Base Load Power Hub (BLPH)

WATER TREATMENT PACKAGE A-50000
INSTALLATION, OPERATING AND MAINTENANCE MANUAL

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

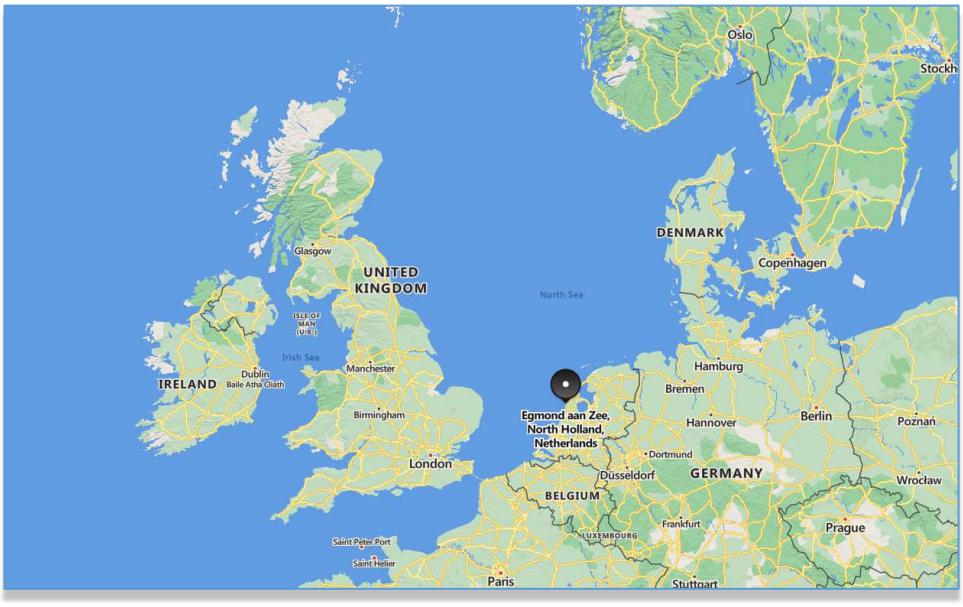


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map

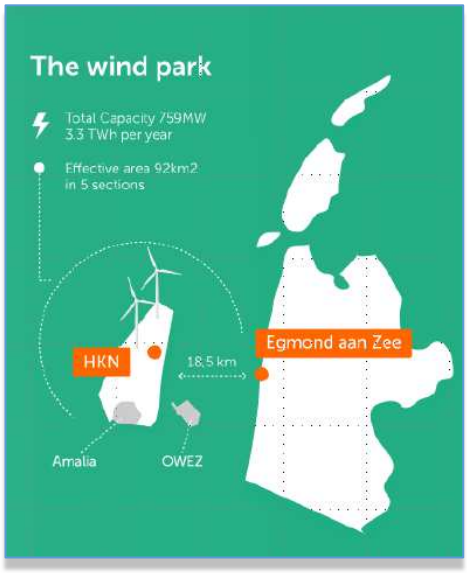


Figure 2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

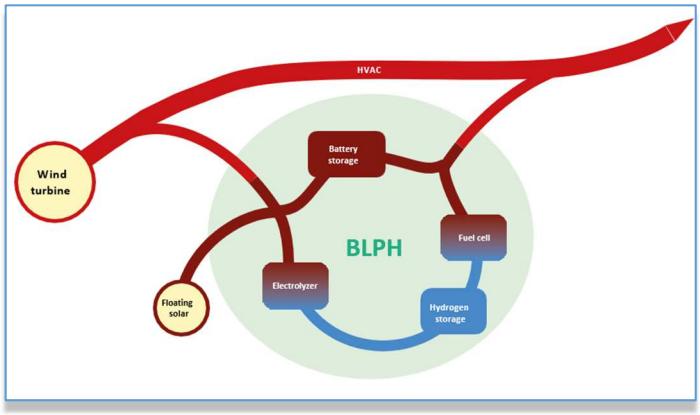


Figure 3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

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2 DOCUMENT SCOPE

This Operation & Maintenance Manual describes the procedures recommended by PSC Engineering & Contracting S.p.A. for operation, maintenance and repairing of the supplied Water Treatment Package and/or its components.

PSC reserves the right to modify such procedures and/or instructions.

All the instructions must be carefully read by the personnel that will be in charge for the use of the unit prior to start up. A careful use of the procedures described in this manual will guarantee the best and long lasting performance of the equipment.

The Operating and Maintenance Manual must be kept with care and must be forwarded along with the equipment in case of property change. The manual must be kept clean and fully readable. No portion of the manual must be removed, teared or modified. The manual must be stored in a dry clean place, far from heating sources and as close as possible to the related equipment.

The User accepts the responsibility of any operation trouble or warranty void due to incorrect use of the procedures and instructions described in this manual.

The User can ask assistance to PSC for any trouble connected with the use of the manual.

In case of revisions of the manual in one or more chapters, it is responsibility of the User to replace the old parts of the manual with the new ones and to update the revision index.

The manual is dedicated to: Installer, Operator and all qualified personnel in charge of equipment use and maintenance.

We specify that "OPERATOR" is intended as the person in charge of equipment use, set up, cleaning and ordinary maintenance execution.

"QUALIFIED PERSONNEL or QUALIFIED OPERATOR" is intended as persons who have attended specialization courses, etc. and have experience regarding the installation, use, maintenance, repairing and transport of the equipment.

"EXPOSED PERSON" is intended as the person whose presence in areas near or within the unit that may be dangerous for the safety and health of the person himself.

Water Treatment Package is supplied for professional use therefore its operation must be executed only by qualified personnel that must be:

- adult;
- physically and mentally able to make technical operations;
- trained and instructed about the use and maintenance of the equipment;

- able to fully understand the manual and all safety prescriptions.
- aware of emergency procedures.

2.1 PROPERTY CLAUSE

All what included in this manual is property of PSC and cannot be copied, forwarded or used for other scopes neither directly or indirectly.

It can be used only as a reference guide for the supplied equipment and shall not be forwarded to third party for examination without written approval from PSC.

2.2 RESPONSIBILITY

PSC's supply is guaranteed against defects in materials and workmanship for a period defined under contract from the date of the FAT (or from the "goods ready for shipment" date if no FAT has been performed).

PSC accepts, during the validity of the warranty period, to repair and, if necessary, to replace within a reasonable number of days and free of charge the defective parts of PSC's supply - the costs to arrange and send the material(s) to PSC designated workshop shall be at Client' care.

PSC warranty does not cover defects or damages caused by mishandling, improper use, improper operation or caused by events of force majeure.

PSC warranty does not cover the intervention or services at site of PSC's technician(s) but only the repair of the part c/o PSC designated workshop (or the replacement of the damaged part that cannot be repaired) – transport arrangement and costs shall be at Client' care.

PSC warranty will expire if any personnel intervention occurs without the previous written approval of PSC.

Commissioning or Start-Up performed without written approval of PSC shall be considered as acts of invalidation of the warranty, from the date of commissioning or start-up, whichever may happen.

ATTENTION:

- Activities of dismantling, reassembling, modifying, handling of chemicals (or powders), changes to the supply (including software or hardware), replacing of parts, performing of technical assistance, provision and installation of spare parts and/or devices that may alter the original supply, maintenance and/or repair to be performed on PSC's package(s) or part(s) of PSC products or supply that are not authorized without PSC written consent, will result in an immediate termination of contractual guarantees.
- Any part must be supplied by PSC and any work shall be performed by PSC' authorized personnel during the contract warranty period.
- During warranty period any site activity of dismantling, remounting, modifying, handling chemicals (or powders), changes to the supply (software or hardware), replacing of parts, technical assistance shall be performed by PSC authorized personnel or under PSC's personnel supervision who will be available at daily rate(s).

