (2), it should be installed.

For Reference:

Analysis Method for NaCl Contained in NaOH (JIS-K1204)

Sample of 45% NaOH (Caustic Soda) solution

w g = 5ml x specific gravity x %/100

add some water

Phenolphthalein indicator

Titrate with (1+1)HNO_3 + excess 5 ml

Titrate with N/20 $AgNO_3$ --- A ml

Filtrate with No. 5 filter paper

Liquid Paper

Wash with (2+100) HNO_3

Liquid Paper

$(NH_4)_2SO_4$*$Fe_2(SO_4)_3$ indicator

Titrate with N/20 NH_4SCN --- B ml

$$NaCl(\%) = \frac{0.002923 \times (A - B)}{W} \times 100$$

Note: $AgNo_3$: Silver Nitrate

$(NH_4)_2SO_4$*$Fe_2(SO_4)_3$: Ferric ammonium sulfate

*10 g $(NH_4)_2SO_4$*$Fe_2(SO_4)_3$/80 ml + (1+2)HNO_3 10 ml

NH_4SCN : Ammonium tiocyanate

6) Secondary Water Treatment

a. Chemical Injection Equipment

Each unit have an individual chemical injection equipment. When tank level is low, chemical is charged and is diluted by manual operation. Concentrated hydrazine tank for the system lay-up should be installed as is being done in Japanese power plants.

b. Chemical Feed Control

In Gardner/Snyder and Malaya Thermal Power Station, stroke of ammonia pump is adjusted manually base on the result of pH analysis. When pH meters are out of order, stroke of ammonia pump is adjusted manually on the basis of alkalinity obtained from the analysis.

For hydrazine, injection rate for all stations is based mostly on the results of analysis obtained. Rate of phosphate injection is also based on the result of analysis for drum type boilers. It is only at Gardner-1 that pH control is adjusted by the addition of morpholine.

Concentration of dissolved chemicals are not always constant and variation occurs at some other time. Records on the amount of consumed chemicals reflected in the daily water analysis reports are not collected monthly.

c. Management of Chemicals

Reference-6, -7, -8 and -9 shows NAPOCOR specification for liquid ammonia, aqua ammonia, morpholine and hydrazine respectively. Reviewing the NAPOCOR specifications for these chemicals, impurities are not specified, therefore, efficiency, of QA/QC could not be expected. It is only the hydrazine specification that 0.03% of chloride meets the Japanese specifications.

d. Recommendation

Additional hydrazine tank and pump for the system lay-up must be installed aside from the existing hydrazine tank and pump being used in normal operation. Suitable hydrazine concentration to be used for the system lay-up must be about 15-20% as N_2H_4-H_2O.

Automatically chemical injection should be installed to keep the water quality conform with the specifications. chemicals should be injected automatically based on the reading of the monitoring device for the system. An example of this automatic chemical injection is shown on the attached figure 5C-14.

Hydrazine injection is adjusted based primarily on two parameters, that is, one is on the continuous flow rate of deaerator inlet water and the other is by the residual hydrazine at the deaerator inlet.

Ammonia injection is adjusted also on the continuous measurement of the flow rate and the other is by the conductivity measurement at the deaerator water inlet.

Chemicals should be prepared through automatic control hence, chemical solution of hydrazine injected to the system must be prepared by means of a measuring tank likewise ammonia solution must also be prepared by measurement of the solution conductivity.

Ammonia injection should be adjusted based on the measurement of the conductivity in feed water. Ammonia concentration, pH and conductivity are related to each other as per Figure 5C-4. In this figure, measurement of each value can easily be obtained.

Specification of: hydrazine, ammonia, trisodium phosphate, disodium phosphate and morpholine should be based on American Chemical Society for reagent grade chemicals. As an example, the specifications of Ammonium hydroxide is shown in Table 5C-29. JIS specifications of hydrazine is shown in Table 5C-30. In Table 5C-31, it shows results of analysis on the impurities of hydrazine and ammonia used in plant at Kyushu Electric Power Co. of Japan.

Records on the amount of consumed chemicals for each unit reflected daily on the water analysis report should be collected and recorded monthly.

Chemicals for boiler used should be stored properly. If possible there should be a separate storage for chemicals alone. Chemicals must be kept at a safe place free from unfavorable damaged caused by natural calamities like water, fire and other hazards which might affect the efficiency of chemicals.

