SERVICE MANUAL AND GUIDELINES

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Annexure – 1
General Guidelines for Service Engineers

- All service calls should be recorded in a service registration format for evaluation purposes.
- Engineers must return the call, understand the problem from the client, and identify the cause.
- as either electrical, mechanical, instrumentation, or process-related.
- The engineer must inform the client of the date of the service visit, confirm if charges are applicable, and plan the activity accordingly.
- The engineer must review old records from the service file and prepare for anticipated problems.
- Technicians must be informed of all relevant details, and they should return the call if the problem is not clearly identified.
- Service technicians should visit the site with all necessary tools and instruments to identify and troubleshoot the problem. If materials are required, a list should be prepared.
- Technicians must report back to the Service Engineer, verifying the actions taken during the service visit, especially for service call visits.
- Quotations should be submitted to the client within 24 hours, including all requirements and a clear identification of the problem.
- Job requests, servicing, and invoicing should be carried out according to company procedures.
- Maintain a history sheet of the plant at the client's location, and technicians must sign it with a record of the details of the work carried out for documentation purposes.

Annexure – 2:
General Guidelines for Service Technicians

- Technicians should always wear a neat and clean uniform to reflect the company's professional image to clients.

- Technicians should be punctual and adhere to the agreed-upon time commitments.

- Technicians should always carry necessary instrumentation, including:

- Calibrated pH and TDS meters
- Calibrated ammeter for current measurement
- Calibrated pressure gauges for quick testing when applicable
- Team leaders should have a proper toolbox and equipment for carrying out services
- Technician vehicles should be equipped with the minimum materials required for normal service at the site.

- Technicians should be capable of evaluating the problem and providing detailed information to the service engineer.

- Technicians must accurately fill out data sheets and service reports, paying attention to any abnormal variations observed.

- It is essential to avoid multiple visits to the same site for data collection. This saves time, effort, and minimizes client inconvenience.

Annexure – 3
General Guidelines for attending services calls and check list

- Check the cleanliness of equipment and clearly remark if the equipment is not properly maintained.
- Inspect the piping system (LP and HP) for leaks and identify the cause and location of the leakage for evaluation and record purposes.
- Perform a backwash of the media filter and inquire about the client's backwash procedure and frequency. Check the quality of the backwash water and record it if it is dirty.
- Consider increasing the frequency of backwashing if necessary.
- Assess the condition of bag and cartridge filters and inquire about the replacement frequency. Increase the replacement frequency if the last stage cartridge appears dirty.
- Examine the condition of all pressure gauges, ensuring they are not rusted and are functioning properly. Record any gauges that are not working.
- Verify the condition of the PH and TDS meters and calibrate them if needed. If a meter is not functioning, make a note of it in your report for further action.
- Evaluate the dosing tank and dosing pump, and obtain the following information:

  a) Inquire about the method of chemical-water mixing.

  b) Determine the time it takes for the solution to finish, as it indicates the dose rate.

  c) Check if the solution is dirty and not properly mixed.

  d) Inspect dosing tubes for any accumulation of dirt and dust.
- Measure the feed water TDS and reject water TDS and compare them with the recovery ratio to ensure accuracy.
- Inspect the condition of flow meters, ensuring they are properly calibrated. Note any faults in your report.
- Check all rotating parts for overheating.
- Measure and record the current consumed by the FP and HPP motors.
- Look for rust on the plant and advise the operator to clean it. Record this in the logbook.
- Measure the TDS of each vessel and record the readings.
- Test the TDS, pH, and post-chlorination level of the product water. Ensure that the product water is stored properly.
- Provide proper training to the operator to prevent problems.

- Verify the functioning of safety features such as feed water tank level, product tank level, flush tank level, and low-pressure switch.
- Check the maintenance and cleanliness of the control panel. Use a blower if it is dirty.
- Examine the stock of chemicals and consumables, advising the client to maintain a minimum stock for three months.
- Record the in-time and out-time for each visit.

Check list for technician for service visit

S. No	Checklist	Result	Remarks
1	Check cleanliness of all equipments		
2	Check for leakage in low pressure piping and specify reason if any		
3	Check for leakage in HPP line and specify reason if any		
4	Check for working of all pressure gauges. Make and range if defective		
5	Check for working / calibration of TDS meter. Make and model no if defective		
6	Check for working of PH meter. Make and model no if defective		
7	Check for working of flow meter and specify make and model if defective		
8	Check for working of all dosing pumps. Make and model if defective		
9	Check for vibration and overheating on feed pump motor. Measure current if overheating		
10	Check for vibration and overheating on HP pump motor. Measure current if overheating		
11	Check for process parameters and record if they are as per design		
12	Check for media filter backwash and see condition of backwash water		
13	Open cartridge filter and check frequency of replacement based		

	on condition of filters		
14	Check solution preparation method of chemical		
15	Verify consumption of chemical and consumables		
16	Check for operator training level		
17	Check for safety device operation like pressure and level switches		
18	General comments on plant operation		

Parameters collection list for Technician

S no	Parameters	Unit	Value
1	Media filter inlet pressure	Bar	
2	Media filter outlet pressure	Bar	
3	CF1 outlet pressure	Bar	
4	CF2 outlet pressure	Bar	
5	CF3 outlet pressure	Bar	
6	System Pressure	Bar	
7	Reject Pressure	Bar	
8	Product flow	GPM	
9	Reject flow	GPM	
10	Recovery by flow	%	
11	Feed TDS	PPM	
12	Product TDS	PPM	
13	Reject TDS	PPM	
14	Recovery by TDS	%	
15	TDS Each vessel		
	PV – 1		
	PV – 2		
	PV – 3		
	PV – 4		
	PV – 5		
	PV – 6		
	PV – 7		
	PV – 8		

Status of Electrical motor

S no	Description of equipment	KW rating	Max allowed current	Actual Current	Vibration	Heating
1	Feed pump					
2	Backwash pump					
3	High pressure pump					
4	Flush pump					

Indicate your remarks on the following condition/observation:

General Condition of plant:

……

……

Media backwash observation:

……

……

Cartridge filter Observation:

……

……

Leakage Observations:

……

……

Dosing check and comments:

……

……

Technician signature:_____ **Service Engineer**_____

Additional Parameters to be collected for service/reconditioning / service contract

Sno	Equipment details	Make	Model no	Specification	Qty
1	Feed pump				
2	High Pressure pump				
3	Flush pump				
4	Pressure Vessels				
4a.	Pressure vessel array				
5	Membranes				
6	Dosing pumps				
6a.	Pre chlorination				
6b.	De chlorination				
6c.	Coagulant				
6d.	Antiscalant				
6e.	Acid				
6f.	Post PH correction				
6g.	Post chlorination				
7	Instrumentation				
7a.	Pressure Gauges				
7b.	Flow meter product				
7c.	Reject flow meter				
7d.	Feed / Product PH				
7e.	Feed / product TDS				
7f.	Feed / product ORP				
8	Cartridge filter – 1				
9	Cartridge filter – 2				
10	Cartridge filter – 3				
11	Media Filter				
12	Media filter valves				
13	Backwash pump				
14	Backwash blower				
15	VFD details				
16	Control panel PLC				
17	High pressure control valve				
18	Reject control valve				

Piping size details and specification

SNo	Details	Suction	discharge	Type
1	Feed pump			
2	Media filter			
3	Cartridge filter			
4	High pressure pump			
5	Main header on membranes	NA		
6	Pressure vessels	NA		
7	Product pipe	NA		
6	Reject pipe	NA		

Supplier name and details: ……..

……..

Year of installation: ……. Last time membrane replaced: ……. Why need reconditioning: …….

……

……

General condition of plant and Remarks: ……

……..

……..

Client specific requirement: …….

……

Technician _____**Service Engineer**_____**Dept. Head**_____

Pre-Start-Up Check and Commissioning Audit

After loading the elements into the pressure vessels and prior to starting up the membrane unit, it is crucial to ensure that the entire pre-treatment section is operating in accordance with the specified requirements. If the pre-treatment process involved altering the chemical characteristics of the raw water, a comprehensive analysis of the water entering the membrane unit should be conducted. Additionally, it is essential to determine the absence of chlorine, turbidity, and SDI (Silt Density Index). The stability of the raw water intake must be assessed in relation to the following parameters:

- Flow rate
- SDI
- Turbidity
- Temperature
- pH level
- Conductivity
- Bacteria count (standard plate count)

1. Pre-Startup Checks:
   - Ensure all pre-treatment processes (filtration, chemical dosing, etc.) are operating correctly.
   - Confirm that all necessary equipment, such as pumps, motors, and valves, are in good working condition.
   - Verify that the RO membranes are installed properly and are free from any visible damage.
   - Check the integrity of the piping system and make sure there are no leaks.
2. System Flushing:
   - Flush the entire RO system with clean water to remove any debris or contaminants.
   - Open all flush valves and allow water to flow through the system for a sufficient duration.
   - Close the flush valves once the water runs clear, indicating that the system is clean.
3. Pre-Startup Instrumentation Checks:
   - Calibrate and verify the accuracy of all instruments, such as pressure gauges, flow meters, and conductivity meters.
   - Ensure that all sensors are properly installed and functioning correctly.
   - Check the power supply and control system for any issues.
4. Membrane Soaking:
   - If required, soak the RO membranes in a compatible preservative solution as recommended by the membrane manufacturer.

- Follow the manufacturer's instructions for the soaking duration and conditions.

5. System Start-Up:
    - Gradually open the feed water supply valve to allow water into the system.
    - Monitor the system pressures, flow rates, and other parameters to ensure they are within the specified range.
    - Check for any abnormalities, such as excessive pressure drops or unusual noises
    - Allow the system to stabilize and reach its operating conditions gradually.

6. Post-Startup Checks:
    - Monitor the product water quality, including conductivity, pH, and any specific parameters relevant to the application.
    - Verify that the system is producing the desired flow rate and recovery ratio.
    - Check for any leaks or abnormal pressure fluctuations.
    - Document and record all startup parameters and observations for future reference.
7. System Optimization:
    - Fine-tune the operating parameters, such as feed pressure, recovery ratio, and reject flow, to optimize system performance.
    - Monitor and adjust any necessary chemical dosing for proper system operation.
    - Conduct regular sampling and analysis of the product water to ensure it meets the desired quality standards.

Sno	Check list	Result	Remakrs
1	Corrosion-resistant materials of construction are used for all equipment from the supply source to the membrane including piping, vessels, instrument, s and wetted parts of pumps		
2	All piping and equipment is compatible with designed pressure		
3	All piping and equipment is compatible with designed pH range (cleaning)		
4	Media filters are backwashed and rinsed		
5	New/clean cartridge filter is installed directly upstream of the high pressure pump		
6	Feed line, including RO feed manifold, is purged and flushed, before pressure vessels are connected		
7	Chemical addition points are properly located		
8	Check/anti-siphon valves are properly installed in chemical addition lines		
9	Provisions exist for proper mixing of chemicals in the feed stream		
10	Provisions exist for preventing the RO system from operating when the dosage pumps are shut down		
11	Provisions exist for preventing the dosage pumps from operating when the RO system is shut down		
12	If chlorine is used, provisions exist to ensure complete chlorine removal prior to the membranes Planned instrumentation allows proper operation and monitoring of the pretreatment and RO system		
13	Planned instrumentation is installed and operative		
14	Instrument calibration is verified		
15	Pressure relief protection is installed and correctly set		
16	Provisions exist for preventing the permeate pressure from exceeding the feed/concentrate pressure more than 5 psi (0.3 bar) at any time		

Sno	Check list	Result	Remakrs
17	Interlocks, time delay relays, and alarms are properly set		
18	Provisions exist for sampling permeate from individual modules		
19	Provisions exist for sampling raw water, feed, permeate and concentrate streams from each stage		
20	Pressure vessels are properly piped both for operation and cleaning mode		
21	Pressure vessels are secured to the rack or frame per the manufacturer's instructions		
22	Low pressure Pumps are ready for operation: aligned, lubricated, proper rotation		
23	High Pumps are ready for operation: aligned, lubricated, proper rotation		
24	Cleaning system is installed and operative		
25	Permeate line is open		
26	Permeate flow is directed to drain (In double-pass systems, provisions exist to flush first pass without permeate going through the second pass)		
27	The reject flow control valve is in open position		
28	A feed flow valve is throttled and/or the pump bypass valve is partly open to limit feed flow to less than 50% of the operating feed flow		

