ARM 7.5.5A POTABLE WATER PLANT OPERATION

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1. References

a.) Technical Manual – Danfoss Sea Recovery 5200 Basic Desalination System
b.) Drawing 65411-532-01 - Auxiliary Systems Diagram Potable Water
c.) Drawing 65411-524-01 – Auxiliary Systems Diagram – Seawater Service

2. Purpose

The purpose of this procedure is to set forth the guidelines for the operation of the reverse osmosis plant to provide potable water to the vessel as required in the ISM system.

2. Responsibility

It is the responsibility of the Chief Engineer to maintain guidelines for operating the reverse osmosis plant for generating potable water.

3. General

Thoroughly familiarize yourself with the Danfoss, Coral Sea Horizontal 5200 Basic (OEM) manual before operating this equipment. Follow all instructions given therein and those directed by the chief or First Assistant Engineer. This equipment can be started in Automatic and Manual modes.

RO Automatic Start-up Procedure:

1. Check that all valves are in the correct position

Valve Number	Description	Valve Position
MV-1001	Feed water selection valve	Normal position
MV-1002	Media filter by-pass valve	Position per system spec
MV-1003	Media filter inlet valve	Normal position
MV-1004	Media filter outlet valve	Normal position
MV-1005	Media filter rinse valve	Normal position
MV-1007	Cartridge system drain valve	Closed position
NV-1002	Back pressure regulator	Fully open
MV-1010	Brine water selection valve	Normal position
DV-1008	Product water diversion valve	Fully closed
MV-1006	Fresh water flush control valve	Fully closed

2. Ensure that the main circuit breaker located in the top right corner of the control panel is in the 'ON' position and that the 'Power On' Indicator on the front of the control panel is illuminated.

3. Ensure that the E-Stop button is not pressed in. If the E-stop button is illuminated, the button is pressed in, release it by turning the mushroom in a clockwise direction.

4. Ensure no alarms or faults are currently being indicated. If the alarm light is illuminated or flashing, an alarm or performance warning is present. Accept or clear these alarms before attempting to proceed.

5. To initiate an automatic start-up of the system press the 'Auto-Start' button on the control panel door or navigate to the 'System Operation' screen (See Menu Navigation). Press the 'Start' button once the screen has been accessed.

6. Immediately after the 'Auto-Start' button is pressed, the green indicator light embedded in the button will begin to flash rapidly. At this moment the system is performing system pre-checks. If a problem is detected, the system will abort the automatic start-up routine and display a system fault notification screen detailing the problem (See System Critical Error Messages section of the manual). If no pre-check errors are detected, the control system will begin a 10 second count-down. During the count-down the system will beep intermittently and display a warning screen.

7. Once the 10 second count-down has been completed, the control system will start the booster pump. The control system now performs system pressure checks before continuing. If system pressures fail to reach expected levels, the system will abort the automatic operation routine. All running pumps will be shut down, and the controller will display a system fault notification screen detailing the problem (See System Critical Error Messages section of the manual).

8. If pre-filtration pressures reach expected levels, the control system will begin to monitor high pressure pump inlet and outlet pressures. If inlet pressures drop below pre-set limits the automatic operation routine is aborted. All running pumps are shut down and the controller will display a system fault notification screen detailing the problem (See System Critical Error Messages section of the manual). If inlet pressure remains at acceptable levels, the system will monitor the high pressure pump's outlet pressure. If after 60 seconds of operation the outlet pressure of the pump is too low, the control system will display a performance warning message detailing the problem.

9. The system will continue to operate in this state for a further 10 minutes. If the system pressure has not been raised above minimum levels within this time, the automatic operation routine will be aborted. All running pumps are shutdown, and the controller will display a system fault notification screen detailing the problem (See System Critical Error Messages section of the manual).

10. The operator must increase pressure within the specified time in order to avoid the system fault. High pressure pump outlet pressure monitoring is provided to protect the high pressure pumps internal moving parts. If the high pressure pump is operated at too low a pressure, there is not enough internal pressure to effectively lubricate the pump's moving surfaces; this will result in rapid wear of the pump piston shoes and other essential moving parts.

11. If high pressure pump outlet pressures are deemed above minimum and below maximum, the system will begin monitoring product water salinity levels. If at any point, high pressure pump outlet or inlet pressures stray beyond acceptable levels, the automatic operation routine will be aborted. All running pumps are shutdown, and the controller will display a system fault notification screen detailing the problem (See System Critical Error Messages of the manual).

12. If all systems are reporting healthy and within expected limits, the system will continue monitoring product water salinity levels. If acceptable salinity levels are not detected within 10 minutes of operation, the control system will display a performance warning message detailing the problem.

13. Once acceptable salinity levels have been detected and appear stable, the control system will activate the UV Sterilizer warm up routine. Once the UV Sterilizer has completed the warm up cycle, the control system will attempt to activate the diversion valve. If the valve fails to activate correctly, the automatic operation routine will be aborted. All running pumps are shutdown, all activated valves are requested to return to their home position, and the controller will display a system fault notification screen detailing the problem (See System Critical Error Messages section of the manual).

14. If the product diversion valve activates successfully, at this point the unit is classified as fully operational. If product water salinity levels stray beyond acceptable limits, the control system will raise a performance warning detailing the problem. It will also de-activate the product diversion valve, and place the UV Sterilizer system into a shutdown routine. If acceptable salinity levels are detected once again, the control system will activate the UV Sterilizer warm up routine, and when appropriate, will re-activate the product water diversion valve. The system will remain in this cycle until shutdown by the operator or until a system fault is detected.

