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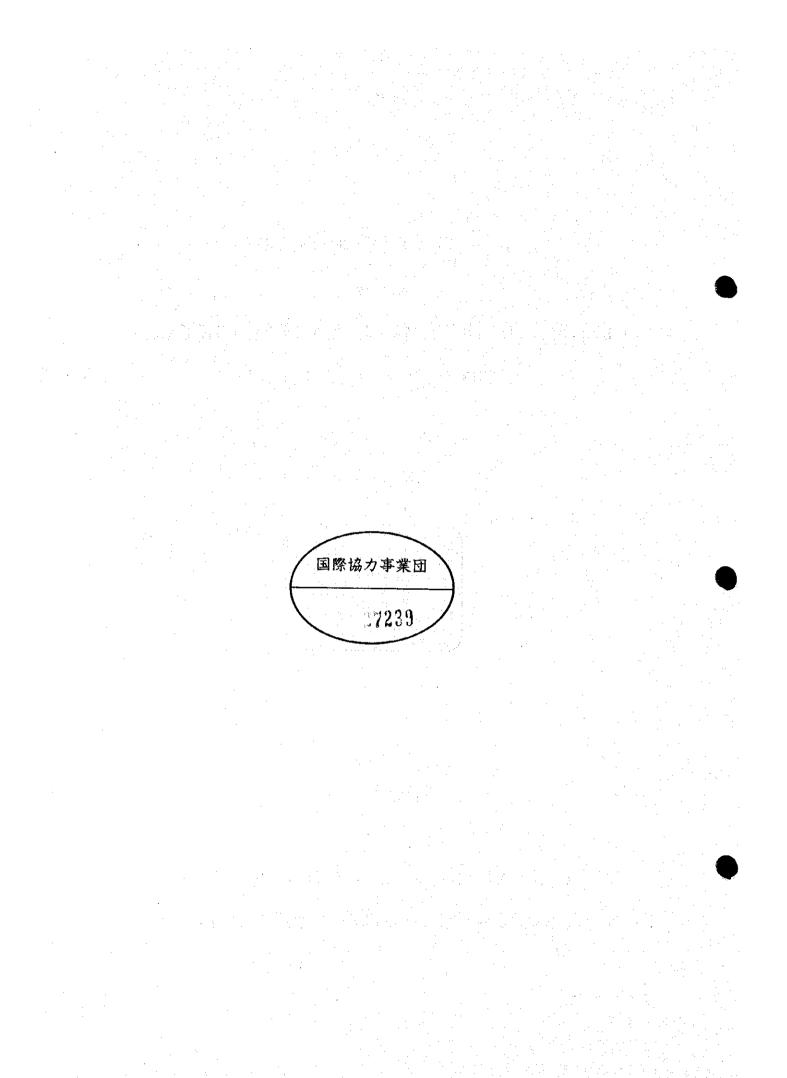
THE PROJECT OF THE SEAWATER DESALINATION TECHNOLOGY IN THE KINGDOM OF SAUDI ARABIA

FINAL REPORT (APPENDIX)



FEBRUARY 1995

JAPAN INTERNATIONAL COOPERATION AGENCY SALINE WATER CONVERSION CORPORATION



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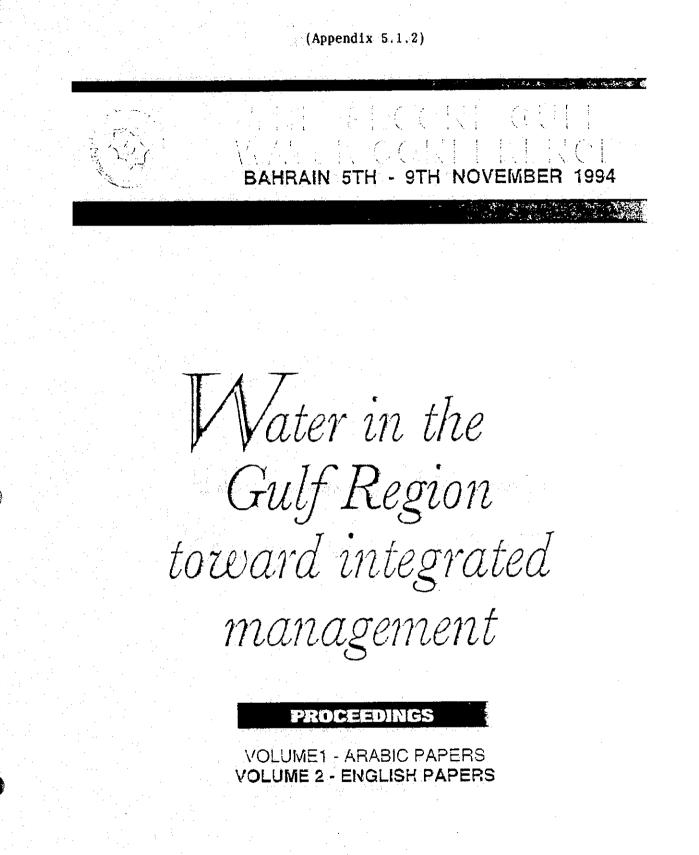
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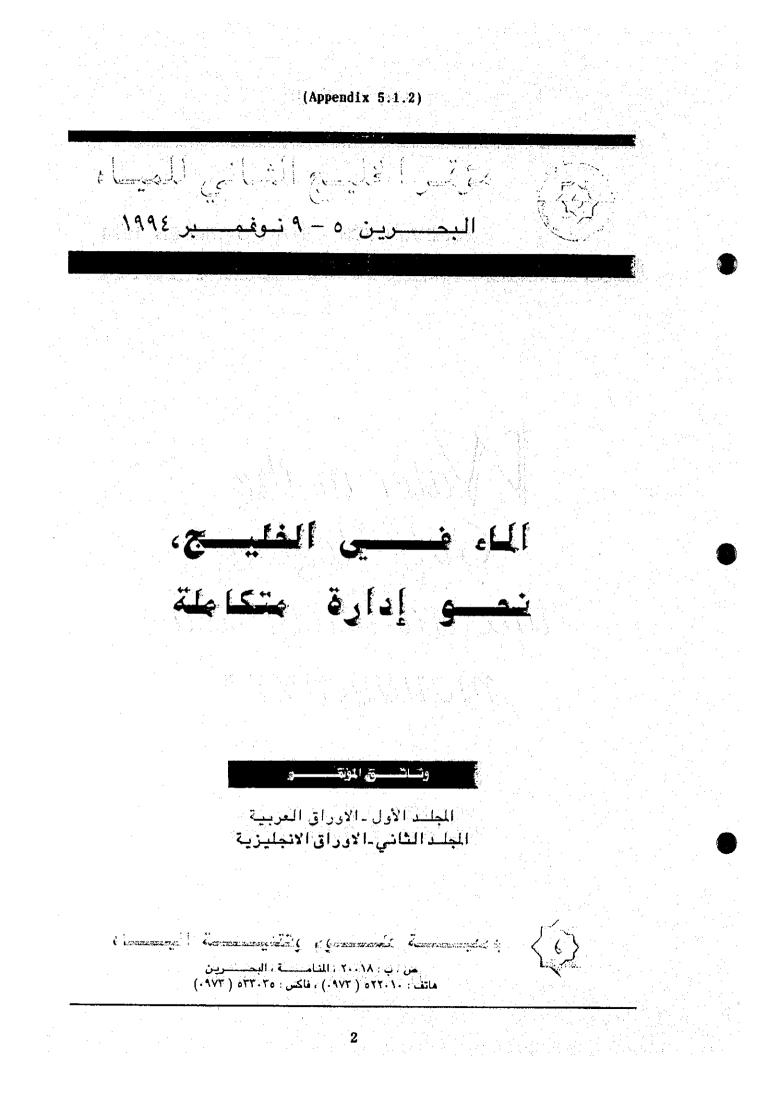
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Presentation to Academic Circles (Experiment for Selection of Scale Inhibitor)



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LABORATORY TESTING OF ANTISCALANT THRESHOLD EFFECTIVENESS

BY

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ABSTRACT

This paper reports laboratory test results carried out to study antiscalant threshold effectiveness. The primary objective of these tests were to establish some reference points to be used as a base for initial evaluation and selection of antiscalants for further testing in a single heat exchanger tube testing. These results are intended to be used for evaluation and selection of antiscalants for MSF Pilot unit.

These bench top tests indicate Magnesium hydroxide precipitation is not time dependent unlike calcium carbonate in the presence of antiscalant in brine solution at pH of 8-9. They also indicate that most antiscalants are effective for up to 20 minutes at 95°C with up to 2 parts per million concentration. While at higher temperature of 110°C this effectiveness dropped down to less than 10 minutes. Furthermore, no major difference was noted on effectiveness at 95°C for a range of antiscalant concentration of 1-2 ppm.

INTRODUCTION

In seawater desalination predominant scales are of calcium combining with either carbonate or sulfate, and magnesium combining with hydroxide. Calcium forms hard scale when it combines with sulfate, but this reaction is of appreciable magnitude only at temperatures of 121°C or more. Calcium sulfate scale can therefore be avoided if operating temperature is maintained below the said value (<121°C). On the other hand calcium and magnesium form softer scales with carbonate and hydroxide (respectively) at lower temperatures and brine concentration of 65000 ppm (or less). In distillation process where temperatures are maintained below 121°C, CaCO₃ and Mg(OH)₂ forma-

1 JICA Researchers working at Al-Jubail, Saline Water Conversion Corporation (SWCC) Research & Development Center (RDC) under cooperation agreement between SWCC and Japan International Corporation Agency (JICA).

tions are controlled by either chelation or depletion. In depletion process carbonate is decomposed down to CO_2 through reaction with acid e.g. H_2SO_4 or HCl. In this process, seawater make up pH drops down to 7.8 or less after CO_2 removal in the decarbonator. Multi Stage Flash (MSF) evaporators which are in operation in Gulf Cooperation Council (GCC) states are being mostly operated with additive treatment at top brine temperatures well below the said value (TBT < 121^{0} C). Further limiting factors of TBT are the capabilities of available additives [1].

EXPERIMENTAL SETUP AND PROCEDURE

1. Reagents Preparations

(a) Sodium carbonate solution:

53 grams of Na_2CO_3 powder was weighed and dissolved in 1L of deionized water to prepare IN solution.

(b) Stock Solutions of antiscalants:

0.5 gram of each antiscalants were weighed accurately and dissolved in 500. ml of deionized water in order to give 1000 ppm stock solutions.

(c) Artificial Brine:

(i) Chemicals used for preparation & mixing ratio:

Chemical A: NaCl

Chemical B: INSTANT OCEAN (a registered commercial name of mixture of salts)

Mixing ratio should be adjusted based on the following ratio: NaCl/INSTANT OCEAN = 1.375

(ii) In order to prepare artificial brine with a concentration equals 1.4 times that of seawater, approximately 8.8 grams of NaCl and 6.4 grams of INSTANT OCEAN were dissolved in unlitered seawater. M-Alkalinity of final solution was adjusted to 180 ppm by dissolving more salts or by diluting with seawater.

(Appendix 5.1.2) Instruments For Analysis & Measurements

- (a) pH meter (Fisher brand Model 825 MP) equipped with glass reference electrode to measure pH of solutions.
- (b) Automatic Titrator (Fisher brand Model 465) to measure M-Alkalinity.
- (c) Atomic Absorption Spectrometer (Varian Model AA-975) for Ca and Mg analysis.

3. Experimental Apparatus

2.

(a) Low temperatre experimental apparatus:

As shown in Figure 1, the apparatus consists of a three neck flask (1L capacity) equipped with a condenser and a thermometer. Heating mantle equipped with a stirrer was used to heat up the brine solution, and a vacuum pump was used in order to create vacuum above the brine surface for flashing to take place.

(b) High temperature apparatus:

As shown in Figure 2, the apparatus consists of a reaction vessel that can withstand high pressure and temperatures. The vessel is equipped with a heating coil and a stirrer. Temperature and stirring speed can be controlled from a control unit.

Test Conditions

4.

(a) Test temperatures :	95 & 110°C
(b) Brine M-Alkalinity (M-Alk) :	180 ppm
(c) Concentration of antiscalant :	2 ppm (or less)
(d) Retention times :	5, 10, 15, 20, 30 & 40 minutes

5. Test Procedure

500 ml of artificial brine was measured accurately and spiked with 1 ml of antiscalant stock solution in order to make 2 ppm of antiscalant in the brine final solu-

tion. The brine was charged to the reaction vessel or flask and it was heated to the desired temperature under refluxing. When the solution reached the required temperature, it was kept refluxing for 15 min to reach equilibrium and to observe any possibility of scale formation. Because there was no precipitation in the presence of antiscalant, 10 ml of $1N Na_2CO_3$ was added to break the supersaturation point and to form the scale. The moment at which Na_2CO_3 was added was considered to be T = 0. Successive samples (25 ml each) were drown from solution at time intervals of 5, 10, 15, 20, 30 and 40 minutes. The samples were filtered through 0.45 micron filter paper and filtrate was analysed for Ca, Mg and M-Alk.

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RESULTS AND DISCUSSION

Scale formation behavior was studied in laboratory at temperatures similar to actual TBT's (95 & 110°C). Figure 3 shows results of tests carried out on calcium and magnesium presence in solution as a function of change in solution M-Alkalinity at 110°C. This Figure clearly demonstrates the dependence of Calcium concentration on M-Alkalinity in brine solution unlike Magnesium. These phenomena are further verified by the results of additional testing of magnesium and calcium ratios versus time in a brine solution heated up to 110°C. Figure 4 & 5 show changes in magnesium and calcium concentration ratios denoted by (f) for final over initial (i) as function of time at 110°C in the presence of 2 parts per million of different antiscalants in a brine solution having salts concentration of 1.4 times gulf seawater (GSW TDS <61000 ppm). After having verified the fact that CaCO₃ scale formation is time dependent further laboratory tests were carried out. To study this time dependance, at 95 and 110°C in the presence of different antiscalants in brine solution (1.4xGSW). Figures 6 & 7 show laboratory test results for different antiscalants at 2ppm concentration and at 95 & 110°C respectively. In addition, brine samples at the above two temperatures were also tested in the absence of antiscalant for CaCO₃ measurement against time. These points are denoted by a solid squares and referred to by the letter (B) for blank in Figures 6 & 7. It can be seen from Figure 6 that at 95°C most antiscalants have almost the same threshold effect for up to 15 minutes. Thereafter, they start to show some variations in their effectiveness between 15-30 minutes at 95°C. However, results at 110°C indicate this variation in effectiveness much faster as can be seen in Figure 7. Figure 7 also shows that loss of effectiveness of almost all antiscalants start after only 10 minutes at 110°C compared to 30 minutes at 95°C which can be seen from Figure 6. Figures 8 to 11 show results of antiscalant concentration optimization laboratory tests on the most outstanding antiscalant of those tested (at 95°C) and reported in Figures 3 to 7.

6

The first pair (Figures 8 & 9) are on a totally synthetic brine of 1.4xGSW TDS. These two Figures show that effectiveness is almost proportionally related to antiscalant concentration. Yet when brine solution was prepared by salt addition to filtered GSW there was a change in behavior which can be seen in Figures 10 & 11 where there is an indication of an optimum dose rate specially as for longer elapsed time of retentions.

Further experimental laboratory and mini module of single tube heat exchanger testing are still underway. Nevertheless the above results could be used to explain some of the earlier reported observations on actual operating plants. In particular the existence of an optimum dose rate plus observed slugging and scaling in flash chambers and demisters [2 & 3].

CONCLUSION

Laboratory experimental results shown in Figures 3-11 can help in making the following observations and recommendations.

- 1. Magnesium hydroxide separation is pH dependent and time independent.
- 2. Calcium carbonate separation is time, temperature and antiscalant concentration dependent.
- 3. At antiscalant dose rates of up to 2 ppm there are quite few brand name antiscalants which are effective for as long as 20 minutes at 95°C and brine concentration of 1.4 GSW TDS.
- 4. At antiscalant dose rate of 2 ppm there appears to be only few which could be considered to be effective at 110°C and brine concentration of 1.4 GSW TDS.
- 5. It seems that to maintain an acceptable threshold effect at 110°C either brine concentration needs to be lowered drastically, antiscalant dose rate optimized, or a second antiscalant injection point near the brine heater needs to be considered so that effectiveness time is further elongated beyond the first 10 minutes.
- 6. To verify these results further tests are required on mini module, (of single tube heat exchanger) pilot units and most importantly actual trial tests on large plants specially where total residence time is 15 minutes or more (up to 30-40).

