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Base Load Power Hub (BLPH)

WATER TREATMENT PACKAGE A-50000

SYSTEM FUNCTIONAL DESCRIPTION (50-LP-001)

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Revision / Change Log

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3	
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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.

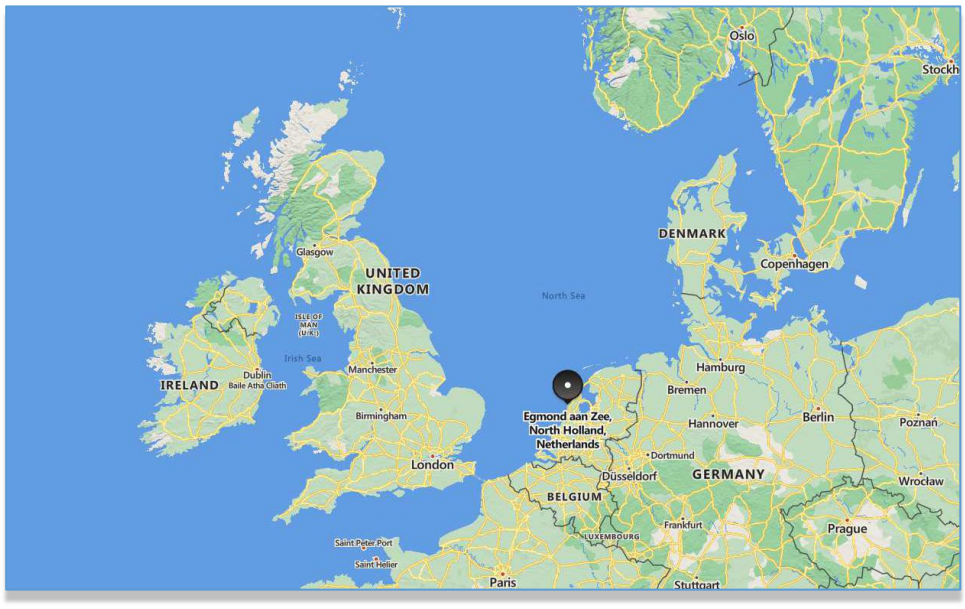


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map



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.

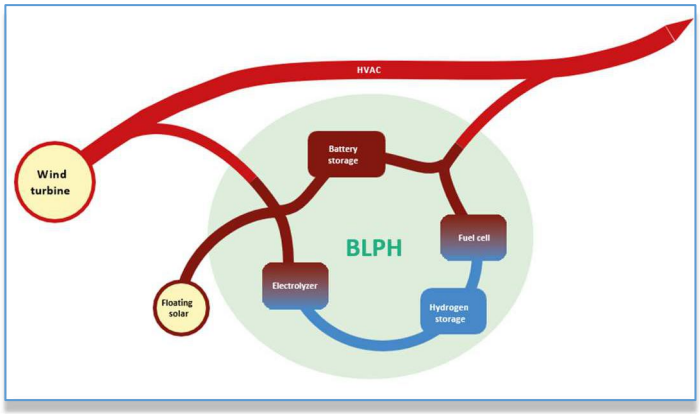


Figure 3 – BLPH Concept

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

Scope of this document is to provide the description of the process and the details on how the Water Treatment Package operates. The above-mentioned package will be supplied to Rosetti Marino S.p.A. for Crosswind off-shore project, producing fresh water from sea water.

2.1 REFERENCES

Doc. No.	Description
1724000448-PR-PID-00013 rev.4	P&I Diagram – Water Treatment Package
1724000448-MAC-CE-00004 rev.3	Package Cause & Effect Matrix

Table 1 - Reference Documents

2.2 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY):	CROSSWIND
CONTRACTOR (CTR):	ROSETTI MARINO S.p.A.
PROJECT:	HOLLANDSE KUST NOORD WIND PARK Project
HC:	High Cube Container

Table 2 - Definitions and Abbreviations

3 GENERAL

Scope of the Water Treatment Package is to treat the sea water to supply 0.8 m^3/h of fresh water to feed the Electrolyser. Platform 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

The desalination plant is mounted inside a container, 40 feet HC; it will have its own independent control system. Other accessories to Water Treatment Package are:

- F&G detection system
- Container Electric Heaters HHS-50003A/B and Container Air Fans HFA-50001A/B/C

3.1 PRETREATMENTS

Sea water feeds the container inlet battery limit (A-50000, TP-017) by Rosetti Marino at with a constant flowrate of 2.5 m^3/h and a constant pressure of 4 barg min – 5 barg max.

3.1.1 Sea Water Coarse Filter (A-50003)

Sea water feeds the Sea Water Coarse Filter (A-50003), a self-cleaning filter that eliminates coarse particles greater than 125 micron. Water enters the filter through the IN inlet and goes through the filtering cylinder from the inside to the outside. This will retain all non-deformable suspended solids that are the same size or bigger than the filtration degree installed (i.e. 125 micron). Filtered water leaves through the outlet pipe (OUT).

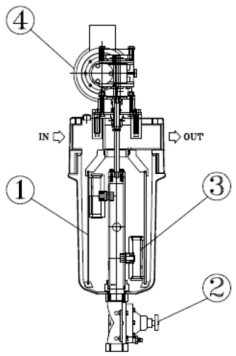


Figure 4 – Sea Water Coarse Filter

The continuous settling of suspended solids inside the filtering cylinder obstructs the passage of water which results in a pressure difference (ΔP). At a preset value of ΔP (range 0.3 - 1 bar) an automatic cycle will start to clean the filter cylinder, this operation begins with a signal that opens the discharge valve (2) and creates communication between the suction nozzles (3) with the outside environment. At the same time, the electric motor (4) creates a rotating motion which enables the nozzles to inspect the filtering surface. Dirt is ejected through the discharge valve (2) and goes to the water drain header. The cleaning cycle lasts approximately 15 seconds.

A switchboard (LP-A-50003) controls the washing phases. The signal that starts the cleaning cycle is given by an internal differential pressure switch. The switchboard gives a "general alarm" signal in case of problems in the washing system. The washing phase can also be controlled manually.

During filter backwashing, the filtered water accumulated in the Filtered Water Tank T-50006 allows the following reverse osmosis section to be fed.

3.1.2 Electric Heater (H-50001)

Site data conditions: Sea Water Temperature (min/max) 1.3 / 20.2 °C.

Since sea water minimum temperature is too low to feed the Water Treatment Package, an Electric Heater (H-50001) is installed downstream Sea Water Coarse Filter (A-50003) to increase sea water temperature up to minimum 10°C during cold season. Sea water inlet temperature is measured by 50-TT-021 and controlled by 50-TIC-021.

3.1.3 Container Ventilation (HFA-50001A/B/C) and Heating (HHS-50003A/B)

Site data conditions: Ambient Temperature (min/norm/max) -8.4 / 10.5 / 25 °C.

Since ambient minimum temperature is too low, Container Electric Heaters (HHS-50003 A/B) are installed inside container to increase ambient temperature up to minimum 10°C during cold season. Inlet temperature is measured by 50-TT-023 and controlled by 50-TIC-023.

The ventilation inside container is maintained with HFA-50001A/B/C fans (3 x 50%, two in operation and one stand-by) that provide enough air change per hour (minimum 15 air change per hour).

