OPERATION & MAINTENANCE MANUAL FOR

SEWAGE TREATMENT PLANT(AUGMENTATION)

SECTION 1 - INTRODUCTION

This manual provides guidelines for operation and maintenance of Augmented STP Plant designed, manufactured and supplied by us.

Trained and qualified personnel should operate the STP Plant. In case you have any clarification regarding operation and maintenance of STP Plant, please do contact us. We will be pleased to offer our service to you.

M/s. WIPRO WATER (A DIVISION OF WIPRO ENTERPRISES LIMITED) declines any and all liability for failure to observe the safety and precautionary measure described in this manual, for damage due to the improper use of the equipment's and/or for modifying it without authorization of M/s. WIPRO WATER (A DIVISION OF WIPRO ENTERPRISES LIMITED)

For any Clarification, please contact:
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SECTION 2: - DESIGN BASIS, PERFORMANCE GUARANTEE & SCHEME

2.1 DESIGN BASIS

Existing STP1 Capacity is – 450 M3/day

Upgradation of Existing STP1 capacity to 1100 m3/day at 24 hours operation.

Revised Design flow of STP 1 will be - 46 m3/hr.

Sr. No.	Parameters	Feed Sewage quality	Treated water Quality after RO
1.	Raw Sewage Temperature	Ambient	Ambient
2.	pH	6.0 -8.0	6.5– 8.3
3.	TSS	350 mg/ltr	<5
4.	Oil & Grease (Free & Floating)	< 20 mg/ltr	Nil
5.	Biological Oxygen Demand – 5-day (BOD5)	350 mg/ltr	< 5 mg/ltr
6.	Chemical Oxygen Demand (COD)	500 mg/ltr	<50 mg/ltr
7.	Alkalinity as CaCO3	70 mg/ltr	-
8.	Total –N	< 50 mg/ltr	< 10 mg/ltr
9.	Total phosphorous, P	5 – 7 mg/ltr	< 2 mg/ltr
10.	TDS of Sewage, mg/lit	< 500 mg/ltr	< 25 mg/ltr @ 25 Deg C
11.	Total Hardness, CaCO3	60 mg/ltr	< 10
12.	Ca as CaCO3	40 mg/ltr	< 5
13.	Total Silica	Nil	Nil

Note:

1. Parameters marked as * are assumed since the data is absent in quality provided by client.
2. Inlet parameters mentioned in above table are considered for design consideration as raw sewage characteristics.
3. The outlet parameters mentioned above are guaranteed based on inlet values as considered in above table. Any change in above parameters will affect performance and operation of the plant.
4. Outlet guarantees will not be linear with respect to the turn down ratio for all the process Parameters especially the BOD & COD.
5. Any other parameters not provided by client and/or not indicated in above table like toxic elements etc. are assumed to be NIL or below threshold value not affecting performance and operation of the plant.
6. Maximum temperature should not exceed more than 35 deg C.
7. Wipro Water guarantees the treated sewage COD based on assumption that all the COD is Biodegradable and are on revolving monthly average basis.
8. The plant must be operated and maintained strictly as per the O&M manual.
9. Wipro Water is assuming that the inlet sewage of STP will be colourless, so we are not envisaging and incorporating any color removal system in STP
10. The dissolved solids will not be removed by Biological treatment system and will remain approx. same as feed sewage quality.

11. The total Heavy metals are assumed to be <1 ppm in the feed effluent. The solvents, oxidizing agents are considered nil in the feed effluent.

2.2 Treated water quality at the outlet of RO plant:

Sr. No.	Parameters	Treated water Quality after RO
1	Raw Sewage Temperature	Ambient
2	Ph	6.5– 8.3
3	TSS	<5
4	Oil & Grease (Free & Floating)	Nil
5	Biological Oxygen Demand – 5-day (BOD5)	< 5 mg/ltr
6	Chemical Oxygen Demand (COD)	<50 mg/ltr
7	Alkalinity as CaCO3	-
8	Total –N	< 10 mg/ltr
9	Total phosphorous, P	< 2 mg/ltr
10	TDS of Sewage, mg/lit	< 25 mg/ltr @ 25 Deg C
11	Total Hardness, CaCO3	< 10
12	Ca as CaCO3	< 5
13	Total Silica	Nil

2.3 RO feed water limiting conditions: -

TOC	3000 ppb
BOD	5000 ppb
COD	8000 ppb
Turbidity	< 1 NTU
SDI	< 4
Heavy Metal	Nil
Organic and Bacteria	Nil
Oil & Grease	Nil
Residual Chlorine	Nil
Oxidizing Materials	Nil
Temperature	< 45 °C (Max)
Colour	Colorless
Odour	Odorless

SECTION 3: PLANT DESCRIPTION

Existing STP1 Capacity is – 450 M3/day
Upgradation of Existing STP1 capacity to 1100 m3/day at 24 hours' operation.
Revised Design flow of STP 1 will be - 46 m3/hr.

Wipro water as augmented the existing STP unit from 450 m3/hr to 1100 m3/hr

3.0 Plant Description:

- Existing Collection Tanks (S2, S3, S4 Tanks)
- Course Bar Screen Chamber (Cbsc-01)
- Collection Tank (S5/ Mb-01)
- Fine Bar Screen Chamber (Fbsc-01)
- Equalisation Tank (Tk-01)
- Mechanical Bar Screen Chamber for MBR (Mbsc-01)
- Oil & Grease Chamber (O&G-01) Including Belt Type Oil Separator and Slop Oil Tank
- Anoxic Tank with Mixture (Tk-05)
- Existing Aeration Tank A & B (Tk-06)
- MBR System
- Ro System
- Dewatering System (Decanter Centrifuge)

3.1 PROCESS DESCRIPTION

Sewage Collection tank: The sewage generated from the Wipro IT Campus is rooted along with canteen waste to Sewage Treatment (STP) unit. The sewage from existing S2 & S3 buildings will be collected at S2 & S3 Collection tanks, also sewage from existing S4 building will be collected at S4 collection tank near the respective building. Bothe sewage will be pumped further for processing towards S5 collection tank. S5 collection tank will also collect sewage coming from S5 (New) Building. The combined effluent shall be passed through a non-mechanized coarse bar screen (CBSC-01) for removal of large floating impurities. S5 collection tank is equipped with HDPE distribution grid mounted at the bottom of the tank and air mixing will be done for even mixing of the sewage received at this tank with the help of air blowers.

Fine bar screen chamber (FBSC-01): From S5 collection tank sewage will be pumped towards fine bar screen chamber (FBSC-01) which will ensure complete removal of larger debris such as scum, plastic, cloth pieces or any of such things which can damage rotating mechanical equipments. The screened sewage will be further collected in equalization tank (TK-04) and will be mixed with the help of air blower and the bottom diffused aeration system. The Equalization Tanks are provided for balancing the hydraulic and organic load fluctuations and for dosing of Alkali / Acid solution for auto pH correction. The chemical solution will be added in order to maintain ideal pH requirement for secondary biological treatment. The automatic dosing will be carried out through a set of chemical dosing pumps controlled by auto pH sensor and analyzer. An on line Electromagnetic flow meter with a totalizer shall also be provided.

Mechanical bar screen (MBSC-01): The equalized sewage is then pumped to in a control flow rate towards Mechanical bar screen (MBSC-01) which is also known as rotating drum skimmer (RDS). The Principal function of MBSC-01 is to screen the floating material in the In-fluent feed. The in-fluent is connected to the MBSC-01 inlet nozzle. The influent is immediately screened in the inlet zone. The solids retrained by the screen are driven by screw flight inside drum, and conveyed to the solid collection bin at the outlet. Mechanized Traveling Bridge Oil Skimmer Unit for removal of free floating oil/ fat and grease material. From the oil Skimmer Tank, the sewage would be led to anoxic tank.

Anoxic tank: Anoxic tank is equipped with moving mixture (MX-01) for even mixing of sewage and return bio

sludge from MBR return sludge line. Anoxic tank will help to reduce any of the shock load to the biological section and also will maintain required feed COD and return sludge concentration. This will further help for control way biological culturing process. After mixing of the organic matter in the anoxic tank through microbial action, the sewage shall flow by gravity to Aeration tank-1 inlet.

Aeration System: The sewage is then taken to Extended Aeration tank followed by Membrane Bio-reactor tank where it shall undergo extended aerobic biological treatment resulting in stabilization of the soluble organic matter in the presence of oxygen. Suitable Flat sheet / Hallow fiber Membrane modules are placed in the MBR tank for Ultra Filtration Membrane separation. The oxygen is supplied with the help of twin lobe air blowers with a set of retractable type fine bubble tubular type silicon diffuser membranes and shall undergo aerobic biological treatment resulting in stabilization of the residual organics. A suitable DO meter, Analyzer with VFD drive for air blowers is provided as an energy efficient measure. The sludge solids in the MBR tank shall be re-circulated to the inlet of the aeration tank to maintain the designed MLSS in the Aeration System.

Alternatively, provision is also given to take half of the effluent to a centrally driven secondary clarifier directly from aeration tank. The clear supernatant (biologically treated effluent) from the MBR / clarifier shall flow by gravity to Treated Water Tank. Electromagnetic flow meters for online measurement of flow of effluent is provided. The effluent at the outlet of the treated water chamber shall conform to the treated effluent characteristics specified in the Table -3.2. The system shall treat the effluent to the extent suitable for disposal for on land / gardening use as per the consent norms prescribed by the State Pollution Control Board.

MBR System comprises of MBR tank, MBR module, Air diffusion grid, Permeate pumps, Back pulse tank, chemical dosing system and sludge re-circulation pumps.

Membrane Holding Tank: Overflow from the existing aeration thank shall be taken to this tank in which the membrane cassettes shall be installed. The clear liquid shall be sucked from the membranes by using permeate cum back wash pump. Hence the complete system shall be converted to MBR which operates on fully automatic mode. The treated waste water overflows from aeration tank in to the MBR tank where the treated waste water is recovered through the membrane filtration of MBR system. To keep the biomass in suspension and maintain the aerobic conditions air is diffused in the tank.

MBR Module: The filtration module consists of cassette of hollow PVDF fibers (Cassettes). The cassette is submerged in the tank. The filtration / permeation process is driven by applying slightly negative pressure on the permeate side of the membrane. Permeate pumps are provided for the purpose. The pumps recover the permeated water and transfer it to the MBR Back pulse tank as well as Secondary Clarifier.

3. Back Pulse / Cleaning System: As the filtration progresses the MBR membranes tend to get covered with the biomass and filtration rate deterioration takes place. To maintain the filtration rate steady and the condition of membranes healthy, the MBR membranes are back flushed periodically. The permeate flow pattern is reversed and the permeate pump pushes back the permeated water from back pulse tank through membranes. To enhance the efficiency of back pulse operation chemicals like citric acid/ sodium hypochlorite are dosed in the back pulse water. Dedicated dosing systems comprising of dosing pumps for citric acid and sodium hypochlorite in the back pulse water is provided.

MBR Air Blower: Air purging is required for scouring the membrane surface on continuous basis to dislodge the accumulated bio mass on the membrane surface. Blowers are provided for the purpose.

Sludge Handling Treatment:
Excess sludge from the UASB digester shall be withdrawn periodically through the sludge valves to be provided at different levels under hydro static pressure in the digester and to a sludge holding tank. Excess sludge from the aerobic treatment shall be conveyed through the sludge recirculation pumps to the sludge tank. The combined sludge is then pumped to a Mono belt type / Volute type mechanized sludge de-watering system where the sludge

is pressed and sludge cakes are formed with 20 % solids. This dried sludge which is very rich in NPK values shall be used as organic fertilizer/compost. The sludge liquor from the de-watering system shall flow under gravity to the primary treatment units for further treatment.

RO System: MBR permeate water will be further treated with reverse osmosis unit. Part of the MBR Permeate will be diverted for gardening purpose & remaining will be fed to RO system, RO system will be equipped with required chemical dosing in the form of HCl, SMBS, Antiscalent. The RO treated water can be used for chiller, HVAC or toilet flushing.

SECTION 4: PLANT DETAILS

4.1 EQUIPMENT LIST: -

Description	Size / Capacity	Quantity	Type/MOC	Scope
S5-MB Collection/Equalization tank				
Bar screens for S5/MB Collection tank	Suitable for 50 m3/hr	1 No.	MSEP	New
Sewage lift pump for Collection tank	50 M3/hr @ 10 mwc	2 nos (1W + 1S)	Submersible. CI Casing, SS 304 shaft & Impeller Grundfos Make	New
Air blowers for collection tank with acoustic hoods	105 m3/hr @ 4.5 mwc	2 nos (1W + 1S)	Twin lobe type/ CI MOC	New
Coarse air diffuser for Collection tanks, Fixed arrangement	Suitable for 105 m3/hr	1 sets	Tubular /EPDM	New
Skid based local control panel	Suitable for pump & blower operation	1 Sets	As per Wipro Standard	New
Sewage Treatment plant (STP1)				
Manual Bar screen for STP	Suitable for 50 m3/hr	1 No.	MSEP Bar	Existing
Blowers for Equalization tank along with Accessories & Acoustic Hood	180 m3/hr @ 5.5 mwc	1 nos (1W + 1S)	Twin lobe type/ CI MOC	Existing
Coarse air diffuser for Equalization tank Fixed arrangement	Suitable for 360 m3/hr	24 nos	Tubular /EPDM	Existing.
Equalization Transfer Pumps submersible for Aeration tank	50 m3/hr @ 10 mwc	2 nos (1w+1s)	Horizontal, CI casing, SS 304 shaft & impeller Grundfos Make	Existing pumps will be replaced
pH correction dosing pump	0-8 LPH	4 Nos (2W+2S)	PP	New
pH correction dosing tank	100 lits	2 No.	HDPE	New
Belt skimmer for O & G trap	Suitable for 50 m3/hr flow	1 No	Oleophilic belt type	New
Slope oil tank for oil collection	50 lit	1 No.	HDPE	New
Mechanical Rotating fine screen	Suitable for 50 m3/hr flow 2 mm punch hole type	1 No	CS Casing and Body with SS 304 filtering drum.	New
Mixer for Anoxic tank	Suitable for 100 m3 tank volume	1 No.	CI with SS stand	New
Aeration tank fine diffusers. With Fixed arrangement	Suitable for 565 m3/hr air supply	1 set	Fine bubble, tubular type, EPDM membrane	New
Blowers for Aeration tank with Accessories. with	565 m3/hr @ 6 mwc	2nos. (1W + 1S)	Twin lobe type/ CI MOC	New

Acoustic Hood & VFD				
Submerged MBR module with < 30 LMH flux	Suitable for 50 M3/hr flow	1 Train	PVDF membrane with SS module frame	New
MBR permeate cum back pulse pumps with Common VFD	60 M3/hr @ 15 mwc	2nos. (1W + 1S)	Horizontal, CI casing, SS 316 shaft & impeller Johnson make	New
Nutrient dosing pump	0-10 LPH	4 Nos (1W+1S)	PP	New
Nutrient dosing tank	500 Ltrs	2 No.	HDPE	New
Return sludge transfer pumps with Common VFD operation	200 m3/hr @ 10 mwc	2 nos (1W + 1S)	CI casing, SS 304 shaft & impeller Johnson make	New
Blowers for Air scouring of Membranes	390 m3/hr @ 5 mwc	2 nos (1W + 1S)	Twin lobe type/ CI MOC	New
NaOCl dosing pump	Suitable LPH @ 20 mwc	2 nos (1W + 1S)	PP	New
NaOCl dosing tank	Suitable quantity	1 No.	HDPE	New
Citric Acid dosing Pump	Suitable LPH @ 20 mwc	2 nos (1W + 1S)	PP	New
Citric Acid dosing tank	Suitable quantity	1 No.	HDPE	New
Poly dosing pump for Sludge dewatering system	0-15 LPH	2 nos (1W + 1S)	PP	Existing
Poly dosing tank for Sludge dewatering system	500 lits	1 No.	HDPE	Existing
Agitator for Poly dosing tank	Suitable	1 No.	SS	Existing
Centrifuge feed pump	2 m3/hr @ 40 mwc	2 nos (1W + 1S)	Centrifugal type CI casing, SS shaft & CI impeller	Existing
Decanter centrifuge for sludge dewatering with VFD	For 2 m3/hr capacity with 16 hrs of operation	1 No.	With SS contact parts & MS frame.	Existing
NaOCl dosing pump in MBR permeate tank	0-5 LPH @ 20 mwc	2 nos (1W + 1S)	PP	Existing
NaOCl dosing tank for MBR permeate tank	100 lits	1 No.	HDPE	Existing
RO feed pump	20 m3/hr @ 20 mwc	2 nos (1W + 1S)	Vertical Centrifugal type CI casing, SS 316 shaft & impeller Make Grundfos	New
Acid dosing tank	100 lit	1No	FRP	New
Acid dosing pump	0 -6 LPH	2 Nos. (1W+1S)	Metering Pump, MOC – PP	New
SMBS Dosing pump	0-6 LPH	2Nos.(1W+1S)	Metering Pump, MOC – PP	New
SMBS Dosing tank	100 Lits	1Nos.(1W+0S)	FRP	New
SMBS Dosing tank Agitator	Suitable	1Nos.(1W+0S	SS316	New

		)		
Antiscalant Dosing pump	0-6 LPH	2Nos.(1W+1S)	Metering Pump, MOC – PP	New
Antiscalant Dosing tank	100 Lits	1Nos.(1W+0S)	FRP	New
Antiscalant Dosing tank Agitator	Suitable	1Nos.(1W+0S)	SS 316	New
Cartridge filter	Suitable for 20.0 m^3/hr (5 micron)	2Nos.(1W+1S)	Vertical Cylindrical spun type, SS304 Housing & PP element	New
High pressure pumps	24 m^3/hr @ 80mwc	2Nos.(1W+1S)	Vertical multistage, Casing –SS 316, Impeller-SS 316 Make Grundfos	New
RO pressure tubes	Suitable for 24 m3/hr	1 lot	FRP Make Aventura/UKL/Advance Composite/Pentair	New
RO membranes < 17 LMH flux	For suitable capacity 75 % recovery	1 lot	BW30XFR/ Make Dow	New
Skid for RO system	Suitable size	1 No.	SS304	New
Common CIP Tank for RO & MBR	3000 lits	1 No.	HDPE	New
Common Cartridge filter for CIP line	Suitable for 20.0 m3/hr (5 micron)	1 No.	Vertical Cylindrical spun type, PVC Housing & PP element	New
Common CIP Pump for RO & MBR	20 M3/Hr @ 20 mwc	1 No.	Vertical, Casing –SS 304, Impeller-SS 304 Make Grundfos	New
Air compressor for instrument air	Suitable capacity	1 No.	CI	New
Civil pipe Puddles	Suitable size	1 Lot	MSEP	New
Low pressure inter connecting Piping/ Fittings within Battery Limit	Suitable size	1 Lot	UPVC Suitable sch 40	
High Pressure line piping	Suitable size	1 Lot	SS 316	
Chemical dosing line	Suitable size	1 lot	UPVC	
All air header piping	Suitable size	1 lot	MS	
Submerged air piping	Suitable size	1 lot	PVC /HDPE	
MBR Air header piping	Suitable size	1 Lot	SS304	

4.2 STRUCTURE & TANKS BY CLIENT .: List of Civil structures: (Not in Scope of Wipro Water)

Name of the unit	**Size (holding Capacity)**	**Qty.(Nos.)**	**MOC**	**Scope**
Bar Screen Chamber for Collection tank	1.6 x 0.1 x 0.5 m + 0.5 FB	1 No.	RCC	New
S5/MB collection tank	150 M3 (8 x 8 x 2.5 m +0.5 FB) Or suitable as per client	1 No.	RCC	New

	requirement			
Bar Screen Chamber for STP 1 Eqt	1.6 x 0.1 x 0.5 m + 0.5 FB	1 No.	RCC	Existing
STP Equalization tank	200 m3 (HRT of 4 hrs at Average Flow)	1 no.	RCC	Existing
Rotating bar screen chamber	Suitable capacity	1 No.	RCC	New
Oil & Grease chamber before anoxic tank	12 m3 + 0.5 FB	1 No.	RCC	New
Anoxic Tank	100 m3 + 0.5 FB	1 Nos.	RCC	New
Aeration Tank	374 m3 + 0.5 FB	1 Nos.	RCC	Existing
MBR Module tank	36 m3 – 3.0 x 3.0 x 4.0 m + 0.5 FB	1 No.	RCC	Existing CCT of 111 m3 will be divided in two tanks
MBR back pulse tank	2.5 m3 min capacity is required	1 No.	RCC	
MBR permeate (Flushing water + Gardening Tank)	240 m3 + 0.5 FB	1 no.	RCC	Existing
RO Permeate (HVAC make Water) tank	250 M3 + 0.5 FB	1 No.	RCC	Existing
Sludge Sump	24 m3 + 0.5 FB	1 No.	RCC	Existing
Pump pad / shed/ for pumps	Suitable	1 Lot	Brick/Frame/AC Roof	New
Blower shed	Suitable	1 lot	Brick/Frame/AC Roof	New

4.3 CHEMICAL CONSUMPTION:

PDC-02 PUNE STP UNIT CHEMICAL DOSING RATE CALCULATION											
SR. NO	1	2	3	4	5	6	7	8	9	10	11
ITEM DISCRIPTION	HCl	Nao H	UREA	DAP	Citric	NaOCl	NaOCl	HCl	SMBS	Antiscalant	POLY
Dosing system Tag No.	ACIDDT-01	NAoHDT-01	UREA DT-01	DAPDT-01	ACIDDT-02	NAOClDT-02	HYPODT-01 (Existing)	HClDT-01	SMBSDT-01	ANTIDT-01	POLYDT-01
Locations	EQ Tank	EQ Tank	A. TK.	A. TK.	MBR CIP	MBR CIP	MBR Perm. Tank	RO Feed	RO Feed	RO Feed	Decanter
Flow (m3/hr)	50	50	50	50	35	35	50	20	20	20	1
Required dosage in	10	5			2000	200	1	5	5	5	80

PPM											
Operation Hours per Day	24	24			0.001389	0.0013889	24	24	24	24	20
Dosing Tank Capacity (LPH)	100	100			200	500	100	100	100	100	1000
% of purity for available for supplied chemicals	33	100			100	10	10	33	100	100	100
Concentration prepared in dosing tanks	11	5			50	5	1.00	3.3	5	5	0.10
Quantity of chemicals to be added in the dosing tank (Kg or Lit)	33.3	5.0			100.0	250.0	10.0	10.0	5.0	5.0	1.0
Dosing pump discharge flow rate (LPH)	4.5	5.0			140.0	140.0	5.0	3.0	2.0	2.0	80.0
Dosing pump Capacity (LPH)	8	8			198	512	8	6	6	6	80
% of Stroke for the dosing pumps to be set	57	63			71	27	63	51	33	33	100
Quantity of chemical req. per day (Kg or Lit)	36.4	6.0			0.1	0.1	12.0	7.3	2.4	2.4	1.6
3 month Stock required Quantity (Kg/Lit)	3272.7	540.0			8.8	8.8	1080.0	654.5	216.0	216.0	144.0

4.4 Termination Points: -

- Raw sewage at the inlet of collection tank S5/MB with required flow.
- Raw sewage at inlet of Screen chamber for equalization tank in STP1 area with required flow and pressure.
- Air exhaust and HVAC System by client.
- Chemicals at the Inlet of dosing tank.
- Sewage lift pumps for collection tank S5/MB discharge up to header 5 mtr distance will be in Wipro water scope and the remaining piping after 5 meters up to STP existing equalisation tank will be under client scope of supply.
- Treated Water from MBR common permeates Header up to MBR permeate tank/Flushing water tank within STP Area.
- RO discharge permeate header up to HVAC tank within STP area.
- RO reject from RO Skid reject header up to 5 m long.
- 3 phase 415V AC power supply at incomer of hardwire MCC local panel for S5 MB area.
- 3 phase 415V AC power supply at incomer of hardwire MCC panel of STP area.
- Service water inlet at one point in STP area & receiving tank area as per suggested by Wipro Water.
- Drain pipe up to the drain pit below each vessel max 5 mtr from discharge point.
- Disposal of sludge from Centrifuge outlet chute with 12-15% consistency.

SECTION 5: MECHANICAL BAR SCREEN / ROTARY DRUM SCREEN

5.1 Components of Screen:

- Top Cover
- Bottom Casing
- Geared Motor Unit
- Rotary Drum
- Washing Header with Spray Nozzles
- Plummer Blocks
- Effluent Inlet Flange
- Effluent Overflow Flange
- Screenings Outlet

5.2 General Information:

- **Introduction: -**Please read the manual carefully before installing and operating the RDS-S Screen. This manual is prepared to help understand the equipment and operate it, safely and properly.

- **Technical service: -**Please follow the instructions given in this manual to obtain the best performance from your RDS -S Screen. In case support is required please provide serial number of the machine as written on the name plate, to Auric service engineer

5.3. Technical specifications

Sr. No.	Model	Flow Rate m3/hr.			Power connected	Weight Kg (Approx.)	T. S.S. In PPM
		2 mm	3 mm	5 mm			
1	RDS(S) 300 X 500	-	-	-	-	-	<500
2	RDS(S) 500 X 1000	30	45	60	0.37Kw	225	<500
3	RDS(S) 640 x 1000	60	75	90	0.55kw	400	<500
4	RDS(S) 640 x 2000	75	90	110	0.55kw	400	<500

The washing water requirement for model is

Model	Washing water requirement
RDS(S) 300 X 500	2.5 m3/hr @ 5 bar pressure
RDS(S) 500 X 1000	
RDS(S) 640 x 1000	
RDS(S) 640 x 2000	5 m3/hr @ 5 bar pressure

5.4. Safety

WARNING:

Never put hands, objects etc inside the moving parts. Ensure top cover is always closed during normal operation. Top Cover should be opened only for maintenance purposes.

Safety directive for Maintenance operations:
Besides the general safety rules prescribed by the local authority, the following directives will have to be complied with:

- The check and maintenance operations should be performed by qualified and skilled staff thoroughly

instructed on the content of this manual.

- Qualified and skilled staff refers to operators that have acquired throughout their work experience the necessary knowledge on the operating conditions and on the prevention of risks.
- All the maintenance works should only be performed when the machine is completely stopped and isolated from the power supply.
- During the maintenance and repair operations, it is fundamental to ensure protection from the involuntary re connection of the machine, for instance by indicating, by way of a note on the main switch/switches, that the operations are under way.
- It is forbidden to have any contact with electrical appliances with wet body parts or barefoot.
- The spare parts must satisfy the technical requirements set by the manufacturer, which is guaranteed if original spares are used.
- Adequately protect areas due for repair.
- In case of prolonged maintenance, display a sign “Undergoing Maintenance”.
- The machine’s electrical equipment must be periodically inspected and examined. Any defects, such as disconnected or damaged cables, must be promptly fixed.
- Suitable protection measures should be adopted against the dispersion of toxic vapours from the cleaning liquids used. The machine parts should never be cleaned with flammable solvents.
- During the repair and maintenance operations, the maximum level of cleanliness must be ensured.
- After repair and maintenance operations, the safety devices and the repaired parts must be tested before restarting the machine.

5.5. Transportation and Installation

5.5.1. Check upon receipt

Please check that the material received is as per the packing slip. If any discrepancy is observed, report immediately to the concerned authority. If any damage is observed, please ensure that it is reported on the LR and a copy is sent to Auric.

5.5.2. Packing

Normally the machine is delivered in a wood crate packing unless otherwise specified by the customer in the purchase order.

5.5.3 Lifting and Positioning

Lifting and positioning of the machine can be done by means of suitable lifting system.
For the weight and dimension, please check the respective GA drawing in this manual. In case the unit is provided with the wooden crate packing, take that weight also into consideration. The lifting of the machine must always be done by means of the suitable lifting tools & tackles. It is always recommended to use the lifting belt and not the chain or sling. Packing must be removed only near the installation area. Please refer the following Fig 01

Fig.01 Lifting & Positioning

5.5.4 Installation

It is recommended to provide adequate space all around the machine to allow ease of movement and for safe maintenance (2 m of free space from all sides of machine is recommended). Provide necessary utilities as specified below. Machine is to be placed on solid level ground (level to be checked with level gauge). After the position of the machine is deemed okay with respect to the maintenance space required as above, machine is to be anchored with the help of suitable anchor bolts (M12 recommended) through the holes provided on the base plate of all 4 legs of the machine. In case any difficulties are faced during this operation, kindly contact AURIC team at info@auricent.com

5.5.5 Electrical connection

Machine is supplied as a standard with a geared motor. Please connect 4 wires, 3 phase, 415V (As per equipment supply), 50 Hz supply with proper 'earthing' to the motor Please provide necessary protection in case of overload. I. e. Overload Relay. Electrical work must be performed only by skilled technician. In case the washing pump is also provided along with the equipment, mount the washing pump on the base plate provided for it on the machine (as indicated in the GA drawing) with the help of the nut-bolts provided for that specific purpose. In case any difficulties are faced during this operation, kindly contact AURIC team at info@auricent.com

5.6. Checks before Start up

Before start-up of the machine, please ensure the following:

- Carefully Read this OPERATION and MAINTENANCE MANUAL.
- Check the positioning and installation of the machine as described above
- Check that the inlet/outlet connections for In-fluent, Washing Water, Overflow, Filtrate are properly done
- Check the solid collection bin & bin securing arrangement
- Check the power supply voltage and electrical connections to the motor as described above
- Check gear box oil level. Gearbox is prefilled with lifelong synthetic oil and does not need a refill under normal operating conditions
- Check Plummer block bearing is greased properly at the required frequency.

5.7. Operation

Subject to specific contractual conditions the purchaser must arrange the following:
Logistical arrangements I. e. Tools & Tackles, lifting and transportation arrangement skilled manpower etc. Installation of the machine; as detailed above Electrical supply as per requirement Inlet waste water Washing Water Overflow pipe, Outlet waste water, Installation of the piping connected to the machine (Also refer the Fig.02):

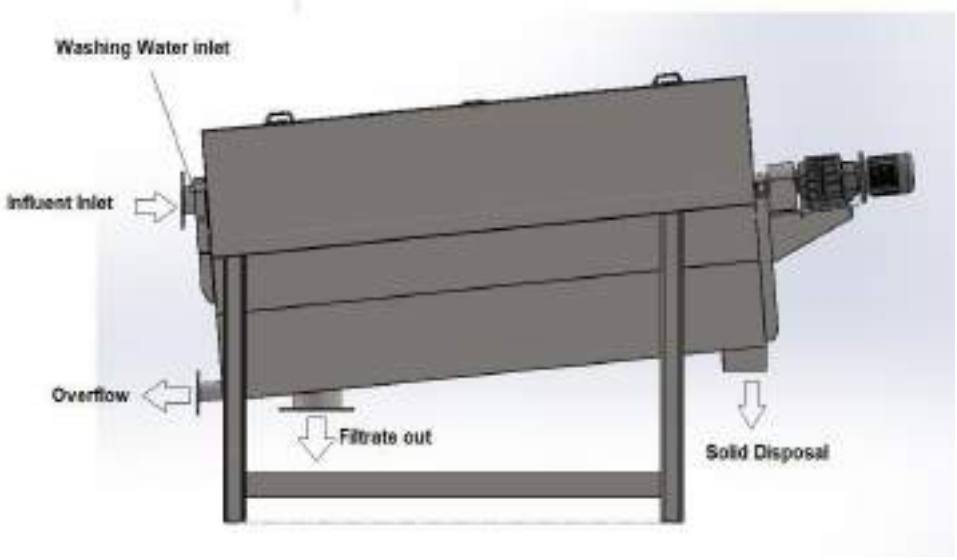


Fig.02 Utilities connection

5. 8. Connections:

The machine must be connected to the power supplies and sources, as per annexed drawing.
Types of connections:

Model	Waste water inlet N1:	Wash water inlet N2:	Overflow outlet N3 :	Filtered Water outlet N4 :	Screening Outlet
RDS(S) 300 X 500	40 NB	20 NB	40 NB	50 NB	375 x 150
RDS(S) 500 X 1000	80 NB	25 NB	65 NB	150 NB	375 x 150
RDS(S) 640 x1000	100 NB	25 NB	65 NB	150 NB	450 x 200
RDS(S) 640 x 2000	100 NB	25 NB	65 NB	2000 NB	450 x 200

It is recommended to check the correct functioning of the emergency stop button regularly.

In case of malfunction of the emergency stop button, the machine must be shut down.

5.9. Control Philosophy

- RDS-S supplied without washing pump and control panel - Washing pump and machine to be operated separately
- RDS-S supplied with washing pump without control panel- Washing cycle is to be operated manually as per site condition.
- RDS-S supplied with washing pump and control panel
- RDS-S supplied without washing pump with control panel - Machine can be can be operated in Auto mode by selector switch and washing pump to be operated manually.
- Please refer following operation philosophy for option 'C' RDS-S supplied with washing pump and control panel.

Operating Philosophy

A. Auto Mode:

Selector Switch to auto mode (Refer Annexure I for wiring diagram)
As per logic provided in control panel washing cycle is to be operated by automatically with timer

Washing cycle is of 5 minute after every 20 minutes' operation of machine is recommended or timing can be changed as per site condition.

B. Manual Mode:

Selector Switch to Manual mode.
Washing pump should be operated manually as per site condition.

5.10 Operating Principles:

The Principal function of RDS -S is to screen the floating material in the In-fluent feed. The in-fluent is connected to the RDS-S inlet nozzle. The in-fluent is immediately screened in the inlet zone. The solids retrained by the screen are driven by screw flight inside drum, and conveyed to the solid collection bin at the outlet. Intermittent washing should be provided at @ 4-5bar pressure *(*Washing cycle is of 5 minute after every 20 minutes' operation of machine is recommended or to be adjusted as per site conditions). It will avoid the choking of screen & reduce

odour of screening material. For correct functioning of the unit it is necessary to ensure that the level of the effluent inside the bottom casing does not rise above the screening zone of the machine.

** Incorrect use of the machine will void the warranty.

5.10.1 Setup and adjustments

Following the installation procedures, it is important to check all the devices, and in particular:
Ensure the machine installed in level.

- Check the correct functioning of the emergency stop button (if applicable).
- Check the functioning modes of selector switch (if applicable).
- Check the regular stopping procedure of the machine through the regular stop push button.
- Check that the RDS -S rotating drum is moving in the correct direction as per the sticker mounted on the machine at motor end.
- Check the tightening of all the bolts and the flanges
- Check that the container for collection of the screened material is arranged by customer.

NOTE - Do not weld anything to the screen or attach additional items to the screen without getting clearance from AURIC else this will void the warranty.

5.11. Machine Start-up & Stop

Machine Start

- Place the selector switch Auto/Manual mode. (if applicable)
- Turn the main switch on the main switchboard onto [ON] mode. This operation will supply power that will operate the machine.
- Push start button on the panel / local switch board & ensure that the direction of rotation is correct as per the sticker
- Push STOP button to stop the machine.
- Open all the valves of In-fluent and effluent discharge line:
- Open the washing water line on the RDS -S rotary screen inlet (if selector switch is applicable in auto mode). The washing water line should be operated manually if the selector switch is in manual mode.
- Open the overflow line on the rotary screen RDS -S.
- Put the collection tank for the screened material under the RDS -S outlet.
- The inlet should be restricted to the maximum value indicated in the manual or given in the offer contract whichever is lower.

Machine Stop

In order to normally stop the machine, the following procedure should be followed:

- Stop the In-fluent line by stopping the feeding pump.
- Wait until the screened material inside the drum is released from the RDS -S outlet.
- Stop the machine by using the “STOP” button.

5.12 Restart after an Emergency Stop

In case of emergency, the machine can be stopped by pressing the emergency stop button on the switchboard (if applicable). This will cause the machine to disconnect from all power sources as well as its moving parts to stop. Before restarting the machine, it is important to eliminate the cause that led to its emergency stop. In order to restart the machine, twist and lift the emergency stop key. Now the machine is ready to be restarted by pressing the start button on the local switchboard.

Noise levels: The machine complies with the existing regulations on noise levels; the low-noise operations and the low-speed movements of the machine generate an acoustic pressure of the A weighted sound pressure level lower than 80 dB (A).

The machine has no workstations, as it is an automated machine that does not require the presence of any operator. In case excessive noise levels are detected during its first functioning, it is recommended to contact

AURIC customer support.

During 1st STARTUP :-During the first operation period, it is important to carefully monitor the moving parts in order to detect any irregular noises or vibrations.

WARNING:
The maintenance operations must be carried out only when the machine is isolated from any power source and when all the movable parts are stopped.

5.13. Checks and scheduled Maintenance
This section contains a table aimed at specifying the frequency and the type of maintenance interventions that must be performed periodically on the machine, in order to guarantee its correct operation.

Safety warnings:

- All maintenance work should only be performed when the machine is completely stopped and isolated from the power supply.
- During the maintenance and repair operations, it is fundamental to ensure protection from the involuntary re-connection of the machine, for instance by indicating, by way of a note on the main switch/switches, that the operations are under way, or by locking the main switch.
- The user is in charge of performing the maintenance, as mentioned in this manual, by utilizing AURIC original spare parts. An incorrect maintenance may lead to a malfunctioning of the machine and may compromise the safety conditions. The manufacturer declines any responsibility for injuries to persons and damages to property caused by incorrect maintenance. The following table illustrates the frequency of the maintenance operations; the operative instructions are shown in the following section.

Please note:
The maintenance frequency mentioned below is described as weeks / months / years, taking into account that the machine is in operation 24h /day.

Frequency	Operational Instructions
At the machine start-up	Please ensure and verify all components are assembled on RDS as per Auric drawing. (In case of some loosen spares dispatch separately) Check availability of water in the washing system
	Check the operation of the emergency button if applicable
	Check the correct direction of rotation of the RDS-S
Daily	Clean all the nozzles by using air or water pressure. Do not use wire to clean, it will enlarge the hole size.
	Ensure that the water line is closed when you are cleaning the Nozzles as O'ring might get removed because of water pressure, Resulting the nozzles useless.
	Start Washing cycle for 5 minute after every 20 minutes operation of machine is recommended or timing can be changed as per site condition for better cleaning of drum screen.
Weekly	General cleaning of the machine. The components of the system are built with good quality materials and generally resistant to the most common types of waste water; might corrode the plastic cover of the electric cables. Wipe the outer side of however, it is recommended not to use solvents that machine with wet cloth please do not touch the wet cloth on Gear Box and Motor.
	Check for water leakages on connecting pipes and flanges.
Monthly	Check the fastening bolts of the RDS.
	Cleaning of the screen by using nylon brush and water (depend on site condition) and the cooling fan of the electric motors.

	General checks of noise level and vibration of Gear Box, Motor and Bearings.
	Check for oil leakages in the gearbox.
	Greasing of bearings. (Please apply grease to bearing when machine is in operation)
	Check hardware of hinges.
Yearly	Fully replace the bearings (Please replace the complete bearing with bearing CI housing)
Every two	Check the operation of the circuit breaker in the main switchboard.
years	Perform a general visual check to assess the condition of the machine and the welded joints and of the anchoring bolts.

5.14 Troubleshooting:

Group	Problem	Possible cause	Solution
1	Failure to start the machine	Emergency push-button pressed(if applicable)	Reset the emergency push-button and give the start command
		No power	Check if there is voltage at the main switchboard.
		Single phase Power supply	Check the power supply in main panel as well as motor end .
2	The machine does not produce treated water	Unavailability of in-fluent	Check the availability of in-fluent
			supply to the pump
		The outlet of RDS is clogged	Clean the outlet of the treated water nozzle
		Influent pump not Discharging	Check the pump condition.
3	Washing pump failure	The washing system does	Check the pores of the nozzles and
		not work properly	clean it as well as check spray of nozzles.
		Dry run of Washing pump	Please ensure service water/treated waters steady flow during operation of washing pump.
		Washing pump not working	Check the impellers, strainer, and need of priming.
		Filtrate line chocked	Remove chocking of filtrate line
4	All water passing through overflow nozzle	Perforated drum pores Chocked	Start washing mode to clean the drum properly
		Over capacity inlet flow feed to RDS- S	Operate the RDS-S on desired flow rate.
			Immediate inform to AURIC. Please rD9:F20efer order.

5.15. Accessories and spare parts

To Optimize the efficiency of the machine only original spare parts must be used. To order spare parts it is necessary to check the following on the label present on the unit: Machine / Equipment model and serial number. Manufacturing year.

spare parts

Find here the list of main Spare parts:

Sr. no	Description	Auric code	Qty

1	Spray nozzle head (Qty Depend on model)	AU0181	26
2	Spray nozzle O ring (Qty Depend on model)	AU0177	26
3	Spray nozzle base with O ring (Qty Depend on model)	AU1135	26
4	Plummer block with bearing	AU0039	2
5	Brush FOR RDS –S (Depend on model)	AU0013	2
6	Complete Motor reducer assembly		1
	500 x 1000	AU0407 (Motor), AU0095 (Gear Box)	1
	640 x 1000	AU0482 (Motor), AU0014 (Gear box)	1
	640 x 2000	AU0998 (Motor), AU0014 (Gear box)	1
7	Coupling		
	640 x 1000	AU1402	1
	640 x 2000	AU1402	1

SECTION 6: AEROBIC TREATMENT PROCESS

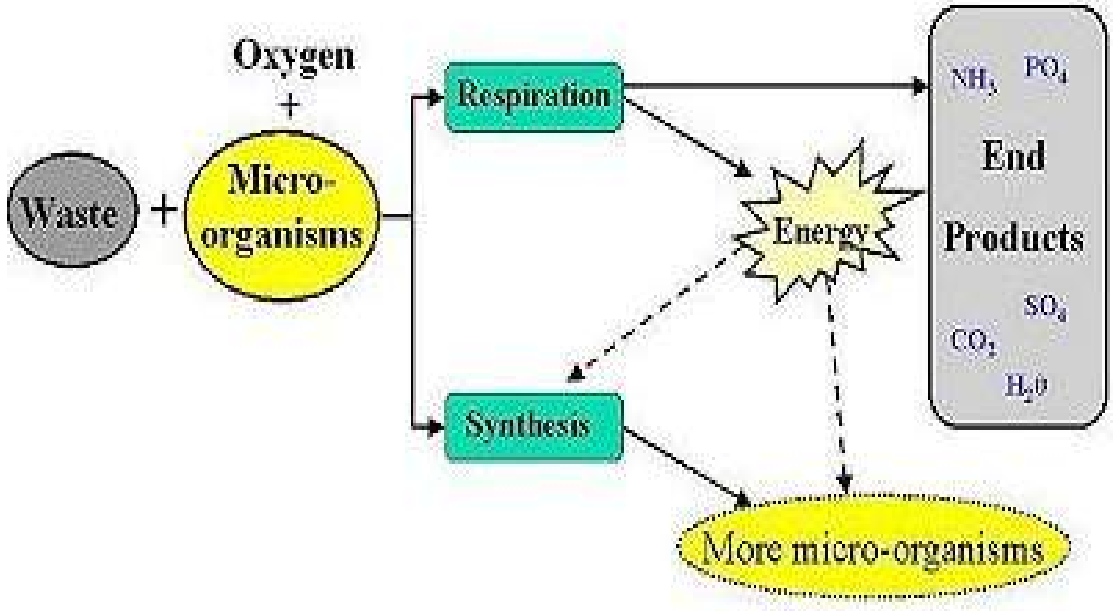
6.1 Introduction of Activated Sludge:

Activated sludge consists of sludge particles produced in Waste water or Primary treated sewage by the growth of organisms (including zoological bacteria) in aeration tanks in the presence of dissolved oxygen. The term 'activated' comes from the fact that the particles are teaming with bacteria, fungi and protozoa.

The activated sludge process is a biological Waste water treatment process that uses micro-organisms for decomposition of wastes. When activated sludge is added to waste water, the micro-organisms feed and grow on impurities (waste particles) in the waste water. As the organisms grow and reproduce, more and more waste is removed, leaving the Waste water partially cleaned. To function, efficiently, the mass of organisms (SOLID CONCENTRATION) needs a steady balance of food (FOOD / MICRO-ORGANISMS RATIO) and oxygen.

6.2 Process Description:

The treatment process in the form of the activated sludge is aimed at OXIDATION and removal of soluble or finely divided suspended materials that were not removed by earlier process, if any. Aerobic organisms do this in few hours as Waste water flows through an aeration tank. The organisms stabilize soluble or finely divided suspended solids by partial oxidation forming carbon dioxide, water, sulfates and nitrite compounds. The remaining solids are changed to a form that can be settled and removed as sludge during sedimentation. After the designed aeration period, the Waste water is routed to a settling tank for a liquid-organism (water-solids) separation. A part of settled organisms is returned to the aeration tank as activated sludge.



Conversion of dissolved and suspended material to settleable solids is the main objective of activated sludge process. In the activated process, the bio chemical oxidation is carried out by living organisms. The same organisms also are effective in conversion of substances to settable solids if the plant is operated properly.

When Waste water enters the aeration tank it is mixed with the activated sludge which is added contains many different types of helpful living organisms that were grown during previous contact with waste water.

These organisms are the workers in the treatment process. They use the incoming wastes for food and as a source of energy for their life processes and for the reproduction of more organisms. These organisms will use more food contained in the Waste water in treating the wastes. The activated sludge also forms a lace network or floc mass that entraps many materials not used as food. Some organisms (workers) will require a long time to use the available food in the Waste water at a given waste concentration. Many organisms will compete with each other in the use of available food (waste) to shorten the time factor and increase the portion of stabilized waste. The ratio of food to organism is a primary control in the activated sludge process.
Organisms tend to increase with load (food) and time spent in the aeration tank. Under favorable conditions, the operator will remove the excess organisms (sludge wasting) to maintain the required number of workers for effective waste treatment. Therefore, removal of organisms forms the treatment process (sludge wasting) is a very important control technique.

Oxygen, usually supplied from air, is needed by the living organisms for oxidation of wastes to obtain energy for growth. Insufficient oxygen will slow down aerobic organisms, make facultative organisms work less efficiently and favors production of foul-smelling intermediate products of decomposition and incomplete reactions.

As increase in organisms in aeration tank will require greater amounts of oxygen. More food in the effluent encourages more organism activity and more oxidation; consequently, more oxygen is required in the aeration tank. An excess of oxygen is required for complete waste stabilization. Therefore, the dissolved oxygen (DO) content in the aeration tank is an essential controlling factor. Some minimum level of oxygen must be maintained to favor the desired type of organism activity, to achieve the necessary treatment efficiency. The DO level must be maintained so solids will settle properly and the plant effluent will be clear.

Activated sludge solids concentration in the aeration tank and the settling tank should be determined by the operation for process control purposes. Depth of sludge blanket in the settling tank and concentration of solids in the aeration tank are very important for successful Waste water treatment.

Clarifiers are designed to remove material that settles to the bottom of floats to the top. Activated sludge helps this process along by collecting and agglomerating the tiny particles in the effluent so that they will settle better. For the activated sludge process to work properly, the operator must control the number of organisms, the dissolved oxygen in the aeration tanks, and the treatment time. When these factors are under proper control, the organisms, will convert soluble solids and agglomerate the fine particles into a floc mass.

A floc mass is made up of millions of organisms (1012 to 1018/100 ml in a good activated sludge), including bacteria, fungi, yeast, protozoa and worms. When a floc mass is returned to the Aeration Tank from the clarifier, the organisms grow as a result of taking food from the in flowing waste water. The surface of the floc mass is irregular and promotes the transfer of Waste water pollutants into the solids by means of mechanical entrapment, absorption, adsorption or adhesion. Many substances not used as food also are transferred to the floc mass, thus improving the quality of the treated effluent.

Material taken into the floc mass is partially oxidized to form cell mass and oxidation products. Ash or inorganic material (silt and sand) consumed by the floc mass, increase the density of the mass. Mixing the contents of the

Aeration Tank causes the floc masses to bump into each other and form larger clumps. Eventually these masses become heavy enough to settle to the bottom of the clarifier where they can be removed easily. The sludge now contains most of the organisms and waste material that had been mixed in the waste water.

The next step in the activated sludge process is removal of sludge from the clarifier. Some of material is converted and released to the atmosphere in the form of stripped gases (carbon dioxide or other volatile gases not converted and released from aeration tank). That leaves water and sludge solids. A certain amount of the solids (waste activated sludge) will be returned to the Aeration Tank to treat incoming waste water. The operator must pump these solids to the aeration tank. The rest of the waste activated sludge must be removed and disposed of, so that it does not get recirculated in the process flow. After the sludge solids have been removed from the final clarifier, the treated Waste water moves to advanced waste treatment processes.

The successful operation of an activated sludge plant requires the operator to be aware of the many factors influencing the process and check them repeatedly.

6.3 Factors Affecting Aerobic Treatment:

The factors, which affect aerobic treatment, are as under:

[a] Micro-organisms
[b] Food
[c] Loading
[d] Aeration
[e] Environment

The purpose of this section is to describe the factors needed for good treatment. All of these affect the process and all can be monitored and controlled by the operator.

1. Micro-organisms:

Activated sludge is a mixed culture of micro-organisms consisting of bacteria, protozoans, rotifers, fungi, algae, protists and sometimes worms.
Bacteria and blue-green bacteria belong to the kingdom Monera.

A) Bacteria: Bacteria are single cell (unicellular) organisms and are the main workers in the activated sludge process. Individual cells have one of three shapes and are designated as:
1) coccus-round or spherical,
2) bacillus – cylindrical or rod shaped, and
3) spirillum – spiral or corkscrew – shaped.
Most bacteria measure approximately 0.5 to 1.0 micron wide and 2.0 to 5.0 micron long (1 micron = 1/1000 mm). Bacterial reproduce by binary fission.

Due to growth of filamentous bacteria in activated sludge, bulking of sludge occurs. This prevents compaction in the Clarifiers and the sludge blanket increases in depth. Long filaments usually grow quickly once they become established in the system. A non-bulking sludge can become a bulking sludge within two or three days.
Undesirable environments, which promote the growth of long filaments, can be caused by-
Process guidelines (such as low DO) out of adjustment. Nutrient deficiency (low nitrogen or phosphate) in the influent waste water. An undesirable substance in the influent Waste water or in a waste side stream being returned to the plant (such as a toxic substance or H_2S).
The sulphur bacteria are the long filaments that grow well in the presence of sulfide ions.

B) Protozoa: Protozoa are single cell protists that range in size from 10 micron to over 300 microns and are most easily observed through the microscope. Protozoa can be called “indicator organisms”. Their presence or absence

indicates the amount of bacteria in the activated sludge and the degree to treatment. The five types of protozoa observed are;

- Amoeba
- Mastigophora
- Free swimming ciliates
- Stacked ciliates
- Suctoria.