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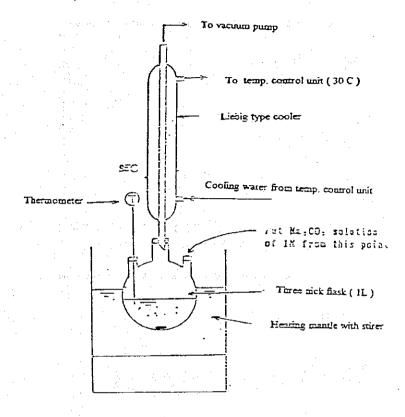
ACKNOWLEDGEMENT

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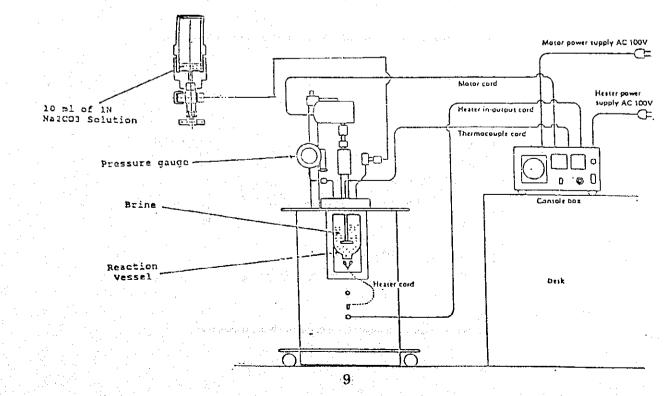
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(Appendix 5.1.2) Figure 1 : Low Temperature Test Equipment

Figure 2 : High Temperature Test Equipment



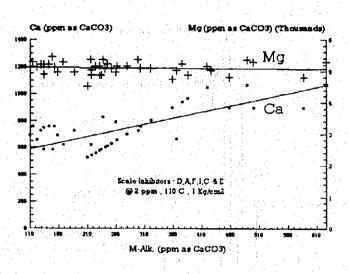


Figure 3 : Relationship Between M-Alkalinity and Ca & Mg Concentrations

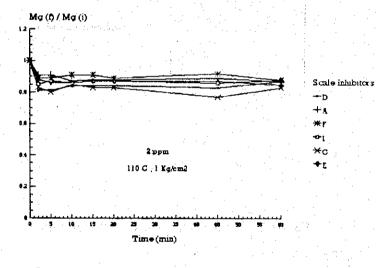


Figure 4 : Changes of Threshold Effect Mg(f)/Mg(i) With Ratintion Time

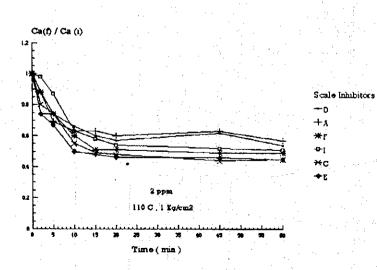
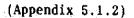


Figure 3 : Changes of Threshold Effect Ca(f)/Ca(j) With Retintion Time

(Appendix 5.1.2)

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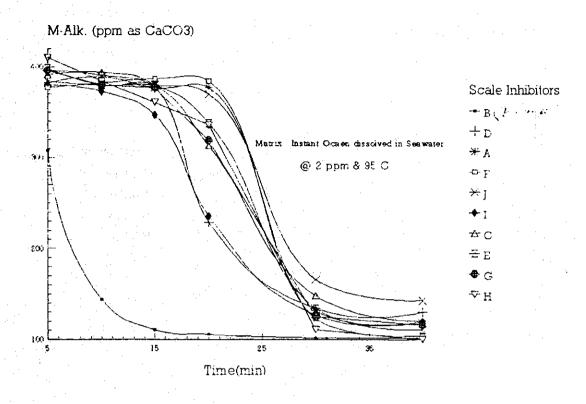


Figure 6 : Threshold Effect of Scale Inhibitors

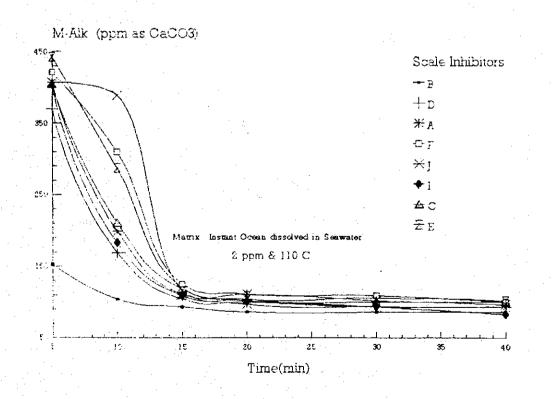
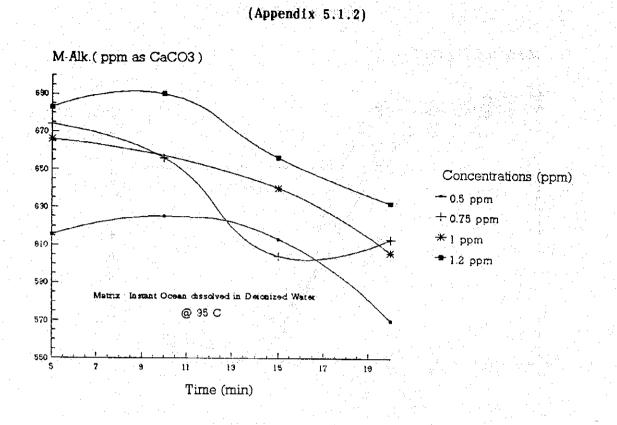
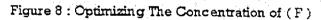


Figure 7 : Threshold Effect of Scale Inhibitors





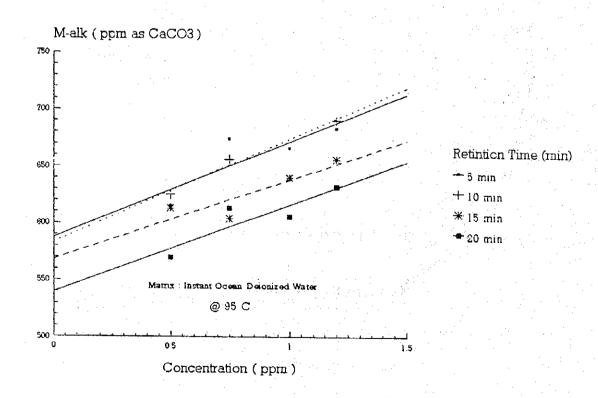
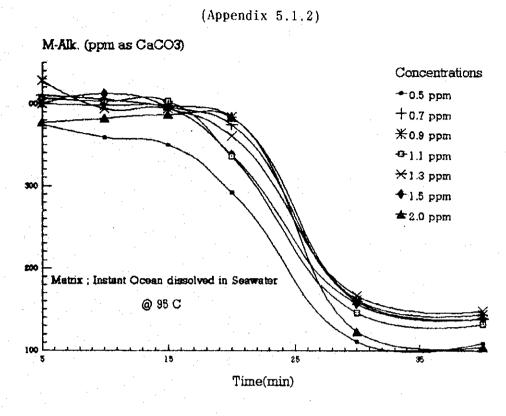
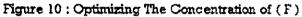


Figure 9 : Optimizing The Concentration of (F)





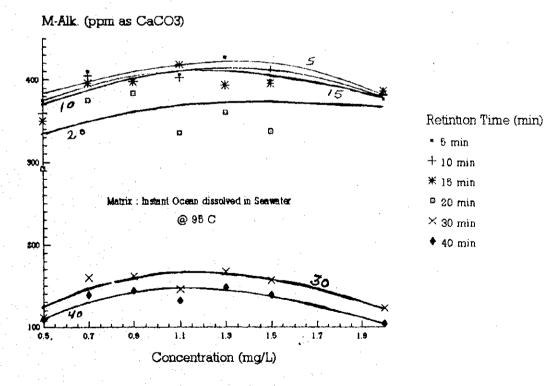


Figure 11 : Optimizing The Concentration of (F)

Appendix 5.3.1

M S F Test Plant Operation Manuals

(Appendix 5.3.1)

OPERATION MANUAL CHAPTER 1 START-UP AND SHUT-DOWN PROCEDURE

1.1 GENERAL GUIDANCE

These instructions are intended to guide qualified personnel in the operation of the desalination plant. They are not intended to cover every possible contingency in the complex desalting process.

Operators should be thoroughly familiar with the layout of equipment, instruments and control devices.

Piping and instrument diagrams should be studied for the arrangement of instrumentations, piping and valves.

They should also be familiar with the access way to the plant equipment, valves, control devices etc..

The desalination plant should not be operated beyond the specified top brine temperature and heating steam temperature. Higher temperature than those will cause rapid scale formation that obliges to shutdown for acid cleaning and scale removal.

Operators should pay careful attention to the process conditions of temperatures, pressures and flows. The various alarm systems should warn the operators of any condition which might lead to disruption Of the desalination plant.

During operation, various components of the plant are interdependent due to the critical heat-to-fluid flow balance. For example, an increase of recycle brine flow will require more heat at the brine heater to keep the top brine temperature. If the heat input is kept constant, the top brine temperature lowers, resulting in a decrease of vapor flashing off in the first stage, and the level of flashing brine in the stage will rise. This will adversely affect the heat balance in the second and all succeeding evaporator stages, causing a chain reaction throughout the plant. Those changes will eventually work out into a new balance condition, but many other adjustments would be required to make the new balance satisfactory.

(Appendix 5, 3, 1)

1.1 <u>GENERAL GUIDANCE</u> (cont'd)

Often, over-controlling and over-adjusting will magnify the original problem instead of correcting it. The plant operators should make simple adjustments in small increasing and/or decreasing, allowing ample time to settle for the new conditions to achieve.

The manufacturer's instructions on boiler, pumps, motors, pneumatic, electric and manual operated valves, instruments and other components of the desalination plant are also given in the other part of this manual. Any operating precaution in those part must be observed on the

1.1.1 Outline of Description

In this chapter each operation procedure is described in the following manner.

and the star

a. Block diagram which gives the idea of operation sequence.

b. Step-by-step procedure which details the indivisual actions required for operation with the tag numbers of the equipment and the indications appeared on the instruments.

Followings are the explanations of the form and the symbols used in the description of step-by-step procedure.

a: Explanation of Columns and Symbols

operation of the desalination plant.

(1) Tag No. : Identification number of equipment, valve, instrument, switch etc. are indicated.

(Appendix 5.3.1)

SET

GENERAL GUIDANCE (cont'd) 1.1

and

(2) Position : Position of valve, controller, switch and indication of instrument are shown.

> Followings are the terms showing the position of controllers.

> ADJUST means to ADJUST by HAND control mode or by shifting the set point when in AUTO control mode.

> AUTO means to put the controller in AUTO control mode.

> means to SET the set point at AUTO and

> > put the controller in AUTO control mode.

REMOTE means to put the controller in REMOTE control mode.

(3) Operation : Explanation to the operation, judgement of the condition, supplemental information Judgement etc. are described.

(4) Location : Location of equipment, instrument or place of action is indicated.

> : Field (Desalination area) F CP : Control panel in control room

In the step-by-step procedure, the operation of vent, drain and instrument isolation valves are not included except when those require to be in special positions. Common practice shall be applied to those valves i.e. vent and drain valves shall be closed and instrument isolation valves opened during the plant is in service.

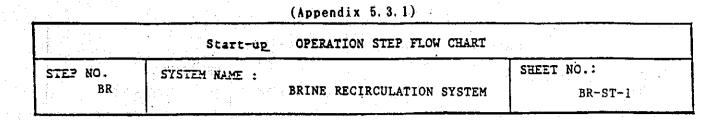
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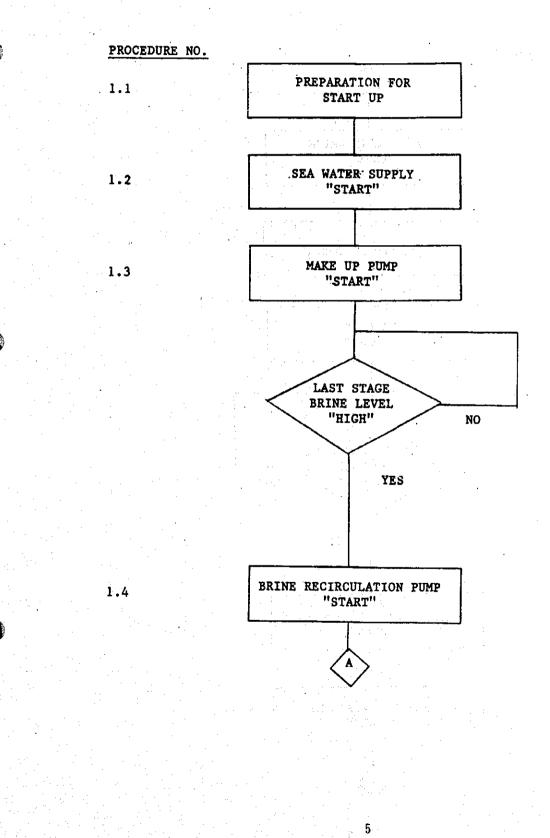
1.2 START-UP PROCEDURE

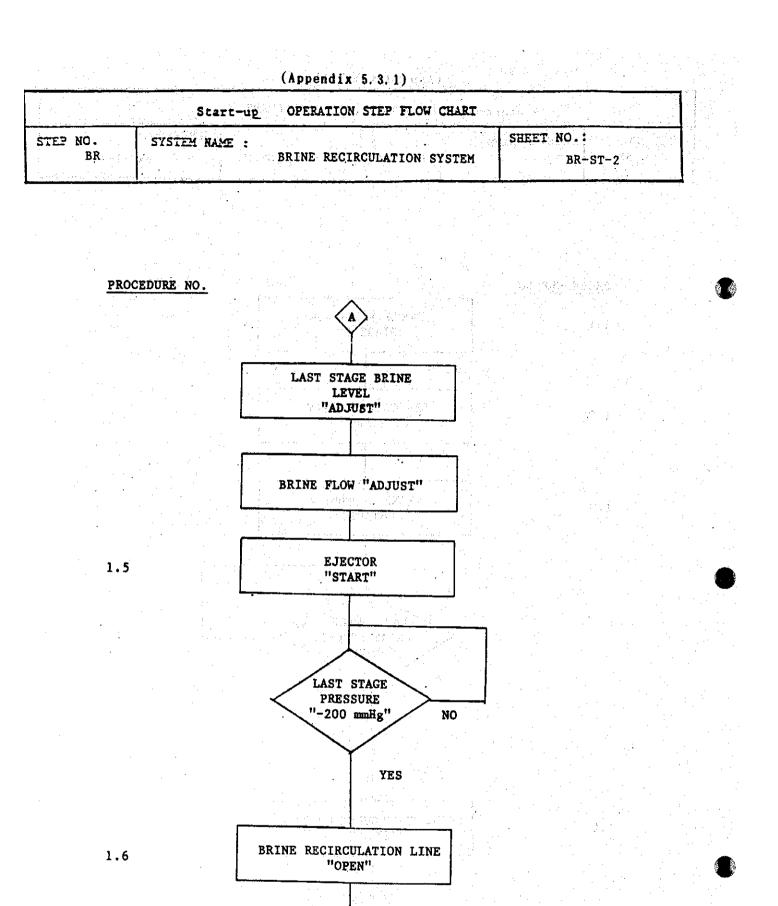
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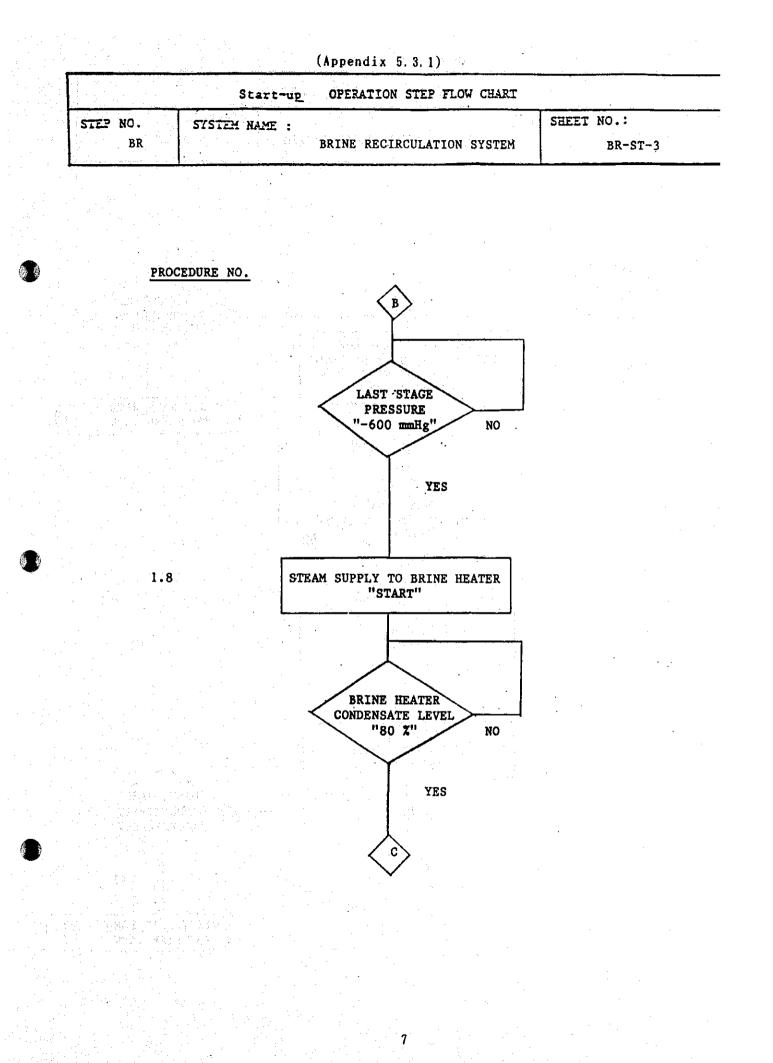


