K-Sim

ERS Wärtsilä 12RT-Flex 82(C) High Voltage

Machinery & Operation

Part 3

Machinery & Operation

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Section **Page**

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

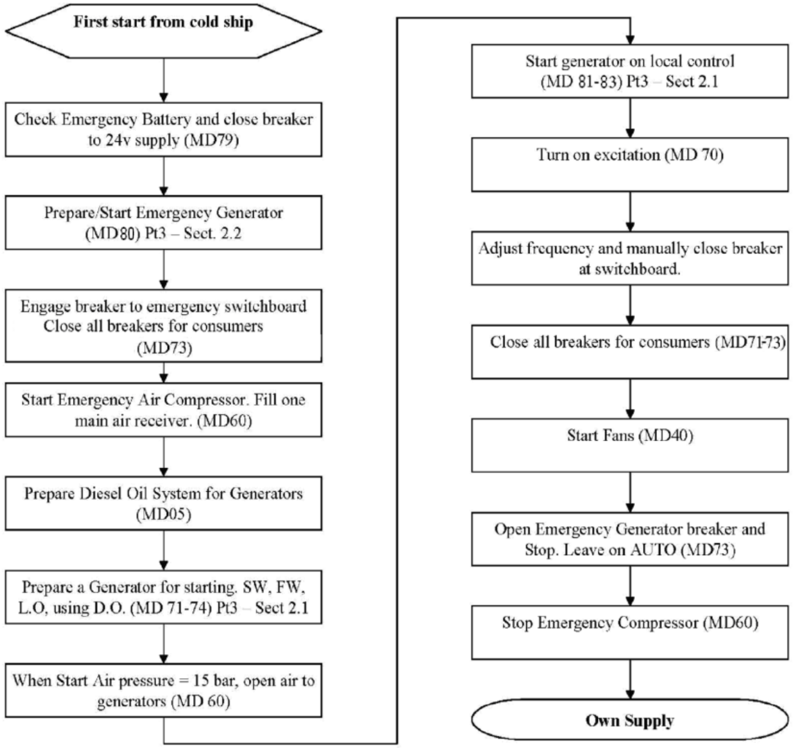
- Blue: Fresh water (low and high temperature)
- Green: Sea water
- Yellow: Diesel oil
- Brown: Fuel oil
- Light brown: Lubrication oil
- Grey: Start and service air
- Light blue: Steam

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

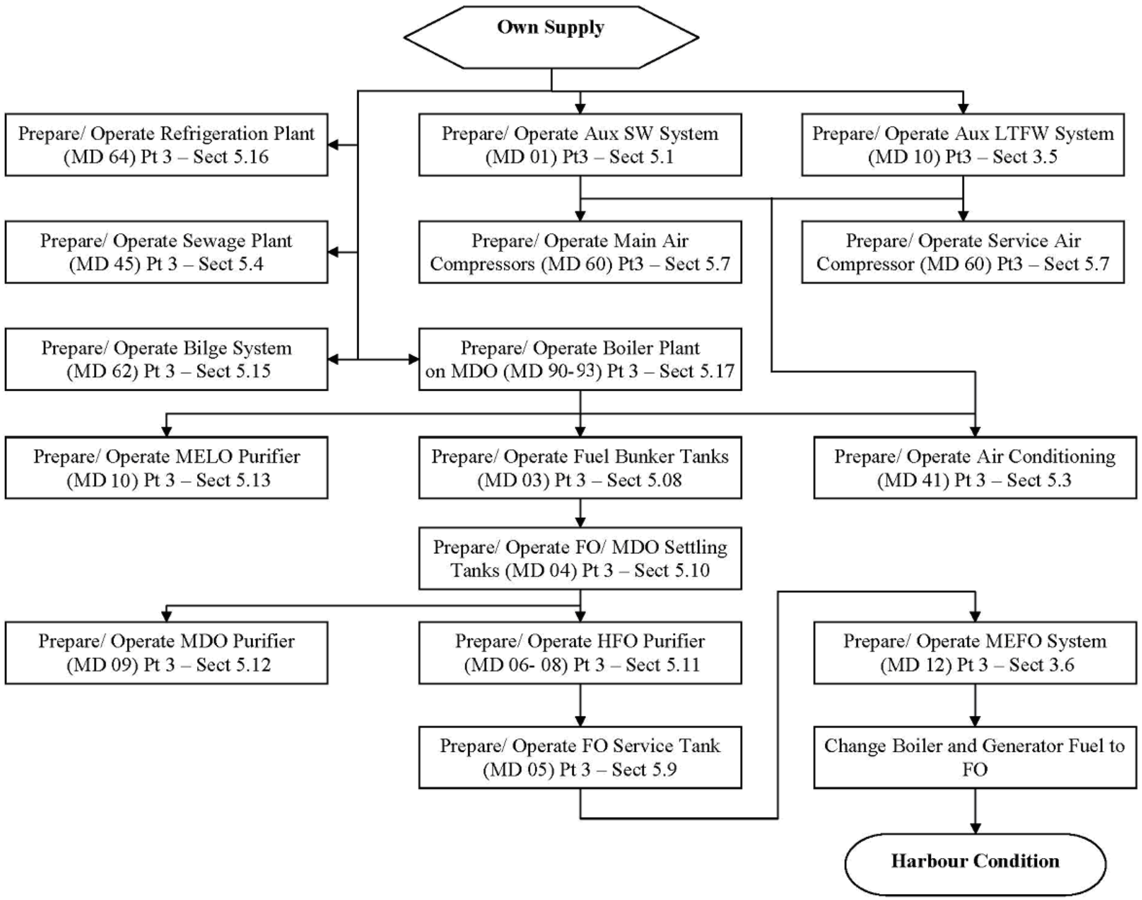
T:	Temperature
G:	Flow
P:	Pressure
N:	Rpm
Q:	Power
I:	Ampere
U:	Voltage
F:	Frequency
E:	Electrical power
V:	Valve
L:	Level
X:	Miscellaneous variable
Z:	Water or other undesirable contamination index variable
W:	Viscosity

1 SEQUENCE DIAGRAMS

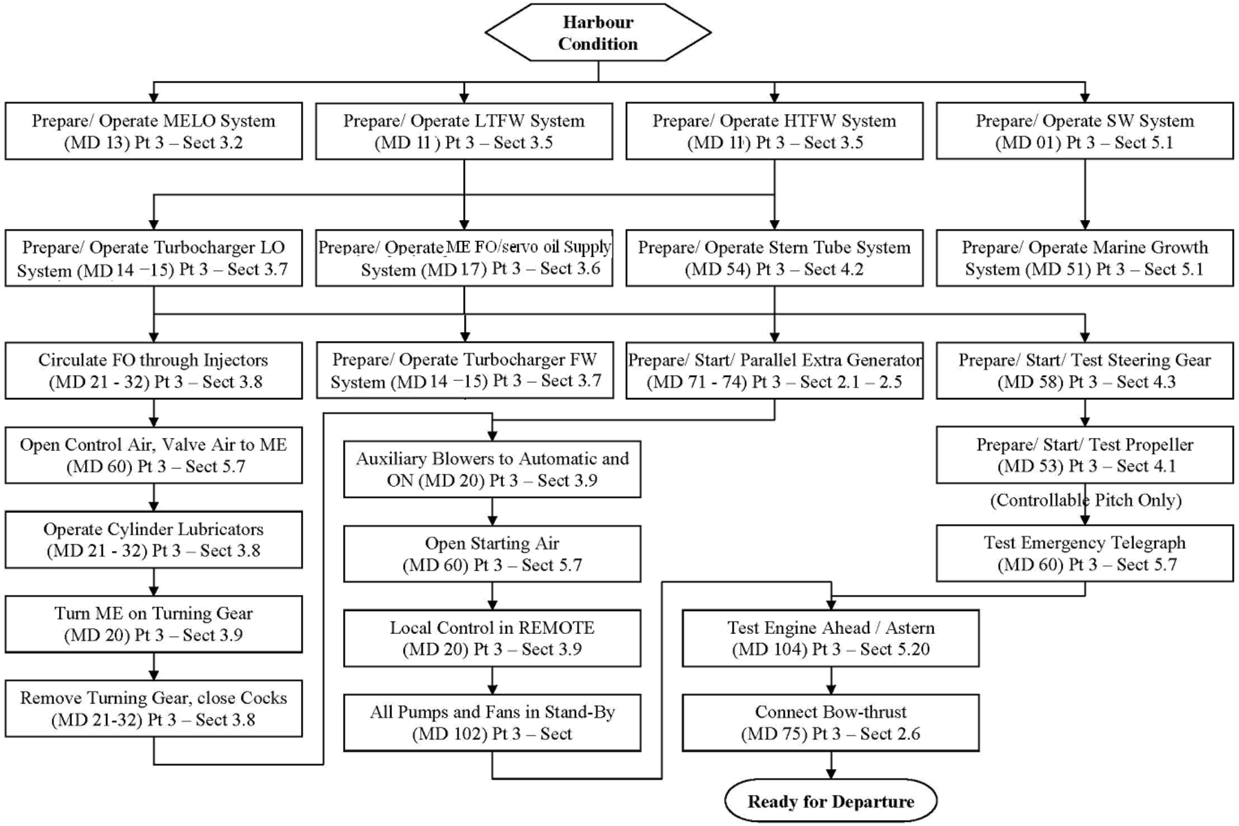
1.1 First Start to Own Supply



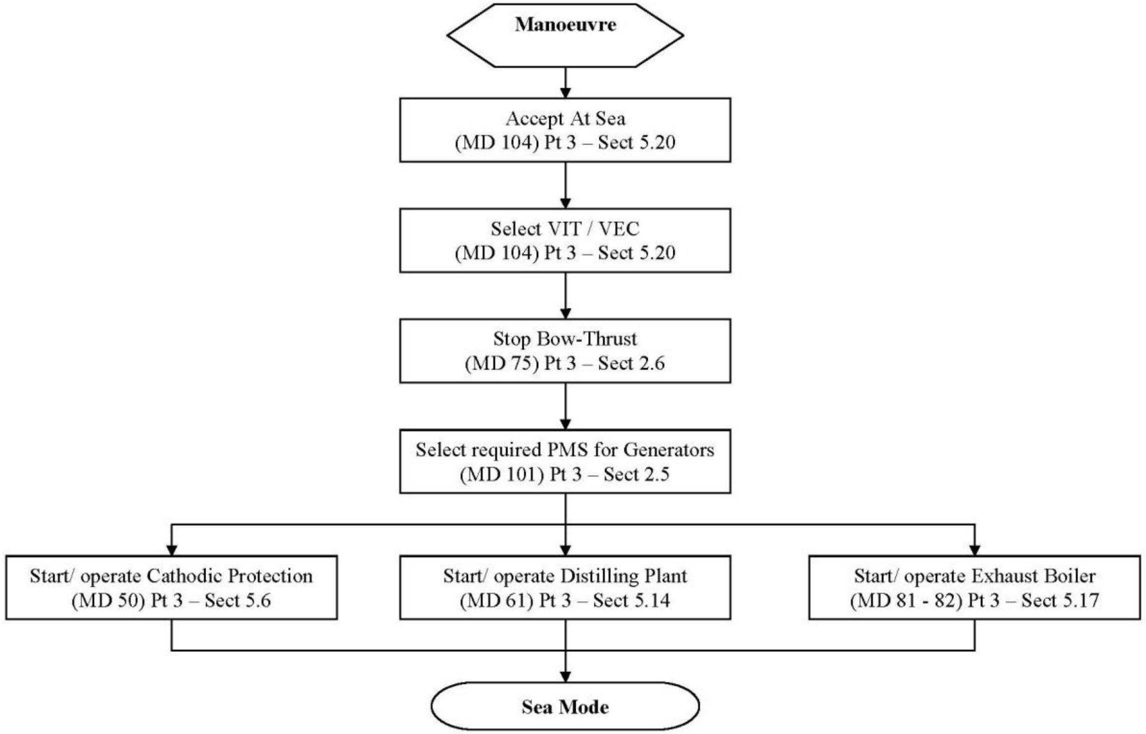
1.2 Own Supply to Harbour Condition

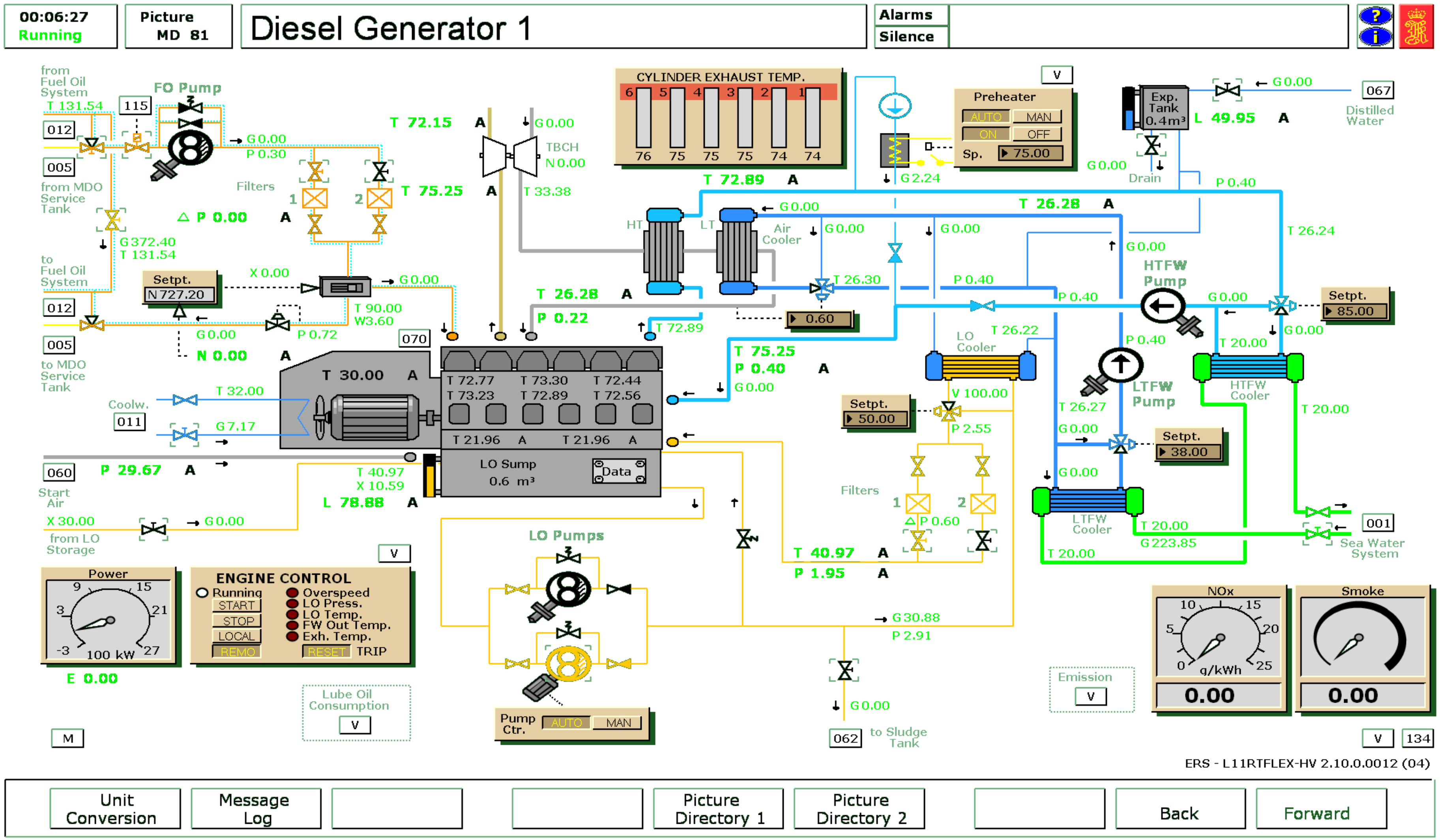


1.3 Harbour Condition to Ready for Departure



1.4 Manoeuvre Mode to Sea Passage Mode




00:06:27
Running
Picture
MD 81
Diesel Generator 1
Alarms
Silence
from Fuel Oil System
FO Pump
from MDO Service Tank
to Fuel Oil System
to MDO Service Tank
Filters
Setpt.
N 727.20
CYLINDER EXHAUST TEMP.
TBCH
Preheater
AUTO
MAN
ON
OFF
Sp.
75.00
Exp. Tank 0.4m³
Drain
Distilled Water
HT
LT
Air Cooler
HTFW Pump
LTFW Pump
LO Cooler
HTFW Cooler
LTFW Cooler
Sea Water System
Coolw.
Start Air
from LO Storage
LO Sump
0.6 m³
Data
LO Pumps
Pump Ctr.
Power
100 kW
ENGINE CONTROL
Running
START
STOP
LOCAL
REMO
Overspeed
LO Press.
LO Temp.
FW Out Temp.
Exh. Temp.
RESET
TRIP
Lube Oil Consumption
to Sludge Tank
Emission
NOx
g/kWh
Smoke
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2 ELECTRICAL PLANT

2.1 Diesel Generators MD81-83

General
The ship is equipped with three 2700kW/6.6kV/60Hz diesel engine driven synchronous generators. Each generator is driven by a turbocharged, four-stroke, 6-cylinder auxiliary diesel engine.

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 piping from Fuel supply system (MD12) to the diesel generators (MD81-83) can be heated by steam tracing and is also kept hot by fuel recirculation at each generator. To keep the fuel injection pumps hot, a non-return fuel circulation valve is mounted in parallel with the fuel pump, also a pressure control valve in the fuel return line is included. The fuel quality at injection pumps is indicated. For a safe start the viscosity at injection pumps should not be higher than 17-18 cSt. If a change-over is made from HFO to DO while the engine is running, there will be a short loss of power, but the engine will keep running. A change-over to HFO while the engine is running on DO will cause misfiring/engine stop due to too low temperatures of the metal part in the fuel feeder line and injection pumps. 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 system depending on the position of the double 3-way valve.
An electrically operated shut-off valve on the suction side of the fuel oil pump shuts off the fuel oil supply in case of an emergency. The valve is controlled from the Remote Emergency Operating Panel.

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 discharges though a fresh water cooled oil cooler and a duplex filter. The oil sump can be refilled from the lubricating oil storage and the oil can be drained to the sludge tank by using the electrical oil pump.
The electrical oil pump can be operated in manual or in automatic mode.

Seawater for the LT and HT fresh water coolers is provided by the vessel’s main sea water system.

A shaft driven LT fresh water circulating pump circulates fresh cooling water through the lubricating oil cooler and the scavenging air cooler. A shaft driven HT fresh water circulating pump circulates the scavenge air heater and cylinder jackets. The temperature is controlled by a simple proportional controller, controlling the temperature at inlet cylinder jackets. The HT can be pre-heated, using an electric heater.

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

- Speed-droop (speed controller droop setting): Default setting = 60%, which represents a speed droop approx. 3%, or 1.8Hz. 100 % = approx. 5% speed droop.
- Speed set point (basic speed at unloaded engine): Default setting = 909 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 65.
- Compensation valve (speed controller integral time): Default setting = 20 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: 8 seconds on and 20 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 Lube Oil Pressure	1,0 bar
High Lube Oil Temp.	90°C
High fresh water Temp.	96°C
High Exhaust Temp.	700°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 8115/8215/8315.

Operation procedure

In normal operation the generator is in standby mode with AUTO and priority selected on the POWER CHIEF. While in AUTO mode the generator must be prepared ready to start.

1. Preparation

1.1 Check level in the fresh cooling water expansion tank and refill if necessary.
1.2 Check that the fresh water pre-heater is working and in AUTO – normal set point is 75°C.
1.3 Ensure sea water flow shut off valve to LTFW cooler is open.
1.4 Ensure, from MD01 that DG cooling water supply valve is open and sea water flow is normal.
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 on stand-by.
1.7 Ensure that lubrication oil valve to the sludge 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 valves from diesel oil service tank, MD05, and fuel oil system, MD12, to generator engine are open.
1.12 Open fuel oil emergency shut off valve.
1.13 Open HFO bypass circulation valve.
1.14 Open fuel oil valve before fuel oil filters. Normally one filter is in operation and one filter is cleaned and on stand-by.
1.15 Check the position of the fuel oil supply 3-way valve.
1.16 Open start air valves, MD60. Start air must be at least 15 bar (218 psi) on the starting air line.
1.17 If any of the alarm lamps (red) at the local panel are lit, press the RESET button.
1.18 Start the engine from the local panel by pressing the START button.

2. Starting

2.1 When the Engine Control panel is in Remote the engine can only be started from the POWER CHIEF panel or Electric Power Plant, MD70.
2.2 To start locally select local on the Engine Control Panel.
2.3 Start the Lubricating oil priming pump manually (if not already in Auto).
2.4 Press Start.
2.5 When engine is running, the electrical Lubricating oil priming pump will stop automatically (if in AUTO).
2.6 The generator can now be connected to the main bus using the Synchroscope panel, MD134, or Electric Power Plant panel, MD70.
2.7 To use the POWER CHIEF the generator must be switched to Remote.

3. Stopping

3.1 The generator can be stopped when in remote from the POWER CHIEF panel or the Electric Power Plant panel.

3.2 To stop locally, firstly ensure that generator breaker is open.
3.3 With the Engine Control in Local, press STOP.
3.4 If the generator is to be stopped for maintenance, leave control in Local and close starting air valve.

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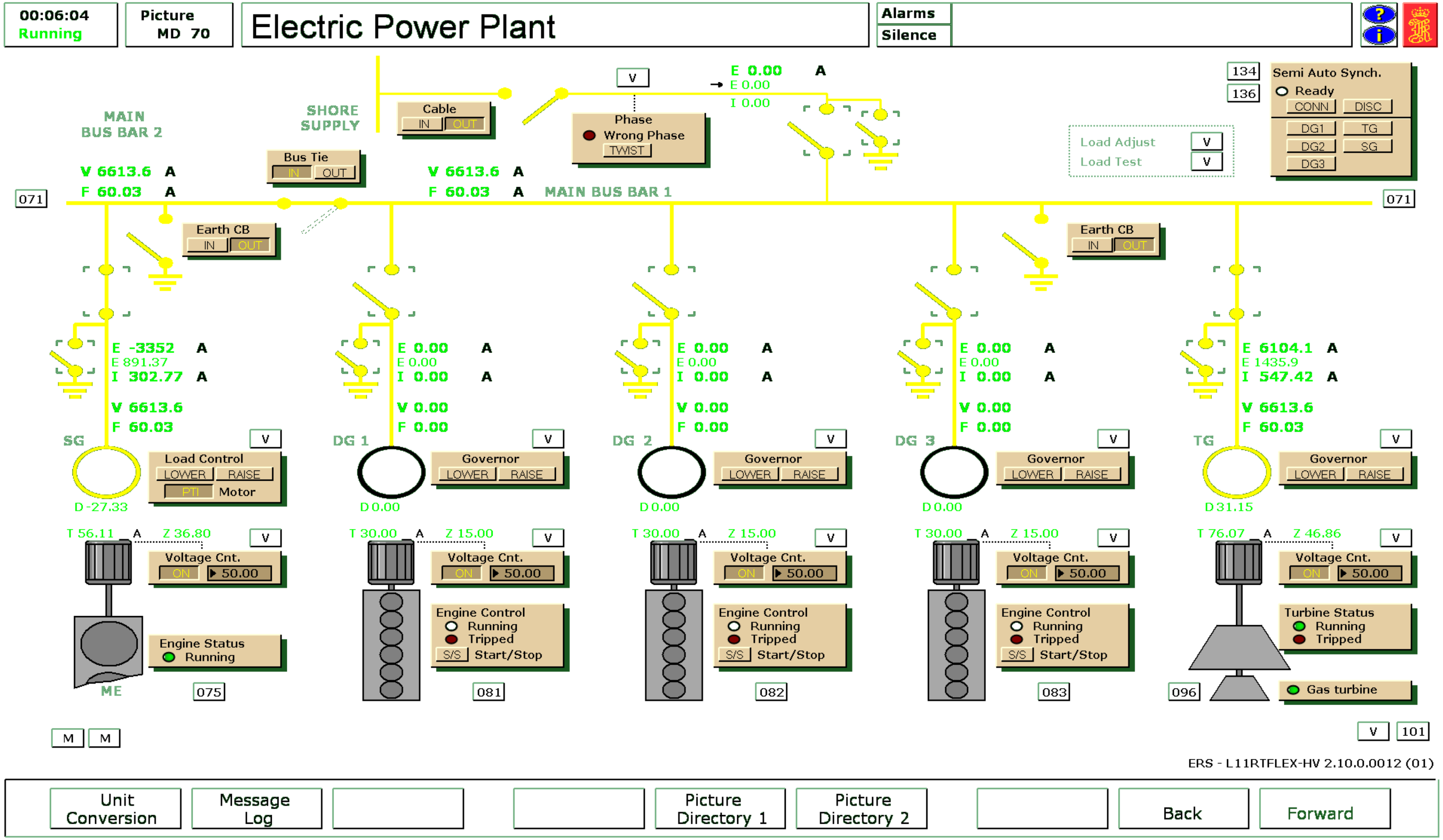
00:06:04
Running
Picture
MD 70
Electric Power Plant
Alarms
Silence
SHORE SUPPLY
Cable
IN OUT
Phase
Wrong Phase
TWIST
E 0.00 A
E 0.00
I 0.00
134
136
Semi Auto Synch.
Ready
CONN DISC
DG1 TG
DG2 SG
DG3
Load Adjust
Load Test
MAIN BUS BAR 2
Bus Tie
IN OUT
V 6613.6 A
F 60.03 A
MAIN BUS BAR 1
071
Earth CB
IN OUT
E -3352 A
E 891.37
I 302.77 A
V 6613.6
F 60.03
SG
Load Control
LOWER RAISE
PTI Motor
D -27.33
T 56.11 A Z 36.80
Voltage Cnt.
ON 50.00
Engine Status
Running
ME
075
DG 1
DG 2
DG 3
E 0.00 A
E 0.00
I 0.00 A
V 0.00
F 0.00
Governor
LOWER RAISE
D 0.00
T 30.00 A Z 15.00
Engine Control
Running
Tripped
S/S Start/Stop
081
082
083
TG
E 6104.1 A
E 1435.9
I 547.42 A
V 6613.6
F 60.03
D 31.15
T 76.07 A Z 46.86
Turbine Status
Running
Tripped
Gas turbine
096
101
M M
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2.2 Electrical Power Plant MD70

General

The ship's electric power is generated by:

- One 5000 kW/6.6kV/60Hz Shaft generators
- Three 2700 kW/6.6kV/60Hz diesel engine driven synchronous generators
- One 6500kW/ kW/6.6kV/60Hz generator driven by a steam turbine (ST) and an exhaust gas turbine (PT)
- One 250 kW/440 V/60Hz emergency generator

and distributed via:

- one main switchboard, divided into two main 6.6kV bus bars
- one 440V bus bar
- one 220V bus bar
- one emergency 440V bus bar
- one emergency 220V bus bar
- one 24V bus

Bus bar 1 powers all the electrical main consumers and the emergency bus bar via 6.6kV/440V transformers.
Bus bar 2 powers the bow thrusters, reefer containers and the deck machinery.

The 220v bus bar is supplied from 440V bus bar via a circuit breaker and transformer.

The emergency switchboard supplies the emergency 220v bus bar via a circuit breaker and transformer. Emergency batteries are supplied by two battery chargers, one for starting battery and one for emergency supplies.

The 6.6kV bus bars can also be supplied via a shore connection link that has the ability to alter phase rotation to ensure that motors turn in the correct direction.

Description

The status of all prime movers is indicated, with the diesel generators having a remote start available.

The emergency generator can be set to either AUTO or MAN mode. It is normally kept in AUTO. Test 1 starts the generator, test 2 connects the breaker while disconnecting the emergency bus bar from the main bus bar. In AUTO mode if power is lost to the emergency bus bar the generator starts and connects automatically. Reconnecting the emergency bus bar to a live main bus bar automatically stops the generator.

Each generator is excited by an AVR based on a PI controller. Changing the excitation setting alters the controller base setting.

Each main generator has indication for rotor phase (between current and voltage), active and reactive power. See also own chapter for phase diagram.

The main generators governor speed control and shaft generator load control can be accessed. All are based on a PI controller with droop setting.

The shaft generator can be used as a power take in (motor) in case of excessive electric power.

All main generators are protected by a circuit breaker. The breaker protects against:

- Fast overload
- Slow overload
- Reverse power
- High voltage, fast acting
- High voltage, slow acting
- Low voltage
- High frequency
- Low frequency

The settings of the above are easily accessed on the breaker itself. The breaker also sets the level at which the preferential trips operate, this function does not trip the circuit breaker. Whichever trip has activated is indicated and can be reset from the circuit breaker. The emergency generator cannot be synchronised its breaker is accessed via variables page 8020.

On the main bus bar there are two mechanical earth down isolator switches and one mechanical bus-tie isolator switch, all manually operated. The bus-tie isolator is normally connected during normal operation. When maintenance on bus 2 and/or consumers connected to this bus is to be carried out, the mechanical bus-tie isolator switch should be disconnected and the bus earthed down. The earth down device is interlocked such that it’s not possible to earth down a “live” bus.

Normal operating modes

Emergency generator on AUTO at all times.

- In port.
  - diesel generators supplying power as required, normally one is sufficient.

- Manoeuvring.
  Fixed pitch operation.
  - both diesel generators supplying all electrical power.

  Variable pitch operation.
  - both diesel generators supplying main bus
  - bus tie open
  - Shaft generator supplying power to bow thruster.
- Sea passage
  - Turbine generator supplying all power
  - Shaft generator in PTI

  Turbine out of action
  - Shaft generator supplying all power.

Operation

1. **Shore Connection.**

1.1 Ensure all generators disconnected, emergency bus bar and bus tie disconnected.
1.2 Connect incoming cable.
1.3 Check phase rotation, use phase twist if required.
1.4 Close shore circuit breaker to supply main bus.
1.5 Close emergency bus if required or starting from cold and continue start sequence.
1.6 Shore circuit breaker must be tripped before connecting main generator to bus.

2. **Emergency Generator Starting**

2.1 Ensure battery voltage is correct. MD73.V72691.
2.2 Generator in manual operation press start.
2.3 Turn on voltage control and adjust to 440v.
2.4 Use governor control to give 60Hz output.
2.5 Connect emergency generator breaker.
2.6 Trip main bus breaker connection to emergency bus.

1.1 **Emergency Generator Stopping**

3.1 Ensure that main bus bar has supply.
3.2 Connect main bus bar breaker connection to emergency bus.
3.3 Open emergency generator breaker.
3.4 Stop generator.

4. **Emergency Generator Automatic Operation**

4.1 The generator is normally in AUTO, voltage control on, circuit breaker open.
4.2 If supply is lost to the emergency switchboard the generator will automatically start and close the circuit breaker supplying the emergency bus.
4.3 The main bus will be isolated due to the connection circuit breaker opening on low voltage.
4.4 When the emergency bus is again supplied from the main bus, connection circuit breaker closed, the emergency generator will automatically stop and open the circuit breaker.

5. **Emergency Generator Testing**

5.1 The generator should be tested regularly to ensure that it will function when required.
5.2 With the generator in AUTO, TEST 1 will simulate low voltage on the emergency bus causing the generator to start.
5.3 The generator will attempt a maximum of three starts.
5.4 Releasing TEST 1 the generator stops.
5.5 Before using TEST 2 the bridge must be informed and check that the elevator is not in use. TEST 2 will temporarily interrupt the emergency supply.
5.6 TEST 2 disconnects the emergency bus from the main bus simulating total supply failure, the generator starts and supplies the emergency bus.
5.7 Releasing TEST 2 reconnects the emergency bus to the main bus and the generator stops.

6. Main Generators

6.1 It is normal to have the generators in AUTO, (MD101), and priorities set on shaft and diesel generators so that load sharing is achieved as the control mode dictates.
6.2 The Turbine generator will always be priority one when running.
6.3 With generators not in AUTO mode connection can be made from MD70.
6.4 Before attempting connection check that the generator is ready to run. (MD75, MD76, MD86).
6.5 The turbine generator must be running before connection can be attempted.
6.6 Ensure that voltage control is on.
6.7 Start required generator by pressing start/stop button.
6.8 When engine is running adjust voltage control if necessary to match main bus voltage.
6.9 The breaker can be made by the semi auto sync – select generator and adjust speed until ready light shows, press conn.
6.10 Manual synchronising can be carried out from the main switchboard (MD140 – MD144).
6.11 Once connected the generators must be manually balanced by adjusting the governor controls.
6.12 To disconnect select generator to be stopped, remove load by lowering the governor control, press disc.
6.13 After disconnection, the generator can be stopped by pressing the start/stop button.
6.14 The turbine generator must be stopped from MD96.

7 Shaft Generator, Power Take Off mode

7.1 Ensure that cooling water is available from MD11 and valve is open in MD75.
7.2 Ensure that the shaft generator is ready on MD75. Auxil. Power, Synch. Cond. On. Ensure voltage control is on.
7.3 Adjust voltage control if necessary (MD70).
7.4 Use Semi Auto Synch. to select SG and raise/lower load control until ready light is on.
7.5 Press connect and raise load as required.
7.6 Manual synchronising can be carried out from the main switchboard.
7.7 To disconnect, select SG, reduce load to zero and press Disc.

8 Shaft Generator, Power Take In mode

8.1 To enable power take in the reverse power setting of the breaker is set to –5500kW.
8.2 Breaker must be connected in PTO mode.
8.3 Press PTI.
8.4 The shaft generator load is gradually reduced and PTI mode initiated.
8.5 PTI may be adjusted using the Lower and Raise load control.
8.6 To change from PTI to PTO press PTO. Power in is reduced to zero.
8.7 Disconnect breaker or adjust load to supply power from SG.

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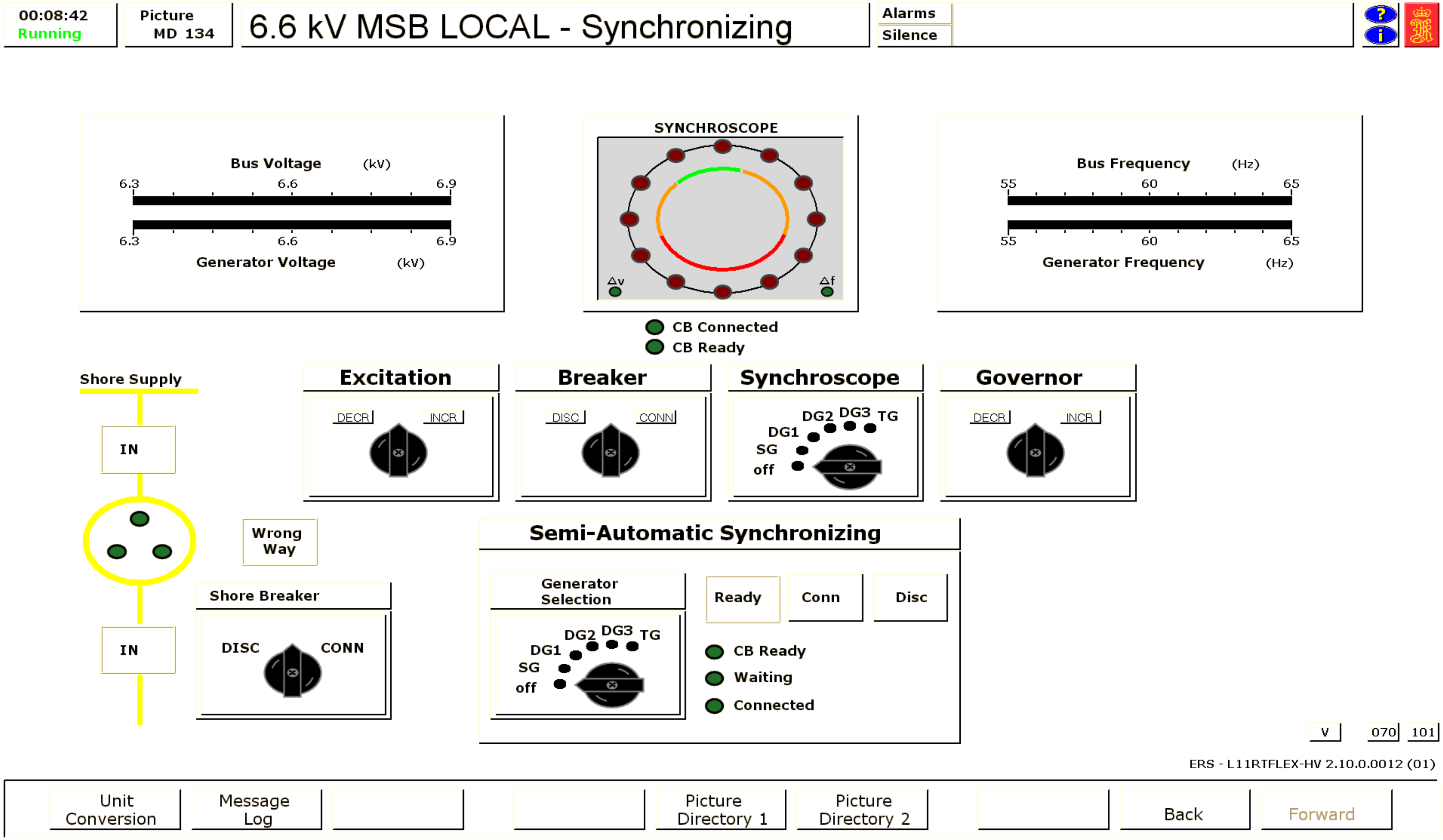
00:08:42
Running
Picture
MD 134
6.6 kV MSB LOCAL - Synchronizing
Alarms
Silence
Bus Voltage (kV)
6.3 6.6 6.9
Generator Voltage (kV)
SYNCHROSCOPE
CB Connected
CB Ready
Bus Frequency (Hz)
55 60 65
Generator Frequency (Hz)
Shore Supply
IN
IN
Wrong Way
Shore Breaker
DISC CONN
Excitation
DECR INCR
Breaker
DISC CONN
Synchroscope
DG2 DG3 TG
DG1
SG
off
Governor
DECR INCR
Semi-Automatic Synchronizing
Generator Selection
Ready
Conn
Disc
CB Ready
Waiting
Connected
V
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2.3 Main Switchboard – Synchronising

General
The synchroscope panel is used for manual connection of the generators to the bus bar.

The panel consists of selector switches for each generator and indicates the voltage and frequency of the bus and of the selected generator. A synchroscope indicates the phase relationship between main bus and selected generator. There is also indicators to show that the selected generator;
-its CB is ready for operation
-DG is waiting for phase similarity during semi synch
-DG connected to the main bus.

The 6.6kVshore supply breaker can be accessed from this panel.

1. **Connection**

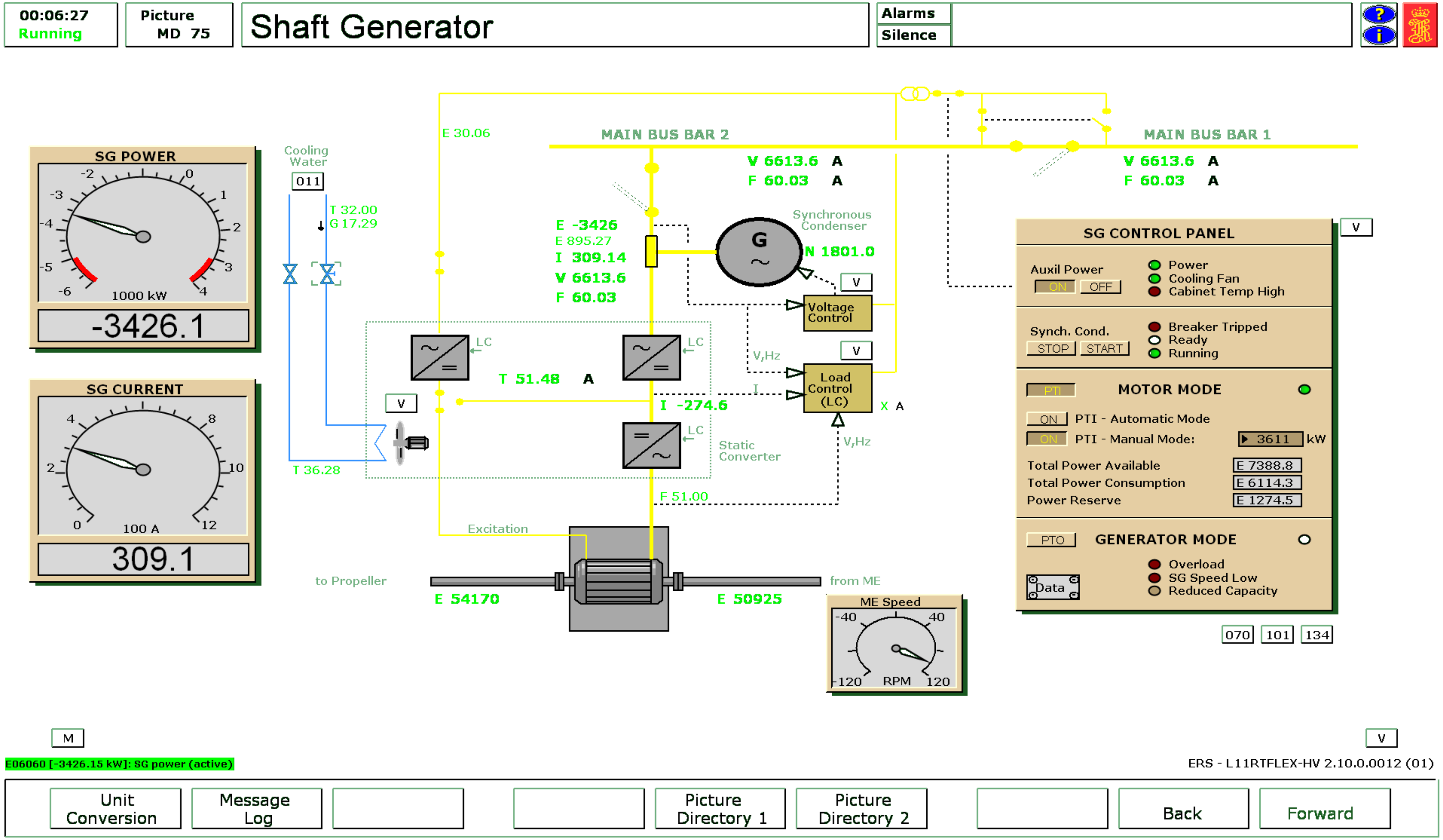
1.1 The incoming generator must be running and not in AUTO on MD101.
1.2 Select incoming generator, voltage and frequency can be compared with bus.
1.3 Adjust excitation if necessary to give equal voltages.
1.4 Adjust governor control so that incoming generator is slightly faster than bus frequency.
1.5 Synchroscope indicator should be turning slowly in a clockwise direction.
1.6 Press “Connect” when “Ready is lit”. After eventually “Waiting” the breaker will connect when in phase with bus. The breaker connected light will show that the generator is now connected to the bus.
1.7 Increase the governor speed to give the incoming generator some load.
1.8 To manually share the load equally use the governor controls on MD70 or from the high voltage switchboard mimic (Full mission)

2. **Disconnection**

2.1 Ensure generator to be disconnected is not in AUTO on MD101
2.2 Use governor controls on MD70 or on each generator to reduce the load on outgoing generator to zero.
2.3 Select outgoing generator.
2.4 Disconnect, breaker connected light goes out.

3. **Shore Supply**

3.1 To connect the 6.6kV shore supply, the 6.6kV main bus must be dead
3.2 Connect the shore supply cable
3.3 Ensure phase rotation is correct
3.4 Close circuit breaker
3.5 The 6.6kV shore supply must be disconnected before resupplying the main bus from the ships’ generators


00:06:27
Running
Picture
MD 75
Shaft Generator
Alarms
Silence
SG POWER
1000 kW
-3426.1
SG CURRENT
100 A
309.1
Cooling Water
011
T 32.00
G 17.29
T 36.28
E 30.06
MAIN BUS BAR 2
MAIN BUS BAR 1
V 6613.6 A
F 60.03 A
V 6613.6 A
F 60.03 A
E -3426
E 895.27
I 309.14
V 6613.6
F 60.03
Synchronous Condenser
N 1801.0
Voltage Control
Load Control (LC)
V,Hz
T 51.48 A
I -274.6
Static Converter
F 51.00
Excitation
to Propeller
from ME
E 54170
E 50925
ME Speed
RPM
SG CONTROL PANEL
Auxil Power
ON OFF
Power
Cooling Fan
Cabinet Temp High
Synch. Cond.
STOP START
Breaker Tripped
Ready
Running
PTI
MOTOR MODE
ON PTI - Automatic Mode
ON PTI - Manual Mode: 3611 kW
Total Power Available E 7388.8
Total Power Consumption E 6114.3
Power Reserve E 1274.5
PTO
GENERATOR MODE
Overload
SG Speed Low
Reduced Capacity
Data
070 101 134
E06060 [-3426.15 kW]: SG power (active)
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2.4 Shaft Generator/Motor MD75

General

The shaft generator/motor system consists of the following main components:

- Control system
- Static converter
- Shaft generator/motor
- Synchronous condenser
- Smoothing reactor

The Shaft Generator can supply the ship's network with electrical energy when SG is running above 40rpm.
The synchronous condenser controls voltage and frequency. Frequency is determined by condenser speed, voltage by a standard AVC.

A load controller controls power flow through the static converter by timing rectifying thyristors; it also controls the excitation of the shaft generator.

The shaft generator is designed for continuous parallel operation with conventional auxiliary generators and exhaust gas turbo-generator sets.

The control panel supplies auxiliary power for the excitation converter and cooling fan. The SG cannot operate if auxiliary power is lost. The synchronous condenser is started from the control cabinet (or remotely from the PowerChief). When starting the Synchronous Condenser, considerable power is drawn from the main distribution supply.

The shaft generator can be used as a motor in Power Take In mode. This enables excess available electrical power to be used to supplement the main engine to give greater shaft output. In PTI mode the motor can either use the available electrical capacity or the maximum consumption can be manually selected. The maximum load on the motor will always leave a reserve of 300kW.

Operation Procedure

During manoeuvring electrical power is supplied from the diesel generators.

When the vessel is on passage the turbine generator is used in parallel with the shaft generator.

If there is available electrical capacity from the turbine generator then the shaft generator may be used in PTI mode to increase efficiency.

In case of main engine reduced power or if extra shaft power is required the shaft generator can be used in PTI mode with the diesel generators.

1. **Starting shaft generator**

1.1 Start Aux. Power from the SG Control Panel (locally). Ensure auxiliary power on and cooling fan is running.
1.2 Check that enough reserve power is available to start synchronous condenser, about 150kW.
1.3 Start synchronous condenser (when Ready is lit). Can be started both locally and from the PowerChief panel (MD101)

2. **Generator Mode**

2.1 Normal mode is generator mode as indicated on the control panel.
2.2 The generator can be connected automatically from the Power Chief panel by pressing the CONN button or semi auto from the main switchboard. From main switchboard, frequency and voltage may be adjusted before connect of breaker is possible.
2.3 When breaker is connected the SG should be put to Auto from the PowerChief panel to include it into the PMS .

3. **Power Take In**

3.1 To use generator in PTI mode the breaker must first be connected in the normal manner.
3.2 PTI can only be selected locally from the SG control panel. If PTI is selected when SG is in Auto mode, SG will go to manual mode. When SG has shifted to PTI mode (indicator flickering stopped) the SG can be put back to Auto mode.
3.3 In PTI mode select either Automatic Mode to use all available power (300kW will be in reserve) or select Manual Mode where the motor power can be set up to a maximum of 300Kw in reserve. Note! When PTI is selected, the PTI lamp will flicker until PTI mode is established.

4. **Stopping**

4.1 If the generator is not required, disconnect circuit breaker in the normal manner.
4.2 The synchronous generator may now be stopped.
4.3 If maintenance is to be carried out it will be necessary to turn off the auxiliary power.

Non Essential Trip.
At high power, load shedding and non essential trip occurs, sequentially; reefer containers one by one and then non essential consumers. Ref. also section 2.5 for non essential breaker settings.

High Power.
This lamp is on when the power rating is higher than normal rating for the generator, giving warning of possible non-essential trip or blackout.

Gen S/S Req
Lit when power requirements need start or stop of generator.

Blackout Recovery.
Should blackout occur, generators are started and reconnected according to their selected priority.

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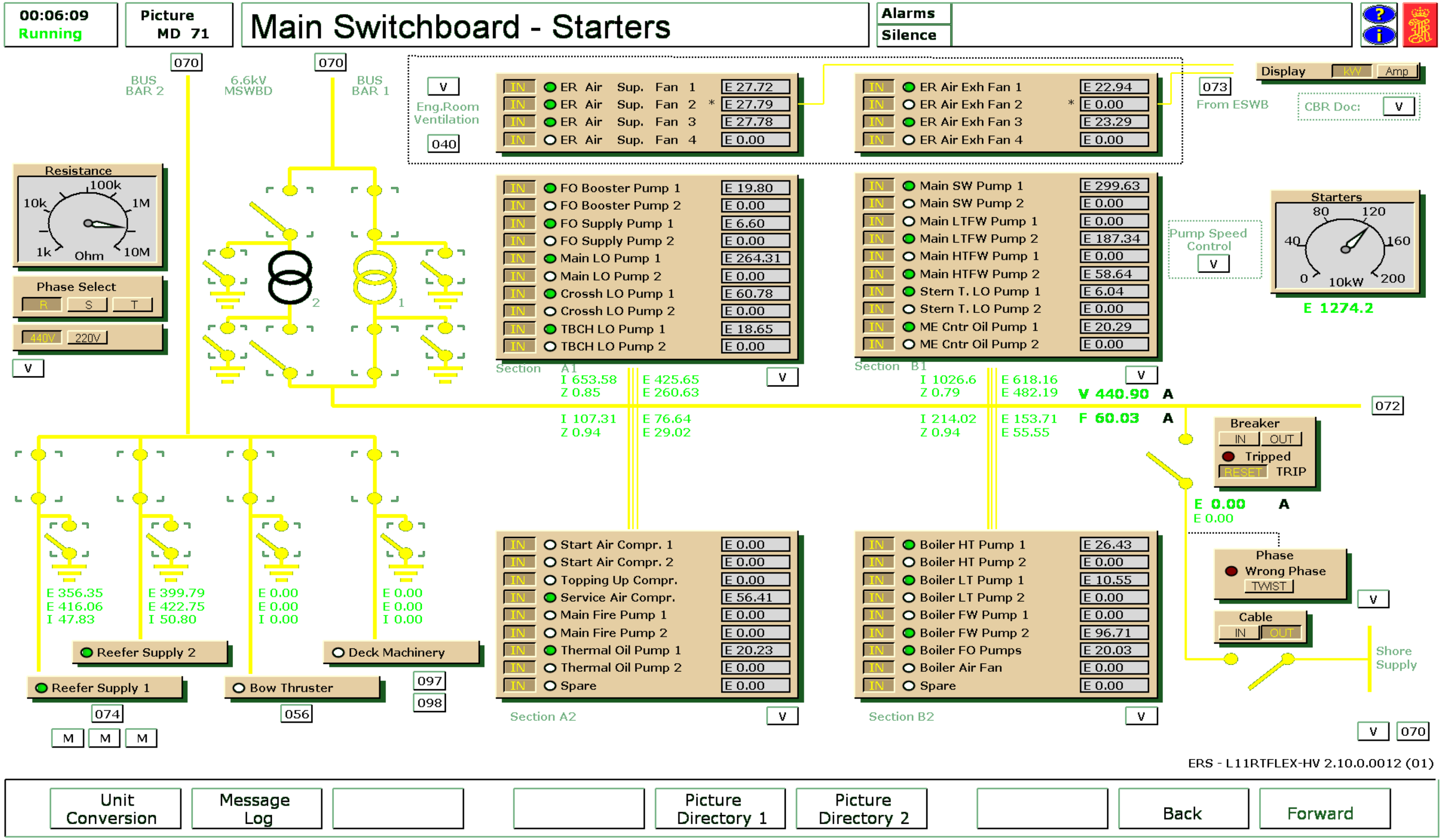
00:06:09
Running
Picture
MD 71
Main Switchboard - Starters
Alarms
Silence
070
070
BUS BAR 2
6.6kV MSWBD
BUS BAR 1
Eng.Room Ventilation
040
IN ER Air Sup. Fan 1 E 27.72
IN ER Air Sup. Fan 2 * E 27.79
IN ER Air Sup. Fan 3 E 27.78
IN ER Air Sup. Fan 4 E 0.00
IN ER Air Exh Fan 1 E 22.94
IN ER Air Exh Fan 2 * E 0.00
IN ER Air Exh Fan 3 E 23.29
IN ER Air Exh Fan 4 E 0.00
073
From ESWB
Display kW Amp
CBR Doc:
Resistance
100k
10k
1M
1k
Ohm
10M
Phase Select
R S T
440V 220V
IN FO Booster Pump 1 E 19.80
IN FO Booster Pump 2 E 0.00
IN FO Supply Pump 1 E 6.60
IN FO Supply Pump 2 E 0.00
IN Main LO Pump 1 E 264.31
IN Main LO Pump 2 E 0.00
IN Crossh LO Pump 1 E 60.78
IN Crossh LO Pump 2 E 0.00
IN TBCH LO Pump 1 E 18.65
IN TBCH LO Pump 2 E 0.00
Section A1
IN Main SW Pump 1 E 299.63
IN Main SW Pump 2 E 0.00
IN Main LTFW Pump 1 E 0.00
IN Main LTFW Pump 2 E 187.34
IN Main HTFW Pump 1 E 0.00
IN Main HTFW Pump 2 E 58.64
IN Stern T. LO Pump 1 E 6.04
IN Stern T. LO Pump 2 E 0.00
IN ME Cntr Oil Pump 1 E 20.29
IN ME Cntr Oil Pump 2 E 0.00
Section B1
Pump Speed Control
Starters
80 120
40 160
0 10kW 200
E 1274.2
I 653.58
Z 0.85
E 425.65
E 260.63
I 1026.6
Z 0.79
E 618.16
E 482.19
V 440.90 A
F 60.03 A
072
I 107.31
Z 0.94
E 76.64
E 29.02
I 214.02
Z 0.94
E 153.71
E 55.55
Breaker
IN OUT
Tripped
RESET TRIP
E 0.00 A
E 0.00
E 356.35
E 416.06
I 47.83
E 399.79
E 422.75
I 50.80
E 0.00
E 0.00
I 0.00
E 0.00
E 0.00
I 0.00
Reefer Supply 2
Deck Machinery
Reefer Supply 1
Bow Thruster
097
098
074
056
M M M
IN Start Air Compr. 1 E 0.00
IN Start Air Compr. 2 E 0.00
IN Topping Up Compr. E 0.00
IN Service Air Compr. E 56.41
IN Main Fire Pump 1 E 0.00
IN Main Fire Pump 2 E 0.00
IN Thermal Oil Pump 1 E 20.23
IN Thermal Oil Pump 2 E 0.00
IN Spare E 0.00
Section A2
IN Boiler HT Pump 1 E 26.43
IN Boiler HT Pump 2 E 0.00
IN Boiler LT Pump 1 E 10.55
IN Boiler LT Pump 2 E 0.00
IN Boiler FW Pump 1 E 0.00
IN Boiler FW Pump 2 E 96.71
IN Boiler FO Pumps E 20.03
IN Boiler Air Fan E 0.00
IN Spare E 0.00
Section B2
Phase
Wrong Phase
TWIST
Cable
IN OUT
Shore Supply
070
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
Message Log
Picture Directory 1
Picture Directory 2
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2.5 Main Switchboard-Starter section MD71

General
The power supply to the 440V consumers and refer containers are fed via 6.6kV/440V transformers.

The starters are grouped into four main sections. Deck machinery, reefer containers and bow thruster are supplied via a bus tie.

Each starter group has indication for current, active power, reactive power and power factor. Starters indicated with an asterisk are supplied from elsewhere and are not included in the calculations for the starter group.