The amoeba is usually present in small numbers in most activated sludge processes. Amoeboid predominates in an activated sludge when a plant is undergoing start-up, when an established system is recovering from an upset condition, and when a system is operated at a high F/M ratio.

Mastigophora are commonly called flagellates because they possess one or more hair-like appendages called flagella. These Mastigophora predominate at high F/M and low DO.

The free-swimming ciliates have numerous short hairs like extensions called cilia. They are predominant in activated sludge with large amount of bacteria. Their presence indicates the process is approaching stable operation. The presence of stalked ciliate indicates a stable process, which produces low turbidity effluent. The Suctoria indicate an older sludge with high mean cell residence time and are most often found in extended aeration plants**.**

C) Rotifers: Rotifers are multi cellular animals with rotating cilia on the head and a forked tail. Rotifers consume enormous qualities of bacteria and can feed on solid particles such as pieces of flocs. The most common rotifers in activated sludge range in size from 400 to 600 microns. Rotifers are an indication of an old activated sludge with a high MCRT and are usually associated with a turbid effluent.

D) Worms: Little is known about the role of the worm or nematode in activated sludge. They are strict aerobes and can metabolize some solid organic matter that is not easily metabolized by other micro-organisms.

2. **Food:** Soluble and colloidal organic matter present in the influent Waste water is the food for microorganism. The ease with which the bacteria (treatability of the waste) can utilize the organic matter (food) varies from waste to waste and also depends upon initial concentration of organic matter.

3. **Loading:** Operator can control loading rate by regulating:

- The flow of incoming waste water.
- The amount of biodegradable matter in the incoming waste.
- The food to microorganism ratio by varying recirculation rate.
- The hydraulic loading which is related to the organism growth and washout.

4. **Aeration:** Aeration serves the dual purposes of providing dissolved oxygen and mixing of the mixed liquor and Waste water in the aeration. Waste stabilization cannot occur unless the microorganisms are brought into contact with food. Oxygen usually supplied from air, is needed by the living organisms for oxidation of wastes to obtain energy for growth. If DO is too high, pinpoint floc will be developed and will not be removed in the secondary clarifier. Therefore, proper DO level must be maintained so solids will settle property.

   Below two methods are commonly used to disperse oxygen from air to the microorganisms also oxygen may also be provided to microorganisms by pure oxygen systems.

A. **Mechanical Aeration System:** Mechanical surface aerators are widely used in Waste water treatment applications. Their primary function is to supply oxygen to water. They are also used for controlling taste and odor problems in water treatment. The mechanical surface aerators commonly consist of an electric

motor suspended on a float provided with a drive shaft operating a propeller located at a short distance below the water surface. The blades in aerators are used to draw up water and then the water is thrown into the air in tiny droplets so that the water may pick up oxygen. They facilitate the dissolution of air into Waste water by vigorously shaking up the water in its contact.

B. **Diffused Aeration System:** Diffused aeration system essentially involves aeration through the membranes of diffusers. These membranes have very small pores through which air flows out in the form of small bubbles. As size of bubbles become smaller the surface area increases for air bubble. This in turn contributes to more oxygen diffusion from gas phase (air) to liquid phase (water). The dissolved oxygen is then consumed by the micro-organisms for BOD reduction in the waste water. Air bubbling out of the diffusers also causes intense mixing of contents helping the reaction.

5. **Environment: -** The microorganisms, which cause the final conversion of Waste water into stable water, are sensitive to conditions in the reactor. Their activity slows down unless optimum conditions are maintained as shown in below table.

Table for Optimum Conditions for Aerobic Treatment

Dissolved Oxygen	1-3 mg/L
Temperature	Less than 40°C
pH	>7.0
Toxic Material	Nil

- **Aerobic Conditions: -** To maintain aerobic condition throughout aeration tank the dissolved oxygen should be as high as possible. The operators should ensure proper working of Surface Aerators to maintain desired DO level in the aeration tank.
- **Temperature: -** Temperature and pH play a vital role in the life and death of microorganisms. It has been observed that the rate of reaction of micro-organisms increases with increasing temperature, doubling with about every 10°C of rise in temperature until some limiting temperature is reached. But this increase in temperature reduces the DO in the aeration tank, which slows down the activity of microorganisms.
- **pH: -** The pH of a solution is also a key factor in the growth of organisms. Most organisms cannot tolerate pH levels above 9.5 or below 4.0. Generally, the optimum pH for growth lies between 6.5 and 7.5.
- **Toxic Material: -** It is important to keep away toxic substances from entering into the system since they inhibit bacterial activity and can cause complete failure. It is also important for operators to recognize
- potential toxicity problems and to apply the right corrective measures.

SECTION 7: OPERATION & MAINTENANCE FOR MBR

ZeeWeed* 500D

Revision: 1

The Operation & Maintenance (O&M) Manual provides installation, operation, maintenance, and ownership information for this ZeeWeed membrane system. It must be read and internalized in its entirety by all operators.

Failure to adhere to the instructions provided in this manual may result in severe injury or damage to property, and may render the warranty null and void.

USING THIS MANUAL

This manual provides a description of the system's overall design and functionality as a single unit, including installation, operation, maintenance, and troubleshooting procedures. Information specific to individual components, such as pumps, valves, and instrumentation, can be found in the documentation provided by the component's manufacturer.

In cases where a procedure requires the operator to perform a function that involves a specific component, such as a valve or meter, a reference to any necessary component-specific information will be provided.

Control documentation and technical drawings have also been provided separately.

TYPOGRAPHICAL CONVENTIONS

Typographical conventions used within this manual are defined as follows:

Bold - indicates a control with which the operator is required to interact.

Bold italicized - indicates important information.

UPPERCASE - indicates the name of a mode or state of operation.

Warns against an unsafe situation or practice that could result in property damage.

Warns against an unsafe situation or practice that could result in minor or moderate injury.

Warns against an unsafe situation or practice that *could* result in severe injury or death.

Warns against an unsafe situation or practice that *will* result in severe injury or death.

1 CAUTIONS SPECIFIC TO THIS SYSTEM

All operators must read and understand the information outlined below before attempting any of the tasks or procedures discussed in these sections.

Failure to adhere to the precautions outlined in this section may result in severe injury or death.

The measures and procedures outlined in this manual do not address all of the safety concerns associated with operating this unit, and do not take the place of a properly designed and implemented facility safety program. It is the end user's responsibility to establish appropriate safety and health practices and ensure that they are implemented.

TOPICS IN THIS SECTION

1.1 storage & handling requirements for ZeeWeed membranes
1.2 ensuring ZeeWeed membrane integrity during operation

1.1 STORAGE & HANDLING REQUIREMENTS FOR ZEEWEED MEMBRNAES

Failure to adhere to the information outlined in this section may result in damage to the system.

Ensure that the following precautions are followed while storing or moving the membranes:

Membranes placed in storage must be kept in the following conditions:

Moist at all times.

Ambient temperature of between 5 - 35ºC (41- 95ºF).

Protected from freezing temperatures.

Do not allow membrane fibers to come in contact with sharp objects, become entangled with equipment or tools, or be pulled tightly.

If the system has been preserved (example: for shipment or shutdown), any shipping preservatives must be flushed from the system prior to start up.

Membranes must be immersed in a biocidal solution prior to storage, shipping, or system shutdowns longer than 72 hours.

Membranes that are to be returned to SUEZ must be cleaned, sanitized, and preserved before shipment. Contact

SUEZ for instructions before returning membranes.

1.2 ENSURING ZEEWEED MEMBRANE INTEGRITY DURING OPERATION

Failure to adhere to the information outlined in this section may result in damage to the system.

Observe the following precautions during operation to reduce the risk of membrane damage or premature wear:

The use of unapproved chemicals on ZeeWeed membranes will render the warranty null and void and will leave the customer solely responsible for any damage incurred as a result. Contact SUEZ before using any chemicals not outlined in this manual.

To avoid damaging the membranes, all pre-screening measures must be in operation at all times. *Do not bypass pre-screening processes under any circumstances*.
Compressed air used to test membrane integrity must be clean, dry, and free of oil. *Do not exceed the maximum recommended pressure.*

Do not clean the membranes with a high-pressure water stream (example: pressure washer, firehose).

At all times, ensure that debris is prevented from entering the membrane tanks. If work that may produce debris (example: grinding) must be performed near a tank, ensure that the tank is sealed, covered, or otherwise protected before starting work.

2 GENERAL SAFETY

This section provides information about general safety procedures and best practices, including those related to personal and environmental safety.

tip Additional safety information specific to the ZeeWeed membrane system, including how to work safely with or around this equipment, is provided separately. (See 1 cautions specific to this system)

Safety information specific to the ZeeWeed* 500D system is provided in *section 1 cautions specific to this system. These sections, along with all other safety information presented throughout this manual should be read, understood, and adhered to by all personnel prior to operating this equipment.*

Material Safety Data Sheets (MSDSs) for chemicals provided by SUEZ and by other manufacturers is provided separately. Safety information for specific components can be found in the manufacturers' instructions.

Failure to observe the following precautions may result in injury or damage to the system.

topics in this section

2.1 PERSONAL SAFETY

The following sections provide general guidelines regarding personal safety and cleanliness. Refer to local codes and regulations for more detailed information.

2.1.1 PERSONAL PROTECTIVE EQUIPMENT

The equipment listed here constitutes the minimum scope of protective gear that should be available to all operators. Local codes and regulations may require the use of additional equipment beyond what is mentioned below.

2.1.1.1 HEAD & FACIAL PROTECTION

At all times while in the plant operating area, wear a hard hat and safety glasses with side shields.

When handling chemicals or working near pressurized lines, (air and liquid), wear a full face shield.

When exposed to noise levels that exceed 80 dB, wear adequate hearing protection.

2.1.1.2 LIMB PROTECTION

When working near pinch or thermal hazards, wear protective gloves. When handling chemicals, wear chemical-resistant gloves.

At all times while in the plant operating area, wear safety boots with crush-resistant toe caps and shank inserts.

2.1.1.3 FALL PROTECTION

When working in a position where the possibility of falling a significant distance (approximately 1 m (3 ft.)) is present, wear an approved safety harness in accordance with local safety requirements. The harness safety line should not allow the person to fall more than 0.5 m (1.5 ft.) before arresting the fall.

2.1.2 CLEANLINESS

Working with or around this system poses a number of potential health hazards that make consistent personal and site cleanliness practices essential. Immunization protects against infection, but common sense and care are required at all times when in the system operating area.

Ensure that cuts and open sores are protected from exposure at all times, and ensure that hands are washed with an antibacterial soap on a regular basis, especially prior to eating, drinking, or smoking.

2.2 SAFETY ON SITE

The following sections provide information regarding general site safety and proper conduct during various procedures that may be performed onsite. This information is not intended to replace or override local codes and regulations.

2.2.1 GENERAL PRECAUTIONS

The following list provides general recommendations intended to ensure the safety of personnel working in and around the system operating area:

- Ensure that all personnel have been made familiar with the proper operating procedures described in this manual and in the manufacturers' instructions for specific components (example: pumps, valves). In particular, emphasize procedures related to the handling of acidic or caustic chemicals, as well as the maintenance of pressurized lines or components with rotating parts.

- Ensure that safety shower and eye wash stations are operational and located within 10 seconds travel-time of areas where chemicals will be used. (10 seconds travel-time is generally considered equivalent to 12 m

(40 ft) across an unobstructed path.)

- Consider installing an alarm (visible and audible throughout the plant operating area) that will activate if an emergency shower or eye wash station is used.
- Install flange guards on all chemical lines.
- Ensure that all guards and other coverings are securely installed before activating either a specific component or the system as a whole.
- Keep up with all preventive maintenance schedules provided in both this manual and in the manufacturer's instructions for individual components (example: pumps, valves).
- Install spray curtains or Plexiglass shields around all chemical skids and ensure that dilution stations are available nearby in case of a chemical spray or leak.
- Ensure that chemical-resistant protective clothing is worn by all personnel working near acidic or caustic substances, or components that may contain such substances.
- When preparing to perform maintenance on pipes or tubing, ensure that all connected lines are either isolated or emptied in accordance with all relevant local government, industry, and facility regulations.
- Ensure that all personnel working with hazardous chemicals are properly trained and familiar with both government and plant-specific safety requirements.

Ensure that areas where chemicals will be handled are well lit and that access is not restricted.

Personnel engaged in a procedure that involves obvious risk of injury (example: entering a confined space) should work under the supervision of a colleague prepared to provide assistance if required. *(See 2.3 high-risk procedures)*

Personnel engaged in a procedure they do not feel properly trained for must cease action immediately and seek advice from a supervisor.

2.2.2 SAFETY INSPECTIONS

- It is recommended that the following checks and inspections be completed before starting up the system for the first time:
- Test all safety showers and eye wash stations.
- Ensure that all chemical flange guards are fitted properly.
- Post contact information for emergency services in a highly visible location.
- Ensure that all operators are familiar with applicable safe work-place practices and regulations.
- Confirm all pump shutoff and emergency kill-switch locations.
- Ensure that all couplings and connectors have been tightened according to the required torque values.
- Confirm that all components are properly tagged.
- Ensure that there is adequate space and lighting around all components.

- Store all required chemical protective gear near the chemical skids and in a clean, dry place. This includes, but is not limited to, full-face shields, rubber suits, and gloves.
- Ensure all components are clean and undamaged.
- Provide adequate ventilation to all plant locations.
- Ensure that a system for maintaining up-to-date operating records is in place.
- Ensure that guidelines are in place to prevent operating temperatures from exceeding maximum limits.
- Ensure that adequate ventilation and air-quality monitoring measures have been installed, as applicable and in accordance with all relevant local government, industry, and facility regulations.

2.2.3 ELECTRICAL & THERMAL HAZARDS

Only qualified personnel should perform installation and maintenance procedures for electrical components.

SERVICING ENERGIZED COMPONENTS: Even with the power switch in the OFF position, certain components inside a control panel or other electrical device may remain energized. No service work can be performed until the power supply to the device is first disconnected. *(See 2.3.1 locking out components)*
HEATED SURFACES: Areas on certain components, such as pumps, can become heated to the point where contact with skin will inflict severe burns. Ensure that all safety guards and other protective measures are in place, including proper labelling. Familiarize personnel working with or around such components with the relevant manufacturer's instructions.

2.2.4 MECHANICAL & CHEMICAL HAZARDS

MSDSs: Retain all MSDSs for chemicals purchased from suppliers other than SUEZ and file them alongside those that may have been provided by SUEZ.

TRAINING & EQUIPMENT: Before working with any mechanical component or chemical, operators must be fully trained and equipped with all necessary protective equipment, as outlined in the relevant manufacturer's instructions.

PUMPS: When working with or around pumps, take the following precautions:

Before performing maintenance, isolate and drain all piping connected to a pump.

Before performing maintenance, turn off power to a pump and complete all lockout procedures required by government and plant-specific regulations *(see 2.3.1 locking out components)*, as well as any included in the manufacturer's instructions.

After completing maintenance, replace any guards or other safety components removed during the procedure.

Personnel working on pumps used to transfer chemicals must be familiar with the safe-handling procedures associated with the chemicals involved.

When working with diaphragm pumps used to transfer chemicals, be aware that some media may remain within the pump’s diaphragm chamber even after the pump has been drained.

Failure to tighten a coupling according to the manufacturer's required torque values may result in an explosive rupture or violent release. Following installation, all couplings must be inspected for tightness as part of the regular preventive maintenance process.

tip for systems equipped with Straub couplings, torque values for each coupling are provided on a decal applied to the coupling itself.

COUPLINGS: During installation, ensure that all couplings have been tightened according to the required torque values. Also, inspect the tightness of all couplings on a regular basis. For more information regarding torque values for a specific coupling, refer to the manufacturer's instructions.

2.2.5 PINCH & FALL HAZARDS

Exposed rotating parts can catch clothing, fingers, or tools and cause severe personal injury or death.

ROTATING COMPONENTS: Before operating components with rotating parts or other possible pinch hazards, ensure that all shields, guards, and emergency kill-switches are in place.

FALL HAZARDS: Fall hazards include any situation where the possibility of either personnel or equipment falling from a significant height (approximately 1 m (3 ft)) is present. Ensure that personnel exposed to this risk are secured using a harness and that all equipment involved is stored and handled in a way that prevents it from falling. *(See 2.1.1 personal protective equipment)*

2.2.6 NOISE HAZARDS

HEARING PROTECTION: Extended exposure to excessive noise levels can be harmful to human hearing. When the possibility of exposure to such noise levels is present, use adequate hearing protection at all times. Generally, levels above 75 dB are considered harmful, however, regulations regarding acceptable levels and required protection will vary between regions. Adhere to all local regulations while working with or around the system.

2.2.7 PRESSURE & RUPTURE HAZARDS

Some pumps and compressors are capable of pressurizing lines to as much as 1,000 psi (69 bar), and the danger of an explosion due to over pressurization may arise if proper operating procedures are not observed.

All pressure-regulating devices, such as relief valves, should be checked regularly according to manufacturer's instructions.

Tubing used to convey pressurized air, such as actuated valve air lines (typically operated at 80 psi (5.5 bar)), should be regularly inspected for cracks.

2.2. 8 INFECTION & EXPOSURE HAZARDS

The degree of risk associated with exposure to feed water will vary greatly between systems. In general, personnel should take every measure to avoid contact with or ingestion of feed water.

If exposed to feed water that poses the risk of bacterial infection or chemical contamination, eyes should be immediately rinsed at an eye wash station and exposed skin should be cleaned thoroughly with soap and warm water, particularly before eating, drinking, smoking. If feed water is ingested, notify a supervisor immediately. Any concerns about possible bacterial infection or chemical exposure should be brought to the attention of a medical physician immediately.

2.3 HIGH-RISK PROCEDURES

The following procedures pose a significant risk to personnel involved. The possibility of severe injury or death will be significant if the instructions provided below, as well as in all relevant local government, industry, and facility regulations, are not followed.

Procedures that are considered "high-risk" should be controlled by detailed protocols and should be performed only by properly trained personnel. The specific tasks and training involved with a high-risk procedure will vary between systems and must be developed in accordance with all local government, industry, and facility regulations.

The following list of common high-risk procedures is provided only as a guideline and is neither specific to this system nor comprehensive:

- Working with energized electrical equipment.
- Work that requires one or more components to be locked-out and tagged out. *(See 2.3.1 locking out components)*
- Entering confined spaces. *(See 2.3.2 entering confined spaces)*
- Working at a significant height.
- Breaking chemical and/or steam lines.
- Hydrostatic testing.

The following sections provide additional information regarding common high-risk procedures, but are not intended to be comprehensive nor to override local regulations.

2.3.1 LOCKING OUT COMPONENTS

- When preparing to lock out a device for service, replacement, or repair, ensure the following:
- All relevant local guidelines and procedures must be observed.
- Only operators qualified to work with the device should per-form a lockout procedure.
- Lockout tags should be applied before performing the lockout procedure and should be removed only after work has been completed and by the person who applied them.

2.3.2 ENTERING CONFINED SPACES

- Any area characterized by one or more of the following features should be considered a confined space:
- The accumulation of hazardous gases, vapours, dust, fumes, biological contaminants, or the creation of an oxygen-deficient atmosphere may occur.
- A space not intended for frequent or extended human occupancy.
- Access is gained through a restricted entry as a result of design, orientation, or location.
- SUEZ strongly recommends that any personnel required to enter a confined space first complete an official confined space entry training program.
- Prior to entering a confined space, ensure that the following equipment is available and functional:
- Gas detector.
- Tripod.
- Body harness and safety line.
- Charged cellular phone and list of emergency numbers.
- Portable ventilator and generator.
- Suitable breathing apparatus.
- Protective clothing (if exposure to harmful substances is possible).
- Ladder (where required).
- Flashlight and alarm horn (where required).
- Manhole opener (where required).
- Traffic control equipment (where required).

The above list of required equipment may vary according to local regulations. Any item that does not pass inspection or that cannot be calibrated properly must be replaced or repaired before work begins.

3 SYSTEM OVERVIEW

This section provides a high-level description of the system, including information about its performance specifications, structure, and production process.
Detailed information about the theory of operation and about specific procedures, modes, and settings is provided later in this manual.
tip Technical illustrations are provided separately.

3.1 SYSTEM DESIGN PARAMETERS

The following table outlines the design and performance parameters for the ZeeWeed UF subsystem.

table 3.1 - ZeeWeed design summary

Parameter	Value

Design Features	
Number of trains	
Cassettes per train	
Modules per cassette	
Surface area per module	
Total surface area	
Performance Parameters	
Average production rate	
Permeate flowrate	
Back pulse flowrate	
Operating temperature	
Maximum operating temperature	
Operating TMP	
Turbidity	

3.2 PRIMARY SUBSYSTEMS

The following sections provide a brief description of the primary subsystems and assemblies that compose this system, and describe the order of subsystems that feed water moves through as it is processed.

Information regarding specific components used in the subsystems described below has been created and supplied by the third-party vendors who manufactured the component.

SUEZ Water Technologies & Solutions has not independently verified information provided by vendors and offers no representations or warranties of any kind, expressed or implied, as to its quality, suitability, accuracy, timeliness, or completeness. SUEZ Water Technologies & Solutions does not accept liability for the consequences of any action or inaction taken on the basis of information provided by third-party vendors.

3.2.1 STRAINER ASSEMBLY

Strainers ([tag]) provide a physical barrier that prevents comparatively large contaminants from damaging the membranes located downstream.

For more information regarding individual components (example: valves, instrumentation) included in this assembly, refer to the manufacturers' instructions.

3.2.2 CARTRIDGE FILTERS

After entering the system, feed water is directed through a cartridge filter assembly ([tag]) containing multiple filter elements. Information about filter quantity, dimensions, and housing arrangements is provided separately. These filters are located upstream of the ZeeWeed* 500D system and screen common contaminants and other particles that would otherwise harm the membranes if permitted to enter the system. This protects the system from particulate intrusion and extends both operating runs (between cleaning procedures) and operating life.

The differential pressure drop is measured by pressure gauges located immediately upstream and downstream of each filter housing. A significant increase in differential pressure will trigger an alarm, prompting the operator to replace the filter.

For more information regarding cartridge filter design, operation, and maintenance, refer to the manufacturer's instructions.

3.2.3 ZEEWEED ULTRAFILTRATION MEMBRANES

The following sections provide an outline of the ZeeWeed Ultrafiltration (UF) subsystem.

3.2.3.1 ZEEWEED TRAINS & MEMBRANES

ZeeWeed membrane modules consist of bundles of hollow fibers that are suspended in the feed water and operate under a negative pressure created within the hollow membrane fibers by the [permeate or process] pump ([tag]). This negative pressure draws feed water across the membranes, leaving solids behind in the membrane tank ([tag]).

The [permeate or process] pump moves permeate to a common header, and then on to the back pulse tank ([tag]), from where it is drawn out of the system according to downstream demand.

For information regarding ZeeWeed train layout, including the number of membrane modules in this system, refer to the technical drawings. Additional information about membrane specifications and performance parameters is provided within this manual.

3.2.3.2 AERATION SYSTEM

Blowers ([tag]) produce air that creates turbulence within the feed water by introducing air into the membrane tank near the bottom of the membranes. This aeration scours the outside of the membrane fibers, which dislodges accumulated solids and extends the amount of operation time between chemical cleans.

This system uses a cyclic aeration process, wherein the valves cycle air between the trains. This limits the amount of air required to operate the system and reduces operating costs. The aeration valves cycle through OPEN and CLOSED states at preset, regular intervals.

Aeration enhances the functionality of the membrane system and must be performed whenever the system is operating. If the system is shut down, the blowers must be manually activated for a minimum of one 30-minute span every 24 hours.

3.2.3.3 AIR EXTRACTION

An ejector ([tag]) is used to intermittently remove air from the permeate header. This process, known as “priming,” prevents large pockets of air from being drawn into the [permeate or process] pump.
The ejector uses compressed air flowing through an orifice to create a vacuum (the Venturi effect). Permeate (liquid or vapour) entering the ejector is discharged to drain along with the ejected air.

It is not usually necessary to reprime the system if air accumulates in the permeate header during production. However, if the amount of accumulated air becomes significant and begins to affect pump performance, an additional priming sequence can be initiated manually.

3.2.4 CLEAN-IN-PLACE ASSEMBLY

In addition to the various subsystems and components involved in treating feed water, a Clean-In-Place (CIP) assembly has also been provided. This subsystem is used to prepare and circulate chemical solutions used to remove accumulated fouling during chemical cleaning sessions. *(See 8 cleaning)*

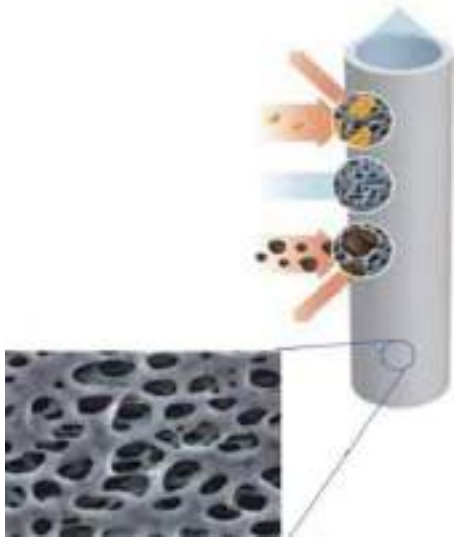
For detailed information regarding specific components included in this assembly, such as valves or instrumentation, refer to the manufacturer's instructions.

3.3 CONTROL INTERFACE

Most processes involved in operating the system can be overseen by the operator at the onscreen interface, which consists of a panel-mounted control display located at the system control panel. *(See 6 operating the system)*
For information about the electrical connections within the control panel, refer to the technical drawings. For information about the specific components contained within the control panel, refer to the manufacturers' instructions.

4 DESIGN & THEORY OF OPERATION

This section provides a general description of the ZeeWeed membrane system, including its primary components, design, and theory of operation.
NOTICE: Operating this system in a manner that deviates substantively from the SUEZ instructions and best practices may render the warranty null and void. If an alternate mode of operation (example: revised cleaning frequency) is being considered, contact SUEZ to request warranty approval before making any changes. *(See 12 service & support)*



4.1 PRIMARY COMPONENTS

The main elements of the ZeeWeed system are the membrane fiber, the membrane module, and the cassette.

4.1.1 MEMBRANE FIBERS

The core of the ZeeWeed UF product line is the membrane fiber. The fibers are tube-like, and are produced from a proprietary polymer material with a poly vinylidene fluoride (PVDF) surface layer. Water is filtered from the outside of the fiber, through the pores in the membrane surface, into the central lumen. The UF membrane fiber is capable of producing high-quality permeate by allowing the passage of water while physically blocking the passage of suspended solids,

protozoa, bacteria, and most viruses.

SUEZ Water Technologies & Solutions produces two distinct types of UF membranes for water-treatment application. The first, with a nominal pore size of 0.04 µm, is intended for use in tough-to-treat, higher-turbidity applications, such as surface water treatment and membrane bioreactors (MBRs). The second has a nominal pore size of 0.02 µm, and is used for lower-turbidity applications, such as drinking water or tertiary treatment.

4.1.2 MEMBRANE MODULES

Membrane fibers are arranged vertically between the membrane module’s two headers.

Water is drawn through the fibers and into the permeate header. From there, it exits the module via the permeate spigot or saddle.

The following table outlines the physical dimensions and operational requirements for the ZeeWeed membrane modules. **figure 4.2 - ZeeWeed 500D module**

4.1.3 CASSETTES

Cassettes provide support to modules, and consist primarily of a reinforced frame, permeate collection piping, and an integral aeration assembly. When installed, modules are connected in parallel into the top and bottom saddles, which are linked by a 5.08 cm (2 in.) PVC permeate down comer pipe. The top saddle connects into the 20.32 cm (8 in.) permeate manifold. The cassette is then linked to an external permeate header on the train using a hard pipe connection

figure 4.3 - ZeeWeed 500D 48M cassette

Each cassette comes equipped with a single 7.6 cm (3 in.) air connection. Air from this line enters a central pipe, and is then directed to the aerator assembly located at the base of the cassette.

The following table outlines the physical dimensions and operational requirements for the ZeeWeed cassette.

Parameter	Value
Height	253.6 cm (99.8 in.)
Width	174.5 cm (68.7 in.)
Depth	211.2 cm (83.1 in.)
Number of Modules	24 - 48
Permeate connection	1 x 6 in. vertical pipe
Air connection	2 x 3 in. pipe
Maximum shipping weight (crated, fully populated)	1,729 kg (3,812 lbs)
Lifting weight (varies with solids accumulation, number of modules, and module surface area)	1,959 – 4,064 kg (4,320 – 9,039 lbs)

Table 4.1 - ZeeWeed 500D 48M cassette specifications

4.2 THEORY OF OPERATIONS

Ultrafiltration (UF) is a process that filters particles on the basis of size. UF is typically used to separate or remove relatively large particles, such as microbes, bacteria, and macromolecules with molecular weights greater than approximately 300,000 Daltons. UF uses "loose" membranes, meaning those that have relatively large pores. The ZeeWeed membrane filtration surface is a neutral, strong polymeric membrane cast on the outside surface of a porous support fiber. Each fiber can be divided into three parts: The membrane, the support braid (or reinforced structure), and the lumen.

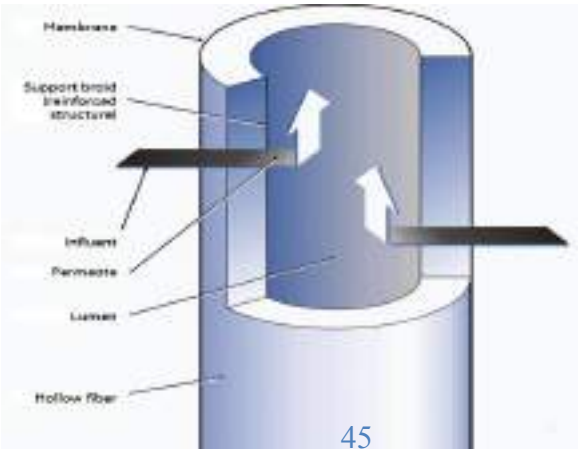


figure 4.4 - ZeeWeed membrane fiber

Treated water passes through the membrane as permeate while solids are rejected. Solids accumulate on the surface of the membrane fibers and in the membrane pores during filtration, causing an increase in trans-membrane pressure (TMP). back pulse sequences help maintain the TMP within acceptable operating limits. Membrane aeration is provided during a [backwash/pulse] by low-pressure membrane aeration blowers. The membrane tank is then drained to remove the solids from the membrane train. *(See 8.6.1 [backwash/pulse])*

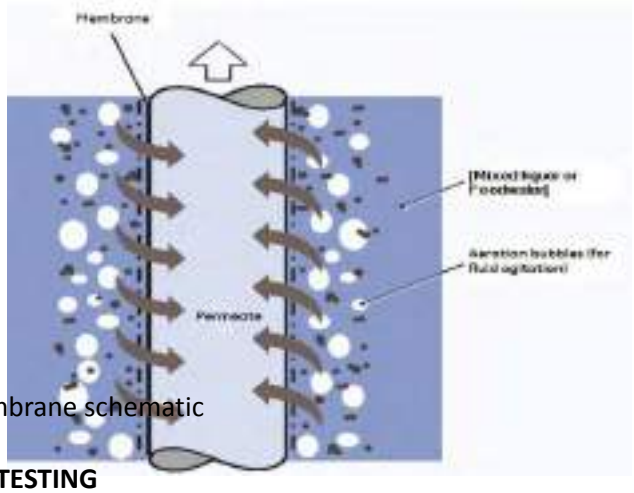


figure 4.5 - ZeeWeed membrane schematic

5 INSTALLATION & TESTING

This section explains how to receive, handle, and install the ZeeWeed membrane system, as well as how to prepare it for operation.
All operators must read and understand the information outlined below before attempting any of the tasks or procedures discussed in these sections.

5.1 INITIAL REQUIREMENTS

The following must be available before installation may begin: APPLICABLE DRAWINGS: The Process and Instrumentation Diagram (P&ID), General Arrangement (GA), and Electrical drawings will be needed during installation. WATER: Water introduced into the system during installation must be free of particulates. Any debris allowed to enter tanks or piping must be removed immediately.

ELECTRICITY: SUEZ is not responsible for supplying power to the system.

All electrical connections meet local government and industry standards.

All electrical cables have been properly fitted.

All motors have been wired for proper rotation.

QUALIFIED PERSONNEL: A qualified electrician, pipefitter, and millwright are required on site when commissioning the system.

figure 5.1 - harness & lanyard

5.2 PERSONAL SAFETY DURING INSTALLATION

It is crucial that fall arrest equipment be worn when working overtop the membrane tank. A fall arrest harness must be worn and appropriate tie-off lanyards must be used while installing and/or working on a cassette.

In addition to the information provided in this manual, operators must also be familiar with all local facility, industry, and government regulations regarding personal protective equipment. general safety

5.3 RECEIVING THE LIFTING MODULE

Cassettes cannot be lifted by connecting chains, hooks or lifting straps directly to the cassette framework. Instead, the ZeeWeed lifting module must be used at all times. This applies when the cassette is first uncrated and installed, as well as when it must be removed from the tank for routine maintenance or repair. *tip The only exception to this rule is the cassette up righting procedure, during which lifting straps may be used as outlined in this manual.*

To prepare for the cassette installation process, the lifting module must be unpackaged, inspected, and readied for use. To do so, perform the following steps:

Only qualified personnel should operate a forklift.

Using a forklift, move the packaged lifting module to its designated set-down area. The lifting module must be stored indoors on a flat, dry surface.

Remove all packaging, including any plastic wrap, crating and shipping straps.

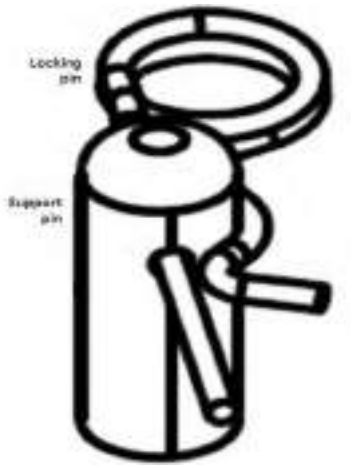
The hook used to connect the lifting module to the hoist (or crane) must meet the minimum width and bearing requirements for the type of lifting module supplied with this system. The hook's specifications must be verified by SUEZ before the lifting module may be used.

Do not allow any part of the lifting module to come into contact with carbon steel. Doing so will contaminate the lifting module, which may in turn contaminate the cassette.

Lower the hook of a properly rated hoist (or crane) and connect it to the lift-point located at the centre of the lifting module.
Raise the lifting module to a height that is comfortable and safe to work with.
Ensure that all four support pins are fitted with locking pins. The support pins are located at each corner of the module.

tip The diagram shown here is a general example. Refer to the GA drawings for specific illustrations of the lifting module provided with this system. (See

figure 5.2 - lifting module pin diagram



Inspect the lifting module for any damage that may have occurred during shipping, such as dents, bent or broken parts, or chipped paint. Slowly lower the lifting module until it sits level on the ground.

5.4 RECEIVING & STORAGE

The following sections provide information regarding the steps involved in receiving, inspecting, and uncarting ZeeWeed membranes and related equipment.

ZeeWeed cassettes are shipped with the modules already installed. Cassettes are sealed in a plastic bag filled with a preservative solution that prevents the membranes from drying out. Ensure that this bag is not damaged while the plywood shipping crate is being removed.

5.4.1 UNLOADING EQUIPMENT

The Installer is responsible for unloading crated equipment when it arrives on site.

During the unloading process, ensure that the following precautions are observed:

Shipping crates and skids must be unloaded onto a stable, level surface.

Only qualified personnel should operate a forklift.

Do not stack shipping crates.

NOTICE

When moving crated cassettes, use an appropriately rated forklift equipped with extended forks.

When moving shipping crates and skids, lift from the bottom using a forklift.

Any damage observed or caused while unloading the equipment must be reported immediately to SUEZ.

5.4.2 CONFIRMING MEMBRANE CONDITION

After the membranes have arrived on site, confirm the following:
All items listed on the shipping manifest have been accounted for.

NOTICE

Do not open the shipping crates when confirming the condition of the membranes. Verification is limited to external examination only.

The membranes have arrived undamaged and with their pack-aging unopened. Any signs of damage or non-conformance must be reported immediately to SUEZ, and should be doc-undented by digital photograph.

None of the handling indicators attached to the shipping crates containing the membranes have triggered. *(See 5.4.3 confirming handling indicators)*

5.4.3 CONFIRMING HANDLING INDICATORS

At all times during shipment, the membranes must be stored at a temperature of 2 - 35°C (35 - 95°F), with an ideal temperature of 20°C (68°F).

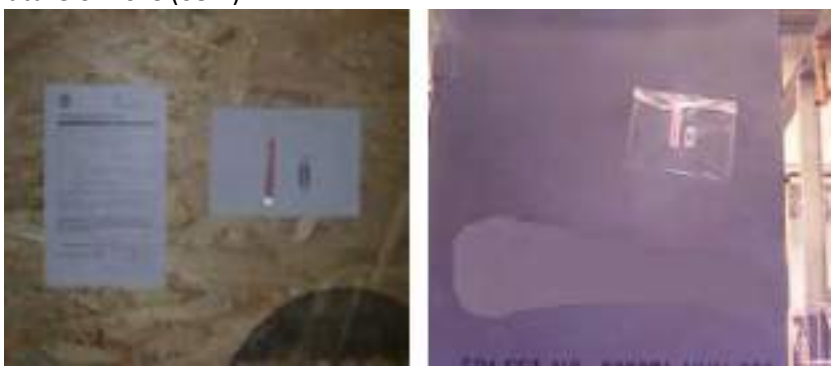


figure 5.3 - handling indicators

All shipping crates containing membranes are equipped with handling indicators that monitor the integrity of the membranes during shipment. These indicators should be checked immediately after the membranes have been unloaded.

A handling indicator will trigger if ideal conditions were not maintained during shipment. If a handling indicator has triggered, inform SUEZ immediately.

5.5 STORING ZEEWEED MEMBRANES

The customer or the customer's contractor must provide all facilities and services required for the storage, maintenance, and protection of the membranes and any other materials provided by SUEZ.

Membranes must remain in their original packaging until the installer is ready to place them in the membrane tank.

When storing membranes, ensure that the following conditions are met:

Store the membranes in assigned lay-down areas, indoors (or within a secure shelter), and atop wooden pallets or a similar form of raised platform. Do not store the membranes in locations where they may be contaminated by dirt or water.

Damage that is determined to have been caused intentionally (example: vandalism) will not be covered under the warranty.

If the membranes must be stored outdoors, the shelter used to house them must be weatherproof, well ventilated, and secure against theft and vandalism (example: construction trailer).

Protect the membranes from exposure to excessive vibration or jostling.

In addition to these general precautions, ensure that the guidelines provided in the sections below are observed, depending upon the current state of the membranes and their packaging material.

5.5.1 STORING PACKAGED MEMBRANES

When storing membranes that are still in their original packaging, ensure that the following conditions are met:

Membranes must be placed in a sheltered area protected from direct sunlight, temperatures below the freezing mark, extreme heat, and winds that may accelerate the drying process.

The glycerine solution used to preserve the membranes can create a severe slip hazard if spilled. Clean any spilled solution immediately.

Membranes are delivered in a vacuum-sealed bag that must remain sealed until the installer is ready to place them in the membrane tank.

The membranes have been manufactured and preserved to comply with the contractually specified delivery and installation schedule. Should installation be delayed longer than one month, contact SUEZ for additional instructions.

New modules that are preserved with glycerine solution, bagged, and factory-sealed may be stored for up to 12 months from the date they were manufactured. For the exact expiry date of a particular module, contact SUEZ.

5.5.2 STORING WETTED MEMBRANES

Allowing membranes to come into contact with water (wetting) will compromise the preservative solution that protected them during shipment. After this has occurred, membranes must not be allowed to dry out under any circumstances.

Membranes will be damaged irreversibly if they are allowed to dry out.

Wetted membranes may be exposed to the air for a maximum of 45 minutes, so long as they are out of direct sunlight and wind. If the membranes are *frequently, lightly misted* (not sprayed with fire hoses or pressure washers) from the time they have been taken out of the water, they may be left exposed to the air for a maximum of 6 hours at a temperature between 5 - 35°C (41 - 95°F).

If required by compliance regulations, the standard procedures for rinsing and disinfection may be used before membranes are put into operation. If the membranes have been wetted and it becomes impractical to immerse or repeatedly spray them during the time before they can be placed in the membrane tank, the membranes should be cleaned, preserved in glycerine solution, and rebadged. *(See 5.11 system shutdown & ZeeWeed membrane preservation)*

5.6 PREVENTING DEBRIS CONTAMINATION

It is critical that debris capable of damaging the membranes (example: anything over 0.5 mm (1/50 in.) in size) be prevented from entering the membrane tanks. While specific screening requirements for membranes depend on the source water type and upstream pretreatment process (if applicable), particulate matter/debris larger than 0.5 mm should be strictly avoided in all membrane tanks.

NOTICE

Damage to the membranes and/or associated equipment due to the introduction of destructive foreign materials into the membrane tanks may not be covered by the warranty.

- Possible contamination pathways include:
- [Mixed liquor or Feed water] laden with debris.
- Debris allowed to enter the tank during work performed nearby.
- Debris left within piping connected to the membrane tank.
- Residue from piping or process equipment.
- Debris resulting from damage to the tank or tank coating, not including damage due to the normal operation and maintenance of the system.
- Examples of common materials that can cause damage include, but are not limited to, the following:
- Cable ties.
- Plastic turnings from drilling.
- Pieces of wire.
- Broken measuring tapes.
- Weld slag and metal debris from grinding.
- Twigs and leaves.
- Shells, sand, and fish.

As a general rule, seal, cover, or otherwise protect the interior of the membrane tank whenever work that may generate debris is being performed nearby.

Sand is an abrasive substance. Failure to remove accumulated sand from within the membrane tank may result in membrane damage that will not be covered by the warranty.

Sand that remains in the feed water after pre-screening and that enters the membrane tank as a result will be defined as a destructive foreign material. The customer is responsible for ensuring that all pre-screening measures remain functioning and in proper working order. The customer is also responsible for the removal of any sand that may accumulate within the membrane tank.

5.7 UNCARTING & INSTALLING ZEEWEED CASSETTES

A SUEZ FSR should be present to assess the site before installation, and provide supervision while the installation process is being performed.
Two operators (at minimum) must be present to perform this procedure.

The physical abuse, misuse, or improper installation or removal of membrane elements by non-SUEZ personnel, including damage caused by operator error while handling membrane elements, may render the warranty null and void.

The unauthorized alteration of equipment or parts provided by SUEZ with the membrane modules may render the warranty null and void.

5.7.1 GENERAL PRECAUTIONS

All piping and tanks must be installed, cleaned, and subjected to a wet test before membranes may be installed.

Failure to observe the following precautions may result in injury or damage to the system.

While performing the installation procedure, ensure that the following precautions are taken:

The membranes must not be allowed to dry out.

Avoid moving or working beneath a cassette while it is being lifted.

Do not allow permeate connections to fill with water while the cassette is being lowered into the membrane tank.

Do not touch, pull, or otherwise handle membrane fibers during installation.

5.7.2 PREPARING THE SITE

The Membrane Pre-Installation Checklist must be completed and signed before cassettes can be uncrated and installed. If this checklist has not been provided by a SUEZ representative by the time cassettes have arrived on

site, request a copy by contacting SUEZ. *(See 12.1 contacting SUEZ)*

The membrane tank must be cleaned thoroughly.

All loose-shipped parts required for the cassette installation must be located. Also, all permeate piping, air piping, and any tank internals and supports must be installed before the membranes can be installed.

The area where cassettes will be uncrated must be clearly designated and closed-off to all personnel who will not be taking part in this procedure.

5.7.3 PARTS & EQUIPMENT

Verify the type and quality of materials available for installation, including the following points:

- Hose length and material.
- Lifting bracket and sling condition. The following tools should be available:
- Two sheets of 90 x 90 x 1 in. foam padding.
- Four hoist-ring assemblies. A single assembly includes the following components:
- One 3/4 in. 316 carbon-steel hoist-ring.
- Two 3/4 in. 316 stainless-steel flat washers.
- One 3/4 in. 316 stainless-steel hex nut.
- Four lifting slings.
- One four-point spreader bar.
- One two-point spreader bar.
- One 1 1/8 in. socket-wrench.

Do not use silicone-based lubricants. For systems intended to produce drinking water or water in any other way intended for human consumption, a food-grade lubricant must be used.

- Water-based lubricant.
- PVC glue and primer.
- Applicable safety equipment (example: gloves, safety harness).
- One Module-removal tool.
- The following materials are required to install a single cassette:
- Four 3 1/4 x 3/4 in. 316 stainless-steel bolts.
- Eight 3/4 in. 316 stainless-steel nuts.
- Four 3/4 in. 316 stainless-steel flat washers.
- Four 3/4 in. 316 stainless-steel Nord-lock washers.

- One MIS-removal tool.

- Four 3/8 x 5 1/2 in. 316 stainless-steel LG bolts, each complete with one nut, one washer, and two flat washers.

  A forklift will be required to move the crated cassettes to the work area. After the shipping materials have been removed, an overhead chain hoist or equivalent lifting device will be required to install the cassette in the membrane tank.

5.7.4 SAFETY DURING INSTALLATION

The uncarting and installation procedures should only be performed under the supervision of a SUEZ FSR.

When uncarting and installing a cassette, always ensure the following:

- Failure to adhere to the following safety requirements may result in serious injury or death.

- A minimum of two operators must be present to perform the installation.

- Confirm that all lifting equipment is in proper working order and rated to carry the required weight.

- Operators must wear an appropriate safety harness or similar fall-arrest equipment when working overtop of the membrane tank or in any other position where a fall from a significant height is possible.

- Ensure that all personnel stand clear and remain within sight of the forklift operator while a cassette headpiece is being moved.

- Cassette headpieces must not be lifted overtop areas where personnel are standing or may enter into.

5.7.5 UNCARTING CASSETTES

The uncarting procedure must be performed with an FSR present to monitor the process. Failure to do so may affect the membrane warranty.

Cassettes must be uncrated on a dry, level surface that is not exposed to direct sunlight.

Cassettes are fragile and must not be tilted, jostled, or exposed to excessive heat or cold.

Cassettes are not to be uncrated if any of the following activities are taking place in the immediate vicinity:

- Painting or wiring.

- Roofing or carpentry.

- Grinding, welding, or other metalwork.
- Pipe-flushing.

- Sandblasting or drilling.

- Use of power tools that discharge debris (example: circular saw).

- Any other activity judged reasonably likely to cause damage to the membranes.

To uncrated a cassette, perform the following steps:

- ✔ Only qualified personnel should operate a forklift.
- ✔ Using a forklift, move a single crated cassette to the work area. *All local regulations concerning the operation of a forklift must be followed*.
- ✔ If a crane is being used in place of a hoist, it must be located at an appropriate distance to prevent collision with the cassette during lifting.
- ✔ Place the crated cassette on level ground directly underneath the hoist.
- ✔ Carefully remove the top panel of the crate.
- ✔ Remove one long side panel. The end panels remain sup-ported by the other long side panel.
- ✔ While another operator supports the long side panel, remove one of the end panels.
- ✔ While the other operator continues to support the long side panel, remove the remaining end panel, and then remove the long side panel.

5.7.6 **REMOVING THE CASSETTE BAG**

Ensure that cassette and membrane fibers are not damaged while removing the membrane bag.

The cassette is packaged in a vacuum-sealed bag *which must remain in place until the installer is ready to place the cassette in the membrane tank*.

To remove this bag without damaging the fibers, select an area well above the membrane fibers, and then make a shallow cut along the bag and roll it down to the crate bottom. The bag can then be cut at the base and discarded.

After the bag has been removed, record the serial numbers for each module and for the cassette itself.

figure 5.4 - shipping braces

Depending upon certain shipping requirements, the cassette may have been fitted with a set of yellow shipping braces. If these braces have been included, remove them prior to up righting the cassette.

5.7.7 INSPECTING CASSETTES PRIOR TO RIGHTING

After the cassette has been uncrated and while it is still on its side, confirm the following:

- Ensure that aeration assembly is secure and has not shifted or come loose during shipment.
- Ensure that the large holes on the aerators are facing down, relative to the cassette.
- Ensure that all saddles are securely clipped to the cassette frame.
- If the cassette is not fully populated with modules, ensure that the non-permeating “blank” headers are installed and in the correct location (that is, wherever there is no module installed).

figure 5.5 - inspecting aerators

Ensure that the correct type of aerators is used under the blank headers (some aerators are “left” aerators and some are “right” aerators, depending on which side the small holes are on).

Ensure that the two main aeration pipes are installed and secure.

5.7.8 INSTALLING UNIONS ON CASSETTE AERATION PIPES

Before the cassette can be righted, either a PVC union or a hose-barb fitting must be glued to the cassette’s PVC aeration pipes.

figure 5.6 - aeration unions installed

5.7.9 RIGHTING CASSETTES

After the cassette has been inspected and the aeration assembly has been prepared, the cassette is ready to be righted.

Before beginning the righting procedure, remove all crating material from the staging area and ensure that there is a clean, flat surface for the righted cassette to be set down upon.

It is recommended that an overhead hoist be used for this procedure. However, if a hoist is not available, a mobile

crane or similar device may also be used, so long as it is fully rated to support the cassette's weight.

If a crane is being used in place of a hoist, it must be located at an appropriate distance to prevent collision with the cassette during lifting.

5.7.9.1 ATTACHING HOIST RINGS

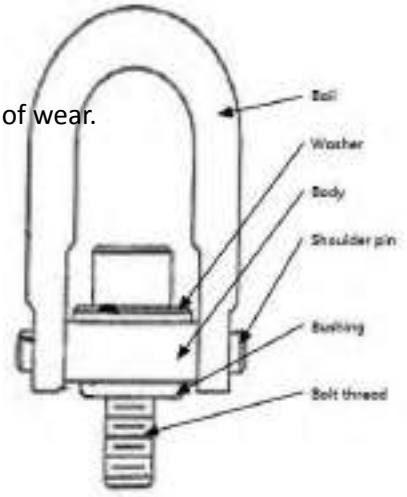
The connection points for the hoist ring assemblies are shown in the following image.