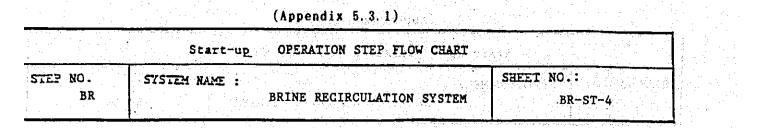
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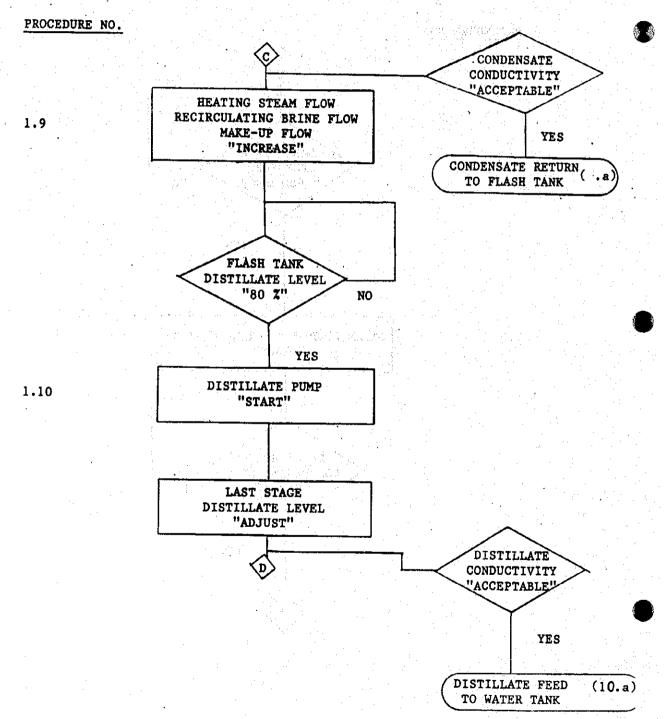
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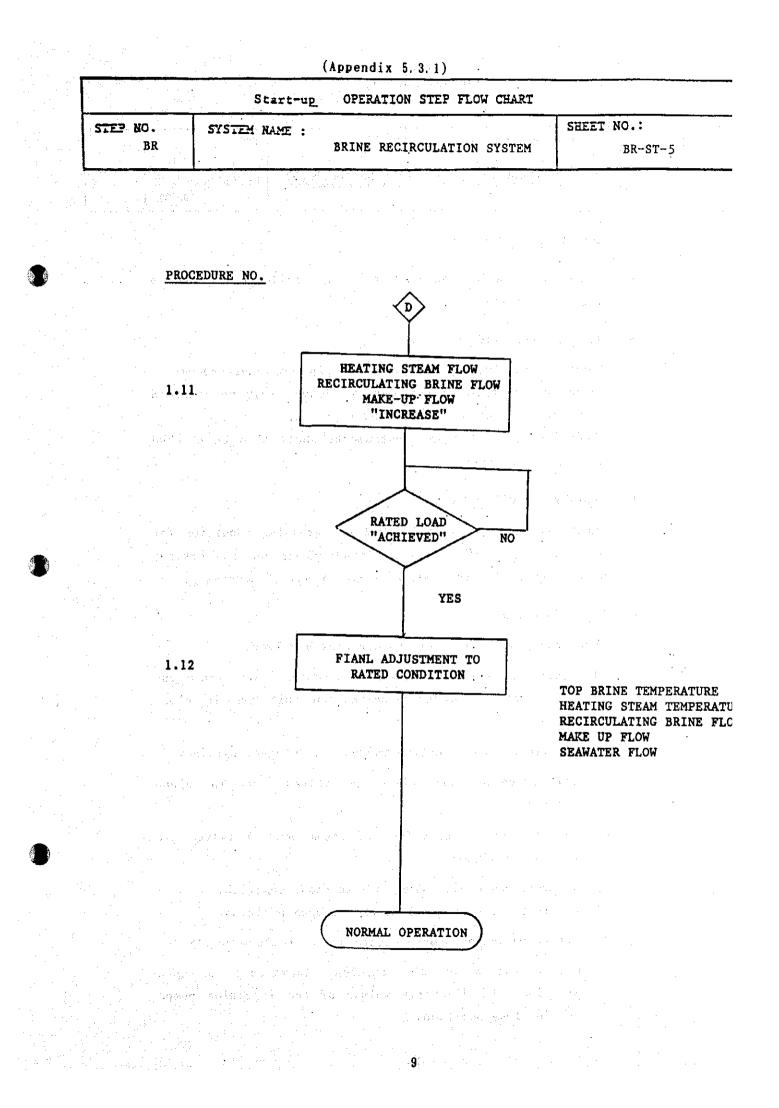
MAKE UP TREATMENT

"START"









(Appendix 5, 3, 1)

	STEP NO.	OPERATION SHEET FOR :	PAGE :
1	BR	START-UP PROCEDURE OF ONE DESALINATION PLANT	REFERENCE SHEET :
1			BR-ST-1

1.2 PREPARATION FOR START-UP

Each time of desalination unit start-up, followings shall be checked and confirmed.

a. General Inspection

Check and confirm all equipment and pipe works are sound. Leaks and loosened connections, if found, must be informed to maintenance department and be repaired.

Electrical equipment and instruments shall also be checked for their soundness.

b. Lubricating Oil and Grease

Check the lubricating oil level and greasing condition for all rotating machines and any other equipment and devices which require lubrication, refill or renew if necessary.

c. Valve Position

Check the positions of all hand operated valves.

- 1) Interface isolation values of seawater, distillate and boiler steam to/from desalination unit are in close posistion.
- 2) All process pump suction valves are in open position.
- 3) All process pump discharge values are in close position.
- 4) Upstream isolation values of steam control values are in close position.
- 5) All vent and drain valves are in close position.
- 6) All instrument root valves are in open position.
- 7) All steam valves around ejectors are in close position.
- 8) Outlet values of the chemical tanks are in open position and, discharge values of the injection pumps are in close position.

10

(Appendix 5.3.1)

STEP NO.	OPERATION SHEET FOR :	PAGE :
BR	START-UP PROCEDURE OF ONE DESALINATION PLANT	1-2
		REFERENCE SHEET : BR-ST-1

c. Valve Position (cont'd)

- 9) Isolation value of service water supply is in open position.
- 10) All valves on instrument air line are in open position.

d. Operational Chemicals

Prepare, or make up anti-scale, acid, anti-foam and sodium sulphite solutions in the tanks.

The stocks and procurement schedule of the above chemicals for the expected opertion period shall also be confirmed.

e. Review of Previous Operation and Maintenance Reports

Review the reports and confirm all the deficiencies and the damages found in previous operation have been repaired or recovered.

f. Operational Staffs

Shift charge engineer, operators and site operating staffs shall be in positions. Also maintenance staffs (mechanical, electrical and instrumental) shall be ready to assist during start-up.

g. Notification to Other Systems

Start-up of desalination plant shall be notified to the relating system control rooms, and the followings shall be confirmed.

- 1) Electric power is available to start the desalination unit.
- 2) Instrument air is available to start the desalination unit.
- 3) Pressure of seawater header is high enough to start for supplying seawater to the desalination unit.

(Appendix 5, 3.1)

 STEP NO.	OPERATION SHEET FOR :	PAGE :
BR	START-UP PROCEDURE OF ONE DESALINATION PLANT	1-3 REFERENCE SHEET :
		BR-ST-1

g. Notification to Other Systems (cont'd)

4) Boiler steam is available to start the desalination unit.

5) Service water is available to start the desalination unit.

6) Water tank is ready to receive distillate from the desalination unit.

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BR		CEDURE OF ONE DESALINATION PLANT REFERENCE	SHEET : R-ST-1
RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION	LOCATION
	1.2	SEA WATER SUPPLY "START"	· · · · · · · · · · · · · · · · · · ·
TRC-102	HAND 307 OPEN	Controller for seawater. discharge valve. (xv-101)	CP
BA-102	307 OPEN	Cooling water valve for Ejector condenser.	F
BV-101	OPEN	Seawater supply valve.	F
	OPEN/CLOSE	Vent valves of heat rejection section water boxes. Open and close after air	F
	OPEN/CLOSE	is expelled.	
	OFEN/ CLOSE	Vent valves of ejector condenser water boxes and piping. Open and close after air is exelled.	F
TRC-102	ADJUST	Controller for XV-101. Adjust the flow rate to 18.4 T/hr.	СР
FR-101	18.4 T/hr	Rejection cooling seawater flow indicator.	CP
BA-102	ADJUST	Cooling water valve for ejector condenser.	F
FI-102	5 T/h	Flow indicator for condenser cooling water	. F
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BR START-UP PROCEDURE OF ONE DESALINATION FLANT 1-5 REFERENCE SHEET : BR-ST-1 RECORD NO. OR OR OR POSITION OR OPERATION LOCATION RECORD NO. OR OR I.3 MAKE UP PUMP "START" Controller for make up flow control valve CP FRC-201 LAND Controller for make up flow control valve (XV-201). CP BA-202 OPEN Isolation valve for make up deserator. F FRC-301 HAND Controller for recirculation brine flow control valve (XV-201). CP JICA-202 HAND Controller for deserator level control CP JICA-202 HAND Controller for deserator level CP JICA-202 HAND Controller for deserator level CP JICA-202 HAND Controller for make up pump. P JICA-202 HAND Controller for deserator level, OPEN Sealing water inlet valve. F JICA-209 OPEN Fump discharge valve open slowly. F JICA-202 AUTO Controller for deserator level control SET 80 X AUTO HODE.<	STEP NO.	OPERATION SH	HEET FOR :	PAGE :		
BR-ST-1 RECORD NO. OR OR SET POINT POSITION OR SET POINT OPERATION LOCATION 1.3 MAKE UP PUMP "START" Controller for make up flow control valve (XV-201). CP (XV-201). CP (XV-201). CP (XV-201). CP (XV-201). BA-202 OPEN BA-206 Isolation valve for make up deserator. F FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). CP J0 X Gradually open. CP CP J1.3 Gradually open. CP CP J0 X Gradually open. CP CP J0 X Gradually open. CP CP J1.3 Controller for deserator level control CP CP J0 X Gradually open. CP CP CP J10 X Gradually open. CP CP CP J0 X Gradually open. CP CP CP J0 X Gradually open. CP CP CP J0 X Gradually open. CP CP CP	BR	START-UP PROC	FROCEDURE OF ONE DESALINATION PLANT			- 1.2
OR VALVE NO. OR SET POINT OPERATION LOCATION I.3 MAKE UP FUMP "START" I.03	• • #* * *					
ZALVE NO. SET POINT Description I.3 MAKE UP PUMP "START" Controller for make up flow control valve (XV-201). CP BA-202 Gradually open. Gradually open. CP BA-206 OPEN Isolation valve for make up deaerator. F FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). CP J0 X Gradually open. CP CP J1.3 Gradually open. CP J1.3 Gradually open. CP J1.4 Controller for recirculation brine flow control valve (XV-301). CP J1.5 Gradually open. CP J1.6 Gradually open. CP J1.7 Gradually open. CP J1.8 Controller for deaerator level control CP J1.0 X Gradually open. CP J1.0 X Gradually open. CP J1.0 X Gradually open. CP J1.10 X Gradually open. CP J1.8 Vent valves for make up pump. F OPEN Sealing water						
FRC-201 HAND Controller for make up flow control valve (XV-201). CP 30 X Gradually open. Gradually open. F BA-202 OPEN Isolation valve for make up deserator. F FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). CP JO X Gradually open: CP LICA-202 HAND Controller for deserator level control valve (XV-203). CP JO X Gradually open. CP Valve (XV-203). CP CP No Z Check the deserator level control valve (XV-203). CP OPEN Vent valves for make up pump. F OPEN Sealing water inlet valve. F OPEN Sealing water inlet valve. F BA-209 OPEN Pump discharge valve open slowly. F LICA-202 AUTO Controller for deserator level control SET 80 Z Controller for deserator level at 80 Z and put			OPERATION		LOCATION	
FRC-201 LAND Controller for make up flow control valve (XV-201). CP 30 X Gradually open. Isolation valve for make up deserator. F BA-202 OPEN Isolation valve for make up deserator. F FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). CP JO X Gradually open: CP LICA-202 HAND Controller for deserator level control valve (XV-203). CP JO X Gradually open. CP Nave (XV-203). CP CP OPEN Check the deserator level control valve (XV-203). CP OPEN Vent valves for make up pump. F OPEN Vent valves for make up pump. F OPEN Sealing water inlet valve. F BA-209 OPEN Pump discharge valve open slowly. F LICA-202 AUTO SET 80 X Controller for deserator level control valve (XV-203). CP						
BA-202 OPEN Isolation valve for make up deaerator. F BA-206 OPEN Isolation valve for make up deaerator. F FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). CP 30 % Gradually open. CP JICA-202 HAND Controller for recirculation brine flow control valve (XV-301). CP JICA-202 HAND Controller for deaerator level control valve (XV-203). CP JICA-202 HAND Controller for deaerator level control valve (XV-203). CP JIO % Gradually open. CP CP Valve (XV-203). CP CP CP BO % Vent valves for make up pump. F F OPEN Vent valves for make up pump. F P DPEN Sealing water inlet valve. F F BA-209 OPEN Pump discharge valve open slowly. F LICA-202 AUTO Controller for deaerator level control CP Valve (XV-203). Adjust deaerator level at 80 % and put CP		1.3	MAKE UP PUMP "START"			ŀ
BA-202 BA-206OPEN OPENIsolation value for make up deserator.FFRC-301HANDController for recirculation brine flow control value (XV-301).CP30 XGradually open.CPLICA-202HANDController for deserator level control value (XV-203).CP10 XGradually open.CP80 XCheck the deserator level.CP0PENVent values for make up pump.F0PENSealing water inlet value.F0PENSealing water inlet value.FBA-209OPENPump discharge value open slowly.FLICA-202AUTO SET 80 XController for deserator level controlCPAdjust deserator level at 80 X and putCP	FRC-201	Hand	Controller for make up flow con (XV-201).	trol valve	CP	· . • .
BA-206 OPEN Controller for recirculation brine flow control valve (XV-301). CP FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). CP 30 % Gradually open: CP LICA-202 HAND Controller for deaerator level control valve (XV-203). CP 10 % Gradually open. CP 80 % Check the deaerator level. CP 0 % Vent valves for make up pump. F 0 % Sealing water inlet valve. F 0 % StART Push button for make up pump. CP BA-209 OPEN Pump discharge valve open slowly. F LICA-202 AUTO Controller for deaerator level control CP SET 80 % X Adjust deaerator level at 80 % and put CP		30 %	Gradually open.			
FRC-301HANDController for recirculation brine flow control valve (XV-301).CP30 %Gradually open:Gradually open:LICA-202HANDController for deaerator level control valve (XV-203).CP10 %Gradually open.CP80 %Check the deaerator level.CP0PENVent valves for make up pump.F0PENSealing water inlet valve.F0PENSealing water inlet valve.F0PENPump discharge valve open slowly.FBA-209OPENPump discharge valve open slowly.FLICA-202AUTO SET 80 %Controller for deaerator level control valve (XV-203).CP				erator.	F	
30 %Gradually open:LICA-202HANDController for deaerator level control valve (XV-203).10 %Gradually open.10 %Gradually open.80 %Check the deaerator level.0PENVent valves for make up pump.0PENSealing water inlet valve.5TARTPush button for make up pump.BA-209OPENPump discharge valve open slowly.FLICA-202AUTO SET 80 %Adjust deaerator level at 80 % and put	FRC-301	HAND	Controller for recirculation br	ine flow	CP	:
LICA-202HANDController for deaerator level control valve (XV-203).CP10 ZGradually open.CP80 ZCheck the deaerator level.CP0FENVent valves for make up pump.F0PENSealing water inlet valve.FSTARTPush button for make up pump.CPBA-209OPENPump discharge valve open slowly.FLICA-202AUTO SET 80 ZController for deaerator level control valve (XV-203).CP		1. Sec. 1.	Gradually open:			
10 ZGradually open.CP80 ZCheck the deserator level.CPOPENVent valves for make up pump.FOPENSealing water inlet valve.FSTARTPush button for make up pump.CPBA-209OPENPump discharge valve open slowly.FCLOSEVent valve at pump discharge.FLICA-202AUTO SET 80 ZController for deserator level control valve (XV-203). Adjust deserator level at 80 Z and putCP	LICA-202		Controller for deserator level	control		- 1
OPENVent values for make up pump.OPENSealing water inlet value.STARTPush button for make up pump.BA-209OPENPump discharge value open slowly.FCLOSEVent value at pump discharge.LICA-202AUTO SET 80 %Controller for deaerator level control value (XV-203).Adjust deaerator level at 80 % and put		10 %	n an			
OPENSealing water inlet valve.FSTARTPush button for make up pump.CPBA-209OPENPump discharge valve open slowly.FCLOSEVent valve at pump discharge.FLICA-202AUTO SET 80 %Controller for deaerator level control valve (XV-203).CP		80. X	Check the deserator level.		CP	
STARTPush button for make up pump.CPBA-209OPENPump discharge valve open slowly.FCLOSEVent valve at pump discharge.FLICA-202AUTO SET 80 %Controller for deaerator level control valve (XV-203).CP		OPEN	Vent valves for make up pump.		n r a th	
BA-209OPENPump discharge valve open slowly.FCLOSEVent valve at pump discharge.FLICA-202AUTO SET 80 %Controller for deaerator level control valve (XV-203).CPAdjust deaerator level at 80 % and putAdjust deaerator level at 80 % and put		OPEN	Sealing water inlet valve.		F	
CLOSEVent value at pump discharge.FLICA-202AUTOController for deaerator level controlCPSET 80 %Adjust deaerator level at 80 % and put		START	Push button for make up pump.		CP	
LICA-202 AUTO SET 80 % Controller for deaerator level control CP valve (XV-203). Adjust deaerator level at 80 % and put	BA-209	OPEN	Pump discharge valve open slowly	7 •	F	
SET 80 % valve (XV-203). Adjust deaerator level at 80 % and put	r	CLOSE	Vent valve at pump discharge.		F	
Adjust deaerator level at 80 % and put	LICA-202	1	Controller for deaerator level ovalve (XV-203).	control	CP	
	<u>.</u>		Adjust deaerator level at 80 % a into AUTO MODE.	and put		
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		(Appendix 5.3,1)		
STEP NO.	OPERATION SH	IEET FOR :	PAGE :	
BR	START-UP PROC	EDURE OF ONE DESALINATION PLANT	1-6	
and a state of the			REFERENCE S	SHEET : •ST-1
RECORD NO.	POSITION		DK-	<u> </u>
OR	OR	OPERATION		LOCATIO
VALVE NO.	SET POINT			
	1.4	BRINE RECIRCULATION PUMP "START	n - 1	
LICA-507	HAND CLOSE	Controller for last stage brine	level	СР
		control valve (XV-302).	10001	
	80 Z	Check the last stage brine leve	l rises	
		about 80 %.		
	OPEN	Sealing water isolation valve.		F
	OPEN	Vent valve at pump suction line		F
	OPEN		:	
	OPEN	Vent valve at pump discharge lin	ne.	F
BA-301	ford Open of the	Isolation valve for pump suction	A.	F
	OPEN	Sealing water inlet valve.		F
	 The end quadrance 	4. 重要の意識が発展したより構成する。 しんどうしょう あんしょう しんしょう しんしょ しんしょ		
	OPEN	Sealing water strainer isolation	n valves.	F
LICA-507	HAND	Controller for last stage brine	level	CP
	107 OPEN	control valve (XV-302).	· · ·	
	START	Push button for brine recirculat	tion pump.	СР
BA-303	ODEN			
BA-303	OPEN	Pump discharge valve. Open slowly.		F
	CLOSE	Vent valve at pump discharge pip		
	02002	tene valve at pump discharge pi	<i>.</i>	F
LICA-507	AUTO SET 80%	Controller for last stage brine Control valve (XV-302).	level.	CP
		Adjust last stage brine level at	80%	
		and put in AUTO MODE.		
			1.00	
	,1970年1月1日日 1971年1月1日日 1971年1月1日日	ngen og som en som en stageförer och för som en som en För som en so För som en so		
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STEP NO.	OPERATION SI	HEET FOR :	PAGE :	
BR	START-UP PRO	CEDURE OF ONE DESALINATION PLANT		
· 문제 : 명 : 2011 · · · · · · · · · · · · · · · · · · ·		n an	REFERENCE S	
RECORD NO.	POSITION		DK-	ST-2
OR VALVE NO.	OR	OPERATION		LOCATION
ALVE NO.	SET POINT			
	1.5	EJECTOR "START"		
EA-414 BA-415	OPEN	Vent valves.		F
		NOTE TAK		
		The opening of this vent valve set to give best thermal effici Therefore this valve should alw left opened.	ency.	
	OPEN	Drain trap isolation valves on ejector steam lines.	common and	
	OPEN A LITTLE	Drain trap bypass valves on com ejector steam lines.	non and	F
	CHECK	Steam valve is full open (XV-60	5).	LCP
SV-603	OPEN	Ejector steam isolation valve.		F
		Firstly open a little for warmin steam pipe.	ng up the	
	•	Then open fully when dry steam from the drain trap bypass value	blows out es.	
	CLOSE	Drain trap bypass valves.		F
	OPEN	Isolation valves for strainer.		₽ ₽
	CLOSE	Bypass valve for strainer.		
SV-615	OPEN	Drain valve ejector condenser to stage flash box.	6th	F
BA-612 BA-613	OPEN	Isolation valves for ST-603.		F
PI-604	8 Kg/cm ² G	Pressure gauge for eject	or steam.	F