- Using parts supplied through alternative sources will have the following consequences:

1. voiding of any remaining warranties
2. invalidation of any compliance certifications (e.g., RoHS, CE, ATEX, IECEx, UKCA, INMETRO, Division 2, UL, etc.)
3. improper operation / misuse of equipment
4. reduced lifetime of equipment and associated components.

PSC will not guarantee the performance(s) of the equipment from the date of replacement of any part supplied through alternative sources without PSC's previous written consent during the contractual warranty period.

3 GENERAL INFORMATION

3.1 MANUFACTURER DATA

PSC Engineering & Contracting S.p.A.

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20813 Bovisio Masciago

Monza e Brianza, Italy

www.pscengineering.com

Tel.: +39.0362.571113

Fax: +39.0362.571115

The warranty period of the unit is according to contractual conditions (36 calendar months from the issuance of Completion Certificate issued by Client, or 48 calendar months from the date of actual delivery of the goods, whichever expires first). Warranty conditions for repair/replace of defective components are according to contractual conditions.

Any modification done by the user without written authorization from PSC will void the warranty and will release PSC from any responsibility in case of damages to equipment or persons. Same applies when non-original spare parts are used.

For all the above we strongly recommend contacting our after-sale office for information or technical assistance.

3.2 SAFETY RULES

Customer shall make sure that installation, start up, maintenance and operation are executed according to the safety rules applicable in the country where the unit is operating.



WARNING: the following manual sections contain safety information, warnings and cautions both mechanical and electrical that can result in bodily harm and/or equipment damage if ignored!

DO NOT operate or service this equipment until after reading this Operation and Maintenance Manual and the safety information it contains. When installing, operating, or performing maintenance on this equipment, always observe caution and warning notices.

Design and Manufacture of all PSC equipment is with due consideration and care for generally accepted safety standards. However, like any mechanical device, the proper and safe performance of this equipment depends upon using sound and prudent operating, maintenance, and servicing procedures by properly trained personnel.

For personal protection and the protection of others:

- Follow the safety guidelines outlined in this manual.
- Form safe working habits by incorporating and abiding by these guidelines in the daily work routine.
- Keep this manual available for review.

Always operate the system within the safety operating guidelines of this manual and the facility where the system is located.

DO NOT:

- Prevent the operation of any safety features.
- Remove the safety guards.
- Operate this equipment with any of the safety devices bypassed or the guards removed. Only qualified personnel should operate this machine.
- Perform service or maintenance procedures when the equipment/machine is running or toxic materials are present.

3.2.1 Safety and operation indicators and symbols

The following highlighted boxes indicate important safety and process instructions or information.

IMPORTANT:



These statements indicate special attention be given a particular procedure or information to prevent damage to equipment, false readings, or disruption to a process.

CAUTION:



Caution indicators identify that potential personal hazards and hardware, or product damage exist with

the procedure and provide information for prevention.

CAUTION:



This lightning symbol indicates that a dangerous voltage or other electrical hazard is present and may constitute a risk of electrical shock with the potential for BODILY HARM.

WARNING:



THIS INDICATES THAT THERE IS AN IMMEDIATE DANGER ASSOCIATED WITH A PARTICULAR PROCEDURE THAT COULD CAUSE BODILY HARM. EXTREME CAUTION MUST BE EXERCISED.

IMPORTANT:



The above symbols and their combinations thereof, provide emphasis to important aspects of safety and the operation of this system.

NOTE: ALL information contained in this document is important for the safe and efficient operation of this system.

3.2.2 Operation safety

Only qualified or authorized personnel should be within the operating zone when there is power applied to the equipment control circuits or when the equipment is in operation. Use a brightly painted guardrail and/or warning strips to define an operating zone. Always operate the system within the safety guidelines of the facility and/or country where the system is located.



CAUTION: Follow all site procedures regarding toxic, bio-hazardous, or corrosive process materials. Any solution drained from the system into a common drain must meet the requirements and/or standards set by the governing authority for waste disposal in the affected community/area.

DO NOT:

- Operate any equipment until thoroughly trained in all facets of its operation.
- Operate faulty or damaged equipment. Make sure that the performance of proper service and maintenance procedures on all equipment is up to date.
- Start any equipment until issuing warnings to all non-essential personnel in the area. After issuing warnings, verify that all non-essential personnel have moved outside the operating zone.

- Have loose clothing, neckties, necklaces, or unrestrained long hair near any operating equipment. These restricted items include rings, watches, bracelets, and other jewelry.
- Place fingers, hands, or any other part of your body on or into any equipment or near moving parts when the power is on.
- Touch surfaces that are in temperature range above 120°F (49°C) or below 0°F (-18°C).
- Operate any equipment if the removal or disconnection of a safety device or guard has occurred.
- Operate any equipment above or below specified speeds, pressures, or temperatures.
- Remove warning labels or signs that appear on any equipment. Replace torn, worn, and unreadable warning markers immediately.
- Sit, stand, kneel, or lay on anything that may cause you to fall against the equipment.
- Perform any unauthorized activity around or on any equipment at any time. This is both dangerous and prohibited.

Attempt to clean any equipment while it is in operation. Always check that the equipment to be cleaned is in a safe condition (not powered, at temperature extremes, etc.) and that approved warning signs are posted and other personnel are aware that cleaning is in progress. Use lockout/tag-out procedures when applicable. Always use approved cleaning materials and dispose of properly.

ALWAYS:

- Remove any tools or other unauthorized objects from the operating zone before starting the equipment.
- Keep the operating zone free of obstacles that could cause a person to trip or fall against the equipment.
- Keep alert. Observe indicator lights, warnings, and alarms displayed on any equipment.
- Know the procedures for shutting down and starting up the system.
- Wear required safety equipment, including gloves, goggles and protective clothing.



SAFETY SHOES USE IS MANDATORY



GLOVES USE IS MANDATORY



SAFETY SCREEN USE IS MANDATORY



SAFETY CLOTHES USE IS MANDATORY

NOTE: air, nitrogen, hydraulic, steam and electrical power must be off when the equipment is not in use unless it is required for maintenance, testing, or troubleshooting purposes.

3.2.3 Safety inspection

BEFORE START-UP OR RE-START MAKE SURE THAT ALL:

- Guards and safety devices are installed and operative.
- Non-required personnel are clear of the equipment.
- Materials, tools, or other foreign objects that could cause bodily injury to personnel and/or damage the equipment are removed from the operating zone.
- Equipment is in operating condition by checking that:
  - ✓ All gas and fluids connections are tight and leak free
  - ✓ All moving components are properly lubricated
  - ✓ All process monitoring lights, horns, pressure gauges, and safety devices or indicators, detectors are in good working order.

3.2.4 Electrical safety

CAUTION:



PSC requires that licensed electricians or those authorized by the facility and/or country of installation perform all required electrical work.

