Functional description and design changes to DAB cooling system

Document control

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1 Contents

1 Introduction

1.1 General

This document describes the function description of the upgrades to the cooling system. The upgrades are to be done on the Freshwater cooling system and the sea water cooling system. The control and monitoring of the upgraded aspects of the cooling systems are to be integrated into the IAS, Integrated Automation System.

1.2 Abbreviations

FW	Freshwater
FWD	Forward
IAS	Integrated Automation System
MCC	Motor control Center
MODU	Mobile offshore drilling unit
PT	Pressure transmitter
STBD	Starboard
SW	Seawater
TBC	To Be Clarified
TT	Temperature Transmitter
TV	Temperature control valve
VFD	Variable frequency drive
VSP	Variable speed pump

2 Summary of changes

- VFD implementation on SW cooling pump.
- VFD implementation on FW cooling pump.
- Automated control of HP Mud pump FW cooling valves.
- Automated control of anchor winch FW cooling valves.
- Automated control of break resistor FW cooling valves.
- Automated control of cement package FW cooling valves.
- Establish routines for closing Chiller unit valves when inactive.

3 VFD implementation for central cooling system

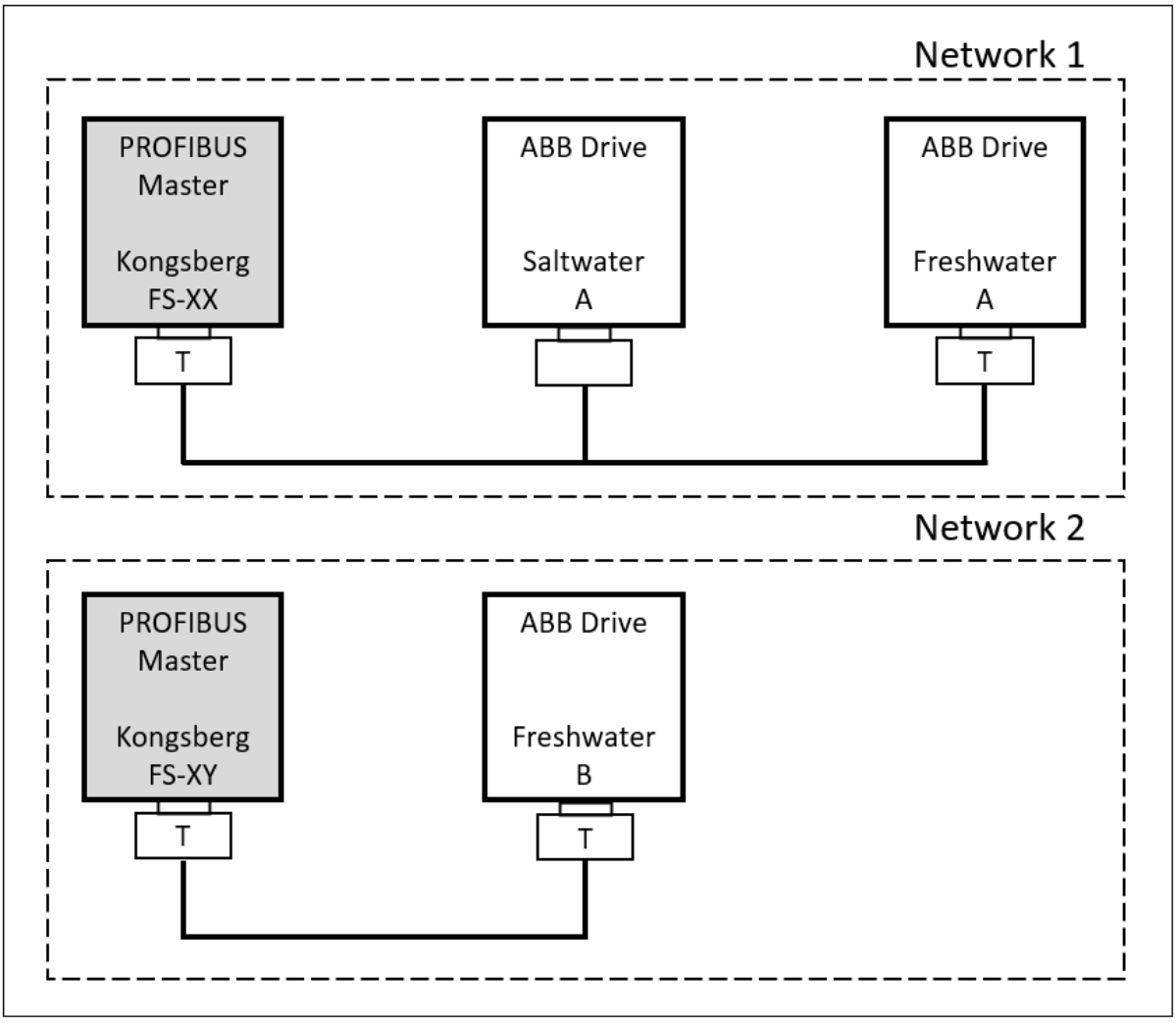
The central cooling system consists of 8 FW cooling pumps and 8 SW cooling pumps.