Figure 5C-14 CHEMICAL INJECTION SYSTEM (Example in Japan, Once-through)

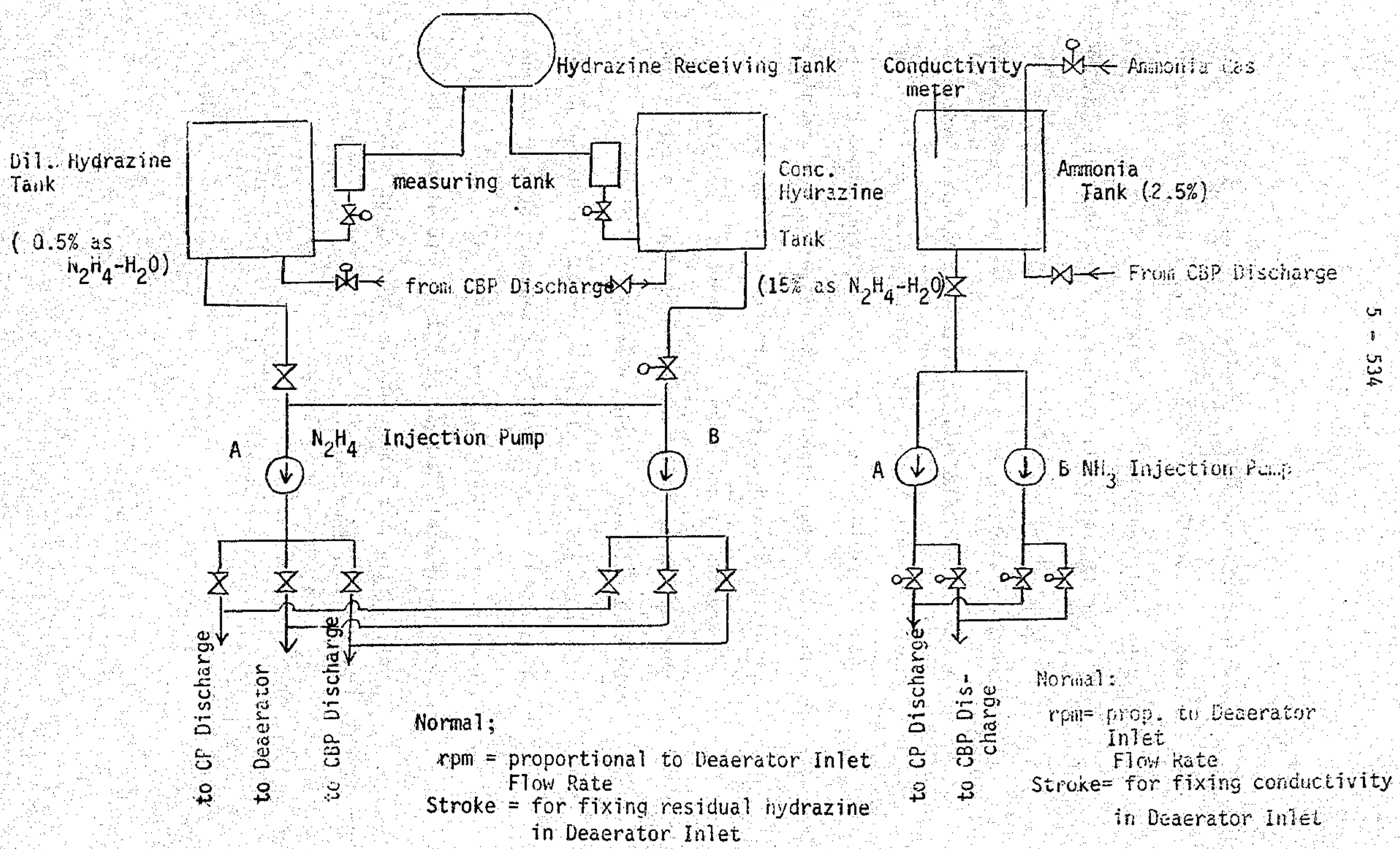


Table 5C-29 AMMONIUM HYDROXIDE

AMMONIUM HYDROXIDE

PO Spec 5220788 through BC
Revision B
Federal Code Identification No. 79500

Westinghouse Corporate Standards
Research and Development
October 5, 1973

PO Spec Designation	Previous PO Spec	Description
5220788	5005-1	Ammonium hydroxide, CP grade, purchased by brand
522078C	5005-2	Ammonium hydroxide, reagent grade

NOTE

Unless otherwise specified, the following requirements apply only to 522078C.