The breakers are operated by pressing the IN button. Pressing IN again will open the breaker. The green indicator shows if the machinery is running.

The display value of the breakers may be changed from active power to current.

Total Earth Leakage current is constantly monitored. Earth fault finding is available by selecting 440v or 220v distribution system and switching between phases.

In case of overload of available supply the breakers can be grouped for non essentials to automatically disconnect. Non essentials must be circuits not required for the safe operation of the vessel.

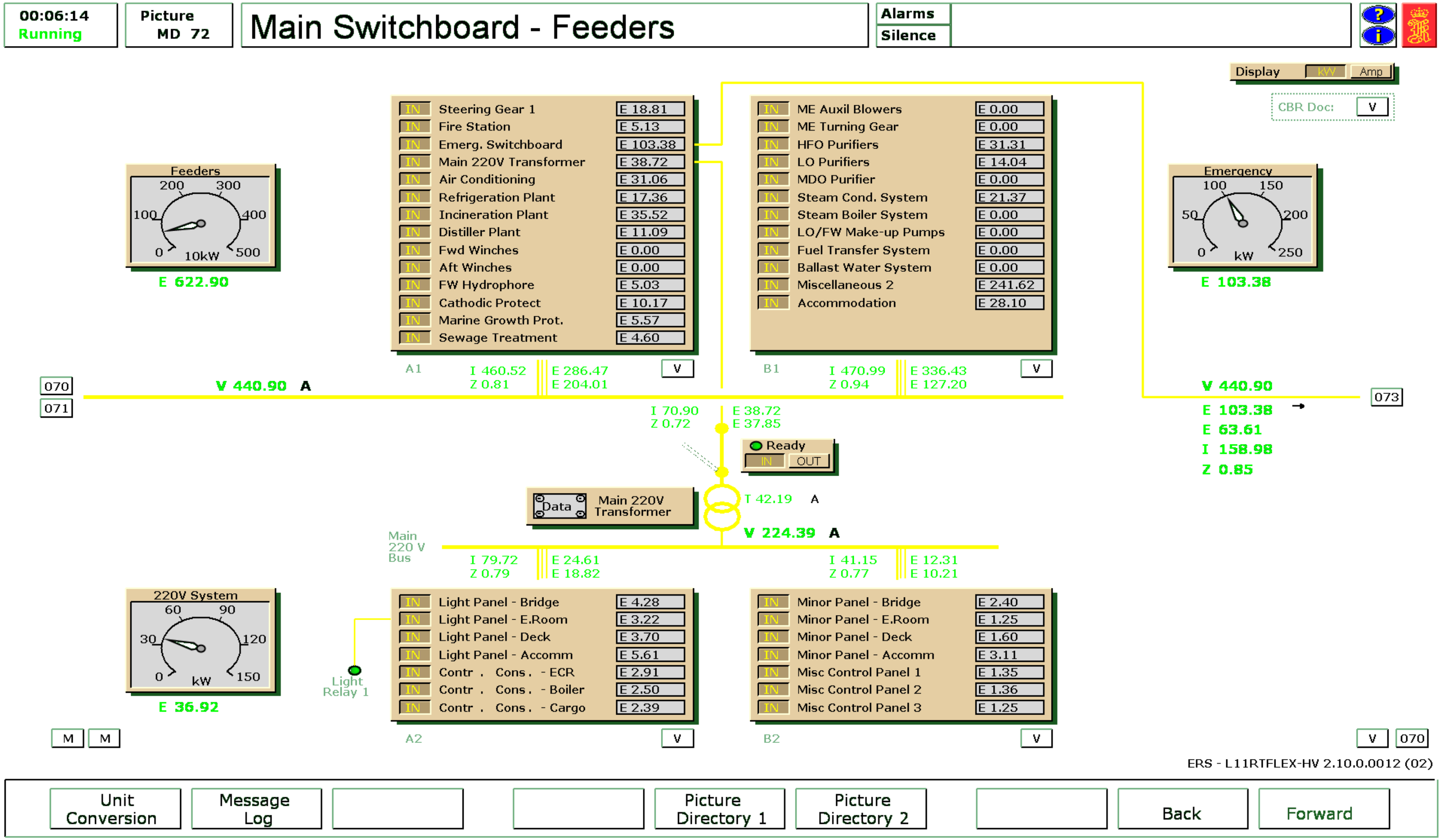
The starter circuit breakers can be individually grouped by setting the function variable to one of eight settings.

1	OL trip only
2	OL trip and auto pump restart
3	OL trip and zero volts disconnection
4	OL trip and zero volts trip
11	Non Essential + 1
12	Non Essential + 2
13	Non Essential + 3
14	Non Essential + 4

The settings can be found on the CBR Doc variables.

Non Essentials trip settings are found in the following variable pages: 7522 for SG, 8122 for DG1, 8222 for DG2, 8322 for DG3 and 9622 for TG.

Note! The reefer containers will be disconnected prior to the other consumers.


00:06:14
Running
Picture MD 72
Main Switchboard - Feeders
Alarms
Silence
Display kW Amp
CBR Doc: V
Feeders
10kW
E 622.90
Steering Gear 1 E 18.81
Fire Station E 5.13
Emerg. Switchboard E 103.38
Main 220V Transformer E 38.72
Air Conditioning E 31.06
Refrigeration Plant E 17.36
Incineration Plant E 35.52
Distiller Plant E 11.09
Fwd Winches E 0.00
Aft Winches E 0.00
FW Hydrophore E 5.03
Cathodic Protect E 10.17
Marine Growth Prot. E 5.57
Sewage Treatment E 4.60
ME Auxil Blowers E 0.00
ME Turning Gear E 0.00
HFO Purifiers E 31.31
LO Purifiers E 14.04
MDO Purifier E 0.00
Steam Cond. System E 21.37
Steam Boiler System E 0.00
LO/FW Make-up Pumps E 0.00
Fuel Transfer System E 0.00
Ballast Water System E 0.00
Miscellaneous 2 E 241.62
Accommodation E 28.10
Emergency
kW
E 103.38
A1 I 460.52 Z 0.81 E 286.47 E 204.01
B1 I 470.99 Z 0.94 E 336.43 E 127.20
070
071
V 440.90 A
V 440.90
E 103.38
E 63.61
I 158.98
Z 0.85
073
I 70.90 Z 0.72 E 38.72 E 37.85
Ready
IN OUT
Data Main 220V Transformer
I 42.19 A
V 224.39 A
Main 220 V Bus
I 79.72 Z 0.79 E 24.61 E 18.82
I 41.15 Z 0.77 E 12.31 E 10.21
220V System
kW
E 36.92
Light Relay 1
Light Panel - Bridge E 4.28
Light Panel - E.Room E 3.22
Light Panel - Deck E 3.70
Light Panel - Accomm E 5.61
Contr . Cons . - ECR E 2.91
Contr . Cons . - Boiler E 2.50
Contr . Cons . - Cargo E 2.39
Minor Panel - Bridge E 2.40
Minor Panel - E.Room E 1.25
Minor Panel - Deck E 1.60
Minor Panel - Accomm E 3.11
Misc Control Panel 1 E 1.35
Misc Control Panel 2 E 1.36
Misc Control Panel 3 E 1.25
A2
B2
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
Unit Conversion
Message Log
Picture Directory 1
Picture Directory 2
Back
Forward

2.6 Main Switchboard-Feeder section MD72

General

The feeders are grouped into four main sections. The 220v sections are fed from the main bus via a circuit breaker and transformer.

Each feeder group has indication for current, active power, reactive power and power factor.

The breakers are operated by pressing the IN button. Pressing IN again will open the breaker.

The display value of the breakers may be changed from active power to current.

In case of overload of available supply the breakers can be grouped for non essentials to automatically disconnect. Non essentials must be circuits not required for the safe operation of the vessel.

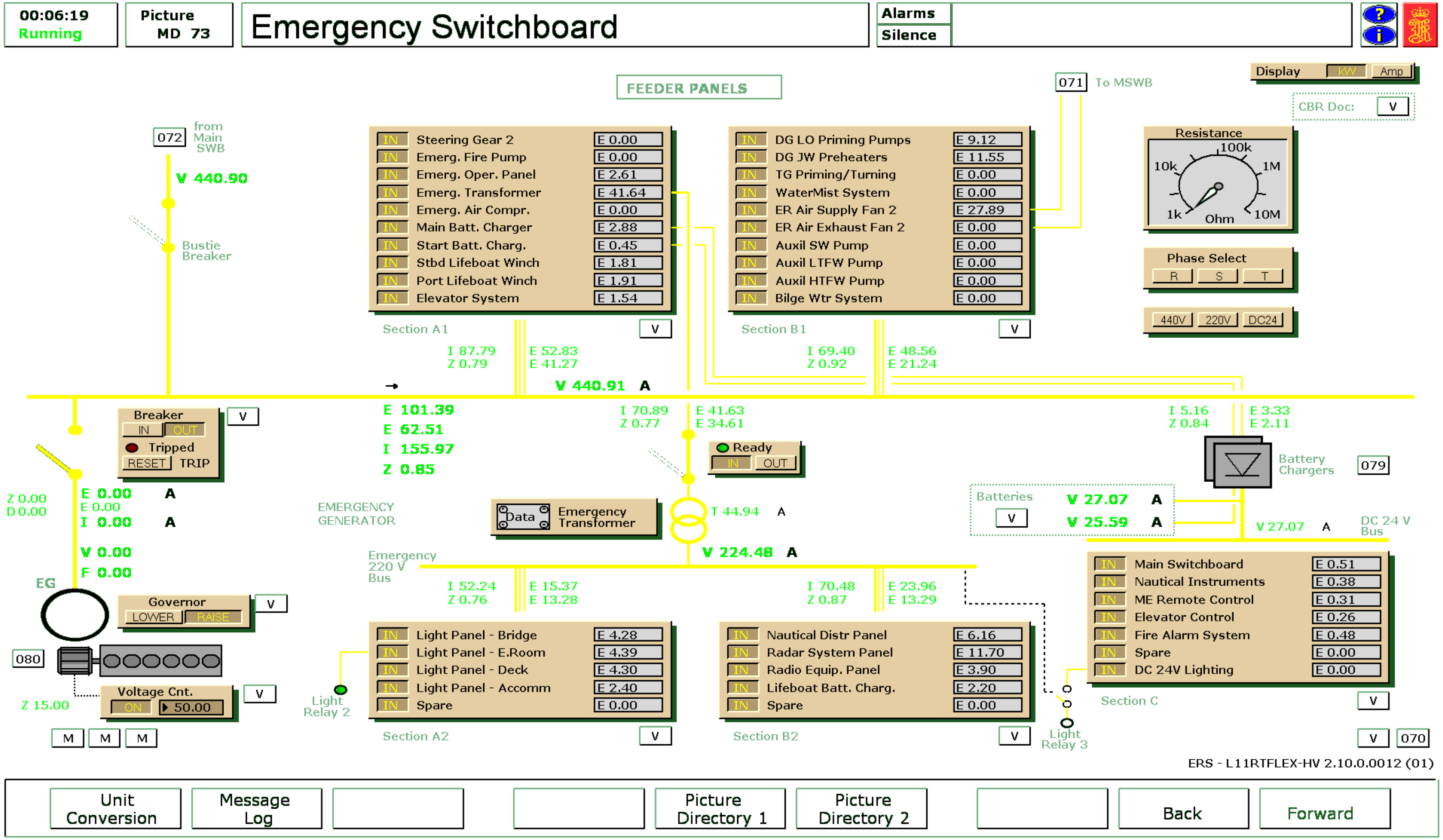
The feeder circuit breakers can be individually grouped by setting the function variable to one of eight settings.

1	OL trip only
2	OL trip and auto pump restart
3	OL trip and zero volts disconnection
4	OL trip and zero volts trip
11	Non Essential + 1
12	Non Essential + 2
13	Non Essential + 3
14	Non Essential + 4

The settings can be found on the CBR Doc variables.

Non Essentials trip as dictated by the settings on the generator breakers from the following variable pages: 7522 for SG, 8122 for DG1, 8222 for DG2, 8322 for DG3 and 9622 for TG.

Non essential load 1 = container reefers
Non essential load 2 = remaining non essential loads
.


00:06:19
Running
Picture
MD 73
Emergency Switchboard
Alarms
Silence
FEEDER PANELS
071 To MSWB
Display kW Amp
CBR Doc: V
072 from Main SWB
V 440.90
Bustie Breaker
Steering Gear 2 E 0.00
Emerg. Fire Pump E 0.00
Emerg. Oper. Panel E 2.61
Emerg. Transformer E 41.64
Emerg. Air Compr. E 0.00
Main Batt. Charger E 2.88
Start Batt. Charg. E 0.45
Stbd Lifeboat Winch E 1.81
Port Lifeboat Winch E 1.91
Elevator System E 1.54
Section A1
DG LO Priming Pumps E 9.12
DG JW Preheaters E 11.55
TG Priming/Turning E 0.00
WaterMist System E 0.00
ER Air Supply Fan 2 E 27.89
ER Air Exhaust Fan 2 E 0.00
Auxil SW Pump E 0.00
Auxil LTFW Pump E 0.00
Auxil HTFW Pump E 0.00
Bilge Wtr System E 0.00
Section B1
Resistance
100k 10k 1M 1k Ohm 10M
Phase Select
R S T
440V 220V DC24
I 87.79 Z 0.79
E 52.83 E 41.27
I 69.40 Z 0.92
E 48.56 E 21.24
V 440.91 A
Breaker
IN OUT
Tripped
RESET TRIP
E 101.39
E 62.51
I 155.97
Z 0.85
I 70.89 Z 0.77
E 41.63 E 34.61
Ready
IN OUT
I 5.16 Z 0.84
E 3.33 E 2.11
Battery Chargers
079
Z 0.00 D 0.00
E 0.00 A
E 0.00
I 0.00 A
V 0.00
F 0.00
EMERGENCY GENERATOR
Data
Emergency Transformer
T 44.94 A
Batteries
V 27.07 A
V 25.59 A
V 27.07 A
DC 24 V Bus
V 224.48 A
Emergency 220 V Bus
EG
Governor
LOWER RAISE
080
Z 15.00
Voltage Cnt.
ON 50.00
M M M
I 52.24 Z 0.76
E 15.37 E 13.28
I 70.48 Z 0.87
E 23.96 E 13.29
Light Relay 2
Light Panel - Bridge E 4.28
Light Panel - E.Room E 4.39
Light Panel - Deck E 4.30
Light Panel - Accomm E 2.40
Spare E 0.00
Section A2
Nautical Distr Panel E 6.16
Radar System Panel E 11.70
Radio Equip. Panel E 3.90
Lifeboat Batt. Charg. E 2.20
Spare E 0.00
Section B2
Light Relay 3
Main Switchboard E 0.51
Nautical Instruments E 0.38
ME Remote Control E 0.31
Elevator Control E 0.26
Fire Alarm System E 0.48
Spare E 0.00
DC 24V Lighting E 0.00
Section C
070
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
Message Log
Picture Directory 1
Picture Directory 2
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2.7 Emergency Switchboard MD73

General
The emergency switchboard supplies circuits necessary for the safety of the vessel. These include communications, navigation lights, fire alarm, fire and flood control.

The feeders are grouped into four main sections. Two 440v sections and two 220v sections supplied via a circuit breaker and transformer.

Each feeder group has indication for current, active power, reactive power and power factor. Feeders indicated with an asterisk supply elsewhere and are not included in the calculations of the feeder group.

The breakers are operated by pressing the IN button. Pressing IN again will open the breaker.

The display value of the breakers may be changed from active power to current.

Earth fault finding is available by selecting 440v, 220v or 24v dc distribution system and switching the resistance meter between phases.

The trip function of feeder circuit breakers is determined by setting the function variable to one of eight settings listed:

1 OL trip only
2 OL trip and auto pump restart
3 OL trip and zero volts disconnection
4 OL trip and zero volts trip

The settings can be found on the CBR Doc variables. The emergency switchboard supplies are all essential and should not be connected to non-essential trips.

The emergency batteries are supplied by battery chargers via the 440v emergency bus. There are two sets of batteries, one for starting the emergency generator and one for the main 24v supply. Terminal voltage of each battery is displayed.

Operation procedure

Auto
At loss of main voltage, the bus-tie breaker opens. At return of voltage the emergency bus is de-energized, by disconnection of the EG if connected, before the bus-tie breaker is reconnected to the main bus. Activation of EG-test2 will “simulate” loss of main voltage and make the bus-tie breaker disconnect.

Manual
The main bus and the emergency bus can be split manually without any restrictions by disconnecting the bus-tie breaker (“Out” command). Note that the EG stand by control (see MD70) requires

the bus-tie control to be in “Auto”, transferring bus-tie control to manual also disables automatic EG operation.

Even in “Manual” mode the bus-tie breaker is automatically disconnected if loss of main bus power.

2.7.1 Emergency Generator Back Feed Mode

The Emergency Switch Board (ESWB) and the Main Switch Board (MSWB) can be connected in two different ways.

Normal Mode
The Emergency Switch Board is connected to the Main Switch Board by a selection switch. If there is voltage on the Main Switch Board the position is kept in “MSWB”. When the switch is deactivated by loss of main voltage or by emergency generator “test 2” override, the switch takes default position, “Emergency Generator”. The selection switch functions as a safe guard against overloading the Emergency Generator by mechanically isolate it from the main bus.

Optional Mode
If it is required that the Emergency Generator in critical situations also should be able to feed the main bus system, the selection switch must be exchanged with a bus-tie breaker with associated bus-tie control logics. In addition, the Emergency Generator must be permanently wired for connection to the emergency bus bar.

Changing from Normal to Optional Mode (Back Feed) is carried out from the Bus Tie Control panel.

Operation procedure
In “Normal Mode” the bus-tie control is always fixed to “Auto” and no manual override is accepted. The bus-tie control is then simply representing the automatic positioning of the selector switch by main bus voltage

In “Optional Mode” the bus-tie control logics function as follows:

Auto
At loss of main voltage the bus-tie breaker opens. At return of voltage the emergency bus is de-energized, by disconnection of the EG if connected, before the bus-tie breaker is reconnected to the main bus. Activation of EG-test2 will “simulate” loss of main voltage and make the bus-tie breaker disconnect.

Manual
The main bus and the emergency bus can be split manually without any restrictions by disconnecting the bus-tie breaker (“Out” command). Note that the EG stand by control (see MD70) requires the bus-tie control to be in “Auto”, transferring bus-tie control to manual also disables automatic EG operation.

Even in “Manual” mode the bus-tie breaker is automatically disconnected if loss of main bus power.
If there is voltage on the emergency bus, the connect (“In”) command will not function, unless the “Back-Feed” override is ‘On’.

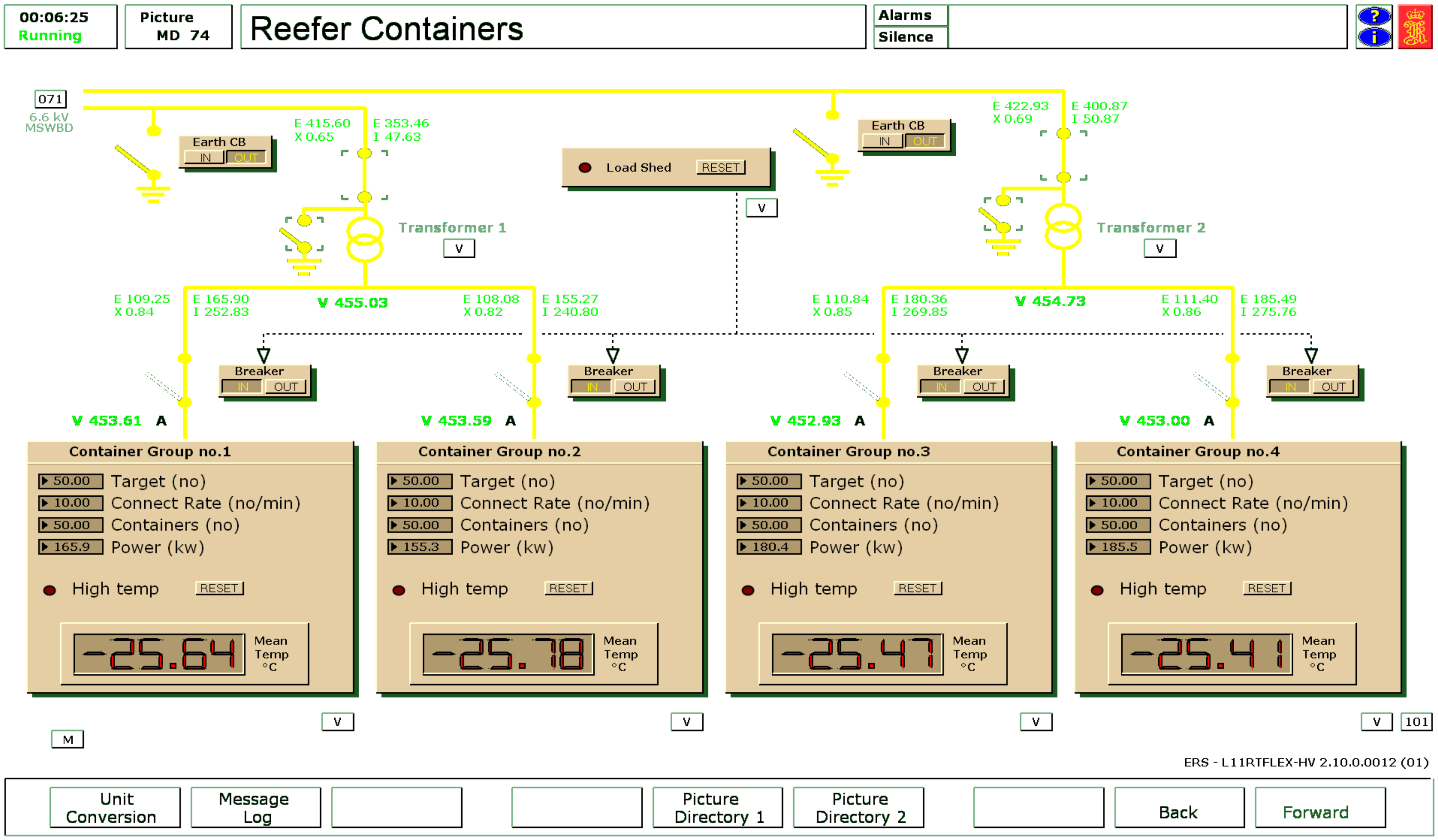
Back-Feed

Selection of bus-tie “Back-Feed” mode is protected by a key lock etc, indicated by a red light when activated.

The bus-tie control will be fixed to “Manual” and the connect-inhibit, which is normally active in “Manual”, is also disabled, leaving the bus-tie to direct operator control.

Connection of the bus-tie should never be attempted when there is voltage on both the main and the emergency switch board.

Note: When then the Emergency Generator is connected to the Main Switch Board by Back-Feed it is easily overloaded. All automatic start-up of equipment must be disabled before supplying voltage to the main bus!
It is possible to run the thrusters in local mode from the engine room by two push buttons.


00:06:25
Running
Picture
MD 74
Reefer Containers
Alarms
Silence
071
6.6 kV
MSWBD
Earth CB
IN
OUT
E 415.60
X 0.65
E 353.46
I 47.63
Load Shed
RESET
Earth CB
IN
OUT
E 422.93
X 0.69
E 400.87
I 50.87
Transformer 1
Transformer 2
E 109.25
X 0.84
E 165.90
I 252.83
V 455.03
E 108.08
X 0.82
E 155.27
I 240.80
E 110.84
X 0.85
E 180.36
I 269.85
V 454.73
E 111.40
X 0.86
E 185.49
I 275.76
Breaker
IN
OUT
V 453.61 A
V 453.59 A
V 452.93 A
V 453.00 A
Container Group no.1
50.00 Target (no)
10.00 Connect Rate (no/min)
50.00 Containers (no)
165.9 Power (kw)
High temp
RESET
-25.64
Mean
Temp
°C
Container Group no.2
50.00 Target (no)
10.00 Connect Rate (no/min)
50.00 Containers (no)
155.3 Power (kw)
High temp
RESET
-25.78
Mean
Temp
°C
Container Group no.3
50.00 Target (no)
10.00 Connect Rate (no/min)
50.00 Containers (no)
180.4 Power (kw)
High temp
RESET
-25.47
Mean
Temp
°C
Container Group no.4
50.00 Target (no)
10.00 Connect Rate (no/min)
50.00 Containers (no)
185.5 Power (kw)
High temp
RESET
-25.41
Mean
Temp
°C
M
V
101
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Unit
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2.8 Reefer Container

General

The reefer container bus bar is grouped into two main sections. Each section consists of one 6.6kV/440V transformer and two container groups with a circuit breaker.

The transformers and supply breakers are located in own HV compartment on deck. The feeder breakers are located in the 6.6kV main switchboard, found in the high voltage room.

Each container group is fed from the bus bar via a circuit breaker and 150 reefers can be connected in the power plugs.
High limit for the breaker is 5000 A (variable page 7401, 7402, 7403 and 7404).

Each container group has indication for current, active power, reactive power and power factor.

The breakers are operated by pressing the IN/OUT button.

It is possible to set a “target number” of reefers and a “connect rate” (that means how many reefers the electrician can plug in per minute, normally 2-3 reefers/min). When reefers are plugged in, it is shown in the container group, and when the breaker is connected, the total power for the group can be read.

The temperature is the mean temperature in ºC for all the reefers in this group.

Note

Before loading reefers, it is important to keep an eye on the total power consumption and the maximum power of the connected diesel generators.
Remember it is important to inform the cargo control officer if the reefers are disconnected under manoeuvre or troubles with the power supply.

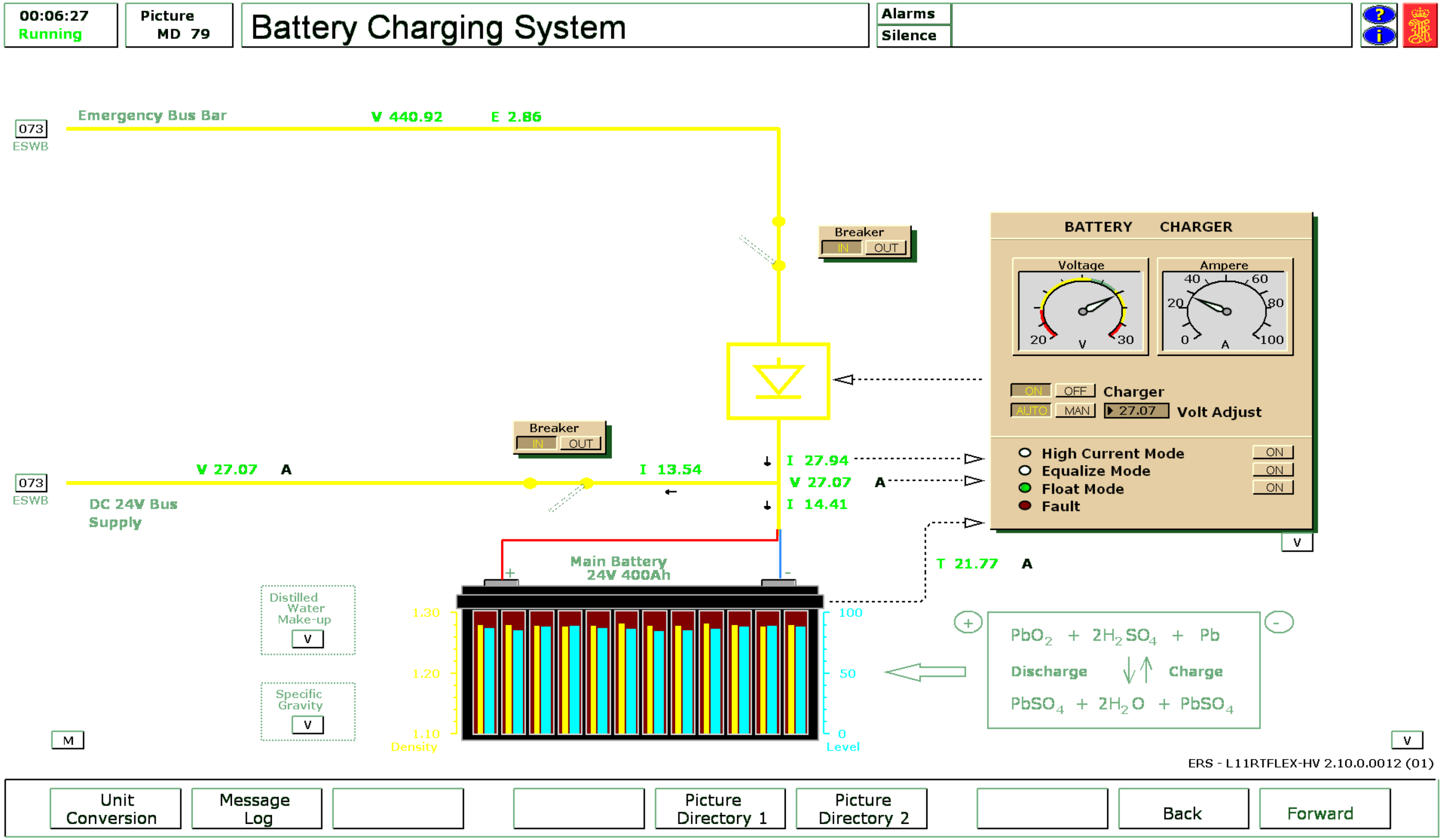
Reefer Containers will trip at overload of generators. The trip sequences can be set up as follows:

Variable page 7415:

C15581 = 0 The highest loaded group will trip first.

C15581 = 1 The highest loaded main breaker will trip first.

C15581 = 2 All reefer containers will trip.


00:06:27
Running
Picture MD 79
Battery Charging System
Alarms
Silence
Emergency Bus Bar
V 440.92
E 2.86
073 ESWB
Breaker
IN OUT
BATTERY CHARGER
Voltage
Ampere
ON OFF Charger
AUTO MAN 27.07 Volt Adjust
High Current Mode
Equalize Mode
Float Mode
Fault
V 27.07 A
DC 24V Bus Supply
I 13.54
I 27.94
V 27.07 A
I 14.41
T 21.77 A
Main Battery 24V 400Ah
Distilled Water Make-up
Specific Gravity
Density
Level
PbO_2 + $2H_2SO_4$ + Pb
Discharge
Charge
$PbSO_4$ + $2H_2O$ + $PbSO_4$
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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2.9 Battery Charging System

General
The battery system consists of a number of batteries with a total capacity of 440 Ah. The battery system is supplied from the emergency switchboard 440 V AC section, through an AC/DC converter. Normal system voltage is 24 V DC. The converter and battery supply the control voltage system of the ship and the emergency light system in case of "black-out". The emergency light system is automatically connected in case of low voltage at the emergency switchboard and is reconnected when the voltage is normal at the emergency switchboard again.

2.9.1 Operation

The converter is controlled either automatically or manually. In automatic operation the converter switches between:

- High Current Mode – set point 30 V
- Equalize Mode – set point 29,5 V
- Float Mode – set point 26,9 V

The converter compensates for the temperature in the electrolyte through a correction of the charging voltage.

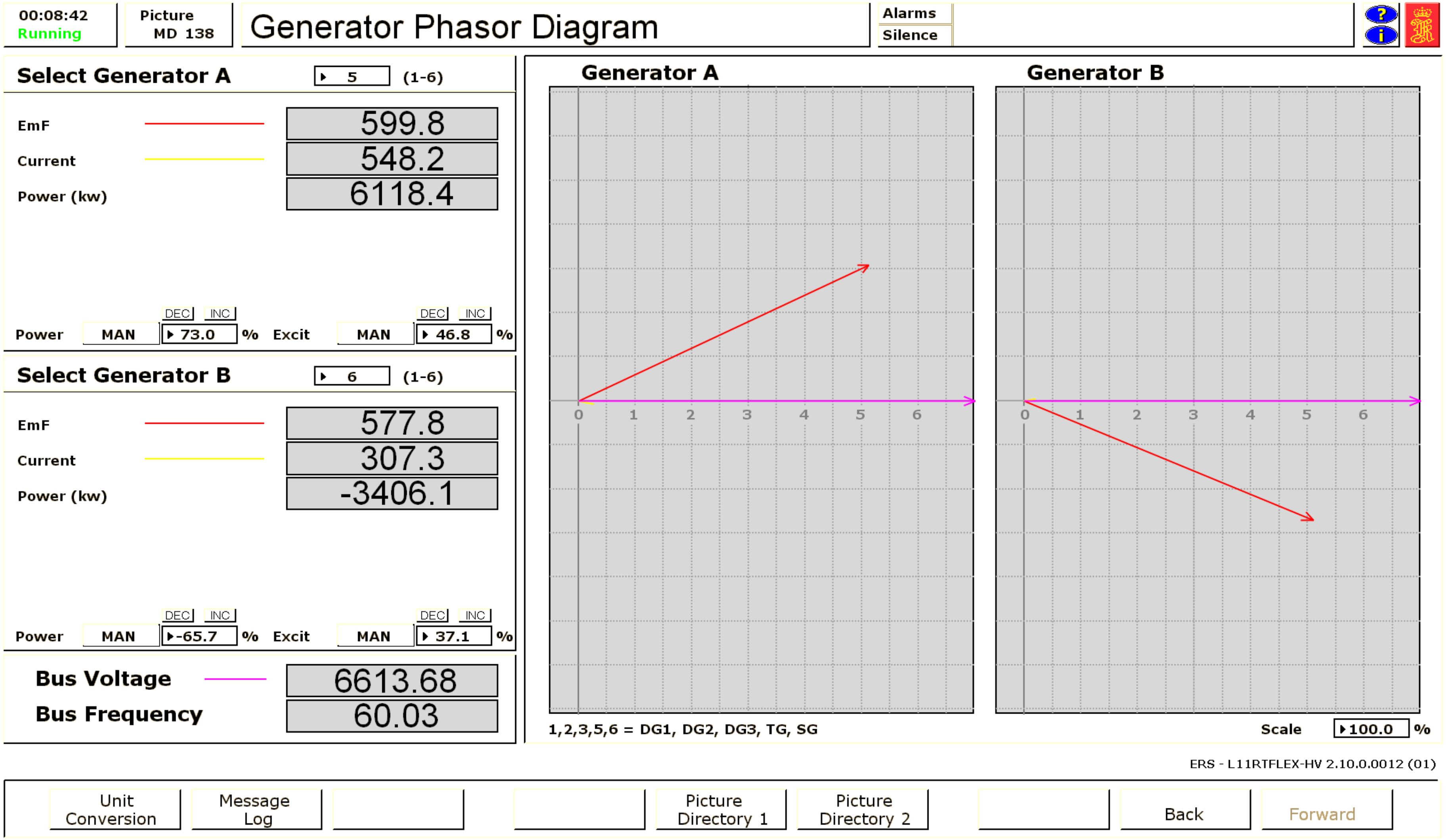
In manual operation the three modes can be selected, or the required charging voltage can be keyed in within the interval 5 to 35 V.

The lead accumulator can be refilled with distilled water by using the short cut key to the variable list. (Give the variable X14401 status = 1).

2.9.2 Fault and restart of the system

Charger fault will be activated by timeout at High Current Mode. A high external battery load could cause this. If the battery temperature exceeds high temp limit, the charger also transfers to fail.

At charger failure, output current is shut off. Reset charger fault by turning the battery charger off/on.


00:08:42
Running
Picture
MD 138
Generator Phasor Diagram
Alarms
Silence
Select Generator A
5
(1-6)
EmF
599.8
Current
548.2
Power (kw)
6118.4
DEC
INC
Power
MAN
73.0
%
Excit
MAN
46.8
%
Select Generator B
6
(1-6)
EmF
577.8
Current
307.3
Power (kw)
-3406.1
DEC
INC
Power
MAN
-65.7
%
Excit
MAN
37.1
%
Bus Voltage
6613.68
Bus Frequency
60.03
Generator A
Generator B
0
1
2
3
4
5
6
1,2,3,5,6 = DG1, DG2, DG3, TG, SG
Scale
100.0
%
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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2.10 Generator Phasor Diagram

General

The Generator Phasor Diagram is designed to be an aid when studying the behaviour of rotating electromagnetic generator(s) at various conditions. Various tests can be performed on a single generator set or generators in parallel.

It is recommended to "isolate" the electric power plant from the rest of the engine room to achieve full control of the events. This is carried of from variable page 9902. When the electric power plant is isolated, the type of load, active/reactive, can be defined from the variable page 7008.

The following test/studies are examples of when the Phasor Diagram can be of worth:

-Excitation studies (constant excitation), how various type of loads influence on the generator(s) condition, such as:

a) Constant excitation, resistive load
b) Constant excitation, inductive load
c) Constant excitation, capacitive load
d) Unbalanced excitation, equal load
e) Balanced excitation, unequal load.

The diagram displays victories dimension of the Bus voltage, Generator current & Generator rotor voltage (EmF) The generator load (power) and excitation can be increased or decreased manually to see the effect on the Phasor diagram.

2.10.1 Operation

Select generator A and B to be displayed,
1 = Diesel generator no: 1
2 = Diesel generator no: 2
3 = Diesel generator no: 3
4 = Turbine generator
5 = Shaft generator.

The diagram scale can be adjusted to make area fit to the vector dimensions.
The generator load (power) can be adjusted my selecting Man power and change load by increase/decrease or entering new % value. The Man load (power) button has to be reset before the generator can be selected to Auto again.
The generator Excitation can also be selected to Man control from this page. When Man control is selected the excitation can be increased/decreased or new value can be entered in %. The Man excitation button has to be reset before getting Auto excitation again.
.

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3 MAIN ENGINE AND MAIN ENGINE SYSTEMS

3.1 Main Engine

The propulsion machinery is based on one Wärtsilä RT-flex82C, low speed, 12 cylinder configuration, 2-stroke, turbocharged, reversible diesel engine. The main engine is coupled to a propeller shaft with both fixed pitch propeller and controllable pitch propeller (selectable by the instructor).

Main engine particulars

- Cylinder Bore 820 mm
- Piston Stroke 2646 mm
- Number of Cylinders 12
- Number of Air Coolers 6
- Number of Turbo Chargers 3
- Continuous Service Rating ME 54.24 MW
- Corresponding Engine Speed 102 rpm
- Mean Indicated Pressure 19.5 Bar
- Scavenge Air Pressure 2.30 Bar
- Turbine Speed 9000 rpm
- Number of Prop. Blades 5
- Propeller Pitch 1.08 P/D
- Specific Fuel Oil Consumption 167 g/kwh

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

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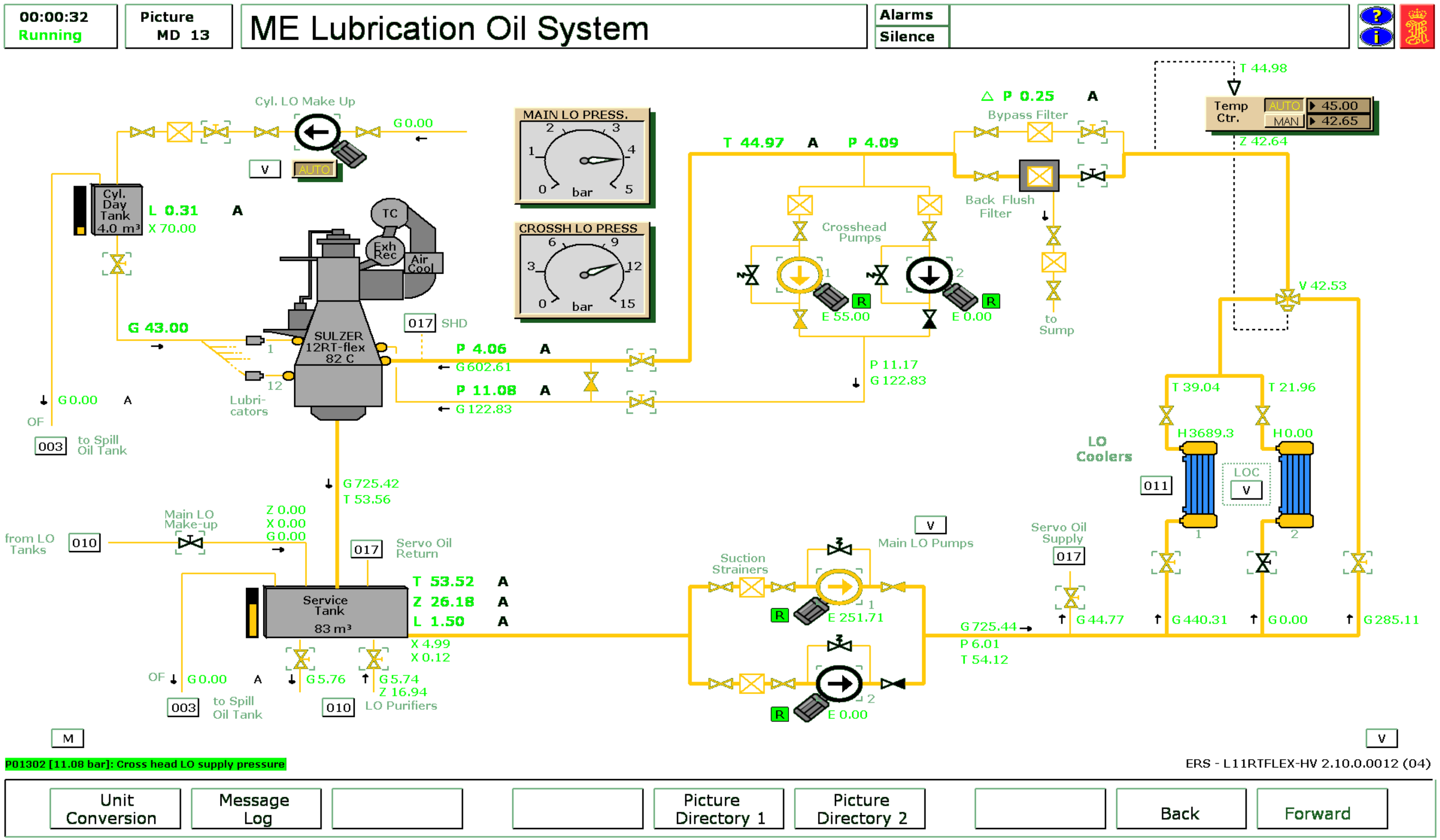
00:00:32
Running
Picture MD 13
ME Lubrication Oil System
Alarms
Silence
Cyl. LO Make Up
MAIN LO PRESS.
CROSSH LO PRESS
Cyl. Day Tank 4.0 m³
TC
Exh Rec
Air Cool
SULZER 12RT-flex 82 C
Lubri-cators
to Spill Oil Tank
Bypass Filter
Back Flush Filter
to Sump
Temp Ctr.
Crosshead Pumps
LO Coolers
Main LO Make-up
from LO Tanks
Servo Oil Return
Service Tank 83 m³
LO Purifiers
Suction Strainers
Main LO Pumps
Servo Oil Supply
P01302 [11.08 bar]: Cross head LO supply pressure
ERS - L11RTFLEX-HV 2.10.0.0012 (04)
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3.2 ME Lubrication Oil System

General

The oil pressure which is necessary for the main bearing lubrication is raised by the main LO pumps and for the crosshead bearings is raised by the crosshead LO pumps. The main bearing and crosshead bearing LO systems are interconnected through a non-return valve.
Main bearing oil is also used via an articulated lever to cool the working piston crown.
The normal operating pressure for the main bearing is 3.4-4.2 bar, while the operating pressure for the crosshead bearing is 10-12 bar. Should the crosshead pump fail, the crosshead bearings will be supplied from the main bearing oil system through the non-return valve. ME can only be operated at low load under such conditions.

The crosshead bearing oil is further used for exhaust valve spindle lubrication and as drive for the cylinder lubricator.
The oil for exhaust valve actuator pumps passes from the crosshead bearing oil system through an air purifier. For actuating the exhaust valves, the oil pressure is raised by the actuator pumps to about 160 bar.

The lubrication oil from the main engine sump is collected in a service tank below the engine.

The LO pumps are protected by a pressure relief valve which opens for pressure over a preset value.
The service tank oil can also be cleaned in a LO purifier.

A make-up pump enters new oil with flow directly to the service tank.
The lubrication oil is cooled in two LT fresh water cooled LO coolers and is then passing a double filter before it enters the main engine. The LO temperature is controlled by a PI controller, which regulates a by-pass valve for the LO coolers.

The LO filters must be cleaned regularly to avoid pressure/flow reduction.

Cylinder Lubrication

The cylinder day tank has a volume on 4.0 m^3 and there is a cylinder LO make up pump to refill the day tank. The make up pump takes suction from the cylinder LO storage tank.
At low cylinder LO tank level there will be ME slow down/shut down.
It is possible to adjust each cylinder lubricator individually from the individual cylinder screen.

Operation procedures

Start up for main engine

- Ensure that main engine sump has sufficient oil.
- Set temperature controller in AUTO at 45°C.
- Ensure that suction and delivery valves on both main lube oil pumps are open.
- Ensure that one cooler has inlet and outlet valves open.
- Ensure that inlet and outlet valves to back flush filter are open.
- Ensure that main bearing supply valve is open.
- Start one of the main lube oil pumps in manual, wait until the lube oil pressure has risen to about 3 bar. Then set pump control to auto in pump/compressor Auto chief page.
- It should only be necessary for one pump to be running with the other in standby.
- Ensure that oil is flowing to main bearings and piston cooling at correct temp.

Start up cross head LO supply

One pump started manually after opening valves, then switch to AUTO when pressure reaches about 8 bar.

Start up for cylinder LO system

Ensure as a minimum 0.5m^3 in the cylinder oil day tank.
Check that all relevant valves are open.
The flow will vary with engine speed.

Normal stop procedure

When engine has stopped at Finished with Engines, wait for approx 30 minutes to ensure that engine has cooled down and stop all lube oil pumps. Sump temperature in port is normally maintained by continually running the lube oil purifier.

Note

Before starting ME, always check the main- and the cross head LO pressure.
On the picture MD 19 it is possible to see the slow- and shutdowns for LO pressure.

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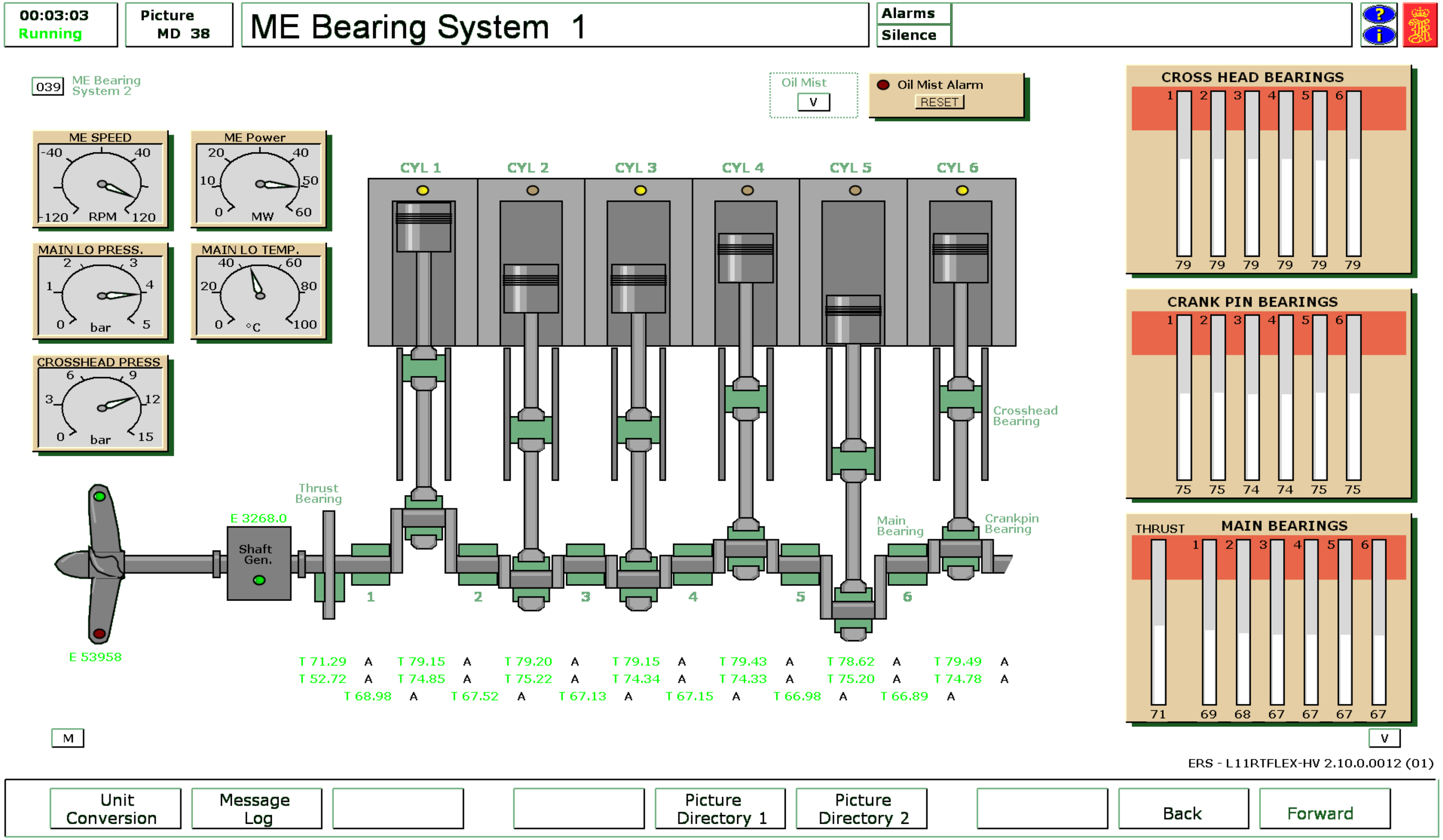
00:03:03
Running
Picture
MD 38
ME Bearing System 1
Alarms
Silence
039
ME Bearing System 2
Oil Mist
V
Oil Mist Alarm
RESET
ME SPEED
-40 40 -120 RPM 120
ME Power
20 40 10 50 0 MW 60
MAIN LO PRESS.
2 3 1 4 0 bar 5
MAIN LO TEMP.
40 60 20 80 0 °C 100
CROSSHEAD PRESS
6 9 3 12 0 bar 15
CYL 1
CYL 2
CYL 3
CYL 4
CYL 5
CYL 6
Crosshead Bearing
Thrust Bearing
Main Bearing
Crankpin Bearing
E 3268.0
Shaft Gen.
E 53958
1 2 3 4 5 6
T 71.29 A
T 79.15 A
T 79.20 A
T 79.15 A
T 79.43 A
T 78.62 A
T 79.49 A
T 52.72 A
T 74.85 A
T 75.22 A
T 74.34 A
T 74.33 A
T 75.20 A
T 74.78 A
T 68.98 A
T 67.52 A
T 67.13 A
T 67.15 A
T 66.98 A
T 66.89 A
M
CROSS HEAD BEARINGS
1 2 3 4 5 6
79 79 79 79 79 79
CRANK PIN BEARINGS
1 2 3 4 5 6
75 75 74 74 75 75
THRUST
MAIN BEARINGS
1 2 3 4 5 6
71 69 68 67 67 67 67
V
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
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3.3 ME Bearings

General

The screen provides the operator with a clear display of all bearing temperatures within the engine, as well as the main parameters that affect bearing load, such as main engine speed, engine power, and the lubricating oil supply.
The bearings temperature shown are:

- Cross head bearing
- Crank pin bearings
- Main bearings
- Thrust bearing

Comparisons between the various bearings can be easily made, and should a bearing temperature increase above 90°C, then the indicating bar will change to red to aid identification. At the same time the bearing concerned will also change colour to red.

The screen will also display the presence of oil mist within the crankcase, as well as which units are affected. Should oil mist be detected, then the engine protection system will activate, and an engine slow down will occur.
Variable page 3810 shows the oil mist detection for each cylinder.

Oil mist alarm

The Sulzer procedures for reaction to an oil mist alarm, or other alarms that could lead to the oil mist situation are:

1. Reduce engine power/pitch down to slow-down level, if this is not an automatic function. This will drastically reduce the load on the engine bearings, and hence the production of oil mist.

2. Contact bridge, and ask to STOP engine. If the vessel is in a confined area, it may not be possible to stop the vessel. Hence the engine would continue on **minimal power**.

3. When stop order is received, stop the engine and close the fuel supply to the engine by stopping the booster pumps.

4. Switch off the auxiliary blowers.

5. Open engine room casing. This will reduce the pressure rise in the engine room, should the crankcase relief devices operate.

6. Personnel to vacate engine room. This is for the personnel safety of the engine room staff should flames issue from the relief valves. It may be prudent to have a minimal staff in the control room to monitor the situation, and to maintain the main services, but under no circumstances should personnel operate on the engine.

7. Prepare fire fighting equipment. A safety precaution against outbreaks of fire in the engine room, from any flames issuing from the crankcase relief doors.

8. **Do not open the crankcase until after at least 20 minutes.** You must allow time for the oil mist to cool and fully condense.

It is also recommended that the oil mist detector alarm level should reset, which indicates that the oil mist levels are well below the Lower Explosive Limit. Obviously no naked flames should be used on the initial entry.