3.1 Du/dt cabinet

Each FW du/dt filter will be placed in a stainless-steel cabinet. This cabinet will act as a mechanical protection barrier for the filter in order to reduce the risk of damage. The cabinet will be installed with two cooling fans and a PT100 RTD (Resistance temperature detector). The first fan is to start when the cabinet reaches a temperature of 25 °C. The second fan is to start when it the cabinet reaches a temperature of 30 °C. Both fans are to stop 5 °C lower than their starting temperature. The fan controller will be implemented on the VFD using the default IO module.

3.2 Profibus-DP communication Interface

Each quadrant will consist of two Profibus-networks to ensure redundancy. Each network consists of a Kongsberg RCU (remote controller unit), one SW pump VFD, and one FW pump VFD. The Kongsberg RCU will act as the Master, and the VFD's will act as slaves.



3.3 Changes to main sea water cooling system

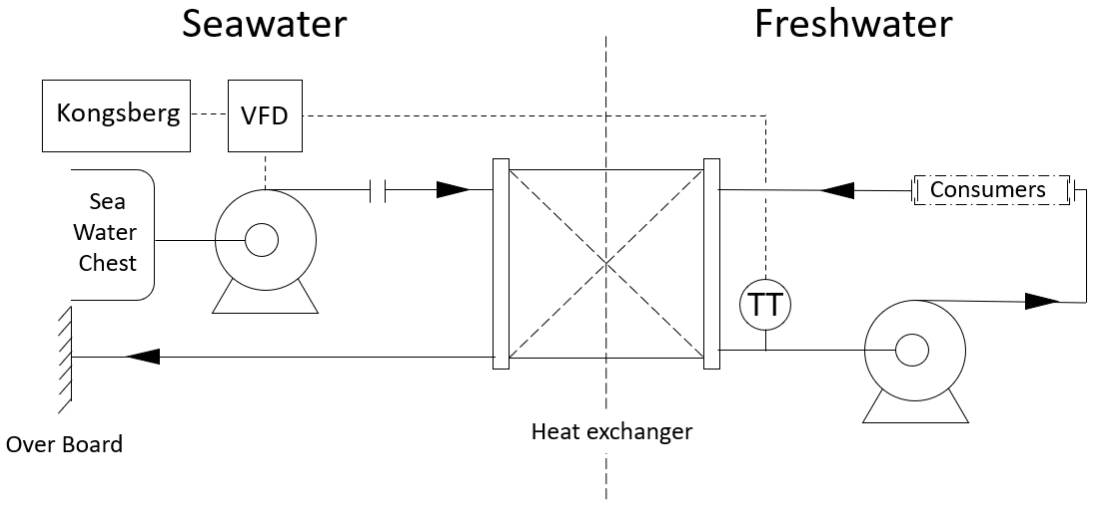
There are eight main sea water cooling pumps. Two in each pump room for cooling the FW cooling system via the central water coolers/heat exchangers. One pump in each quadrant will be fitted with a VFD will be implemented on the SW system to actively regulate the flow of the SW in order to regulate temperature of the FW cooling system.