General Guideline for Multi Media filters

A. Media Filling Details

Filling Details – Multimedia filter only

Media Details		Actual	Max std guideline	Remarks
Gravel 3 - 6mm	50 Kg bag	10%	10%	Bottom layer
Gravel 1 - 2 mm	50 Kg bag	15%	10% - 20%	
Sand 0.8 - 1.2 mm	50 Kg bag	15%	10% - 20%	
Sand 0.3 - 0.6mm	50 Kg bag	35%	30% - 40%	
Sand 0.6 - 0.8mm	50 Kg bag	25%	20% - 40%	To pmost layer

Filling Details – Duel Media filter with Anthracite / Carbon

Media Details		Actual	Max std guideline	Remarks
Gravel 3 - 6mm	50Kg Bag	10%	10%	Bottom layer
Gravel 1 - 2 mm	50Kg Bag	15%	10% - 20%	
Sand 0.8 - 1.2 mm	50Kg Bag	15%	10% - 20%	
Sand 0.3 - 0.6mm	50Kg bag	35%	30% - 40%	
Anthracite 0.6 - 0.8mm	25Kg bag	25%	20% - 40%	Topmost layer

Filling Details – Carbon Media filter

Media Details		Actual	Max std guideline	Remarks
Gravel 3 - 6mm	50Kg Bag	10%	10%	Bottom layer
Gravel 1 - 2 mm	50Kg Bag	15%	10% - 20%	
Sand 0.8 - 1.2 mm	50Kg Bag	15%	10% - 20%	
Activated Carbon	25Kg bag	60%	40% - 60%	Topmost layer

B. Media filling height should be 50% of the Media 'Total Height

C. Specific volume should be

1. **Sand and Gravel : 1650 Kg/M3**
2. **Anthracite : 700Kg/M3**
3. **Activated Carbon : 450Kg/M3**

D. Calculate the Each media quantity

- Check the diameter and height of the multimedia filter. The example diameter is 36" and the height is 72".
- Covert the diameter and heigh into meter (Inch x 2.54/100 = DIA 36"x2.54/100 = 0.9144Meter – Height 72" x2.54/100 = 1.82 meter)
- Calculate surface area = Dia (meter) x Dia(meter)*3.142/4 = 0.9144*0.9144*3.142/4 = 0.656M2

Diameter	36"	0.9144 meter
Height	72"	1.82 Meter
Surface area	0.656	M2

- Select the filling details for the MMF as per the table . For example for duel media filter is as below

Filling Details – Duel Media filter with Anthracite / Carbon

Media Details		Actual	Max std guideline	Remarks
Gravel 3 - 6mm	50Kg Bag	10%	10%	Bottom layer
Gravel 1 - 2 mm	50Kg Bag	15%	10% - 20%	
Sand 0.8 - 1.2 mm	50Kg Bag	15%	10% - 20%	
Sand 0.3 - 0.6mm	50Kg bag	35%	30% - 40%	
Anthracite 0.6 - 0.8mm	25Kg bag	25%	20% - 40%	Topmost layer

- Total filling height (50%) of media height = 1.81/2 = 0.91 meter
- Calculate the media for each section

A. Gravel 3 - 6mm = 10% x 0.91 (filling height) x 0.656 (surface area) x 1450 (sand density) = 86kg = 2 Bag(each bag 50 Kg)

B. Gravel 1- 2mm = 15% x 0.91 (filling height) x 0.656 (surface area) x 1450 (sand density) = 129kg = 3 Bag(each bag 50 Kg)

C. Sand 0.8 – 1.2 mm = 15% x 0.91 (filling height) x 0.656 (surface area) x 1450 (sand density) = 129kg = 3 Bag(each bag 50 Kg)

D. Sand 0.3 – 0.6mm = 35% x 0.91 (filling height) x 0.656 (surface area) x 1450 (sand density) = 302.9 kg = 6 Bag(each bag 50 Kg)

E. Anthracite 0.6 – 0.8 mm = 25% x 0.91 (filling height) x 0.656 (surface area) x 750 (sand density) = 111 kg = 4 Bag(each bag 25 Kg)

Commissioning Audit

1. **System design**

   Product flow: -------- M3/hr

   Recovery: 60%

   Feed flow = ----------M3/hr

   Reject flow = ---------- M3/hr

2. **System information – designed.**

   Feed TDS designed : .....PPM
   Product TDS designed : -------- PPM
   Reject TDS designed : ---------- PPM

3. **System Information – Actual**

   Feed TDS Actual : .....PPM
   Product TDS Actual : -------- PPM
   Reject TDS Actual : ---------- PPM

4. **P&ID actual designed**

5. **Membrane Projection based on designed and actual**

6. **Audit the following critical parameters.**

Sno	Critical Parameter	Unit	Min	Max	Actual	Remarks
1	Check Feed pressure.	Bar	3	5		
2	Check Pressure after MMF	Bar	3	5		
3	Check Pressure after the Cartridge filter – when HPP is operational at full flow	Bar	2.0	4.0		
4	Check the pressure at the High-pressure pump suction	Bar	1.0	2.0		
5	System pressure- Design & Actual	Bar				
6	Reject Pressure - Design & Actual	Bar				
7	Feed Flow - Design & Actual	M3/hr				
8	Product Pressure - Design & Actual	M3/hr				
9	Reject Flow- Design & Actual	M3/hr				
10	Feed TDS – Design & Actual	PPM				
11	Product TDS – Design & Actual	PPM				
12	Reject TDS – Design & Actual	PPM				

13	Recovery flow based – Design & Actual	%				
14	Recovery TDS based – Design & Actual	%				
15	Feed PH		6.2	7.0		
16	Feed ORP	MV	60	120		
17	Product PH					
18	Reject pressure after ERT/ PX (if applicable)	Bar	1	1.5		
19	Feed TDS – if PX applicable					
20	Feed TDS PX – HP side TDS					
21	Feed TDS – high pressure pump					

1. RO Membrane Fouling Symptoms, Causes, and Corrective Measures:

Permeate Flow	Salt Passage	Different. Pressure	Direct Cause	Indirect Cause	Corrective Measure
Decrease	Increase	Increase	Scaling	[1] Insufficient Hardness Removal or [2] System Recovery too High	Clean or Replace Element [1] Check Water Softener or Antiscalant injection. [2] Lower System Recovery
Decrease	Increase	Increase	Colloidal Fouling	Insufficient Pretreatment	Clean or Replace Element, Improve Pretreatment
Decrease	Unchanged	Increase	Biofouling	Contaminated Raw Water, Insufficient Pretreatment	Clean or Replace Element, Disinfection, Improve
Decrease	Unchanged	Unchanged	Organic Fouling	Oil; Cationic Polyelectrolytes	Clean or Replace Element, Improve Preatreatment
Decrease	Decrease	Unchanged	Compaction	Water Hammer	Replace Element or Add Elements
Increase	Increase	Unchanged	Oxidation Damage	Free Chlorine, Ozone, KMnO4	Replace Element. Check Carbon or Sodium Bisulfite Injection Pretreatment.
Increase	Increase	Unchanged / lower	Membrane Leak	[1] Permeate backpressure or [2] Abrasion	[1] Replace Element & Check System Design [2] Replace Element & Check
Increase	Increase	Unchanged / lower	O-Ring Leak	Improper Installation	Check and/or Replace O-Rings
Increase	Increase	Unchanged / lower	Leaking Product Tube	Damaged During Element Loading	Replace Element

*Items in red = Main Symptom

2. Common Foul ants and Their Associated Symptoms

Foulant	Symptoms	Cleaning Solution, per Membrane Type
Biological Growth	The element may have strong odor, possible mold growth on the scroll end. Element will likely exhibit low permeate flow, but salt rejection will usually be as good if not better than the original test.	**Bio Cleaner** CA:50C 6116 Kimberlite **Alkaline Cleaner** CA:50B 8205 Kimberlite
Carbonate Scale	Usually on tap water or brackish water elements only. The element may be noticeably heavier than normal. The element will exhibit low permeate flow and poor salt rejection.	**Acid Cleaner** CA:50A 8204 Kimberlite
Iron Fouling	Rust coloring is seen on the end of the scroll. Possibly some large rust flakes from iron plumbing. Element will exhibit low permeate flow and poor salt rejection. Rust colored reject water may be seen on start of baseline test.	**Acid Cleaner** CA:50A 8204 Kimberlite
Silt or Carbon Fines	Brown or black material on scroll end. Low flow, good rejection in early stages. High flow and very poor rejection in later stages due to the abrasive effects of the material on the membrane.	**Acid Cleaner** CA:50A8204 Kimberlite **Alkaline Cleaner** CA:50B 8205 Kimberlite

3. RO Membrane Fouling Troubleshooting

How quickly did the fouling take place?	Possible causes	Solution for possible cause
Overnight Fouling	Clay, Silt, Oils, Etc.	**Alkaline Cleaner** CA:50B 8205 Kimberlite
Intermediate Length Fouling (5 to 10 Days)	Microbiological Sources. Pre filters will show a slimy deposit.	. **Bio Cleaner** CA:50C 6116 Kimberlite **Alkaline Cleaner** CA:50B 8205 Kimberlite
Slow Fouling	Most common and most difficult to identify.	Follow regular membrane cleaning sequence: Flush **Acid Cleaner** CA:50A 8204 Kimberlite Flush **Alkaline Cleaner** CA:50B 8205 Kimberlite Flush

Annexure – 5
General Guidelines for dosing rate calculation and setting

Dosing chart table – A (quick selection)

Feed flow Capacity GPD GPM M3/hour		% solution at 50% recovery		Dose rate solution (LPH)		
				4ppm	5ppm	6ppm
8.33	1.89	6,000	2%	0.37	0.47	0.56
10.4	2.36	7,500	2%	0.47	0.59	0.709
13.8	3.15	10,000	2%	0.63	0.79	0.94
16.6	3.78	12,000	2%	0.76	0.94	1.13
20.8	4.73	15,000	2%	0.94	1.18	1.41
27.8	6.3	20,000	2%	1.26	1.57	1.89
34.7	7.88	25,000	2%	1.57	1.97	2.36
41.6	9.46	30,000	4%	0.94	1.18	1.42
48.6	11.1	35,000	4%	1.1	1.38	1.65
55.5	12.6	40,000	4%	1.26	1.58	1.89
69.4	15.8	50,000	4%	1.57	1.97	2.36
83.3	19	60,000	6%	1.26	1.57	1.89
97.2	22	70,000	6%	1.47	1.83	2.2
111.1	25.3	80,000	8%	1.26	1.57	1.89
125	28.4	90,000	8%	1.42	1.77	2.12
139	31.5	100,000	8%	1.57	1.97	2.36
167	37.8	120,000	8%	1.89	2.36	2.83
183	41.6	132,000	10%	1.66	2.08	2.49
208	47.3	150,000	10%	1.89	2.36	2.83
222	50.5	160,000	10%	2.01	2.52	3
243	56	175,000	10%	2.2	2.75	3.31
277.7	63	200,000	10%	2.52	3.15	3.78
312	71	225,000	10%	2.83	3.54	4.25
347	79	250,000	10%	3.15	3.94	4.73
381	86.7	275,000	10%	3.46	4.33	5.2
416.7	94.6	300,000	10%	3.78	4.73	5.67
486.1	110.4	350,000	10%	4.41	5.51	6.62
555.5	125.2	400,000	10%	5	6.3	7.57
625	142	450,000	10%	5.67	7.09	8.51
694	158	500,000	10%	6.3	7.88	9.46

Solution preparation method:

Chemical Name		2%	4%	6%	8%	10%
Antiscalant	water	98	96	94	92	90
100% concentration	chemical	2	4	6	8	10
Sodium hypo cloride	water	84	67	51	35	82
12% concentration	chemical	16	33	49	65	18
Calcium hypo chloride	water	97	94	91	87	85
63% concentration	chemical	3	6	9	13	15
SMBS	water	98	96	93	91.5	89.5
93% concentration	chemical	2	4	7	8.5	10.5
NaoH	water	96	92	88	85	80
50% concentration	chemical	4	8	12	15	20
FeCl3 coagulant	water	94.5	89.5	85	79	74
37% concentration	chemical	5.5	10.5	15	21	26