This work includes but is not limited to:

- All electrical/electronic maintenance and service, including cleaning.
- Maintenance of the electrical system to avoid bodily harm to other personnel. All electrical power must be OFF before servicing the equipment unless required for maintenance, testing, or troubleshooting procedures.
- If power is required, EXTREME CAUTION must be observed by all personnel. If applicable, turn the MAIN DISCONNECT switch to the OFF (OPEN) position.
- If a MAIN DISCONNECT switch is not present, isolate (de-energize) the equipment of all power sources before any service takes place unless required for maintenance, testing, or troubleshooting procedures.

Under circumstances where maintenance, testing, or troubleshooting requires the power to be ON, make sure:

- Your tools and body are clear of the chassis.
- Proper grounding is in place.
- To take extra safety precautions in damp areas.
- To be alert and avoid outside distractions.

- To post proper ELECTRICAL HAZARD warning signs.
- To inform all personnel in the area that work is taking place with the electrical power turned on and applied to the equipment.

Always assume that the power is ON.

To remove the load from a circuit or equipment:

- OPEN the disconnect switch or the appropriate circuit breaker and lock it in the open position.
- Make sure that the circuit is OPEN by using the proper test equipment.

IMPORTANT: Check all test equipment at regular intervals for proper calibration and that it is functioning properly. Always check the calibration date tag on the instrument for last calibration date. If the test equipment does not have a tag listing the last calibration date,DO NOT USE IT and report it to management.

- It is mandatory that the power source be LOCKED OUT using a lock for which only the operator has the key. This prevents anyone from accidentally turning on the power while the operator is servicing the equipment/machine.
- Whenever locking-out any power source, always use standard LOCKOUT/TAG- OUT procedures (or the procedures required by the country of installation) when servicing the equipment, or the appropriate procedures of the governing body in the country where the equipment is located.

WARNING: DANGER – USING A POWER SOURCE OTHER THAN THAT SPECIFIED IN THIS MANUAL OR THE SYSTEM DRAWINGS CAN CAUSE BODILY HARM AND/OR PRODUCT DAMAGE! MAKE SURE THE POWER SUPPLY MEETS THE REQUIREMENTS AS SPECIFIED. IMPROPER GROUNDING CAN CAUSE ELECTRICAL SHOCK HAZARDS. MAKE SURE THAT PROPER GROUNDING, BONDING, AND OVERLOAD PROTECTIONS ARE IN FORCE. DO NOT DEFEAT THE GROUNDING OR POLARIZATION OF THE EQUIPMENT/MACHINE.

3.2.5 Chemical safety

This system uses chemicals which may need to be handled during installation and operation.

It is recommended, being chemicals used in the operation, to follow all storage and handling instructions and recommendation shown in the material safety data sheets (MSDS) of each chemical.

CAUTION:



Follow all site procedures regarding toxic, bio-hazardous, or corrosive process materials. Any solution drained during installation, or from the system, into a common drain must meet the requirements and/or standards set by the governing authority for waste disposal in the affected community/area.







WARNING:



CARE IS TO BE TAKEN WHEN HANDLING CHEMICAL CONTAINERS AND COMPONENTS. PERSONNEL HANDLING CHEMICAL CONTAINERS AND COMPONENTS ARE TO WEAR SUITABLE PERSONAL PROTECTION EQUIPMENT (PPE), E.G. – GLOVES, GOGGLES AND PROTECTIVE CLOTHING.

WARNING:



DO NOT USE ANY CHEMICALS OTHER THAN THOSE EXPLICITLY MENTIONED IN THIS MANUAL.

DO NOT MIX CHEMICALS.

3.2.6 Behavior in the event of fire and accidents

Precautions

- Always be prepared for accidents or fire!
- Ensure that first aid supplies (box of dressings, blankets etc.) and fire extinguishers are completely functional and ready to hand.
- Ensure that personnel are familiar with accident reporting, first aid and rescue equipment.
- Check fire and gas detector system is activated
- Check first aid and rescue equipment regularly.

- Keep access routes clear for emergency service.

Actions in the event of accidents

- Immediately use the emergency stop device to trigger an emergency stop.
- Activate the manual call point in case of fire or gas presence to signal the danger zone
- Evacuate and rescue people from the danger zone.
- Initiate first aid measures.
- Notify the rescue services.
- Notify those responsible at the place of use.
- Clear access routes for emergency service.

Precautions for accident prevention

- Safe handling of process additives (Provided by the customer).
- Incorrect handling of process additives can result in damage to health.
- Observe the safety data sheet issued by the manufacturer.
- Wear the personnel protective equipment.
- Remove any chemical spillage and leakage by clean water to dedicated drain
- Only eat, drink and smoke in the allowed areas for these.
- Keep eyewash bottles in the system area ready for use.
- Wash hands thoroughly after completion of the work, before breaks and going to the toilet.

Handling and Storage

The working area should also be well ventilated and equipped with functioning air supply. The following reservations must be maintained:

- Protect against heat and direct sunlight.
- Keep away from strong acid and alkaline materials and oxidation agents in order to avoid exothermal reactions.
- Keep away from ignition sources.

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4 REFERENCE DOCUMENTS

4.1 PSC DOCUMENTS

Doc. No.	Description
1724000448-MD-LIS-00001	SMIR - Supplier Master Information Register
1724000448-PR-PID-00013	P&I Diagram – Water Treatment Package
1724000448-MAC-CE-00004	Package Cause & Effect Matrix
1724000448-MAC-SP-00003	System Functional Description
1724000448-MAC-LIS-00020	Utilities, chemicals, consumables, lubricants consumption list
1724000448-IN-LIS-00021	Instrument list with set point/control/alarm/shutdown
1724000448-PP-DD-00012	Package 3D model
1724000448-EL-DG-00015	Package Interconnecting Diagram
1724000448-MAC-DA-00005	Container General Arrangement
1724000448-QC-PRO-00028	Performance Test Procedure at yard
1724000448-QC-PRO-00035	Handling, shipping, site installation

Table 1 – PSC Documents

4.2 SUBVENDOR IOM MANUALS

ITEM	SUPPLIER
Sea Water Coarse filter	ELFI
Electric Heater	MASTERWATT
Sand Filter	NOBEL
RO Pressure Vessels	PHOENIX / LG CHEM
Reverse Osmosis membranes	LG CHEM
Cartridge filters	EVERBLUE
Backwash pumps	GEMMECOTTI
SW Booster pumps	GEMMECOTTI
Fresh water pumps	GRUNDFOS
High pressure pumps	DANFOSS
Dosing pumps	GRUNDFOS

UV sterilizer	NOBEL
Softening Filter	NOBEL
Container Air Fan	STEGO
Container Electrical Heater	AC GRAF
F&G Detectors	SIA
Emergency luminaire	STAHAL
Pressure gauges	NUOVA FIMA
Ball valves	TRUST
Ball valves plastic	+GF+
PSV	COI TECHNOLOGY
Temperature sensor	+GF+
Conductivity sensor	+GF+
Pressure sensor	+GF+
Transmitter (P and T)	+GF+
pH meter	BÜRKERT
pH probe	BÜRKERT
Insertion fittings	BÜRKERT
Pressure gauges	NUOVA FIMA
Flow transmitter	BÜRKERT
Level transmitter	BÜRKERT
Conductivity meter	BÜRKERT
Conductivity meter	BÜRKERT
Hardness analyser	BÜRKERT
Pressure transmitter	WIKA
Variable frequency driver	SCHNEIDER
Multi-functional valve	GRUNDFOS

Table 2 – Subvendor IOM Manuals

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4.3 SAFETY DATA SHEET

POS.	ITEM	SUPPLIER
a	Antiscalant – EVERBLUE 600	EVERBLUE
b	Non oxidant biocide – EB BIOCIDE PLUS	EVERBLUE
c	Caustic soda	N.A.