No change shall be made in the quality of successive shipments of material furnished under this specification without first obtaining the approval of the purchaser.

Physical Properties and Tests

SPECIFIC GRAVITY - 0.896 to 0.902 at 15.8° C/15.6°C (60°F/60°F)

APPEARANCE - Colorless and free from suspended matter or sediment.

Chemical Properties and Tests

CHEMICAL COMPOSITION - American Chemical Society (ACS) reagent grade ammonium Hydroxide.

	Percent, by Weight
Ammonia (NH_3) content	28.00 - 30.00
Carbon dioxide (CO_2), maximum	0.002
Residue after ignition, maximum	0.002
Chloride (Cl), maximum	0.00005
Phosphate (PO_4), maximum	0.0002
Arsenic (As), maximum	0.0005
Total Sulfur (as SO_4), maximum	0.0002
Heavy metals (as Pb), maximum	0.00005
Iron (Fe), maximum	0.00003
Substances reducing permanganate	Pass ACS test
Pyridine	Pass ACS test

Table 5C-30 JIS SPECIFICATION FOR HYDRAZINE HYDRATE
(Reagent Grade)

I t e m	Percent by Weight
Non-volatile Matter, maximum	0.01
Chloride (Cl), maximum	0.001
Sulfate (SO_4), maximum	0.005
Heavy metals (as Pb), maximum	0.0005
Iron (Fe), maximum	0.0005
Content , minimum	98.0

Table 5C-31 ANALYSES DATA OF IMPURITIES IN HYDRAZINE AND AMMONIA
(Example in Kyushu Electric)

Item	NH4OH (30%)	N2H4.H2O (80 %)	Testing Method
Na (ppm)	0.06	0.16	Atomic Absorption-Spike Sample
Cl (ppm)	0.2	0.2	Evaporation residual - Mercuric Thiocyanate
Heavy Metals (as Pb) (ppm)	< 0.2	< 0.2	Evaporation residual-colorimetric with sulfide
Residual after Evaporation(ppm)	< 10	< 10	
Pb (ppm)	< 0.1	< 0.1	AA - Spike Sample
Zn (ppm)	0.05	< 0.02	-ditto-
Cd (ppm)	< 0.02	< 0.02	-ditto-
Hg (ppm)	< 0.005	< 0.005	Flameless A.A. - Spike Sample
Zn (ppm)	< 0.1	< 0.1	Evaporate residual - Colorimetric
Sb (ppm)	< 0.01	< 0.01	-ditto-
Ca (ppm)	< 0.5	< 0.5	AA - Spike Sample
Mg (ppm)	< 0.05	< 0.05	-ditto-

Reference - 6 Ammonia Anhydrous

COMMON NAME : LIQUID AMMONIA

CHEMICAL FORMULA : NH_3

1. General Requirements

   a) The liquid ammonia shall be of the highest chemical purity, anhydrous, with any one container averaging not less than 99.9% pure, and shall contain no adulterants or of anything of a deleterious nature. It shall not contain more than traces of carbon dioxide and air.

   b) The residue upon evaporation of 100 ml, shall not be greater than 0.02% by weight.

   c) The gas shall be pumped to 1800 pressure in a standard 220 cu.ft. cylinder.

   d) The male connected fitting must be right hand throaded and must have a 14 thread/inch. pitch.

   e) The upper part of the cylinder (1/5 of the cylinder) shall be colored navy blue and the lower part royal blue as per industrial standards.

   f) All cylinders must be marked with Tare Weight.

   g) All cylinders must be properly capped. Those without case will not be accepted.

2. Supplier's Analysis and Identification

   a) The manufacturer shall submit a typical analysis of material being offered.

   b) Each container shall be plainy marked with the name of product, formula and content of active impedient. Manufacturer's name shall appear on all containers.

c) Each container shall carry the caution label in respect to handling and storage.

3. Rejection

a) NAPOCOR reserves the right to reject any or all of the material that fail to meet any of the above requirements.