Option – 1 Using dosing table

- Select the capacity of the plant as per Table A.
- Select the solution % from e A.
- Select the solution preparation method as per Table – B

Example

- Capacity of the plant is 100,000 Gallon
- Select from Table A the followings

1. % solution = 8%
2. Dose rate = 1.57 LPH
   - Chemical Preparation table, check chemical preparation method at 8% as below

     Chemical : Antiscalant
     Water : 92 Ltrs
     Chemical : 8 Ltrs
     Dose rate : 1.57 LPH
     Pump capacity : 6 LPH

= 1.57/6.0 X 100 = 26.2% ,

SO DOSING PUMP WILL OPERATE AT 26%SPEED AND 100% STROKE

Option – 2 (By calculation Method)

3. Product flow = 100,000 US Gallon / day = 100000*3.785/1000 = 378.5M3/day = 15.77 M3/hr

4. Recovery = 50%

5. Feed flow = product flow / recovery *100 = 15.77/50*100 = 31.54 M3/hr

6. Dose rate for the chemicals

A. Pre chlorination = 1 PPM
B. De chlorination = 4PPM
C. Coagulation = 3 PPM
D. Antiscalant = 4 PPM
E. Acid = 5 PPM
F. Post chlorination = 0.5PPM
G. Post PH = 5 PPM

7. Chemical as 100% = feed flow x ppm /1000 = 31.54*4/1000 = 0.126 as 100%
8. Chemical conc: 8%
9. Dose rate = 0.126/8*100 = 1.577

Note: In the case of post-dose rate calculation, please select product flow and calculate as steps 5 to 7.

How to Verify dosing rate as Actual

1. Take a calibrated flask of 500 ml
2. Run the dose pump at a selected speed allow it to dose as an actual to the system
3. Remove the suction from the dosing tank and put in the calibrated flask
4. Note down the amount of liquid consumed in 10 minutes.
5. For Example 100 ml is consumed in 10 min
6. Dose rate is = 100/10*60 = 600ML/hour = 600/1000 = 0.6LPH

Annexure – 6 Quick conversion formulas for service application

[Feed TDS – (Product TDS* recovery/100)] Reject TDS = ----------

[1 – Recovery /100]

Recovery = Product flow / [Feed flow (product + reject flow)] KW of motor = HP /1.35

Test for determining Silt Density Index:

Equipment

Millipore® Filter Pad Holder with a 0.45 micron filter disc.
500 ml. Graduated cylinder
Stopwatch

Procedure

- Unbolt the filter holder, wet it, and place a 0.45 micron filter on the back-up plate using the dull tweezers.
- Place the "O"-ring properly and then replace the top half of the filter holder and bolt loosely.
- Connect apparatus to the feed water line (minimum 30 PSIG) in a vertical, down flow position and open the needle valve a crack.
- Loosen two adjacent filter-holder bolts, tilt the apparatus and bleed out all trapped air, then retighten bolts and adjust the pressure to 30 PSI while starting the stopwatch.
- Immediately run the flow into the graduated cylinder and measure the time required to collect 500
- ml, maintaining a pressure of 30 PSIG during the run. Mark the time (t1) and keep the watch running.

- Repeat the previous step immediately after 5, 10, and/or 15 minutes of total elapsed time. Mark the collection times (t_5, t_{10}, t_F).
- Close the sample valve and disconnect the apparatus after the 15 minute reading. Remove the
- disk and place it in a plastic bag for later examination.

Calculation

Calculate the ratios R = t_1/t_5 , t_1/t_{10} and/or t_1/t_F.
Estimate % P_{30} at the selected time(s) from the following equation:
% P_{30} = [1-R] × 100.
Estimate the Silt Density Index, SDI, from the following equation:
SDI = % P_{30} ÷ Elapsed Time (minutes)

The 15-minute index will generally be the lowest of the three, and should be used for filter sizing purposes.

Conversion Tables

To Convert	Multiply By	To Obtain
Acres	43,560	Sq. feet
Acres	0.00405	Sq. kilometer
Acres	4047	Sq. meter
Acres	4840	Sq. yards
Acre-feet	325,851	Sq. feet
Acre-feet	43560	Cu. feet
Acre-feet	1233.5	m (cubed)
Bar	14.5	Lb/sq.in.
Bar	1019.7	g/cm (cubed)
Bar	29.53	inches Hg at 0 degrees C
Bushels (dry)	0.03524	msquared
Centimeters (cm)	0.03281	Feet
Centimeters	0.3937	Inches
Centimeters	0.1094	Yards
Centimeters	0.01	Meters
Centimeters	10	Millimeters (ml)
cm/sec	1.9685	ft/min
cm/sec	0.0223694	MPH
cm (cubed)	0.0610237	inch (cubed)
Cubic feet	0.0283	Cu. meter
Cubic feet	7.4805	Gallons
Cubic feet	1728	Cubic inches
Cubic feet	0.037	Cubic yards
Cup	8	fl oz
Feet (ft)	30.48	Centimeters
Feet	0.3048	Meters
Feet per minute	0.01136	MPH
Feet head of water	0.433	PSI
Foot candle	10.764	Lux
Gallons (gal)	3.785	Liters

Gal	3785	Millimeters
Gal	128	Ounces (liquid)
Gal/acre	9.354	Liters/hectare
Gal/acre	2.938	Oz/1000 ftsquared (liquid)
Gal/1000 ftsquared	4.0746	L/100 msquared
Gal/minute	2.228 x 10 (-3)	Cubic feet/second
Grams (g)	0.002205	Pounds
Gram	0.035274	oz
G/ha	0.000893	lbs/a
Grams per liter	1000	PPM
Grams per liter	10	Percent
Grams/sq.meter	0.00020481	lb/sq.feet
G/cm (cubed)	0.036127	lb/in (cubed)
G/cm (cubed)	62.428	lb/ft (cubed)
Hectares (ha)	2.471	Acres
Inches	2.540	Centimeters
Inches	0.0254	Meters
Inches	25.40	Millimeters
Insquared	6.4516	cmsquared
In (cubed)	16.3871	cm (cubed)

Kilograms (kg)	2.2046	Pounds
Kg/hectare	0.892	Pounds/acre
Kg/ha	0.02048	lb/1000 ftsquared
Kg/L	8.3454	lb/gal
Kilometers (Km)	100,000	Centimeters
Kilometers	3281	Feet
Kilometers	1000	Meters
Kilometers	0.6214	Miles
Kilometers	1094	Yards
Km/h	0.62137	MPH
Km/h	54.6807	ft/min
Kilopascals (kPa)	0.145	Pounds/sq.in. (psi)
Liters (l)	0.2642	Gallons
Liters	33.814	Ounces
Liters	2.113	Pints
Liters	1.057	Quarts
L/100 msquared	0.2454	gal/1000 ftsquared
Liters/hectare	0.107	Gallons/acre
Meters (m)	3.281	Feet
Meters	39.37	Inches
Meters	1.094	yards
Meters	100	Centimeters
Meters	0.001	Kilometers
Meters	1000	Millimeters
Meters/sec	2.2369	MPH
Msquared	10.764	ftsquared
M (cubed)	35.3147	ft (cubed)
M (cubed)	1.30795	yd (cubed)
Miles (statute)	160,900	Centimeters
Miles	5280	Feet
Miles	1.609	Kilometers
Miles	1760	Yards
Miles/hour (mph)	1.467	Feet/second
Miles/hour	88	Feet/minute
Miles/hour	1.61	Kilometers/hour

Miles/hour	0.447	meter/second
Milliliters (ml)	0.0338	Ounces (fluid)
Milliliters	0.0002642	Gallons
Millimeters (mm)	0.03937	Inches
1 mm Hg @ 0 C	0.13332	kPa
Ounces (fluid)	0.02957	Liters
Ounces (fluid)	29.573	Milliliters
Ounces (weight)	28.35	Grams
Parts per million (ppm)	2.719	lb ai/acre foot of water
PPM	0.001	Grams/l
PPM	8.34	Lb/million gal
PPM	1	mg/kg
PPM	0.013	Ounces/100 gal of water
PPM	0.3295	Gal/acre-foot of water
PPM	8.345	lbs/million gal of water
Percent (%)	10	g/kg
Pint	0.473	liter
pt/A	1.1692	L/ha
pt/A	0.3673	oz/1000 ftsquared

Pounds	0.4536	Kilograms
Pounds	453.6	Grams
Pounds/acre	1.12	Kg/hectare
Pounds/A	0.02296	lb/1000 ftsquared
Pounds/sq.ft.	4883	Grams/sq.meter
Pounds/1000 ftsquared	43.5597	lb/A
Pounds/yd (cubed)	0.0005937	G/cm (cubed)
Pounds/gallon	0.12	Kg/liter
PSI (lbs/sq.in.)	6.9	Kilopascals
PSI	0.06895	Bar
PSI	0.068046	atm
PSI	2.31	feet head of water
PSI	6.89	kPa
Quarts	0.9463	Liters
Qt/A	2.3385	L/ha
Qt/A	0.7346	oz/1000 ftsquared
Sq. centimeters	0.001076	Sq. feet
Sq. centimeters	0.1550	Sq. inches
Sq. feet	929	Sq. centimeters
Sq. feet	0.0929	Sq. meters
Sq. feet	9.294 x 10 (-6)	Hectares
Sq. inch	6.452	Sq. centimeters
Ton (2000 lbs)	907	kg
Yards	91.44	Centimeters
Yards	0.9144	Meters
Yards	914.4	Millimeters
yd (cubed)	27	ft (cubed)
yd (cubed)	0.7645	m (cubed)

Area Equivalents

1 acre = 43,560 ft squared = 4840 yd 2 = 0.4047 hectares = 160 rods squared = 4047 m 2 = 0.0016 sq. mile

1 acre-inch = 102.8 m 3 = 27,154 gal = 3630 ft 3

1 hectare (ha) = 10,000 m 2 = 100 are = 2.471 acres = 107,639 ft squared

1 cubic foot (ft 3) = 1728 in 3 = 0.037 yd 3 = 0.02832 m 3 = 28,320 cm 3

1 square foot (ft 2) = 144 in 2 = 929.03 cm 2 = 0.09290 m 2

1 square yard (yd 2) = 9 ft 2 = 0.836 m 2
1 cubic yard (yd 3) = 27 ft 3 = 0.765 m 3

Units	Sq. In.	Sq. Ft.	Sq Yd.	Sq. cm	Sq. m
Sq. In.	1	0.006944	0.0007716	6.452	0.000645
Sq. Ft.	144	1	0.1111	929	0.0929
Sq Yd.	1296	9	1	8361	0.8361
Sq. cm	0.155	0.001076	0.0001196	1	0.0001
Sq. m	1550	10.76	1.196	10,000	1

Length Equivalents

Centimeter (cm) = 0.3937 inch = 0.01 m = 0.03281 ft.
Meter (m) = 3.28 feet = 39.4 inches = 100 cm = 1.094 yds = 1000 mm
Kilometer = 0.621 statute mile = 1000 meters = 100,000 cm = 3281 ft = 39,370 in. inch = 2.54 cm = 25.4 mm = 0.0254 m = 0.08333 ft.
Foot = 0.3048 meters = 30.48 cm = 12 inches
Yard = 0.9144 meters = 3 feet = 36 inches = 91.44 cm
Statute mile = 1760 yards = 5280 feet = 1.61 kilometers = 1609 meters

Mixture Ratios

1 mg/g = 1000 ppm
1 fl.oz./gal = 7490 ppm
1 fl.oz./100 gal = 75 ppm
1 pt/100 gal = 1 teaspoons/1gal
1 qt/100 gal = 2 tablespoons/1 gal

Flow

1 gpm = 0.134 ft 3 /minute
1 ft (cubed) /min. (cfm) = 449 gal/hr. (gph) = 7.481 gal/min.