9. Stop all lube oil pumps. To allow personnel entry into the crankcase.

10. Isolate the starting air, and engage the turning gear.

11. Open the crankcase doors, and inspect the following areas for overheating:
    - Main and bottom end bearings
    - Thrust bearing
    - Crosshead bearings
    - Piston rods
    - Stuffing boxes
    - Gears
    - Vibration dampers
    - Moment compensators
    - Articulated pipes
    - Cracked piston crown, allowing oil mist to enter crankcase via cooling oil return
    - Overheated diaphragm, from a scavenge fire

12. Overheating can be identified by:
    - Melted or squeezed white metal from the bearings
    - Discoloration of the crankcase paint in the vicinity burnt or carbonized oil deposits
    - Excessive bearing clearances
    - Excessive oil flow from a bearing

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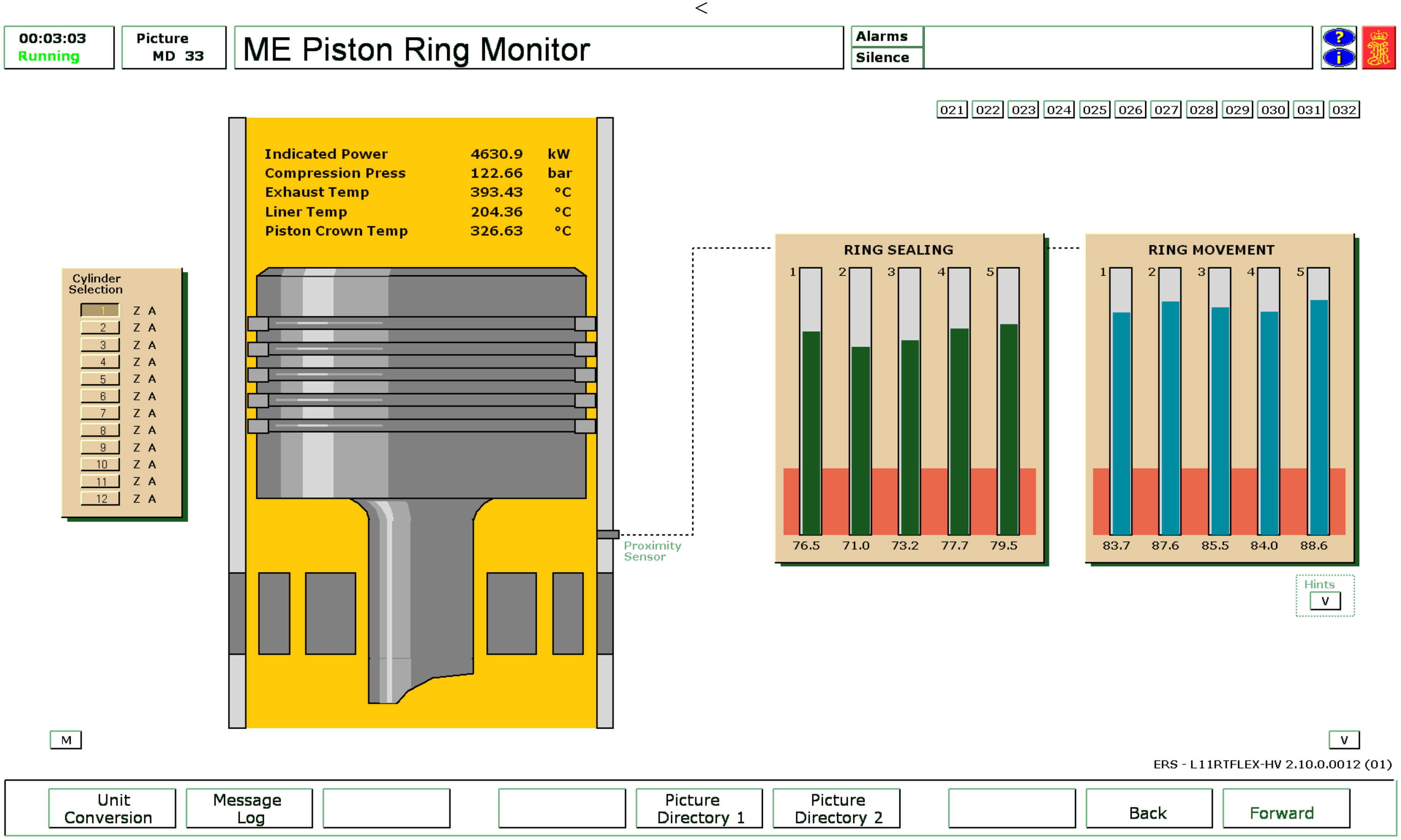
00:03:03
Running
Picture
MD 33
ME Piston Ring Monitor
Alarms
Silence
021 022 023 024 025 026 027 028 029 030 031 032
Indicated Power 4630.9 kW
Compression Press 122.66 bar
Exhaust Temp 393.43 °C
Liner Temp 204.36 °C
Piston Crown Temp 326.63 °C
Cylinder Selection
1 2 3 4 5 6 7 8 9 10 11 12
Z A
Proximity Sensor
RING SEALING
76.5 71.0 73.2 77.7 79.5
RING MOVEMENT
83.7 87.6 85.5 84.0 88.6
Hints
M
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
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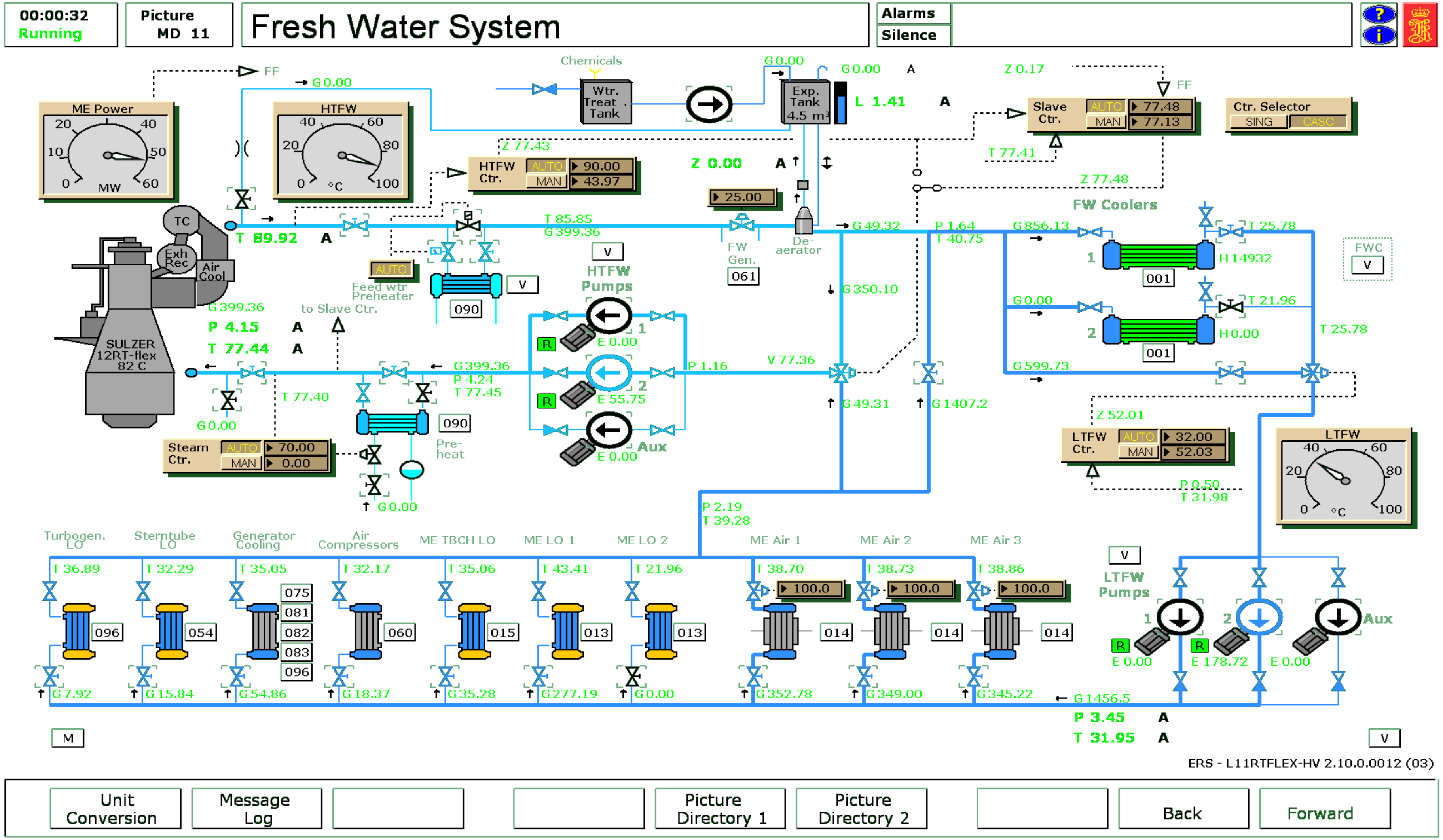
3.4 ME Piston Ring Monitor

General

The screen provides an indication of the piston ring condition within each cylinder. Two bar charts are provided for each cylinder. The cylinder can be selected, and provides a display for each piston ring for sealing and movement.

Under normal circumstances the ring sealing and movement will be high. Should the ring wear increase then ring sealing will reduce whereas should the cylinder lubrication be reduced, then the ring movement will reduce.

When the ring sealing and movement reduces below an acceptable level, then an alarm will be activated.


00:00:32
Running
Picture
MD 11
Fresh Water System
Alarms
Silence
ME Power
MW
HTFW
°C
Chemicals
Wtr. Treat. Tank
Exp. Tank 4.5 m³
L 1.41
Slave Ctr.
AUTO
MAN
77.48
77.13
Ctr. Selector
SING
CASC
HTFW Ctr.
90.00
43.97
Z 0.00
25.00
FW Coolers
TC
Exh Rec
Air Cool
T 89.92
Feed wtr Preheater
to Slave Ctr.
FW Gen.
De-aerator
HTFW Pumps
P 4.15
T 77.44
SULZER 12RT-flex 82 C
Steam Ctr.
70.00
0.00
Pre-heat
Aux
LTFW Ctr.
32.00
52.03
LTFW
FWC
Turbogen. LO
Sterntube LO
Generator Cooling
Air Compressors
ME TBCH LO
ME LO 1
ME LO 2
ME Air 1
ME Air 2
ME Air 3
LTFW Pumps
P 3.45
T 31.95
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3.5 Fresh Water System

General

The fresh water cooling system is separated in two subsystems:

- Low Temperature System
- High Temperature System

The Low Temperature Fresh Water (LTFW) system cools all auxiliary equipment, such as:

- the start- and service air compressors
- Air condition condenser
- stern tube and propeller servo oil system
- main engine air cooling system
- cooling of the oil in the cross head and main engine lube oil system.

The LTFW pumps (normally only one in operation), pump the fresh water through the above mentioned coolers. The FW system is cooled by the SW system. The auxiliary LTFW pump is mainly used when in harbour or during blackout.

The fresh water temperature in the LTFW system is controlled by a PID controller, which actuates a three-way mixing valve, placed after the two fresh water coolers. This controller can be operated in manual or auto mode. The controller input signal is given by the temperature before the LTFW pumps.

From the LT/HT junction, some of the LTFW is led directly to the FW coolers, while some is led to the HTFW loop.

The High Temperature fresh water cools the liners of the main engine. Some of the excessive heat is used for heating the fresh water generator. The fresh water through the main engine is driven by two main and one auxiliary HTFW pumps, of which only one of the main pumps is normally in operation. The auxiliary pump is provided for in port use. If the HTFW pumps stop, a small cooling medium flow will still be present as long as one of the LTFW pumps is running. If the main engine has been stopped for a long period of time, it is required to permit the HTFW flow to pass the pre-heater, which is supplied with steam.

The auxiliary HTFW pump is mainly used when in harbour or during blackout.

The HTFW system is controlled by a PID controller and a slave controller, which operates a three way mixing valve, mixing hot water from main engine outlet with cold water from the LT/HT junction. It is possible to run the PID controller in single or cascade mode. In cascade mode the slave controller gets a feed forward signal from the engines load. (For further information about controllers, please refer to operator’s manual part 2).

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 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 of the ME and start the preheating circulation pump.

1.3 Correct pre-heating temperature is 70°C.

2. Jacket cooling water loop

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

2.2 Check sea - and LT fresh water cooling system is in operation.

2.3 Check the temperature controller. Normal temperature controller set point is 85°C.

2.4 Change to main HTFW pump and put the pump set to AUTO.

2.5 During normal operation with engine running the pre-heater would be shut off.

2.6 The expansion tank level should be checked periodically.

3. Normal stop procedure

3.1 Prior to stopping the engine the fresh water generator must be secured and the jacket cooling water bye-pass opened to prevent under cooling of the jackets during manoeuvring.

3.2 During short stops the main HTFW pump may be left running and the jacket pre-heater put in use.

3.3 For longer stops use the auxiliary HTFW pump and the jacket pre-heater.

3.4 If securing the engine for maintenance shut off steam to the pre-heater until temperature has cooled to about 40°C or ambient engine temperature and stop all pumps.

To secure the LTFW system the plant must be shut down and LTFW pumps stopped.

Note:

When stopping the fresh water generator, it is very important to open the by-pass first before closing the valves to the evaporator otherwise the ME will get a shut down signal and stop.

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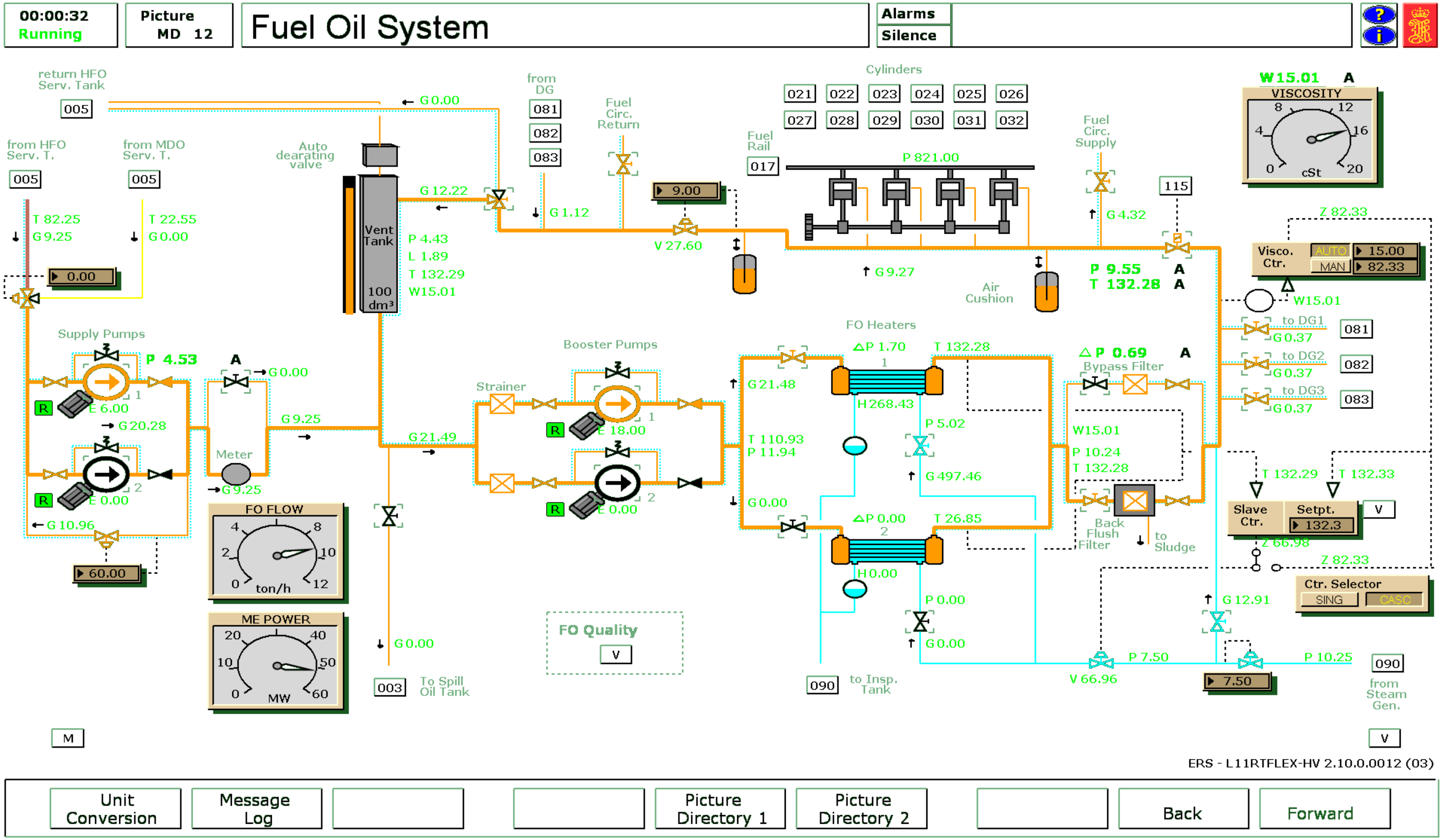
00:00:32
Running
Picture
MD 12
Fuel Oil System
Alarms
Silence
return HFO
Serv. Tank
005
G 0.00
from
DG
081
082
083
Fuel
Circ.
Return
Cylinders
021
022
023
024
025
026
027
028
029
030
031
032
Fuel
Rail
017
P 821.00
Fuel
Circ.
Supply
115
W 15.01
A
VISCOSITY
cSt
from HFO
Serv. T.
005
from MDO
Serv. T.
005
Auto
dearating
valve
G 12.22
Vent
Tank
P 4.43
L 1.89
T 132.29
W15.01
100
dm³
G 1.12
9.00
V 27.60
G 4.32
Z 82.33
Visco.
Ctr.
AUTO
MAN
15.00
82.33
T 82.25
G 9.25
T 22.55
G 0.00
0.00
G 9.27
Air
Cushion
P 9.55
T 132.28
W15.01
to DG1
G 0.37
to DG2
G 0.37
to DG3
G 0.37
Supply Pumps
P 4.53
A
G 0.00
E 6.00
G 20.28
E 0.00
G 10.96
60.00
Meter
G 9.25
G 9.25
G 21.49
Strainer
Booster Pumps
E 18.00
E 0.00
FO Heaters
ΔP 1.70
T 132.28
G 21.48
H 268.43
P 5.02
T 110.93
P 11.94
G 497.46
G 0.00
ΔP 0.00
T 26.85
H 0.00
P 0.00
G 0.00
ΔP 0.69
A
Bypass Filter
W15.01
P 10.24
T 132.28
Back
Flush
Filter
to
Sludge
T 132.29
T 132.33
Slave
Ctr.
Setpt.
132.3
V
Z 66.98
Z 82.33
Ctr. Selector
SING
CASC
G 12.91
FO FLOW
ton/h
ME POWER
MW
G 0.00
003
To Spill
Oil Tank
FO Quality
V
090
to Insp.
Tank
P 7.50
V 66.96
7.50
P 10.25
090
from
Steam
Gen.
M
V
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3.6 Fuel Oil 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 should only be done 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 cat. at 50°C and arranged as a pressurised fuel oil system in order to prevent foaming and high-pressure fuel oil pump cavitations.

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 (totalise) 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 circulation 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 fuel oil filter, one bypass filter and one viscosity controller. The capacity of each heater is sufficient for the max consumption for the main engines and the diesel engines.
There is a facility to run the diesel generators on marine diesel oil with the main engine on heavy fuel oil.

The capacity of each circulating 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.

A fuel circulation circuit is installed to allow pier-to-pier operation on HFO. The circulation oil heats the injection valve and fuel oil distributor even when the ME is stopped.

The fuel oil line to the main engines is equipped with an emergency shut off valve for remote control (outside engine room).

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.

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 fuel oil outlet 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 directly connected PID control.

Operation procedure

1. Preparation and starting at diesel oil

<u>Supply system</u>

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.

<u>Circulation system</u>

2.1 Open valves to one of the fuel oil heaters and the back flush 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 the supply valve for the diesel generators and circulation valves for main engine.
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 Manual.
2.7 Check that the valves for steam supply to fuel oil heaters and steam tracing are closed.
2.8 Start one of the supply pumps manually and check the discharge pressure, temperature and flow.
2.9 When the venting tank is filled up, start one fuel oil booster pump manually and check discharge pressure, temperature and flow.
2.10 Select auto stand by for supply pumps and for booster pumps at the Power Chief – Pump Control panel.

NOTE 1:

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 2:
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.
The supply pump will stop when the casing temperature is raised to 135°C. and can be started again when the temperature is lowered again.
It can be necessary to stop the pump and only circulate the oil through the heater with the booster pump, or to change the return select valve to return to service oil tank so the flow is maintained to cool down the supply pumps casing temperature. Normally when the diesel generators are supplied from the fuel oil system, there will be no problems.

3. Changing from diesel oil to heavy fuel oil.

The main engine load must be max. 30% and the engine well heated.

3.1 HFO purifier to be in operation
3.2 Ensure sufficient level in the 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. (5-8 barg) and check steam pressure.
3.8 Set viscosity controller into manual and set point at 0%, then the steam valve in the supply line is closed to the heaters.
3.9 Slowly admit steam to heater raising temperature 1-2°C in a minute by increasing the manual set point.
3.10 Maintain temperature until pumps, fuel valves etc. are heated to correspond with the oil temperature.
3.11 Ensure oil in the fuel oil service tank is heated to about 75-95°C and change over to fuel operating with mixing valve V00077.
3.12 Slowly increase oil temperature to normal temperature.

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

Reduce the main engine load to 30% of normal.

4.1 Slowly reduce the temperature on HFO by adjusting the viscosity controller manually, maximum reducing 10°C in 5 minutes.
4.2 With mixing valve V0077 change to diesel oil when temperature has dropped to about 5°C above the temperature in the diesel oil service tank.
4.3 After change-over there may be a considerable drop in temperature, the transition must be moderated by supplying a little steam to the pre-heater.

Too quick temperature drop can cause fuel oil high-pressure pump’s plungers to seize due to plunger-liner contraction / reduced lubrication.

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

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

The diesel engines are usually stopped and started with HFO in fuel lines. Diesel oil is used if the engine is going 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.

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.
- Normally HFO gassing develops above 135°C and for DO above 80°C adjustable.

Fuel oil quality

Fuel oil quality (heating value, density, and viscosity) can be set from variable page.

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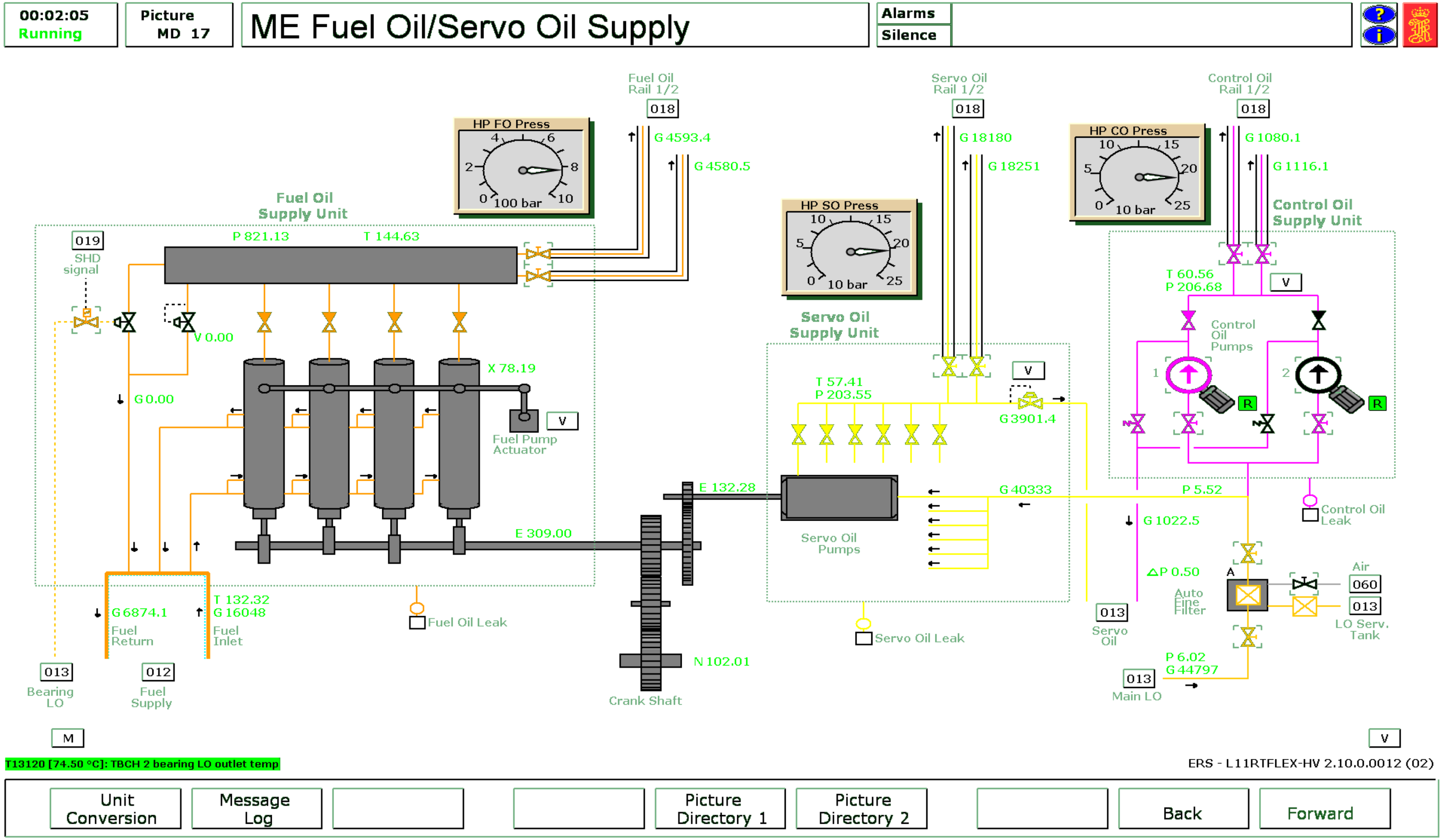

00:02:05
Running
Picture
MD 17
ME Fuel Oil/Servo Oil Supply
Alarms
Silence
Fuel Oil Rail 1/2
018
G 4593.4
G 4580.5
HP FO Press
100 bar
Fuel Oil Supply Unit
P 821.13
T 144.63
019
SHD signal
V 0.00
X 78.19
G 0.00
Fuel Pump Actuator
V
E 309.00
E 132.28
G 6874.1
Fuel Return
T 132.32
G 16048
Fuel Inlet
Fuel Oil Leak
013
Bearing LO
012
Fuel Supply
N 102.01
Crank Shaft
Servo Oil Rail 1/2
018
G 18180
G 18251
HP SO Press
10 bar
Servo Oil Supply Unit
T 57.41
P 203.55
G 3901.4
G 40333
Servo Oil Pumps
Servo Oil Leak
Control Oil Rail 1/2
018
G 1080.1
G 1116.1
HP CO Press
10 bar
Control Oil Supply Unit
T 60.56
P 206.68
Control Oil Pumps
R
P 5.52
G 1022.5
Control Oil Leak
ΔP 0.50
Auto Fine Filter
Air
060
013
LO Serv. Tank
013
Servo Oil
P 6.02
G 44797
013
Main LO
M
V
T13120 [74.50 °C]: TBCH 2 bearing LO outlet temp
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
Unit Conversion
Message Log
Picture Directory 1
Picture Directory 2
Back
Forward

3.6.1 ME Fuel oil/Servo oil supply

General

Fuel injection and exhaust valve operation are controlled by individual control units for each cylinder. The control units are directly mounted on the single-piece rail pipes and are controlled using servo oil through Wärtsilä electro-hydraulic rail valves. Fuel oil and servo oil are supplied to the common-rail system from the very compact supply unit mounted on the side of the engine at the after end. The supply unit is driven through gearing from the crankshaft and is equipped with a five supply pumps

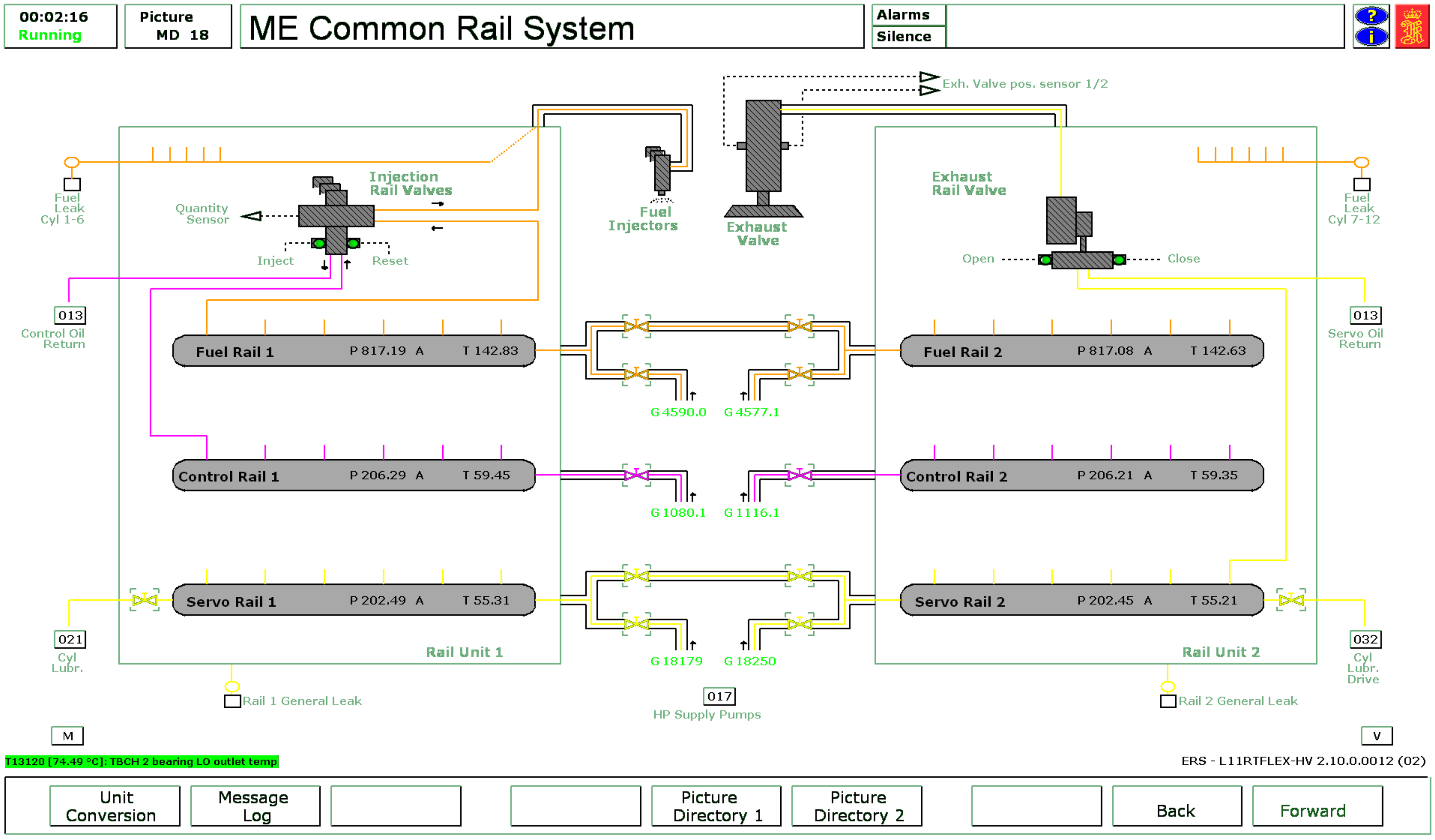
The fuel supply pumps make several strokes during each crankshaft revolution owing to the drive gear ratio. Fuel delivery volume and rail pressure are regulated through suction control of the fuel supply pumps. The servo oil pumps are also incorporated in the supply unit.

All RT-flex functions are governed by the Wärtsilä Engine Control System (WECS) which triggers the electro-hydraulic rail valves for the respective functions. The master input comes from the crank angle sensor which delivers the absolute crank position.
WECS communicates directly with the ship's machinery control system. Variable Page 1902.

Operation procedure

1. Prepare FO circulation System MD12. And Me LO system MD 13.
2. Open V01315 ME HP Servo oil supply MD 13.
3. Line Up Servo/control oil system through Auto filter V17455 & V17456 Open Control Air to Auto Fine Filter V17457. MD 17.
4. Open supply valves V17441 & V 17444 to both control oil pumps. MD 17
5. Open shut off valves V17431 & V17432 to HP Servo oil Supply Rail 1 & 2
6. Open Shut off valves V17451 & V17452 to Control oil Rail 1 & 2. MD 17.
7. Open Shut off valves V17411 & V17412 to Fuel oil Rail 1 & 2. MD 17.
8. Open HP Control oil Rail Valve 1 & 2 MD 18.
9. Open HP Fuel oil Rail Valves V17500 & V17600 1 & 2 MD 18. The cross over valves is also opened to achieve constant pressure. Can be closed if oil leaks.
10. Open HP Servo oil Rail Valves V17520 and V17620 1 & 2 MD 18. The cross over valves is also opened to achieve constant pressure. Can be closed if oil leaks.
11. Open HP Servo oil rail cylinder lubricator drive valves 1 & 2. V 17522 and V17622.
12. Start one of the Control oil pumps manually and check the pressure, temperature and flow.
13. Select auto stand by for Control oil pumps at the Power Chief – Pump Control panel

The Common Rails have General leak sensors that will trig alarm when filled.


00:02:16
Running
Picture
MD 18
ME Common Rail System
Alarms
Silence
Exh. Valve pos. sensor 1/2
Injection
Rail Valves
Quantity
Sensor
Inject
Reset
Fuel
Injectors
Exhaust
Valve
Exhaust
Rail Valve
Open
Close
Fuel
Leak
Cyl 1-6
Fuel
Leak
Cyl 7-12
013
Control Oil
Return
013
Servo Oil
Return
Fuel Rail 1
P 817.19 A
T 142.83
Fuel Rail 2
P 817.08 A
T 142.63
G 4590.0
G 4577.1
Control Rail 1
P 206.29 A
T 59.45
Control Rail 2
P 206.21 A
T 59.35
G 1080.1
G 1116.1
Servo Rail 1
P 202.49 A
T 55.31
Servo Rail 2
P 202.45 A
T 55.21
G 18179
G 18250
Rail Unit 1
Rail Unit 2
021
Cyl
Lubr.
032
Cyl
Lubr.
Drive
Rail 1 General Leak
017
HP Supply Pumps
Rail 2 General Leak
M
V
T13120 [74.49 °C]: TBCH 2 bearing LO outlet temp
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
Unit
Conversion
Message
Log
Picture
Directory 1
Picture
Directory 2
Back
Forward

3.6.2 ME Common Rail System

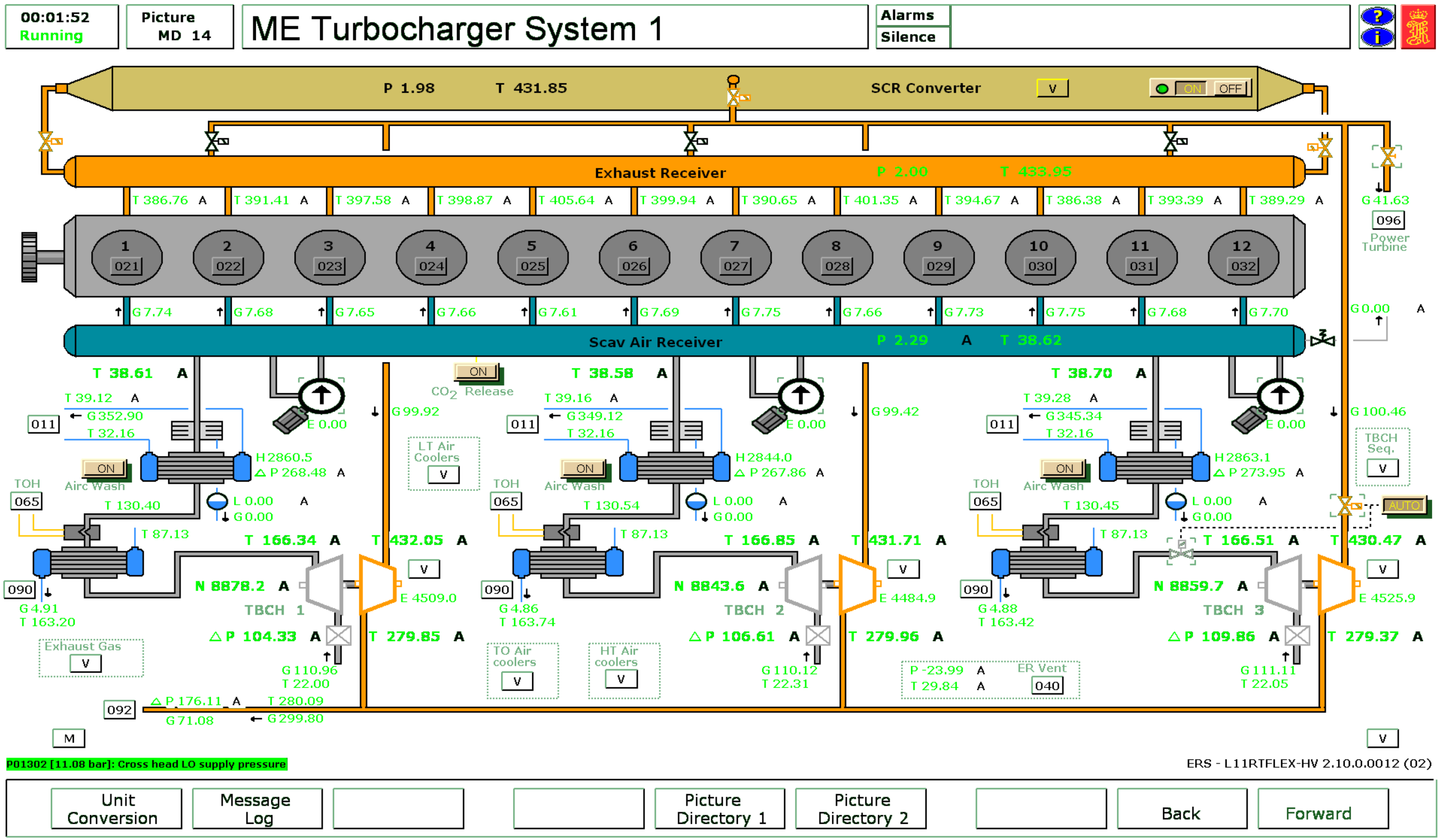
General

Instead of the usual mechanically-controlled fuel injection pumps and exhaust valve drives of Wärtsilä RTA engines, the RT-flex82C has an electronically-controlled common-rail system in which fuel oil and servo oil are delivered at regulated pressures to rail pipes arranged in a rail unit along the side of the cylinders. Heated fuel oil is delivered, ready for injection, at pressures up to 1000 bar. Servo oil is drawn from the engine lubrication system through an automatic self-cleaning fine filter and delivered at pressures up to 200 bar.

Fuel injection and exhaust valve operation are controlled by individual control units for each cylinder. The control units are directly mounted on the single-piece rail pipes and are controlled using servo oil through electro-hydraulic rail valves. Fuel oil and servo oil are supplied to the common-rail system from the very compact supply unit mounted on the side of the engine at the after end MD 17. The supply unit is driven through gearing from the crankshaft and is equipped with a number of fuel supply pumps, the number of pumps depending upon the number of engine cylinders and power output. The fuel supply pumps make several strokes during each crankshaft revolution owing to the drive gear ratio. Fuel delivery volume and rail pressure are regulated through suction control of the fuel supply pumps. The servo oil pumps are also incorporated in the supply unit. All RT-flex functions are governed by the Wärtsilä Engine Control System (WECS) which triggers the electro-hydraulic rail valves for the respective functions. The master input comes from the crank angle sensor which delivers the absolute crank position. WECS communicates directly with the ship's machinery control system.

Operation procedure

See 3.6.1.


00:01:52
Running
Picture
MD 14
ME Turbocharger System 1
Alarms
Silence
P 1.98
T 431.85
SCR Converter
ON
OFF
Exhaust Receiver
P 2.00
T 433.95
T 386.76 A
T 391.41 A
T 397.58 A
T 398.87 A
T 405.64 A
T 399.94 A
T 390.65 A
T 401.35 A
T 394.67 A
T 386.38 A
T 393.39 A
T 389.29 A
G 41.63
096
Power Turbine
G 7.74
G 7.68
G 7.65
G 7.66
G 7.61
G 7.69
G 7.75
G 7.66
G 7.73
G 7.75
G 7.68
G 7.70
G 0.00 A
Scav Air Receiver
P 2.29 A
T 38.62
CO2 Release
LT Air Coolers
TO Air coolers
HT Air coolers
Airc Wash
TOH
TBCH 1
TBCH 2
TBCH 3
N 8878.2 A
N 8843.6 A
N 8859.7 A
TBCH Seq.
AUTO
Exhaust Gas
ER Vent
P -23.99 A
T 29.84 A
040
092
△ P 176.11 A
T 280.09
G 71.08
G 299.80
P01302 [11.08 bar]: Cross head LO supply pressure
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
Unit Conversion
Message Log
Picture Directory 1
Picture Directory 2
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Forward

3.7 ME Turbocharger System

General
The engine has three turbochargers. To increase engine efficiency at part load, one of the turbochargers is equipped with cut-off ports in the exhaust admission and air discharge ducts, so that this unit can be automatically shut off at reduced engine load, below about 40 MW. This "sequential" turbocharger control has additional advantage in conjunction with exhaust power turbine operation. The scavenging air pressure will be higher at part load, increasing the output from the power turbine and allowing it to stay connected to a lower main engine power level.

The turbo-charged air is cooled in a fresh water-cooled air cooler before entering the main engine.

The air cooler must be kept clean to enable it to provide a sufficient amount of cool air to the engine. Hot air will lead to high exhaust temperatures, greater heat losses and increased specific fuel oil consumption.

After the air leaves the air coolers, it enters the demister units that are fitted to reduce the water content of the air. Water is drained off the demister units via the water trap.

Dirty turbo-charger air filters throttle the scavenging airflow and will result in reduced engine performance.

The exhaust gas from the main engine cylinders enters the common exhaust gas receiver. From the receiver the exhaust gas flows through the turbochargers and then to the exhaust gas boiler.
The exhaust boiler must be kept clean. High back pressure reduces scavenging air flow and engine efficiency, especially at high power.

Operation procedure

1. Line up the system by opening the fresh water cooling throttle valves to air coolers 1, 2 and 3.
2. Ensure the scavenge air receiver drains are closed on individual cylinders.
3. Check that the Aux. Blowers 1, 2 and 3 are running. These are operated from MD102. Preset values for start/stop of aux. blower are respectively 0.25 bar and 0.4 bar (variable page 1411).

A blow down valve to drain the contents of the scavenge receiver is provided on each cylinder. This valve should be opened twice daily.

Cleaning
Air coolers:
The air coolers are equipped with a washing arrangement to clean the coolers on the air side. The dirty water will be led out through the water drain. Before starting the washing check that the drain is working.

Turbocharger
Air side:

- The wash-cleaning of the turbocharger air compressor should be carried out every 25-75 hours depending on increase of exhaust temperature.
- The cleaning should be carried out at full service output.
- Keep the “wash-button” press for approximately 8-10 sec.

Exhaust side:

- The wash cleaning of the turbine should be carried out every 50-500 hours depending on the increase of exhaust temperature during constant operating condition.
- The cleaning should be carried out at **reduced ME output** (about 50-55% on the control level) with an exhaust temperature before the turbine approximately 300°C.
- Keep the ME at the reduced power for at least 5 minutes before water is applied to turbine.
- Wash for at least 5 minutes.
- The ME should run at reduced load for at least 5 minutes after wash-cleaning to dry the turbine.
- Check the vibration level for the turbochargers before increasing the ME speed.

Fire in scavenge air box
Warnings of fire:

- An increase in the exhaust temperature of the affected cylinder,
- The turbocharger may surge,
- Smoke from the turbocharger air inlet filters when the surging occurs,
- The scavenge air box being noticeably hotter.

Measures to be taken:
Owing to the possible risk of a crankcase explosion, do not stand near the relief valves – flames can suddenly be violently emitted.

1. Reduce speed/pitch after permission from the bridge to slow and stop the engine.
2. When the engine stop order is received, stop the engine and switch-off the auxiliary blowers.
3. Stop the fuel oil supply.
4. Stop the lube oil supply.
5. Put the scavenge air box fire CO_2 release equipment into function.
6. Before opening to the engine make fire hoses ready for fire-fighting.

Do not open the scavenge air box or crankcase before the site of the fire has cooled down to under 100°C. When opening, keep clear of possible fresh spurts of flame.

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

The main engine is equipped with an exhaust converter of the SCR (Selective Catalytic Reduction) type, cutting the NOx emissions by about 90 %

3.8 ME Selective Catalytic Reduction

General

The Selective Catalytic Reduction unit is provided to reduce the environmental impact of the diesel engine by minimising the Nitrogen Oxides (NO_x) emitted from the main engine exhaust stream.

The SCR unit is used to treat the exhaust before it enters the turbocharger. Ammonia is added to the gas stream, and the mixture then passes through a special catalyst at a temperature between 300 and 400°C. Within the SCR Reactor the hot exhaust gases that contain NO_x gases are mixed with the ammonia stream. This reduces the NO_x to N_2 and H_2O, as detailed:

$$4NO + 4NH_3 + O_2 = 4N_2 + 6H_2O$$

$$6NO_2 + 8NH_3 = 7N_2 + 12H_2O$$

If the temperature of reaction is too high (above 490°C), the ammonia burns and does not react, and at low temperatures (below 250°C) the reaction rate is low and the catalyst can be damaged.

The quantity of ammonia added is pre-programmed into the controlling processor. This provides the base control, with a feed back link provided by the NO_x measurement taken from the exhaust stream. Using the feedback link alone would produce inaccurate control due to the sluggish nature of the reaction process; hence a feed forward signal from the main engine actual power is used to modify the controller output.

The Slip controller will adjust the NOx controller set point down with the specified rate when the slip is below the slip set point (default 3ppm), and up when the slip is above. This “optimal” mode will be turned off if the NO_x controller is not in auto, or if the control state is not “active”, and it has to be manually switched on again. The SCR slip controller controls the rate at which the ammonia flow is changed. Within the pop-up window, these settings can be adjusted, with the default setting of increase 0.02 g/kWh/sec, and decrease 0.01 g/kWh/sec.

The quantity of ammonia which can be added is limited, as excess amounts produce "ammonia slip", by which neat ammonia leaves with the exhaust stream. Thus both ammonia and NO_x levels are recorded in the exhaust stream, and levels of 10ppm and 5g/kWh expected values. These values are reduced from the engine cylinder exhaust NO_x level in the region of 20 g/kWh.

The ammonia is supplied as pressurised water free ammonia feed. The process units are contained within a safety area, as ammonia is combustible. Thus lines are double walled, and leak detection and appropriate venting of the storage and process areas must take place.

Operation procedure

1. Line up the system by pushing the on button in MD 14.
2. The exhaust gas intlet temp must be higher than 240 ^{o}C
3. The operations can be followed from variable page 3500.

The SCR control indicates the status of the system, with the following indications:

- Stopped. When the system is non-operational
- Active. The system is operational, hence the SCR Reactor bypass exhaust valves are closed and all the exhaust gas flow is directed through the reactor, and the ammonia inlet to the static mixer is open.
- Shutting Down. The system is changing from active to stopped, by changing the exhaust gas flow path from the exhaust receiver direct to the turbochargers. Note that during the shut down period (15 second default setting) both the bypass and direct flow paths are open, to prevent a sudden change in the turbocharger operation parameters, and to allow the reactor to gradually cool down.
- Starting. The system is changing from stopped to active, by directing the exhaust gas flow from the exhaust receiver to the SCR Reactor. During the starting period (default 30 seconds) the SCR bypass and inlet /outlet valves are open to allow a gradual heating up of the reactor, and prevent a possible turbocharger surge by rapid change to the turbocharger turbine speed.
- Standby (exh gas temp). When the control system is selected ON, the exhaust temperature must be within pre-set temperatures to enable the system to start. These temperatures are adjustable, and the default settings are low limit 240^{o}C or high limit 510^{o}C.

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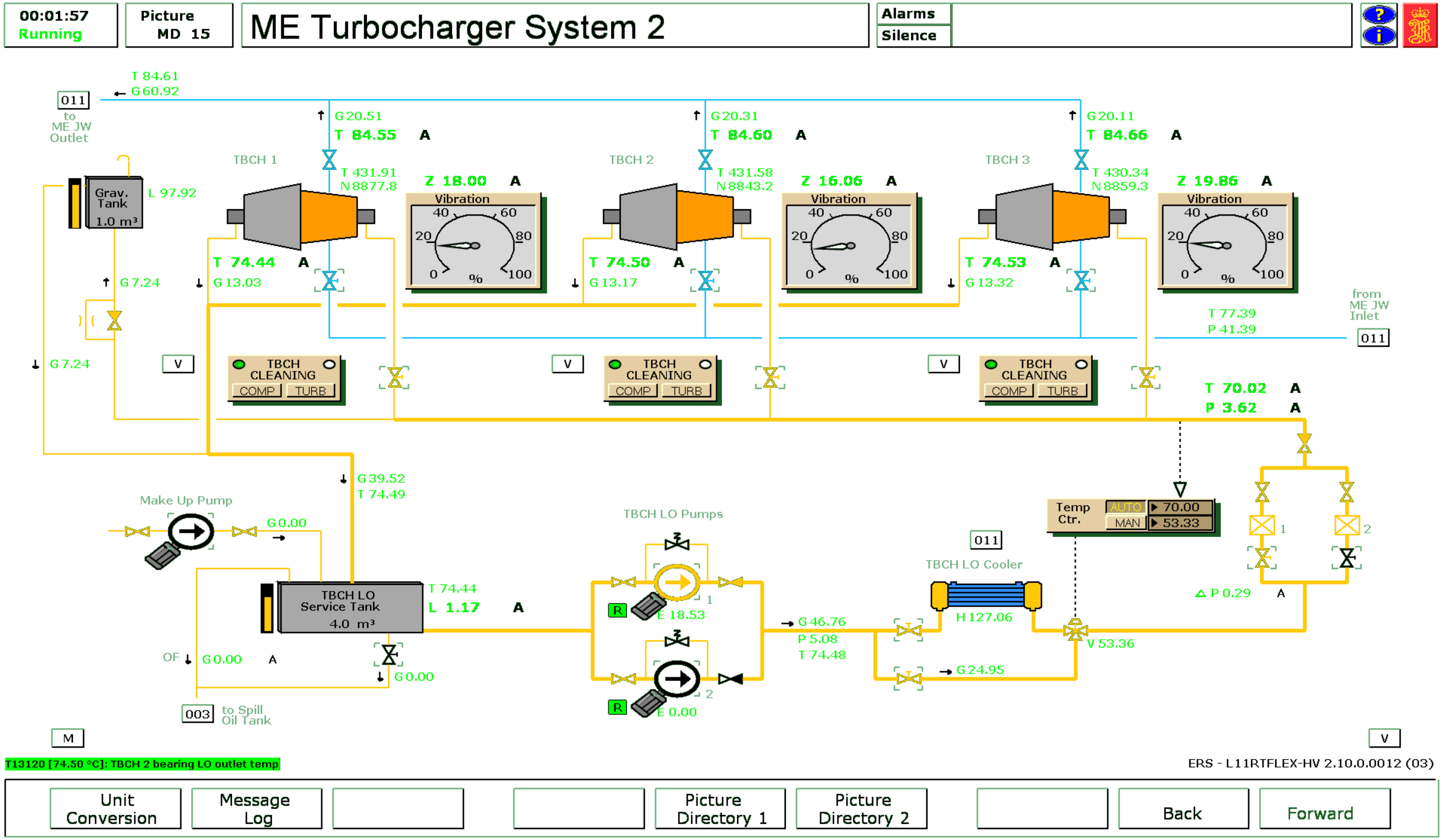
00:01:57
Running
Picture
MD 15
ME Turbocharger System 2
Alarms
Silence
T 84.61
G 60.92
011
to ME JW Outlet
G 20.51
T 84.55 A
G 20.31
T 84.60 A
G 20.11
T 84.66 A
TBCH 1
TBCH 2
TBCH 3
T 431.91
N 8877.8
T 431.58
N 8843.2
T 430.34
N 8859.3
Z 18.00 A
Z 16.06 A
Z 19.86 A
Vibration
Grav. Tank 1.0 m³
L 97.92
T 74.44 A
G 13.03
T 74.50 A
G 13.17
T 74.53 A
G 13.32
G 7.24
G 7.24
from ME JW Inlet
T 77.39
P 41.39
011
TBCH CLEANING
COMP
TURB
T 70.02 A
P 3.62 A
G 39.52
T 74.49
Make Up Pump
G 0.00
TBCH LO Pumps
Temp Ctr.
AUTO
MAN
70.00
53.33
011
TBCH LO Cooler
TBCH LO Service Tank 4.0 m³
T 74.44
L 1.17 A
R
E 18.53
R
E 0.00
G 46.76
P 5.08
T 74.48
H 127.06
V 53.36
G 24.95
△ P 0.29 A
OF
G 0.00 A
G 0.00
003
to Spill Oil Tank
M
V
T13120 [74.50 °C]: TBCH 2 bearing LO outlet temp
ERS - L11RTFLEX-HV 2.10.0.0012 (03)
Unit Conversion
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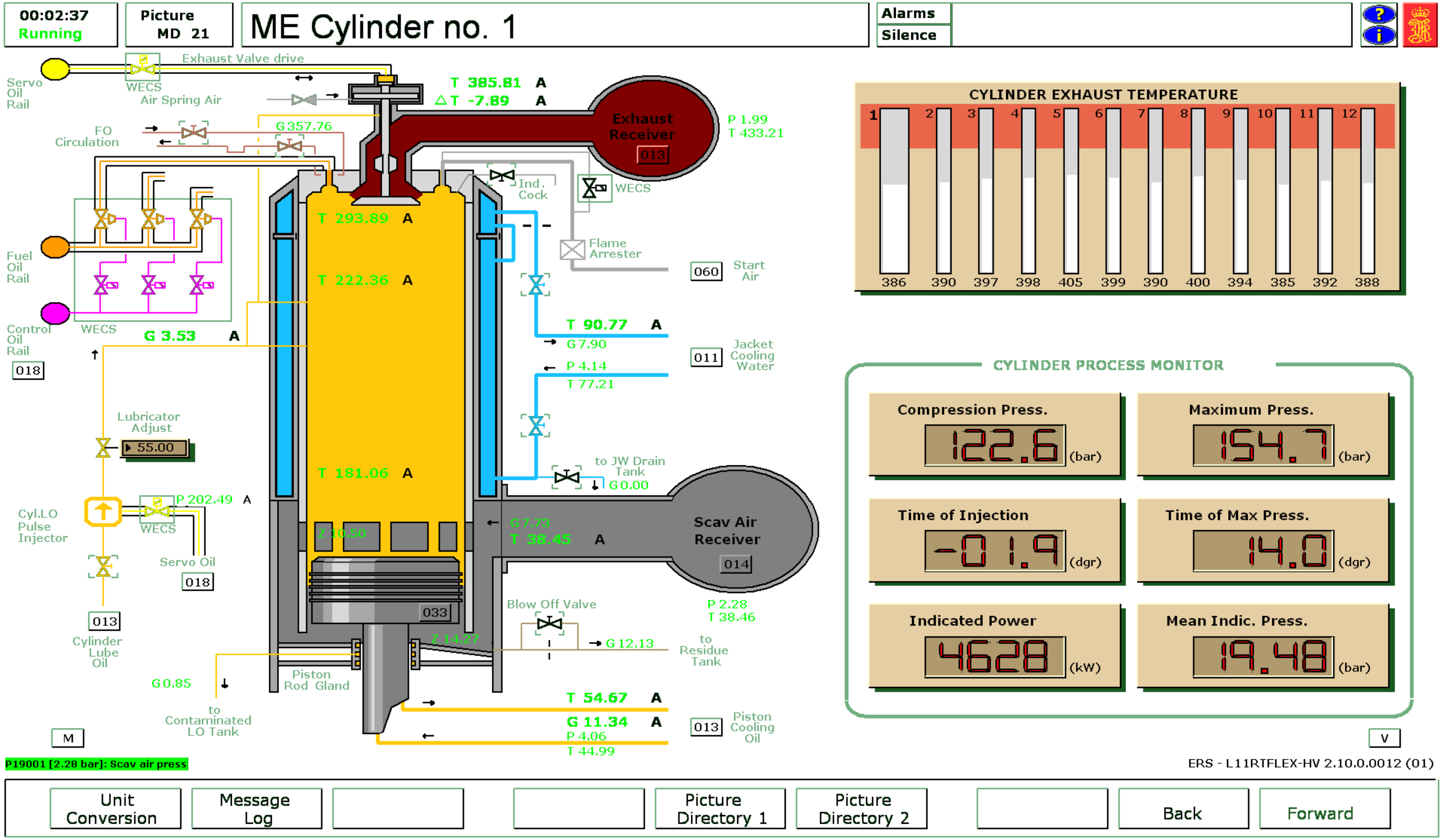
The lubrication oil to the TBCH bearings is pumped from a service tank.
The LO pumps are protected by a pressure relief valve which opens for pressure over a preset value.
A make-up pump enters new oil with flow directly to the service tank.
The lubrication oil is cooled by a LT freshwater cooled LO cooler and is then passing a double filter before it enters the main engine.
The LO temperature is controlled by a PI controller, which regulates a by-pass valve for the LO cooler.
The LO filters must be cleaned regularly to avoid pressure/flow reduction.
The freshwater cooling to the TBCH is coming from the ME LTFW cooling system.

Operation:

1. Ensure that the turbocharger LO tank is filled to the correct level and replenish if necessary.
2. Check that the low temperature central cooling system is operating and that cooling water is circulating through the turbocharger LO cooler.
3. Check that the valves are in the right position.
4. Check that the duplex filter is clean.
5. Start the turbocharger LO pump and check that oil is flowing to the three turbochargers and returning from the turbocharger bearings.
6. Select the second LO pumps as the standby pump.
7. The turbocharger LO system is now operational and the turbochargers may be operated.

Note:
The turbocharger LO must be tested frequently in order to determine whether or not it is fit for further service. Sample should be taken from the circulating oil and not directly from the tank.