Tag	Description	Freshwater TT tag.
721-PA-001A	MAIN SEA WATER COOLING PUMP PORT FWD	TBC
721-PA-001C	MAIN SEA WATER COOLING PUMP STBD FWD	TBC
721-PA-002A	MAIN SEA WATER COOLING PUMP PORT AFT	TBC
721-PA-002C	MAIN SEA WATER COOLING PUMP STBD AFT	TBC

Existing automated failsafe systems based on motor current and discharge pressure is to be disabled.

3.3.1 SW VFD implementation

The VFDs for the SW pumps will be controlled by the IAS via Profibus-DP communication. The motor speed will be determined by a temperature controller integrated in the VFDs software. The Temperature setpoint will be given to the VFD by IAS. This temperature function in the VFD will be set to a default temperature of 36 °C. The VFD will be connected to the relevant TT sensor in series with IAS, giving both the VFD and IAS access to the same TT.



3.3.1.1 SW VFD and du/dt filter spec

ABBVariable frequency drive IP55	ACS880-01-098A-7 Profibus Card: FPBA-01 Thermistor protection: FPTC-01 DNV Product certificate PC Marine installation kit EMC filter
ABB external du/dt filter IP22	FOCH0260-72

3.3.1.2 SW VFD IO

IO	Description	Comment
AI2	FW Temperature Transmitter	4-20mA

3.3.2 IAS Control and monitoring

The IAS indicates the operating mode of the pump and alarm at start of the back-up pump. The IAS will be able to change the output temperature of the freshwater manually. This change in temperature will be sent to VFD and the VFD will act accordingly.

3.3.3 BLACK-OUT RECOVERY

In the case of a black-out, the existing automatic sequential start up system will act as prior to the changes in the system. On restart after blackout the pumps running prior to blackout will start up again and operate at the default setpoint.

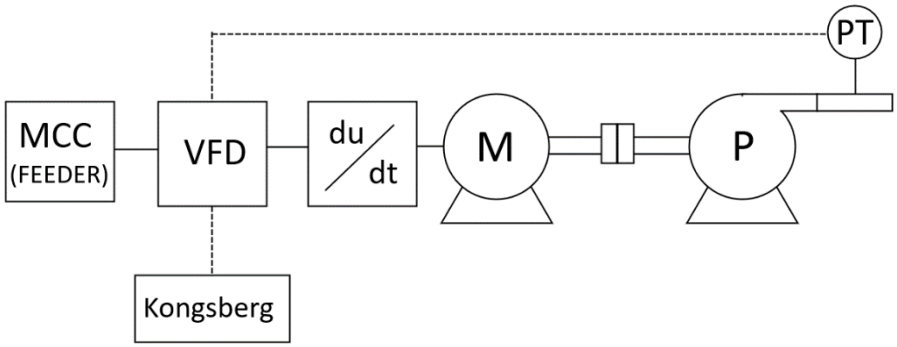
3.4 Changes to main freshwater cooling pump

There are eight main freshwater cooling pumps. Two in each pump room. VFDs will be implemented on the FW pumps to actively regulate the flow of the FW based on the flow needed by the consumers in the system.

Tag	Description	Disch. PT
722-PA-001A	FRESH WATER COOLING PUMP PORT FWD	722-PT-103
722-PA-001B	FRESH WATER COOLING PUMP PORT FWD	722-PT-106
722-PA-001C	FRESH WATER COOLING PUMP STBD FWD	722-PT-203
722-PA-001D	FRESH WATER COOLING PUMP STBD FWD	722-PT-206
722-PA-002A	FRESH WATER COOLING PUMP PORT AFT	722-PT-303
722-PA-002B	FRESH WATER COOLING PUMP PORT AFT	722-PT-306
722-PA-002C	FRESH WATER COOLING PUMP STBD AFT	722-PT-403
722-PA-002D	FRESH WATER COOLING PUMP STBD AFT	722-PT-406

3.4.1 FW VFD implementation

The VFDs for the FW pumps will be controlled by the IAS via Profibus-DP communication. The motor speed will be determined by a pressure controller integrated in the VFD software. The pressure setpoint will be given to the VFD by IAS. The pressure controller in the VFD will be set to a default pressure of 7.2Bat. The VFD will be connected to the relevant PT sensor in series with the IAS, giving both the VFD and IAS access to the same PT data.