3.1.4 Sand Filter (S-50001)

Sand bed filtration is the mechanical process by which suspended particles are removed from water.

Sand (dual media) Filter (S-50001) is installed with automatic backwash of the filtering bed with filtered water. The media filter includes several layers of selected quartz-sand with different size, and anthracite as upper layer. As the filter retains particles, the resistance to the passage of water and thus the pressure drop between inlet and outlet increases. The maximum permissible pressure drop is 1 bar, at which point a backwash is required. Backwashing means restoring the efficiency of the filter bed by removing from it the particles that were retained during operation. Backwashing is programmed at operating time, when a pressure drop of 0.6 - 0.7 bar is reached, or at least once a week. A switchboard (LP-S-50001) controls the washing phases. The signal that starts the cleaning cycle is given by the package control system on the basis of differential pressure transmitter 50-PDT-023 high value.

Backwashing is performed with filtered water stored in T-50006 with pumps P-50002 A/B. A flow transmitter (50-FT-020) is installed at the inlet of the filter and gives an alarm in case of low and high flow. Spent filter backwash goes to water drain header.

During filter backwashing the filtered water accumulated in the tank T-50006 allows the reverse osmosis section to be fed.

3.1.5 Antiscalant dosage

Antiscalant is dosed upstream cartridge filters, in order to avoid the occurrence of scaling phenomena on Sea Water Reverse Osmosis.

An antiscalant continuous dosage is foreseen on the filtered water to avoid clogging phenomena on cartridge filters and RO membranes.

Antiscalant Dosing Pumps P-50006 A/B shall be equipped with a stroke regulator which allow to regulate the dosage flow.

Antiscalant Dosing Pumps shall be fed from Antiscalant Storage Tank T-50003 equipped with a level transmitter 50-LT-023, which provides an alarm for the refilling requirement (50-LAL-023) and the trip (50-LALL-023) for avoid the dry running of the pumps.

In Antiscalant Storage Tank a manual valve MV-585 is dedicated for chemical filling.

3.1.6 Cartridge Filters (S-50002A/B, S-50003A/B)

Filtered water is stored in Filtered Water Tank T-50006 equipped with level transmitter 50-LT-020, which provides the alarms and trip for the SW Booster Pumps P-50003A/B.

Filtered sea water conductivity is measured by analyser 50-AT-023 upstream cartridge filters: High level conductivity shall give an alarm.

Two lines (2x100%) of cartridge filters and SWRO are installed: line A operates when valve 50-XV-021 opens (and 50-XV-022 closes), line B operates when valve 50-XV-022 opens (and 50-XV-021 closes).

A double stage of fine filtration system is foreseen with cartridge filters having size poring of 20 and 5 microns to protect the RO membranes from clogging phenomena. Each SWRO line has two cartridge filters: S-50002A 20 micron and S-50003A 5 micron for line A, S-50002B 20 micron and S-50003B 5 micron for line B. Cartridges are not reusable type and the substitution is required after reaching high differential pressure value. Cartridges substitution is scheduled every six months, even if differential pressure does not reach high value.

At SW Booster Pump P-50003A delivery, a pressure transmitter, 50-PT-025 is installed to report the pressure value to PLC. At the outlet of Cartridge Filter S-50003A a pressure transmitter, 50-PT-026 is installed to report the pressure value to PLC. When pressure difference between 50-PT-025 and 50-PT-026 is more than 2 bar cartridge filters S-50002A and S-50003A need to be changed.

At SW Booster Pump P-50003B delivery, a pressure transmitter, 50-PT-027 is installed to report the pressure value to PLC. At the outlet of Cartridge Filter S-50003B a pressure transmitter, 50-PT-028 is installed to report

the pressure value to PLC. When pressure difference between 50-PT-027 and 50-PT-028 is more than 2 bar cartridge filters S-50002B and S-50003B need to be changed.

3.1.7 Biocide dosage

Non-oxidant biocide is dosed to inhibit bacterial growth and the formation of organic silt. Non-oxidant biocide is dosed in three different points:

- A continuous dosage is foreseen at the inlet of Water Treatment Package.
- A shock dosage (20 min every two days) is foreseen on the Intake Sea Water Pumps.
- A shock dosage (60 min every week) is foreseen on Waste Water Tank T-55001.

Biocide Dosing Pumps shall be equipped with a stroke regulator which allow to regulate the dosage flow.

All dosing pumps shall be fed from Biocide Storage Tank T-50004 equipped with a level transmitter 50-LT-024, which provides an alarm for the refilling requirement (50-LAL-24) and the trip (50-LALL-24) for avoid the dry running of the pumps. In Biocide Storage Tank a manual valve MV-601 is dedicated for chemical filling.

Dosing Pumps P-5007A/B dose the biocide at the inlet of container, upstream SW Coarse Filter A-50003, continuously when the plant is in operation.

Dosing Pumps P-50008A/B dose the biocide to sea water intake: every two days one pump starts for 20 minutes. It may be necessary to do the shock dosing when the Water Treatment Package is not in operation, because the permeate may contain slightly elevated levels of organics.

Dosing Pumps P-50010A/B dose the biocide to Waste Water Tank T-55001: every week one pump starts for 60 minutes.

3.2 SEA WATER REVERSE OSMOSIS

Sea Water Reverse Osmosis will be used to provide the removal of dissolved solids and ions from the feed filtered water. Reverse osmosis membranes reject the salts contained in the feed water in a salt concentrated stream leaving a low salinity stream called "permeate".

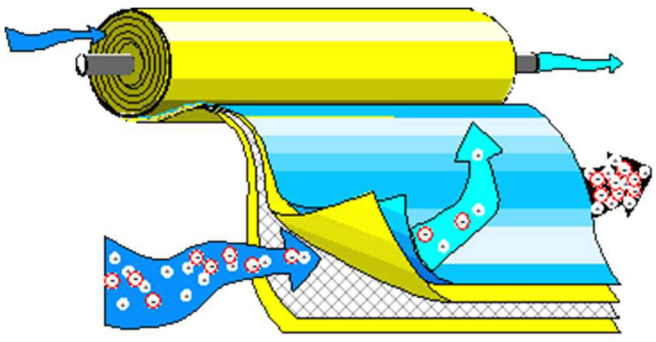


Figure 5 – Reverse Osmosis Membrane

In normal condition Reverse Osmosis unit shall operate with one line in operation and the second in conservation.

Chemically conditioned and filtered water will reach the suction side of the RO High Pressure Pumps (P-50004 A/B) and will be fed to the RO units (A-50007 A/B).

These pumps shall operate in a fixed pressure range and are protected from the suction low pressure (and therefore from low flow) by the pressure transmitter 50-PT-026 / 50-PT-028, which give an alarm.

RO High Pressure Pumps P-50004A/B are protected from high suction pressure by pressure transmitter 50-PT-026 / 50-PT-028, which give an alarm and from safety valves 50-PSV-034 / 50-PSV-037 that will open in case of overpressure.

RO High pressure pumps P-50004A/B are equipped with VFD in order to maintain the constant flow of the pump, independently of the RO recovery. Pumps delivery pressure is controlled by 50-PIC-030/ 50-PIC-032 that operate on pump's VFD. SWRO membranes are also protected from the high delivery pressure from the pressure transmitter 50-PT-030 / 50-PT-032, which give an alarm for the high pressure and from safety valves 50-PSV-035 / 50-PSV-038 that will open in case of overpressure.