00:02:37
Running
Picture
MD 21
ME Cylinder no. 1
Alarms
Silence
Exhaust Valve drive
Servo Oil Rail
WECS
Air Spring Air
T 385.81 A
△T -7.89 A
FO Circulation
G 357.76
Exhaust Receiver
013
P 1.99
T 433.21
Ind. Cock
WECS
Fuel Oil Rail
T 293.89 A
Flame Arrester
060
Start Air
T 222.36 A
Control Oil Rail
WECS
G 3.53 A
018
T 90.77 A
G 7.90
P 4.14
T 77.21
011
Jacket Cooling Water
Lubricator Adjust
55.00
T 181.06 A
to JW Drain Tank
G 0.00
Cyl.LO Pulse Injector
P 202.49 A
WECS
G 7.73
T 38.45 A
Scav Air Receiver
014
Servo Oil
018
Z 10.50
033
013
Cylinder Lube Oil
Blow Off Valve
P 2.28
T 38.46
Z 14.27
G 12.13
to Residue Tank
G 0.85
Piston Rod Gland
to Contaminated LO Tank
T 54.67 A
G 11.34 A
P 4.06
T 44.99
013
Piston Cooling Oil
M
CYLINDER EXHAUST TEMPERATURE
1 2 3 4 5 6 7 8 9 10 11 12
386 390 397 398 405 399 390 400 394 385 392 388
CYLINDER PROCESS MONITOR
Compression Press.
122.6 (bar)
Maximum Press.
154.7 (bar)
Time of Injection
-01.9 (dgr)
Time of Max Press.
14.0 (dgr)
Indicated Power
4628 (kW)
Mean Indic. Press.
19.48 (bar)
V
P19001 [2.28 bar]: Scav air press
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
Message Log
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3.9 ME Cylinder

General

The twelve screens are indications of the various parameters of the individual cylinders. The following indications are present:

- Cylinder exhaust temperature and deviation from the average exhaust temperature.
- Exhaust receiver pressure and temperature gauges.
- Cylinder exhaust temperature chart illustrating each cylinder.
- Scavenge receiver pressure and temperature gauges.
- Piston oil cooling temperature and flow indications.
- Cylinder cooling water temperature and flow.
- Cylinder process readings for compression pressure, maximum pressure, injection timing, timing of max pressure, indicated power and MIP.

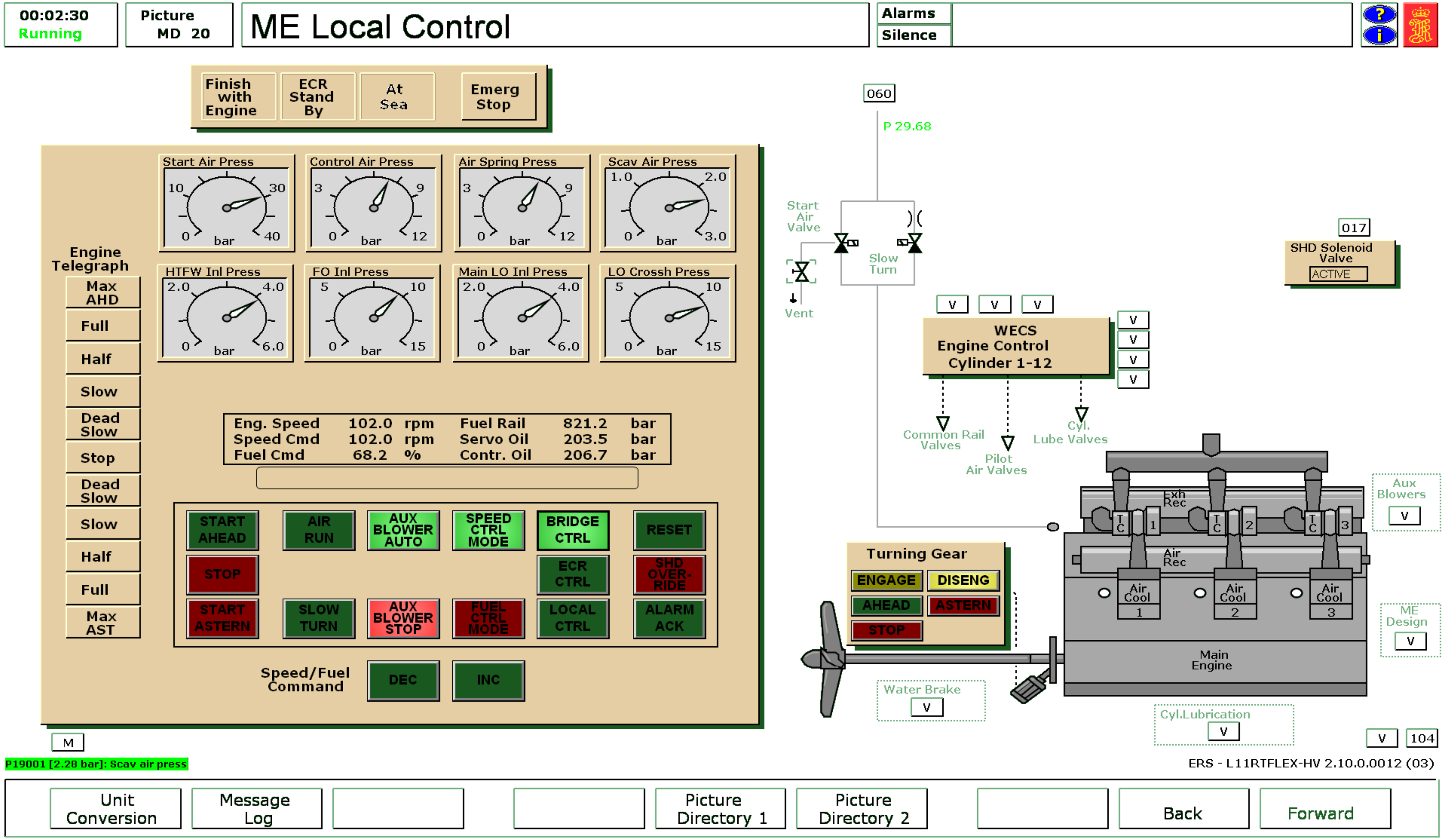
The contents of the scavenge space around each cylinder are led to a residue tank and are constantly blown via an orifice. A blow down valve is also provided on each cylinder. This valve should be opened twice daily.

The cylinder lubrication oil quantity can be adjusted to suit the running conditions and manufacturer’s recommendations. Before starting the engine, the cylinder can be individually pre-lubricated by use of the crank, or activation of pre/post lubrication from the AutoChief.

Fuel is constantly circulated around the injectors to cool down/heat up the injectors.

Indicator cocks are provided at each cylinder.

The cooling water may be isolated and drained for each cylinder for maintenance purposes.


00:02:30
Running
Picture
MD 20
ME Local Control
Alarms
Silence
Finish with Engine
ECR Stand By
At Sea
Emerg Stop
Engine Telegraph
Max AHD
Full
Half
Slow
Dead Slow
Stop
Dead Slow
Slow
Half
Full
Max AST
Start Air Press
Control Air Press
Air Spring Press
Scav Air Press
HTFW Inl Press
FO Inl Press
Main LO Inl Press
LO Crossh Press
bar
Eng. Speed 102.0 rpm
Speed Cmd 102.0 rpm
Fuel Cmd 68.2 %
Fuel Rail 821.2 bar
Servo Oil 203.5 bar
Contr. Oil 206.7 bar
START AHEAD
AIR RUN
AUX BLOWER AUTO
SPEED CTRL MODE
BRIDGE CTRL
RESET
STOP
ECR CTRL
SHD OVER-RIDE
START ASTERN
SLOW TURN
AUX BLOWER STOP
FUEL CTRL MODE
LOCAL CTRL
ALARM ACK
Speed/Fuel Command
DEC
INC
060
P 29.68
Start Air Valve
Slow Turn
Vent
017
SHD Solenoid Valve
ACTIVE
WECS
Engine Control
Cylinder 1-12
Common Rail Valves
Pilot Air Valves
Cyl. Lube Valves
Exh Rec
Air Rec
Air Cool
Main Engine
Aux Blowers
ME Design
Turning Gear
ENGAGE
DISENG
AHEAD
ASTERN
STOP
Water Brake
Cyl.Lubrication
104
M
P19001 [2.28 bar]: Scav air press
ERS - L11RTFLEX-HV 2.10.0.0012 (03)
Unit Conversion
Message Log
Picture Directory 1
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3.10 ME Local Control

General

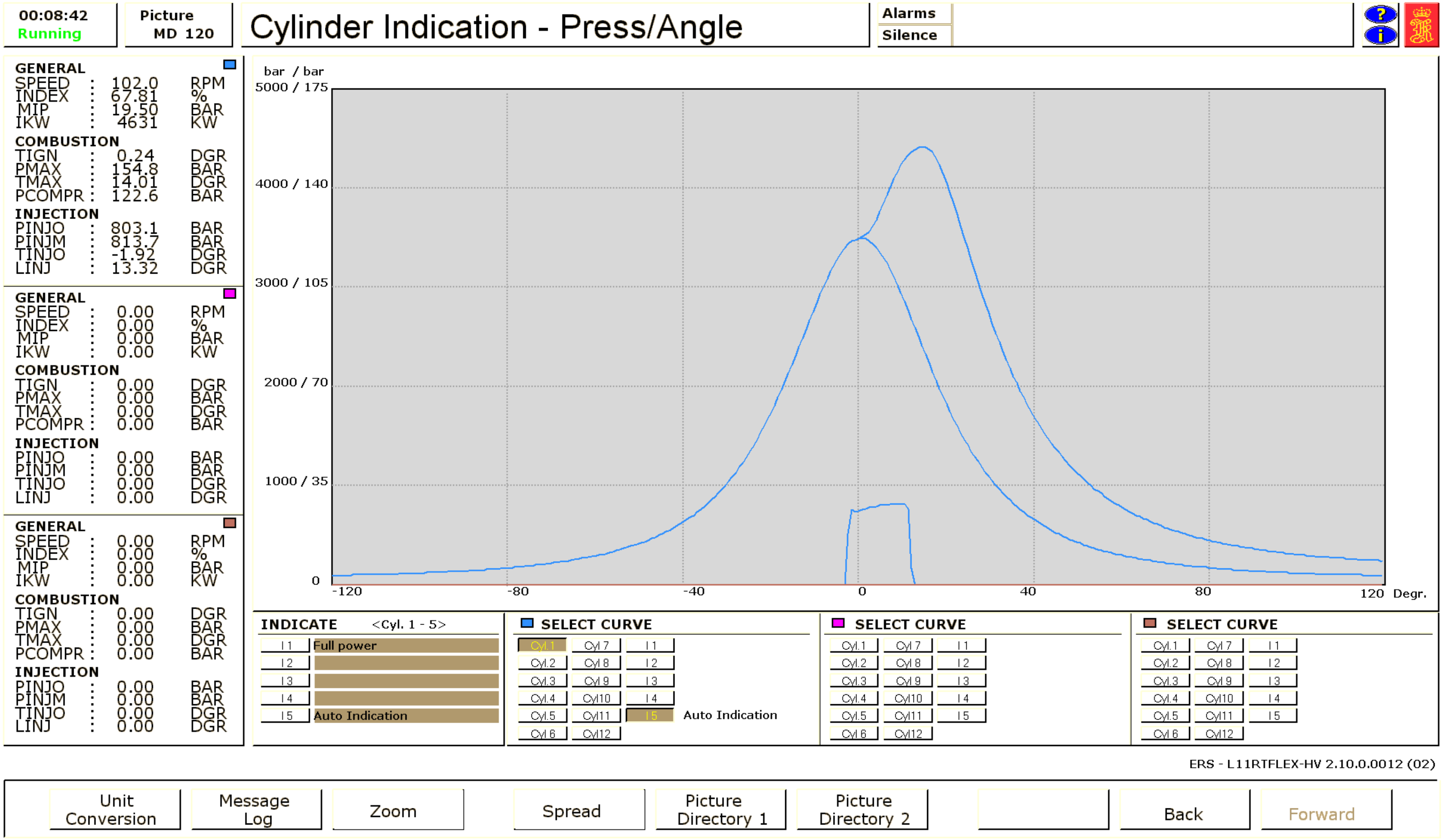
Local control of the main engine is provided to enable operation and control of the main engine should a defect or malfunction of the main control or manoeuvring system occur.
In Local control the automatic thermal load programme, main governor functions, and slow down protection is overridden.

The following functions are available on the local panel:

- Indication of start air and control air pressure
- Indication of air spring pressure
- Indication of scavenging air pressure
- Indication of HTFW inlet pressure
- Indication of FO inlet pressure
- Indication of Main LO inlet pressure
- Indication of LO crosshead pressure
- Indication of responsibility
- Indication of ME speed
- Indication of engine rotation direction
- Fuel and speed control modes
- Indication of fuel and speed command
- Indication of air run (ME on air)
- Slow Turning
- Turning gear engage/disengage
- Shut Down Override
- Emergency Stop
- Telegraph handle
- Auxiliary blower control

Start/stop procedure of the ME at the Local Panel:
Note!
Before starting engine after prolonged stop, always "blow through" engine with starting air with indicator cocks open. When stoppage exceeds 30 minutes while manoeuvring, it is recommended to perform a slow turning of engine before starting attempt is commenced.

1. Checklist for departure must be completed.
2. The local control is selected at Local Control stand.
3. The Emergency telegraph should be observed, and any command from the Bridge acknowledged.
4. Set the engine speed setpoint to approx. 15 rpm (or above 15% in Fuel Control mode.
5. Select Start Ahead and speed according to order.
6. If reversing, reduce and stop engine. Re-type min. speed or fuel command (minimum for start) and start Astern.
7. Stop the ME has to be done by the stop button.


00:08:42
Running
Picture
MD 120
Cylinder Indication - Press/Angle
Alarms
Silence
GENERAL
SPEED : 102.0 RPM
INDEX : 67.81 %
MIP : 19.50 BAR
IKW : 4631 KW
COMBUSTION
TIGN : 0.24 DGR
PMAX : 154.8 BAR
TMAX : 14.01 DGR
PCOMPR : 122.6 BAR
INJECTION
PINJO : 803.1 BAR
PINJM : 813.7 BAR
TINJO : -1.92 DGR
LINJ : 13.32 DGR
GENERAL
SPEED : 0.00 RPM
INDEX : 0.00 %
MIP : 0.00 BAR
IKW : 0.00 KW
COMBUSTION
TIGN : 0.00 DGR
PMAX : 0.00 BAR
TMAX : 0.00 DGR
PCOMPR : 0.00 BAR
INJECTION
PINJO : 0.00 BAR
PINJM : 0.00 BAR
TINJO : 0.00 DGR
LINJ : 0.00 DGR
GENERAL
SPEED : 0.00 RPM
INDEX : 0.00 %
MIP : 0.00 BAR
IKW : 0.00 KW
COMBUSTION
TIGN : 0.00 DGR
PMAX : 0.00 BAR
TMAX : 0.00 DGR
PCOMPR : 0.00 BAR
INJECTION
PINJO : 0.00 BAR
PINJM : 0.00 BAR
TINJO : 0.00 DGR
LINJ : 0.00 DGR
bar / bar
5000 / 175
4000 / 140
3000 / 105
2000 / 70
1000 / 35
0
-120
-80
-40
0
40
80
120 Degr.
INDICATE <Cyl. 1 - 5>
I 1 Full power
I 2
I 3
I 4
I 5 Auto Indication
SELECT CURVE
Cyl 1 Cyl 7 I 1
Cyl 2 Cyl 8 I 2
Cyl 3 Cyl 9 I 3
Cyl 4 Cyl10 I 4
Cyl 5 Cyl11 I 5 Auto Indication
Cyl 6 Cyl12
SELECT CURVE
Cyl 1 Cyl 7 I 1
Cyl 2 Cyl 8 I 2
Cyl 3 Cyl 9 I 3
Cyl 4 Cyl10 I 4
Cyl 5 Cyl11 I 5
Cyl 6 Cyl12
SELECT CURVE
Cyl 1 Cyl 7 I 1
Cyl 2 Cyl 8 I 2
Cyl 3 Cyl 9 I 3
Cyl 4 Cyl10 I 4
Cyl 5 Cyl11 I 5
Cyl 6 Cyl12
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
Unit Conversion
Message Log
Zoom
Spread
Picture Directory 1
Picture Directory 2
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3.11 Cylinder indications

3.11.1 Press/Angle

General

The cylinder indicator is used as an investigative system to enable regular monitoring of the engine cylinders to be undertaken. Faults within the combustion system can be located.
There are two different displays that can be selected to indicate the cylinder pressure conditions, pressure/volume (also called a power card, or in-phase diagram). Each diagram can be used to illustrate differing combustion traits.

The pressure/angle diagram would be used for:

- Display the compression pressure curve, for comparisons with the other cylinders, to indicate cylinder sealing efficiency.
- Display the approximate timing of the fuel ignition.
- Display the fuel pressure trace (using the alternate pressure measurements of 0-3000bar).

To enable the cylinder indicator to measure the combustion pressure, the following actions are required:

1. Select one of the field button (I1 to I5) in the INDICATE column.
2. Type in your identifying comments in the INDICATE field to aid future fault identification.
3. Select the same field button (I1 to I5) in the SELECT CURVE column. Either the blue, magenta, or brown curve can be selected.
4. Select the cylinder 1 to 12 that you wish to be measured.

To measure and compare the same cylinder after a period of operation, or when a malfunction is present. Using cylinder 2 as an example:

1. Carry out the tasks 1 to 3 above using the blue curve column and I2.
2. Select cylinder 2 to measure.
3. Select another field button (not chosen in point 1 such as I3) in the Indicate column.
4. Type in your identifying comments in the Indicate field.
5. Select I3 in Select Curve of the magenta column.
6. Select cylinder 2 to measure the combustion parameters of cylinder 2 again.

The following parameters are displayed in the numeric data display, at the instant when the cylinder indicator is taken, once a cylinder is selected together with the two indicate (I) buttons:

Speed - This is the engine speed (N).
Index - This is a measure of the fuel index
MIP - This is the Mean Indicated Pressure (MIP) measured in bar. This pressure is the equivalent pressure that acts on the piston throughout its vertical power stroke.

IkW - This is the Indicated Power of the cylinder, and is calculated from

$$MIP \times volume \ \ of \ \ \ working \ \ \ piston \times N$$

T_{IGN} - This is the timing of the ignition. The time between the T_{INJO} and T_{IGN} indicates the ignition delay present for that cycle. Increasing ignition delays will cause increased P_{MAX} and large delta pressure/angle ($\delta P/\delta\alpha$)

P_{MAX} - This is the maximum pressure present during the working cycle. This will be affected by the quantity and timing of the fuel admission.

T_{MAX} - This is the position of the timing of the maximum pressure during the working cycle.

P_{COMPR} - This is the pressure due to compression alone after the compression stroke. It provides valuable information to the efficiency of the compression stroke, and the sealing efficiency of the piston rings, liner, and cylinder cover valves.

P_{INJO} - This is the fuel pressure when the fuel injector opens. It provides useful information that the fuel injector is correctly adjusted.

P_{INJM} - This is the maximum fuel pressure generated by the fuel pump. This indicates the internal sealing properties of the pump, and whether internal wear is present.

T_{INJO} - This is the timing of the fuel injection. The fuel pump timing will change when the VIT operation is selected on MD110, but it should be similar for all fuel pumps.

L_{INJ} - This is the length of the fuel injection period, and is dependent on the setting of the fuel control lever.

On the lower part of the diagram, the button Zoom can be used to zoom the diagram in horizontal direction to 300%.
The button Spread is used to move overlaying curves apart vertically.

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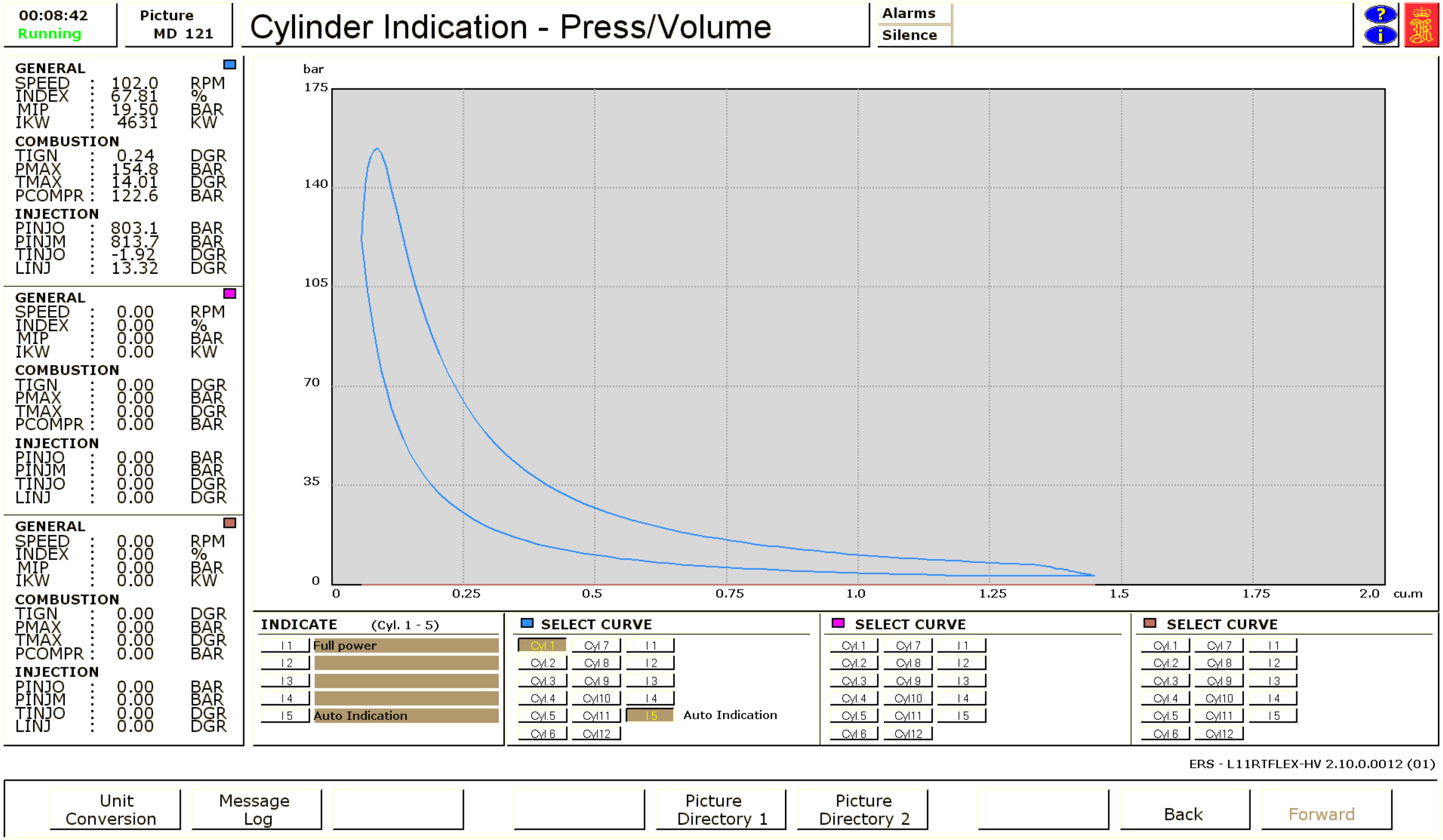
00:08:42
Running
Picture
MD 121
Cylinder Indication - Press/Volume
Alarms
Silence
GENERAL
SPEED : 102.0 RPM
INDEX : 67.81 %
MIP : 19.50 BAR
IKW : 4631 KW
COMBUSTION
TIGN : 0.24 DGR
PMAX : 154.8 BAR
TMAX : 14.01 DGR
PCOMPR : 122.6 BAR
INJECTION
PINJO : 803.1 BAR
PINJM : 813.7 BAR
TINJO : -1.92 DGR
LINJ : 13.32 DGR
GENERAL
SPEED : 0.00 RPM
INDEX : 0.00 %
MIP : 0.00 BAR
IKW : 0.00 KW
COMBUSTION
TIGN : 0.00 DGR
PMAX : 0.00 BAR
TMAX : 0.00 DGR
PCOMPR : 0.00 BAR
INJECTION
PINJO : 0.00 BAR
PINJM : 0.00 BAR
TINJO : 0.00 DGR
LINJ : 0.00 DGR
GENERAL
SPEED : 0.00 RPM
INDEX : 0.00 %
MIP : 0.00 BAR
IKW : 0.00 KW
COMBUSTION
TIGN : 0.00 DGR
PMAX : 0.00 BAR
TMAX : 0.00 DGR
PCOMPR : 0.00 BAR
INJECTION
PINJO : 0.00 BAR
PINJM : 0.00 BAR
TINJO : 0.00 DGR
LINJ : 0.00 DGR
bar
175
140
105
70
35
0
0
0.25
0.5
0.75
1.0
1.25
1.5
1.75
2.0
cu.m
INDICATE (Cyl. 1 - 5)
I 1 Full power
I 2
I 3
I 4
I 5 Auto Indication
SELECT CURVE
Cyl 1 Cyl 7 I 1
Cyl 2 Cyl 8 I 2
Cyl 3 Cyl 9 I 3
Cyl 4 Cyl10 I 4
Cyl 5 Cyl11 I 5 Auto Indication
Cyl 6 Cyl12
SELECT CURVE
Cyl 1 Cyl 7 I 1
Cyl 2 Cyl 8 I 2
Cyl 3 Cyl 9 I 3
Cyl 4 Cyl10 I 4
Cyl 5 Cyl11 I 5
Cyl 6 Cyl12
SELECT CURVE
Cyl 1 Cyl 7 I 1
Cyl 2 Cyl 8 I 2
Cyl 3 Cyl 9 I 3
Cyl 4 Cyl10 I 4
Cyl 5 Cyl11 I 5
Cyl 6 Cyl12
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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3.11.2 Press/Volume

General

The pressure/volume diagram displays the classical p~V diagram used in thermodynamic calculations to measure the power produced within a cylinder.
The x –axis displays the swept volume of the piston.

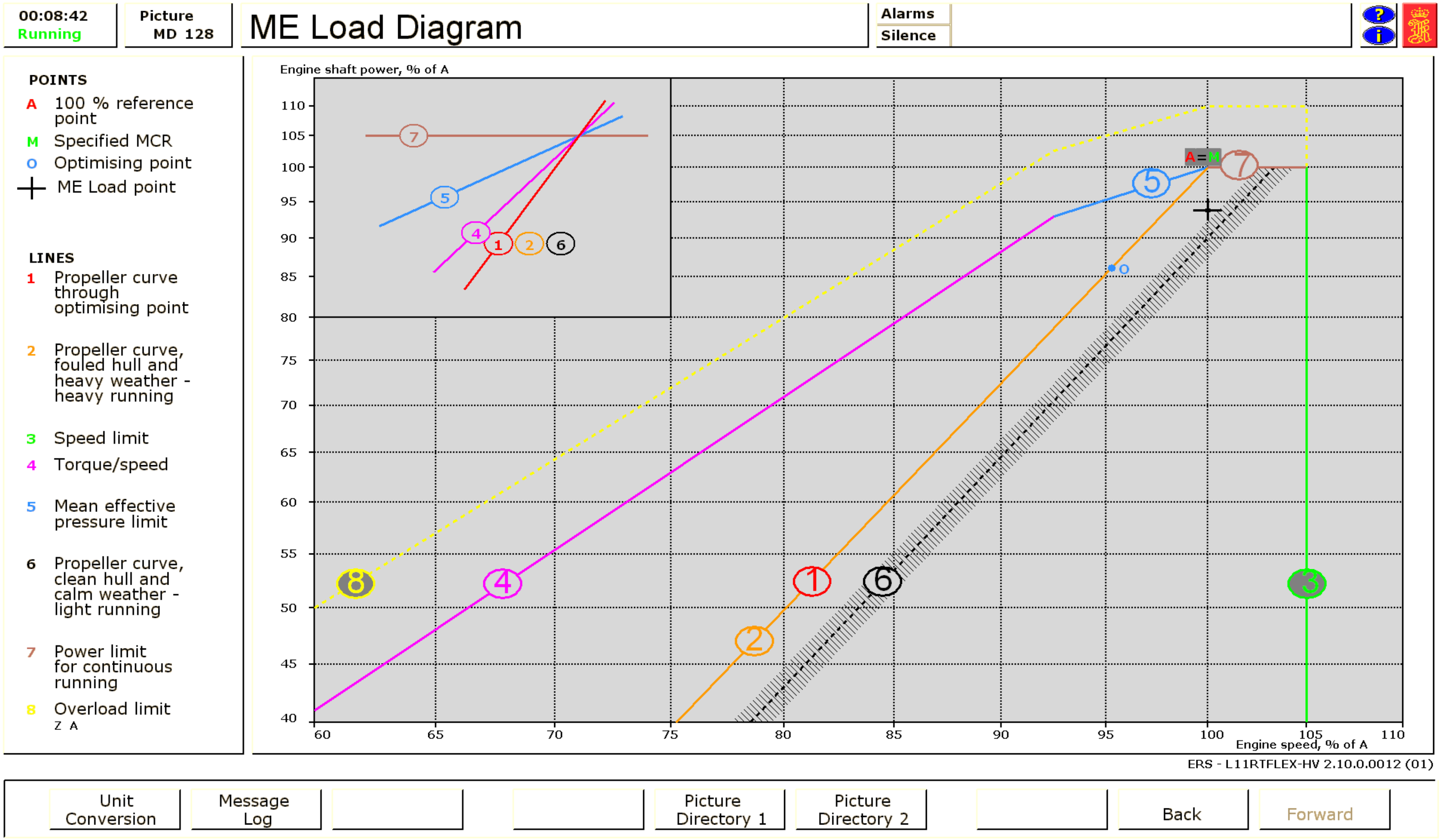
The pressure/volume diagram would be used for:

- Display the classical power diagram, where the area within the diagram equates to the power developed by that power stroke.
- Display the maximum pressure.
- Display the expansion curve and thus indicating whether there is slow burning fuel or afterburning of the cylinder combustion products present.

To enable the pressure indicator to measure the same procedure is required as for any of the cylinder indication screens. Once one screen has been activated, then ALL screens will indicate the same numerical information on the left side of the screen display, although the graphical information will change.

To enable the cylinder indicator to measure the combustion pressure, the following actions are required:

1. Select one of the field buttons (I1 to I5) in the INDICATE column.
2. Type in your identifying comments in the INDICATE field to aid future fault identification.
3. Select the same field button (I1 to I5) in the SELECT CURVE column. Either the blue, magenta, or brown curve can be selected.
4. Select the cylinder 1 to 12 that you wish to be measured.


00:08:42
Running
Picture
MD 128
ME Load Diagram
Alarms
Silence
POINTS
A 100 % reference point
M Specified MCR
O Optimising point
ME Load point
LINES
1 Propeller curve through optimising point
2 Propeller curve, fouled hull and heavy weather - heavy running
3 Speed limit
4 Torque/speed
5 Mean effective pressure limit
6 Propeller curve, clean hull and calm weather - light running
7 Power limit for continuous running
8 Overload limit
Z A
Engine shaft power, % of A
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
60
65
70
75
80
85
90
95
100
105
110
Engine speed, % of A
A=M
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
Message Log
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Picture Directory 2
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3.12 Load Diagram

General

The load diagram is used to provide a graphical representation of the engine power and speed at any given time of the engine operation.

Logarithmic scales are used for both power and speed, so that the relationship $P \alpha N^3$ between them for a fixed pitch propeller installation can be shown as a straight line. The load diagram also provides valuable information about the limitations of engine operation. Normally the engine would be expected to operate within the limits of line 1-7 and 100% speed, but during shallow water operations, heavy weather, and during load-up periods, then operation within lines 4-5-7-3 are permissible.

These specific lines are:

Line 4 This represents the limit of thermal loading that should be placed on the engine. Should the engine operate to the left of this line, then there is insufficient air for combustion, and hence this will impose a limitation of the torque the engine can produce at a given speed.

Line 5 This represents the maximum mean effective pressure the engine can produce under continuous operation.

Line 7 This represents the maximum power the engine can produce under continuous conditions (100% of Maximum Continuous Rating (MCR))

Line 3 This represents the maximum acceptable speed under continuous operation (105% of the given speed for that engine)

Line 8. This represents an overload condition of the engine. The engine is designed to be able to operate for 1 hour in 12 between the lines 4 and 8, but in moderately heavy weather engine overload would easily occur when operating close to line 4 due the varying load imposed on the engine.

Within this normal operating range, the lines of 1, 2 and 6 represent the relationship of $P \alpha N^3$, thus reflect the expected operation of the engine for various conditions.

Line 1 represents the expected operation of the engine with the shaft alternator operating. This line passes through the optimisation point of the propeller / engine st-up, where the maximum fuel efficiency of the engine will occur.

Line 2 represents the operation of the engine when the shaft alternator is not operating. This will reduce the power output of the engine, whilst it still delivers the expected speed.

Line 6 represents the light running operations of the engine. It is at this condition that the engine / propeller would be expected to operate at sea trails. However, once delivered the expected fouling of the hull, propeller and engine, combined with realistic weather and wind condition will dictate that for a given speed output a higher power output is required. By illustrating the original clean set-up of the engine, then the engineer can quickly see how much deterioration has occurred, and hence decide when cleaning of the hull, propeller and engine is required. Note that operation with increasing hull fouling will cause the engine to operate in an overload condition, i.e. to the left of line 8.

The other points to note on this diagram are:
Point A – this represents the intersection between the expected operation line 6 and the maximum power line 7.
Point M – this represents the maximum continuous rating (MCR) of the engine as specified by the engine manufacturer, thus for this engine this will be 16MW at 74 rev/min.

The load diagram can be used to determine:

- When the engine is overloaded due to environmental conditions. Note this does not need to occur when the engine is developing excess power, as most damage occurs when operating to the left of line 8.
- The effectiveness of the load limiters. They should prevent operation to the left of line 4. If the engine was initially loaded on line 2 then when the engine is loaded up, the speed~power relationship will leave this line and move closer to line 4, especially if the shaft alternator is operating. The load limiter parameters must be adjusted if the engine load diagram indicates operation to the left of line 4 during load-up conditions. This will extend the time taken for the engine and vessel to speed up, but should prevent premature damage to the cylinder combustion components.

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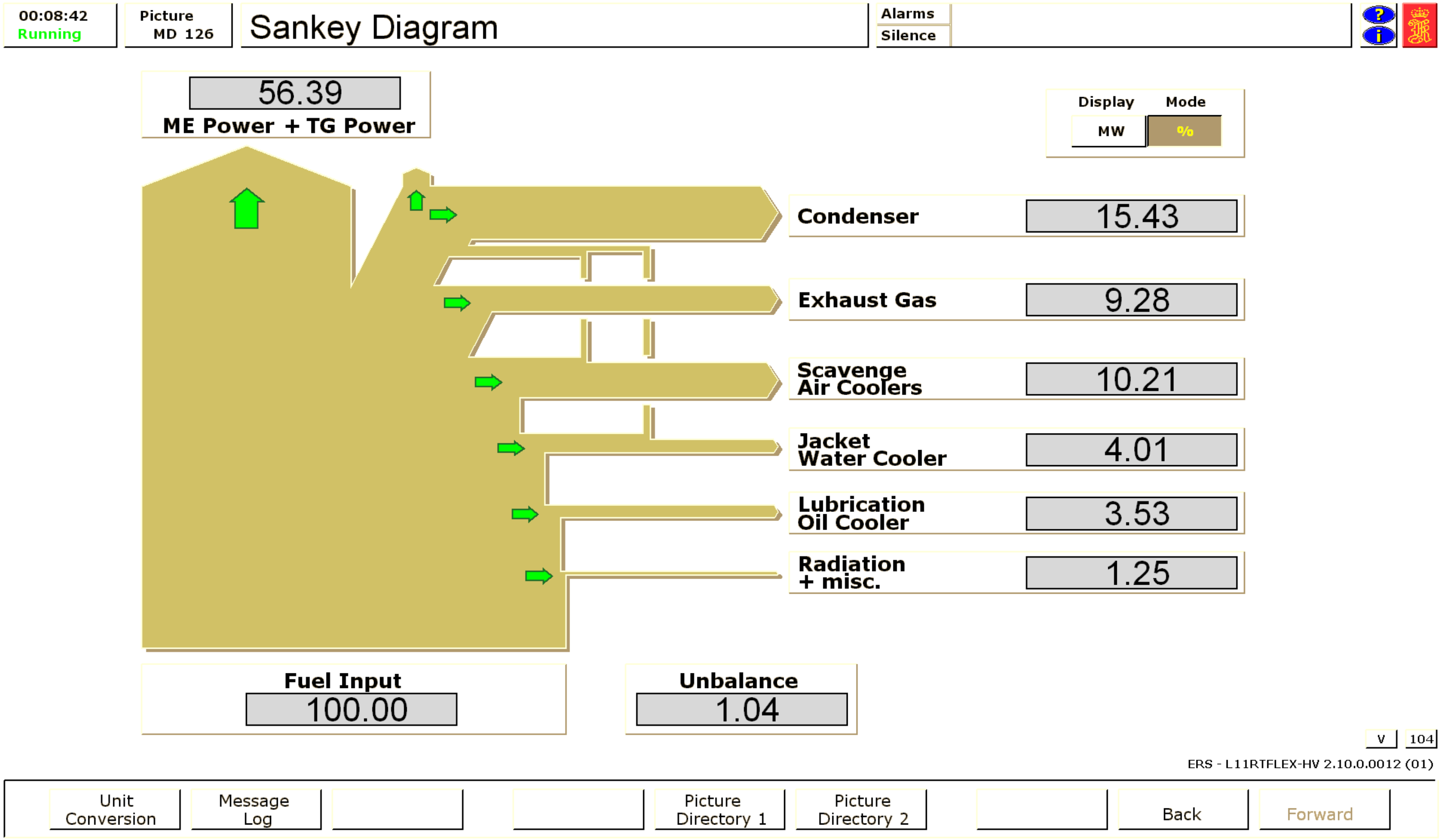
00:08:42
Running
Picture
MD 126
Sankey Diagram
Alarms
Silence
56.39
ME Power + TG Power
Display Mode
MW
%
Condenser
15.43
Exhaust Gas
9.28
Scavenge Air Coolers
10.21
Jacket Water Cooler
4.01
Lubrication Oil Cooler
3.53
Radiation + misc.
1.25
Fuel Input
100.00
Unbalance
1.04
V
104
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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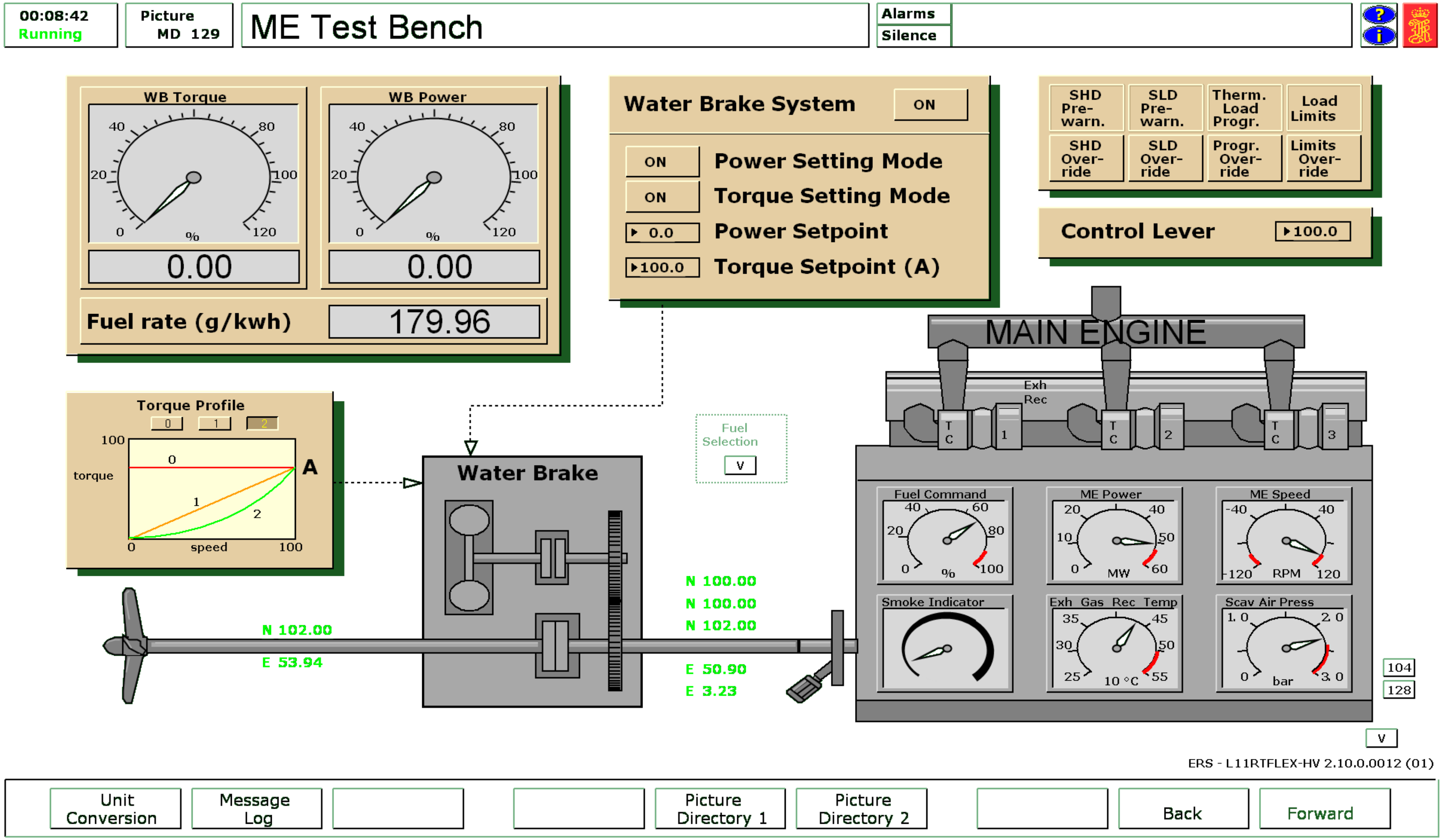
3.13 Sankey Diagram

General

The Sankey diagram is a simple bottom to top breakdown of the energy contained in the fuel input. Useful energy on the power train is shown as a vertical flow to the top, while losses branch out to the right. The display can be toggled between "MW" and percent.
This visualization is one of the "approach [es] Kongsberg Digital has towards enabling the Green Ship".

Description

The Sankey diagram is used for environmental engineering to show % or MW quantities in the process system. It is meant to commonly visualize the energy accounts on in different levels of the plant. Sankey diagrams put a visual emphasis on the major transfers or flows within the system. It is helpful in locating dominant contributions to the overall fuel/energy consumption.


00:08:42
Running
Picture
MD 129
ME Test Bench
Alarms
Silence
WB Torque
WB Power
0.00
0.00
Fuel rate (g/kwh)
179.96
Water Brake System
ON
Power Setting Mode
Torque Setting Mode
Power Setpoint
Torque Setpoint (A)
0.0
100.0
SHD Pre-warn.
SLD Pre-warn.
Therm. Load Progr.
Load Limits
SHD Over-ride
SLD Over-ride
Progr. Over-ride
Limits Over-ride
Control Lever
100.0
MAIN ENGINE
Torque Profile
torque
speed
Water Brake
Fuel Selection
N 102.00
E 53.94
N 100.00
N 100.00
N 102.00
E 50.90
E 3.23
Fuel Command
ME Power
ME Speed
Smoke Indicator
Exh Gas Rec Temp
Scav Air Press
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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3.14 ME Test Bench

General
Water brakes (or dynamometers) are commonly used by engine manufacturers to perform precision testing of engines with varying load. The water brake provides a well-controlled torque to the rotating shaft. The power absorbed by the brake is proportional to the rotational speed and brake torque i.e. $P = \omega T$.

The water brake is attached to the main engine via a lamella clutch and the reduction gearbox.

The main engine can be loaded in two ways: Power setting and torque setting.

I Power Setting Mode the torque will change according to Power Setpoint and actual ME speed. Note that speed has to be controlled from the AutoChief or local stand.

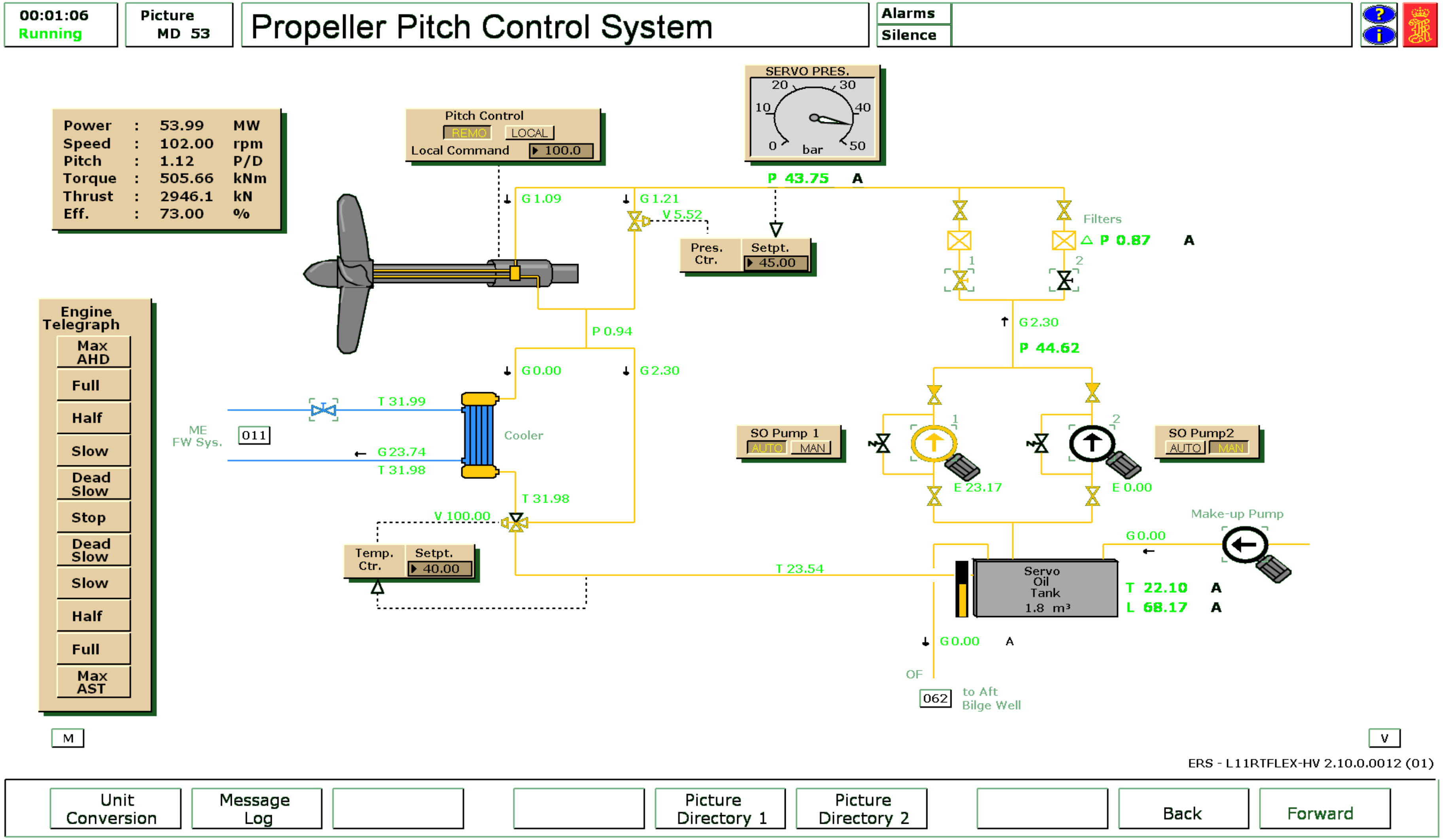
In Torque Setting mode, there are 3 different torque curves, 0 = fixed torque, 1 = linear and 2 = typical propeller.

Selecting fixed torque (0) the torque is set instantly and the power will depend on the ME rpm.

Selecting linear torque profile (0) the set torque and ME rpm will follow the linear curve at a fixed ramping speed.
Example 1: speed is 30% and the torque set-point is set to 50%. The final WB torque will be 30% of 50% = 15%.

The propeller curve (2) is the default setting since its the same curve as the actual propeller.

Example 2: Speed is 50.7 % and the torque set-point is set to 40%. The final WB torque is 10.3 % because the torque follows the propeller curve.


00:01:06
Running
Picture MD 53
Propeller Pitch Control System
Alarms
Silence
Power : 53.99 MW
Speed : 102.00 rpm
Pitch : 1.12 P/D
Torque : 505.66 kNm
Thrust : 2946.1 kN
Eff. : 73.00 %
Pitch Control
REMO
LOCAL
Local Command 100.0
SERVO PRES.
bar
P 43.75 A
Pres. Ctr.
Setpt. 45.00
Filters
P 0.87 A
G 2.30
P 44.62
Engine Telegraph
Max AHD
Full
Half
Slow
Dead Slow
Stop
Dead Slow
Slow
Half
Full
Max AST
ME FW Sys.
011
Cooler
T 31.99
G 23.74
T 31.98
V 100.00
Temp. Ctr.
Setpt. 40.00
SO Pump 1
AUTO
MAN
SO Pump2
E 23.17
E 0.00
Make-up Pump
G 0.00
T 23.54
Servo Oil Tank 1.8 m³
T 22.10 A
L 68.17 A
OF
062
to Aft Bilge Well
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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4 Propeller and Steering Gear Systems

4.1 Propeller Servo Oil System

General

The propeller pitch servo is operated by high-pressure hydraulic oil supplied by two electrically driven pumps. Usually only one pump is used with the other in stand-by mode.

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

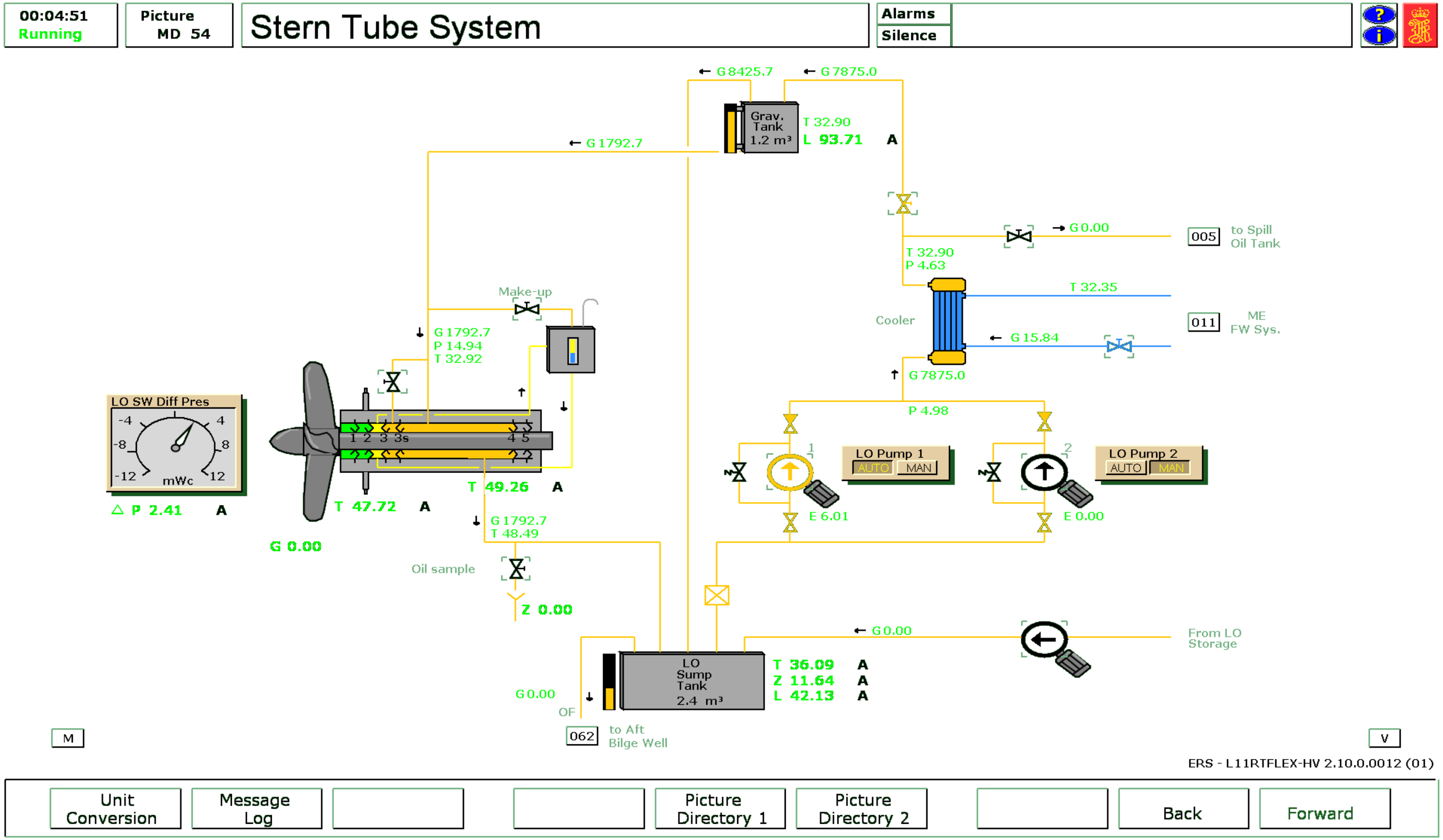
High pressure oil is delivered to the pitch servo. The pressure is controlled by bypassing oil through the pressure control valve, using a P-controller. Default pressure is 45 bar.
The return oil is cooled by LT fresh water and is controlled to be 45°C, again using a P-controller. The oil drains to the servo oil tank.

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 and LT fresh water system must be in service.
1.2 Open fresh water inlet valve to servo lubricating oil cooler.
1.3 Open selected filter inlet valve.
1.4 Check level in Servo oil tank.
1.5 Select Local or Remote pitch control.
1.6 Start the lubricating oil pump locally or from the PowerChief Pump Control panel.
1.7 Put the lubricating oil pumps into AUTO mode from the Pump and Compressor Panel.


00:04:51
Running
Picture
MD 54
Stern Tube System
Alarms
Silence
G 8425.7
G 7875.0
Grav. Tank 1.2 m³
T 32.90
L 93.71
A
G 1792.7
G 0.00
005
to Spill Oil Tank
T 32.90
P 4.63
T 32.35
Cooler
011
ME FW Sys.
G 15.84
G 7875.0
P 4.98
Make-up
G 1792.7
P 14.94
T 32.92
LO SW Diff Pres
mWc
△ P 2.41
A
T 47.72
A
T 49.26
A
G 0.00
LO Pump 1
AUTO
MAN
E 6.01
LO Pump 2
AUTO
MAN
E 0.00
G 1792.7
T 48.49
Oil sample
Z 0.00
G 0.00
From LO Storage
LO Sump Tank 2.4 m³
T 36.09
Z 11.64
L 42.13
A
G 0.00
OF
062
to Aft Bilge Well
M
V
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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4.2 Stern Tube System

General

The stern tube bearings are lubricated by two separate gravity LO tanks, one high and one low gravity. These are selectable and should be chosen according to vessel draft.

Description

The oil is pumped from the stern tube sump tank to the selected 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.

The oil is cooled as it is pumped to the gravity tank. The heat exchanger is LT fresh water cooled.

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 the 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 oil can be transferred to the spill oil tank in case of contamination.

The stern tube has a fwd seal oil system that can be topped up from the gravity feed line.