Table 3 – MSDS

5 GENERAL DESCRIPTION

The purpose of this section is to describe the Water Treatment Package, treating sea water to supply 0.8 m^3/h of fresh water to feed the Electrolyser. The desalination plant is mounted inside a container, 40 feet High Cube, and will operate normally unmanned with minimal maintenance, approx. every 6 months. The operation is discontinuous: it is estimated to operate the package 45 times in 6 months, each operation lasts 8-12 hours.

The Water Treatment Package mainly consists of three process sections:

- Pretreatments
- Sea Water Reverse Osmosis
- Post-treatments

Other accessories to Water Treatment Package are:

- Container Electric Heaters and Container Air Fans
- F&G detection system

5.1 DESIGN DATA

Area classification:		safe area
Design temperature (mechanical):	+40	°C
Design low pressure (mechanical):	6	barg
Design high pressure (mechanical):	69	barg

5.1.1 Water quality inlet/outlet

PARAMETERS	MEASURING UNIT	SEA WATER INLET	FRESH WATER OUTLET
Flow Rate	(m^3/h)	2.5	0.8
Pressure	(barg)	4-5	4
TDS	(mg/l)	36682	540
Temperature	(°C)	1.3-23	10-23

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PARAMETERS	MEASURING UNIT	SEA WATER INLET	FRESH WATER OUTLET
TOC	(mg/l)	10	3
TSS	(mg/l)	10	
pH	(-)	8.2	7-7.9
Sulphates	(mg/l)	2800	
Bicarbonate	(mg/l)	150	
Chloride	(mg/l)	20310	
Calcium	(mg/l)	435	
Magnesium	(mg/l)	1410	
Sodium	(mg/l)	11150	
Potassium	(mg/l)	420	
Barium	(mg/l)	0.1	
Strontium	(mg/l)	0.6	
Total Iron	(mg/l)	0.02	0.1
Manganese	(mg/l)	0.01	0.05
Silica as SiO_2	(mg/l)	1	
Oil and grease	(mg/l)	0.1	0.1
Total Hardness	(°F)		0.9
Conductivity	(µS/cm)		703

Table 4 – Water quality inlet/outlet

5.1.2 Battery limits

TERMINAL POINT	NPS	FINISH	RATING	FACE	MATERIAL	DESCRIPTION
TP-017	1 ½"	FLG	150#	RF	PVC	Sea water from intake pumps
TP-002	1"	FLG	150#	RF	PVC	Fresh water
TP-003	3"	FLG	150#	RF	PVC	Sea water drain
TP-005	1"	FLG	150#	RF	PP	Biocide to sea water intake
TP-006	1"	FLG	150#	RF	PP	Biocide to waste water tank
TP-007	1 ½"	FLG	150#	RF	PVC	Chemical drain
TP-008	½"	FLG	150#	RF	PVC	Container open drain

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TERMINAL POINT	DESCRIPTION
Terminal strips	For Main power feeding, analog, digital, motors
Junction Box 1	Panel Feeding 400 V, 50 Hz
Junction Box 2	UPS Feeding 230 V, 50Hz
Communication Card	Signals from/to ICCS
Communication Card	Signals from/to Fire & Gas Panel

Table 5 – Battery limits

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6 PRE-COMMISSIONING AND COMMISSIONING

6.1 UNIT RECEIPT AND INSPECTION

At time of receiving the Water Treatment Package, check immediately if there is any evident damage to any equipment due to transportation. Transportation damages shall be signaled immediately to the shipper.

The plant is delivered already installed inside the container.

In case of long term storage, please contact PSC to check the proper storage solution and procedure. Make sure that SWRO membranes are stored in a sheltered area, according to manufacturer's indication as per Attachment N° 7.

6.1.1 Visual inspection

After complete installation and placing of the container, the following site checks shall be done:

a) Visual checking of the outside of container, referring to construction drawing, including the following:
   - No visible damages to the following parts: walls, roof, floor, protection hood of the air intake, air fans and junction boxes.
   - External painting integrity.
   - Proper hydraulic tie-ins points connection (inlet, outlet, drainage, chemical dosage, etc.) specified in the P&IDs and lay-out documents. Drainage points to be free and at lowest point to assure a free flow.
   - All external interconnecting pipes shall have proper supports, to avoid stress loading to internal pipes inside the container.
   - Correct installation in horizontal level.
   - Correct opening and closing of each access door.
   - Check proper wiring of the two junction boxes on the container roof to client's DCS. For further detail see document 1724000448-EL-DG-00015 "Package Interconnecting Diagram".
   - Check container earthing connection to primary earthing system.

b) Visual checking of the items installed inside container, with reference project documents (drawings P&ID general Arrangement), including the following:
   - all equipment shall be properly located and well fixed.
   - all flanged and threaded connections shall be tight and aligned.
   - check opening and closing of each manual valve (including instrument root valve, drain and sampling points).

6.2 PRE-COMMISSIONING

Pre-commissioning phase occurs after construction and installation, and before the plant is put into operation. Pre-commissioning involves various activities to ensure all systems and components of the facility are properly installed, tested and ready for operation.

This section does not substitute the installation, operation and maintenance manuals for each equipment, but must be considered as general guidelines.

6.2.1 All the TP must be connected :

- TP-017: Sea water
- TP-02 Fresh water
- TP 03 Water drain to brine discharge caisson

6.2.2 Power UP



Electrical connections must be done by technical qualified personnel.

Before electrical power feeding, the wiring of power control panel 50-LP-001 shall be verified .

Power up the MCC and control panel (main power switch on) following this sequence step by step: Switch on internal lighting system;

- Switch on ambient electric heaters;
- Switch on PLC system;
- Switch on electronic field instruments and local panels (including F&G panel);
- Switch on motorized valves;
- Switch on pumps and process heater;

6.2.3 Pre-commissioning

The scope of this paragraph is to describe a procedure for the flushing and cleaning of the entire Water Treatment Package to be used as guideline.

After complete installation of the Water Treatment Package, all piping lines shall be flushed to remove any solid deposit and dirty matter (dust, plastic residue, organic matter, glue, grease, etc.) before installing SWRO membranes, cartridges and sand media filling.

The flushing shall be done by means of service water with low turbidity (5 NTU), no TSS presence or other substance and low salinity (TDS < 500 mg/l).

Service water shall be available at TP-017 at a minimum pressure of 4 barg and flowrate 2.5 m^3/h.

In the pre-commissioning phase, the main purpose is to flush the piping, to remove dust and residues, and check for any leakage. Before the activities it's necessary to perform a visual inspection and check again that:

- all manual isolation valves of any process equipment (pump, filter, tank, etc.) are closed.
- all manual isolation valves of any field instrument (transmitter, on-line analyzer and gauge) are opened.
- all manual drain valves and motorized drain valves (installed on storage tanks, chemical dosing tanks, lines and each filter, lines, etc.) are closed.
- All vent manual valves are open

Here below are listed the pre-commissioning activities necessary for any part of the plant before starting the Commissioning activities.

A-50003 Coarse Filter (self-cleaning filter) and H-50001 Heater

Feed service water by opening MV-500. Water will be discharged from drain MV-501 (use a flexible hose/pipe to drain water to disposal). After a short flushing time open 50-XV-020 and close MV-501. Flush the piping and the equipment A-50003 and H-50001. Open 50-XV-033 and A-50003 XV drain valve to discharge the flushing fluid into the Water Treatment Package drain.