NOTICE

Hoist rings are made of carbon steel. To avoid contaminating the stainless-steel cassette frame, ensure that the stainless-steel flat

washers and hex nut are used. figure 5.7 - hoist ring locations

While installing the hoist rings, ensure the following:



Confirm that the hoist ring bolt, shoulder pins, and bail are free of cracks or signs of wear.

The hoist ring bolts must be tightened to 100 ft/lbs.

Ensure that the bushing of the hoist ring is sitting flush against the frame.

figure 5.8 - hoist ring assembly

Verify that the hoist is free to swivel and pivot in every direction.
Ensure that the shoulder pins are secure.

5.7.9.2 REMOVING THE SKID

After the hoist rings have been attached, the skid must be removed in preparation for righting the cassette.

To remove the skid, perform the following steps:

Place one of the foam sheets on the ground in the area where the cassette will be righted. Ideally, this will be directly next to where the cassette currently sits upon the skid.

Ensure that the hoist rings do not touch or press against the cassette frame.

NOTICE

Use slings made of a fabric capable of supporting the cassette's full weight. Using chains may cause damage to the

cassette.

Attach the lifting assembly to the hoist rings. If possible, a four-point lift frame and spreader bar should be used. If this is not possible, use slings that have been arranged according to the following requirements:

Connect a fabric sling (1.2 m (4 ft) long) to each hoist ring, and a properly rated cable (6 m (20 ft) long) to each sling.

When taut, the slings should be at a minimum 60º angle to the cassette if a spreader bar is used, or at 75º for a single-point lift.

figure 5.9 - lifting cassette without a four-point lift frame & spreader bar

Ensure that all personnel have been cleared from the immediate area before beginning the lift.

If a crane is being used in place of a hoist, it must be located at an appropriate distance to prevent collision with the cassette during lifting.

After attaching the lifting assembly, slowly lift the cassette until it is high enough that it can be moved without touching the skid underneath (not more than 5 cm (2 in.) above the skid).

Carefully move the cassette over to the foam sheet, and then gently lower it onto the sheet.

Remove the skid and the remains of the vacuum-sealed bag.

Ensure that any spills or debris have been thoroughly cleaned.

Disconnect the lifting assembly, and then remove the two hoist rings attached to the bottom side of the cassette (that is, the side that will be placed on the ground when the cassette is righted).

5.7.9.3 LIFTING CASSETTES DURING RIGHTING

After the skid has been removed and the work area cleared of spills and debris, right the cassette by performing the following steps:

Place the second foam sheet on the ground next to the cassette.

NOTICE

The lifting assembly must be equipped with a two-point spreader bar.

2. Attach the lifting assembly to the two hoist rings.

⚠ WARNING

Ensure that all personnel have been cleared from the immediate area before beginning the lift.

NOTICE

If a crane is being used in place of a hoist, it must be located at an appropriate distance to prevent collision with the cassette during lifting.

NOTICE

At all times during the lift, keep the hoist (or crane) aligned directly overtop the hoist rings. Failure to do so could result in the cassette swinging violently when it leaves the ground. Do not attempt to stop the cassette if it begins to swing.

figure 5.10 - hoist with spreader bar

Carefully begin lifting the cassette. As it is raised, the cassette will begin to tilt. As the cassette tilts, move the hoist (or crane) horizontally to keep it above the hoist rings.

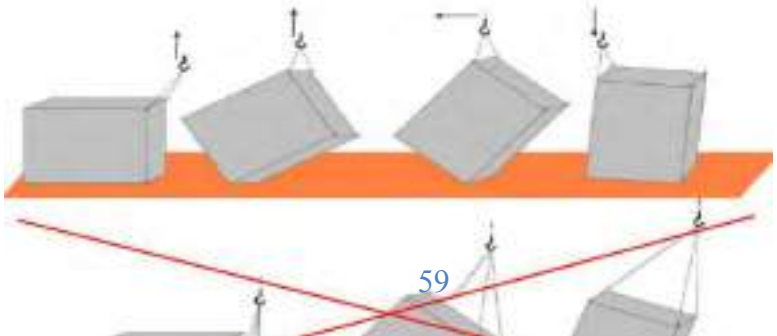


figure 5.11 - proper righting procedure

Lift the cassette until it pivots onto its side, then lower it until it rests in the upright position and fully atop the second foam sheet. After the cassette sits firmly upon the ground, disconnect the lifting assembly, and then remove the hoist rings.

5.7.10 INSTALLING CASSETTE HANGER ARMS

The cassette hanger arms allow the cassette to be moved using the lifting bracket, and support the cassette after it is installed in the tank. These arms can be installed only after the cassette has been righted.

A torque of 104 ft-lbs must be applied to all 3/4 in. Nord-lock

NOTICE

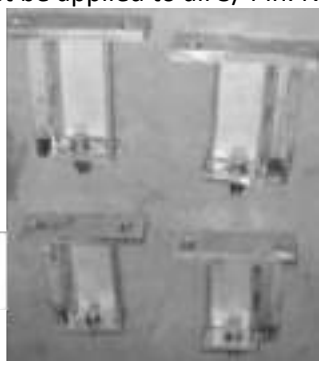


figure 5.12 - cassette hanger arms

nuts used to fasten the cassette arms in place.

There are two left-side arms and two right-side arms. When installing them, ensure that the correct arm is attached to the correct side of the cassette.

Hanger arms are installed on the four corners of the cassette. When installed correctly, each arm should be identical to the one installed on the opposite (diagonal) corner, and should be the opposite type compared to those installed on the two

figure 5.13 - hanger arms attached adjacent corners.

When identifying the two types of arms, note the position of the open end of the arm and the position of the small tab at the bottom of the arm.

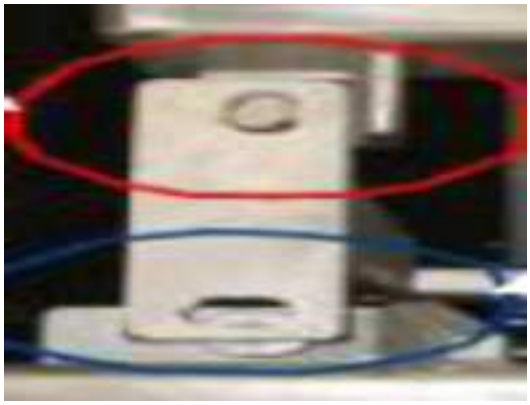
There are two different types of slots found on the top of each hanger arm. The slot that is nearest the center of the cassette when the arm is installed is for connecting the cassette lifting bracket. This slot is circled at the top of the image to the right.

If the hanger arm has been installed correctly, the other slot will sit on top of the support beam when the cassette is installed in the tank. This slot is elongated parallel to the beam, and is circled at the bottom of the image to the

right.

5.7.11 USING MEMBRANE TANK COVERS

ZW500D tanks may be covered by either Fiberglass Reinforced Plastic (FRP), or aluminium or stainless steel covers or grates. These covers or grates are often supported by the SUEZ-supplied cassette tank beams.



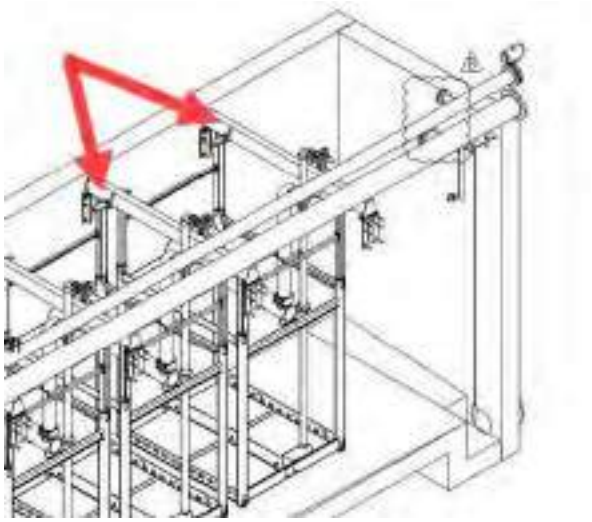


figure 5.15 - SUEZ-supplied cassette tank beams

figure 5.16 - membrane tank with FRP cover

Before placing anything on top of these covers, it is important to note the following:

Confirm that the covers or grates are designed to support the weight being placed on them. For example, if a fully-sludged cassette is being placed on a cover for inspection or maintenance, ensure that the cover being used is designed to sup-port that weight (approximately 9,500 lbs (5 tons)).

The covered tank is filled to at least the minimum operating level. The cassette lifting bracket contains a warning to this effect.

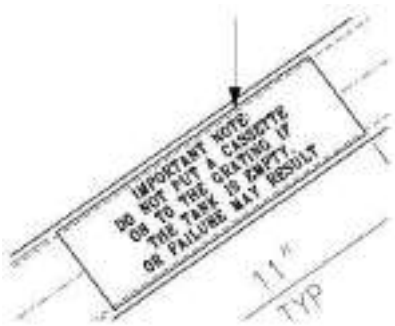


figure 5.17 - warning label on cassette lifting bracket

5.7.12 REMOVING THE PLASTIC WRAP

Cassettes are shipped with a plastic wrap beneath the sealed cassette bag. This wrap must be removed carefully so that the membrane fibers are not damaged.

To remove the wrap, make a cut close to the corner of the cassette frame, away from the membranes.

To avoid contaminating the stainless-steel frame, do not allow the blade to touch the cassette frame while the cut is being made. Discard the wrap after it has been removed.

5.7.13 REMOVING THE PROTECTIVE FOAM

Cassettes are shipped with protective foam placed against the vertical permeate piping. Before removing the foam, ensure that any fibers that may have become stuck to it are carefully separated. After doing so, slowly pull the foam out of the cassette.

NOTICE

figure 5.19 - removing the protective foam
To avoid damaging the membranes, use extreme caution when removing the foam.

5.7.14 INSPECTING CASSETTES AFTER RIGHTING

After the cassette has been righted, confirm the following:

Check the entire cassette for loose or missing nuts and bolts. Torque specifications are noted in the technical drawings.

- Inspect all welded joints for rust spots.
- Verify that all MIS strips are installed, and that all wedges are securely fastened.
- Verify that the module keys are in the locked (vertical) position.
- ✦ Ensure that the aerator end caps are properly engaged into the metal frame of the cassette.
- ✦ Record the serial numbers of each membrane module on the membrane map (provided separately). Also, if multiple cassettes will be installed within the same membrane tank,
- record the position within the tank where each cassette will be installed.

figure 5.20 - aerator end cap

5.7.15 ASSEMBLING AERATION PIPING

Some parts of the cassette aeration spool may be assembled before the cassette is installed within the membrane tank. After the cassette is in place, the pre-assembled piping can then be connected.

The technical drawings provide a detailed illustration of the piping assembly. After the piping has been assembled, set it aside in a safe area

where it will be protected from damage or contamination until it can be installed.

5.7.16 LEVELLING CASSETTES

The cassettes must be individually levelled to a tolerance of ± 1/8 in. per cassette within a train. All cassettes across adjoining trains must be within ± 1/4 in. level tolerance of one another.

Prior to installing the cassettes, it is recommended that a laser level be used to ensure that the required tolerances are achieved. Cassettes that are not properly levelled may exhibit more rapid fouling as a result of improper air distribution.

Cassettes are levelled by setting the angle of the cassette support beam. If necessary, shims may be used to adjust the level of the support beam.

Refer to the technical drawings for detailed illustrations that show how support beams should be positioned.

5.7.17 INSTALLING CASSETTES IN THE MEMBRANE TANK

When ready to install a cassette within the membrane tank, do so by performing the procedures outlined in the following sections.

These procedures apply to both the initial installation process as well as whenever a cassette is being returned to the membrane tank following routine inspection or repair.

5.7.17.1 CONNECTING THE LIFTING MODULE TO THE CASSETTE

Before using the lifting module, inspect it for any obvious signs of wear or damage, including the following:

- Worn or deformed parts.
- Cracked welds.
- Extensive rusting or other corrosion that appears significant enough to possibly compromise the structural integrity of the lifting module.
- When using a lifting module, ensure that the following dangerous activities are avoided:
- Do not exceed the rated load capacity of the lifting module, or use it to lift anything other than the cassettes it was designed for.
- Do not lift cassettes higher than necessary, and do not leave suspended cassettes unattended.
- Do not remove the warning or identification labels from the lifting module.
- Do not attempt to operate a damaged or malfunctioning lifting module.

The lifting module supplied by SUEZ must be used at all times when lifting cassettes. *Do not use chains or fabric straps to lift cassettes unless specifically instructed otherwise by SUEZ.*

- ✔ Ensure that all local government and facility regulations regarding fall-arrest precautions and tie-off points are observed during this procedure.
- ✔ After ensuring that the precautions outlined above have been observed, connect the lifting module to the cassette by performing the following steps:
- ✔ Lower the hook of the hoist (or crane) and connect it to the lift-point located at the center of the lifting module.
- ✔ Raise the lifting module to a height that is comfortable and safe to work with.
- ✔ If the cassette is already installed within the membrane tank, lower the water level within the membrane tank so that the permeate header is above the water.

- ✔ Remove the locking pin from the support pin located at each corner of the lifting module.
- ✔ Position the lifting module above the cassette, and then care-fully lower it until it nears the cassette hanger arms. At this point, an operator will need to tilt the lifting module so that it can be lowered to just beneath the connection-points on the hanger arms.
- ✔ Carefully raise one corner of the lifting module and guide the module's support pin up through the hole in the cassette's hanger arm, and then secure the support pin with the locking pin.
- ✔ Slowly raise the lifting module while guiding each support pin into the corresponding hole. Secure each pin with a locking pin after it has been positioned correctly.
- ✔ After all, four support pins have been secured, the cassette is ready to be lifted.

5.7.17.2 LOWERING CASSETTES INTO THE MEMBRANE TANK

After connecting the lifting module to the cassette, install it within the membrane tank by performing the following steps:

- ✔ The hoist (or crane) must be load-tested, inspected, and properly rated for the full weight being lifted. All hoist (or crane) operators must be fully certified.

- ✔ Ensure that all personnel have been cleared from the immediate area before beginning the lift.
- ✔ Lift the cassette a short distance off the ground, and then confirm that the load is secure before continuing.

- ✔ If using poles or lines to guide the cassette, touch only the cassette frame. Do not push or pull on the membrane fibers.
- ✔ Carefully manoeuvre the cassette until it is above the mem-brane tank.
- ✔ Slowly lower the cassette down into the tank. Another operator should stand facing the far side of the cassette to assist with placement.
- ✔ After the cassette is low enough that the cassettes permeate header can be reached comfortably, mount the permeate coup-ling onto the cassette header.
- ✔ Connect the first section of the permeate pipe spool to the coupling on the cassette header, and then tighten the coupling so that it supports the full weight of the pipe spool section. Do not install the entire pipe spool at this time.
- ✔ Tighten the coupling so that it can support the full weight of the spool.
- ✔ Continue to lower the cassette until it rests firmly within the membrane tank.
- ✔ After the cassette is sitting level within the membrane tank, install the rest of the piping spool. If necessary, remove the lifting module to continue installing the rest of the spool.

5.7.18 INSTALLING PERMEATE & AIR CONNECTIONS

After the cassette has been installed in the membrane tank, the final piping and hose connections must be installed as shown in the technical drawings and as described in the procedures outlined below.

Failure to tighten a coupling according to the manufacturer's required torque values may result in an explosive rupture or violent release. Following installation, all couplings must be inspected for tightness as part of the regular preventive maintenance process.

5.7.18.1 CONNECTING PERMEATE PIPING

The permeate header will come through the tank wall and align directly with the cassette header.

The cassette is not designed to support significant weight. Do not walk, lean, or climb on the cassette while installing connections.

Regardless of the connection type, after the hoist and lifting assembly have been removed, complete the permeate connection by installing the remaining permeate spool pieces onto the partially assembled spool that has already been mounted on the cassettes permeate header.

5.7.18.2 CONNECTING AERATION PIPING

A single cassette comes equipped with two 7.6 cm (3 in.) air connections, each of which provides air to half of the membranes in the cassette. Depending on the system design, these lines will connect to the aeration header in one of two ways:

- FOR SYSTEMS WITH CYCLIC AERATION: The two lines merge into a 10 cm (4 in.) tee that then connects to the aeration header.
- FOR SYSTEMS WITH SEQUENTIAL AERATION: The lines run independently and connect to two separate 7.6 cm (3 in.) headers.
- To determine which design this system uses, refer to the technical drawings.
- After the permeate connection has been installed, complete the aeration connection by performing the following steps:
- To avoid damaging the cassette aeration assembly, connect the line to the train's aeration header first and then to the cassette aeration connection.
- Connect the aeration line to the train's aeration header.
- Connect the other end of the line to the union on the cassette. *(See 5.7.8 installing unions on cassette aeration pipes)*

5.7.19 DOCUMENTING INSTALLATION

Using the Membrane Map, record the serial number and location of each cassette and membrane module as it is installed. This form should be retained and updated whenever cassettes or modules are moved or replaced.

5.8 FLUSHING ZEEWEED MODULES

All ZeeWeed membranes are shipped in a glycerine solution with a pH of 3.5 - 4.5 to prevent the membranes from drying out. This solution has a high organic carbon content that exerts a high oxygen demand (as measured by any of the following methods: Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and/or Total Organic Carbon (TOC)), and is not suitable for discharge into the open environment.

A series of flushing sequences are required to purge the glycerine from the membrane fibers. These sequences consist of filling the membrane tank with clean water that is then permeated through the membranes in a closed loop and drained. Alternately, for small systems, clean water can be permeated through the membranes at a flux of 20-40 LMH (20-40 GFD) for a duration of seven hours. The installer is responsible for supplying a suitable means of disposing of the spent water used to flush the solution from the system. Refer to local industry and government regulations for more information regarding disposal procedures.

To flush the solution from the system, perform the following steps:

- After the membranes have been installed, fill the membrane tank with potable water. Take a sample of the raw water and measure COD or TOC to be used as a baseline.
- Run the system so that the membranes are permeating at 40 LMH (24 GFD). Recycle the permeate from the pump discharge to the membrane tank for 30 minutes. *Tip If there are multiple trains, the glycerine flushing water can be reused. SUEZ will provide calculations to determine the volume of water required.*
- Drain the contents of the membrane tank to a suitable dis-charge point (example: waste holding tank).
- Refill the membrane tank with potable water for at least three pipe/membrane volumes, and then drain the contents of the tank again. It is important that all water containing glycerine is drained completely from all tanks, membranes, pipes, pumps, etc., otherwise the number of required flushes to achieve glycerine removal will increase.
- Refill the membrane tank with potable water.
- Repeat steps 2 - 5 with a recycle time of 2 hours.
- Repeat steps 2 - 5 with a recycle time of 4 hours.
- Refill the tank with raw water, permeate for 15 minutes and collect final sample for TOC/COD analysis.
- Verify that TOC is less than 3 mg/L above the background level, or that the COD is less than 10 mg/L above the back-ground level.

5.9 TESTING INTEGRITY DURING COMMISSIONING

With the cassette(s) installed, the following tests must be conducted to confirm the integrity of the membranes:

- Piping Pressure Test (PPT).
- Pressure Decay Test (PDT).
- Bubble Test (if required based on PDT results).
- Aeration check.

Although some of these processes may be performed automatically by the PLC during normal operating conditions, while in the commissioning stage, they will need to be conducted manually.

5.9.1 PIPING PRESSURE TEST

Before a membrane PDT can be performed, the associated piping must be tested for leaks by performing a Piping Pressure Test (PPT).

To conduct a PPT, close all valves and perform a PDT on the permeate and air piping as described in the Pressure Decay Test procedure. *(See 5.9.2 pressure decay test)* The result should be a pressure decay of less than 0.007 bar (0.1 psi) over a 10 minute period.

Depending on the results, do one of the following:

- If results meet this criteria, the test is complete and a PDT can be performed on the membranes.
- If results exceed this criteria, use a spray bottle to apply a soap solution to piping and associated fittings, and then watch for bubbles, which indicate leaks. Repair as needed and repeat the test until acceptable results have been achieved.

5.9.2 PRESSURE DECAY TEST

Although some ZeeWeed systems include an automated PDT as part of the normal production cycle, *this feature will not be available at times when the PLC is deactivated.* If the system does not include the automated PDT feature, or if the PLC is currently deactivated, a manual PDT can be performed using a Portable Pressure Test Device (PPTD).

The manual PDT procedure involves pressurizing the inside of the membrane fibers with clean, oil-free air, after which the rate of gradual depressurization (pressure decay) is measured at regular intervals over the duration of the test.
The rate of pressure decay is a function of the rate of air loss through the membranes due to diffusion, dry pores, and leaks. Intact, wetted pores will prevent the flow of air in all forms other than the natural diffusion of air through the water in each pore. As a result, a higher than expected PDT level provides a reliable indication of the presence of damaged fibers that require repair.

Even if no leaks are present, the pressure reading will decrease gradually as air diffuses across the membranes. This rate of depressurization provides the baseline pressure decay, and will change slightly over time due to changes in certain parameters, such as temperature, membrane fouling, and feed water characteristics.

5.9.2.1 PREPARING FOR A PDT

- Read this section in its entirety before performing a PDT.
- Before performing a PDT, complete the following steps:
- Perform a PPT on all associated piping. *(See 5.9.1 piping pressure test)*
- Ensure that a supply of filtered, oil-free air is available. Also, confirm that the PDT apparatus has been fitted with an oil coalesce.

Ensure the PPTD is fully functional and includes all components outlined in the diagram below.

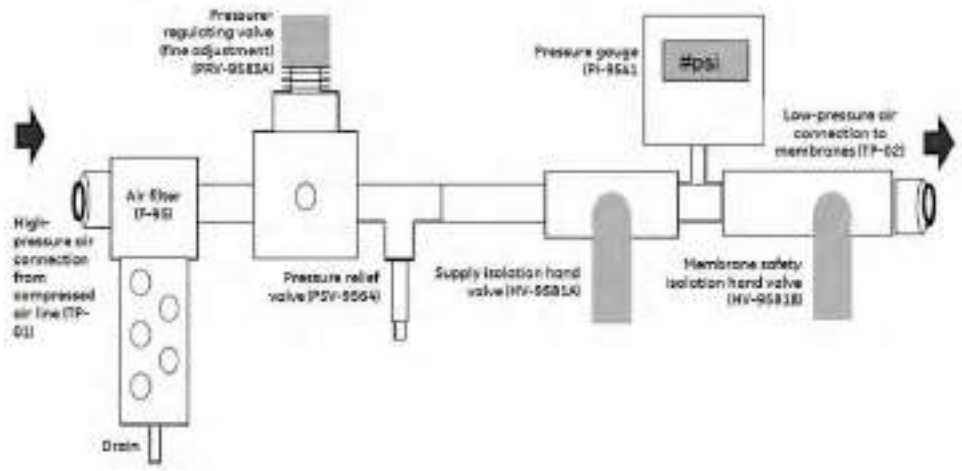


figure 5.21 - pptd parts diagram

Isolate the cassette by closing the permeate and air isolation hand valves.
When installing adapters, prevent water or materials from entering the open permeate hose.

Disconnect the permeate connections and attach the adapters supplied with the PPTD to the permeate connections on the cassette.

Adjust the water level to 10 cm (4 in.) above the top of the cassette header and maintain this depth for the entire test. All PDTs must be performed at the same liquid depth for the test to be repeatable.

5.9.2.2 PERFORMING A PDT

To conduct a PDT, perform the following steps:

- Ensure that the membrane safety isolation hand valve (HV-9581B) is closed. *Tip If the test pressure value was not provided during the commissioning stage, contact SUEZ before proceeding.*
- Ensure that the setting for the pressure relief valve (PSV-9564) is set sufficiently low enough to prevent damage to the membranes. This setting will be slightly above the specified test pressure provided by SUEZ.
- Open the supply isolation hand valve (HV-9581A).
- Attach the high-pressure air connection (TP-01) to the com-pressed air supply. The connection is found on the side of the PPTD and is labelled “IN.”
- Attach the low-pressure air connection (TP-02) to the tube fitting on the membrane hose adapter, which is on the supplied camlock fitting. The connection is found on the side of the PPTD and is labelled “OUT.”
- *tip The button used to turn the gauge ON and off is located just above the screen.*
- Ensure that the pressure gauge (PI-9541) has been turned ON. If the display fails to activate when the button is pressed, check the battery. If the value displayed does not appear accurate, disconnect the air supply. If the value does not revert to “0.00,” contact SUEZ, as the gauge may need to be recalibrated.
- Ensure that pressure does not exceed the level recommended by SUEZ.

- Slowly adjust the pressure regulating valve (fine adjustment) (PRV-9583A) until the pressure reading shown on the gauge reaches the required level.
- After the pressure reading has reached the required level, wait a minimum of 30 seconds to allow the pressure to stabilize, and then slowly open the membrane safety isolation hand valve (HV-9581B).

- Do not spray the soap solution on electronic components.
- *tip Leaks that develop upstream of the supply isolation hand valve (HV-9581A) will not affect test results.*

- After the membrane safety isolation hand valve (HV-9581B) has been opened, wait 15 minutes while the air enters the membranes and flushes water from within the fibers. During this time, test for leaks along the piping between the supply isolation hand valve (HV-9581A) and the camlock fitting by using a spray bottle to apply a soap solution to piping, and then watching for bubbles, which indicate leaks. Repair as needed.

- After completing the steps outlined above, begin taking measurements by performing the following steps:

- After water has been flushed from the membranes and the pressure within the fibers has stabilized, close the supply isolation hand valve (HV-9581A).

- Membranes must not be exposed to air for more than 60 minutes at a time. If for any reason the test lasts longer than this amount, stop and reconnect the cassette to the system, allowing it to permeate for at least 1 hour before attempting to resume the PDT.

2. Begin recording the pressure reading shown on the gauge (PI-9541) at 15-second intervals using either of the following tables as a template, depending on the test scenario. While recording these values, also make note of any bubbles seen rising from the membranes and the location(s) they appear from.

tip Copy/print the following table templates for use when recording test data.

table 5.1 - PDT test values (single cassette tested)

Time Over 5 Minutes (Seconds)	Pressure (Indicate Unit of Measure)	Time Over 5 Minutes (Seconds)	Pressure (Indicate Unit of Measure)
0 (start)		165	
15		180	
30		195	
45		210	
60		225	
75		240	
90		255	
105		270	
120		285	
135		300	
150			
Site:	Operator:		Date

table 5.2 - PDT test values (sub-group of four cassettes tested)

Time Over 10 Minutes (Seconds)	Pressure (Indicate Unit of Measure)	Time Over 10 Minutes (Seconds)	Pressure (Indicate Unit of Measure)

0 (start)		315	
15		330	
30		345	
45		360	
60		375	
75		390	
90		405	
105		420	
120		435	
135		450	
150		465	
165		480	
180		495	
195		510	
210		525	
225		540	
240		555	
255		570	
270		585	
285		600	
300			
Site:	Operator:		Date

5.9.2.3 ANALYSING PDT RESULTS

The test criteria for a PDT are generally site-specific and depend on a number of factors, including the type of membrane used and the system's size and configuration. If the criteria were not provided during the commissioning stage, contact SUEZ for more information.

Even if there are no leaks present, the pressure reading is expected to decrease gradually due to the diffusion of air across the membranes. This natural decay is the baseline pressure decay, and is expected to change slightly with time due to variations in certain parameters, such as temperature, membrane fouling, and feed water characteristics.

Because the baseline pressure decay provides the measure to which all PDT test results are compared, a PDT should be conducted to update the baseline value on a regular basis. How often this update must be performed depends heavily upon site-specific requirements, and SUEZ should be consulted for customized support in this area.

After the pressure values have been recorded and the data analysed, if the results are acceptable, the cassette can be placed back into service. If the results are unacceptable, a Bubble Test must be performed to locate the broken fibers. *(See 5.9.3 bubble test)*

5.9.2.4 RETURNING CASSETTES TO SERVICE FOLLOWING A PDT

If the cassette passed the PDT, return it to service by performing the following steps:

- Close the membrane safety isolation hand valve (HV-9581B).
- Allow air to begin escaping from the apparatus by removing the line from the PPTD adaptors fitted to the cassette.

- To increase the rate at which air is released, carefully remove the adaptors.
- Wait 5 minutes for the air to be released to the atmosphere, and then reconnect the cassette's air and permeate connections to the subsystem piping.

- When priming the permeate line after a PDT, initiate a [backwash/pulse] with one or more air vent valves open on the header to allow the water to push out the air. The air vent valves should be located as far from the water inlet points as possible to maximize air removal.

5.9.3 BUBBLE TEST

- A Bubble Test is used to locate leaks in the membranes. This procedure is to be performed on all new cassettes following installation, as well as whenever turbidity rises above acceptable levels.

- To ensure that bubbles from broken fibers can be easily seen, the Bubble Test should be performed with the cassette submerged in relatively clean, clear water, such as UF permeate. This requires that the cassette first be removed from the membrane tank, desludged, and placed in a separate dip tank where the Bubble Test can be performed.

- To complete a Bubble Test, perform the following steps:

- Reduce the water level in the membrane tank to a point below the permeate connection, so that no water can get into the cassette after the connection is removed. *The membranes must remain completely submerged.*

- Isolate the cassette by closing the permeate and air isolation hand valves.

- When installing adapters, prevent water or materials from entering the open permeate line.

- Disconnect the permeate connection and attach the adapter supplied with the Portable Pressure Test Device (PPTD) to the permeate connection on the cassette.

- Before making any connections, ensure that the membrane safety isolation hand valve (HV-9581B) and the pressure relief valve (PSV-9564) are closed.

Connect the PPTD to the cassette by performing the following steps:

- Ensure that the membrane safety isolation hand valve (HV-9581B) is closed.

- *tip If the test pressure value has not already been provided by SUEZ, contact SUEZ now and request it before proceeding.*

- Ensure that the setting for the pressure relief valve (PSV-9564) is set sufficiently low enough to prevent damage to the membranes. This setting will be slightly above 207 mbar (3 psig).

- Open the supply isolation hand valve (HV-9581A).

- Attach the high-pressure air connection (TP-01) to the compressed air supply. The connection is found on the side of the PPTD and is labelled "IN."

- Attach the low-pressure air connection (TP-02) to the tube fitting on the membrane hose adapter, which is on the supplied camlock fitting. The connection is found on the side of the PPTD and is labelled "OUT."

- *tip The button used to turn the gauge ON and OFF is located just above the screen.*

- Ensure that the pressure gauge (PI-9541) has been turned ON. If the display fails to activate when the

button is pressed, check the battery. If the value displayed does not appear accurate, disconnect the air supply. If the value does not revert to “0.00,” contact SUEZ, as the gauge may need to be recalibrated.

- Ensure that pressure does not exceed the required test level.
- Slowly adjust the pressure regulating valve (fine adjustment) (PRV-9583A) until the pressure reading shown on the gauge reaches the required test pressure of 207 mbar (3 psig).
- After the pressure reading has reached the required level, slowly open the membrane safety isolation hand valve (HV-9581B), and then wait a minimum of 30 seconds to allow the pressure to stabilize.
- After the pressure has stabilized, adjust the water level to 5 cm (2 in.) above the bottom of the cassettes permeate header (the membranes will remain fully submerged), and then wait 15 minutes to ensure the water has been purged from within the membranes.
- Examine the membranes for escaping bubbles (indicating a leak).
- If a leak is found, analyse it and determine what type of bubble stream is being produced. *(See 5.9.4 bubble types)* The repair procedure will vary depending on the type of bubble stream.
- *(See 7.5 repairing ZeeWeed fibers)*
- Repair any leaks found during the first examination, and then reduce the water level until it is level with the bottom of the cassette permeate header. Continue to examine the membranes and repair as needed. If a module requires difficult or numerous repairs, contact SUEZ for further information.

- **5.9.4 BUBBLE TYPES**

The size and type of bubbles released by a leak during a Bubble Test indicate the type of leak that has occurred. Bubbles are classified according to four types, as outlined below.

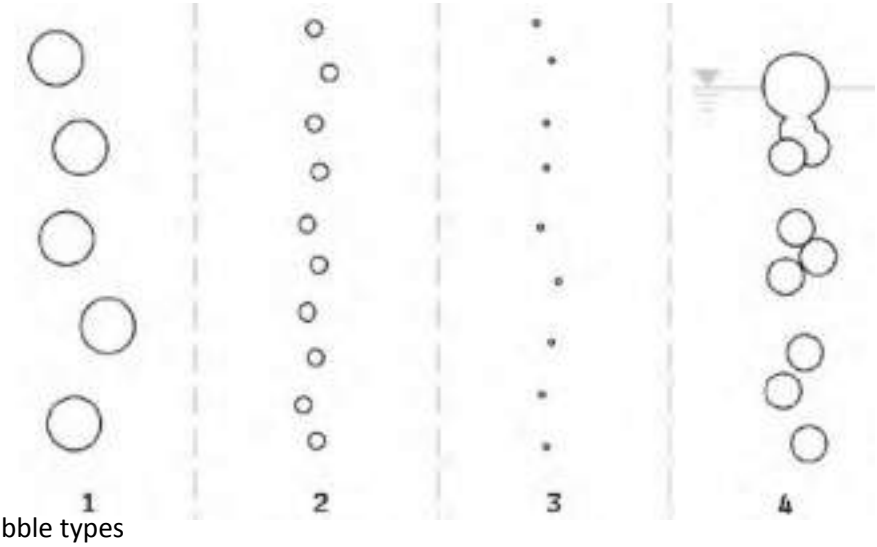


figure 5.22 - bubble types

TYPE 1: A Type 1 bubble stream appears as a steady flow of large bubbles, typically 10 mm (0.4 in.) in diameter or greater. Type 1 streams are usually released by a severed membrane fiber. However, if the stream appears to come from one of the permeate headers, it may also be caused by an improperly installed O-ring.

TYPE 2: A Type 2 bubble stream is characterized by a steady flow of moderate-sized bubbles between 1 - 10 mm (0.04 - 0.4 in.). This form of leak is typically minor and often caused by punctured fibers or “pin holes” in the membrane. Type 2 leaks may not always require repair. Any larger leaks found during the Bubble Test should be repaired first, after which a second test will determine whether additional repairs for Type 2 leaks are necessary to

bring performance up to specified levels.

TYPE 3: A Type 3 bubble stream appears as an intermittent stream of small bubbles (less than 1 mm (0.04 in.)). This type of stream is typically due to air passing through unwetted pores. Unwetted pores allow passage of air but not water, and do not need to be repaired.

TYPE 4: Type 4 bubbles gather at the top of the cassette and release when the bubble is sufficiently large. This type of bubble is usually formed by accumulated Type 2 or Type 3 bubbles.

5.9.5 CHECKING AERATION

If the installation procedure has been carried out correctly, the aeration assembly should be perfectly horizontal, providing an even distribution of air over the membranes.

Before installing hatches or other coverings over the cassettes, perform an aeration check by completing the following steps:

- Install all cassettes before performing an aeration check.
- Start the blower and ensure that air is being supplied to the membrane cassettes.
- Air distribution must be as even as possible. If aeration is too high, it may cause excess vibration that will damage the membrane modules. If aeration is too low, it may not dislodge accumulated solids as intended.
- Observe the bubble pattern on the surface of the tank. The sur-face should bubble evenly above the cassettes. If any uneven aeration is observed, the system must be stopped and the cause isolated. If the airflow is uneven, check the cassette's alignment and ensure that it rests level in the tank.
- Check the air pipe connections for leakage and repair as necessary.
- If multiple membrane tanks are used, turn aeration on in one membrane tank and off in another tank. Ensure there is no aeration in the membrane tank that is off.
- After the system is fully installed and put into production, observe the aeration pattern within the individual cassettes to determine whether all of the modules are receiving equal airflow.

5.10 RETURNING ZEEWEED MEMBRANES

Membranes that are still in their original packaging and that have been stored in accordance with SUEZ instructions may be returned to SUEZ. *(See 5.5 storing ZeeWeed membranes)* Any membranes received by SUEZ that have been stored improperly or that have had their original packaging damaged may be subject to rejection or to additional fees required to restore the membranes to saleable condition.

Membranes that have been in operation may also be returned to SUEZ, so long as the proper repackaging and shipment procedures are observed. *(See 5.10.2 preparing membranes for shipment)*

Be advised that destructive testing may be required during the evaluation of a returned membrane module. Therefore, modules sent to SUEZ for evaluation may not be returned. If this presents a problem, inform SUEZ prior to shipment.

5.10.1 ARRANGING THE RETURN OF GOODS

- SUEZ will only receive membranes that are returned with a valid Return Goods Authorization (IBS) number.
- To obtain an IBS number, contact SUEZ by phone. *(See 12.1 contacting SUEZ)* When calling, have the original sales order or invoice ready.

- When arranging shipment, ensure that membranes will be protected from extreme temperatures. Storage temperatures must remain within 2 - 35°C (35.6 - 95°F) at all times.

5.10.2 PREPARING MEMBRANES FOR SHIPMENT

- All membranes being returned under warranty or for evaluation *with the exception of those being returned for cleaning study* must be preserved prior to repackaging. *(See 5.11.2 long-term shutdown)*

- Membranes being returned for cleaning study *must not* be cleaned or preserved. Instead, to ensure membrane integrity during shipment, pour 0.5 - 0.75 L (2 - 3 cups) of potable water into the bag containing the membranes prior to sealing the bag.

- Membranes will be damaged irreversibly if they are allowed to dry out.

- Boxes used to return membranes must support the module's top and bottom headers to prevent shifting during transport.

- *tip If the original bag in which the membranes were delivered has been kept and stored safely, it may be reused to return them.*

- Membranes must be bagged and boxed individually. Bags must be sealed to prevent liquid from escaping, and boxes must be of a suitable size and durability. SUEZ can provide shipping materials, if necessary.

- If tape is used to seal bags containing membranes, do not allow the tape to come into contact with the membranes themselves. Doing so will cause permanent damage to the membranes.

- Seal membranes within a leak-proof bag. To seal the bag, use a bag sealer or leak-proof tape. If tape is used, *do not* allow the tape to come into contact with the membranes themselves. Confirm that the bag has been securely sealed before placing the bagged membranes in a shipping box.

- Individual membranes must be crated in a way that protects them from damage during handling and transport.

The following information must be clearly marked on the outside of the box and crate containing the membranes:

- IBS number.

- Site/facility name.

- SUEZ project number.

- Membrane module serial number.

5.11 SYSTEM SHUTDOWN & ZEEWEED MEMBRANE PRESERVATION

- It is strongly recommended that a chemical clean be performed before membranes are taken offline. *(See 8 cleaning)*Periodic aeration may also be necessary to prevent anoxic or anaerobic conditions from developing in the membrane tank.

- Membranes that have been isolated must be cleaned before being returned to service. If membranes are isolated for less than a week, perform a sodium hypochlorite maintenance clean. If isolated for longer than a week, perform a sodium hypochlorite recovery clean.

- The following sections provide instruction on how to preserve the membranes, depending on how long they will be taken offline.

5.11.1 SHORT-TERM SHUTDOWN

For storage periods of up to approximately 15 days, submerging membranes in water containing sodium hypochlorite at a maximum residual concentration of 3 mg/L is adequate.

- To perform a short-term shutdown, complete the following steps:
- Perform a recovery clean on the train containing the mem-branes that are being taken out of service.
- At the main control panel, set the train(s) being taken out of service to OFF.
- Submerge membranes taken out of service in water with a maximum residual sodium hypochlorite concentration of 3 mg/L.
- Test water concentration weekly to ensure that sodium hypo-chlorite levels have not changed significantly. Adjust as needed.
- To prevent excessive bioactivity within the membrane tank, the aeration blowers must continue to operate for 30 minutes every 24 hours.

5.11.2 LONG-TERM SHUTDOWN

- If a long-term shutdown is being initiated so that a cassette can be reconfigured or rebuilt, a SUEZ representative must be present to maintain the warranty.
- To perform a long-term shutdown, complete the following steps:
- Perform a recovery clean on the train containing the mem-branes that are being taken out of service.
- Ensure that the membranes are free of solids.
- The glycerine solution used to preserve the membranes can create a severe slip hazard if spilled. Clean any spilled solution immediately.
- Prepare a solution of 50 weight percent glycerine.
- Use one of the following procedures to impregnate the modules:

OPTION 1 - SINGLE MODULE: To impregnate a single module, soak the module in the preservative solution and apply 0.34 bar (5 psi) vacuum (0.66 bar absolute) for 30 minutes. Take the module out of the solution and place it in a container for 30 minutes to allow excess solution to drain off, then bag and seal it immediately, as described later in this procedure.

OPTION 2 - MULTIPLE MODULES IN A CASSETTE: To impregnate multiple modules contained within a cassette, perform the following steps:

With the cassette immersed in water, ensure that the membranes are full of water by operating under vacuum (permeation).

Close the permeate isolation valve(s).

- Connect a reservoir (drum or small tank) with 60 L (15.8 gal) of preservative solution to a sample port or

connection on the piping between the cassette and the isolation valve. Keep the reservoir level at least 91 - 183 cm (36 - 72 in.) above the top of the cassette. Do not open the glycerine supply valve yet.

- Drain the membrane tank until the liquid level is below the bottom of the cassette.

- Open the glycerine supply valve. The glycerine flows into the permeate side of the membrane and displaces the water in the fibers.

- *tip If a module is removed from water and the permeate connection is left open, air will enter the fiber as water reverse-permeates. If the preservative is added manually while air remains in the fiber, the preservative will not enter the fibers.*

- The level in the preservative reservoir falls as the preservative replaces water within the mem-branes. Continue until a sufficient volume of preservative is reverse-permeated for each module in the cassette (at least 3 L (0.8 gal) per module). The volume of the hose or permeate header and sub header should be added to determine the total preservative solution needed.

- The level in the preservative reservoir falls as the preservative replaces water within the mem-branes. Continue until a sufficient volume of preservative is reverse-permeated for each module in the cassette (at least 3 L (0.8 gal) per module).

- The volume of the hose or permeate header and sub header should be added to determine the total preservative solution needed.

- Bag each module using a 0.15 mm (6 mil) thick plastic bag. These bags are available from SUEZ. Seal the plastic bag using either a hand-held sealer or tape. If using tape, remove as much air as possible from the bag before taping most of the opening closed, and then remove the excess air with a shop vacuum.

- *tip If possible, double-bag membranes or seal them in cardboard cartons.*

- Store the bagged membranes in a cool, dry area, out of the direct sunlight and protected from accidental contact that could damage the module or bag.

5.12 INSTALLING & UNINSTALLING NEW ZEEWEED MODULES

New cassettes will be shipped with the modules already installed. The following sections provide information on how to install new modules that have been provided as replacements, as well as how to uninstall modules from the cassette for inspection or repair.

5.12.1 INSTALLING NEW MODULES

A minimum of two operators are required to install a single module.

Before removing a new module from its packaging, inspect the amount of slack within the cassette and determine whether an adjustment should be made.

The following equipment will be required during the installation procedure:

- Step ladder.

- Flashlight (optional).

- Box-cutter or similar knife.

- Water-soluble lubricant.
- MIS Locking Tool.

Module Interconnecting Strip(s). MISs come in two lengths, four-module and six-module. The pattern in which the MISs are installed will vary depending on the number of modules in the cassette.

Number of Modules	Installation Pattern	Number of Four-Module MIS Req.	Number of Six-Module MIS Req.
48 Frame Cassette			
48M	6, 6, 6, 6	0	16
44M	6, 4, 6, 6	4	12
40M	6, 4, 4, 6	8	8
36M	6, 6, 6	0	12
32M	6, 4, 6	4	8
28M	6, 4, 4	8	4
24M	6, 6	0	8
64 Frame Cassette			
64M	6, 6, 4, 4, 6, 6	8	16
60M	6, 6, 6, 6, 6	0	20
56M	6, 6, 4, 6, 6	4	16
52M	6, 4, 4, 6, 6	8	12

table 5.3 - MIS installation patterns

Number of Modules	Installation Pattern	Number of Four-Module MIS Req.	Number of Six-Module MIS Req.
48M	6, 6, 6, 6	0	16
44M	6, 4, 6, 6	4	12
40M	6, 4, 4, 6	8	8
36M	6, 6, 6	0	12
32M	6, 4, 6	4	8

table 5.3 - MIS installation patterns

To remove the module from its packaging, perform the following steps:
Open the cardboard box, and then, with the assistance of another operator, lift the bagged module out of the box and transfer it to a table long enough to support the entire module when laid flat. Grasp the module by the headers at either end when lifting and carry it as shown below.

figure 5.23 - carrying a module

Without removing the clear plastic bag, examine the module within for obvious signs of damage that may have occurred during shipping. Also, confirm that all O-rings are present. If an O-ring is missing, do not open the bag until a replacement can be found.

figure 5.24 - O-rings on permeate spigot

- The glycerine solution used to preserve the membranes can create a severe slip hazard if spilled. Clean any spilled solution immediately.
- Carefully cut lengthwise across one end of the bag, ensuring that the knife does not touch the module header or any of the fibers. Ensure that any glycerine preservative that escapes from the bag is cleaned immediately.
- While an assisting operator holds the module header nearest the cut end of the bag, grasp the opposite end and slowly slide the bag off the module.
- After unpackaging the module, install it within the cassette by performing the following steps:
- Modules are delicate and can be damaged easily if mishandled. Do not use excessive force when installing or removing modules from a cassette, and ensure that the membrane fibers are protected from contact with tools or other objects.
- Apply a water-soluble lubricant to the O-rings on the modules permeate spigot.
- *tip When facing the front of the cassette, the aeration pipes can be seen on the left side of the cassette.*
- Each module has one square header and one rounded header. When installed, modules will alternate, with one inserted rounded header-up while the neighbouring module is inserted square header-up. Ensure that the module being installed is inserted properly by comparing it to the adjacent module(s). When populating an empty cassette, insert the first module rounded header-up and into the far-right position when facing the front of the cassette.
- While an assisting operator holds the opposite header, grip the module header (rounded or square) that will have inserted at the top of the cassette, and then carefully lift the module off the table.
- When moving a module, ensure that the membrane fibers are not allowed to drag along the floor or to bump against any other surface or object.
- *tip If necessary, clean the cassette rail and apply a water-soluble lubricant to the module grooves.*

- Using a step ladder and while the assisting operator continues to support the bottom header, raise the top header and align the grooves on the top of the header with the cassette rail. Insert the grooves into the rail, and then *gently* slide the module into place until approximately 25 cm (10 in.) of its length remains outside the cassette.

figure 5.25 - sliding module top header into cassette rail

- While the operator holding the partially installed top header continues to support it, align the permeate spigot on the bottom header with the permeate collector port on the cassette (a flashlight may be required when locating the port).

- Ensure that the spigot and port are properly aligned, and then, using gentle but firm pressure, carefully push the bottom header into the cassette until the O-ring seal between the spigot and the collector has been fully formed

figure 5.26 - inserting the bottom header

After the bottom header has been connected to the collector, gently lift the header, *without twisting or placing excessive pressure on the collector,* until the locating nipples on the front of the header can be slipped into the corresponding holes on the cassette frame After the bottom header has been installed, slide the top header into the cassette until it is fully. installed as well.

9. Lock the module in place by turning the module keys on both the top and bottom headers to the locked (vertical) position. A slight “click” will be heard when the key is fully locked

10. After the module keys have been locked, the Module Interconnecting Strips (MIS) that secure the newly installed module to its neighbours must be locked in place along the top and bottom headers. MISs come in two lengths, four-module and six-module. The pattern in which the MISs are installed will vary depending on the number of modules in the cassette. To install the MISs, perform the following steps:
Select either a four-module or six-module MIS, depending on the cassette's MIS installation pattern. *(See table 5.3 - MIS installation patterns)*

Ensure that all locking pins on the MIS are in the unlocked (diagonal) position, and then set the MIS against the module headers so that each pin is aligned directly below (top header) or above (bottom header) a module key.

figure 5.29 - MIS locking pin location (far-left), locking pin unlocked (center-left), using locking tool (center-right) & locking pin locked (far-right)

tip Contact SUEZ if an MIS Locking Tool is not available.

Using an MIS Locking Tool, turn each locking pin clock-wise until a slight "click" is heard, indicating that the pin is in the locked (vertical) position.

To ensure that the module has been installed properly, con-firm the following:

Both of the module's locking keys are in the locked (vertical) position.

Both the top and bottom headers have been secured with an MIS.

5.12.2 removing modules from cassettes

A minimum of two operators are required to remove a single module from a cassette.

Do not use screwdrivers, pry bars or any other type of tool aside from the Module Removal Tool to remove modules from the cassette.

Typically, modules can be removed by hand without much difficulty, however, SUEZ does provide a Module Removal Tool (MRT) that can be used to remove modules that do not slide out easily on the first attempt.

figure 5.30 - Module Removal Tool

Each MRT is issued with a standard faceplate. An additional repair adaptor faceplate is also available for use with modules that have undergone repair and that have been fitted with the repair adaptor.

figure 5.31 - standard (right) & repair

adaptor (left) MRT faceplates

The MRT can be used to remove both the top and bottom header of a cassette by removing the MRT's cotter pin, sliding the faceplate to align with a new pin position, and then reinserting the pin. There are four pin locations along the main body (handle) of the MRT.

table 5.4 - pin location & function

Pin Location	Function
One	For installing and removing the top header
Two	For future use (not currently used)
Three	For future use (not currently used)
Four	For installing and removing the bottom header

figure 5.32 - MRT cotter pin in first (left) & fourth (right) positions

To remove a module from a cassette, perform the following steps:

Using a 5 mm hex wrench, loosen the module's top and bottom key-side outer support expanders. Use care not to scrape or strip the hardware while loosening.

figure 5.33 - tightening expanders

Unlock the top and bottom module keys. A key is unlocked when turned fully horizontal. Do not apply excessive force when turning.

With one operator supporting the top header and another operator supporting the bottom header, attempt to slide the module out of the cassette by hand. If the module does not slide out easily, confirm that the key-side outer support expanders are loosened and that the module keys are unlocked. If the module still cannot be removed by hand, use the MRT to remove it.

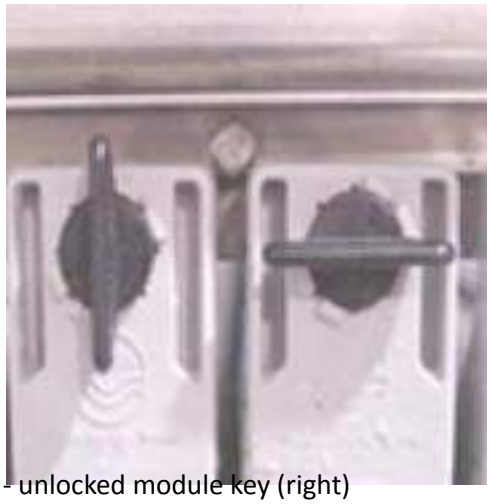


figure 5.34 - unlocked module key (right)

tip to ensure a proper fit, clean any accumulated solids from grooves and cavities on the module face before the MRT faceplate is set in place.