Operation procedure

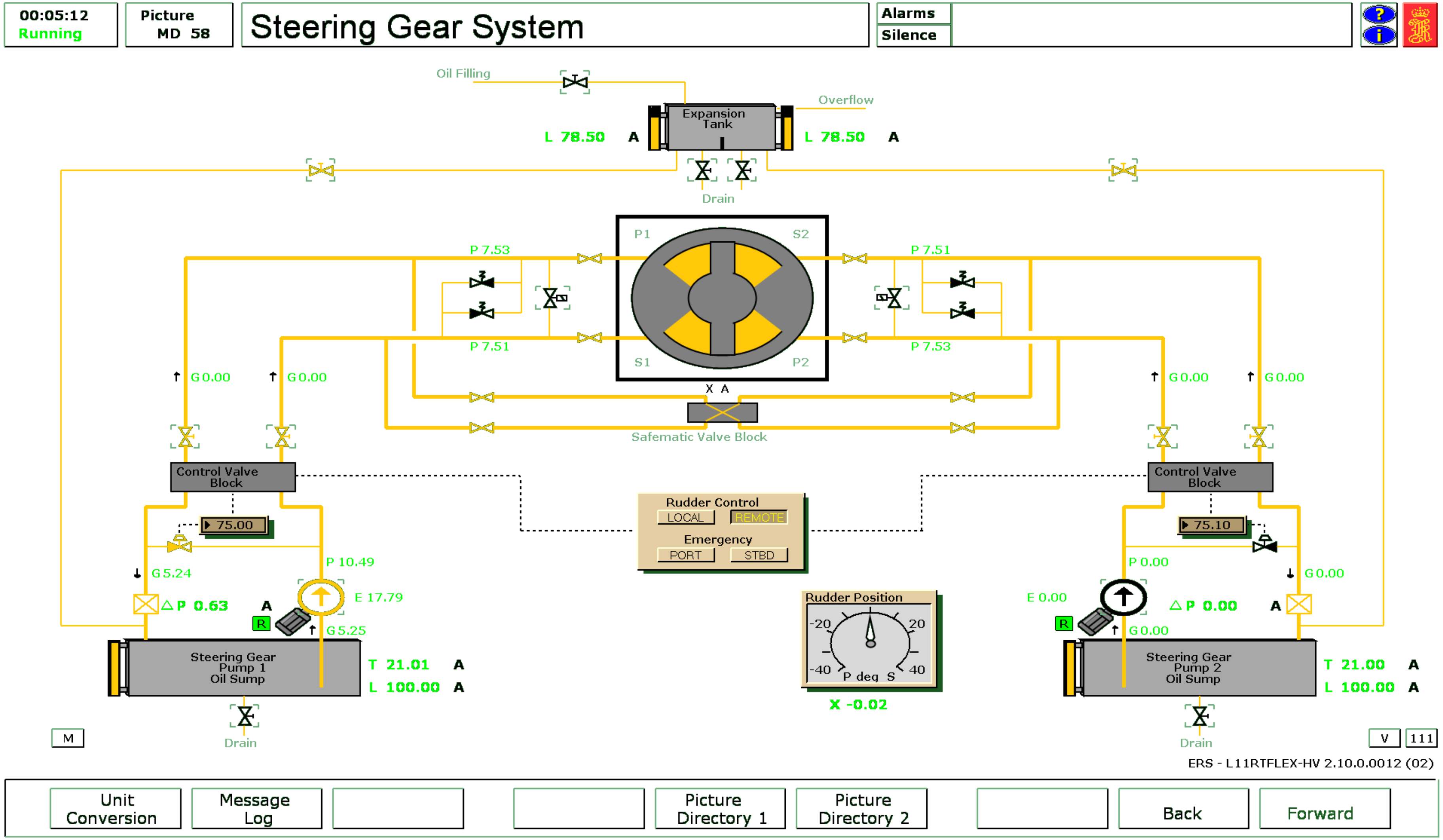
1.1 Ensure cooling water to Stern Tube cooler.
1.2 Refill lubricating oil sump tank if necessary.
1.3 Select required gravity tank using 3-way valve in filling line.
1.4 Select correct gravity feed to stern tube.
1.5 Start the lubricating oil pump in manual.
1.6 When one pump is started, set the other pump in Auto.
1.7 If the running pump is unable to maintain the level in the gravity tank, the stand-by pump starts automatically.
1.8 Check level of oil in sealing tank, fill from make-up valve. Drain water if required.
1.9 Stop of pumps to be carried out manually.

Daily:

Control the contamination (water) in the LO sump tank.

Weekly:

Take a LO sample and check the water content.


00:05:12
Running
Picture
MD 58
Steering Gear System
Alarms
Silence
Oil Filling
Expansion Tank
Overflow
L 78.50 A
L 78.50 A
Drain
P1
S2
S1
P2
P 7.53
P 7.51
P 7.51
P 7.53
G 0.00
X A
Safematic Valve Block
Control Valve Block
Control Valve Block
Rudder Control
LOCAL
REMOTE
Emergency
PORT
STBD
75.00
75.10
P 10.49
P 0.00
G 5.24
G 0.00
P 0.63 A
P 0.00 A
E 17.79
E 0.00
G 5.25
Rudder Position
-20
20
-40
40
P deg S
X -0.02
Steering Gear Pump 1 Oil Sump
Steering Gear Pump 2 Oil Sump
T 21.01 A
L 100.00 A
T 21.00 A
L 100.00 A
Drain
M
V
111
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
Unit Conversion
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4.3 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 shock-relief control valve block with two adjustable relief control valves protecting the steering gear and the hydraulic system against pressure shocks 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 shock 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 centre- and flow control valves, necessary for mechanical and hydraulic safety and control.

Normal control (Follow up control)
The directional-control valve receives 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 receive 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 systems 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 14 knot and the rudder angle must not exceed 15°.

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 and expansion tank shut off valves are open.

1.3 Check that Safematic valve block valve is open.

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 the autopilot.

4.2 To set specific rudder commands, select MAN and enter numeric values in %.

4.3 Autopilot can be set to specified course commands at bridge steering console.

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.

4.7 To use the emergency steering select OFF on the autopilot.

4.8 Emergency control can be operated locally or from the bridge console.

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

Manually operation of Safematic Valve block is carried out by clicking on Safematic Valve block symbol, observe change of symbol.

Manually operation of the by-pass valve is carried out by clicking on the valve symbol.

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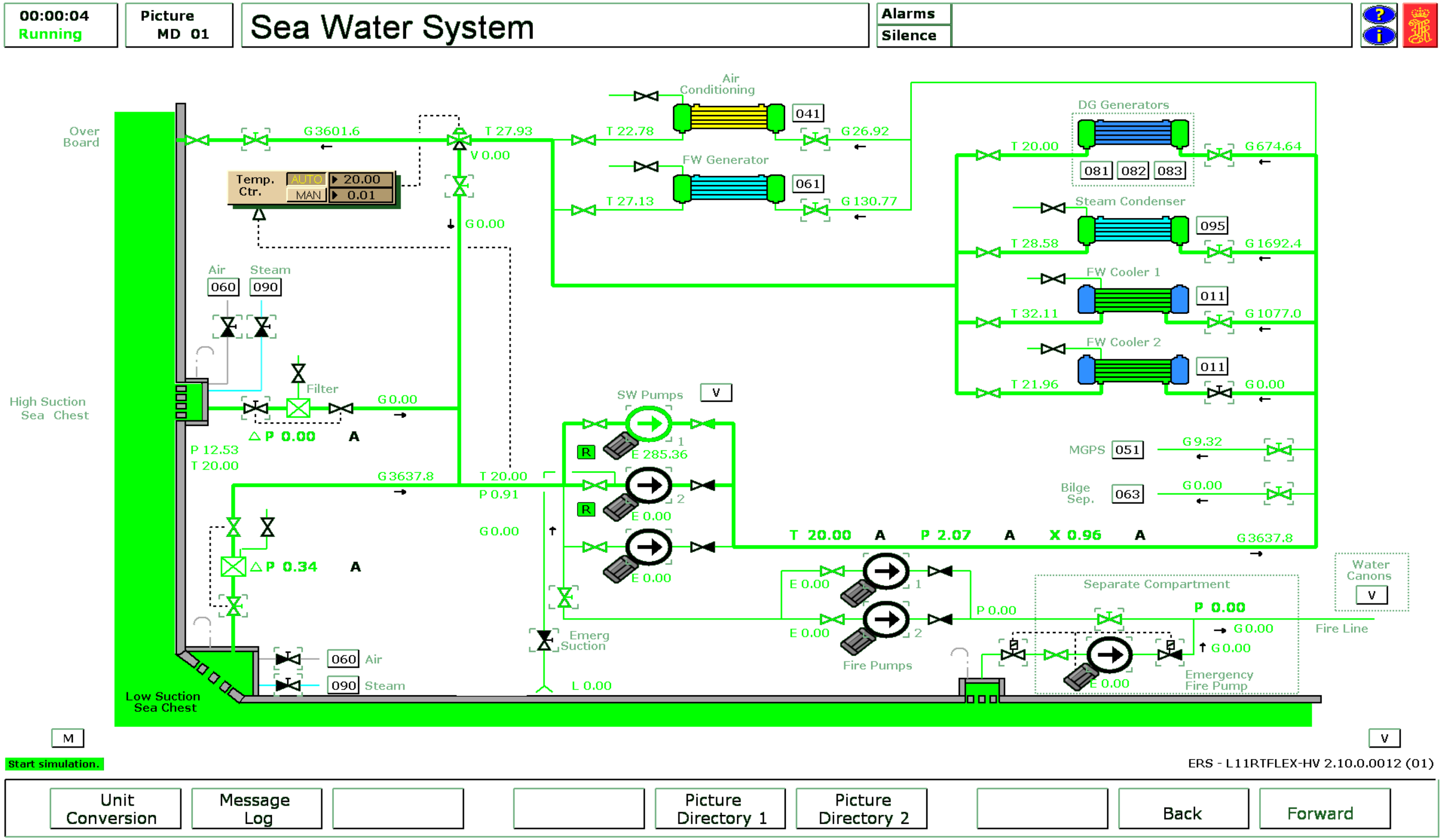
00:00:04
Running
Picture
MD 01
Sea Water System
Alarms
Silence
Over Board
G 3601.6
T 27.93
V 0.00
Temp. Ctr.
AUTO
MAN
20.00
0.01
G 0.00
Air Conditioning
041
T 22.78
G 26.92
FW Generator
061
T 27.13
G 130.77
DG Generators
081
082
083
T 20.00
G 674.64
Steam Condenser
095
T 28.58
G 1692.4
FW Cooler 1
011
T 32.11
G 1077.0
FW Cooler 2
011
T 21.96
G 0.00
Air
060
Steam
090
Filter
G 0.00
High Suction Sea Chest
△P 0.00
A
P 12.53
T 20.00
G 3637.8
T 20.00
P 0.91
G 0.00
△P 0.34
A
SW Pumps
V
E 285.36
E 0.00
E 0.00
R
R
MGPS
051
G 9.32
Bilge Sep.
063
G 0.00
T 20.00
A
P 2.07
A
X 0.96
A
G 3637.8
E 0.00
E 0.00
P 0.00
Fire Pumps
Separate Compartment
P 0.00
G 0.00
G 0.00
Emergency Fire Pump
E 0.00
Water Canons
V
Fire Line
Emerg Suction
L 0.00
060
Air
090
Steam
Low Suction Sea Chest
M
V
Start simulation.
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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5 SERVICE SYSTEMS

5.1 Main Sea Water System

General

Sea water is circulated by two main and one auxiliary electrically driven SW pumps from sea chests through suction filters. The flow from the pumps goes to three coolers, which are connected in parallel:

- Fresh Water Cooler 1
- Fresh Water Cooler 2
- Fresh Water Generator

Sea water is also fed to a marine growth protection system.

Description

Sea water is taken from either a high suction sea chest via a filter when the vessel is loaded or a low suction sea chest when the vessel is in ballast. The sea chests have both steam and air weed clearing fitted.

In order to avoid too low sea water temperatures at the cooler inlets a controllable re-circulation valve is used to circulate water from the overboard line back to the common sea water suction line.

The re-circulation valve is pneumatically operated and controlled by a standard PID controller. The re-circulation line is smaller and has higher flow resistance than the overboard line. The total sea water flow will therefore be reduced in the re-circulation line.

A choke valve is provided for reduced sea water flow.

Two fire pumps are provided to service the fire main system. They take suction from a bottom suction sea chest and can also take suction from the main sea water service pump suction line.

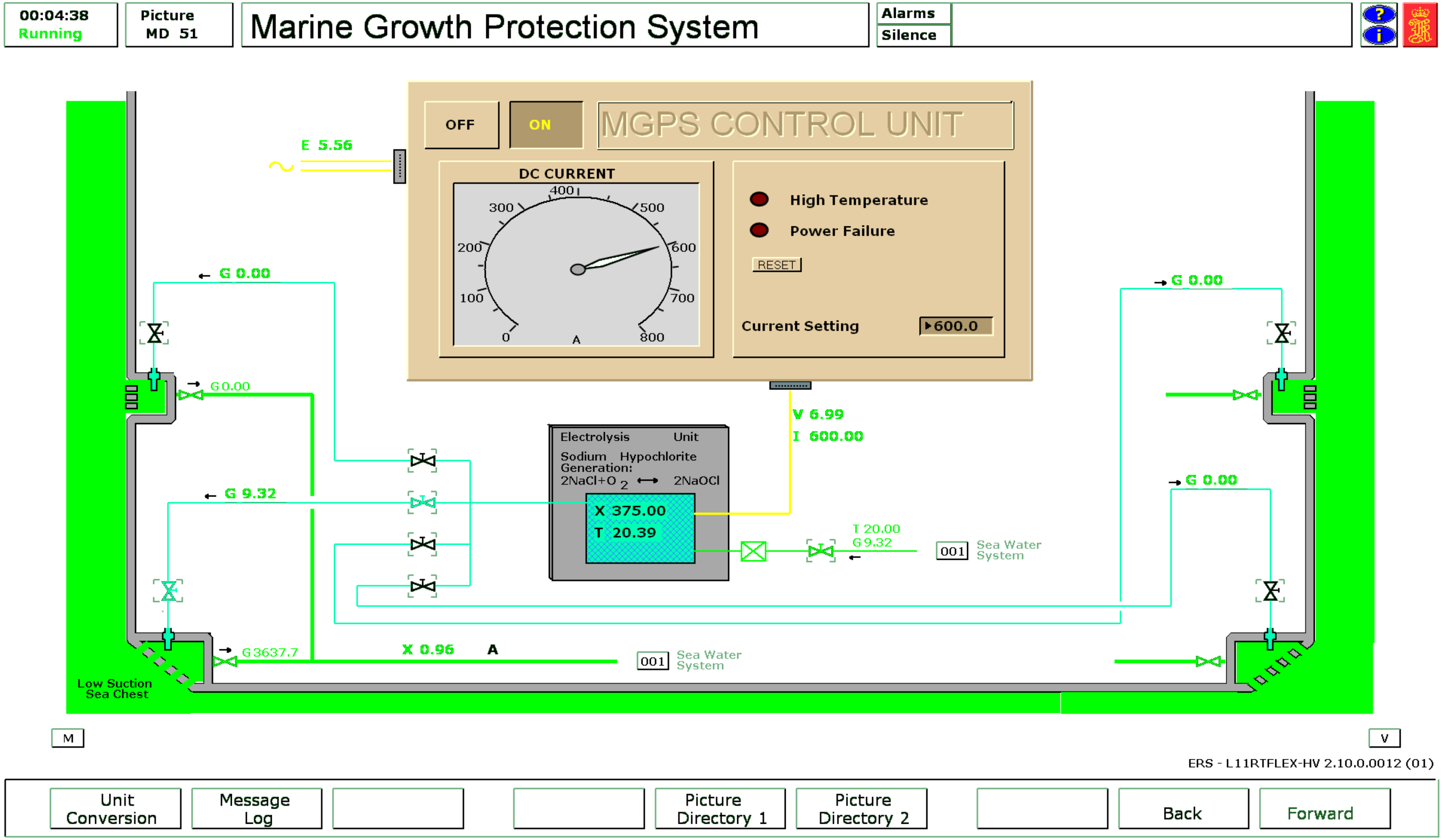
The SW pumps can be used as emergency bilge pumps in the case of flooding via a connection to the main bilge line. No 2 main SW pump can be used for emergency bilge injection. A separate pipe to the tank tops is provided for this operation. When using the Bilge Injection ensure the sea chest suction valves are closed.

The emergency fire pump has a separate suction from its own sea chest.

Auxiliary SW pump is supplied from the emergency switchboard.

Operation Procedure

1.1 Open relevant sea suction and discharge valves.
1.2 Open valves to relevant coolers. Under normal circumstances only one fresh water cooler need to be in use.
1.3 Set controller for re-circulation valve to auto and 20°C.
1.4 Start one sea water pump locally.
1.5 Put one pump in Auto mode from pump/compressor control panel. Normally one pump is running and one is set to standby.


00:04:38
Running
Picture
MD 51
Marine Growth Protection System
Alarms
Silence
OFF
ON
MGPS CONTROL UNIT
DC CURRENT
High Temperature
Power Failure
RESET
Current Setting
600.0
E 5.56
G 0.00
G 0.00
G 9.32
G 0.00
G 0.00
V 6.99
I 600.00
Electrolysis Unit
Sodium Hypochlorite Generation:
2NaCl+O 2 2NaOCl
X 375.00
T 20.39
T 20.00
G 9.32
001 Sea Water System
G3637.7
X 0.96 A
001 Sea Water System
Low Suction Sea Chest
M
V
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
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5.1.1 Marine Growth Protection System

The sea water system is equipped with a hychlorator system, of which a leading manufacturer is MGPS system.

The hychlorator system is used for the electro-chlorination of seawater used in the sea waters cooling system. It works by producing Sodium hypochlorite from seawater as it flows through an electrolyser fabric of anode>cathode>anode which are connected to a current source.

The sodium hypochlorite produced has the effect of sterilizing the salt water, thereby eliminating any marine growth and biological compositions that can otherwise damage and foul the cooling system and other seawater based system components.

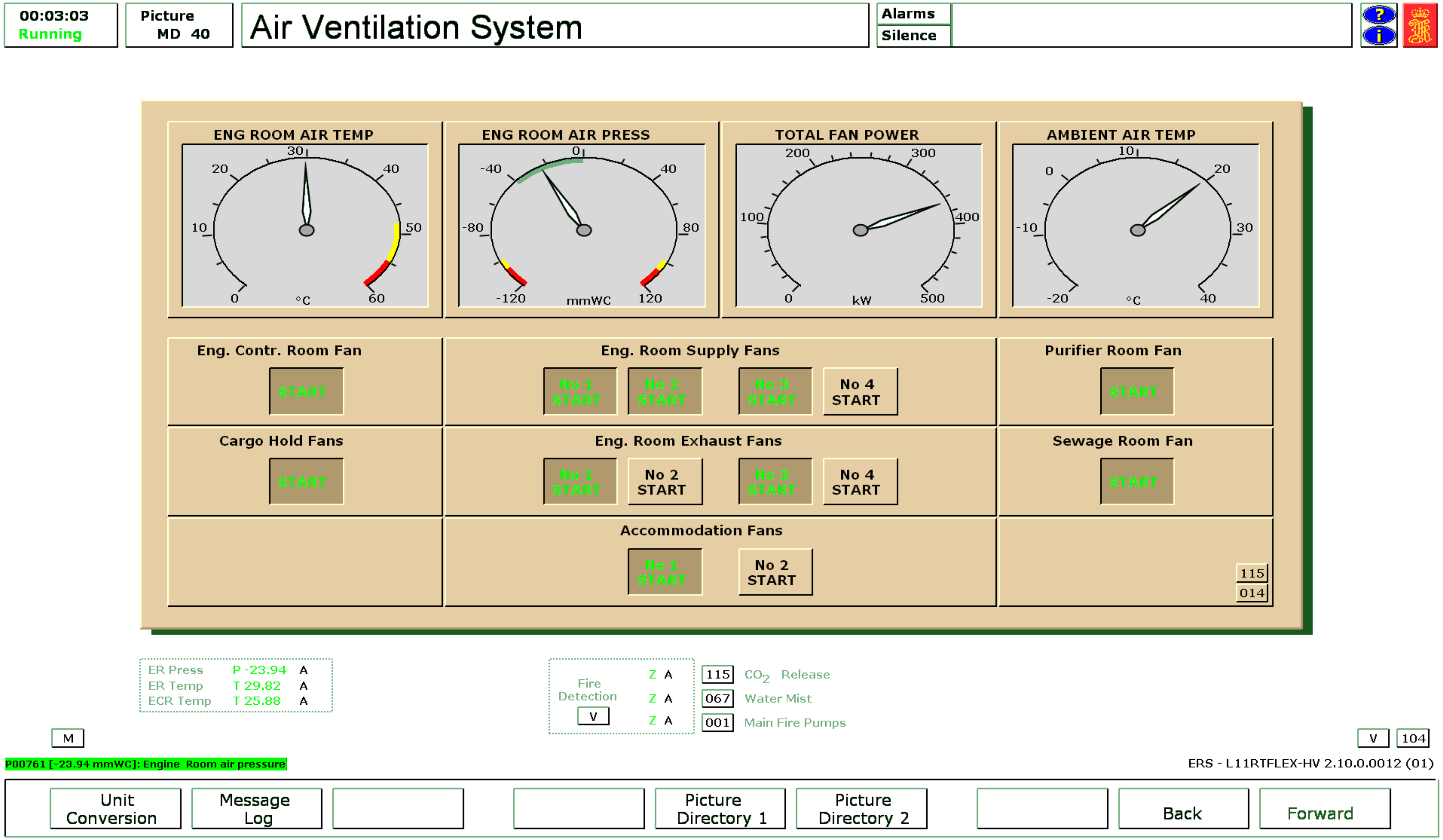
MGPS control unit creates an antifouling agent, sodium hypochlorite (NaOCl), directly from seawater, which is distributed to the sea chests and seawater piping system for protection against all types of fouling. MGPS operates by using an electrolytic cell containing titanium anodes to transform the salt in seawater into sodium hypochlorite (NaOCl) through a process of electrolysis.

Electrolysis begins when the current is switched on at the control panel and the valves are opened. The resulting sodium hypochlorite is piped to the injection nozzles where the disinfecting agent is injected into the sea chests to mix with incoming seawater to prevent fouling in the whole seawater system. The system consists of three parts:
Control panel (located near electrolysis group)
Electrolysis group (located in the engine room near the sea chests)
Injection nozzles (located in sea chests, connected to the electrolysis group via pipes and control valves).

A picture of the electrolytic cell producing an antifouling solution to keep the sea chests and sea water circuits free from fouling.

Operation Procedure

1.1 Ensure sea water system has flow
1.2 Open sea water valve and injection nozzle of valve chest in use
1.3 Turn on control unit and adjust current to give a hypochlorite level of approximately 1.5ppm in the sea water system.
1.4 If sea suctions are changed remember to change the injection nozzle.


00:03:03
Running
Picture
MD 40
Air Ventilation System
Alarms
Silence
ENG ROOM AIR TEMP
°C
ENG ROOM AIR PRESS
mmWC
TOTAL FAN POWER
kW
AMBIENT AIR TEMP
°C
Eng. Contr. Room Fan
START
Eng. Room Supply Fans
No 1 START
No 2 START
No 3 START
No 4 START
Purifier Room Fan
START
Cargo Hold Fans
START
Eng. Room Exhaust Fans
No 1 START
No 2 START
No 3 START
No 4 START
Sewage Room Fan
START
Accommodation Fans
No 1 START
No 2 START
115
014
ER Press P -23.94 A
ER Temp T 29.82 A
ECR Temp T 25.88 A
Fire Detection
Z A
Z A
Z A
V
115 CO2 Release
067 Water Mist
001 Main Fire Pumps
M
V
104
P00761 [-23.94 mmWC]: Engine Room air pressure
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Unit Conversion
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5.2 Air Ventilation System

General

Engine room:
The system consists of two axial flow, two speed, supply fans (one PS and one SB) and two reversible, two speed extractor fans.
Each ventilator has a capacity 25.000 m^3/h.
The supply air is distributed to the hot areas of the engine room through ducts to adjustable nozzle outlets.
The air exhausts through the funnel and through flaps in the casing top, which can be closed in the event of fire. In case of fire, the ventilation can be shut down by means of pneumatically operated flaps fitted to the louvers and remotely operated from either the deck office or outside the funnel in casing top.

Engine control room
To start ventilation of ECR, open air vane from the air condition plant, variable page 4105. Start supply fan from ventilation control panel MD40.

Purifier room
For removal of dangerous oil vapour from the purifier room, a centrifugal extractor ventilator is located at E-deck PS.
The ventilator has a capacity of 18.000 m^3/h.

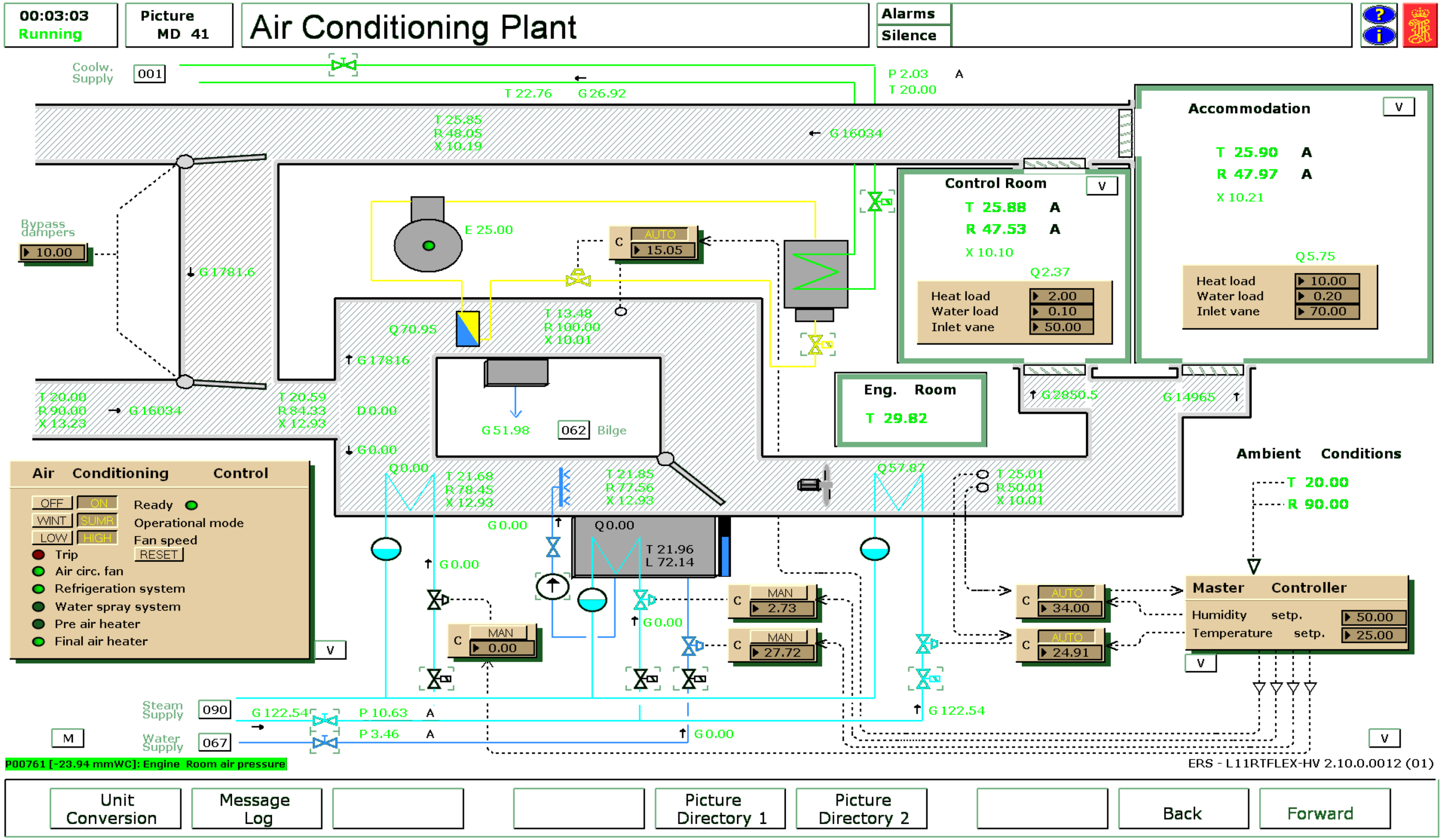
Sewage room
For removal of possible hydrogen sulphide and methane vapours from the sewage room, a centrifugal extractor ventilator is located at E-deck SB.
The ventilator has a capacity of 8.000 m^3/h.

The ventilation panel gives indication of engine room and ambient temperature as well as engine room air pressure.

When the CO_2 cabinet door is opened, engine room supply and exhaust fans are stopped.

No.2 engine room fans are supplied from the emergency switchboard for CO_2 removal and emergency ventilation. All other fans are supplied from the non-essential bus bar

- engine room: 2 supply fans each with low or high speed. – 2 x 10/27 kW
- engine room: 2 exhaust fans each with low or high speed and the possibility of reversing the direction of the rotation. – 2x8/24 kW
- engine control room: 1 supply fan. – 7,5 kW
- cargo holds
  controlled as one fan: 6 fans – 6 x 20 kW
- purifier room: 1 exhaust fan - 12 kW
- sewage room: 1 exhaust fan - 5 kW
- accommodation: 2 supply fans – 2 x 15 kW


00:03:03
Running
Picture
MD 41
Air Conditioning Plant
Alarms
Silence
Coolw. Supply
001
P 2.03 A
T 20.00
T 22.76 G 26.92
T 25.85
R 48.05
X 10.19
G 16034
Accommodation
T 25.90 A
R 47.97 A
X 10.21
Q 5.75
Heat load 10.00
Water load 0.20
Inlet vane 70.00
Control Room
T 25.88 A
R 47.53 A
X 10.10
Q 2.37
Heat load 2.00
Water load 0.10
Inlet vane 50.00
Bypass dampers
10.00
E 25.00
AUTO
15.05
G 1781.6
Q 70.95
T 13.48
R 100.00
X 10.01
G 17816
T 20.00
R 90.00
X 13.23
G 16034
T 20.59
R 84.33
X 12.93
D 0.00
G 51.98
062 Bilge
G 0.00
Eng. Room
T 29.82
G 2850.5
G 14965
Ambient Conditions
T 20.00
R 90.00
Air Conditioning Control
OFF ON
WINT SUMR
LOW HIGH
Ready
Operational mode
Fan speed
RESET
Trip
Air circ. fan
Refrigeration system
Water spray system
Pre air heater
Final air heater
Q 0.00
T 21.68
R 78.45
X 12.93
T 21.85
R 77.56
X 12.93
Q 57.87
T 25.01
R 50.01
X 10.01
G 0.00
Q 0.00
T 21.96
L 72.14
MAN
0.00
MAN
2.73
MAN
27.72
AUTO
34.00
AUTO
24.91
Master Controller
Humidity setp. 50.00
Temperature setp. 25.00
Steam Supply
090
G 122.54
P 10.63 A
Water Supply
067
P 3.46 A
G 0.00
G 122.54
M
P00761 [-23.94 mmWC]: Engine Room air pressure
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5.3 Air Conditioning Plant

Introduction
The air is supplied to the accommodation and the engine control room by an air handling unit (AHU) located in the air conditioning unit room situated in the accommodation block on the starboard side of the upper deck (accessed from the engine room).
The AHU consists of an electrically driven fan drawing air through the following sections from inlet to outlet:

- One air filter
- One steam preheating unit
- A humidifier section
- One steam final heat section
- One air cooler evaporator coil
- A water eliminator section
- A fan section
- A discharge section

Humidification of the air is arranged with automatic control and this is fitted at the outlet part of the AHU.
The air is forced into the distribution ducting, which supplies the accommodation and the engine control room.
The system is designed for fresh air with heat recovery by means of two bypass dampers using a part of the heat in the outgoing stale air.
Cooling is provided by a direct expansion R134a system. The plant is automatic and consists of one compressor/condenser units supplying the evaporators contained in the accommodation air handling unit. The expansion valve for the coil is fed with liquid refrigerant from the air conditioning compressor, the refrigerant having been compressed in the compressor then cooled in the condenser where it is condensed to a liquid. The liquid R134a is then fed, via dryer units, to the evaporator coils where it expands under the control of the expansion valves, before being returned to the compressor as a gas. In the evaporator coil, it extracts heat from the air passing over the coils.
Air is circulated through ducting to outlets in the cabins and public rooms.
The plant is controlled by a master controller where it is possible to set the set point for humidity and temperature before the inlet to the accommodation and ECR.
Summer or winter operation may be selected on the air conditioning panel in the engine room.
The bypass dampers allow recirculation of the air if the ship is in poor ambient conditions i.e. in harbour with a sandstorm.
Normally the bypass dampers must only be opened 30% to reduce the recirculation of bad air spreading such things as colds etc. through the vessels personnel.

1 Winter operating procedure:

1.1 Prepare and start the steam supply for the pre- and final heating section in AUTO mode.
1.2 Prepare and start the water supply for the humidifier section in AUTO mode.
1.3 Set the bypass damper at 10%.
1.4 Start the plant in winter mode with low fan speed.
1.5 Set the master controllers set points at the wanted values.
1.6 Control the plant with appropriate intervals and adjust the plant if necessary.

2. Summer operating procedure:

2.1 Prepare and start the steam supply for the final heating section in AUTO mode.
2.2 Prepare and start the water supply for the condenser.
2.3 Set the bypass damper at 10%.
2.4 Start the plant in summer mode with low fan speed.
2.5 Set the master controllers set points at the wanted values.
2.6 Control the plant with appropriate intervals and adjust the plant if necessary.

Note:
It is possible to adjust the capacity of the plant by opening/closing the bypass damper and/or low/high speed of the fan.

Note:
Steam valve V15605 and water valve V15606 must be open for starting the plant.

Note:
Pressing the MAN buttons on the controllers, they will change to AUTO mode and visa versa.
The compressor starts when pressing the ON button on the control panel.

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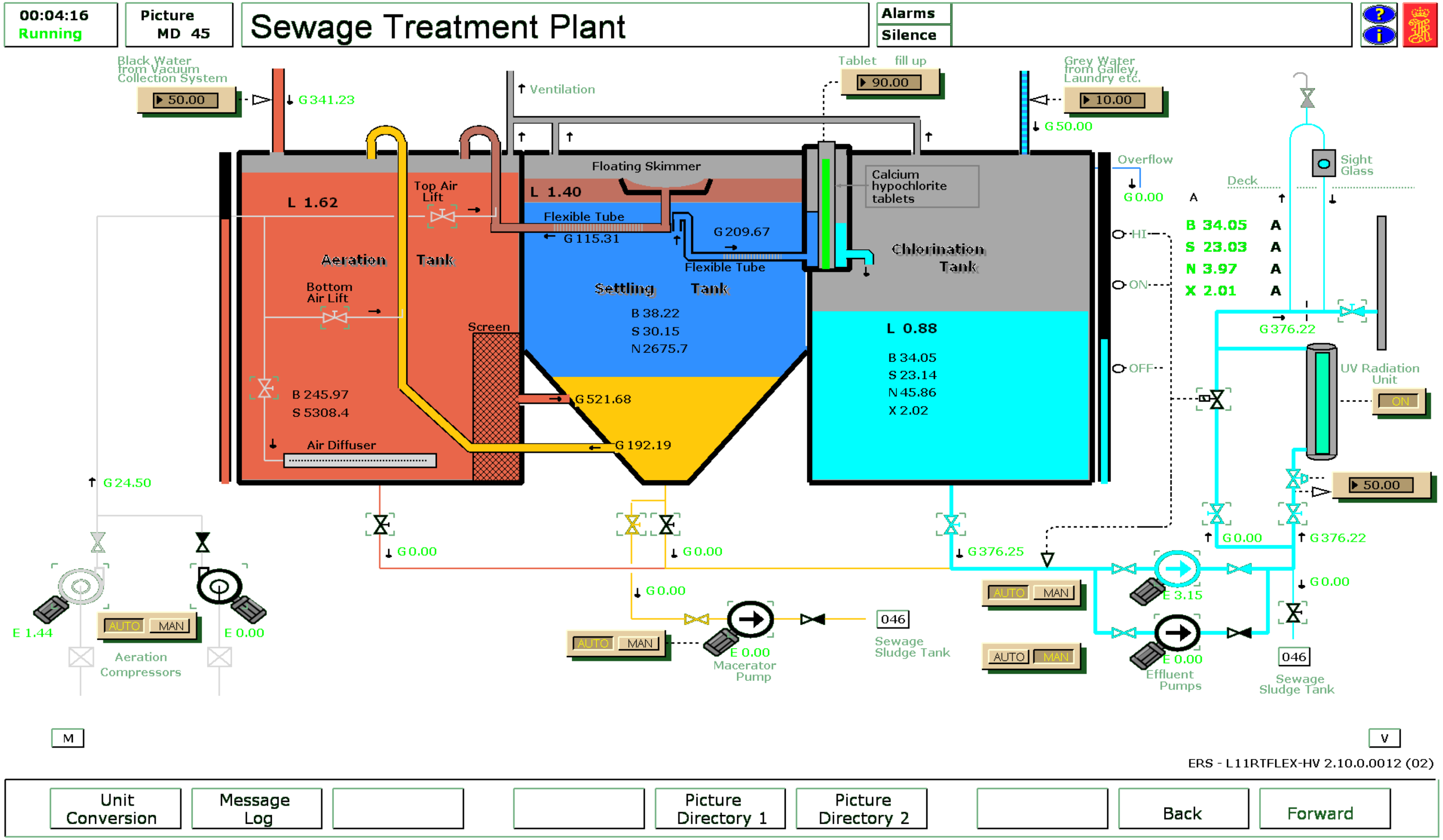
00:04:16
Running
Picture
MD 45
Sewage Treatment Plant
Alarms
Silence
Black Water from Vacuum Collection System
50.00
G 341.23
Ventilation
Tablet fill up
90.00
Grey Water from Galley, Laundry etc.
10.00
G 50.00
Floating Skimmer
Calcium hypochlorite tablets
Overflow
G 0.00
Sight Glass
Deck
L 1.62
Top Air Lift
L 1.40
Flexible Tube
G 115.31
G 209.67
Flexible Tube
HI
B 34.05
S 23.03
N 3.97
X 2.01
Aeration Tank
Settling Tank
Chlorination Tank
ON
Bottom Air Lift
B 38.22
S 30.15
N 2675.7
G 376.22
Screen
L 0.88
B 34.05
S 23.14
N 45.86
X 2.02
OFF
UV Radiation Unit
ON
B 245.97
S 5308.4
G 521.68
Air Diffuser
G 192.19
G 24.50
50.00
G 0.00
G 0.00
G 376.25
G 0.00
G 376.22
G 0.00
G 0.00
E 3.15
AUTO
MAN
046
Sewage Sludge Tank
E 1.44
E 0.00
E 0.00
Macerator Pump
E 0.00
Effluent Pumps
Aeration Compressors
Sewage Sludge Tank
M
V
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5.4 Sewage Treatment

Sewage Treatment Plant
Type: Biological oxidation and discharge
Capacity: 38 persons
One aeration compressor
One sludge pump
One effluent pump (discharge overboard)
One tablet chlorination dispenser
One sewage sludge tank (at the incinerator system)

Sewage from the accommodation spaces flows through pipes, under the effect of a vacuum collection system, to the sewage treatment plant located in the machinery space.
The sewage treatment plant is a biological unit which works on the aerobic activated sludge principle. The plant will treat black and grey water and is fully automatic in operation.
This sewage treatment plant consists of a tank with three main compartments:

- Aeration compartment
- Settling tank (clarification) compartment
- Chlorination and discharge compartment

Aeration tank
The sewage in this compartment is from the lavatory pans, urinals and hospital in the accommodation spaces. The incoming effluent material mixes with the activated sludge already present in this compartment. Air is supplied by means air pipes and distributed though the tank by aerators. The gas produced during the bacterial action which takes place is vented to atmosphere. Oxygen is essential for the aerobic activity. The organisms require oxygen for digesting the raw sewage and it also assists in mixing the incoming sewage with the water, sewage sludge and bacteria already present in the compartment.
A screen at the outlet from the aeration compartment prevents the passage of inorganic solids to this compartment.

Settling tank
The mixed fluid passes into this compartment and settles out into sludge and liquid. The water passes into the treatment and discharge compartment, whilst the remaining sludge, which contains the active bacteria, returns to the aeration compartment by means of an air lift tube for further processing. The surface is skimmed of detritus which is returned it to the aeration compartment.

Chlorination and Discharge tank
Water from the clarification section is mixed with disinfectants (sodium hypochlorite) and is sterilised. The compartment has float operated switches which activate the effluent pump (discharge) when the high level is reached and stop the pump when the compartment is nearly empty. Chemical dosing is by means of tablets added to the basket in the chamber and these dissolve slowly when in contact with the water in the chamber as the water level rises.

CAUTION
Discharge overboard of untreated sewage should not take place within 12 nautical miles of the coast and local restriction concerning treated sewage discharge must be strictly observed.
The sewage treatment plant works automatically once it is set but periodic attention is required and the unit must be monitored for correct operation.
(**Note:** Rules governing the discharge of raw sewage must be complied with at all times and the discharge of raw sewage overboard must only be contemplated should the sewage plant be out of service. The bacterial action requires a regular supply of raw sewage and the discharge of raw sewage overboard can impair effective bacterial action.)

Operating the Sewage Treatment Plant
There is a black water supply from the vacuum collection system and a grey waterline supply from the galley and laundry system.
In both supply lines there is a control valve.
The effluent pump has a direct connection to the overboard discharge line.

Set the system valves as in the following table:

- Open overboard valves in the discharge line from the effluent pump
- Open suction valve from chlorination tank
- Close suction valve from settling tank
- Close suction valve from aeration tank
- The sewage treatment unit should be initially filled with water
- Activated sludge shall be added if it has been emptied for any reason or when commissioning the plant for the first time. This will not be required when the unit has been operating previously but the description is included for completeness.
- Check that effluent pump is selected for operation.
- Check that dosing chemical tablets have been added to the basket in the discharge chamber.
- The sludge and the effluent pumps are set in “auto” mode.
- Open diffuser and air lift valves
- Start the aeration compressor.
- Set the UV radiation unit on.
- Start to supply the unit with black/grey water.
- Operate the unit to maintain output levels within Marpol IV requirements.

At high level in the chlorination tank, the bypass valve will open across the UV radiation unit.

1 Operation in local restriction areas

1.1 Open the valve to the sewage sludge tank
1.2 Close the valve before the UV unit.
1.3 Check the levels in the sewage sludge tank and in the oil sludge tank.
1.4 The sewage unit discharge can be stored and disposed of later, solids via the incinerator, liquids via the OWS.

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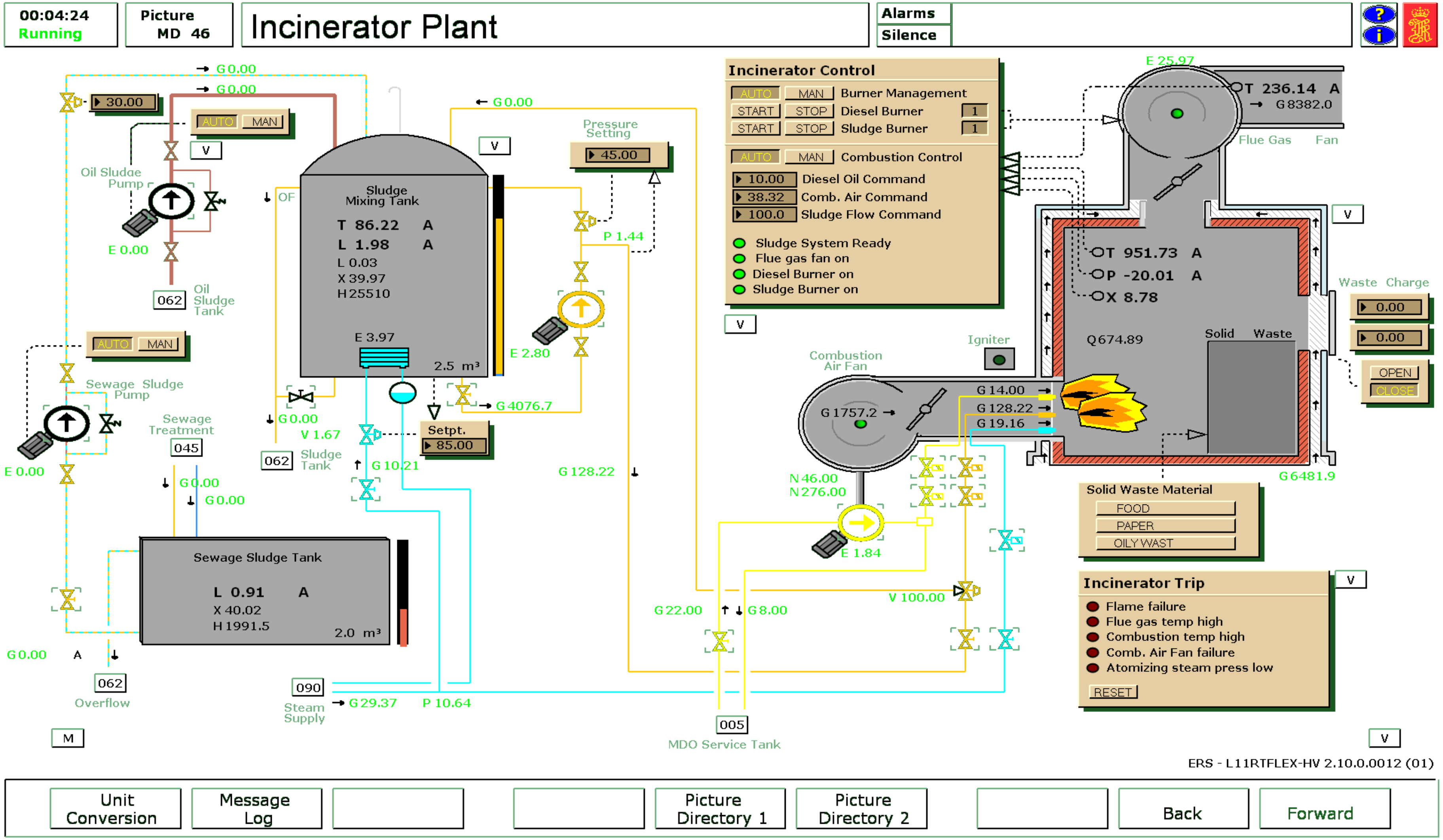
00:04:24
Running
Picture
MD 46
Incinerator Plant
Alarms
Silence
Incinerator Control
AUTO MAN Burner Management
START STOP Diesel Burner 1
START STOP Sludge Burner 1
AUTO MAN Combustion Control
10.00 Diesel Oil Command
38.32 Comb. Air Command
100.0 Sludge Flow Command
Sludge System Ready
Flue gas fan on
Diesel Burner on
Sludge Burner on
Sludge Mixing Tank
T 86.22 A
L 1.98 A
L 0.03
X 39.97
H 25510
E 3.97
2.5 m³
Oil Sludge Pump
E 0.00
Oil Sludge Tank
062
Sewage Sludge Pump
Sewage Treatment
045
Sludge Tank
Sewage Sludge Tank
L 0.91 A
X 40.02
H 1991.5
2.0 m³
Overflow
Steam Supply
090
G 29.37
P 10.64
Pressure Setting
45.00
P 1.44
E 2.80
G 4076.7
Setpt.
85.00
V 1.67
G 10.21
G 128.22
G 22.00
G 8.00
V 100.00
005
MDO Service Tank
Combustion Air Fan
G 1757.2
N 46.00
N 276.00
E 1.84
Igniter
G 14.00
G 128.22
G 19.16
T 236.14 A
G 8382.0
Flue Gas Fan
E 25.97
T 951.73 A
P -20.01 A
X 8.78
Q 674.89
Solid Waste
G 6481.9
Waste Charge
0.00
0.00
OPEN
CLOSE
Solid Waste Material
FOOD
PAPER
OILY WAST
Incinerator Trip
Flame failure
Flue gas temp high
Combustion temp high
Comb. Air Fan failure
Atomizing steam press low
RESET
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5.5 Incinerator

General:
It is possible to burn sludge from the sewage system or from the oil sludge system in the incinerator.
The incinerator has to run on diesel oil together with sludge and/or solid waste.

- One sewage sludge pump.
- One sewage sludge tank.
- One sludge pump taking sludge from the oil sludge tank placed near the bilge system.
- One sludge circulation pump
- One combustion unit place at the front of the incinerator consisting of a combustion air fan, 2 DO valves, 2 sludge valves.
- One incinerator with a waste charge unit for solid waste material.
- One incinerator control unit with manual/auto mode and incinerator trip unit.

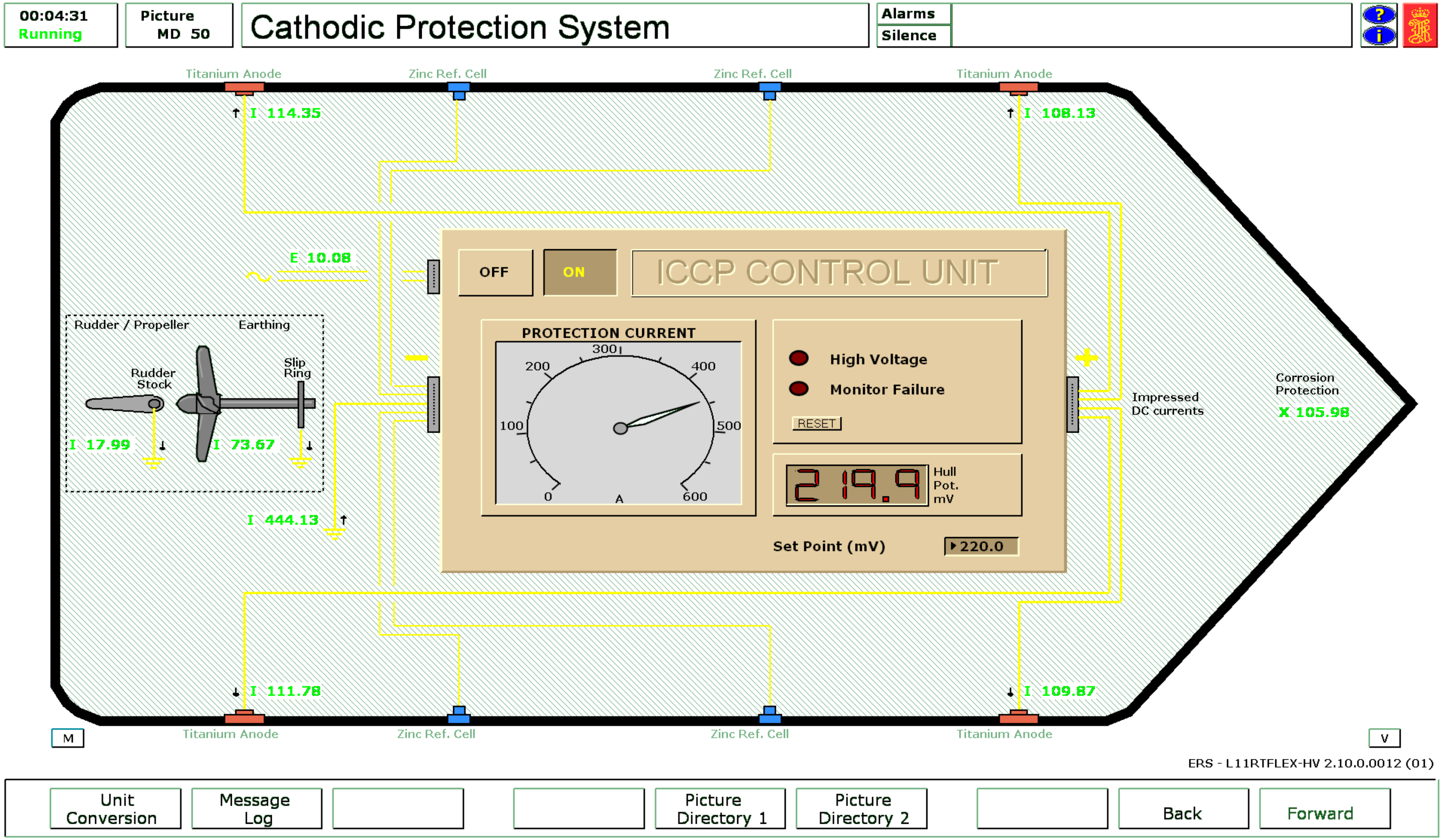
CAUTION
Burning sludge/solid waste should not take place within 12 nautical miles of the coast.

The incinerator plant works automatically once it is set but periodic attention is required and the unit must be monitored for correct operation.

(**Note:** Rules governing the burning sludge/solid waste must be complied with at all times.)

Start procedure

1. Solid waste can be added by opening the door, adding paper, plastic, food and closing the door.
2. The incinerator controller must be in “manual” mode and the combustion controller in “auto” mode.
3. Heat the sludge in the mixing tank to about 85°C by supplying steam and circulate with the circulating pump.
4. Drain any free water from the sludge mixing tank
5. Open sludge mixing tank outlet valve
6. Open DO supply, sludge supply and atomising steam valve
7. Start DO burner in manual.
8. When the DO burner is burning OK, start the sludge burner.
9. In order to run in full ‘auto’ operation then sludge system must be ready.


00:04:31
Running
Picture
MD 50
Cathodic Protection System
Alarms
Silence
Titanium Anode
Zinc Ref. Cell
Zinc Ref. Cell
Titanium Anode
I 114.35
I 108.13
E 10.08
OFF
ON
ICCP CONTROL UNIT
Rudder / Propeller
Earthing
Rudder Stock
Slip Ring
I 17.99
I 73.67
PROTECTION CURRENT
High Voltage
Monitor Failure
RESET
Hull Pot. mV
219.9
Set Point (mV)
220.0
Impressed DC currents
Corrosion Protection
X 105.98
I 444.13
I 111.78
I 109.87
Titanium Anode
Zinc Ref. Cell
Zinc Ref. Cell
Titanium Anode
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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5.6 Cathodic Protection System ICCP

Type: Impressed current
Power supply: AC 440V, 60Hz

The vessel is provided with an Impressed Current Cathodic Protection (ICCP) system. This method of corrosion protection automatically controls electrochemical corrosion of the ship's hull structure below the waterline.

Cathodic protection can be compared to a simple battery cell, consisting of two plates in an electrolyte. One of the battery plates in the electrolyte will waste away through the action of the flow of electrical current, if the two battery electrodes are connected electrically. When two metals are immersed in sea water, which acts as the electrolyte, one of the metals acts as the anode and will waste away. Which metal, in any pair, acts as the anode depends upon their relative positions in the electrochemical series but steel will act as an anode to copper, brass or bronze. The strength of the electric current generated in the corrosion cell, and hence the rate at which wastage takes place depends upon the metals involved and the strength of the electrolyte.

If a third electrode is added to the cell and current is forced to flow, the third electrode now acts as the anode and the old anode (hull) will act as the new cathode.

When a vessel is fitted with ICCP, the hull steel is maintained at an electrical potential more negative than the surrounding sea water.

For this reason, loading and discharging terminals normally comply with the ISGOTT Recommendation 20.6, Earthing, Bonding and Cathodic Protection, which states, that ship shore bonding cables should be discouraged. High currents that can occur in earthing cables and metallic connections are avoided. These are due to potential differences between ship and terminal structure particularly due to the residual potential difference that can exist for up to 24 hours after the shipboard ICCP has been switched off. These terminals usually utilise insulating flanges on hose connections to electrically isolate the ship and terminal structure. During preparations for berthing at terminals where such insulation is not employed, or where earth connections are mandatory by local regulation, or when bunker barges come alongside, the ICCP should be switched off at least 24 hours in advance.

Fresh Water Operation
When the vessel enters a river estuary, the fresh or brackish water may limit the spread of current from the anodes, due to the higher resistance of the water.
Normally, the voltage output increases to compensate for this and would be accompanied by very low current levels and the reference electrode potentials may indicate under protection. However, in this system, the output is adjusted automatically and the system returns the hull to the optimum protection level when the vessel returns to sea water.