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			(Appendix 5.3.1)		
	STEP NO.	OPERATION SH	HEET FOR : PAG	GE :	·····,,,,,,
	BR	START-UP PROC	CEDURE OF ONE DESALINATION PLANT	1-8 FERENCE S	
				-	ST-2
	RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION		LOCATION
		1.6	RECIRCULATION LINE "OPEN"		
	PR-506	-200 mmHg	Pressure gauge for last stage. After the last stage pressure reach -200 mmHg, Brine recirculation line opened.	ing can be	F
	FRC-301	HAND 30 % OPEN	Controller for recirculating brine control valve (XV-301).	flow	CP
	BA-304	OPEN	Brine recirculation on line valve. Open slowly.		F
			In case of once through operation, valve shall be kept closed.	this	
•	FRC-301	ADJUST	Controller for recirculating brine control valve (XV-301).	flow	Ср
		n an an an Anna Anna Anna Anna Anna Anna Anna	Adjust the flow to about 4.0 T/hr.	- - -	
	FRC-301	4.0 T/hr	Recirculating brine flow recorder.		CP
			CAUTION		
			When opening brine recirculating lit the last stage brine level may fall quickly even it is controlled in au matic mode. Carefully observe and regulate not	to-	
			loose the level.		
				:	
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STEP NO.	OPERATION S	HEET FOR .	PAGE :		
			PAGE : 1-9		
BR	START-UP PRO	CEDURE OF ONE DESALINATION PLANT	REFERENCE S		
			BR-		
RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION		LOCATION	
	1.7	MAKE UP TREATMENT" START"			in di Barta
		(CHEMICAL CONTROL)			
				397	
FrC-201B	AUTO	Anti scale injection pump select Select "AUTO" (or "REMOTE").	t switch.	CP	
BA-807 BA-809	OPEN	Pump suction valve.		P	
BA-811	OPEN	Pump discharge valve.		F	
	START	Switch for Anti scale injection	pump.	CP	
	OPEN	Pulsation damper isolation valve	이 같은 것이 같은 것이 같은 것이 같이 같이 없다.	F	
		n la companya na pana ang pangangan ang pangangan ang pangangan ang pangangan ang pangangangan ang panganganga			
FI-801	CHECK	Anti-scale solution injection ra	ite.	F	
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		n shekara na shina na shekara na fati na shekara na shekara na shekara na shekara na shekara na shekara na she Ta shekara shekara shekara na shekara na shekara shekara shekara shekara shekara shekara shekara shekara shekar			
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STEP NO.	OPERATION SH	HEET FOR :	PAGE :	
BR	START-UP PROC	CEDURE OF ONE DESALINATION PLANT	1-1	
			REFERENCE S	SHEET :
			BR-	ST-2
RECORD NO.	POSITION			
OR Valve no.	OR SET POINT	OPERATION	2	LOCATIO
	1.7	MAKE UP TREATMENT" START"		
		(ACID CONTROL)		
LIC-201	CHECK	Local control.		F
XV-202				P
BA-204	OPEN	Decarbonator isolation valve.	- -	F
BA-202	CLOSE	Decarbonator by-pass valve.		F
	START	Decarbonator blower.		ĊP
				UP CP
FrC-201A	AUTO	Acid injection pump select swit	ch.	СР
		Select "AUTO".		
BA-802 BA-803	OPEN	Pump suction valve.	•	F
DR-003			-	
BA-804	OPEN	Pump discharge valve.		_
		Tump discharge varve.	:	F
	START	Switch for acid injection pump.		СР
	OPEN	Pulsation damper isolation valve		
		resolution sumper isolation valve	: ••••••••••••••••••••••••••••••••••••	F
FI-802	CHECK	Acid injection rate.		F
	OPEN	PHRA-201 isolation valve.		F
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STEP NO. CHONING MALL FOR 1 IAR 1 BR START-UP PROCEDURE OF ONE DESALINATION PLANT I-11 RECORD NO. POSITION ICR OR OR OR OPERATION I.7 MAKE UP TREATMENT "START" (cont'd) IOCATION NLVE NO. SET POINT IOCATION IOCATION HC-804 REMOTE Anti foam injection isolation valve. F BA-822 OPEN Pump discharge valve. F BA-823 OPEN Pump discharge valve. F BA-824 OPEN Pump discharge valve. F FI-804 CEECK Antifoam solution flow rate. F DV-817 OPEN Sodium sulphite injection pump. CP FI-804 CEECK Antifoam solution flow rate. F BA-814 OPEN Pump suction valve. F BA-815 DEN Pump discharge valve. F BA-816 OPEN Pump discharge valve. F StART Switch for Sodium sulphite injection pump. CP FI-803 CHECK Sodium sulphite solution injection r	STEP NO.	OPERATION S	HEET FOR :	PAGE :	<u></u>	
REFERENCE SHEET : BR-ST-2 BR-ST-2 RECORD NO. OR OR SET FOINT 1.7 MAKE UP TREATMENT "START" (cont'd) I.7 MAKE UP TREATMENT "START" (cont'd) DPEN Anti form injection isolation valve. SET FOINT HC-804 REMOTE Anti scale injection pump speed Controller. CP BA-822 OPEN Pump suction vavle. F START Switch for Anti form injection pump. FI-804 CHECK DV-817 OPEN PUTP Sodium sulphite injection isolation valve. F Sodium sulphite injection pump speed Controller. BA-814 OPEN BA-815 Pump discharge valve. BA-816 OPEN Pump discharge valve. F START Switch for Sodium sulphite injection pump. FI-803 CHECK START Switch for Sodium sulphite injection pump. F Start Switch for Sodium sulphite injection pump. CP FI-803 CHECK Start Switch for Sodium sulphite injection rate.					n an 1980 - Sang Galjas Maria da Sang Sang Maria da Sang Sang Sang Sang Sang Sang Sang San	
RECORD NO. OR POSITION OR OPERATION LOCATION VALVE NO. .SET POINT OPERATION LOCATION 1.7 MAKE UP TREATMENT "START" (cont'd) Anti foam injection isolation valve. F HC-804 REMOTE Anti foam injection pump speed controller. CP BA-822 OPEN Pump suction vave. F BA-823 BEN Pump discharge valve. F START Switch for Anti foam injection pump. CP FI-804 CHECK Antifoam solution flow rate. F DV-817 OPEN Sodium sulphite injection isolation valve. F HC-803 REMOTE Sodium sulphite injection pump speed controller. F BA-814 OPEN Pump discharge valve. F BA-815 OPEN Pump discharge valve. F BA-816 OPEN Pump discharge valve. F START Switch for Sodium sulphite injection pump. CP FI-803 CHECK Sodium sulphite solution injection pump. CP FI-803 CHECK Sodium sulphite solution injection pump. CP FI-8	BR					
VALVE NO. SET FOINT DOMNION 1.7 MAKE UP TREATMENT "START" (cont'd) F HC-804 REMOTE Anti foam injection isolation valve. F BA-822 OPEN Anti scale injection pump speed coutroller. F BA-822 OPEN Pump suction vavle. F BA-824 OPEN Pump discharge valve. F START Switch for Anti foam injection pump. CP FI-804 CHECK Antifoam solution flow rate. F DV-817 OPEN Sodium sulphite injection isolation valve. F HC-803 REMOTE Sodium sulphite injection pump speed controller. F BA-814 OPEN Pump discharge valve. F BA-815 OPEN Pump discharge valve. F BA-816 OPEN Pump discharge valve. F FI-803 CHECK Sodium sulphite solution injection pump. CP FI-803 CHECK Sodium sulphite solution injection pump. CP FI-803 CHECK Sodium sulphite solution injection pump. CP FI-803 CHECK Sodium sulph			_			
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HG-804 REMOTE Anti scale injection pump speed controller. CP BA-822 OPEN Pump suction vavle. F BA-824 OPEN Pump discharge valve. F BA-824 OPEN Pump discharge valve. F START Switch for Anti foam injection pump. CP FI-804 CHECK Antifoam solution flow rate. F DV-817 OPEN Sodium sulphite injection isolation valve. F HC-803 REMOTE Sodium sulphite injection pump speed controller. F BA-814 OPEN Pump suction valve. F BA-815 OPEN Pump discharge valve. F BA-816 OPEN Pump discharge valve. F START Switch for Sodium sulphite injection pump. CP FI-803 CHECK Sodium sulphite solution injection rate. F Lt is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is F		1.7	MAKE UP TREATMENT "START" (cont	'ð)		
BA-822 BA-823 OPEN Pump suction vavle. F BA-823 OPEN Pump discharge valve. F BA-824 OPEN Pump discharge valve. F START Switch for Anti foam injection pump. CP FI-804 CHECK Antifoam solution flow rate. F DV-817 OPEN Sodium sulphite injection isolation valve. F HC-803 REMOTE Sodium sulphite injection pump speed controller. CP BA-814 OPEN Pump discharge valve. F BA-815 OPEN Pump discharge valve. F BA-816 OPEN Pump discharge valve. F FI-803 CHECK Sodium sulphite solution injection pump. CP FI-803 CHECK Sodium sulphite solution injection rate. F Start Switch for Sodium sulphite injection rate. F Lt is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical in jection shall start at early stage after the recirculating brine line is	· · · · · · · · · · · · · · · · · · ·	OPEN	Anti foam injection isolation va	lve.	F	
BA-823 Finite Section varie: F BA-824 OPEN Pump discharge valve. F START Switch for Anti foam injection pump. CP FI-804 CHECK Antifoam solution flow rate. F DV-817 OPEN Sodium sulphite injection isolation valve. F HC-803 REMOTE Sodium sulphite injection pump speed controller. F BA-814 OPEN Pump suction valve. F BA-816 OPEN Pump suction valve. F START Switch for Sodium sulphite injection pump. CP FI-803 CHECK Sodium sulphite injection pump. F BA-816 OPEN Pump discharge valve. F START Switch for Sodium sulphite injection pump. CP FI-803 CHECK Sodium sulphite solution injection rate. F It is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is Stage after the recirculating brine line is	HC-804	REMOTE	Anti scale injection pump speed controller.		CP	
BA-824 OPEN Pump discharge valve. F START Switch for Anti foam injection pump. CP FI-804 CHECK Antifoam solution flow rate. F DV-817 OPEN Sodium sulphite injection isolation valve. F HC-803 REMOTE Sodium sulphite injection pump speed controller. CP BA-814 OPEN Pump suction valve. F BA-816 OPEN Pump discharge valve. F BA-816 OPEN Pump discharge valve. F FI-803 CHECK Sodium sulphite solution injection pump. CP FI-803 CHECK Sodium sulphite solution injection pump. CP FI-803 CHECK Sodium sulphite solution injection pump. CP FI-803 CHECK Sodium sulphite solution injection rate. F NOTE It is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is Start at early stage after the recirculating brine line is		OPEN			n Afrikanski Frankrij Frankrijski	
STARTSwitch for Anti foam injection pump.CPFI-804CHECKAntifoam solution flow rate.FDV-817OPENSodium sulphite injection isolation valve.FHC-803REMOTESodium sulphite injection pump speed controller.CPBA-814 BA-815OPENPump suction valve.FBA-816OPENPump discharge valve.FSTARTSwitch for Sodium sulphite injection pump.CPFI-803CHECKSodium sulphite solution injection rate.FIt is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is	BA-824	OPEN			F	
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BA-814 BA-815OPENPump suction valve.FBA-816OPENPump discharge valve.FSTARTSwitch for Sodium sulphite injection pump.CPFI-803CHECKSodium sulphite solution injection rate.FNOTEIt is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is	DV-817	OPEN	Sodium sulphite injection isolati	ion valve.	F	
BA-815 Pump discharge valve. F BA-816 OPEN Pump discharge valve. F START Switch for Sodium sulphite injection pump. CP FI-803 CHECK Sodium sulphite solution injection rate. F It is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is F	HC-803	REMOTE	Sodium sulphite injection pump sp controller.	peed	CP	
BA-815 Pump discharge valve. F BA-816 OPEN Pump discharge valve. F START Switch for Sodium sulphite injection pump. CP FI-803 CHECK Sodium sulphite solution injection rate. F It is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is F						
FI-803 START Switch for Sodium sulphite injection pump. CP FI-803 CHECK Sodium sulphite solution injection rate. F NOTE It is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is		OPEN	Pump suction valve.			
FI-803 CHECK Sodium sulphite solution injection rate. F <u>NOTE</u> It is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is	BA-816	OPEN	Pump discharge valve.		n di se	
<u>NOTE</u> It is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is		START	Switch for Sodium sulphite inject	tion pump.	СР	
It is very important that these chemical are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is	FI-803	CHECK	Sodium sulphite solution injectio	on rate.	F	
are throughly mixed and circulated in the recirculating brine before which is heated. To ensure this, chemical injection shall start at early stage after the recirculating brine line is						
put in service.			are throughly mixed and circulate the recirculating brine before wh heated. To ensure this, chemical injection shall start at early st after the recirculating brine lin	ed in hich is age		
			bar in sciaice.			