3.4.1.1 FW VFD and du/dt filter spec

ABBVariable frequency drive IP55	ACS880-01-142A-7 Profibus Card: FPBA-01 Thermistor protection: FPTC-01 DNV Product certificate PC Marine installation kit EMC filter
ABB external du/dt filter IP22	FOCH0260-72

3.4.1.2 FW VFD IO

IO	Description	Comment
AI1	Cabinet PT100	ohm
AI2	FW Pressure Transmitter	4-20mA
XR01	Fan 1	Relay
XR02	Fan 2	Relay

3.4.2 IAS Control and monitoring

The IAS indicates the operating mode of the pump and alarm at start of the back-up pump. The IAS will be automatically changing the output pressure of the freshwater pump based on if the cement package is active or not. The control room operator will be able to change the pressure manually, but it is recommended that the pump operates with the automated pressure control.

The existing automated failsafe systems based on motor current will be disabled. Failsafe systems regarding discharge pressure on the pump will have to be adapted to operate between 7Bar and 10Bar.

3.4.3 BLACK-OUT RECOVERY

In the case of a black-out, the existing automatic sequential start up system will act as prior to the changes in the system. On restart after blackout the pumps running prior to blackout will start up again and operate at the default setpoint.

4 Changes to HP MUD Pump

There are four high pressure drill fluid pumps. The FW cooling system consists of two valves one for pump A and B, and one for C plus D. We will get the running signal from the mud pump drives to the IAS and will using the running signal as an indicator to control the already existing valves.

Tag	Description	Cooling Circuit Valve
325-BK-101-A	HIGH PREASSURE MUD PUMP A	Valve-1 TBC
325-BK-101-B	HIGH PREASSURE MUD PUMP B	Valve-1 TBC
325-BK-101-C	HIGH PREASSURE MUD PUMP C	Valve-2 TBC
325-BK-101-D	HIGH PREASSURE MUD PUMP D	Valve-2 TBC

4.1 IAS Control and monitoring

The valves will open instantly on running signals from the respective mud pumps drives, and for closing the valve, there is a timer that initiates the closing after the respective pumps have been offline for a specified amount of time. This time variable should be possible for us to control so it's not that important to specify yet.

The IAS indicates the operating mode of the mud pumps, and status of the hydraulic valves in the respective cooling circuits. In the case of a failure, the control IAS is to activate an alarm in the control system.

The operator can manually control the valve position.

5 Changes to anchor winch cooling circuit

There are four different anchor winches, each one consists of an individual cooling circuit with a heat exchanger. We will be adding a Temperature transmitter on each of the systems, to determine if there is a need for external cooling. We will also be adding a pneumatic actuator controlled by a digital signal from the IAS.

Tag	Description	Freshwater TT
431-OJ-001-A	DYNAMIC BREAK ANCHOR WINCH A	TBC
431-OJ-001-B	DYNAMIC BREAK ANCHOR WINCH B	TBC
431-OJ-001-C	DYNAMIC BREAK ANCHOR WINCH C	TBC
431-OJ-001-D	DYNAMIC BREAK ANCHOR WINCH D	TBC

5.1 IAS Control and monitoring

The IAS will control the pneumatic actuator depending on measurements from a temperature sensor. The pneumatic actuator will set the valve to either fully open or fully closed state. The setpoint for the system will be able to be changed from the IAS.

Some form of hysteresis will also have to be implemented to limit wear and tear on the valve and system.

5.1.1 Actuator

The actuator used to open and close the valve will be a single acting pneumatic quarter turn actuator with a positional feedback signal.

5.1.2 Temperature transmitter

We will be adding a new temperature transmitter on the rolls Royce side of the cooling system.

Suggested temperature transmitter:

- ABB TSP341-N - non-invasive temperature sensor (4-20mA)

5.1.3 Fail-safe

The actuator is spring loaded and will be set to have the valve normally open, so that in the event of signal loss, power loss, pressure loss in the pneumatic actuator or if the positional sensor of the valve does not correspond with the valves current setpoint, the valve will always be open to prevent damage on the anchor winch due to lack of cooling. This event will also send an alarm to the IAS monitoring system.