Weight Equivalents

1 ton (US) = 2000 lb = 0.907 metric tons = 907.2 kg
1 metric ton = 10 6 g = 1000 kg = 2205 lb
1 lb = 16 oz = 453.6 grams (g) = 0.4536 kg
1 oz (weight) = 28.35 g = 0.0625 lb
1 gram = 1000 mg = 0.0353 oz = 0.001 kg = 0.002205 lb milligrams (mg) = 0.001 grams
1 kilogram (kg) = 1000 grams = 35.3 oz = 2.205 lbs microgram (mg) = 10 -6 grams = 0.001 mg
nanogram (ng) = 10 -9 grams = 0.001 micrograms (mg)
picogram = 10 -12 grams
1 ppm= 0.0001%= 0.013 fl oz in 100 gal =1 mg/kg=1 mg/L=1 mg/g= 0.379 g in 100 gal water= 8.34 x 10 -6 lb/gal=1ml/l
10 ppm = 0.001% = 10 mg/L 100 ppm = 0.01% = 100 mg/L1000 ppm = 1mg/g = 0.1% = 1000 mg/L
1 ppb = 1 ug/kg or 1 ug/L or 1 ng/g
1 ppt = 1 picogram/g
1 % = 10,000 ppm = 10g/L = 1g/100ml = 10g/kg = 1.33 oz by weight/gal water = 8.34 lbs/100 gal water

Leather Substance
The measurement of the thickness of a finished leather, in millimeters (1 mm. = 0.03937 inch),
irons (1 iron = 1/48 inch),
ounces (1 ounce = 1/64 inch):

Inch	Ounces	Irons	Millimeters
1/64	1	0.75	0.4
1/32	2	1.5	0.8
3/64	3	2.25	1.2
1/16	4	3.0	1.6
5/64	5	3.75	2.0
3/32	6	4.5	2.4
7/64	7	5.25	2.8
1/8	8	6.0	3.2
9/64	9	6.75	3.6
5/32	10	7.5	4.0
11/64	11	8.25	4.4
3/16	12	9.0	4.8
13/64	13	9.75	5.2
7/32	14	10.5	5.6
15/64	15	11.25	6.0
1/4	16	12.0	6.4
17/64	17	12.75	6.8
9/32	18	13.5	7.2

Annexure – 7 other related information

Quick Selection of Cable size selection

1	0 - 2.2KW	Four core	2.5MM2
2	2.2 - 5.5KW	Four core	4mm2
3	5.5 - 11KW	Four core	6mm2
4	11 - 18.5KW	Four core	10mm2
5	18.5 - 26KW	Four core	16mm2
6	26 - 37KW	Four core	25mm2
7	37 - 45KW	Four core	35mm2
8	45-55KW	Four core	50mm2
9	55 - 75KW	Four core	70mm2
10	75 - 90KW	Four core	90mm2
11	90-110KW	Four core	150mm2
12	110 - 132KW	Four core	185mm2
13	160KW	Four core	240mm2
14	200KW	Four core	2x150mm2

Special Note:

- Cable size selection depends on length also. If length of cable is more than 50 meter, please select the next available size.
- Power supply is assumed as 410V / 3 Phase / 50Hz. For different rating in power supply, please refer to technical department.

Three phase motor loading chart.

The following table shows the load current drawn by three phase motors various power ratings and supply voltages. To read this table, look up the power of your motor in the either of the yellow columns and then read along to the appropriate voltage current. The value indicated is the full load current in amps.

Power		Current in Amps at indicated voltage				
KW	HP	220V	240V	380V	415V	440V
0.75	1	3.6	3.3	2.1	1.9	1.8
1.1	1.5	4.7	4.3	2.7	2.5	2.4
1.5	2	6.4	5.9	3.7	3.4	3
2.2	3	9.1	8.3	5.3	4.8	4.6
3	4	12.1	11	7	6.4	6.1
3.7	5	14.6	13.4	8.5	7.8	7.3
5.5	7.5	21.8	20	12.6	11.6	10.9
7.5	10	27.2	25	15.8	14.4	13.6
9.32	12.5	32.6	30.1	18.9	17.3	16.3
11	15	39.7	36.5	23	21.1	19.9
15	20	52	48	31	28	26
18.5	25	66	60	38	35	33
22	20	78	72	45	41	39
25	35	92	84	53	48	46
30	40	105	96	61	55	52
33	45	118	108	68	62	59
37	50	131	120	76	69	65
45	60	157	144	91	83	78
51	70	183	168	106	97	91
59	80	207	190	120	110	104
67	90	232	212	135	123	116
75	100	258	235	149	136	129
90	125	317	290	188	171	158
110	150	377	345	218	200	188

129	175	436	403	252	231	218
147	200	496	454	288	263	248
168	225	---	---	320	293	276
185	259	---	---	354	324	306
220	300	---	---	420	385	363
257	350	---	---	490	449	424
295	400	---	---	546	505	473

More addition

1. Check list for commissioning of rotating equipment.
2. Check list for preventive maintenance of the rotating equipment's
3. Check list for preventive maintenance.
4. Preventive maintenance check list

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Annexure – 8
Sample Log sheet copy

Daily Operation and Maintenance Log sheet

PROJECT: SWRO system - MMF Date :

Client : Month :

Capacity: 3x 400,000 IGPD

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
Design Limits										
1	**Plant capacity - 3x400,000 IGPD**	**M3/day**	5400							
2	**Designed TDS**	**PPM**	45000 / 47000							
3	**Designed Recovery**	**%**	40%							
4	**Product flow - Total / Each stream**	**M3/hr**	225 / 75							
5	**Feed flow - Total / Each stream**	**M3/Hr**	562.5/ 187.5							
6	**Reject flow - Total / Each stream**	**M3/hr**	337.5 / 112.5							
7	**System pressure**	**Bar**	15.1							
8	**Reject TDS**	**PPM**	74900 / 78316							
MMF - Feed water/ BW pumps/ Air blower										
1	Feed pump - MMF - Run hours P 101A/B/C	hours	P101A							
	302M3/hr - 2D + 1 standby - 37KW		P101B							
			P 101C							
2	Feed pump outlet pressure PG203/204/205	Bar	3 - 4							
3	Feed pump common pressure - PT 201	Bar	3 - 4							
4	Feed water tempreture - TS 201	Deg C	25 - 37 Deg C							
5	Feed water flow- MMF- FI- 201	M3/hr	187.5 - 562.5							
6	Backwash pump run hours P 301A/B	hours	P301A							
	300M3/hr at 2 Bar - 30KW	hours	P301B							
7	Backwash pump pressure	Bar	2- 3 Bar							
8	BW pump outlet pressure PG 303/304	Bar	2 Bar							
9	BW pump common pressure - PT 301	Bar	2 Bar							
10	BW water flow- MMF- FI- 301	M3/hr	300							
11	Air Blower run hours AB 301A/B	Hours	AB301A							
	550M3/hr at 0.5 Bar - 15KW	Hours	AB301B							
12	Air blower Pressure	Bar	0.5 - 0.7							
MMF Section										
1	MMF 401 - Total Run hrs	hours	MMF 404							
	MMF 401 - outlet flow -FI 401	M3/hr	86 - 105							
	MMF inlet Pressure - PG 401	Bar	1.5 - 2 Bar							
	MMF outlet Pressure - PG 402	Bar	1.5 - 2 Bar							
2	MMF 402 - Total Run hrs	hours	MMF 404							
	MMF 402 - Outlet flow -FI 402	M3/hr	86 - 105							
	MMF inlet Pressure - PG 403	Bar	1.5 - 2 Bar							
	MMF outlet Pressure - PG 404	Bar	1.5 - 2 Bar							
3	MMF 403 - Total Run hrs	hours	MMF 404							
	MMF 403 - outlet flow -FI 403	M3/hr	86 - 105							
	MMF inlet Pressure - PG 405	Bar	1.5 - 2 Bar							
	MMF outlet Pressure - PG 406	Bar	1.5 - 2 Bar							
	Diffrential pressure swtich DPS -1	Bar	1.5 Bar							
4	MMF 404 - Total Run hrs	hours	MMF 404							
	MMF 404 - outlet flow -FI 404	M3/hr	86 - 105							
	MMF inlet Pressure - PG 407	Bar	1.5 - 2 Bar							
	MMF outlet Pressure - PG 408	Bar	1.5 - 2 Bar							
5	MMF 405 - Total Run hrs	hours	MMF 404							
	MMF 405 - Outlet flow -FI 405	M3/hr	86 - 105							
	MMF inlet Pressure - PG 409	Bar	1.5 - 2 Bar							
	MMF outlet Pressure - PG 410	Bar	1.5 - 2 Bar							
6	MMF 406 - Total Run hrs	hours	MMF 404							
	MMF 406 - outlet flow -FI 411	M3/hr	86 - 105							
	MMF inlet Pressure - PG 412	Bar	1.5 - 2 Bar							
	MMF outlet Pressure - PG 408	Bar	1.5 - 2 Bar							
7	MMF 407 - Total Run hrs	hours	MMF 404							
	MMF 407 - Outlet flow -FI 407	M3/hr	86 - 105							
	MMF inlet Pressure - PG 413	Bar	1.5 - 2 Bar							
	MMF outlet Pressure - PG 414	Bar	1.5 - 2 Bar							
8	Diffrential pressure swtich DPS -2	Bar	1.5 Bar							
9	Feed waterTurbidity after MMF- AE 01	NTU	1 - 3							
10	Air Compressor run hours - common set 1	Hours	AC 401A							
		Hours	AC 401B							
11	Air compressor pressure	Bar	04-Jun							
Tank Section										
1	Feed water tank - LT 201	level - Mtrs	2- 4 Meter							
2	Intermediate water tank - LT 501	level - Mtrs	2- 4 Meter							
3	Reject water tank - LT 1101	level - Mtrs	2- 4 Meter							
4	Product water tank - LT 1001	level - Mtrs	2- 4 Meter							
5	Flush tank level 2.65M x 1.5M x 2M - LT 701	level - Mtrs	1 - 2Meter							
6	CIP tank level 2.65M x 1.5M x 2M - LT 702	level - Mtrs	1 - 2Meter							