STEP NO.	OPERATION S	HEET FOR :	PAGE :	
BR	START-UP PRO	START-UP PROCEDURE OF ONE DESALINATION PLANT		
			REFERENCE S	
RECORD NO.	POSITION		BR-	-ST-3
OR VALVE NO.	OR SET POINT	OPERATION	· · ·	LOCATI
	1.8	STEAM SUPPLY TO BRINE HEATER "S	TART"	
		Reconfirm followings before sta steam supply to brine heater.	rting	
FRC-301	4 T/hr	Recirculating brine flow record	er.	CP
FRC-201	3.62 T/hr	Make up seawater flow controller	r	CP
PR-506	-600 mmHg	Pressure gauge for last stage. -600 mmHg or higher vacuum.	:	Ср
SV-610	OPEN	Isolation valve for drain trap of the XV-602.	lownstream	F
SV-611	CLOSE	Bypass valve for drain trap down the XV-602.	nstream	F
TRCA-303	HAND 207 OPEN	Controller for brine heater outl brine temperature control valve	et (XV-602).	CP
PIC-606	AUTO SET 2.0 kg/cm ² G	Heating steam pressure controlle open by HAND mode until the pres to 2.0 kg/cm ² G, then put in AUTO	Sure rises	СР
LIC-601	CHECK	Controller for brine heater cond level control valve (XV-604).	ensate	, F .
	OPEN	Condensate dump valve.		F
TRCA-303	HAND	Controller for brine heater outl temperature control valve (XV-60	et brine 2).	CP
		Gradually open to Obtain the con flow of 300 kg/hr,		
FR-601	300 kg/h	Flow recorder for condensate.		Ср
BA-408 BA-409	OPEN OPEN	Isolation valves for strainer or neater cooling water line.	desuper-	F

STEP NO.	OPERATION SI	HEET FOR :	PAGE :
	START-UP PRO	CEDURE OF ONE DESALINATION PLANT	1-13
BR		PLOREINALION TRAIL	REFERENCE SHEET :
	<u> </u>		BR-ST-3
RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION	LOCATION
	1.8-a	CONDENSATE RETURN TO FLASH TANK	
	en alterativa alterativa a	The condensate tends to be cont	aminated
		because of the rust and dirt in	
		when it is started.	
		Then, once the line is flashed	out by
		the steam and the condensate, t	그는 것 같은 것 같은 것 같은 것 같아요. 이 가지 않는 것 같은 것 같이 많이
		ductivity of the condensate sta	
an stran Line stran		fall and the indication appears	the second se
		condensate conductivity recorde	and the second
	ender an en de la seconda de la seconda En seconda de la seconda de	601.	
CRA-601	less 100 ມປີ/cm	Condensate conductivity recorder confirm indication appears and falling down.	r. is steadily
SV-609		🖬 나라는 것 같은 것 같아요. 그는 것 같아요. 한 것 같아요. 이 가지 않는 것 같아.	
	OPEN	Condensate return valve to flash	tenk F
	OPEN	Condensate return valve to flas	r tank. F
	OPEN	Condensate return valve to flas	
	OPEN		valve and
		The positions of feed (return)	valve and cally
		The positions of feed (return) dump valve will change automatic	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
	OPEN	The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally
		The positions of feed (return) dump valve will change automatic when the conductivity becomes a	valve and cally

		(Appendix 5,	3.1)		
STEP NO.	OPERATION SP	LEET FOR :		PAGE :	
BR	START-UP PROC	EDURE OF ONE DE	SALINATION PLANT	1-1	
				REFERENCE S	
				BR	ST-4
RECORD NO. OR VALVE NO.	POSITION OR SET POINT		OPERATION		LOCATION
					· · · · · · · · · · · · · · · · · · ·
	1.9	INCREASE HEAT	ING STEAM FLOW		
	• •				
		RECIRCULATING	······································		
		MAKE UP SEAWAT	TER FLOW]
			ing the heating		
			recirculating b	rine start	
		to rise its te			
			res the adjustmen	nts of pro-	
		cess flows.		:	
		Followings are	e typical proces	s flow	
		adjustments ba	sed on the top l	brine	
		temperature, wh	nich shall gener	ally be	
		observed durin	ng start up proce	edure.	
				·	
	1	n an the Real and a first state of the			2
	Top Brine <u>Temperature</u>	Recirculating Brine flow	Make up sea Water flow	Condensate (steam) Flow	
	35 °C	4 T/hr	2 co m/h	000 1 /1	
	50 °C		3.62 T/hr	300 kg/hr	
	60 °C	4.5 T/hr	3.62 T/hr	300 kg/hr	
		4.8 T/hr	3.62 T/hr	300 kg/hr	
	80 °C	5 T/hr	3.62 T/hr	300 kg/hr	
	100 °C	5.5 T/hr	3.62 T/hr	300 kg/hr	
	110 °C	6 T/hr		330 kg/hr	
	120 °C	6.58 T/hr	3.62 T/hr	333 kg/hr	
					1
			e ne grafie - se be		
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			· · ·		
				·	
	I		· . · ·		

OPERATION SHEET FOR : PAGE : STEP NO. 1-15 START-UP PROCEDURE OF ONE DESALINATION PLANT BR **REFERENCE SHEET :** BR-ST-4 RECORD NO. POSITION OPERATION OR OR LOCATION VALVE NO. SET POINT 1.10 DISTILLATE PUMP "START" During the heating up of recirculating brine, flash evaporation starts and thus the distillate starts to accumulate in the flash tank. Also condensate is introduced to the tank. Distillate pump shall be started when the distillate level rises to 80 %. LIC-401 CHECK Controller for distillate level control valve (XV-401). 807 Confirm the level rises to 80 %. BA-401 OPEN Suction valve of distillate pump. F **OPEN** Suction vent valve. F OPEN Discharge vent valve. F OPEN Sealing water isolation valve. F OPEN. Isolation valves for sealing water F strainer. START Swtich for distillate pump. CP BA-403 OPEN Discharge valve of distillate pump. F Open slowly. CLOSE Discharge vent valve. F LIC-401 CHECK Auto at 60 % level. F

(Appendix 5.3.1)

			(Appendix 5.3.1)		
	STEP NO.	OPERATION SE	HEET FOR :	PAGE :	
	BR	START-UP PROC	CEDURE OF ONE DESALINATION PLANT	1-1	6
				REFERENCE S	
				BR-	ST-4
	ECORD NO. OR ALVE NO.	POSITION OR SET POINT	OPERATION		LOCATION
		1.10-a	PRODUCT WATER FEED TO WATER TAN	K	
				_	
i i			The product water may not be ve	ry pure	ан сайта. 2
			during start up, but it will so		
			pure when the evaporation condition		
		and a state of the	stabilized.		
	CRA-401	less 100 سر 100 / cm	Distillate conductivity recorder confirm indication appears and r falling down.	r. is steadily	СР
	XV-402	417770		·	
	AV-4UZ	AUTO	Three way valve.		СР
			The positions of feed line and o	iumn line	
			will change automatically when t		
			ductivity becomes acceptable ran		
			•	- 0	
1					
				•	
				•	1
				:	
		an a			
					1

	OPERATION SH	FFT FOD .	PAGE :	and a second	
			1-1	7	politi n na secolo
BR	SIARI-UP PROC	EDURE OF ONE DESALINATION PLANT	REFERENCE S		
، مربق المربي المربي الم			BR-:	ST-5	
RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION		LOCATION	
	1.11	INCREASE HEATING STEAM FLOW			
		RECIRCULATING BRINE FLOW			
		MAKE UP SEAWATER FLOW			
		The process flows shall be furth	her		
•		increased toward the rated load			
		tions.			
		The adjustments of various flow			
		relating to the top brine temper	the second se		
		shall be referred to step 1-9 in	n this		
• 4 1 •		procedure.			. :
•					
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•					
			3		
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STEP NO.	OPERATION S	HEET FOR :	PAGE :	
BR STATE	START-UP PRO	CEDURE OF ONE DESALINATION PLANT	1-1	
		······································	REFERENCE S	SHEET : ST-5
RECORD NO.	POSITION			
OR VALVE NO.	OR SET POINT	OPERATION	· · ·	LOCATI
	1.12	FINAL ADJUSTMENT TO RATED CONDIT	<u>.10n</u>	
		When the rated production is ach	ieved,	
		check whether process conditions are	steady	
	ty a tyter≜yka a	and nearly equal to those shown	on the	
	н. Н	heat and mass balance diagram.		
		Put the controllers in AUTO mode	•	
FR-401	1,100 kg/hr	By Product water flow recorder, chec rate is 1,100 kg/hr and constant	k the flow •	СР
LIC-401	AUTO SET 50%	By Distillate level controller, chec Level is constant, then graduall the set point to 50 % (normal le	v lower	F
FRC-201	AUTO SET 3,620 kg/hr	By Make up seawater flow controller, flow rate is 3,620 kg/hr. Put the controller, into AUTO mode.	·	Ср
TRC-102	AUTO SET 40 °C	Controller for rejection cooling outlet temperature (XV-101).	seawater	Ср
FR-101	18.4 T/hr	Rejection cooling seawater flow a	recorder.	CP
BA-102	ADJUST	Vent and ejector condensers coold valve. Adjust the opening of the obtain the flow rate about 5 T/hr	e valve to	F
FI-102	5 T/hr	Ejector condensers cooling water indicator.	flow	F
FRC-301	6.58 T/hr	By Recirculating brine flow controll the flow rate is 6.58 T/hr.	er, check	CP
LICA-507	AUTO SET 50%	Last stage brine level controller Check the level is kept constant. Then gradually lower the set poin (normal level).		Ср

BR DIALT OF PROCEDURE OF ONE DESALINATION PLANT REFERENCE SHEET : BR-ST-5 RECORD NO. POSITION OR OPERATION LOCATIO		19	PAGE : 1-1		OPERATION SHEET FOR :	
RECORD NO. OR OR VALVE NO.POSITION OR SET POINTOPERATIONLOCATION1.12FINAL ADJUSTMENT TO RATED CONDITION SET POINT(cont'd)TRCA-303AUTO SET 120 °CErine heatar cutlet brine temperature controller. Check the brine temperature is 120 °C or a little below. Put the controller in AUTO mode.CPTR-602127 °CHeating steam temperature recorder. Check the steam temperature is 127 °C.CPLIC-601AUTO SET 50%Condensate level controller. Check the level is kept constant.FLICA-202AUTO SET 		SHEET :	REFERENCE S	LEDURE OF ONE DESALINATION PLANT		BR
OR VALVE NO.OR SET POINTOPERATIONLOCATION1.12FINAL ADJUSTMENT TO RATED CONDITION FINAL ADJUSTMENT TO RATED CONDITION (cont'd)(cont'd)TRCA-303AUTO SET 120 °CErine heater cutlet brine temperature controller. Check the brine temperature is 120 °C or a little below. Put the controller in AUTO mode.CPTR-602127 °CHeating steam temperature recorder. Check the steam temperature is 127 °C.CPLIC-601AUTO SET 507Condensate level controller. Check the level is kept constant.FLICA-202AUTO SETDeserator level controller. Check the level is kept constant.CPLIC-201AUTODecarbonator level controller. Check the level is kept constant.F		-91-2	DA		POSTTION	RECORD NO.
TRCA-303AUTO SET 120 °CErine heater cutlet brine temperature controller. Check the brine temperature is 120 °C or a little below. Put the controller in AUTO mode.CPTR-602127 °CHeating steam temperature recorder. Check the steam temperature is 127 °C.CPLIC-601AUTO SET 50%Condensate level controller. Check the level is kept constant.FLICA-202AUTO SETDeaerator level controller. Check the level is kept constant.CPLIC-201AUTODecarbonator level controller. Check the level is kept constant.CP	Ň	LOCATION		OPERATION	OR	OR
SET 120 °Ccontroller. Check the brine temperature is 120 °C or a little below. Put the controller in AUTO mode.CPTR-602127 °CHeating steam temperature recorder. Check the steam temperature is 127 °C.CPLIC-601AUTO SET 50%Condensate level controller. Check the level is kept constant.FLICA-202AUTO SETDeaerator level controller. Check the level is kept constant.CPLIC-201AUTODecarbonator level controller. Check the level is kept constant.F		·4)	<u>IION</u> (cont'	FINAL ADJUSTMENT TO RATED CONDI	1.12	
a little below. Put the controller in AUTO mode.TR-602127 °CHeating steam temperature recorder. Check the steam temperature is 127 °C.LIC-601AUTO SET 50%Condensate level controller. Check the level is kept constant.LICA-202AUTO SETDeaerator level controller. Check the level is kept constant.LIC-201AUTODecarbonator level controller. F		CP		controller.		TRCA-303
TR-602127 °CHeating steam temperature recorder. Check the steam temperature is 127 °C.CPLIC-601AUTO SET 50%Condensate level controller. Check the level is kept constant.FLICA-202AUTO SETDescrator level controller. Check the level is kept constant.CPLIC-201AUTODecarbonator level controller. Check the level is kept constant.CP			120 °C or Ller in	a little below. Put the contro AUTO mode.	,是"养好"的感觉。 人们的"你们"。 人们的"你们"。	
LIC-601AUTO SET 50%Condensate level controller. Check the level is kept constant.FLICA-202AUTO SETDeaerator level controller. Check the level is kept constant.CPLICA-201AUTO SETDecarbonator level controller. Check the level is kept constant.CP					127 00	<u> ም</u> ₿-602
LIC-601AUTO SET 50%Condensate level controller. Check the level is kept constant.LICA-202AUTO SETDeaerator level controller. Check the level is kept constant.LIC-201AUTODecarbonator level controller. F		CP	ler. 127 °C.	Check the steam temperature is		~~~ ~~~
SETCheck the level is kept constant.CPLIC-201AUTODecarbonator level controller.F						LIC-601
a standard react conclution.		СР		Deaerator level controller. Check the level is kept constant		LICA-202
		F		Decarbonator level controller. Check the level is kept constant		LIC-201
				a a la casa a sa s		
						· · ·

1.3 SUPPLEMENTAL OPERATION

Ball Cleaning System

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STEP NO.	OPERATION SE	IEET FOR : PAGE :	
BR	START-UP PROC	CEDURE OF ONE DESALINATION PLANT	and the second
		REFERENCE	SHEET :
RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION	LOCATION
	DEI TOIRI		
		BALL CLEANING SYSTEM	
		Ball cleaning system shall be operated	
		when the desalination plant is operated	
		steadily.	
		A. FILLING WATER TO THE LINE	
BA-314	OPEN	Drain valve at brine inlet line.	F
	Open	Ball injection valve at recovery inlet.	F
BA-308	OPEN	Ball collector outlet valve.	F
BA-309	OPEN	Ball collector inlet valve.	F
•	OPEN/CLOSE	Ball collector vent valve.	F
	ON-LINE	3 way valve at ball collector outlet.	F
	CLOSE	Brine inlet and outlet valves.	F
BA-306 BA-307	OPEN	Ball collection valve at the ball strainer.	F
		Slowly open the valve.	
GV-312	OPEN	Hot brine return valve.	F
	OPEN/CLOSE	Ball collector vent valve. Carefully open the vent valve to expel the air in the pipe between the ball strainer and the ball collector, then close.	F
		CAUTION	
		As hot brine may come out at the collector vent outlet pipe, venting operation shall be done very carefully. Do not touch nor., stand at the vent pipe outlet.	
BA-306 BA-307	CLOSE	Ball collector value at the ball collector.	