The SWRO desalinated permeate water (fresh water) will be sent directly to the Fresh Water Tank T-50008, whereas the concentrated brine will be sent to water drain.

Permeate quality of both lines is checked by a conductivity meter (50-AT-024), which reports a value on PLC: if conductivity exceeds the design product value (High conductivity alarm, High High conductivity discharge), permeate is automatically discharged, thought the opening of the automatic off-spec valve 50-XV-026 and closing the automatic valve 50-XV-025. When the conductivity value will return below the proper value, the treated water is automatically diverted at the Fresh Water tank, closing 50-XV-026 and opening 50-XV-025.

3.2.1 Flushing

In case of shutdown for a period greater than 24 hours, the SWRO unit must be flushed at low pressure, in order to remove the salt water before the stop. Flushing is performed with RO permeate through SW Booster Pumps P-50003A/B when one RO line has finished its operation. For line A automatic valves 50-XV-023 (flushing inlet), 50-XV-027 (flushing outlet) and 50-XV-026 (off-spec) shall be opened, while 50-XV-025 (permeate outlet) shall be closed. For line B automatic valves 50-XV-021 (flushing inlet), 50-XV-030 (flushing outlet) and 50-XV-026 (off-spec) shall be opened, while 50-XV-025 (permeate outlet) shall be closed.

During the flushing all the dosing units shall be stopped. Flushing shall operate for 10-15 minutes to remove the brine. During flushing of one line the plant does not produce fresh water. Flushing discharge is collected into water drain.

3.3 POST-TREATMENTS

SWRO permeate is stored in Fresh Water Tank T-50008 equipped with level transmitter 50-LT-021, which provides alarms for the Fresh Water Pumps P-50009A/B.

3.3.1 Softening Filter (S-50004)

Softening is the process by which calcium and magnesium (hardness) are removed from water. These two elements, together with the presence of carbonates, are the main causes of limescale build-up.

Softening is achieved by passing the water through a bed of ion exchange resins. The resins in the columns exchange sodium ions, with which they are charged, against calcium and magnesium ions. The softened water will therefore be free of hardness and have an increased sodium content.

When the resins are exhausted, i.e. fully charged with Ca^{++} and Mg^{++} ions and now have no Na^{+} to exchange, it is necessary to regenerate them. Regeneration means restoring the sodium level in the resins: this is available in the regenerant sodium chloride (NaCl). Frequency of regeneration is approx. every 40 m^3 of produced fresh water, i.e. approx. every two weeks.

The device automatically prepares the required brine from granular salt. The vessel contains resins and brine tank assembled in a compact unit. A switchboard (LP-S-50004) controls the operation.

3.3.2 UV Sterilizer (S-50010)

Softened permeate is treated with sterilization system, consisting of special low pressure mercury germicidal lamp. The light emitted from this lamp is concentrated (90%) into the luminous spectrum around 254 nm wavelength and is able to destroy or inactivate microorganisms such as bacteria, viruses, yeasts and molds. The UV-C light emitted by this lamp penetrates the cells wall of microorganism.

The lamp is immersed, inside the disinfection chamber, in the treating fluid and is separated from it with quartz sleeves, transparent for more than 98% to UV-C rays.

A switchboard (LP-S-50010) controls the operation.

At the outlet of UV are installed four analysers:

- Hardness 50-AT-026: high level gives and alarm and high high level opens off-spec valve 50-XV-032 and closes 50-XV-031.
- pH 50-AT-027: high level or low level give and alarm and high high level or low low level open off-spec valve 50-XV-032 and closes 50-XV-031.
- Pressure 50-AT-041: gives alarm for high and low pressure.
- Temperature 50-AT-024.
- Flow 50-FT-025: gives alarm for high and low flow.

3.3.3 Caustic soda dosage

Caustic soda (2% solution) is continuously dosed downstream the softener, in order to increase the pH of fresh water up to value of 7 – 7.9 as required by the Electrolyser.

Caustic Soda Dosing Pumps P-50005A/B shall be equipped with a dosing stroke regulator which allow to regulate the dosage flow.

Please add the following sentence:
The following software information of water analysers 50-AT-024/026/027 are sent to electrolyzer through control system PCS:
- pH (50-AI-027)
- Temperature (50-AI-026)
- Hardness (50-AI-026)
- Conductivity (50-AI-024)

pH thought analyser 50-AT-027 is measured downstream UV system: low level pH and high level pH shall give an alarm, while high high and low low level alarm open off-spec valve 50-XV-052 to discharge the flow to drain and close valve 50-XV-031.

Caustic Soda Dosing shall be fed from Caustic Soda Storage Tank T-50002 equipped with a level transmitter 50-LT-022, which provides an alarm for the refilling requirement (50-LAL-022) and the trip (50-LALL-022) for avoid the dry running of the pumps.

In Caustic Soda Storage Tank a manual valve MV-573 is dedicated for chemical filling.

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4 FUNCTIONAL DESCRIPTION / PROCESS CONTROL NARRATIVES

4.1 SEA WATER PRE-TREATMENT SYSTEM

4.1.1 Purpose of the process control

The purpose process control of the Sea Water Pre-Treatment System is to ensure the correct filtration and heating of the stream of sea water entering the package. The Sea Water Coarse Filter A-50003 (see Section 3.1.1) is a self-cleaning filter and provide the first filtration of the inlet sea water stream.

The Electric Heater H-50001 (see Section 3.1.2), heats the sea water up to 10°C and operates in cold time when the sea water temperature entering the system is low.

The Sand Filter S-50001 (see Section 3.1.3) provides a better filtration of the sea water. The Sand Filter requires periodic backwash for cleaning.

The filtered water is stored in the Filtered Water Tank T-50006 and the Backwash Pumps P-50002A/B (one operating and the other stand-by) provide water at required pressure for the Sand Filter backwash.

4.1.2 Description of the process operation

A stream of sea water enters the package at the required conditions (controlled by Customer) of 4-5 barg and 2.5 m^3/h.

A small flow of biocide is added to the stream before coarse filtration. The flow of biocide is stopped if valve 50-XV-020 is closed, see par. 4.6.

The stream passes through the shutoff valve 50-XV-020, that is opened during the normal operation of the Sea Water Treatment System and it's closed when the Sea Water Filter is in backwash.

The position of the shutoff valve is indicated by the limit switches 50-XZSH-020 (open) and 50-XZSL-020 (closed).

The pressure of the inlet steam is measured and indicated by pressure transmitter 50-PT-020. An alarm is activated in case of low inlet pressure 50-PAL-020.

The Sea Water Coarse Filter A-50003 is a self operating package. An internal sensor starts the self-cleaning operation in case of high differential pressure (or based on a timer) and activates the rotation of cleaning blade while opening the bottom discharge valve to flush the filtered solid and clean the filter surface. The operation lasts approx. 15 seconds and it's activated every 15-30 minutes or more, depending on the inlet sea water quality.

The Sea Water Coarse Filter A-50003 package generates a cumulative alarm output 50-XA-A50003.

The sea water pressure downstream the Sea Water Coarse Filter A-50003 is indicated the pressure gauge 50-PI-048.