NOTICE

figure 5.35 - fitting faceplate to module

Fit the appropriate MRT faceplate (standard or repair adaptor) to the face of the module.

Do not use tools or excessive force to turn the rotating ring. Doing so may damage the locking tabs. If the ring does not turn easily, apply a small amount of lubricant and
continue attempting to turn it by hand until successful.

Ensure that the faceplate sits flush against the module, and then turn the circular rotating ring counter-clockwise until the locking tabs slide into place and the faceplate is locked onto the module. Avoid pinching, catching, or stretching membrane fibers while sliding the module header out from the cassette.

With the faceplate locked firmly to the module, pull back on the MRT handle with a smooth, persistent force (do not wrench the handle back or jerk repeatedly) until the module comes free from the permeate saddle and begins to slide forward. Continue to slide the module outward until it protrudes approximately 25 cm (10 in.) from the

cassette.
figure 5.36 - removing module with MRT

Turn the rotating ring clockwise until the locking tabs dis-engage and the MRT comes free from the module. Adjust the faceplate position on the MRT body, and then repeat this process for the module's other header.

After both headers have been partially removed from the cassette, set the MRT aside, and with one operator supporting the top header and another operator supporting the bottom, slide the module the rest of the way out by hand.

6 OPERATING THE SYSTEM

This section outlines the procedures for starting up and operating the system as a whole.

For detailed information regarding specific components included in this assembly, such as valves or instrumentation, refer to the manufacturer's instructions.

6.1 USING THE CONTROL PANEL

The following sections describe the controls and indicators found on the system control panel, as well as how to access the onscreen interface and use it to control the system.

6.1.1 POWER CONTROL HARDWARE

The control panel includes the following power control elements:

- Disconnect switch.
- System stop button.
- Reset button.
- Pilot light.

6.1.1.1 control panel disconnect switch

The disconnect switch can be used to cut power to the control panel, which will in turn de-energize the PLC and any components controlled by the PLC.

6.1.1.2 SYSTEM STOP BUTTON

tip All manually operated components will retain pre-shutdown status. Components in AUTO mode will remain in

AUTO mode.

Pressing the system stop button initiates an automated shutdown sequence that ends operation in a controlled manner and places all PLC-controlled components into OFF mode. *(See 6.3 triggering an alarm shutdown)* After this button is pulled back out, operation will resume automatically in accordance with the start-up sequence outlined in the CLC. A power-up status bar will display on the onscreen interface as operation resumes.

Pressing the system stop button initiates an automated shutdown sequence that ends operation in a controlled manner and places all PLC-controlled components into OFF mode. *(See 6.3 triggering an alarm shutdown)* All manually operated components will retain pre-shutdown status. Components in AUTO mode will remain in AUTO mode.

To restore power to the system, the operator must pull the system stop button back out, and then press the system reset button. The pilot light will illuminate when power has been restored.

6.1.2 USING THE ONSCREEN INTERFACE

The onscreen interface is the operator's primary means of controlling the system. Using the onscreen interface, the operator can adjust the operating modes of various components, set schedules and set points, and monitor system status and performance levels.

6.1.2.1 ACCESSING THE ONSCREEN INTERFACE

To access the onscreen interface controls, perform the following steps:

- *tip Depending on the operator's security access level, some system controls may not be available.*
- At the control panel, ensure that power is ON.
- At the onscreen interface, ensure that the screen displays the system control graphics. If power is ON but the screen remains dark, touch the screen to activate.
- After the onscreen interface has been activated, the Login screen appears. Enter the username and password in the appropriate fields, and then select the Enter button.

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figure 6.1 - login screen
The first screen to appear is the Overview screen, which provides a high-level display of the system and the current status of all subsystems and major components. All other screens and menus can be accessed by selecting the buttons and symbols displayed on this screen.

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figure 6.2 - overview screen

6.1.2.2 UNDERSTANDING THE ONSCREEN INTERFACE

When using the onscreen interface, the operator navigates between screens by selecting both the labelled buttons and the images that represent various subsystems and individual components.

In the case of symbols for individual components (example: pumps, valves), the shape indicates the type of component, while the Color shows its current mode.

To access the Legend screen, perform the following steps:

In the Overview screen *(see figure 6.2 - overview screen)*, select the GoTo Graphics button. The Graphics menu

appears.

In the Graphics menu, select the HMI Legend button. The Legend screen appears.

6.2 STARTING UP THE SYSTEM

Use one of the following procedures to start up the system, depending on present conditions.

6.2.1 STARTING UP THE ZEEWEED UF SUB-SYSTEM UNDER NORMAL CONDITIONS

To start up the ZeeWeed UF subsystem, perform the following steps:

Ensure that the circuit-breaker is set to ON and that the selector switches for all components related to the system are set to AUTO. For information regarding start up procedures for specific components, refer to the manufacturer's instructions.

tip Automatic valves may not function properly if air pressure falls below this level.

Ensure that the compressed air supply is at a high enough level to satisfy the operating requirements of all pneumatically actuated valves. For more information about these requirements, refer to the manufacturers' instructions. Set all manually operated valves in the proper position for nor-mal operation. For information regarding valve positioning, refer to the technical drawings. For more on valve operation, refer to the manufacturer's instructions.

In the Overview screen, select the symbol for the train that is to be put into production. *(See figure 6.2 - overview screen)* The Train screen for that train appears.

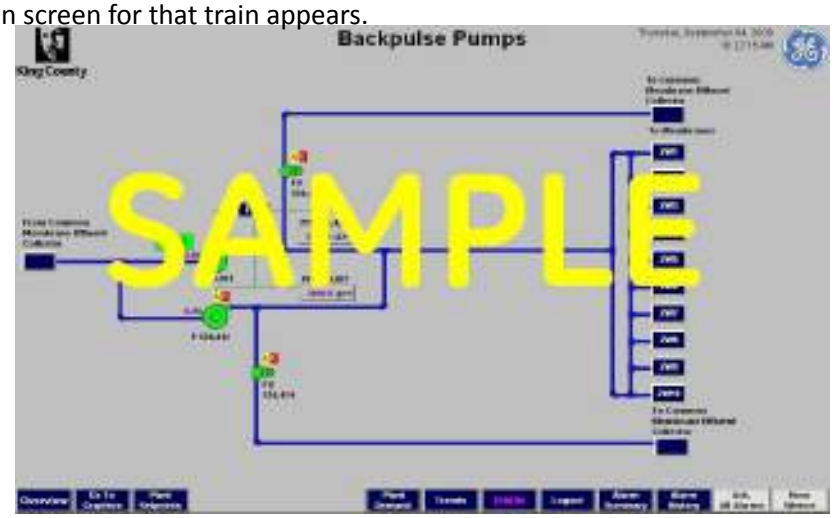

figure 6.5 - typical train screen

To set an operating mode for all components associated with the selected train, in the Train screen, select the Mode Controls button. The Modes pop-up screen appears.

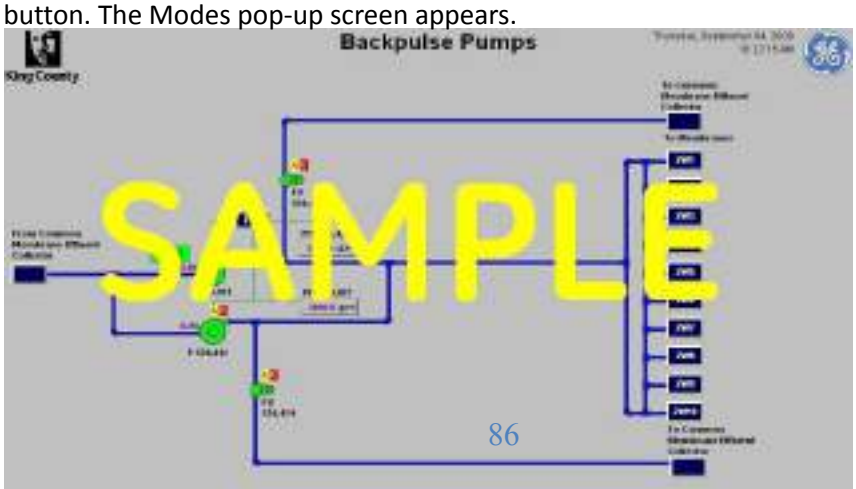

figure 6.6 - typical UF modes pop-up screen

tip The train will first enter STANDBY mode after being activated.

To activate the train, in the Modes pop-up screen, select the ON button. The train begins operating in AUTO mode.

When finished, select the Exit button. The Modes pop-up screen closes.

If more trains are to be activated, repeat this procedure for each additional train.

6.2.2 STARTING UP THE ZEEWEED UF SUB-SYSTEM FOLLOWING AN ALARM SHUTDOWN

There are numerous operating conditions that, if detected, will trigger an alarm. Examples of an alarm condition include component failure, a flow exceeding a preset safety set point, or an unacceptable reading from an instrument monitoring production capacity or quality.

Depending on the nature and severity of the condition, the resulting alarm may cause the system to shut down automatically to preserve product quality and protect the system and the operators from harm.

When an alarm occurs, the Alarm Summary pop-up screen appears and displays a list of alarms and their associated conditions.

The Active Alarms pop-up screen lists all alarms that are in the alarm state, both acknowledged and unacknowledged.
The Alarm History pop-up screen lists all alarms that have occurred.

If an alarm causes an emergency shutdown, use the following procedure to acknowledge the alarm, address the cause(s), and resume operation:

To deactivate the alarm horn, in the Overview screen, select the Horn Silence button. *(See figure 6.2 - overview screen)* The horn stops.

After deactivating the horn, select the Alarm Summary button. The Alarm Summary screen appears. *(See figure 6.7 - alarm summary pop-up screen)*

Based on the information provided in the Alarm Summary screen, determine what condition caused the shutdown.

After the alarm condition has been identified, to acknowledge the alarm, in the Alarm Summary screen, select either the Ack Alarm or Ack All Alarms button.

tip If an alarm condition remains when the operator attempts to resume operation, the alarm will sound again and this procedure will need to be repeated.

Resolve the alarm condition before proceeding. For information on resolving alarms, refer to the CLC. For information regarding a particular component, refer to the manufacturer's instructions.

The action required to reset an alarm depends on the type of alarm that was triggered. After all alarm conditions have been resolved, to reset the alarm, complete one of the following steps:

In the Overview screen, select the Alarm Reset button. The alarm resets. *(See figure 1.2 - overview screen.)*

If the affected component is set in STOP mode, set it in AUTO. The alarm resets.

In the Modes pop-up screen, select the train's On button. *(See figure 6.6 - typical UF modes pop-up screen)* The alarm resets.

Reactivate the system. *(See 6.2 starting up the system)*

If an alarm sounds but does not trigger an emergency shutdown and deactivates automatically, consult the Alarm History pop-up screen for an explanation. *(See figure 6.9 - alarm history pop-up screen)* In most cases where this occurs, the condition that triggered the alarm was resolved automatically. However, operators should confirm this to rule out the possibility of a faulty alarm.

6.3 TRIGGERING AN ALARM SHUTDOWN

An alarm shutdown should only be triggered if there is an emergency, such as danger to life or limb.

Because an emergency shutdown does not trigger the same cycles that a normal shutdown would, resuming operation immediately may damage the system. As a result, after an emergency shutdown has been triggered, all system components must be inspected and reset for start up before operation resumes.

If there is an emergency and you must trigger an alarm shutdown, press the system stop button. This causes the following to occur:

An alarm sounds.

The onscreen interface displays an emergency shutdown notice.

An immediate shutdown sequence is triggered, halting operation.

Before starting the system again after an emergency shutdown, inspect all system components and reset them for start-up.

6.4 CONTROLLING SPECIFIC COMPONENTS MANUALLY

Although the PLC controls most system components during normal operation, the operator may, if necessary, manually adjust the operational setting of a specific component, such as a valve or pump.

Do not leave unattended any system component that has been adjusted manually (that is, one that has been taken out of AUTO mode).

The level of manual control that an operator has over the system depends on his or her security level access. Many of the controls outlined below will not be available (that is, they will not appear on the screen) if the operator who has logged in does not have authority to override the automated settings already in place.

The following sections provide general instructions for controlling specific components from the onscreen interface. For more detailed information about a particular component, refer manufacturer's instructions.

6.4.1 ACCESSING COMPONENT CONTROLS

To open the pop-up screen for a specific component, at the onscreen interface, select the symbol for that component. The component's pop-up screen opens.

6.4.2 VALVES

Valves can be set in the following modes:

- AUTO - the valve is controlled by the PLC.
- OPEN - the valve is opened manually.
- CLOSE - the valve is closed manually.

Valves in OPEN or CLOSE mode must be monitored and controlled manually (that is, the PLC will only control valves in AUTO mode).

To switch modes, perform the following steps:

- At the onscreen interface, select the symbol for the valve. The valve's pop-up screen appears.
- In the valve's pop-up screen, select the Open, Close or Auto button, as needed. The valve enters the selected mode of operation.

6.4.3 PUMPS

The controls used to adjust a pump's settings can vary depending on the type of pump in question.

Do not leave unattended any system component that has been adjusted manually (that is, one that has been taken out of AUTO mode).

6.4.3.1 chemical pumps

Chemical pumps can be set in the following modes:

- AUTO - the pump is controlled by the PLC.
- START - the pump is activated manually.
- STOP - the pump is stopped.

Do not leave unattended any system component that has been adjusted manually (that is, one that has been taken out of AUTO mode).

To switch modes, perform the following steps:

- At the onscreen interface, select the symbol for the pneumatic valve associated with the pump. The valve's pop-up screen appears.
- In the valve's pop-up screen, select the Open, Close, or Auto button, as needed. The valve switches to the selected mode.
- To adjust a pump's stroke speed, use the controls found on the pump itself. For more information, refer to the manufacturer's instructions.

6.5 SYSTEM SET POINTS

Most of the system's operating parameters, including alarm triggers, flow settings, and production schedules, are defined using set points. The default values for these settings are programmed during the initial commissioning process, but can be updated as necessary through the onscreen interface.

tip The design values for system set points are listed in the CLC.

Record all set point changes. In the event of a complete loss of power, the system will restart with set points taken from the electronically erasable programmable read only memory (EEPROM) and any recent changes will be lost.

To preserve the controls design, back up the PLC processor onto the system's EEPROM memory. In addition, the PLC ladder logic and operator interface design must be copied to an external archive for future maintenance and emergency recovery.

To change a system set point, perform the following steps:

tip The Plant Set points *button is also available from most other screens.*

In the Overview screen, select the Plant Set points button. *(See figure 6.2 - overview screen)*The Plant Set points pop-up screen appears.

In the Plant Set points screen, select the button for the required set point subgroup. The set points included in that subgroup appear.

From the set points listed, select the box that displays the cur-rent value for the set point that will be updated. The keypad control for the selected value appears.

Enter the new value, and then select the Reset button. The setting is updated.

To close the Plant Set points screen, select the Exit button. The Plant Set points screen closes.

This same procedure can be used to adjust the set point values found on other screens as well.

6.6 LOGGING OUT OF THE SYSTEM

To log out of the system, perform the following steps:

In the Overview screen, select the Logout button. *(See figure 6.2 - overview screen)* The Confirm Logout screen appears.

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figure 6.12 - logout screen

In the Confirm Logout screen, select the Logout button. The session ends and the Login screen appears.

6.7 SHUTTING DOWN THE SYSTEM

To shut down the system, perform the following steps:
Before initiating a shutdown, consult the related information within this manual, as well as vendor literature on specific components, and ensure that all preservation and storage procedures are understood and adhered to.

In the Overview screen, select the Plant Shutdown button. *(See figure 6.2 - overview screen)* The Shutdown Verification pop-up screen appears.

In the Shutdown Verification pop-up screen, select the Yes button to shut down the system, or the No button to return to the Overview screen.

7 INSPECTION & REPAIR

This section outlines the various maintenance procedures required to ensure optimal membrane performance and

lifespan, including information related to membrane fouling, handling, inspection, and repair.
topics in this section

7.1 MEMBRANE FOULING

The following section provides information on membrane fouling, types of foulants, and the processes used to remove them from the membranes.

7.1.1 EFFECTS OF FOULING

The term “fouling” refers to the accumulation of unwanted deposits on a membrane surface.

Membranes form a physical barrier between water and the impurities it carries. During filtration, permeate is drawn by vacuum across the membrane, leaving impurities on the outside surface. This gradual accumulation of impurities creates an increased resistance to permeation, which in turn increases the amount of transmembrane pressure (TMP) required during operation.

Membrane fouling can have the following negative effects:

Increased TMP in order to maintain normal permeate production.

Increased energy requirement for normal operation.

Reduced overall membrane efficiency.

Reduced membrane lifespan.

7.1.2 FOULANT TYPES

Foulants include any materials that accumulate on the surface of a membrane and decrease that membrane’s performance. Foulants are divided into the following four groups:

BIOLOGICAL: Aerobic and anaerobic living materials, such as bacteria, fungus, and algae. These organisms colonize on the surface of the membrane, blocking flow through the pores.

ADSORPTIVE: Adsorptive foulants include compounds that stick to the surface of the membrane, such as oil, polymers, cationic surfactants, and hydrocarbons.

PRECIPITATIVE: Precipitative foulants, often caused by high pH levels and extremely hard feed water, usually appear in the form of scale. Scale develops when compounds in feed water are concentrated beyond their solubility. Common precipitative foulants include calcium carbonate and magnesium sulfate

SOLIDS ACCUMULATION: In UF systems used to treat feed water containing a high level of solids, it is possible for solids to accumulate between the membrane fibers. At best, this type of fouling causes an increased TMP requirement. At worst, it will permanently damage membrane fibers. Adequate pre-screening measures and optimized upstream pretreatment unit-processes (where applicable) are the best methods for preventing this type of fouling.

7.1.3 MONITORING FOULING

Regardless of the system’s application, solids accumulation must be monitored regularly. Inspections should be performed monthly at first, although this frequency may be adjusted in accordance with how often the membranes become fouled to the point where performance is affected.

Although all systems will become fouled over time, the following factors will generally result in more frequent and severe fouling:

High TMP levels.

Insufficient air flow during aeration.

Non-uniform air distribution across the membranes during aeration (the cassette may not be level; the aeration assembly may be clogged or missing components).

Operating at a high solids mass flux (either a high net flux, high MLSS, or both).

Inadequate or malfunctioning pre-screening measures.
Poor effluent turbidity or effluent nutrients are indicators of high solids accumulation, however, the most accurate way of determining the presence of solids in the membranes is through regular membrane inspections. It is important to regularly inspect the tanks and modules for accumulation. If sludging is allowed to worsen, the accumulation will quickly become more compacted and difficult to remove.

Reoccurring high solids accumulation may indicate that the system has mechanical- or process-related issues that require resolution. If frequent and/or extreme fouling becomes a problem, Contact SUEZ for additional support.

7.1.4 PREVENTING FOULING

Preventive steps to minimize the extent and frequency of membrane fouling include [backwash/pulse] sequences to scour solids from the membrane surface; chemically-enhanced maintenance cleans to prevent fouling; and recovery cleans to mitigate fouling.

Depending on the type of fouling, a chemical cleaning sequence may be performed with *either* [high-pH] solution targeting organic foulants *or* [low-pH] solution targeting mineral, precipitative foulants. *(See 8 cleaning)*

tip The procedures and associated chemicals used may vary depending on system configuration.

7.1.5 REMOVING FOULANTS

The procedure used to remove fouling depends upon the type of foulant.

BIOLOGICAL: Exposure to a solution containing sodium hypochlorite will remove most biological foulants. Because it is easier to remove early biological growth, rather than established colonies, it is recommended that a schedule of frequent cleaning sessions with a low-strength sodium hypochlorite solution be established in place of infrequent cleaning sessions with a high-strength solution.

PRECIPITATIVE: Membranes fouled with precipitative scale are cleaned using a citric acid solution. However, the best method of reducing precipitative fouling is to prevent it from occurring by lowering the concentration of precipitative foulants entering the system. Adding a lime water-softener and adjusting the feed water pH level are common ways of controlling precipitative fouling.

ADSORPTIVE: Adsorptive fouling is extremely difficult to reverse, making it critical that oils, polymers, hydrocarbons, and other foulants of this type be removed from feed water before it encounters the membranes. For more information about preventing adsorptive fouling, or if considering the use of polymers or surfactants, contact SUEZ.

SOLIDS ACCUMULATION: Because proper aeration is the most effective method of preventing solids accumulation, it is important that the aeration process be inspected on a routine basis.

7.2 LIFTING & MOVING ZEEWEED CASSETTES

The following section explains how to safely lift and manoeuvre the cassette using the lifting module.

Membranes will be damaged irreversibly if they are allowed to dry out.

The membranes may only be exposed to open air for a limited amount of time. To avoid unnecessary delay, ensure that this section is read in its entirety before attempting to perform any of the procedures outlined below.

7.2.1 PERSONNEL & EQUIPMENT

A minimum of two operators are required for this procedure, including at least one who is properly trained and certified to operate the crane, hoist, or other lifting apparatus that will be used.

It is also recommended that this process be completed under the supervision of a SUEZ FSR. If an FSR cannot be present, ensure that one has been consulted regarding this procedure and any system-specific requirements before continuing.

This procedure will require approximately 2 hours to complete.

The hoist (or crane) must be load-tested, inspected, and properly rated for the full weight being lifted. All hoist (or crane) operators must be fully certified.

The following equipment will be required:

ZeeWeed cassette lifting module.

Safety gloves, safety glasses, and any additional personal protective equipment as required by local government or facility regulations.

Additional, system-specific tools or hardware (to be outlined by the FSR, if applicable).

7.2.2 DISCONNECTING CASSETTE AERATION & PERMEATE PIPING

The following procedure must be performed when preparing to lift a cassette that is currently installed within the membrane tank.

- To disconnect the cassette from the rest of the system, perform the following steps:
- This procedure involves tasks that may result in injury due to limbs or equipment becoming caught. Use caution while working and make note of possible pinch-points.

- This procedure involves tasks that may result in injury due to strain or overexertion if the proper care is not taken. Avoid awkward postures or repetitive movements while working and rest as needed if discomfort occurs.

- Close and lock-out the cassette's aeration isolation valve.

- Stand off to the side when disconnecting the aeration line from the cassette. Pressurized air may cause the coupling to release violently.

- Partially open the aeration line's coupling and allow any pressurized air to escape slowly before continuing.

- Disconnect the aeration line from the cassette.

- Close and lock-out the cassettes permeate isolation valve.

- Using potable water, thoroughly wash the permeate piping and coupling. Ensure that any accumulated sediment or debris is removed before proceeding.

- Do not allow feed water or debris to contaminate the coupling, or to enter the permeate piping.

- Loosen the coupling that connects the cassette's permeate line to the permeate collection header, and then slide the coup-ling along the cassette's manifold, away from the permeate col-lection piping. Ensure that the cassette is completely disconnected from the permeate header.

- Release the cassette lock(s). For more information about cassette lock location(s) and operation, refer to the technical drawings.

- If necessary, move or restrain disconnected lines so that they will not entangle the cassette as it is lifted.

7.2.3 PREPARING TO LIFT

The lifting module supplied by SUEZ must be used at all times when lifting cassettes. *Do not use chains or fabric straps to lift cassettes unless specifically instructed otherwise by SUEZ.*

When preparing to lift a cassette, connect the lifting module to it in the same manner as when the cassette was first installed. *(See 5.7.17.1 connecting the lifting module to the cassette)*

7.2.4 WEIGHING CASSETTES PRIOR TO LIFTING

This procedure is to be performed whenever a cassette that has been in service is to be removed from the membrane tank.

A cassette that has been in service will weigh more than it did when it was first installed. To avoid severe personal injury caused by a collapse, carefully evaluate the load limits of all lifting equipment, and of the surface that the cassette will be set upon.

A cassette that has been in operation for extended periods may have accumulated significant amounts of fouling. This will increase the cassette's overall weight. The amount of accumulated fouling will vary greatly depending on several factors, including how long the cassette has been in operation since it last underwent a cleaning sequence.

To ensure that a fouled cassette does not exceed the maximum capacity of the lifting apparatus, a crane scale must be used to determine the cassette's full weight before it can be removed from the membrane tank.

If the cassette has not yet been disconnected from the permeate and aeration lines and/or if the lifting module has not yet been connected to the cassette, perform these tasks as outlined in the sections above before continuing.

To measure a cassette's weight, perform the following steps:

Attempting to remove a heavily fouled cassette from the membrane tank may cause excessive stress on the lifting apparatus, resulting in a collapse that could endanger nearby personnel and cause severe damage to the system.

Disconnect the hoist (or crane) from the cassette lifting module and install a properly rated crane scale between the crane hook and the lifting module's lift-point.

While monitoring the reading on the crane scale, begin slowly lifting the cassette. *If the reading begins to approach the maximum capacity of the lifting apparatus, immediately stop lifting, slowly*

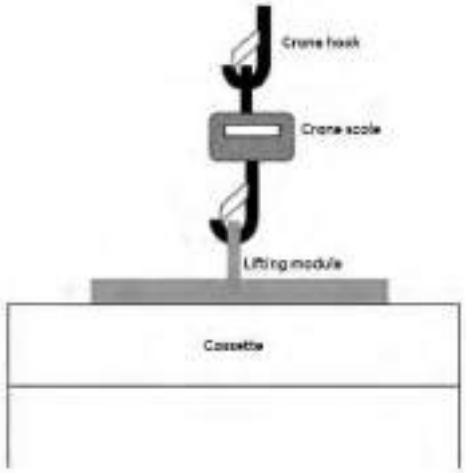


figure 7.2 - typical crane scale assembly diagram

Lower the cassette back into the tank, and initiate a desludging procedure. (See 7.2.6 desludging heavily fouled cassettes prior to lifting)

If the reading does not approach the maximum capacity, continue lifting until the cassette has been raised 15 cm (6 in.), and then pause the lift.

Drain the tank until the water level has been reduced by 5 cm (2 in.), and then monitor the crane scale. After the reading has stabilized, resume the lift.

Repeat steps 3 - 4 until the cassette has been lifted completely out of the water. The cassette's full weight cannot be properly determined until it is fully suspended above the water level.

Record the cassette's final weight, and then lower it back into the tank.

After the cassette has settled into place, remove the crane scale, connect the crane directly to the lifting module, and then perform the cassette removal procedure. *This procedure should not be attempted while the crane scale is still attached to the crane.*

7.2.5 removing accumulated solids during a lift

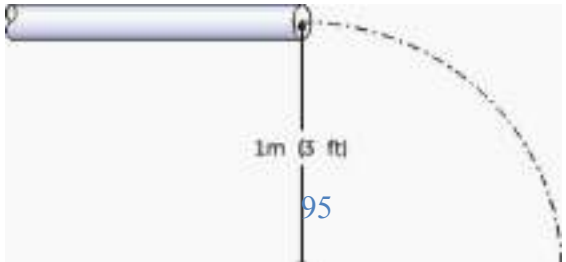


figure 7.3 - water pressure test

Never spray membranes with a high-pressure water stream.

If the cassette's weight is within the acceptable limits of the lifting apparatus, but it still contains a significant amount of accumulated solids, use a garden hose with a rounded head and a low-pressure *stream* to dislodge solids from the cassette as it is being lifted.

To ensure that the water pressure is not excessive, with the hose held horizontally and 1 m (3 ft) above the ground, confirm that the stream does not extend more than 1 m (3 ft) from the hose before reaching the ground. A stream that extends any further with the hose held at this height is too strong to be used on the membranes.

While performing this procedure, wear protective gloves, safety glasses, and any other protective equipment that may be required by local regulations.

tip Dense patches of sludge that have accumulated within 10 cm (4 in.) of the top or bottom headers may be left in place if they prove too difficult to remove without risking damage to the membranes.

To remove accumulated solids during the lift, begin at the top of the cassette and work downward, spraying the cassette frame and the outermost membrane fibers. If several fibers have been bound together by dense sludge, gently remove the sludge by hand while continuing to spray the affected area.

If dense sludge is found nearer to the center of the cassette, consider partially removing the affected module(s) to access the buildup, rather than trying to reach through the fibers of neighbouring modules.

Ensure that the base of the cassette, including the aeration assembly, is also checked for excessive buildup.

7.2.6 DESLUDGING HEAVILY FOULED CASSETTES PRIOR TO LIFTING

- If, after weighing, a cassette is considered too fouled to be safely lifted, remove the accumulated fouling by allowing it to aerate without permeation for 2 - 12 hours, as deemed necessary, and then weigh it again.
- If it is not possible to keep the cassette out of service for an extended aeration period, performing the following desludging procedure instead:
- Initiate a [backwash/pulse] sequence.
- After the [backwash/pulse] sequence has been completed, deactivate the train.
- *tip for best results, use water that is approximately 30 - 35ºC (86 - 95ºF).*
- Drain the tank, and then fill it with permeate or potable water.
- Manually aerate the membranes for 20 minutes at the standard aeration rate. While continuing to aerate the membranes, drain the tank until the first (top) quarter of the cassette is above the waterline, and then stop draining.
- Continue to aerate the membranes for 5 minutes.
- While continuing to aerate the membranes, drain the tank until the first (top) half of the cassette is above the waterline, and then stop draining.

- Continue to aerate the membranes for 5 minutes.
- While continuing to aerate the membranes, drain the tank until the first (top) three quarters of the cassette are above the water-line, and then stop draining.
- Continue to aerate the membranes for 5 minutes.
- While continuing to aerate the membranes, drain the remainder of the tank.
- *tip for best results, use water that is approximately 30 - 35ºC (86 - 95ºF).* Refill the tank with permeate or potable water.
- Repeat steps 4 - 11 while recording the turbidity value of the drained contents. Continue to repeat these steps as needed until the turbidity reading no longer shows a significant change in solids removal from one drain sequence to the next.
- After completing this process, weigh the cassette again before proceeding with the cassette lifting procedure.
- If the cassette is still overweight after the tank has been filled and drained several times, perform a short (2 - 3 hour) recovery clean using permeate or potable water that is approximately 30ºC (86ºF). *(See 8.6.3 recovery clean)*

7.2.7 LIFTING CASSETTES

If, after weighing, a cassette is considered light enough to lift safely, remove the cassette from the membrane tank by performing the following steps:

Ensure that all disconnected lines have been moved so that they will not entangle the cassette as it is lifted.

Slowly begin lifting the cassette. Continue to lift until the bottom of the cassette is at least 15 cm (6 in.) above the top of the tank Membranes will be damaged irreversibly if they are allowed to dry out.

Remove the cassette to a clear, level location and inspect or replace membranes as needed *as quickly as possible*.

7.3 INSPECTING ZEEWEED CASSETTES

When inspecting the membranes, check for the following:

- Obvious signs of damage or wear.
- Clear differences in one module compared to others in the cassette.
- Loose or missing fasteners or other hardware.
- Broken membrane fibers.
- Cracking or breaks in piping and headers.

If any of the above signs of damage are found, contact SUEZ for further assistance. *(See 12.1 contacting SUEZ)*

When replacing the membrane cassette or installing new membranes, ensure that the new membranes are flushed and sanitized before resuming production. The glycerine preservation solution and packing that the

membranes are shipped in are not hazardous materials, but should be disposed of in compliance with local environmental regulations.

7.4 ZEEWEED FIBER SLACK & SHRINKAGE

The amount of distance that separates the two headers in a membrane module can be adjusted to meet the specific operating requirements of each system. Although some adjustment may be required due to unique feed water characteristics, ZeeWeed membrane modules are manufactured with an inherent amount of fiber slack (that is, the length of the membrane fibers is greater than the actual distance between the two headers).

Allowing the proper amount of fiber slack between the headers ensures that the fibers move freely during operation, which improves the effects of air scouring. Additionally, it is common for membranes to shrink slightly during operation, and permitting the proper amount of slack will accommodate this reduction in fiber length.

figure 7.4 - correct (left) & incorrect (right) slack adjustment

7.4.1 FACTORS THAT CAUSE FIBER SHRINKAGE

Shrinkage is a physical change that can be expected in any product composed of synthetic polymers, and is not the result of a defective or damaged product. Shrinkage can cause damage, however, if the initial amount of fiber slack is not sufficient enough to accommodate the reduction in fiber length.

The optimal amount of fiber slack is a function of operating temperature, chlorine concentration, and time, and is thus specific to each system. Significant changes in fiber slack are generally observed in systems with higher operating temperatures, or where modules are exposed to certain solvents sometimes found in certain water treatment applications.

The expected rate of fiber shrinkage is also system-specific. As a general rule, however, high feed water temperatures will result in higher rates of fiber shrinkage.

For example, a system operating at 35ºC (95ºF) will typically exhibit more fiber shrinkage than a system operating at 30ºC (86ºF) over the same period of time. Systems operating at temperatures below 25ºC (77ºF) are not expected to exhibit significant fiber shrinkage, and the need for slack adjustment is unlikely.

7.4.2 RESULTS OF FIBER SHRINKAGE & INSUFFICIENT SLACK

- If the fibers shrink during operation, the predetermined slack will disappear. A module with insufficient slack (“taut fibers”) may not perform at top efficiency because the random motion of the fibers during aeration is critical to efficient filtration.

- It is important for operators to monitor the amount of slack in each module, even with systems operating below 25ºC (77ºF). Any module found to exhibit an insufficient amount of slack should be adjusted

immediately

- Allowing modules to operate with insufficient slack for an extended period of time may cause irreversible damage to the membranes.

- The following table provides a general guide as to how often fiber slack should be inspected, based upon the system's operating temperature. Photographs clearly showing the amount of slack in the module being inspected should be taken to track gradual changes over time.

- If it appears that the slack requires adjustment, it is strongly recommended that these photographs and any other recorded observations be forwarded to SUEZ for review and examination before the adjustment procedure is performed.

Maximum Operating Temperature	Recommended Inspection Frequency
0 - 24ºC (32 - 76ºF)	Every two years
25 - 30ºC (77 - 86ºF)	Once per year
Above 30ºC (86ºF)	Twice per year

table 7.1 - recommended inspection intervals

Failure to identify and promptly address insufficient fiber slack may result in damage to the system. In extreme cases, failure to act may contribute to premature module failures, which may not covered under the warranty

7.4.3 SLACK ADJUSTMENT PROCEDURE

The following section provides information regarding the procedure for loosening or tightening membrane fiber slack.

- Do not allow bare skin to come into contact with feed water during the following procedure.

- This procedure requires the participation of two operators, both of whom should be equipped with proper safety equipment, including face mask, protective gloves, and boots at minimum.

- *tip Depending on environmental conditions, it may be necessary to soak the membranes more frequently than described here.*

- This procedure requires that the cassette be removed from the membrane tank for an extended period. Using a *low-pressure hose*, rinse the membrane fibers after the cassette has been removed from the membrane tank to clear any solids accumulation, and then continue to gently soak the membranes every 30 minutes during the slack adjustment procedure.

7.4.3.1 TOOLS & EQUIPMENT FOR ADJUSTING SLACK

The following equipment will be required during the slack adjustment procedure:

- Slack measurement device.

- Vice-grip clamp.

- Pull rod.

- Measuring tape.

- Indelible marker.

The following equipment will be required during the slack adjustment procedure:

- ✔ Flat-head screwdriver (stainless-steel or plated).
- ✔ *tip If necessary, use the mallet when inserting the pry bar under the cassette beams.*
- ✔ Rubber mallet.
- ✔ Pry bar (stainless-steel or plated).
- ✔ Food-grade anti-seize.
- ✔ Module removal tool.
- ✔ 3/8 in. or 1/2 in. torque wrench (25 - 250 In.-lbs or 3.6 - 29 Nm).
- ✔ 3/8 in. or 1/2 in. ratchet.
- ✔ 17 mm open wrench.
- ✔ 17 mm socket.
- ✔ Food-grade anti-seize.
- ✔ 19 mm socket.
- ✔ 90 mm-long M12 full-thread bolt (stainless-steel or plated) (4).
- ✔ Replacement M10 Nordlocks (12).
- ✔ MIS removal tool.
- ✔ Thin sheet of metal.
- ✔ Module removal tool.

7.4.3.2 SLACK POSITIONS

Membrane slack can be set in one of the following four positions:

POSITION 1: Standard (as-manufactured) position.

POSITION 2: Raises the modules 8 mm (0.3 in.) up from Position 1.

POSITION 3: Raises the modules 16 mm (0.6 in.) up from Position 1.

POSITION 4: Raises the modules 24 mm (0.9 in.) up from Position

figure 7.5 - position holes on center beam

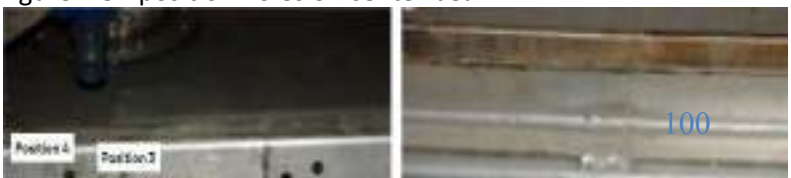


figure 7.6 - position holes on center beam (left) & bottom beam (right)

7.4.3.3 Adjusting slack

Adjusting the amount of slack within the cassette involves two separate procedures, one for repositioning the front and back bottom beams, and another for repositioning the center bottom beam. Before the slack can be adjusted, the following steps must be performed:

tip When facing the front of the cassette, the aeration pipes can be seen on the left side of the cassette.
Using the MIS removal tool, remove all MIS from both the top and bottom beams on the front side of the cassette. *(See 5.12.2 removing modules from cassettes)*

figure 7.7 - MIS

Unlock all module keys (top and bottom). A key is unlocked when turned fully horizontal. Do not apply excessive force when turning.

To adjust the front and back bottom beams, perform the following steps:

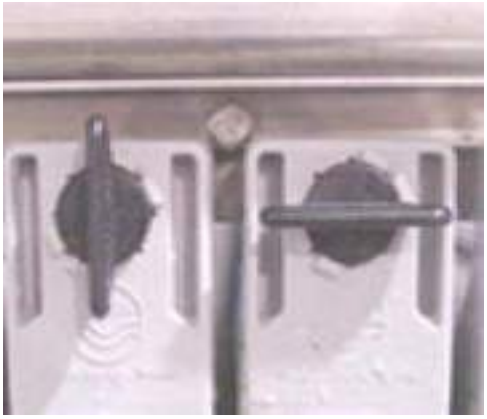


figure 7.8 - unlocked module key (right)
Certain modules will need to be removed to provide access to the positioning bolts on each beam. Which modules must be removed will vary depending on the number of modules installed within the cassette. For more on which modules must be removed, refer to the GA drawings.

tip When facing the front of the cassette, the aeration pipes can be seen on the left side of the cassette.

Loosen the positioning bolt found on the far left end of the front bottom beam *without removing it completely*. Leaving this bolt in place will allow the beam to remain aligned with the adjustment holes.

Remove all other positioning bolts found along the front bottom beam.

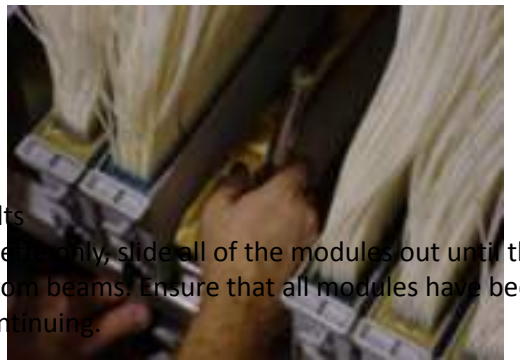


figure 7.9 - removing the bolts
On the front side of the cassette only, slide all of the modules out until they protrude approximately 5 - 8 cm (2 - 3 in.) beyond the top and bottom beams. Ensure that all modules have been completely disengaged from the permeate saddles before continuing.

figure 7.10 - module slid out of cassette

Using the pry bar, lift the far-right end of the front bottom beam until the required amount of slack has been achieved.

figure 7.11 - adjusting the front bottom beam

To secure the beam at the required level, apply a food-grade anti-seize to a positioning bolt, and then insert it into the adjustment hole on the far-right end of the front bottom beam. Ensure that the bolt is inserted with the threads facing outside the cassette. Do not fasten with a bolt at this time.

Remove the positioning bolt from the far-left end of the front bottom beam and repeat steps and, lifting that end of the beam to the same height as the far-right end and securing it with the bolt (as with the previous bolt, apply food-grade anti-seize).

Apply food-grade anti-seize to the remaining positioning bolts, install them, and then tighten all bolts as described in the GA drawings. Ensure that all Nordlock nuts are discarded and replaced with new ones during reinstallation.

Re-install the modules that had been removed, *but do not slide any of the modules back into the permeate saddles.*

After the front bottom beam has been secured, repeat this procedure for the back bottom beam on the opposite side of the cassette.
After both bottom beams have been adjusted, reposition the center bottom beam by performing the following steps:

Slide all modules on both sides of the cassette to the “stop” position on the top header.

figure 7.12 - sliding the modules to the stop position

Remove two bolts from each end of the center bottom beam.

To avoid stepping on the aerators or damaging the membranes, install the bolts from the sides of the cassette.
figure 7.13 - removing two bolts from each end of the center bottom beam

tip Place a piece of thin sheet-metal underneath the L bracket to prevent the bolt and the floor from being damaged.

3. Install the four 90 mm M12 bolts into the L brackets on the centre bottom beam.

figure 7.14 - installing a bolt in the L-bracketv*tip Stagger the adjustment of the four bolts.*

Turn the bolts clockwise with a ratchet until the desired adjustment height is reached.

figure 7.15 - adjusting bolt height
While aligning the adjustment holes, avoid touching any plastic components.

Adjust the ends of the center bottom beam to align the holes. If necessary, insert a screwdriver through one of the holes to help bring the others into alignment.

Apply food-grade anti-seize to the positioning bolts, install them, and then tighten as described in the GA drawings. Ensure that all Nordlock nuts are discarded and replaced with new ones during re-installation.

Remove the 90 mm M12 bolts from the L-brackets.

Reinstall all membranes, and then lock the MIS into place.

Update the Membrane Map by indicating the date of the slack adjustment, the amount of slack added or removed, and the new bolt positions used.

7.5 REPAIRING ZEEWEED FIBERS

Membrane fiber repair is part of the routine preventive maintenance schedule. There are numerous site-specific

factors that influence how often fiber repair is required, however, this procedure should be performed whenever regular testing indicates that broken fibers may be impacting performance. *(See 9 monitoring integrity & performance)*

The procedure used to repair a damaged fiber will vary depending on the type of damage and the location along the fiber where it has occurred. The following sections outline the two primary repair techniques.

The Membrane Map (provided separately) must be updated whenever the fiber repair procedure is performed. Failure to do so may limit future warranty eligibility.

tip SUEZ's optional DispensGun® silicone delivery tool can be used in place of a syringe during the following procedures.

Do not separate strands that are glued together at the header, as this will cause damage to the membranes.

7.5.1 AXIAL SILICONE INJECTION

For leaks detected at the end of the membrane fiber, or for fibers that have been cut badly or completely severed, perform an axial-injection repair by completing the following steps:
Remove the membrane module from the membrane tank and cut off the damaged portion 20 mm (3/4 in.) from the potting material on the ZeeWeed header.

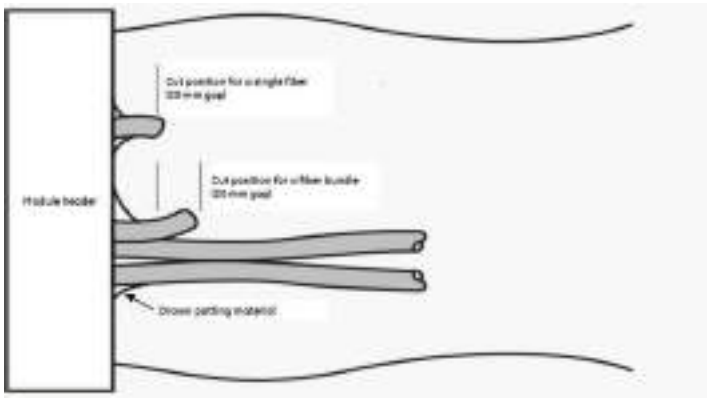


figure 7.16 - membrane fiber cut positions

Using a hypodermic syringe filled with silicone sealant (available from SUEZ as part of a Membrane Repair Kit) insert the tip of the needle 10 mm (7/16 in.) into the centre of the membrane lumen.

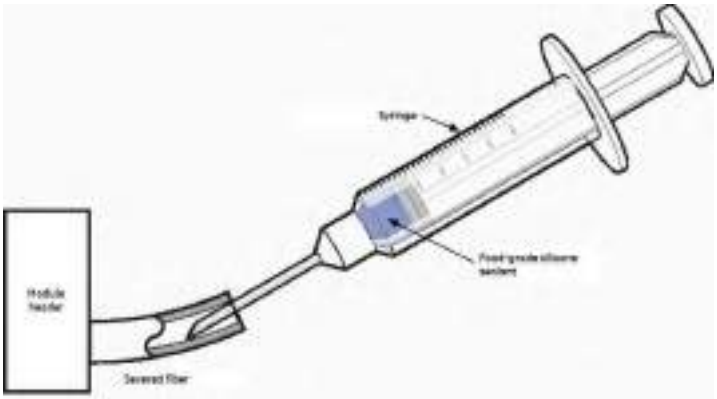


figure 7.17 - axial silicone injection (step one of four)

Apply light pressure when injecting the silicone. Fill the lumen back to the header, as indicated by the darkened zone in *(See figure 7.18 - axial silicone injection (step two of four))*. Filling typically takes 15 - 45 seconds.

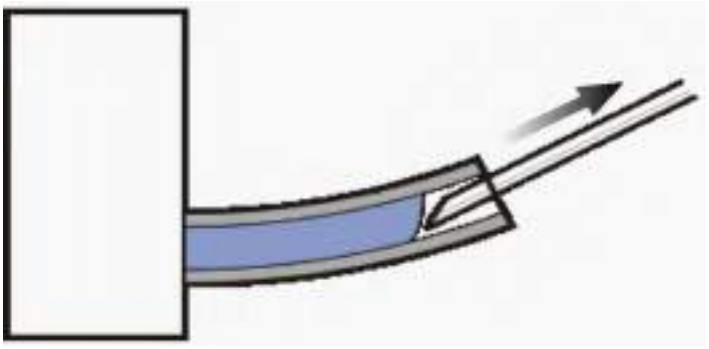


figure 7.18 - axial silicone injection (step two of four)

Slowly withdraw the needle while still injecting silicone to assure the lumen is completely filled.

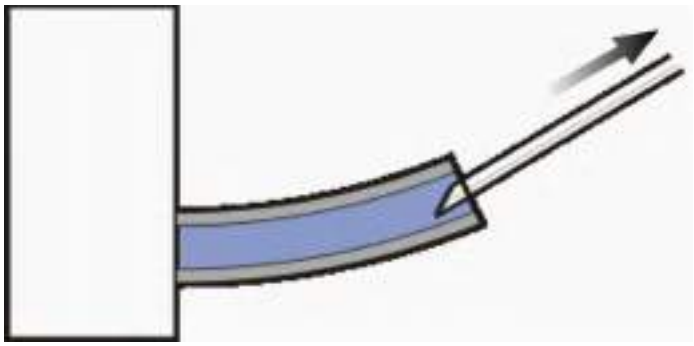


figure 7.19 - axial silicone injection (step three of four)

While still applying pressure to the syringe, use the tip of the needle to spread silicone over the cut end of the lumen.

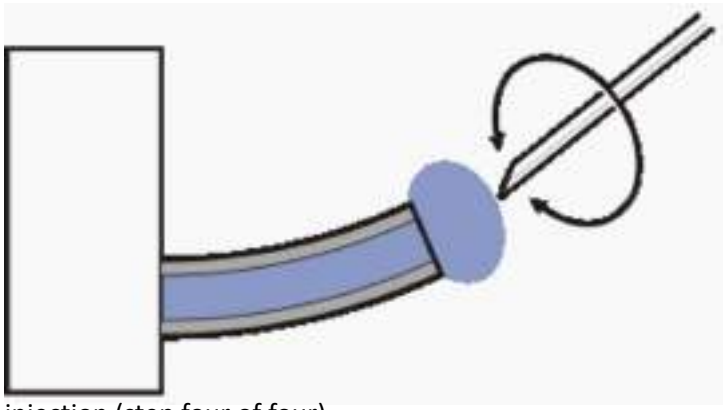


figure 7.20 - axial silicone injection (step four of four)

After the repair is complete, place the cassette back into the membrane tank. Allow 10 minutes for curing before performing further membrane testing.

7.5.2 SUBJACENT SILICONE INJECTION

For leaks detected along the middle of the membrane fiber, perform a subjacent-injection repair by completing the following steps:

1. Remove the membrane module from the membrane tank.
A metal barrier (example: steel ruler) should be used to protect the hand holding the fiber.

Using a hypodermic syringe filled with silicone sealant (available from SUEZ as part of a Membrane Repair Kit), insert the tip of the needle into the lumen. When inserting, hold the syringe at an angle of 5 - 10º to the lumen and insert the tip 5 - 10 mm (3/16 - 7/16 in.) from the leak. Ensure that the needle does not pass through the

lumen completely, but only into the hollow centre.

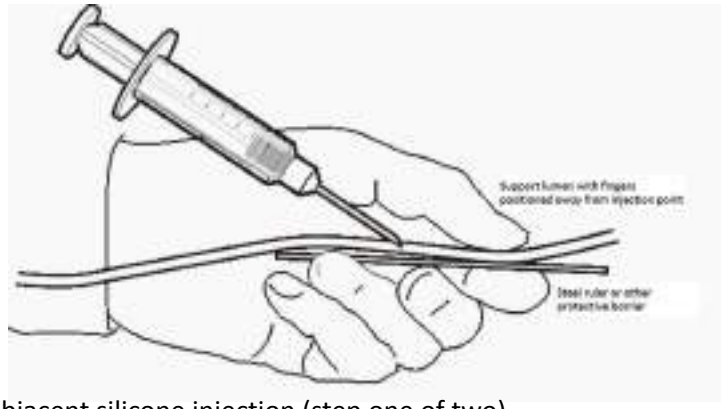


figure 7.21 - subjacent silicone injection (step one of two)

Apply light pressure to fill the lumen with silicone. Continue applying pressure while withdrawing the needle from the lumen, ensuring the puncture is sealed.

