Engine Room Simulator

ERS M22 10 PC4 - Ferry

Operator's Manual

Part 3

Machinery & Operation

TABLE OF CONTENTS

The Process diagrams presented on the monitors have the following colour codes for pipelines:

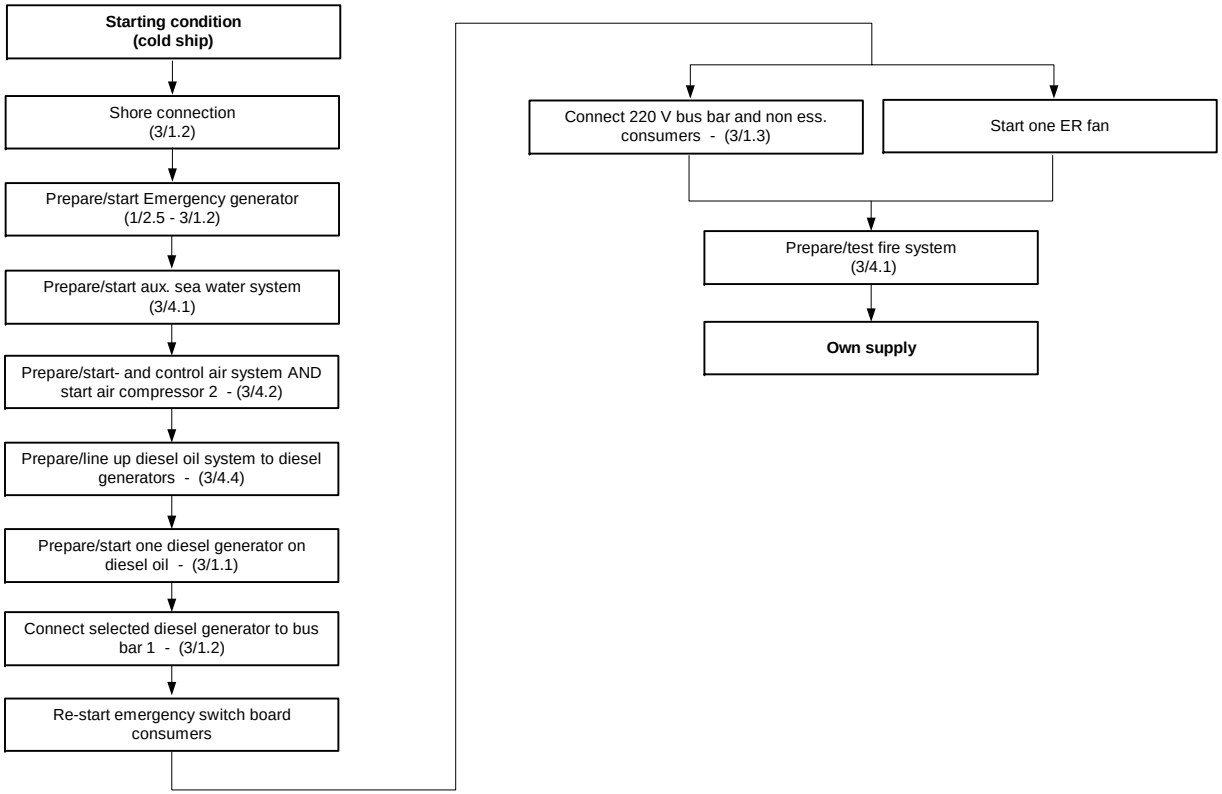
- Blue: Fresh water (low and high temperature)
- Green: Sea water
- Yellow: Diesel oil
- Brown: Fuel oil
- Light brown: Lubrication oil
- Grey: Start and service air
- Light blue: Steam

The Process Diagrams are abbreviated T, G, P, etc.; meaning:

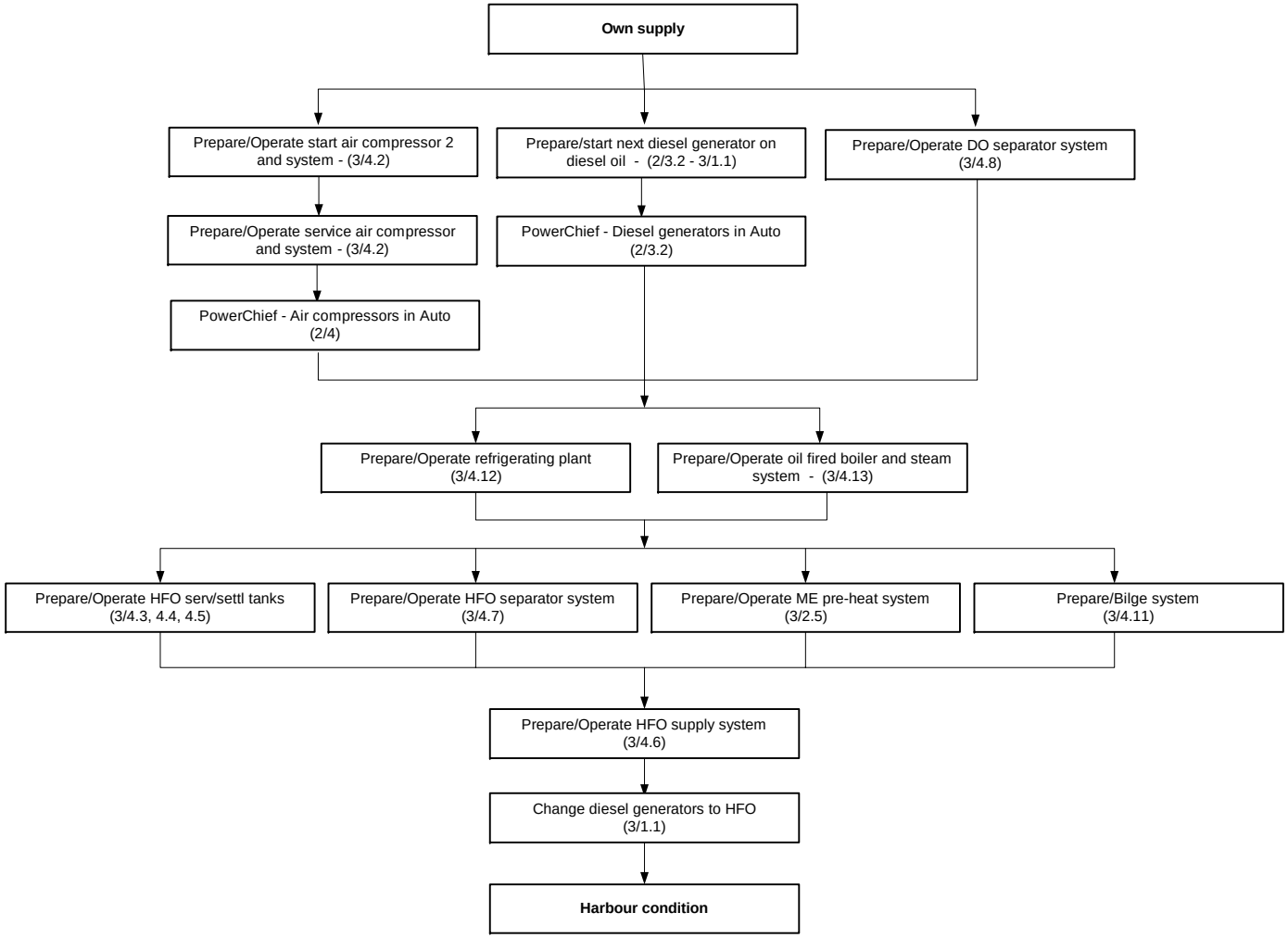
T: Temperature
G: Flow
P: Pressure
N: Rpm
Q: Power
I: Ampere
U: Voltage
F: Frequency
E: Electrical power
V: Valve
L: Level
X: Miscellaneous variable
Z: Water or other undesirable contamination index variable
W: Viscosity

1 SEQUENCE DIAGRAMS

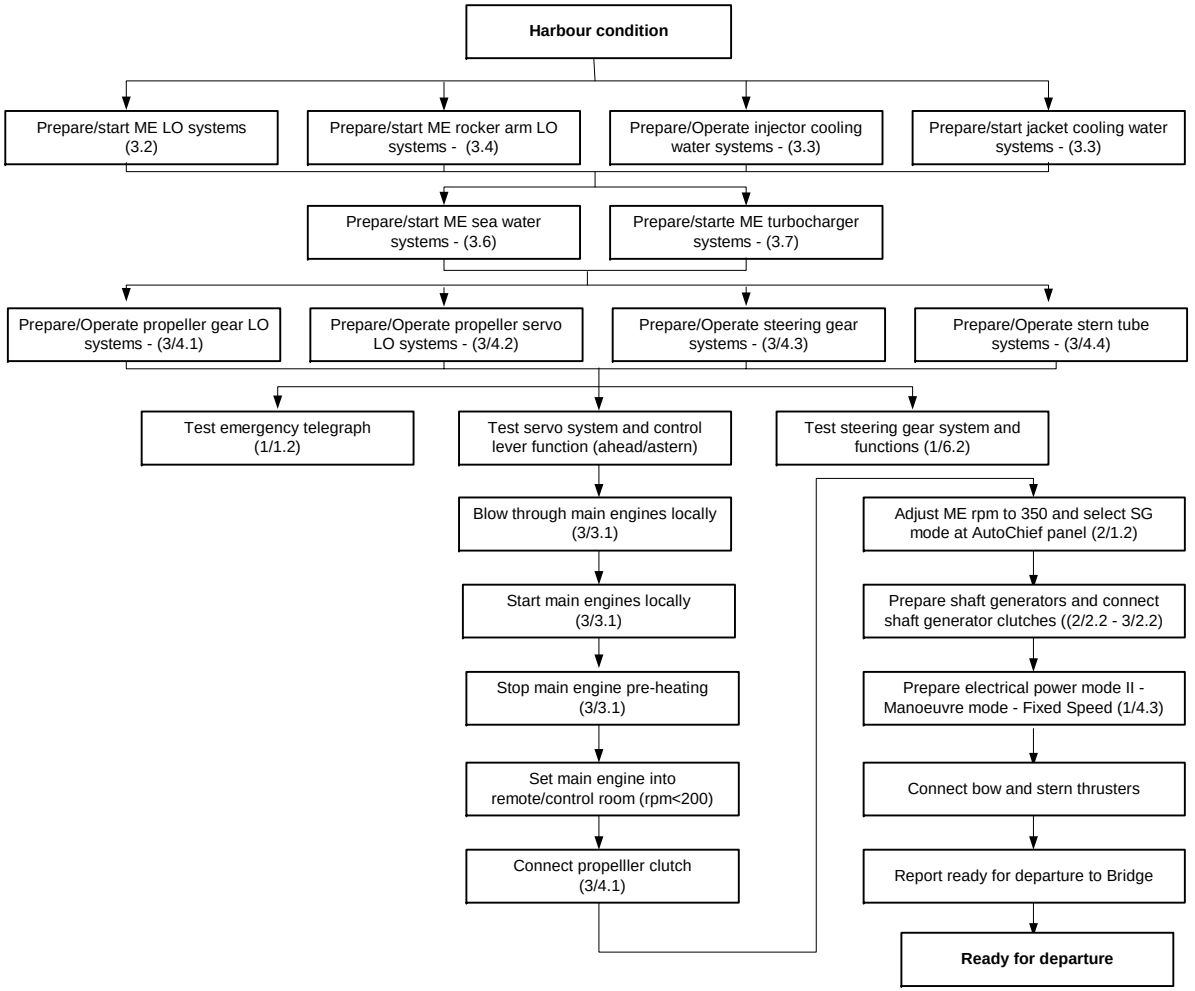
1.1 Cold ship to own supply



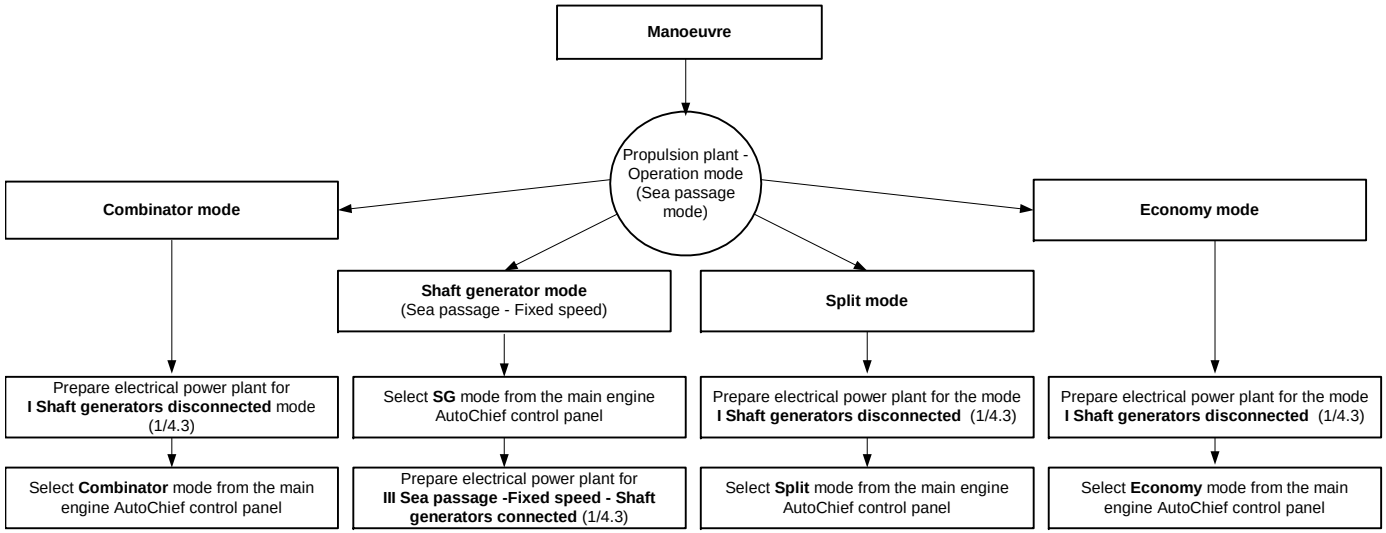
1.2 Own supply to harbour condition

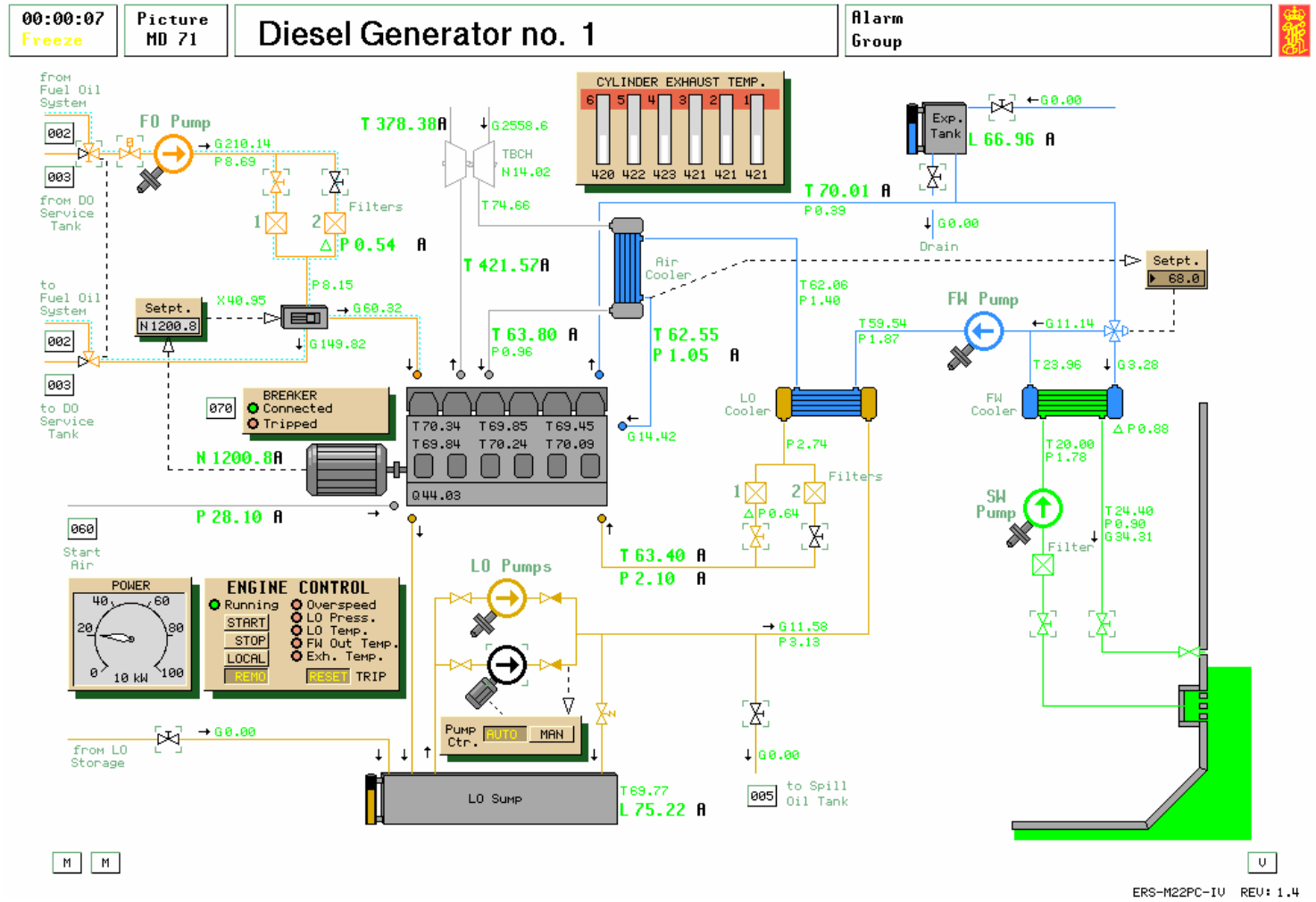


1.3 Harbour condition to ready for departure



1.4 Manoeuvre mode to sea passage mode




00:00:07
Freeze
Picture
MD 71
Diesel Generator no. 1
Alarm
Group
CYLINDER EXHAUST TEMP.
6 5 4 3 2 1
420 422 423 421 421 421
from Fuel Oil System
002
003
from DO Service Tank
to Fuel Oil System
to DO Service Tank
FO Pump
G210.14
P8.69
Filters
P 0.54 A
P8.15
T 378.38A
G2558.6
TBCH
N14.02
T74.66
T 421.57A
Air Cooler
T 70.01 A
P0.39
Exp. Tank
L 66.96 A
G0.00
Drain
Setpt.
68.0
Setpt.
N1200.8
X40.95
G60.32
G149.82
T 63.80 A
P0.96
T 62.55
P 1.05 A
T62.06
P1.40
T59.54
P1.87
FW Pump
G11.14
T23.96
G3.28
FW Cooler
P0.88
T20.00
P1.78
070
BREAKER
Connected
Tripped
T70.34 T69.85 T69.45
T69.84 T70.24 T70.09
Q44.03
G14.42
LO Cooler
P2.74
Filters
P0.64
N 1200.8A
P 28.10 A
060
Start Air
T 63.40 A
P 2.10 A
SW Pump
Filter
T24.40
P0.90
G34.31
POWER
10 kW
ENGINE CONTROL
Running
START
STOP
LOCAL
REMO
Overspeed
LO Press.
LO Temp.
FW Out Temp.
Exh. Temp.
RESET
TRIP
LO Pumps
G11.58
P3.13
Pump Ctr.
AUTO
MAN
from LO Storage
G0.00
LO Sump
T69.77
L 75.22 A
005
to Spill Oil Tank
M
M
U
ERS-M22PC-IU REV: 1.4

2 ELECTRICAL PLANT

2.1 Diesel Generators

General

The ship is equipped with two 600 kW/880A/440 V/60Hz/1200 rpm synchronous main generators. Each generator is driven by a turbocharged, four-stroke, 6-cylinder auxiliary diesel engine (DG1 and DG2).

The auxiliary diesel engines are equipped with separate, integrated systems for cooling water and lubrication oil.
The diesel engines are designed for both diesel and heavy fuel oil operation (700 cSt).
In order to prevent carbonising and heavy smoke emission during low load, the fresh water cooling system is arranged in such a way that the scavenge air is heated during low load.

Description

The engine is equipped with a shaft driven fuel oil pump. The pump takes suction either from the fuel oil supply system or direct from the diesel oil service tank. Shifting between diesel oil and fuel oil is carried out by means of the double 3-way valve, shifting both supply and return direction. The fuel oil pump discharges to the high-pressure pump header through a duplex filter. Surplus oil is returned to the diesel oil service tank or the fuel oil service tank depending on the position of the double 3-way valve.

The lubrication system is equipped with an electrical oil pump and a shaft driven main lubrication oil pump. The electrical pump serves as a pre-lubrication oil pump and as a stand by oil pump in case of break down of the shaft driven main pump. The pumps take suction from the diesel engine lubricating oil sump and discharge though a seawater cooled oil cooler and a dublex filter. The oil sump can be refilled from the lubricating oil storage and the oil charge can be drained to the spill oil tank by using the electrical oil pump.
The electrical oil pump can be operated in manual or in automatic mode.

Seawater for low temperature cooling is provided by a shaft driven sea water pump.

A shaft driven fresh water circulating pump circulates fresh cooling water through the lubricating oil cooler, the scavenging air cooler/heater, cylinder jackets, and the fresh water cooler. The temperature is controlled by a simple proportional controller, controlling the temperature at inlet cylinder jackets.

The governor (rpm controller) settings are available in a pop-up window with the following variables:

- Speed-droop (speed controller droop setting): Default setting = 50%, which represents a speed, droop approx. 2%. 100 % = approx. 4% speed droop.
- Speed set point (basic speed at unloaded engine): Default setting = 1212 rpm.
- Load limit (speed controller max. Output limit): Default setting for the "maximum fuel lever position" = 100%.
- Compensation lever (speed controller gain): Default setting for the proportional gain is set to 12.
- Compensation valve (speed controller integral time): Default setting = 0,6 seconds.
- The governor response at different settings can be studied by means of the pop-up TREND window.

NOTE! Frequency regulation stops when the Engine is overloaded (when alarm is activated).

The FW temperature controller is a proportional gain controller with BIAS setting. BIAS default setting is 50%, which means that 50% is added. (Deviation * P-Gain) + BIAS = Output.

The pre-lubrication pump: Interval lubrication with default setting: 3 seconds on and 60 seconds off. The pre-lubrication pump will stop when the diesel starts, if lubrication oil pump control is set to AUTO, and start when the diesel engine stops.

The Engine Control Panel has the following functions and indications:
- Selection of local/remote control of engine
- Start/stop of engine
- Trip indications
- Reset of trip

Safety System

The diesel engines are equipped with a separate, independent safety system acting as a back-up system to the safety system of the PowerChief. The system monitors the engine condition by binary sensors and includes the following adjustable parameters:

Parameter	**Normal setting**
Over speed	112%
Low Lub Oil Pressure	0,6 bar
High Lub Oil Temp.	85^{o}C
High fresh water Temp.	96^{o}C
High Exhaust Temp.	700^{o}C

If one of the parameters is exceeded the diesel engine will shut down and a trip alarm is given. A lamp at the local panel indicates the trip condition. To restart the engine the cause must be found and corrected and the safety system must be reset by pushing the RESET button.
The trip limits can be inspected and changed from the variable page.

An electrically operated shut-off valve in the fuel oil supply line may be operated from the Remote Emergency Operating Panel in case of fire.

Operation procedure

1. Preparation and starting procedure

1.1 Check level in the fresh cooling water expansion tank and refill if necessary.
1.2 Check that the fresh water temperature controller is working and in AUTO – normal set point is 75-80°C.
1.3 Open sea water pump suction valve from sea chest.
1.4 Open sea water discharge valve (overboard after cooler)
1.5 Check level in lubricating oil sump tank, (min 40%) - refill from storage tank if necessary.
1.6 Line up lubrication oil system. Normally one filter is in operation and one filter is cleaned and stand by.
1.7 Ensure that lubrication oil valve to spill oil tank is closed.
1.8 Start the electrically driven lubricating oil pump (pre-lubrication oil pump), and check that the oil pressure is increasing.
1.9 Set the electrical lubricating oil pump in AUTO mode by pressing the AUTO button on the PUMP. CTR. panel.
1.10 Check water level in the fuel oil service tanks and drain if necessary.
1.11 Ensure that fuel oil supply valve from diesel oil and/or fuel oil system to generator engine is open.
1.12 Open fuel oil inlet valve to fuel oil pump.
1.13 Open fuel oil valve before fuel oil filters. Normally one filter is in operation and one filter is cleaned and stand by.
1.14 Check the position of the fuel oil supply 3-way valve.
1.15 Open start air valves. Start air must be at least 15 bar (218 psi) on the starting air line.
1.16 If any of the alarm lamps (red) at the local panel are lit, press the RESET button.
1.17 Start the engine from the local panel by pressing the START button.

IMPORTANT: Local safety trip functions must be checked regularly and if engine has had major overhaul or has been out of operation for a longer period.
If the button REMOTE on the ENGINE PANEL is activated, and the pre-lubrication oil pump is in AUTO the diesel generators may be started from the "PowerChief" panel or from IN button on the main switch board (S/S button – Electrical Power Supply).

2. Connecting the generator

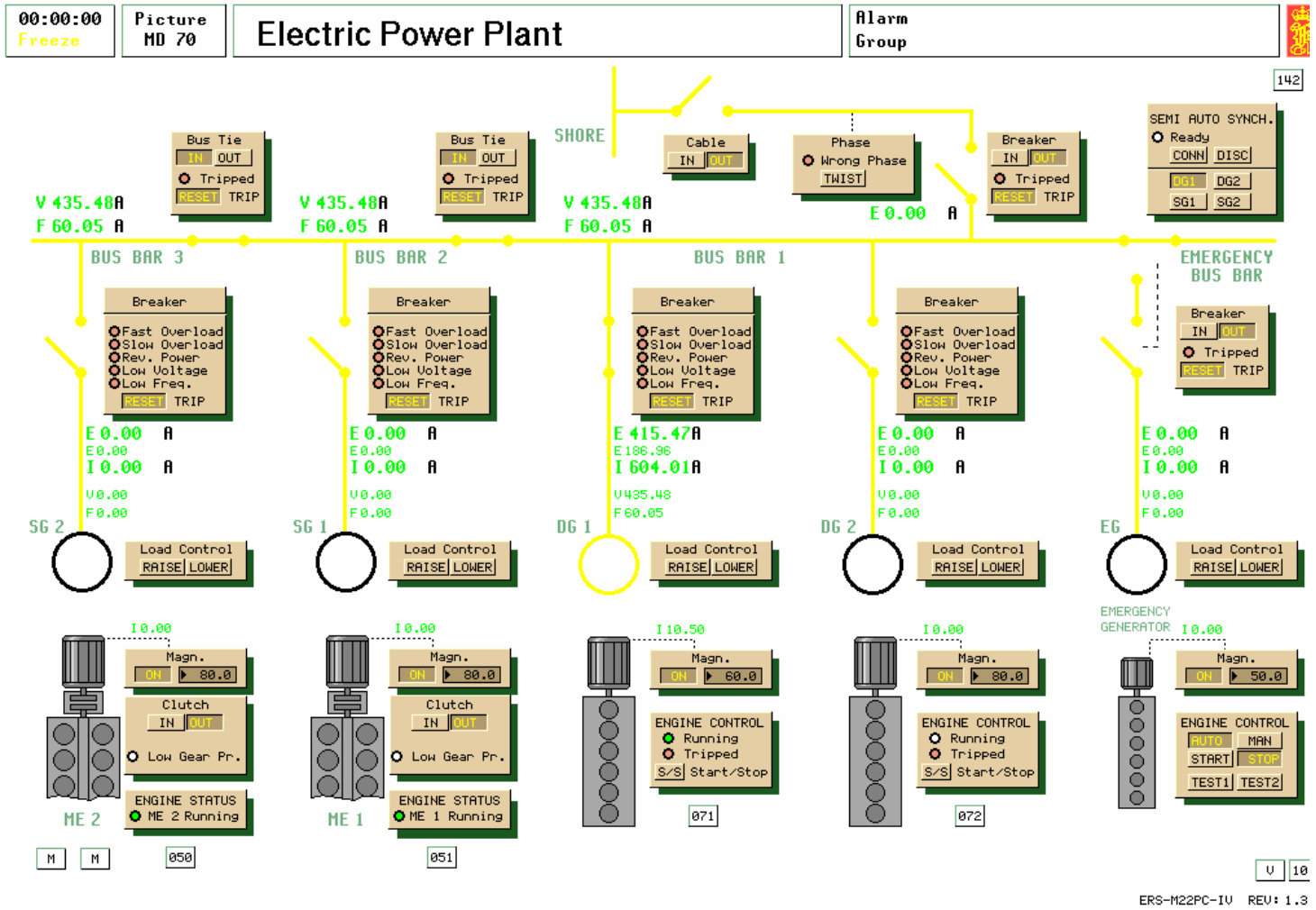
2.1 The generator may be synchronised and connected manually, semi-automatic or from the PowerCheif-Generator Control panel.
2.2 If the generator is to be synchronised and connected from the PowerChief – Diesel Generator panel the engine must be set in REMOTE at the local ENGINE PANEL and the pre-lubrication pump must be in AUTO.

3. Diesel and fuel oil operation

3.1 The diesel engines may be started, operated, and stopped on heavy fuel oil if steam pressure is present.
3.2 Before the engine is stopped for maintenance, the engine must be operated on diesel oil for at least 15 minutes.

Model particulars

Studies of the diesel engines' behaviour while running in parallel, with different governor settings are recommended.


00:00:00
Freeze
Picture
MD 70
Electric Power Plant
Alarm
Group
142
SHORE
Cable
IN OUT
Phase
Wrong Phase
TWIST
Breaker
IN OUT
Tripped
RESET TRIP
SEMI AUTO SYNCH.
Ready
CONN DISC
DG1 DG2
SG1 SG2
Bus Tie
IN OUT
Tripped
RESET TRIP
V 435.48A
F 60.05 A
E 0.00 A
BUS BAR 3
BUS BAR 2
BUS BAR 1
EMERGENCY
BUS BAR
Fast Overload
Slow Overload
Rev. Power
Low Voltage
Low Freq.
E 0.00 A
E0.00
I 0.00 A
V0.00
F0.00
E 415.47A
E186.96
I 604.01A
V435.48
F60.05
SG 2
SG 1
DG 1
DG 2
EG
Load Control
RAISE LOWER
I0.00
I10.50
Magn.
ON 80.0
ON 60.0
ON 50.0
Clutch
IN OUT
Low Gear Pr.
ENGINE STATUS
ME 2 Running
ME 1 Running
ENGINE CONTROL
Running
Tripped
S/S Start/Stop
AUTO MAN
START STOP
TEST1 TEST2
ME 2
ME 1
EMERGENCY
GENERATOR
M M
050
051
071
072
V 10
ERS-M22PC-IV REV: 1.3

2.2 Electrical Power Plant

General

The ship's electric power is generated by:

- two 600 kW/880A/440 V/60Hz/1200 rpm diesel engine driven synchronous generators - diesel generator 1 (DG1) and diesel generator 2 (DG2).
- two 600 kW/880A/440 V/60Hz/1200 rpm kW propeller shaft driven synchronous generators - shaft generator 1 (SG1) and shaft generator 2 (SG2), driven via the port and the starboard main propeller gear respectively.
- one 180 kW/440 V/60Hz emergency generator.

and distributed via:

- one main switchboard, divided into three main 440V bus bars
- one 220 lightning bus bar
- one emergency bus bar

Bus bar 1 powers all the electrical main consumers and the emergency bus bar.
Bus bar 2 powers the stern thruster and the heavy deck consumer's switchboards.
Bus bar 3 powers the bow thruster and other miscellaneous consumers.

The 220 V lightning bus bar is supplied from bus bar 1 via the lightning bus bar circuit breaker and two transformers.

Description

(Please also refer to part 1 Vessel and Machinery – Main Particulars)
The electrical power system is designed for four operation modes.

I. Shaft generators disconnected
II. Manoeuvre mode – Fixed speed
III. Sea passage – Fixed speed - Shaft generators connected
IV. Sea passage – Diesel generators connected

I Shaft generators disconnected

a) Shaft Generators disconnected
b) One or two diesel generators power all three bus bars, which are connected by the tie-line breakers.
c) This mode is normally used during:
   - Harbour, main engine stopped.
   - Sea passage with main engines in combinator mode.

II Manoeuvre mode – Fixed speed

a) Shaft generators and thrusters connected
b) Tie-line breaker 1 and 2 are open.
c) Two diesel generators power main consumers via bus bar 1.
d) Shaft Generator 1 powers the stern thruster.
e) Shaft Generator 2 powers the bow thruster and the heavy consumers.
f) Main engines are operated in Shaft Generator mode.

III Sea passage – Fixed speed - Shaft generators connected

a) Diesel generators disconnected.
b) Tie-line breaker 2 is open.
c) Shaft generator 2 powers bus bar 3.
d) Tie-line breaker 1 is closed.
e) Shaft generator 1 powers the main consumers via bus bar 1.
f) Diesel generators are stopped and stand by.
g) Main engines are operated in shaft generator mode.

In this mode the pitch change rate is reduced in order to avoid too heavy frequency fluctuations. Thus, the manoeuvrability is reduced.

IV Sea passage – Diesel generators connected

a) High electrical load at bus bar 1.
b) Tie-line breaker 1 and 2 are open.
c) Two diesel generators power main consumers via bus bar 1.
d) Shaft Generator 1 powers bus bar 2.
e) Shaft Generator 2 powers the bus bar 3. Also one of the shaft generators may power both bus bar 2 and 3.
f) This mode is used during sea passage if high electrical load at bus bar 1.
g) Main engines may be operated in any of the four modes.

In the event of maintenance or breakdowns of one of the four generators other appropriate operation modes may be chosen.

NOTE!
The shaft generator and the diesel generators must only be operated in parallel during synchronising and load transfer. Two shaft generators may never be operated in parallel.

The load sharing between the two diesel generators are primary controlled by the characteristic (speed-droop) of the governors and secondary by the PowerChief Generator Control.
The frequency is primary controlled by the characteristic of the governors and subsequently adjusted by of the automatic frequency controller (if active).
The bus bar voltage and reactive load sharing between generators must be adjusted by trimming the generator magnetisation.

Generator breakers

Each generator circuit breaker is equipped with the following automatic and adjustable trip functions:

- Slow overload current, (> I), i.e. overload current
- fast overload current, (>>I), i.e. connection shock e.g. due to incorrect phase sequence when connecting
- low voltage
- low frequency
- reverse power

If an attempt is made to parallel a generator to other generators in wrong phase sequence condition, the generator circuit breakers of the connected generators will trip due to connection shock (fast overload).