S – 50001 Sand filter and T-50006

Open the inlet valve MV-506, M-509 and close the drain valve 50-XV-033 to flush the sand filter S-50001 and the tank T-50006. Open the vessel drain valve 50-XV-034 to discharge the flushing fluid into the Water Treatment Package drain. When the flushing is completed, close the drain valve 50-XV-034 and fill the vessel with clean water.

P-50002 A/B

Fill the pumps with clean water (without running it) opening manual valves MV-514, MV-516, MV-517, MV-519 and purge the air from the impellers.

Close manual valve MV-506, open partially MV-637 and start pump P-50002A. After some time stop pump P-50002A and start P-50002B. when the flushing of both pumps is complete stop the pumps and drain tank T-50006 opening valve 50-XV-034.

When the vessel is empty repeat flushing of S-50001 to fill again vessel T-50006.

During the following operation leave this section in flushing with valve 50-XV-034 closed in order to have the tank T-50006 always filled with water. If water is not used in the flushing operating downstream the excess will be drained through the vessel T-50006 overflow.

P-50003 A/B (Pumps)

Fill the pumps with clean water (without running it) opening manual valves MV-514, MV-519, MV-657, MV-659, MV-658 and 50-XV-021 or 50-XV-022 (automatic valves shall be opened one at a time) and purge the air from the impellers.

S-50002 A/B and S-50003 A/B - Filters (to be flushed one at a time)

Open valves MV-527 or MV-535 and fill the filters with clean water purging the air from the valve on the top (MV-528 and MV-529, MV 536 and MV-537).

When all the air is purged from filter's vent it's possible to close the filter's vent valves.

Open the filters drain valves MV-667, MV-668 or MV-669, MV-670.

Start pump P-50003A to flush filters S-50002A/S-50003A. When the flushing is finished stop the pumps and repeat with pump P-50003B to flush filters S-50002B/S-50003B.

After this operation will be possible to insert the cartridge: close the filter inlet/outlet valves MV-527/MV-531/MV-535/MV-539, open the filters drain valves MV-667/MV-668/MV-669/MV-670 and then open the filters vent valves MV-528/MV-529/MV-536/MV-537

When the filters are depressurized and drained it's possible to install the cartridges. See manufacturer's IOM for further details.

P-50004 A/B Pumps and A-50007 A/B Vessel (to be flushed one at a time)

The vessels A-50007A/B shall be flushed before installing membranes. Open valve MV-531 or MV-539 and fill the pumps P-50004A/B with clean water (without running it) and purge the air from the impeller.

Open valve 50-XV-027 or 50-XV-030 and start pump P-50003A or P-50003B respectively. Flush the vessel and drain water into Water Treatment System drain.

When the reject side of the membrane vessel is flushes open valves MV-643, MV-660, MV-662, MV-661 and 50-XV-026 (MV-646 for line B).

Close the valve 50-XV-027 or 50-XV-030 to flush the permeate side of the A-50007A or A-50007B respectively.

T-50008 Tanks

When the flushing of vessels A-50007A/B is completed, leave one of the vessel in flushing mode, open valve 50-XV-025 and close 50-XV-026. Fill the tank with clean service water until it is filled (Till the overflow) to eliminate the presence of processing residues, then empty the vessel opening valve 50-XV-035.

Repeat the rinsing few times to complete the flushing of T-50008 tank.

When the flushing is completed, close the drain valve 50-XV-035 and fill the vessel. The water will be used to flush the section downstream or will be drained through the vessel's overflow pipe.

P-50009 A/B

Open valves MV-561 and MV-564 and fill the pump with clean water (without running it) purging the air from the impeller.

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S-50004 Softener, S-50010 UV System

Open the valves MV-563, MV-566, MV-569, MV-663, MV-665, MV-664 and 50-XV-032. Start pump P-50009A or P-50009B and flush all the line discharging water into Water Treatment System drain.

T- 50002, T-50003 and T-50004 Tanks

Fill the tank with clean water until it is completely filled (overflow) to eliminate any manufacturing debris, then empty through the drain valve MV-574 (T-50002), MV-586 (T-50003) and MV-602 (T-50004).

P-50005 A/B (Caustic soda) and P 50006 A/B (Antiscalant)

Open valves:

- MV-575, MV-576, MV-577, MV-578, MV-579 for P-50005A/B
- MV-587, MV-588, MV-589, MV-590, MV-591 for P-50006A/B.

Start the pumps. The dosing pumps are already calibrated.

P-50005A/B will work through a pulse regulation managed by the PLC.

P-50006A/B will work through a set point that is set on the pump according to the process condition

P-50007 A/B (Biocide to container), P-50008 A/B (Biocide to sea water intake) and P-50010 A/B (Biocide to waste water tank)

Open valves MV-603 and:

- MV-604, MV-610, MV-609, MV-614 for pumps P-50007A/BMV-615, MV-620, MV-655, MV-622 for pumps P-50008A/B
- MV-625, MV-630, MV-656, MV-632 for pumps P-50010A/B

Start the pumps. The dosing pumps are already calibrated.

P-50007A/B will work through a set point that is set on the pump according to the process condition

Chemical Dosing pipes flushing when the dosing pumps are flushed, open the outlet manual valves to the dosing pipes to complete the flushing:

MV-582/MV-583/MV-649 to flush the caustic soda dosing pipe;

MV-594/MV-595/MV-523 to flush the antiscalant dosing pipe;

MV-607/MV-613/MV-503 to flush the biocide dosing pipe to container;

MV-618/MV624 to flush the biocide dosing pipe to sea water intake.

MV-628/MV634 to flush the biocide dosing pipe to waste water tank.

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6.3 COMMISSIONING

The scope of the commissioning procedure is to verify that the whole plant, running with sea water, does not show any fault and the plant, when started up, will operate smoothly.

The commissioning fluid will be sea water: available sea water quality shall be analyzed before commissioning to check if it is in compliance with section 5.1.1.

The operations will be performed step by step from HMI by trained personnel.

It is important that the operators have become familiar with HMI system and it is suggested that the operating staff attend the pre commissioning activities.

Commissioning operations mainly consist of following steps:

6.3.1 General visual checking

- All by-pass manual valve of each on-line analyzer shall be closed.
- All manual isolation valves for each chemical injection line shall be opened.
- At least one of the motorized valves 50-XV-021 and 50-XV-022 at SW Booster Pumps suction is opened.
- All motorized valves 50-XV-023, 50-XV-024, 50-XV-025, 50-XV-027, 50-XV-030, dedicated to SWRO automatic flushing are closed.
- Off-spec automatic motorized valves 50 XV-026 and 50-XV-032 shall be opened.
- Manual control valve MV-550 and MV-558 of each SWRO brine stream is fully opened.

6.3.2 Start of Container Electrical Heaters and Air Fans

- Start/stop N° 3 Container Air Fans HFA-50001A/B/C from local control panel (only nr.2 fans at one time).
- Start Container Electric Heater HHS-50001A/B, one at a time, from local control panel to check correct operation.

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6.3.3 Initial operation

Service water shall be available at PSC' battery limit at 2.5 m^3/h as flow rate and 4 barg as feed pressure.

Procedure

To avoid any damage, fouling or plugging of delicate items such as sea water reverse osmosis membranes, high pressure pumps and dosing pumps, proceed with commissioning **only if flushing operation has been done during pre-commissioning phase.**,.