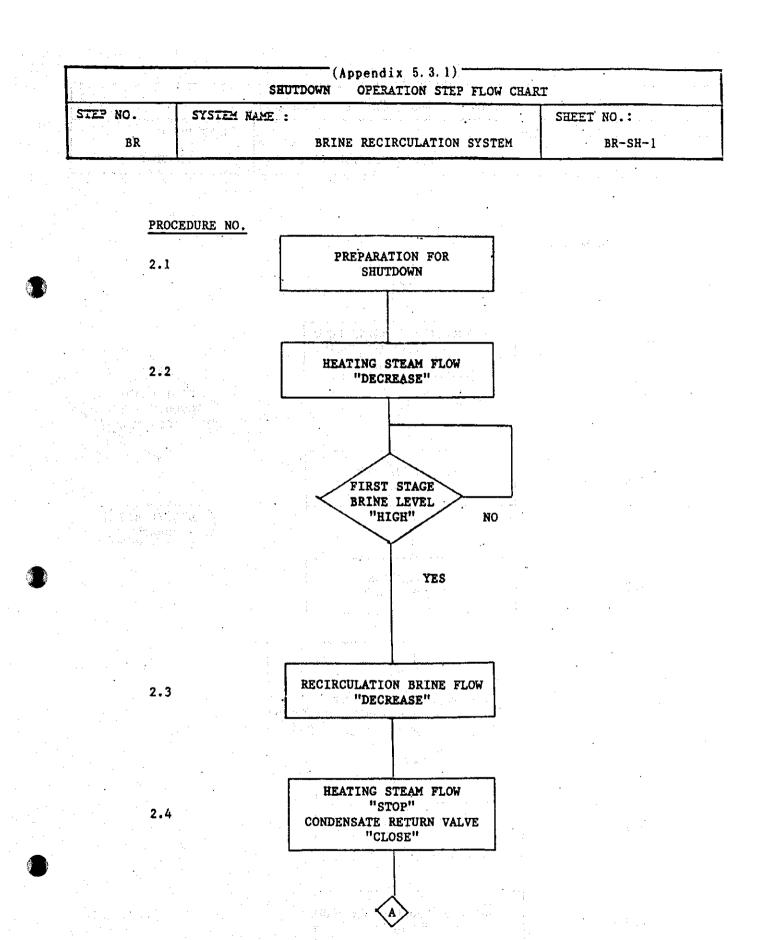
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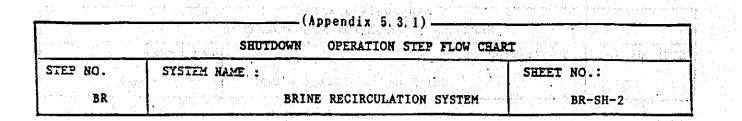
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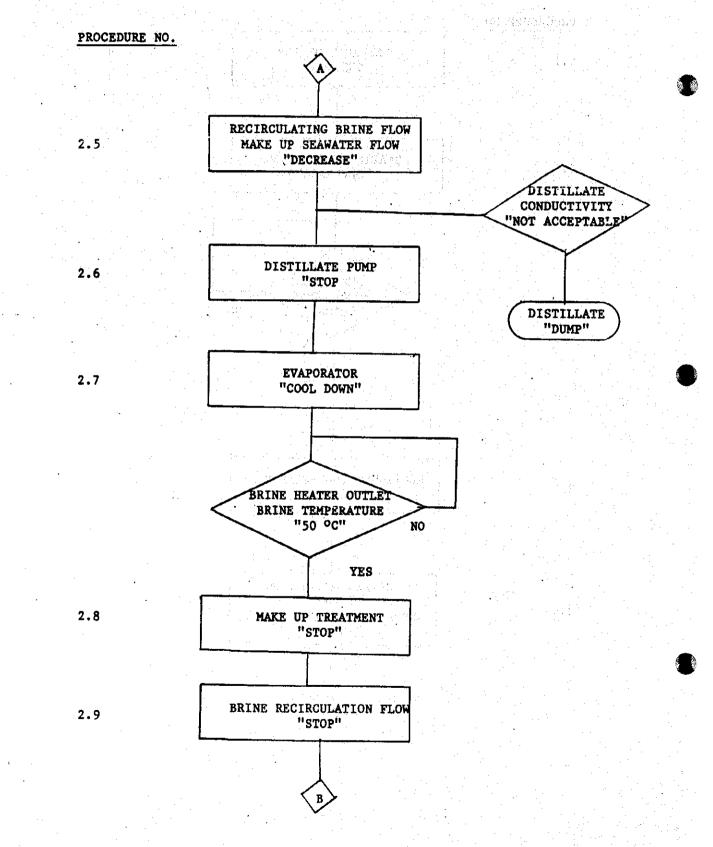
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STEP NO.	OPERATION ST	HEET FOR :	PAGE :	
BR	START-UP PRO	CEDURE OF ONE DESALINATION PLANT	1-2	
			REFERENCE SHEET :	
RECORD NO.	POSITION	1		
OR VALVE NO.	OR SET POINT	OPERATION		LOCATION
		B. CLEANING OPERATION		
	CATCH	Ball strainer positon.		F
	OPEN	Ball collector vent valve.		F
	OPEN	Ball collector lid.		F
· · · ·		Open the collector lid. Put the	sponge	
		balls in the collector basket.	-	
	A Constant	the balls in the water to expel		
· · · ·		Check that the all balls are sun water.	k in the	
••	CLOSE	Ball collector lid.		_
		Confirm that the all clips of the	. 124	F
		are fastened tightly.	3 110	
BA-313 BA-309	OPEN	Ball collector inlet line valve.		F
DA- 309		Open a little to fulfil the water collector. (The collector vent valve is left		
	CLOSE	Ball collector vent valve.		
	OPEN	Ball collector inlet valve. Open fully.		F
	OPEN	Ball collector outlet valve.		F
BA-308	CLOSE	Brine inlet and outlet valves.		F
•	OPEN	Ball collector valves.		F
		Repeat above cycle if necessary.		
	· · ·			
and the second sec				
			1	1

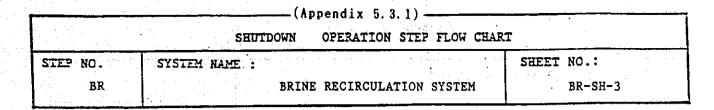
SHUTDOWN PROCEDURE 1.4

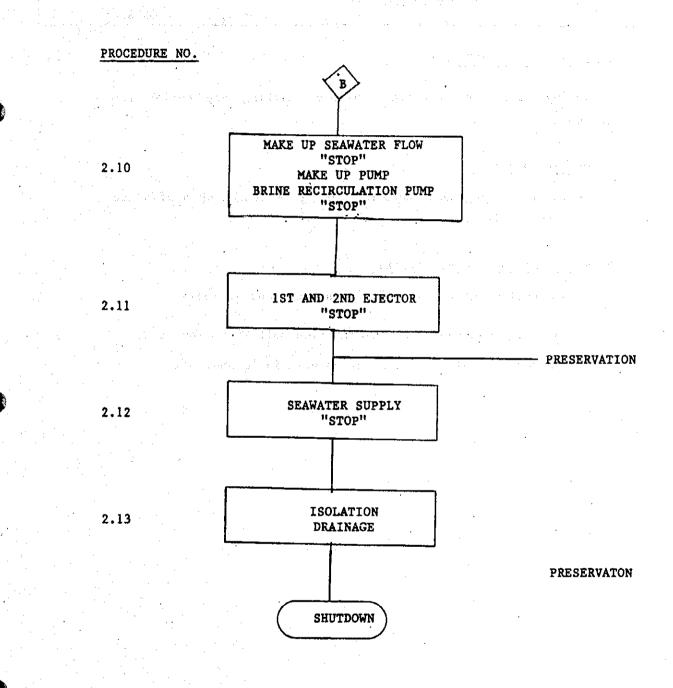
4.4.6











NOTE

For preservation method and procedure, see SECTION 3 MAINTENANCE

STEP NO.	OPERATION SHEET FOR :	PAGE : 2-1
BR	NORMAL SHUTDOWN	REFERENCE SHEET :
		BR-SH-1

2.1 PREPARATION FOR SHUTDOWN

Followings shall be confirmed before starting any action for shutdown.

a. Operation staffs

Shift charge engineer, operator and site operating staffs are in their positions.

b. Notification to other systems

Inform followings to the relating system control rooms.

(1) Boiler steam supply to desalination unit is to shut off.

(2) Seawater supply to desalination unit is to shut off.

STEP NO.	OPERATION :	SHEET FOR : PAGE : 2-2	· · · · · · · · · · · · · · · · · · ·
BR		NORMAL SHUTDOWN REFERENCE S	SHEET : SH-1
RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION	LOCATION
	2.1	PREPARATION FOR SHUTDOWN (cont'd)	
		Following controller shall be changed	ļ
		this operation mode from "AUTO" to "MANUAL".	
FDG 661	V 1 1 1		
FRC-201	HAND	Controller for make up seawater flow control valve (XV-201).	СР
TRCA-303	HAND	Controller for recirculating brine temperature control valve (XV-602).	CP
FRC-301	HAND	Controller for recirculating brine flow control valve (XV-301).	CP
TRC-102	HAND	Controller for rejection cooling seawater temperature control valve (XV-101).	CP
	n in station Station		
	2.2	HEATING STEAM FLOW "DECREASE"	
TRCA-303	HAND	Controller for brine heater outlet brine temperature control Valve (XV-602). Reduce opening by 10 % every 6 minutes.	CP

BR NORMAL SHUTDOWN REFERENCE SHEET : BR-SH-1 RECORD NO. OR VALVE NO. POSITION SET FOINT OPERATION LOCATION 2.3 RECIRCULATING BRINE FLOW "DECREASE" LOCATION 1st stage brine level rises as the top brine temperature falls. Recirculating brine flow shall be reduced not to rise the level excess sively. OPERATION COC FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). Reduce the flow rate when first stage brine level high. F Ist stage brine level shall carefully be watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water until the evaporation ceases completely. F	STEP NO.	OPERATION S	SHEET FOR :	PAGE : 2-3	
OR VALVE NO. OR SET FOINT OPERATION LOCATION 2.3 RECIRCULATING BRINE FLOW "DECREASE" Ist stage brine level rises as the top brine temperature falls. Recirculating brine flow shall be reduced not to rise the level exces- sively. Ist stage brine flow shall be reduced not to rise the level exces- sively. FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). Reduce the flow rate when first stage brine level high. CP NOTE Ist stage brine level shall carefully be watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water F	BR		NORMAL SHUTDOWN	(c) the provide state of the	
Ist stage brine level rises as the top brine temperature falls. Recirculating brine flow shall be réduced not to rise the level exces- sively. FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). Reduce the flow rate when first stage brine level high. NOTE lst stage brine level shall carefully be watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water	OR	OR	OPERATION		LOCATION
brine temperature falls. Recirculating brine flow shall be réduced not to rise the level excessively. FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). Reduce the flow rate when first stage brine level high. NOTE lst stage brine level shall carefully be watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water		2.3	RECIRCULATING BRINE FLOW "DECRI	EASE"	
FRC-301 HAND Controller for recirculation brine flow cp control valve (XV-301). CP control valve (XV-301). Reduce the flow rate when first stage F brine level high. NOTE Ist stage brine level shall carefully be watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water				the top	
FRC-301 HAND Controller for recirculation brine flow control valve (XV-301). Cp Reduce the flow rate when first stage F brine level high. F NOTE Ist stage brine level shall carefully be watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water			reduced not to rise the level		
control valve (XV-301). Reduce the flow rate when first stage F brine level high. <u>NOTE</u> lst stage brine level shall carefully be watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water	FRC-301	HAND			
brine level high. <u>NOTE</u> lst stage brine level shall carefully be watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water	106-041		control valve (XV-301).		
lst stage brine level shall carefully be watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water		4 1 ₁₁ - Andrews			
watched during the shutdown. Good controlling by the recirculating brine flow keeps pure product water				refullv he	
brine flow keeps pure product water			watched during the shutdown.		
			brine flow keeps pure product	water	

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			(Appendix 5.3.1)		
	STEP NO.	OPERATION S	SHEET FOR :	PAGE :	· · · · · · · · · · · · · · · · · · ·
BR		NORMAL SHUTDOWN BR-SH			
	RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION		LOCATION
				· · · · · · · · · · · · · · · · · · ·	
		2.4	HEATING STEAM FLOW "STOP" CONDENSATE RETURN VALVE "CLOSE"		• • •
			When the brine heater outlet bri temprature control valve (XV-602 to close position by manual step operation, the controller for he	2) comes o-by-step	
			steam pressure control valve (XX shall also put in HAND mode and valve fully.	7-601) close	
			Then, at plant site, close the u isolation valve for XV-601.	ıpstream	
	TRCA-303	HAND CLOSE	Controller for XV-602.	·	• СР
· · ·	PIC-606	HAND CLOSE	Controller for XV-601.		CP
	SV-608	CLOSE	Isolation valve for XV-601.		F
			When the condensate flow becomes close condensate level control v 604 and close the condensate ret	alve XV-	F
 	FR-601	$0 m^{3/hr}$	valve. Condensate flow recorder.		CP
	LIC-601	HAND	Controller for cordensate level	control	F
		CLOSE	valve (XV-604). Put the controller in HAND mode, level below 50 % if necessary, a fully.	1	
: •• ••	SV-609	CLOSE	Condensate return valve.		F

STEP NO.	OPERATION	SHEET FOR :	PAGE :	
			2-5	
BR		NORMAL SHUTDOWN	REFERENCE S BR-	HEET : SH-2
RECORD NO.	POSITION			
OR Valve no.	OR SET POINT	OPERATION		LOCATION
	2.5	RECIRCULATING BRINE FLOW "DEC	REASE"	
		MAKE UP SEAWATER FLOW "DECREA		
		Recirculating brine flow shal	l further	
		be reduced as the top brine t	emperature	
· · · · ·		falls to make the brine level	not too	
		high.		
		Also the make up seawater flo	(1) 11 (1) (1) (1) (1) (1) (1) (1) (1) (
		reduced roughly step-by-step	as product	
	ense i tratta e	flow reduces.		
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• 8				
		and the second second second		
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STEP NO.	OPERATION	SHEET FOR :	PAGE : 2-6	
BR		NORMAL SHUTDOWN	REFERENCE S BR-	SHEET : SH-2
RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION		LOCATION
	2.6	DISTILLATE PUMP "STOP"		
FR-401	$0 m^3/hr$	Distillate flow recorder.		CF
LICA-507	HAND CLOSE	Controller for distilalte level valve (XV-601).	control	CP ·
		Put the controller in HAND mode, level if necessary, and close for	-	
BA-403	CLOSE	Distillate pump discharge valve.	•	F
	STOP	Switch for distillate pump.	: : :	Ср
	CLOSE	Isolation valve for service wate distillate pump.	er to	F
			•	

NOTE

During shutdown, the conductivity of distillate may exceed acceptable level because of unstable brine level. The stream of distillate will be automatically changed to dump line when the conductivity rises to unacceptable level.