The temperature downstream the Electric Heater H-50001 is controlled by 50-TIC-021. The temperature is measured by temperature transmitter 50-TT-021. If the temperature measured by 50-TT-021 is below set point of 12°C (adjustable), the controller 50-TIC-021 increase the power of the electric heater (controlled via

SCR). If the temperature measured by 50-TT-021 is above set point the controller 50-TIC-021 decrease the power of the electric heater.

The pressure at Sand Filter S-50001 inlet is indicated by pressure gauge 50-PI-022.

The sea water flowrate at Sand Filter S-50001 inlet is measured and indicated by flow transmitter 50-FT-020. An alarm is activated in case of low or high flowrate, 50-FAL-020 / 50-FAH-020. (Note: set point of alarms during normal operation are different than during sand filter backwash).

The differential pressure across Sand Filter S-50001 is measured by differential pressure transmitter 50-PDT-023. An alarm is activated in case of high differential pressure 50-PDH-023.

The Sand Filter S-50001 is a self operating package. The backwash operation in case of differential pressure 50-PDI-023 above a set point of 0.7 bar (adjustable). The ...he production cycle.

Please consider the following:
The main seawater pump will be stopped when sand filter S-50001 is in backwash sequence. The signal 50-HS-005S will be serial type from Water Treatment package 50-LP-001 panel to PCS.

Sand Filter S-50001 backwash sequence:

- Check the T-50006 level. Wait for high level > 80% to have enough water holdup for backwash; otherwise the Sand Filter is kept in operation until high level is achieved in the tank and the rotation of speed of High Pressure Pump P-50004A/B is decreased at minimum value;
- Stop the heater H-50001;
- If 50-TI-020 is >50°C, wait 120 sec for heater cooling;
- Stop the Sea Water Intake Pump (signal tag XXXX by ROSETTI) and simultaneously stop SW Booster Pumps P-5003A/B, HP Pumps P-50004A/B;
- When the Sea Water Intake Pump is stopped (signal tag XXXX by ROSETTI), close the inlet shutoff valve 50-XV-020. In case of valve position failure, the backwash sequence cannot proceed and advice alarm is displayed;
- Start the Sand Filter self cleaning sequence;
- Start the Backwash Pump P-50002A (or P-50002B);
- Wait for backwash complete (timer 20 min, adjustable);
- Stop the Sand Filter self cleaning sequence;
- Stop the Backwash Pump P-50002A (or P-50002B);
- Open the inlet shutoff valve 50-XV-020, restart Sea Water Intake Pump (signal tag XXXX by ROSETTI);
- Start the Electric Heater H-50001 and temperature controller 50-TIC-021;
- High level in Filtered Water Tank T-50006 restart again the SW Booster Pump P-50003A/B, that was in previous service before filter backwashing.

As agreed the "NOT RUNNING" signal will be used by WT package.
PCS sends to 50-LP-001 WT panel the “Main sea water pump running status” (serial signal 50-XL-001S).
This signal shall be a.cumulative between the signals:
- 50-XL-001A (running sea water pump PM-50001A)
- 50-XL-001B (running sea water pump PM-50001B)

The filtered water is collected in the Filtered Water Tank T-50006. The level of this tank is measured and indicated by level transmitter 50-LT-020. An alarm is activated in case of low level or high level, 50-LAH-020 / 50-LAL-020.

The flowrate downstream the Backwash Pump P-50002A/B is measured by flow transmitter 50-FT-020.

PCS waits for the signal “Sea water pump start request” by 50-LP-001 WT panel (serial signal 50-HS-001S).

4.1.3 Safeguarding intent

The main safeguarding of the system are:

- Prevent overheating of water downstream Electric Heater H-50001
- Prevent heater H-50001 element's overheating and damage
- Prevent dry running of Backwash Pumps P-50002A/B and SW Booster Pumps P-50003A/B
- Prevent high level of chlorides in fresh water.

In order to prevent overheating of water downstream H-50001and high level of chlorides in fresh water, temperature transmitter 50-TT-022 measures the seawater temperature and the following events will happen:

- if the temperature > 22°C pre-alarm 50-TAH-022 is activated;
- in case of temperature > 25 °C, an alarm 50-TAHH1-022 is displayed and interlock I-020 is activated to open off-spec valve 50-XV-026, close forward valve 50-XV-025;
- for high temperature > 40° C an alarm 50-TAHH2-022 is displayed and interlock I-001 is activated to stop electric heater H-50001.

In order to prevent Heater H-50001 element's overheating, a temperature element 50-TE-020 is embedded in one of the heater's element. In case of high high temperature (> 110°C) 50-TSHH-020 interlock I-011 trips the electric heater.

In order to prevent dry running of pumps P-50002A/B and P-50003A/B, Filtered Water Tank T-50006 level is monitored by 50-LT-020, in case of low low level 50-LALL-20 activates interlock I-002 that stops pumps P-50002A/B, P-50003A/B and 50004A/B. In case of low level PLC will send a permissive signal to DCS to start Sea Water Intake pumps. In case of high level, PLC starts SW Boster pumps and High Pressure pumps (and no simultaneously running of Backwash pumps). In case high high level, PLC sends to DCS a signal to stop Sea Water Intake pumps.

Start signal for main sea water pump is 50-HS-001S (from 50LP001 to PCS)

Stop signal for main sea water pump is 50-HS-005S (from 50LP001 to PCS)

At startup the Coarse Filter A-50003, the Electric Heater E-50001 and the Sand Filter S-50001 are off and valve 50-XV-020 is closed.

Start Sea Water Pump (tag signal by ROSETTI), then valve 50-XV-020 is then opened to allow the flow of seawater. Once the inlet flowrate is established (check 50-FT-020) and the feed pressure is at minimum 1.5 barg it is possible to start automatically Coarse Filter A-50003, the Electric Heater E-50001 control loop 50-TIC-021 and the Sand Filter S-50001.

Please verify the "Main seawater pump running" 50-XL-001S (from PCS to 50LP001)

Adjust manual valve MV-509 (outlet of sand filter) to have a back pressure of 1.3 barg at the outlet of Sea Water Coarse Filter A-50003 by reading pressure gauge 50-PI-048 and a flowrate of 2.5 m^3/h. Re-check that the feed pressure is 1.5 barg. If the feed pressure is higher than 5 barg (50-PT-020), stop the Sea Water Pump and close the inlet valve 50-XV-020.

Check also the proper operation of the air vent valve MV-635.

4.1.4 Start-up of the section

At startup the Coarse Filter A-50003, the Electric Heater E-50001 and the Sand Filter S-50001 are off and valve 50-XV-020 is closed.

The valve 50-XV-020 is then opened and the Sea Water Pump (tag signal by ROSETTI) to allow the flow of seawater. Once the flow is established (check 50-FT-020) it is possible to start Coarse Filter A-50003, the Electric Heater E-50001 control loop 50-TIC-021 and the Sand Filter S-50001.

4.1.5 Normal process shut down of the section

In case of normal shutdown of the section, turn off the control loop 50-TIC-021 and the Electric Heater E-50001. After 5 minutes turn off the Coarse Filter A-50003 and the Sand Filter S-50001 (in case of backwash), stop the Sea Water Pump (tag signal by ROSETTI) and close inlet shutoff valve 50-XV-020.

See above comment: 50-HS-005S

Please add the following sentence for each para. where the process shut down is descripted.:
In case of process shutdown of water treatment system the signal 50-XA-003 will be sent to SIS system that will also shut-down the seawater pumps and the electrolyzer.