6 Changes to break resistor cooler

There are four break resistor coolers, each connected to a separate freshwater cooling circuit. Temperature sensors are located within each of the coolers. Each cooler has two butterfly valves located at the suction and discharge side. The butterfly valves have gear boxes, which effectively makes them multi-turn valves. The existing gearboxes will be removed on discharge side.

Valve type: Butterfly Quarter Turn (rotary control valve)

Actuator Type: Pneumatic quarter turn (single acting)

Actuator feedback: Variable position feedback

Temperature sensor: Unknown

Tag	Description	TT tag.	Valve tag.
866-EY-010	BREAK RESISTOR COOLER PORT FWD	TBC	TBC
866-EY-020	BREAK RESISTOR COOLER STBD FWD	TBC	TBC
866-EY-030	BREAK RESISTOR COOLER PORT AFT	TBC	TBC
866-EY-040	BREAK RESISTOR COOLER STBD AFT	TBC	TBC

6.1 IAS Control and monitoring

Butterfly valves are controlled by pneumatic actuators and corresponding position controllers (for single-acting pneumatic actuators) to actively regulate for the temperature in the system.

The operator can manually control the valve position.

6.1.1 Actuator

The single acting pneumatic actuator controls the quarter turn butterfly valve. The actuator can be controlled by a set point position with a position controller. The actuator is spring loaded which is configured to be normally open in the case of loss in power or loss in actuator input pressure.

6.1.2 Actuator Position Controller

The actuator position controller regulates the actuator to a set position. The position controller receives setpoint from temperature controller from IAS.

6.1.3 Temperature controller

Active regulation of the temperature in the IAS, by implementing a simple PI controller. The system will aim to maintain a constant operating temperature of x °C.

6.1.4 Fail-safe

The single acting pneumatic actuator is spring loaded and will be configured to have the valve normally open. In the event of signal loss, power loss, pressure loss in the pneumatic actuator the actuator will return to a fully open state. This is to prevent damage on the break resistors due to lack of cooling in the case of system failure. This event will also send an alarm to the IAS monitoring system.

7 Changes to cement package

The cement package consists of an individual cooling circuit with a heat exchanger. We will be adding a pneumatic controlled actuator to the existing valve. The Schlumberger system to adjust the required cooling from the central cooling system based on demand.

Tag	Description	Valve
371- B1001	CEMENT PACKAGE	TBC

7.1 Schlumberger Control and monitoring

Schlumberger will be Implementing a temperature controller on the cement package that control the flow from the central cooling system to the cement package. The schlumberger system will have to send a running signal to the IAS when it is active to indicate that the setpoint FW pump outlet pressure needs to be increased.

7.1.1 Temperature controller

The cement package has an integrated temperature sensor and heat exchanger. This temperature sensor will be used to control a pneumatic actuator which will open when the internal cooling system reaches a temperature of x and close when it reaches a temperature of 40 °C. This will account for the hysteresis in the system.

7.1.2 Actuator

The actuator used to open and close the valve will be a single acting pneumatic quarter turn actuator with a positional feedback signal.

7.1.3 Fail-safe

The actuator will be spring loaded and set the valve to be normally open, so that in the event of signal loss, power loss, pressure loss in the pneumatic actuator or if the positional sensor of the valve does not correspond with the valves current setpoint, the valve will always be open to prevent damage on the cement unit due to lack of cooling. This event will also send an alarm to Schlumberger's monitoring system.

The signal to the IAS is digital high when the system does not require the IAS to increase the setpoint. In the case of communication loss the IAS will automatically adjust the setpoint FW pump outlet pressure.

8 Establish routines for chiller units.

We will establish routines to close the main chiller units for the colder temperature periods when the chiller units are inactive. This is relevant for the following units:

Tag	Description	Valve tag.
571-HE-001-A	CHILLER UNIT A, PORT FWD	TBC
571-HE-001-B	CHILLER UNIT B, STBD FWD	TBC