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RO Section										
1	Feed pump - RO system - Run hours P 501A/B/C	hours	P501A							
	287M3/hr- 3.5Bar - 2D + 1 standby - 45KW		P501B							
			P501C							
2	Feed pump outlet pressure PG503/504/505	Bar	3 - 4							
3	Feed pump common pressure - PT 501	Bar	3 - 4							
4	Feed water flow- RO plant- FI- 501	M3/hr	187.5 - 562.5							
5	CF inlet pressure CF 601A/B/C (287M3/hr - 2D + 1 sb)	Bar	3.0 - 4.0							
6	CF inlet pressure CF 601A/B/C (287M3/hr - 2D + 1 sb)	Bar	2.0 - 3.5							
7	Feed Water PH level - AIT 601		6.4 - 7.5							
8	Feed water Conductivity - AIT 602	conductivity	50 - 55,000							
9	Feed water OPR level - AIT 603	MV	150- 200							
10	Feed water OPR level - AIT 604	MV	150 -200							
11	**RO - 1 operating Parameters**									
11.1	HPP suction pressure - PT 701	Bar	> 1.5							
11.2	Systen pressure - PT - 702	Bar	64 - 66							
11.3	Reject pressure - PG 704	Bar	62- 64							
11.4	Diffrential pressure across membranes	Bar	2- 3.5							
11.5	Product flow meter - FI 701	M3/hr	75							
11.6	Reject flow meter - FI 702	M3/Hr	112.5							
11.7	Product PH - AIT 701		6.8 - 7.8							
11.8	Product conducitivty - AIT 702	micro simens/cm	300 - 800							
11.9	Reject conductivity - AIT 1101	micro simens/cm	78000							
11.9.1	Feed conductivity - AIT 602	micro simens/cm	55000							
	Recovery based on flow - (11.5/(11.5+11.6)	%								
12	**RO - 2 operating Parameters**									
12.1	HPP suction pressure - PT 801	Bar	> 1.5							
12.2	Systen pressure - PT - 802	Bar	64 - 66							
12.3	Reject pressure - PG 804	Bar	62- 64							
12.4	Diffrential pressure across membranes	Bar	2- 3.5							
12.5	Product flow meter - FI 801	M3/hr	75							
12.6	Reject flow meter - FI 802	M3/Hr	112.5							
12.7	Product PH - AIT 801		6.8 - 7.8							
12.8	Product conducitivty - AIT 802	micro simens/cm	300 - 800							
12.9	Reject conductivity - AIT 1101	micro simens/cm	78000							
12.9.1	Feed conductivity - AIT 602	micro simens/cm	55000							
	Recovery based on flow - (12.5/(12.5+12.6)	%								
13	**RO - 3 operating Parameters**									
13.1	HPP suction pressure - PT 901	Bar	> 1.5							
13.2	Systen pressure - PT - 902	Bar	64 - 66							
13.3	Reject pressure - PG 894	Bar	62- 64							
13.4	Diffrential pressure across membranes	Bar	2- 3.5							
13.5	Product flow meter - FI 901	M3/hr	75							
13.6	Reject flow meter - FI 902	M3/Hr	112.5							
13.7	Product PH - AIT 901		6.8 - 7.8							
13.8	Product conducitivty - AIT 902	micro simens/cm	300 - 800							
13.9	Reject conductivity - AIT 1101	micro simens/cm	78000							
13.9.1	Feed conductivity - AIT 602	micro simens/cm	55000							
	Recovery based on flow - (11.5/(11.5+11.6)	%								
Common Equipments RO system										
1	Flushing / CIP system - Run hrs - P701A/B	Hrs	P 701A							
	198M3/hr at 4.5 Bar - 37KW		P 701 B							
	Feed pump outlet pressure PG 707/708	Bar	4 - 4.5 Bar							
	Pressure before and after CF - PG 709 / 710	Bar	1.5 Bar diff							
	PH - AIT 707		,4 - 11							
2	Reject transfer pump - Run hours - P 1101 A/B/C	hours	P 1101 A							
	172 M3/hr- 3 Bar - 2D + 1 standby - 22 KW		P 1101 B							
			P 1101 C							
	Feed pump outlet pressure PG1101 / 1102 / 1103	Bar	2 - 3Bar							
	Feed pump common pressure - PT 1101	Bar	2 - 3 Bar							
	Feed water flow- RO plant- FI- 1101	M3/hr	175 - 335 M3/hr							
	Reject conductivity - AIT 1101	Micro simens/cm	68000 - 78000							
3	Drain transfer system Run hours P 801A/B	Hrs	P801A							
	50 M3/hr- 2.0 Bar - 1D + 1 standby - 5.5 KW	Hrs	P801 B							
	Feed pump common pressure - PG 807	Bar	1 - 2 Bar							
Chemical Preparation RO system							3 / 1 trains operational			
Sno	**Chemical dose**	**Dosing tank**	**Neat Chemical %**	**Water**	**Chemical**	**Dose rate**	**solu. Consp**	**Note**		
1	Pre chlorination dosing - 15LPH @ 6 Bar		12%	0	100	1 PPM	1.56 - 4.69LPH	***30 min on and 4 hours off***		
2	Schock Chlorination - 50LPH@ 6 Bar		12%	0	100	10 PPM	1.56 - 4.69LPH	***30 min on and 8 hours off***		
3	Coagulation - Ferric chloride - 9 LPH @ 6 Bar		37%	0	100	3 PPM	4.56 - 1.52LPH	37% direct solution		
4	Dechlorination - SMBS - 30 LPH @ 6 Bar		63%	100	15	4 PPM	22.5 - 7.5LPH	10% solution		
4	Acid dosing system - HCL - 9LPH @ 6 Bar		33%	0	100	5 PPM	8.52 - 2.84LPH	20% solution		
3	Antiscalant - 9LPH @ 6 Bar		100%	50	50	4 PPM	4.5 - 1.5 LPH	50% solution		
4	Post PH correction - 9LPH @ 6 Bar		50%	70	30	5 PPM	7.5 - 2.5LPH	15% solution		
5	Post Chlorination - - 9LPH @ 6 Bar		12%	90	10	0.5 PPM	1.88 - 0.63 LPH	12% solution		

Note

TEST CONDUCTED BY:----------

WITNESSED BY: _____

OEM

Client / CONSULTANT REPRESENTATIVE

SERVICE MANUAL AND GUIDELINES

Daily Operation and Maintenance Log sheet

PROJECT: SWRO system - MMF Date :

Client : Month :

Capacity:

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
Design Limits										
1	**Plant capacity - 5x416.6 M3/day**	**M3/day**	416.6							
2	**Designed TDS**	**PPM**	45000 / 36000							
3	**Designed Recovery**	**%**	30%							
4	**Product flow**	**M3/hr**	17.4							
5	**Feed flow**	**M3/Hr**	57.9							
6	**Reject flow**	**M3/hr**	40.5							
7	**System pressure**	**Bar**	15.1							
8	**Reject TDS**	**PPM**	64285 / 51428							
MMF Section (Set - 1)										
1	Feed pump Run hours	hours	P101A							
			P101B							
			P 101C							
2	Feed pump outlet pressure	Bar	3 - 4							
3	MMF outlet pressure - S101 A/B	Bar	3 - 4							
	MMF outlet pressure - S101 C/D	Bar	3 - 4							
	MMF outlet pressure - S101 E/F	Bar	3 - 4							
4	Backwash pump run hours	hours	P102A							
		hours	P102B							
5	Backwash pump presusre	Bar	2- 3 Bar							
6	Backwash flow	M3/hr	118							
7	Air Blower run hours	Hours	AB201A							
		Hours	AB201B							
8	Air blower Pressure	Bar	0.5 - 0.7							
MMF Section (Set - 2)										
1	Feed pump Run hours	hours	P101D							
			P101E							
			P 101F							
2	Feed pump outlet pressure	Bar	3 - 4							
3	MMF outlet pressure - S101 G/H	Bar	3 - 4							
	MMF outlet pressure - S101 I/J	Bar	3 - 4							
4	Backwash pump run hours- common set 1	hours	P102A							
			P102B							
5	Backwash pump presusre	Bar	2- 3 Bar							
6	Backwash flow	M3/hr	118							
7	Air Blower run hours - common set 1	Hours	AB201A							
		Hours	AB201B							
8	Air blower Pressure	Bar	0.5 - 0.7							
MMF Section (Set - 3)										
1	Feed pump Run hours	hours	P101G							
			P101H							
2	Feed pump outlet pressure	Bar	3 - 4							
3	MMF outlet pressure - S101 K/L	Bar	3 - 4							
	MMF outlet pressure - S101 M/N	Bar	3 - 4							
4	Backwash pump run hours- common set 1	hours	P102C							
			P102D							
5	Backwash pump presusre	Bar	2- 3 Bar							
6	Backwash flow	M3/hr	118							
7	Air Blower run hours - common set 1	Hours	AB201C							
		Hours	AB201D							
8	Air blower Pressure	Bar	0.5 - 0.7							
RO Section - SET 1(RO 1&2)										
1	RO Run hours	Hrs	RO 1							
			RO 2							
2	**RO - 1 operating Parameters**									
2.1	CF Inlet Pressure	CF - Bar								
	CF intermediate pressure									
	CF outlet Pressure	CF - Bar	Min 2.0 Bar							
2.2	Feed flow	M3/Hr	57.8							
2.3	Feed TDS	PPM	< 45000							
2.3	Feed water ORP	MV	110- 150							
2.4	Feed water PH		<7.2							
2.5	HPP operating hours	P103A								
		P103B								
		P103C								
2.6	HPP outlet pressure	Bar	30 - 42							
2.7	System Pressure RO 1	Bar	<68							
2.8	Reject Pressure RO 1	Bar								
2.9	Pressure drop	Bar	<1.5							
2.9.1	Product flow RO 1	M3/hr	41.7							
2.9.2	Reject flow RO1	M3/hr	13.9							
2.9.3	TDS product RO 1	PPM	<500							
2.9.4	PH product RO 1		<7.8							
3	**RO - 2 operating Parameters**									
3.1	CF Inlet Pressure	CF - Bar								
	CF intermediate pressure									
	CF outlet Pressure	CF - Bar	Min 2.0 Bar							
3.2	Feed flow	M3/Hr	57.8							
3.3	Feed TDS	PPM	< 45000							
3.4	Feed water ORP	MV	110- 150							
3.5	Feed water PH		<7.2							
3.6	HPP operating hours	P103A								
		P103B								
		P103C								
3.7	HPP outlet pressure	Bar	30 - 42							
3.8	System Pressure RO 2	Bar	<68							
3.9	Reject Pressure RO 2	Bar								
3.9.1	Pressure drop	Bar	<1.5							
3.9.2	Product flow RO 2	M3/hr	41.7							
3.9.3	Reject flow RO 2	M3/hr	13.9							
3.9.4	TDS product RO 2	PPM	<500							
3.9.5	PH product RO 2		<7.8							

SERVICE MANUAL AND GUIDELINES

RO Section - SET 2(RO 3&4)										
1	RO Run hours	Hrs	RO 3							
			RO 4							
2	**RO - 3 operating Parameters**									
2.1	CF Inlet Pressure	CF - Bar								
	CF intermediate pressure									
	CF outlet Pressure	CF - Bar	Min 2.0 Bar							
2.2	Feed flow	M3/Hr	57.8							
2.3	Feed TDS	PPM	< 45000							
2.3	Feed water ORP	MV	110- 150							
2.4	Feed water PH		<7.2							
2.5	HPP operating hours	P103D								
		P103E								
		P103F								
2.6	HPP outlet pressure	Bar	30 - 42							
2.7	System Pressure RO 3	Bar	<68							
2.8	Reject Pressure RO 3	Bar								
2.9	Pressure drop	Bar	<1.5							
2.9.1	Product flow RO 3	M3/hr	41.7							
2.9.2	Reject flow RO3	M3/hr	13.9							
2.9.3	TDS product RO 3	PPM	<500							
2.9.4	PH product RO 3		<7.8							
3	**RO - 4 operating Parameters**									
3.1	CF Inlet Pressure	CF - Bar								
	CF intermediate pressure									
	CF outlet Pressure	CF - Bar	Min 2.0 Bar							
3.2	Feed flow	M3/Hr	57.8							
3.3	Feed TDS	PPM	< 45000							
3.4	Feed water ORP	MV	110- 150							
3.5	Feed water PH		<7.2							
3.6	HPP operating hours	P103A								
		P103B								
		P103C								
3.7	HPP outlet pressure	Bar	30 - 42							
3.8	System Pressure RO 4	Bar	<68							
3.9	Reject Pressure RO 4	Bar								
3.9.1	Pressure drop	Bar	<1.5							
3.9.2	Product flow RO 4	M3/hr	41.7							
3.9.3	Reject flow RO 4	M3/hr	13.9							
3.9.4	TDS product RO 4	PPM	<500							
3.9.5	PH product RO 4		<7.8							
RO Section - SET 3(RO 5)										
1	RO Run hours	Hrs	RO 5							
2	**RO - 5 operating Parameters**									
2.1	CF Inlet Pressure	CF - Bar								
	CF intermediate pressure									
	CF outlet Pressure	CF - Bar	Min 2.0 Bar							
2.2	Feed flow	M3/Hr	57.8							
2.3	Feed TDS	PPM	< 45000							
2.3	Feed water ORP	MV	110- 150							
2.4	Feed water PH		<7.2							
2.5	HPP operating hours	P103G								
		P103H								
2.6	HPP outlet pressure	Bar	30 - 42							
2.7	System Pressure RO 5	Bar	<68							
2.8	Reject Pressure RO 5	Bar								
2.9	Pressure drop	Bar	<1.5							
2.9.1	Product flow RO 5	M3/hr	41.7							
2.9.2	Reject flow RO 5	M3/hr	13.9							
2.9.3	TDS product RO 5	PPM	<500							
2.9.4	PH product RO 5		<7.8							
10	Pressure drop second pass (7-8)	Bar	1.1							
11	Inlet flow - HPP2	M3/hr	55 - 56							
12	System Pressure RO 2	Bar	14-16							
13	Inter stage pressure RO 2	Bar								
14	Reject Pressure RO 2	Bar								
15	Pressure drop 1st Pass(12-13)	Bar	1.1							
16	Pressure drop second pass (12 - 14)	Bar	1.1							
17	Product flow RO 1	M3/hr	41.7							
18	Reject flow RO1	M3/hr	13.9							
17	Product flow RO 2	M3/hr	41.7							
18	Reject flow RO2	M3/hr	13.9							
19	Cumulative flow RO 1 & RO 2	M3/hr								
20	Blend flow	M3/hr	1 - 2							
21	Product TDS	PPM	120 - 200							
22	Product PH									
Chemical Preparation UF system										
Sno	**Chemical dose**	**Dosing tank**	**Neat Chemical %**	**Water**	**Chemical**	**Dose rate**	**solu. Consp**	**Note**		
1	Pre chlorination dosing - 6LPH @ 6 Bar	300 Ltrs	12%	90	10	1 PPM	4.8 LPH	***Dosing for 30 min every 4 hour and w***		
2	Coagulation - Perric chloride - 10 LPH @ 6 Bar	300 Ltrs	33%	90	10	2 PPM	3.50 LPH	10% solution		Not required to
3	Dechlorination - SMBS - 6 LPH @ 6 Bar	300 Ltrs	63%	90	10	4 PPM	3.56 LPH	10% solution		
4	Acid dosing system - 6LPH @ 6 Bar	300 Ltrs	33%	100	20	5 PPM	4.38 LPH	20% solution		Not required to
3	Antiscalant - 6LPH @ 6 Bar	300 Ltrs	100%	90	10	4 PPM	2.31 LPH	10% solution		
4	Post PH correction - 6LPH @ 6 Bar	300 Ltrs	50%	90	10	1 PPM	2.45 LPH	as per PH value		
5	Post Chlorination - - 6LPH @ 6 Bar	300 Ltrs	12%	90	10	0.5 PPM	1.73 LPH	as per Cl2 value		