Here below are listed the activities to be carefully followed:

- Check that every filter element is placed inside each dosing pump suction strainer.
- Cartridge filter elements shall be installed inside each filter (refer to manufacturer procedure in Attachment N° 8).
- **Any hydraulic leakage occurrence shall be repaired as soon as possible to avoid splashing and flooding inside a container.**
- **Dry and clean any spillage on the container floor.**

6.3.4 Sand filter loading

Proceed as follow, see also manufacturer IOM (Attachment):

- Unscrew the control valve (top cover of the sand filter).
- Keep the distribution pipe with bottom nozzle, exactly in the center of the vessel, while loading the media. Take care that media do not fall inside the pipe; it can be useful to put on the hole a scotch tape or similar, during the loading. It suggested to use a hand trowel and special funnel (supplied with filter) to load the filtering media inside the filter.
- Filtering shall be loaded according to the following order:
    - Quartz sand 2-3 mm (1st layer)
    - Quartz sand 1-2 mm (2nd layer)
    - Quartz sand 0.4-0.7 mm (3rd layer)
    - Anthracite (upper layer)

  Take care to flatten the surface of each layer of sand, before loading the next one.

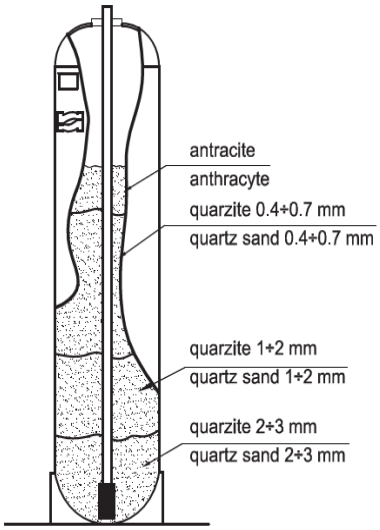


Figure 6 – Sand filter layers

- After the loading has been completed, remove the scotch tape, if used, and clean perfectly the thread hole of the vessel.
- Fill completely the Sand Filter with service water using a flexible hose pipe, without overflowing.
- Proceed in screwing on the control valve placed on top of the filter as before explained.
- Fill the Filtered Water Tank with service water and start the automatic backwashing sequence from local control panel to wash the filter media and to vent the entrapped air.
- Repeat the backwash sequence until that water outlet from filter has low turbidity.

6.3.5 SWRO membranes loading

- Depressurize and drain pressure vessel SWRO A-50007A/B opening valves 50-XV-027/MV-545 and 50-XV-030/MV-554. Remove both end caps of as per Sub-Vendor Instruction Manual (Attachment N° 6).
- Clean the inside of the pressure vessels if they are dirty. **Be careful not to scratch the inside surface of the pressure vessels.**
- Refer to Attachments, N° 6 and N° 7, Pressure vessel manual and element loading guidelines, TSB 102. Wear protective gloves during the membrane loading operation.
- Proceed to load six SWRO membranes in each SWRO pressure vessel, removing the original packing.

6.3.6 Chemical tanks first filling

- Protective clothing, gloves and glasses shall be worn during this operation.

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- Remove the tank top cover and, fill each chemical dosing tank with a portable drum pump up to half volume.
- To avoid chemicals cross contamination, the drum pump shall be washed and cleaned every time at the end of any refilling operation.
- Pay attention to avoid any chemical splashing and spillage. If they occur, dry and clean immediately.

6.3.7 Chemical dosing pumps filling and venting

- Turn the manual multifunctional valve in recycle position to vent air from the dosing pumps.
- Start each dosing pump from local control panel and wait for priming.
- Adjust manually the dosage flow rate of each dosing pump.
- When liquid only exits from the valve, then close it
- Check the pump calibration as per Sub-Vendor Manual
- Stop the dosing pumps.

6.3.8 Softener filter start up

The start-up of the unit consists of running a first regeneration cycle during which the column of resins and brine tank will be filled with water, all automatic features will be checked, and the unit will be prepared to start the service. During the start-up it is not required that salt is available inside the brine tank. At the end of the first regeneration, fill the brine tank with salt. See manufacturer IOM for further
To start up the unit, proceed as follows:

- Close both inlet and outlet valve
- Switch on electrical power
- Start a manual regeneration: press button "man/set" for 5 consecutive seconds, choose IMM using ▲ or ▼ and confirm with "man/set"
- Wait until the programmer reaches the backwash position, indicated on the display by 1C followed by a fixed number
- Disconnect electric power
- Open slowly and not completely the inlet valve. Water will enter from the bottom of the column as air will be expelled from the top to the drain
- When only water comes out, open completely the inlet valve and allow the water to flush until the water looks clear
- Using a pail, add water in the brine tank, until the water mark is approx. 30 cm from the bottom
- Switch on electrical power
- Wait until the regeneration is completed, checking that the suction of water from brine tank features correctly
- Open the outlet valve
- Put the salt into the brine tank (it can also be completely filled). Take care not to put salt inside the protection pipe.

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6.3.9 Sea water filling and venting of overall hydraulic circuit

- Check that no alarm is displayed to HMI, otherwise, recheck and resolve the relevant issue.
- Throttle the inlet manual valve MV-500 to reduce the inlet flow rate.
- Start Rosetti's seawater pump and flush the inlet line with seawater feeding, for approx. 10 min, draining it by sample point manual valve MV-501 and temporary connection with flexible hose to drain outside the container.
- Check feed seawater quality (visual low Turbidity, No significant TSS presence, Conductivity, No visible colour, NO visible free oil, NO odor).
- Check the operation of air vent valves MV-635.
- Close the previous sample point valve.
- Open automatic inlet valve 50-XV-020 to fill slowly the following items:
  - Coarse Filter A-50003
  - Process Electric Heater H-50001
  - Filtered Water Tank T-50006
- After 10 min open totally the inlet manual valve MV-500.
- Start biocide pump P-50007A or B to feed container, from local control panel.
- Before sending the filtered liquid to further steps, ensure through appropriate analysis (TSS -Total suspended solids, turbidity, particle count, Silt Density Index), that the quality of the filtered liquid is suitable to feed SWRO (refer to Attachment N° 7).
- When Filtered Water Tank level is high and the filtered water quality is within acceptable values, start SW Booster Pump P-50003A from local panel.
- Throttle the cartridge filters outlet manual valve MV-531.
- Check the operation of air vent valves MV-640 and MV-641.
- Fill the line and Cartridge Filters S-50002A, S-50003A and close the vent valve after only liquid overflowing.
- Open totally the manual outlet valve MV-531 and when the pressure is approx. > 2 barg at HP Pump suction, start the HP Pump P-50004A at low-speed rotation value from VFD panel.
- Proceed with the same steps described above to fill and vent SWRO line B.

6.3.10 Fresh water filling and venting of overall hydraulic circuit

- Fill the Fresh water tank T-50008 with service water.
- Throttle Fresh water pump delivery valves MV-563 and MV-566.
- Close 50-XV-031 valve and open 50-XV-032 valve.
- Start Fresh water pumps P-50009A/B, vent and prime the pump for 10 minutes.

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- Put the common pretreatment section and one SWRO line in automatic mode for plant start up from control panel.