Operation procedure

1. Shore power

1.1 Bus bar 1 is supplied from shore connection via the shore cable and the shore connection circuit breaker. The maximum electric load obtained via the shore connection is **280 kW**

1.2 To connect shore cable press IN button on the CABLE panel.

1.3 If the phase is wrong (Indicated by WRONG PHASE lamp on PHASE panel), correct the order by pressing the button TWIST. (Normally a wrong phase order is corrected by interchanging the connecting points of two of the shore cable wires.)

1.4 If the breaker is tripped (TRIPPED lamp on shore BREAKER panel lit), press the RESET button.

1.5 Press button IN on the shore BREAKER panel to connect shore cable to bus bar 1.

NOTE:

- The shore breaker and the generator breakers can never be connected simultaneously.
- Often shore power frequency is 50 hertz, while ship's power frequency is 60 hertz.

2. Shifting from shore connection to ship's own electrical power supply

2.1 Diesel engine to be started from the local engine panel. If the diesel engine has been set in REMOTE control at the local engine panel, the engine may also be remote started by pressing the start/stop (S/S button) at the main switch board generator panel or from the PowerChief – Generator Control panel.

2.2 When shifting from shore supply to ship's own supply the breaker of the generator to be connected first is to be manually connected.

2.3 Ensure that "magnetisation" is ON at the generator section of the running generator and check the voltage.

2.4 Adjust frequency by the RAISE/LOWER button on the LOAD CONTROL panel until the reading of the network frequency is slightly above 60 Hz (0-1 Hz)

2.5 Disconnect the shore breaker. Interlock prevents the shore breaker and the generator breakers to be connected simultaneously.

2.6 Connect the generator breaker.

2.7 If tripped, reset the BREAKER panel by pressing the button RESET on the BREAKER panel and retry connection of the breaker.

2.8 Readjust the frequency, if necessary.

2.9 If the emergency generator is in AUTO mode it will automatically start, connect, and supply the emergency switchboard when the shore breaker is opened. The emergency generator is automatically disconnected when the diesel generator takes over supply.

3. Connecting procedure for the second generator

3.1 The second generator can be connected to the main bus bar as soon as the electrical load is sufficient for two generators.

3.2 After starting, the diesel engine the generator breaker may be connected manually, by semi-automatic or from the PowerChief – Generator Control panel.

4. Connecting procedure for the shaft generator

4.1 The shaft generator can be connected to the bus bar as soon the SG mode for the main engine has been selected from the AutoChief panel.

4.2 Engage SG clutch locally or remote from the main switchboard.

4.3 Synchronise and connect the shaft generator breaker.

4.4 Operate tie line breaker to split bus bar – shaft generator must only be paralleled with diesel generators during synchronising and load transfer.

The generator breaker may be connected manually, by semi-automatic or from the PowerChief – Generator Control panel.

5 Semi-automatic synchronising – generator breakers

5.1 The engines may be remotely started from the switchboard panel if REMOTE has been selected at the local engine panel.

5.2 Press the button RESET on the BREAKER panel, if necessary.

5.3 Select generator to be connected at the Semi-Auto Panel.

5.4 Adjust voltage and frequency until Ready lamp is lit.

5.5 Press connect button.

5.6 Generator will automatically synchronise and connect within 180 sec. (default)

If the breaker is not connecting, fine adjustment of frequency and voltage may be necessary until breaker connects.
The limits for ready signal and for connection can be viewed and adjusted from the variable page 7005.

Recommended settings are (VP 7005):

Synchronisation - Time limit:	180 sec
Ready lamp indication - frequency:	
- Low freq	0,00 Hz
- High freq	0,10 Hz
Connect:	
- Low freq limit	0,00 Hz
- High freq limit	0,10 Hz
Ready lamp indication - voltage	
– Low voltage (generator)	440 V
– High voltage (generator)	450 V
- Diff. Voltage (bus bar)	0.00 V (below)
- Diff. Voltage (bus bar)	+10.0 V (above)

6. Emergency generator supply

6.1 In the event of low voltage at bus bar 1 the following sequence will take place, provided that the emergency generator is in AUTO:
   a) The emergency generator is started
   b) The emergency tie-line breaker is opened
   c) The emergency generator breaker connects the emergency generator to the emergency bus bar.

6.2 When the voltage at bus bar 1 is re-established the sequence is:
   a) The emergency generator circuit breaker is disconnected
   b) The emergency tie-line breaker is closed and the emergency generator stops after a few minutes of idling.

7. Emergency generator TEST

7.1 The emergency switchboard is equipped with a TEST button.

7.2 The TEST function is used when testing the emergency generator auto function. If the TEST button is activated a zero-voltage at bus bar 1 is simulated. The emergency generator will start, the emergency tie-line breaker is opened and the generator will connect provided that the emergency generator is in AUTO. A lamp indicates when the test function is active.

7.3 When pressing the TEST button again the test function is cancelled and the power supply from bus bar 1 to emergency bus bar is re-established.

7.4 If the emergency generator is not in AUTO it may be manually started and connected.

7.5 The emergency tie-line breaker and the emergency generator circuit breaker are interlocked, i.e. the emergency generator circuit breaker cannot connect unless the emergency bus bar tie-line breaker is open and vice versa.

7.6 The TEST function may also be used if emergency generator is to supply to the emergency bus bar independently of bus bar 1.

NOTE: It is not possible to run the emergency generator in parallel with the main generators.

Model particulars

- The reverse current protection takes place
- If the generator's prime mover is shut down the generator breaker is disconnected by the reverse current protection function. If not disconnected the generator will function as an electric motor driving the prime mover.
- “Bus bar shock” is most likely caused by a very rough connection of a generator or wrong phase sequence.
- The load at bus bar 3 is calculated according to the actual stern thruster load. The instructor can set the variable “heavy consumers load” from variable pages.
- The load at bus bar 2 is calculated according to the actual bow thruster load. Additionally the instructor can set the variable via the variable pages.
- The load at bus bar 1 is a function of a base load variable, which can be set by the instructor and the calculated load from the main consumers.
- Additionally a number of fixed loads at each bus bar can be activated from the sim control variable pages
- The typical current increase during the starting phase of asynchronous electric motors is modelled.
- Some of the pumps are modelled in more details. The electrical load is computed from hydraulic load based on pump characteristic and operation condition.
- The lightning bus bar load is modelled as a variable base load – adjusted from the variable pages.
- The cable from shore can only be connected if the instructor has activated the “STOP SHIP” function (mooring condition).
- At cable connection, the electric phase will be chosen at random. A rotating light-wheel indicates the phase sequence. Clockwise rotation is correct. Pressing the “WRONG PHASE” button simulates a corrective phase change and the shore connection can be set.

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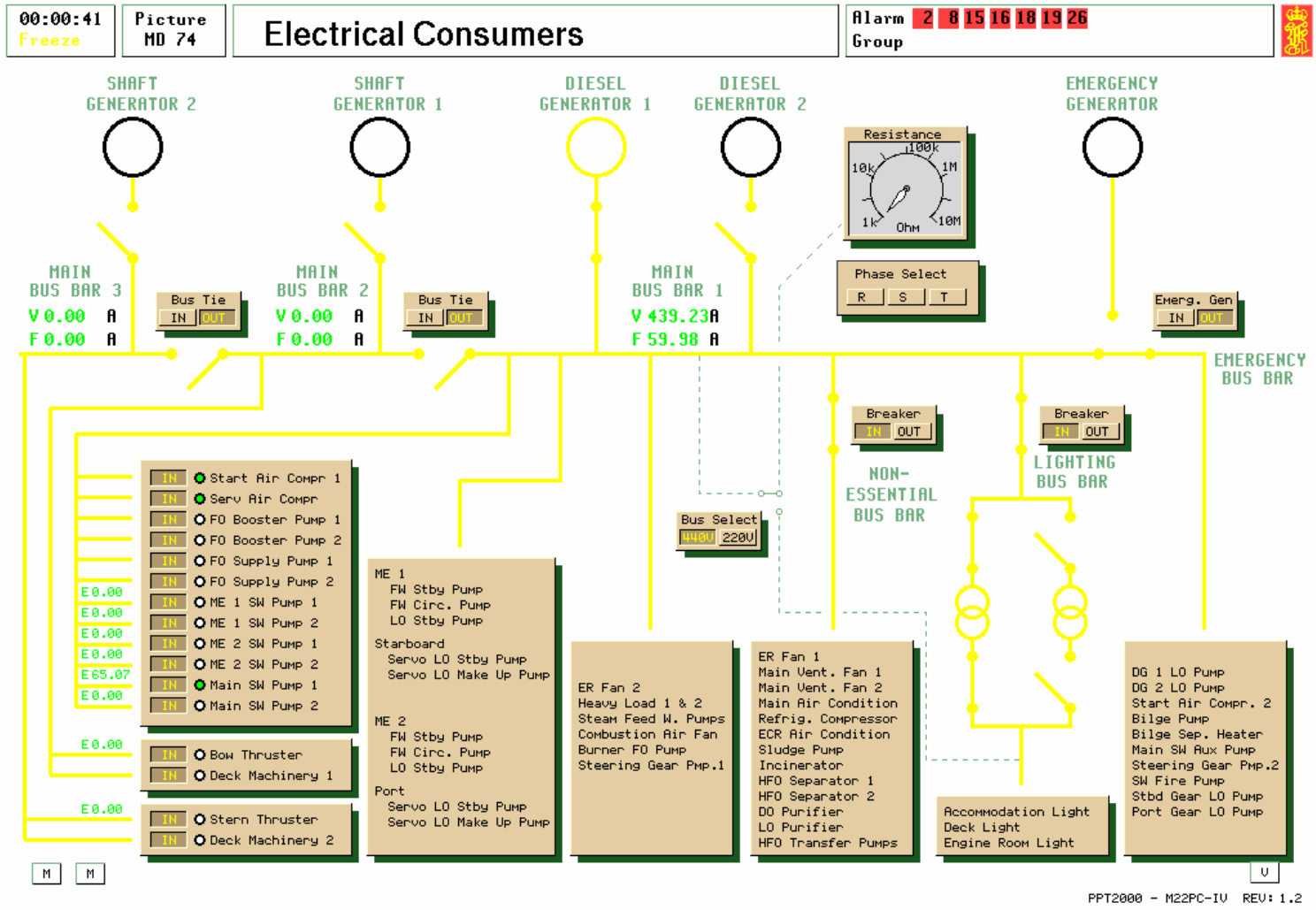
00:00:41
Freeze
Picture
MD 74
Electrical Consumers
Alarm 2 8 15 16 18 19 26
Group
SHAFT GENERATOR 2
SHAFT GENERATOR 1
DIESEL GENERATOR 1
DIESEL GENERATOR 2
EMERGENCY GENERATOR
Resistance
100k
10k
1M
1k
10M
Ohm
Phase Select
R S T
MAIN BUS BAR 3
V 0.00 A
F 0.00 A
Bus Tie
IN OUT
MAIN BUS BAR 2
V 0.00 A
F 0.00 A
Bus Tie
IN OUT
MAIN BUS BAR 1
V 439.23A
F 59.98 A
Emerg. Gen
IN OUT
EMERGENCY BUS BAR
Breaker
IN OUT
NON-ESSENTIAL BUS BAR
Breaker
IN OUT
LIGHTING BUS BAR
Bus Select
440V 220V
IN Start Air Compr 1
IN Serv Air Compr
IN FO Booster Pump 1
IN FO Booster Pump 2
IN FO Supply Pump 1
IN FO Supply Pump 2
E0.00
E0.00
E0.00
E0.00
E65.07
E0.00
IN ME 1 SW Pump 1
IN ME 1 SW Pump 2
IN ME 2 SW Pump 1
IN ME 2 SW Pump 2
IN Main SW Pump 1
IN Main SW Pump 2
E0.00
IN Bow Thruster
IN Deck Machinery 1
E0.00
IN Stern Thruster
IN Deck Machinery 2
M M
ME 1
FW Stby Pump
FW Circ. Pump
LO Stby Pump
Starboard
Servo LO Stby Pump
Servo LO Make Up Pump
ME 2
FW Stby Pump
FW Circ. Pump
LO Stby Pump
Port
Servo LO Stby Pump
Servo LO Make Up Pump
ER Fan 2
Heavy Load 1 & 2
Steam Feed W. Pumps
Combustion Air Fan
Burner FO Pump
Steering Gear Pmp.1
ER Fan 1
Main Vent. Fan 1
Main Vent. Fan 2
Main Air Condition
Refrig. Compressor
ECR Air Condition
Sludge Pump
Incinerator
HFO Separator 1
HFO Separator 2
DO Purifier
LO Purifier
HFO Transfer Pumps
Accommodation Light
Deck Light
Engine Room Light
DG 1 LO Pump
DG 2 LO Pump
Start Air Compr. 2
Bilge Pump
Bilge Sep. Heater
Main SW Aux Pump
Steering Gear Pmp.2
SW Fire Pump
Stbd Gear LO Pump
Port Gear LO Pump
V
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2.3 Electrical Consumers

General

The electrical power is distributed via bus bar 1, bus bar 2, bus bar 3, the emergency bus bar, and the lightning bus bar.

Tie-line breakers connect the three bus bars and the emergency bus bar.

The lightning bus bar is supplied from bus bar 1 via two 440/220 V transformers in parallel. Tie-line breakers can isolate each transformer. A manually operated breaker can disconnect the lightning bus bar.

The distributions of consumers on the bus bars are as follows:

Bus bar 1

Group 1
- Start air compressor 1
- Service air compressor
- FO Booster pump 1
- FO Booster pumps 2
- FO Supply pump 1
- FO Supply pump 2
- Main engine 1, sea water pump 1
- Main engine 1, sea water pump 2
- Main engine 2, sea water pump 1
- Main engine 2, sea water pump 2
- Main sea water pump 1
- Main sea water pump 2

Group 2

ME 1
- Jacket cooling water stand-by pump
- Jacket cooling water Circulation pump
- Lubricating oil stand-by pump
- Stbd servo lubricating oil pump
- Stbd servo make up pump

ME 2
- Jacket cooling water stand-by pump
- Jacket cooling water Circulation pump
- LO stand-by pump
- Port servo lubricating oil pump
- Port servo make up pump

Group 3
- Engine room fan 2
- Heavy load 1 & 2
- Steam feed water pumps
- Combustion air pumps
- Burner FO pump

- Steering gear pump 1

Group 4 – Non Essential Load

- Engine room fan 1
- Main ventilation 1
- Main ventilation 2
- Main ventilation air condition Plant
- Refrigerating compressor
- ECR air condition
- Sludge pump
- Incinerator
- HFO Purifier 1
- HFO Purifier 1
- DO Purifier
- LO Purifier
- HFO Transfer pump 1 and 2

220 V Lightning bus bar

– Accommodation light
- Deck light
- Engine room light

Bus bar 2

– Bow Thruster
– Deck machinery 1 (Heavy deck consumers, i.e. reefer container switch boards and deck crane)

Bus bar 3

– Stern Thruster
– Deck machinery 2 (Heavy deck consumers, i.e. reefer container switch boards and deck crane)

Emergency bus bar:

– DG 1 LO pump
– DG 2 LO pump
– Starting air compressor 2
– Bilge pump
– Bilge separator
– Main sea water auxiliary pump
– Steering gear pump 2
– Emergency sea water fire pump
– Stbd gear LO stand-by pump
– Port gear LO stand-by pump

Operation procedure

The ECR air condition is ready to start when the green indication lamp is lit (sea water differential pressure more than 0.5 bar and the valve to the air condition cooler is open).
The ER (engine room) ventilation 1 and 2 is started by pressing the corresponding buttons or from the variable page.

Non-essential Consumers

The consumers will be disconnected by the non-essential bus-bar breaker at overload on generators to prevent blackout.
The value is adjustable from the variable page.

Earth Leakage

Isolation resistance to earth for both 440 V and 220 V is continuously measured and indicated. If earth leakage exceeds an adjustable limit an alarm will sound.

An instrument for measuring resistance against earth is included. Selecting of bus bar (440/220) and phase (R,S,T) by pressing the corresponding buttons.

Model particulars

- Set point for ECR temperature is 25°C. When ECR air condition is OFF, the temperature in the ECR will gradually increase to ER temperature.
- Actual stern- and bow thruster load is computed and added to the total electrical load. The electrical current is computed and indicated.
- Heavy consumer's consumption is set by the instructor and the load is added to the total electrical consumption
- The consumers from bus bar 1, group 1 are modelled with fuse breakers and the electrical current is calculated and indicated for each of these consumers.
- Group 1 breakers are found at the switch board miscellaneous section.
- The Fire and Ballast pumps, engine room fans and engine control room air condition can be started/stopped from the miscellaneous section of the switchboard.

Non-essential bus bar:

- The Power Chief – Generator Control Units, controls the non-essential breaker – the value can be set at variable page.
- Breakers for main air condition, main refrigeration system (not MD64!), main ventilation 1 & 2 are available from the variable page and are meant for simulating extra electric load.

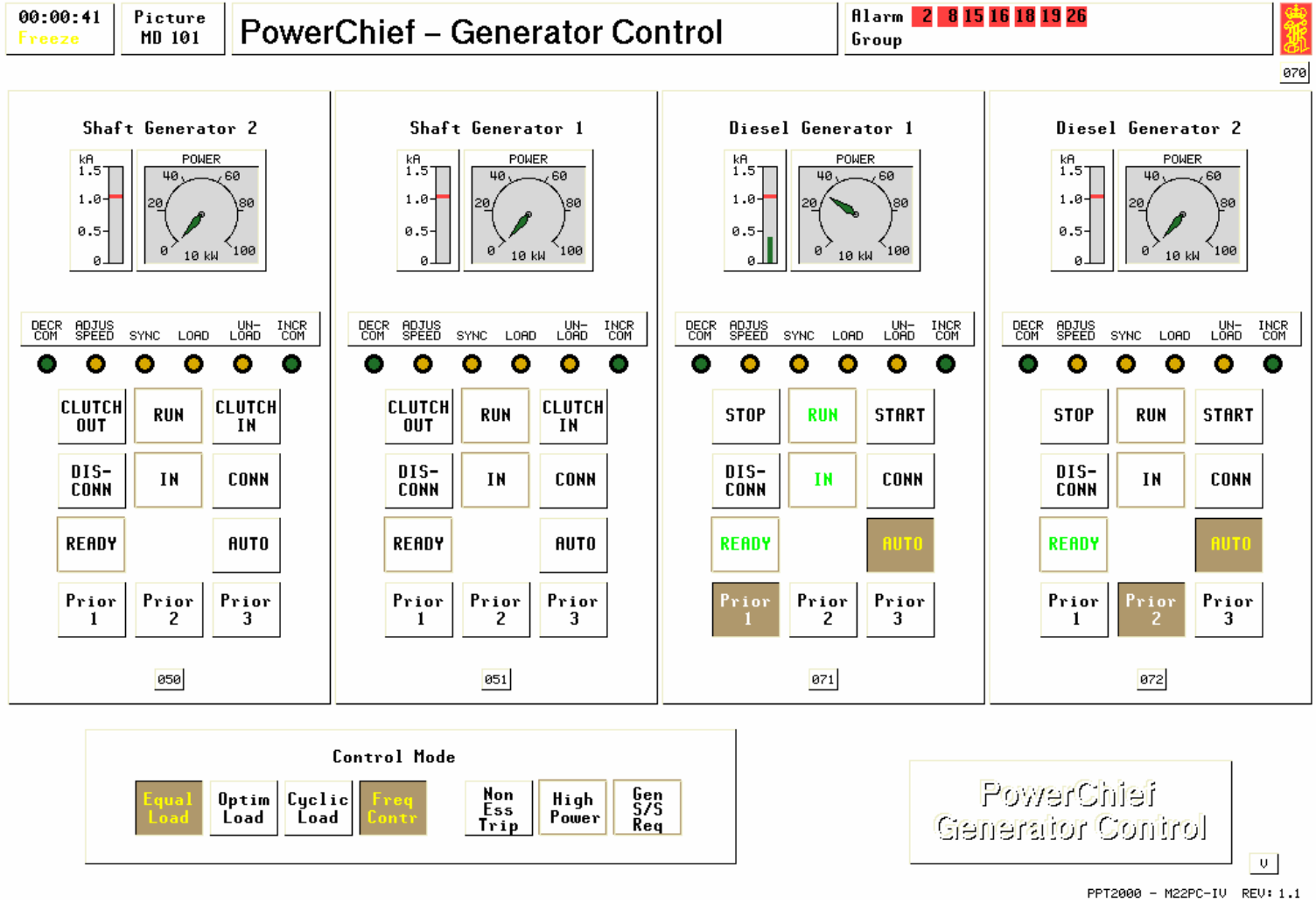
Lightning bus bar:

- To be able to connect the lightning bus circuit breaker, the breakers to the transformer(s) have to be connected. Carried out from the variable page 7007 or from the main Switchboard panel.

Earth leakage:

- Electric earth leakage can be set on the accommodation, deck and engine room light from the malfunction page.
- Earth leakage is modelled for:

- Each electric motor connected to group 1
- Cables connecting each of group 1 consumers
- Bow thruster
- Stern thruster
- Heavy deck consumers
- Accommodation light
- Deck light
- Engine room light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Freeze
Picture
MD 101
PowerChief – Generator Control
Alarm 2 8 15 16 18 19 26
Group
070
Shaft Generator 2
Shaft Generator 1
Diesel Generator 1
Diesel Generator 2
kA
POWER
10 kW
DECR COM
ADJUS SPEED
SYNC
LOAD
UN-LOAD
INCR COM
CLUTCH OUT
RUN
CLUTCH IN
DIS-CONN
IN
CONN
READY
AUTO
STOP
START
Prior 1
Prior 2
Prior 3
050
051
071
072
Control Mode
Equal Load
Optim Load
Cyclic Load
Freq Contr
Non Ess Trip
High Power
Gen S/S Req
PowerChief
Generator Control
V
PPT2000 - M22PC-IV REV: 1.1

2.4 Power Chief – Generator Control

General

Refer to the section 2; Generator – Power Chief Remote Control.

Description

AUTO activates automatic power management. If active the diesel generators will start, stop, and perform load sharing according to priority and control mode. To activate, the READY lamp must be lit. To get READY indication, the diesel must be in remote mode and possible alarms must be acknowledged.

Priorities

The PRIOR (priority) buttons determine the starting/stopping sequence of the diesel generators (in AUTO mode). The desired priority is selected by pressing one button in each panel.

Control Mode

The modes are selected by pressing the buttons on the CONTROL MODE panel.

EQUAL LOAD - Balances load evenly between generators, when two or more are running in parallel. Is normally selected when safety is the most important issue (during manoeuvring, loading, discharging etc.).

OPTIMAL LOAD - Provides maximum fuel economy. Is selected for economy, usually during sea voyages. Diesel(s) is running at max. load. First priority takes “max load” while second priority takes the rest of the load.

CYCLIC LOAD (Asymmetric load sharing) - Runs one generator on maximum load alternately in pre-set intervals. The mode will cycle the load between the engines in such way that one of the diesels is running at max. load while the other diesel handles the remaining load and thereby prevents carbonising of the cylinders, valves etc. Is selected when it is necessary to run more than one diesel on low power.

FREQUENCY CONTROL - Controls frequency on both or one generator. Is selected to automatically perform network frequency control. This mode is normally always selected in addition to one of the above mentioned modes.

NON ESSENTIAL LOAD TRIP - Flashes when alternators have been overloaded and non-essentials are tripped. Reset function by clicking on button.

HIGH POWER - Flashes when generator set reaches upper limit. To reset/acknowledge alarm click flashing button.

GENERATOR STAND-BY - START REQUEST - Flashing button indicates upper load limit is near for running set. If in manual mode, next generator set is started and connected manually from the panel.

Operation procedure

1. Preparations before operating Power Chief-Generator Control

1.1 Diesel generators to be ready and in alarm free condition.

2. MANUAL mode

2.1 Push START button for the respective generator engine. When running light appears, generator is ready for connection to main bus bar.

2.2 Push CONNECT to connect generator to main bus bar.

2.3 If emergency generator is running it will automatically disconnect and stop. Shore power must be manually disconnected.

2.4 After connection of generator(s), voltage and frequency must be checked.

Note: On an actual ship adjusting frequency and load sharing is a continuous task unless switchboard is automated. When load changes, so do bus bar values.

3. Automatic power management

3.1 Connect first generator manually as described. Press buttons AUTO and PRIORITY 1 for this generator set.

3.2 After preparing of second generator, READY signal will be lit on PowerChief panel. Press buttons AUTO and PRIORITY 2 for this generator.

3.3 Second generator will automatically start, take load, and stop according to the electrical consumption and the selected control mode.

4. Shaft generators

4.1 A prerequisite for shaft generator operation is that the main engine remote control is in the Shaft Generator Mode.

4.2 The functions AUTO and PRIORITY are not applicable for shaft generators– the shaft generators must always be managed manually.

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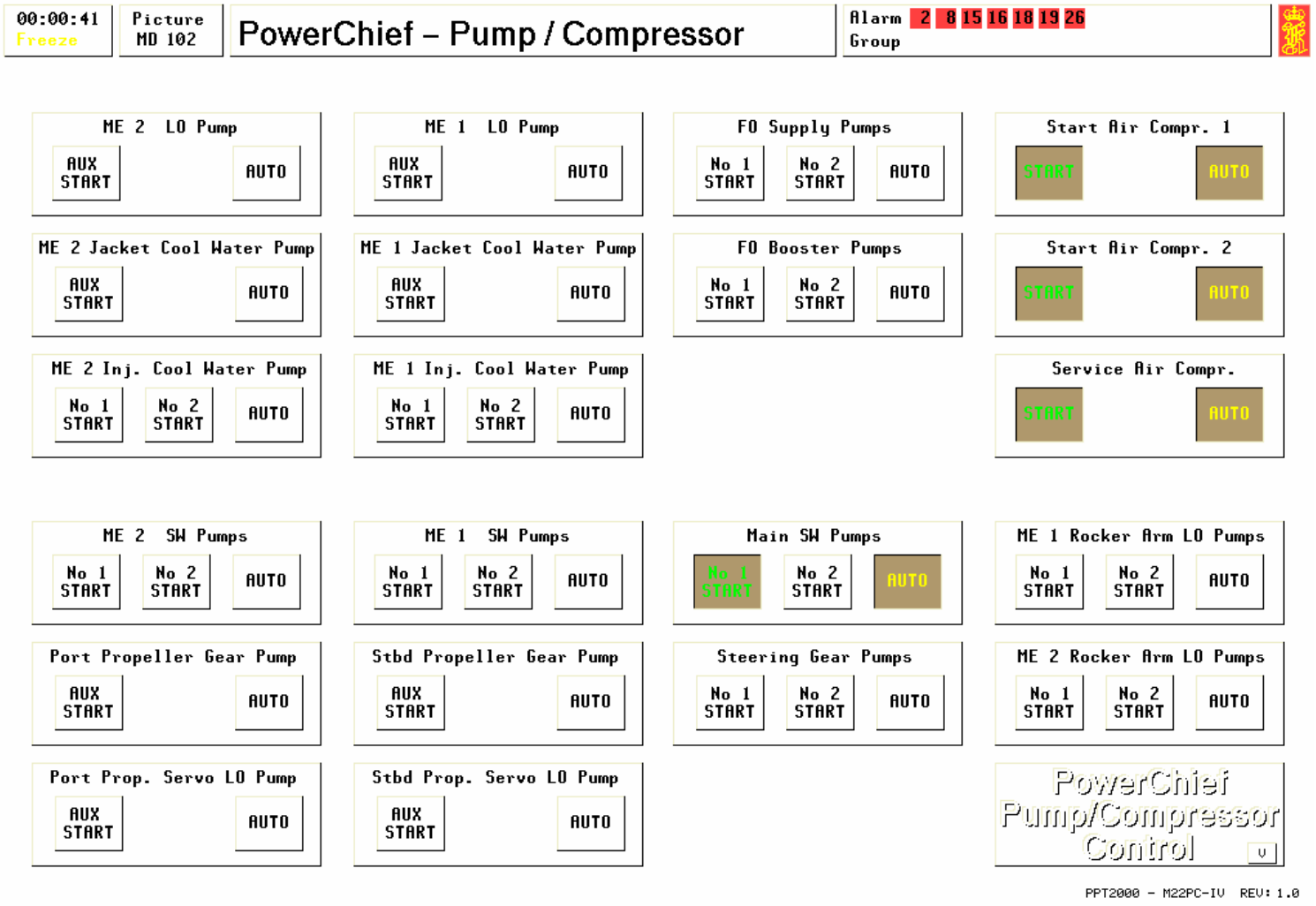

00:00:41
Freeze
Picture
MD 102
PowerChief – Pump / Compressor
Alarm Group
2 8 15 16 18 19 26
ME 2 LO Pump
AUX START
AUTO
ME 1 LO Pump
AUX START
AUTO
FO Supply Pumps
No 1 START
No 2 START
AUTO
Start Air Compr. 1
START
AUTO
ME 2 Jacket Cool Water Pump
AUX START
AUTO
ME 1 Jacket Cool Water Pump
AUX START
AUTO
FO Booster Pumps
No 1 START
No 2 START
AUTO
Start Air Compr. 2
START
AUTO
ME 2 Inj. Cool Water Pump
No 1 START
No 2 START
AUTO
ME 1 Inj. Cool Water Pump
No 1 START
No 2 START
AUTO
Service Air Compr.
START
AUTO
ME 2 SW Pumps
No 1 START
No 2 START
AUTO
ME 1 SW Pumps
No 1 START
No 2 START
AUTO
Main SW Pumps
No 1 START
No 2 START
AUTO
ME 1 Rocker Arm LO Pumps
No 1 START
No 2 START
AUTO
Port Propeller Gear Pump
AUX START
AUTO
Stbd Propeller Gear Pump
AUX START
AUTO
Steering Gear Pumps
No 1 START
No 2 START
AUTO
ME 2 Rocker Arm LO Pumps
No 1 START
No 2 START
AUTO
Port Prop. Servo LO Pump
AUX START
AUTO
Stbd Prop. Servo LO Pump
AUX START
AUTO
PowerChief
Pump/Compressor
Control
PPT2000 - M22PC-IV REV: 1.0

2.5 Power Chief – Pump and Compressor Control

General

Refer to the description in the manual Machinery and Automation, PowerChief - Pump and Compressor Control.

Description

The PowerChief – Pump and Compressor Control manages automatic and manual remote operation of the compressors and pumps.

Operation procedure

1. Preparations before operating the compressors and pumps in remote or automatic

1.1 All systems must be lined up and tested before remote or automatic management.

2. **MANUAL mode**

2.1 Push START button.
2.2 When steady light, pump/compressor is running.
2.3 Push button on running pump/compressor to stop the pump/compressor.

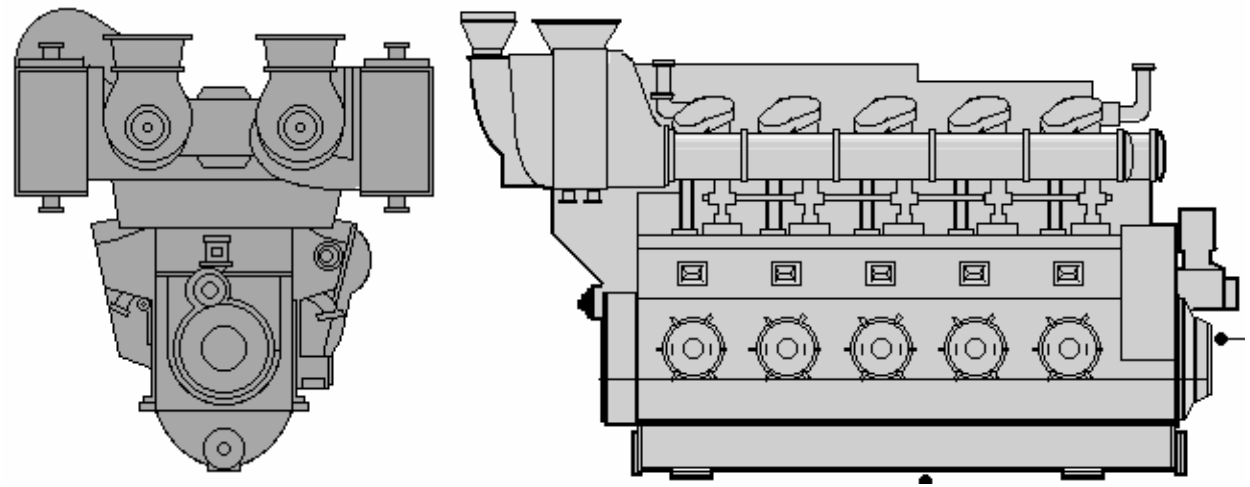
3. AUTO mode:

3.1 As in manual mode.
3.2 When first pump/compressor is running push AUTO.
3.3 Changing pumps/compressors in AUTO, deactivate AUTO and start selected pump/compressor and stop running pump/compressor.
3.4 Push button AUTO.

NOTE! If an object has developed faults, stand by pump/compressor will start. Flashing light in start button indicates start of stand by object. To remedy condition, stop object. Locate problem and “repair”. After a repair attempt or rectifying of running condition, follow normal AUTO procedure.

3 MAIN ENGINE AND MAIN ENGINE SYSTEMS

3.1 Main Engine Power



Pielstick PC 4.2

The main engines are of Pielstick 10 PC 4.2 2*5V, medium speed, 10 cylinders/V-configuration, 4-stroke type engines. The engines are non-reversible and equipped with clutch and reduction gear.
The engines are connected to a variable pitch propeller.

Main engine data:

Type	Pielstick 10 PC 4.2	
Cylinder bore	570	mm
Piston stroke	620	mm
Number of Cylinders in line	2*5 V	
Number of air coolers	2	
Number of turbochargers	2	
Continuous service rating ME	10930	kW
Corresponding engine Speed	400	rpm
Mean effective pressure	23	bar
Specific fuel oil consumption, max	186	g/kWh
Specific fuel oil consumption,85%	183	g/kWh
Reduction gear	1:3	
Propeller diameter:	4.60	m
Propeller speed:	133	rpm
Maximum speed	22.5	knots

Description

Each of the main engines is connected to a propeller shaft via reduction gear and clutch.

The clutch is operated by control air. Decreasing control air pressure reduces the maximum transmittable torque. At low control air pressure the clutch may start slipping and it can be damaged by the heat generated.