Note: If the product diversion valve cycles 8 times within a 60 minute period, the control system will issue a performance warning message detailing the problem; it is advisable to check system settings at this time to ensure optimum performance. This type of message is usually generated when system pressures are insufficient to generate acceptable potable water given the quality of the current feed water.

RO Automatic Shutdown Procedure:

1. At any time in the automatic start-up process, the system can be shut down by pressing the “Auto-Stop” button. Controlled shutdown of the system occurs when pressing this button. This controlled shut down can take up to 45 seconds to complete depending on where the system was in its automatic start up routine at the time the ‘Auto-Stop’ button was pressed. Once pressed the ‘Auto-Stop’ button will begin to flash. This response is to inform you a system shutdown is now in progress. Once the system shutdown is completed, the ‘System Auto Stop’ light will remain steadily illuminated. If a system fault is detected during shutdown the controller will display a system fault notification screen detailing the problem (See System Critical Error Messages section of the manual).

RO Manual Start-up Procedure:

1. Check that all valves are in the correct position:

Valve Number	Description	Valve Position
MV-1001	Feed water selection valve	Normal position
MV-1002	Media filter by-pass valve	Position per system spec
MV-1003	Media filter inlet valve	Normal position
MV-1004	Media filter outlet valve	Normal position
MV-1005	Media filter rinse valve	Normal position
MV-1007	Cartridge system drain valve	Closed position
NV-1002	Back pressure regulator	Fully open
MV-1010	Brine water selection valve	Normal position
DV-1008	Product water diversion valve	Fully closed
MV-1006	Fresh water flush control valve	Fully closed

2. Ensure that the main circuit breaker located in the top right corner of the control panel is in the ‘ON’ position and that the ‘Power On’ Indicator on the front of the control panel is illuminated.

3. Ensure that the E-Stop button is not pressed in. If the E-stop button is illuminated, the button is pressed in, release it by turning the mushroom in a clockwise direction.

4. Ensure no alarms or faults are currently being indicated. If the alarm light is illuminated or flashing, an alarm or performance warning is present. Accept or clear these alarms before attempting to proceed.

5. Turn the booster pump operator switch to the 'On' position.

6. Turn the high pressure pump operator switch to the 'On' position. If the booster pump is currently running, and no system faults are present, the high pressure pump operator switch indicator will illuminate. If there are any problems preventing the high pressure pump from operating, the control system will raise a performance warning detailing the problem.

7. Once the operator has successfully started all connected and enabled pumps the control system will examine the health of the system salinity sensor; if the salinity sensor reports an unhealthy state, refer to the section labeled (Manual Salinity Control Operation). If the sensor reports a healthy state the control system will begin to monitor membrane pressures. If the system detects pressure below the recommended minimum required to product potable water, the control system will raise a performance warning message detailing the problem.

8. The system will continue to run for a limited time (max 10 minutes), but during this limited time it will not be able to progress any further. The operator must manually increase system pressure by turning the system pressure regulator in a clockwise direction. If the operator fails to increase system pressure to acceptable levels within the time allowed, the control system will automatically shut down the water maker to prevent damage.

9. If the operator does manually increase the pressure to acceptable levels as requested, the controller will begin to monitor product water salinity levels. Once acceptable salinity levels are detected, the controller will activate the UV Sterilizer for 30 seconds. Once the UV Sterilizer has completed its warm-up cycle, it will then attempt to activate the product water diversion valve. If the valve fails to activate properly, the control system will raise a performance warning message detailing the problem.

10. The system will continue to run but will not be able to progress any further. The operator must manually actuate the product diversion valve (See Manual Actuation of System Valves). Once the operator has manually actuated the product diversion valve, the controller will continue to monitor product water salinity levels. If the salinity levels become unacceptable, the controller will attempt to close the diversion valve. If the valve fails to

activate properly the control system will raise a performance warning message detailing the problem. The operator must now manually close the product diversion valve as soon as possible to prevent contamination of the potable water supply (See Manual Actuation of System Valves).

Manual Shutdown:

Note: To stop the system at any point within manual mode operation, press the 'Auto-Stop' button. All pumps will stop simultaneously and all activated valves will be requested to return to their home positions. If any valve fails to activate properly, the control system will raise performance warning messages or system fault messages detailing the problem(s).

Note: To perform a phased stop of the system in manual mode, individually turn off running pumps. To prevent fault screens from being displayed, it is advisable to shut the pumps down in the reverse order in which they were started.

1. Turn off the high pressure pump. When doing so the control system will attempt to return the domestic product water diversion valve to its home position. If this valve fails to activate properly, the control system will raise a performance warning message detailing the problem.

2. The system will continue to run in this state. The operator should manually actuate the failed valve (See Manual Actuation of Valves). Once the valve has been manually placed in the correct position turn the booster pump off.

RO Emergency Shutdown Procedure:

1. To shut down the system in an emergency, press the E-Stop button. Pressing this button will cause all rotating equipment to cease immediately. It will also cause the 'Auto-Stop' button to flash. This flashing indicator is signaling what will happen when you release the E-Stop button. Once the E-Stop is released, the system will move any activated valves to their home position (if applicable). The 'Auto-Stop' button will remain steadily illuminated once this action is completed.