6.4 PLANT ACTIVITIES AFTER START UP

Alter Water Treatment Package Plant started, the minimum activities required are the following:

- Remote monitoring of all process parameters (pressure, flowrate, conductivity, etc.).
- Increase High Pressure Pumps pressure in case of lower fresh water flowrate.
- Switch the SWRO line from stand-by to service and stop the previous operating SWRO line every week by remote, in order to use line A and line B for similar period.
- In case of any alarm signal or interlock activation, it is recommended a technical evaluation of the situation to identify the problem and plan the best solution procedure.

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7 MAINTENANCE

It is recommended to register all the checks and operations activities on a book. This kind of management will make easy to identify any unit malfunction.

Normal maintenance includes:

1. Replacement of cartridges in cartridge filters.
2. Check and refilling of chemicals.
3. Check of instrumentation (calibration of analysis instrument).
4. Check for any leakage.
5. Check the level of salt in the brine tank of the softener and refill it.
6. Replacement of RO membranes.

Extraordinary maintenance could include:

- Sand filter refilling or replacement.
- Maintenance or replacement of electric heating element.
- Maintenance or replacement of valves.
- Replacement of UV lamp.
- Maintenance of coarse filter

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7.1 REPLACEMENT OF CARTRIDGES

It is essential to replace the cartridges when the differential pressure (manometric difference between inlet of First stage CF and outlet of Second stage gauges) exceeds 2 bar, or every six months.

To extract the cartridges from the housing proceed as below:

- Close filters inlet and outlet valves.
- Open the ball valve installed on the drainage until the filters have been completely emptied.
- Open the vent valve.
- Make sure that there is no more pressure inside the filter and that all the liquid contained in it has been completely expelled.
- Unscrew the handwheel of the CLAMPING BAND, then remove it.
- Lift and remove the CAP.
- Remove the filter cartridge from the filter body.
- Insert the new cartridge into filter body.
- Position the clamping band on the cap, then tighten using the handwheel.
- Since some filtering elements may release particles when they are used for the first time, the discharge or recirculation of the first filtered liquid is recommended.
- Make sure that there is no leakage of liquid.

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7.2 CHECK AND REFILLING OF CHEMICALS

If the chemicals level is near to the minimum, the operator shall refill chemical tank.


CAUTION. Always use personal protection devices when chemicals are handled. Wear protective gloves / protective clothing / eye protection / face protection.


CAUTION. Before removing the hand hole cap make sure that the tank is:

- completely intercepted (by valves) and vented
- in absence of pressure
- connected pumps switched off.

Before filling the tank close the drain and delivery valves. After closing drain and delivery valves open the hand hole cap. Fill each tank with proper chemical solution at recommended dosage.

The recommended chemical concentrations are indicated below:

- Antiscalant (T-50003): commercial product 100%
- Non-oxidant biocide (T-50004): commercial product 100%
- Caustic soda solution (T-50002): NaOH (1% - 5%)

Caustic soda solution is prepared offshore depending of pH of sea water at the inlet of water treatment package and its consumption.

(E.g. to prepare 60 litres of a 2% soda solution mix 54 l of demi water and 6 l caustic soda 20%. Please contact PSC Engineering SpA in case of doubt)

1) Isolate the storage tank closing the outlet valve.
2) Check the opening and closing of the tank drain valve.
3) Check if suction and delivery valves of dosing pumps are fully opened.
4) Check the action of PSV closing the delivery valves, the water is flowing back the suction pipe.
5) Check the suction filters on metering pumps suction lines are clean.
6) Open the tank outlet valve and select the duty dosage pump to start it from local control panel.

Low and very low level are installed in the Dosing Tanks in order alarm for chemical refilling at low level set to the PLC system and stop the dosing pumps in case of very low level.

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7.3 ELECTRICAL MOTOR BEARING LUBRICATION

CAUTION. Before lubrication, the motor must be switched off.

CAUTION. Do not lubricate motors while in operation, since excess grease will be forced through the bearings and into the motor before it will force its way out of the drain plug. Excessive grease accumulation on windings reduces insulation life.

Re-lubricate bearing every six months, as follow:

1. Stop the motor. Lock out the switch.
2. Thoroughly clean off pipe plugs and remove from housings.
3. Remove hardened grease from drains with stiff wire or rod.
4. Add grease to inlet with hang gun until small amount of new grease is forced out of drain.
5. Remove excess grease from ports, replace inlet plug, and run motor ½ hour before replacing drain plug.
6. Put motor back in operation.

For further details please refer to the manufacturer instructions.

7.4 CHECK OF INSTRUMENTATION CALIBRATION

All instruments shall be recorded in a database along with details of calibration and the next scheduled calibration check. At the beginning of each maintenance visit a list of instruments due for calibration will be implemented. If the instrument calibration date has expired an appropriate label shall be attached to the instrument with the indication: “Uncalibrated”.

For further details please refer to the manufacturer instructions.

7.5 PUMPS OPERATING CHECK

Even if there is no noise or vibration, check the pump-motor unit alignment at least once per year.

At regular time intervals check the proper operation of the bearings, the seal system, pressure downstream from the pump, and power absorbed.

For further details please refer to the manufacturer instructions.

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7.6 CHECK OF TANK INTERNALS



CAUTION. Before removing any flange and/or connection make sure that the tank is:

- insulated from any electrical energy source
- its insulation is warranted
- completely intercepted (by valves and/or spectacle blinds), vented and drained
- in absence of pressure
- at ambient temperature

Tanks shall be internally checked in order to verify the integrity of the surfaces, internals and the absence of extraneous substance, debris, dust and dirt.

For further details please refer to the manufacturer instructions.

7.7 MEMBRANES REPLACEMENT

In case of membrane replacement, recommended every six months, ensure that the system is NOT pressurized before starting the work. Disconnect the pressure vessel piping, open and remove the end caps of each pressure vessel. Push the membrane out from the feeding inlet side to the outlet side (refer to the arrow on the pressure vessel). Once all membranes are removed, fill the new membranes following the procedure described below.

This is a summarized procedure. If in doubt, please refer to the Pressure Vessels and Membranes manufacturer's manual for detailed explanations.

7.7.1 Pressure Vessel preparation

The interior walls of the pressure vessels must be thoroughly cleaned prior to loading membrane elements in order to prevent dust, construction debris or other foreign matter from being deposited onto the membrane surface. Simply hosing down the interior of the vessels with freshwater is NOT adequate to clean the vessel thoroughly. Use a sponge ball wrapped in a cloth or towel that has been soaked in a 50% solution of glycerin and chlorine-free water. The cleaning ball may either be pulled through the vessel when attached to a rope or pushed through the vessel when mounted to a PVC flange affixed to an appropriate length of PVC pipe. Use appropriate caution to ensure that the inside surface of the vessel is not scratched or damaged during cleaning.

7.7.2 Element loading

1. Make sure that pressure vessel parts, fittings and connecting piping (especially permeate piping) are removed for RO element installation are protected from dirt and airborne dust and debris. Keep floors and parts clean during the RO element loading process. Cover the endcaps to minimize exposure to airborne

debris. Remember, the center port of the endcap carries RO permeate. Do not handle the endcap by touching the inside of the center port.

2. It is good practice to stage RO elements for each pressure vessel prior to loading. RO Elements with standard u-cup brine seals are loaded in the direction of process flow, so the first elements loaded is the concentrate end element. The feed end element will be the last to be loaded. It is strongly recommended to keep RO elements in their plastic bags during the staging process. While the elements are staged for each pressure vessel, record the elements serial numbers and the corresponding pressure vessel number. Make note of the position of each element in each pressure vessel.