Stop of the main engine caused by physical damage on the engine is indicated by one of the following "ME damage"- functions:

- Exhaust temperature high
- Lubricating oil temperature high
- Fresh water temperature high
- Bearing temperature high
- Engine room fire damage

The main engine remote control system, AutoChief, takes care of the safety of the engine (slow down/shut down) and the start/stop and connect/disconnect functions.
The following functions are managed by the AutoChief system:

Main engine start inhibit if:

- ME in local control
- Turning gear engaged
- Start air pressure low
- Control air pressure low
- Rocker arm lubrication oil temperature low
- ME Clutch connected
- Jacket water temperature low
- Lubrication oil temperature low
- ME damage (ruined)

Slow down if:

- Low lubricating oil pressure
- Low fresh water pressure
- High lubricating oil temperature

- High fresh water temperature
- High scavenging. air temperature
- High bearing temperature
- Low rocker arm pressure
- High rocker arm temp

Shut down if:
- Low-low lubricating oil pressure
- High-high fresh water temperature
- Over speed
- Low-low rocker arm pressure

ME start/stop status:
- ME stopped
- ME running
- lubricating oil priming
- Starting
- Wait for ignition
- Stopping
- Starting fail
- Stopping fail

ME-Clutch connect/disconnect status:
- ME disconnected
- ME connected
- lubricating oil priming
- Connection
- Waiting for connection
- Disconnection
- Connection failure
- Disconnection failure

RPM controller

A hydraulic PI controller mounted on the engine controls the speed of the engine. The set point of the speed controller is normally set remotely by the AutoChief system, but it can also be set by a speed knob on the local control panel if the control mode is "LOCAL". The gain and the integration (reset) time of the controller can be adjusted.

Operation procedure

Local operation

1. **Preparation**

1.1 Check that engine is pre-heated
1.2 Check that jacket cooling water system is in operation and that pre-heater loop is turned off.
1.3 Check that sea water cooling system is lined up and in operation
1.4 Check that the main lubricating oil system is lined up and in operation.
1.5 Check that the injector cooling system is lined up and in operation and pre-heated
1.6 Check that the rocker arm lubrication system is lined up and pre-heated
1.7 Disconnect turning gear
1.8 Open indicator cocks
1.9 Set Clutch control in LOCAL and disconnect
1.10 RESET any trip if present.
1.11 Set Speed control in LOCAL with setting point 6 mm (idling speed = 140 rpm).

2. Local start and connect

2.1 Set fuel link cylinder in STOP position
2.2 Blows through the engine with open indicator cocks by pushing slow turn button.
2.3 Close indicator cocks and set fuel link cylinder in RUN position.
2.4 Push the start button and the start air valve will open.
2.5 When engine rpm increases, start valve will close and fuel high-pressure pumps will supply fuel oil to the injectors.
2.6 Check engine condition
2.7 Disengage propeller shaft brake
2.8 Engage the clutch
2.9 After connection of engine to the gear, the engine load can be increased slowly
2.10 If local operation of engine and propeller the engine revolution is normally adjusted to **380 rpm** and only the propeller pitch is controlled according to bridge order

3. Remote start and control

3.1 Engine to be prepared as to the guidelines under 1.1 to 1.7.
3.2 Speed, clutch and brake controls to be set in REMOTE at local panels
3.3 Slow down/ shut down condition to be rectified before start attempt. After systems are normal, push slow down/ shut down twice to reset condition
3.4 Engines in alarm free condition with tripping functions RESET. Gears to be disconnected before start.
3.5 Before starting the engine test the propeller servo by moving the throttle handle to full ahead, respective full astern while watching that the propeller pitch changes according to position of throttle.
3.6 Start engines by pushing button START.
3.7 Connect clutch when at idling speed.
3.8 Engine control room/ bridge responsibility can be transferred

3.9 Pushing EMERGENCY RUN button allows engine(s) to run regardless of condition

Note: If engine has been out of operation for more than 1 hour, local blow through and start of engine is recommended.

Model particulars

The main engine model ("cylinder model") is a comprehensive, semi-empirical software program module where the result of the combustion process is calculated. Important variables are:

- Mean indicated cylinder pressures
- Mean effective cylinder pressures
- Total shaft torque
- Exhaust temperatures
- Total heat to liners (FW)
- Total heat to pistons (FW)
- Total heat to bearings (LO)

The result is dependent on several variables and the most influential ones are:

- Engine speed
- Injected amount of fuel
- Fuel heat value/viscosity
- Scavenging air pressure
- Lubricating oil inlet flow/temperature
- Jacket water inlet flow/temperature
- Mean liner metal temperature

The overall shaft torque is computed from the mean cylinder pressures. The torque balance differential equation between the propeller (water) torque and the shaft (engine) torque is then solved by integration to give the engine speed.

If the cooling water flow is reduced or cooling water pumps are stopped, the cooling effect of the fresh water is drastically reduced and the liner/exhaust temperatures will be very high. If the engine is operated without lubrication, the mechanical friction increases the piston and bearing temperatures will increase. Eventually piston seizure and bearings damage will occur. Long operation at extreme high exhaust temperatures will cause damage to the exhaust valves.

Stop of the main engine caused by physical damage on the engine is indicated by "ME damage", and may result from:

- Exhaust valve breakdown
- Piston breakdown
- Cylinder liner breakdown
- Bearing breakdown
- Fire damage

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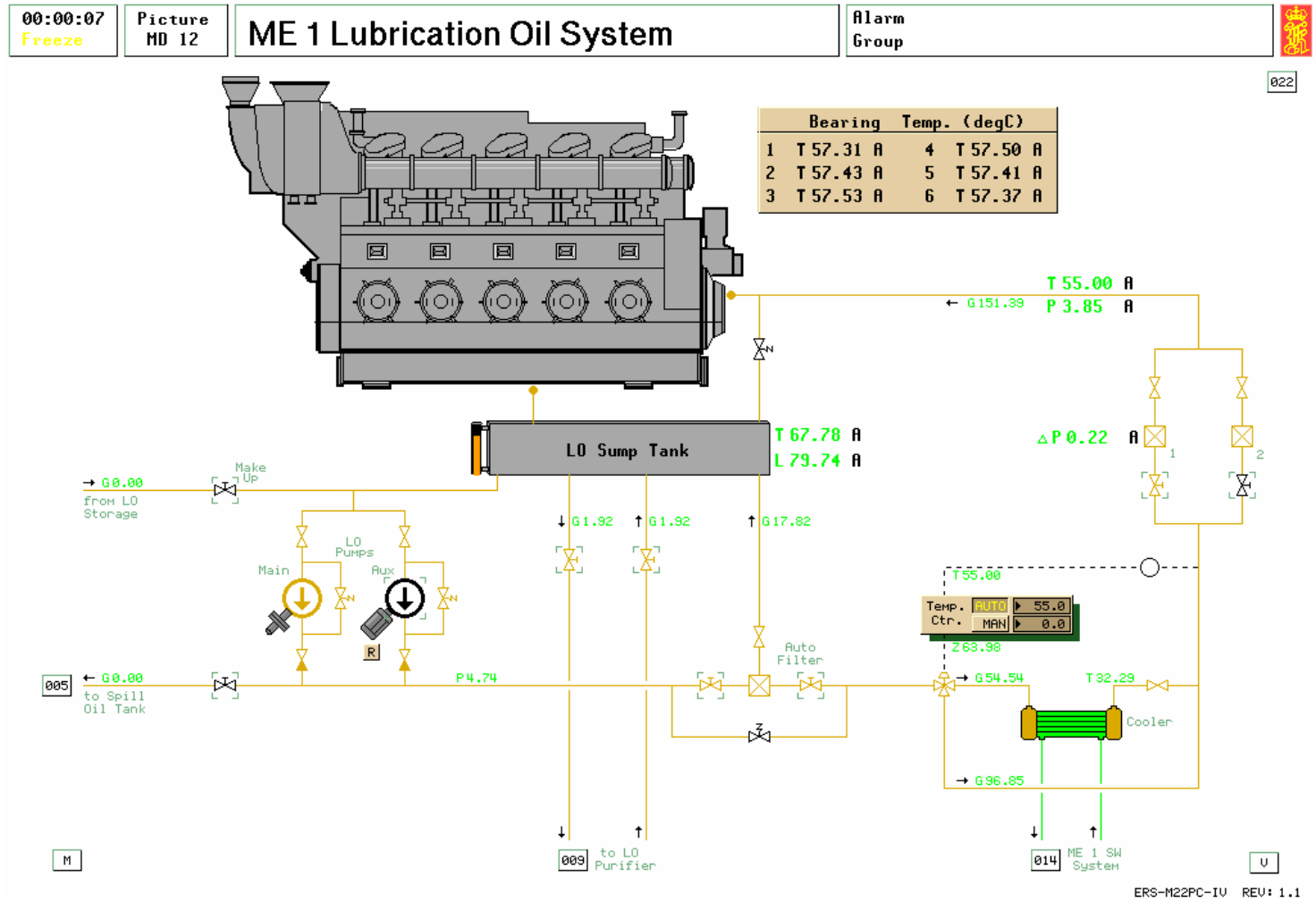
00:00:07
Freeze
Picture
MD 12
ME 1 Lubrication Oil System
Alarm
Group
022
Bearing Temp. (degC)
1 T 57.31 A
2 T 57.43 A
3 T 57.53 A
4 T 57.50 A
5 T 57.41 A
6 T 57.37 A
T 55.00 A
P 3.85 A
G151.38
LO Sump Tank
T 67.78 A
L 79.74 A
ΔP 0.22 A
Make Up
G0.00
from LO Storage
LO Pumps
Main
Aux
R
G1.92
G1.92
G17.82
T55.00
Temp. Ctr.
AUTO
MAN
55.0
0.0
Z63.98
Auto Filter
005
G0.00
to Spill Oil Tank
P4.74
G54.54
T32.29
Cooler
G96.85
M
009
to LO Purifier
014
ME 1 SW System
V
ERS-M22PC-IV REV: 1.1

3.2 Main Engine Lubrication Oil System

General

The purpose of the main engine lubrication oil system is to provide lubrication for main engine main- and thrust bearings, bottom end bearings, gudgeon pin bearings, piston cooling and camshaft gears and bearings.

Description

The lubrication oil from the main engine is collected in a drain (sump) tank below the engine. The drain tank is equipped with low and high level alarm.

Each main engine lubrication oil system has one electrically driven auxiliary pump and one shaft driven main lubrication oil pump. The electrical driven pump serves both as a pre-lubrication oil pump and as a stand by lubrication oil pump in the event of break down of the main lubrication oil pump.
Both pumps take suction from the main engine drain tank. The lubrication oil pumps are protected by a pressure relief valve, which opens at a pressure above a pre-set value.

A small portion of the lubrication oil is bled off to the sump tank through the auto fine filter unit. In this manner, there is a continuous fine filtering of the oil charge. The oil can also be cleaned in a lubrication oil purifier, common to both main engines.

The lubrication oil passes a duplex filter after it has been cooled in a sea water cooled lubrication oil cooler before entering the engine's lubrication oil distribution pipe.
A PID controller, controlling the temperature at inlet cooler regulates temperature of lubrication oil.

The lubrication oil charge may be discharged to the spill oil tank through the discharge valve located after the lubrication oil pumps.
Make-up to the lubrication oil drain tank is by gravity flow from the lubricating oil storage.

As medium speed engines are very sensitive to high bearing temperature, main bearing metal temperatures are measured as lubrication oil temperature outlet from each bearing.

The electrical lubrication oil pump can be operated either in manual or in automatic mode. In automatic mode, the AutoChief will automatically pre-lubricate the engine before starting.

Note: As a prevention against starting the engine without oil pressure, the electrically driven lubrication oil pump will always receive a start signal when the engine is started remotely from the DataChief panel.

Operation procedure

1. When low ambient temperature heating of the lubricating oil by the lubrication oil purifier is required.

2. Starting procedure

2.1 Check the position of all valves in suction and discharge line and start the electrical auxiliary lubrication oil pump manually.

2.2 Check main engine seawater cooling system and the temperature controller. Normal temperature controller set point: 55°C.

2.3 Put the auxiliary lubrication oil pump into AUTO from the PowerChief Pump Control panel. The main lubricating oil pump will then take control as soon as the main engine has reached normal speed.

3. Filters

3.1 Fine filter must always be in operation.

3.2 Normally one main oil filter is in operation and one filter is cleaned and stand-by.

3.3 The lubrication oil filters must be cleaned regularly to avoid too high-pressure drop, which may cause the filter cartridge to collapse, resulting in sudden release of the dirt accumulated.

Note: Sump tank must be checked for level and periodically refilled.

Model particulars

- The sump tank oil level will gradually decrease due to oil consumption and possible drain/sludge discharge from the purifier. The level is unstable in poor weather and if the level is low, there may be alarms/shut downs.

- If the purifier is operated with "broken" water seal, much oil is continuously discharged to the sludge tank and there is a risk of emptying the lubrication oil well completely. The oil pressure after the pumps will be reduced towards zero as the lubrication oil service well runs dry.

- The return oil flow/temperature from the main engine, the oil flow/temperature from the purifier and the heat loss to the surroundings affect the oil temperature in the service tank. If all inlet flows stop, the temperature will gradually approach ambient air temperature. Low oil temperature gives reduced pressure at main engine.

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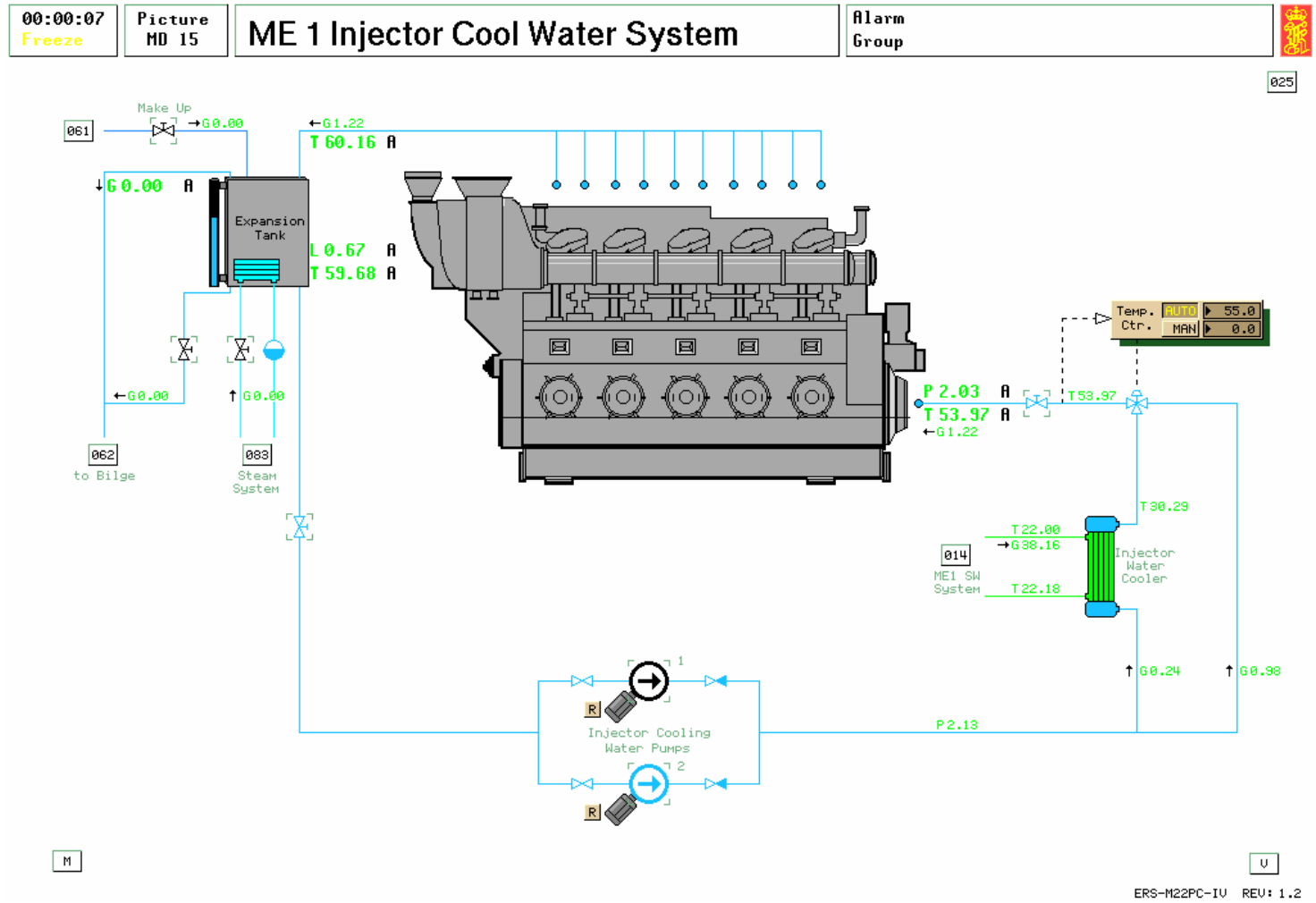

00:00:07
Freeze
Picture
MD 15
ME 1 Injector Cool Water System
Alarm
Group
025
Make Up
061
→G0.00
←G1.22
T 60.16 A
↓G 0.00 A
Expansion Tank
L 0.67 A
T 59.68 A
Temp. Ctr.
AUTO
MAN
55.0
0.0
P 2.03 A
T 53.97 A
←G1.22
T53.97
←G0.00
↑G0.00
062
to Bilge
083
Steam System
T30.29
T22.00
→G38.16
014
ME1 SW System
T22.18
Injector Water Cooler
↑G0.24
↑G0.98
1
R
Injector Cooling Water Pumps
2
R
P2.13
M
U
ERS-M22PC-IU REV: 1.2

3.3 Injector Cooling Water System

General

The purpose of the injector cooling water system is to keep the nozzle metal temperature at the correct level during all running conditions.
Too high temperature may cause carbon accumulations at the fuel injection nozzle causing poor atomisation and too high injection pressure, which may lead to rupture of the high-pressure pipe or damage of the fuel cam.
Too low temperature may cause acid corrosion of the fuel injection nozzle.
The separate injector cooling water system prevents contamination of jacket water with heavy fuel oil in case of leakage and limits the temperature to about 60°C (140°F).

Description

The system is equipped with two electrical driven pumps. The pumps take suction from an expansion tank with treated water and discharge to headers on each engine bank, distributing the cooling water to the injectors on each cylinder head.
After cooling each injector, the cooling water is directed to a funnel above the expansion tank via individual return pipes. The return pipes are fanned out at the funnel for easy checking of adequate flow to all injectors.

A steam coil in the expansion tank permits heating of the water in the system when engines are not in operation, preventing congelation of heavy fuel oil in the injectors.

The expansion tank overflow pipe is equipped with an overflow switch for alarm. Overflow is led to engine room bilge well.
The expansion tank may be drained to the engine room bilge well.

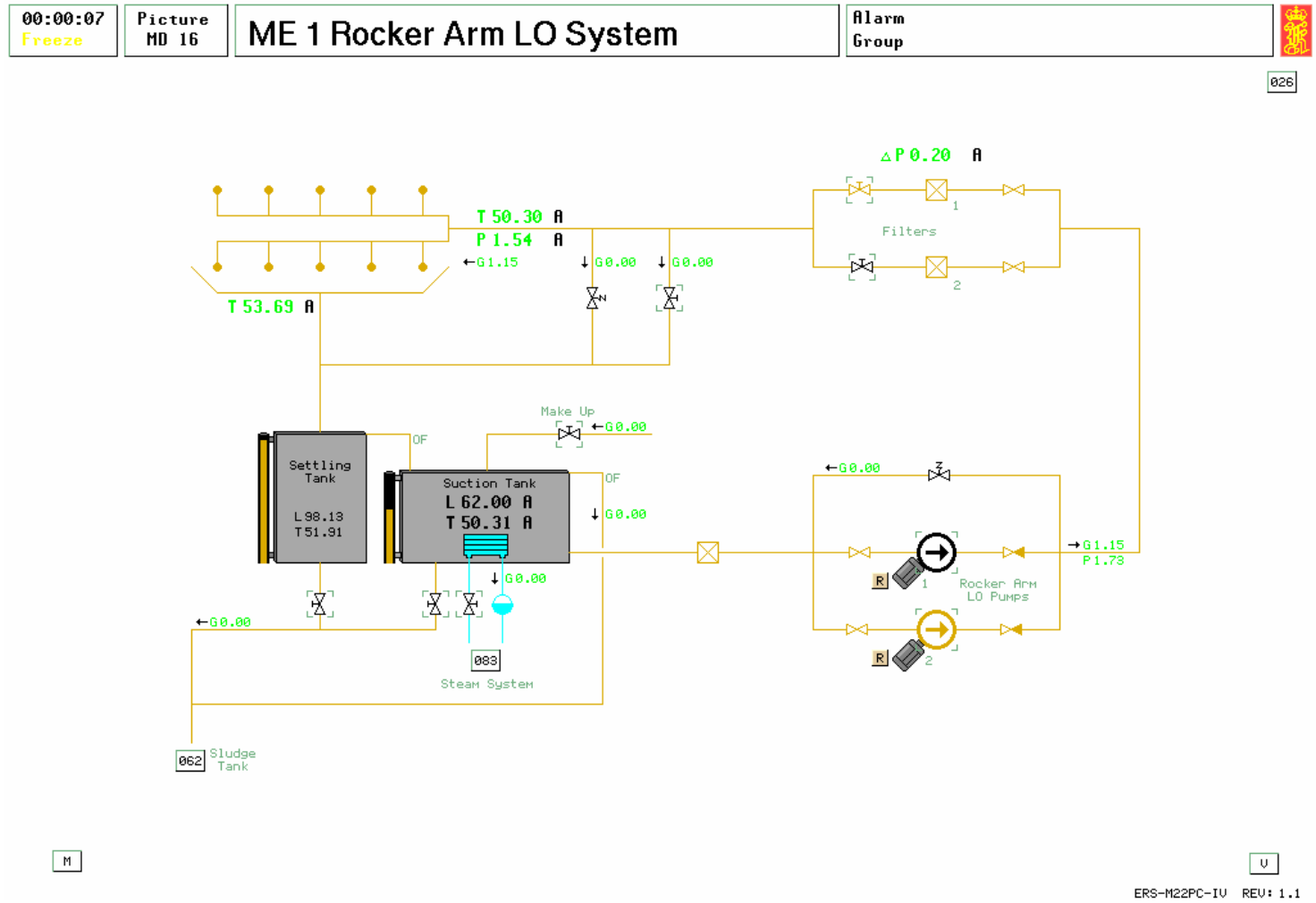
Operation procedure

1. Starting procedure

1.1 Open the pump suction valve and the engine header inlet valve, and start one pump local.
1.2 As soon as steam pressure is present, open the steam inlet valve to the expansion's tank heating coil. The temperature should be monitored, as alarms will be activated at high expansion tank temperature.
1.3 Adjust temperqature controller – check that the controller is in AUTO mode. Normal operation temperature is 60°C (140°F).
1.4 Put the Injector cooling water pumps in AUTO from the Pump and Compressor panel. Normally one pump is running and one pump is stand by.
1.5 Refill expansion tank when necessary, i.e. before the alarm system is activated.

Model particulars

No comments.


00:00:07
Freeze
Picture
MD 16
ME 1 Rocker Arm LO System
Alarm
Group
026
ΔP 0.20 A
T 50.30 A
P 1.54 A
G1.15
G0.00
G0.00
T 53.69 A
Filters
1
2
Make Up
G0.00
OF
Settling Tank
L 98.13
T 51.91
Suction Tank
L 62.00 A
T 50.31 A
OF
G0.00
G0.00
G0.00
G0.00
G1.15
P 1.73
R
1
Rocker Arm
LO Pumps
R
2
083
Steam System
062
Sludge Tank
M
U
ERS-M22PC-IU REV: 1.1

3.4 Main Engine Rocker Arm Lubrication Oil System

General

The purpose of the main engine rocker arm lubricating oil system is to supply lubrication to the rocker arm bushings and valve tappet assemblies.
The main engine rocker arm lubrication system is completely separated from the main lubricating oil system. If fuel oil or jacket water leakage occurs in the cylinder head cover area, it will contaminate only this small system.

Description

The system is equipped with two electrical driven pumps. Each pump takes suction from the small suction tank via a suction strainer and discharge through a duplex filter and headers on each engine bank, distributing the lubricating oil to the rocker arms at each cylinder head.
The pumps have a common adjustable pressure control valve. The valve setting can be adjusted from variable page 1252.

After lubricating the rocker arm bushings the oil is drained to the cylinder head top, and returned to the settling tank by gravity flow.
An adjustable pressure control valve maintains the discharge header pressure at 1.4 - 1.6 bar (20 - 24 psi) returning excess oil to the settling tank. The valve setting can be adjusted from variable page 1252.

Prior to starting the ME from the engine control room, the AutoChief performs a pre- lubrication.

The rocker arm lubrication oil system is equipped with sensors disabling start of the main engine when the rocker arm lubrication oil temperature at inlet ME is too low. In addition, too low lubrication press and too high temperature will lead to slow down. If the pressure continues to drop, the AutoChief will shut down the engine.

The suction tank is provided with a heating coil to be used during starting up if lubricating oil temperature is too low.
If the oil is contaminated, it can be drained through one or both of the drain valves from the settling or suction tank.
Overflow from the settling tank is drained to the suction tank. Overflow from the suction tank is drained to the sludge tank.

Operation procedure

1. Starting procedure

1.1 Ensure that there is enough lubrication oil in the suction tank. If not, refill by opening the make-up valve.

1.2 Open suction valve and discharge valve, and start one rocker arm lubricating oil pump locally. As soon as steam pressure is present, open the steam inlet valve to the Suction Tank. The temperature should be monitored, as alarms will activate at high temperature in the tank. If the temperature exceeds 80°C (175°F)., the AutoChief will perform a Slowdown.

1.3 Adjust temperature controller – check that the controller is in AUTO mode. Normal operation temperature is 60°C (140°F).

1.4 Put the rocker arm lubricating oil pumps in AUTO from the Pump and Compressor panel. Normally one pump is running and one pump is stand by.

1.5 Refill the suction tank when necessary or when alarm occurs.

1.6 The settling tank must be drained regularly.

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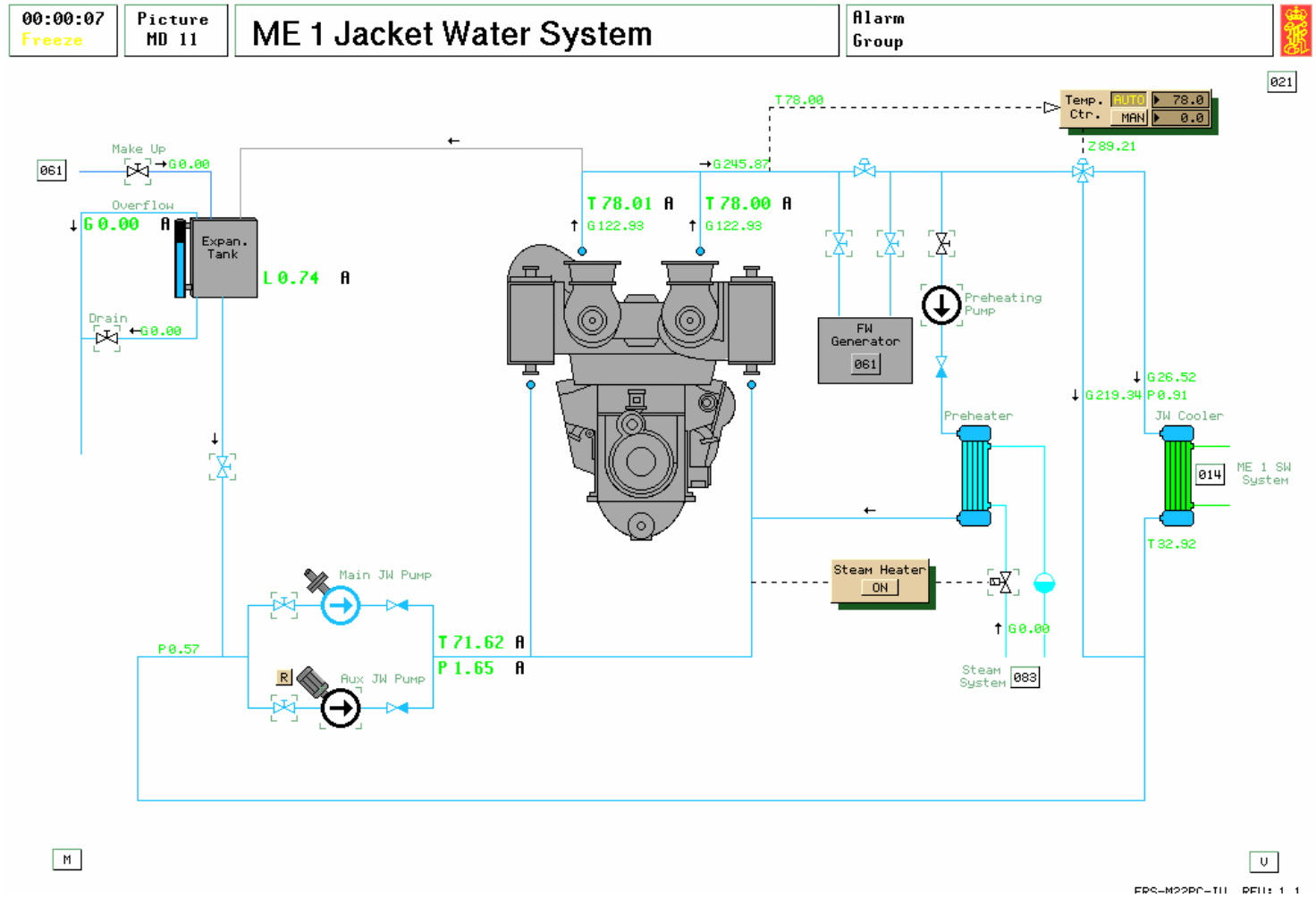
00:00:07
Freeze
Picture
MD 11
ME 1 Jacket Water System
Alarm
Group
021
T 78.00
Temp. Ctr.
AUTO
MAN
78.0
0.0
Z 89.21
Make Up
061
G 0.00
G 245.87
Overflow
G 0.00 A
Expan. Tank
L 0.74 A
T 78.01 A
G 122.93
T 78.00 A
G 122.93
Drain
G 0.00
FW Generator
061
Preheating Pump
G 26.52
G 219.34
P 0.91
JW Cooler
Preheater
014
ME 1 SW System
T 32.92
Steam Heater
ON
Main JW Pump
P 0.57
T 71.62 A
P 1.65 A
R
Aux JW Pump
G 0.00
Steam System
083
M
V

3.5 Main Engine Jacket Cooling water system

General

The fresh water jacket cooling system consists of two integrated loops:

- Jacket pre-heating water loop
- Jacket cooling water loop

The purpose of the pre-heater loop is to ensure correct pre-heating of the main engine when not in service.
The purpose of the jacket cooling water loop is to provide cooling for cylinder liners, cylinder heads, exhaust valves, and the casing of the turbochargers.

Description

Pre-heater loop

The pre-heater loop is equipped with a separate circulation pump and a steam-heated pre-heater. The rate of water circulation and the capacity of the pre-heater is customised in such a way that the main engine will gain correct pre-heating temperature provided that the circulating pump is running and the steam heater temperature control is turned on.
The pre-heater temperature control is an on-off controller, measuring the temperature at the main engine inlet pipe and controlling the heater steam inlet valve.

Cooling water loop

The system is equipped with one auxiliary electrical driven circulating pump and one shaft driven main circulating pump in parallel and a sea water cooled jacket water cooler. The pump circulates the cooling water through the main engine and the jacket water cooler.
The electrical driven pump serves as a cooling water pump during starting up and as a stand by pump in the event of break down of the shaft driven circulation pump.

A PID controller, controlling a 3-way distribution valve, located before the jacket water cooler controls the jacket cooling water outlet temperature.

The general pressure level in the fresh water system is given by the water level in the fresh water expansion tank.
The expansion tank overflow pipe is equipped with an overflow switch. Overflow is drained to engine room bilge.
The expansion tank may be drained to the engine room bilge.

Operation procedure

1. Pre-heating

1.1 During out of service periods or if stopped for a prolonged period during manoeuvre the main engine must always be pre-heated. Insufficient pre-heating of the main engine before starting may cause misalignment of the main bearings and fresh water leaking.

1.2 Line up the pre-heating loop, and start the preheating circulation pump. When steam pressure is present, switch on the steam heater controller. The controller will ensure that the jacket water will maintain correct temperature.

1.3 Correct pre-heating temperature is 55 – 60^{o}C.

2. Jacket cooling water loop

2.1 Check the position of all valves in suction and discharge line and start the electrical auxiliary jacking cooling water pump locally.

2.2 Check sea cooling water system and the temperature controller. Normal temperature controller set point is 80°C (175°F).

2.3 Put the auxiliary jacket cooling water pump into AUTO from the PowerChief Pump Control panel. The main jacket cooling water pump will then take control as soon as the main engine has reached normal speed and the auxiliary pump is automatically stopped.

2.4 During normal operation the pre-heating pump should be stopped.

2.5 The expansion tank must be checked and filled periodically.

Model particulars

- There is a constant consumption of fresh water because of leakage and evaporation.
- In bad weather, unsteady expansion tank level is simulated and alarms may arise.
- If the water out of the main engine is at the point of boiling, evaporation is simulated.
- At abnormal low suction pressure and/or high water temperature, the pump discharge pressure will drop due to cavitation.