Principle of Operation
Protection is achieved by passing low voltage DC current between the hull metal and anodes, insulated from the hull, but in contact with the sea water.
The electrical potential of the hull is maintained more negative than the anodes, i.e. cathodic. In this condition corrosion is minimised. Careful control is necessary over the flow of impressed current, which will vary with the ship's speed, salinity and temperature of the sea water and the condition of the hull paint work. If the potential of the hull is made too negative with respect to the anode, then damage to the paint film can occur electrolytic or through the evolution of hydrogen gas between hull steel and paint. The system on this vessel controls the impressed electrical current automatically to ensure optimum protection. Current is fed through titanium anodes situated port and starboard on the ship. The titanium prevents the anodes themselves from corroding and the surfaces are streamlined into the hull. Fixed zinc reference electrodes port and starboard are used to compare the potential of the hull with that normally found between unprotected steel and zinc electrodes. Sufficient current is impressed via the anodes to reduce this to a level of between 150 and 250mV.

Operation
Once the unit is switched on, the unit's transformer rectifier converts the ship's 440V AC supply to a low voltage finely controlled DC current, the positive is connected to the anodes and the negative is connected to the ship's hull.

The system is completely automatic in normal use. In the normal operating mode, the display will show the following readings:
• Anode current and voltage
• Set point mV AVE (average value)
The system should be regularly monitored and the readings taken once a day.

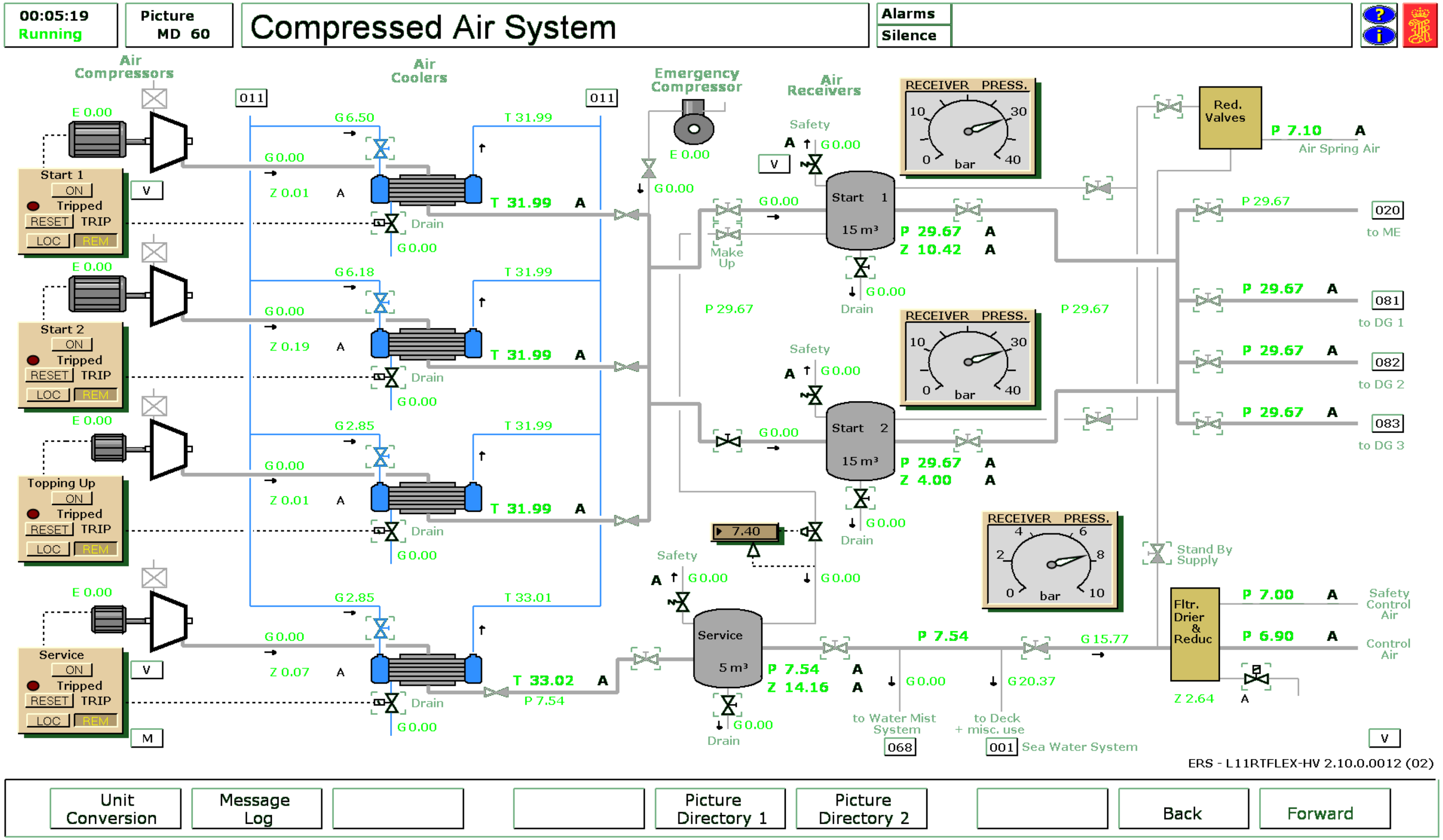
Electrical Installation
The system consists of a monitoring panel and two rectifier units. The rectifier units, one forward and one aft, are wired to port and starboard reference electrodes and port and starboard anodes. The monitoring unit is also equipped with facilities to raise an external alarm to give warning of any system abnormalities, via the main alarm system.

Propeller and Rudder Stock Earthing
To avoid electrolytic corrosion of the propeller shaft, a slip ring is clamped to the shaft and is earthed to the hull via brushes. A second set of brushes, insulated from earth, monitors the shaft mV potential and this signal is fed to a millivolt meter. To ensure efficient bonding, the slip ring should be cleaned on a regular basis. The shaft potential value should ideally remain below 75mV.
The rudder stock is also earthed for protection via a flexible copper earth cable between the deck and rudder stock to minimise any electrolytic potential across the bearings and bushes.

Routine Checks
1 Record the output current and all voltages on a daily basis.
2 Check the reference electrode voltage on a daily basis.

3 Check and clean the propeller shaft slip ring and brushes every week.
4 Inspect the rudder stock earth strap every month.
5 Return completed log sheets to the manufacturer for scrutiny every month.
6 Inspect and clean the control unit cooling fans and grills every three months.
7 The anodes and reference cells must be externally inspected every dry dock period. The anodes are fitted with an insulating shield cover to prevent excessive local over-protection and the condition of this shield must be closely inspected at this time.
8 Detailed instructions are available in the manufacturer's manual.

Sacrificial Anodes
The areas of the hull shielded from the hull face, such as thruster tunnels, rudder and sea water intakes, receive only limited protection from the ICCP system. These areas are therefore fitted with separate sacrificial anodes. Several sacrificial zinc anodes are provided within each of the water ballast tanks.


00:05:19
Running
Picture
MD 60
Compressed Air System
Alarms
Silence
Air Compressors
Air Coolers
Emergency Compressor
Air Receivers
RECEIVER PRESS.
Red. Valves
P 7.10 A
Air Spring Air
Start 1
Start 2
Topping Up
Service
ON
Tripped
RESET TRIP
LOC REM
Drain
Safety
Make Up
15 m³
5 m³
P 29.67 A
Z 10.42 A
Z 4.00 A
P 7.54 A
Z 14.16 A
to ME
to DG 1
to DG 2
to DG 3
Stand By Supply
Fltr. Drier & Reduc
Safety Control Air
Control Air
to Water Mist System
to Deck + misc. use
Sea Water System
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
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5.7 Starting Air Compressors

General

The purpose of the start air is to provide starting air to the diesel engines and ensure that first start is available should all power to the vessel be lost.

The compressed air system consists of:

- two start air compressors
- one topping up compressor
- one service air compressor
- one emergency air compressor
- two start air receivers
- one service air receiver
- 4 air coolers with drain valves
- reduction valves for HP control air and air spring for exhaust valves
- filter, drier and reduction unit for safety control air and LP control air.

All compressors start and stop automatically according to need by the compressor control system included in the Power Chief system if the compressor is in AUTO position. The emergency compressor is supplied from the emergency switchboard.

Description

Each air compressor is monitored by an independent, local safety system.

The air compressors will trip at:

	Start air comp.	Emergency air comp.
Disch. air temp.	> 110°C	> 110°C
Lube oil press.	< 0.75 bar	< 0.75 bar

The start, topping up and service air compressors are cooled by LTFW. The emergency air compressor is air cooled.

Trip condition is indicated by a red alarm light on the compressor panel.

The starting air compressors are normally operated with one compressor selected as Master. This is achieved at the Power Chief panel. Master cut in and cut out setting can be set on variable page 6020.

The start air receivers can be operated in parallel, or one of the receivers can be pressurised and shut off in order 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.

If the service air compressor fails, make-up air can be taken from the #1 start air receiver. 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 shutdown of the main engine in narrow waters. Carefully consider if or when to close the service air make-up valve.

An emergency supply for the LP control air is supplied from the air spring reduction valve.

Operation procedure

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

1.1 Check that main sea water system and LT fresh water system are in operation and that the valve to air compressor coolers is open.
1.2 Open fresh 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 Operate drain valve(s) from start air receiver(s) to ensure that no water is present.

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 Power Chief panel. Select the desired Master compressor. The compressors will then start and stop according to the limits given. These limits are adjustable from the variable page 6020. **Note:** When a compressor is started manually it is not stopped automatically by a pressure control.
2.4 When pressure in air receivers increases open air supply valve(s) to selected consumer(s).

3. Normal operation

3.1 Normally all start air receivers are pressurised and in operation.
3.2 Both of the start air compressors are in AUTO mode with one selected as Master.
3.3 The service air compressor is in auto mode.
3.4 Emergency start air compressor in manual mode.
3.5 Air receivers and air coolers must be drained regularly.

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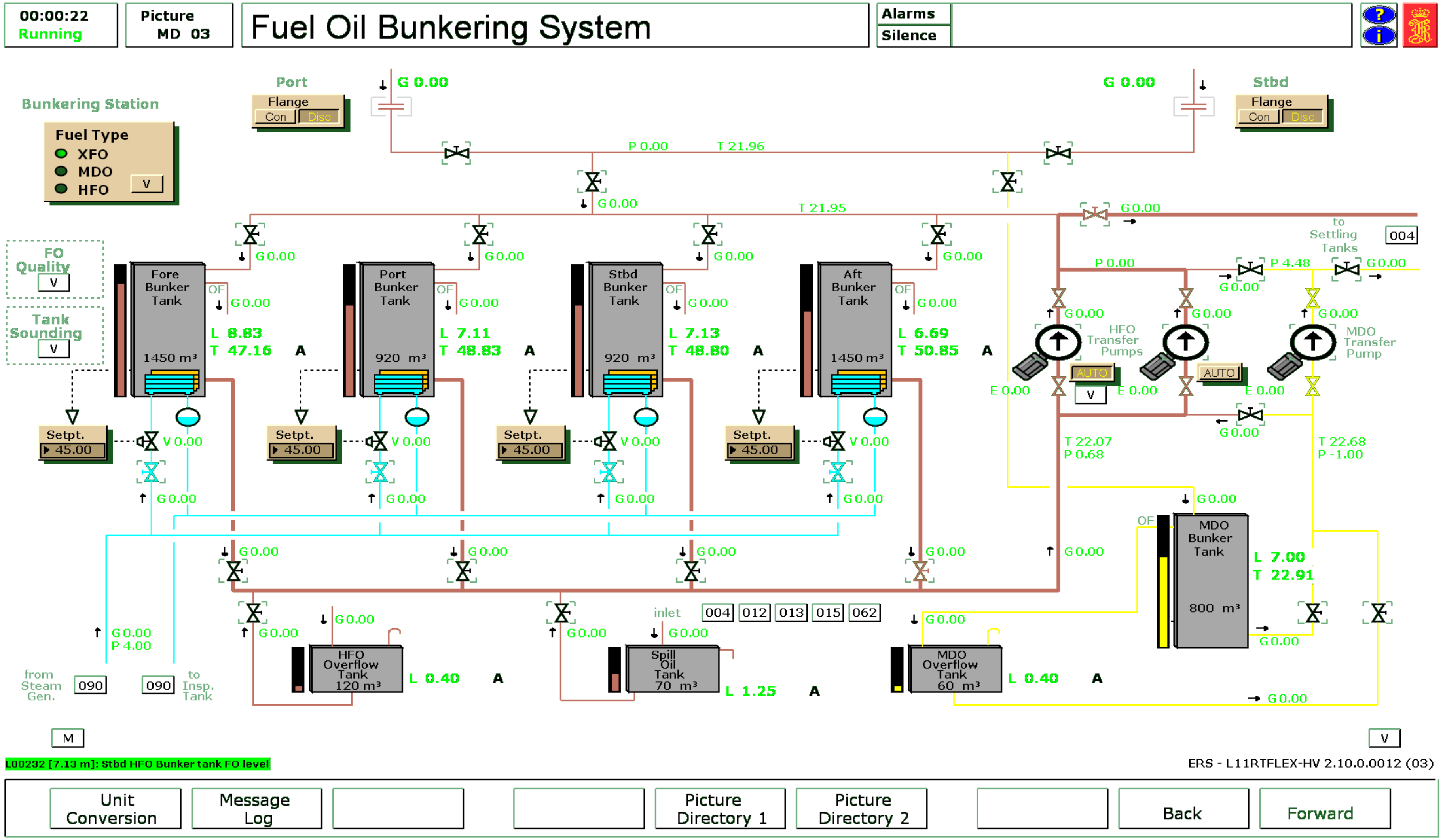
00:00:22
Running
Picture
MD 03
Fuel Oil Bunkering System
Alarms
Silence
Port
Flange
Con
Disc
Stbd
Bunkering Station
Fuel Type
XFO
MDO
HFO
FO Quality
Tank Sounding
Fore Bunker Tank
1450 m³
Port Bunker Tank
920 m³
Stbd Bunker Tank
920 m³
Aft Bunker Tank
1450 m³
L 8.83
T 47.16
L 7.11
T 48.83
L 7.13
T 48.80
L 6.69
T 50.85
Setpt.
45.00
HFO Transfer Pumps
MDO Transfer Pump
AUTO
to Settling Tanks
004
MDO Bunker Tank
800 m³
L 7.00
T 22.91
HFO Overflow Tank
120 m³
L 0.40
Spill Oil Tank
70 m³
L 1.25
MDO Overflow Tank
60 m³
inlet
004 012 013 015 062
from Steam Gen.
090
to Insp. Tank
L00232 [7.13 m]: Stbd HFO Bunker tank FO level
ERS - L11RTFLEX-HV 2.10.0.0012 (03)
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5.8 Fuel Oil Bunker System

General

The heavy fuel oil transfer system includes:

- Four HFO bunker tanks
- One MDO bunker tank
- One HFO overflow tank
- One spill oil tank
- One MDO overflow tank
- Two HFO transfer pumps
- One MDO transfer pump
- Two filling stations port and starboard

No pumping should be attempted from any fuel tank before the oil is pumpable, meaning that the viscosity must be below about 700 cSt and that the fuel suction and pressure lines are open.

All heavy fuel tanks are equipped with heating coils and pipe lines in engine room with steam tracing.
When applying steam to steam tracing always be sure that the oil in the pipe system is free to expand. Never apply steam tracing to pipes where closed valves isolate a section.

The following tanks are drained to the spill oil tank:

- Settling tanks
- Service tanks
- FO system drains
- LO drain from ME system
- LO drain from turbocharger system

1 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.

Ensure that valves to bunker tanks are closed when transferring to settling tanks.

Fuel oil in the bunker tanks is 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 settling tank, it may cause a considerable temperature drop in the settling tank, which again may cause purifier disturbance.

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

Total HFO capacity on board 4740 m^3

2 Bunkering Procedure

2.1 Observe all bunkering precaution prior to and during loading of bunkers
2.2 Ensure that overflow tank is empty
2.3 Select bunkers to be loaded by use of variable page 0320
2.4 Input fuel details of bunkers into variable page 0320
2.5 Open bunker tank filling valves as required
2.6 Connect flange and line up system ensuring shut off valve of opposite station is closed
2.7 At completion of bunkers ensure that all valves are closed

Precautions to be observed prior to and during the loading of bunkers.

The bunkering procedures must be observed at all times and all personnel involved in the bunkering procedure, whether planning or actual operation of bunkering, must be fully aware of the contents of Oil Transfer Procedures - Bunkering.
It is essential that all personnel involved in the bunkering procedure know who is in charge of the bunkering operation.

- The following licensed officers are designated as persons in charge: Chief Engineer Officer, Second Engineer Officer, Chief Officer.
- All engineers and other personnel involved in the bunkering process should know exactly what role they are to play and what their duties are to be.
- Personnel involved should know the location of all valves and gauges and be able to operate valves both remotely and locally as applicable.
- A bunker plan must be drawn up prior to bunkering and all personnel involved in bunkering need to be fully aware of the contents of the plan and understand the entire operational procedure.
- The Chief Engineer should calculate the estimated finishing ullages/dips, prior to the starting of loading.
- Shore or barge tanks, whichever form is being used, should be checked for water content.
- Representative samples are to be drawn using the continuous drip method for the duration of the loading operation dispatched for analysis. Samples should be taken at the bunker supply manifold inlet to the ship system.
- As far as possible new bunkers should be segregated from existing bunkers on board. If bunkers being received are to be loaded into the same tanks as existing bunkers on board, great care must be taken to avoid problems of incompatibility. If there is any doubt about the compatibility between the new and existing bunkers, the new bunkers should not be loaded on of existing bunkers.
- No internal transferring of bunkers should take place during bunker loading operations, unless permission has been obtained from the Chief Engineer.
- Bunker tanks should not exceed 95% full; high level alarms fitted at the 95% full level for all tanks.
- Any bunker barges attending the vessel are to be safely moored alongside before any part of the bunker loading operation begins.

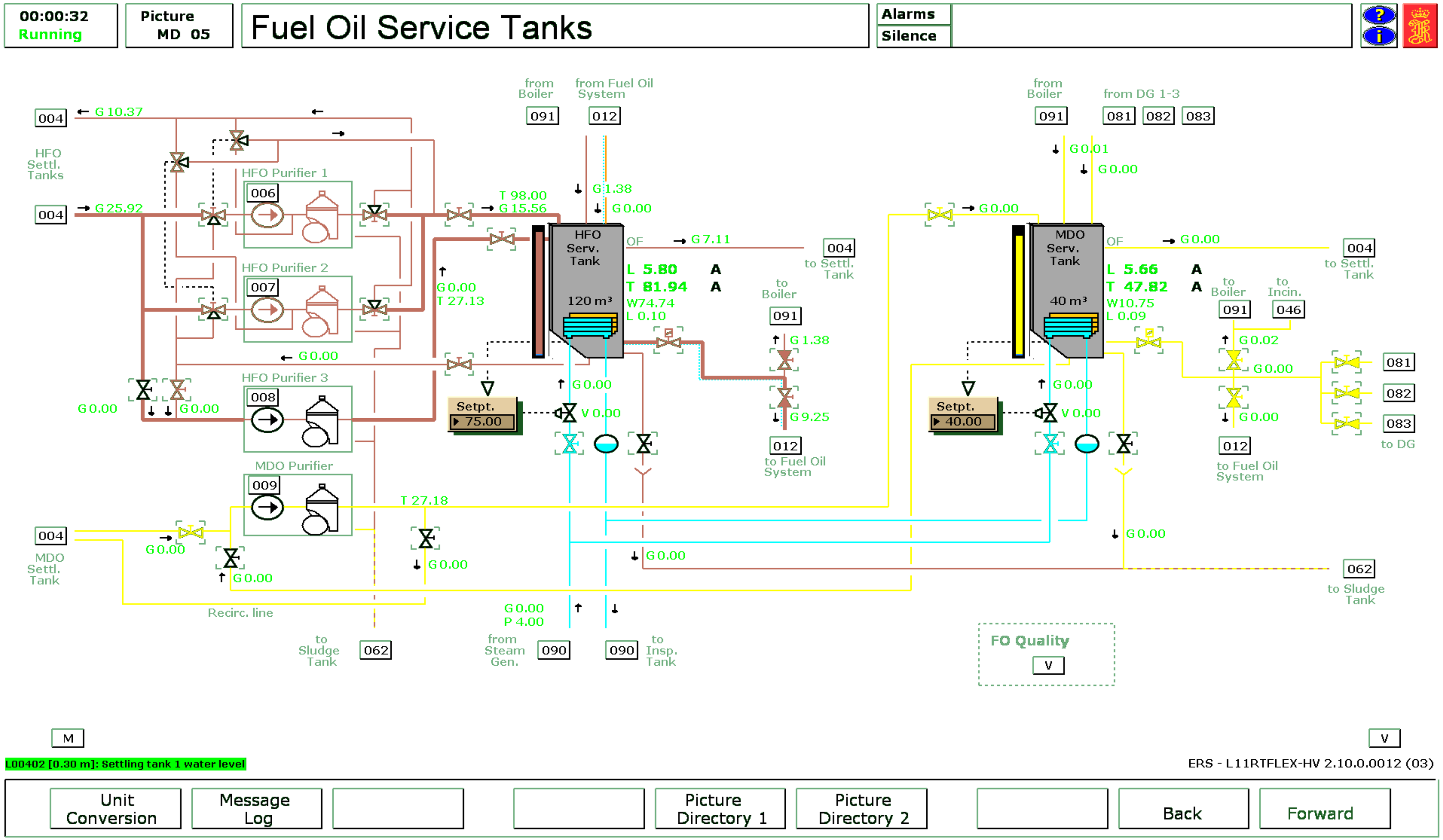
- Level alarms fitted to bunker tanks should be tested prior to bunker loading operations.
- The soundness of all lines should be verified by visual inspection.
- The pre-bunkering checklist should be completed.
- When the final tank is full, the barge or shore station must be signalled to stop pumping.
- Close all bunker stations and tank filling valves.
- Open the bunker line vent valve and allow the hose to drain back to the supplier.
- Disconnect the hose and replace the blank at the bunker station connection.
- Check tank levels and agree quantity supplied, then, if satisfied, sign the bunker receipt.
- Ensure that the sample containers are properly sealed and have them despatched for analysis.

3 Fuel Oil Quality

The overall fuel quality of the individual tanks can be found on variable pages 0330 to 0332. The quality depends on the fuel that was bunkered into the tanks.

4 Tank Sounding

The quantity of bunkers on board may be calculated by using the tank sounding variables pages 0340 to 0344. Input variables are vessels trim and heel, tank level, density and temperature.


00:00:32
Running
Picture
MD 05
Fuel Oil Service Tanks
Alarms
Silence
HFO Settl. Tanks
MDO Settl. Tank
HFO Purifier 1
HFO Purifier 2
HFO Purifier 3
MDO Purifier
HFO Serv. Tank
120 m³
MDO Serv. Tank
40 m³
from Boiler
from Fuel Oil System
from DG 1-3
to Settl. Tank
to Boiler
to Incin.
to Fuel Oil System
to DG
to Sludge Tank
from Steam Gen.
to Insp. Tank
Recirc. line
Setpt.
75.00
40.00
L 5.80
T 81.94
W74.74
L 0.10
L 5.66
T 47.82
W10.75
L 0.09
FO Quality
L00402 [0.30 m]: Settling tank 1 water level
ERS - L11RTFLEX-HV 2.10.0.0012 (03)
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5.9 Fuel Oil Service Tanks

General

Fuel oil service tanks comprise the HFO service tanks and the MDO service tank.
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
- Boiler burner system
- Incinerator system

HFO purifiers

One HFO purifier capacity is enough for full speed of the ship, but normally two purifiers will be in service because of a better cleaning effect with lower flow rates.
Purifier 1 and 2 are ALCAP purifiers and can take suction from the settling tanks or service tank delivering to the service tanks or settling tanks. Circulation of settling tanks and service tank is available in case of heavy contamination.
Purifier 3 is a standard purifier and takes suction from either settling tanks or service tank delivering to the service tank only.

Steam heating

The service tanks are equipped with steam heaters.
The temperature is controlled by P-controllers.
The temperature in the HFO service tank will normally be maintained at a temperature at 75°C.

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 HFO service tank overflows to settling tank No.1

The MDO service tank has return pipe from the diesel generators and the oil fired boiler.
Overflow from the service tanks goes to MDO settling.

The service tanks are provided with drain valves and the drain are led to the Spill Oil tank.

The service tanks are provided with shut off valves (quick-release, remote controlled shut-off valves) at the tank outlet, which can be operated from the deck office in emergency situations.

The fuel quality within the tanks can be found on variable page 0530

Operation procedure

- Open the heating supply valve to the heating coils and set the desired temperature from the controller.
- HFO service tank temperature controller to be set at 60 – 80°C.
- DO service tank to be set at 35°C.
- Settling tank temperature to be set 5-10°C below.
- HFO requires temperatures minimum 30°C to be pumped.
- Drain water from tanks periodically.
- When switching tanks, always open inlet/outlet valves to "new" tanks before closing respectively on "old" tank.

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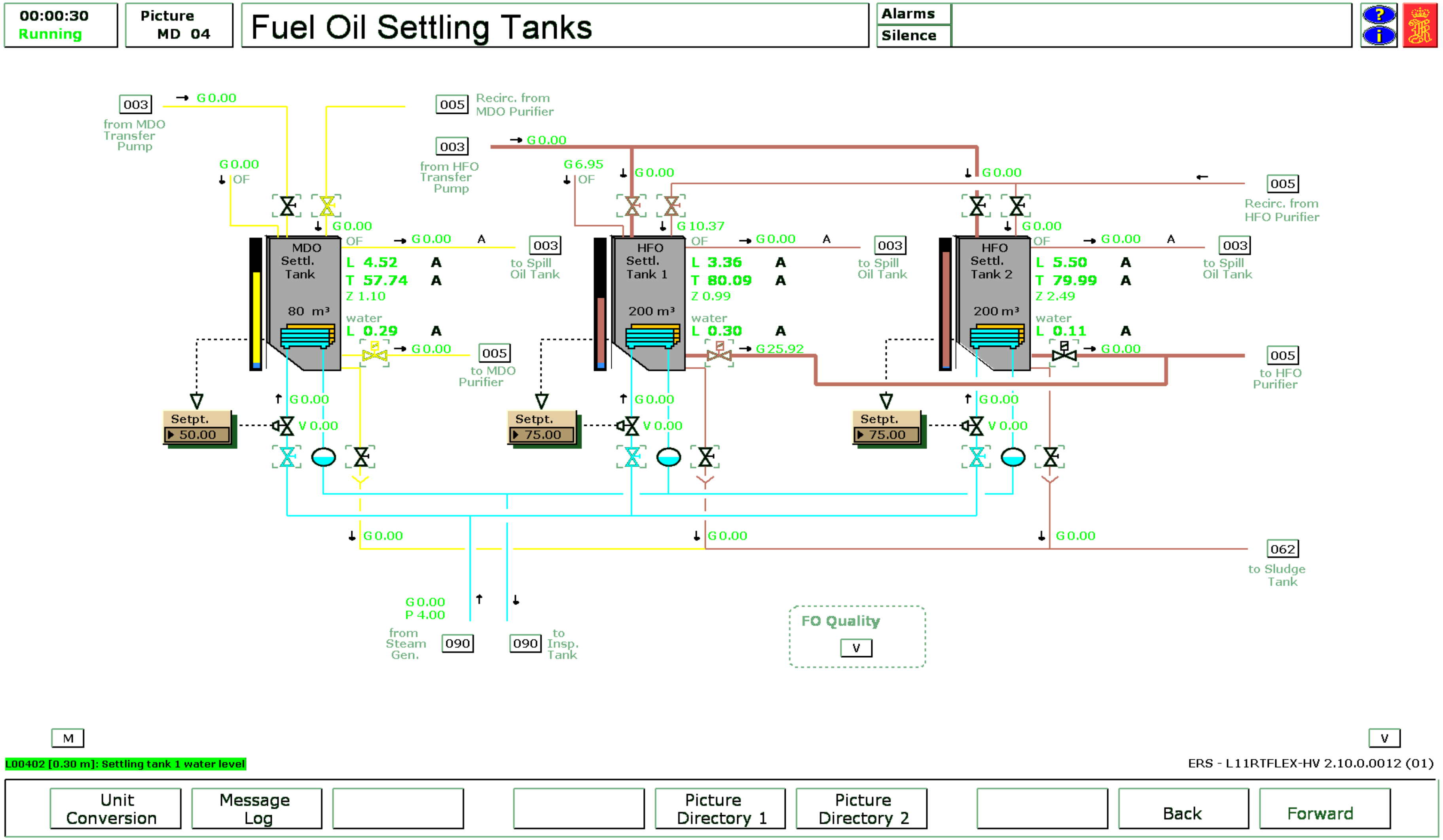
00:00:30
Running
Picture
MD 04
Fuel Oil Settling Tanks
Alarms
Silence
003
from MDO Transfer Pump
005
Recirc. from MDO Purifier
003
from HFO Transfer Pump
005
Recirc. from HFO Purifier
MDO Settl. Tank
80 m³
L 4.52
T 57.74
Z 1.10
water
L 0.29
HFO Settl. Tank 1
200 m³
L 3.36
T 80.09
Z 0.99
water
L 0.30
HFO Settl. Tank 2
200 m³
L 5.50
T 79.99
Z 2.49
water
L 0.11
003
to Spill Oil Tank
005
to MDO Purifier
005
to HFO Purifier
Setpt.
50.00
Setpt.
75.00
Setpt.
75.00
062
to Sludge Tank
G 0.00
P 4.00
from Steam Gen.
090
090
to Insp. Tank
FO Quality
L00402 [0.30 m]: Settling tank 1 water level
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
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5.10 Fuel Oil Settling Tanks

General

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

The purpose of the settling tanks is to:

- Settle bulk water and sludge.
- Act as buffer tank for the HFO purifier system.
- Supply the purifiers with fuel oil of an almost constant temperature.

Description

The settling tanks are filled from the oil transfer system by the transfer pumps taking suction from either the bunker tanks or the fuel oil spill tank. The filling line at each settling tank is provided with a shut-off valve.

The purifiers take suction by means of shut-off valves (quick-release, remote controlled shut-off valves) at the outlet from each Settling tank.

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 P-controllers, positioning the steam control valves according to tank temperature and temperature set.

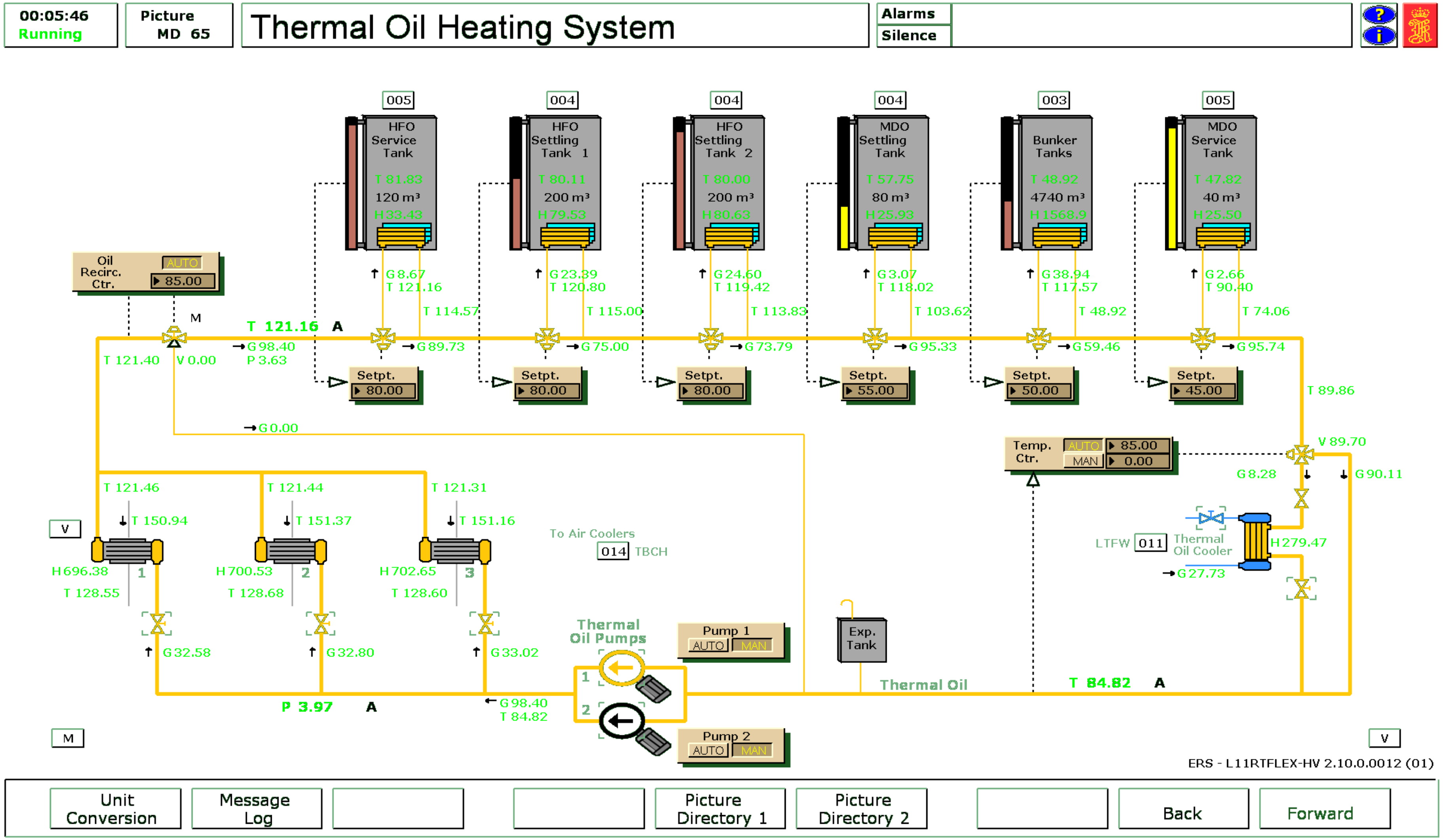
Miscellaneous

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

Operation procedure

1. Open the heating supply valve to the heating coils and set the desired temperature from the controller.
2. Settling tank temperature to be set to a maximum of 5-10°C below flash point.
3. HFO requires temperatures at minimum 30°C to be pumped.
4. Drain water from tanks periodically.
5. 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 quality of the fuel within the settling tanks can be found on variable page 0430.


00:05:46
Running
Picture
MD 65
Thermal Oil Heating System
Alarms
Silence
HFO Service Tank
HFO Settling Tank 1
HFO Settling Tank 2
MDO Settling Tank
Bunker Tanks
MDO Service Tank
Oil Recirc. Ctr.
AUTO
85.00
Setpt.
Temp. Ctr.
Thermal Oil Cooler
LTFW
Thermal Oil Pumps
Pump 1
Pump 2
AUTO
MAN
Exp. Tank
Thermal Oil
To Air Coolers
TBCH
T 121.16
T 84.82
P 3.97
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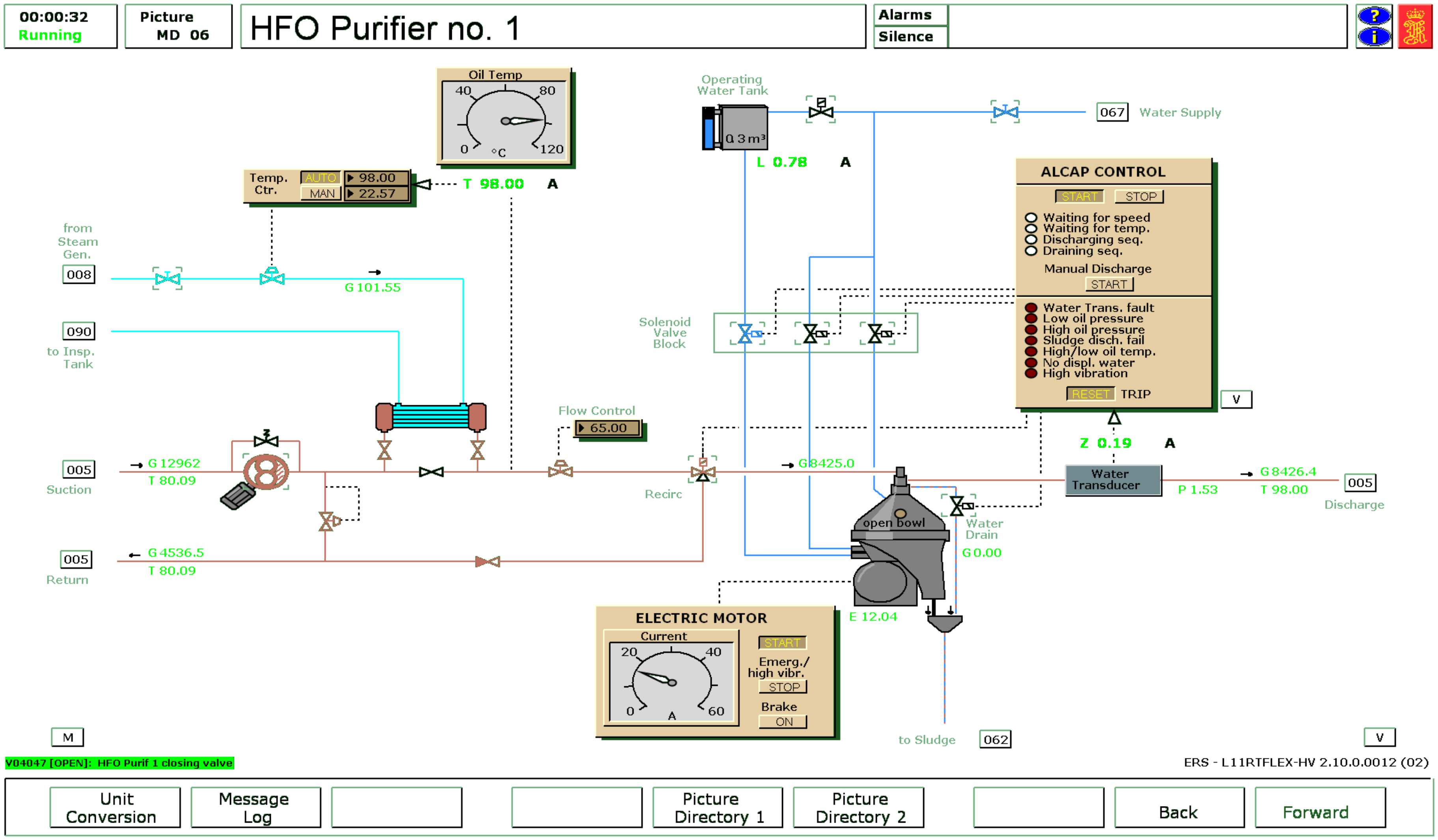
5.11 Thermal Oil Heating System

The three heat exchangers are mounted in the main air cooler inlet before the LTFW heat exchangers.
The Thermal Oil circulates through the heat exchanger with the help of two pumps, which may be started and stopped manually, both in manual and auto mode.
When the pumps are set to Auto, the stand-by pump will start if the oil pressure is lower than 2 bar. Low pressure alarm will be activated at 2.5 bar.

The controllable three way valves for the recirculation and the various heater elements are controlled by thermostatic P-gain controllers. These controllers are available in separate pop-up windows.
To avoid excessive heat generation in the fuel tanks, and by this assure sufficient low oil temperature on the oil return to the ME air coolers, a P-gain controlled oil cooler is included. The controller is available in an own pop-up window.
This model is made to observe the saved amount of fuel in case of installation of a waste heat recovery system.
It should be noted that this control loop is a very slow system when installed, but may be speeded up in the simulator.


00:00:32
Running
Picture
MD 06
HFO Purifier no. 1
Alarms
Silence
Oil Temp
40
80
0
°C
120
Temp. Ctr.
AUTO
MAN
98.00
22.57
T 98.00
A
Operating Water Tank
0.3 m³
L 0.78
A
067
Water Supply
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
V
from Steam Gen.
008
G 101.55
090
to Insp. Tank
Solenoid Valve Block
Flow Control
65.00
Z 0.19
A
005
Suction
G 12962
T 80.09
G 8425.0
Recirc
Water Transducer
G 8426.4
005
P 1.53
T 98.00
Discharge
open bowl
Water Drain
G 0.00
005
Return
G 4536.5
T 80.09
ELECTRIC MOTOR
Current
20
40
0
A
60
START
Emerg./ high vibr.
STOP
Brake
ON
E 12.04
to Sludge
062
M
V
V04047 [OPEN]: HFO Purif 1 closing valve
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
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5.12 HFO Purifier System

General

The purpose of the HFO purifier 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 purifiers of the "ALCAP" type and one of the ordinary type MPOX. The HFO purifiers take suction from the settling tanks and the service tank and discharge to the HFO service tank.

Operation Mode

Pumping up service tank:

> The purifiers taking suction from the selected HFO settling tank and discharge to the HFO service tank.

Re-circulating service tank:

> The purifiers taking suction from the HFO service tank and discharge to the HFO service tank.

Each purifier is provided with a separate electrically driven feed pump, the “ALCAP” system with constant displacement and the “MOPX” system with variable pump.
The flow to the purifier is controlled by means of an adjustable flow control valve or the variable pump. The excess flow from the feed pump is returned to the HFO settling tank or to the HFO service tank.
Each feed pump/purifier has a capacity, which is 10% above maximum total HFO consumption.

Each purifier 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 purifier bowl. A PID controller controlling a control valve at the pre-heater steam inlet controls the temperature.

Normally, operation is two HFO purifiers pumping up from the settling tank to the service tank.
If it is a very bad HFO the third purifier will circulate on the service tank.

5.12.1 HFO Purifier ALCAP no. 1+2

Operating Principle:

The oil to be cleaned is continuously fed to the purifier. 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. The increase in water content is sensed by a water transducer installed in the clean oil outlet.
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 discharged with the sludge through the sludge ports at the periphery of the bowl.

If the water contamination 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
- Low Oil Pressure
- High Oil Pressure
- Sludge Discharge Failure
- High/Low Oil Temperature
- No Displ. 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 a water content below this value in this purifier system, this limit is used to indicate a fault condition of the transducer. This failure could be loose connections, faulty oscillator unit, etc.
After repair of transducer the ALCAP must be reset before it is possible to start the purifier.

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.

When we the pressure has been adjusted the ALCAP has to be reset.

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 the ALCAP has to be reset.

No displ. water alarm is activated when the ALCAP control system tries to fill water but there is no water supply because the shut-off valve is closed.
When the water supply is opened the ALCAP has to be reset.

High vibration alarm is activated when there is high vibration in the purifier bowl. When this alarm is activated, the purifier will be

emptied, the ALCAP control system will be shut down, the oil will be recirculated (three-way valve will close against purifier) and the electrical motor will stop.
After repair attempt, the ALCAP has to be reset.

Sludge discharge failure alarm is activated if the purifier is not able to empty the purifier for water and sludge. The ALCAP control system will directly try a new sludge/discharge sequence. If the water transducer still measures too high water content in the oil, the purifier will be emptied, the ALCAP control system is shut down and the oil will be recirculated.
After repair attempt, the ALCAP has to be reset.

Operation procedure

- Normally two HFO purifiers are in service, but one HFO purifier capacity is enough for full speed. The HFO purifiers 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 "ALCAP"

1.1 Open supply and return valves from selected HFO settling tank.
1.2 Open HFO SEP oil inlet valve to purifier.
1.3 Open HFO SEP oil outlet valves 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 "ALCAP"

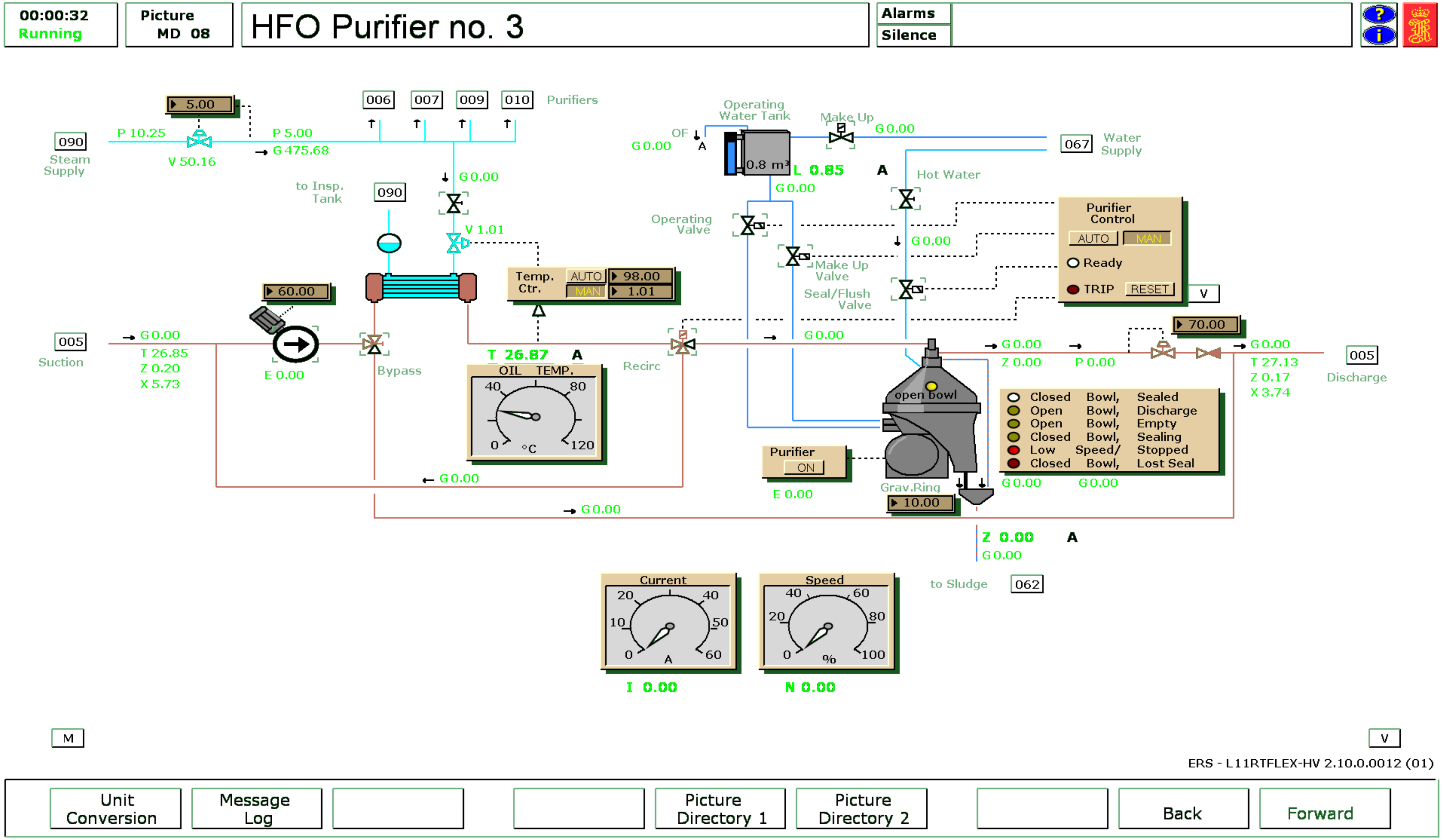
2.1 Start HFO SEP feed pump. Adjust desired flow.
2.2 Set temperature controller to AUTO and adjust set point to 98°C.
2.3 Check that the purifier brake is not engaged.
2.4 Start electric motor of the purifier.
2.5 Wait for purifier speed to stabilise. Observe the ammeter and "waiting for speed" indication on ALCAP control panel.
2.6 Put the ALCAP control into operation by pressing the start button on the control panel.

When correct oil temperature is reached (observe indication on the ALCAP control panel), the three-way valve will open for delivery to the purifier.

2.7 Observe and adjust flow after purifier.

3. Stopping procedure "ALCAP"

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.


00:00:32
Running
Picture MD 08
HFO Purifier no. 3
Alarms
Silence
5.00
006
007
009
010
Purifiers
090
Steam Supply
P 10.25
V 50.16
P 5.00
G 475.68
to Insp. Tank
090
G 0.00
V 1.01
Temp. Ctr.
AUTO
MAN
98.00
1.01
60.00
005
Suction
G 0.00
T 26.85
Z 0.20
X 5.73
E 0.00
Bypass
T 26.87
A
OIL TEMP.
°C
Recirc
Operating Water Tank
OF
G 0.00
0.8 m³
L 0.85
Make Up
G 0.00
067
Water Supply
Hot Water
Operating Valve
Make Up Valve
Seal/Flush Valve
Purifier Control
AUTO
MAN
Ready
TRIP
RESET
70.00
G 0.00
Z 0.00
P 0.00
T 27.13
Z 0.17
X 3.74
005
Discharge
open bowl
Closed Bowl, Sealed
Open Bowl, Discharge
Open Bowl, Empty
Closed Bowl, Sealing
Low Speed/ Stopped
Closed Bowl, Lost Seal
Purifier
ON
E 0.00
Grav.Ring
10.00
Z 0.00
to Sludge
062
Current
A
I 0.00
Speed
%
N 0.00
M
V
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5.12.2 HFO Purifier MOPX no. 3

Description

There is one HFO purifier of the ordinary type MOPX operating after the same principle as the DO- and the LO purifiers.
The purifier takes suction from the HFO oil settling tank and discharge to the HFO service tank or circulating on the service tank.
The purifier is provided with a separate electrically 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 purifier.
The purifier 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 may heat the diesel oil before it is led to the purifier bowl. The temperature is controlled by a PID controller controlling a control valve at the pre-heater steam inlet.

Normal operation:

a) The purifier feed pump takes suction from the HFO settling tank and discharges to the HFO service tank via the purifier.

b) The purifier feed pump takes suction from the HFO service tank and recirculates to the HFO oil service tank via the purifier.

1. Preparation

1.1 Open outlet valve from HFO settling tank. Open inlet valve to HFO service tanks.
1.2 Start purifier feed pump. Adjust desired flow by using the variable delivery supply pump (when starting less than 20%).
1.3 Set temperature controller in auto and adjust set point to 98°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).
1.6 Set the gravity ring about 40 – 50 %.

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 BOWL CLOSED AND EMPTY.
2.2 Open seal/flush valve for 15 seconds to ensure proper water seal in bowl.
2.3 When mimic reads BOWL CLOSED AND 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 Change the three-way valve to stop the flow of oil to the purifier.
3.2 After lost seal appears, open seal/flush valve for 5 seconds to empty bowl.
3.3 Close make-up valve.
3.4 Open operating valve for 5 seconds, mimic reads BOWL OPEN DESLUDGING and BOWL OPEN, EMPTY.
3.5 Close operating valve. Wait 15 seconds.
3.6 Open make-up valve.
3.7 When indicator reads BOWL CLOSED&EMPTY open seal/flush valve until mimic reads BOWL CLOSED AND SEALED.
3.8 When BOWL CLOSED AND SEALED appears, open re-circulation valve towards purifier.
3.9 When operating valves, indicating lamps must be observed to prevent rushing the procedure of starting cycle/ejection cycle.

4. AUTO mode

4.1 Press purifier on button, press start and switch to auto.

5. Re-purification of HFO service tank:

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

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

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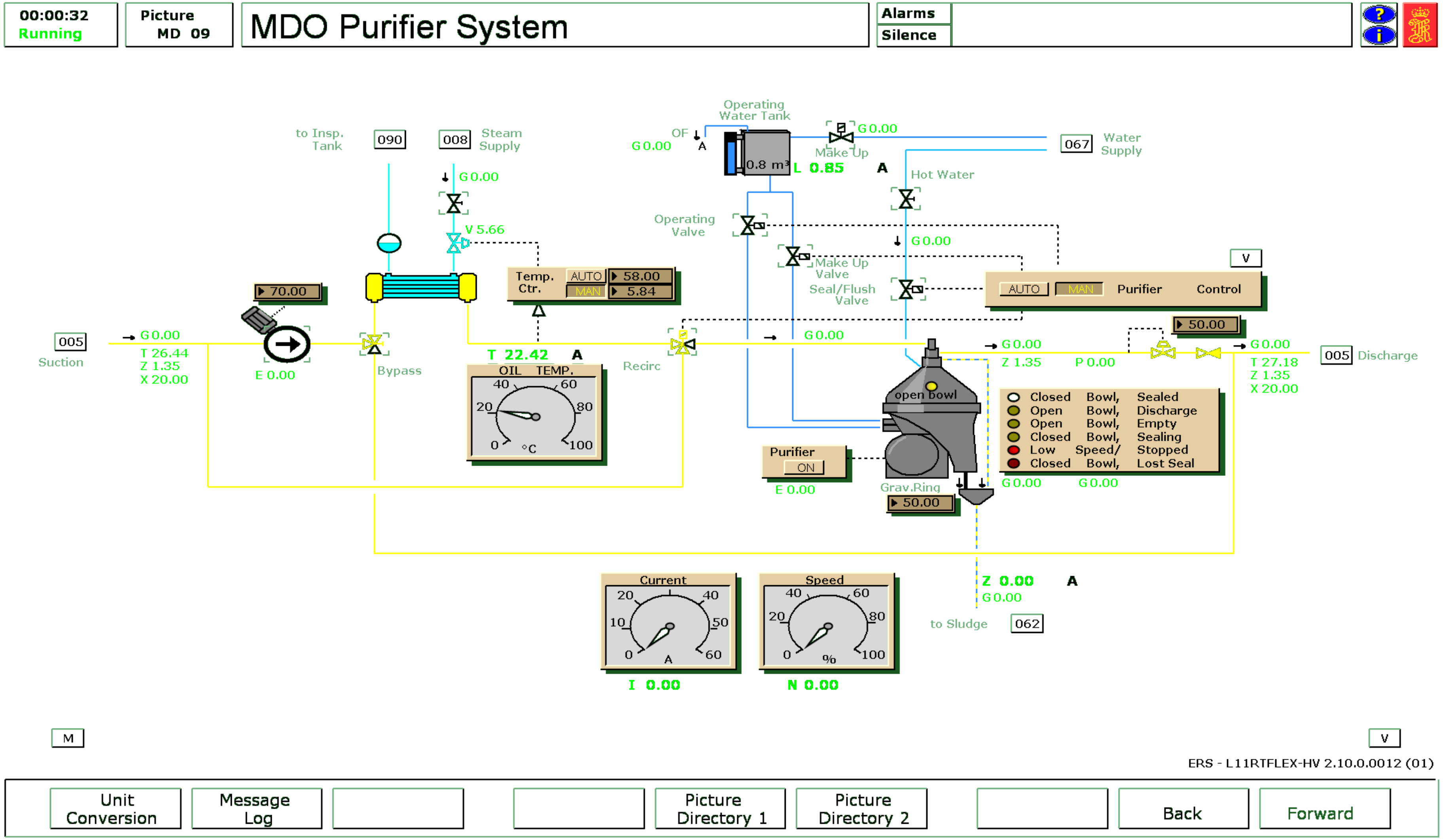
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Running
Picture
MD 09
MDO Purifier System
Alarms
Silence
to Insp. Tank
090
008
Steam Supply
G 0.00
V 5.66
Temp. Ctr.
AUTO
MAN
58.00
5.84
70.00
005
Suction
G 0.00
T 26.44
Z 1.35
X 20.00
E 0.00
Bypass
T 22.42
A
OIL TEMP.
°C
Recirc
Operating Water Tank
OF
0.8 m³
L 0.85
Make Up
067
Water Supply
Hot Water
Operating Valve
Make Up Valve
Seal/Flush Valve
Purifier
Control
50.00
Z 1.35
P 0.00
T 27.18
Z 1.35
X 20.00
Discharge
open bowl
Closed Bowl, Sealed
Open Bowl, Discharge
Open Bowl, Empty
Closed Bowl, Sealing
Low Speed/ Stopped
Closed Bowl, Lost Seal
Purifier
ON
E 0.00
Grav.Ring
Current
Speed
I 0.00
N 0.00
Z 0.00
to Sludge
062
M
V
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5.13 Diesel Oil Purifier System

General

The purpose of the diesel oil purifier 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 purifier. The diesel oil purifier takes suction from the diesel oil storage tank and discharges to the diesel oil service tank.
The purifier is provided with a separate electrically 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 purifier.
The purifier 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 may heat the diesel oil before it is led to the purifier bowl. The temperature is controlled by a PID controller controlling a control valve at the pre-heater steam inlet.