3. Install endcap assembly in the concentrate (brine) end of the pressure vessel. Make sure the retaining ring is properly installed and the thrust cone installed downstream. Refer to pressure manufacturer's literature for installation instructions. Determine if it is preferable to install the concentrate endcap/element adapter into the concentrate endcap or concentrate element before loading. The adapter is supplied by the pressure vessel manufacturer. If it is preferred to have the adapter inserted in the endcap, make sure it is properly inserted and lubricated before installing the concentrate endcap assembly. Secure the concentrate endcap per the manufacturer's instruction.

4. Load the first element (concentrate end element) approximately 2/3rd of its length into the feed end of the pressure vessel. If the concentrate endcap/element adapter was not inserted into the concentrate endcap, make sure that it is properly lubricated and inserted in the concentrate face of the concentrate element before loading in the pressure vessel. Make sure that the u-cup brine seal is properly installed on the upstream (feed end) ATD (anti- telescoping device) of the RO element.

(NOTE: Only one u-cup seal is required per element. Never put u-cup seals at both ends of the RO element. U-Cups will only seal if properly oriented on the ATD).

5. Lubricate the u-cup seal with 50% glycerin / and chlorine-free water solution.
(NOTE: If silicone-based lubricant is used, only a small amount is needed. Using sparingly as excess amounts could foul the membrane surface.)

6. The product water tubes of each RO element are connected by an interconnector with pre-installed o-rings. Make sure that all o-rings are installed and lubricated properly. Firmly insert the interconnector in the product water tube of the first element with a gentle twisting motion. The interconnector will seat on a shoulder that is recessed about 3 inches inside the product water tube. Never use a hammer or pounding motion to insert interconnectors.

7. With another person holding the first elements stationary, slide the next element on to the interconnector of the first element. Make sure that the ATDs of the two elements touch each other and the interconnector

is fully seated within each element.

8. Slowly push the element stack into the vessel so that 1/3rd of the next element being loaded is overhanging the feed end of the pressure vessel.
(NOTE: Be careful not to push elements too fast as the ATDs can be damaged if they slide roughly over the retaining ring grooves in the pressure vessel.)
(NOTE: Never allow an interconnector to support the weight of an element.)

9. Repeat the steps above until the last element has been connected and extends only 1/3rd beyond the feed end of the pressure vessel. Make sure that concentrate endcap assembly is installed and secured.

10. Firmly push the entire element stack so that the concentrate end element seats against the concentrate endcap assembly.

11. In most cases, there will be space between the shoulder of the feed endcap adapter and the feed endcap itself that will allow movement of the elements during startups and shutdowns. Excessive movement can lead to o-ring leaks. Shims can easily be added to prevent excessive movement of the elements stack.

12. Follow pressure vessel manufacturer's and RO unit fabricator's instructions for installation of feed endcap assemblies and all interconnecting piping.

7.8 REPLACEMENT OF MEDIA FILTER

Whether the filtering bed is clogged and packed, in order that is impossible to backwash it properly, the replacing of the media filter is required. Proceed as follows for the emptying:

- Switch OFF the control panel
- Close the valves upstream and downstream of the filter
- Remove the automatic valve
- Extract the media from the column, using a syphon or an aspirator
- During the last part of the operation, take care not to damage the lower distributor
- Replace the damaged distributor, if necessary
- Disposal of filtration media shall be made according to local laws concerning the waste of the materials.

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7.9 REPLACEMENT OF SALT AND RESINS IN SOFTENING FILTER

Verify the level of salt inside the brine tank and every six months add more salt. During the operation of loading, pay attention that not any foreign body enters inside the tank. Place again the cover on the tank immediately after the loading of salt. It is recommended to use only food grade salt, preferably in the form of tablets. Tablet salt is usually very clean and avoids making the brine dirty.

If the brine tank appears dirty (foams, foreign bodies, sand, etc.) it is required to make an accurate cleaning, following supplier's manual.

When the softener does not supply softened water or the service cycle is by far lower than expected, although it works correctly hydraulically and mechanically, the replacement of resins is required. It is suggested to replace the resins, in any case, after 10 years of service.

Whether the replacement of the resins is required, proceed as follows for the emptying:

- Disconnect the power supply
- Close the valves upstream and downstream of the softener
- Remove the automatic valve
- Extract the resins from the column, using a syphon or an aspirator
- During the last part of the operation, take care not to damage the lower distributor
- Replace the damaged distributor, if necessary
- Disposal of resins shall be made according to local laws concerning the waste of the materials

7.10 REPLACEMENT OF UV LAMP

Change the lamp after 8000 hours of work and however not later than 24 months for discontinuous work.

WARNING:



Live parts

Disconnect the device from the power supply before opening it.

Disconnect damaged and defective devices or devices that have been tempered with from the mains power supply.

WARNING:



UV-C radiation

UV-C radiation is harmful to the eyes and skin.

Only start up the lamp when it is properly installed.

Install the UV lamp into the UV system in accordance with the regulations prior to commissioning.

CAUTION:



Fingerprints on the UV lamp

Only touch the glass of the UV lamp when wearing cotton gloves.

Fingerprints or impurities burn into the glass and can result in premature failure.

For this reason, always clean the lamp thoroughly with a cloth moistened with alcohol before installing it.

Then wipe the UV lamp with a soft, dry cloth.

NOTICE:



Clean the lamp protection tubes each time a lamp is replaced.

Dispose of used lamps in accordance with the applicable guidelines and directives. Usually they can be disposed of together with used fluorescent tubes.

1 Switch off the UV system.
2 Switch off the master switch or disconnect it from the main power supply.
3 Close the shut-off valve upstream and downstream of the reactor.
4 Fully remove the UV lamp and place it to one side.
5 Introduce the new lamp into the quartz sleeve living out the end side to be connected with the electric wire.
6 Connect the lamp with the electric 4-pin connector.
7 Be sure that the rubber cap is placed all around the lamp without folds.
8 Introduce the lamp into the quartz and push inside the plastic-plug with O-ring.

WARNING:



Insufficient treatment efficiency

Check the minimum radiation intensity and warning threshold.

Check and, if necessary, reset the safety and warning threshold when the UV lamp is replaced.

Only a correctly adjusted minimum radiation intensity will guarantee adequate treatment.

For other maintenance procedures on UV system refer to "Operating Manual" from Supplier.

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7.11 EXTRAORDINARY MAINTENANCE

The following activities are considered as extraordinary:

- Check all transmitter hook ups for physical damage and integrity of enclosure seal; make good any defects. Check calibration in accordance with manufacturer's instruction.
- Inspect all actuated valves, with reference to manufacturer instruction, confirm the correct operation of valves, limit switch and fail action.
- Check all process instrument isolation valves, check that there are no leaks and all manifold valves open and close satisfactorily.
- Check the tightness of bolting and security of pipe supports.
- Check oil level in all machineries, referring to the manufacturer's instructions enclosed in this O&M Documentation.
- Check right flow rate of chemicals; adjust, if necessary, by means of the relevant valves.
- Check operation of drain and vent valves to ensure there are no blockages.
- Inspect all painted equipment for physical damage or corrosion and repair where necessary.
- Check all earth connections and wiring for tightness of terminations, physical damage and corrosion, repair and test continuity resistance if necessary.
- Check condition of cable tray and supports, make good any defects, replace cable tray cover if any.
- Execute other inspections and maintenance operations particularly for each equipment, machinery, instrument, as recommended by the Manufacturer manuals included in this O&M Documentation.