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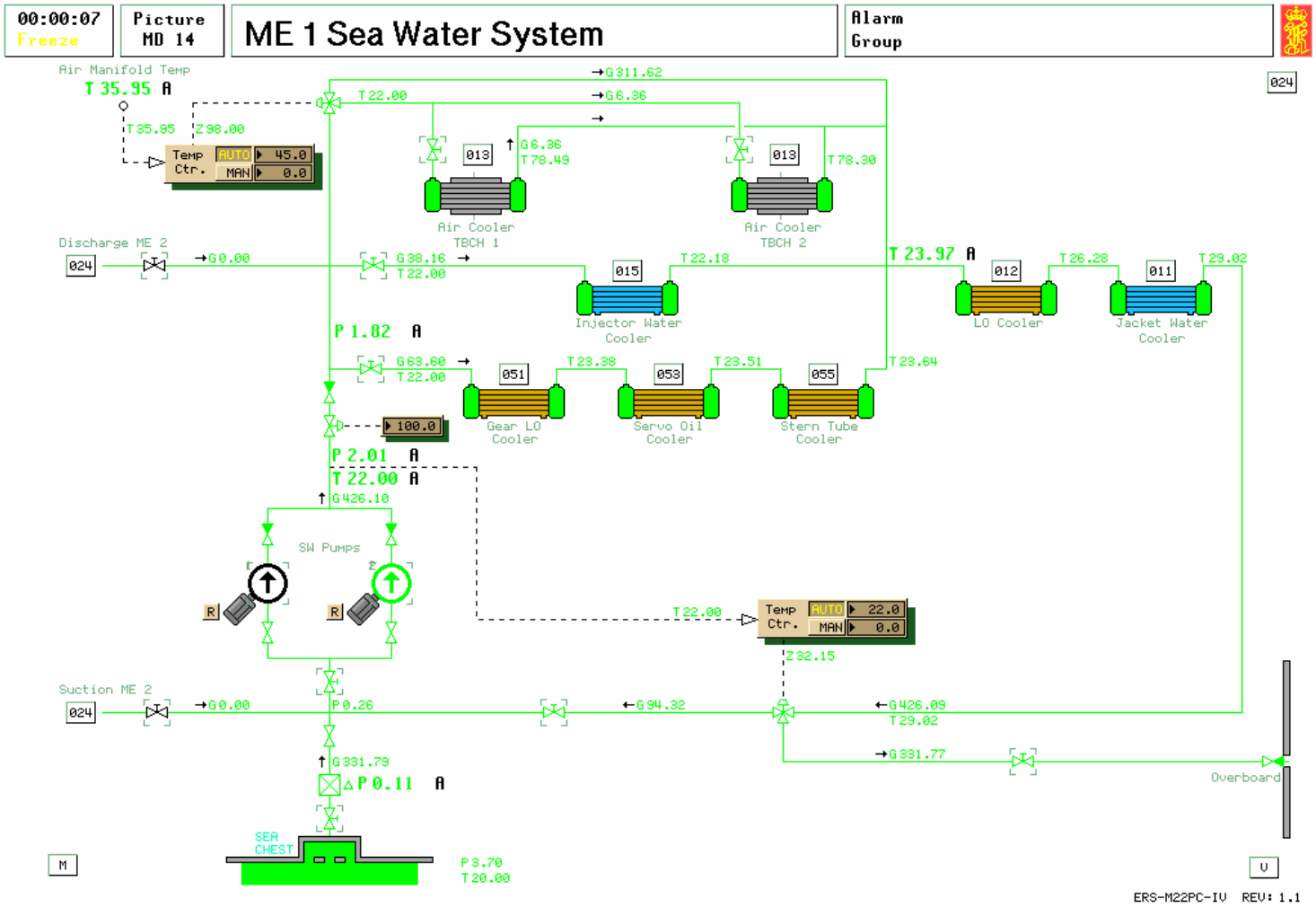
00:00:07
Freeze
Picture
MD 14
ME 1 Sea Water System
Alarm
Group
Air Manifold Temp
T 35.95 A
T35.95
Z98.00
Temp
Ctr.
AUTO
45.0
MAN
0.0
G311.62
T22.00
G6.36
013
G6.36
T78.49
T78.30
Air Cooler
TBCH 1
Air Cooler
TBCH 2
024
Discharge ME 2
G0.00
G38.16
T22.00
015
T22.18
T 23.97 A
012
T26.28
011
T29.02
Injector Water
Cooler
LO Cooler
Jacket Water
Cooler
P 1.82 A
G63.60
T22.00
051
T23.38
053
T23.51
055
T23.64
Gear LO
Cooler
Servo Oil
Cooler
Stern Tube
Cooler
100.0
P 2.01 A
T 22.00 A
G426.10
SW Pumps
R
R
T22.00
Temp
Ctr.
AUTO
22.0
MAN
0.0
Z32.15
Suction ME 2
024
G0.00
P0.26
G94.32
G426.09
T29.02
G331.77
Overboard
G331.79
ΔP 0.11 A
SEA
CHEST
P3.70
T20.00
M
V
ERS-M22PC-IV REV: 1.1

3.6 Main Engine Sea Water System

General

Each main engine has a separate sea water cooling system.

The purpose of the main engine sea water system is to provide cooling for the following main engine low temperature parts:

- Turbocharger casings
- Scavenging air coolers
- Injector water coolers
- Gear lubrication oil cooler
- Servo lubrication oil cooler
- Stern tube lubrication oil cooler

The common outlet from the above coolers form the inlet to the following coolers lined in order:

- Main engine lubrication oil cooler
- Main engine jacket water cooler

Description

Sea water is taken from the sea chest, through the sea water filter by one of the two electrically driven sea water pumps, discharging the water to the main engine coolers.

In order to avoid condensation of air-humidity at the surface of the sea water pipes and also in order to avoid too low temperatures at lubrication oil cooler inlet, sea water is re-circulated from overboard line to suction line. A PID controller controls the re-circulation valve. The re-circulation line is smaller and has higher flow resistance than the overboard line. The total sea water flow will therefore be reduced at re-circulation. This increases the effect of the temperature control ("positive feed back").

As a safety measure, there is cross over between starboard and port engine sea water systems.

The sea water coolers are designed for a sea water temperature of 32^{o}C.
Normally, only one of the sea water pumps in each system is in operation.

Operation procedure

1.1 Open sea chest valves
1.2 Open pump outlet and inlet valves
1.3 Open valves to coolers
1.4 Open re-circulation valve
1.5 Start one sea water pump locally
1.6 Check temperature controller. Normal re-circulation temperature is 22°C (70°F).
1.7 Put one pump in AUTO mode from the Pump and Compressor panel. Normally one pump is running and one pump is stand by.

Model particulars

- Dirty sea water filter will result in low pump pressure and reduced flow. And cause cavitation.
- Dirty coolers in the engine or gear systems increase the flow resistance and reduce the flow.

Sea water temperature controller

The control valve is operated by control air. Low control air pressure (< 3 bar) increases the effective time constant of the actuator. The nominal (full pressure) time constant of the valve actuator can be inspected/changed.

The standard valve actuator can be changed with a motor driven actuator. The motor control interface is modulated as follows:

- 100 % controller signal gives full opening speed
- 50 % controller signal gives zero speed
- 0 % controller signal gives full closing speed

Studies comparing the dynamic behaviour of the standard actuator system with the motor actuator system are recommended.

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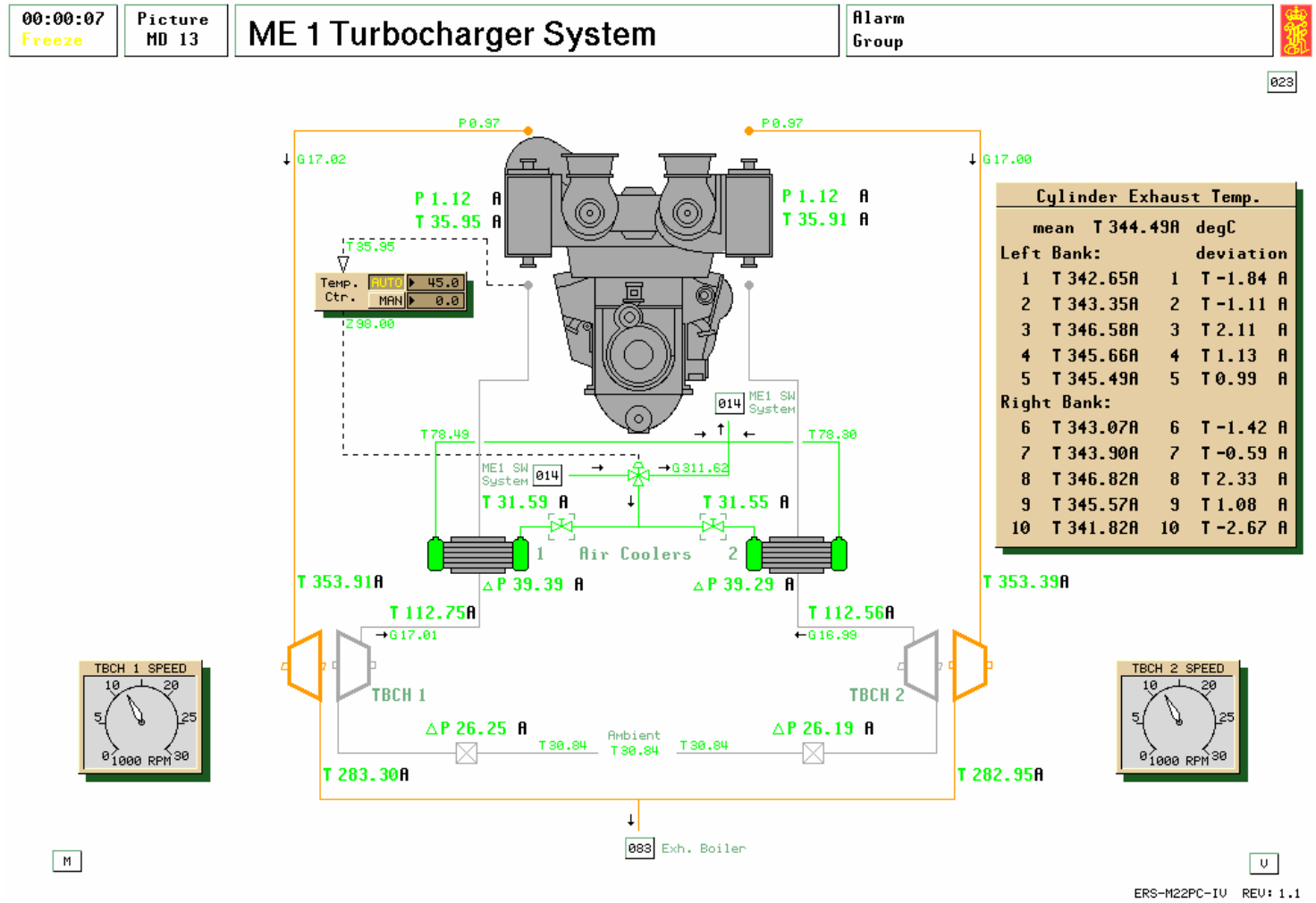

00:00:07
Freeze
Picture
MD 13
ME 1 Turbocharger System
Alarm
Group
023
P 0.97
P 0.97
G17.02
G17.00
P 1.12 A
T 35.95 A
P 1.12 A
T 35.91 A
T35.95
Temp. Ctr.
AUTO
MAN
45.0
0.0
Z98.00
014 ME1 SW System
T78.49
T78.30
ME1 SW System 014
G311.62
T 31.59 A
T 31.55 A
1 Air Coolers 2
T 353.91A
ΔP 39.39 A
ΔP 39.29 A
T 353.39A
T 112.75A
T 112.56A
G17.01
G16.99
TBCH 1
TBCH 2
ΔP 26.25 A
ΔP 26.19 A
Ambient
T30.84
T30.84
T30.84
T 283.30A
T 282.95A
083 Exh. Boiler
Cylinder Exhaust Temp.
mean T 344.49A degC
Left Bank: deviation
1 T 342.65A 1 T -1.84 A
2 T 343.35A 2 T -1.11 A
3 T 346.58A 3 T 2.11 A
4 T 345.66A 4 T 1.13 A
5 T 345.49A 5 T 0.99 A
Right Bank:
6 T 343.07A 6 T -1.42 A
7 T 343.90A 7 T -0.59 A
8 T 346.82A 8 T 2.33 A
9 T 345.57A 9 T 1.08 A
10 T 341.82A 10 T -2.67 A
TBCH 1 SPEED
TBCH 2 SPEED
1000 RPM
M
U
ERS-M22PC-IU REV: 1.1

3.7 Main Engine Turbocharger System

General

The main engine is supercharged by two turbochargers. The charged air is cooled in the air cooler by sea water before entering the cylinders. The air coolers must be kept clean to provide a sufficient amount of charge and cooling air to the cylinders. Too hot charge air will lead to high exhaust temperatures and increased specific fuel oil consumption.

Dirty turbocharger air filters throttle the scavenging air flow and will result in reduced engine performance.

Description

A PID controller, controlling a 3-way sea cooling water distribution valve controls the charge air receiver air temperature.

Operation procedure

1. Line up the system by opening the sea cooling water valves to air cooler 1 and 2.
2. Set the receiver air temperature controller to Auto and adjust the set point to approximately 45°C.

Note: Differential pressure across cooler and air inlet filter must be checked regularly.

Model particulars

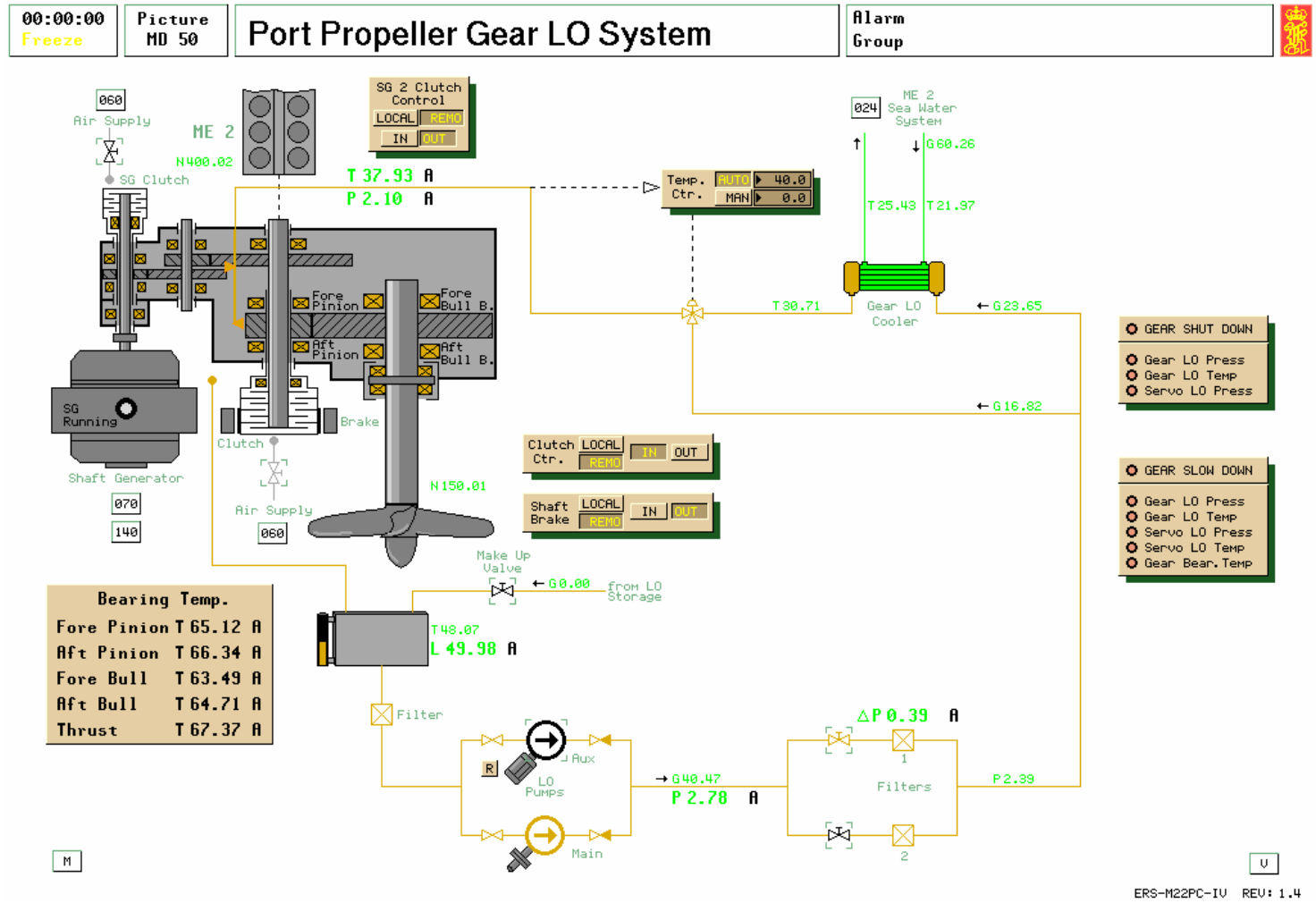
The turbocharger models are composed of two separate units, a centrifugal air compressor, and a single stage gas turbine.

Major variables influencing the compressor torque:
- Discharge pressure (air receiver)
- Suction pressure (air filter differential pressure)
- Air inlet temperature (density)
- Compressor speed

Major turbine torque variables:
- Exhaust receiver pressure
- Exhaust receiver temperature
- Turbine speed

The rpm of the turbochargers is computed on the basis of the torque balance differential equation shared by the turbine and the compressor model units.

Main engine exhaust gas outlet temperatures from each cylinder are presented in this picture, as well as mean temperature and deviation temperatures. DataChief alarms for thermal overload on engines is computed from these values.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Freeze
Picture
MD 50
Port Propeller Gear LO System
Alarm
Group
060
Air Supply
ME 2
N400.02
SG Clutch
SG 2 Clutch Control
LOCAL
REMO
IN
OUT
T 37.93 A
P 2.10 A
Temp. Ctr.
AUTO
MAN
40.0
0.0
024
ME 2 Sea Water System
G60.26
T25.43
T21.97
Fore Pinion
Fore Bull B.
Aft Pinion
Aft Bull B.
SG Running
Shaft Generator
070
140
Brake
Clutch
Air Supply
060
N150.01
T30.71
Gear LO Cooler
G23.65
G16.82
Clutch Ctr.
Shaft Brake
GEAR SHUT DOWN
Gear LO Press
Gear LO Temp
Servo LO Press
GEAR SLOW DOWN
Gear LO Press
Gear LO Temp
Servo LO Press
Servo LO Temp
Gear Bear. Temp
Make Up Valve
G0.00
from LO Storage
T48.07
L 49.98 A
Bearing Temp.
Fore Pinion T 65.12 A
Aft Pinion T 66.34 A
Fore Bull T 63.49 A
Aft Bull T 64.71 A
Thrust T 67.37 A
Filter
ΔP 0.39 A
R
Aux
LO Pumps
Main
G40.47
P 2.78 A
Filters
P2.39
1
2
M
U
ERS-M22PC-IU REV: 1.4

4 PROPELLER AND STEERING GEAR SYSTEMS

4.1 Propeller Gear Lubrication Oil System

General

The propeller gear joins the drive torque from the main engine and transfers it at reduced speed to the propeller shaft and the shaft generator. The drive torque is transferred via air operated frictional clutches.
The propeller thrust bearing is part of the aft gear bearing.
A brake prevents the propeller shaft from rotating when the propeller shaft clutch is not connected.

Description

An electrically driven auxiliary pump or a shaft driven main pump supplies lubricating oil. The electrical auxiliary pump serves both as the lubrication oil pump during starting up and as a stand by pump in the event of break down of the main pump. The pumps take suction from the gear oil drain via a suction strainer and discharge, through duplex filters and the gear oil lubricating oil cooler, to the shaft bearings and thrust bearing and to a number of nozzles providing lubrication for the gear wheels.

The shaft generator clutch, the propeller clutch, and the brake can be operated locally (MAN) or remote from the control room. Clean air for the clutches and the brake is supplied from the control air system.

There is significant heat dissipation in the gear system, and the lubrication oil has to be cooled. The oil is cooled by water from ME sea water system.

A simple P-controller controls the gear inlet lubricating oil temperature by bypassing the coolers. The default settings for the controller are as follows: P-gain is set to 8 and BIAS is set to 25% which means that the output = (P multiplied with deviation) + 25%. There is a small consumption of oil and the gear sump level must be checked and refilled at regular intervals.

The AutoChief monitors the gear system. Slow down command is given at alarm conditions, shut down (disconnection) at critical conditions.

Gear slow down indication:
- Low gear lubricating oil pressure
- High gear lubricating oil temperature
- High bearing temperature

Gear shut down indication:
- Low-low gear lubricating oil pressure
- High-high bearing temperature

Operation procedure

1. Preparation procedure:

1.1 Main engine sea water system must be in service.
1.2 Control air system must be in service.
1.3 Open sea water inlet valves to gear lubricating oil cooler.
1.4 Open selected filter inlet valve.
1.5 Set temperature controller to Auto and check the controller set point.
1.6 Start the electrical gear lubricating oil pumps locally or from the PowerChief Pump Control panel.
1.7 Put the electrically driven gear lubricating oil pump into AUTO from the Pump and Compressor Panel.

2. Clutch Manual Connect

2.1 Open clutch air supply
2.2 Disengage propeller shaft brake manually
2.3 Set propeller clutch in LOCAL and press IN

3. Clutch Manual Disconnect

3.1 Set propeller clutch in Local and press out
3.2 Engage propeller shaft brake

4. Remote Connect and Disconnect

4.1 Set propeller clutch into REMOTE
4.2 Set propeller shaft brake into REMOTE
4.3 Manage the clutch from the AutoChief main engine panel in the control room or from the bridge panel.

Model particulars

- The temperature in the gear lubricating oil sump will gradually cool down to ambient temperature at stand still.
- If clutch is engaged without releasing the shaft brake the main engine torque is increased and the clutch frictional liner will eventually burn of (CLUTCH DAMAGED).

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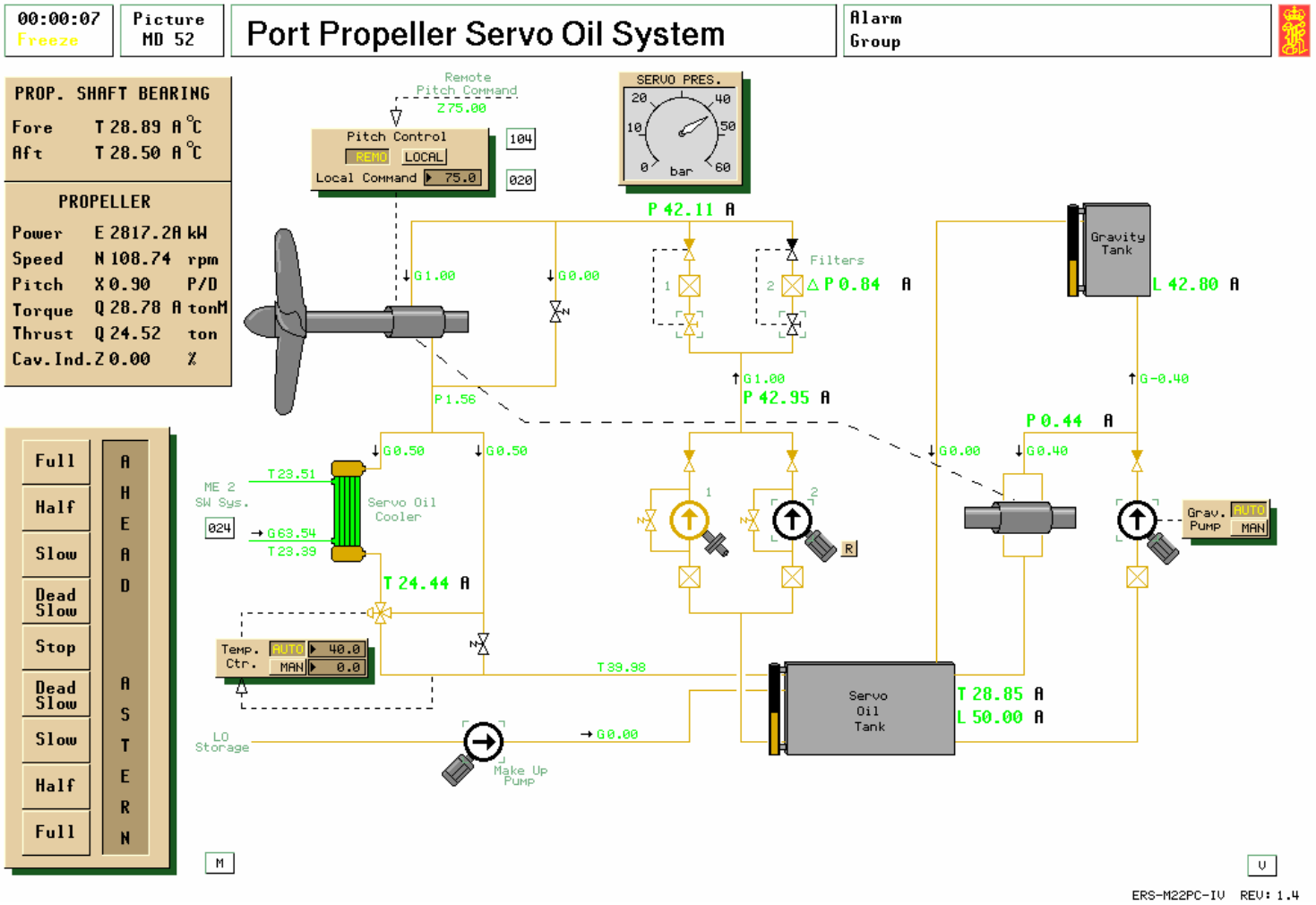

00:00:07
Freeze
Picture
MD 52
Port Propeller Servo Oil System
Alarm
Group
PROP. SHAFT BEARING
Fore T 28.89 A °C
Aft T 28.50 A °C
PROPELLER
Power E 2817.2A kW
Speed N 108.74 rpm
Pitch X 0.90 P/D
Torque Q 28.78 A tonM
Thrust Q 24.52 ton
Cav.Ind.Z 0.00 %
Remote Pitch Command
275.00
Pitch Control
REMO
LOCAL
Local Command 75.0
104
020
SERVO PRES.
bar
P 42.11 A
G1.00
G0.00
Filters
P 0.84 A
Gravity Tank
L 42.80 A
P1.56
G1.00
P 42.95 A
G-0.40
P 0.44 A
Full
Half
Slow
Dead Slow
Stop
Dead Slow
Slow
Half
Full
AHEAD
ASTERN
G0.50
G0.50
T23.51
ME 2 SW Sys.
024
G63.54
T23.39
Servo Oil Cooler
T 24.44 A
G0.00
G0.40
Grav. Pump
AUTO
MAN
Temp. Ctr.
AUTO
MAN
40.0
0.0
T39.98
Servo Oil Tank
T 28.85 A
L 50.00 A
LO Storage
G0.00
Make Up Pump
M
V
ERS-M22PC-IV REV: 1.4

4.2 Propeller Servo System

General

The propeller pitch servo is operated by high-pressure hydraulic oil supplied by a shaft driven pump. An electric pump is used at start and as stand-by.

The pitch control is dependent on hydraulic pressure. At low oil pressure, the maximum rate of pitch change is reduced correspondingly. If the oil is cold, the pitch servo acts more slowly.

Description

The propeller shaft bearings are lubricated via the propeller servo system. When gravity tank pump controller is set to Auto, the pump will start/stop at certain levels. Default settings: start at 30% tank level, stop at 90% tank level, adjustable from variable page.
The generated heat is removed by a sea water cooled lubricating oil cooler, controlled by a P-controller. The arrangement is similar to that of the gear lubricating oil system. Output = (P multiplied with deviation) + BIAS.
When pitch control is set to Local control, the pitch command is set in the numeric window in % of pitch range.

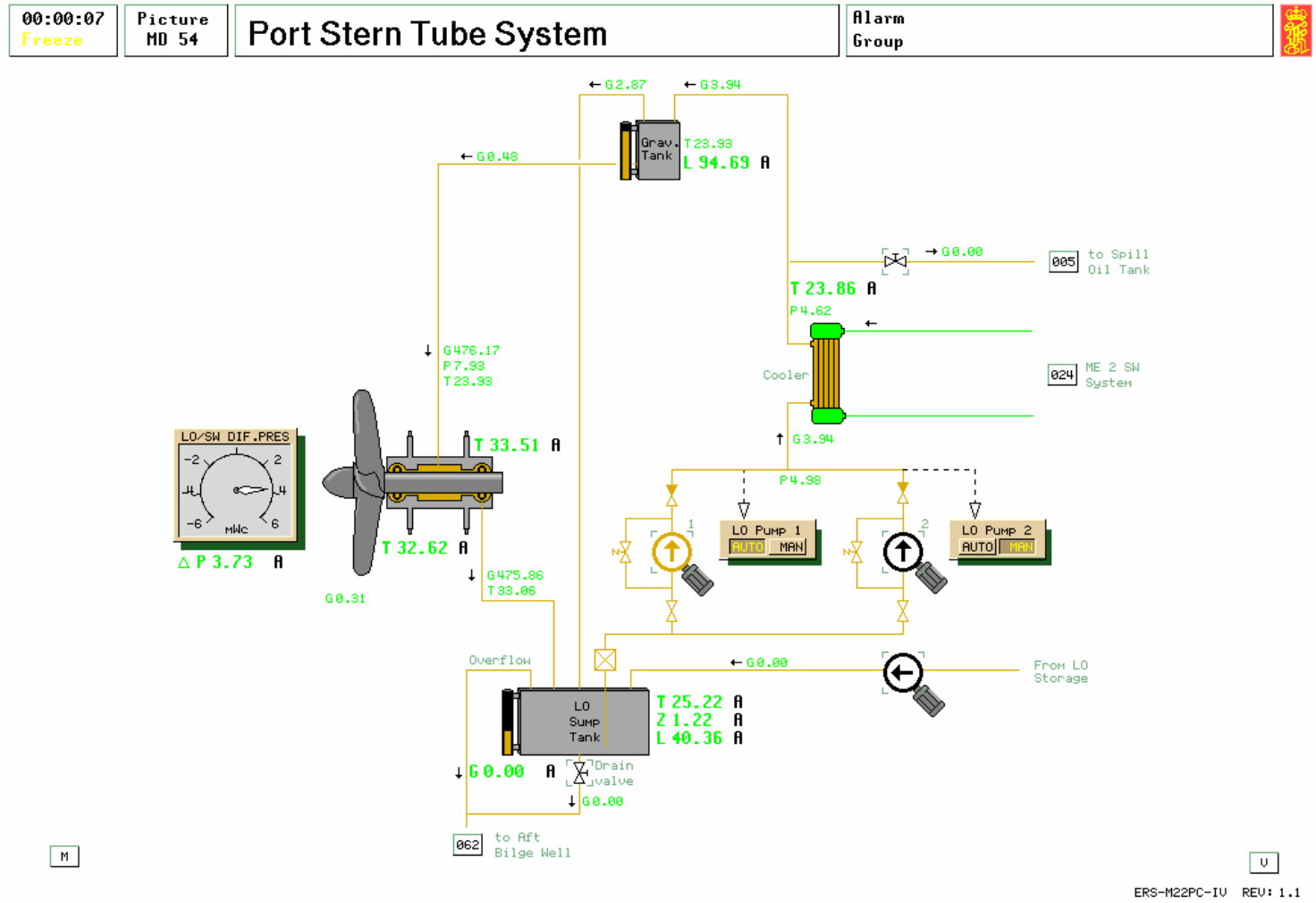
Operation procedure

1. Starting procedure:

1.1 Main engine sea water system must be in service
1.2 Open sea water inlet valves to servo lubricating oil cooler.
1.3 Open selected filter inlet valve.
1.4 Check level in gravity tank.
1.5 Set temperature controller to Auto and check the controller set point.
1.6 Select Local or Remote pitch control
1.7 Start the electrical gear lubricating oil pumps locally or from the PowerChief Pump Control panel
1.8 Put the electrically driven gear pump into AUTO from the Pump and Compressor Panel.

Model particulars

No comments.


00:00:07
Freeze
Picture
MD 54
Port Stern Tube System
Alarm
Group
G2.87
G3.94
G0.48
Grav. Tank
T23.93
L 94.69 A
G0.00
005
to Spill Oil Tank
T 23.86 A
P4.62
G476.17
P7.93
T23.93
Cooler
024
ME 2 SW System
G3.94
LO/SW DIF.PRES
-2
2
-4
4
-6
6
MWc
T 33.51 A
P4.98
LO Pump 1
AUTO
MAN
LO Pump 2
AUTO
MAN
T 32.62 A
Δ P 3.73 A
G475.86
T33.06
G0.31
Overflow
G0.00
From LO Storage
LO Sump Tank
T 25.22 A
Z 1.22 A
L 40.36 A
G 0.00 A
Drain valve
G0.00
062
to Aft Bilge Well
M
V
ERS-M22PC-IV REV: 1.1

4.3 Stern Tube Lubrication Oil System

General

The port and starboard stern tube bearings have separate lubricating systems.

Description

The oil is pumped from the stern tube sump tank to the gravity tank, from where it flows to the stern tube bearings by gravity.
The gravity tank is automatically filled by one of the lubricating oil pumps and surplus oil is continuously drained to the sump tank through an overflow pipe.
If the running pump fails to maintain the level in the gravity tank the stand by pump will start at low level in the gravity tank provided that the pump is in Auto mode. The low-level limit can be adjusted from a variable page.
Stopping of pumps has to be carried out manually.
Refilling of the lubricating oil sump tank is carried out by starting the make-up pump.

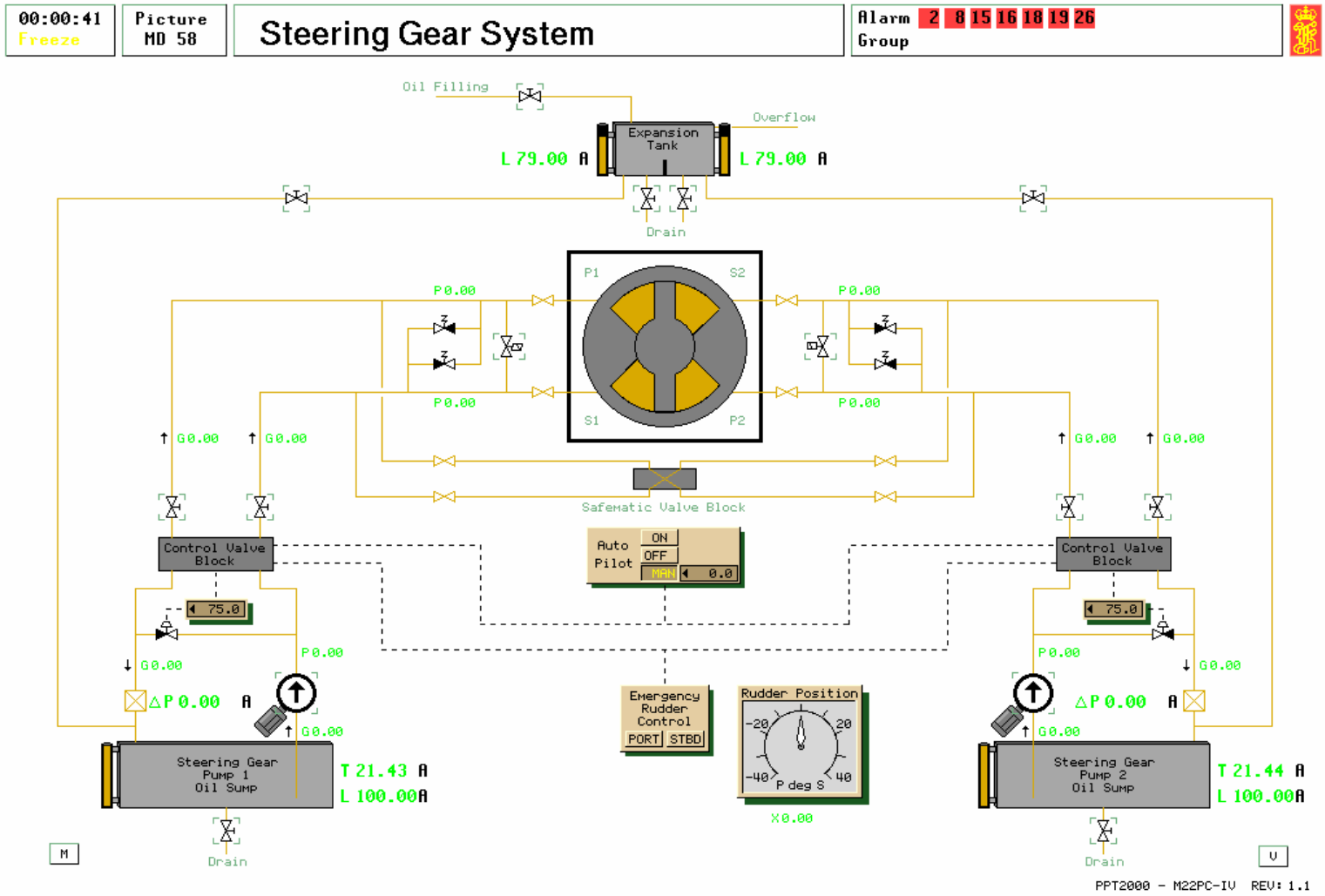
The stern tube lubricating oil is cooled by the main engine sea water system.