Repeat these steps on the other side of the leak, positioning the needle 5 - 10 mm (3/16 - 7/16 in.) from the leak on the opposite side to the first injection point.

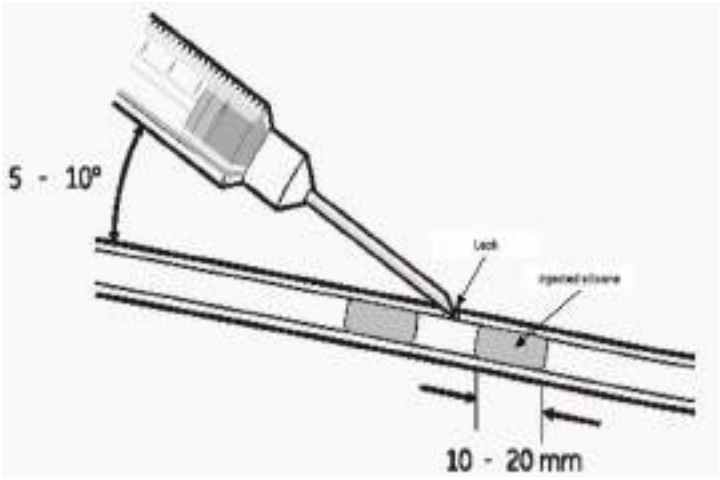


figure 7.22 - subjacent silicone injection (step two of two)

After the repair is complete, place the cassette back into the membrane tank. Allow 10 minutes for curing before performing further membrane testing.

8 CLEANING

This section provides information regarding the various procedures and chemicals used to clean and maintain the system as a whole.

For information specific to individual components, such as pumps and valves, Refer to the manufacturers' instructions

A substantive failure to adhere reasonably to the cleaning guidelines provided by SUEZ, including the use of cleaning chemicals not approved for use in this application by SUEZ, may render the warranty null and void.

8.1 CLEANING SUMMARY

The following table provides key details regarding the chemical cleaning sequences used in this system.

- ✔ Do not pour chemicals directly onto the membranes.
- ✔ Sodium hypochlorite cleaning solution generates a corrosive gas that poses a safety risk to those nearby. Adequate ventilation must be provided.
- ✔ Excessive scaling may raise the pH level of citric acid. When performing an acid maintenance or recovery clean, ensure that the solution pH level is monitored throughout the process.
- ✔ The information provided in the following table is accurate at the time of installation, but is subject to change over time. Contact SUEZ for up-to-date cleaning information. Annotate this table as needed.

Chemical	Purpose	Design Concentration	Frequency	Design pH
High-pH Maintenance Clean				
Sodium hypochlorite 10.8%	Organic Cleaner	200 mg/L	Twice Per Week	Maximum 10.5 at under 30°C (86ºF), 10 at 30 - 40°C (86 -104ºF)
Low-pH Maintenance Clean				
Citric acid 50%	Scale Removal	2000 mg/L	Once Per Week	2.5 - 3.5
High pH Recovery Clean				
Sodium hypochlorite 12 %	Organic Cleaner	1000 mg/L	Twice Per Year	Maximum 10.5 at under 30°C (86ºF), 10 at 30 - 40°C (86 -104ºF)
Low-pH Recovery Clean				
Citric acid 50%	Scale Removal	2000 mg/L	Twice Per Year	2.5 - 3.5

table 8.1 - ZeeWeed cleaning summary

8.2 CLEANING CHEMICALS

- ✔ Allowing solutions containing citric acid and sodium hypochlorite to mix may create deadly chlorine gas, posing a severe safety hazard to all personnel within the facility. Under no circumstances should such solutions be permitted to come into contact with one another.
- ✔ Chemicals must be segregated based on compatibility. When storing chemicals, ensure that all relevant manufacturer's instructions regarding safe storage and handling are observed.
- ✔ *tip for more severe fouling, SUEZ offers additional cleaning chemicals designed specifically for use with systems prone to fouling. Contact SUEZ for more information.*
- ✔ The type of cleaning chemical required depends on the type of fouling that needs to be cleaned. In this system, [high-pH] solution is used to remove biological fouling, while [low-pH] solution is used to remove precipitative fouling caused by accumulated mineral scales, iron, or other metals.
- ✔ Failure to observe all safety precautions outlined in the applicable MSDSs while handling cleaning chemicals may result in injury.
- ✔ Use of unapproved chemicals during a cleaning procedure may void the warranty.
- ✔ Safety and handling instructions for all cleaning chemicals that SUEZ has supplied can be found in the applicable MSDSs.
- ✔ Contact SUEZ for more information regarding chemicals that have been approved for use with this system.

8.3 PREPARING CLEANING CHEMICALS

The sodium hypochlorite cleaning solution should be limited to a maximum pH of 10.5 at a temperature of less than 30ºC (86ºF), and a maximum pH of 10 at a temperature between 30 - 40ºC (86 - 104ºF).

Citric acid solubility is 500 g/L at 10ºC (50ºF). SUEZ does not recommend increasing the concentration beyond this amount.

Ensure that the chemical solution has been prepared in sufficient quantity. Use the following calculation to determine the amount of chemical required per liter of solution:

$$x \times y = z$$

Symbol Represented Value

% by weight (as decimal)

Density

Amount (kg) required per liter of solution

EXAMPLE: For a 50% by-weight solution with a density of 1.24:

$$0.5\,kg \times 1.24\,kg = 0.62\,kg/L$$

If a chemical injection pump will be used to add the solution into the system, ensure that the pump has been set to dose the proper amount when activated. If the solution will be added manually, reconfirm the amount being added before beginning and monitor the addition carefully.

8.4 FREQUENCY OF CLEANS

During normal operation, membranes can become fouled by mineral salts (example: calcium carbonate), iron, insoluble organics (example: oil), and biological matter, all of which can cause a decrease in membrane permeability. How often membranes require cleaning to remove these foulants depends on specific operating conditions, including operating time, various flowrates, and feed water characteristics.
tip Permeability drops if feed water temperature decreases. This decrease is normal and does not necessarily indicate fouling.

8.5 CLEANING LOG SHEET

All information gathered during a clean should be recorded on the cleaning log sheet (provided separately in electronic format). This log sheet should be emailed or faxed to SUEZ so that the effectiveness of cleaning procedures can be verified. *(See 12.1 contacting SUEZ)*

8.6 cleaning methods

The following types of cleaning procedures must be performed at regular intervals in order to maintain normal operating parameters.

When performing a [backwash/pulse], never apply pressure greater than 0.55 bar (8 psig) across the membranes, as doing so may decrease membrane lifespan.

BACKPULSE: A [backwash/pulse] reverses the normal production flow path by pumping permeate back through the membranes from the inside out. This process helps to remove fouling that may have accumulated on the membranes during operation, and is performed frequently at regular intervals. *(See 8.6.1 [backwash/pulse])*

MAINTENANCE CLEAN: Fouling that cannot be removed by performing a [backwash/pulse] must be cleaned using a chemical solution. This process, known as a maintenance clean, involves the use of specialized chemical solutions to dissolve various types of foulants. *(See 8.6.2 maintenance clean)*

RECOVERY CLEAN: A recovery clean is performed only to remove substantial amounts of fouling and involves the use of highly concentrated chemical solutions and extended soak periods. *(See 8.6.3 recovery clean)*

8.6.1 [backwash/pulse]

back pulse cleans are initiated automatically during the normal production cycle according to set point values defined by the operator. back pulse-related set points should be updated periodically to account for changes in operating conditions and feed water quality.

8.6.1.1 initiating a [backwash/pulse]

If necessary, a [backwash/pulse] can also be initiated manually by selecting the related Initiate button in the train's Modes pop-up screen. *(See figure 6.6 - typical UF modes pop-up screen)* The [backwash/pulse] will run for the same duration as an automatically initiated sequence and the [backwash/pulse] timer will be reset so that future sequences occur according to the set frequency.

A [backwash/pulse] cannot be initiated manually if the system is in OFF mode, or if another train is currently undergoing a [backwash/pulse].

When the operator initiates a [backwash/pulse] the sequence begins immediately. The selected train becomes the lead train and the system adjusts the production cycle time to maintain a staggered [backwash/pulse] schedule.

8.6.1.2 analysing [backwash/pulse] data

The information recorded before, during, and after a [backwash/pulse] can be used to determine whether

[backwash/pulse] sequences are being conducted with adequate frequency and duration, as shown below.

TMP values provided in the tables below are intended as examples only and do not reflect the actual parameters of this system.

The sample [backwash/pulse] results shown in the following table indicate an effective sequence.

table 8.2 - [backwash/pulse] results (effective [backwash/pulse])

Point in Cycle		TMP
1	(before [backwash/pulse])	-45 kPa (-6.5 psi)
2	(during [backwash/pulse])	48 kPa (7.0 psi)
3	(after [backwash/pulse])	-41 kPa (-6.0 psi)
4	(after previous [backwash/pulse])	-41 kPa (-6.0 psi)

The fact that there is no difference in TMP between points 3 and 4 indicates that [backwash/pulse] settings are adequate. As the pressure differential between points 1 and 3 is only 4 kPa (0.5 psi), the [backwash/pulse] duration set point does not need to be adjusted.

The sample [backwash/pulse] results shown in the table below indicate a potentially ineffective sequence.

table 8.3 - [backwash/pulse] results (ineffective [backwash/pulse])

Point in Cycle		TMP
1	(before [backwash/pulse])	-45 kPa (-6.5 psi)
2	(during [backwash/pulse])	48 kPa (7.0 psi)
3	(after [backwash/pulse])	-41 kPa (-6.0 psi)
4	(after previous [backwash/pulse])	-38 kPa (-5.5 psi)

The difference in TMP after consecutive [backwash/pulse] sequences (points 3 and 4) indicates that [backwash/pulse] duration may need to be increased, as the membranes appear to be becoming progressively more fouled following each [backwash/pulse] and are not recovering TMP. To verify this, the operator can program an additional [backwash/pulse] beyond the regularly scheduled sessions to see if additional TMP is recovered.

If the membranes cannot be cleaned with more frequent or longer sequences, it is likely that more frequent chemical cleans are necessary.

The sample [backwash/pulse] results shown in the table below indicate another example of a potentially ineffective sequence.

table 8.4 - [backwash/pulse] results (infrequent [backwash/pulse])

Point in Cycle		TMP
1	(before [backwash/pulse])	-48 kPa (-7.0 psi)
2	(during [backwash/pulse])	48 kPa (7.0 psi)
3	(after [backwash/pulse])	-28 kPa (-4.0 psi)
4	(after previous [backwash/pulse])	-28 kPa (-4.0 psi)

The significant difference in TMP pre- and post-[backwash/pulse] (points 1 and 3) indicates that [backwash/pulse] frequency needs to be increased, as there is significant fouling accumulating between each session. The [backwash/pulse] duration is sufficient as it achieves full recovery of TMP, but more frequent cleaning will allow the system to run at a lower average TMP. With a higher number of sequences, it may even be possible to achieve full TMP recovery with a shorter [backwash/pulse] duration.

8.6.2 Maintenance clean

The operator must ensure that there are sufficient cleaning chemicals available and must set the day and time when the maintenance clean is to occur for each train.

tip Cleans should be scheduled during periods when system demand is at its lowest.

figure 8.1 - maintenance clean schedule pop-up screen

There are two types of chemicals used during a maintenance clean. When performed using [high-pH] solution, the maintenance clean removes organic fouling, including bacteria colonies. When performed using [low-pH] solution, the maintenance clean targets inorganic foulants, such as scaling.

Because fouling can consist of a variety of substances, rotating between [high-pH] and [low-pH] cleans (two separate sequences performed during the same cleaning session) is recommended. Other chemical cleaners may also be used if approved by SUEZ. It is recommended that the correct chemicals be selected for each site during the initial operating period.

Other chemical cleaners may also be used if approved by SUEZ. It is recommended that the correct chemicals be selected for each site during the initial operating period.

8.6.2.1 Scheduling a maintenance clean

tip A train cannot undergo a maintenance clean if another train has already entered a non-production mode (examples: [backwash/pulse], maintenance clean).

To schedule a maintenance clean, perform the following steps:

- In the Maintenance Clean Schedule screen, for days when a clean is to occur, enter the start and end times, and then select the Enable button. For days when a maintenance clean is not required, select the Disable button.

- For each scheduled clean, determine the type of chemical that will be used by selecting either of the two chemical buttons.

- In the Maintenance & Recovery Clean Set points pop-up screen, confirm that all set point values are properly defined and then select the type of chemical solution that will be used during the cleaning session. The factory default values and acceptable ranges for these set points are listed in the CLC.

figure 8.2 - maintenance & recovery clean set points pop-up screen

- Record all set point changes.

8.6.2.2 Performing a maintenance clean

If necessary, a maintenance clean can also be initiated manually.

Before doing so, read the information provided in this section.

NOTICE

To avoid damaging the membranes during a cleaning sequence, the CIP or cleaning assembly, including all tanks and piping, must be kept clean at all times (free of debris or other contaminants).

To perform a maintenance clean, in the train's Modes pop-up screen, select either of the two chemical buttons, as needed. *(See figure 6.6 - typical UF modes pop-up screen)*A clean using the selected chemical is initiated and carried out by the PLC. For more information about the automated steps involved in this sequence, refer to the OSC.

To perform a maintenance clean, in the train's Modes pop-up screen, select the related Initiate button. *(See figure 6.6 - typical UF modes pop-up screen)* A clean using the selected chemical is initiated and carried out by the PLC. For more information about the automated steps involved in this sequence, refer to the OSC.

To perform a Maintenance Clean, complete the following steps:

- In the Maintenance & Recovery Clean Set points screen, select the chemical solution that will be used during the cleaning session.

- In the Modes pop-up screen, select the M.CLEAN button. A clean using the selected chemical(s) is initiated and carried out by the PLC.

8.6.3 Recovery clean

A recovery clean should be performed on a regular basis, as well as whenever other, regularly scheduled cleaning sequences fail to restore TMP to the extent required.
This procedure is operator-initiated and requires that the operator be present during the majority of the clean.

A recovery clean can be conducted using *either* [high-pH] (removes organic fouling) *or* [low-pH] (removes inorganic fouling) solution. If two separate sequences are performed during the same cleaning session, the [low-pH] clean typically follows the [high-pH] (site specific).

The complete recovery clean procedure normally requires approximately 6 - 9 hours per train, per chemical (12 - 18 hours if both cleaning chemicals are used).

8.6.3.1 Preparing for a recovery clean

tip as the recovery clean procedure requires that the train be shut down for a minimum of 6 hours, it is recommended that this process be conducted during low-demand periods.

Recovery cleans are initiated manually, and so cannot be scheduled through the PLC.

Before initiating a clean and while the train is still in PRODUCTION mode, record the current water temperature, flux, and TMP level.

8.6.3.2 Performing a recovery clean

After preparing the cleaning solution, perform a recovery clean by completing the following steps:

To avoid damaging the membranes during a cleaning sequence, the CIP or cleaning assembly, including all tanks and piping, must be kept clean at all times (free of debris or other contaminants).

tip The train must be in OFF mode in order for a recovery clean to be initiated.

In the Train Control pop-up screen, select the START RC button. *(See figure 6.6 - typical UF modes pop-up screen)* A recovery clean sequence is initiated and carried out by the PLC. For more information about the automated steps involved in this sequence, refer to the OSC.

Allowing solutions containing citric acid and sodium hypochlorite to mix may create deadly chlorine gas, posing a severe safety hazard to all personnel within the facility. Under no circumstances should such solutions be permitted to come into contact with one another.

8.6.4 neutralization

Following both the maintenance and recovery clean sequences, the contents of the membrane tank must be neutralized before being drained.

To perform a Neutralization sequence, complete the following steps:

[CUSTOM PROCEDURE]

8.7 ventilation

If the system is located indoors, the membrane tank must be properly ventilated. This should include both standard ventilation as outlined by local regulations, as well as forced-air vents in the checker plate above the tank. Vents should only create a small amount of negative pressure above the tank and should be operating at all times.

9.0 MONITORING INTEGRITY & PERFORMANCE

This section provides information regarding the various tools and procedures used to gather performance data and to monitor the physical condition of the system.
This information is essential when assessing long-standing performance issues, establishing trends, and determining the durability of various components.
tip Data must be normalized before it can be properly evaluated. (See 13 calculations)

9.1 ZeeWeed membrane permeability

Membrane permeability is a calculated operating parameter (flux divided by TMP) and should be measured at the following points:

Before and after each membrane clean.

At least once a day before and after a [backwash/pulse].

The effectiveness of each clean can be verified by comparing the membrane permeability measurements taken before and after the clean is performed.

The Membrane Performance screen displays flow and TMP values before, during, and after a [backwash/pulse].

[DELETE THIS TEXT AND INSERT SCREEN ON THIS LINE]

figure 9.1 - membrane performance screen

Water temperature directly affects water viscosity. Therefore, membrane permeability values must be corrected for temperature fluctuation over time in order to provide a meaningful long-term basis for comparison.

9.2 monitoring permeate quality

The following sections outline the various instruments used to monitor permeate quality.

9.2.1 Turbidity meters

Monitoring the turbidity of the permeate produced by a train is one of the primary means of gauging the integrity of the train's membrane fibers. The sample flowrate is critical to obtaining an accurate measurement with a turbidimeters. To avoid false readings, ensure that the flowrate is within the specified range of the instrument. For more information about operating and maintaining turbidimeters, refer to the manufacturer's instructions.

9.2.2 Particle counters

Particle counters are used to detect particles greater than 2 µ and are more sensitive to changes in permeate quality than turbidimeters. In theory, no particle of this size can pass through the membranes, however, air bubbles within the permeate stream can give a false indication of particles. Therefore, values around 10 counts/ml are considered acceptable.

In the event of a permeate particle count greater than 30 counts/ml, a timer starts. If the count has not fallen when the timer elapses, the train is shut down. If the permeate turbidity alarm occurs at greater than 0.5 NTU, the train is shut down immediately.

High counts may occasionally occur following a [backwash/pulse], but they will quickly settle after the permeate

from the [backwash/pulse] tank is flushed from the instrument by new permeate from the membranes.

If there are high counts during permeation, check first for bubbles in the permeate stream, as these will cause the particle counter to register a false high count.

9.3 Membrane Integrity Test

The MIT involves introducing air under pressure into the lumen-side of the membrane. This test provides information on the condition of the membranes and the existence of any broken fibers.

MIT stages include pressurization, pressure decay test (PDT), and repriming steps. Compressed air from an oil-free compressor is fed to the membrane header to pressurize the membranes. The membrane system integrity is then determined by measuring the pressure decay.

The MIT is performed at regular intervals scheduled by the operator (recommended minimum frequency is once a day).

The operator can set the time of day when the MIT will be carried out. Normally, the test is run during off-peak hours. For additional information regarding the MIT procedure and criteria for MIT failure, refer to the controls documentation.

An MIT may be initiated at any point while the train is in ON mode, so long as no other train is currently undergoing an MIT or cleaning sequence.

The MIT result is used to calculate Log Removal Value (LRV). This calculated LRV represents the degree of removal of pathogenic organisms equal to or greater than 3 µm in diameter. For the ZeeWeed system, the calculation is based on removal.

The onscreen interface displays only the current MIT data.

If the train passes the MIT, the membranes are depressurized for a preset amount of time using the air vent valve. [Mixed liquor or Feed water] is then drawn into the membranes by the ejector. If the PLC initiated the MIT, the train switches to STANDBY, ready to enter PRODUCTION mode when required. If the MIT was initiated while the train was in OFF mode, the train returns to OFF.

If the train fails the MIT, membrane repair may be required. *(See 7.5 repairing ZeeWeed fibers)*

9.4 log sheets

Log sheets, which are provided as electronic copies, are used for manually recording operational data and analytical results.

PERFORMANCE LOGSHEETS: Performance log sheets include those used for recording process data. Electronic copies of these documents will be provided by SUEZ. Completed performance log sheets should be emailed to SUEZ on a weekly basis to facilitate the ability of SUEZ to provide guidance.

SETPOINT LOGSHEET: The set point log sheet is used to record all changes made to set points associated with the system or its various components (example: pumps). Because a complete loss of power to the system will cause the PLC to reboot using the original set points stored in the electronically erasable programmable read only memory (EEPROM), it is essential that this log sheet be updated whenever set points are changed so that the most recent values can be re-entered.

9.5 Insight remote monitoring

Insight is a powerful remote-monitoring support tool available as an option with most SUEZ systems. Contact SUEZ for more information about subscribing to this service. *(See 12.2.1 Insight service & support)*

10 PREVENTIVE MAINTENANCE

The information provided in this section is intended as a general preventive maintenance outline that addresses the system as a whole. This section does not cover the entire scope of work required to keep the system operating at peak efficiency.

For detailed preventive maintenance information regarding specific components (example: pumps, valves), refer to the instructions provided by that component's manufacturer.

Before attempting to inspect or repair a component, read all information provided in the manufacturer's instructions.

10.1 SCHEDULING PREVENTIVE MAINTENANCE

Failure to adhere to the preventive maintenance schedule outlined in this manual may render the warranty null and void.

The following schedule outlines the inspection and maintenance tasks that must be performed regularly to maintain optimal performance, and to prevent damage due to wear or corrosion.

For detailed information regarding the inspection and maintenance of specific components (example: pumps, instrumentation), refer to the instructions provided by that component's manufacturer.

Failure to perform the preventive maintenance tasks outlined in the manufacturer's instructions, and to log when these activities are performed, may impact future warranty eligibility.

The following preventive maintenance schedule includes general procedures that should be performed for all assemblies and components in the system, as applicable.

table 10.1 - general preventive maintenance schedule

Task
Daily
Complete the daily log sheet.
Inspect all piping and connections for signs of leakage.

- Check that all chemicals are available in sufficient quantity.
- Clean any spills or debris and remove any corrosion from piping or instruments.
- Confirm all components are fitted securely.
- Check for leaks and excessive condensation.

table 10.1 - general preventive maintenance schedule

Task
Weekly
Check that all flow and pressure instruments are functioning and properly calibrated.
For details, refer to the manufacturers' instructions.
Collect a complete set of water samples.
Check the spare parts inventory and order replacements as needed.
Check all pump seals for signs of leakage and repair as needed.

During production, inspect all pumps for excessive vibration or high oil temperature.
Inspect all pump motor mountings.
Review the most recent operating data and make note of any trends or changes in performance.
Check all couplings for looseness and ensure proper torque values are applied. Refer to the manufacturer's instructions for details.
Monthly
Lubricate all pumps.
Inspect and calibrate all instruments.
Quarterly

Where possible, remove fan covers and clean dust from fans and airways using low-pressure compressed air and/or a dry cloth.

Back up the PLC processor onto the system's EEPROM memory, and copy the PLC ladder logic and operator interface design to an external archive.

Annually

- ✔ Disassemble and inspect all touch-points (that is, locations where two components touch) for corrosion.
- ✔ Disassemble and inspect all flange and gasket mating surfaces for corrosion.
- ✔ Where possible, inspect grounding rods for signs of wear.
- ✔ preventive maintenance schedule
- ✔ Check the ground rod. Copper-clad ground rods last longer than galvanized rods.
- ✔ Also, check the clamp or weld connections for corrosion.
- ✔ Check the tightness of all gaskets, piping, and electrical connections.
- ✔ Confirm all switches and indicators are working properly.
- ✔ Check the expiration date for all chemicals, and replace as needed.
- ✔ Replace the corrosion inhibitor emitters in all electrical enclosures.

Inspect all actuators and replace or repair as needed. Refer to the manufacturer's instructions for details.

- ✔ Five-Year Period
- ✔ Every 2 - 4 years, replace the PLC battery.
- ✔ Every 5 years, replace the UPS.

The following preventive maintenance schedule is specific to the ZeeWeed membranes and related components.

table 10.2 - ZeeWeed preventive maintenance schedule

- ✔ Measure pH of feed water, membrane tank, and permeate samples.ly
- ✔ Measure permeate color, TOC/DOC, and total coliform.
- ✔ Measure feed water Color, TOC/DOC, and TSS/VSS.

Check the indicator cassette's frame and all associated components for corrosion. *(See 10.2 general inspection)*

Confirm that aeration is normal by inspecting aeration pattern(s).

Perform *separate* [low-pH] and [high-pH] chemical cleans.* *(See 8 cleaning)*

table 10.2 - ZeeWeed preventive maintenance schedule Perform a general inspection on the indicator cassette from each train. *(See 10.2 general inspection)* Inspect the inside of the membrane tank for damage. Repair as needed. Confirm that all cassettes sit level in membrane tank(s). cassettes

* Monthly initially until optimum interval is established.

10.2 GENERAL INSPECTION

The general inspection procedure is used to determine the overall state of the system and its various components.

10.2.1 GATHERING & RECORDING INFORMATION

Record the following information for each cassette inspected:

Site name.

Inspector's name.

Inspection date.

Train number.

Cassette position.

Cassette serial number.

In addition to collecting the information listed above, take photos at each step of the inspection and file them with the recorded findings.

Contact SUEZ regarding templates that can be used to organize information collected during inspection.

After completing the inspection, submit all findings, photos, and any updated documents to SUEZ.

10.2.2 INSPECTION FREQUENCY

Inspections should be carried out every 3 months on a single cassette from each train, using the same cassette during each inspection. This cassette, known as the "indicator cassette," acts as a sample for the entire train, eliminating the need to inspect each individual cassette.

tip After the first year of operation, inspection frequency can be adjusted based on past findings and recorded trends in system operation.

For systems with operating temperatures greater than 30ºC (86ºF), or where there is a high possibility that suspended solids might accumulate within the membrane tanks, it is recommended that the inspection procedure be carried out on a monthly basis, rather than every 3 months.

Contact SUEZ for assistance with determining the optimum inspection frequency for this system.

10.2.3 before removing the cassette

The following information should be recorded before the indicator cassette is removed from the membrane tank.

10.2.3.1 checking aeration pattern

Before the cassette is removed from the membrane tank for inspection, perform a visual examination of the aeration pattern with the water level within the membrane tank 7.62 - 10.16 cm (3 - 4 in.) above the top of the cassette. While the cassette is being aerated, a rectangular bubble pattern should be visible on the surface of the water directly above it. Note any inconsistencies, including insufficient or imbalanced air distribution.

10.2.3.2 CHECKING LINES & CONNECTORS

Examine the following components for signs of damage or wear:

PIPING: Confirm that all piping sections connected to the cassette are in good condition. Note any cracks or discoloration and check that all connections are tight.

CONNECTORS & HOSES: Confirm that all connectors and hoses are securely attached and show no signs of wear or damage.

Failure to tighten a coupling according to the manufacturer's required torque values may result in an explosive rupture or violent release. Following installation, all couplings must be inspected for tightness as part of the regular preventive maintenance process.

10.2.4 removing the cassette

When removing a cassette with accumulated solids, verify the rated capacity of lifting modules, cranes, and the cassette lifting frame before attempting a lift. *(See 7.2 lifting & moving ZeeWeed cassettes)*

As the cassette is removed from the tank, use a weight scale to ensure that components under load are within their design capacity. Ensure that the cassette remains level throughout the lift and inspect the aeration assembly for solids accumulation.

10.2.5 AFTER REMOVING THE CASSETTE

The following information should be recorded after the indicator cassette has been removed from the membrane tank.

The unauthorized alteration of equipment or parts provided by SUEZ with the membrane modules may render the warranty null and void.

AERATION TUBES: Clear any blockage found in the aeration tubes and note the location of plugged or clogged aeration tubes on the Inspection Template. To remove blockage, the aeration end caps will need to be removed. These end caps are located on the bottom of the back side of the cassette.

Recheck the aeration pattern

figure 10.1 - removing aeration caps after cleaning.

SHELLS: Closely examine the cassette and membranes for signs of aquatic life, particularly in the form of shells, which can be as small as 1 mm in length.

figure 10.2 - shells

CASSETTE FRAME & HARDWARE: Check the cassette frame welds for signs of leaking or corrosion. Check all connections for loose or missing fasteners.

SOLIDS ACCUMULATION PATTERNS: Take full-length photographs of all four sides of the cassette. Note any solids accumulation on the Inspection Template. Contact SUEZ if excessive solids accumulation or debris (example: twigs, leaves) is found.

figure 10.3 - acceptable (left) & unacceptable (right) solids accumulation

MEMBRANE FIBER SLACK: Check the amount of slack exhibited by membrane fibers in the indicator cassette. *(See 7.4 ZeeWeed fiber slack & shrinkage)*

10.3 inspecting ZeeWeed module interconnecting strips

The Module Interconnecting Strip (MIS) holds groups of membrane modules together in the cassette. MISs require monthly inspection to ensure proper operation.

To complete this inspection, perform the following steps:

Visually inspect all of the MISs and verify that they are firmly attached.

figure 10.4 - MIS location

Verify that all locking keys are tightly locked in the vertical position.

Inspect the MIS locking pins. The locking pins should be in the vertical (locked) position.

Check for wear on the MIS. Each locking pin should lock into position tightly and securely. If the locking pins move freely, the MIS is worn.

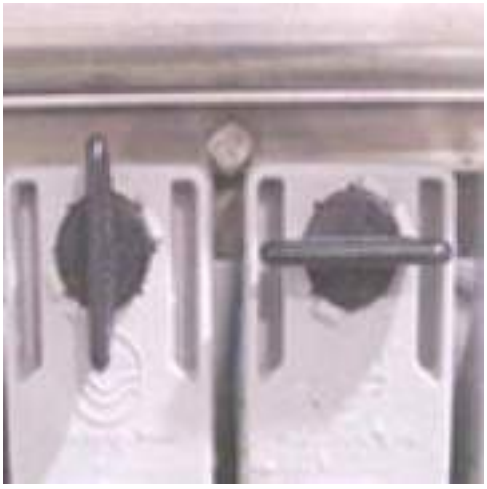


figure 10.5 - locking key locked (left) & unlocked (right)

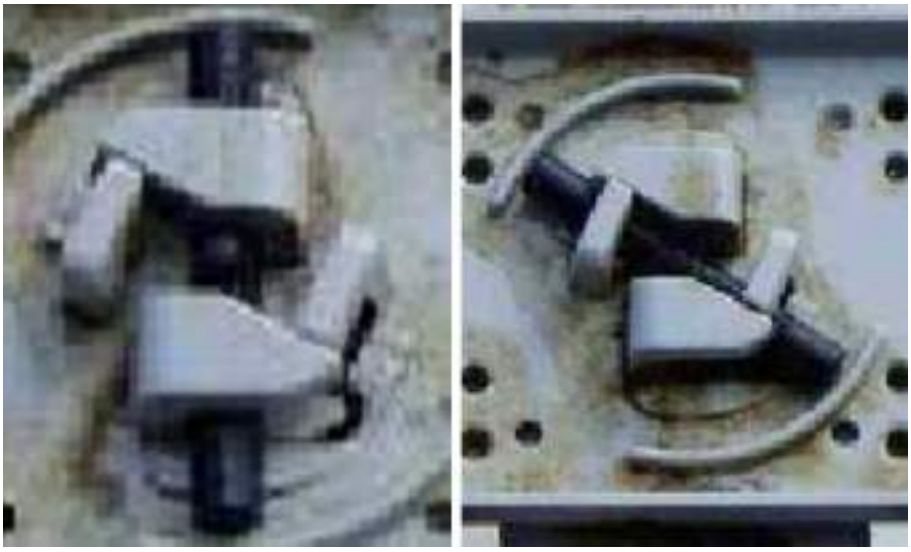


figure 10.6 - locking pin locked (left) & unlocked (right)

Check for independent movement between the module and the locking key mechanism.

Look for wear on the locking key mechanism.

10.4 SPECIAL REQUIREMENTS FOR ZEEWEED LIFTING MODULE OWNERS

Customers who have purchased a lifting module are subject to the owner's responsibilities outlined under ASME code B30.20-2010. Key duties defined by this code include, but are not limited to, the following:

tip These requirements apply only to customers who have purchased one or more lifting modules.

- ✔ Lifting modules that have been altered are no longer rated to perform as per original factory specifications and may present a serious threat to personnel if used. Structural assessments and lift test results confirming that the altered module is safe must be provided by the lifting module's owner, in accordance with all relevant local government, industry, and facility regulations.
- ✔ Regular inspection of a module that has been altered or repaired.
- ✔ Regular confirmation that all necessary decals are present on the lifting module and are legible. In addition to any notices required by local government, industry, and facility regulations, these include decals that display the following information:
- ✔ Empty (unloaded) weight.
- ✔ 'Read O&M manual before using' notice.
- ✔ Rated lift capacity.
- ✔ Load-testing for modules that have been altered or repaired.
- ✔ Creation of a maintenance program.

tip Refer to the relevant ASME regulations for details regarding minimum inspection requirements.

- ✔ Regular recorded service inspections in accordance with frequency of use.
- ✔ Creation of training programs for new operators required to work with or around lifting modules.
- ✔ Ensuring that modules are operated safely.
- ✔ Ensuring that modules are kept in compliance with ASME code B30.20-2010.
- ✔ For a full outline of owner's responsibilities, refer to ASME code B30.20-2010.
- ✔ *tip The codes listed below have been provided here as an additional reference only. Some are specific to certain regions or industries and may not be applicable to this system.*
- ✔ Additionally, the following table lists other codes and conventions that provide further instruction for owners.

table 10.3 - additional codes for owners of lifting modules

Organization or Governing Body	Code
American Society of Mechanical Engineers (ASME)	(B30.20) Below the Hook Lifting Devices
	(BTH-1) Design of Below the Hook Lifting Devices
Occupational Safety & Health Administration (OSHA)	(1926.251) Rigging Equipment for Material Handling
Occupational Health & Safety Act/Regulations (OHSA)	(British Columbia) Reg. 296/97 Part 15 -Rigging
	(Ontario) O. Reg. 213/91 sec. 111 and Reg. 851, sec. 51
American Welding Society (AWS)	(AWS D14.1) Specification for Welding Industrial and Mill Cranes and Other Material Handling Equipment
Canadian Standards Association (CSA)	(CSA W47.1) Certification of Companies
	for Fusion Welding of Steel; (CSA W59)
	Welded Steel Construction (Metal Arc Welding)
American National Standards Institute (ANSI)	(Z535.4) Product Safety Signs and Labels

10.5 PREVENTING STAINLESS STEEL CORROSION

A water treatment system may include various stainless steel components, such as piping and associated fittings and connectors. System operators must follow the preventive maintenance steps provided below to prevent corrosion from forming on stainless steel piping and components.

10.5.1 CAUSES OF CORROSION

Surface contamination and chlorine attack are the primary causes of stainless steel corrosion. Both issues can lead to serious degradation if they are not resolved quickly.

SURFACE CONTAMINATION: If stainless steel components are installed with carbon steel tools, or if they are not protected from nearby welding or grinding work, carbon steel particles may embed in stainless steel surfaces. Exposure to water that contains rust particles or to iron-laden dust and dirt can also cause surface corrosion.

CHLORINE ATTACK: Chlorine-induced corrosion can occur when chlorinated water splashes on stainless steel surfaces, or when chlorine vapours condense on these surfaces due to inadequate ventilation or high humidity.

CREVICE LOCATIONS: Any point where two components touch, and where condensation or moisture may gather, can be considered a crevice location. Streaks of rust that appear to originate from within a crevice location may be indicators of more extensive corrosion that can only be exposed by disassembling the components, so regularly disassembling and inspecting crevice locations is recommended.

10.5.2 PROTECTING AGAINST CORROSION

Take the following precautions to reduce instances of stainless steel corrosion:

CLEAN REGULARLY: Stainless steel piping and components should be kept clean and dry. Keep potential contaminants (example: solvents, carbon steel tools), away from stainless steel components.

MINIMIZE CONTACT: Protect stainless steel surfaces from contact with chlorinated water, and remove contamination as soon as it is observed. Avoid performing tasks such as welding or grinding near stainless steel components. If this sort of work must be done near a stainless steel surface, ensure that it is properly protected.

HANDLING AND INSTALLING COMPONENTS: Properly weld and passivate new or repaired piping. Avoid the use of different metal fasteners and joining components. Ensure that the interior and exterior surfaces of new components are thoroughly cleaned before installation.

If excessive condensation appears on piping surfaces, adjust the ventilation system or add dehumidification measures.

10.5.3 DETECTING, CLEANING & REPAIRING CORROSION

The following sections include recommendations on detecting, cleaning, and repairing corroded or contaminated components.

10.5.3.1 DETECTING EMBEDDED IRON

The simplest test for free, embedded iron is to wash down the stainless steel part with clean water, allow it to dry (or drain), and wait 24 hours. If there are rust streaks on the surface of the stainless steel, iron is present.

The following list provides examples of corrosion and where they may occur:

- ✔ Any rust found on stainless steel.
- ✔ Streaks of rust coming from behind a crevice location (that is, a location where two components touch).
- ✔ Pitting patterns, especially in the vicinity of a weld or weld Heat Affected Zone (HAZ).
- ✔ Cracking, which may be revealed with a dye penetrant.

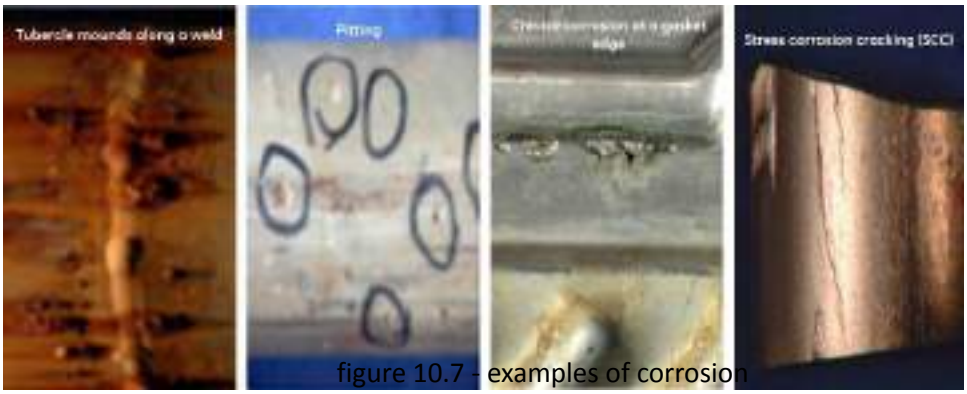


figure 10.7 - examples of corrosion

The ferroxyl test is a more sensitive indicator of embedded iron. To perform this test, apply a ferroxyl solution with a spray bottle, and then check for a blue stain within 15 seconds of the application. A blue stain will indicate iron contamination.

table 10.4 - ferroxyl test solution ingredients

Ingredient	Amount
Distilled Water	1,000 ml
Nitric Acid, 60-67%	20 mL
Potassium Ferricyanide	30 g

When handling this test solution, wear rubber gloves, protective clothing, and a face shield. Avoid inhaling the atomized spray. For additional safety information, refer to the MSDSs for the chemicals used to create the solution.

Prepare the solution specified in the table above by first adding the nitric acid to the distilled water, mixing well, and then adding the potassium ferricyanide.

10.5.3.2 CLEANING & REPAIRING SURFACE CORROSION

Do not allow cleaning compounds to fall into tanks or other vessels.

Any corrosion found on a stainless steel surface can be removed by scrubbing with the appropriate wire brush. After the oxidized areas have been brushed clean, apply a pickling paste to the affected area to chemically clean the surface and remove any embedded contaminants.

table 10.5 - effective cleaning methods

Task	Cleaning Agents	Notes
Routine cleaning	Warm water, soap, ammonia, and detergent 3M Stainless Steel Cleaner	Apply with a sponge or soft cloth.
Smears and fingerprints	and Polish, Arcal 20, Lac-O-Nu, Lumin Wash, Stainless Shine 3M	Provides a barrier film to minimize fingerprints.
Stubborn stains and discoloration	Stainless Steel Cleaner and Polish, Twinkle, Liquid Nu Steel, Household Cleaners	Using a dry or damp cloth, rub lightly in the direction of the polish lines of the stainless steel.
Grease and oil	Any good commercial detergent or caustic cleaner.	Apply with a sponge or soft cloth in the direction of the polish lines of the stainless steel.

There are various protective coatings that can be used as an added precaution to help prevent stainless steel contamination and corrosion. Clear lacquers are preferred over the coloured lacquers and paints, as they allow the operator to check the condition of the stainless steel surface below the coating.

11 TROUBLESHOOTING

This section provides information regarding some of the most common issues and frequently asked questions related to this system and its associated components.

Several training courses related to troubleshooting techniques and skills are available upon request. For more information, contact SUEZ. *(See 12.1 contacting SUEZ)*

11.1 GENERAL PRECAUTIONS

Observe the following precautions at all times while attempting to resolve issues with the system:

Failure to observe the following precautions may result in injury or damage to the system.

When working with a system or component that contains stored energy (example: a pressurized line, a panel with a residual electric charge), ensure that the energy has been dis-charged from all associated components and piping before beginning work. For example, when working with valves connected to compressed air lines, the line must be fully dis-connected from the valve before work may begin. Simply actuating the valve will not sufficiently depressurize the line.

All routine troubleshooting must be carried out according to the safety regulations and instructions specified by

the component's manufacturer. Read all relevant safety information provided in the manufacturer's instructions before attempting repairs.

Wear suitable protective equipment when working with pumps, piping, or other components that may have contained caustic or acidic chemicals.

Proper Personal Protective Equipment (PPE) must be used when carrying out troubleshooting activities involving hazardous materials or situations. Procedures should be developed by the end user to address potential hazards and the PPE required for those situations.

Any questions about the cause or response to a system problem should be addressed to SUEZ field services. Completed daily operating log sheets will be necessary for helping determine the cause.

In the event of a contradiction between information provided in this section and that supplied by the manufacturer, the manufacturer’s information will always take precedence.

Always use the manufacturer's literature for troubleshooting instructions for specific components.

When the diagnostic procedure states that a component should be 'checked', electrical, signal, and/or hydraulic connections should be examined to see if there may be any corroded connections, lose or burned wires, or short circuits. Fuses should be examined for continuity. Switches should be examined for proper position and operation.

Do not change system operating parameters to address any problem where the cause cannot be identified. This may serve to mask operating problems and damage equipment.

11.2 TROUBLESHOOTING QUICK-REFERENCE

The solutions provided in this manual address common issues related to this system. This information is intended only as a brief summary and does not cover all possible issues and scenarios. For more detailed troubleshooting information regarding a specific component, refer to the manufacturer's instructions.

In the event of a contradiction between troubleshooting information provided in this manual and information supplied by the manufacturer, the manufacturer’s information will always take precedence.

In the troubleshooting procedures provided in this manual, when instructed to “check” a component, ensure that the following actions are performed where applicable:

Any and all electrical, signal, hydraulic, and pneumatic connections should be examined for corrosion, loosening, or breakage.

Electrical wiring should be inspected for short-circuits.

Fuses should be examined for continuity.

Switches should be examined for proper positioning and operation.

In situations where the cause of a problem is not clear, or where process changes appear to be required, contact SUEZ before making any significant changes to operating parameters.

If the problem caused a system shutdown, after addressing all possible causes, restart the system. If the system restarts and runs normally for approximately 30 minutes, the problem has been corrected or was transitory. If another system shutdown is triggered, stop all operation and contact SUEZ. Completed operating log sheets will be necessary for SUEZ representatives to determine the cause of the issue.

Troubleshooting procedures involving mechanical or electrical components should be performed only by qualified personnel. All operators must familiarize themselves with the applicable safety information before performing any of the procedures outlined here.

The following table provides troubleshooting information for the ZeeWeed membranes and related components.

table 11.1 - ZeeWeed troubleshooting quick-reference

Cause	Corrective Action
Low Flow Shutdown	
Flow valve or solenoid valve downstream of pump discharge is closed	Check valves for correct operation
Hand valves on pump discharge are throttled or closed	Verify correct position of hand valve, as per P&IDs
High TMP Shutdown (Low Pressure)	
Hand valve upstream of pump inlet is throttled or closed	Verify correct position of hand valve, as per P&IDs
System recovery has drifted to higher than designed limit	Compare current with design system recovery
Membranes require cleaning	Perform a recovery clean. (See 8.6.3 recovery clean)
PID tuning overshooting the flow or pressure control set points after back pulse	Contact SUEZ
Permeate header pressure transmitter or any of the membrane tank level float switches malfunctioning	Check instrument calibration; check readings on HMI
High-Pressure Shutdown (back pulse)	
Hand valve upstream of pump inlet is throttled or closed	Verify the correct position of hand valves, as per P&IDs
System recovery has drifted to higher than designed limit	Compare current with design system recovery
Timers for pressure shutdowns too quick	Contact SUEZ
Level Problems (Analog)	
Failed 24 V DC power supply	Verify power supply outlet
Problems with moisture in probe	Check probe seals

table 11.1 - ZeeWeed troubleshooting quick-reference

Cause	Corrective Action
Level Problems (Digital)	
Switch compromised by chemicals	Inspect switch
Blown fuse	Inspect fuses, replace as needed
Switch programmed incorrectly	Verify switch input to PLC compared to program
Leaking or Cut Fiber	
Damaged fiber	Repair fiber.(See 7.5 repairing ZeeWeed fibers)

11.3 PERMEATE QUALITY

Several issues may result in reduced permeate quality, though the most common are damaged membranes and a leak in the cassette seal. The following information can be used to address both of these problems.

11.3.1 MEMBRANE DAMAGE

To determine if membrane fibers have been damaged, examine the permeate from each membrane cassette, taking particular note of the permeate turbidity and comparing current readings to historical trends. If the permeate does not meet acceptable standards, it is likely that a module within that cassette contains one or more damaged fibers.

After identifying the cassette, locate the damaged module by either visual fiber inspection or by conducting a Bubble Test. *(See 5.9.3 bubble test)*Inspect and repair or replace any damaged modules to bring the overall system performance up to appropriate levels. *(See 7.5 repairing ZeeWeed fibers)*

11.3.2 CASSETTE SEAL LEAKAGE

A leak in a cassette seal may be the result of either improper installation or gradual loosening during operation. Check these connections periodically to ensure that they are properly installed and to avoid permeate contamination by feed water.

11.4 (PERMEATE OR PROCESS) PUMP

Certain types of pumps will lose their prime if excessive amounts of air enter the flow. Water in contact with air at atmospheric pressure naturally contains dissolved gases. After the water crosses the membrane boundary, the lower pressure encountered within the membranes reduces the solubility of these gases, creating bubbles in the permeate flow.

This system includes an air-extraction assembly designed to remove entrained air from the permeate flow before it encounters the [permeate or process] pump. However, if a leak has developed, or if TMP levels are too high, this may not always prevent air from disrupting the pump's operation.

PROBLEM: The [permeate or process] pump will not achieve prime due to air inside permeate header or pump intake line.

Possible causes include the following:

- Air leaks along piping.
- Cracks or missing seals along permeate piping.
- Failed check valves.
- Valves that may allow air to enter the permeate header (example: permeate sample valves) are not closed properly.
- Excessive TMP.

Recommended solutions include the following:

- Close all valves that may allow air to enter the permeate header.
- If a leak is suspected, use a spray bottle to coat fittings and piping along the permeate header with a soap solution and watch for soap bubbles formed during a [backwash/pulse] sequence (when the header is positively pressurized). After locating the leak(s), repair or replace damaged connectors, fittings, or piping

as needed.

- Ensure that the [backwash/pulse] tank volume is well above the discharge point on the tank.

- Determine if the air release valve rubber seat has become stuck. If so, it will prevent air from being vented from the permeate header.

- The higher the TMP, the greater the likelihood of air being pulled across the membranes. If high TMP is suspected of causing excessive entrained air within the permeate header, initiate a chemical clean to restore TMP to an optimal level.

- Request a program change to ensure that flow valves remain open in STANDBY.

11.5 AIR RELEASE VALVES

PROBLEM: Air cannot be removed from the permeate header, due either to the air release valve seat sticking in the top discharge port on the valve housing, or blockage inside the orifice port.

Possible causes include the following:

- Rust formed on the internal surface of the air release valve is preventing the float from rising and falling freely inside the housing.

- The seat is set too far away from the top side of the support arm.

- Flakes of rust from a non-epoxy–coated air release valve housing have broken free and lodged in the orifice vent, creating a blockage and preventing air from being removed from the air separator.

Recommended solutions include the following:

- Shut down the train, remove the air release valve housing cover, and inspect the interior surface of the air release valve. Ensure that the valve fits snugly against the orifice and check for rust. If rust is present, refer to the manufacturer's instructions for additional troubleshooting information.

- Ensure that the float moves freely inside the air release valve housing. If not, remove any obstructions preventing movement.

11.6 AERATION COMPONENTS

Proper aeration is essential for normal operation. To avoid aeration problems, ensure that air filters are replaced in accordance with the manufacturer instructions, and regularly inspect all air connections and piping for damage. Immediately repair any damaged or worn aeration components found during inspection.

11.7 CHEMICAL METERING PUMPS

Use extreme caution when working with or around chemical pumps and associated piping, as significant pressure can build within a blocked discharge line. Proper protective equipment must be worn at all times (goggles, gloves, and a suitable splash apron at minimum).

PROBLEM: The chemical metering pump has lost pressure.

- Possible causes include the following:

- Associated valves are malfunctioning.

- Pump is malfunctioning.

Recommended solutions include the following:

- After ensuring that the pump is deactivated and that all associated lines are depressurized, remove the foot valve from the pump inlet and ensure that no blockage has formed around it or the inlet. After reinstalling the foot valve, perform the same check on all ball valves associated with the chemical skid.

- After inspecting the valves, if the pump still does not operate properly, consult the associated manufacturer's instructions.

- If the manufacturer's instructions do not provide a solution, contact SUEZ for further assistance.

11.8 GENERAL COMPONENT FAILURE

If a component has failed and cannot be repaired by performing maintenance and troubleshooting procedures as outlined in the manufacturer's instructions, ensure that the component has been locked out (if applicable), and then record the make, model, part number, and tag number. *(See2.3.1 locking out components)*

After isolating and documenting the component, check the Recommended Spare Parts List (RSPL) for parts availability and contact SUEZ to order a replacement.

11.9 BACK PULSE TANK ALARM

PROBLEM:

- The back pulse tank level low low alarm has triggered.

- The pump is set in STOP mode.

- Possible causes include the following:

- back pulse tank level is at or below the low low set point.

- Level transmitter has failed.

To resolve this issue, perform the following steps:

- Check the level in the back pulse tank. If the level is not low, then the transmitter is not functioning correctly. Refer to the manufacturer's instructions for troubleshooting procedures.