Note

TEST CONDUCTED BY:----------

WITNESSED BY: _____

OEM

Client / CONSULTANT REPRESENTATIVE

SERVICE MANUAL AND GUIDELINES

Daily Operation and Maintenance Log sheet

PROJECT: BWRO system - MMF

Date :

Client :

Month :

Capacity: 2x1000M3/day

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
Design Limits										
1	**Plant capacity - 2x1000M3/day**	**M3/day**	**1000**							
2	**Designed TDS**	**PPM**	**3000**							
3	**Designed Recovery**	**%**	**75%**							
4	**Product flow**	**M3/hr**	**41.7**							
5	**Feed flow**	**M3/Hr**	**55.6**							
6	**Reject flow**	**M3/hr**	**13.9**							
7	**System pressure**	**Bar**	**15.1**							
8	**Reject TDS**	**PPM**	**12000**							
MMF Section										
1	Feed pump Run hours	hours	P101A / P101B							
2	Feed pump VFD freequency Point 1& Point 2	Hz	30-35 / 45 -50							
3	Feed pump outlet pressure	Bar	3 - 4							
4	MMF outlet pressure	Bar	3 - 4							
5	Diffrential pressure - MMF (1-2)	Bar	0.5 - 1.0							
6	Backwash pump run hours	hours	P101A / P101B							
7	Backwash pump presusre	Bar	2- 3 Bar							
8	Backwash flow	M3/hr	45							
9	Air Blower run hours	Hours	AB101A / AB101B							
10	Air blower Pressure	Bar	0.5 - 0.7							
RO Section										
1	RO Run hours	Hrs	RO 1 / RO 2							
2	CF outlet Pressure	CF - Bar	Min 2.0 Bar							
3	Feed water ORP	MV	110- 150							
4	Feed water PH									
5	Inlet flow - HPP1	M3/hr	55 - 56							
6	System Pressure RO 1	Bar	14-16							
7	Inter stage pressure RO 1	Bar								
8	Reject Pressure RO 1	Bar								
9	Pressure drop 1st Pass(6-7)	Bar	1.1							
10	Pressure drop second pass (7-8)	Bar	1.1							
11	Inlet flow - HPP2	M3/hr	55 - 56							
12	System Pressure RO 2	Bar	14-16							
13	Inter stage pressure RO 2	Bar								
14	Reject Pressure RO 2	Bar								
15	Pressure drop 1st Pass(12-13)	Bar	1.1							
16	Pressure drop second pass (12 - 14)	Bar	1.1							
17	Product flow RO 1	M3/hr	41.7							
18	Reject flow RO1	M3/hr	13.9							
17	Product flow RO 2	M3/hr	41.7							
18	Reject flow RO2	M3/hr	13.9							
19	Cumulative flow RO 1 & RO 2	M3/hr								
20	Blend flow	M3/hr	1 - 2							
21	Product TDS	PPM	120 - 200							
22	Product PH									

Chemical Preparation UF system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Pre chlorination dosing - 6LPH @ 6 Bar	200 Ltrs	12%	80	20	2 PPM	4.3 LPH	***Dosing for 30 min every 4 hour and w***
2	Dechlorination - SMBS - 10 LPH @ 6 Bar	200 Ltrs	63%	85	10	4 PPM	6.15 LPH	10% solution
3	Antiscalant - 6LPH @ 6 Bar	200 Ltrs	100%	90	10	4 PPM	2.2 LPH	15% solution
4	Post PH correction - 6LPH @ 6 Bar	200 Ltrs	50%	90	10	5 PPM	4.17 LPH	as per dose rate
5	Post Chlorination - - 6LPH @ 6 Bar	200 Ltrs	12%	95	5	0.5 PPM	3.77 LPH	as per dose rate

Note

1. Dosing pump 1st set will work if RO 1 is working
2. Dosing pump 2nd pump will work if RO 2 is working
3. Both dosing pump will be on if both RO 1 and RO operational

TEST CONDUCTED BY:----------

WITNESSED BY: _____

OEM

Client / Consultant

SERVICE MANUAL AND GUIDELINES

Daily Operation and Maintenance Log sheet

PROJECT: 1000 M3/day -UF - SWRO system

Client :

Capacity :

Date :

Month :

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
UF Section										
1	UF system Run hours - surface area 26x70 =1820m2	Hours								
2	UF Feed pump Pressure	P 101 - Bar	125 M3/hr @ 3bar							
3	UF Feed pump VFD freequency	P 101 - Hz								
4	Pressure - self cleanign filter out	Bar								
5	Diffrential Pressure - SCF	Bar								
6	Instant flow - UF inlet	M3/hr	122 M3/hour							
7	Turbidity at UF inlet	NTU								
8	Pressure at UF Inlet - PT 02	Psig								
9	Pressure at UF outlet - PT-03	Psig								
10	TMP UF - filtreation mode (PT02 - PT 03)	psig	< 1.2							
11	Backwash pump pressure-BW flux 230 LMH	P -102 - Bar	218m3/hr - 3Bar							
12	Backwash effective pressure - PT 01	Psig								
12	TMP - Backwash cycle (PT01-PT03)	psig	< 1.2							
13	Unit status	Run/ BW/ MC								
14	Filteration cycle time	Min	30							
15	Backwash cycle time	Min								
16	CEB 1.1 freequency (NaoH + 200PPM hypo chloride	cycle	after 20 cycle							
17	CEB 1. 2 freequency (Hcl) - 2.2 PH level to maintain	cycle	after 30 cycle							
19	Coagulant tank level									
20	Caustic tank level									
21	Acid tank level									
22	Intermediate tank level									

Chemical Preparation UF system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Pre chlorination dosing		12%	0	100	5 PPM	4.34 LPH	***intermittent chlorination is used - 10***
2	Coagulant dosing pump - Ferric chloride	100 Ltrs	33%	80	20	3 PPM	4.75 LPH	***20 ltrs chemical - 80 ltrs water***
3	NaoCl - CEB 1.1 - 200 PPM- pump capacity 280 LPH	100 Ltrs	12%	0	100	200 PPM	182 LPH	***CEB flow rate = 109M3/hour***
4	NaOH - CEB 1.1 - 125PPM-pump capacity 50LPH	100 Ltrs	50%	0	100	125 PPM	28 LPH	***CEB flow rate = 109M3/hour*** -check
5	Hcl - CEB 1.2 - 550PPM-pump capacity 460LPH	100 Ltrs	33%	0	200	550 PPM	181 LPH	***CEB flow rate = 109M3/hour*** -check

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
RO Section										
1	RO run hours	Hrs								
2	RO Feed pump Pressure	P 103 - Bar	104 M3/hr @ 3.5 bar							
3	CF outlet Pressure	CF - Bar								
4	Feed water ORP	MV	120- 150							
5	RO HP pump VFD Freequency	P 104 A - Hz								
6	RO system pressure	Bar								
7	RO Reject pressure	Bar								
8	RO Booster pump VFD Freequency	P 106 A & B - Hz								
9	PX inlet flow	M3/hr	104 M3/hr							
10	PX high pressure flow	M3/hr	62.5 M3/hr							
11	Reject flow	M3/hr	62.5 M3/hr							
12	Product flow	M3/hr	41.67 M3/hr							
13	Feed TDS	PPM								
14	Reject TDS	PPM								
15	Product TDS	PPM								
16	Product PH									
17	Antiscalant tank level									
18	Post PH tank level									
19	SMBS tank level									

Chemical Preparation RO system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Dechlorination - SMBS - 6LPH @ 6 Bar	100 Ltrs	63%	85	15	4 PPM	4.27 LPH	15% solution
2	Antiscalant	100 Ltrs	100%	90	10	4 PPM	4.20 LPH	10% solution
3	NaOH	100 Ltrs	50%	0	100	5 PPM	0.50 LPH	as per dose rate

TEST CONDUCTED BY:----------

WITNESSED BY: _____

OEM

Client / CONSULTANT REPRESENTATIVE

SERVICE MANUAL AND GUIDELINES

Daily Operation and Maintenance Log sheet

PROJECT: SWRO system - MMF- PX Date :

Client : Month :

Capacity: 1200M3/day

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
Design Limits										
1	**Plant capacity**	**M3/day**	**1200**							
2	**Designed TDS**	**PPM**	**20,000.00**							
3	**Designed Recovery**	**%**	**50%**							
4	**Product flow**	**M3/hr**	**50**							
5	**Feed flow**	**M3/Hr**	**100**							
6	**Reject flow**	**M3/hr**	**50**							
7	**System pressure**	**Bar**	**37**							
MMF Section										
1	MMF inlet Pressure	Bar	3 - 4							
2	MMF outlet pressure	Bar	3 - 4							
3	Diffrential pressure - MMF (1-2)	Bar	0.5 - 1.0							
4	MMF backwash time remaining	Hours	24 Hours Max							
5	Cartridge filter Out Pressure	Bar	Min 2.0 Bar							
6	Diffrential pressure - CF (2-5)	Bar	Max. 1.5 Bar							
7	Feed flow meter - normal Service	M3/Hr	100							
8	Feed flow metter - Rinse	M3/Hr	100							
9	Backwash flow	M3/hr	45							
RO Section										
1	RO Run hours	Hrs								
2	CF outlet Pressure	CF - Bar	Min 2.0 Bar							
3	Feed water ORP	MV	110- 150							
4	RO HP pump VFD Freequency (4655 RPM)	HPP 101- Hz	150 - 160Hz							
5	RO system pressure	Bar	37							
6	RO Reject pressure	Bar	36							
7	RO Booster pump VFD Freequency	Hz	48							
8	PX inlet flow	M3/hr	50 M3/hr							
9	PX high pressure flow	M3/hr	50.5 M3/hr							
10	Reject flow	M3/hr	50 M3/hr							
11	Product flow	M3/hr	50 M3/hr							
12	Feed TDS	PPM	20000							
13	Reject TDS	PPM	40000							
14	Product TDS	PPM	120							
15	Product PH		7-8.5							
16	Flow totalizer - product	M3/hr	-							