Operation procedure

1.1 Ensure cooling water to Stern Tube coolers.
1.2 Refill lubricating oil sump tank if necessary.
1.3 Start the lubricating oil pump in manual.
1.4 When one pump is started, set the other pump in Auto.
1.5 If the running pump is unable to maintain the level in the gravity tank, the stand-by pump starts automatically.
1.6 Stop of pumps to be carried out manually.

Model particulars

No comments.


00:00:41
Freeze
Picture
MD 58
Steering Gear System
Alarm 2 8 15 16 18 19 26
Group
Oil Filling
Overflow
Expansion Tank
L 79.00 A
L 79.00 A
Drain
P1
S2
S1
P2
P0.00
G0.00
Safematic Valve Block
Auto Pilot
ON
OFF
MAN
0.0
Control Valve Block
75.0
ΔP 0.00 A
Steering Gear Pump 1 Oil Sump
T 21.43 A
L 100.00A
Emergency Rudder Control
PORT
STBD
Rudder Position
-20
20
-40
40
P deg S
X0.00
Steering Gear Pump 2 Oil Sump
T 21.44 A
L 100.00A
M
V
PPT2000 - M22PC-IV REV: 1.1

4.4 Steering Gear System

General

The steering gear system comprises:

- one hydraulic steering gear of the rotary vane type,
- two identical hydraulic systems. Each system includes:
  - one steering gear pump Unit
  - one control valve block assembly
  - necessary measuring, indication and alarm facilities for pressure, temperature, level and flow
  - necessary control and safety equipment
- one expansion tank common to both hydraulic systems
- emergency steering control equipment
- rudder angle indication

The steering gear is able to change the rudder position from 35 deg. to –30 within 48 sec. with one pump and 24 sec. with two pumps, independent of ship speed. The increased demand of thrust on the rudder at higher ship speed is taken care of by increased pump pressure.

The steering gear system is of the “IMO model” with the functionality required according to Classification Societies for gas carriers and oil tankers above 100000 tons.

Hydraulic system description

The steering gear itself is operated by two open type, low pressure hydraulic systems.

Each hydraulic system is supplied from a steering gear pump Unit (Power Pack) comprising:

– oil tank with a bottom drain valve
– steering gear pump of the fixed displacement type
– return line oil filter
– level indication
– equipment for monitoring of temperature, pressure and level

Additionally each system is equipped with:

– One adjustable system pressure-relief control valve controlling the maximum discharge pressure from the steering gear pump. Default setting is 75 bar. Above this pressure, the hydraulic oil will be by-passed back to the oil suction tank.
– one chock-relief control valve block with two adjustable relief control valves protecting the steering gear and the hydraulic system against pressure chocks when braking the rudder movement
– stop valves for manual isolating of the system
– one manual operated stop valve for by-pass of the pressure-relief chock valves

The oil tank is connected to the bottom of the expansion tank, common to both hydraulic systems and normally the oil tank is full (100% level).

Each system is provided with the following alarms and safety functions:
– LOW LEVEL - STEERING GEAR UNIT TANK
– LOW LEVEL STOP - STEERING GEAR PUMP
– OIL FILTER HIGH DIFFERENTIAL PRESSURE
– HIGH OIL TEMPERATURE

Steering gear pump no 1 and the belonging controls are supplied from bus bar 1.
Steering gear pump no 2 and the belonging controls are supplied from Emergency bus bar.

Emergency steering may be carried out, in case of system communication failure with the bridge.

Control system description

The steering gear control system is of the on-off type (3-point control). The electrical controlled directional-control valve integrated in each of the control valve blocks controls the rudder angel. The control valve block also includes over center- and flow control valves, necessary for mechanical and hydraulic safety and control.

Normal control (Follow up control)
The directional-control valve receive its control signals from the automatic rudder control system, having its set point either from the auto pilot or from the manual rudder control located both locally and at the bridge steering console.

At deviations between the actual rudder position and the desired rudder position, a port or starboard signal is given to the electrical directional-control valve. The control valve changes its position and hydraulic oil is lead in an out of the respective chambers at the steering gear, shifting the rudder angle towards the desired position as long as the deviation exists.

Emergency control (Non follow up control)
The directional-control valve can be manually controlled by means of the emergency control buttons fitted both at the bridge steering console and locally at the control valve.

Automatic separation control system (Safematic system)

According to international regulations, the steering gear system of larger ships must be provided with automatic separation of the two hydraulic systems, in case of a large oil leakage at one of the systems.

Both steering gear systems are connected to the common expansion tank.
A major oil leak at one of the systems will lead to a decrease of the oil level in the expansion tank and a “LOW LEVEL ALARM - EXPANSION TANK” is activated.
If the oil level continues to decrease both steering gear pumps receives a START command resulting in a start of the stand by steering gear pump.
If the expansion tank oil level is still decreasing it will reach the level where the expansion tank is split up into two chambers by an internal partition plate. Each steering gear system is now supplied from its own expansion tank chamber and the decrease in oil level

will only take place in the chamber connected to the defective system. A low level switch in the chamber in question stops the respective steering gear pump and shifts the safematic control valve block into a position where:

– the two system are separated from each other
– the steering gear chambers connected to the defective system are by-passed (short-circuited)

After the separation the defective system will be shut down (pump stops, control valve block will close)

NOTE
In this condition, the steering gear torque is reduced and the ship's speed must immediately be reduced to 7 knot and the rudder angle must not exceed 15^{o}.

The separation system can be tested by draining the expansion tank.

The systems can also be separated manually by means of the safematic valve block and the by-pass valves.

Operation procedure

1. **Preparation**

1.1 Check content in hydraulic oil tanks, refill if necessary.
1.2 Check that steering gear shut off valves are open.
1.3 Check that Safematic valve block valve is open (position is changed from variable page).
1.4 Start steering gear pump(s) locally or remotely from control room or bridge.

Testing of steering gear should be carried out before leaving port. This is normally carried out from the bridge.

2. Pumps

2.1 During normal operation at sea only one pump is in operation
2.2 During manoeuvre and in congested waters two pumps must be in operation.
2.3 Starting and stopping of the pumps can be carried out locally or remote via the Power Chief - Pump Control system or from the bridge steering consoles.

3. Drain and oil filling

3.1 Oil and water drainage from the steering gear systems can take place from:
  3.1.1 The bottom of each chamber in the common expansion tank
  3.1.2 The button of each steering gear pump unit tank
3.2 Oil filling is done via the filling valve fitted at the expansion tank.

4. Rudder commands

4.1 Rudder command can be set manually on SERVO.
4.2 To set specific rudder commands, select SERVO and enter numeric values in %.
4.3 Autopilot can be set to specified course commands.
4.4 Select ON and enter course.
4.5 Servo speed is dependent on servo oil pressure.
4.6 In bad weather, two pumps can be run to obtain quicker servo response to auto pilot.

Emergency steering to be carried out by pressing the port/stbd buttons, remotely from bridge or locally by manually control of the control valve block position.

Note that if a failure of automatic control of by-pass and safematic valves should occur, these valves have to be operated locally.

Model particulars

For studies of mutual influence between the steering gear and autopilot the autopilot is made available in the mimic diagram 58.

When the leakage fault is identified and “repaired”, the valves have to be manually put back to normal position.

Rudder command can be set manually on SERVO to study effects of sudden large variations on rudder.

Servo speed is dependent on servo oil pressure.

As long as the directional-control valve is activated the discharge pressure is a function of the pressure drop in the control valves and system piping and at the rudder torque and the maximum pressure is limited by the set point of the pressure-relief control valve. When the directional-control valve is **not** activated, the system pressure-relief control valve is relieved and the pump pressure decreases to a very low value (5-10 bar - caused by the very short piping around the pump unit and the return line filter).

If the rudder command causes the rudder angle to shift to one of the extreme positions, the steering gear vane is limited by the steering gear body at 35° and the pressure will increase to set point of system pressure-relief control valve (normally 75 bar).

If this condition remains for a prolonged period, the oil temperature will rise. At temperature level above approx. 65^{o}C decomposing of the oil and pump wear will increase exponentially and end with a break down of the pump.

Steering gear system malfunctions

Pump units

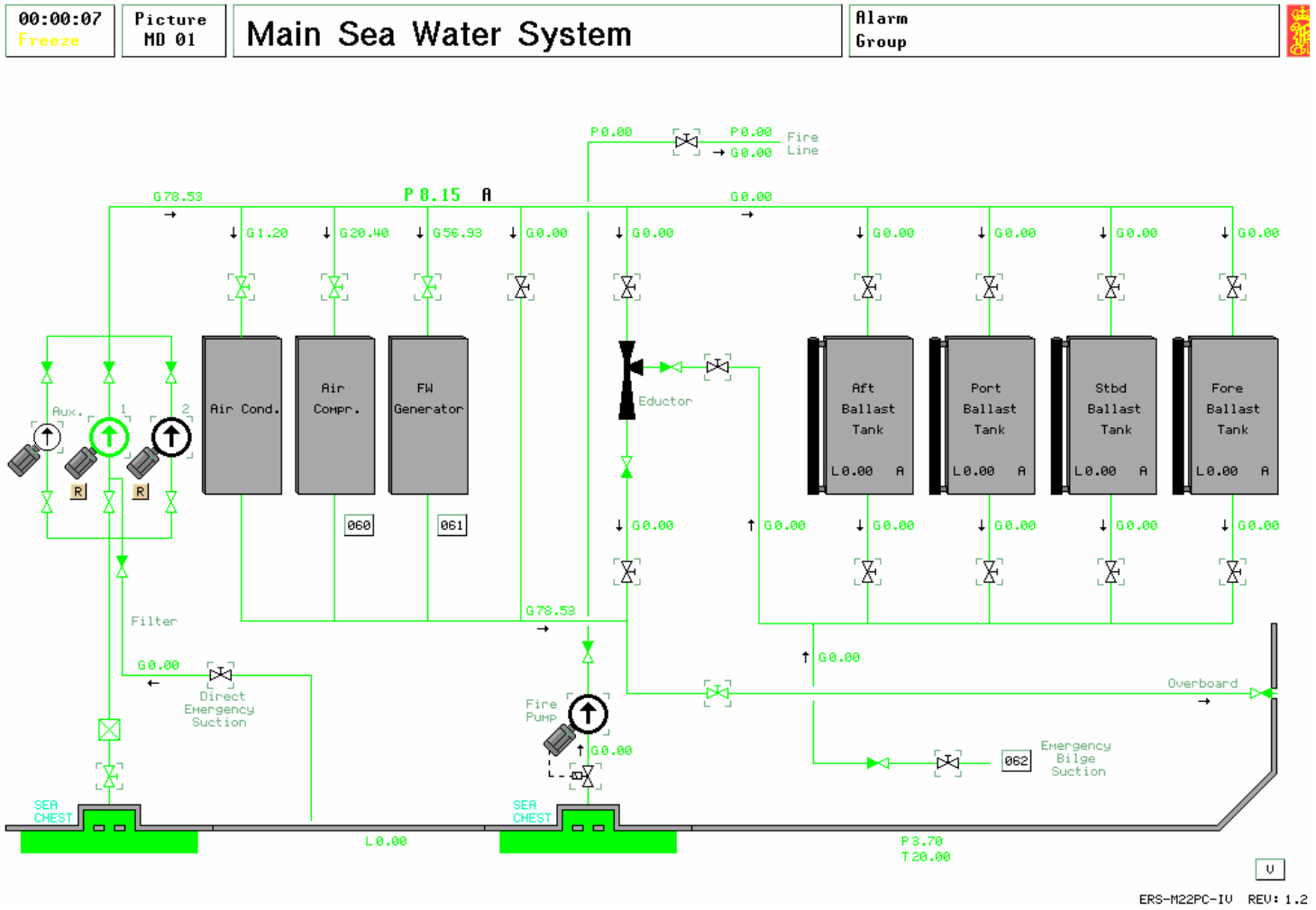
- Pump wear
- Pump failure
- Filter blocked (Normal pressure drop across the return line filter is below 1 bar).

Hydraulic system

A leak (0-100%) can be set for each system causing decreasing level in the expansion tank resulting in low level alarm followed by stop of steering gear pump and activation of the safematic control valve.

Control system

Rudder command signal from bridge failure (off).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Picture
MD 01
Main Sea Water System
Alarm
Group
P0.00
P0.00
G0.00
Fire
Line
G78.53
P 8.15 A
G0.00
G1.20
G20.40
G56.93
G0.00
G0.00
G0.00
G0.00
G0.00
G0.00
Aux.
1
2
R
R
Air Cond.
Air
Compr.
FW
Generator
060
061
Eductor
Aft
Ballast
Tank
L0.00 A
Port
Ballast
Tank
L0.00 A
Stbd
Ballast
Tank
L0.00 A
Fore
Ballast
Tank
L0.00 A
G0.00
G0.00
G0.00
G0.00
G0.00
G0.00
Filter
G78.53
G0.00
G0.00
Direct
Emergency
Suction
Overboard
Fire
Pump
G0.00
062
Emergency
Bilge
Suction
SEA
CHEST
SEA
CHEST
L0.00
P3.70
T20.00
U
ERS-M22PC-IU REV: 1.2

5 SERVICE SYSTEMS

5.1 Main Sea Water System

General

The main sea water system provides sea water for ballast and cooling systems, except the main engines and ship service generators, which have separate sea water systems.

Description

Two main sea water pumps and one auxiliary pump discharge sea water to the main sea water pipe going from the stern to the bow of the ship. The sea water ballast tanks are filled from the main sea water pipe and emptied through a common bottom line by means of an eductor.

The control room air conditioning will not work until the sea water supply valve is opened.

Sea water to the start air and service air compressors and air coolers is supplied through a common supply line.

Emergency suction lines from the bilge system are connected to the sea water pumps, and in critical situations the bilge may be pumped directly over board.

The fire line is a fully independent system with a separate pump and suctions.

A separate line is connecting the eductor to the bilge wells thus enabling the eductor to be used if the bilge panel breaks down.

Operation procedure

1. Sea water cooling

1.1 Open sea water pump sea chest suction valves. Open sea water discharge overboard valve. Open sea water inlet valve(s) to cooler(s).

1.2 Open sea water stop valves to the systems which are to be put into service.

1.3 Start sea water pump. When starting from shore power or emergency generator, only the AUXILIARY pump can be started.

1.4 If the fresh water generator is not in operation and there is no need for ballasting, the aux. pump is sufficient both in port and at sea.

1.5 If the fresh water generator is in operation, one of the main sea water pumps must be in service.

1.6 The main sea water pumps may be put in stand by mode by selecting AUTO mode at the PowerChief-Pump and Compressor panel.

2. Ballasting

2.1 One or two main sea water pumps to be in service during ballasting.

2.2 The ballast tanks can only be emptied with the eductor.

2.3 The performance of the eductor is dependent on drive pressure and suction pressure/flow.

3. Fire pump and fire main line

3.1 Fire pump sea chest suction valve and fire pump discharge valve must always be open.

3.2 Before starting the pump, ensure that a valve on the fire main is open in order to prevent over heating of the pump.

Model particulars

- The pressures at the tank bottom valves are corrected for geodetic height differences of tank bottoms. Therefore, sea water ballast will flow by force of gravity between tanks with the result that tank levels will adjust according to trim and heel of the ship.
- Contrary to other tank systems, the level time response of the sea water ballast tanks (and fuel oil bunker tanks) is modelled in real time. Filling / emptying these tanks is time consuming. The level response of these tanks can be increased separately by the factor from 1 to 10 in order to speed up the simulation lessons.
- **Note:** On actual ships, ballast pumps and cooling water pumps are often separated. On the simulator plant, ballast can be correctly pumped into tanks, but only emptied with eductor.
- If pumps on the simulator are used with direct suction from tanks, risk of loosing coolant pressure would be imminent.
- Opening the water cannon from variable page creates fire main consumption.

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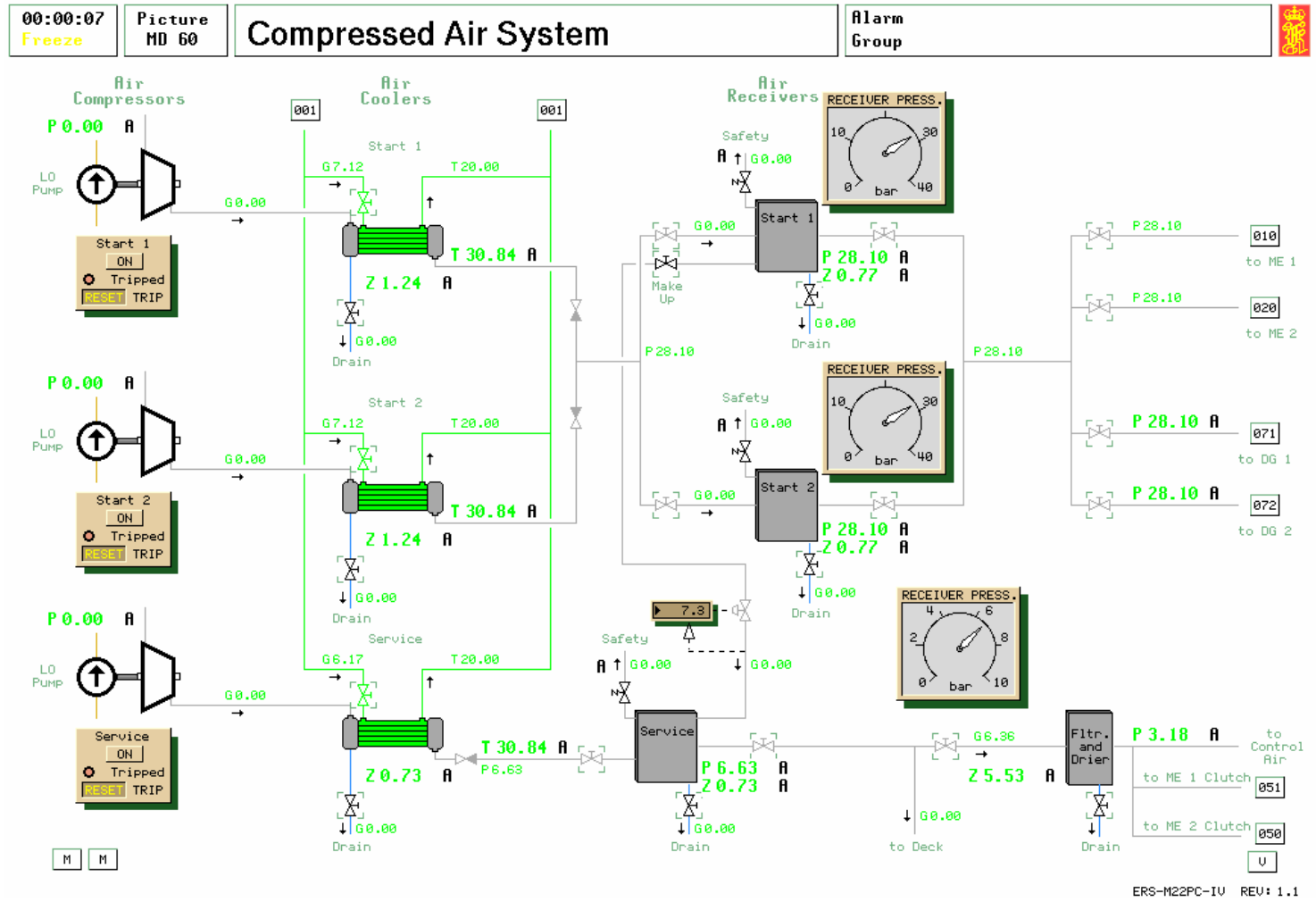
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Picture
MD 60
Compressed Air System
Alarm
Group
Air Compressors
Air Coolers
Air Receivers
P 0.00 A
LO Pump
Start 1
ON
Tripped
RESET TRIP
Start 2
Service
G0.00
G7.12
G6.17
T20.00
T 30.84 A
Z 1.24 A
Z 0.73 A
P6.68
Drain
001
RECEIVER PRESS.
bar
Safety
Make Up
P 28.10 A
Z 0.77 A
P 28.10
7.3
P 6.63 A
Z 0.73 A
G6.36
Z 5.53 A
to Deck
Fltr. and Drier
P 3.18 A
to Control Air
to ME 1 Clutch
to ME 2 Clutch
051
050
V
010
to ME 1
020
to ME 2
071
to DG 1
072
to DG 2
M
ERS-M22PC-IV REV: 1.1

5.2 Compressed Air System

General

The purpose of the compressed air system is to provide starting air to the diesel engines and to supply service air to the control equipment and control valves in the engine room, and for general consumption purposes in engine room and at deck.

The compressed air system consists of two start air compressors, one service air compressor, two start air receivers, one service air receiver, and a filter drier assembly for control air.

All compressors start and stop automatically according to need by the compressor control system included in the PowerChief system if the compressor is in AUTO position.

Description

Each air compressor is monitored by an independent, local safety system.
The air compressors will trip at:

	Start air comp.	Service air comp.
Disch. air temp.	> 110°C	> 100°C
Lub oil press.	< 0.75 bar	< 0.75 bar

All compressors are cooled by sea water. High air outlet temperature is indicated by a red alarm light on the compressor panel.

The start air receivers can be operated in parallel, or one of the receivers can be pressurised and shut off to be kept as a standby receiver. The main and the auxiliary diesel engines are supplied by separate air lines and stop valves from one or both of the air receivers.

The safety valves for the start air receivers open at approximately 32 bar. The settings of the safety valves can be changed from the variable page.

The air receivers and the air coolers will gradually fill with water, depending on compressed air production and air humidity. The receivers and coolers must be manually drained regularly. Much water in the start air receivers will reduce starting capacity.

The air to the control equipment is filtered and dried and pressure reduced by a pressure reduction valve (part of the filter/drier assembly).

If the service air compressor fails, make-up air can be taken from the #1 start air receiver. An air reduction control valve closes the make-up gradually at increasing service air pressure. The valve is pressure controlled, with an opening set point set slightly lower than the auto start set point of the service air compressor.
The air make-up valve is usually left open for safety reasons. If the service air compressor trips, service, and control air pressure is not lost, but supplied through the starting air receivers. This may prevent a serious situation like a shut down of the main engine in narrow waters.

Under certain conditions, starting air compressors "produce" a considerable amount of water. The starting air may also contain a small amount of oil. This will gradually reduce the efficiency of the air dryer/cooler and is therefore not desirable. By keeping the service air compressor in service, carry over of dirty air from the starting air compressors to the control air system is prevented.

Carefully consider if or when to close the service air make-up valve.

The safety valve of the service air receiver opens at approximately 8 bar.

Operation procedure

Start air compressors

1. Preparations before starting start air compressors after a longer period out of operation.

1.1 Check that main sea water system in operation and that the valve to air compressor coolers is open. Auxiliary seawater pump capacity is sufficient.
1.2 Open sea water inlet valve(s) to start air cooler(s).
1.3 Open drain valve(s) from start air cooler(s).
1.4 Open air inlet valve(s) to start air receiver(s).
1.5 Open air outlet valve(s) from start air receiver(s).
1.6 Open drain valve(s) from start air receiver(s).

Note: Start air compressor no 2 is supplied from emergency switch board.

2. Starting procedure

2.1 If the selected compressor is tripped (TRIPPED lamp lit), press RESET button on the compressor panel. Start the compressor by pressing button ON.
2.2 Close drain valves.
2.3 Select AUTO mode on the PowerChief panel. The compressor will then start and stop according to the limits given. These limits are adjustable from the variable page 7024.
Note: When a compressor is started manually it is not stopped automatically by a pressure control.
2.4 When pressure in air vessel increases open air supply valve(s) to selected consumer(s).

3. Normal operation

3.1 Normally both start air vessels are pressurised and in operation.
3.2 During sea passage one of the start air compressor and the service air compressor is in AUTO mode.
3.3 During manoeuvre both starting air compressors to be put into AUTO mode.
3.4 Air receivers and air coolers must be drained regularly.

Service Air Compressor

4. Preparations before starting start air compressors after a longer period out of operation.

4.1 Check that main sea water system in operation and the valve to air compressor coolers.
4.2 Open sea water inlet valve to service air cooler.
4.3 Open drain valve from service air cooler.
4.4 Open air inlet valve to service air receiver.
4.5 Open drain valve from service air receiver.
4.6 Open air outlet valve from service air receiver.
4.7 Open air inlet valve to service air filter and dryer.
4.8 Open drain valve from service air dryer.

5. Starting procedure

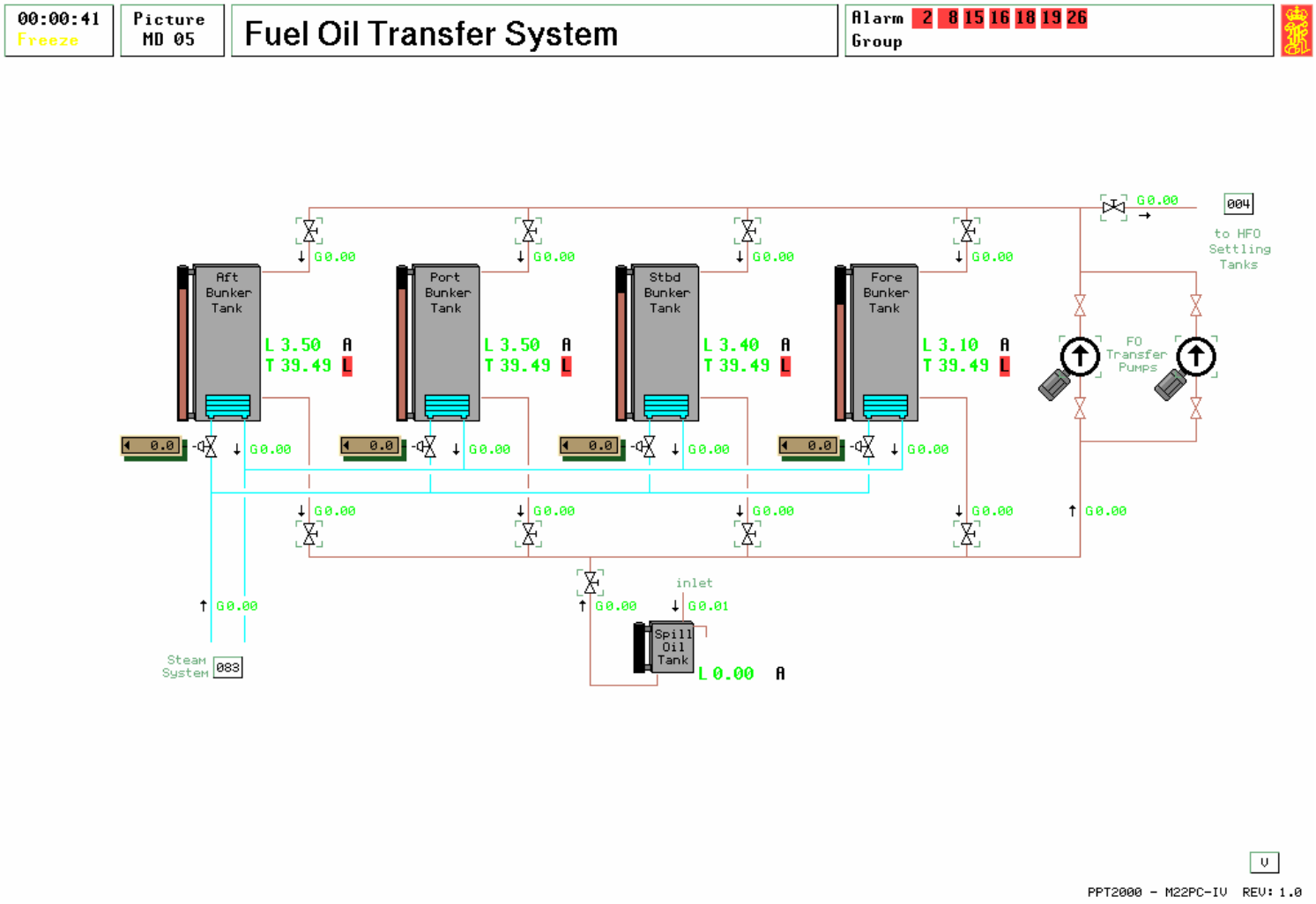
5.1 If the compressor is tripped (TRIPPED lamp lit), press RESET button on the compressor panel. Start the compressor by pressing button ON.
5.2 Close service air make-up valve from start air receiver no. 1 (see note).
5.3 Close drain valves.
5.4 Select AUTO mode on the PowerChief panel. The compressor will then start and stop according to the limits given. These limits are adjustable from the variable page 7024.
Note: When a compressor is started manually, it is not stopped automatically by a pressure control.

6. Normal operation

6.1 The service air compressor is normally operated in AUTO mode.
6.2 The stop valve for the make-up line is normally open.
6.3 Check that the set point of the make-up valve is slightly below the set point of the service air compressor.
6.4 Drain air receiver, air cooler, and filter drier regularly.

Model particulars

- The basic start air leakage is set to give 2-3 compressor starts per hour. The air flow delivered from the start air or service air compressor is dependent on the discharge (receiver) pressure.
- The start air consumed during a main engine start depends on start duration and engine speed. The diesel generators draw an equal amount of air for each start.
- All main control valves included in the ship machinery are assumed to be air operated. As the control air pressure is reduced, these devices will be slower and the effective actuator time constants are increased. Various control loop problems may develop at low control pressure. Some of the loops will be slow and stable, others conditionally unstable (unstable in an intermediate range).
- The service air compressor in this system is often called an "instrument air compressor" and is usually of the "oil free" type. In addition there is often a "working air compressor" supplying consumers not including delicate instrument systems.
- Much water in the service air receiver will lead to problems with the oil viscosity controller. If the intermediate air cooler is not drained regularly, it will gradually fill with water and overheat.


00:00:41
Freeze
Picture
MD 05
Fuel Oil Transfer System
Alarm 2 8 15 16 18 19 26
Group
G0.00
004
to HFO
Settling
Tanks
Aft
Bunker
Tank
L 3.50 A
T 39.49 L
Port
Bunker
Tank
L 3.50 A
T 39.49 L
Stbd
Bunker
Tank
L 3.40 A
T 39.49 L
Fore
Bunker
Tank
L 3.10 A
T 39.49 L
FO
Transfer
Pumps
0.0
G0.00
inlet
G0.01
Spill
Oil
Tank
L 0.00 A
Steam
System
083
V
PPT2000 - M22PC-IV REV: 1.0

5.3 Fuel Oil Transfer System

General
The heavy fuel oil transfer system include four bunker tanks, one spill oil tank, two transfer pumps and necessary piping.

Description
The transfer pumps take suction from any of the bunker tanks or the spill oil tank and discharge to the settling tanks or return to any of the bunker tanks.

The transfer pumps must be started manually at low settling tank level or high spill oil tank level.

The spill oil tank receives oil from:
over flows:

- HFO settling tank l
- HFO settling tank 2
- HFO service tank
- DO service tank

drain flows:

- Venting tank
- HFO service tank
- DO service tank

Steam heating
The bunker tanks are heated by steam. The steam flow to the heating coils is manually controlled by throttle valves.

Engine room fire
If overflow from the Spill Oil tank is disregarded, engine room fire will develop. The fire can be extinguished after the following actions have been taken:

- the engine room ventilation fans stopped
- fuel oil pumps stopped
- the main engines stopped.
- the sea water fire line made operational

Operation procedure

1.1 Co-ordinate with the deck department before attempting to transfer fuel oil.
1.2 Open inlet to selected tank from HFO transfer pump.
1.3 Open outlet from selected bunker tank.
1.4 Observe that transfer of oil between bunker tanks is possible.
1.5 Start transfer pump after opening of outlet valve. Normally one pump is sufficient.
1.6 **Ensure that valves to bunker tanks are closed when transferring to settling tanks.**

Fuel oil in the bunker tanks to be heated and kept at a temperature corresponding to the temperature at delivery.

Note: If large amount of heavy fuel is transferred to the settle tank, it may cause at considerable temperature drop in the settling tank, which again may cause separator disturbance.

Note: Transfer of diesel oil is done with diesel oil purifier on separate instruction.

Model particulars

The heating is proportional to the steam flow, which is set by manually controlled throttle valves. If the heating is turned off, the bunker tank temperature will slowly cool down towards ambient (sea water) temperature.

The flow resistance in the heavy fuel oil lines is dependent on temperature. The resistance increases at temperatures below 60°C, and below 20°C, no flow is possible.