50-XA-003 is a cumulative of critical alarms of the water treatment package. Please clarify wich process shutdown are involved (for which alarm the signal 50-XA-003 will be activated).

4.2 SEA WATER REVERSE OSMOSIS SYSTEM

4.2.1 Purpose of the process control

The purpose process control of the Sea Water Reverse Osmosis System is to control the sea water correct parameters (mainly pressure and flowrate) at SWRO module inlet and to the outlet fresh water characteristics and flowrate.

The Sea Water Reverse Osmosis System is composed by 2x100% SWRO trains, one operating and the other in stand-by.

In normal operation the switchover of the lines is periodically to keep all the lines ready for operation.

The Sea Water Booster Pump P-50003A (P-50003B) pumps water from Filtered Water Tank T-50006 through the 1st and 2nd Cartridge Filters S-50002A (S-50002B) and S-50003A (S-50003B) and to the Sea Water High Pressure Pump P-50004A (P-50004B).

The Sea Water High Pressure Pump P-50004A (P-50004B) is controlled to ensure the correct inlet pressure at SWRO membranes inlet.

The produced fresh water passes through a conductivity analyzer and then is collected in the Fresh Water Tank T-50008 while the SWRO membrane reject (brine) is discharged.

4.2.2 Description of the process operation

The seawater coming from Filtered Water Tank T-50006 passes through the conductivity analyzer 50-AT-023. Alarm is activated in case of high conductivity, 50-AAH-023.

A small flow of antiscalant is added to the stream before filtration. The flow of antiscalant is stopped if both valves 50-XV-021 and 50-XV-022 are closed and SW Booster Pump P-50003A/B stops (see Section 4.5).

There are 2x100% lines of SWRO in parallel, the selection of the operating line is made with shutoff valves 50-XV-021 and 50-XV-022, one is open and the other is closed.

The position of valve 50-XV-021 is indicated by the limit switches 50-XZSH-021 (open) and 50-XZSL-021 (closed).

The position of valve 50-XV-022 is indicated by the limit switches 50-XZSH-022 (open) and 50-XZSL-022 (closed).

Automatic shutoff valves are installed on the fresh water flushing line on the SW Booster Pumps P-50003A/B suctions: 50-XV-023 and 50-XV-024.

The position of valve 50-XV-023 is indicated by the limit switches 50-XZSH-023 (open) and 50-XZSL-023 (closed).

The position of valve 50-XV-024 is indicated by the limit switches 50-XZSH-024 (open) and 50-XZSL-024 (closed).

50-XV-023 and 50XV-024 are closed during the system normal operation.

SW Booster Pump P-50003A (P-50003B) feeds water to the Cartridge Filters S-50002A (S-50002B) and S-50003A (S-50003B).

The pressure at pump discharge is measured by 50-PT-025 (50-PT-027). Alarm is activated in case of low pressure, 50-PAL-025 (50-PAL-027).

Flowrate at pump's discharge is measured by 50-FT-022 (50-FT-023). Alarm is activated in case of low or high flowrate, 50-FAH-022 (50-FAH-023), 50-FAL-022 (50-FAL-023).

The pressure downstream Cartridge Filters S-50002A and S-50003A (50002B and 50003B) is measured by 50-PT-026 (50-PT-028). Alarm is activated in case of low pressure, 50-PAL-026 (50-PAL-028).

Differential pressure across filters 50002A and S-50003A (50002B and 50003B) is calculated by control system with the formula:

[50-PDI-024] = [50-PI-025] - [50-PI-026]

([50-PDI-029] = [50-PI-027] – [50-PI-028])

Alarm is activated in case of high differential pressure, 50-PDAH-024 (50-PDAH-029) >2bar.

High Pressure Pump P-50004A (P-50004B) delivers high pressure pump to SWRO membranes.

Pressure at pump's discharge is measured by 50-PT-030 (50-PT-032) and controlled by 50-PIC-030 (50-PIC-032). If the pressure measured by 50-PT-030 (50-PT-032) is below set point (60 barg - adjustable), 50-PIC-030 (50-PIC-032) increases the speed of pump P-50004A (P-50004B). If the pressure measured by 50-PT-030 (50-PT-032) is above set point, 50-PIC-030 (50-PIC-032) decreases the speed of pump P-50004A (P-50004B).

Alarm is activated in case of high and low pressure, 50-PAH-030 (50-PAH-032) 50-PAL-030 (50-PAL-032).

Pressure at brine outlet of SWRO membranes is measured by pressure gauge 50-PI-031 (50-PI-033).

Automatic shutoff valves are installed on the SWRO membrane brine discharge line: 50-XV-027 and 50-XV-030.

The position of valve 50-XV-027 is indicated by the limit switches 50-XZSH-027 (open) and 50-XZSL-027 (closed).

The position of valve 50-XV-030 is indicated by the limit switches 50-XZSH-030 (open) and 50-XZSL-030 (closed).

50-XV-027 and 50XV-030 are closed during the system normal operation.

Flowrate of fresh water at common SWRO membranes outlet is measured by 50-FT-024. Alarm is activated in case of low flow, 50-FAL-024.

The seawater coming from both lines of SWRO membranes passes through the conductivity analyzer 50-AT-024 and then flows to Fresh Water Tank T-50008. Alarm is activated in case of high conductivity, 50-AAH-024.

Automatic shutoff valve 50-XV-025 is installed on the fresh water line to Fresh Water Tank T-50008.

The position of valve 50-XV-025 is indicated by the limit switches 50-XZSH-025 (open) and 50-XZSL-025 (closed).

Automatic shutoff valve 50-XV-026 is installed on the fresh water line to drain (off-spec).

The position of valve 50-XV-026 is indicated by the limit switches 50-XZSH-026 (open) and 50-XZSL-026 (closed).

4.2.3 Safeguarding intent

The main safeguarding of the system are:

- Prevent overpressure of suction side of HP Pump P-50004A (P-50004B);
- Prevent overpressure of SWRO membranes A-50007A (A-50007B) inlet;
- Prevent overpressure of SWRO membranes A-50007A (A-50007B) permeate outlet;
- Prevent off-spec fresh water to Fresh Water Tank T-50008.

In order to prevent overpressure of suction side of HP Pump P-50004A. In case of low low pressure 50-PALL-026 activates interlock I-013 that stops the HP Pump P-50004A. A pressure safety valve 50-PSV-034 with set point of 4 barg is installed at pump inlet.

In order to prevent overpressure of suction side of HP Pump P-50004B. In case of low low pressure 50-PALL-028 activates interlock I-014 that stops the HP Pump P-50004B a pressure safety valve 50-PSV-037 with set point of 4 barg is installed at pump inlet.

In order to prevent overpressure of SWRO membranes A-50007A (A-50007B) a pressure safety valve 50-PSV-035 (50-PSV-038) with set point of 65 barg is installed at membranes inlet.

In order to prevent overpressure of SWRO membranes A-50007A (A-50007B) a pressure safety valve 50-PSV-036 (50-PSV-039) with set point of 6 barg is installed at permeate outlet.

In order to prevent off-spec fresh water to flow into the Fresh Water Tank T-50008, in case of high high conductivity alarm 50-AAHH-024, interlock I-003 closes the shutoff valve to Fresh Water Tank T-50008, 50-XV-025 and open off-spec drain valve 50-XV-026.