Operation procedure

Normal operation:

c) The purifier feed pump takes suction from the diesel oil storage tank and discharges to the diesel oil service tank via the diesel oil purifier.

d) The purifier feed pump takes suction from the diesel oil service tank and recirculates to the diesel oil service tank via the diesel oil purifier.

Emergency operation:

The purifier feed pump takes suction from the diesel oil storage tank and bypasses the purifier to the diesel oil service tank.

1. Preparation

1.1 Open outlet valve from diesel oil storage tank. Open inlet valve to diesel oil service tanks.
1.2 Start purifiers feed pump. Adjust desired flow by using the variable delivery supply pump (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).
1.6 Set the gravity ring about 40 – 50%.

Starting procedure

2. **MANUAL mode**:

After purifier has reached full speed, and purifier controller is in manual, open make-up valve and wait until mimic reads BOWL CLOSED AND EMPTY.

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

3. **Ejection cycle:**

3.1 Change the three-way valve for stopping the flow to the purifier.
3.2 After lost seal appears, open seal/flush valve for 5 seconds to empty bowl.
3.3 Close make-up valve.
3.4 Open operating valve for 5 seconds, mimic reads BOWL OPEN DESLUDGING and BOWL OPEN, EMPTY.
3.5 Close operating valve. Wait 15 seconds.
3.6 Open make-up valve.
3.7 When indicator reads BOWL CLOSED&EMPTY open seal/flush valve until mimic reads BOWL CLOSED AND SEALED.
3.8 When BOWL CLOSED AND SEALED appears, open re-circulation valve towards purifier.
3.9 When operating valves, indicating lamps must be observed to prevent rushing the procedure of starting cycle/ejection cycle.

4. **AUTO mode**

4.2 Press purifier on button, press start and switch to auto.

5. **Re-purification of diesel oil service tank:**

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

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

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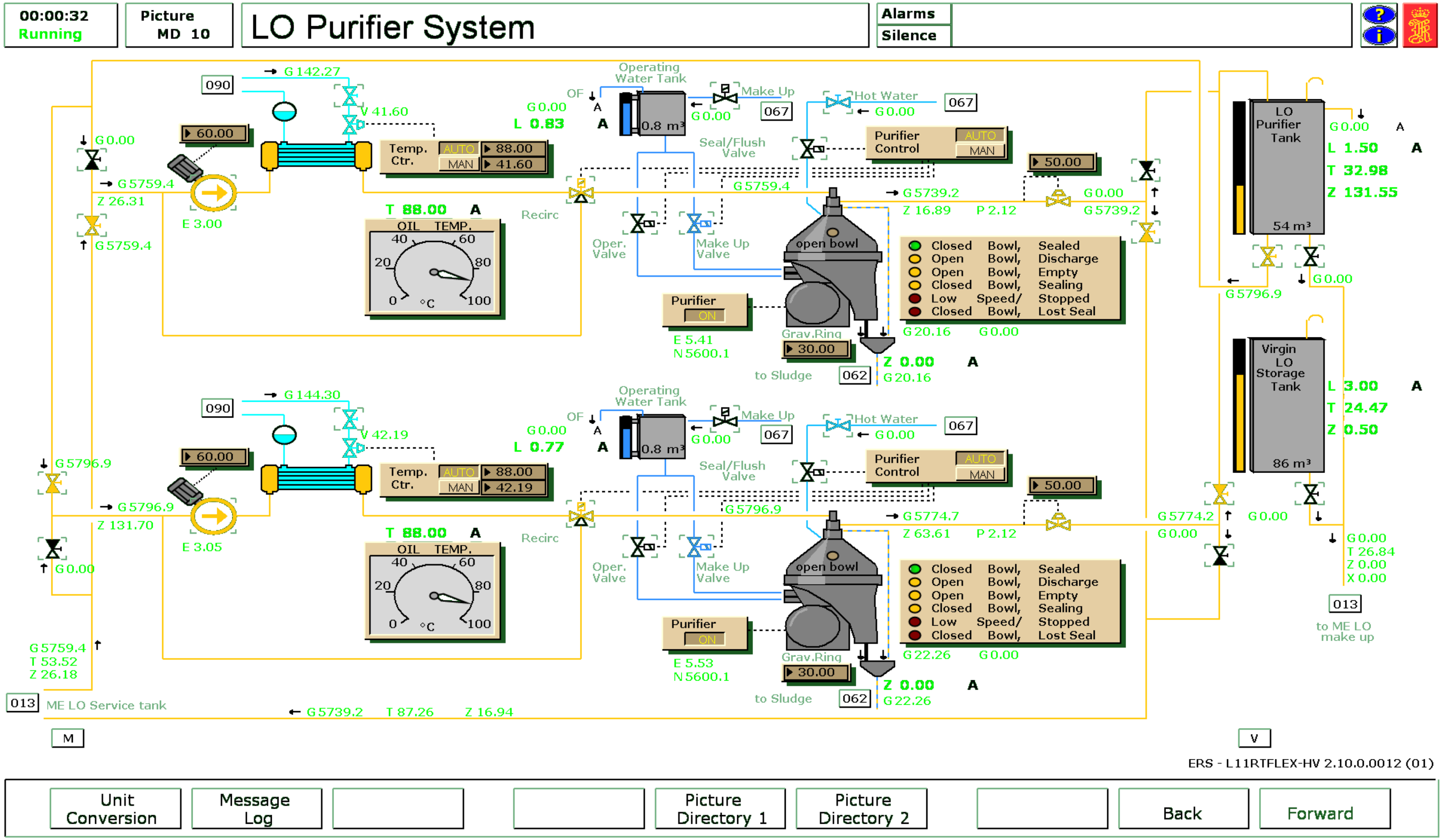
00:00:32
Running
Picture
MD 10
LO Purifier System
Alarms
Silence
Operating Water Tank
Make Up
Hot Water
Purifier Control
AUTO
MAN
Seal/Flush Valve
Temp. Ctr.
OIL TEMP.
°C
Recirc
Oper. Valve
Make Up Valve
open bowl
Purifier
ON
Grav.Ring
to Sludge
Closed Bowl, Sealed
Open Bowl, Discharge
Open Bowl, Empty
Closed Bowl, Sealing
Low Speed/ Stopped
Closed Bowl, Lost Seal
LO Purifier Tank
54 m³
Virgin LO Storage Tank
86 m³
to ME LO make up
ME LO Service tank
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5.14 Lubrication Oil Purifier System

General

- There are two lubricating oil purifiers
- One fresh oil storage tank
- One LO purifier tank
- The lubricating oil purifiers clean lubricating oil taken from the ME LO service tank from the main engine and discharges it to back to the service tank.
- It is also possible to clean oil from the LO purifier tank by re-circulating,
- or to transfer oil from the ME LO service tank to the LO purifier tank because of engine trouble.

The purifiers are provided with a separate electrically driven displacement feed pump with adjustable speed.

The purifiers are 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 separated oily water and the drain from the bowl discharge are collected in the sludge tank.

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

Operation procedure

1. **Preparation**

1.1 Prepare the purifiers for running depending of which systems to be cleaned.
1.2 Open outlet valve from selected lubrication oil tank.
1.3 Open inlet valve to selected lubrication oil 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 (5600), and purifier controller is in manual, open make-up valve and wait until mimic reads BOWL CLOSED AND EMPTY.
2.2 Start purifying process with gravity ring less than 20% of full scale. This can be changed when the purifier is running to allow optimisation of settings
2.3 Open seal/flush valve for 15 seconds to ensure proper water seal in bowl.
2.4 When mimic reads BOWL CLOSED AND SEALED, open oil flow to purifier by clicking open on three-way re-circulation valve towards purifier. The supplied oil must have sufficient temperature.

2.5 Adjust gravity ring to maximum value without loosing water seal and adjust oil flow gradually to achieve optimum balance of cleaning and flow by monitoring oil dirt content.

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 BOWL OPEN DESLUDGING and BOWL OPEN, EMPTY.
3.4 Close operating valve. Wait 15 seconds. Open make-up valve.
3.5 When indicator reads BOWL CLOSED&EMPTY open seal/flush valve until mimic reads BOWL CLOSED AND SEALED.
3.6 When BOWL CLOSED AND 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 Press purifier on button, press purifier pump start and when purifier is up to speed switch purifier control to auto. Switching the purifier from auto to manual and back again initiates a sludge cycle.

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.

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

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

Note:
When cleaning oil in the LO purifier tank it is a must to take samples for analysing the efficiency of the purifiers.

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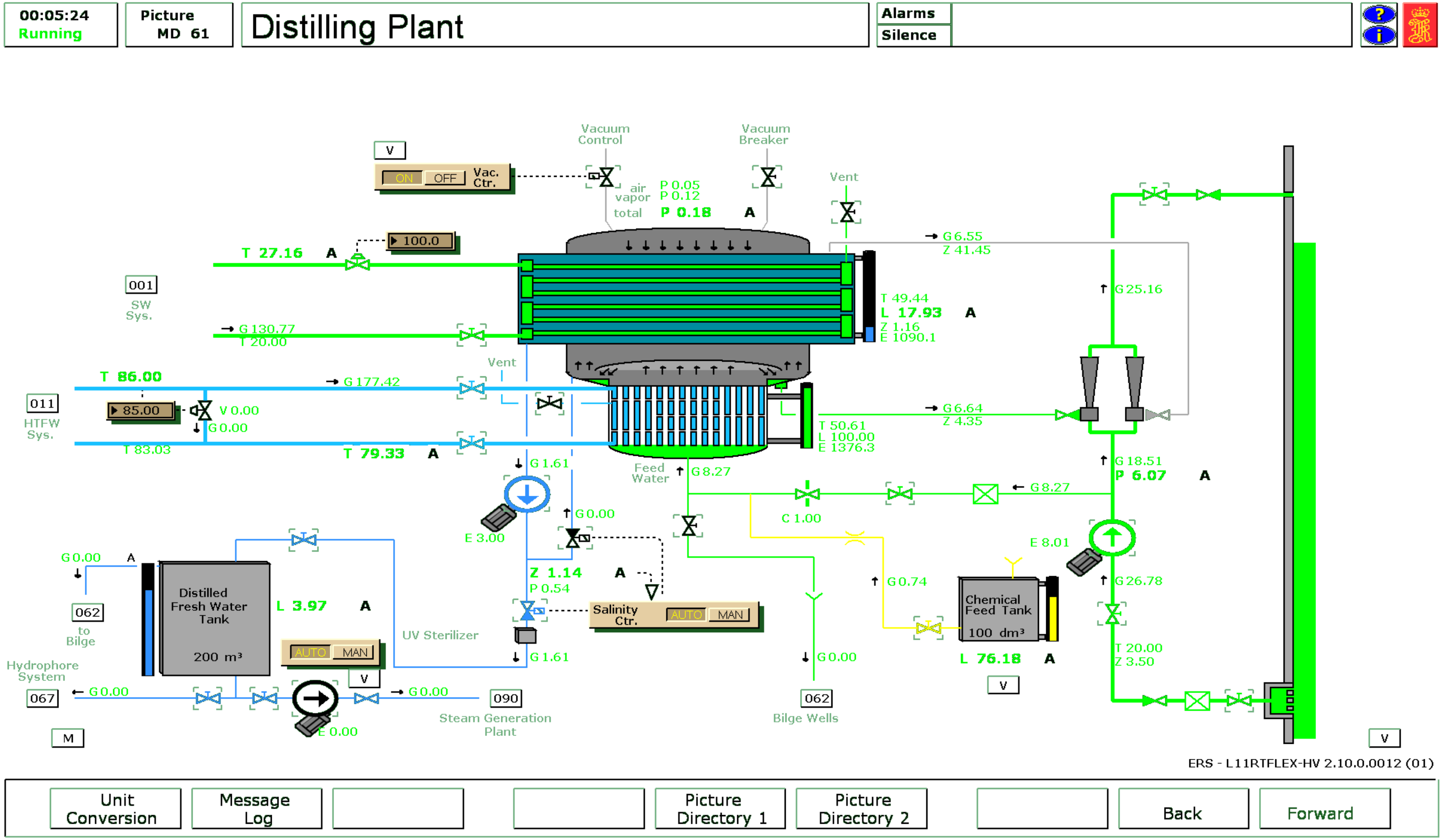
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MD 61
Distilling Plant
Alarms
Silence
Vacuum Control
Vacuum Breaker
Vac. Ctr.
ON
OFF
air P 0.05
vapor P 0.12
total P 0.18
Vent
T 27.16
100.0
001
SW Sys.
G 130.77
T 20.00
011
HTFW Sys.
T 86.00
85.00
V 0.00
G 0.00
G 177.42
T 83.03
T 79.33
G 6.55
Z 41.45
T 49.44
L 17.93
Z 1.16
E 1090.1
G 25.16
G 6.64
Z 4.35
T 50.61
L 100.00
E 1376.3
Feed Water
G 8.27
G 18.51
P 6.07
C 1.00
G 1.61
E 3.00
G 0.00
Z 1.14
P 0.54
Salinity Ctr.
AUTO
MAN
Distilled Fresh Water Tank
200 m³
L 3.97
062
to Bilge
Hydrophore System
067
UV Sterilizer
E 0.00
090
Steam Generation Plant
Bilge Wells
G 0.74
Chemical Feed Tank
100 dm³
L 76.18
E 8.01
G 26.78
T 20.00
Z 3.50
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5.15 Fresh Water Generator

General
Considerable waste heat sources may be utilised when connecting a fresh water generator to the main engine jacket cooling water system. Normally this temperature is 80 - 90°C.

The function is as follows:
A controlled amount of sea water is channelled via an adjustable orifice to the evaporator where it is heated by the HTFW. The fresh water generator operates under vacuum conditions in order to reduce the evaporation temperature. The vacuum, and thus the evaporation temperature, must be controlled to reduce the scale formation in the sea water side of the evaporator.

The vacuum allows utilisation of low temperature heating sources. The vapours generated pass through a fine mesh demister, to prevent salt water carryover, to the condenser.

The condenser is cooled by sea water so the vapour condenses into fresh water. The fresh water falls by gravity to the bottom of the condenser and is led to the suction of the fresh water pump.

The condition of the fresh water is monitored by a salinometer and if the salinity is high the condensate is recirculated to the evaporator.

Description

The evaporator is made up by heat exchangers of the tubular type.

The evaporator heating is supplied from the main engine HTFW circuit by controlling a bypass valve. In parallel to this is a manual by-pass which ensures fresh water flow to the main engine cannot be shut off.

The ejector pump is supplied from the main sea water system.

The maximum evaporator capacity is 30 ton/24 hours at sea water temperature 32°C.

The distillate water is led to the distilled fresh water tank via an ultra violet sterilisation unit.

Warning!
Do not operate the plant in polluted water. Fresh water must not be produced from polluted water, as the produced water will be unsuitable for human consumption.

Operation procedure

1. **Preparation**
1.1 Set salinity controller to MAN.
1.2 Close evaporator drain valve.
1.3 Close vacuum breaker valve.
1.4 Close vents on FW stack and condenser stack
1.5 Check that automatic fresh water by-pass valve is fully open and the manual valve is set at 50%
1.6 Check that fresh water inlet and outlet valves from main engine system to generator are closed.
1.7 Open the sea water inlet valve to the ejector pump.

1.8 Open sea water valve for condenser (V00674, MD01).
1.9 Open sea water overboard valve from ejectors.

2. Starting /stopping procedure:

2.1 Start ejector pump and check pressure and flow.
2.2 Open sea water flow to condenser, adjusting valve, gradually to 100%.
2.3 Open sea water feed valve to evaporator.
2.4 Prepare and start the addition to the evaporator of the chemical to prevent scaling in the evaporator.
2.5 Wait for the total pressure in the generator to drop to approximately 0.10 bar (1.5 psia).
2.6 Open evaporator heating outlet shut off valve (to HTFW system).
2.7 Vent the heating stack
2.8 Open evaporator heating inlet shut off valve (from HTFW system).
2.9 Close evaporator heating by-pass valve gradually while checking that the generator pressure does not exceed 0.1 bar.
2.10 Activate the automatic vacuum control valve by pressing ON at Vacuum Ctr. panel.
2.11 When distilled fresh water is visible in sight glass, open distillate re-circulation valve and start the distillate pump.
2.12 When salinity control is below alarm limit, open the distilled water tank inlet valve and activate salinity control by pressing AUTO at Salinity Ctr. Panel.
2.13 To **stop** the fresh water generator.
2.14 Stop the distillate pump.
2.15 Set the salinity control in manual.
2.16 Close the valve to the distilled fresh water tank.
2.17 Gradually open the bypass valve in the HT fresh water system.
2.18 Close the fresh water valves to the evaporator and allow to cool
2.19 Close the sea water feed valve to the evaporator.
2.20 Stop the ejector pump and closed valves in this circuit.
2.21 Open the vacuum breaker and set the vacuum controller on off.
2.22 Open the drain valve from the evaporator.
2.23 Stop the sea water to the condenser and closed valves in the circuit.
2.24 Close the valves to the chemical tank.

Note:
Chemical treatment is added to the sea water in order to minimize foaming in the evaporator and restrict the formation of salt water scale. It is essential that the correct dosage of chemical is used and frequent check must be made on the dosing unit to ensure that the correct treatment is being applied.

Note:
When stopping the fresh water generator, it is important to check that the manual bypass valve is open before closing the valves to the evaporator, otherwise it can cause a shutdown of the ME because the flow in the HT fresh water system is stopped. The manual valve will normally be set at 50% and left at this position.

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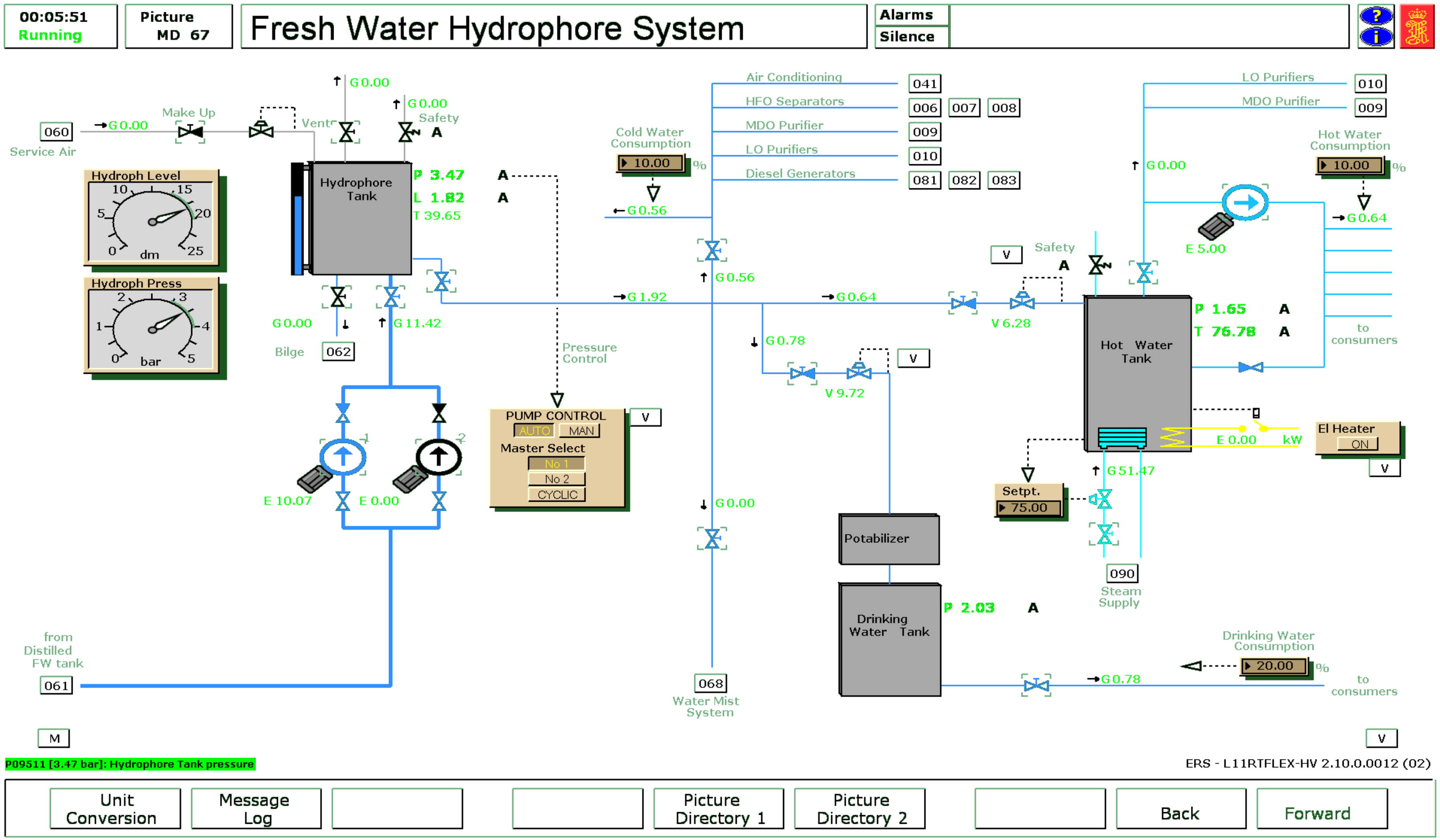
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Picture
MD 67
Fresh Water Hydrophore System
Alarms
Silence
Make Up
Vent
Safety
Service Air
060
Hydroph Level
dm
Hydroph Press
bar
Hydrophore Tank
P 3.47
L 1.82
T 39.65
Bilge
062
Pressure Control
PUMP CONTROL
AUTO
MAN
Master Select
No 1
No 2
CYCLIC
E 10.07
E 0.00
from Distilled FW tank
061
Cold Water Consumption
10.00
Air Conditioning
HFO Separators
MDO Purifier
LO Purifiers
Diesel Generators
041
006
007
008
009
010
081
082
083
LO Purifiers
MDO Purifier
Hot Water Consumption
Hot Water Tank
P 1.65
T 76.78
E 5.00
V 6.28
V 9.72
to consumers
El Heater
ON
E 0.00
kW
Setpt.
75.00
Potabilizer
Drinking Water Tank
P 2.03
090
Steam Supply
Drinking Water Consumption
20.00
068
Water Mist System
P09511 [3.47 bar]: Hydrophore Tank pressure
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
Unit Conversion
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5.16 Fresh Water Hydrophore System MD67

General

Fresh Water Hydrophore System, MD67, consists of a pressurised hydrophore tank with necessary pumps and valves, a drinking water tank and a hot water tank.

The hot water is heated by electric immersion heater or steam.

The drinking water is supplied via a potabiliser to sterilise before use.

The capacity of the system is approx. 10 t/h of cold water, hot water and drinking water, supplied to different users.

The hydrophore tank volume is 3.0 m³, pressure is kept between 3 and 4 bar.

The system interfaces to the following subsystems:

- Cold Water
  - Purifiers
  - Generator FW make up
  - ME FW make up
  - Fire Sprinkler Pump Unit
  - Other consumers – consumption adjustable
- Hot water
  - LO and DO purifiers sealing water
  - Other consumers – consumption variable
- Drinking water
  - Other consumers – consumption variable.

Operation procedure

1. **Preparation**

1.1 Main busbar to be active.

Starting procedure

2. **MANUAL mode**:

2.1 Open valve from distilled FW tank.
2.2 Set pump control to MAN.
2.3 Start pump.
2.4 Open for service air if necessary.
2.5 Set temperature controller (steam or electric) to suitable value.
2.6 Start hot water circulation pump.
2.7 Open valves to consumers.

4. AUTO mode

4.1 Open valves and set temp. controllers as in manual.
4.2 Set pump control to AUTO.
4.3 Select which pump to be the master pump.

5. Cyclic

5.1 Set pump control to AUTO.
5.2 Press the button CYCLIC.

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5.17 Bilge System and Bilge Separator

Pollution prevention

To reduce pollution of the world's coasts and waters by the shipping industry, extensive regulations and penalties have been established and are being enforced. Of greatest interest to the engineering officer are the regulations concerning the pumping of machinery space bilges. The law, as established by MARPOL 73/78 ANNEX I, for ships of 10,000 gross tons and above, defines permissible discharge of machinery space oily mixtures., as follows:

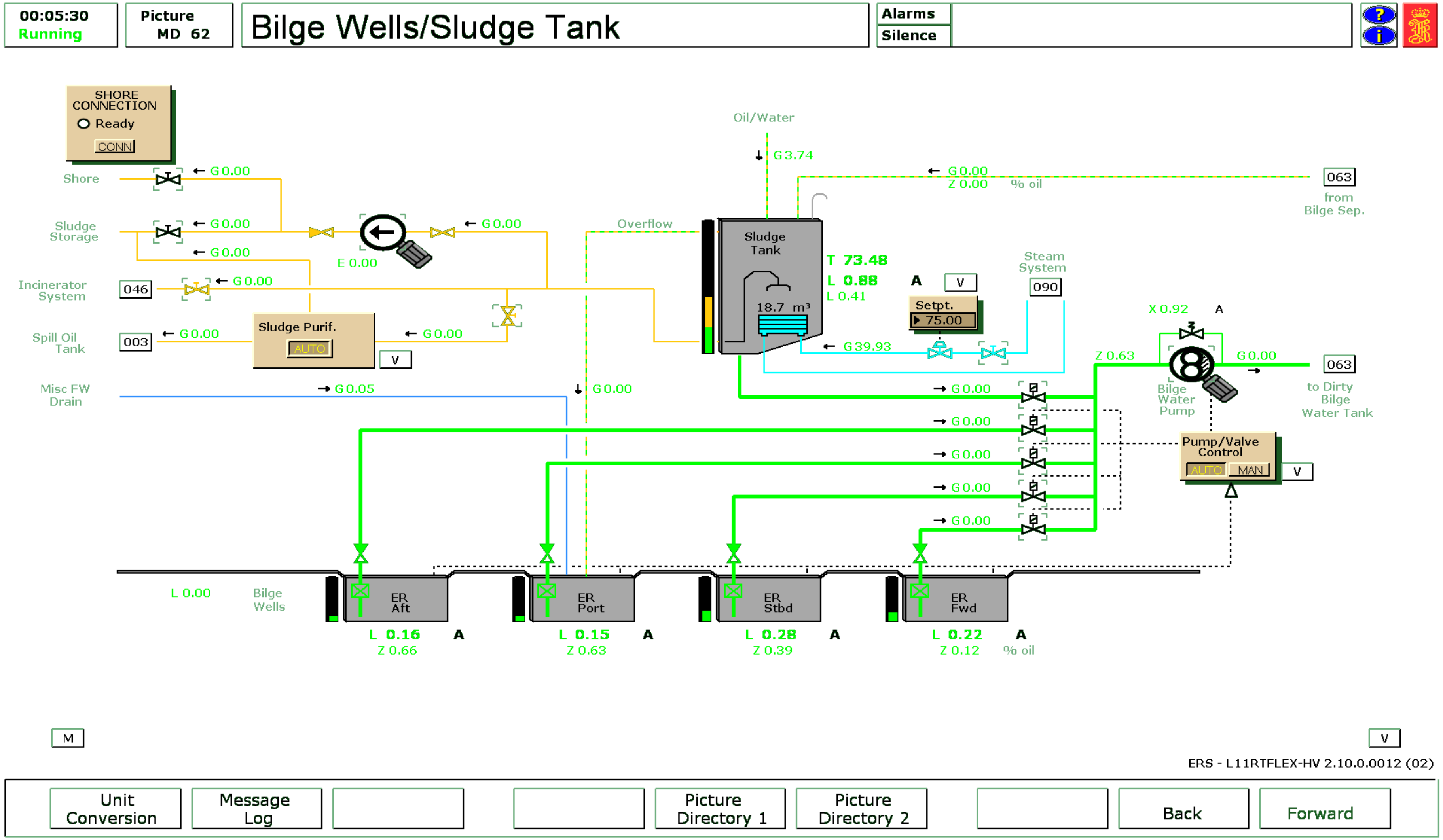
1. *No Discharge* is permitted, except when:
    1. The vessel is en-route outside port limits,
    2. the ship is operating an approved oil content monitor, oil separating or filtering device which will automatically alarm and stop discharging when the oil content of the effluent exceeds 15 parts per million (ppm), and
    3. the oil content of the effluent without dilution does not exceed 15 ppm and is not mixed with any cargo residues or chemicals

    With reference to machinery space bilges all sea areas are treated as special areas unless stricter local controls exist such as Antarctica when zero discharge is allowed.

The MARPOL regulations are more restrictive for oil tankers cargo residues and these should be treated in their own right under appropriate MARPOL regulations.

ALWAYS REFER TO THE LATEST REGULATIONS AS AMENDED. THE REQUIREMENTS OF WHICH WILL BE INCLUDED IN YOUR SHIPS SAFETY MANAGEMENT SYSTEM AND STANDING ORDERS.

It is your responsibility as a marine engineer to know, understand, and obey the law.


00:05:30
Running
Picture
MD 62
Bilge Wells/Sludge Tank
Alarms
Silence
SHORE CONNECTION
Ready
CONN
Shore
Sludge Storage
Incinerator System
Spill Oil Tank
Misc FW Drain
046
003
Sludge Purif.
AUTO
E 0.00
Overflow
Oil/Water
G 3.74
G 0.00
Z 0.00
% oil
063
from Bilge Sep.
Sludge Tank
18.7 m³
T 73.48
L 0.88
L 0.41
A
Setpt.
75.00
Steam System
090
G 39.93
G 0.05
X 0.92
Z 0.63
Bilge Water Pump
to Dirty Bilge Water Tank
Pump/Valve Control
AUTO
MAN
L 0.00
Bilge Wells
ER Aft
ER Port
ER Stbd
ER Fwd
L 0.16
Z 0.66
L 0.15
Z 0.63
L 0.28
Z 0.39
L 0.22
Z 0.12
M
V
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
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5.18 Bilge Wells

General
Bilge well description
The following bilge wells are included:
- Engine room aft
- Engine room forward
- Cargo hold port
- Cargo hold starboard

A small amount of oil and water is constantly leaking into the bilge wells (from unspecified sources). The engine room bilge well, in addition, receives possible overflow from the sludge tank and miscellaneous freshwater leakage/overflows from the engine room systems.
The bilge pumps can take suction from any of the four bilge wells, or from the sludge tank, and discharge it to the bilge separator.

There is a reciprocating pump for normally service use with the oily water separator. A centrifugal pump for pumping larger quantities of water direct to the bilge tank and an emergency bilge suction arrangement from the main SW centrifugal pumps for use when engine room flooding is occurring.

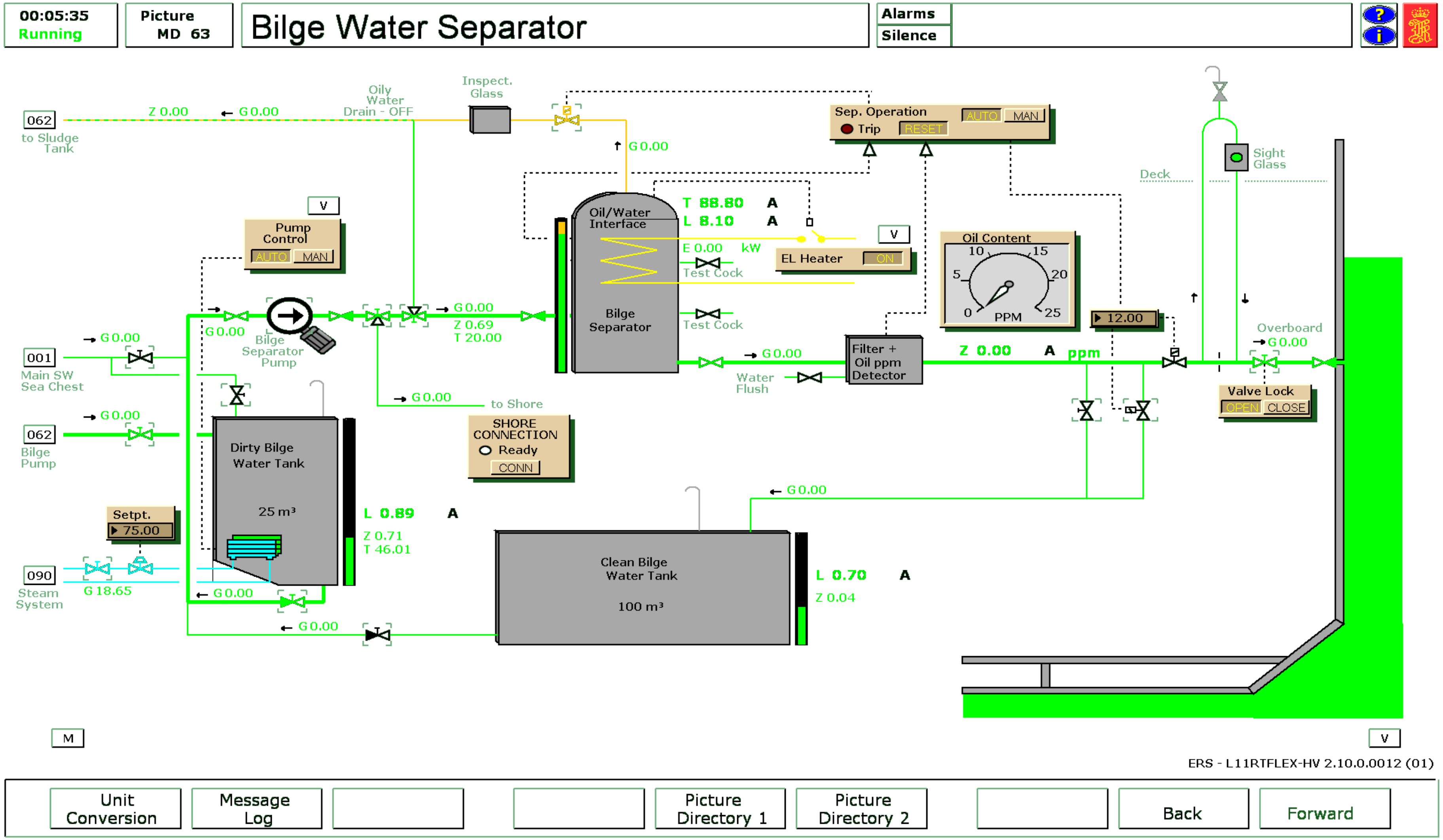
Sludge tank
The sludge tank receives drain from the following sources:
- HFO purifier sludge
- DO purifier sludge
- LO purifier sludge
- The settling tanks 1& 2

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

Sludge can be drawn from the sludge tank by the incinerator oil sludge pump and delivered to the sludge mixing tank. Otherwise sludge is discharged to a shore reception facility using the dedicated sludge pump. The suction from the sludge tank is taken from the top (oil) part of the sludge tank by means of a float device.

Pumping sludge water ashore
- Follow the onboard written procedure for pumping sludge ashore. It will be considered as a bunkering operation using the same onboard management systems. i.e. planning and check lists etc This will include
- Be aware of who is responsible for the job and inform the bridge.
- Connect the hose between the ship and the shore installation. (Press connect on shore connection panel)
- Prepare the emergency equipment as per S.O.P.E.P.
- Check the communication line.
- Open the valve after the sludge pump.
- Check the emergency stop of the pump with the watch man from the ship.
- Start the pumping and keep good communication with the watch man on the deck.

- Get the receipt from the sludge company when the job is finished.
- Complete all records i.e. log and oil record book.


00:05:35
Running
Picture
MD 63
Bilge Water Separator
Alarms
Silence
062
to Sludge Tank
Z 0.00
G 0.00
Oily Water Drain - OFF
Inspect. Glass
G 0.00
Sep. Operation
Trip
AUTO
MAN
RESET
Sight Glass
Deck
Oil/Water Interface
T 88.80 A
L 8.10 A
E 0.00 kW
Test Cock
EL Heater
ON
Oil Content
PPM
12.00
Pump Control
AUTO
MAN
Bilge Separator
Test Cock
G 0.00
Z 0.69
T 20.00
Bilge Separator Pump
001
Main SW Sea Chest
G 0.00
Water Flush
Filter + Oil ppm Detector
Z 0.00 A ppm
Overboard
G 0.00
Valve Lock
OPEN
CLOSE
062
Bilge Pump
to Shore
SHORE CONNECTION
Ready
CONN
Dirty Bilge Water Tank
25 m³
L 0.89 A
Z 0.71
T 46.01
Setpt.
75.00
090
Steam System
G 18.65
Clean Bilge Water Tank
100 m³
L 0.70 A
Z 0.04
M
V
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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5.18.1 Bilge Separator

General

The separator is provided to eliminate engine room bilge water in accordance with current pollution prevention regulations by discharging water containing no more than 12 ppm of oil overboard.

The bilge separator separates oily water taken from the sludge tank and bilge wells via the dirty bilge water tank. Clean water is pumped overboard or to the clean water bilge tank, while the oil is returned to the sludge tank.

The separator unit consists of a tank divided into several zones by internal baffles. A positive displacement bilge pump pumps unprocessed oil/water through the separator which discharges clean water via the oil content monitor overboard or to the clean bilge water tank. The reciprocating bilge pump can also be used to transfer high oil content waste to the sludge tank.

As the oil/water mixture flows through the tank, oil droplets are attracted to the coalesce 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 to the Clean Bilge Water Tank, depending on residual oil content. Effluent will only be discharged overboard when its oil content is less than 12 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 (50ºC).
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 water tank and sludge drain from separator to sludge tank are automatic controlled.

3. Manual bilge from engine room to clean bilge water tank

3.1 Check oil content in bilge well(s).
3.2 Open suction valve from bilge well(s).
3.3 Open valves to/from dirty bilge water tank
3.4 Open valves through separator.
3.5 Check that over board valve is closed.
3.6 Open discharge valve to the clean bilge water tank.
3.7 Check that bilge separator is in Auto.
3.8 Start bilge pump (piston) in manual.
If high oil content from bilge, let oil and water separate before starting the bilge separator pump.
3.9 Start bilge water separator and monitor that bilge water flows to clean bilge water tank.

4. Automatic bilge from engine room to clean bilge tank

4.1 Check that over board valve is closed.
4.2 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.
4.3 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 over board

5.1 Check and write down time and ship's 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 separator pump.
5.7 Observe PPM-meter to ensure limits are being maintained.
5.8 Check and write down time and ship's position when finished.
5.9 Complete the oil record book.

6 Stopping Bilge Separator

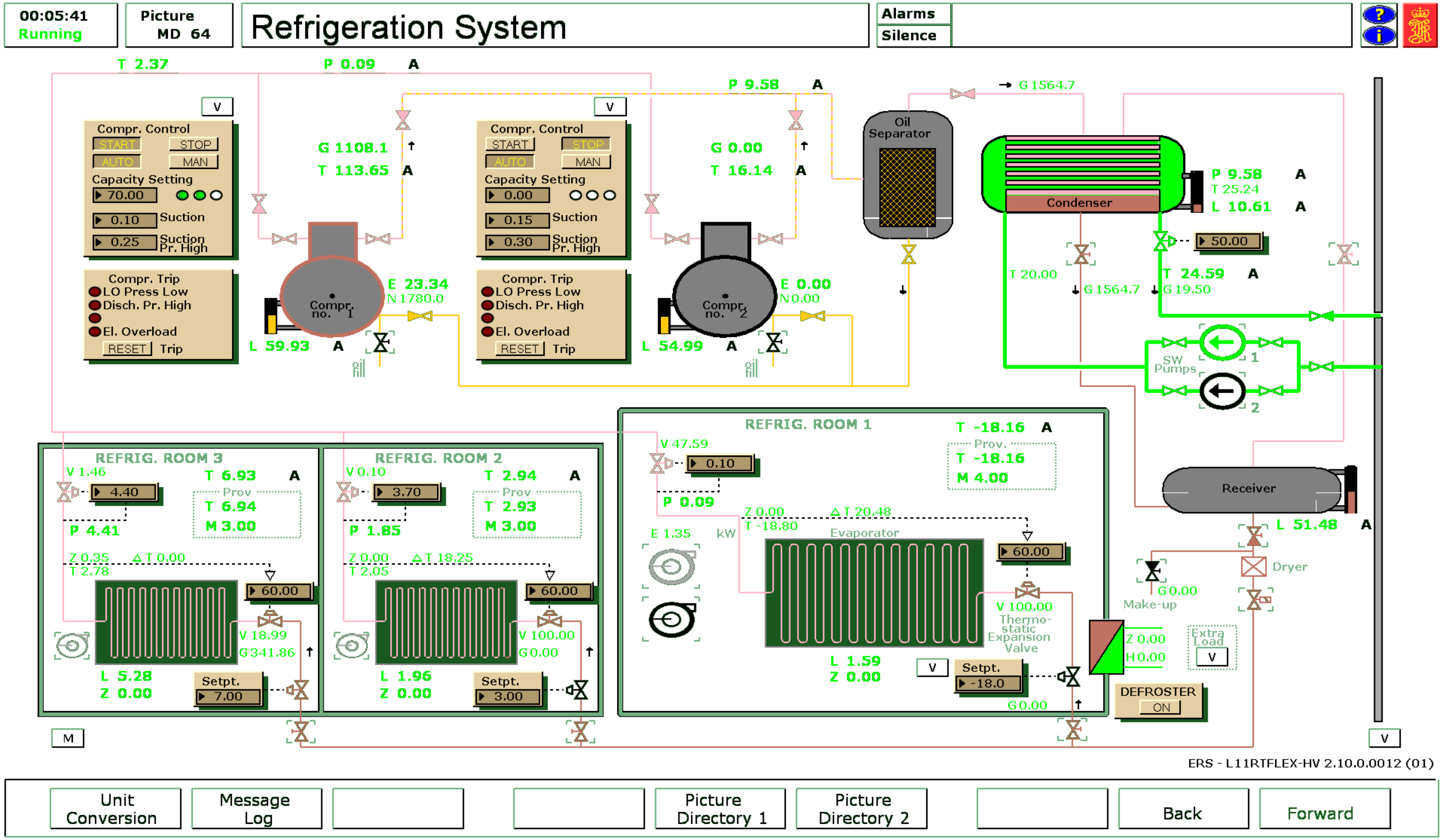
6.1 Manually open Sludge valve to remove recovered oil.
6.2 Stop bilge separator pump and close the bilge tank suction valve and overboard valves.

7 Pumping sludge or bilge water ashore

Bilge water can be pump ashore through the oil sludge pump.

Oily mixtures are transferred to the sludge tank by changing over the 3 way valve on the separator inlet and using the bilge separator pump to transfer the mixtures direct from the dirty bilge tank.

Water can be transferred to shore using the bilge separator pump via the 3 way valve provided for this purpose.


00:05:41
Running
Picture
MD 64
Refrigeration System
Alarms
Silence
T 2.37
P 0.09 A
P 9.58 A
G 1564.7
Compr. Control
START
STOP
AUTO
MAN
Capacity Setting
70.00
0.10 Suction
0.25 Suction Pr. High
Compr. Trip
LO Press Low
Disch. Pr. High
El. Overload
RESET Trip
G 1108.1
T 113.65 A
E 23.34
N 1780.0
L 59.93 A
Compr. no. 1
Compr. Control
START
STOP
AUTO
MAN
Capacity Setting
0.00
0.15 Suction
0.30 Suction Pr. High
Compr. Trip
LO Press Low
Disch. Pr. High
El. Overload
RESET Trip
G 0.00
T 16.14 A
E 0.00
N 0.00
L 54.99 A
Compr. no. 2
Oil Separator
Condenser
P 9.58 A
T 25.24
L 10.61 A
50.00
T 20.00
T 24.59 A
G 1564.7
G 19.50
SW Pumps
1
2
REFRIG. ROOM 1
T -18.16 A
V 47.59
0.10
Prov.
T -18.16
M 4.00
P 0.09
Z 0.00
ΔT 20.48
T -18.80
E 1.35
kW
Evaporator
60.00
V 100.00
Thermo-static Expansion Valve
L 1.59
Z 0.00
Setpt.
-18.0
G 0.00
REFRIG. ROOM 3
V 1.46
T 6.93 A
4.40
Prov
T 6.94
M 3.00
P 4.41
Z 0.35
ΔT 0.00
T 2.78
60.00
V 18.99
G 341.86
L 5.28
Z 0.00
Setpt.
7.00
REFRIG. ROOM 2
V 0.10
T 2.94 A
3.70
Prov
T 2.93
M 3.00
P 1.85
Z 0.00
ΔT 18.25
T 2.05
60.00
V 100.00
G 0.00
L 1.96
Z 0.00
Setpt.
3.00
Receiver
L 51.48 A
Dryer
G 0.00
Make-up
Z 0.00
H 0.00
Extra Load
DEFROSTER
ON
M
V
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
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5.19 Refrigeration System

General

The refrigeration plant is based on R404A and consists of the following main components:

- Electrically driven compressor (2 off)
- Compressor lubrication oil recovery system
- Sea water cooled condenser
- Refrigerant liquid receiver
- Three evaporators in three refrigeration rooms.

Nominal capacities are as follows:

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

The plant comprises following compartments:

Room 1

Meat/Fish compartment (-18°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 evaporator back pressure controller.

Room 2

Provision store compartment for perishable goods (+7°C) including:

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

Room3

Provision store compartment for perishable goods (+4°C) including:

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

Description

The compressors are lubricated and cooled by oil injection. The lubrication oil is separated from the compressed refrigerant gas in the oil separator. Oil from the bottom of the separator drains back to the compressor sumps, which have level monitoring and filling arrangements.

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 would be done by sea water in the lubricating oil cooler. (not shown)

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 compressor is adjusted by means of a suction slide valve.

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 outlet. 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 Set room temperature and back pressure control settings to appropriate values. Ref saturation temps required.
1.2 Open vapour and liquid valves between condenser and receiver.
1.3 Open sea water cooling valves to the condenser and start sea water pump.
1.4 Condenser cooling water control valve must be set to a suitable level to maintain appropriate condensation pressure.
1.5 Check compressor oil levels and top up as required.

2. **Starting**

2.1 Start compartments fans.
2.2 Open the liquid valves from receiver to evaporators.
2.3 Reset the trip functions if any present and start the compressor.
2.4 Set compressor temperature control into MAN and adjust capacity control slide valve to 10%, (otherwise compressor will trip on overload). Start the compressor.
2.5 Gradually increase compressor capacity manually checking the compressor electric power consumption during cooling down.
2.6 Set compressor temperature controller into AUTO when temperature in Room 1 is below –10°C.
2.7 Normal temperature in Room 1 is -20°C.
2.8 When Room 1 temperature approaches -18°C change to 1.5 kW fan.
2.9 Adjust Room 2 and 3’s evaporator capacity regulator to the desired temperatures.

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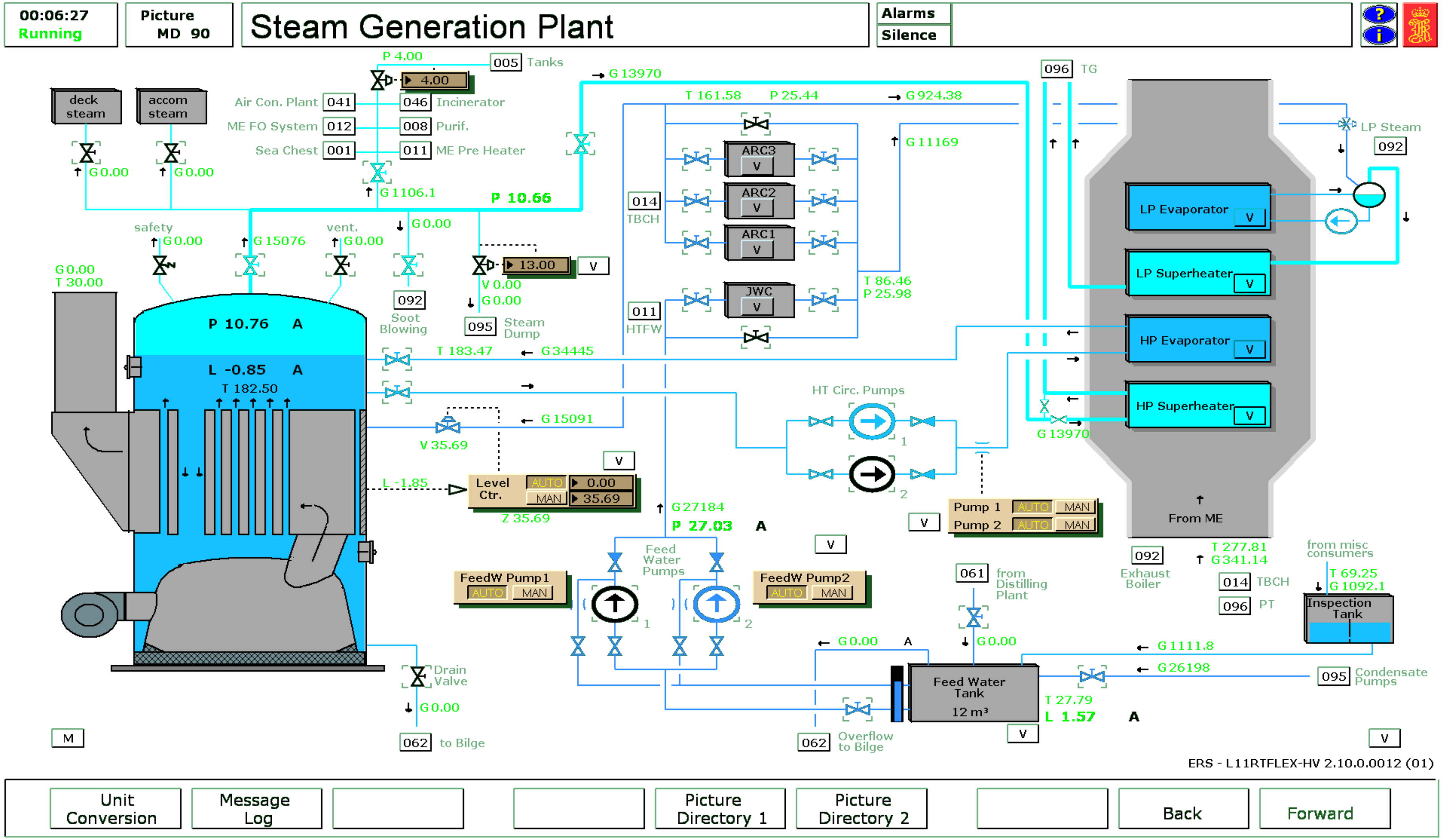
00:06:27
Running
Picture
MD 90
Steam Generation Plant
Alarms
Silence
deck steam
accom steam
Air Con. Plant
ME FO System
Sea Chest
Tanks
Incinerator
Purif.
ME Pre Heater
safety
vent.
Soot Blowing
Steam Dump
P 10.76 A
L -0.85 A
T 182.50
Level Ctr.
AUTO
MAN
ARC3
ARC2
ARC1
JWC
TBCH
HTFW
HT Circ. Pumps
Pump 1
Pump 2
TG
LP Steam
LP Evaporator
LP Superheater
HP Evaporator
HP Superheater
From ME
Exhaust Boiler
Feed Water Pumps
FeedW Pump1
FeedW Pump2
Drain Valve
to Bilge
from Distilling Plant
Feed Water Tank
12 m³
Overflow to Bilge
from misc consumers
Inspection Tank
PT
Condensate Pumps
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5.20 Steam Generation Plant

General

The major components in the steam system are:

- Steam receiver / oil fired boiler
- Exhaust gas evaporator heat exchanger.
- Steam consumers
- Inspection tank
- Feed water tank
- Two feed water pumps
- Exhaust gas economiser feed heat exchanger.
- Two circulation pumps for the exhaust boiler
- Necessary valves/controllers

Description

The oil fired boiler is a water tube boiler with a capacity of approx. 3.5 t/h at 7.0 bar for operation in port. The boiler can be operated on MDO or HFO manual or automatic.

The exhaust gas boiler has a capacity of approx. 11.0 t/h. for operation when the ME is running.
The oil fired boiler can be operated together with the exhaust boiler if it is necessary.

To control the steam pressure when the exhaust boiler is in 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 vices versa.

The oil burner is tripped at

- Flame out
- Low-low water level
- High-high water level
- High-high steam pressure

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.

The exhaust boiler has the option of being expanded by a third steam system, a very-low-pressure (VP) evaporator/superheating system. This is combined by a necessary pass-in function for the VP steam to the last expansion stages of the steam turbine. The steam pressure of the VP system is about 1 bar abs.

With the third steam system, the final exhaust temperature is reduced to110 ºC, well below the sulphuric acid dew point in the flue gas. This requires that the exhaust boiler is built by acid-resistant steel and equipped with efficient soot blowers.

The extended boiler version offers extra power in the order of 600-700 kW at full main engine load.

All condensate returns back to the Inspection tank.

Boiler feed water/main engine relationship
The boiler feed water is related to the main engine as follows;
The feed water is preheated by the main engine's HTFW circuit, refer HTFW system (MD11).

The Boiler feed water is also used as cooling medium for the turbo charger HT air coolers, (ref MD14). The feed water flows through the pre-heater in the HTFW circuit (MD11) and then through the air coolers back to the boilers.

When the optional VP (very low pressure) system is in operation, a large portion of the cooling water after the air coolers are flowing through the VP steam system and then back to the LP steam drum.

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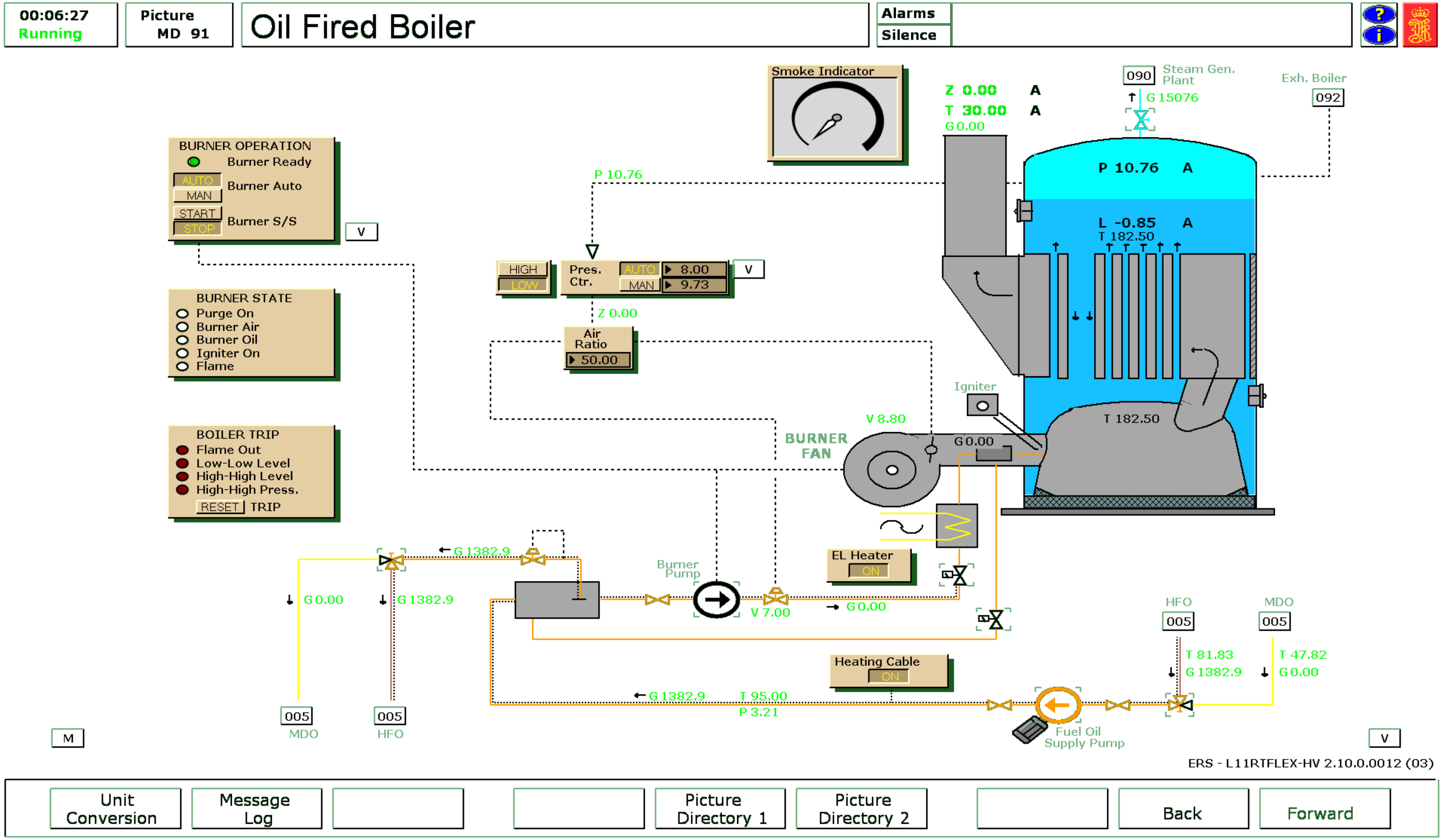
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Running
Picture MD 91
Oil Fired Boiler
Alarms
Silence
Smoke Indicator
BURNER OPERATION
Burner Ready
AUTO
MAN
Burner Auto
START
STOP
Burner S/S
BURNER STATE
Purge On
Burner Air
Burner Oil
Igniter On
Flame
BOILER TRIP
Flame Out
Low-Low Level
High-High Level
High-High Press.
RESET TRIP
P 10.76
HIGH
LOW
Pres. Ctr.
8.00
9.73
Z 0.00
Air Ratio
50.00
Z 0.00 A
T 30.00 A
G 0.00
090 Steam Gen. Plant
G 15076
Exh. Boiler 092
P 10.76 A
L -0.85 A
T 182.50
Igniter
V 8.80
BURNER FAN
G 0.00
EL Heater ON
Burner Pump
V 7.00
G 0.00
G 1382.9
G 0.00
005 MDO
005 HFO
HFO 005
MDO 005
T 81.83
G 1382.9
T 47.82
G 0.00
Heating Cable ON
T 95.00
P 3.21
Fuel Oil Supply Pump
M
V
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Operation procedure oil fired boiler

1. **Preparation**
1.1 Select fuel oil service tanks.
1.2 Connect the heating cable.
1.3 Line up valves on fuel systems D.O. and start the fuel oil supply pump.
1.4 Open boiler drum air ventilation valve. 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. After filling stop the pump again.