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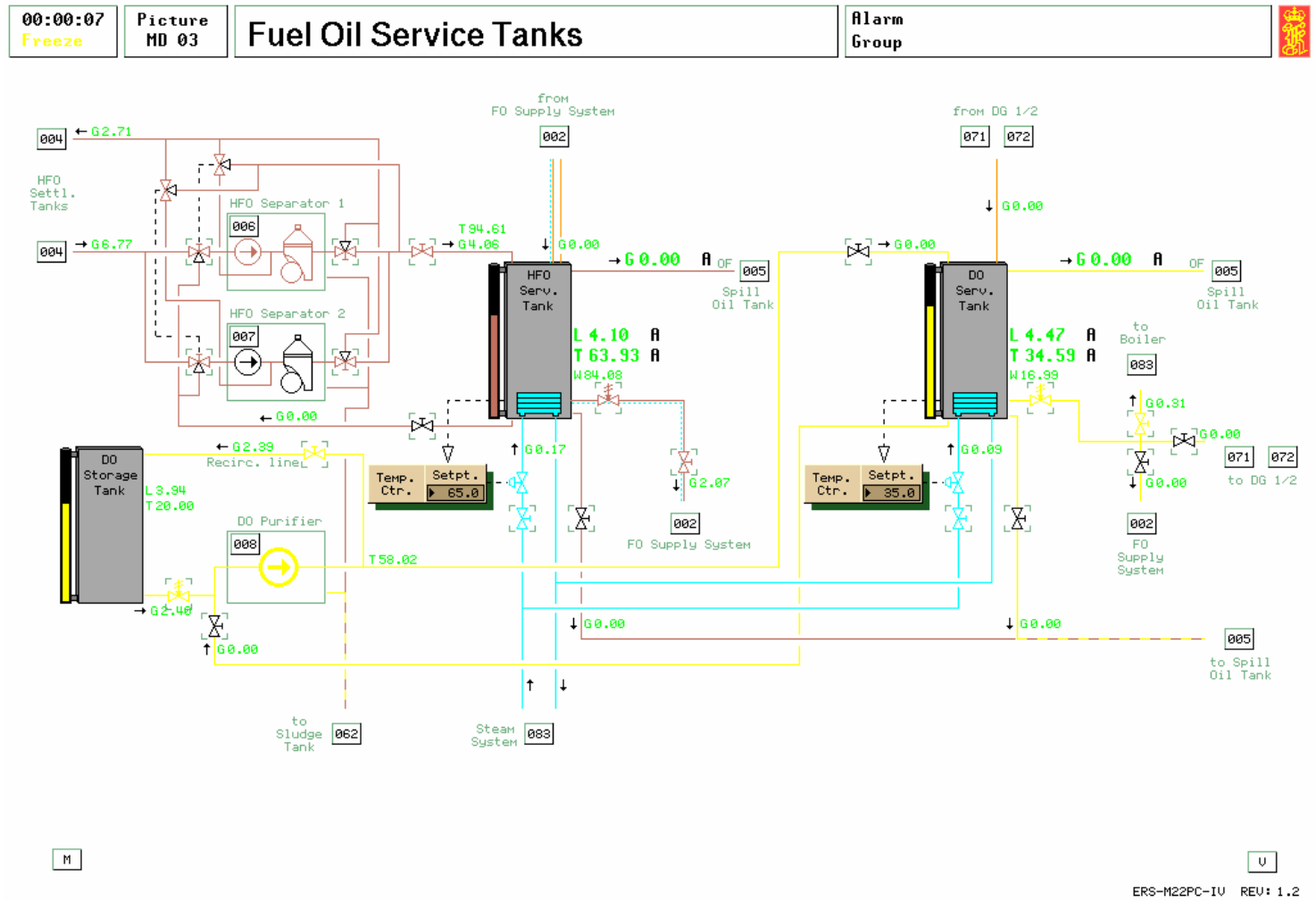
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Picture
MD 03
Fuel Oil Service Tanks
Alarm
Group
from
FO Supply System
002
from DG 1/2
071
072
004
G2.71
HFO
Settl.
Tanks
004
G8.77
HFO Separator 1
006
HFO Separator 2
007
T94.61
G4.06
G0.00
G 0.00 A
OF
005
Spill
Oil Tank
HFO
Serv.
Tank
L 4.10 A
T 63.93 A
W84.08
G0.00
G0.00
G 0.00 A
OF
005
Spill
Oil Tank
DO
Serv.
Tank
L 4.47 A
T 34.59 A
W16.99
to
Boiler
083
G0.31
G0.00
071
072
to DG 1/2
G0.00
G2.39
Recirc. line
DO
Storage
Tank
L 3.94
T 20.00
Temp.
Ctr.
Setpt.
65.0
G0.17
G2.07
002
FO Supply System
Temp.
Ctr.
Setpt.
35.0
G0.09
002
FO
Supply
System
DO Purifier
008
T58.02
G2.40
G0.00
G0.00
G0.00
005
to Spill
Oil Tank
to
Sludge
Tank
062
Steam
System
083
M
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5.4 Fuel Oil Service Tanks

General

Fuel oil service tanks comprise the fuel oil service tank, the diesel oil storage tank, the diesel oil service tank and the separator systems for fuel oil and for diesel oil.

The fuel oil service tanks store and preheat the cleaned fuel oil.

The HFO service tank supplies fuel oil to:
- Fuel oil service system.
- Boiler burner system.

The diesel oil service tank supplies diesel oil to:
- Fuel oil service system.
- Diesel generators (when operated on diesel oil).
- Boiler burner system (when operated on diesel oil).

Description

HFO service tank and HFO separator system.
HFO separator 1 and 2 fills the HFO service tank.

Both HFO separators can take suction from:
- HFO Settling tanks.
- HFO service tank.

Both HFO separators discharge to:
- HFO service tank.

Only one HFO separator is intended to be in operation with a capacity corresponding to the present total consumption of heavy fuel oil.

DO service tank, storage tank and DO separator system.
The diesel oil separator fills the DO service tank.

The diesel oil separator can take suction from:
- Diesel oil storage tank.
- Diesel oil service tank.

The diesel oil separator discharge to:
- Diesel oil service tank.

Steam heating

The service tanks are equipped with steam heaters.
The temperature is controlled by simple P-controllers, positioning the steam control valves according to tank temperature and temperature set point.

The temperature in the service tanks will normally be maintained at a temperature corresponding to the normal discharge temperature from the separator.

All HFO supply and return lines are steam traced supplied from the steam reduction valve - refer to the FO service system.

Miscellaneous

The HFO service tank has return pipes from venting tank, fuel oil service system, and boiler burner system and from the diesel generators.
The diesel oil service tank has return pipe from the diesel generators.
Overflow from the service tanks goes to the Spill Oil tank.

The service tanks are provided with drain valves and the drain are led to the Spill Oil tank.
The diesel oil storage tank is provided with a drain valve and the drain is led to the sludge tank.

The service tanks and the diesel oil storage tank are provided with shut off valves (quick-release, remote controlled shut-off valves) at the tank outlet.

Operation procedure

1.1 Open the heating supply valve to the heating coils and set the desired temperature from the controller.
1.2 HFO service tank temperature controller to be set at 60^{o} C.
1.3 DO service tank to be set at 35^{o}C.
1.4 Settling tank temperature to be set 5-10^{o}C below flame point.
1.5 HFO requires temperatures above 20^{o}C to be pumped.
1.6 Drain water from tanks periodically.
1.7 At high water level, the DataChief will activate the alarm system.
1.8 Water content can be read in %.
1.9 When switching tanks, always open inlet/outlet valves to "new" tanks before closing respectively on "old" tank.

Model particulars

The heat effect is proportional to the steam flow, which depends on the control valve position and the steam pressure. The temperature of the service tanks depends on steam heating, loss to surroundings and temperature of inlet flow from purifier and return flows. The fuel oil viscosity in the service tanks is computed.

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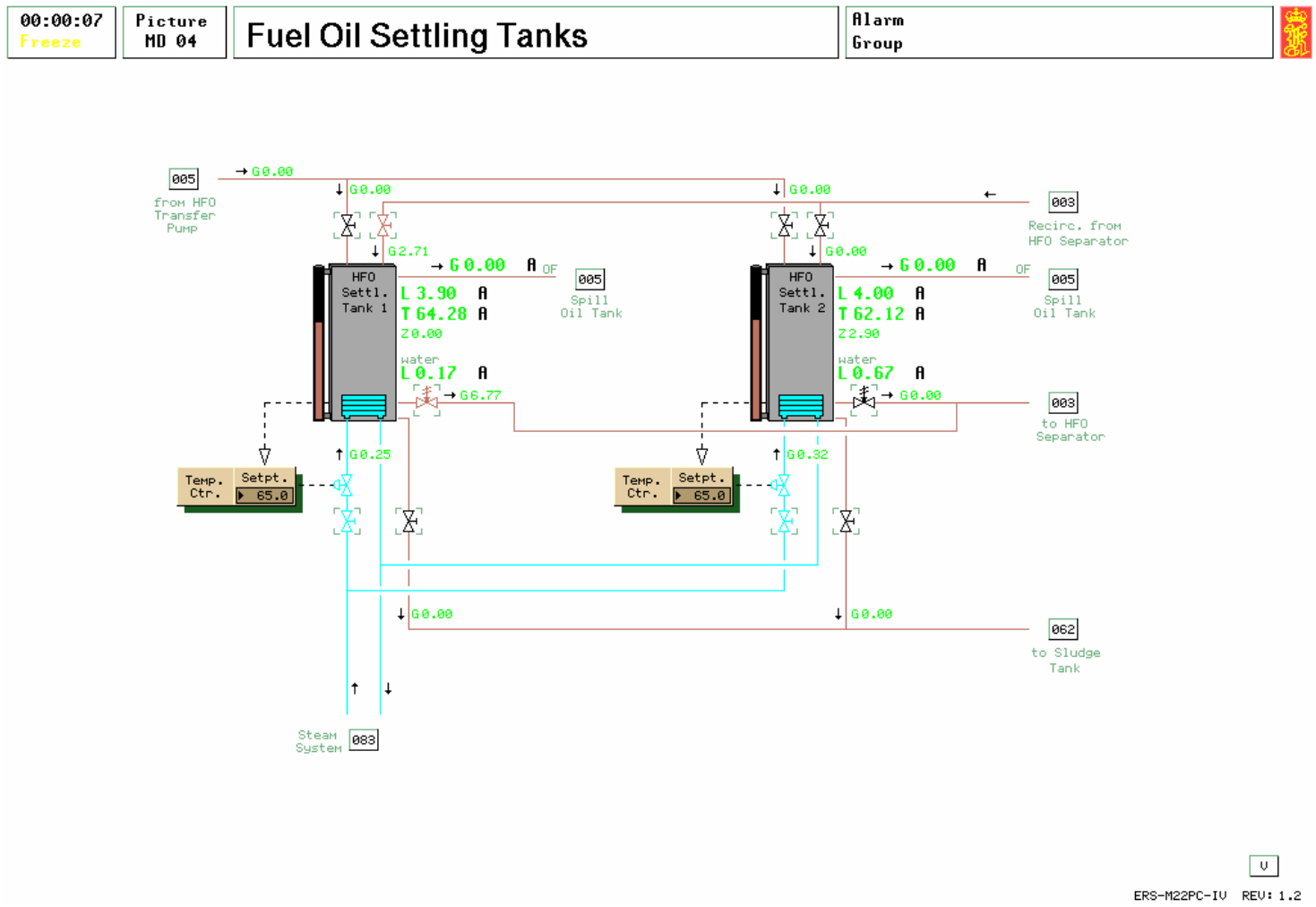
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Freeze
Picture
MD 04
Fuel Oil Settling Tanks
Alarm
Group
005
from HFO
Transfer
Pump
G0.00
G2.71
HFO
Settl.
Tank 1
L 3.90 A
T 64.28 A
Z0.00
G 0.00 A OF
005
Spill
Oil Tank
water
L 0.17 A
G6.77
HFO
Settl.
Tank 2
L 4.00 A
T 62.12 A
Z2.90
G 0.00 A OF
005
Spill
Oil Tank
water
L 0.67 A
G0.00
003
Recirc. from
HFO Separator
003
to HFO
Separator
Temp.
Ctr.
Setpt.
65.0
G0.25
G0.32
G0.00
062
to Sludge
Tank
Steam
System
083
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5.5 Fuel Oil Settling Tanks

General

Fuel oil settling tanks comprises HFO Settling tank no. 1 and no. 2.

The purpose of the HFO settling tanks is to:

- Settle bulk water
- Act as buffer tank for the HFO separator system
- Supply the HFO separators with fuel oil of an almost constant temperature

Description

There are two identical HFO settling tanks. Both tanks are filled from the oil transfer system by the HFO transfer pumps. The filling line at each settling tank is provided with a shut-off valve.

By means of shut-of valves (quick-release, remote controlled shut-off valves) at the outlet from each HFO Settling tank and belonging piping system, provision is made to have the HFO separators to take suction from one or both settling tanks.

Bulk water settled in the settling tanks can be drained from the bottom of the tank to the sludge tank via a drain valve.

Steam heating

The temperature is controlled by simple thermostatic P-controllers, positioning the steam control valves according to tank temperature and temperature set.

Miscellaneous

Overflow from the settling tanks is led to the Spill Oil tank.
Each HFO settling tank has a return line with shut-of valve for excess oil from the HFO separator feed pumps.

Operation procedure

1.1 Open the heating supply valve to the heating coils and set the desired temperature from the controller.
1.2 Settling tank temperature to be set 5-10^{o}C below flame point.
1.3 HFO requires temperatures above 30^{o}C to be pumped.
1.4 Drain water from tanks periodically.
1.5 Water content can be read in %.

Model particular

- If the temperature of the oil in the settling tank cools below a certain limit (40°C), it will be difficult for the purifier feed pump to transport the oil.

- The process of water precipitation in the settling tanks is properly modelled so that the water in the oil from the bunker tank will gradually fall towards the tank bottom by force of gravity. The water content in the oil from the bunker tank can be adjusted.
- If the collected water is not discharged regularly, HFO purifier problems will finally be experienced (such as excess water to sludge tank).

- In order to simulate visual inspection of the water/oil mixture, oil/water interface level is presented on screen at each tank.

- The fuel oil quality (heat value, viscosity and density) in the settling tanks is set manually by the instructor. These values will influence the separator system, the fuel oil service system (viscosity and heating demands) and the operation of the diesel engines (mass flow, fuel oil pump index, exhaust temperatures and the output from the diesel engines).
- Studies of how the fuel oil quality influences on the main engine (governor response) are recommended.
- The water content in the oil from the bunker tank can be adjusted from the variable page.

If local engine room panels are used in the simulator configuration:
The drain valves can be opened at the local panel. In order to simulate visual inspection of the water/oil mixture, use is made of the panel light of the valve. A steady light indicates that the valve is open and water is flowing. A flashing light indicates that the valve is open and mostly oil is flowing. Note that the flashing light function is available only when Local Panel is used for operating the fuel oil settling tanks, in the engine room.

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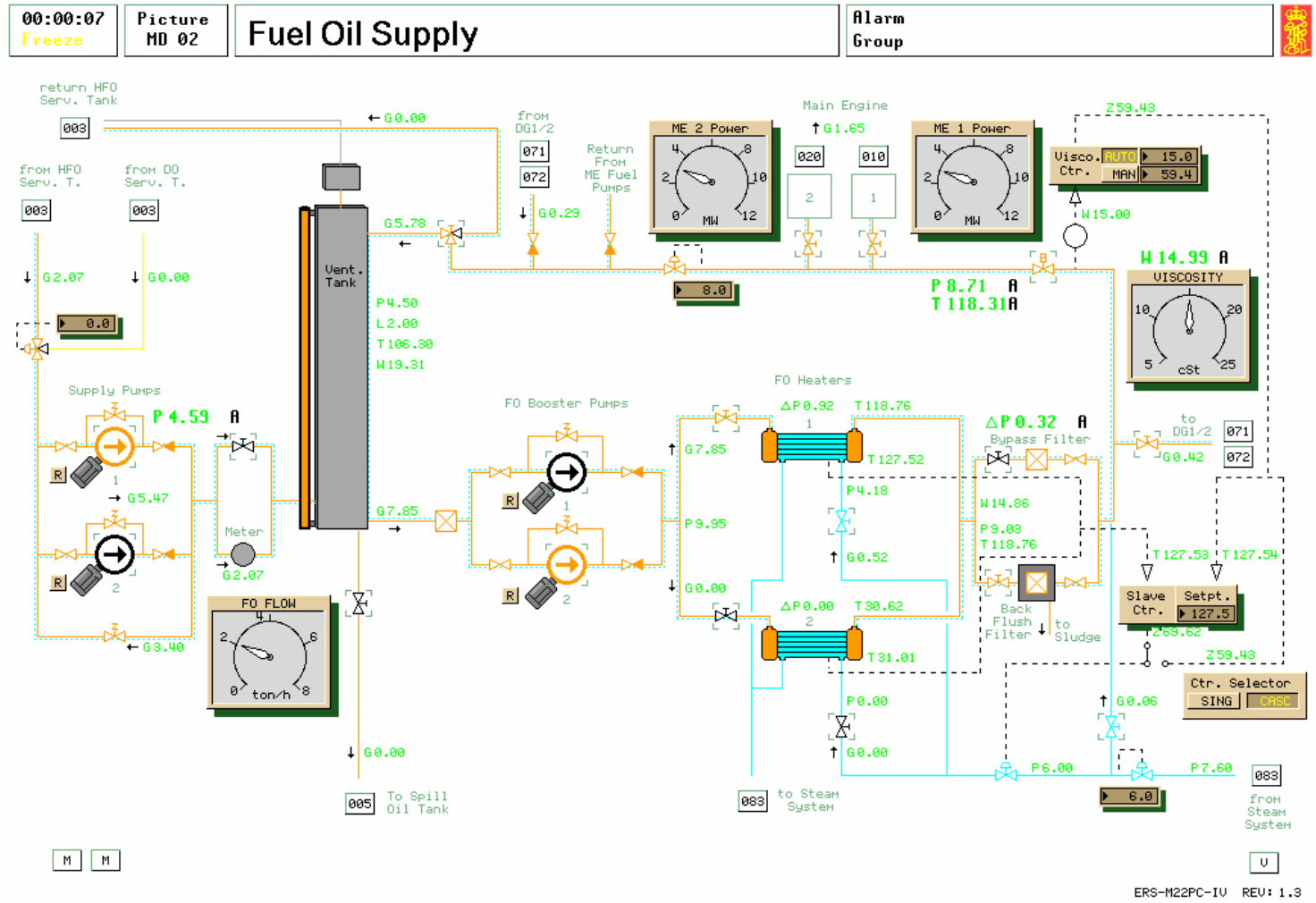
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003
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DG1/2
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G0.29
Return
From
ME Fuel
Pumps
Main Engine
G1.65
ME 2 Power
ME 1 Power
MW
020
010
Z59.43
Visco.
Ctr.
AUTO
MAN
15.0
59.4
W15.00
W 14.99 A
VISCOSITY
cSt
from HFO
Serv. T.
from DO
Serv. T.
G2.07
G0.00
0.0
G5.78
Vent.
Tank
P4.50
L2.00
T106.30
W19.31
8.0
P 8.71 A
T 118.31A
Supply Pumps
P 4.59 A
G5.47
Meter
G2.07
G3.40
FO FLOW
ton/h
FO Booster Pumps
G7.85
FO Heaters
ΔP0.92
T118.76
T127.52
P4.18
G0.52
P9.95
G0.00
ΔP0.00
T30.62
T31.01
P0.00
G0.00
ΔP 0.32 A
Bypass Filter
W14.86
P8.03
T118.76
Back
Flush
Filter
to
Sludge
to
DG1/2
G0.42
T127.53
T127.54
Slave
Ctr.
Setpt.
127.5
Z69.62
Ctr. Selector
SING
CASC
G0.06
P6.00
P7.60
6.0
083
from
Steam
System
005
To Spill
Oil Tank
to Steam
System
M
V
ERS-M22PC-IV REV: 1.3

5.6 Fuel Oil Supply System

General

The purpose of the fuel oil service system is to preheat the fuel oil to correct injection viscosity, to fine-filter the fuel oil and to supply the main engines and the diesel generators with a continuous flow of fuel oil at a correct pressure.
All engines are running at the same viscosity and intended to operate on heavy fuel oil at all times, full power, manoeuvring and in port.
Operation on diesel oil is only during abnormal conditions and during major overhaul of the fuel oil system.
The system is capable of preparing heavy fuel oil with a viscosity of 700 cSt. at 50^{o}C and arranged as a pressurised fuel oil system in order to prevent foaming and high-pressure fuel oil pump cavitation.

Description

Two supply pumps take suction from the heavy fuel oil service tanks or from the diesel oil service tank through an adjustable 3-way mixing valve. The supply line from each service tank is equipped with none-return valves in order to prevent confluence.
The supply pumps discharge to the venting tank at a pressure of approx. 4 bar(g). The total amount of fuel oil supplied to the venting tank. is measured by a flow meter (totaliser) equipped with a by-pass valve.

The capacity of each supply pump exceeds the max. consumption of the main engines and the diesel engines.

The venting tank can be drained to the spill oil tank through a drain valve.
Two fuel oil booster pumps take suction from the venting tank and discharge to the fuel oil circulating line, supplying fuel oil to the injection system of the main engines and of the diesel generators. The circulating line is equipped with two steam heated fuel oil heaters, one back flush filter, one by pass filter and one viscosity controller. The capacity of each heater is sufficient for the max consumption for the main engines and the diesel engines.

The capacity of each booster pump exceeds the max consumption of the main engines and the diesel engines.

Excess fuel is normally returned to the venting tank. Provision is also made to return the fuel oil to the service tanks through a 3-way changeover valve.
An adjustable (5-10 barg) back-pressure valve maintains a constant pressure in the circulation line.

The fuel oil line to the main engines is equipped with an emergency shut off valve for remote control from the Remote Emergency Operating Panel.

Steam for heating of the venting tank and all fuel oil lines (steam tracing) is supplied through an adjustable (0-10 barg) steam reduction valve. Steam for fuel oil heaters and steam tracing can be shut off by stop valves.
The back flush filter may be cleaned by opening the by pass filter supply valve and closing the back flush filter supply valve.

Fuel oil viscosity control
The viscosity controller positions the steam valve of the fuel oil heater directly (single PID loop), or indirectly by adjusting the set point of a separate slave controller (cascade control).

The feedback signal to the slave controller is the mean tube metal temperature of the fuel oil heaters (High Selected).
At low load, it may prove to be necessary to stabilise the controller by reducing the steam supply to the fuel oil heaters.
This controller can be configured in cascade. A controller connected this way will be more stable and less sensitive to supply steam pressure than with a direct connected PID control.

Operation procedure

1. Preparation and starting at diesel oil

Supply system

1.1 Set 3-way valve into diesel oil position (100% for pure diesel oil).
1.2 Ensure sufficient level in diesel oil service tank and drain the tank.
1.3 Line up system from diesel oil service tank to venting tank – by pass valve for fuel oil flow meter normally to be closed.
1.4 Close venting tank drain valve.
1.5 Start one of the supply pumps manually and check the discharge pressure and flow.

Booster system

2.1 Open valves to one of the fuel oil heaters and the back flush filter. Shut off the by pass filter.
2.2 Check that the main engine fuel oil emergency shut off valve is open
2.3 Open fuel oil shut off valves for both main engines and the supply valve for the diesel generators
2.4 Return line valve pressure controller must be set to 7-8 barg.
2.5 Check that the 3-way valve in the return line is set to return to venting tank
2.6 Set fuel oil viscosity controller into Manuel
2.7 Check that the valves for steam supply to fuel oil heaters and steam tracing is closed
2.8 Start one fuel oil booster pump manually and check discharge pressure and flow
2.9 Select auto stand by for supply pumps and for booster pumps at the PowerChief – Pump Control panel.

NOTE: If steam system is not shut off effectively by closing the stop and control valves of the steam system there is a risk of heating the diesel oil. Too high temperature of the diesel oil may cause poor lubrication of high-pressure pump's plunger and of fuel oil nozzle needle valve due to low viscosity. This again may cause piston or needle valve to seize.

Note: If there is no fuel oil consumption from the fuel oil supply system the supply pumps must be stopped in order to avoid damage of the pump due to high temperature.

3. Changing from diesel oil to heavy fuel oil.

3.1 HFO purifier to be in operation
3.2 Ensure sufficient level in then HFO service tank and proper temperature in order to get a suitable oil viscosity.
3.3 Drain the tank
3.4 Line up the system from HFO service tank to 3-way mixing valve.
3.5 Open steam valves to selected FO heater.
3.6 Open steam valve for steam tracing.
3.7 Set steam line pressure controller to desired setting. (5-6 barg) and check steam pressure.
3.8 Set viscosity controller into Auto and set point at 11-14 cSt
3.9 Gradually change value of 3-way mixing valve to pure HFO while checking that the controller keeps the viscosity within appropriate limits.

Quicker change-over can be obtained with return to service tank open. This, however, may cause needle valves to seize in fuel injectors.

4. Changing from heavy fuel to diesel oil

4.1 Slowly reduce the temperature on HFO by adjusting the viscosity controller manually.

4.2 When temperature drops, gradually mix in diesel oil by adjusting the 3-way mixing valve.

4.3 Observe the rate of temperature reduction. Too quick temperature drop can cause fuel oil high-pressure pump's plungers to seize due to plunger-liner contraction / reduced lubrication.

Note: If for some reason venting tank must be drained, the three-way valve can return the fuel oil to the settling tank(s).

With main engine running, best result in viscosity control is obtained with controllers in CASCADE, VISCOSITY CONTROLLER in AUTO.

The diesel engines are usually stopped and started with HFO in fuel lines. Diesel oil is used if engines to be stopped for a prolonged period (dry-docking) or when conducting major overhauls to fuel system. If ambient temperature is extremely low, or if steam system is out of commission, change to diesel oil before stopping or empty lines by changing to diesel oil and re-circulating oil back to HFO service tank.

Model particulars

If the plant is shut down with no heating, the oil in the venting tank will cool down because of heat loss to surroundings. The oil viscosity in the venting tank is computed, depending on temperature and possible dilution by diesel oil.

If a water leakage in the service tank heater has occurred it will collect in the vent tank and disturb the running of the diesel engines. The venting tank can be drained or emptied to the Spill Oil tank.

If the viscosity at the booster pump inlet is high, the fuel oil booster pump discharge pressure will decrease.
The oil viscosity in the circulating line is computed, depending on temperature and possible dilution by diesel oil.
The flow resistance in fuel oil heaters and filters is dependent on viscosity. A pressure drop in fuel oil filters and fuel oil heater results in a correspondingly drop of fuel oil pressure at the DG's and ME's high-pressure pumps.

Above a viscosity of approximately 600 cSt the oil is beyond the pumping limit.

If the rate of temperature reduction/rise when changing from HFO to diesel oil is too high, some of the HP injection plungers might stick due to plunger liner contraction/reduced lubrication.

The oil delivery from the booster pumps is reduced if the suction pressure drops below a certain limit.

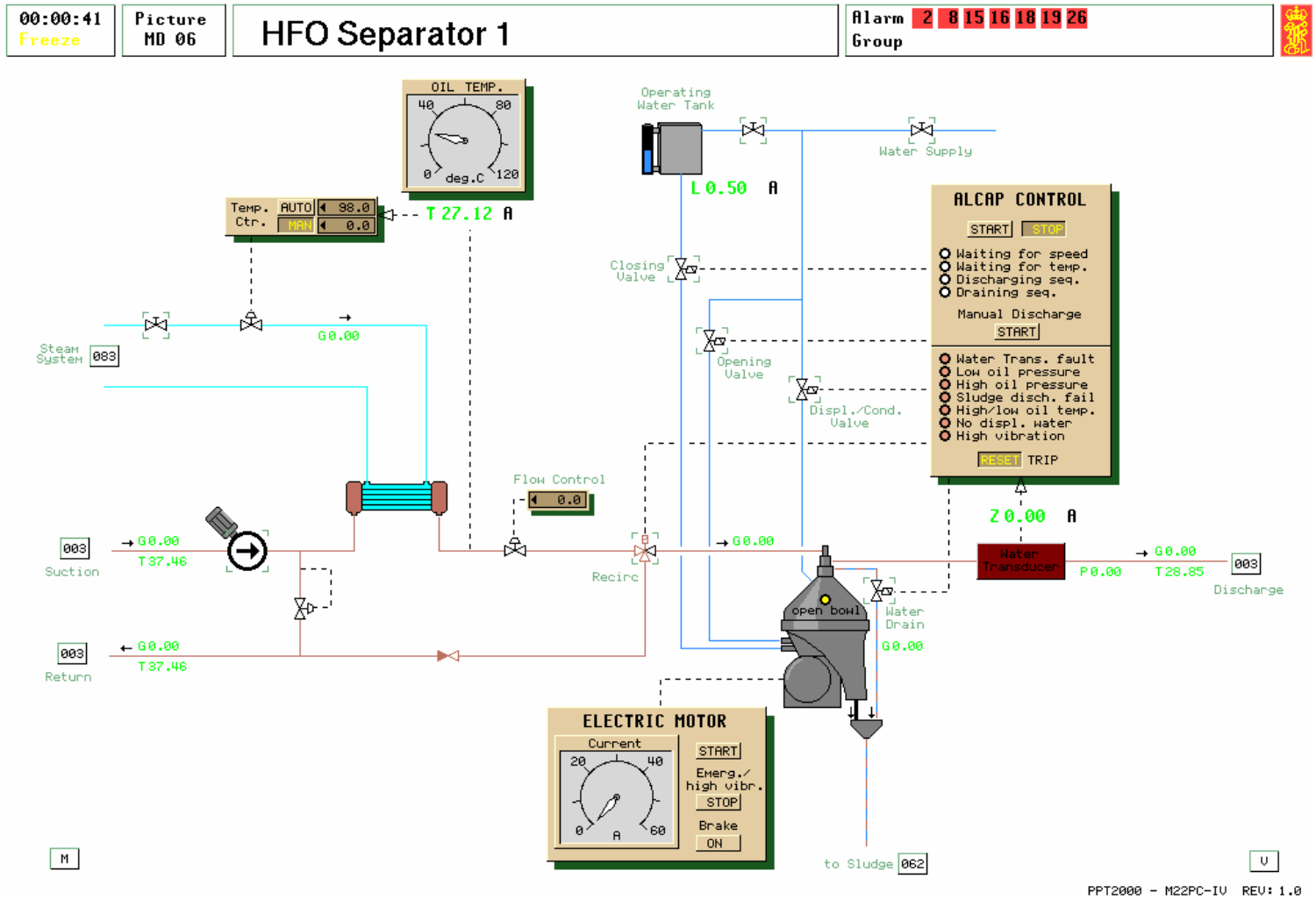
Fuel oil gassing

If the fuel oil temperature after the fuel oil heaters rises higher than the fuels boiling temperature "gassing" of the oil is simulated. Fuel oil gassing causes that:

- the running of the main engine is disturbed.
- the signal from the viscosity meter becomes very noisy.

Fuel oil quality

Fuel oil quality (heating value, density, and viscosity) can be set from variable page.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Freeze
Picture
MD 06
HFO Separator 1
Alarm 2 8 15 16 18 19 26
Group
OIL TEMP.
40
80
0
deg.C
120
Temp. Ctr.
AUTO
MAN
98.0
0.0
T 27.12 A
Operating Water Tank
Water Supply
L 0.50 A
ALCAP CONTROL
START
STOP
Waiting for speed
Waiting for temp.
Discharging seq.
Draining seq.
Manual Discharge
START
Water Trans. fault
Low oil pressure
High oil pressure
Sludge disch. fail
High/low oil temp.
No displ. water
High vibration
RESET
TRIP
Closing Valve
Opening Valve
Displ./Cond. Valve
Steam System
083
G0.00
Flow Control
0.0
Z 0.00 A
003
Suction
G0.00
T37.46
Recirc
G0.00
Water Transducer
P0.00
T28.85
G0.00
003
Discharge
open bowl
Water Drain
G0.00
003
Return
G0.00
T37.46
ELECTRIC MOTOR
Current
20
40
0
A
60
START
Emerg./ high vibr.
STOP
Brake
ON
M
to Sludge
062
V
PPT2000 - M22PC-IV REV: 1.0

5.7 HFO Separator System

General

The purpose of the HFO separator system is to supply the main engine and the diesel generators with fuel oil, free from impurities and water to the highest degree.

Description

There are two HFO separators of the "ALCAP" type. The two HFO separators take suction from the settling tanks and the service tank and discharge to the HFO service tank.

Operation Mode

Pumping up service tank:

One separator taking suction from the selected HFO settling tank and discharge to the HFO service tank.

Re-circulating service tank:

One separator takes suction from the HFO service tank and discharge to the HFO service tank.

Each separator is provided with a separate electrical driven feed pump with constant displacement. The flow to the separator is controlled by means of an adjustable throttle valve. The excess flow from the feed pump is returned to the HFO settling tank or to the HFO service tank.
Each feed pump/separator has a capacity, which is 10% above maximum total HFO consumption.

Each separator is provided with an operation water gravity tank. During operation, there is a constant consumption of operating water and the operating water gravity tank must be manually refilled on low alarm.

The oily water sludge and the drain from the shooting are collected in the sludge tank.

A steam heated pre-heater heats the heavy fuel oil before it is led to the separator bowl. A PID controller controlling a control valve at the pre-heater steam inlet controls the temperature.

ALCAP Operating Principle

The oil to be cleaned is continuously fed to the separator. Separated sludge and water accumulate at the periphery of the bowl.

Normally a sludge discharge takes place at specific time intervals, but if the water contamination is high, an earlier discharge may be initiated.

When separated water reaches the disk stack, some water escapes with the cleaned oil. A water transducer installed in the clean oil outlet senses the increase in water content.

When the water content in the cleaned oil reaches a specific "trigger level", the control program will initiate an automatic

discharge of the water in the bowl. The water is normally discharged with the sludge through the sludge ports at the periphery of the bowl.

If the water contamination in the oil from the settling tank is so high that the "trigger" level is reached within 15 minutes (adjustable) after the last sludge discharge, the water drain opens. The valves remain open for a specific time after the water content has passed the "trigger" level on its way down.

If the water content in the cleaned oil does not decrease below the "trigger" level within 2 minutes after a sludge discharge or a water discharge through the water drain valve, there will be an alarm and the inlet oil valve will close.

On the ALCAP control panel there are indications of the following alarms:

-Water transducer failure
-Sludge discharge failure
-High oil pressure
-Low oil pressure
-High/low oil temperature
-No displacement water
-High vibration

Water transducer failure alarm is activated if the transducer is measuring less than 0.05% water content in the outlet oil. Since it is not possible to measure water content below this value in this separator system, this limit is used to indicate a fault condition of the transducer. Onboard, this failure could be loose connections, faulty oscillator unit, etc.

High oil outlet pressure alarm is indicated when oil pressure out is more than 1.9 bar.

Low oil outlet pressure alarm is indicated when oil pressure out is less than 1.45 bar.

High/low oil temperature alarm is activated if the oil temperature differs more than 5% from set point.
When the oil temp is within 5% from set point we have to reset the ALCAP before start.

No displacement water alarm is activated when the ALCAP control system tries to fill water but there is no water supply caused of a shut water supply valve.

High vibration alarm is activated at high vibration of the separator bowl. When this alarm is activated, the separator will be emptied, the ALCAP control system will be shut down, the oil will be re-circulated (three way valve will close against separator) and the electrical motor will stop.

Sludge discharge failure alarm is activated if the separator is not able to empty the separator for water and sludge. The ALCAP control system will directly try a new sludge/discharge sequence. If the water transducer still measures to high water content in the oil,

the separator will be emptied, the ALCAP control system is shut down and the oil will be re-circulated.

Operation procedure

- Normally one HFO purifier is in service and one HFO purifier is stand by. The HFO purifier in service take suction from one of the settling tanks and discharge to the service tank.
- The flow through the HFO purifier in service should always be adjusted according to the current HFO consumption in order to optimise the purification at all times.

1. Preparation

1.1 Open outlet valve from selected HFO settling tank.
1.2 Open HFO SEP oil inlet valve to separator.
1.3 Open HFO SEP oil outlet valve to HFO service tank.
1.4 Open HFO SEP HEATER STEAM shut off valve.
1.5 Open valve for displacement water.
1.6 Drain settling tank.