4.2.4 Start-up of the section

At startup the valves 50-XV-021/022/023/024/025/026/027/030 are closed.

- Open the inlet shutoff valve of the selected line, 50-XV-021 or 50-XV-022;
- Open the off-spec valve 50-XV-026;
- SW Booster Pumps P-50003A/B shall not start if PLC recognizes the following abnormal conditions:
  - .. Simultaneous closure of 50-XV-025 and 50-XV-026 by limit switches signal feed back.
  - .. Failure opening of inlet shutoff valve of the selected line 50-XV-021 or 50-XV-022; by means limit switches signal feed back.
- Start the SW Booster Pump P-50003A or P-50003B;
- Check properly operation of air vent valves MV-640 and MV-641;
- When the pressure downstream cartridge filters measured by 50-PT-026 or 50-PT-028 is higher than 2 barg and stable, it is allowed to start one High Pressure Pump P-50004A/B;
- Start slowly by VFD ramp the High Pressure Pump P-50004A or P-50004B;

? what means ".."

- Gradually throttle manual valve MV-550 or MV-558 until permeate flowrate, measured by 50-FT-024, is 0.8 m^3/h and in same time the 50-PIC-030 or 50-PIC-032 will adjust the feed pressure up to set-point value, changing the pump speed rotation
- Check the properly operation of air vent valves MV-642 and MV-645;
- Check the flow and pressure indicator for correct parameters readings: 50-PT-025/026/030/031 and 50-FT-022/024 or 50-PT-027/028/032/033 and 50-FT-023/025;
- Check the conductivity analyzer 50-AI-024: if the value is below the maximum allowable value then it's possible to open the valve 50-XV-025 to the Fresh Water Tank T-50008 and close the off-spec valve 50-XV-026.

4.2.5 Normal process shut down of the section

During normal shutdown it's necessary to flush the SWRO membranes circuit to displace seawater with fresh water. The sequence for normal shutdown is the following:

- Check if the level of fresh water inside the Fresh Water Tank T-50008 is above minimum level of 80%;
- Stop the High Pressure Pump P-50004A or P-50004B slowly to decrease rotation speed down to stop;
- Close the fresh water valve 50-XV-025 and open off-spec valve 50-XV-026:
- Close the filtered water inlet valve 50-XV-021 or 50-XV-022;
- In case of automatic switching valve failure, the automatic sequence is immediately interrupted, SW Booster Pump P-50003A or P-5000B are stopped and advise alarm is displayed.

Fresh water from tank T-50008 flows in the SWRO line to displace the seawater through the brine outlet to the drain. After 10-15 minutes the flushing is complete and it's necessary to stop the flushing:

- Stop the SW Booster Pump P-50003A or P-5000B;
- Close the fresh water inlet valve 50-XV-023 or 50-XV-024;
- Close the brine drain valve 50-XV-027 or 50-XV-030.

In case of **shutdown for a period greater than 24 hours**, the SWRO unit must be flushed at low pressure, in order to remove the salty water before the stop. **Flushing** is performed with RO permeate through SW Booster Pumps P-50003 A/B when one SWRO line has finished its operation. During the flushing all the dosing units shall be stopped. During the flushing High Pressure Pumps P-50004 A/B are stopped.

Flushing of line A: automatic valves 50-XV-023 (flushing inlet line A), 50-XV-027 (flushing outlet line A) and 50-XV-026 (off-spec) shall be opened, while 50-XV-025 (permeate outlet) shall be closed.

Flushing of line B: automatic valves 50-XV-024 (flushing inlet line B), 50-XV-030 (flushing outlet line B) and 50-XV-026 (off-spec) shall be opened, while 50-XV-025 (permeate outlet) shall be closed.

When line A is in flushing mode, it is possible to start line B if fresh water if required.

4.3 FRESH WATER STORAGE AND POST-TREATMENT

4.3.1 Purpose of the process control

The purpose of the process control of the Fresh Water Storage and Post-Treatment System is to collect the produced fresh water, pump it to the user at battery limits while performing the final treatments and check on the water quality.

The fresh water flows from the Fresh Water Tank T-50008 to the Fresh Water Pumps P-50009A/B (one operating and the other stand-by).

The pump discharge flows into a softening filter, an UV Sterilizer, it's added with a sodium hydroxide solution to control the pH and then goes to the battery limit after a series of transmitter and analyzers to check:

- Total Hardness
- pH
- Temperature
- Pressure
- Flowrate

A dedicated shutoff valve discharges the fresh water to the drain in case of off-spec.

4.3.2 Description of the process operation

See above comments

The level in the Fresh Water Tank T-50008 is measured by level transmitter 50-LT-021.

- An alarm is activated in case of low low level, 50-LLAH-021: trips Fresh Water Pumps P-5009A/B.
- An alarm is activated in case of low level, 50-LAL-021: PLC starts the SW Booster pumps.
- An alarm is activated in case of high and 50-LAH-021: PLC is ready to start Fresh Water Pumps P-5009A/B and wait for a permissive command from DCS.
- An alarm is activated in case of high high and 50-LAHH-021: PLC stops the SW Booster pumps, HP Pressure Pumps and after 24 hours start SWRO automatic flushing sequence.

The pressure downstream the Fresh Water Pumps P-50009A/B is measured by pressure transmitter 50-PT-047. An alarm is activated in case of high or low pressure, 50-PAH-047, 50-PAL-047.

The softening filter is a package and includes all the equipment for regeneration. Regeneration is activated from control system on the basis of the totalized flow or off-spec residual hardness concentration or manual command and it's performed at system shutdown.

When the softener regeneration is activated, the resin is backwashed by water and then the brine solution is hydraulically transferred to resin. The brine solution not consumed by the resin is discharged to the drain. As last sequence step, the regenerated resin is water rinsed again to displace the exceeding brine solution.

During the regeneration sequence, a status indication is displayed to HMI and the Fresh Water Pump P-5009A/B is in service. After the regeneration, the softener returns in service.

The UV Sterilizer ensures final sterilization of the fresh water.

Fresh Water outlet temperature is measured by temperature transmitter 50-TT-024.

Fresh Water outlet pressure is measured by pressure transmitter 50-PT-041. An alarm is activated in case of high and low pressure, 50-PAH-041 and 50-PAL-041.

Fresh Water outlet total hardness is measured by analyzer 50-AT-026. An alarm is activated in case of high hardness, 50-AAH-026.

Fresh Water outlet pH is measured by analyzer 50-AT-027 and controlled by pH controller 50-AIC-027. An alarm is activated in case of high and low pH, 50-AAH-027 and 50-AAL-027.

Fresh Water outlet flow is measured and totalized by 50-FT-026. Alarm is activated in case of high and low flow, 50-FAH-026 and 50-FAL-026.

pH controller 50-AIC-027 automatically controls the flowrate sodium hydroxide dosing pump P-50005A/B, basing to gap annulling between measured and set-point values.

Automatic shutoff valve 50-XV-031 is installed on the fresh water line to battery limit.

The position of valve 50-XV-031 is indicated by the limit switches 50-XZSH-031 (open) and 50-XZSL-031 (closed).

Automatic shutoff valve 50-XV-032 is installed on the fresh water line to drain (off-spec).