- *tip for detailed information regarding a particular valve's location or natural state, refer to the technical drawings. For operation and maintenance information, refer to the manufacturer's instructions.*

- Ensure that all valves associated with the back pulse tank are functioning correctly by confirming the following points for each valve:

- The valve actuates correctly when triggered.

- The valve returns to its natural state when the system is deactivated.

- The valve shows no obvious signs of damage or wear.

- When the level of the back pulse tank returns to the operating level, switch the pump back to AUTO.

12 SERVICE & SUPPORT

This section provides information regarding the various support services offered by SUEZ Water Technologies & Solutions. All service bulletins associated with this system are to be inserted at the end of this section.

12.1 CONTACTING SUEZ

When calling to request technical assistance, have the following information ready:

- System model and serial number.
- The date when the system was installed.
- A detailed description of the issue.
- Recently completed Daily Log sheets and a list of current performance parameters (example: flowrates, pressure readings, pH levels).
- The date when a chemical clean was last performed (if applicable).
- Use the following information when contacting SUEZ Water Technologies & Solutions to request technical assistance:

  CONTACT PERSON: Shailesh Patel (service leader).
  PHONE: 099 988 02401
  EMAIL: shailesh.patel@suez.com.

12.2 AVAILABLE SERVICES

SUEZ Water Technologies & Solutions delivers a comprehensive range of services beyond system design and installation. Contact the Service Department (use the support number above) to inquire about the following services:

- ✔ Insight remote-monitoring support and data analysis.
- ✔ Site visits and component audits.
- ✔ Training programs.
- ✔ 24/7 technical support.
- ✔ Emergency call-out support.
- ✔ OEM components and consumable products inventory.
- ✔ Operation & Maintenance agreements.
- ✔ Plant commissioning, optimization, and upgrades.
- ✔ System controls support.
- ✔ Component calibration and preventive maintenance planning.

12.2.1 IN SIGHT SERVICE & SUPPORT

Insight is a powerful plant support tool available to those system owners who choose to subscribe. It provides fully automated process data monitoring and trend analysis, and stores information in a centralized database. This information is then presented to the client in regular reports and is also readily available to SUEZ support personnel.

With Insight, operators can assess trends, solve process problems quickly, improve plant productivity, reduce the impact of operator turnover, and manage continuous software enhancements.
For additional information regarding Insight, or to subscribe to this service, contact SUEZ.

12.2.2 SITE VISITS

SUEZ Water Technologies & Solutions service professionals are on-hand for both emergency service calls (call-outs) and planned service visits. Areas of plant operation that they can assist with include instrument calibration, preventive maintenance planning, process monitoring, and programming modifications. Contact the service department and ask them to develop a service plan tailored to this system.
Emergency call-outs are invoiced based on the field services labour rate sheet, which can be obtained by contacting SUEZ.

12.2.3 TRAINING

Training for all operators is provided at the time of plant commissioning. Customized training packages are available. Contact SUEZ Water Technologies & Solutions for more information.

13 CALCULATIONS

This section provides calculations used in various aspects of system operation and maintenance, such as evaluating performance data and determining chemical requirements.

Additional information may be provided by SUEZ Water Technologies & Solutions personnel during the initial start up period or as part of a regular maintenance service.

13.1 UNIT CONVERSION

- ✔ Convert all values to metric equivalents before performing the calculations provided in this section.
- ✔ *tip Multiply a value in US gpm by 3.785 to get the equivalent in lpm. Multiply a value in lb/ft^3 by 0.016 to get the equivalent in kg/L.*
- ✔ To find the corresponding value in kg/L for a known solution density, look up the density in the following table.
- ✔ Concentrations are given as weight percentages. To create a solution using a dry chemical, use [x]/(1-[x]) kg of chemical for every liter of water, where [x] is the solution concentration written as a decimal.
- ✔ EXAMPLE: To make a 35% calcium chloride solution, 0.35/(1-0.35)
- ✔ 0.538 kg of calcium chloride for every liter of water used to make the solution.

table 13.1 - solution concentrations and densities

Chemical	Solution Concentration (Weight %)	Solution Density (kg/L)
Aluminium sulphate	48.5	1.335

Ammonium chloride	10	1.08
Calcium chloride (35% solution)	35	1.25
Calcium chloride (15% solution)	15	1.15
Calcium hydroxide	5	1.05
Ferric chloride	35	1.36
Citric acid	50	1.24
Phosphoric acid (75% solution)	75	1.582

table 13.1 - solution concentrations and densities

Chemical	**Solution Concentration (Weight %)**	**Solution Density (kg/L)**
Phosphoric acid (85% solution)	85	1.694
Polyaluminum chloride	33	1.205
Potash	25	1.15
Potassium permanganate	3	1.03
Powdered activated carbon slurry	5	1.025
Sodium aluminate (10% solution)	10	1.09
Sodium aluminate (32% solution)	32	1.3
Sodium bicarbonate	3.5	1.035
Sodium bisulfite	40	1.37
Sodium carbonate	10	1.11
Sodium hydroxide (25% solution)	25	1.26
Sodium hydroxide (50% solution)	50	1.52
Sodium hypochlorite (12% solution)	12	1.168
Sodium hypochlorite (6% solution)	6	1.076
Sulfuric acid (77.67% solution	77.67	1.704

table 13.1 - solution concentrations and densities

Chemical	**Solution Concentration (Weight %)**	**Solution Density (kg/L)**
Sulfuric acid (93.19% solution)	93.19	1.834
Sulfuric acid (98% solution)	98	1.836
Urea	23	1
ZenoTreat 150 (antiscalant)	100	1.15
ZenoTreat 450 (antiscalant)	100	1.08

Before mixing solution, consult the applicable MSDS for chemical purity.

13.2 GENERAL DOSING CALCULATION

To determine the amount of chemical(s) required when dosing the subsystem, use the following calculation:

Calculate the flow rate of 35% ferric chloride solution to dose to 60 ppm in a 100 lpm stream.

figure 13.1 - dosing calculation diagram

[Mixed liquor or Feed water] flow rate	Q_f = 100 lpm
Chemical concentration in feed water stream	C_f = 60 ppm (60 mg/L)
Stock solution concentration	C_c = 35% by weight
Stock solution density	r_c = 1.36 kg/L

The mass flowrate of ferric chloride in the feed water stream equals the mass flowrate of ferric chloride dosed.

In the equations below, Q_f and Q_c are in lpm, C_f is in mg/L, r_c is in kg/L, and C_c is weight percent written as a decimal (example: 35% as 0.35).

$$Q_c = \frac{Q_f \times C_f}{\rho_c \times C_c \times 10^6}$$

EXAMPLE:

$$\frac{100 \times 60}{136 \times 0.35 \times 10^6} = 0.0126\, lpm$$

13.3 CALCULATING MEMBRANE PERMEABILITY

To gauge the effectiveness of a cleaning session, calculate the overall permeability of the membranes before versus after the session has been performed.

Refer to the example below when calculating membrane permeability.

EXAMPLE: A system has a typical operating temperature of 20ºC (68ºF) (T_1) and an actual (observed) operating temperature of 15ºC

(59ºF) (T_2). The permeate flowrate was recorded at 3,285.4 lpm (868 gpm) at a membrane pressure of 0.414 bar (6 psi), while total membrane surface area equals 4,548.53 m^2 (48,960 ft^2), based on three cassettes of 48 modules, where each module contains 340 ft^2 of membranes.

1. Calculate the membrane area:

$$M = x \times y \times z$$

Symbol	Represented Value
M	Membrane area per train
x	modules per cassette

y	cassettes per train

$$48 \times 3 \times 340\ ft^2 = 48,960\ ft^2$$

$$48x3x31.59m2 = 4548m2$$

2. Convert flowrate to flux at the observed temperature:

T2 = (x/y) * Z

Symbol	Represented Value
T2	Observed Flux at (15^0C (59^0F))
x	Flow
y	Membrane surface area per train
z	Minutes per day

$$\frac{868\ gpm}{48{,}960\ ft^2} \times 1,440 = 25.5\ gfd$$

$$\frac{3285lmin}{4584m2} \times 1,440 = 43.4lmh$$

Correct the flux value from the observed temperature (15ºC (59ºF)) (T_2) to the reference temperature (20ºC (68ºF)) (T_1).

table 13.2 - water viscosity

Temp. (°C (°F))	Viscosity (cP)	Temp. (°C (°F))	Viscosity (cP)	Temp. (°C (°F))	Viscosity (cP)
1 (34)	1.7311	23 (73)	0.9356	45 (113)	0.5988
2 (36)	1.6736	24 (75)	0.9142	46 (115)	0.5884
3 (37)	1.6192	25 (77)	0.8935	47 (117)	0.5782
4 (39)	1.5677	26 (79)	0.8736	48 (118)	0.5683
5 (41)	1.5188	27 (81)	0.8544	49 (120)	0.5587
6 (43)	1.4723	28 (82)	0.8359	50 (122)	0.5494
7 (45)	1.4281	29 (84)	0.818	51 (124)	0.5403
8 (46)	1.386	30 (86)	0.8007	52 (126)	0.5315

table 13.2 - water viscosity

Temp. (°C (°F))	Viscosity (cP)	Temp. (°C (°F))	Viscosity (cP)	Temp. (°C (°F))	Viscosity (cP)
9 (48)	1.3459	31 (88)	0.784	53 (127)	0.5229
10 (50)	1.3077	32 (90)	0.7679	54 (129)	0.5145
11 (52)	1.2712	33 (91)	0.7523	55 (131)	0.5064
12 (54)	1.2362	34 (93)	0.7372	56 (133)	0.4984
13 (55)	1.2029	35 (95)	0.7225	57 (135)	0.4907
14 (57)	1.1709	36 (97)	0.7084	58 (136)	0.4832

15 (59)	1.1403	37 (99)	0.6946	59 (138)	0.4758
16 (61)	1.1109	38 (100)	0.6813	60 (140)	0.4687
17 (63)	1.0828	39	0.6685	61 (142)	0.4617
18 (64)	1.0558	40	0.656	62 (144)	0.4549
19 (66)	1.0298	41	0.6438	63 (145)	0.4482
20 (68)	1.0049	42	0.6321	64 (147)	0.4418
21 (70)	0.9809	43	0.6207	65 (149)	0.4355
22 (72)	0.9578	44	0.6096		

T1 =T2 * (x/y)

Symbol	Represented Value
T_1	Flux at reference temperature 20°C (68°F)
T_2	Observed flux at 15°C (59°F)
x	Viscosity at T_1
y	Viscosity at T_2

$$25.5\,gfd \times \frac{1.0049}{1.1403} = 22.47\,gfd$$

$$43.4lmhx\frac{1.0049}{1.1403} = 38.2lmh$$

Using the recorded membrane pressure, convert the temperature-corrected flux to membrane permeability.

$$x = \frac{y}{z}$$

X = Membrane permeability

Y = Corrected flux

Z = Membrane pressure

$$\frac{22.47\,gfd}{6psi} = 3.7\,gfd/1\,psi$$

$$\frac{38.2lmh}{0.414bar} = 92.3lmh/bar$$

To accurately assess the effectiveness of a cleaning procedure, measure and record the membrane permeability immediately before and after each cleaning session is perform.

SECTION 8: - REVERSE OSMOSIS

8.1 Basic concept for Reverse osmosis: -

Osmosis is a natural process. When a dilute solution is separated from concentrated solution by a semipermeable membrane pure solvent flows from the dilute solution to the concentrated one through the membrane. If the solvent concerned is water then pure water, separated from a salt solution by a semipermeable membrane readily passes through the membrane. The concentrated solution becomes dilute with this flow of pure water; this flow of water continues until the pressure created by the osmotic head equals the osmotic pressure of the salt solution. This is known as “Osmotic Equilibrium.”

If an external pressure applied on the concentrated solution side, then one of the following three processes can occur. If the applied pressure is less than the osmotic pressure, then pure water continues treat by a high-pressure pump. Feed stream gets divided into a `permeate' stream low in dissolved salts and brine (or reject) stream very high in dissolved salts content.

Dissolved salts rejected by the membrane are continuously flushed from the system via brine stream. A flow control value on the brine stream controls the percentage of feed water that is converted into permeate to flow through the membrane. Its flow rate gets reduced, as it is proportional to the difference between applied pressure and the osmotic pressure.

If this applied, pressure is equal to the osmotic pressure then the net flow of pure water through the membrane stops. If applied pressure is greater than the osmotic pressure, then the pure water flow is reserved. It flows from the concentrated solution to the dilute solution side. This third process is termed as `Reverse Osmosis'. It is advantageously used to remove water from the concentrated solution. During Reverse Osmosis process pressure is continuously applied to the feed.

8.2. Pre checks before RO Installations: -

- Status for RO skid in terms of foundation, alignment for piping
- Status for preservatives inside the RO Membranes before loading
- Availability for oil free instrumental air (requires during backwashing)
- Loop testing for all auto valves, Reediness for operational sequence/ logic for the system
- Lab analysis report for UF permeate water quality (At least for last 3-4 days) consisting of Ph, ORP, TDS, Conductivity, Turbidity, COD, SDI.
- High & Low Pressure switch should be preset.
- Availability of chemicals & Service water for chemical preparations & initial flushing
- Desired chemicals as per the recommended grade/ concentrations
- Availability of loose spares recommended by vendor
- Status for Pipeline flushing, Tank cleaning & closing of the tanks from top to avoid sharp & foreign particles.
- Availability of Micron Cartridge filter as per the recommendation.

8.3. Pre Start up Checks for RO Skid: -

- The MBR pre-treatment system should operate properly and the RO feed water should meet the design requirements.
- Ensure that chemical addition points are properly located and that proper mixing of chemicals in the feed streams can occur. Check the addition of pretreatment chemicals.
- Verify that the drain/waste collection system is functional
- Verify that the PLC program is loaded and functioning
- Complete and electrical system check. Verify that the instrumentation is working and calibration is completed. Calibrate gauges and meters based on manufacturers' recommendations.
- Clean and connect interconnecting piping. Flush pressure vessels & RO piping without membranes to remove fabrication debris. During the flushing operation, check all pipe connections and valves for leaks. Tighten connections where necessary.
- Residual air should be removed from the system during start-up. START UP Check that all valves are closed and pumps are off before starting the system.

8.4. Start up checks of RO membranes: -

- Fill the RO feed tank & analyses its feed parameters such as Ph, TDS, Conductivity, SDI, COD
- Flush the Pressure vessels, pipe lines before RO start up.
- Make sure before taking water inside the RO system, all valve sequence should be ready as per the provided control philosophy & all electrical & instrumental fronts should be ready.
- Operate the RO system as per the slandered process sequence for checking all interlocks.
- Pl install CF as per the standard procedure.
- Insert RO membranes with arrow directions & with all required membrane inter connecting fittings as per

the standard procedure.

- Flush the RO membranes for an hour to remove the preservative used in shipping or the storage solution before starting the equipment.
- Target a filtrate flow of 60% of design during initial operations.
- After 24 hours the filtrate flow can be adjusted to design conditions.

8.5. Start the equipment by following the steps below:

- Pumps should be aligned, lubricated, and properly rotated.
- RO Reject control valves should be fully open along with RO feed pump suction, discharge valves
- Start the feed pump,
- Allow the RO system to flush for few minutes to ensure the system is leakage free & air free.
- Set and adjust the reject control valve manually till designed flow rate.

8.6 pre checks for RO system: -

- Tanks and stationary equipment: -
- Check that all connection is provided in accordance with drawings.
- Check all the tank accessories are suitably installed viz. level gauge, vent, overflow, drain valve etc.
- Check all the flanges are property tightened. Gaskets are placed at all flanges joints.
- Remove temporary supports, bracing etc. if it is installed on equipment.
- Check vessel is thoroughly cleaned from inside and no construction/erection material is left inside the tank. In large size tank it is advisable to enter in the tank and make visual checks.
- Check removal of blind gaskets from nozzles.
- Check whether internal lining (if provided) is done properly.
- Ensure installation of instruments like Level Indicator transmitter & Flow transmitter are provided.
- Check that painting, insulation etc. are done as per requirement
- After through check for all the tanks shall be tested by filling up with water to check for any leakage from joints etc. The procedure for the same is given below.

8.7 Water fill test for non-pressure vessels: -

- The water fill test will be conducted for RO Feed, Permeate, CIP and dosing tanks
- Fill the tank/vessel with service water up to the overflow nozzle or full water supply level.
- Check for leakage from any flange joint etc. and arrest the leakage.
- Check the level indicators while filling the tank, and calibrate the same wherever required.
- Keep the tank in this condition for approximately 4 to 8 hours and observe for any minor leakage.
- Open the tank outlet valve and check for any leakage in outlet pipe. Drain the water from the tank/vessel by opening drain valve.

8.8 Pre-commissioning checks for pumps as explained under:

All pumps will be checked according to the following procedure:

- Check the level of base plate for all pumps
- Check that pump is properly aligned tightened to the base plate.
- Check that inlet and outlet of the pumps are connected and tightened.
- Check that pressure gauges are installed on the delivery of all pumps.
- The pumps alignment has been done after no load test of motors. Ensure the proper direction of rotation of rotating equipment.
- Check the lubricant level before starting the pump. If required fill up to the mark.
- Keep the suction valve in full open position before starting the pump.
- See that tank is filled with water before starting the pump.
- For metering pumps positive displacement type screw pumps. Twin lobe blower, keep the delivery valve of the pump blower in open position before starting.
- Start the pump by pressing ‘ON’ button.
- Slowly open the discharge valve and bring the pump delivery pressure at normal operating pressure.
- The metering pump flow rate will be adjusted by operating the stroke adjustment knob.
- Check for the motor load, pump vibration, overheating etc.

- Run the pump for 6-8 hours and record the bearing temperature, motor load, delivery pressure etc. at regular intervals viz – hr.
- During the test, see that there is sufficient water in the connected tank. Ensure that continuous supply of water to sump/tank is maintained.
- Rectify any abnormality and continue the test.

8.9 Electrical Pre checks: -

- All motors have their running indication on PLC.
- All motors are provided with Local Start/ Stop facilities
- Motors having interlock are provided with Local/ Remote selector switch (local), Auto/ manual switch, Start/ Stop push button and Main/ Standby switch on PLC in Control Room.
- All motors Start/ Stop push buttons, selector for operation of equipment is through soft keys in DCS console.
- While in running condition, motor will not stop due to changer over of mode from Local to remote or Auto to manual and vice- versa.
- For pumps/ blowers acting on interlocks/ program, if the running pump/ blower fails, standby pump/ blower will start automatically, provided, it is in Auto Mode. Manual override for the same is also available. All pumps/ blowers are interchangeable.
- Under no point, working & standby pump will run together in Auto mode and the same is not applicable for Manual mode.
- In auto mode, removal of high level signal will not cause stoppage of running pump.
- All pumps are interchangeable and start depending on liquid level in sump.
- Open & close indication lamps of all on-off valves, running & stop indication for pumps blowers, mixers is provided on PLC SCADA in control room.

8.10 Water Run: -

- The water run shall be conducted after successful pre-commissioning of all the equipment Viz. Motors, pumps, piping, instrumentation, loop checking etc. During water run, water will be taken in the first unit and run through all the process units. This test shall be conducted to check the normal flow conditions and hydraulic system of the plant

- Following checks and procedure shall be conducted before the water run of the plant. Make sure that all the equipment are cleaned thoroughly and all construction debris and removed. All temporary blinds that were put during hydro test of pipe lines and equipment etc. are removed. Make sure that all the utilities are available. Check all valves and gates for smooth operation. Ensure availability of adequate water quantity so as to fill up all the sumps, processing units, storage tanks etc to its full supply level.

- The complete plant can be subdivided into various sections for ease of conducting the water run. This will be done as per convenience of the operator, however ensure that no portion of the plant is left during the water run.

8.11 Commissioning of the Plant :-

- After completion of all trial runs of equipment, water run and checking all systems, the plant shall be commissioned. Commissioning for plant will be done based on the quantity of effluent available and its chemical analysis.

8.12 Sampling and analysis :-

- Start taking samples of influent and effluent and analyse for parameters as given in the later part of the Manual.

SECTION 9: EQUIPMENT PROCESS DESCRIPTION FOR RO PLANT AND TROUBLESHHOTNG

9.1 Equipment process description for RO system:

RO FEED PUMPS (PU-07 A/B):

These pumps are used to feed MBR permeate water to RO plant. These pumps ensure proper pressure and flow at the inlet of High pressure Pumps for Smooth operation of High Pressure Pumps.

ANTISCALENT DOSING PUMPS & TANKS FOR RO (ANTDP-01-A / B & ANTDT-01):

It is proposed to dose special grade Antiscalant in the feed prior to the cartridge filter to prevent saturation of sparingly soluble salts & Silica etc. on RO membrane surface. Raw water contains some sparingly soluble salts, which may be precipitated when its concentration limit is exceeded during RO
Process. This system is provided for dosing of Special Antiscalant, which prevents such probable precipitation.

ACID DOSING PUMPS & TANK (HCLDP-01-A / B & HCLDT-01):

Acid dosing is provided for pH adjustment of RO system to adjust the pH to optimum values as per RO projections. Acid dosing is usually done to increase the pH when Calcium & Magnesium Hardness is present in RO feed.

SMBS DOSING PUMPS & TANK (SMBSDP-01-A / B & SMBSDT-01):

SMBS is provided to remove free residual chlorine from feed water before it enters into RO membrane. Free Residual chlorine is harmful to RO membrane can irreversibly damage to RO membrane.

CARTRIDGE FILTERS (ROCF-01):

Water is further passed to 5 micron cartridge filter Inlet provided to remove fine suspended solids which may escape from the upstream unit, and hence it ensures that RO feed water is free from suspended matter. Micron cartridge filter is an SS 316 Pressure vessel fitted internally with PP wound cartridge elements of 5 micron rating, which removes micron size particles up to 5 microns.

RO HIGH PRESSURE PUMP (PU-11-A / B):

The RO High Pressure Pump provides the required pressure to RO feed to pass through the membranes and to achieve the desired value of TDS reduction. Motor of RO HPP shall be VFD compatible.

REVERSE OSMOSIS SKID (RO PRESSURE TUBES & MEMBRANE):
Osmosis: Osmosis is a natural phenomenon that occurs when two solutions with different Concentrations of dissolved solids are separated by a SEMI- PERMEABLE MEMBRANE. In natural osmosis, the solvent or water in this application travels through the membrane from the solution with the lower concentration of ionic material to the solution with the higher ionic concentration. This process continues until the ionic concentration of both solutions is equal or until the resultant passage of the water through the membrane reaches the OSMOTIC PRESSURE of the solution if the solutions are trapped in a container.

RO pressure vessels & Membranes: These are the cylindrical tube made of GRP or FRP usually 8 inch bore and 4 to 6 meters long. These pressure tube hold the RO membranes inside it and provides flow path to Feed, Permeate & Reject Produced From RO membrane. The water pressure flowing though it is comparatively high hence it is called as pressure tube. We have total 6 nos of Pressure tubes in RO skid. Each pressure tube contains 4 RO membrane element.3 pressure tubes are in 1^{st} stage 2 nos of pressure tubes are in 2^{nd} stage and there is 1 nos of Pressure tube in last stage i.e. 3^{rd} stage.

RO CLEANING SOLUTION TANK & RO CLEANING TRANSFER PUMPS (TK-14 & PU- A / B):
It is necessary to clean the RO unit from time to time as a result of the natural accumulation of some type of Membrane surface foulants. This requirement to clean the RO unit Membrane will be evidenced by one or more of the following symptoms including a reduction in the NORMALIZED PRODUCTIVITY RATE, a reduction in the RO UNIT TOTAL DISSOLVED SOLIDS REJECTION RATE, or an increase in the RO unit operating pressure.

CARTRIDGE FILTER – RO CLEANING (CIPCF-01):
Chemical from CIP tank is further passed to 5-micron cartridge filter Inlet provided to remove fine suspended solids which may present in chemical, and hence it ensures that chemical is free from suspended matter. Micron cartridge filter is an SS 316 Pressure vessel fitted internally with PP wound cartridge elements of 5-micron rating, which removes micron size particles up to 5 microns. Pressure gauges are provided at the inlet & outlet of the micron cartridge filter to measure the differential pressure across the Unit

9.2 Trouble shooting for RO :-
Introduction: -
Loss of salt rejection and loss of permeate flow are the most common problems encountered in reverse osmosis (RO). Plugging of the feed channels associated with pressure drop increase is another typical problem. If the rejection and/or the permeate flow decreases moderately and slowly, this may indicate a normal fouling which can be handled by proper and regular cleaning. An immediate decline in performance indicates a defect or miss operation of the plant. In any case, it is essential that the proper corrective measure is taken as early as possible because any delay decreases the chance of restoring the plant performance – apart from other problems that might be created by an excessively low permeate flow and/or too high permeate TDS.
A prerequisite for early detection of potential problems is proper record keeping and plant performance normalization. This includes proper calibration of all instruments. Without accurate readings it might be too late before a problem is detected and corrected.

Once a performance decline has been identified, the first step in solving the problem is to localize the problem and to identify the cause(s) of the problem. The first step is to evaluate the performance and the operation of the system. This can be done using the data of the record keeping log sheet or of some additional on-line measurements. Then some checks and system tests should be made. Troubleshooting is much more effective if certain system features and equipment are provided, System Design for Troubleshooting Success. If the system data is not sufficient in determining the cause(s) and to recommend corrective action, one or more membrane elements must be taken from the plant and analysed. Element performance analysis includes non-destructive and destructive analysis. Finally, corrective measures are taken to restore the plant performance and to avoid future problems.

Evaluation of System Performance and Operation
If the performance of the membrane system is not satisfactory, the first step is to evaluate the performance and the operation of the entire system. This is done on the basis of normalized plant data, Plant Performance Normalization. When the actual normalized plant performance is compared against the performance at start-up, any significant performance deterioration can be identified.
In case that the initial system performance at start-up is not satisfactory, a comparison of the actual system performance with the ROSA projected system performance under actual conditions is helpful.

ROSA is a tool used to estimate the stabilized performance of a new RO or NF system under design conditions, but it can also be used to estimate the performance of an existing RO/NF system under prevailing actual conditions. This projected performance is based on the nominal performance specification for the FILMTEC™ element(s) used in that system. A fouling factor of 1.00 in the projection is used to calculate the performance of new elements with exact nominal flow rate. A fouling factor of < 1 should be applied when making a design for long-term operation. In a real system, the elements may have a flow performance variation of +/-15% of the nominal value, or whatever variation is specified for this element type. Also the salt rejection of an individual element may be higher or lower than the nominal salt rejection (but not lower than the minimum salt rejection). Therefore, the measured stabilized performance is unlikely to exactly hit the projected performance, but for systems with more than 36 new elements it should come close.

The actual fouling factor of a stabilized new RO system with at least 36 elements should range between 0.95 and 1.05. The actual measured TDS of the permeate should be no higher than about 1.5 times the calculated TDS. For systems with only one or a few elements, the deviation of the measured actual performance from the projected performance may become as large as the specified element performance variation.

If the normalized actual performance has deteriorated too much compared to the initial performance, or the measured actual performance does not match close enough with the projected performance, check the following: Are all meters, sensors and pressure gauges calibrated?

Symptoms of Trouble, Causes and Corrective Measures:
- Trouble with the performance of an RO/NF system normally means at least one of the following:
- Loss of normalized permeate flow rate; in practice this is normally seen as a feed pressure increase in order to maintain the permeate output.
- Increase in normalized solute passage; in RO this is typically associated with an increase in permeate conductivity.
- Increase in pressure drop: the difference between feed pressure and concentrate pressure at constant flow rate becomes larger.
- From such symptoms, their location and kind of occurrence, the causes of the trouble can often be determined. In the following sections, the mentioned three main troubles are discussed systematically.
- Low Flow
- If the system suffers from loss of normalized permeate flow performance and the problem can be localized, the general rule is:
- First stage problem: deposition of particulate matter; initial biofouling
- Last stage problem: scaling
- Problem in all stages: advanced fouling
- A low flow performance may be combined with a normal, a high or a low solute passage. Depending on this combination, conclusions as to the causes may be drawn.

Low Flow and Normal Solute Passage
Low permeate flow associated with normal solute passage can have the following causes:

Biofouling and Natural Organic Matter (NOM): Biofouling of the membranes is indicated by the following changes in the operating parameters, predominantly at the front end of the system:
Permeate flow decreases when operated at constant feed pressure and recovery.
Recovery decreases when operated at constant feed pressure, in cases where biofouling is advanced to large

biomasses.
Feed pressure has to be increased if the permeate flow is to be maintained at constant recovery. Increasing the feed pressure is however self-defeating when done for a long time, since it increases the fouling, making it more difficult to clean later.
Differential pressure increases sharply when the bacterial fouling is massive or when it is combined with silt fouling. Since pressure drop across the pressure vessels can be such a sensitive indicator of fouling, it is strongly recommended that provisions for installing differential pressure monitoring devices be included for each stage in a system.
Solute passage remains normal or even low at the beginning, increasing when fouling becomes massive.
High counts of microorganisms in water samples taken from the feed, concentrate, or permeate stream indicate the beginning or the presence of biofouling. For proper microbiological monitoring. Assessment of the Biological Fouling Potential. When biofouling is suspected, the system should be checked according to the items, System

- **Design Considerations to Control Microbiological Activity.**

Biofilms feel slippery to the touch, often have a bad smell
A quick test for biofouling is the burn test: a sample of biofilm is collected with a spatulum or the point of a knife and incinerated over the flame of a lighter. The smell of a burnt biofilm is like the smell of burnt hair.

Causes for biofouling are mostly the combination of a biologically active feed water and improper pre-treatment. The corrective measures are:
Clean and sanitize the entire system, including the pre-treatment section and the elements. An incomplete cleaning and disinfection will result in rapid re-contamination.
High pH soak and rinse.
The installation or optimization of the pre-treatment system to cope with the fouling potential of the raw water.
Installation of Fouling Resistant (FR) elements.

- **Aged Preservation Solution**

Elements or RO systems preserved in a bisulphite solution can also become biologically fouled, if the preservation solution is too old, too warm, or oxidized by oxygen. An alkaline cleaning usually helps to restore the permeate flow. Renew preservative solution if storing elements. Store in cool, dry, dark environment.

- **Incomplete Wetting**

FILMTEC™ elements that have been allowed to dry out may have a reduced permeate flow, because the fine pores of the Polysulfone layer are not wetted. The techniques to rewet dry membranes.

Low Flow and High Solute Passage

Low flow associated with high solute passage is the most commonly occurring condition for plant failure. Possible causes are:

a. Colloidal Fouling

To identify colloidal fouling:

- Review recorded feed water SDI ‘s. The problem is sometimes due to infrequent excursions or pre-treatment upsets.
- Analyse residue from SDI filter pads.
- Analyse accumulations on Prefilter cartridges.
- Inspect and analyse deposits on feed scroll end of 1st stage lead elements.

The corrective measures are:

- Clean the elements depending on foulants.
- Adjust, correct and/or modify the pre-treatment.

Metal Oxide Fouling: Metal oxide fouling occurs predominantly in the first stage. The problem can more easily be localized when permeate flow meters have been installed in each array separately. Common sources are:

- Iron or aluminium in feed water
- Hydrogen sulphide with air in feed water results in metal sulphides and/or elemental sulphur.
- Corrosion of piping, vessels or components upstream of membrane elements.

To identify metal oxide fouling:

- Analyse feed water for iron and aluminium.
- Check system components for evidence of corrosion.
- Iron fouling can easily be identified from the look of the element

The corrective measures are

- Clean the membrane elements as appropriate.
- Adjust, correct and/or modify the pretreatment
- Retrofit piping or system components with appropriate materials.

Scaling

- Scaling is a water chemistry problem originating from the precipitation and deposition of sparingly soluble salts. The typical scenario is a brackish water system operated at high recovery without proper pretreatment. Scaling usually starts in the last stage and then moves gradually to the upstream stages. Waters containing high concentrations of calcium, bicarbonate and/or sulphate can scale a membrane system within hours.
- Scaling with barium or with fluoride is typically very slow because of the low concentrations involved.
- To identify scaling:
- Check feed water analysis for the scaling potential at prevailing system recovery.
- Analyse the concentrate for levels of calcium, barium, strontium, sulphate, fluoride, silicate, pH and Langlier Saturation Index (Stiff & Davis Saturation Index for seawater). Try to calculate the mass balance for those salts, analysing also feed water and permeate.
- Inspect concentrate side of system for scaling.
- Weigh a tail element: scaled elements are heavy.
- Autopsy tail element and analyse the membrane for scaling: the crystalline structure of the deposits can be observed under the microscope. A foaming reaction with acid indicates carbonate scaling. The type of scaling is identified by a chemical analysis, EDXRF or ICP analysis.
- Scaling is hard and rough to the touch – like sand paper. Cannot be wiped off.

The corrective measures are:

- Cleaning with acid and/or an alkaline EDTA solution. An analysis of the spent solution may help to verify the cleaning effect.
- Optimize cleaning depending on scaling salts present.
- Carbonate scaling: lower pH, adjust Antiscalant dosage.
- Sulphate scaling: lower recovery, adjust Antiscalant dosage and type.
- Fluoride scaling: lower recovery, adjust Antiscalant dosage or type.

Low Flow and Low Solute Passage

a. Compaction and Intrusion

Membrane compaction and intrusion is typically associated with low permeate flow and improved salt rejection. Compaction is the result of applied pressure and temperature compressing the membrane which may result in a decline in flux and salt passage. Intrusion is the plastic deformation of the membrane when pressed against the permeate channel spacer under excessive forces and/or temperatures. The pattern of the permeate spacer is visibly imprinted on the membrane. Intrusion is typically associated with low flow. In practice, compaction and intrusion may occur simultaneously and are difficult to distinguish from each other. Although the FILMTEC™ membrane shows little compaction and intrusion when operated properly, significant compaction and intrusion might occur under the following conditions:

- ✔ high feed pressure

- ✔ high temperature
- ✔ water hammer

Water hammer can occur when the high pressure pump is started with air in the system
Damaged elements must be replaced, or new elements must be added to the system to compensate for the flux loss. If new elements are installed together with used elements, the new elements should be loaded into the tail positions of a system to protect them from too high flux operation. New elements should be distributed evenly into parallel positions. It should be avoided to have vessels loaded exclusively with new elements installed in parallel with other vessels containing exclusively used elements. This would cause an uneven flow distribution and recovery of the individual vessels.

For example, if six elements of a 4(6):2(6) system is to be replaced, the new elements should go into position 4, 5 and 6 of each of the two vessels of the 2nd stage. Likewise, if six elements are to be added, they should go into positions 5 and 6 of the 3 vessels of the 2nd stage of an enlarged 4(6):3(6) system. If for some reason this is not possible, at least positions 1 and 2 of the first stage should not be loaded with brand new elements.

b. Organic Fouling

The adsorption of organic matter present in the feed water on the membrane surface causes flux loss, especially in the first stage. In many cases, the adsorption layer acts as an additional barrier for dissolved salts, or plugs pinholes of the membrane, resulting in a lower salt passage. Organics with a high molecular mass and with hydrophobic or cationic groups can produce such an effect. Examples are oil traces or cationic polyelectrolytes, which are sometimes used in the pretreatment. Organics are very difficult to remove from the membrane surface.
To identify organic fouling:
Analyse deposits from filter cartridges and SDI filter pads.
Analyse the incoming water for oil and grease, as well as for organic contaminants in general.
Check pre-treatment coagulants and filter aids, especially cationic polyelectrolytes.
Check cleaning detergents and surfactants.

The corrective measures are:
Clean for organics. Some organics can be cleaned successfully; some cannot (e.g. heating oil).
Correct pre-treatment: use minimal coagulant dosages; monitor feed water changes to avoid overdosing.
Modify pre-treatment, i.e. oil/water separators.

B. High Solute Passage

1 High Solute Passage and Normal Permeate Flow

High solute passage at normal permeate flow may have different causes.

a. Leaking O-Ring
Leaking O-rings can be detected by the probing technique. Inspect O-rings of couplers, adapters and end plugs for correct installation and as-new condition. Replace old and damaged O-rings.

O-rings may leak after exposure to certain chemicals, or to mechanical stress, e.g. element movement caused by water hammer. Proper shimming of the elements in a pressure vessel is essential to minimize the wear to the seals. Sometimes, O-rings have simply not been installed, or they have been improperly installed or moved out of their proper location during element loading.

b. Telescoping
FILMTEC elements can be mechanically damaged by an effect called telescoping, where the outer membrane layers of the element unravel and extend downstream past the remaining layers. A modest telescoping does not necessarily damage the membrane, but in more severe cases the glue line and/or the membrane can be ruptured.

Telescoping is caused by excessive pressure drop from feed to concentrate. Make sure that a thrust ring is used with eight inch elements to support the elements 'outer diameters.
The operating conditions that lead to excessive pressure drop are detailed in High Differential Pressure.
Telescoping damage can be identified by probing and by a leak test Replace the damaged element(s) and correct the causes.

c. Membrane Surface Abrasion
Crystalline or sharp-edged metallic particles in the feed water may enter into the feed channels and scratch the membrane surface. This would cause salt passage increase from the lead elements. Check the incoming water for such particles. Microscopic inspection of the membrane surface will also reveal the damage. Damaged membranes must be replaced. The prefiltration must be verified to cope with this problem. Ensure that no particles are released from the pump and the high pressure piping, and the piping has been rinsed out before the start-up.

d. Permeate Backpressure
When the permeate pressure exceeds the concentrate pressure by more than 5 psi (0.3 bar) at any time, the membrane may tear. The damage can be identified by probing and by the leak test and confirmed by a visual inspection during autopsy.
When a leaf of a backpressure damaged element is unrolled, the outer membrane typically shows creases parallel to the permeate tube, usually close to the outer glue line. The membrane delaminates and forms blisters against the feed spacer. The rupture of the membrane occurs mostly in the edges between the feed-side glue line, the outer glue line, and the concentrate-side glue line.

2 High Solute Passage and High Permeate Flow

a. Membrane Oxidation
A high salt passage in combination with a higher than normal permeate flow is mostly due to oxidation damage. When free chlorine, bromine, ozone or other oxidizing chemicals are present in the incoming water, the front end elements are typically more affected than the others. A neutral to alkaline pH favours the attack to the membrane.

Oxidation damage may also occur by disinfecting with oxidizing agents, when pH and temperature limits are not observed, or when the oxidation is catalysed by the presence of iron or other metals. In this case, a uniform damage is likely.

A FILMTEC™ element with just oxidation damaged membrane is still mechanically intact when tested with the vacuum decay test. The chemical membrane damage can be made visible by a dye test on the element or on membrane coupons. Autopsy of one element and analysis of the membrane can be used to confirm oxidation damage. No corrective action is possible. All damaged elements must be replaced.
b. Leak

Severe mechanical damage of the element or of the permeate tubing can allow feed or concentrate to penetrate into the permeate, especially when working at high pressures. The vacuum test will show a distinct positive response.

3 High Pressure Drop
High differential pressure, also called pressure drop or Δp from feed to concentrate, is a problem in system operation because the flux profile of the system is disturbed in such a way that the lead elements have to operate at excessively high flux while the tail elements operate at a very low flux. The feed pressure goes up which means increased energy consumption. A high differential pressure causes a high force in flow direction on the feed side of the element. This force has to be taken by the permeate tubes and, in the case of 8" elements, by the membrane scrolls and the fiberglass shells of adjacent elements in the same vessel. The stress on the last element in the vessel is the highest: it has to bear the sum of the forces created by the pressure drops of upstream elements.

The upper limit of the differential pressure per multi-element vessel is 50 psi (3.5 bar), per single fiber glassed element 15 psi (1 bar). When these limits are exceeded, even for a very short time, the FILMTEC™ elements might

become telescoped and mechanically damaged.

Eight-inch elements will break circumferentially at any location of the fiberglass shell, or the end cap will be pushed out, or the spokes of the end cap will break, or the feed spacer will be pushed out from the concentrate channels. Although such damage is easily visible, it does not normally affect the membrane performance directly. However, they indicate that the differential pressure has been too high. Cracks around the end cap because bypass of feed water and may lead to fouling and scaling.

An increase in differential pressure at constant flow rates is usually due to the presence of debris, foulants or scale within the element flow channels (feed spacer). It usually occurs together with a decreasing permeate flow.

An excessive pressure drop occurs when the recommended maximum feed flow rates are exceeded. It can also occur when the feed pressure builds up too fast during start-up (water hammer). The effect is dramatically increased with a foulants being present; especially biofilm causes a high pressure drop.

Water hammer, a hydraulic shock to the membrane element, can also happen when the system is started up before all air has been flushed out. This could be the case at initial start-up or at operational start-ups, when the system has been allowed to drain. Ensure that the pressure vessels are not under vacuum when the plant is shut down (e.g. by installation of a vacuum breaker); otherwise air might enter into the system. In starting up a partially drained RO system, the pump may behave as if it had little or no backpressure. It will suck water at great velocities, thus hammering the elements. Also the high pressure pump can be damaged by cavitation.

The feed-to-concentrate differential pressure is a measure of the resistance to the hydraulic flow of water through the system. It is very dependent on the flow rates through the element flow channels and on the water temperature. It is therefore suggested that the permeate and concentrate flow rates be maintained as constant as possible in order to notice and monitor any element plugging that is causing an increase in differential pressure.

The knowledge of the extent and the location of the differential pressure increase provide a valuable tool to identify the cause(s) of a problem. Therefore, it is useful to monitor the differential pressure across each array as well as the overall feed-to-concentrate differential pressure.

Some of the common causes and prevention of high differential pressure are discussed below.

a. Bypass in Cartridge Filters

Cartridge filters have to protect the RO system from large debris that can physically block the flow channels in the lead-end elements. Such blocking can happen when cartridge filters are loosely installed in their housing, connected without using interconnectors, or completely forgotten.

Sometimes cartridge filters will deteriorate while in operation due to hydraulic shock or the presence of incompatible materials. Cellulose- based filters should be avoided because they may deteriorate and plug the FILMTEC™ elements

b. Pre-treatment Media Filter Breakthrough

Occasionally, some of the finer media from sand, multimedia, carbon, weak acid cation exchange resin, or diatomaceous earth pre-treatment filters may break through into the RO feed water.

c. Pump Impeller Deterioration

Most of the multistage centrifugal pumps employ at least one plastic impeller. When a pump problem such as misalignment of the pump shaft develops, the impellers have been known to deteriorate and throw off small plastic shavings. The shavings can enter and physically plug the lead-end RO elements. It is suggested that the discharge pressure of RO pumps be monitored before any control valves as part of a routine maintenance schedule to see if the pump is maintaining its output pressure. If not, it may be deteriorating.

d. Scaling

Scaling can cause the tail-end differential pressure to increase. Make sure that scale control is properly taken into

account, and clean the membranes with the appropriate chemicals. Ensure that the designed system recovery will not be exceeded.

e. Brine Seal Issues

Brine seal damage can cause a random increase in differential pressure. Brine seals can be damaged or —turned overll during installation or due to hydraulic surges. This results in a certain amount of feed water bypass around the element and less flow and velocity through the element, thus exceeding the limit for maximum element recovery. When this occurs, the element is more prone to fouling and scaling. As a fouled element in one of several multi-element pressure vessels becomes more plugged, there is a greater tendency for the downstream elements to become fouled due to insufficient concentrate flow rates within that vessel.

Sr.	Problem	Cause	Consequences	Action
1	Increase in SDI at CF outlet	a) Change in quantity of raw water. b) Coagulant / Flocculent dosing Malfunction. c) Channelling in the Sand filter. d) Inferior quality of Chemical. e) Inadequate backwash of filter	Fouling of membranes leading to reduction in product flow.	a) Check raw water / Quality. b) Check coagulant flocculants dosing System. Carry out fresh jar test if Required. c) Check sand filter. d) Use right quality of Chemicals. e) Give sufficient backwash to Filters.
2	High / Low pH	a) Acid level low / feed water quality / Flow change. b) Blockage in acid Line.	a) Fouling of Membranes. b) Damage to membranes.	a) Refill acid / Check acid pump suction & discharge. b) Check feed water low. c) Adjust dosage as Needed.
3	Residual chlorine at cartridge filter outlet.	a) Change in quality of raw water. b) Mal operation with sodium bisulfate Dosing pump. c) Mal operation with sodium Hypochlorite Dosing pump. d) Change in raw Water flow.	Damage to RO membranes. (decrease in salt rejection)	a) Check raw water Quality. b) Adjust dosing rate. c) Adjust raw water Flow.
4	Increase in RO feed pressure	a) Increase in RO Feed conductivity. b) Fouling / scaling of Membranes. c) Reject valve mal Operation. d) Pressure gauge Malfunction.	a) Lesser product Flow. b) Lesser Membrane life.	a) Check raw water Quality / SDI. b) Check pressure Gauge. c) Adjust recovery. d) Clean the Membranes.
5	Decrease in normalized permeate flow	a) Scaling / Fouling of Membranes. b) Malfunction of Permeate flow Meter. c) Change in temperature of water	a) Low product Flow. b) Increase in RO Feed pressure.	a) Check raw water quality & SDI. Clean the membranes. b) Use suitable temperature correction factor.
6	Low concentrate flow.	a) RO flow pressure imbalance b) H.P. Pump Malfunctions. c) Malfunction of reject Flow meter.	Scaling / fouling of membranes.	a) Check H.P. Pump. b) Adjust reject valve. c) Calibrate reject flow Meter.
7	Increase in pressure drop.	a) Pressure gauge malfunction. b) Membranes scaling / fouling c) Entry of foreign materials. (e.g. particles coming from the damaged H.P. Pump)	a) Decrease in product flow. b) Lesser membrane life.	a) Check raw water quality & SDI. b) Clean the membranes. c) Check pressure gauge.
8	Decrease in normalized salt rejection.	a) 'O' ring leakage. b) Membrane damage. c) membrane scaling / fouling d) Product Conductivity Meter malfunction.	a) Inferior product quality (high product Conductivity)	a) Probing / profiling to find 'O' ring leakage / Membrane damage. b) Replace damage membranes / 'O' c) Clean the membranes d) Recalibrate Product Conductivity meter.
9	Low pressure at H.P. Pump suction	a) Raw water pump Malfunction. b) Excessive pressure drop at MGF/CF. c) Malfunction of Auto feed water valve / Solenoid valve.	a) H.P. Pump may get damaged due to dry running.	a) Check raw water Pump. b) Give backwash to MGF, change Cartridges. c) Recalibrate pressure Gauge / Pr. Switch. Check solenoid valve / Auto feed water valve.

PROBLEMS	POSSIBLE CAUSES	REMEDY / ACTION

Service/ Regeneration Start permit not coming	1 Local Panel not selected in remote/ or power Off 2 All valves and pumps might not be selected in Auto	1 ON Local Panel and Keep Local Panel in Remote 2 Keep all valves and pumps in Auto
Valves not opening from DCDAS	1 Air supply may not be available 2 Local Panel not selected in Remote 3 Valve open manually 4 Marshalling panel power off	1 Check air supply to Local Panel 2 Select Local Panel in Remote 3 Close valve from hand wheel if open 4 ON power supply to Marshalling panel.
Sodium High Alarm	1 Sodium Analyser sample not coming 2 Analyser chemical empty 3 Sampling solenoid valve, and field sampling valve not open due to power off. 4 MB exhausted or regeneration not proper	1 Check solenoid valve of Sodium Analyser functioning properly. 2 Top up chemicals if less 3 Open sampling valve in field and ON power supply to solenoid and then open sampling solenoid valve from DCDAS 4 Regenerate MB.
Silica High Alarm	1 Silica Analyser sample not coming 2 Analyser chemical empty. 3 Sampling solenoid valve, and field sampling valve not open due to power off. 4 Resin exhausted or regeneration not proper	1 Check solenoid valve of Silica Analyser functioning properly 2 Top up chemicals if less 3 Open sampling valve in field and ON power supply to solenoid and then open sampling solenoid valve from DCDAS 4 Regenerate MB.
MB outlet flow meter not showing any flow.	1 DM Storage tank inlet valve Auto/ Manual not open 2 MB in Rinse due to conductivity high	1 Open DM storage tank inlet valve Auto/ Manual 2 Check the conductivity in field and on DCDAS.
Plant trip due to DP high alarm	1 DP switch valves Low/ High not open or any one open. 2 Vessel/ Resin trap DP switch valves not open or any one open. 3 Resin Leakage from Vessel	1 Open both DP switch low/ high valves 2 Open both Vessel/ Resin trap DP switch valves 3 Open Resin trap valve and check for any resin leakage and take necessary action.
Limit switch feed-back signal not coming	1 Limit switch adjustment disturbed	1 Adjust again limit switch.

In case of full fit or heat Sanitizable elements there are no brine seals installed. This is to deliberately encourage a flow around the sides of the elements to keep them free from bacterial growth. Brine seals should not be installed in plants that use full fit elements as there is no groove in the element to keep the brine seal in place, it would eventually become dislodged and cause unpredictable problems in the system.

f. Biological Fouling

Biological fouling is typically associated with a marked increase of the differential pressure at the lead end of the RO system. Biofilms are gelatinous and quite thick, thus creating a high flow resistance.

g. Precipitated Antiscalant

When polymeric organic antiscalant come into contact with multivalent cations like aluminium, or with residual cationic polymeric flocculants, they will form gum like precipitants, which can heavily foul the lead elements. Cleaning will be difficult; repeated application of an alkaline EDTA solution may help.