2. Starting procedure:

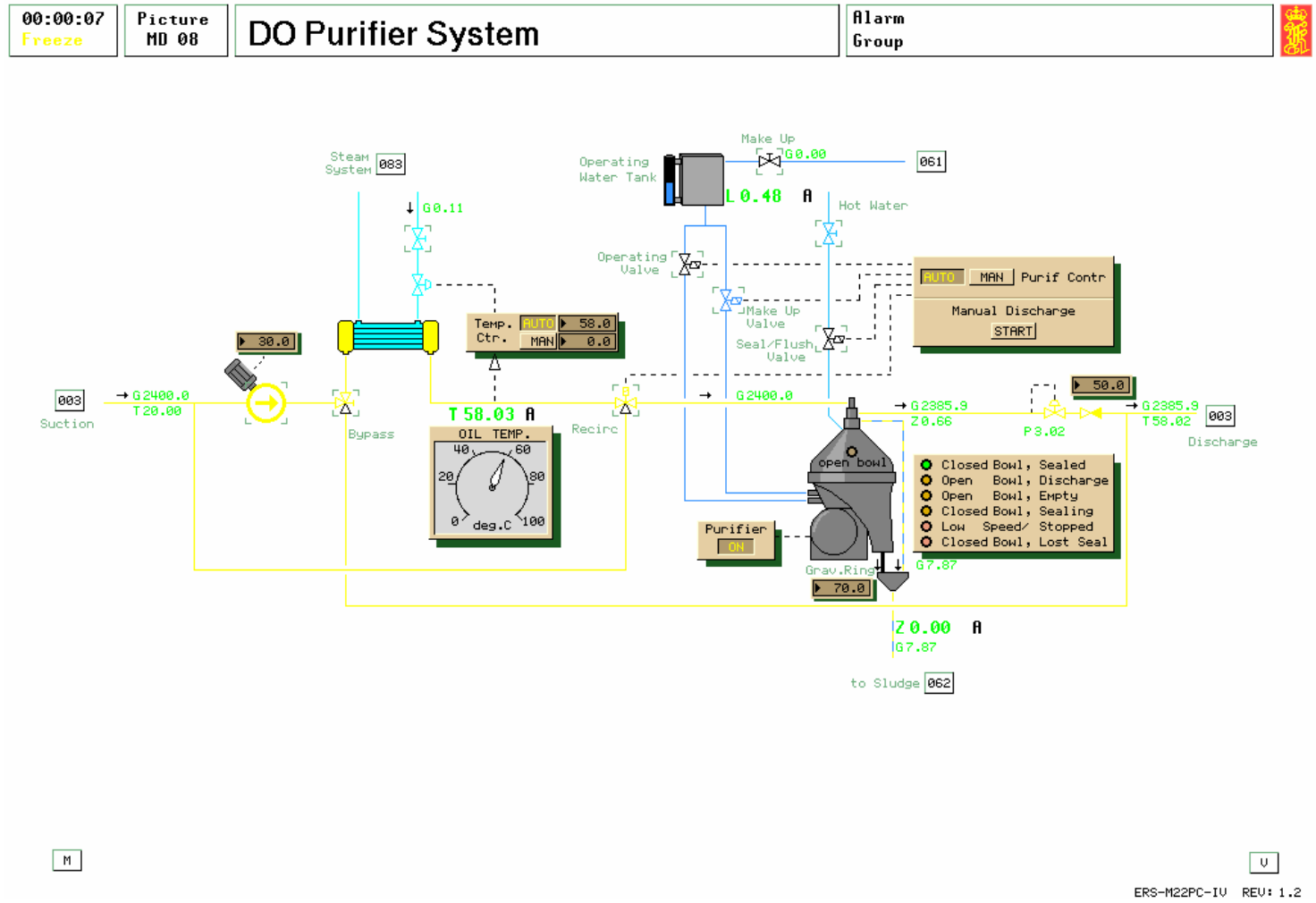
2.1 Start HFO SEP feed pump. Adjust desired flow.
2.2 Set temperature controller to AUTO and adjust set point to 98°C.
2.3 Check that the purifier brake is not engaged.
2.4 Start electric motor of the purifier.
2.5 Wait for purifier speed to stabilise. Observe the am-meter and “waiting for speed” indication on ALCAP control panel.
2.6 Put the ALCAP control into operation by pressing the start button on the control panel.
2.7 When correct oil temperature (observe indication on the ALCAP control panel), the three way valve will open for delivery to the separator.
2.8 Observe and adjust flow after separator.

3. Stopping procedure

3.1 Perform a manual discharge
3.2 When discharge sequence has finished, push the stop button on the ALCAP control panel.
3.3 Stop the purifier
3.4 Stop the feed pump
3.5 If high vibration occurs stop the purifier and engage the brake immediately.

Model particulars

- The purifier is modelled with an automatic dirt build up within the bowl. After each shooting sequence, the bowl is cleaned. If the dirt cumulative exceeds an upper limit, the cleaning efficiency will be reduced. The purifier therefore must be shot regularly.
- The instructor can adjust the rate of dirt build up.
- The cleaning efficiency and a contamination index at the separator outlet is computed and displayed.
- The amount of water separated is dependent of the water content in the settling tank.


00:00:07
Freeze
Picture
MD 08
DO Purifier System
Alarm
Group
Steam System
083
G0.11
Operating Water Tank
Make Up
G0.00
061
L 0.48 A
Hot Water
Operating Valve
Make Up Valve
Seal/Flush Valve
AUTO
MAN
Purif Contr
Manual Discharge
START
Temp. Ctr.
AUTO
58.0
MAN
0.0
30.0
003
Suction
G2400.0
T20.00
Bypass
T 58.03 A
OIL TEMP.
deg.C
Recirc
G2400.0
G2385.9
Z0.66
50.0
P3.02
G2385.9
T58.02
003
Discharge
open bowl
Closed Bowl, Sealed
Open Bowl, Discharge
Open Bowl, Empty
Closed Bowl, Sealing
Low Speed/ Stopped
Closed Bowl, Lost Seal
Purifier
ON
Grav.Ring
70.0
G7.87
Z 0.00 A
G7.87
to Sludge
062
M
V
ERS-M22PC-IV REV: 1.2

5.8 Diesel Oil Separator System

General

The purpose of the diesel oil separator system is to supply the main engine and the diesel generators with diesel oil, free from impurities and water.

Description

There is one diesel oil separator. The diesel oil separator takes suction from the diesel oil storage tank and discharge to the diesel oil service tank.
The separator is provided with a separate electrical driven displacement feed pump with adjustable speed.
By means of a 3-way changeover valve located before the pre-heater, the feed pump may discharge directly to the service tank, bypassing the separator.
The separator is provided with an operation water gravity tank. During operation, there is a constant consumption of operating water and the operating water gravity tank must be manually refilled on low alarm.

Discharge of oily water sludge takes place at preset regular intervals, but it is also possible to start the shooting process manually at any time.

The oily water sludge and the drain from the shooting are collected in the sludge tank.

A steam-heated pre-heater may heat the diesel oil before it is led to the separator bowl. The temperature is controlled by a PID controller controlling a control valve at the pre-heater steam inlet.

A steam-heated pre-heater may heat the oil before it is led to the separator bowl. The temperature is controlled by a PID controller controlling a control valve at the pre-heater steam inlet.

Operation procedure

Normal operation:

a) The separator feed pump take suction from the diesel oil storage tank and discharge to the diesel oil service tank via the diesel oil separator.

b) The separator feed pump take suction from the diesel oil service tank and discharge to the diesel oil service tank via the diesel oil separator.

Emergency operation:

The separator feed pump take suction from the diesel oil storage tank and discharge directly to the diesel oil service tank.

1. Preparation

1.1 Open outlet valve from selected diesel oil settling tank. Open inlet valve to diesel oil service tanks.

1.2 Start purifiers feed pump. Adjust desired flow (when starting less than 20%).
1.3 Set temperature controller in auto and adjust set point to 60°C. Start purifier by pushing the ON button.
1.4 Fill operating water tank if necessary.
1.5 Open make up water valve (Hot water for bowl content displacement).

Starting procedure

2. **MANUAL mode**:

2.1 After purifier has reached full speed, and purifier controller is in manual, open make-up valve and wait until mimic reads CLOSED BOWL EMPTY.
2.2 Open seal/flush valve for 15 seconds to ensure proper water seal in bowl after mimic reads CLOSED BOWL SEALING.
2.3 When mimic reads CLOSED BOWL SEALED, open oil flow to purifier by clicking open on three way re-circulation valve towards purifier. The supplied oil must have sufficient temperature.
2.4 Start purifying process with gravity ring less than 50 % of full scale.
2.5 Adjust gravity ring to maximum value without loosing water seal and adjust oil flow gradually to 100 %.

3. Ejection cycle:

3.1 Close re-circulation valve by pointing to valve flange facing purifier and click the close button. (Right tracker ball button).
3.2 After lost seal appears, open seal/flush valve for 5 seconds to empty bowl. Close make-up valve.
3.3 Open operating valve for 5 seconds, mimic reads OPEN BOWL DISCHARGE and OPEN BOWL EMPTY.
3.4 Close operating valve. Wait 15 seconds. Open make-up valve, mimic reads CLOSED BOWL SEALING
3.5 When indicator reads CLOSED BOWL, open seal/flush valve until mimic reads CLOSED BOWL SEALED
3.6 When CLOSED BOWL SEALED appears, open re-circulation valve towards purifier.
3.7 When operating valves, indicating lamps must be observed to prevent rushing the procedure of starting cycle/ejection cycle.

4. AUTO mode:

4.1 When purifier has reached full speed, push AUTO button on purifier control.

5. Re-purification of diesel oil service tank:

5.1 Open fuel oil purifier suction valve from diesel oil service tank.
5.2 Close fuel oil purifier suction valve from diesel oil settling tanks.
5.3 Open fuel oil discharge valve from purifier to diesel oil service tank.
5.4 Close fuel oil discharge valve to diesel oil settling tanks.
5.5 Always open valves on diesel oil service tank before closing valves on diesel oil settling tanks.

6. Adjusting gravity ring:

6.1 The efficiency of the purifier is dependent on the gravity ring setting and the feed flow. Low feed flow and large gravity ring result in better purification while small gravity ring increases the maximum flow admitted before broken water seal is likely to occur.

6.2 The cleaning must always be optimised according to the current flow through purifier.

6.3 The gravity ring is slowly maximised until oil is observed in the sludge flow.

6.4 When oil is observed the sludge flow, decrease the gravity diameter a few percent until there is no oil in the sludge flow.

6.5 If the gravity ring is too small, increase the pressure, if it is too big, reduce the pressure. By changing tje bacj pressure setting the gravity ring size can be check: If you can increase the back pressure to 90% without loss of water seal, the ring is probably too small. If you must operate with back pressure lower than 20% it is too big (or your feed flow is too high).

Model particulars

The oil discharge pressure will build up to normal value when the separation process starts functioning properly.

The oily water sludge and the drain from the shooting is collected in a sludge tank common for all purifiers. At loss of water seal, the oil/water will drain through sludge line to sludge tank. The oil discharge pressure will be low and the central alarm system will be activated.

The purifier is modulated with an automatic dirt build up within the bowl. After each ejection cycle, the bowl is cleaned. If the dirt cumulated exceeds an upper limit, lost water seal will occur. The purifier therefore must be cleaned regularly. The instructor can adjust the rate of dirt build up.

If the oil inlet temperature drops under a given limit or increases above a given limit, the normal separation process is disturbed, resulting in lost water seal. If the flow resistance of the discharge line is too high, the water seal will break.

If the oil temperature reaches a critical low limit, the purifier will stop due to motor overload.

There is a constant consumption of operating water and the operating water tank must be manually refilled on low alarm or before.

The efficiency of the purifier is dependent on the gravity ring setting and the feed flow. Low feed flow and large gravity ring result in better purification while small gravity ring increases the maximum flow admitted before broken water seal is likely to occur.

The cleaning procedure described will be done automatically at regular intervals by the PowerChief central monitoring system if the selector switch on the local purifier panel is in AUTO position.
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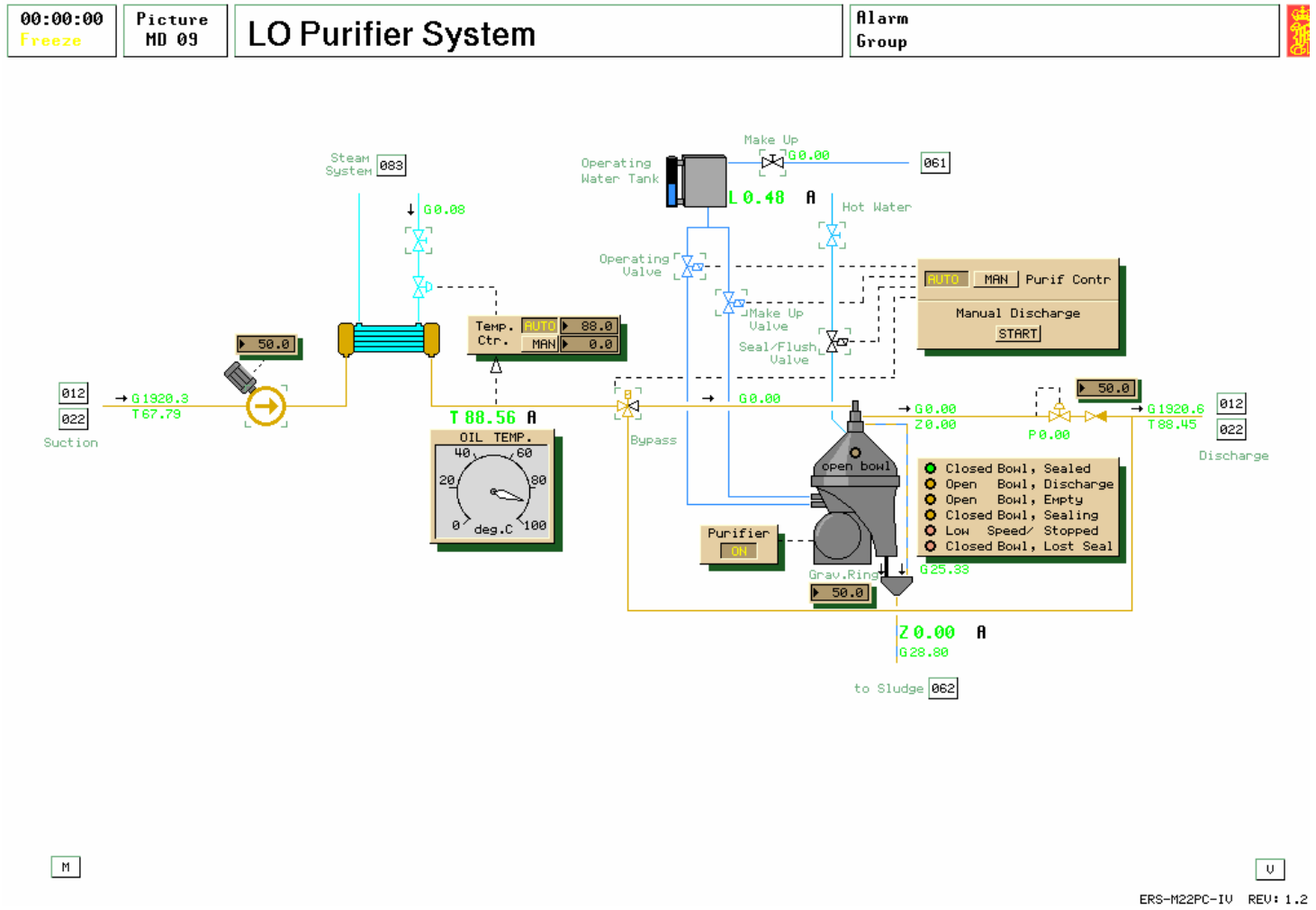
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Freeze
Picture
MD 09
LO Purifier System
Alarm
Group
Steam System
083
G0.08
Operating Water Tank
Make Up
G0.00
061
L 0.48 A
Hot Water
Operating Valve
Make Up Valve
Seal/Flush Valve
AUTO
MAN
Purif Contr
Manual Discharge
START
Temp. Ctr.
AUTO
88.0
MAN
0.0
50.0
012
022
Suction
G1920.3
T67.79
T 88.56 A
OIL TEMP.
40
60
20
80
0
100
deg.C
Bypass
G0.00
Z0.00
P0.00
50.0
G1920.6
T88.45
012
022
Discharge
open bowl
Purifier
ON
Grav.Ring
50.0
G25.33
Closed Bowl, Sealed
Open Bowl, Discharge
Open Bowl, Empty
Closed Bowl, Sealing
Low Speed/ Stopped
Closed Bowl, Lost Seal
Z 0.00 A
G28.80
to Sludge
062
M
U
ERS-M22PC-IU REV: 1.2

5.9 Lubrication Oil Purifier System

General

The lubricating oil purifier cleans lubricating oil, taken from the sump tank (drain tank) from one of the main engines and discharges it to engine sump tanks.

Description

There is one lubricating oil separator. The lubricating oil separator take suction from one end of the main engine drain tank and discharge back to the other end of the drain tank.

The separator is provided with a separate electrical driven displacement feed pump with adjustable speed.

The separator is provided with an operation water gravity tank. During operation there is a constant consumption of operating water and the operating water gravity tank must be manually refilled on low alarm.

Discharge of oily water sludge takes place at preset regular intervals, but it is also possible to start the shooting process manually at any time.

The oily water sludge and the drain from the shooting process are collected in the sludge tank.

A steam-heated pre-heater may heat the oil before it is led to the separator bowl. The temperature is controlled by a PID controller controlling a control valve at the pre-heater steam inlet.

A back pressure control valve is mounted in the clean oil discharge line. Pressure set point range from 0-100% corresponding to 2-4 bar. Normal setting is 50%. Adjustment of the back pressure can compensate for a not optimal gravity ring size. Instead of installing a new gravity ring (much work in real life) adust the back pressure.

Operation procedure

1. **Preparation**

1.1 Select the lubrication oil system of one of the main engines.
1.2 Open outlet valve from selected lubrication oil drain tank.
1.3 Open inlet valve to selected lubrication oil drain tank.
1.4 Start purifiers feed pump. Adjust desired flow (when starting less than 20%).
1.5 Set temperature controller in auto and adjust set point to 85°C.
1.6 Start purifier by pushing the ON button.
1.7 Fill operating water tank if necessary.
1.8 Open make up water valve. (Hot water for bowl content displacement.)

Starting procedure

2. **MANUAL mode**:

2.1 After purifier has reached full speed, and purifier controller is in manual, open make-up valve and wait until mimic reads CLOSED BOWL EMPTY.
2.2 Open seal/flush valve for 15 seconds to ensure proper water seal in bowl after mimic reads CLOSED BOWL SEALING.
2.3 When mimic reads CLOSED BOWL SEALED, open oil flow to purifier by clicking open on three way re-circulation valve towards purifier. The supplied oil must have sufficient temperature.
2.4 Start purifying process with gravity ring less than 50% of full scale.
2.5 Adjust gravity ring to maximum value without loosing water seal and adjust oil flow gradually to 100%.

3. Ejection cycle

3.1 Close re-circulation valve by pointing to valve flange facing purifier and click the close button. (Right tracker ball button).
3.2 After lost seal appears, open seal/flush valve for 5 seconds to empty bowl. Close make-up valve.
3.3 Open operating valve for 5 seconds, mimic reads OPEN BOWL DISCHARGE and OPEN BOWL EMPTY.
3.4 Close operating valve. Wait 15 seconds. Open make-up valve, mimic reads CLOSED BOWL SEALING
3.5 When indicator reads CLOSED BOWL, open seal/flush valve until mimic reads CLOSED BOWL SEALED
3.6 When CLOSED BOWL SEALED appears, open re-circulation valve towards purifier.
3.7 When operating valves, indicating lamps must be observed to prevent rushing the procedure of starting cycle/ejection cycle.

4. AUTO mode:

4.1 When purifier has reached full speed, push AUTO button on purifier control.

5. Adjusting gravity ring

5.1 The efficiency of the purifier is dependent on the gravity ring setting and the feed flow. Low feed flow and large gravity ring result in better purification while small gravity ring increases the maximum flow admitted before broken water seal is likely to occur.

5.2 The cleaning must always be optimised according to the current flow through purifier.
5.3 The gravity ring is slowly maximised until oil is observed in the sludge flow.
5.4 When oil is observed the sludge flow, decrease the gravity diameter a few percent until there is no oil in the sludge flow.
5.5 If the gravity ring is too small, increase the pressure, if it is too big, reduce the pressure. By changing tje bacj pressure setting the gravity ring size can be check: If you can increase the back pressure to 90% without loss of water seal, the ring is probably too small. If you must operate with back pressure lower than 20% it is too big (or your feed flow is too high).

Model particulars

The oil discharge pressure will build up to normal value when the separation process starts functioning properly.

The oily water sludge and the drain from the shooting is collected in a sludge tank common for all purifiers. At loss of water seal, the oil/water will drain through sludge line to sludge tank. The oil discharge pressure will be low and the central alarm system will be activated.

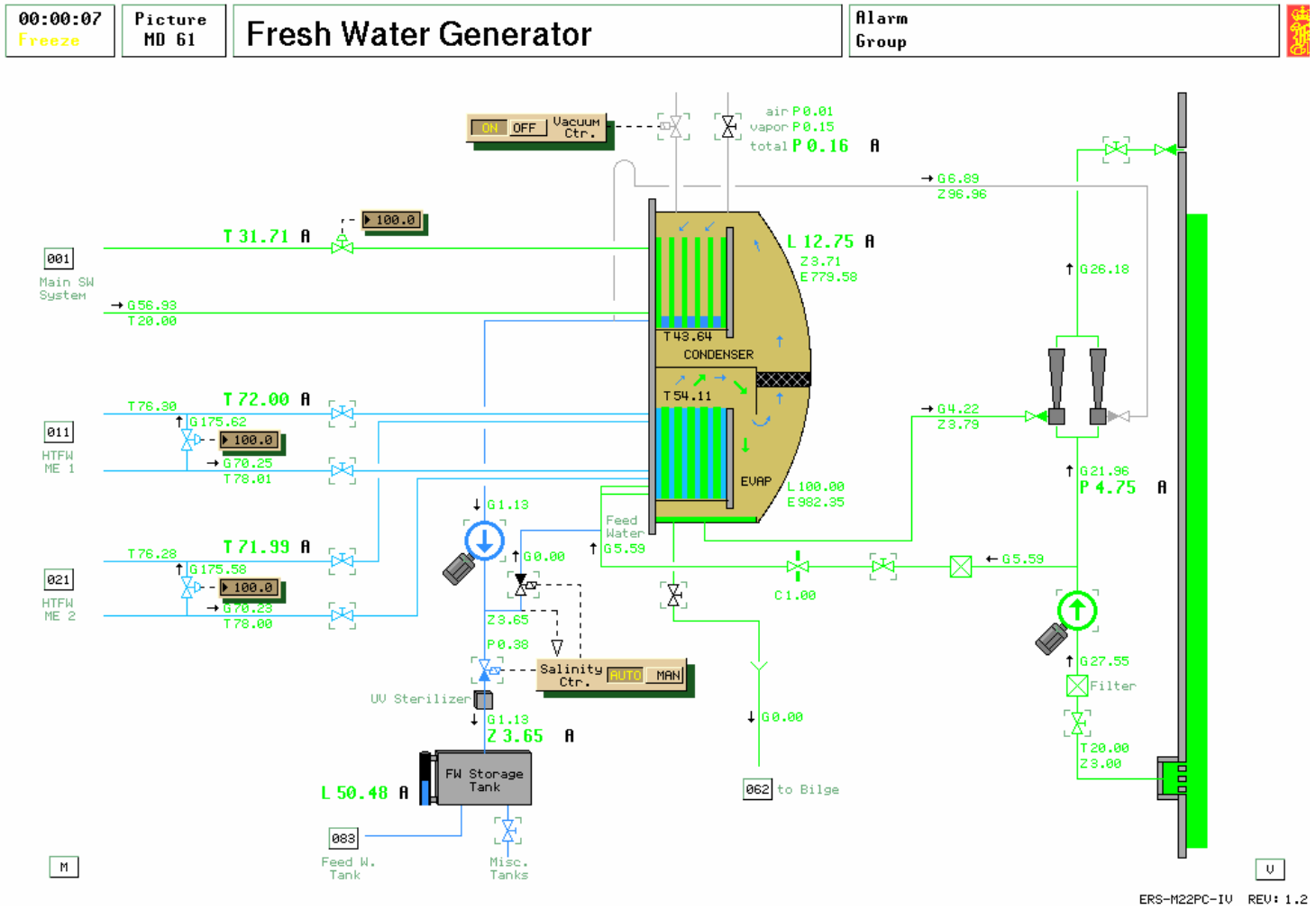
The purifier is modulated with an automatic dirt build up within the bowl. After each ejection cycle, the bowl is cleaned. If the dirt cumulated exceeds an upper limit, lost water seal will occur. The purifier therefore must be cleaned regularly. The instructor can adjust the rate of dirt build up.

If the oil inlet temperature drops under a given limit or increases above a given limit, the normal separation process is disturbed, resulting in lost water seal. If the flow resistance of the discharge line is too high, the water seal will break.

If the oil temperature reaches a critical low limit, the purifier will stop due to motor overload.

There is a constant consumption of operating water and the operating water tank must be manually refilled on low alarm or before.

The cleaning procedure described will be done automatically at regular intervals by the PowerChief central monitoring system if the selector switch on the local purifier panel is in AUTO position.


00:00:07
Freeze
Picture
MD 61
Fresh Water Generator
Alarm
Group
ON OFF Vacuum Ctr.
air P 0.01
vapor P 0.15
total P 0.16 A
G6.89
Z96.96
T 31.71 A
100.0
001
Main SW System
G56.33
T20.00
L 12.75 A
Z3.71
E779.58
T43.64
CONDENSER
T54.11
G26.18
T76.30
T 72.00 A
G175.62
011
HTFW ME 1
100.0
G70.25
T78.01
G4.22
Z3.79
EVAP
L 100.00
E982.35
G21.96
P 4.75 A
G1.13
Feed Water
G5.59
T76.28
T 71.99 A
G175.58
021
HTFW ME 2
100.0
G70.23
T78.00
G0.00
G5.59
C1.00
Z3.65
P0.38
Salinity Ctr. AUTO MAN
UV Sterilizer
G1.13
Z 3.65 A
G0.00
G27.55
Filter
T20.00
Z3.00
FW Storage Tank
L 50.48 A
062 to Bilge
083
Feed W. Tank
Misc. Tanks
M
U
ERS-M22PC-IU REV: 1.2

5.10 Fresh Water Generator

General

Very huge waste heat sources may be utilised when connecting a fresh water generator to the main engine jacket cooling water system. Normally this temperature is 65-70°C (149 - 158°F). The function is as follows:

A controlled amount of sea water is channelled to the heat exchanger tubes where it is heated by the surrounding heating media.

The supply from the sea water system evaporates under vacuum conditions in order to reduce the evaporation temperature, thus avoiding scale formations inside the tubes.

The vacuum allows utilisation of low temperature heating sources. The vapours generated, pass to the separator where the sea water drops are separated.

The dry and fresh vapours raise to the condenser, which is cooled by water. The vapours condense on the outside of the tubes, where by gravity they fall to the collection shell of the condenser, and flow into the suction of the fresh water pump.

Description

The evaporator is made up by heat exchangers of the plate type.
The evaporator can be supplied from both main engines, but maximum capacity can be achieved by utilising the heat from only one main engine.

The maximum evaporator capacity is 30 ton/24 hours at sea water temperature 32^{o}C.

Operation procedure

1. **Preparation**

1.1 Set load controller to MAN.
1.2 Set salinity controller to MAN.
1.3 Close evaporator drain valve.
1.4 Close vacuum breaker valve.
1.5 Check that fresh water by-pass valve is fully open.
1.6 Check that fresh water inlet and outlet valves from main engine system to generator are closed.
1.7 Close sea water feed valve from ejector pump
1.8 Open valve for sea water supply from main sea water system.
1.9 Open ejector pump suction valve from sea.
1.10 Open sea water overboard valve from ejectors.

2. Starting procedure:

2.1 Start ejector pump and check pressure and flow.
2.2 Open sea water flow adjusting valve, gradually to 100 % .
2.3 Open sea water feed valve to evaporator.
2.4 Wait for the total pressure in the generator to drop to approximately 0.10 bar. (1.5 psia).
2.5 Open fresh water generator outlet shut of valve (to ME cooling system).
2.6 Open fresh water generator inlet shut of valve (from ME cooling system).
2.7 Close fresh water by-pass valve gradually while checking that the total pressure does not exceed 0.1 bar.
2.8 Activate the automatic vacuum control valve by pressing ON at LOAD CTR. panel.
2.9 When distilled fresh water is visible in sight glass, open distillate re-circulation valve and start the distillate pump.
2.10 When salinity control is below alarm limit, activate salinity control by pressing AUTO at SALINITY CTR. panel

Model particulars

No comments.

5.11 Bilge System and Bilge Separator

Pollution prevention

To reduce pollution of the world's coasts and waters by the shipping industry, a great number of laws, regulations and penalties have been established and are being enforced. These include regulations set forth by the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78 Annex I), the Federal Water Pollution Control Act of 1970 (FWPCA), and the Oil Pollution Act of 1990 (OPA 90).

Of greatest interest aboard the training ship are the regulations concerning the pumping of machinery space bilge. The law, as established by MARPOL 73/78 ANNEX I, for ships of four hundred gross tons and above, defines permissible discharge of oil or oily waste from machinery space bilge and fuel oil tank ballast water, as follows:

1. When the vessel is anywhere within a "Special Area" which includes the entire Mediterranean Sea, Black Sea, Baltic Sea, Red Sea, and Gulf Areas; *No Discharge* is permitted, except when:
    1. The vessel is underway, and
    2. the ship is operating an oil content monitor, oil separating or filtering device which will automatically stop discharging when the oil contend of the effluent exceeds 15 parts per million (ppm), and
    3. the oil content of the effluent without dilution does not exceed 15 ppm.
2. Outside of the "Special Areas," and more than 12 nautical miles from land, the requirements are the similar to the ones above except that the oil content of the effluent discharge is relaxed to 100 ppm. In addition, discharge is permitted when the vessel is not underway, if the oil content of the effluent does not exceed 15 ppm.
3. Outside of the "Special Areas," and less than 12 nautical miles from land, *No Discharge* is permitted except when the oil content of the effluent without dilution does not exceed 15 ppm.

The MARPOL regulations are more restrictive for oil tankers, and slightly more flexible for vessels of less than 400 gross tons. Before pumping bilge on your license, make sure you understand the law.

> **It is no longer legal anywhere in the world to pump machinery space bilge directly overboard without going through some kind of oil content monitor that will automatically stop the discharge when the legal limits are exceeded!**

In addition, U.S. laws prohibit any discharge which forms a sheen, sludge, film, or emulsion in U.S. territorial seas. Such seas are defined by the navigable waters, including river systems and tributaries or into or upon waters of the contiguous zone. The Department of Justice may prosecute an unlawful discharge or act in Federal District Court. Penalties set down by OPA 90 and the

FWPCA are generally up to $25,000 per day of violation or $1,000 per barrel discharged. The master of the ship must immediately notify the nearest Coast Guard of an unlawful discharge and proceed in the clean up. Gross negligence or wilful misconduct could cause penalty costs to triple.
MARPOL regulations also require every vessel to maintain an *Oil Record Book*, where a permanent record of almost every handling of oil or oil waste is maintained. For non tank vessels, the following operations must be recorded in the oil record book:

- Ballasting or cleaning of oil fuel tanks
- Discharge of dirty ballast or cleaning water from oil fuel tanks
- Collection and disposal of oil residues (sludge)
- Automatic and Non-automatic discharge overboard or disposal otherwise of bilge water which has accumulated in machinery spaces.
- Condition of oil discharge monitoring and control system (failures and repairs)
- Accidental or other exceptional discharge of oil
- Bunkering of fuel or bulk lubricating oil
- Additional operational procedures and general remarks

The FWPCA and OPA 90 established additional regulations regarding the transfer of oil to or from a vessel. They state that no person may perform oil transfer operations unless he holds a valid license authorising service on such vessels as a master, mate, or engineer, and has full knowledge of current oil transfer procedures that are maintained aboard that vessel.
During vessel-to-vessel transfers each tank vessel with a capacity of 250 or more barrels of cargo oil must have a means that enables continuous two way communication between the person in charge of the transfer of operations on both vessels.
There must be onboard an emergency means to enable a person in charge of an oil transfer operation to stop the flow of oil to a facility, another vessel or within the vessel. This may be by the means of the pump control, quick acting power actuated valve or an operating procedure. There must be adequate and protected lighting in areas of oil transfer operation.
It is your responsibility as a marine engineer to know, understand, and obey the law.

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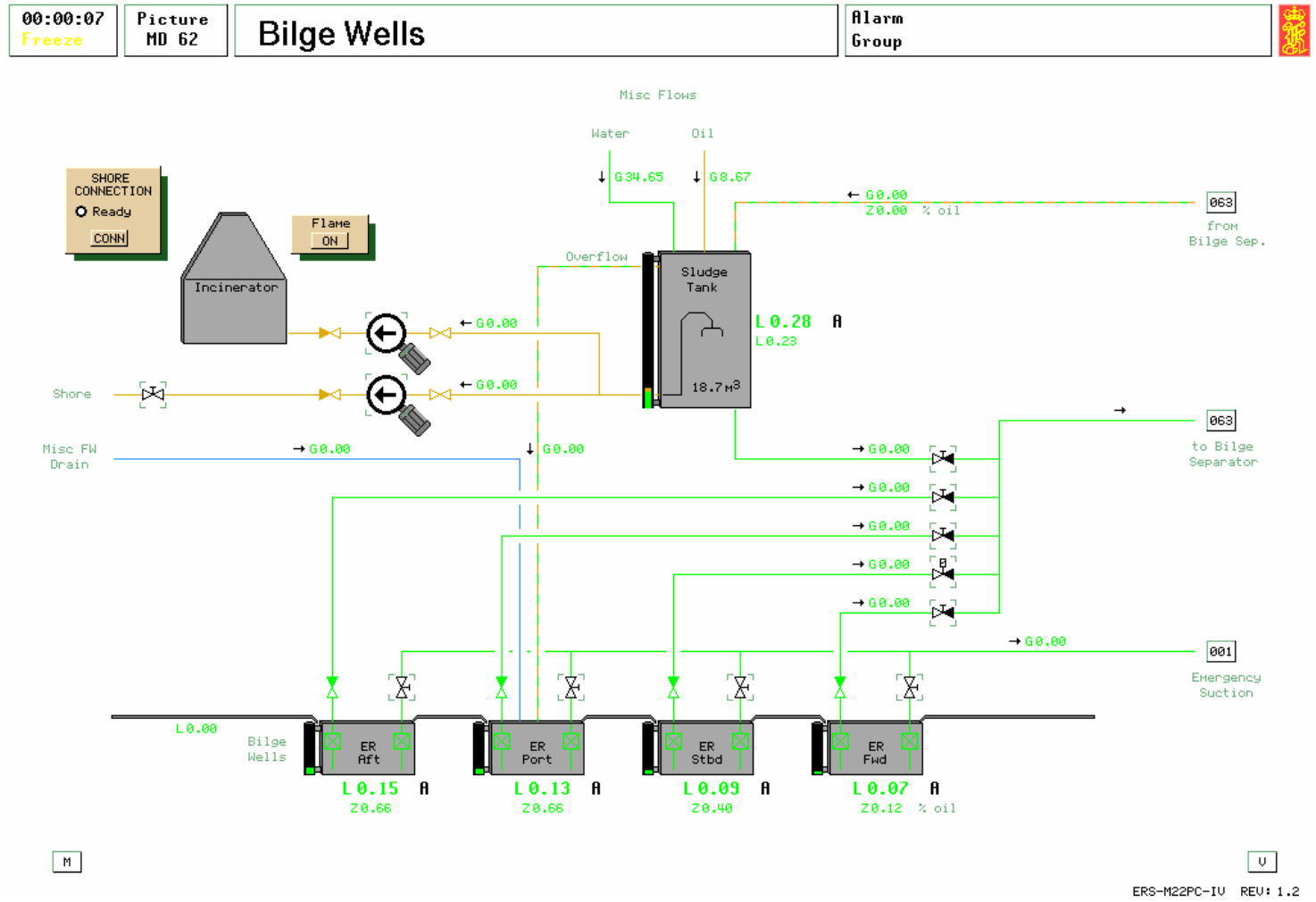

00:00:07
Freeze
Picture
MD 62
Bilge Wells
Alarm
Group
Misc Flows
Water
Oil
G34.65
G8.67
G0.00
Z0.00 % oil
063
from
Bilge Sep.
SHORE
CONNECTION
Ready
CONN
Flame
ON
Incinerator
Overflow
Sludge
Tank
L0.28 A
L0.23
18.7m3
Shore
Misc FW
Drain
063
to Bilge
Separator
001
Emergency
Suction
L0.00
Bilge
Wells
ER
Aft
ER
Port
ER
Stbd
ER
Fwd
L0.15 A
Z0.66
L0.13 A
Z0.66
L0.09 A
Z0.40
L0.07 A
Z0.12 % oil
M
V
ERS-M22PC-IV REV: 1.2

5.11.1 Bilge Wells

General

Bilge well description

The following bilge wells are included:

- Fore hold
- Cargo hold
- Engine room
- Aft hold

A sludge tank and an incinerator are also part of the bilge system.