Reference - 7 Ammonium Hydroxide

COMMON NAME : Aqua Ammonia

CHEMICAL FORMULA : NH_4OH

1. General Requirements

   a) The chemical needed under this specification shall be technical grade ammonium hydroxide.

   b) It shall be free from suspended matter.

   c) It shall contain 25% NH_3.

2. Supplier's Analysis and Identification

   a) Manufacturer shall submit a typical analysis of the chemical being offered.

   b) Each container shall be marked with the name of product and manufacturer.

   c) Each container shall carry the CAUTION label in respect to handling and storage.

3. Rejection

   a) Failure of the sample to conform to requirements of this specification shall be cause for rejection.

Reference - 8

COMMON NAME : Morpholine

CHEMICAL FORMULA : C_4H_9NO

1. General Requirements

   a) The material offered shall be clear, nearly colorless solution with a characteristic ammoniacal odor.

   b) Distillation range of material offered shall be from 110°C to 132°C at 760 mm Hg.

   c) The seals of the sample containers shall not be tampered.

   d) The material furnished under this specification shall contain not less than 91% morpholine by weight.

   e) The flash point determined by cleveland open cup method shall not be less than 109°F and a 40% by weight solution in water shall not flash.

   f) Surface tension of the material furnished shall be 41 dynes/cm.

   g) A 1% solution by weight in freshly boiled cooled distilled water shall have a pH value of about 10.6.

2. Supplier's Analysis and Identification

   a) Manufacturer shall submit typical analysis of material being offered.

   b) Each container shall be plainly marked with name of product. Manufacturer's name shall appear on all containers.

   c) Each container shall bear the CAUTION label in respect to handling and storage.

3. Rejection

a) Failure of any representative sample to conform to requirements of this specification shall constitute cause for rejection.

Reference - 9 Hydrazine

COMMON NAME : Hydrazine

CHEMICAL FORMULA : N_2H_4

1. General Requirements

   a) The material desired under this specification is technical grade hydrazine.

   b) The hydrazine shall be colorless liquid.

   c) The seals of the sample containers shall not be tampered.

   d) The product shall contain 35% hydrazine corresponding to 54.7% hydrazine hydrate ($N_2H_4.H_2O$)

   e) The hydrazine shall not contain more than 0.03% chloride.

   f) The flash point (open cup method) shall not be less than 193°F and fire point shall not be less than 204°F.

   g) The pH value of a 1% solution of hydrazine shall be around 9.9.

2. Supplier's Analysis and Identification

   a) The manufacturer shall submit a typical analysis of the material being offered.

   b) Each container shall be plainly marked with the name of the product. Manufacturer's name shall appear on oil containers.

   c) Each container shall bear the CAUTION label in respect to handling and storage.

3. Rejection

   a) Failure of the sample to conform to requirements of this specification shall constitute a cause for rejection.

7) Sampling Rack

a. Result of Survey

The actual condition of the sampling rack of GSTP and MTP are shown in Table 5C-32. Except for M-2, most of the sampling points have no sample flowing. If there is sample flowing, its temperature is very high and the flow is uncontrollable. The flow rate of the sample is very important in crud analysis. The said analysis is not done daily. This might be the reason why the flow rate is not adjusted suitably. As stated above, the temperature of the sample is very high due to lack of proper cooling. In this case, the sample could not be considered representative. The analysis of pH, conductivity, hydrazine and ammonia are greatly influenced by the sample temperature. Dissolved oxygen in hot water is impossible to analyze.

The sampling rack in all units have rather bad environments. SO_2 gas contents near the sampling rack at M-2 seem to be very high. The sample is exposed to contamination. Maintenance of the sampling rack is very important to be able to get a representative sample. But it is not done properly. The sampling line has no label indicating its source. The sampling line should be flushed periodically to prevent adhesion of the crud on the tube. This procedure is not being done in the plant.