The position of valve 50-XV-032 is indicated by the limit switches 50-XZSH-032 (open) and 50-XZSL-032 (closed).

4.3.3 Safeguarding intent

The main safeguarding of the system are:

- Prevent dry running of Fresh Water Pumps P-50009A/B and pumps SW Booster Pumps P-50003A/B;
- Prevent off-spec fresh water (high pH) to battery limit;
- Prevent off-spec fresh water (low pH) to battery limit;
- Prevent off-spec fresh water (high total hardness) to battery limit;
- Prevent Fresh Water Pumps P-50009A and P-50009B running simultaneously.

To prevent dry running, in case of low low level of Fresh Water Tank T-50008, 50-LALL-021 activates interlock I-004 that stops Fresh Water Pumps P-50009A/B and SW Booster Pumps P-50003A/B (only if SWRO flushing is activated).

To prevent off spec (high pH) fresh water to battery limit, in case of high high pH 50-AAHH-027, interlock I-006 closes shutoff valve to battery limit 50-XV-031 and opens off-spec valve 50-XV-032.

To prevent off spec (low pH) fresh water to battery limit, in case of low low pH 50-AALL-027, interlock I-007 closes shutoff valve to battery limit 50-XV-031 and opens off-spec valve 50-XV-032.

To prevent off spec (high total hardness) fresh water to battery limit, in case of high high total hardness 50-AAHH-026, interlock I-005 closes shutoff valve to battery limit 50-XV-031 and opens off-spec valve 50-XV-032.

To prevent pumps P-50009A and P-50009B running simultaneously, interlock I-018 stops pump P-50009 if P-50009B is running and interlock I-019 stops pump P-50009B if P-50009A is running.

4.3.4 Start-up of the section

At startup the valves 50-XV-031/032 are closed.

- Open the off-spec valve 50-XV-032;
- Start the Fresh Water Pump P-50009A or P-50009B;
- If PLC recognizes the simultaneous closure of 50-XV-032 and 50-XV-031 by limit switches, Fresh Water Pump P-50009A/B shall not start;
- Check the flowrate, temperature and pressure indicator for correct parameters readings: 50-FT-026, 50-PT-041 and 50-TT-024;
- Switch on the UV Sterilizer S-50010;
- Check the total hardness analyzer 50-AI-026 and pH analyzer 50-AI-027: if the value of total hardness is below the maximum allowable value and the value of pH is inside the acceptable range, then it's possible to open the valve 50-XV-031 and close the off-spec valve 50-XV-032.
- Check the proper operation of air vent valves MV-652.

4.3.5 Normal process shut down of the section

During normal shutdown it could be necessary to regenerate the softening filter.

- Check if totalized flow is above 20 m^3 (adjustable) and proceed with softening filter regeneration. If totalized flow is below 20 m^3 than go directly to normal shutdown;
- Check if the level of fresh water inside the tank Fresh Water Tank T-50008 is above minimum level of 80%;
- Close the fresh water valve 50-XV-031 and open off-spec valve 50-XV-032;
- Start the softener filter regeneration sequence;
- Fresh water from tank T-50008 flows in the softening filter to perform regeneration. After 15 minutes (adjustable) the regeneration is complete;
- When regeneration is completed proceed with normal shutdown.

The sequence for normal shutdown is the following:

- Stop the UV Sterilizer S-50010;
- Stop the Fresh Water Pump P-50009A or P-50009B.

4.4 CAUSTIC SODA DOSING SYSTEM

4.4.1 Purpose of the process control

The purpose of the process control of the Caustic Soda Dosing System is to store and dose sodium hydroxide for pH correction of the fresh water at package outlet.

Sodium Hydroxide 2% solution is stored in Caustic Soda Dosing Tank T-50002 and dosed by Caustic Soda Dosing Pumps P-50002A/B (one operating and the other in stand-by).

4.4.2 Description of the process operation

The level of Sodium Hydroxide 2% tank T-50002 is measured by 50-LT-022. Alarm is activated in case of low level, 50-LAL-022.

Sodium Hydroxide from T-50002 is dosed by Caustic Soda Dosing Pumps P-50005A (P-50005B) to fresh water pipe downstream Softening Filter S-50004.

P-50005A (P-50005B) dosing speed is linked to operation of Fresh Water Pumps and dosing speed is automatically controlled by 50-AIC-027, comparing the measured value with set point values (7.5 adjustable), as described below:

- At low pH value < 6, Max 100% dosing speed.
- At pH value between 6.5 and 7.0, linear proportional dosing speed with step increasing.
- At high pH value 7.9, Min 0% dosing speed.

Pressure downstream P-50005A/B is indicated by pressure gauge 50-PI-042.

4.4.3 Safeguarding intent

The main safeguarding of the system is:

- Prevent dry running of pumps P-50005A/B.
- Prevent overdosage of chemicals.

In case of low low level of tank T-50002, 50-LALL-022, interlock I-008 stops pumps P-50005A/B.

Dosing pump start/stop is linked to Fresh Water Pump running.

Fault alarm of pH analyser is displayed in case of instrument failure and dosage control is automatically interrupted.

4.4.4 Start-up of the section

Check if level in T-50002 is above minimum level and start dosing pump P-50005A or P-50005B.

4.4.5 Normal process shut down of the section

Stop Caustic Soda Dosing Pumps P-50005A or P-50005B.

4.5 ANTISCALANT DOSING SYSTEM

4.5.1 Purpose of the process control

The purpose of the process control of the Antiscalant Dosing System is to store and dose antiscalant agent upstream the SWRO system (at T-50006 outlet to SW Booster Pumps P-50003A/B).

Antiscalant is stored in Antiscalant Dosing Tank T-50003 tank and dosed by dosing pumps Antiscalant Dosing Pumps P-50006A/B (one operating and the other in stand-by).

4.5.2 Description of the process operation

The level of Antiscalant tank T-50003 is measured by 50-LT-023. Alarm is activated in case of low level, 50-LAL-023.

Antiscalant from T-50003 is dosed by Antiscalant Dosing Pumps P-50006A (P-50006B) at Filtered Water Tank T-50006 outlet to SW Booster Pumps P-50003A/B and linked to these pumps operation.

Antiscalant Dosing Pump P-50006A (P-50006B) dosing speed is fixed and pre-set during commissioning.

Pressure downstream P-50006A/B is indicated by pressure gauge 50-PI-043.

4.5.3 Safeguarding intent

The main safeguarding of the system are:

- Prevent dry running of pumps Antiscalant Dosing Pumps P-50006A/B.
- Prevent antiscalant dosing when SWRO is not operating.

In case of low low level of tank T-50003, 50-LALL-023, interlock I-009 stops Antiscalant Dosing Pumps P-50006A/B.

If shutoff valves 50-XV-021 and 50-XV-022 are contemporaneously closed interlock I-015 stops Antiscalant Dosing Pumps P-50006A/B or if SW Booster Pump P-50003A/B is stopped.

4.5.4 Start-up of the section.

Check if level in Antiscalant Dosing Tank T-50006 is above minimum level and start Antiscalant Dosing Pumps P-50006A or P-50006B.

4.5.5 Normal process shut down of the section.

Stop Antiscalant Dosing Pumps P-50006A or P-50006B.