The bilge pump can take suction from any of the four bilge wells, or from the sludge tank, and discharge to the bilge separator.

A separate line is connecting the bilge wells to the suction side of the eductor in the Main Sea Water System thus enabling the eductor to be used if the bilge pump breaks down.

The engine room port bilge well, in addition, receives possible overflow from the sludge tank and miscellaneous fresh water leakage/overflow from the engine room systems.

Sludge tank

The sludge tank receives drain from the following sources:

- HFO purifier sludge
- DO purifier sludge
- LO purifier sludge
- HFO settling tank 1 drain
- HFO settling tank 2 drain

The total water and oil input flows are summed up and displayed as two separate variables (oil, water) for convenience.

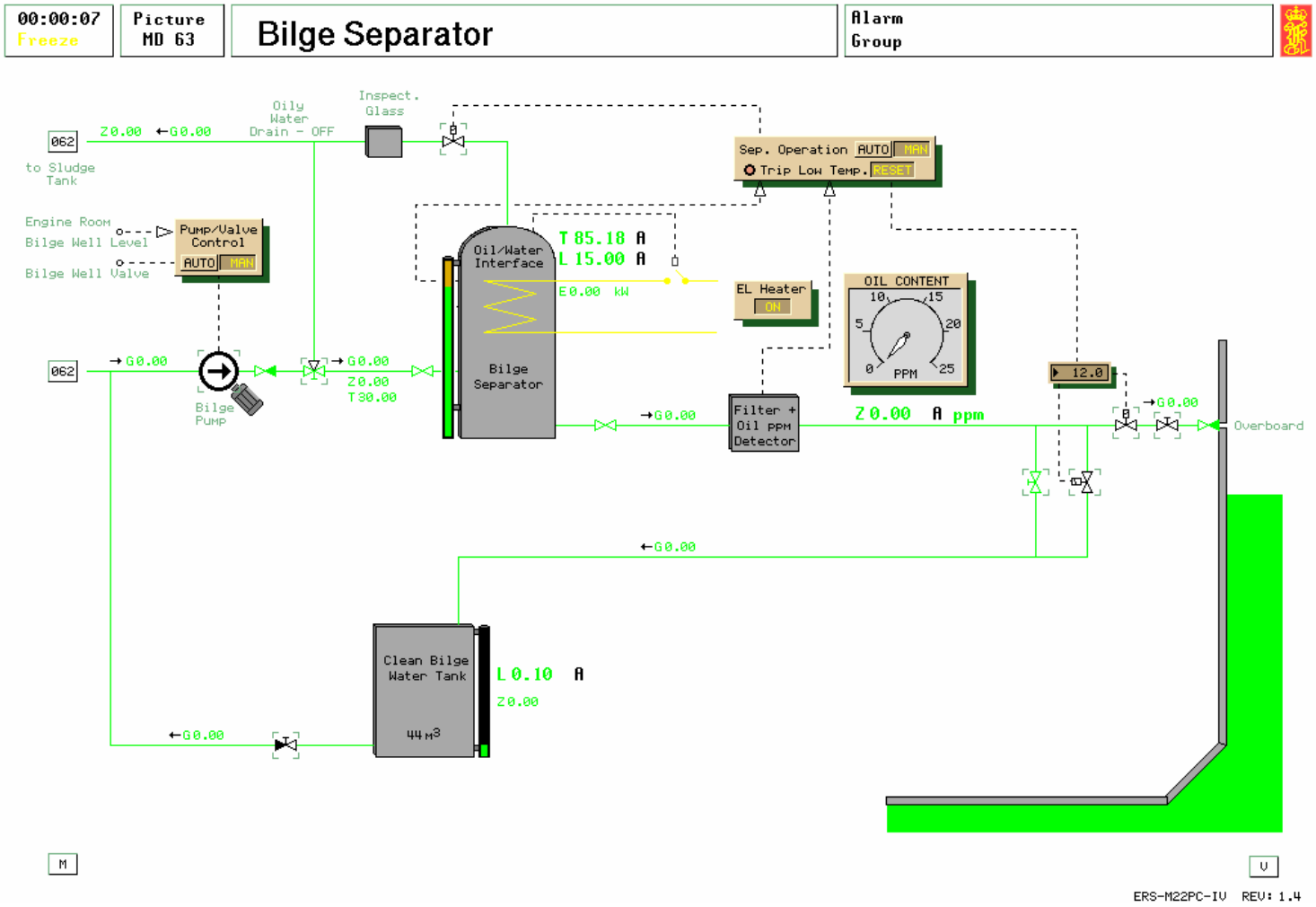
Oily return flow from the bilge water separator also enters the sludge tank.

Incinerator

The incinerator takes suction from the oil (top) part of the sludge tank by means of a float device. To initiate incinerator operation, start the pump and ignite the burner. If the pump light begins to flash, this flashing indicates automatic stop of the pump. Auto stop can be caused by:

- No oil in the sludge tank
- Time out for burner ignition

Flashing burner light indicates that the burner is ready for ignition.


00:00:07
Freeze
Picture
MD 63
Bilge Separator
Alarm
Group
Oily
Water
Drain - OFF
Inspect.
Glass
062
Z0.00 ←G0.00
to Sludge
Tank
Sep. Operation AUTO MAN
Trip Low Temp. RESET
Engine Room
Bilge Well Level
Bilge Well Valve
Pump/Valve
Control
AUTO MAN
Oil/Water
Interface
T 85.18 A
L 15.00 A
E0.00 kW
EL Heater
ON
OIL CONTENT
10
15
5
20
0
25
PPM
062
→G0.00
Bilge
Pump
→G0.00
Z0.00
T30.00
Bilge
Separator
→G0.00
Filter +
Oil ppm
Detector
Z 0.00 A ppm
12.0
→G0.00
Overboard
←G0.00
Clean Bilge
Water Tank
44 m3
L 0.10 A
Z0.00
←G0.00
M
V
ERS-M22PC-IV REV: 1.4

5.11.2 Bilge Separator

The separator is provided to eliminate engine room bilge water in accordance with current pollution prevention regulations by discharging water containing no more than 15 ppm of oil overboard.
The bilge separator separates oily water taken from the sludge tank or from the bilge wells. Clean water is pumped overboard or to the clean water bilge tank, while the oil is returned to the sludge tank.

The unit consists of a tank divided into several zones by internal baffles. A positive displacement bilge pump supplies unprocessed oil/water downstream into the separator and simultaneously discharges treated water out of the tank.
As the oil/water mixture flows through the tank, oil droplets are attracted to the coalescer beads while water is repelled under the influence of gravity and heat. Water passes around the beads but oil temporarily attaches to them. Oil droplets accumulate on the beads until they become large enough to break away and float to the top of the tank.
Meanwhile, the treated water is discharged from the bottom of the tank, through the oil content monitor and then either overboard or back to the bilge, depending on residual oil content. Effluent will only be discharged overboard when its oil content is less than 15 ppm.
Eventually the oil layer at the top of the tank increases sufficiently to trip a sensor which causes the separator drain solenoid to open. The accumulated oil is forced out through the oil discharge valve to the sludge tank.

If the separator is operated in “AUTO” mode, the following functions are automatic:

- The overboard valve is closed and the re-circulation valve opened if the ppm limit in the overboard water is above a pre-set limit.

- If the oil/water interface sensor detects low level (much oil), the sludge valve is opened.

- The bilge separator pump may be started/stopped automatically according to the bilge well level. This function is dependent on suction from the engine room bilge well.

A flashing AUTO light indicates functional failure. The cause can be high oil content (low-low oil/water interface level) or low separator temperature. The separator pump will then be stopped, the sludge valve opened and the overboard and re-circulation valves closed.

The heating power is turned on/off according to temperature, by a thermostatic switch as long as the main switch is on. This switch works independently of the AUTO mode.

Operation procedure

1. Preparation of bilge separator

1.1 START electric heating of bilge separator and set separator operation in MANUAL
1.2 Set the separator into AUTO mode when sufficient temperature (50^{o}C)
1.3 Check the setting of the ppm detector.

2. Automatic or manual operation of the separator

2.1 Normally the separator is operated in AUTO. In Auto the valves for bilge over board, bilge re-circulation to clean bilge tank and sludge drain from separator to sludge tank are automatic controlled.

3. Daily service bilge from engine rooms.

3.1 Check oil content in bilge well.
3.2 Open suction valve from bilge well.
3.3 Open valves through separator.
3.4 Check that over board valve is closed.
3.5 Open discharge valve to clean bilge tank..
3.6 Check that bilge separator is in Auto.
3.7 Start bilge pump in manual.

3.8 If bilge has high oil content open 3-way valve before bilge separator and discharge directly to sludge tank.
3.9 Let the oily water mixture separate in sludge tank before emptying water to clean bilge tank.

4. Automatic bilge from engine room bilge well.

4.1 If AUTO bilge control is active, the bilge suction valve from the engine bilge and the bilge pump will be activated according to the level in the bilge.
4.2 If the bilge pump is ON for more than 20% (adjustable) of the OFF time an alarm is activated. Immediate action must be taken.

5. Emptying clean bilge tank.

5.1 Check and note down ships position.
5.2 Check that bilge separator is ready.
5.3 Open suction valve from clean bilge tank
5.4 Open discharge over board
5.5 Check that bilge separator is in Auto.
5.6 Start bilge pump
5.7 Observe PPM-meter to avoid pumping oil overboard.
5.8 Check and not down ships position when finished.

6. Incinerator operation

6.1 Open valve from sludge tank to burner pump.
6.2 Open valve to incinerator.
6.3 Start incinerator by pushing flame ON.
6.4 Incinerator will automatically stop at low level in sludge tank.

NOTE. The incinerator should only be used during sea passage.

7 Sludge to shore

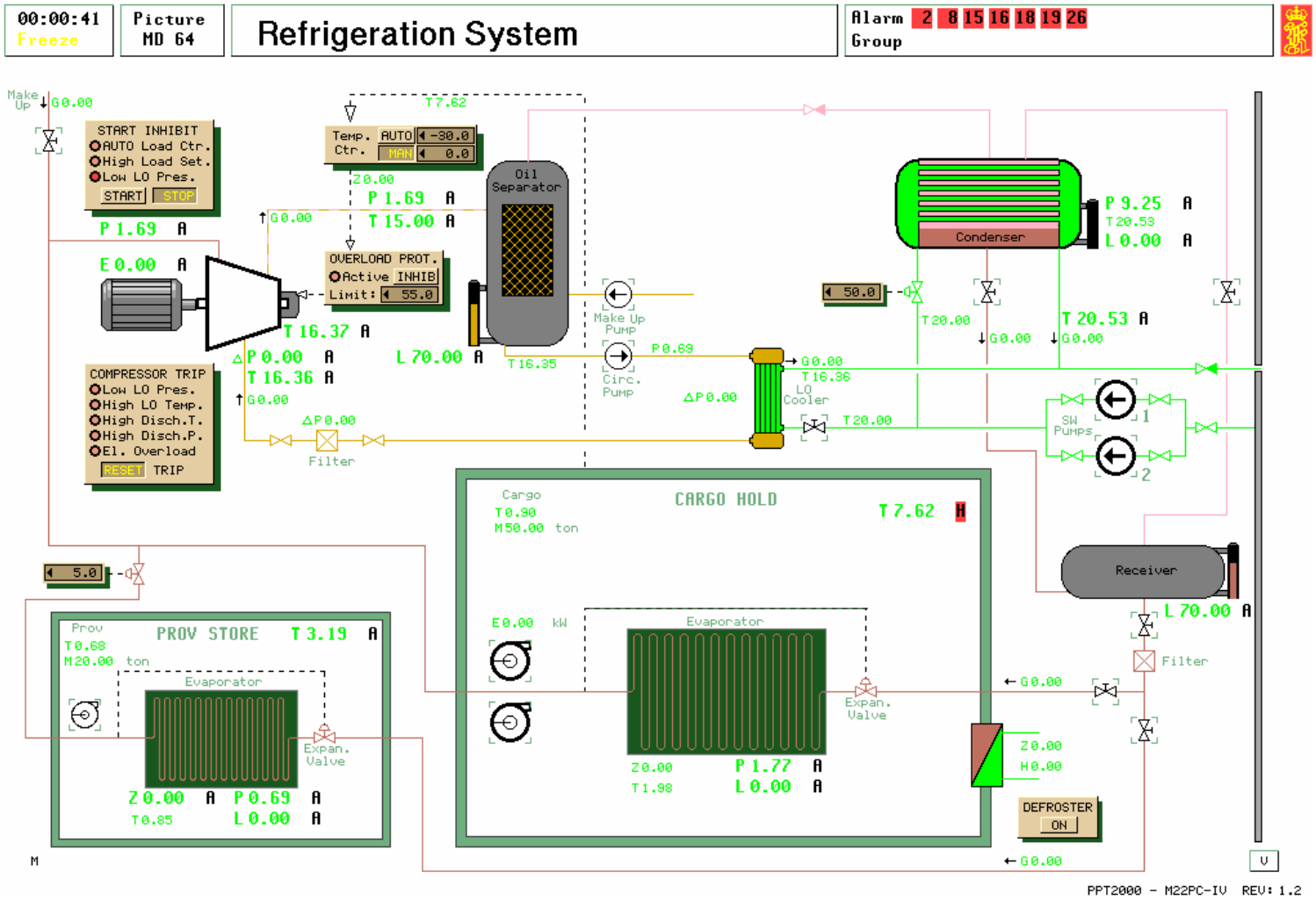
7.1 Check that shore connection has been established.
7.2 Open valve for discharge sludge ashore.

7.3 Start shore pump
7.4 Close discharge valve before removing the shore connection.

NOTE: Before discharge to shore remote stop of the shore pump from deck location must be tested.

Model particulars

- A small amount of oil and water is constantly leaking into the bilge wells (from unspecified sources).
- The content of the sludge tank is assumed to separate immediately into oil and water.
- The settling process in the separator vessel is modelled to be dependent on settling time, inlet flow oil content, temperature and position of oil/water interface level.
- Shore connection can only be activated if ship is in “mooring condition” (VP 9000, Z07005=1).
-


00:00:41
Freeze
Picture
MD 64
Refrigeration System
Alarm 2 8 15 16 18 19 26
Group
Make Up
G0.00
START INHIBIT
AUTO Load Ctr.
High Load Set.
Low LO Pres.
START
STOP
P 1.69 A
E 0.00 A
COMPRESSOR TRIP
Low LO Pres.
High LO Temp.
High Disch.T.
High Disch.P.
El. Overload
RESET
TRIP
T7.62
Temp. Ctr.
AUTO
MAN
-30.0
0.0
Z0.00
P 1.69 A
T 15.00 A
OVERLOAD PROT.
Active
INHIB
Limit:
55.0
T 16.37 A
P 0.00 A
T 16.36 A
L 70.00 A
T16.35
Oil Separator
Make Up Pump
Circ. Pump
P0.69
ΔP0.00
Filter
Condenser
P 9.25 A
T20.53
L 0.00 A
50.0
T20.00
T 20.53 A
LO Cooler
T16.36
T20.00
SW Pumps
Cargo
T0.90
M50.00 ton
CARGO HOLD
T 7.62 A
E0.00 kW
Evaporator
Z0.00
T1.98
P 1.77 A
L 0.00 A
Expan. Valve
Receiver
L 70.00 A
Filter
Z0.00
H0.00
DEFROSTER
ON
5.0
Prov
T0.68
M20.00 ton
PROV STORE
T 3.19 A
Z 0.00 A
T0.85
P 0.69 A
L 0.00 A
M
V
PPT2000 - M22PC-IV REV: 1.2

5.12 Refrigeration System

General

The refrigeration plant is based on R22 and consists of the following main components:

- Electrically driven screw compressor
- Compressor lubrication system
- Sea water cooled condenser
- Refrigerant liquid receiver

Nominal capacities are as follows:

Cooling capacity:	110 kW at - 18°C/30°C
Screw compressor motor:	50kW (67hp)
Refrigerant flow:	0.6 kg/sec
Sea water cooling flow:	20 t/h

The plant comprises following compartments:

One freezing compartment (-18 ^{o}C) including:

- One 4 kW air fan for cooling down
- One 1.5 kW air fan for normal operation
- One evaporator with dry expansion
- Evaporator electrical defrost device

One provision store compartment for perishable goods (+5^{o}C) including:

- One air fan
- One evaporator with dry expansion
- One evaporator pressure controller

Description

The compressor is lubricated and cooled by oil and refrigerant gases. The lubrication oil is separated from the compressed refrigerant gas in the oil separator. The bottom part of the separator serves as an oil reservoir. If the oil level is less than 20% of full, new oil must be added.

A substantial part of the compressor heat is transferred to the cooling oil in the compressor screw, and the oil must be cooled. This is done by sea water in the lubricating oil cooler.

The electric compressor motor load varies according to compressor condition, suction pressure, discharge pressure and gas flow. Electric overload will occur if the load is higher than a pre-set adjustable limit.

The effective (internal) compression ratio and thus the compressor capacity of the screw compressor is adjusted by means of a suction slide valve. It is positioned by a PID controller, controlled by the cargo room temperature.
The sea water flow to the condenser is supplied by two sea water pumps. Normally just one is in operation, while the other is stand-by. The sea water flow can be adjusted by a throttle valve at the condenser inlet. Normally 50% valve setting is used, giving a flow of approx. 20 ton/h.

The condensed refrigerant flows by gravity to the liquid receiver. The valve called "vapour valve" is for pressure equalising between condenser and the liquid receiver vessel. If it is closed, the draining of the condenser will be obstructed.

Operation procedure

1. **Preparation**

1.1 Line up valves in the lubrication oil system and start the pump. Check and if necessary, refill the lubrication oil by means of the make-up pump.
1.2 Open vapour valve between compressor and condenser.
1.3 Open vapour and liquid valves between condenser and receiver.
1.4 Open sea water cooling valves to lubrication oil cooler and condenser.
1.5 Condenser cooling water control valve must be set to a suitable level to maintain appropriate condensation pressure.

2. Starting

2.1 Open the liquid valves from receiver to evaporators.
2.2 Start forced draft fans in compartments.
2.3 Reset the trip functions if any present and start the compressor.
2.4 Set temperature control into MAN and adjust capacity control slide valve to 10%, (otherwise compressor will trip on overload).
2.5 Gradually increase compressor capacity manually checking the compressor electric power consumption during cooling down.
2.6 Set temperature controller into AUTO when temperature in Cargo Hold is below $-10^{o}C$
2.7 Normal temperature in cargo hold is $-18^{o}C$.

NOTE:
Start Inhibit functions:
- AUTO selected : X06615 = 1
- High controller setting : Z06616 > 26%
- Low lubricating oil Pressure: P06571 < 0.75 bar

Model particulars

- Heat loss to surroundings is dependent on ambient temperature. At steady state condition this is the only heat load modelled, in addition to the air circulation power dissipation.
- To enable more versatile steady state operations, an extra heat load can be activated. This "extra load" can be interpreted as a secondary brine system cooled by the circulating air. The load setting represents the rate of flow circulation on the brine side. The additional heat flow is computed as being proportional to load setting and to the difference between the brine temperature (= 0°C) and refrigerated air temperature.

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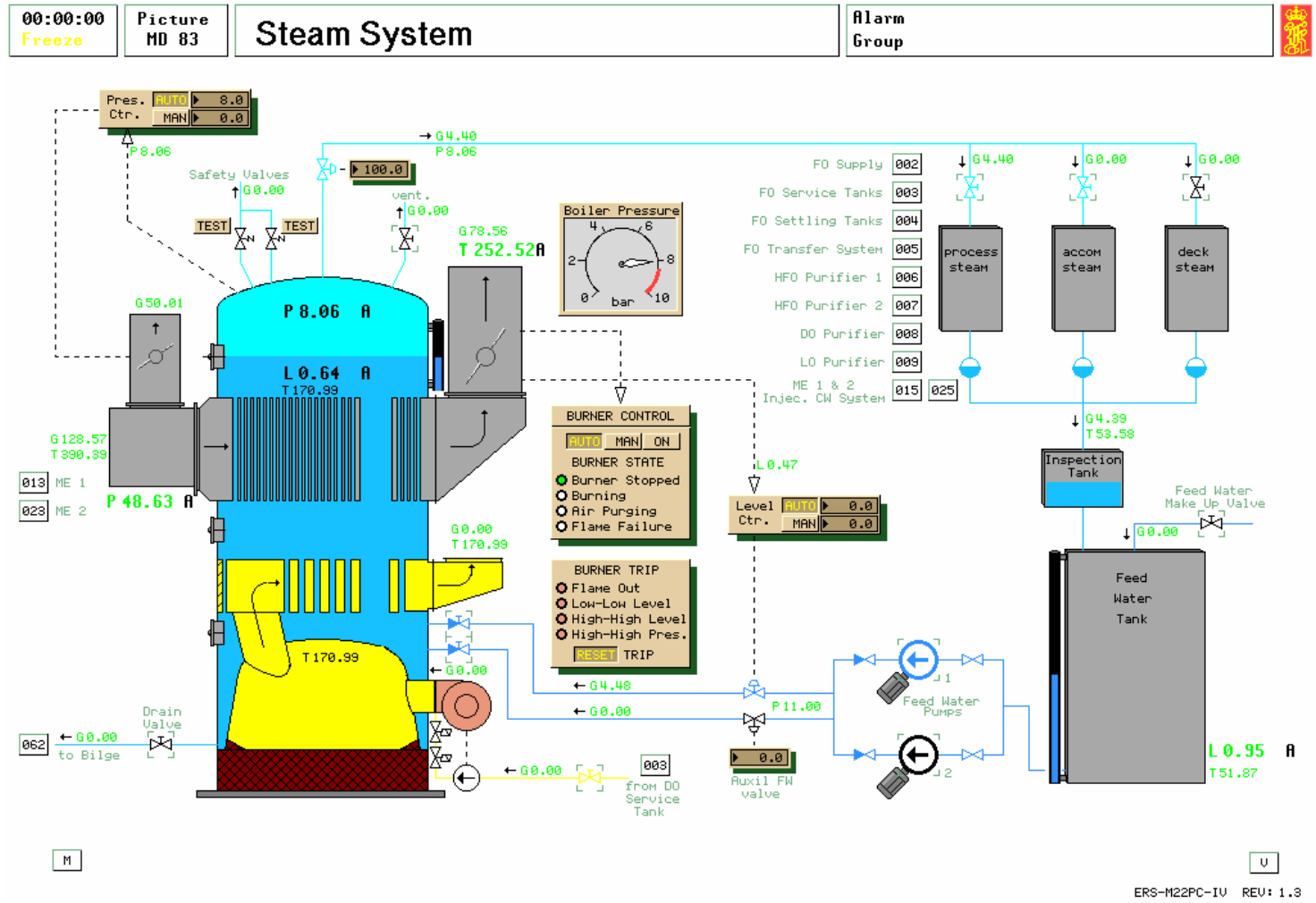
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Freeze
Picture
MD 83
Steam System
Alarm
Group
Pres. Ctr.
AUTO
MAN
8.0
0.0
P8.06
G4.40
P8.06
100.0
Safety Valves
G0.00
vent.
G0.00
TEST
TEST
G78.56
T 252.52A
Boiler Pressure
bar
G50.01
P 8.06 A
L 0.64 A
T170.99
G128.57
T390.39
013 ME 1
023 ME 2
P 48.63 A
G0.00
T170.99
T170.99
BURNER CONTROL
AUTO MAN ON
BURNER STATE
Burner Stopped
Burning
Air Purging
Flame Failure
BURNER TRIP
Flame Out
Low-Low Level
High-High Level
High-High Pres.
RESET TRIP
L0.47
Level Ctr.
AUTO
MAN
0.0
0.0
G0.00
G4.48
G0.00
P11.00
0.0
Auxil FW valve
G0.00
003
from DO Service Tank
062
G0.00
to Bilge
Drain Valve
FO Supply 002
FO Service Tanks 003
FO Settling Tanks 004
FO Transfer System 005
HFO Purifier 1 006
HFO Purifier 2 007
DO Purifier 008
LO Purifier 009
ME 1 & 2 Injec. CW System 015 025
G4.40
G0.00
G0.00
process steam
accom steam
deck steam
G4.39
T53.58
Inspection Tank
Feed Water Make Up Valve
G0.00
Feed Water Tank
L 0.95 A
T51.87
1
2
Feed Water Pumps
M
V
ERS-M22PC-IV REV: 1.3

5.13 Steam Boiler

General

The major components in the steam system are:

- Steam boiler
- Steam consumers
- Inspection tank
- Feed water tank
- Feed water pumps
- Necessary valves/controllers

Description

The boiler is of the composite type having an exhaust gas section for seagoing operation and oil fired section for port operations. Both means of firing may be used simultaneously.

The boiler capacity is approx. 3.0 t/h at 7.0 bar when used as oil fired boiler. Used as an exhaust boiler the capacity is approx. 4.5 t/h assuming both main engines are operating at full power. One fully automatic oil burner fires the oil-fired section. Fuel supply is from the diesel oil service tank.
A pressure controller modulating the fuel flow to the burner and the air fan flow controls the steam pressure. Also, if necessary, the burner can be automatically started and stopped.

To control the steam pressure when the oil-fired section is out of operation, a separate steam pressure controller is included. It positions the damper according to need. When the steam load is low, more exhaust gas is by-passed and vice versa.

The oil burner is tripped at
- Loss of flame
- Low-low water level
- High-high steam pressure
- High-high water level

The water to the boiler is supplied from a feed water tank by two feed water pumps of which just one is normally running. A feed water valve and a PID level controller control the boiler water level.

Both feed water pumps trip at high-high water level to protect steam consumers from "water strike" caused by water in outgoing steam pipe. The boiler protection also includes a safety valve, which opens at high steam pressure.
A vent valve for use during start up heating and a water drain valve is also included. The steam condensate returning from the miscellaneous steam consumers is collected in the feed water tank. When necessary, more water can be added by the feed water make-up valve.

All condensate returns back to the Inspection tank.

Operation procedure

1. **Preparation**

1.1 Select fuel oil service tanks.
1.2 Open diesel oil to boiler.
1.3 Open ventilation valve. (De-aerating valve).
1.4 Put level controller in manual mode.
1.5 Start one feed water pump and check the pressure and flow. Stop the first pump and start the other pump and fill up boiler drum to 10% below normal level.

Starting procedure

2. **MANUAL mode**

2.1 Observe the control panel and rectify any tripping faults.
2.2 High-high water level: Drain water by opening valve to bilge. Low–low water level: Check that water level controller is set to suitable value, normally 0 mm and wait for feed water pumps to fill up the boiler drum to correct level.
2.3 After rectifying faults, push the RESET button.
2.4 Push button ON at burner control panel to start the burner.
2.5 Fire up the boiler slowly to reduce thermal strain. After a suitable time, when air has escaped, close de-aerating valve.
2.6 When pressure rises to normal level set feed water controller in auto.
2.7 Slowly open steam outlet valve and steam to consumers.

3. AUTO mode

3.1 Level controller to be set in auto mode (the Feed water pumps are attached to this function).
3.2 Put the Boiler into AUTO from the burner control panel.
3.3 Burner will start and stop automatically depending on steam consumption.

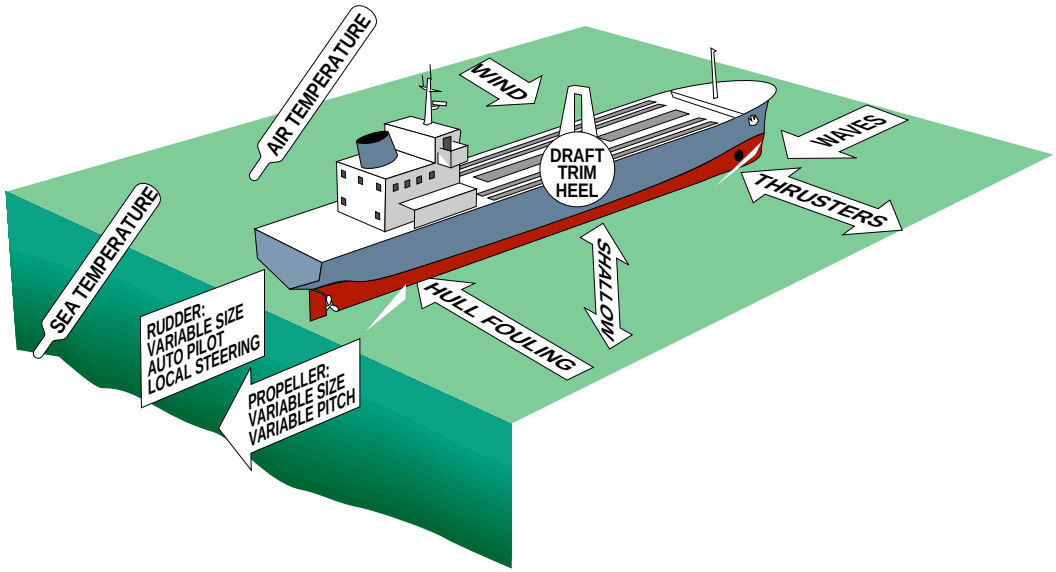
The feed water tank is to be manually filled from the fresh water storage tank.

Model particulars

No comments.

6 SHIP PROPULSION - MODEL PARTICULARS

This part holds only model particulars.



Ship Model Characteristic

6.1 Propeller and Ship Model Characteristics

The propeller characteristic is realistically modulated. The propeller torque and thrust depend on ship speed, propeller revolution, and propeller pitch and rudder deflection. The hull resistance is set for a typical ferry ship. It is made dependent on ship speed, ship draft, heel and trim, depth of water, weather condition (wave/wind) and the hull's degree of fouling.

The basic ship speed response-constant is correctly modulated in dependence of load condition. By using the "Ship Dynamics" from the Operating Condition picture, the instructor can change the apparent speed response to save time:

- 1 times true response
- 2 times true response
- 4 times true response

The steady state thrust or the time scale does not influence propulsion power!

The hull model includes dynamic description of the ship's movement ahead, its speed and rate of turn, its yawing, rolling and pitching etc. The hull drag force includes water resistance due to waves, wind, and ice. The weather condition sets the general level of wave disturbance. The wind force is specified by mean wind speed and wind direction.
The ice resistance is composed of one steady and one dynamic component. If the ship gets stuck in the ice, "ice breaking" can be tried. Reverse the ship some ship lengths and then ram with full power towards the ice edge.

The influence of the weather condition, set by the instructor, is modulated in three ways:

- The waves' effect on the propeller is simulated by adding the hydrodynamic propeller torque random disturbances (low-pass filtered, white noise). The rpm will vary somewhat and the AutoChief system will be disturbed in its speed controlling function.

- The pitch and roll movement of the ship is simulated by adding the liquid level in the following tanks:

  - ME jacket water expansion tanks
  - ME injection cooling water tanks
  - ME lubrication oil sump tanks
  - ME rocker arm lubrication oil tanks
  - DG1 & 2 sump lubrication oil tanks
  - HFO service tanks
  - DO service tank
  - Engine room bilge well

The breaking effect of the waves on the ship speed is simulated by increasing the propulsion resistance. The ship speed will drop and the main engines will thus be heavier loaded.

The water depth can be specified and the "shallow water" effect demonstrated. The effect is noticeable only if the depth is less than 2-3 times ship draft.
A Bow and Stern Thruster can be operated from the bridge (Instructor's Station). The thruster pitch is adjustable. Note that the bow thruster force will decrease at increasing speed ahead and at full speed the bow thruster will have no influence.

6.2 Ship Load

All tanks are assumed prismatic in form (tank masses proportional to level). The following main tanks are included:

- FO settling tanks
- FO service tanks
- Spill oil tank
- FO bunker tanks
- DO storage tank
- Lubrication oil storage tank

Storage tanks are modelled as masses entered by the instructor, and set the boundaries for the simulated systems.

Ballast tanks are represented on this ship as followed:

- -2 x 1 Ballast wing tank
- 1 Fore peak tank
- 1 Aft peak tank

The load in "cargo holds" (fore/aft/port/starboard) can be altered by the operator or the instructor from Variable Page 5701, Ship Load Condition.

Ship Load override

The instructor can override the actual calculated load of the ship by changing the "SHIP LOAD" parameters from page 9002, "Sim Control; External Conditions":

X07015 0(M)= load set by hull program
1(P)= load set by "potentiometer"X06317 at the same page (pot meter input)
2(F)= full loaded ship (100% dwt)
3(E)= light ship (20% dwt)

6.3 Ambient Temperatures

The ambient sea water and air temperature is adjustable through the variable page 9002 "SIM CONTROL; External Conditions". The sea water temperature effects the operational condition of all FW, lubricating oil and air coolers. Changes in the sea water temperature will over time impact the temperature in various tanks, on condition they were left without heating.

The air temperature in the engine room depends on the total power from the main auxiliary engines, ambient air temperature and the number of engine room ventilation fans in operation. In case an engine room fire is simulated, the temperature will increase rapidly. The air temperature in the engine room also effects the scavenging air temperature of the diesel engines.
A simple model of the engine control room (ECR) air conditioning system is included. If the air conditioning system is turned off or has failed, the engine control room temperature will gradually approach machinery space temperature. Fire in the engine room will lead to an overload of the air conditioning system, and will finally fail.