Table 5C-32-1 SAMPLING RACK AND MONITORING (GARDNER 1 & 2)

Gardner - 1

		Manual
1.	HSCC (House Service Closed Cycle)	O
2.	Condensate	O
3.	Condensate after Heater	X
4.	SH Outlet	O
5.	Saturated Steam	O
6.		X
7.	Boiler Saline	O
8	Condensate after Heater	O
9.	HP Feed Water	O

Table 5C-32-1 SAMPLING RACK AND MONITORING (GARDNER 1 & 2)

Gardner - 2

(Overhauling)	(Sample valves were already repaired) Manual	Na Monitor
1. High Pressure Heater Drips Flow (HP Drain)		
2. Hot RH Steam		
3. RH Inlet		
4. Main Steam		
5. Feed Water before Economizer	cannot check	
6. Condensate before Deaerator		
7. Deaerator		
8. Condensate Discharge Outlet	at laboratory	0 (at laboratory)
9. Boiler Water wall Header		
10. Boiler before Attempt heater		
11. HSCC		
12. Ammonex Outlet		0 (at laboratory)

REMARKS:

0 = sample flowing

X = no flow

Table 5C-32-2 SAMPLING RACK AND MONITORING (SNYDER 1 & 2)

Snyder - 1

	Manual	Na Monitor
1. HSCC	X	
2.	X	
3.	X	
4. Eco inlet	0	
5.	X	
6.	X	
7. CP Discharge	at laboratory	0 (at laboratory)
8. Main Steam	0	
9. Flash Tank	X	
10. Hot RH South	X	
11. Water Wall	X	
12. Hot RH North	X	
13. Ammonex Outlet	0 (individual beds, at local)	0 (at laboratory)

Table 5C-32-2 SAMPLING RACK AND MONITORING (SNYDER 1 & 2)

Snyder - 2

1.	Primary SH	X	
2.	Main Steam	0	
3.	Water wall	X	
4.	Deaerator Heater	X	
5.	Eco inlet	0	
6.	Cold RH	X	
7.	CP Discharge	at laboratory	0 (At laboratory)
8.	Flash tank	0	
9.	Hot RH	X	
10.	Auxiliary condenser	X	
11.	EXT. HP. Htr. B	X	
12.	HSCC	0	
13.	Deaerator inlet	0	
14.	Ammonex outlet	0 (individual beds, at local)	0 (at laboratory)

REMARKS:

0 = sample flowing

X = no flow

Table 5C-32-3 SAMPLING RACK AND MONITORING (MALAYA 1 & 2)

Malaya - 1

		Manual	pH	Na Monitor	SiO_2
1.	HSCC	0			
2.	Condensate to deaerator heater	X			
3.	Flash tank drain to condenser	X			
4.	Deaerator Storage tank	to lab.	0 (at lab)	0 (at lab.)	
5.	Boiler by-pass system to flash tank	X			
6.	Cold RH	X			
7.	H. RH	X			
8.	Main condenser	to lab.			0*
9.					
10.	H. RH	X			
11.	Water wall outlet mixing box	X			
12.	Main Steam	X			
13.	Main Steam	0			
14.	Boiler feedwater before Eco	X			
15.	Boiler feedwater before Eco	X			
16.	Main Condensate to Sink				
17.	HP Heater Drain	X			

REMARKS: 0 = Sample Flowing X = no flow

* = normally for demineralizer outlet

Table 5C-32-4 SAMPLING RACK AND MONITORING (MALAYA 1 & 2)

Malaya - 2

	Manual	Conductivity	pH	O_2	H_2
1. CP out left	0	0	Ø		
2. CP out right	0	0	Ø		
3. CP out Common	0	Ø	Ø		
4. Deaerator inlet	0	Ø	Ø	Ø	
5. Deaerator outlet	0	0	0	0	
6. Eco inlet	0	0	0	Ø	
7. Boiler saline	0	0	0		
8. Saturated Steam	0	Ø	Ø		Ø
9. SH	0	0	Ø		Ø
10. H. RH	X	0	Ø		Ø
11. C. RH	0	0	Ø		Ø

REMARKS: X = no flowing

0 = working

Ø = not working

pH Recorder = no chart

Condensate Recorder = no chart

O_2, H_2 = no chart

b. Recommendation

The basic specification of the sampling rack system should be based on the Preliminary Survey Report by JICA team (II-63, II-74, 75) and the "Report on Technical Services" by UTL team (pp. 2-180 to 2-184). The recommendation about the sampling rack system (including monitoring) for once-through and drum type boilers are shown in Table 5C-33 and 5C-34, respectively. The most important things are the temperature, flow rate and the pressure reducing mechanism. The sample temperature should be adjusted around 25°C. The corresponding flow rate should be high enough to supply the different monitoring instruments associated to it. The wire type system is better than the valve type as pressure reducing mechanism. The sampling rack is necessary for proper water quality management. In this regard, the sample to be used in the analysis should be the representative of the system. The sample flow rate should always be maintained constant and the sampling line should be flushed once a week.