Trouble Shooting for Mechanical Parts:

Sr. No.	Name of the section or part to be attend	Maintenance to be Carried Out	Frequency at which maintenance & inspection to be done	Remarks

1	Bearings	Checking of Temperature with thermometer	Two months	Hot ball or roller bearings point to too much oil or grease. Hot sleeve bearings need more oil or heavier lubricant. If does not correct, dissemble and inspect the bearing alignment of pump and driver.
2	Glands	Changing of Gland packing	Two months	
3	Bearings	Lubrication (greasing)	Two months	Check for saponification resulting in whitish color. washout with kerosene.
4	Gauges	Checking of pressure and vacuum gauges.	Three months	
5	Valves	Changing of gland packing in delivery sluice valve, suction valves, bye pass valve. Reflux valve.	Six months	
6	Exhaust pump & Its auxiliaries	Checking of gland packing & its auxiliaries	Six months	
7	Impeller.	Checking of impeller blades. Sleeves efficiency rings, bearings necking impeller nut	One Year	

F. Troubleshooting for electrical parts:

Sr. No.	**Name of the section or part to be attend**	**Maintenance to be carried out**	**Frequency at which Maintenance & inspection to be done**	**Remarks.**
1	Motor stator and Rotor	Opening of end covers dust blowing and checking of air gap.	One month	-
2	Slip ring device.	Cleaning of slip rings and adjustment of carbon brushes short circuiting jaws, oiling of cloth etc.		Depending on the working conditions & maintenance staff available.
3	Bearings		Two months	
4	Windings	Checking of motor after taking out its Rotor. dust blowing. Checking of end connections of stator. Rotor and taking insulation test no load rest before putting the motor on load.	Two years	

G. Safety tips:

There are a number of precautionary measures, which are common to all acids. These are as follows:

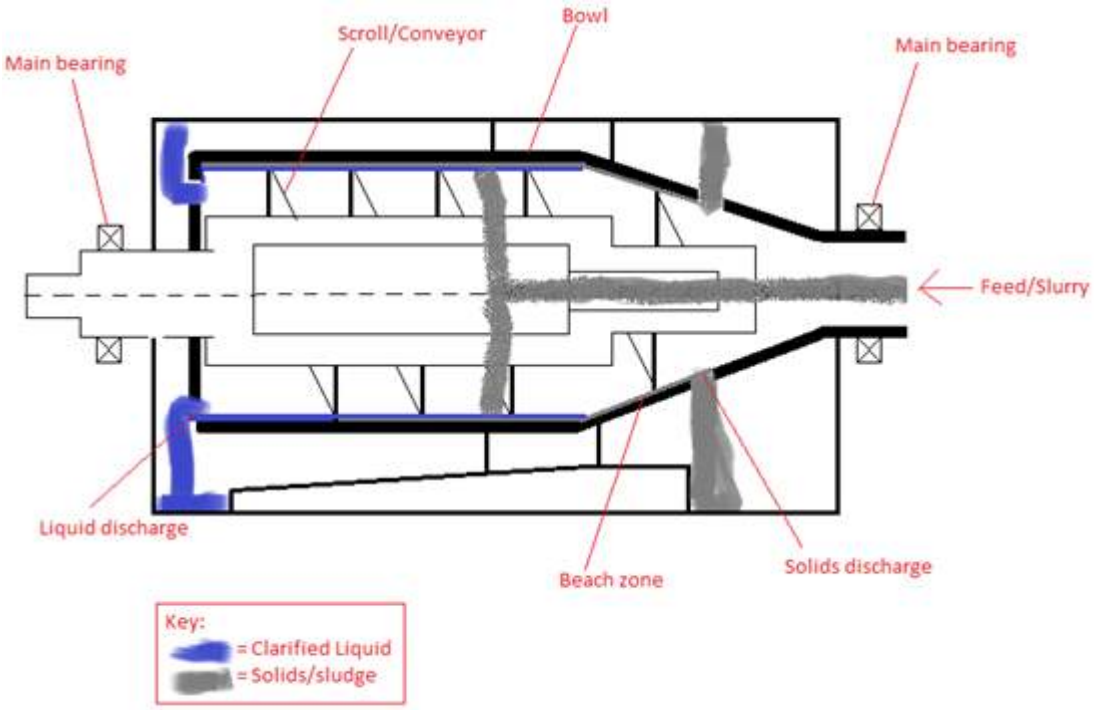
- Personnel should be aware of the character of the acids and their hazards.
- Avoid contact with the eyes, skin and clothing.
- Goggles must always be worn during the handling of corrosive acid.

- Protective clothing should be worn, rubber boots or clogs for the feet, aprons for the body and gauntlets or gloves for the bands.
- A plentiful supply of water must always be available. A bath or shower of water adjacent to the working area is an advantage. Tepid water should be supplied so that any possibility of shock is reduced to a minimum. The shower must be equipped with fool proof and easily - operated valve.
- An eye wash bottle, containing clean water, should be readily available.
- Smoking or naked lights should be prohibited in the vicinity of vessels containing acid.
- Acid supplied in mid steel drums may liberate hydrogen. The bung should therefore, be carefully slackened to release any excess pressure before removal, and this should be done on receipt and after that at frequent intervals or at any time when bulging of the drum is noticeable.
- Do not discharge drums or carboys by the application of pressure to the containers. Discharge by pouring, siphoning or by means of an approved discharge device.

SECTION 10.0 SLUDGE DEWATERING SYSTEM

10.1 Decanter centrifuge:

The Decanter Centrifuge works on the principal of gravitational separation. The natural tendency of the higher density materials to settle out from bulk stream is further enhanced in the Centrifuge through continuous rotation, producing a gravitational force between 1000 to 4000 times to that of normal gravitational force which reduces the settling time.
The schematic given below explains the feed path and separation of solids.



10.2 Start Up & Shut Down Procedure:

The Pre-treatment section of chemical treatment and filtration is semi auto. The individual drives and valves can be operated from the field as well as from the PLC.

Please refer the Control Philosophy for the detailed description of the startup and shut down procedures. For understanding purpose following manual start up sequence is described.

10.3 Decanter Centrifuge (Sludge Handling)

Start Up:

Decanter operations are semi auto and the Centrifuge feed pumps to Centrifuge & Centrifuge feed pumps. Polyelectrolyte dosing pumps to Centrifuge respectively as required. And the decanter machine is protected with level switches in the respective tanks.

- Check the sludge consistency of the feed sludge available in the sludge tank.
- Conduct the Jar Test for sludge dewatering with selected Polyelectrolyte and work out the optimum dosage.
- Check and ensure Polyelectrolyte solution tank level and concentration of the solution.
- Check and ensure feed pump isolation valves are full open.
- Start the Decanter and after it attains full speed open the flushing inlet valve.
- Flush the decanter at 1-2 m3/hr for 5-10 minutes.
- Close the flushing inlet valve and Start the Decanter feed pump
- Start the Polyelectrolyte dosing pumps to Centrifuge respectively as required.
- Check the Centrate and sludge quality and adjust the feed flow rate or Polyelectrolyte dosing rate as per requirement.

Shut Down:

- Stop the decanter feed pumps & Polyelectrolyte dosing pump.

- Open the flush line valve and start flushing the decanter for 10-20 minutes.
- Close the flushing inlet valve.
- Stop the decanter.

10.4 Operation Limits & Guidelines:

Sr. No	Parameter	Unit	Limit Value & Guidelines
1	Feed Flow	m3/hr	< 2
2	Feed Sludge Consistency	wt/V %	< 1.5 %
3	TSS in Centrate	mg/ltr	< 500
4	Flushing Frequency	NA	At Every Start & Stop **OR** After Every 8 hrs of continuous operations.

10.5 Trouble shooting for Decanter Centrifuge

Defect	Cause	Remedy
Carryover of solids in Centrate	Decanter feed flow rate high.	Check and adjust the feed flow rate.
	Feed sludge TSS high.	Check inlet sludge quality, you may have to decrease feed flow proportionately.
	Inadequate Dewatering Polyelectrolyte dosing.	Check and adjust the poly electrolyte dosing.
	Channelling/ scaling in the decanter bowl.	Flush the decanter for 20-30 minutes with clear service water.
	Low Decanter Scrapper speed	Check and adjust the scrapper speed.
Low sludge cake consistency.	Decanter feed flow rate high.	Check and adjust the feed flow rate.
	Low feed sludge TSS	Check and adjust the feed flow rate.
	Inadequate Dewatering Polyelectrolyte dosing.	Check and adjust the poly electrolyte dosing.
Vibrations in the feed line or Decanter machine.	Decanter feed flow rate high.	Check and adjust the feed flow rate.
	Channelling/ scaling in the decanter bowl.	Flush the decanter for 20-30 minutes with clear service water. Check performance, open and clean the bowl if required.
	Feed Line choked.	Check and clean the feed line.

SECTION 11: CONTROL PHILOSOPY

11.1 MBR STP CONTROL PHILOSOPHY

Read this document in conjunction with the following documents:

1	P & ID for Sewage Treatment Plant –PID A1-JWL-2852-01-01 TO 09 Rev 05 dtd: 26.03.19	
2	PLC I/O List	-A4-JWL-2852-INST-SCH -01- Rev. R0 dtd : 26.04.2018

We have design control concept for Sewage Treatment System will be such that the operation of the total Treatment System can be monitored and controlled through PLC based Local Control Panel.

LT ELECTRICAL DRIVES

The Following are the signals available from MCC for each Electrical drive. These signals will be used in the drive logic, SCADA indication and alarm generation.

I/O	QTY (No's)	DESCRIPTION	STATUS	INDICATION
DI	3	Run Feedback	Event	SCADA indication
		Trip Feed back	Alarm	
		Local remote Feedback	Event	

DO	1	Start /Stop COMMAND	Command	SCADA indication

- When any pump is selected to REMOTE mode from its Dedicated MCC Panel, it is deemed to be available to the control system for AUTO/MAN operation from the SCADA. It can be selected to AUTO OR MANUAL mode from the soft selector switch on the SCADA

- When a pump is selected to AUTO mode, it runs as per the PLC logical sequence. When selected to MANUAL mode, it can be started/stopped from the Local push buttons. However, the pump can be stopped by pressing the EMERGENCY STOP P.B on the LPBS either on Auto/Manual mode

- All the pumps shall have Running hours indication on the SCADA.

- Pump run command shall be withdrawn on loss of status signals and on the receipt of alarm signals (as mentioned in the table) and the corresponding alarm shall be generated.

- Individual pump & blower motor running hours will be monitored on the SCADA. If the running hours of a particular motor reaches or exceed 24 hrs it will be stopped and the next available pump/Blower will be started if the pump starts permissive are satisfied.

- If there is no standby pumps available the same pump would continue to run.
  CONTROL PHILOSOPHY FOR PNEUMATICALLY ACTUATED VALVES Pneumatic valves will have the following PLC I/O's

I/O	QTY (No's)	DESCRIPTION	STATUS	INDICATION
DI	2	Open Limit switch feedback	Event	SCADA indication
		Close Limit switch feedback.		
DO	1	OPEN/CLOSE COMMAND	Command	SCADA indication

Each valve will have AUTO/ MAN soft selector switch on SCADA. In AUTO mode, the valve operates as per the PLC logic. In MANUAL mode, the valve can be operated (open/close) from the SCADA push buttons.

When a valve OPEN/CLOSE command is given, if the feedback is not received for more than 10 sec alarms will be generated on SCADA

STP OPERATION PHILOSOPHY

The system has 1100 M3/day feed single stream. And includes one Sewage sump, transfer sump, transfer pump, equalization tank, equalization transfer pump & aeration tank, MBR Unit & RO system.

THE OPERATION OF MBR & RO MEMBRANES ARE PLC BASED (Sumps S5MBTK-01, S2S3TK- 02, & S4TK-03 & related pumps will be operated from panel which is in client scope):

COLLECTION/EQUALIZATIONTANK(S5/MBTK-01), COLLECTION/EQUALIZATION TRANSFER PUMPS (PU-01A/B)

Tank (S5/ MBTK-01) is provided with Level Switch (LS 0101). This Level Switch is envisaged to sense the High, Mid & low, level set point in respective tanks [A4-JWL-2852-INST-SCH -01- Rev. R0 dtd: 26.04.2018]. The Raw Sewage Transfer Pump (PU-01A/B) will be started automatically when level reach above (User settable time) than low level & trips automatically when the level reaches low level in respective tanks.

The Raw Sewage Transfer Pump (PU-01A/B) with 1 working 1 standby philosophy are provided for transferring Sewage from the collection tank to STP Equalization Tank Any of the pumps will be selected for standby duty, which would start manually in the event of failure of running pump.

The Flow Transmitter (FT 0101) is provided in discharge line of Raw sewage transfer pump (PU-01A/B) to provide flow in PLC system.

RAW SEWAGE TANK AIR BLOWERS (ABL-01A/B)

These air blowers will aerate and mix the sewage collected in Raw Sewage Tank (S5 / MBTK 01). The Two sets of blowers are provided for Sewage tank ABL-01A/B with 1 working 1 standby philosophy each. The air blower ABL-01A or 01B rotate on the duty cycle timer or if any of the running blower fails the standby blower would start manually.

In case of high pressure at the outlet of the Blower, the pressure safety PSV0101 & PSV0102 valve will release the pressure into the atmosphere

EQUALIZATION TANK (TK- 04), EQUALIZATION TRANSFER PUMPS (PU-04A/B)

Equalization tank (TK 04) is provided with Level Switch (LS 0301). The Level Switch is envisaged to sense the High, Mid & low, level set point in tank. The Equalization Transfer Pump (PU-04A/B) will be started automatically when level reach above low level & trips automatically when the level reaches low level in respective tanks.

The Equalization Transfer Pump (PU-01A/B) with 1 working 1 standby philosophy are provided for transferring Equalized Sewage from the above tank to bar screen chamber (MBSC-01). Any of the pumps will be selected for standby duty, which would start manually in the event of failure of running pump.

The pumps running is interlocked with the low level alarm in the equalization tank as well as the Membrane Tank (TK-07) level High High alarm (LT 0501). Equalization Tank Transfer Pump are also interlocked to stop run If the MBR is in MAINTENANCE or RECOVERY CLEAN.

LS 0301	Level indication on SCADA
LAL 0301	According to the set point of low level of EQUALIZATION TANK, The Equalization Transfer Pump (PU-04A/B) will be tripped.

MIXING BLOWERS (ABL-04A/B)

Mixing blowers will aerate equalization tank TK 04 as well aeration tank TK-06. We have provided two mixing blowers (ABL-04A/B) with 1 working 1 standby philosophy. The blowers rotate on the duty cycle timer or if any of the running blower fails the standby blower would start manually.

PSV 0401 & PSV0402,	In case of high pressure at the outlet of the Blower, the pressure safety valve will release the pressure into the atmosphere

ACID DOSING TANK (ACIDDT-01); PUMP (ACIDDP-01A/B)

Acid dosing pumps (ACIDDP-01A/B) are used to dose Acid in equalization tank (TK-04). The stroke adjustment on the pump is auto with respect pH Level in inline transmitter (AT0301); it will be set during the commissioning. Further optimization of the pump stroke can be done during plant operation.
There is low level switch (LS0801) in acid dosing tank, to provide feedback to the PLC for alarming on the SCADA. The operator can take necessary action of loading the chemical in the tank. The pump running is interlock with the low switch. If the level low alarm is active the pump will stop.

LAL–0801 According to the set point of low level of – Acid Dosing Tank; Acid dosing pump (ACIDDP-01A/B) will be Tripped.

CAUSTIC DOSING TANK (NaOHDT-01); PUMP (NaOHDP-01A/B)

Caustic dosing pumps (NaOHDP-01A/B) are used to dose caustic/Alkali in equalization tank (TK-04). The stroke adjustment on the pump is auto with respect pH Level in inline transmitter (AT0201); it will be set during the commissioning. Further optimization of the pump stroke can be done during plant operation.

There is low level switch (LS0802) in Caustic dosing tank, to provide feedback to the PLC for alarming on the

SCADA. The operator can take necessary action of loading the chemical in the tank. The pump running is interlock with the low switch. If the level low alarm is active the pump will stop.

According to the set point of low level of – Caustic Dosing Tank

LAL–0802 NaOHDT-01; Caustic dosing pump (NaOHDP-01A/B) will be Tripped.

Caustic dosing tank is provided with a mixer. The mixer will run if the level is not low in the dosing tank. It will stop in case of routine maintenance or failure or operator stops it in manual.

As per pH of sewage pH Analyser will automatically select acid/alkali pump

BELT TYPE OIL SKIMMER (BTOS-01)
The belt type oil skimmer BTOS-01 is always running if the raw sewage is available. It will stop manually in case of failure of routine maintenance. Operator must access the condition of the feed and start and stop the skimmer accordingly from main control panel.

Alarm will be generated if belt skimmer motor is not running with running indication on SCADA RUN/ STOP shall be from SCADA
Fine Mechanical Screen (FMSC-01)
The rotating drum screen machine will be operated from SCADA system.

The Fine Mechanical / Rotating Drum Screen (RDS) has the following functions.:

RDS three-position selector switch:

Three different commands can be selected Local Remote Switch

LOC	Start-up & Stop of the machine through MCC.
REM	The machine is controlled by the operator using the SCADA.
INTERLOCK	RDC Should START after one of the feed pump (PU04 A/B) is ON

Rotary screen start/stop selector switch: This switch can start & stop the rotary screen after a suspended cycle (Washing of screen with service water for removal of solids retain on screen surface).

Emergency stop button: The red & yellow button must be used only in case there is a need to instantly block the movements of the machine. It should not be used as a general way to stop the machine, not even temporarily.

Machine Start-up Procedure:

- Place the selector switch LOC-0-REM in “0” mode.
- Turn the main switch on the main switchboard onto [ON] mode. This operation will supply power to the automatic devices on local switchboard that operate the machine.
- Place the selector switch in “LOC” mode.
- Press start on the machine, checking that the rotation verse is correct.
- Stop the machines with the STOP switch.
- Place the selector switch LOC-0-REM in “REM” mode.

- All the water feeding and discharge lines will be on:
- Open the wash water lines through valve (BV0405) on the RDS rotary screen inlet.
- Put the tank for the screened material under the RDS outlet.
- Press the START button on the SCADA screen.

Regular Stop of the machine:

- In order to normally stop the machine, the following procedure should be followed:
- Stop the waste waters line by stopping the feeding pump (PU- 04A/B).
- Wait until the screened material is released from the RDS outlet.
- Stop the machine by using the “STOP” switch on SCADA.

Emergency Stop button:

- The machine features mushroom head push-pull emergency stop button, red & yellow.
- In all the operational modes, this key has an absolute priority over all the other commands.
- If necessary, the machine can be stopped instantly & power supply is cut from the auxiliary devices.
- A relay is in charge of controlling & identifying potential faults in the safety circuit & in the switches, by also detecting short circuits & ground leakages.

Restoring the work conditions:

In order to restore the work conditions after the machine has been stopped through the

emergency key,

It is necessary to:

Solve the problem that has led to the emergency stop.

Rotate the stop key anti-clockwise. When it lifts, it has been restored to its original position. It is now possible to restart the machine by pressing the relevant start and/or reset button.

Troubleshooting Table:

Group	Problem	Possible Cause	Solution
RDS	Failure to start the machine	Emergency push-button pressed	Reset the emergency push-button and give the start command
		No Power	Check if there is voltage at the main switchboard.
		No phase from the grid	Check the power supply clamps of the electric motor.
		Incorrect motor connection	Check the electric connection of the motor (See Manuals).

		Control LOC-)-REM in position “LOC” or “0”	If in “LOC” position use the start & stop controls to verify the operation of the machine. If in “REM” position give the start control from the main switchboard prepared by the user.
RDS	The Machine does not produce treated water	There is no supply of wastewater	Check the feed supply pump
		The outlet is clogged	Clean the outlet of the treated water
		The cleansing system does not work	Check the operation of the solenoid valve
			Check the cleanliness of the Nozzles
RDS	The machine goes into overflow alarm	The cleansing system does not work	Check the operation valve of the solenoid
			Check the cleanliness of the nozzles
		The input capacity is greater than the designed one	Verify the operation of the supply pumps

ANOXIC TANK (TK-03)

Sewage flows into the anoxic tanks (TK-05) from Oil & Grease (O&G-01). The anoxic tank is equipped with a mechanical mixer MX-01. These mixers are always running. They will only stop in case of routine maintenance or failure. Any stoppage of the motors of these mixers will generate only ALARM in panel. (START /STOP can be done from SCADA)

AERATION TANK (TK06), PROCESS BLOWER (ABL-04A/B)

Sewage will flow from anoxic tank (TK-05) to aeration tank (TK-06). Aeration tank is equipped with Dissolved Oxygen Analyser (AT 0401) for monitoring and alarming Dissolved Oxygen (DO) level in the respective aeration tank.

The process blowers (ABL-04A/B) will provide air to aeration tank (TK-06) and maintains the DO level inside tank. We have provided two blowers with 1 working 1 standby philosophy. Both process blower is equipped with a VFD for speed control as DO analyser reading. These air blowers rotate on the duty cycle timer or if any of the running blower fails the standby blower would start manually.

AT 0401	At low DO, increase speed of the blower ABL-04A/B through VFD & At high DO decrease speed of blower ABL -04A/B through VFD.
	(Upper / Lower limits for DO will be fine-tuned during commissioning for blower operations as per site condition)
	DO analyser indicate LOW/HIGH DO Value for 5 sec. alarm should be generated .
PSV 0401,	In case of high pressure at the outlet of the Blower, the pressure safety valve
PSV 0402	will release the pressure into the atmosphere

The Dissolved oxygen (DO) is monitored in the aeration tanks through (AT 0401) DO analyser. On operator selection of DO analyser, at a regular frequency, (E.g. every 5 minutes), the DO in tank is compared to an operator entered DO set point to control the output from the air blower (ABL-04 A/B).

Operator can enable or disable speed step function from the SCADA. If the step function is disabled, the air blower (ABL-04A/B) will run as per the speed set point entered by the operator as per data provided.

NEUTRIENT DOSING TANK (UREADT-01 & DAPADT-01); PUMP (UREADP-01A/B & DAPDP-01A/B)

Urea & DAP nutrient dosing pumps (UREADP-01A/B & DAPDP-01A/B) are used to dose nutrients in Aeration tank (TK-06). The stroke adjustment on the pump is manual; it will be set during the commissioning. Further optimization of the pump stroke can be done during plant operation.

There is low level switch (LS0803 & LS0804) in each dosing tank, to provide feedback to the PLC for alarming on the SCADA. The operator can take necessary action of loading the chemical in the tank. The pump running is interlock

with the low level switch. If the level low alarm is active the pump will stop.

Both nutrient dosing tanks are provided with a mixer. The mixer will run if the level is not low in their respective dosing tank. It will stop in case of routine maintenance or failure or operator stops it in manual.

LAL–0803	According to the set point of low level of – Urea Dosing Tank; Urea dosing pump (UREADP-01A/B) will be Tripped.
LAL–0804	According to the set point of low level of – DAP Dosing Tank; DAP dosing pump (DAPDP-01A/B) will be Tripped.

MEMBRANE TANK (TK-07)

The membrane tank (TK-07) is installed with Suez Membrane bio reactor (MBR) skid. MBR skid is functionally described as a group of Suez's Zee Weed® modules and cassettes connected by a common permeate collection header. Membrane tank is provided with Level transmitter (LT 0501).

LT 0501	Level indication on SCADA.
	According to the set point of High level of MBR TANK; equalization transfer pump (PU-04A/B) will be Tripped.
PT 0501	Pressure indication on SCADA

ZeeWeed® MBR Train Modes & States of Operation

The MBR Train is sequenced by the PLC. The sequencing of the Train can be described by the mode and state of the Train. Train is in one and only one mode and one and only one state at any given time. Buttons displayed on the SCADA screen that the operator can press to initiate a mode or state or other operation are shown with the first letter capitalized. For example, one button that is used to put a train to the OFF mode is the Off button.

Production Cycle

The Production Cycle is the alternation of the train's states between PRODUCTION and BACKPULSE or RELAX. This alternation is controlled by a timer.

ZeeWeed® MBR Train Modes

Modes define how the transitions occur for a Train from one operating state to another. Modes can only be selected by the operator, using pushbuttons on the SCADA. The mode button Semi-Auto is available in all states. The OFF-mode button is available in all states except OFF. The Auto mode

- OFF Mode
- SEMI-AUTO Mode
- AUTO Mode

button is available in all states except MAINTENANCE & RECOVERY CLEANs. The modes of MBR Train are described in the following sections.

This is the normal mode of operation for a MBR Train for production of clean water. For the train equipment to operate automatically, the operator needs to have all related devices set to AUTO and the train set to AUTO. The operation of the train is automatic when in AUTO, and there is minimal operator attention required unless an alarm is activated.

In AUTO mode, the train changes state between the Production Cycle and STANDBY according to train start & stop triggers, which are based on the membrane tank operating level (LT0501).

This mode immediately places the Train to OFF state and prevents the operator from manually selecting other

states until the Train is placed in another mode.

The operator may turn a train OFF at any time. Pressing the Off button places the train into OFF mode and OFF state. It is the responsibility of the operator to ensure that if the Off button is pressed when a train is in a clean, the tank's contents are suitable for a train to proceed to another mode.
This mode safely places the Train to OFF state, but permits the operator to manually select other sequences such as a Back pulse, Maintenance Clean, and Recovery Clean. Upon completion of a sequence, the Train will return to the OFF state and wait for further operator selection.

MBR Train States
States are a series of steps the train follows to perform various operations, such as producing water. A specific state discussed in this document is shown in capital letters, such as PRODUCTION. The states available are: OFF, PRIME, STANDBY, PRODUCTION, BACKPULSE or RELAX, MAINTENANCE CLEAN, and RECOVERY CLEAN. Each of these states is discussed further in the following sections of the Control Philosophy. The train proceeds to the selected state once the resources are available.

FOR OPERATION SEQUENCE & LOGIC OF ZEEWEED MBR PLEASE REFER TO OUR MEMBRANE CONTROL LOGIC CHART (JWL-2852-CP-CCL-STP) & MEMBRANE OPERATING SEQUENCE CHART (JWL-2852-CP-OSC-STP)

PRIME System Control
MBR Train is provided with an ejector (EJECTOR 01), which uses compressed air to operate and primes the permeate piping in PRIME and at the beginning of BACKPULSE, RELAX, MAINTENANCE CLEAN, & RECOVERY CLEAN.

The train's ejector compressed air valve (SOVBFV-0501) opens which also opens the permeate header isolation valve (XVBFV-0501). During this time, air in the permeate header is pulled up and out through the ejector, which also pulls water into the membranes and Permeate pump suction. Any water that is drawn into the ejector drains out by gravity in to respective membrane tank.

The PRIME state is used to remove air from the suction of the Permeate pump. A train proceeds to PRIME after the Auto button is pressed in the OFF state. The ejector operates for typically 60 seconds, a longer duration than what is used for intermittent operation, and the duration is adjustable at the SCADA.

Trains are intermittently primed in STANDBY for an adjustable duration. The duration of the Master Ejector Cycle timer is adjustable and the default time. The Master Ejector Cycle timer operates as long as there is at least one train in STANDBY, with a time assigned for each train when the ejector operates, provided the train is in STANDBY.

The operator can manually initiate PRIME by pressing the Prime button at the SCADA. The Prime button is available in SEMI AUTO and OFF state.

Standby and the Production Cycle

The MBR train switch between Standby and the Production Cycle based on Start & Stop Train Triggers. The Start trigger is based on the membrane tank operating level.

6.1. Standby:
The steps for the STANDBY are:

- Fills the membrane tank to a level above the membranes;
- While a train is in Standby, the train remains in this step until one of the following is active:
- A start trigger;
- Back pulse button is selected;

6.2. Production

In Production, the train is producing permeate. The steps for the PRODUCTION are:

Align the valves;

The Permeate/Back pulse starts and runs until the production cycle timer triggers one of the following:

BACKPULSE or RELAX can be triggered by either the pushbutton or a scheduled time.

6.3. Back pulse

Treated water is periodically reversed back through the membranes to maintain stable transmembrane pressures.

The steps for the BACKPULSE are:

Stops the permeate/back pulse pump (PU-06 A/B);

Align the valves;

Start the permeate/back pulse pump (PU-06 A/B) and it runs (Permeate Flow Set Point =

$24m^3$/hr & Back pulse set point = $24m^3$/hr) for the back pulse duration time. The water is drawn from the back pulse tank (TK-08) and pumped through the membranes into the membrane tank (TK-07).

Stops the permeate/back pulse pump;

After the BACKPULSE is complete and if the membrane tank level is ok (LT 0501) for the Production the train proceeds to PRODUCTION. After the BACKPULSE is complete and if the membrane tank level is below operating set point the train proceeds to STANDBY.

The master Production cycle timer starts when there are no trains in Production and one train is requested to start PRODUCTION. The timer restarts every time it times out.

The PLC controls the permeate/back pulse pump speed to back pulse the train at a set flow rate per train up to a maximum TMP.

A transmitter on the membrane header (PT 0501) is used to calculate the BACKPULSE TMP. This TMP limit provides membrane protection against over-pressurization. If the TMP is too high, the TMP high trigger is active and the flow control PID loop output is captured. This value becomes the maximum value for the output of the flow control PID loop.

When the TMP high trigger becomes active, the PLC gradually reduces the maximum for the flow PID loop output until the TMP high trigger is not active, (i.e., TMP is less positive). At the moment when the TMP high trigger becomes inactive, the maximum value is then gradually increased until the TMP high trigger is active again, or continues to increase until the maximum value for the flow control PID loop output equals 100%. This control strategy allows the PLC to vary the pump speed to maximize flow while avoiding excessive TMP across the membranes.

The Operator can enable or disable the TMP limiting function from the SCADA. If the TMP limiting function is disabled, the PID Output won't be limited. It will vary from 0-100%.

The back pulse duration, production cycle duration, TMP set point and flow set point for the MBR train can be set through the SCADA. The operator can initiate a BACKPULSE from the SCADA for any MBR train by pressing the Back pulse button. This button is disabled if any other train is in BACKPULSE.

Low Level switch (LS-0501) is located in Back pulse tank to provide the level feedback to PLC. If the Level Switch Low is active during back pulse the Process pump stops and the ZeeWeed® continues without any back pulse.

6.4. RELAX

During RELAX, the solids that have concentrated around the membrane are distributed away from the membrane surface by the aeration. The steps for the RELAX are:

Stops the Permeate/Back pulse pump (PU-06 A/B),

When the back pulse duration timer times out proceeds to the next step,

After the RELAX is complete, and if there is demand for the train to run the train proceeds to PRODUCTION. After the RELAX is complete and if there is no demand for the train to run the train proceeds to STANDBY.

Membrane Tanks Level & Permeate Flow Control

Flow set point will be entered for the ZeeWeed manually. The supervisor can do this by setting the production flow rate of the ZeeWeed on the SCADA. The system will maintain the entered production flow rate up to a maximum Trans Membrane Pressure (TMP) or an operating membrane tank level.

Production Trans Membrane Pressure (TMP)-

Trans Membrane Pressure is the differential pressure across the membranes as measured by the level transmitter in the membrane tank (LT-0501) and pressure transmitter (PT-0501) on the permeate header.

In PRODUCTION, the process pump draws the water through the membranes so the pressure in the permeate header is lower than on the outside of the membranes resulting in a negative value for TMP.

During BACKPULSE and back pulsing steps in CIP the water is flowing in the opposite direction so the pressure in the permeate header is higher than the outside of the membranes resulting in a positive value for TMP.

8.1. Trans Membrane Pressure (TMP) Calculation

TMP is calculated by using the equation below. During PRODUCTION the value is negative, for back pulses and CIP, it is positive.

TMP = Header Pressure (absolute) + C x (A + B -

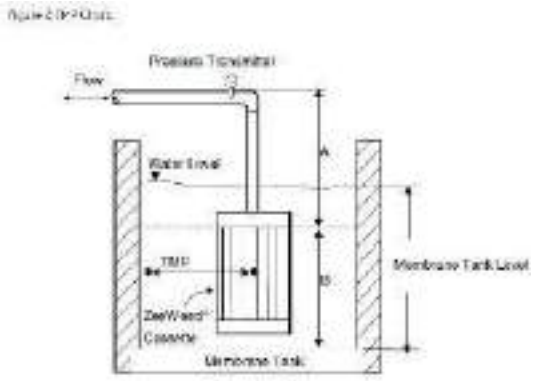
Membrane Tank Level) Where:

A is the height of the pressure transmitter above the top of the membranes.

B is the height to the top of membranes in the membrane tank.

C is a conversion factor (0.0001 kg / cm2)

In PRODUCTION, an increased TMP value means a larger pressure differential because the pressure inside the membranes is lower than outside the membranes. This corresponds to a lower number as expressed in engineering units. Therefore, a high production TMP is actually expressed as a Pressure Differential Alarm Low Low.



8.2. TMP Limiting the Permeate/Back pulse Pump Speed

The PLC continuously calculates the TMP value while in PRODUCTION. If the TMP is too low, (i.e., too negative) the TMP low trigger is active and the flow control PID loop output is captured. This value becomes the maximum value for the flow control PID loop output.

When the TMP low trigger becomes active, the PLC gradually reduces the maximum for the flow PID loop output until the TMP low trigger is not active, (i.e., TMP is less negative). At the moment when the TMP low trigger becomes inactive, the maximum value is then gradually increased until the TMP low trigger is active again, or continues to increase until the maximum value for the flow control PID loop output equals 100%. This control strategy allows the PLC to vary the pump speed to maximize flow while avoiding excessive TMP across the membranes.

The Operator can enable or disable the TMP limiting function from the SCADA. If the TMP limiting function is disabled, the PID Output won't be limited. It will vary from 0-100%.

Start & Stop Train Triggers

The train is in operation at any given time varies depends on a Start, Stop train trigger. When Start trigger is active, a train switches from STANDBY to PRODUCTION. When a Stop train trigger is active, a train switches from PRODUCTION to STANDBY. The Start, stop trigger is based on the operating tank level in the membrane tank.

10. Membrane Aeration Blowers (ABL-05 A/B)

The membrane blowers (ABL-05A/B) aerates the membrane tank (TK-07). The blower will start and stop depending on the sequence. There are two blowers 1 working and 1 standby. The blowers rotate on the duty cycle timer or if the auto running blower fails then standby blower becomes lead and starts running.

PSV 0501	In case of high pressure at the outlet of the Blower, the pressure safety valve
PSV 0502,	will release the pressure into the atmosphere

11. Turbidity Analyser –
Integrity of the ZeeWeed Membrane is monitored with On-line turbidity meter when it is in "PRODUCTION". We have provided online turbidity analyser (AT 0501) to measure permeate turbidity.

The turbidity alarm set points are adjustable at the SCADA. The time delays before the alarms become active are not adjustable.

High High Turbidity Alarm will put the MBR to Faulted State.

AT 0501	Turbidity indication of MBR permeate stream on SCADA

12. MBR Train Cleaning: -

The membranes require cleaning to maintain performance. There are two types of cleaning methods; MAINTENANCE CLEANS and RECOVERY CLEANS.

Both MAINTENANCE CLEANS and RECOVERY CLEANS are operator initiated and should have the operator present during the majority of the clean. The maintenance cleans are short pulses chemical through the membranes without emptying the membrane tank. These pulses with chemical are used to prevent biological growth inside the membranes and reduce the required frequency of recovery cleans.
Recovery Cleans are operator initiated and should have the operator present during the majority of the clean. The recovery cleans commonly occur only twice a year with sodium hypochlorite and twice a year with citric acid to remove fouling or scaling of the membranes.

12.1. Citric Acid Dosing Tank (ACIDDT-02); Pump (ACIDDP-02A/B)

Citric acid is periodically used to remove organic contaminants from the membranes. The PLC will request a Citric acid pump (ACIDDP-02A/B) for MAINTENANCE CLEANS and RECOVERY CLEANS per operator selection, to run in specific steps during the cleaning procedure. The stroke adjustment on the pump is manual; it will be set during the commissioning. Further optimization of the pump stroke can be done during plant operation.

There is low level switch (LS0805) in the dosing tank, to provide feedback to the PLC for alarming on the SCADA. The operator can take necessary action of loading the chemical in the tank. The pump running is interlock with the low switch. If the level low alarm is active the pump will stop.
Citric Acid tank is provided with a mixer (ACIDAG-01). The mixer will stop manually when low level alarms in the citric acid tank. It will stop in case of routine maintenance or failure or operator stops it in manual.

12.2. Hypochlorite Dosing Tank (NaOCLDT-01); Pump (NaOCLDP-01A/B)
Hypochlorite is used to remove organic contaminants from the membranes. The PLC will request a sodium hypochlorite pump (NaOCLDP-01A/B) for MAINTENANCE CLEANS and RECOVERY CLEANS per operator selection, to run in specific steps during the cleaning procedure. The stroke adjustment on the pump is manual; it will be set during the commissioning. Further optimization of the pump stroke can be done during plant operation.

There is low level switch (LS0806) in the dosing tank, to provide feedback to the PLC for alarming on the SCADA. The operator can take necessary action of loading the chemical in the tank. The pump running is interlock with the low switch. If the level low alarm is active the pump will stop.

LAL−0805	According to the set point of low level of Citric Acid Dosing Tank – Citric Dosing Pumps (ACIDDP-02A/B) will be Tripped.
LAL−0806	According to the set point of low level of − Hypochlorite Dosing Tank, Hypo dosing pump (NaOCLDP-01A/B) will be Tripped.

12.3. Maintenance Clean

Maintenance Cleans are operator initiated. During a Maintenance Clean there are several prompts which the operator must address. As a result, it is suggested to have the operator present during the Maintenance Clean so that these prompts can be responded to in a timely manner.

The operator is required to turn the train in SEMI AUTO mode. The cleaning solution for MAINTENANCE CLEANS is either citric acid or sodium hypochlorite. The operator selects either M. Clean with Citric Acid button or M. Clean with Sodium Hypochlorite button to select the cleaning mode and the type of cleaning solution.

12.4. Recovery Clean Controls

Recovery Cleans are operator initiated. During a Recovery Clean there are several prompts which the operator must address. As a result, it is suggested to have the operator present during the Recovery Clean so that these

prompts can be responded to in a timely manner.

The operator is required to turn the train in SEMI AUTO mode. The cleaning solution for RECOVERY CLEANS is either citric acid or sodium hypochlorite. The operator selects either R. Clean with Citric Acid button or R. Clean with Sodium Hypochlorite button to select the cleaning mode and the type of cleaning solution.

13. MBR Train Triggers & Alarms

A trigger is a normal event that can clear an alarm or be one of several points in a sequence of events

13.1. MBR Alarms-

Alarms are used to identify a problem with the system. Depending on the nature of the problem the alarm may either put the MBR, to STANDBY, or initiate a callout to notify the operator that there is a problem. It is understood that the operator will acknowledge the alarm and address the situation. If the problem is not corrected, production quality and quantity will drop off quickly. Devices which are being controlled remotely cannot have their status changed by the PLC.

Typical alarms that shutdown a train are listed in the following table Below:

Train Shutdown Alarms

Alarm Description	Possible Causes for Alarm	Reset
High Flow Alarm - permeate	Suction disconnecting from fittings.	Alarm reset button
Low Flow Alarm - permeate	Loss of prime of process pump	Alarm reset button
Pressure High-High Alarm – permeate (measured by pressure Transmitter PT0501)	Suction disconnecting from fittings.	Alarm reset button
Transmembrane Pressure Low, Low	Fouled MBR membranes	Alarm reset button
Process pump Fault	VFD Fault	Alarm reset button
Compressed Air – Low pressure	Insufficient Compressed Air Supply to operate pneumatically actuated valves	Automatic restart with sufficient compressed air Pressure
Low Level Alarm – membrane tank	Permeate flow rate is higher than the Feed flow rate	Automatic restart when the membrane tank is above a set point
Power Failure	Tripped breaker inside panel	Automatic restart after power is restored

RETURN SLUDGE TRANSFER PUMPS-RAS PUMP (PU- 03 A/B)
RAS Pump (PU- 05 A/B) recirculates the mixed liquor from Membrane tank to the Anoxic tank. There is 1 working & 1 standby Pump provided.
Auto mode the RAS pump is always running except the ZeeWeed OFF mode, or MAINTENANCE CLEANING mode or RECOVERY CLEAN mode. The RAS pump running is interlocked with the Low level (LT-0501) in the Membrane Tank. During periodic sludge draining operator will open valve (BFV 0513).

BACKPULSE TANK (TK -08); PERMEATE/BACKPULSE PUMP (PU-06A/B)
The Back Pulse Tank (TK -08) stores the water for back pulse. The Tank is equipped with the High & Low Level Switch (LS-0501) for alarming, monitoring and interlocking. The Tank fill valve (XVBFV-0503) is interlocked with the High & Low level in the Back pulse tank.

We have provided 2 nos. of permeate cum back pulse pump (PU-06A/B) for MBR system with 1 working & 1 standby philosophy. During failure of any of the working pump standby pump will be started manually. And each pump has a dedicated VFD for flow control. There are two set point entered by the operator one for Permeating and one for Back pulse. The Permeate/Back pulse pump is interlocked by low level alarm (LT-0501) in Membrane Tank during PRODUCTION or low level alarm in back pulse tank during back pulse.

Discharge permeate header of the Permeate/Back pulse pump is equipped with the dedicated flow transmitter (FT0501). There will be three totalizers derived from the transmitter operator resettable Net totalizer, daily totalizer and non-resettable totalizer

LS 0501	Level indication on SCADA
LAL 0501	According to the set point of low level of BACKPULSE TANK XVBFV-0503.
LAH 0501	Alarm will be generated according to the set point of High level of
	BACKPULSE TANK XVBFV-0503 will be closed.
PT 0501	Pressure indication of backwash in SCADA
FT 0501	Flow indication for MBR permeate generated in SCADA

MBR PERMEATE TANK (TK – 09); RO FEED / PERMEATE TRANSFER PUMP (PU- 07A/B) Permeate from the MBR system is collected in the MBR Permeate Tank (TK-09). The tank is Equipped with Level Switch (LS 0502) for alarming. Level Switch is envisaged to sense the Low, level set point in permeate tanks. The Tank fill valve (XVBFV-0504) is interlocked with the High & Low level in the Permeate tank (TK-09).
The RO feed pump / Permeate Transfer Pump (PU-07A/B) will be started automatically when level reach 0.5 m above than low level & trips automatically when the level reaches low level in respective tanks (Levels will be user settable at site).
The Permeate Transfer Pump (PU-07A/B) with 1 working 1 standby philosophy are provided for transferring MBR permeate water from the TK-09 to RO system for further polishing. Any of the pumps will be selected for standby duty, which would start manually in the event of failure of running pump.

LS 0502	Level indication on SCADA
LAL 0502	According to the set point of low level of MBR PERMEATE TANK; RO FEED PUMP (PU- 07A/B) will be Tripped.

HYPOCHLORITE DOSING TANK (HYPODT-01); PUMP (HYPODP-01A/B) (Existing/ Client Scope)
Hypochlorite dosing pump (HYPODP-01A/B) is used to disinfect Permeate collected in tank (TK-09). The stroke adjustment on the pump is manual; it will be set during the commissioning. Further optimization of the pump stroke can be done during plant operation.
There is low level switch in the dosing tank, to provide feedback to the PLC for alarming on the SCADA. The operator can take necessary action of loading the chemical in the tank. The pump running is interlock with the low switch. If the level low alarm is active the pump will stop.

LAL	According to the set point of low level of – Hypochlorite Dosing Tank
	(HYPODT-01); Hypo dosing pump (HYPODP-01A/B) will be Tripped.

SLUDGE HODLING TANK (TK-11), CENTRIFUGE FEED PUMP (PU-09A/B)
The sludge from RAS pump discharge header is periodically drained to the sludge holding tank (TK-11). This can only be achieved when one of the RAS pump is running.
The sludge holding tank is equipped with Level switch (LS 0601) for alarming. This level switch is envisaged to sense the Low, level set point in sludge tanks. The Centrifuge Transfer Pump (PU-09A/B) will be started automatically when level reach 0.5 m above than low level & trips automatically when the level reaches low level in respective tanks.

LS 0601	Level indication on SCADA

LAL 0601	According to the set point of low level of SLUDGE HODLING TANK, Centrifuge feed pump (PU−09A/B) gets tripped.
LAH 0601	According to the set point of High level of SLUDGE HODLING TANK,
PU-06A/B	Auto trip Centrifuge (DECF−01) and De−watering poly dosing pump (POLYDP-01A/B) when Centrifuge feed pump (PU−09A/B) gets tripped.

CENTRIFUGE (DECF-01)

The centrifuge is used to separate the water from the sludge and make it more concentrated. The centrifuge operation is controlled by VFD system. The output of the centrifuge is centrate which is sent to STP Equalization tank (TK-04) and dry cake which is disposed of by client. The Centrifuge will be operated from SCADA screen.

DECF−01	Auto trip Centrifuge feed pump (PU-09A/B) and De−watering poly dosing pump (POLYDP-01A/B) when Centrifuge (DECF−01) gets tripped.

POLYELECTROLYTE DOSING TANK (POLYDT-01); PUMP (POLYDP-01A/B)

Polyelectrolyte is dosed at the discharge of the centrifuge feed pump (PU-09A/B) for coagulating the solid particles so it can be separated in the centrifuge. Polyelectrolyte dosing system consists of the 2 polyelectrolyte dosing pump (POLYDP-01A/B), 1 working 1 standby philosophy and dosing tank (POLYDT-01).

The dosing tank is equipped with a low level switch (LS0810) for feedback and alarm to the PLC. Operator has to start one of the dosing pumps after starting the centrifuge pump. Low level alarm in the dosing tank and if no Centrifuge pumps are running poly dosing pump will trip.
Polyelectrolyte dosing tank is provided with a mixer (POLYAG-01). The mixer will stop manually when low level alarms in the polyelectrolyte dosing tank. It will stop in case of routine maintenance or failure or operator stops it in manual.

LAL−0810	According to the set point of low level of − Polyelectrolyte dosing Tank; Poly dosing pump (POLYDP-01A/B) will be Tripped.

REVERSE OSMOSIS PLANT

Please refer attached RO control logic Chart Separately Rev 0, PROCESS LOGIC RO - Client JWL 2852 “JWL-2852-CP-STPRO-R0” dated 27.02.2019

		Rev 0 PROCESS LOGIC RO - Client- 02) JWL 2852
		During stop mode or in case of emergency shutdown the following sequence shall be followed.
RO System shut down sequence		First auto valve BFVXV- 0702 will be set in full open position.
	1	After 20 - 60 sec RO HP Pump PU-11 A/B will trip.
		Further after 20 sec RO feed Pump-PU-11 A/B, SMBSDP-01 A/B, ANTIDP-01 A/B, HCLDP-01A/B will trip.
		In case of any mechanical or process failure, plant will be stopped in shut down sequence immediately and alarm shall be displayed on HMI.
		Major shut down conditions are listed below.
Conditions for Emergency Shut down	1	If there is a low level in any of chemical dosing tanks or RO feed tank. Or operator has not selected at least one dosing pump of each type.
	2	Treated water conductivity (AT-0701) is above set level.
	3	Low pressure at suction or at discharge of RO high pressure pump (PU- 11A/B)
	4	The ORP value (AT0701) at the inlet of RO is beyond the set values. The Dump valve BFVXV-0701 will open first.

	5	High level (LS-702) in RO Permeate water storage tank TK-12 (Client Scope).

LOGIC FOR RO SYSTEM				
SR. No	Equipment / Valve Tag	Description	Normal Operation	CIP Operation
1	PU-07 A/B	RO FEED PUMP	ON	OFF
2	PU-11 A/B	RO- HP PUMP	ON	OFF
3	PU-14	RO CIP PUMP	OFF	ON
4	HCLDP-01 A/B	Acid Dosing Pump	ON	OFF
5	SMBSDP-01 A/B	SMBS Dosing Pump	ON	OFF
6	ANTIDP-01 A/B	Antiscalant Dosing Pump	ON	OFF

Rev 0 PROCESS LOGIC RO - Client- 02) JWL 2852
Notes :

1	On the HMI, there will be a button for RO Start and Stop. Once the start is selected, the entire start sequence shall proceed automatically.
2	There will be 2 different modes on HMI. A) Normal Mode B) CIP Mode
3	Every pump system in RO has One WORKING and One STAND-BY Pump. Operator has to select the operating pump for each stream. (Except for CIP)
4	During normal Running, if any of the dosing pumps trips for any reason, the standby dosing pump will be started automatically.
5	The CIP mode of RO system is Manual operation.
6	If a stream is in CIP mode. Normal mode should be selectable from HMI.
7	There is pH transmitter (pHAT0701) at the downstream of acid dosing in RO feed line. Depending upon the indication of pH meter stroke of acid dosing pump (HCLDP- 01A/B) shall be adjusted automatically.
8	The Flow Transmitter (FT 0701) has been provided at the inlet of RO Unit for monitoring the feed quantity to RO system.
9	The Flow Transmitter (FT-0702) has been provided at the outlet line of RO Unit for monitoring Permeate quantity generated from RO system.
10	There is High pressure switch (PS 0702) at the common discharge header of RO HPP (PU 11 A/B) which will trip RO HPP once discharge pressure reaches set point.
11	Dosing tank HCLDT 01, SMBSDT 01, ANTIDT 01 are provided with low level switch (LS0807, LS 0808, LS 809) which will trip the corresponding dosing pump once the level reaches low level in respective tanks. (low level alarm will be annunciate in PLC Panel.

SECTION 12 : MATERIAL SAFETY DATA SHEET FOR THE CHEMICALS

Material Safety Data Sheet Ferric chloride (FeCl3) MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ferric chloride **Catalog Codes:** SLF1675, SLF2188 **CAS#:** 7705-08-0 **RTECS:** LJ9100000 **TSCA:** TSCA 8(b) inventory: Ferric chloride **CI#:** Not available. **Synonym:** **Chemical Formula:** FeCl3	**Contact Information:** **Sciencelab.com, Inc.** 14025 Smith Rd. Houston, Texas 77396 US Sales: **1-800-901-7247** International Sales: **1-281-441-4400** Order Online: ScienceLab.com **CHEMTREC (24HR Emergency Telephone), call:** 1-800-424-9300 **International CHEMTREC, call:** 1-703-527-3887 **For non-emergency assistance, call:** 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Ferric chloride	7705-08-0	100

Toxicological Data on Ingredients: Ferric chloride: ORAL (LD50): Acute: 900 mg/kg [Rat]. 1278 mg/kg [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:

Very hazardous in case of ingestion. Hazardous in case of skin contact (irritant), of eye contact (irritant), of inhalation. Slightly hazardous in case of skin contact (permeator). Corrosive to eyes and skin. The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering.

Inhalation of dust will produce irritation to gastro-intestinal or respiratory tract, characterized by burning, sneezing and coughing. Severe over-exposure can produce lung damage, choking, unconsciousness or death.

Potential Chronic Health Effects:

CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available.

DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to lungs, mucous membranes. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage.

Section 4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.

Skin Contact:

If the chemical got onto the clothed portion of the body, remove the contaminated clothes as quickly as possible, protecting your own hands and body. Place the victim under a deluge shower. If the chemical got on the victim's exposed skin, such as the hands : Gently and thoroughly wash the contaminated skin with running

water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.
Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.
Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.
Ingestion:
Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.
Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.
Auto-Ignition Temperature: Not applicable.
Flash Points: Not applicable.
Flammable Limits: Not applicable.
Products of Combustion: Not available.
Fire Hazards in Presence of Various Substances: Not applicable.
Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.
Fire Fighting Media and Instructions: Not applicable.
Special Remarks on Fire Hazards: Not available.
Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.
Large Spill:
Corrosive solid. Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapours. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up Keep container dry. Keep away from heat. Keep away from sources of ignition. Keep away from direct sunlight or strong incandescent light. Do not ingest. Do not breathe dust. Never add water to this product Avoid shock and friction.