STEP NO. OPERATION	OPERATION SHEET FOR : <u>NORMAL SHUTDOWN</u>		SHEET : -SH-2
ECORD NO. POSITION OR OR VALVE NO. SET POINT	OPERATION		LOCATION
2.7	COOLING DOWN OF EVAPORATOR		
	After stopping distillate pum		
	recirculating brine and make shall be continued until the	highest	
	system temperature presented heater outlet temperature fal		
	below.		
	Keep the following flow rate	en de la composition de la composition Característica de la composition de la c	
	Recirculating brine Make up seawter	4 T/hr 3.62 T/hr	
	$\frac{1}{2} \left\{ \begin{array}{ccc} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 2 & 1 & 1 $		

STEP NO.	OPERATION S	DN SHEET FOR : PAGE :		
BR	NORMAL SHUTDOWN BR-S			
RECORD NO. OR VALVE NO.	POSITION OR SET POINT	OPERATION		LOCATION
	2.8	MAKE UP TREATMENT "STOP"		-
		Stop injection of chemicals when top brine temperature falls to !		
	STOP	Switch for anti-scale injection pump.		CP
	STOP	Switch for antifoam injection pump.		LCP
	STOP	Switch for sodium sulphite injection pump.		LCP
	CLOSE	Anti foam injection isolation va		F
	CLOSE	Sodium sulphite injection isolat Anti scale injection pump discha	F	
	CLOSE	Anti foam injection pump discharge valve.		F
	CLOSE	Sodjum sulphite injection pump of	lischarge	F
		In case of acid control, the wor scale" should be read as "Acid".		
			• .	

STEP NO.	OPERATION S	HEET FOR :	PAGE :		
BR	NORMAL SHUTDOWN		2-9 REFERENCE SHEET : BR-SH-2		
ECORD NO.	POSITION				
OR ALVE NO.	OR SET POINT	OPERATION		LOCATION	
	2.9	BRINE RECIRCULATION FLOW "STOP"			
FRC-301	HAND 10 Z OPEN	Controller for recirculating brackstring b	ine flow	СР	
		Reduce opening to 10 %.			
BA-304	CLOSE	On line valve.		F	
	2.10	MAKE UP SEAWATER FLOW "STOP"			
		MAKE UP PUMP, BRINE RECIRUCLATIO	ON PIIMP		
		"STOP"			
FRC-201	HAND CLOSE	Controller for make up flow cont (XV-201).	trol valve.	СР	
LICA-202	HAND CLOSE	Controller for deaerator level (valve (XV-203).	control	CP	
BA-209	CLOSE	Discharge valve of make up pump		F	
	STOP	Switch for make up pump.		CP	
LICA-507	AUTO SET 20%	Controller for last stage brine control valve (XV-302).	level	CP	
	• •	Gradually lower the set point to	o 20 %,		
• .		then put the controller in HAND	mode and		
		close fully.			
BA-303	CLOSE	Discharge valve of the brine rec pump.	irculation:	F State	
· · ·	STOP	Switch for brine recirculation p	pump.	CP	
	CLOSE	Isolation valve of pump sealing	wator	F	

					·
	STEP NO.	OPERATION	SHEET FOR : PAGE : 2-		
ta star a Sin star	BR		NORMAL SHUTDOWN	REFERENCE S	
алан Алан Алан Алан Алан Алан Алан Алан Алан				BR-	SH-3
	RECORD NO. OR VALVE NO.	POSITION OR	OPERATION	<i>,</i>	LOCATION
	VALVE NU.	SET POINT			
B		2.11	1ST AND 2ND STAGE EJECTOR "STOP	-	
	SV-603	CLOSE	Steam valve of ejector.		F
		CLOSE	Switch for ejector steam shut-of (XV-605).	f valve	CP
		agus an fais sua an sinn. Tha	$\mathcal{T}_{A_{1}}(\mathbf{g},\mathbf{h}) = (\mathbf{g},\mathbf{h}) + (\mathbf$	$\mu_{i}=1,\dots,1,m$	
:		i <mark>na sana</mark> na sana na s			
а. 					
		2.12	SEAWATER SUPPLY "STOP"		•
	BV-101	CLOSE	Seawater supply valve.		
					:
		2.13	ISOLATION AND DRAINAGE		· ·
	SV-603 SV-608	CLOSE	Steam isolation valve.		F
		CLOSE	Service water isolation valve.		F
			NOTE	· · · .	
:			When the draining is required fo	r main-	
		a di seri di peri diteri di secondo di second Secondo di secondo di se	tenance work, open vent and drai	and the second	
			of the required part of the equi and pipes.	the second se	
			During maintenance work, the uni	4 .1.11	
			also electrically be isolated.	L SHAIL	1 · · · ·
light of			Ask electrical staffs before sta	ntin-	}
			the works.		
		andar Alah Anger Angerbaa	Proper preservation method is re	quired	
			after the plant is shutdown. Details shall be referred to Sec	tion ?	· ·
			MAINTENANCE MANUAL.	CIQU),	
1 N N N N	E the second second	1			•

SECTION 2 OPERATION MANUAL CHAPTER 2 ROUTINE CHECK LIST

2.1 INTRODUCTION

Good maintenance of the Desalination Plant will result in longer plant life and more economic production of high purity water.

Therefore, evaporator and auxiliary equipment, all instruments and controls and all rotary equipment such as pumps and motors shall be well maintained.

In this section, the routine and specific check works which are required during normal operation are given.

Daily patrol shall be made to see the general condition of the equipment.

Any unusual observations shall be recorded and necessary countermeasure shall be taken immediately, or depending on the cases shall be scheduled for the next shut down. Daily patrol shall includes following checks :

- (1) Check operating condition of rotating machines such as pump, motor, mixer for noise and vibration.
- (2) Check pumps for proper effluent from gland, lubricating oil level and temperature of the bearings.
- (3) Check for loosen connections, leaks at pipe joints, instrument connections etc.
- (4) Check valves for leakage.
- (5) Check and clean glass gauges and indicator for legibility, looseness and cracks.
- (6) Check structural members and exposed metal parts for damage.
- (7) Check electrical cables and instrument leads for fraying, worn or damage.

2.2 ROUTINE CHECK SCHEDULE

These tables summarized in this section are general guidance for periodical inspection which are required for stable and safe operation of the plant equipment.

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1.5 EMERGENCY OPERATION

1.5.1 INTRODUCTION

It should be understood that the steady operation of desalination plant is entirely dependent upon the heat and mass, or temperature and pressure balance of the whole desalination process. And this is fully supported by the good functions of the equipment and control system.

Therefore sudden trip of any major stream or equipment will greatly affect the balance in the process and, eventually, the desalination plant may not continue its operation.

Emergency operation is in every case the essence and quick form of normal shut down procedure, with the exception of the steps on which the failure or trip occurs.

In principle, the operator shall reduce or stop steam supply to brine heater as a primitive action to avoid over shooting of the top brine temperature. Thereafter take necessary and quick actions for shut down in accordance with the normal shut down procedure.

It may be aware from the above explanation that the operators should fully study and understand the procedure of normal shut down.

CAUTION

- 1. When the steam supply is stopped by closing the control valve, followed by or after ceasing the recirculating brine flow, the isolation valve shall also be closed as the control valve may have some leak.
- 2. If water hammering occurs in the evaporator during and/or after any case of emergency operation, open air vent valves on water boxes of evaporator and brine heater to break uneven pressure locally appeared in the system.

1.5 EMERGENCY OPERATION PROCEDURE

1.5.2 Power Supply Failure

Destination : Treatment after abnormal shut down.

All pumps stop.

Heating steam pressure control valve closes. Ejector steam shut off valve closes.

Vacuum in evaporator breaks.

 Put all controllers on the panel in manual mode and close them all. (When the control power and the instrument air remain alive.)

(2-1) Close all pump discharge valves.

(2-2) Close isolation valve on boiler steam line.

(2-3) Close isolation valves on seawater lines.

(2-4) Put all other valves in the position of normal shut down.

(3) Wait for recovery of power supply.

(4) Cool down the evaporator.

(5) Re-start or shut down.

1.5 EMERGENCY OPERATION PROCEDURE

1.5.3 Seawater Supply Failure

Destination : Quick shut down.

Ejector steam shut off valve closes.

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(1-1) Close brine temperature control valve. Close heating steam pressure control valve.

(1-2) Close make up flow control valve.

(1-3) Close brine level control valve to keep brine level in the last stage.

(2) Reduce recirculating brine flow.

(3-1) Close condensate level control valve.

- (3-2) Close distillate level control value and stop distillate pump.
- (4-1) Close recirculating brine flow control valve.
- (4-2) Close brine level control value and stop brine recirculation pump.

1.5 EMERGENCY OPERATION PROCEDURE

1.5.3 Seawater Supply Failure (cont'd)

(5-1) Close all pump discharge valves.

(5-2)	Close	isolation	valve	on	boiler	steam
	line.					

.6)	Stop anti scale chemical injection pump (or acid injection pump) antifoam injection pump and sodium sulphite injection pump.	,,
	The second s	

(7-1) Close isolation valves on seawater line.

(7-2) Put all other valves in the position of normal shut down.

(8) Wait for recovery of seawater supply.

.

(9) Cool down the evaporator.

(10) Re-start or shut down.

1.5 EMERGENCY OPERATION PROCEDURE

1.5.4 Instrument Air Supply Failure

Destination : Quick shut down without control system.

Heating steam pressure control valve closes. Brine temperature control valve closes. Ejector steam shut off valve closes.

(1) Stop brine recirculation pump. Stop distillate pump. Stop make up pump.

(2) Close the make up flow control valve.

- (3-1) Close all pump discharge valves.
- (3-2) Close isolation valve on boiler steam line.

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- (4) Stop and scale chemical injection pump,
 (or acid injection pump) anti-foam injection pump and sodium sulphite injection pump.
- (5-1) Close isolation valves on seawater line.
- (5-2) Put all other values in the position of normal shut down.

1.5 EMERGENCY OPERATION PROCEDURE

1.5.4 Instrument Air Supply Failure (cont'd)

(6) Wait for recovery of instrument air supply.

(7) Cool down the evaporator.

(8) Re-start or shut down.

NOTE

Action of control valves on failure of instrument air supply is summarized in clause 1.6 in this chapter.

1.5 EMERGENCY OPERATION PROCEDURE

1.5.5 Boiler Steam Supply Failure

The situation is considered almost the same as normal shut down except that boiler steam (for brine heater and ejector) is cut off suddenly and at once.

Sec. A Sec.

Destination : Normal shut down.

(1) Reduce recirculating brine flow not to rise the level in evaporator.

Follow normal shut down procedure.

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1.5 EMERGENCY OPERATION PROCEDURE

1.5.6 In-plant Equipment Failure

<u>Trip of Pump</u>

Same procedure as 1.5.4.

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CONTROL VALVE ACTION ON AIR FAILURE 1.6

The position of each control valve on instrument air failure are as follows.

Definitions

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Open	:	the valve opens when the air supply fails.
Close	:	the valve closes when air supply fails.
Lock	:	the valve keeps its opening when the air supply fails.
Free	:	the valve has no determinate action nor be locked

when the air supply fails, may open or close slowly.

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Control valve	Tag No.	Action on air failure
Heating steam pressure control valve.	XV-601	Close
Brine temperature control valve.	XV-602	Close
Ejector steam shut off valve.	XV-605	Close
Condensate level control valve.	XV-604	Close
Seawater temperature control valve.	XV -101	Open
Make up flow control valve.	XV-201	Close
Recirculating brine flow control valve.	XV-301	Open
Brine level control valve	XV-302	Close
Distillate level control valve.	XV-401	Close
Distillate conductivity control valve. (dump line)	XV-402	(Open)
Deaerator level control valve.	XV-203	Close

1.7 COOLING DOWN OF EVAPORATOR

When the desalination plant is stopped suddenly resulted from any failure or trip, the temperature gradient through the stages of the evaporator will soon be broken and the evaporator is saturated with vapour and brine of high temperature.

This will make re-start of the plant difficult because the ejector system has to evacuate enormous quantity of vapour which generates from hot brine as the vacuum rises.

Therefore the cooling down of the evaporator become necessary. Cooling down of the evaporator is simply a few steps of the normal start up procedure.

After recovering the failure or trip, carry out the cooling down as follows.

- (1) Start seawater supply to rejection section condenser.
- (2) Start make up pump.
- (3) Start make up seawater supply to the brine line.
- (4) Start brine recirculation pump.
- (5) Circulate the brine while supplying make up and discharging blowdown until the brine temperature measured at any point of recirculating brine line falls below 50 °C.

NOTE

If the situation allows, hot brine remaining in the evaporator may be drained through drain valves and by operating blowdown line before starting make up seawater supply.

	SKS	level				level.						
PAGE : CL1	*SET POINT *OTHERS *ALARN POINT *TRIP POINT	distillate	Last stage brine level	: 50 mm (Low)		heater condensate						
	REMARKS	 Flash tank 	b) Last st	(Alarm)		a) Brine he						
	INSPECTION FREQUENCY	Daily		۰ ۹۰٫۰ ۹۰ ۹۰ ۱۰		Daily	Daily	na santa Na santa Na santa		Daily	· · · · · · · · · · · · · · · · · · ·	
SYSTEM NAME :	TEM	lash in each stage.	each stage.	ndicators for and cracks.	from connections of pipes.	el in the hotwell.	om connections of pipes.			om connections of pipes.		
SYSTEM NO. BR	INSPECTION ITEM	. Check distillate reflash in	. Check brine level in each st	. Inspect gauges and indicator legibility , loseness and cre	Check for leakage	. Check condensate level in th	. Check for leakage from conne			. Check for leakage from		
ROUTINE CHECK, LIST	INSPECTION OBJECT	Evaporator 1.	5		4	Brine Heater 1.	3.			Ejector Condenser 1.		