Table 5C-33 SAMPLING RACK SYSTEM SPECIFICATION FOR GARDNER UNIT NO. 2, SNYDER UNIT NO. 1, 2 AND MALAYA UNIT NO. 1

(Once-Through)

Sampling Point	M	C	(C)	P	0	N	Tu
Main Condenser at CP Discharge	0	0	0		0		0
Deaerator Tank	0						
Deaerator Heater Inlet	0	0		0		0	
Boiler Feedwater befor Economizer	0		0	0		0	
Waterwall Outlet	0*						
Primary/Roof Superheater	0*						
Main Steam	0		0				
Hot Reheat Steam	0		0				
Cold Reheat Steam ,	0		0				
Flash Tank	0						
5th Feedwater Heater Drain	0						
Auxiliary Condenser	0	0					

Symbols
M = Manual
(C) = Cation Conductivity
0 = Dissolved Oxygen
Tu = Turbidity
C = Conductivity
P = pH
N = Hydrazine

NOTE: * = Exchangeable by selector valve

Table 5C-34 SAMPLING RACK SYSTEM SPECIFICATION

FOR GARDNER UNIT NO. 1 (DRUM)

Sampling Point	M	C	Ⓒ	P	O	N	S
Main Condenser at CP Discharge	0		0		0		
Condensate after Heater No. 3	0	0				0*	
High Pressure Boiler Feedwater	0		0	0		0*	
Boiler Saline	0		0				0
Saturated Steam	0		0				
Main Steam	0		0				
Reheater outlet	0		0				
Cold Reheater	0		0				
5th Stage Heater Drain	0						

SYMBOLS: M = Manual; C = Conductivity; P = pH; O = Dissolved Oxygen; N = Hydrazine; S = Silica; Ⓒ = Cation Conductivity

NOTE: * = Exchangeable by selector valve

When hydrazine injection became automatic, deaerator inlet should be selected.

8) Monitoring Instruments

a. Result of Survey

- Table 5C-32 [see 7) Sampling Rack)] shows the chemical monitoring instruments at GSTP and MTP. Except for M-2, monitoring instruments at other units are not working. Even at M-2, the maintenance of the instruments is not satisfactory and some monitors are not working. Some of the recorders have no chart paper so that the reading could not be preserved. Only M-2 unit has annunciator which is located at the control room.
- Recently, sodium monitors by Orion were installed for the condensate pump dischargers and ammonex effluents at G-2, S-1, S-2 and for the deaerator outlet at M-1. The above instruments are working well. At GSTP, there is no isolation valve before the sodium monitor. The condensate sample flow must be stopped prior to the inspection of the equipment.
- One silica meter is installed for the anion and mixed bed effluents and condensate pump discharge of M-1 which is located at the chemical laboratory of MTP. There is a selector valve so that the said sampling points are accommodated in one silica meter.
- Calibration or checking of monitor seems to be done, periodically. Sodium monitor is calibrated with the standard solutions of 10 ppb and 100 ppb every month.

b. Recommendation

- Continuous monitoring of the system water quality is of great importance and to maintain its efficiency, proper maintenance and management should be done. Our experience in Japan indicates that the chemical monitoring instruments are hard to maintain compared to the other instruments of the thermal plant. The chemical monitoring instruments are very delicate instruments that need proper maintenance to make them reliable. The said instruments should be checked frequently.
- Items and frequency of checking of the monitoring instruments should be standardized. The items to be included in the check list are the sample temperature, flow rate, detector, consumption of chemicals and practice of calibration, etc. The calibration should be done once a week. When the reading is different from the result of laboratory analysis, the calibration must be done immediately. The readings of each sodium monitor frequently drift or rise up over the alarm point. The change of span is not so big, so that the adjustment is estimated to be suitable at the frequency of once a month. Zero adjustment should be done at the frequency of at least once a week in order to minimize the drift. The reading should be checked by atomic absorption with the flameless atomizer periodically.