4.6 BIOCIDE DOSING SYSTEM

4.6.1 Purpose of the process control

The purpose of the process control of the Biocide Dosing System is to store and dose biocide agent in several positions:

- To sea water package inlet, upstream Coarse Filter A-50003 – continuous dosing.

- To sea water intake system (outside our scope of supply) – shock dosing (20 minutes every 2 days).
- To Waste Water Tank (T-55001, outside our scope of supply) – shock dosing (1 hour every week).

Shock dosages are controlled by PLC on a time basis.

Biocide is stored in Biocide Dosing Tank T-50004 and dosed by Biocide Dosing Pumps P-50007A/B (package inlet), P-50008A/B (sea water intake), P-50010A/B (Waste Water Tank T-55001). For each position one pump is operating and the other is in stand-by.

4.6.2 Description of the process operation

The level of Biocide Dosing Tank T-50004 is measured by 50-LT-024. Alarm is activated in case of low level, 50-LAL-024.

Biocide from Biocide Dosing Tank T-50004 is dosed by Biocide Dosing Pumps P-50007A (P-50007B) to package inlet, upstream Coarse Filter A-50003. P-50007A (P-50007B) dosing speed is fixed and pre-set during commissioning. Pressure downstream P-50007A/B is indicated by pressure gauge 50-PI-044.

Biocide from Biocide Dosing Tank T-50004 is dosed by dosing pump P-50008A (P-50008B) to sea water intake system. P-50008A (P-50008B) dosing speed is fixed and pre-set during commissioning. Pressure downstream P-50008A/B is indicated by pressure gauge 50-PI-045.

Biocide from Biocide Dosing Tank T-50004 is dosed by dosing pump P-50010A (P-50010B) to Waste Water Tank T-55001. P-50010A (P-50010B) dosing speed is fixed and pre-set during commissioning. Pressure downstream P-50010A/B is indicated by pressure gauge 50-PI-046.

4.6.3 Safeguarding intent

The main safeguarding of the system are:

- Prevent dry running of pumps Biocide Dosing Pumps P-50007A/B, P-50008A/B, P-50010A/B.
- Prevent biocide dosing when package is not operating.

In case of low low level of tank Biocide Dosing Tank T-50004, 50-LALL-024, interlock I-010 stops pumps - 50007A/B, P-50008A/B, P-50010A/B.

If shutoff valves 50-XV-020 is closed, interlock I-012 stops pumps P-50007A/B.

Biocide dosing pumps P-50008A/B and P-50010A/B will continue dosing biocide to sea water intake and Waste Water Tank, with the dosing pre-set during startup, even if the Water Treatment Package is stopped for any reason. The above mentioned pumps can be start and stopped only locally by PLC HMI.

4.6.4 Start-up of the section

Check if level in Biocide Dosing Tank T-50004 is above minimum level and start Biocide Dosing Pumps P-50007A/B, P-50008A/B, P-50010A/B.

4.6.5 Normal process shut down of the section

Stop Biocide Dosing Pumps P-50007A/B, P-50008A/B, P-50009A/B.

4.7 CONTAINER VENTILATION (HFA-50001A/B/C) AND HEATING (HHS-50003A/B)

4.7.1 Purpose and description of the process control

Container Electric Heaters (HHS-50003 A/B) are installed inside container to increase ambient temperature up to minimum 10°C during cold season.

Inlet temperature is measured by 50-TT-023 and controlled by 50-TIC-023.

If the temperature inside container is lower than 10°C, 50-TIC-023 switch on the Container Electric Heater HHS-50003A or HHS-50003B.

If the temperature inside container is higher than 12°C, 50-TIC-023 switch off the Container Electric Heaters HHS-50003A and HHS-50003B.

If after starting up of one Container Electric Heater it does not start automatically according to ambient temperature (due to default or various problems), after a certain delay switch on the other heater that was in stand-by in automatic.

The automatic drainage of Water Treatment Package will be activated by a timer or when air ambient temperature is lower than 2°C (measured by temperature transmitter 50-TT-023).

The ventilation inside container is maintained with HFA-50001A/B/C fans (3 x 50%, two in operation and one stand-by) that provide enough air change per hour (minimum 15 air change per hour).

4.7.2 Safeguarding intent

N/A

4.7.3 Start-up of the section

Container ventilation is always in operation. Heating is started up when required by the ambient temperature (50-TIC-023).

4.7.4 Normal process shut down of the section

N/A

4.8 WATER TREATMENT PACKAGE SHUTDOWN

4.8.1 Purpose of the process control

The normal shutdown of each package section is described in the relevant chapters above.

In some cases, it's necessary a particular shutdown of the whole Water Treatment Package:

- Long Period Stop of Water Treatment Package;
- SIS Shutdown.

Please add the following sentence:
In case of process shutdown of water treatment system the signal 50-XA-003 will be sent to SIS system that will also shut-down the seawater pumps and the electrolyzer.

50-XA-003 is a cumulative of critical alarms of the water treatment package. Please clarify wich process shutdown are involved (for which alarm the signal 50-XA-003 will be activated).

4.8.2 Long Period Stop safeguarding intent

In case of long stop of the water treatment package, longer than one month, the package will be automatically drained. Electric Heater drain valve 50-XV-033, Filtered Water Tank T-50006 drain valve 50-XV-034 and Fresh Water Tank T-50008 drain valve 50-XV-035 will be opened and water is discharged into water drain collector.

In case of "long period stop" signal (signal by RM) interlock I-016 will be activated.

Please note that when valve 50-XV-020 is closed, 50-XZAL-020 alarm activates interlock I-012, a timer is reset and started, and the following actions are performed with a delay of 30 days:

- Send Profibus signal "Long Stop Period Drain of Water Treatment Package"
- Open drain valve 50-XV-033
- Open drain valve 50-XV-034
- Open drain valve 50-XV-027
- Open drain valve 50-XV-030
- Open drain valve 50-XV-035
- Open off-spec valve 50-XV-026
- Open off-spec valve 50-XV-032
- Close forward valve 50-XV-031

Is this signal the STOP? because otherwise we don't know al which signal you are reffering to.

A timer inside the water treatment package will be started and evaluate if 1 months is passed o not.

4.8.3 SIS Shutdown safeguarding intent

Shutdown signal 50-XS-001 from ROSETTI SIS System, activates Interlock I-017 performing the following actions and tripping all the package electric users:

- Close inlet battery limit valve 50-XV-020 and stops Sea Water Pump (tag signal by ROSETTI)
- Close forward valve 50-XV-031
- Trip Coarse Filter A-50003
- Trip Sand Filter S-50001
- Trip Softening Filter S-50004
- Trip Container Electric Heater HHS-50003A/B
- Trip Container Air Fan HFA-50001A/B/C
- Trip UV Lamp S-50010
- Trip Heater H-50001
- Stop Pump P-50002A/B
- Stop Pump P-50003A/B
- Stop Pump P-50009A/B
- Stop Pump P-50004A/B

- Stop Pump P-50005A/B
- Stop Pump P-50006A/B
- Stop Pump P-50007A/B
- Stop Pump P-50008A/B
- Stop Pump P-50010A/B
- Open drain valve 50-XV-033
- Open drain valve 50-XV-034
- Open drain valve 50-XV-027
- Open drain valve 50-XV-030
- Open drain valve 50-XV-035
- Open off-spec valve 50-XV-026

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