	S									<u>,</u>						
: CL2	NT *OTHERS OINT INT		· · ·										3 2 2 2	•		•
PAGE	*SET POINT *ALARM POINT *TRIP POINT													· · · · · · · · · · · · · · · · · · ·	·	·
	REMARKS		• • • •	·						·				•		
	INSPECTION FREQUENCY		Daily	Daily	-	Daily	Daily	Daily	Daily	Daily	Daily	Daily	· · · · · · · · · · · · · · · · · · ·			
SYSTEN NAME :	I TTEM		drop.	from pipe connection.	· · ·	oil level. d.	ssure.	from gland.		y hand).	erature (by hand).	pipe connections.				
IST SYSTEN NO. BR	INSPECTION ITEM		1. Check for pressure drop.	l. Check for leakage from pipe		 Check lubricating oil level. Top up when lowered. 	2. Check delivery pressure.	3. Check effluent from	4. Check noise.	5. Check vibration (by hand).	6. Check bearing temperature (by	7. Check leakage from pipe connections.				
ROUTINE CHECK, LIST	INSPECTION OBJECT	<u>Ball Cleaning</u> System	<u>Ball Strainer</u>	Ball Collector		Horizontal Pump	•	· · · ·		· · · · · · · · · · · · · · · · · · ·	-					

ct.4	*OTHERS				
PAGE :	*SET POINT * *ALARM POINT * *TRIP POINT				
	REMARKS				
	INSPECTION FREQUENCY	Daily Daily	Daily Daily	Daily States and States	
SYSTEM NAHE :	TEN	e feeling stic when cted. ame temperature thermometer when cted).	of bearing housing [cation is applied). (by hand).		
T SYSTEM NO. BR	INSPECTION ITEM	 Check noise use noise feeling stic when abnormality is suspected. Check bearing and Frame temperature (by hand, or and by thermometer when abnormality is suspected). 	 Check oil level of bearing (where oil lubrication is 4. Check vibration (by hand). 	5. Check current and voltage.	
ROUTINE CHECK, LIST	INSPECTION OBJECT	<u>Electric Motors</u>			

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	PAGE : CL5	*SET POINT *OTHERS REMARKS *ALARM POINT *TRIP POINT										
		INSPECTION FREQUENCY		Daily	Daily	Daily	Daily		Daily.	Daily	:	
	SYSTEM NO. SYSTEM NAME : IST BR	INSPECTION ITEM		1. Check noise.	2. Check vibration.	3. Check leakage from pipe connection.	1. Check presure after strainer.		1. Check for leakage.	1. Check vibration (by hand).		
	ROUTINE CHECK, LIST	INSPECTION OBJECT	Chemical Injection	Pump			Strainer	Tank and Agitator	Tank	<u>Agitator</u>		

T. cout tesp. $R - 103$ ∇ Γ usa $R - 303$ ∇ Γ Γ usa $R - 303$ ∇ Γ Γ Γ usa $R - 303$ ∇ Γ Γ Γ Γ usa $R - 301$ $P - 301$ $P P - 301$ $P P - 301$ $P P - 301$ $P - 301$ use $D R - 511$ $P P - 301$ $P P - 301$ $P P - 301$ $P P - 301$ $P - 301$ <th>E q +</th> <th>Tag No</th> <th>11-1 + +</th> <th></th> <th></th> <th></th> <th></th> <th>1</th> <th>0</th> <th></th> <th></th> <th>-</th> <th></th> <th></th>	E q +	Tag No	11-1 + +					1	0			-		
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Re - 50i $calgr $	Top brine temp.	TR - 303	u									-	-	
PHR = 201 PHR = 201 PHR = 301 ppb DOR ~ 201 ppb DOR ~ 201 ppb CR = 401 $\mu\nu/cas$ CR = 401 $\mu\nu/cas$ CR = 401 $\mu\nu/cas$ FR = 101 e^2/hr FR = 201	Last stage vacuum	PR - 506	cm Hg V											
PHR - 301 PHR - 301 PhD D07 - 301 PhD PhD D07 - 301 $\mu \nu / cas$ PhD ER - 401 $\mu \nu / cas$ PhD ER - 101 $\mu \nu / cas$ PhD ER - 201 μ^2 / hr PhD ER - 301 π^2 / hr PhD PhD - 905 $\mu e / cdc$ PhD	Decarbonator out PH	PHR - 201											-	
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D0R - 301 p0b $(21 - 401)$ $\mu\nu/cas$ $(21 - 401)$ μ^{2}/hr $(21 - 401)$ μ^{2}/hr $(21 - 401)$ μ^{2}/hr $(21 - 201)$ π^{2}/hr $(21 - 102)$ π^{2}/hr $(21 - 201)$ π^{2}/hr $(21 - 202)$ <td< td=""><td>Hake up D02</td><td>DOR ~ 201</td><td>bpb</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	Hake up D02	DOR ~ 201	bpb											
$(2i - 401)$ $\mu \nu / cac$ $(2i - 401)$ $\mu \nu / cac$ $(2i - 401)$ π^2 / hr $(2i - 313)$ ∇ $(2i - 313)$ ∇ $(2i - 311)$ π^2 / hr $(2i - 312)$ V $(2i - 312)$	Brine D02	DOR - 301	dqq				·						-	:
$(31 - 401)$ $\mu \nu / cas$ $[37 - 101]$ a^3 / hr $[37 - 101]$ a^3 / hr $[37 - 101]$ a^3 / hr $[37 - 102]$ a^3 / hr $[101 - 201]$ g^3 / hr $[101 - 202]$	Condenszie conductivity	CR - 801	1									- - -	-	
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$R = 201$ π^3 / hr $R = 301$ π^3 / hr $TC = 102$ ∇ $TC = 303$ ∇ $TC = 303$ ∇ $TC = 303$ ∇ $TC = 201$ π^3 / hr $FC = 303$ \mathcal{G} $TR = 101$ ∇ $TR = 101$ ∇ $TR = 101$ ∇ $TR = 201$ ∇ R^4 R^4	Seawater to reject. flow	FR - 101	\mathbb{N}		-						<u>-</u>			-1
$R = 301$ $z^3 \land hr$ $z^3 \land hr$ 11C = 102 ∇ 11C = 103 ∇ 11C = 203 ∇ 11C = 201 $k_K \neq clc$ 11L = 201 $k_K \neq clc$ 11L = 202 $K_K \neq clc$ 11L = 201 ∇ 11L = 202 ∇ 11R = 101 ∇	Make up flow	F2 - 201	1										-	
TIC - 102 ∇ $11C - 303$ ∇ $11C - 201$ $kx < kdc$ $11C - 202$ $x < kdc$ $11E - 202$ $x < kdc$	Recirc. brine flow	F8 - 301												
TIC = 313 \mathbb{C} PIC = 616 $k_Z \wedge cdG$ FIC = 201 $\pi^2 \wedge hr$ fect. $Fr = 201$ $F_1 = 201$ 96 $F_1 = 201$ 96 $F_1 = 202$ 96 $F_1 = 202$ 96 $F_1 = 202$ ∇ $F_2 = 202$ ∇ $F_1 = 201$ ∇ $F_2 = 202$ ∇	Seawater reject. out temp.	TIC - 102	p							•				· .
PIC - 616 kx/cdC FIC - 201 x^3/Lr fect. $Fr - 201$ x^3/Lr $Fr - 201$ x^3/Lr r $Fr - 201$ x^3/Lr r $Fr - 202$ S_1 r $Fr - 202$ S_1 r $Fr - 202$ S_1 r $Fr - 301$ x^2/Lr r $Fr - 302$ V r $Fr - 302$ V r $Fr - 301$ V r $Fr - 301$ V r $Fr - 301$ V r $Fr - 302$ V r	Top brine temp.	TIC - 303	þ											·
Fit - 201 $\pi^3 \ hr$ <td>Reating steam press.</td> <td>PIC - 606</td> <td>ker/edG</td> <td></td> <td>-1</td>	Reating steam press.	PIC - 606	ker/edG											- 1
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Brine recirc. pump discharge press.	PI - 301	ite∕calG								w				
Make up pump discharge press.	PI - 201				-			2 - 2 - 2 - 2 - 2						
Distillate puep discharge press.	PI - 402	ter / calif	•			· · ·		- - 				-		
Antifors tank level	L1 - 804		1					<u>e ,e</u>	·					
Antifora flov	F1 - 804	1 / hr			:									
Antifora pump disch. press.	PI - 804	kg/cdC												
Antiscale tank level	LI - 801		-				 	-						
Antiscale flow	FI - \$01	1 / hr										 -		
Antiscale pump disch. press.	10\$ - 1d	kg/cdC	<u>.</u>	 	•				 	: : : : :				
Sodium tank level	L1 - 803												1.	
Sodium flov	Fl - 3 03	1/ hr		-	-	-	-							
sodium pump disch. press.	PI - 1 03	kg / cal G	:						.	- - 			•	
Acid tank level	LI - 802				3 2 3 3	1 1 1 1				-				
Acid flow	F1 - \$02	1 hr		<u>.</u>						 				-
Acid pusp disch. press	P1 - 3 02	ker/cali	1 - 2 - 1		- 							-		
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Acid cleaning pump disch. press.	PI -805	kg/cdG												
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Air tank press.	100 - Jd	its/alc								 - (
Water tank level	LI - 402													
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LOG SHEET (4) (Boiler) Unit No.

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2.3 CHECK DURING NORMAL OPERATION

2.3.1 Data Reading

The readings of panel instruments and local instruments shall be logged periodically on log sheets.

The logged data shall be served for checking of plant production, thermal performance and operating conditions of the equipment.

When readings are not usual, such condition should be confirmed by the readings of related line or equipment condition or by using other calibrated instrument and appropriate countermeasure should be taken to recover it.

Recommended form of the plant log sheet is attached herewith.

2.3. CHECK DURING NORMAL OPERATION

2.3.2 Functional Checks

Control room operators must take note of any changes in operating conditions.

Local operators shall also make regular patrols over the entire desalination plant and report any abnormality when found.

LOOK - for leak, smoke, discoloration, deposition, water accumulations, steam escape, etc.

LISTEN - for sound, noise and squealing, etc.

FEEL - for heat, vibration, etc.

SMELL - for scent of burning or leaking.

A periodical functional checks shall be carried out by analyzing operational data obtained at the control panel and also local instruments. If any abnormal function is noted, immediate corrective action shall be taken to avoid consequent damages and a possible shut down. In case of disturbance in operation, refer to "TROUBLE SHOOTING" in this section and take correct action immediately.

Following items shall be checked daily and occasionally.

2.3 CHECK DURING NORMAL OPERATION

2.3.2 Functional Checks (cont'd)

a. Brine Concentration

The concentration of recirculating brine is one of the most important factor in designing and operating of seawater desalination plant.

The concentration shall preferably be confirmed by water analysis in the terms of total dissolved solids or of specific scale forming components. However, when the seawater concentration is observed steady and constant by regular analysis, this can easily checked through the mass balance of the plant operation using the following formula.

 $CR = \frac{Wmu \times Rmu (Wbr \times Rbr - Wd \times Rd)}{(Wmu \times Rmu - Wd \times Rd) \times Wbr \times Rbr}$

Cbr = CR x Csw

Where,	CR	: Concentration ratio = Cbr/Csw ()
	Cbr	: Concentration of recirculating brine (ppm)
ti utranti sure S	Csw	: Concentration of seawater (ppm)
	Wmu	: Make-up water flow rate (m^3/hr)
	Wbr	: Recirculating brine flow rate (m^3/hr)
• .	Wd	: Product water flow rate (m^3/hr)
- ·	Rmu	: Density of make-up water (kg/m^3)
· · · ·	Rbr	: Density of recirculating brine (kg/m^3)
-	Rd	: Density of product water (kg/m^3)

Cbr shall not be more than 58,500 ppm as total dissolved solids (TDS).

Unacceptable level of concentration will cause precipitation of non-alkaline scale in the tubes of brine heater and heat recovery section.

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2.3 CHECK DURING NORMAL OPERATION

2.3.2 Functional Checks (cont'd)

b. Chemical Injection Rate

For anti scale chemical, anti foam chemical and sodium sulphite, the following calculation can be applied for checking of consumption and injection rate.

The injection rates of the chemicals indicated in the heat and mass balance disgram are to be considered as standard dosage. The injection rates may be optimised while observing the effects of the chemicals.

(1) Consumption

 $W = O \times C$

W (kg/hr) :	Consumption rate of chemical
Q (m ³ /hr) :	Consumption of chemical solution
en de la composition de la composition La composition de la c	obtained from :
	a. descent of tank level
	b. pump capacity by stroke indicator
C (kg/hr) :	Concentration of chemical solution
	actually made.

(2) Injection Rate

R = (W / Wmu) x 1000

R	(ppm)		Injection rate of chemical	
W	(kg/hr)	:	Consumption rate of chemical	
Wm	u (m ³ /hr)	1	Average make up seawater flow	rate.

2.3 CHECK DURING NORMAL OPERATION

2.3.2 Functional Check (cont'd)

c. Water Production

Water production is checked from the operating condition using the following equation.

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Where

Wdc

Wbr	:	Measured recirculating (m ³ /hr)	brine	flow	rate
Wbr'	:	Design recirculating (m ³ /hr)	brine	flow	rate
Tmax	:	Measured top brine temper	rature (°C)	
Tmax'	:	Design top brine tempera	ture (°C)	
Tr	-1	Measured last stage brind	e temper	ature	(%0)
Tr'	ens ŧ	Design last stage brine	temperat	ure (^o	C)
Wd'	:	Design product water flow	w rate (m ³ /hr)	
Wdc	* 	Calculated product water	flow ra	te (m ³	/hr)

(Appendix 5, 3, 1)

- 2.3 CHECK DURING NORMAL OPERATION
- 2.3.2 Functional Check (cont'd)

c. Water Production (cont'd)

Another calculation is made by the equation below :

. .

$$Wdc = \frac{2Cpbm (Tmax - Tr)}{2Lm + Cpbm (Tmax - Tr)} \times Wbr \times \frac{Rbr}{Rd} \dots (2)$$

Where

```
brine at mean temperature
(Tmax + Tr)/2
```

```
: Latent heat of vapour at
                                            (kcal/kg)
Lm
          mean temperature
          (Tmax + Tr)/2
          Density of product water
                                            (kg/m^3)
Rđ
     . .
Rbr
          Density of recirculating brine (kg/m<sup>3</sup>)
       :
                                            (m^3/hr)
          Calculated product flow rate
Wdc
       :
```

- 2.3 CHECK DURING NORMAL OPERATION
- 2.3.2 Functional Check (cont'd)
 - d. Gained Output Ratio

Gained output ratio (GOR) is calculated by the following formula.

(1) As Plant Performance

 $GOR = \frac{Wd}{Ws}$

Ws = Wc x Rc + Wse

(2) <u>As Evaporator Performance</u>

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$$GOR = \frac{Wd}{Wc \times Rc}$$

Where	Ws	:	Steam for desalination plant	(kg/hr)
an an an	Wc	:	Condensate flow rate	(m^3/hr)
	Rc	:	Density of condensate	(kg/m ³)
i.	Wse	:	Steam for ejector	(kg/hr)
1944 - Alexandria	and a state		and the second	

The daily transition of GOR shall be watched carefully. If abrupt decrease is found, anti scale chemical feed system must be checked for its operation.

2.4 WATER ANALYSIS

2.4.1 General

The desalination plant has been designed based on the results of chemical analysis of seawater. The change in chemical compositions of the seawater will affect qualitative and quantitative plant production and sometimes will affect plant material resistivity. Therefore, if unacceptable level of components is found, the plant operation must be re-adjusted in order not to cause troubles and to keep reliable production or keep the plant safe.

The scale precipitation which greatly affect the performance of the plant is depending on the concentrations of scale components such as Ca^{++} , Mg^{++} , SO_4^{--} and strength of alkalinity.

The tendency of the precipitation is also affected by the amount of total dissolved solid content.

In addition, the electrical conductivity of the product water and the condensate return may be measured for checking of the reliability of the plant inistalled instruments.

2.4.2 Guidance of Water Analysis

The following table shows general guidance of chemical analysis for good operation of the desalination plant. Excessive deviations from the normal values will predict contamination of streams or unsatisfactory operation of the plant. In such case proper countermeasure should be taken immediately.

NOTE

Measurment of electrical conductivity is very useful as it represents the content of chloride ion or total dissolved solids, and is instant and simple.

Typical relation curve of electrical conductivity and total dissolved solids for seawater is attached in this chapter. However, it is recommended to make calibration curve from the actual seawater at the site.

2.4 Water Analysis

2.4.2 Guidance of Water Analysis (Cont'd)

RECOMMENDED INTERVALS FOR WATER ANALYSIS

Item	Fluid	Seawater Brine	Recycle Water	Product
рĦ	Biweekly	Weekly		
Conductivi	ty	Daily	Daily	Daily
M-Alkalini	ty	Biweekly		
Chloride 1	lon	Biweekly	Weekly	· · ·
Sulfate Ic	on Biweekly		······································	
Total Hard	iness	Biweekly	••••••••••••••••••••••••••••••••••••••	
Residual Chlorine	As needed	· · · · · · · · · · · · · · · · · · ·		
Hydrogen a	ulphide	Seasonally		·
Ammonia	Seasonally			

2.4 WATER ANALYSIS

2.4.2 Guidance of Water Analysis (Cont'd)

Following data given in the specification is taken into consideration in designing the desalination plant.

	Unit	Data	Normal Seawater*
pH	e 1 - En <mark>la</mark> nde	8.2	ne alterative. Antonio de la composición de la composi
Turbidity	NTU		
제 24 이 사람은 공장에서는 이 것 같아요.			
Electrical conductivity	umho/cm		
Total alkalinity as CaCO3	ppm	an a	
M-alkalinity as CaCO3	ppm		14月1日 - 第 月月
Total hardness as CaCO3	ррт		
Total dissolved solid at 100 °C	Ppm	45,000	35,174
Suspended solid	ppm ···		an a
ta ang santa na santa sa santa sa santa. Na	ang tanàng sa kaona Mangkatang kaona		400
Calcium	Ррш		408
Magnesium	ppm		1,297
Sodium	ppm	· · · · ·	10,768
Potasium	ppm		388
Iron	ppm		1.3
Copper	1	e La constante La constante da const	
	ърш		
Chloride	₽ р m	25,000	19,360
Sulphate	ppm		2702
Bicarbonate as CaCO3	ррш		116
Carbonate as CaCO3	ppm		
Nitrate nitrogen	ррш		
Silicate as SiO ₂	ррпа		
- · · · · ·			
Total sulphide as H ₂ S	ppm		
Free CO ₂	ppm		
0il content			

2.4 WATER ANALYSIS

2.4.2 Guidance of Water Analysis (Cont'd)

NOTE

*: "Normal seawater" as prepared by the Hydrographic Laboratories of Copenhagen, Denmark.

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