- The resin in the cation column for the cation conductivity monitoring must be carefully regenerated with the regular frequency in order to prevent exhaustion.
- Set points and the kind of chemical monitoring instruments are recommended in Table 5C-33, 34. It is desirable that the alarm is noticed in the control room.
- JICA team recommends the following improvements of the monitoring instruments at M-2 because it is not included in the new plan.
    - ₒ sample temperature: 23°C --- about 25°C
    - ₒ condensate pump discharge (see Table 5C-32)

	Manual	Conductivity	pH
CP outlet left*	X	X	X
CP outlet right*	X	X	X
CP outlet common	O	after cation**	O

* Usually closed, for the prevention of air inleakage. In case of high dissolved oxygen (DO) in CP outlet common, the sample should be taken individually.

** Cation conductivity monitor from hotwell could not be used.

- ₒ pH meter
    - condensate pump discharge
    - economizer inlet
    - boiler saline

- N_2H_4 monitor (new)

  Deaerator inlet and economizer inlet

  (exchangeable)

- Also at G-1, the cation conductivity monitor is proposed to be installed at the CP out for the rapid detection of condenser leakage.

9) Cooling Water Treatment

a. House Service Closed Cycle

Gardner/Snyder and Malaya Thermal Plants make-up to House Service Closed Cycle came from the condensate pump discharge. Its analysis is being done only once a week. Turbidity and dissolved oxygen are not being analyzed.

In the house service closed cycle, no chemical injection is done because its make-up came from the condensate pump discharge. An analysis of the above system revealed high concentration of dissolved oxygen and pH. Its presence will cause corrosion of copper alloy metal in the system. Below is the corrosion reaction process.

$$Cu_2O + O_2 \longrightarrow CuO$$

$$CuO + NH_4OH \longrightarrow Cu\ (NH_3)\ OH$$

Like in the case of Malaya-2 heat exchanger B, JICA team advised that leak test be done. Prior to the test 5 gals. (20 liter) of Hydrazine was injected to the house service closed cycle. An analysis of the system showed presence of 27 ppb N_2H_4 concentration which confirm the leak on the said heat exchanger. Inspection of the above revealed presence of 17 tubes leaking.

Below is the actual percentage of number of tubes plugged on Gardner/Snyder and Malaya Thermal Plants heat exchangers.

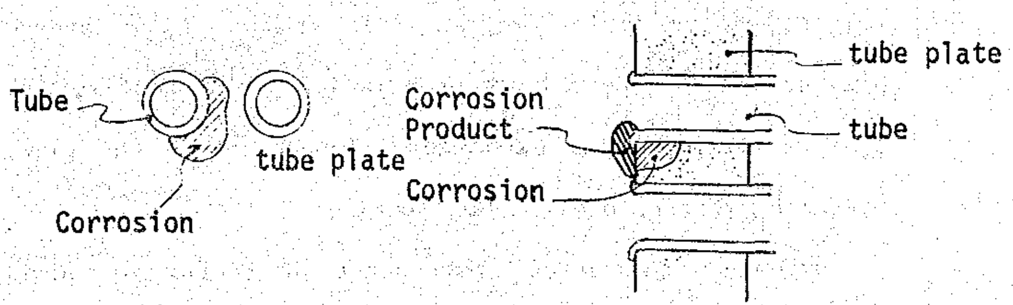
Table 5C-34 NUMBER OF PLUGGED TUBES OF HEAT EXCHANGER

		G-1	G-2	S-1	S-2	M-1	M-2
A	Number of Plugged Tube	29	110	2	117	10	696
	%	1.79	5.97	0.11	6.30	0.49	19.06
B	No. of Plugged Tube	261	92	124	118	16	67
	%	16.13	5.00	6.73	6.35	0.78	1.84
C	No. of Plugged Tube						55
	%						1.51

Results of inspection of Malaya-2

2B heat exchanger

The heat exchanger tubes and tube plate were found to be covered with mud deposits. The plate surfaces had a maximum corrosion depth of 1 cm. Below is the diagram of the heat exchanger with mud deposits.



It was also observed that the zinc metal cathodic protection was not consumed. The unit was in operation since 1979 and its cathodic protection did not change its size with water.

The heat exchanger was hydro tested by filling the shell side with water. The tubes and tube plate were not cleaned. During the process of testing, it was observed that the tube plate was all wet. JICA team is in doubt in the certainty of the leak test.