Wear suitable protective clothing In case of insufficient ventilation, wear suitable respiratory equipment If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes
Storage: Corrosive materials should be stored in a separate safety storage cabinet or room.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.
Personal Protection:
Splash goggles. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.
Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor and dust respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits:
TWA: 1 CEIL: 2 (mg/m3) Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid.
Odor: Not available.
Taste: Not available.
Molecular Weight: 162.21 g/mole
Color: Not available.
pH (1% soln/water): 2 [Acidic.]
Boiling Point: 316°C (600.8°F)
Melting Point: 306°C (582.8°F)
Critical Temperature: Not available.
Specific Gravity: 2.9 (Water = 1)
Vapor Pressure: Not applicable.
Vapor Density: 5.61 (Air = 1)
Volatility: Not available.
Odor Threshold: Not available.
Water/Oil Dist. Coeff.: Not available

Section 10: Stability and Reactivity Data

Stability: The product is stable.
Instability Temperature: Not available.
Conditions of Instability: Not available.
Incompatibility with various substances:
The product may undergo hazardous decomposition, condensation or polymerization, it may react violently with water to emit toxic gases or it may become self-reactive under conditions of shock or increase in temperature or pressure.
Corrosivity: Non-corrosive in presence of glass.
Special Remarks on Reactivity: Not available.
Special Remarks on Corrosivity: Not available.

Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Eye contact. Inhalation. Ingestion.
Toxicity to Animals: Acute oral toxicity (LD50): 900 mg/kg [Rat].
Chronic Effects on Humans: The substance is toxic to lungs, mucous membranes.
Other Toxic Effects on Humans:
Very hazardous in case of ingestion. Hazardous in case of skin contact (irritant), of inhalation. Slightly hazardous in case of skin contact (permeator).
Special Remarks on Toxicity to Animals: Not available.
Special Remarks on Chronic Effects on Humans: Not available.
Special Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

Ecotoxicity: Not available.
BOD5 and COD: Not available.
Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation: The products of degradation are more toxic.
Special Remarks on the Products of Biodegradation: Not available

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: CLASS 8: Corrosive solid.
Identification: Ferric chloride, anhydrous: UN1773 PG: III
Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Pennsylvania RTK: Ferric chloride Massachusetts RTK: Ferric chloride TSCA 8(b) inventory: Ferric chloride CERCLA:
Hazardous substances.: Ferric chloride
Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
Other Classifications:
WHMIS (Canada):
CLASS E: Corrosive solid. CLASS F: Dangerously reactive material.
DSCL (EEC): R36/38- Irritating to eyes and skin.
HMIS (U.S.A.):
Health Hazard: 3
Fire Hazard: 0
Reactivity: 2
Personal Protection: j
National Fire Protection Association (U.S.A.):
Health: 3

Flammability: 0
Reactivity: 2
Specific hazard:
Protective Equipment:
Gloves. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References: Not available.
Other Special Considerations: Not available.
Created: 10/09/2005 05:32 PM
Last Updated: 05/21/2013 12:00 PM
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Material Safety Data Sheet Hydrochloric acid (HCl) MSDS

1: Chemical Product and Company Identification

Product Name: Hydrochloric acid **Catalog Codes:** SLH1462, SLH3154 **CAS#:** Mixture. **RTECS:** MW4025000 **TSCA:** TSCA 8(b) inventory: Hydrochloric acid **CI#:** Not applicable. **Synonym:** Hydrochloric Acid; Muriatic Acid **Chemical Name:** Not applicable. **Chemical Formula:** Not applicable.	**Contact Information:** **Sciencelab.com, Inc.** 14025 Smith Rd. Houston, Texas 77396 US Sales: **1-800-901-7247** International Sales: **1-281-441-4400** Order Online: ScienceLab.com **CHEMTREC (24HR Emergency Telephone), call:** 1-800-424-9300 **International CHEMTREC, call:** 1-703-527-3887 **For non-emergency assistance, call:** 1-281-441-4400

2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Hydrogen chloride	7647-01-0	20-38
Water	7732-18-5	62-80

Toxicological Data on Ingredients: Hydrogen chloride: GAS (LC50): Acute: 4701 ppm 0.5 hours [Rat].

3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, Slightly hazardous in case of inhalation (lung sensitizer). Non-corrosive for lungs. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract,

characterized by coughing, choking, or shortness of breath.
Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.
Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Hydrochloric acid]. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, Circulatory System, teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation.
Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.
Ingestion:
If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.
Serious Ingestion: Not available.

5: Fire and Explosion Data

Flammability of the Product: Non-flammable.
Auto-Ignition Temperature: Not applicable.
Flash Points: Not applicable.
Flammable Limits: Not applicable.
Products of Combustion: Not available.
Fire Hazards in Presence of Various Substances: of metals
Explosion Hazards in Presence of Various Substances: Non-explosive in presence of open flames and sparks, of

shocks.
Fire Fighting Media and Instructions: Not applicable.
Special Remarks on Fire Hazards:
Non-combustible. Calcium carbide reacts with hydrogen chloride gas with incandescence. Uranium phosphide reacts with hydrochloric acid to release spontaneously flammable phosphine. Rubidium acetylene carbides burns with slightly warm hydrochloric acid. Lithium silicide in contact with hydrogen chloride becomes incandescent. When dilute hydrochloric acid is used, gas spontaneously flammable in air is evolved. Magnesium boride treated with concentrated hydrochloric acid produces
spontaneously flammable gas. Cesium acetylene carbide burns hydrogen chloride gas. Cesium carbide ignites in contact with hydrochloric acid unless acid is dilute. Reacts with most metals to produce flammable Hydrogen gas.
Special Remarks on Explosion Hazards:
Hydrogen chloride in contact with the following can cause an explosion, ignition on contact, or other violent/vigorous reaction:
Acetic anhydride AgClO + CCl4 Alcohols + hydrogen cyanide, Aluminium Aluminium-titanium alloys (with HCl vapour), 2-Amino ethanol, Ammonium hydroxide, Calcium carbide Ca3P2 Chlorine + dinitroanilines (evolves gas), Chlorosulfonic acid Cesium carbide Cesium acetylene carbide, 1,1-Difluoroethylene Ethylene diamine Ethylene imine, Fluorine, HClO4 Hexalithium
disilicide H2SO4 Metal acetylides or carbides, Magnesium boride, Mercuric sulfate, Oleum, Potassium permanganate, beta-Propiolactone Propylene Oxide Rubidium carbide, Rubidium, acetylene carbide Sodium (with aqueous HCl), Sodium hydroxide Sodium tetraselenium, Sulfonic acid, Tetraselenium tetranitride, U3P4, Vinyl acetate. Silver perchlorate with carbon tetrachloride in the presence of hydrochloric acid produces trichloromethyl perchlorate which detonates at 40 deg. C.

6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.
Large Spill:
Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapour drift. Use water spray to reduce vapours. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal.
Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

7: Handling and Storage

Precautions:
Keep locked up. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapour/spray. Never add water to this product.
In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, organic materials, metals, alkalis, moisture. May corrode metallic surfaces. Store in a metallic or coated fibreboard drum using a strong polyethylene inner package.
Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.
Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.
Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits:
CEIL: 5 (ppm) from OSHA (PEL) [United States] CEIL: 7 (mg/m3) from OSHA (PEL) [United States] CEIL: 5 from NIOSH
CEIL: 7 (mg/m3) from NIOSH TWA: 1 STEL: 5 (ppm) [United Kingdom (UK)] TWA: 2 STEL: 8 (mg/m3) [United Kingdom (UK)]Consult local authorities for acceptable exposure limits.

9: Physical and Chemical Properties

Physical state and appearance: Liquid.
Odor: Pungent. Irritating (Strong.)
Taste: Not available.
Molecular Weight: Not applicable.
Color: Colourless to light yellow.
pH (1% soln/water): Acidic.
Boiling Point:
108.58 C @ 760 mm Hg (for 20.22% HCl in water) 83 C @ 760 mm Hg (for 31% HCl in water) 50.5 C (for 37% HCl in water)
Melting Point:
-62.25°C (-80°F) (20.69% HCl in water) -46.2 C (31.24% HCl in water) -25.4 C (39.17% HCl in water)
Critical Temperature: Not available.
Specific Gravity:
1.1- 1.19 (Water = 1) 1.10 (20%and 22% HCl solutions) 1.12 (24% HCl solution) 1.15 (29.57% HCl solution) 1.16 (32% HCl solution) 1.19 (37% and 38%HCl solutions)
Vapor Pressure: 16 kPa (@ 20°C) average
Vapor Density: 1.267 (Air = 1)
Volatility: Not available.
Odor Threshold: 0.25 to 10 ppm
Water/Oil Dist. Coeff.: Not available.
Ionicity (in Water): Not available.
Dispersion Properties: See solubility in water, diethyl ether.
Solubility: Soluble in cold water, hot water, diethyl ether.

10: Stability and Reactivity Data

Stability: The product is stable.
Instability Temperature: Not available.
Conditions of Instability: Incompatible materials, water
Incompatibility with various substances:

Highly reactive with metals. Reactive with oxidizing agents, organic materials, alkalis, water.

Corrosivity:

Extremely corrosive in presence of aluminium, of copper, of stainless steel (304), of stainless steel (316). Non-corrosive in presence of glass.

Special Remarks on Reactivity:

Reacts with water especially when water is added to the product. Absorption of gaseous hydrogen chloride on mercuric sulfate becomes violent @ 125 deg. C. Sodium reacts very violently with gaseous hydrogen chloride. Calcium phosphide and hydrochloric acid undergo very energetic reaction. It reacts with oxidizers releasing chlorine gas. Incompatible with, alkali metals, carbides, borides, metal oxides, vinyl acetate, acetylides, sulphides, phosphides, cyanides, carbonates. Reacts with most metals to produce flammable Hydrogen gas. Reacts violently (moderate reaction with heat of evolution) with water especially when water is added to the product. Isolate hydrogen chloride from heat, direct sunlight, alkalies (reacts vigorously), organic materials, and oxidizers (especially nitric acid and chlorates), amines, metals, copper and alloys (e.g. brass), hydroxides, zinc (galvanized materials), lithium silicide (incandescence), sulfuric acid (increase in temperature and pressure) Hydrogen chloride gas is emitted when this product is in contact with sulfuric acid. Adsorption of Hydrochloric Acid onto silicon dioxide results in exothermic reaction. Hydrogen chloride causes aldehydes and epoxides to violently polymerize.

Hydrogen chloride or Hydrochloric Acid in contact with the following can cause explosion or ignition on contact or

Special Remarks on Corrosivity:

Highly corrosive. Incompatible with copper and copper alloys. It attacks nearly all metals (mercury, gold, platinum, tantalum, silver, and certain alloys are exceptions). It is one of the most corrosive of the nonoxidizing acids in contact with copper alloys.

No Corrosivity data on zinc, steel. Severe Corrosive effect on brass and bronze

Polymerization: Will not occur.

11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation.

Toxicity to Animals:

Acute oral toxicity (LD50): 900 mg/kg [Rabbit]. Acute toxicity of the vapour (LC50): 1108 ppm, 1 hours [Mouse]. Acute toxicity of the vapour (LC50): 3124 ppm, 1 hours [Rat].

Chronic Effects on Humans:

CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Hydrochloric acid]. May cause damage to the following organs: kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, Circulatory System, teeth.

Other Toxic Effects on Humans:

Very hazardous in case of skin contact (corrosive, irritant, permeator), of ingestion, Hazardous in case of eye contact (corrosive), of inhalation (lung corrosive).

Special Remarks on Toxicity to Animals:

Lowest Published Lethal Doses (LDL/LCL) LDL [Man] -Route: Oral; 2857 ug/kg LCL [Human] - Route: Inhalation; Dose: 1300 ppm/30M LCL [Rabbit] - Route: Inhalation; Dose: 4413 ppm/30M

Special Remarks on Chronic Effects on Humans:

May cause adverse reproductive effects (fetoxicity). May affect genetic material.

Special Remarks on other Toxic Effects on Humans:

Acute Potential Health Effects: Skin: Corrosive. Causes severe skin irritation and burns. Eyes: Corrosive. Causes severe eye irritation/conjuntivitis, burns, corneal necrosis. Inhalation: May be fatal if inhaled. Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract. Inhalation of

hydrochloric acid fumes produces nose, throat, and larryngeal burning, and irritation, pain and inflammation, coughing, sneezing, choking sensation, hoarseness, laryngeal
spasms, upper respiratory tract edema, chest pains, as well has headache, and palpitations. Inhalation of high concentrations can result in corrosive burns, necrosis of bronchial epithelium, constriction of the larynx and bronchi, nasospetal perforation, glottal closure, occur, particularly if exposure is prolonged. May affect the liver. Ingestion: May be fatal if swallowed. Causes irritation and burning, ulceration, or perforation of the gastrointestinal tract and resultant peritonitis, gastric hemorrhage and infection. Can also cause nausea, vomitting (with "coffee ground" emesis), diarrhea, thirst, difficulty swallowing, salivation, chills, fever, uneasiness, shock, strictures and stenosis (esophogeal, gastric, pyloric). May affect behavior (excitement), the cardiovascular system (weak rapid pulse, tachycardia), respiration (shallow respiration), and urinary system (kidneys- renal
failure, nephritis). Acute exposure via inhalation or ingestion can also cause erosion of tooth enamel. Chronic Potential Health
Effects: dyspnea, bronchitis. Chemical pneumonitis and pulmonary edema can also

12: Ecological Information

Ecotoxicity: Not available.
BOD5 and COD: Not available.
Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.
Special Remarks on the Products of Biodegradation: Not available.

13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material
Identification: Hydrochloric acid, solution UNNA: 1789 PG: II
Special Provisions for Transport: Not available

15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Hydrochloric acid Illinois toxic substances disclosure to employee act: Hydrochloric acid Illinois chemical safety act: Hydrochloric acid New York release reporting list: Hydrochloric acid Rhode Island RTK hazardous substances: Hydrochloric acid Pennsylvania RTK: Hydrochloric acid Minnesota: Hydrochloric acid Massachusetts
RTK: Hydrochloric acid Massachusetts spill list: Hydrochloric acid New Jersey: Hydrochloric acid New Jersey spill list:
Hydrochloric acid Louisiana RTK reporting list: Hydrochloric acid Louisiana spill reporting: Hydrochloric acid California Director's List of Hazardous Substances: Hydrochloric acid TSCA 8(b) inventory: Hydrochloric acid TSCA 4(a) proposed test rules: Hydrochloric acid SARA 302/304/311/312 extremely hazardous substances: Hydrochloric acid SARA 313 toxic chemical notification and release reporting: Hydrochloric acid CERCLA: Hazardous substances.: Hydrochloric acid: 5000 lbs. (2268 kg)
Other Regulations:

OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.
Other Classifications:
WHMIS (Canada):
CLASS D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.
DSCL (EEC):
R34- Causes burns. R37- Irritating to respiratory system. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
HMIS (U.S.A.):
Health Hazard: 3
Fire Hazard: 0
Reactivity: 1
Personal Protection:
National Fire Protection Association (U.S.A.):
Health: 3
Flammability: 0
Reactivity: 1
Specific hazard:
Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

16: Other Information

References:
-Hawley, G.G. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987. -SAX, N.I. Dangerous Properties of Industrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984. -The Sigma-Aldrich Library of Chemical Safety Data, Edition II. -Guide de la loi et du règlement sur le transport des marchandises dangeureuses au canada. Centre de conformité international Ltée. 1986.
Other Special Considerations: Not available.
Created: 10/09/2005 05:45 PM
Last Updated: 05/21/2013 12:00 PM
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Material Safety Data Sheet Sodium Hypochlorite (NaOCl) 5% MSDS

1: Chemical Product and Company Identification

Product Name: Sodium Hypochlorite, 5%	**Contact Information:**
Catalog Codes: SLS1654	**Sciencelab.com, Inc.**
CAS#: Mixture.	14025 Smith Rd.
RTECS: Not applicable.	Houston, Texas 77396
TSCA: TSCA 8(b) inventory: Sodium hypochlorite;	US Sales: **1-800-901-7247**

Sodium hydroxide; Water **CI#:** Not applicable. **Synonym:** Chlorine Bleach, Bleach, Soda Bleach, Chlorox; Sodium Hypochlorite, Solution, 5% Available Chlorine **Chemical Name:** Hypochlorous acid, sodium salt, solution **Chemical Formula:** Not applicable.	International Sales: **1-281-441-4400** Order Online: ScienceLab.com **CHEMTREC (24HR Emergency Telephone), call:** 1-800-424-9300 **International CHEMTREC, call:** 1-703-527-3887 **For non-emergency assistance, call:** 1-281-441-4400

2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium hypochlorite	7681-52-9	4-7
Sodium hydroxide	1310-73-2	<1
Water	7732-18-5	>92

Toxicological Data on Ingredients: Sodium hypochlorite: ORAL (LD50): Acute: 5800 mg/kg [Mouse]. 8910 mg/kg [Rat].

3: Hazards Identification

Potential Acute Health Effects:

Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion. Hazardous in case of skin contact (corrosive), of eye contact (corrosive). Slightly hazardous in case of inhalation (lung sensitizer). Non-corrosive for lungs. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by
coughing, choking, or shortness of breath. Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:

Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Sodium hypochlorite]. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. [Sodium hypochlorite].
Mutagenic for mammalian somatic cells. [Sodium hydroxide]. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL
TOXICITY: Not available. The substance may be toxic to lungs, mucous membranes, skin, eyes. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection.

4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash

clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.
Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.
Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious
person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.
Serious Ingestion: Not available.

5: Fire and Explosion Data

Flammability of the Product: Non-flammable.
Auto-Ignition Temperature: Not applicable.
Flash Points: Not applicable.
Flammable Limits: Not applicable.
Products of Combustion: Not available.
Fire Hazards in Presence of Various Substances: combustible materials, metals, organic materials
Explosion Hazards in Presence of Various Substances:
Slightly explosive in presence of open flames and sparks. Non-explosive in presence of shocks.
Fire Fighting Media and Instructions: Not applicable.
Special Remarks on Fire Hazards:
Releases chlorine when heated above 35 deg. C. The substance itself is non-combustible and does not burn. However, when heated to decomposition it emits corrosive and/or toxic fumes. May ignite combustibles. Fire risk in contact with organic materials. Contact with metals may evolve flammable hydrogen gas.
Special Remarks on Explosion Hazards:
Anhydrous Sodium Hypochlorite is very explosive. Primary amines and calcium hypochlorite or sodium hypochlorite react to form normal chloroamines, which are explosive. Interaction of ethyleneimine with sodium (or other) hypochlorite gives the explosive N-chloro cmpd. Removal of formic acid from industrial waste streams with sodium hypochlorite soln becomes explosive at 55 deg C. Several explosions involving methanol and sodium hypochlorite were attributed to formation of methyl hypochlorite, especially in presence of acid or other esterification catalyst. Use of sodium hypochlorite soln to destroy acidified benzyl cyanide residues caused a violent explosion, thought to have been due to formation of nitrogen trichloride. (Sodium hypochlorite)

6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container.
Large Spill:
Corrosive liquid. Oxidizing material. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material.

Do not get water inside container. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep substance damp using water spray.
Do not touch spilled material. Use water spray curtain to divert vapour drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

7: Handling and Storage

Precautions:
Keep locked up. Keep container dry. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material. Do not ingest. Do not breathe gas/fumes/ vapour/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as reducing agents, combustible materials,
organic materials, metals, acids.
Storage:
Keep container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalies, reducing agents and combustibles. See NFPA 43A, Code for the Storage of Liquid and Solid Oxidizers. Air Sensitive to light. Store in light-resistant containers.

8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value.
Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.
Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits:
Sodium hypochlorite TWA: 1 CEIL: 1 (ppm as Cl2) STEL: 1 (ppm as Cl2) from ACGIH (TLV) [United States] Sodium hydroxide
STEL: 2 (mg/m3) from ACGIH (TLV) [United States] TWA: 2 CEIL: 2 (mg/m3) from OSHA (PEL) [United States] CEIL: 2 (mg/ m3) from NIOSH Consult local authorities for acceptable exposure limits.

9: Physical and Chemical Properties

Physical state and appearance: Liquid.
Odor: Characteristic. Chlorine-like (Slight.)
Taste: Not available.
Molecular Weight: Not applicable.
Color: Colourless to light greenish yellow
pH (1% soln/water): Neutral.
Boiling Point: Decomposition temperature: 40°C (104°F)
Melting Point: Not available.
Critical Temperature: Not available.
Specific Gravity: 1.07 - 1.093 (Water = 1)

Vapor Pressure: 2.3 kPa (@ 20°C)
Vapor Density: The highest known value is 0.62 (Air = 1) (Water).
Volatility: Not available.
Odor Threshold: Not available.
Water/Oil Dist. Coeff.: Not available.
Ionicity (in Water): Not available.
Dispersion Properties: See solubility in water.
Solubility: Easily soluble in cold water.

10: Stability and Reactivity Data

Stability: The product is stable.
Instability Temperature: Not available.
Conditions of Instability: Incompatible materials. light, air, heat
Incompatibility with various substances: Reactive with reducing agents, combustible materials, organic materials, metals, acids.
Corrosivity:
Extremely corrosive in presence of aluminium. Corrosive in presence of stainless steel (304), of stainless steel (316). Noncorrosive in presence of glass.
Special Remarks on Reactivity:
Decomposed by carbon dioxide from air. Slowly decomposes on contact with air. Unstable in air unless mixed with sodium hydroxide. Incompatible with ammonium acetate, ammonium carbonate, ammonium nitrate, ammonium oxalate, and ammonium phosphate. Decomposition of sodium hypochlorite takes place within a few seconds with these salts. Also incompatible with primary amines, phenyl acetonitrile, ethyleneimine, methanol, acidified benzyl cyanide, formic acid,
urea, nitro compounds, methylscellulose, cellulose, aziridine, ether, ammonia. Mixing this product with chemicals (e.g. ammonia, acids, detergents, etc.) or organic matter (e.g. urine, feces, etc.) will release chlorine gas. Chloramine gas may be evolved when ammonia and bleach are mixed. Decomposed by hot water. Sensitive to light. Exposure to light accelerates decomposition.
Special Remarks on Corrosivity:
Sodium Hypochlorite is extremely corrosive to brass, and moderately corrosive to bronze. There is no Corrosivity information for copper.
Polymerization: Will not occur.

11: Toxicological Information

Routes of Entry: Absorbed through skin. Eye contact. Inhalation. Ingestion.
Toxicity to Animals: Acute oral toxicity (LD50): 5800 mg/kg [Mouse]. (Sodium hypochlorite).
Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Sodium hypochlorite]. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. [Sodium hypochlorite]. Mutagenic for mammalian somatic cells. [Sodium hydroxide]. Contains material which may cause damage to the following organs: lungs, mucous membranes, skin, eyes.
Other Toxic Effects on Humans:
Very hazardous in case of skin contact (irritant), of ingestion, Hazardous in case of skin contact (corrosive), of eye contact (corrosive). Slightly hazardous in case of inhalation (lung sensitizer, lung corrosive).
Special Remarks on Toxicity to Animals: Not available.
Special Remarks on Chronic Effects on Humans: May affect genetic material (mutagenic) (Sodium hypochlorite)
Special Remarks on other Toxic Effects on Humans:

Potential Health Effects: Can cause severe irritation and possible burns to skin and eyes. Eye contact may also cause corneal and conjunctival edema, conjunctival hemorrhages. Contact with skin may also cause vesicular eruptions and eczematoid dermatitis which becomes evident upon re-exposure. Prolonged or repeated eye contact may cause conjunctivitis.
Ingestion can cause burns to the digestive tract. Symptoms may include: 1. pain and inflammation of the mouth, pharynx, esophagus, and stomach, 2. erosion of the mucous membranes (chiefly of the stomach), nausea, vomiting, choking, coughing, hemorrhage, 3. circulatory collapse with cold and clammy skin (due to methemoglobinemia), cyanosis, and shallow respirations, 4. confusion, delirium, coma, 5. edema of the pharynx, glottis, larynx with stridor and obstruction, 6. Perforation of the esophagus, or stomach, with mediastinitis or peritonitis. Inhalation causes slight to severe respiratory tract irritation and delayed pulmonary edema. Prolonged or repeated inhalation may cause allergic respiratory reaction (asthma).

12: Ecological Information

Ecotoxicity: Not available.
BOD5 and COD: Not available.
Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.
Special Remarks on the Products of Biodegradation: Not available.

13: Disposal Considerations

Waste Disposal:
Dilute with water and flush to sewer of local ordinances allow, otherwise, whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Waste must be disposed of in accordance with federal, state and local environmental control regulations.

14: Transport Information

DOT Classification: Class 8: Corrosive material
Identification: Hypochlorite solution UNNA: 1791 PG: III
Special Provisions for Transport: Not available.

15: Other Regulatory Information

Federal and State Regulations:
Illinois toxic substances disclosure to employee act: Sodium hydroxide Illinois chemical safety act: Sodium hydroxide New York release reporting list: Sodium hydroxide Rhode Island RTK hazardous substances: Sodium hydroxide Pennsylvania RTK:
Sodium hypochlorite; Sodium hydroxide Florida: Sodium hypochlorite Minnesota: Sodium hypochlorite; Sodium hydroxide
Massachusetts RTK: Sodium hypochlorite; Sodium hydroxide New Jersey: Sodium hypochlorite; Sodium hydroxide Louisiana spill reporting: Sodium hydroxide TSCA 8(b) inventory: Sodium hypochlorite; Sodium hydroxide; Water CERCLA: Hazardous substances.: Sodium hypochlorite: 100 lbs. (45.36 kg); Sodium hydroxide: 1000 lbs. (453.6 kg);
Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
Other Classifications:
WHMIS (Canada): CLASS E: Corrosive liquid.
DSCL (EEC):

R8- Contact with combustible material may cause fire. R31- Contact with acids liberates toxic gas. R36/38- Irritating to eyes and skin. S28- After contact with skin, wash immediately with plenty of water. S36/37/39- Wear suitable protective clothing, gloves and eye/face protection. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
HMIS (U.S.A.):
Health Hazard: 3
Fire Hazard: 0
Reactivity: 0
Personal Protection:
National Fire Protection Association (U.S.A.):
Health: 1
Flammability: 0
Reactivity: 0
Specific hazard:
Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information

References: Not available.
Other Special Considerations: Not available.
Created: 10/09/2005 06:32 PM
Last Updated: 05/21/2013 12:00 PM
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Material Safety Data Sheet Sodium bisulfite (SBS) MSDS

1: Chemical Product and Company Identification

Product Name: Sodium bisulfite
Catalog Codes: SLS3526, SLS1309
CAS#: 7631-90-5
RTECS: VZ2000000
TSCA: TSCA 8(b) inventory: Sodium bisulfite
CI#: Not available.
Synonym: Sulfurous acid, monosodium salt; Sulfurous acid, monosodium salt; Sodium sulhydrate; Sodium hydrogen sulfite; Sodium acid sulfite; Monosodium sulfite; Hydrogen sulfite sodium
Chemical Name: Sodium Bisulfite
Chemical Formula: NaHSO3

Contact Information:
Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396
US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**
Order Online: ScienceLab.com
CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300
International CHEMTREC, call: 1-703-527-3887
For non-emergency assistance, call: 1-281-441-4400

2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium bisulfite	7631-90-5	100

3: Hazards Identification

Potential Acute Health Effects: Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.

Potential Chronic Health Effects:

Slightly hazardous in case of inhalation (lung irritant). CARCINOGENIC EFFECTS: 3 (Not classifiable for human.) by IARC.

MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL

TOXICITY: Not available. The substance may be toxic to lungs, skin. Repeated or prolonged exposure to the substance can produce target organs damage.

4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:

In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions: Not applicable.
Special Remarks on Fire Hazards: Not available.
Special Remarks on Explosion Hazards: Not available.

6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.
Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

7: Handling and Storage

Precautions:
Do not ingest. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, alkalis.
Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.
Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.
Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits:
TWA: 5 (mg/m3) from OSHA (PEL) [United States] Inhalation TWA: 5 (mg/m3) from ACGIH (TLV) [United States] Inhalation TWA: 5 (mg/m3) [United States] Inhalation TWA: 5 (mg/m3) [United Kingdom (UK)] Inhalation TWA: 5 (mg/m3) [Canada] Inhalation Consult local authorities for acceptable exposure limits.

9: Physical and Chemical Properties

Physical state and appearance: Solid.
Odor: Sulfurous. (Slight.)
Taste: Disagreeable.
Molecular Weight: 104.07 g/mole
Color: White. Off-white.
pH (1% soln/water): Not available.
Boiling Point: Not available.
Melting Point: Decomposes.
Critical Temperature: Not available.

Specific Gravity: 1.48 (Water = 1)
Vapor Pressure: Not applicable.
Vapor Density: Not available.
Volatility: Not available.
Odor Threshold: Not available.
Water/Oil Dist. Coeff.: Not available.
Ionicity (in Water): Not available.
Dispersion Properties: See solubility in water.
Solubility: Easily soluble in hot water. Soluble in cold water. Soluble in 3.5 parts cold water. Soluble in 2 parts boiling water. Soluble in 70 parts alcohol Insoluble in liquid chloride, ammonia.

10: Stability and Reactivity Data

Stability: The product is stable.
Instability Temperature: Not available.
Conditions of Instability: Incompatible materials
Incompatibility with various substances: Reactive with oxidizing agents, acids.
Corrosivity: Non-corrosive in presence of glass.
Special Remarks on Reactivity: Slowly oxidized to sulfate on exposure to air.
Special Remarks on Corrosivity: Not available.
Polymerization: Will not occur.

11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.
Toxicity to Animals: Acute oral toxicity (LD50): 2000 mg/kg [Rat].
Chronic Effects on Humans:
CARCINOGENIC EFFECTS: 3 (Not classifiable for human.) by IARC. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. May cause damage to the following organs: lungs, skin.
Other Toxic Effects on Humans: Hazardous in case of skin contact (irritant), of ingestion, of inhalation.
Special Remarks on Toxicity to Animals: Not available.
Special Remarks on Chronic Effects on Humans:
May affect genetic material (mutagenic). May cause cancer based on animal test data. No human data found.
Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: Causes skin irritation. Eyes: Causes eye irritation. Inhalation: Can cause respiratory tract irritation with cough, wheezing, and shortness of breath. It can produce anaphylaxis or other hypersensivity reactions in some sensitized individuals. Ingestion: May be harmful if swallowed. It may cause nausea, vomiting, diarrhea, abdominal pain, gastric hemorrhage. Extremely large amounts may affect behavior/central nervous system and may produce central
nervous system stimulation, irritation, seizures and may also cause, cyanosis, respiratory depression, apnea, circulatory disturbances, hypotension and cardiovascular collapse. May cause asthmatic reaction in sensitized individuals. Chronic Potential Health Effects: Inhalation: Prolonged or repeated inhalation may cause bronchitis to develop with cough, phlegm, and/or shortness of breath. It can cause an asthma-like allergy or other hypersensivity reactions such as anaphylaxis, angioedema, bronchoconstriction, flushing, diaphoresis, urtiacaria, tachycardia, and hypotension in sensitized individuals.
Futures exposures may cause shortness of breath, wheezing, cough, and/or chest tightness. Skin: Prolonged or repeated skin contact can cause dermatitis. Ingestion: Prolonged or repeated ingestion may affect the liver, and blood

12: Ecological Information

Ecotoxicity: Not available.
BOD5 and COD: Not available.
Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.
Special Remarks on the Products of Biodegradation: Not available.

13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

14: Transport Information

DOT Classification: Not a DOT controlled material (United States).
Identification: Not applicable.
Special Provisions for Transport: Not applicable.

15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Sodium bisulfite Illinois toxic substances disclosure to employee act: Sodium bisulfite Illinois chemical safety act: Sodium bisulfite New York release reporting list: Sodium bisulfite Pennsylvania RTK: Sodium bisulfite Minnesota: Sodium bisulfite Massachusetts RTK: Sodium bisulfite Massachusetts spill list: Sodium bisulfite New
Jersey: Sodium bisulfite New Jersey spill list: Sodium bisulfite Louisiana spill reporting: Sodium bisulfite California Director's List of Hazardous Substances: Sodium bisulfite TSCA 8(b) inventory: Sodium bisulfite TSCA 8(a) PAIR: Sodium bisulfite TSCA 8(d) H and S data reporting: Sodium bisulfite: Effective date: 1/26/94; Sunset date: 6/30/98 CERCLA: Hazardous substances.: Sodium bisulfite: 5000 lbs. (2268 kg)
Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.
Other Classifications:
WHMIS (Canada): CLASS D-2B: Material causing other toxic effects (TOXIC).
DSCL (EEC):
R22- Harmful if swallowed. R31- Contact with acids liberates toxic gas. S25- Avoid contact with eyes. S46- If swallowed, seek medical advice immediately and show this container or label.
HMIS (U.S.A.):
Health Hazard: 2
Fire Hazard: 0
Reactivity: 0
Personal Protection: E
National Fire Protection Association (U.S.A.):
Health: 2
Flammability: 0
Reactivity: 0
Specific hazard:
Protective Equipment:

Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

16: Other Information

References: Not available.
Other Special Considerations: Not available.
Created: 10/11/2005 12:32 PM
Last Updated: 05/21/2013 12:00 PM
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Material Safety Data Sheet Sodium metabisulfite (SMBS) MSDS

1: Chemical Product and Company Identification

Product Name: Sodium bisulfite
Catalog Codes: SLS3526, SLS1309
CAS#: 7631-90-5
RTECS: VZ2000000
TSCA: TSCA 8(b) inventory: Sodium bisulfite
CI#: Not available.
Synonym: Sulfurous acid, monosodium salt; Sulfurous acid, monosodium salt; Sodium sulhydrate; Sodium hydrogen sulfite; Sodium acid sulfite; Monosodium sulfite; Hydrogen sulfite sodium
Chemical Name: Sodium Bisulfite
Chemical Formula: NaHSO3

Contact Information:
Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396
US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**
Order Online: ScienceLab.com
CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300
International CHEMTREC, call: 1-703-527-3887
For non-emergency assistance, call: 1-281-441-4400

2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium bisulfite	7631-90-5	100

Toxicological Data on Ingredients: Sodium bisulfite: ORAL (LD50): Acute: 2000 mg/kg [Rat].

3: Hazards Identification

Potential Acute Health Effects: Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.
Potential Chronic Health Effects:
Slightly hazardous in case of inhalation (lung irritant). CARCINOGENIC EFFECTS: 3 (Not classifiable for human.) by IARC.
MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL
TOXICITY: Not available. The substance may be toxic to lungs, skin. Repeated or prolonged exposure to the

substance can produce target organs damage.

4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.
Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.
Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Serious Inhalation: Not available.
Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.
Serious Ingestion: Not available.

5: Fire and Explosion Data

Flammability of the Product: Non-flammable.
Auto-Ignition Temperature: Not applicable.
Flash Points: Not applicable.
Flammable Limits: Not applicable.
Products of Combustion: Not available.
Fire Hazards in Presence of Various Substances: Not applicable.
Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.
Fire Fighting Media and Instructions: Not applicable.
Special Remarks on Fire Hazards: Not available.
Special Remarks on Explosion Hazards: Not available.

6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.
Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities

7: Handling and Storage

Precautions:
Do not ingest. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, alkalis.
Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended
exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.
Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.
Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits:
TWA: 5 (mg/m3) from OSHA (PEL) [United States] Inhalation TWA: 5 (mg/m3) from ACGIH (TLV) [United States] Inhalation TWA: 5 (mg/m3) [United States] Inhalation TWA: 5 (mg/m3) [United Kingdom (UK)] Inhalation TWA: 5 (mg/m3) [Canada] Inhalation Consult local authorities for acceptable exposure limits.

9: Physical and Chemical Properties

Physical state and appearance: Solid.
Odor: Sulfurous. (Slight.)
Taste: Disagreeable.
Molecular Weight: 104.07 g/mole
Color: White. Off-white.
pH (1% soln/water): Not available.
Boiling Point: Not available.
Melting Point: Decomposes.
Critical Temperature: Not available.
Specific Gravity: 1.48 (Water = 1)
Vapor Pressure: Not applicable.
Vapor Density: Not available.
Volatility: Not available.
Odor Threshold: Not available.
Water/Oil Dist. Coeff.: Not available.
Ionicity (in Water): Not available.
Dispersion Properties: See solubility in water.
Solubility: Easily soluble in hot water. Soluble in cold water. Soluble in 3.5 parts cold water. Soluble in 2 parts boiling water. Soluble in 70 parts alcohol Insoluble in liquid chloride, ammonia.

10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.
Conditions of Instability: Incompatible materials
Incompatibility with various substances: Reactive with oxidizing agents, acids.
Corrosivity: Non-corrosive in presence of glass.
Special Remarks on Reactivity: Slowly oxidized to sulfate on exposure to air.
Special Remarks on Corrosivity: Not available.
Polymerization: Will not occur.

11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.
Toxicity to Animals: Acute oral toxicity (LD50): 2000 mg/kg [Rat].
Chronic Effects on Humans:
CARCINOGENIC EFFECTS: 3 (Not classifiable for human.) by IARC. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. May cause damage to the following organs: lungs, skin.
Other Toxic Effects on Humans: Hazardous in case of skin contact (irritant), of ingestion, of inhalation.
Special Remarks on Toxicity to Animals: Not available.
Special Remarks on Chronic Effects on Humans:
May affect genetic material (mutagenic). May cause cancer based on animal test data. No human data found.
Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: Causes skin irritation. Eyes: Causes eye irritation. Inhalation: Can cause respiratory tract irritation with cough, wheezing, and shortness of breath. It can produce anaphylaxis or other hypersensivity reactions in some sensitized individuals. Ingestion: May be harmful if swallowed. It may cause nausea, vomiting, diarrhea, abdominal pain, gastric hemorrhage. Extremely large amounts may affect behavior/central nervous system and may produce central
nervous system stimulation, irritation, seizures and may also cause, cyanosis, respiratory depression, apnea, circulatory disturbances, hypotension and cardiovascular collapse. May cause asthmatic reaction in sensitized individuals. Chronic Potential Health Effects: Inhalation: Prolonged or repeated inhalation may cause bronchitis to develop with cough, phlegm, and/or shortness of breath. It can cause an asthma-like allergy or other hypersensivity reactions such as anaphylaxis, angioedema, bronchoconstriction, flushing, diaphoresis, urtiacaria, tachycardia, and hypotension in sensitized individuals.
Futures exposures may cause shortness of breath, wheezing, cough, and/or chest tightness. Skin: Prolonged or repeated skin contact can cause dermatitis. Ingestion: Prolonged or repeated ingestion may affect the liver, and blood

12: Ecological Information

Not available.
BOD5 and COD: Not available.
Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.
Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.
Special Remarks on the Products of Biodegradation: Not available.

13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

14: Transport Information

DOT Classification: Not a DOT controlled material (United States).
Identification: Not applicable.
Special Provisions for Transport: Not applicable.

15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Sodium bisulfite Illinois toxic substances disclosure to employee act: Sodium bisulfite Illinois chemical safety act: Sodium bisulfite New York release reporting list: Sodium bisulfite Pennsylvania RTK: Sodium bisulfite Minnesota: Sodium bisulfite Massachusetts RTK: Sodium bisulfite Massachusetts spill list: Sodium bisulfite New Jersey: Sodium bisulfite New Jersey spill list: Sodium bisulfite Louisiana spill reporting: Sodium bisulfite California Director's List of Hazardous Substances: Sodium bisulfite TSCA 8(b) inventory: Sodium bisulfite TSCA 8(a) PAIR: Sodium bisulfite
TSCA 8(d) H and S data reporting: Sodium bisulfite: Effective date: 1/26/94; Sunset date: 6/30/98 CERCLA: Hazardous substances.: Sodium bisulfite: 5000 lbs. (2268 kg)
Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.
Other Classifications:
WHMIS (Canada): CLASS D-2B: Material causing other toxic effects (TOXIC).
DSCL (EEC):
R22- Harmful if swallowed. R31- Contact with acids liberates toxic gas. S25- Avoid contact with eyes. S46- If swallowed, seek medical advice immediately and show this container or label.
HMIS (U.S.A.):
Health Hazard: 2
Fire Hazard: 0
Reactivity: 0
Personal Protection: E
National Fire Protection Association (U.S.A.):
Health: 2
Flammability: 0
Reactivity: 0
Specific hazard:
Protective Equipment:
Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

16: Other Information

References: Not available.
Other Special Considerations: Not available.
Created: 10/11/2005 12:32 PM
Last Updated: 05/21/2013 12:00 PM
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consequential or exemplary damages, howsoever arising, even if ScienceLab.com has been advised of the possibility of such damages.

Material Safety Data Sheet Sodium hydroxide (NaOH)	
1: Chemical Product and Company Identification	
Product Name: Sodium hydroxide Catalog Codes: SLS3298, SLS1081, SLS2503, SLS3925, SLS1705 CAS#: 1310-73-2 RTECS: WB4900000 TSCA: TSCA 8(b) inventory: Sodium hydroxide CI#: Not available. Synonym: Caustic Soda Chemical Name: Sodium Hydroxide Chemical Formula: NaOH	Contact Information: Sciencelab.com, Inc. 14025 Smith Rd. Houston, Texas 77396 US Sales: 1-800-901-7247 International Sales: 1-281-441-4400 Order Online: ScienceLab.com CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300 International CHEMTREC, call: 1-703-527-3887 For non-emergency assistance, call: 1-281-441-4400

2: Composition and Information on Ingredients		
Composition:		
Name	CAS #	% by Weight
Sodium hydroxide	1310-73-2	100
Toxicological Data on Ingredients: Sodium hydroxide LD50: Not available. LC50: Not available.		

3: Hazards Identification
Potential Acute Health Effects: Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation. The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering. Inhalation of dust will produce irritation to gastro-intestinal or respiratory tract, characterized by burning, sneezing and coughing. Severe over-exposure can produce lung damage, choking, unconsciousness or death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering. Potential Chronic Health Effects: CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to mucous membranes, upper respiratory tract, skin, eyes. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage.

4: First Aid Measures

Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.
Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.
Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.
Serious Ingestion: Not available.

5: Fire and Explosion Data

Flammability of the Product: Non-flammable.
Auto-Ignition Temperature: Not applicable.
Flash Points: Not applicable.
Flammable Limits: Not applicable.
Products of Combustion: Not available.
Fire Hazards in Presence of Various Substances: metals
Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Slightly explosive in presence of heat.
Fire Fighting Media and Instructions: Not available
Special Remarks on Fire Hazards:
sodium hydroxide + zinc metal dust causes ignition of the latter. Under proper conditions of temperature, pressure and state of division, it can ignite or react violently with acetaldehyde, ally alcohol, allyl chloride, benzene-1,4-diol, chlorine trifluoride, 1,2 dichlorethylene, nitroethane, nitromethane, nitroparaffins, nitropropane, cinnamaldehyde, 2,2-dichloro-3,3-dimethylbutane.
Sodium hydroxide in contact with water may generate enough heat to ignite adjacent combustible materials. Phosphorous boiled with NaOH yields mixed phosphines which may ignite spontaneously in air. sodium hydroxide and cinnamaldehyde + heat may cause ignition. Reaction with certain metals releases flammable and explosive hydrogen gas.
Special Remarks on Explosion Hazards:
Sodium hydroxide reacts to form explosive products with ammonia + silver nitrate. Benzene extract of allyl benzenesulfonate prepared from allyl alcohol, and benzene sulfonyl chloride in presence of aqueous sodium

hydroxide, under vacuum distillation, residue darkened and exploded. Sodium Hydroxide + impure tetrahydrofuran, which can contain peroxides, can cause serious explosions. Dry mixtures of sodium hydroxide and sodium tetrahydroborate liberate hydrogen explosively at 230-270 deg. C. Sodium Hydroxide reacts with sodium salt of trichlorophenol + methyl alcohol + trichlorobenzene + heat to cause an explosion.

6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. If necessary: Neutralize the residue with a dilute solution of acetic acid.
Large Spill:
Corrosive solid. Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal.
Neutralize the residue with a dilute solution of acetic acid. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

7: Handling and Storage

Precautions:
Keep container dry. Do not breathe dust. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If you feel unwell, seek medical attention and show the label when possible. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, metals, acids, alkalis, moisture.
Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Hygroscopic. Deliquescent.

8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.
Personal Protection:
Splash goggles. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.
Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor and dust respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.
Exposure Limits:
STEL: 2 (mg/m3) from ACGIH (TLV) [United States] TWA: 2 CEIL: 2 (mg/m3) from OSHA (PEL) [United States] CEIL: 2 (mg/m3) from NIOSH Consult local authorities for acceptable exposure limits.

9: Physical and Chemical Properties

Physical state and appearance: Solid. (Deliquescent solid.)
Odor: Odorless.
Taste: Not available.
Molecular Weight: 40 g/mole
Color: White.
pH (1% soln/water): 13.5 [Basic.]
Boiling Point: 1388°C (2530.4°F)
Melting Point: 323°C (613.4°F)
Critical Temperature: Not available.
Specific Gravity: 2.13 (Water = 1)
Vapor Pressure: Not applicable.
Vapor Density: Not available.
Volatility: Not available.
Odor Threshold: Not available.
Water/Oil Dist. Coeff.: Not available.
Ionicity (in Water): Not available.
Dispersion Properties: See solubility in water.
Solubility: Easily soluble in cold water.

10: Stability and Reactivity Data

Stability: The product is stable.
Instability Temperature: Not available.
Conditions of Instability: Incompatible materials, moisture, moist air
Incompatibility with various substances:
Highly reactive with metals. Reactive with oxidizing agents, reducing agents, acids, alkalis, moisture.
Corrosivity: Not available.
Special Remarks on Reactivity:
Hygroscopic. Much heat is evolved when solid material is dissolved in water. Therefore cold water and caution must be used for this process. Sodium hydroxide solution and octanol + diborane during a work-up of a reaction mixture of oxime and diborane in tetrahyrofuran is very exothermic, a mild explosion being noted on one occasion. Reactive with water, acids (mineral, non-oxidizing, e.g. hydrochloric, hydrofluoric acid, muriatic acid, phosphoric), acids (mineral, oxidizing e.g. chromic
acid, hypochlorous acid, nitric acid, sulfuric acid), acids (organic e.g. acetic acid, benzoic acid, formic acid, methanoic acid, oxalic acid), aldehydes (e.g. acetaldehyde, acrolein, chloral hydrate, foraldehyde), carbamates (e.g. carbanolate, carbofuran), esters (e.g. butyl acetate, ethyl acetate, propyl formate), halogenated organics (dibromoethane, hexachlorobenzene, methyl
chloride, trichloroethylene), isocyanates (e.g. methyl isocyanate), ketones (acetone, acetophenone, MEK, MIBK), acid chlorides, strong bases, strong oxidizing agents, strong reducing agents, flammable liquids, powdered metals and metals (i.e aluminum, tin, zinc, hafnium, raney nickel), metals (alkali and alkaline e.g. cesium, potassium, sodium), metal compounds (toxic e.g. berylium, lead acetate, nickel carbonyl, tetraethyl lead), mitrides (e.g. potassium nitride, sodium nitride), nitriles (e.g. acetonitrile, methyl cyanide), nitro compounds (organic e.g. nitrobenzene, nitromethane), acetic anhydride, chlorohydrin, chlorosulfonic acid, ethylene cyanohydrin, glyoxal, hydrosulfuric acid, oleum, propiolactone, acylonitrile, phorosous pentoxide, chloroethanol, chloroform-methanol, tetrahydroborate, cyanogen azide, 1,2,4,5 tetrachlorobenzene, cinnamaldehyde. Reacts with formaldehyde hydroxide to yield formic acid, and hydrogen.
Special Remarks on Corrosivity: Very caustic to aluminum and other metals in presence of moisture.
Polymerization: Will not occur.

11: Toxicological Information
Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion. Toxicity to Animals: LD50: Not available. LC50: Not available. Chronic Effects on Humans: MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. May cause damage to the following organs: mucous membranes, upper respiratory tract, skin, eyes. Other Toxic Effects on Humans: Extremely hazardous in case of inhalation (lung corrosive). Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (corrosive), of ingestion, Special Remarks on Toxicity to Animals: Lowest Published Lethal Dose: LDL [Rabbit] - Route: Oral; Dose: 500 mg/kg Special Remarks on Chronic Effects on Humans: May affect genetic material. Investigation as a mutagen (cytogenetic analysis) Special Remarks on other Toxic Effects on Humans:

12: Ecological Information
Ecotoxicity: Not available. BOD5 and COD: Not available. Products of Biodegradation: Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise. Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic. Special Remarks on the Products of Biodegradation: Not available.

13: Disposal Considerations
Waste Disposal: Waste must be disposed of in accordance with federal, state and local environmental control regulations.

14: Transport Information
DOT Classification: Class 8: Corrosive material Identification: Sodium hydroxide, solid UNNA: 1823 PG: II Special Provisions for Transport: Not available.

15: Other Regulatory Information

Federal and State Regulations:
Illinois toxic substances disclosure to employee act: Sodium hydroxide Illinois chemical safety act: Sodium hydroxide New York release reporting list: Sodium hydroxide Rhode Island RTK hazardous substances: Sodium hydroxide Pennsylvania
RTK: Sodium hydroxide Minnesota: Sodium hydroxide Massachusetts RTK: Sodium hydroxide New Jersey: Sodium hydroxide Louisiana spill reporting: Sodium hydroxide California Director's List of Hazardous Substances: Sodium hydroxide TSCA 8(b) inventory: Sodium hydroxide CERCLA: Hazardous substances.: Sodium hydroxide: 1000 lbs. (453.6 kg)
Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.
Other Classifications:
WHMIS (Canada): CLASS E: Corrosive solid.
DSCL (EEC):
R35- Causes severe burns. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S37/39- Wear suitable gloves and eye/face protection. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
HMIS (U.S.A.):
Health Hazard: 3
Fire Hazard: 0
Reactivity: 2
Personal Protection: j
National Fire Protection Association (U.S.A.):
Health: 3
Flammability: 0
Reactivity: 1
Specific hazard:
Protective Equipment:
Gloves. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

16: Other Information

References: Not available.
Other Special Considerations: Not available.
Created: 10/09/2005 06:32 PM
Last Updated: 05/21/2013 12:00 PM
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SECTION 13: LIST OF ENCLOSURES

- As build PID's approved / final PFDs, PIDs & drawings
- Vendors catalogue and manual
- Log Sheet
- Analysis Manual
- Laboratory analysis requirements and procedure