Chemical Preparation UF system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Pre chlorination dosing - 6LPH @ 6 Bar	100 Ltrs	12%	50	50	2 PPM	3.3 LPH	***Dosing for 30 min every 4 hour and w***
2	Dechlorination - SMBS - 10 LPH @ 6 Bar	100 Ltrs	63%	85	10	4 PPM	6.15 LPH	10% solution
3	Antiscalant - 6LPH @ 6 Bar	100 Ltrs	100%	90	10	5 PPM	3.3 LPH	15% solution
4	Post PH correction - 6LPH @ 6 Bar	100 Ltrs	50%	85	15	5 PPM	3.3 LPH	as per dose rate
5	Post Chlorination - - 6LPH @ 6 Bar	100 Ltrs	12%	90	10	0.5 PPM	2.08 LPH	as per dose rate

TEST CONDUCTED BY:----------

OEM

WITNESSED BY: _____

CONSULTANT REPRESENTATIVE

SERVICE MANUAL AND GUIDELINES

Daily Operation and Maintenance Log sheet

PROJECT: 1000 M3/day -UF - SWRO system

Client :

Capacity: 1000M3/day

Date :

Month :

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
UF Section										
1	UF system Run hours - surface area 26x70 =1820m2	Hours								
2	UF Feed pump Pressure	P 101 - Bar	125 M3/hr @ 3bar							
3	UF Feed pump VFD freequency	P 101 - Hz								
4	Pressure - self cleanign filter out	Bar								
5	Diffrential Pressure - SCF	Bar								
6	Instant flow - UF inlet	M3/hr	122 M3/hour							
7	Turbidity at UF inlet	NTU								
8	Pressure at UF Inlet - PT 02	Psig								
9	Pressure at UF outlet - PT-03	Psig								
10	TMP UF - filtreation mode (PT02 - PT 03)	psig	< 1.2							
11	Backwash pump pressure-BW flux 230 LMH	P -102 - Bar	218m3/hr - 3Bar							
12	Backwash effective pressure - PT 01	Psig								
12	TMP - Backwash cycle (PT01-PT03)	psig	< 1.2							
13	Unit status	Run/ BW/ MC								
14	Filteration cycle time	Min	30							
15	Backwash cycle time	Min								
16	CEB 1.1 freequency (NaoH + 200PPM hypo chloride	cycle	after 20 cycle							
17	CEB 1. 2 freequency (Hcl) - 2.2 PH level to maintain	cycle	after 30 cycle							
19	Coagulant tank level									
20	Caustic tank level									
21	Acid tank level									
22	Intermediate tank level									

Chemical Preparation UF system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Pre chlorination dosing		12%	0	100	5 PPM	4.34 LPH	***intermittent chlorination is used - 10***
2	Coagulant dosing pump - Ferric chloride	100 Ltrs	33%	80	20	3 PPM	4.75 LPH	***20 ltrs chemical - 80 ltrs water***
3	NaoCl - CEB 1.1 - 200 PPM- pump capacity 280 LPH	100 Ltrs	12%	0	100	200 PPM	182 LPH	***CEB flow rate = 109M3/hour***
4	NaOH - CEB 1.1 - 125PPM-pump capacity 50LPH	100 Ltrs	50%	0	100	125 PPM	28 LPH	***CEB flow rate = 109M3/hour*** -check
5	Hcl - CEB 1.2 - 550PPM-pump capacity 460LPH	100 Ltrs	33%	0	200	550 PPM	181 LPH	***CEB flow rate = 109M3/hour*** -check

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
RO Section										
1	RO run hours	Hrs								
2	RO Feed pump Pressure	P 103 - Bar	104 M3/hr @ 3.5 bar							
3	CF outlet Pressure	CF - Bar								
4	Feed water ORP	MV	120- 150							
5	RO HP pump VFD Freequency	P 104 A - Hz								
6	RO system pressure	Bar								
7	RO Reject pressure	Bar								
8	RO Booster pump VFD Freequency	P 106 A & B - Hz								
9	PX inlet flow	M3/hr	104 M3/hr							
10	PX high pressure flow	M3/hr	62.5 M3/hr							
11	Reject flow	M3/hr	62.5 M3/hr							
12	Product flow	M3/hr	41.67 M3/hr							
13	Feed TDS	PPM								
14	Reject TDS	PPM								
15	Product TDS	PPM								
16	Product PH									
17	Antiscalant tank level									
18	Post PH tank level									
19	SMBS tank level									

Chemical Preparation RO system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Dechlorination - SMBS - 6LPH @ 6 Bar	100 Ltrs	63%	85	15	4 PPM	4.27 LPH	15% solution
2	Antiscalant	100 Ltrs	100%	90	10	4 PPM	4.20 LPH	10% solution
3	NaOH	100 Ltrs	50%	0	100	5 PPM	0.50 LPH	as per dose rate

TEST CONDUCTED BY:----------

WITNESSED BY: _____

OEM

CONSULTANT REPRESENTATIVE

SERVICE MANUAL AND GUIDELINES

Daily Operation and Maintenance Log sheet

PROJECT: 2x500,000 SWRO - UF system Date :

Client : Month :

Capacity: 1000M3/day

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
UF Section										
1	UF system Run hours - surface area 3640M2	Hours								
2	UF Feed pump Pressure	P 101 - Bar	238M3/hr @ 3bar							
3	UF Feed pump VFD freequency	P 101 - Hz								
4	Pressure - self cleanign filter out	Bar								
5	Diffrential Pressure - SCF	Psig								
6	Instant flow - UF inlet	M3/hr	238 M3/hour							
7	Turbidity at UF inlet	NTU								
8	Pressure at UF Inlet	Psig								
9	Pressure at UF outlet	Psig								
10	Backwash pump pressure	P -102A - Bar	210m3/hr - 3Bar							
		P-102 B - Bar	210m3/hr - 3Bar							
11	Backwash pump total flow BW flux 230 LMH	M3/hour	420M3/hour							
12	Backwash effective pressure	Psig								
13	Unit status	Run/ BW/ MC								
14	Filteration time	Min	30							
15	Backwash time	Min								
16	CEB 1.1 freequency (NaoH + 200PPM hypo chloride	cycle	after 20 cycle							
17	CEB 1. 2 freequency (Hcl) - 2.2 PH level to maintain	cycle	after 30 cycle							
19	Coagulant tank level									
20	Caustic tank level									
21	Acid tank level									
22	Intermediate tank level									

Chemical Preparation UF system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Pre chlorination dosing		12%	100	50	0.8 PPM	4.75 LPH	***intermittent chlorination is used***
2	Coagulant dosing pump - Ferric chloride	200 Ltrs	40%	0	100	4 PPM	4.75 LPH	50% chemical - 50% water
3	NaoCl - CEB 1.1 - 200 PPM- pump capacity 600LPH	200 Ltrs	12%	0	200	200 PPM	600 LPH	detect chlorine at CEB outlet
4	NaOH - CEB 1.1 - 125PPM-pump capacity 100LPH	200 Ltrs	50%	0	200	125 PPM	100 LPH	check PH is 9.5 at outlet
5	Hcl - CEB 1.2 - 550PPM-pump capacity 750LPH	200 Ltrs	33%	0	200	550 PPM	732 LPH	check PH is 2.5 at the outlet

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
RO Section										
1	RO run hours	Hrs								
2	RO Feed pump Pressure	P 103 - Bar	200M3/hr @ 3.5 bar							
3	CF outlet Pressure	CF - Bar								
4	Feed water ORP	MV	120- 150							
5	RO HP pump VFD Freequency	P 104 A - Hz								
6	RO system pressure	Bar								
7	RO Reject pressure	Bar								
8	RO Booster pump VFD Freequency	P 106 A & B - Hz								
9	PX inlet flow	M3/hr	118 M3/hr							
10	PX high pressure flow	M3/hr	118 M3/hr							
11	Reject flow	M3/hr	118 M3/hr							
12	Product flow	M3/hr	78.85 M3/hr							
13	Feed TDS	PPM								
14	Reject TDS	PPM								
15	Product TDS	PPM								
16	Product PH									
17	Antiscalant tank level									
18	Post PH tank level									
19	SMBS tank level									

Chemical Preparation RO system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Dechlorination - SMBS	200 Ltrs	63%	85	15	4 PPM	8.33 LPH	15% solution
2	Antiscalant	200 Ltrs	100%	90	10	4 PPM	7.88 LPH	10% solution
3	NaOH	200 Ltrs	50%	90	10	5 PPM	5.27 LPH	as per dose rate

TEST CONDUCTED BY:----------

OEM

WITNESSED BY: _____

CONSULTANT REPRESENTATIVE

SERVICE MANUAL AND GUIDELINES

Daily Operation and Maintenance Log sheet

PROJECT: 2x3250 m³/Day TSE Polishing Plant Date :

Client : Month :

Capacity: 3250 M3/day

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
UF Section										
1	UF Feed pump Pressure	P 101 A - Bar								
		P 101 B - Bar								
		P 101 C - Bar								
2	UF Feed pump VFD freequency	P 101 A - Hz								
		P 101 B - Hz								
		P 101 C - Hz								
3	UF feed water flow before SCF	FIT01-M3/hr	250m3/hr							
		FIT 01-M3/hr	250m3/hr							
4	Pressure inlet / outlet Self cleaning Filter	SCF01A- bar								
		SCF01A- bar								
5	Pressure inlet/outlet of MMF	MMF101A- Bar								
		MMF101B- Bar								
		MMF101C- Bar								
		MMF102A- Bar								
		MMF102B- Bar								
		MMF102C- Bar								
6	Pressure Backwash pump inlet /outlet	P 102 A - Bar								
		P 102 B - Bar								
7	Backwash water flow	FIT03- M3/hr	150-160M3/Hr							
8	UF Air blower Pressure	AB 101 A - Bar	0.7bar							
		AB 101 B - Bar	0.7bar							
		AB 101 C - Bar	0.7bar							
9	Inlet / outlet Pressure across UF 1	PT01- Bar								
		PT02- Bar								
10	Diffrential pressure - TMP - UF 1	PT02-PT01-Bar	<1.5 Bar							
11	UF treated water flow - UF 1	FIT04- M3/hr	250 M3/Hr							
12	UF 1- status	Run/ BW/ MC								
13	Total Run hours - total UF1	Hours	24							
14	Inlet / outlet Pressure across UF 2	PT03- Bar								
		PT04- Bar								
15	Diffrential pressure - TMP - UF 2	PT04-PT03-Bar	<1.5 Bar							
16	UF treated water flow - UF2	FIT05- M3/hr	250 M3/Hr							
17	UF 2- status	Run/ BW/ MC								
18	Total Run hours - total UF2	Hours	24							
19	Max. air flow	M3/hr	790 M3/hr							
20	Max air pressure	Bar	0.6 Bar							
21	RC Pump flow	M3/hr	126.4 M3/hr							
22	RC / CIP pump pressure	P 103A- Bar	219M3/hr							
		P 103B- Bar								
23	Chlroine dose rate - MC 1	LPH	189							
24	Caustic dose rate - MC 1	LPH	199.6							
25	Acid dose rate - H2So4 - MC 2	LPH	104.1							
26	Chlroine dosing tank level - DTK 1	Ltrs								
27	Alkali dosing tank level - DTK 2	ltrs								
28	Acid dosing tank level - DTK 3	ltrs								
Chemical Preparation UF system										
Sno	**Chemical dose**	**Dosing tank**	**Chemical %**	**Water**	**Chemical**	**Dose rate**	**solu. Consp**	**Note**		
1	NaoCl - MC 1 - 350LPH - 1D+1SB	500 Ltrs	8%	0	200	110 PPM	342LPH	Fill neat chemical from ECU unit		
2	NaOH - MC 1 - 350LPH - 1D+1SB	500 Ltrs	50%	0	200	700PPM	346 LPH	Fill neat chemical		
3	Hcl - 200LPH- 1D+1SB	500 Ltrs	33%	0	200	840 PPM	200 LPH	Fill neat chemical		
Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM

SERVICE MANUAL AND GUIDELINES

RO Section										
1	RO Feed pump Pressure	P 104 A - Bar								
		P 104 B - Bar								
		P 104 C - Bar								
2	CF Inlet / outlet Pressure	CF -102 A - Bar								
		CF -102 B - Bar								
		CF -102 C - Bar								
3	RO stream -1 Feed SDI	AIT -02	<2							
4	RO stream -1 Feed ORP	AIT -03	<150							
5	RO stream -1 Feed TDS	AIT -04	<1500							
6	RO stream -1 Feed PH	AIT -05	<7.0							
7	RO stream -2 Feed SDI	AIT -02	<2							
8	RO stream -2 Feed ORP	AIT -03	<150							
9	RO stream -2 Feed TDS	AIT -04	<1500							
10	RO stream -2 Feed PH	AIT -05	<7.0							
11	RO High pump Pressure In/ out	HPP101A - Bar	<10 Bar							
		HPP101B - Bar	<10 Bar							
		HPP101C - Bar	<10 Bar							
12	RO stream1-Product flow	FIT06-m3/hr	125M3/hr							
13	RO stream 1 -Reject flow	FIT 07 - m3/hr	53.5M3/hr							
14	RO stream 1 - feed pressure	PT05 - Bar								
15	RO stream 1 - Reject pressure pressure	PT06 - Bar								
16	RO stream 1 - Diffrential pressure	PT06-PT05	<1 Bar							
17	RO stream 1 - Product TDS	AIT 06	<100							
18	RO stream 1 - Product PH	AIT 07	7-8							
19	RO stream2-Product flow	FIT09-m3/hr	125M3/hr							
20	RO stream 2 -Reject flow	FIT 10 - m3/hr	53.5M3/hr							
21	RO stream 2 - feed pressure	PT08 - Bar								
22	RO stream 2 - Reject pressure pressure	PT09 - Bar								
23	RO stream 2 - Diffrential pressure	PT08-PT09	<1 Bar							
24	RO stream 2 - Product TDS	AIT 06A	<100							
25	RO stream 2 - Product PH	AIT 07A	7-8							
26	RO stream -Blend flow	FIT 08 - m3/hr	20.83 M3/hr							
27	RO stream -blended TDS	AIT 08	<150							
28	RO stream -Blend chlorine	AIT 09	<0.2							
29	Antiscalant dose rate	PPM	4							
30	Post PH dose rate	PPM								
31	SMBS dose rate	PPM								
32	Antiscalant tank									
33	Post PH dose rate									
34	SMBS dose rate									

Chemical Preparation RO system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Pre chlorination dosing - 5LPH - 2D + 1 SB	ECU unit tank	8%	0	ECU tank	1PPM	3.2LPH	1 hour working and 4 hours off (Neat
2	Membrane Biocide dosing- 15LPH - 2D + 1 SB	200 Ltrs	100%	0	50	40PPM	10 LPH	20 Min working every after 12 hours
3	De Chlorination dosing - 15LPH - 2D + 1 SB	200 Ltrs	15%	180	200	4 PPM	10 LPH	10% solution to be prepared
4	Antiscalant - 10LPH - 2D + 1 SB	200 Ltrs	15%	170	30	4 PPM	6.67 LPH	15% chemical solution to be prepare
5	Post PH - 6LPH - 2D + 1 SB	200 Ltrs	20%	82	18	4 PPM	6.29 LPH	20% of caustic solution to be prepare
6	Post Chlorination- 6LPH - 2D + 1 SB	ECU unit tank	8%	0	ECU tank	0.5 PPM	0.84 LPH	direct from ECU unit tank

Water analysis report

1	PH
2	TDS
3	TSS
4	COD
5	TOC
6	Feed turbidity
7	Permeate turbidity
8	RO feed water SDI

TEST CONDUCTED BY:----------

WITNESSED BY: _____

OEM

CONSULTANT REPRESENTATIVE

SERVICE MANUAL AND GUIDELINES

Daily Operation and Maintenance Log sheet

PROJECT: 2x1750 m³/Day TSE Polishing Plant Date :

Client : Month :

Capacity: 1750M3/day

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
UF Section										
1	UF Feed pump Pressure	P 101 A - Bar								
		P 101 B - Bar								
2	UF Feed pump VFD freequency	P 101 A - Hz								
		P 101 B - Hz								
3	Feed water tempreture	Deg C								
4	Pressure After Disc Filter	Bar								
5	Instant flow - Disc filter inlet	M3/hr								
6	Diffrential Pressure - Disc filter									
7	UF - filtreaiton - inlet Pressure - PIT 01	Psig								
8	UF - filtreation - Outlet pressure - PIT 03	Psig								
9	UF TMP - filteration	Psig								
10	UF - backwash - inlet Pressure - PIT 03	Psig								
11	UF - backwash - Outlet pressure - PIT 01	Psig								
12	UF TMP - Backwash	Psig								
13	Instant flow - UF outlet	M3/hr	133 M3/hour							
14	Average flow - UF outlet	M3/hr	113.6 M3/hr							
15	UF run hours - total	Hours	24							
16	UF run hours - production cycle	Hours	19.9							
17	Unit status	Run/ BW/ MC								
18	Filteration time	Min	30							
19	Max. air flow	M3/hr	456.3 M3/hr							
20	Air scoure time	Min	4.53 Min							
21	Max air pressure	Bar	0.6 Bar							
22	RC Pump flow	M3/hr	126.4 M3/hr							
23	RC / CIP pump pressure	Bar								
24	RC / CIP pump pressure after CF	Bar								
25	Chlroine dose rate - MC 1	LPH	189							
26	Caustic dose rate - MC 1	LPH	199.6							
27	Acid dose rate - H2So4 - MC 2	LPH	104.1							
28	Intermediate tank level	%								
29	CIP flow meter - cumulatuive	M3								
30	Chlroine dosing tank level - DTK 1	Ltrs								
31	Alkali dosing tank level - DTK 2	ltrs								
32	Acid dosing tank level - DTK 3	ltrs								

Chemical Preparation UF system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	NaoCl - MC 1	200 Ltrs	12%	0	200	180 PPM	189 LPH	Fill neat chemical
2	NaOH	200 Ltrs	50%	0	200	790 PPM	199.6LPH	Fill neat chemical
3	H2So4	200 Ltrs	98%	0	200	840 PPM	104.1 LPH	Fill neat chemical

Sno	Equipment Details	Time interval	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
RO Section										
1	RO Feed pump Pressure	P 102 A - Bar								
		P 102 B - Bar								
2	CF outlet Pressure	S - 401 A - Bar								
		S - 401 B - Bar								
4	Total Flow - RO inlet	M3	106.69							
5	Feed water conductivity	US/cm	1800							
6	Feed water ORP	MV								
7	RO HP pump VFD Freequency	P 103 A - Hz								
		P 103 B - Hz								
8	RO HP pump Pressure	P 103 A - Bar	9.8 Bar							
		P 103 B - Bar								
	RO inter stage pressure	Bar	8.6 Bar							
9	RO Reject pressure	Bar	7.6 Bar							
10	RO product flow	M3/hr	66.4	1593.6						
11	RO Blending flow	M3/hr	4.54	108.96	1702.56					
12	RO reject flow	M3/hour	35.75	858						
13	RO product conductivity (with blending)	US/cm	162	102.15						
14	RO product conductivity (without blending)	US/cm	50	0.650024474						
15	RO Reject conductivity		5050							
16	RO product PH	--	7.5							
17	Antiscalant dose rate	PPM	4							
18	Post PH dose rate	PPM								
19	SMBS dose rate	PPM								
20	Antiscalant tank									
21	Post PH dose rate									
22	SMBS dose rate									

Chemical Preparation RO system

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note
1	Antiscalant	200 Ltrs	100%	90	10	4 PPM	4.09 LPH	Prepare chemical at 50 Ltrs level
2	SMBS	200 Ltrs	63%	90	10	4 PPM	6.29 LPH	Prepare chemical at 50 Ltrs level
3	NaOH	200 Ltrs	50%	90	10	5 PPM	5.27 LPH	Prepare chemical at 50 Ltrs level

Water analysis report

1	PH
2	TDS
3	TSS
4	COD
5	TOC
6	Feed turbidity
7	Permeate turbidity
8	RO feed water SDI

TEST CONDUCTED BY:----------

OEM

WITNESSED BY: _____

CONSULTANT REPRESENTATIVE

SERVICE MANUAL AND GUIDELINES

Daily Operation and Maintenance Log sheet

PROJECT: RO+ EDI Date :

Client : Month :

DM Plant Capacity: 20 M3/Day

S.No	Parameter	Unit	Design Value	8:00 AM	12:00 PM	2:00 PM	6:00 PM	10:00 PM	12:00 AM	4:00 AM
RO +EDI										
1	MMF inlet Pressure	Bar	3 - 4							
2	MMF outlet pressure	Bar	3 - 4							
3	Cartridge filter Outlet Pressure	Bar	Min 2.0 Bar							
4	RO Run hours	Hrs								
5	RO system pressure	Bar								
6	RO Reject pressure	Bar								
7	RO product flow	LPM	14							
8	RO reject flow	LPM	4.7							
9	RO feed flow	LPM	18.7							
10	Feed TDS	PPM	<500							
11	Product TDS	PPM	< 20							
12	Product PH		7-8.5							
13	FEDI inlet pressure									
14	FEDI oulet pressure									
15	FEDI concentrate inlet pressure									
16	FEDI concentrate out pressure									
17	FEDI outlet flow	LPM	18							
18	FEDI concentrate outlet flow	LPM	2.5							
19	FEDI voltage	V								
20	FEDI current	A								
21	Flow Totalizer-FEDI out	M3/hr	-							
22	MMF backwash	Daily								
23	CF-1 change	Every 15 days								
24	CF-2 Change	Every Month								
25	Antiscalant dosing level OK		-							
EDI Section										

Chemical Preparation

Sno	Chemical dose	Dosing tank	Chemical %	Water	Chemical	Dose rate	solu. Consp	Note	
1	Antiscalant - 6LPH @ 6 Bar	40 Ltrs	100%	39	1	5 PPM	0.55 LPH	1% solution	stroke Set at 12%

OPERATOR ENGINEER

MAINTENANCE CHECK LIST - PUMPS

A regular maintenance schedule will help avoid expensive repairs and contribute to trouble-free, reliable operation of the pump; here followings the list of pump inception check

Sr. N	Pump Inspection and Maintenance Schedule	Routinely	Monthly	Quartile	Every 6 Month	Every 1 Year
1	Check Discharge Pressure rating in gauge	✓	-	-	-	-
2	Check of Discharge Flow in line	✓	-	-	-	-
3	Check pump Unusual noise if any	✓	-	-	-	-
4	Visual inspection of lifting Piping Connections	✓	-	-	-	-
5	Check motor direction and rotation	✓	-	-	-	-
6	Check tightness and fixation of the pump	✓	-	-	-	-
7	Check that the pump is properly grouted	✓	-	-	-	-
8	Check functionality of the pump logic / controls,	✓	-	-	-	-
9	Safety devices and operation	-	✓	-	-	-
10	Checking the power cables & connections	-	✓	-	-	-
11	Check Discharge Pressure rating in gauge	-	✓	-	-	-
12	Emergency stop push button	-	✓	-	-	-
13	Check the correct electrical termination and availability of electric power	-	✓	-	-	-
14	Check pump skid / base plate leveling	-	✓	-	-	-
15	Check oil leaks at the gaskets	-	-	✓	-	-
16	Add oil to the bearing reservoirs, if required	-	-	✓	-	-
17	Oil level of the pump	-	-	✓	-	-
18	Clean & oil linkage & valve stems	-	-	✓	-	-
19	Inspect the impeller for corrosion or excessive wear (anytime a pump is opened,)	-	-	✓	-	-
20	Mechanical seal (should be no leakage)	-	-	✓	-	-
21	Check coupling alignment and integrity	-	-	✓	-	-
22	Add grease to pump anti-friction bearings	-	-	-	✓	-
23	Add oil to the bearing reservoirs, if required	-	-	-	✓	-
26	Make sure that the oil level is the correct distance from the shaft centerline. Adjust if necessary.	-	-	-	✓	-
27	Change anti-friction bearing oil	-	-	-	-	✓
27	Inspect the impeller running clearance.	-	-	-	-	✓

28	Inspect operation of all valves in system	-	-	-	-	✓
29	Tightness of foundation and hold-down bolts	-	-	-	-	✓
30	Change Pump Oil	-	-	-	-	✓
31	Inspect the impeller corrosion or excessive wear	-	-	-	-	✓

SERVICE MANUAL AND GUIDELINES