RECOMMENDATION

i. Water Quality Management of HSCC

The house service closed cycle should be properly treated in order to avoid corrosion on the system. The pH, dissolved oxygen, hydrogine and turbidity should always be monitored. Hydrazine concentration of 0.5 to 2.0 ppm should be maintained so that presence of dissolved oxygen will be eliminated. The pH limit of 8.5 to 9.0 should always be followed.

During normal operation, if there is a big consumption of hydrazine in the system. The dissolved oxygen should be checked. Likewise, leak test on the heat exchanger should be done.

ii. Corrosion Protection Method

Inspection of Malaya-2 heat exchanger B showed corrosion on the tube plate surfaces. It should be protected with its cathodic protection. The Zinc metal installed since 1979 did not change its size which indicated that it is not the right material or it is not properly installed.

iii. Hydrostatic Test

Before hydrostatic testing of the heat exchanger, the tube plate and tubes should be changed and dried. In this manner, small leak could easily be seen.

Figure 5C-15 INSTALLED METHOD OF ZINC PLATE

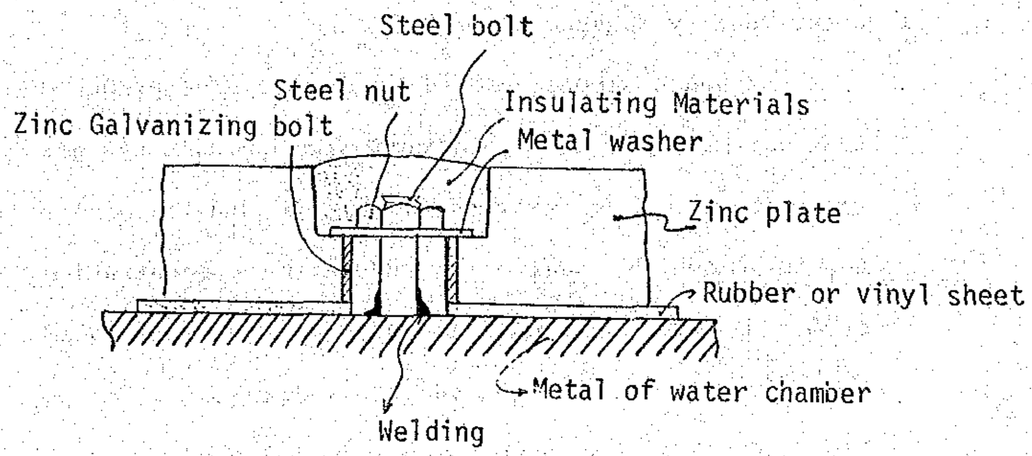


Table 5C-35 DAILY WATER ANALYSIS REPORT REGARDING TO HOUSE SERVICE CLOSED CYCLE (Gardner/Snyder Plant)

	Month Day	9/9	9/2	9/1	8/28	8/22	8/20	8/19	8/18	8/17	8/16	8/15	8/14
	Unit	S-1	G-1	S-1	S-1	G-1	S-2	S-2	G-1	G-1	S-1	S-2	G-1
P. Alkalinity	ppm CaCO3	6	2	2	3	2		3	2	2	2	2	2
M.O. Alkalinity	ppm CaCO3	12	8	8	7	8	8	8	8	7	7	7	8
Chloride	ppm NaCl	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate	ppm Na2SO4	0	0		0	0	0	0	0				
Total Hardness	ppm CaCO3	0	0	0	0	0	0	0	0	0	0	0	0
Ca Hardness	ppm CaCO3	0	0	0	0	0	0	0	0	0	0	0	0
Mg Hardness	ppm CaCO3												
Silica	ppm	0.015	0.18	0.09	0.089	0.095	0.12	0.175	0.085	0.061	0.05	0.075	0.10
Water Temperature	^oC	28	27	28	26	26	27	28	26	28	27	27	
Sodium Chromite	ppm Na2CrO4												
pCa													
pAlk													
C at Tw													
pHs													
Actual pH		9.1	9.1		9.1	9.1	9.2	9.2	9.1	9.0	9.1	9.0	9.0
pH - pHs (SI)													
Cunductivity	uS/sm												
Turbidity	ppm	0											
Total Solids	ppm												