Starting procedure oil fired boiler

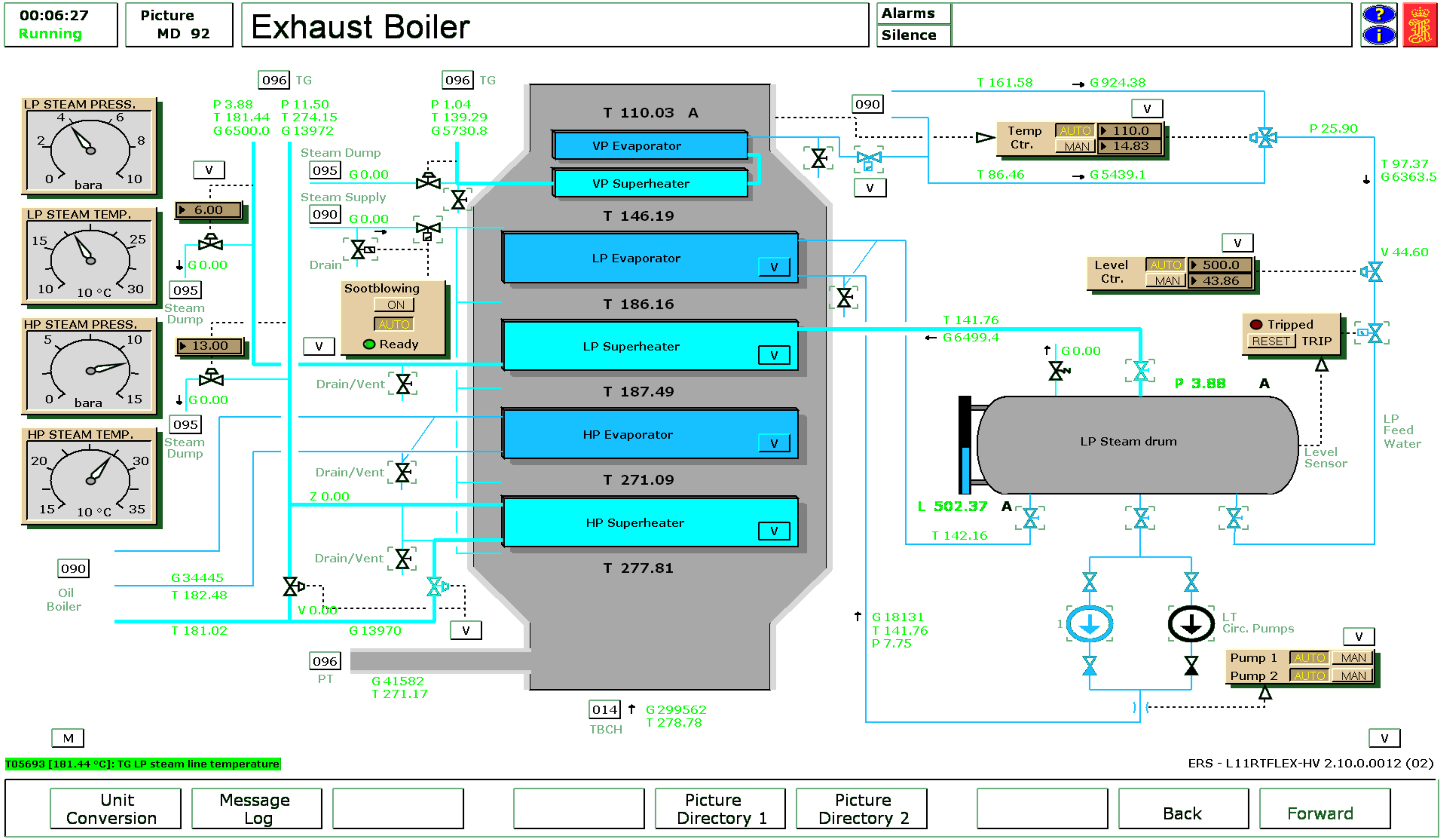
2. **MANUAL mode**
2.1 Observe the control panel and rectify any tripping faults.
2.2 High-high water level: Drain water by opening valve to bilge. Low–low water level: add water.
2.3 After rectifying faults, push the RESET button.
2.4 Set the pressure controller in manual mode with a set point on 5%.
2.5 Set the air ratio on 50%.
2.6 Start the burner in manual mode on the burner operation panel and check the burner state panel for the start sequence.
2.7 Check the smoke indicator.
2.8 Fire up the boiler slowly to reduce thermal strain by changing the set point on the pressure controller.
2.9 When the steam pressure is rising to about 1 – 2 bars pressure then close the vent valve.
2.10 When pressure rises to normal level, set feed water controller in auto and start the feed water pump.
2.11 Set up H.O. system and change to HFO.
2.12 Slowly open steam outlet valve and steam to consumers.
2.13 Set the pressure controller in auto mode.
2.14 Check the level, pressure, smoke indicator.

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.

Note!
It is only possible to set burner operation to auto for DO if heating cable and el heater are switched off.

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

Note:
Firing the boiler from cold condition to full steam pressure 7 bar, must take 1½ hour (manufacturer demand).


00:06:27
Running
Picture
MD 92
Exhaust Boiler
Alarms
Silence
LP STEAM PRESS.
bara
LP STEAM TEMP.
°C
HP STEAM PRESS.
bara
HP STEAM TEMP.
°C
Steam Dump
Steam Supply
Drain
Sootblowing
ON
AUTO
Ready
Drain/Vent
Oil Boiler
VP Evaporator
VP Superheater
LP Evaporator
LP Superheater
HP Evaporator
HP Superheater
T 110.03 A
T 146.19
T 186.16
T 187.49
T 271.09
T 277.81
Temp Ctr.
Level Ctr.
Tripped
RESET TRIP
LP Steam drum
P 3.88 A
L 502.37 A
Level Sensor
LP Feed Water
LT Circ. Pumps
Pump 1
Pump 2
AUTO
MAN
TBCH
PT
TG
T05693 [181.44 °C]: TG LP steam line temperature
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
Unit Conversion
Message Log
Picture Directory 1
Picture Directory 2
Back
Forward

5.21 Exhaust Boiler

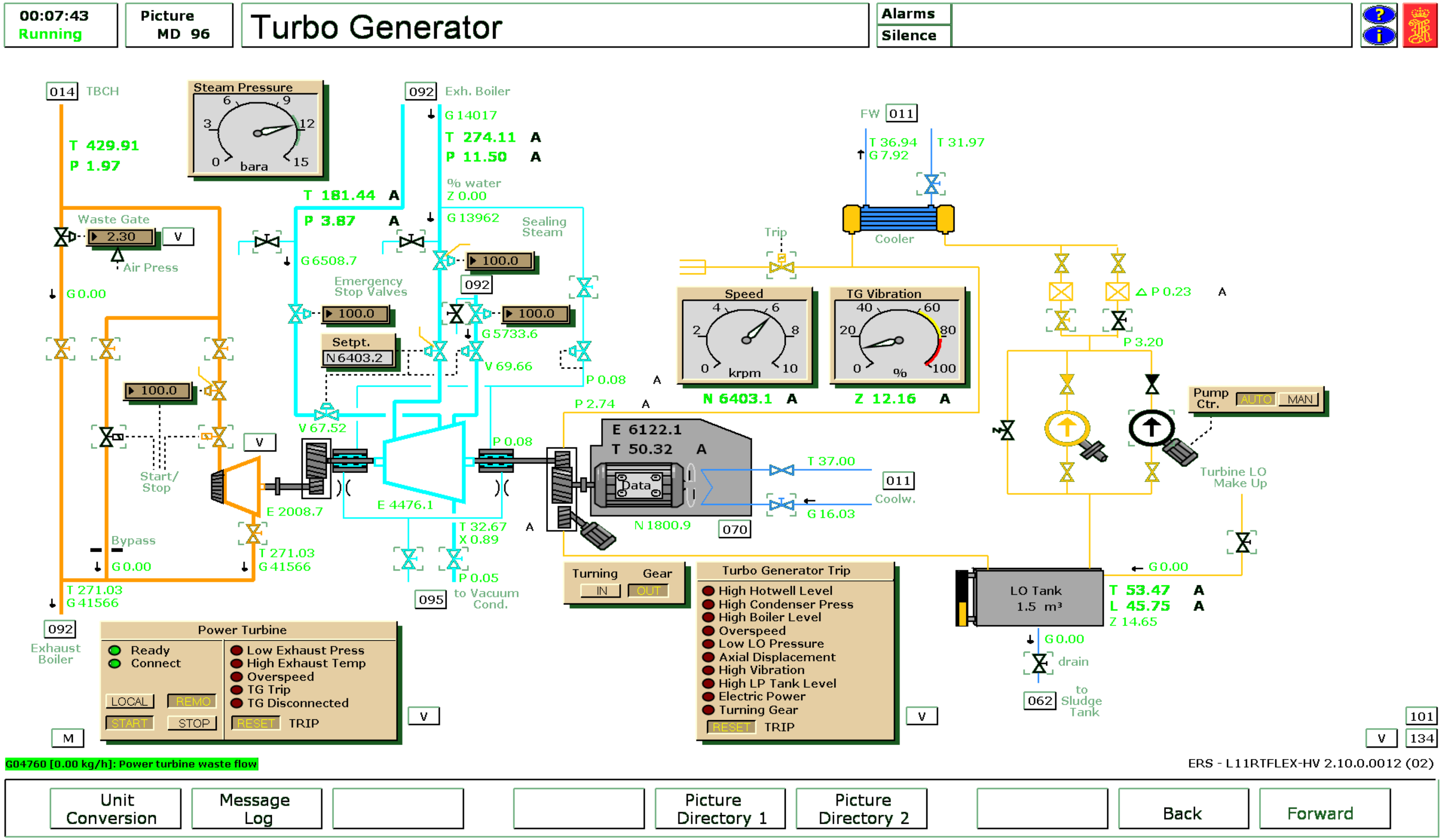
General
The exhaust boiler comprises a high-pressure part with HP evaporator and superheating sections and a low-pressure part with LP evaporator and superheating sections as well. Water is circulating between an auxiliary oil-fired boiler and the HP evaporator. The steam drum of the oil-fired boiler is used as steam/water separator. The pressures are sliding up and down depending on engine and boiler load. At full engine power the pressure in the high-pressure system is about 11.5 bar abs and in the low-pressure system about 5.0 bar abs. Flue gas temperature after the exhaust boiler is 150 ºC. Note! If he VP valve is open, the flue gas temperature is lowered to approximately 110 ºC.

There is a steam soot blower fitted for cleaning the exhaust tubes.

Operation
The Economiser section will be put into operation once the oil fired boiler main feed system is in use.
The Evaporator section is started up before stand-by engines and after the oil fired boiler feed system is in use by:

1. Starting one of the two circulating pumps.
2. Place the circulating pumps on auto to provide standby operation.

Caution:
In order to prevent damage of the exhaust gas boiler by eventual soot fire, the circulating pumps should always be kept in continuous service – also during stay in port. If shutting down wait 12 hrs before stopping the pumps.


00:07:43
Running
Picture
MD 96
Turbo Generator
Alarms
Silence
Steam Pressure
bara
TBCH
T 429.91
P 1.97
Exh. Boiler
G 14017
T 274.11 A
P 11.50 A
% water
Z 0.00
T 181.44 A
P 3.87 A
G 13962
Sealing Steam
Waste Gate
2.30
Air Press
G 6508.7
Emergency Stop Valves
100.0
G 5733.6
V 69.66
Setpt.
N 6403.2
G 0.00
P 0.08
P 2.74
V 67.52
Start/ Stop
Bypass
E 2008.7
E 4476.1
T 271.03
G 41566
T 32.67
X 0.89
P 0.05
to Vacuum Cond.
Exhaust Boiler
FW
T 36.94
G 7.92
T 31.97
Cooler
Trip
Speed
krpm
TG Vibration
N 6403.1 A
Z 12.16 A
P 0.23
P 3.20
Pump Ctr.
AUTO
MAN
Turbine LO Make Up
E 6122.1
T 50.32 A
Data
T 37.00
G 16.03
Coolw.
N 1800.9
Turning Gear
IN
OUT
Turbo Generator Trip
High Hotwell Level
High Condenser Press
High Boiler Level
Overspeed
Low LO Pressure
Axial Displacement
High Vibration
High LP Tank Level
Electric Power
Turning Gear
RESET TRIP
LO Tank 1.5 m³
T 53.47 A
L 45.75 A
Z 14.65
G 0.00
drain
to Sludge Tank
Power Turbine
Ready
Connect
LOCAL
REMO
START
STOP
Low Exhaust Press
High Exhaust Temp
Overspeed
TG Trip
TG Disconnected
RESET TRIP
G04760 [0.00 kg/h]: Power turbine waste flow
ERS - L11RTFLEX-HV 2.10.0.0012 (02)
Unit Conversion
Message Log
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5.22 Turbine generator

General
A 5000kW turbo-generator is fitted for use at sea with steam supply from the exhaust gas boiler. The turbo-generator is fed with superheated steam from the exhaust boiler. The exhaust fired boiler produces steam of 11 bar and superheated to approx. 270°C.

There is also 2300kW exhaust turbine, which is connected to the steam turbine via gear.

The turbine is modelled realistically with torque dependent on steam flow, inlet steam pressure/temperature and condenser vacuum. The throttle valve is controlled by a speed governor. The speed can be remotely adjusted by lower/raise signals from the electric switch board, or the manual set-point adjustment at the throttle valve.

When the turbo-generator is shut down, a gradual collection of water in the steam line/turbine casing is modelled. Before start of cold turbo-generator the main steam line and turbine casing must be drained for water.
If the turbo-generator is started with much water present in the steam line, “water strike” will occur. This can severely damage the turbine rotor, and is indicated by a turbine trip.

The Turbine generator is modelled with engine driven LO pump as well as an electric pump drawing from a LO tank and discharging to the Turbine generator via a fresh water cooled cooler. Two filters are provided, to allow one set to be used, and the other set on standby.
Water ingress into the lubricating oil sump is modelled. Hence the turbo-generator lube oil tank should be drained off regularly and new oil added. Very low/high lube. oil temperature or very high water content will reduce the lubrication ability of the oil and cause rotor instability and possible turbine trip (high vibration trip).

Sealing steam for the glands is provided from the main inlet line, via a pressure reducing valve. The sealing steam drains exhaust to the main condenser.

The turbo-generator is protected by a separate safety system, and trip signal is given on the following conditions:
- high condenser hotwell water level
- high condenser pressure (low vacuum)
- high boiler water level
- turbo-generator overspeed
- low lub.oil pressure
- axial displacement
- high vibration (due to cold start)
- high LP tank level
- Electric power
- turning gear engaged

All trips must be manually reset before the turbo-alternator can be started.

Power turbine

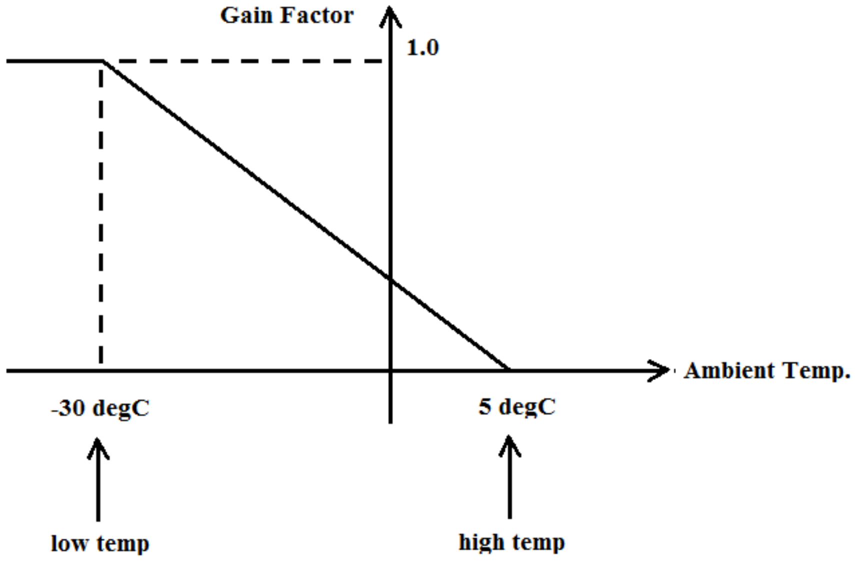
A power turbine is installed to utilize excess exhaust gas. The power turbine together with the steam turbine will form the total output power for the turbine generator (PT=1800kW + ST=5000kW). The gear ratio is 1.9 which means that the SSS clutch will engage at once the power turbine speed (12000) reaches the steam turbine speed (6400).

The purpose of the Waste Gate valve is to divert exhaust gas from the main engine away from the turbochargers when running in cold weather conditions. Cold air is more dens than warm air and can lead to too high scavenger receiver pressure and cylinder compression pressure. This pressure can be reduced by reducing the turbocharger speed by opening of the Waste Gate valve. Waste gate will open the by-pass when scavenging air pressure is higher than the setpoint (2.3 bar). The waste gate controller gain is adjusted against ambient air temperature. Lower temperature = higher gain. Max gain at outside temp -30 ºC, 0 gain at temperature above 5 ºC.

If, for any reason (ref trip list in variable page 9632), a trip of the PT is activated, the power turbine by-pass valve is opened and the power turbine exhaust trip valve will close, as well as the PT start/stop valve (V04753)

Waste Gate Valve

The valve is controlled by a simple P-controller that measure the scavenger air pressure.



Valve position setp = Gain * (Scav air press. – Press. set point)

The Gain is dynamic as a function of measured ambient temperature (T04763):

Gain = gain factor * nominal gain (C04760) where gain factor is:

Ambient temp > high temp (C04764): gain factor = 0

Ambient temp < low temp (C04765): gain factor = 1

Low temp < Ambient temp < high temp : gain factor = (high temp - ambient temp)/(high temp - low temp)

Valve position = timer (valve set point), where time constant for increase and decrease can be adjusted (C04761 and C04762)

Turbine generator operation

Before start-up, ensure that super heater is drained to avoid water in steam lines. When steam is available either from the oil fired boiler or the exhaust gas boiler then:

1. MD01; open seawater to steam condenser (V00673)
2. MD95; start Main Condensate pump R 04721 and No 1 vacuum pump R 04720
3. MD96; Open the following valves
   - steam line drain (V04657),
   - Sealing steam outlet (V04655),
   - turbine generator outlet to main condenser (V04660),
   - LO Filter No 1 (V04668)
   - LO cooling water shutoff valve (V04661)
   - Sealing steam valve (V04656)
4. MD96; Place Lube oil pump in AUTO.
5. MD96; Engage the turning gear for about 1 minute. On dis-connection reset the turbine trip.
6. MD96; Open the turbine generator HP emergency stop valve (V04652) to 15%.
7. MD96; The Turbine generator should start to roll slowly. Let the turbine rotate for 2 minutes at this speed.
8. MD96; Continue to open the valve very slowly, up to 40% over 15 minutes.
9. MD96; Once the machine is up to speed (6400 rev/min) the emergency stop valve should be opened to 100% and steam line drain (V04657) closed.
10. MD96; Gradually, open the turbine generator LP emergency stop valve (V04690) to 100%.
11. Monitor all temperatures and pressures to ensure no alarms are active. The turbine generator can now be put on electrical supply.
12. MD96; Put the power turbine into READY condition by open the power turbine exhaust shut off valve (V04570)
13. MD96; Start the power turbine by open the Power turbine emergency stop/start valve (V05743) until 100% open.
14. MD96; When the power turbine has reached steam turbine speed, (note gear ratio = 1.9 and power turbine speed, variable N04756) the power turbine SSS clutch will engage and the PT will be connected to the TG shaft.

It is important that the turbine is started slowly. This is to reduce thermal tension during start up. If the turbine speed is taken up too fast, high vibration will occur and the turbine will trip.

To stop the turbine generator

1. MD101; Disconnect the power turbine by pressing the ETURB DISC button. Note! TG must be out of AUTO.
2. Disconnect the turbine generator from the main switchboard by pressing DIS-CONN button. Note! TG must be out of AUTO.
3. MD96; Close the turbine generator LP emergency stop valve (V04690).
4. MD96; Slowly close the emergency stop valve (V04652) to 20% open over 3 minutes. This will remove instability within the steam supply system.
5. MD96; open the steam line drain (V04657)

6. MD96 After the turbo-generator has cooled down (leave for 10 minutes), close the emergency stop valve (V04652).
7. MD96; After the turbo-generator has stopped, stop the electrical driven lubricating pump.
8. MD96; Close the following valves:
   - steam line drain (V04657),
   - Sealing steam outlet (V04655),
   - turbine generator outlet to main condenser (V04660),
   - sealing steam valve (V04656).
   - LO Filter No 1 (V04668).
   - LO cooling water shutoff valve (V04661).
   - TG enclosure cooling water shutoff valve (V06055).

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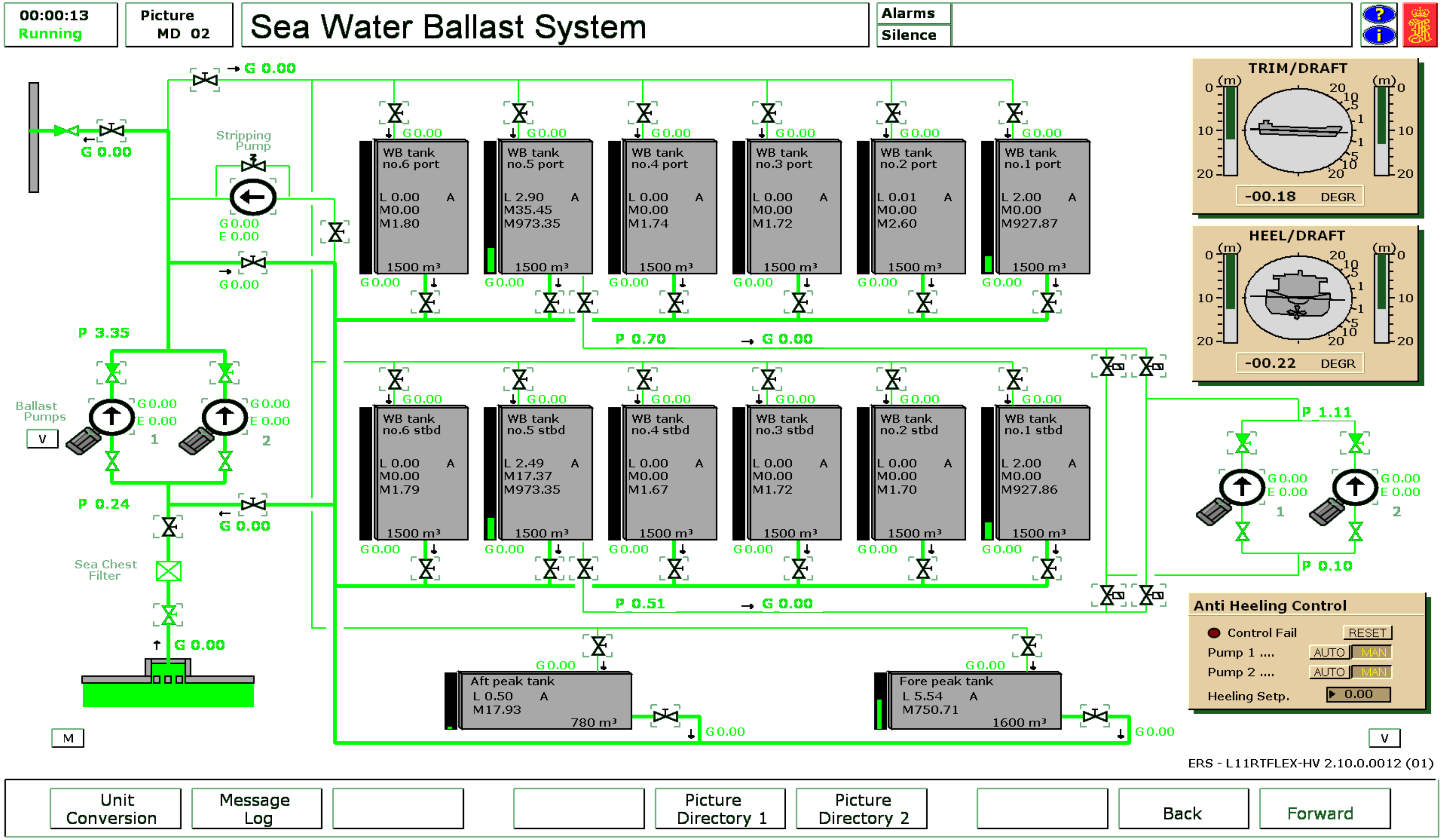
00:00:13
Running
Picture
MD 02
Sea Water Ballast System
Alarms
Silence
Stripping Pump
Ballast Pumps
Sea Chest Filter
WB tank no.6 port
WB tank no.5 port
WB tank no.4 port
WB tank no.3 port
WB tank no.2 port
WB tank no.1 port
WB tank no.6 stbd
WB tank no.5 stbd
WB tank no.4 stbd
WB tank no.3 stbd
WB tank no.2 stbd
WB tank no.1 stbd
Aft peak tank
Fore peak tank
TRIM/DRAFT
-00.18 DEGR
HEEL/DRAFT
-00.22 DEGR
Anti Heeling Control
Control Fail
RESET
Pump 1 ....
Pump 2 ....
AUTO
MAN
Heeling Setp.
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
Message Log
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5.23 Sea Water Ballast System

General:
The purpose with the ballast system is to continue a safe stability (trim/ heeling/draft) for the ship in any condition.
The ballast system consists of the following:

- Water ballast pump 1
- Water ballast pump 2
- Water ballast pump 3 (piston pump)
- Two heeling pumps
- Six wing ballast tank port, each volume 1500 m^3
- Six wing ballast tanks starboard, each volume 1500 m^3
- One after peak tank 780 m^3
- One fore peak tank 1600 m^3
- An anti heeling control panel

Wing ballast tank no. 5 port and stbd can be used as heeling tanks. The heeling system can be operated in manual or auto mode.

BALLAST OPERATIONS
Ballast water must only be pumped into ballast tanks or out of ballast tanks when full consideration has been given to the effect of transfer on the trim, draught, stability and stresses of the ship. No more than one single tank, or one pair of tanks, should be in the partly filled (slack) condition simultaneously.
Local regulations must be taken into account before discharging ballast water and any restrictions on the discharge of ballast water must be strictly observed.
All ballast and deballasting operations for each tank must be entered into the ballast log record book, form ID 207Q, stating date, ship's position, temperature, specific gravity, pumped quantity, tank quantity and any further remarks. Additionally, the IMO Ballast Water Reporting Form, ID 208Q must be filled in.

Procedure for Setting Up for Ballasting
The chief officer is responsible for the ballast system in cooperation with the chief engineer.
Filling ballast tanks

a) Ensure that all suction strainers are clear.
b) Ensure that all the pressure gauge and instrumentation valves are open and that the instrumentation is reading correctly.
c) Open the required hydraulically operated remote control ballast valves.

WARNING
Under no circumstances must both ballast pumps be used to fill a single tank due to possible over pressurisation of the tank. The ballast tanks must NOT be over filled, as this can lead to ballast water entering the cargo holds and flooding the space via the open ventilation covers.
(**Note:** Under normal circumstances no more than one pair of ballast tanks (port and starboard) should be partly filled at any one time in order to prevent stability problems due to the effect of slack tanks. Tanks not currently being filled or emptied should be either completely full or empty.)

d) When the ballasting operations are complete, shut down the pumps and close all system valves.
e) Fill in the ballast log record sheet.

ANTI-HEELING SYSTEM

The anti-heeling tanks are located on the port and starboard sides of the ship and are No.5 side water ballast tanks.

The heeling tanks are filled and emptied as part of the ballast system.

The heeling system consists of two pumps located in a pipe joining the two heeling tanks.

There are four valves opening and closing in response to the control system, opening when the pump operates to move water from one tank to the other and closing when water has been transferred so that water cannot flow between tanks by means of gravity.

The valve closes gradually in order to prevent water hammer.

The valve is closed when the system is not operating. The pump is started and stopped from the system control panels, either in the ECR or on the bridge.

The maximum allowed level in any tank during heeling operations is 14.80 m and the minimum level at which the pump will automatically cut out is 0.3 m.

High level floats are fitted in each tank, these are connected to the alarm and monitoring system. A low level transmitter is fitted in each tank which stops the pump if the low level is reached. If the heel of the ship exceeds 6° when the pump is in operation, the system automatically shuts down.

CAUTION

If a heeling tank is ballasted to full capacity, the overflow can enter the cargo hold via the open ventilation covers.

The anti-heeling system enables the vessel to remain in the upright position during cargo loading and discharge operations. In order to ensure that containers move freely in the cell guides, the vessel should be in the upright position but the loading and discharge of containers can result in a slight port or starboard list. Correction of the list is achieved by moving a quantity of water from the port to the starboard anti-heeling tank, or vice versa.

Operation of the system may be set to manual or automatic. When set to manual, operation the pump is controlled as required but in automatic mode the pump is completely under the control of the anti-heeling system. The pumping system operates in response to a sensor, which detects any change in the ship from the upright position. The heel detector unit is located on a mounting plate, which is fitted athwart ships on the ship’s centre line. The signal from this is transferred to the anti-heeling control system and this responds by operating the pump to transfer water between the anti-heeling tanks in order to correct the list. An indicator panel is fitted on the bridge.

The pump cut-in and cut-out angles of heel are set in the alarm and monitoring control display. The start angle is normally set at 0.05° and the stop angle at 0.02°. If the start angle is made less, the frequency of pump operation will increase and that can be detrimental to the system.

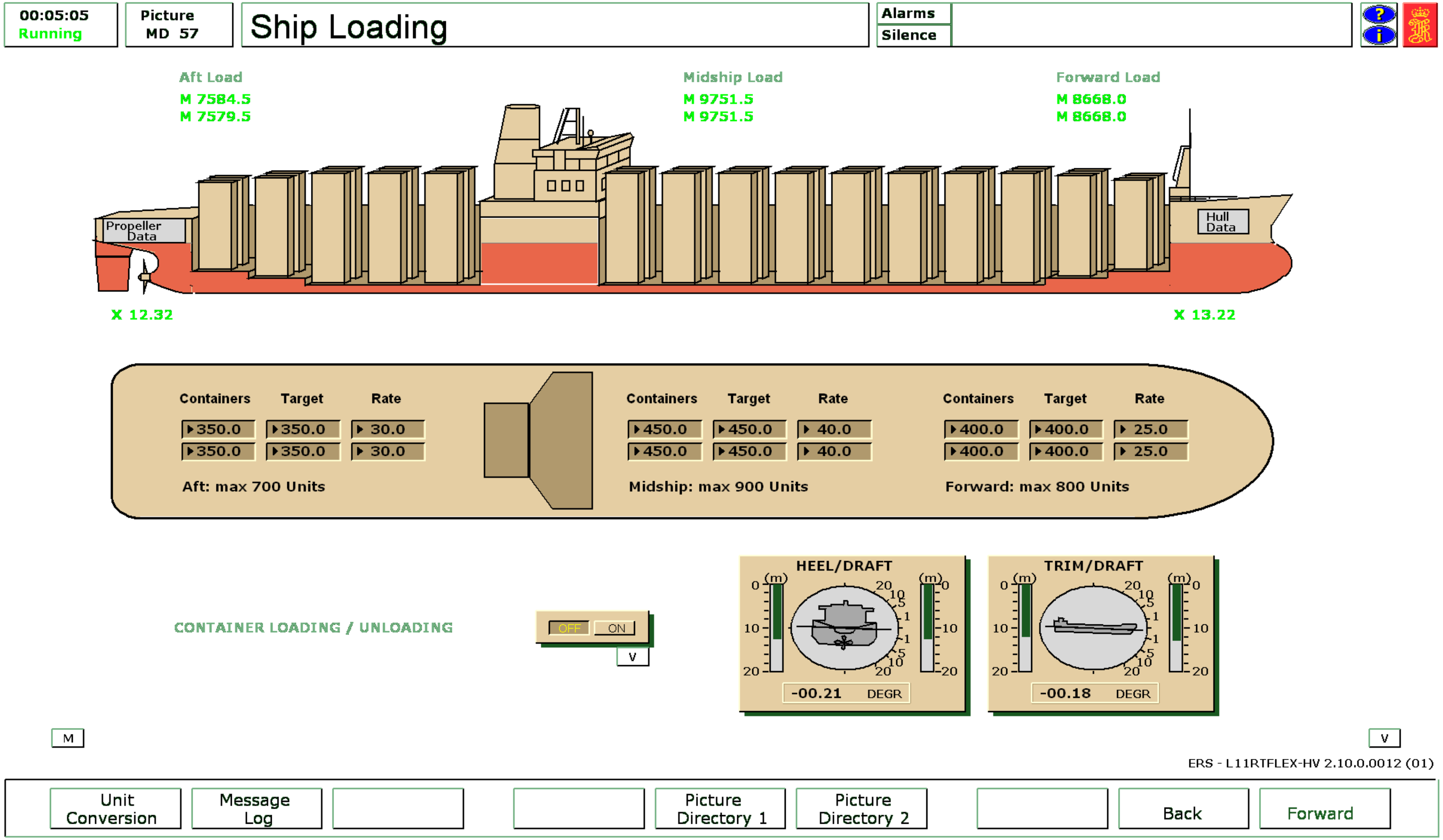
A microprocessor based on programmable logic control system controls the anti-heeling system and allows for adjustment of angles and the valve closing time.

CAUTION
It is essential that only authorised personnel with a knowledge of the system and an understanding of ship stability make any adjustment to the anti-heeling system. Errors in adjustment can have serious implications on the vessel's stability and operational performance.

CAUTION
Operation of the anti-heeling system is only permitted in harbour.

Procedure for Operating the Anti-Heeling System in Automatic

a) Ensure that the anti-heeling tanks are filled with sea water to the correct level.
b) Ensure that there is electrical power at the pump and the anti-heeling system control panel and system devices. Ensure that the local control panel is set to AUTO for one pump.
c) The anti-heeling system will operate automatically detecting any changes from the upright position and operating the pump and automatic valve to direct water between the heeling tanks in order to correct the heel.


00:05:05
Running
Picture
MD 57
Ship Loading
Alarms
Silence
Aft Load
M 7584.5
M 7579.5
Midship Load
M 9751.5
M 9751.5
Forward Load
M 8668.0
M 8668.0
Propeller Data
Hull Data
X 12.32
X 13.22
Containers
Target
Rate
350.0
350.0
30.0
350.0
350.0
30.0
Aft: max 700 Units
450.0
450.0
40.0
450.0
450.0
40.0
Midship: max 900 Units
400.0
400.0
25.0
400.0
400.0
25.0
Forward: max 800 Units
CONTAINER LOADING / UNLOADING
OFF
ON
HEEL/DRAFT
-00.21 DEGR
TRIM/DRAFT
-00.18 DEGR
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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5.24 Ship Load

General
The container load of the vessel can be changed using Ship Load.

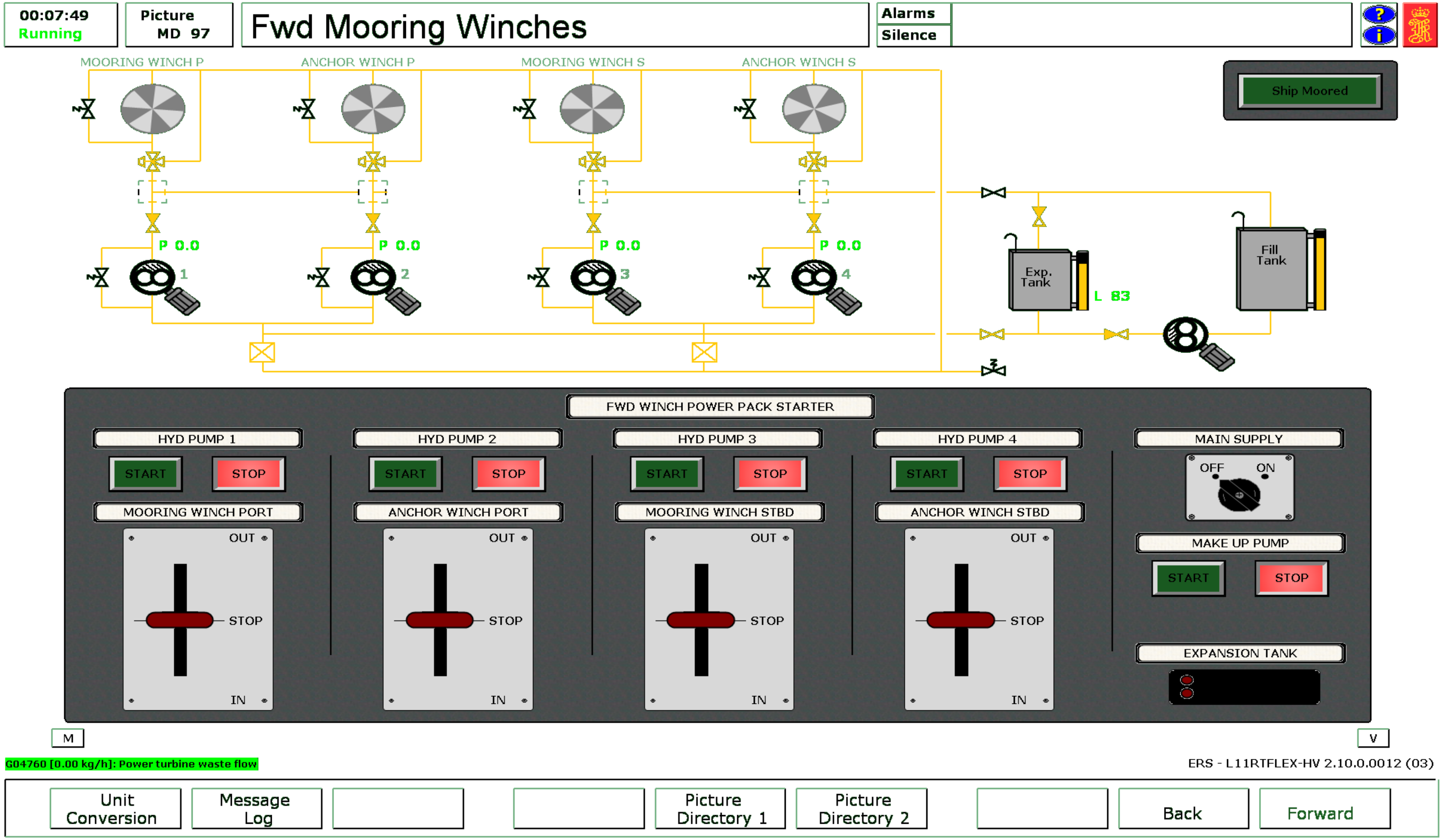
Containers may be loaded or discharges from Port and/or Stbd in the forward, midship and aft sections of the vessel.

Maximum container load is 2100 units.

In order to load or discharge containers the vessel must be in port.

To load or discharge the vessel input the target number of containers and the rate. Turn on container loading / unloading.

During cargo operations the heeling system should be in operation and loading adjusted to ensure that the vessel trim and list do not become excessive. Care must also be taken to prevent high sheer stress in the hull due to uneven loading.


00:07:49
Running
Picture
MD 97
Fwd Mooring Winches
Alarms
Silence
MOORING WINCH P
ANCHOR WINCH P
MOORING WINCH S
ANCHOR WINCH S
Ship Moored
P 0.0
P 0.0
P 0.0
P 0.0
Exp. Tank
L 83
Fill Tank
FWD WINCH POWER PACK STARTER
HYD PUMP 1
HYD PUMP 2
HYD PUMP 3
HYD PUMP 4
MAIN SUPPLY
START
STOP
OFF
ON
MOORING WINCH PORT
ANCHOR WINCH PORT
MOORING WINCH STBD
ANCHOR WINCH STBD
OUT
STOP
IN
MAKE UP PUMP
EXPANSION TANK
M
V
G04760 [0.00 kg/h]: Power turbine waste flow
ERS - L11RTFLEX-HV 2.10.0.0012 (03)
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5.25 Deck Machinery MD97

General

The vessel is equipped with four low pressure hydraulic winches forward and aft. There are two anchor winches and two mooring winches forward and four mooring winches aft. The power pack is sized to operate two windlasses or four winches at specified capacity simultaneously.

The Hydraulic Power Pack unit consisting of four electric motor driven hydraulic pumps, filter, valves, pressure gauges, drain valve, make up pump, servo unit, and expansion tank with level switches.

Working pressure:	64 bar.
El. power:	4 x 152 kW.
Oil delivery:	4 x 1313 l/min.

Speed and rotation direction can be locally operated.
The pumps are screw type.

Typical return pressure:	3 Bar
Expansion tank volume:	140 l

The package consists of a Group starter with local start / stop buttons, isolating switch, and running light. Low level alarm and low/low level alarm with automatic stop and extension to AMS.

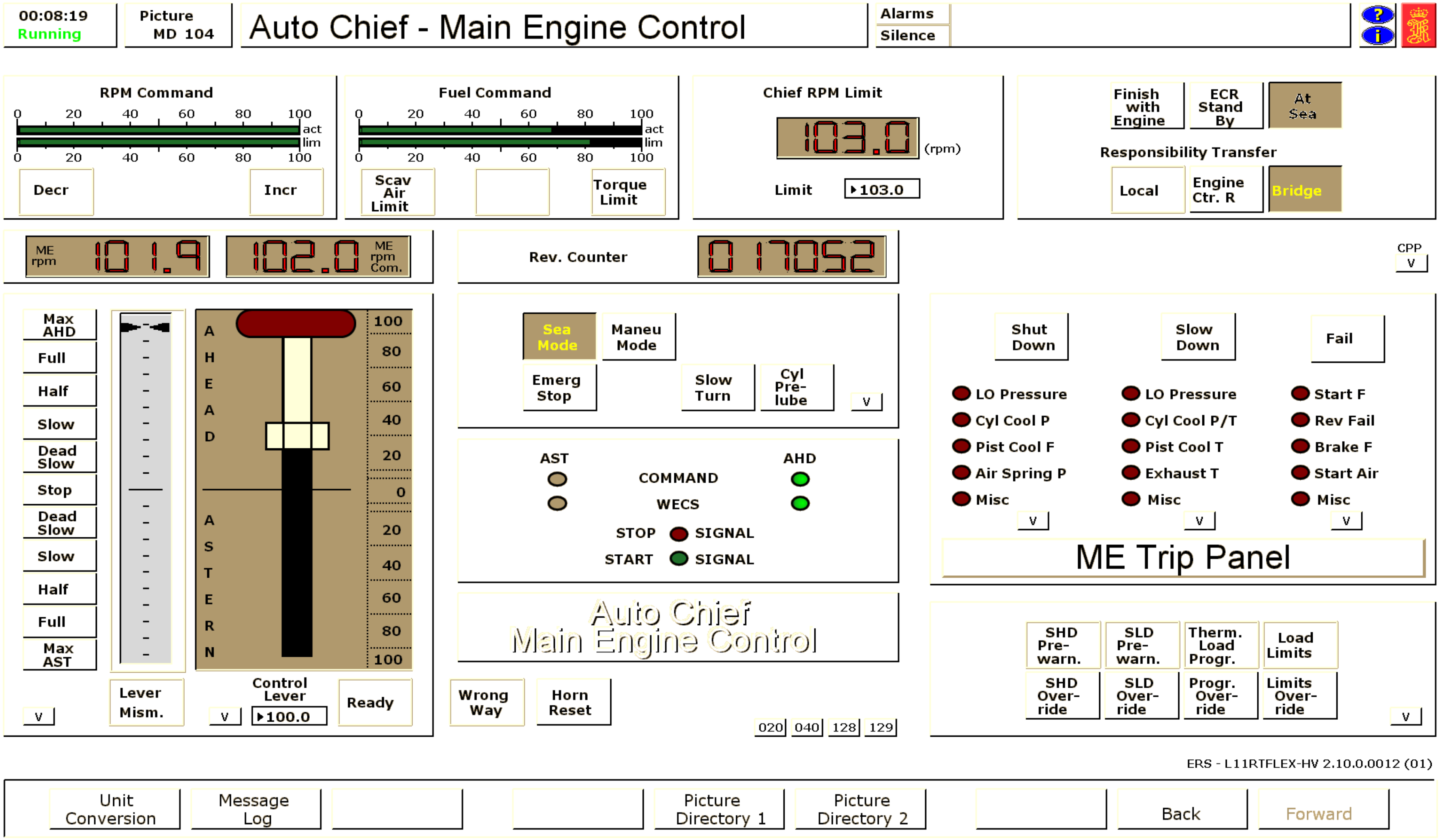
Operation

Preparation

Check content in hydraulic oil tanks, refill if necessary.
Check that change-over valves are in correct position (open for flow).
Check ship status (moored in Port?)

Start procedure

Connect main power supply.
Set the changeover valves to correct position.
Start hydraulic pump(s) locally from Powerpack starter Panel.
Throttle is moved in order to run the winch in our out.
Normal operation is one pump for each winch. Change over valves gives the possibility for selection two pumps for one winch, in order to increase winch speed. By running one winch with two pumps at full speed and without load will case overspeed damage of the winches after some time.
It is also possible to interlock in order to select two pumps in parallel with two winches.


00:08:19
Running
Picture MD 104
Auto Chief - Main Engine Control
Alarms
Silence
RPM Command
Fuel Command
Chief RPM Limit
103.0
(rpm)
Limit
103.0
Decr
Incr
Scav Air Limit
Torque Limit
Finish with Engine
ECR Stand By
At Sea
Responsibility Transfer
Local
Engine Ctr. R
Bridge
ME rpm
101.9
102.0
ME rpm Com.
Rev. Counter
0 17052
CPP
Max AHD
Full
Half
Slow
Dead Slow
Stop
Dead Slow
Slow
Half
Full
Max AST
AHEAD
ASTERN
Lever Mism.
Control Lever
100.0
Ready
Sea Mode
Maneu Mode
Emerg Stop
Slow Turn
Cyl Pre-lube
AST
AHD
COMMAND
WECS
STOP SIGNAL
START SIGNAL
Auto Chief
Main Engine Control
Wrong Way
Horn Reset
020
040
128
129
Shut Down
Slow Down
Fail
LO Pressure
Cyl Cool P
Pist Cool F
Air Spring P
Misc
LO Pressure
Cyl Cool P/T
Pist Cool T
Exhaust T
Misc
Start F
Rev Fail
Brake F
Start Air
Misc
ME Trip Panel
SHD Pre-warn.
SLD Pre-warn.
Therm. Load Progr.
Load Limits
SHD Over-ride
SLD Over-ride
Progr. Over-ride
Limits Over-ride
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
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5.26 AutoChief – Main Engine Control

General
The following controls are present at the AutoChief - ME Control Panel:

Controls

- Fuel control lever (also the combined RPM/Pitch lever when in cpp mode)
- Emergency Stop
- Responsibility Transfer between Local/Engine Control Room/Bridge
- Status communication between Bridge and Engine Control Room for Finished with Engines/ECR Stand By/At Sea
- Control Mode between manoeuvring mode and sea mode
- Slow turn request button
- Cylinder pre-lube
- VIT select
- VEC select

Status indication

- Fuel lever command request
- Bridge Telegraph
- Main Engine Shut Down
- Main Engine Slow Down
- Main Engine Fail Status
- Over-ride indicators for Shut Down/Slow Down/Thermal Load-Up programme/Load Limits
- Running hour
- Revolution counter
- ME RPM actual (digital and graphical display)
- ME RPM command (graphical display)
- ME RPM limit (graphical display)
- Bridge/ECR lever mismatch
- Fuel command actual (graphical display)
- RPM command limit (graphical display)
- Fixed speed indication and set-point input

Controllable Pitch Propeller
To operate in CPP mode the variable on page 1940 must be set to 1. This will display the CPP panel which displays the pitch and from where the main engine may be stopped and started. Access is also allowed to page MD53

Combinator mode is used when the Controllable Pitch Propeller (CPP) function is selected.
At zero pitch the engine speed is reduced to improve manoeuvrability, and as the fuel control lever is increased, then the pitch and engine speed increases until the engine is operating at full speed. The relationship between speed and pitch is fixed,

Fixed Pitch
In this mode the propeller pitch is fixed at the optimum setting, close to the full power output of the engine. The speed of the engine is varied by the fuel control lever, with the speed signal being adjusted by the various limiters and filters.

.

Emergency Stop

When this switch is activated, the engine is stopped as the fuel pump suction valves are opened, spilling the high-pressure fuel generated by the fuel pump.

Transfer of Responsibility

The responsibility buttons are provided to select the appropriate control station for the main engine. The options are:

- **Local** – This control station would be selected when a problem or defect was present within the main engine control system, such as governor or control station hardware defect. Local control will not overcome a starting system malfunction, as the starting system is common to all control stations.
- **Engine Control Room** – This control station would be selected for engine manoeuvring from the engine control room, such as engine testing, or in situations when specific engine control is required (such as when a shut down or slowdown is over-ridden)
- **Bridge** – This control station is normally the default control station and would be used under most operating conditions. Operating from the Bridge releases engine room personnel to monitor engine room operations.

Transfer from the ECR to Bridge

1. Check that the Bridge and ECR levers are matched by observing the indicators on the left of the fuel control lever, and the Lever mismatch light is unlit.
2. Press the push-button “BRIDGE” on AutoChief panel. The “BRIDGE” button then starts to flash.
3. When the Bridge accepts the transfer then the “BRIDGE” button turns to steady light.

Note the Bridge personnel may be engine operators manning the Bridge panel MD110.

The ship is now controlled from the Bridge, ref MD110 for details. The engine would start up in standby mode (SBE), see SBE entry data for details.

Transfer from the Bridge to ECR

1. Check that the Bridge and ECR levers are matched by observing the indicators on the left of the fuel control lever, and the Lever mismatch light is unlit.
2. Press the push-button “ECR” on Bridge panel on MD110
3. The “ECR” button then starts to flash.
4. The operator now accepts the transfer to ECR by pressing the “ECR” button
5. The “ECR” button turns to steady light.

The ECR now has control of the engine, and should utilise the engine control lever to match the requested speed and direction from the bridge.

In case of failure of the bridge control lever the Emergency Telegraph may be used to convey engine movement requests from the Bridge.

This is carried out by:

1. Bridge presses the button of the required movement (on screen MD110)
2. The selected button on the telegraph on the Bridge and ECR starts to flash
3. The ECR personnel confirms the engine request by pressing the flashing button on their panel (MD104)
4. The engine direction and speed should be adjusted to comply with the Bridge request.
5. Move handle to relevant engine speed by point and click on the interactive field (default settings are dead slow/slow/half and full positions) or by typing in desired command in the numeric window.

The engineer on duty can visually see the operation of the engine controls, with regard to ahead and astern command and actual WECS state position. The activation of both the stop and start signals can also be seen on this panel. If Wrong Way alarm is activated, the WECS state direction does not correspond with command from bridge.

Transfer from ECR to Local control

1. Press the push-button “Local” on AutoChief panel
2. The “Local” button then starts to flash.
3. On the Local Control screen MD20, the operator accepts the transfer then the “Local” button turns to steady light.

The ship is now controlled from the Local control station, ref MD20 for details.

The Local Control station personnel should utilise the telegraph system to convey engine movement requests from the Bridge.

This is carried out by:

1. Bridge presses the button of the required movement (on screen MD110)
2. The selected button on the telegraph on the Bridge and Local Control panel starts to flash
3. The Local Control personnel confirms the engine request by pressing the flashing button on their panel (MD20)
4. The engine direction and speed should be adjusted to comply with the Bridge request.

Transfer from the Local Control to EC R

1. Press the push-button “ECR” on the Local Control screen on MD20
2. The “ECR” button then starts to flash.

4. The operator now accepts the transfer to ECR by pressing the “ECR” button on screen MD104
5. The “ECR” button turns to steady light.

ME Status indication
The status lights are used as a communication between the Bridge and ECR as the request for engine readiness. The actual engine readiness would be discussed by verbal communications, but the status lights are used to convey a request by the Bridge and an acceptance by the ECR.

Finished with Engines – This would be selected when the main engine is no longer required. Finished with Engine (FWE) would be selected when the vessel is in port, or at a secure anchorage. When the FWE signal is received, the engine systems would be partly shut down, and possible heating introduced.

The following procedure could be instigated when FWE order is received:

1. Close the main engine start air isolation valve (MD60)
2. Place the Start air valve in the block position (MD20)
3. Engage the turning gear (MD20)
4. Open the Indicator Cocks) on individual cylinders
6. Close the bypass valve of the HTFW Preheater, and open the steam inlet valve (MD10)

ECR Stand By – When standby (SBE) is selected, then the main engine should be ready for manoeuvring, up to and including full ahead or astern. The ECR should only accept SBE when the engine and its associated system are ready to provide full manoeuvring capabilities.

As a minimum preparation the following subsystems would be ready:

1. Two diesel generators connected to the 440V board
2. Oil fired boiler operating and on-line
3. Sea suction on high (unless in light ballast conditions)
4. Auxiliary blowers operating in automatic
5. Two steering gear motors operating
7. Check that start air block valve is open.
8. Check that start air distributor block valve is open.
9. Check that indicator cocks are closed.
10. Check that turning gear is disengaged.
11. Reset any slow down or shut down alarms. Note: the speed lever must be set to stop position to be able to reset any shut downs.
12. Check that no safety overrides are present.

At Sea – This button is selected to communicate that the Bridge no longer requires full manoeuvring of the engine as the vessel is in open water. This will allow the engineering staff to operate the engine room systems in economical mode. As such one or more of the diesel engine would be then shut down.

The speed and power of the engine would be increased up to the required full sea speed by pressing the button marked “sea mode” which ramps the engine up in a controlled manner from manoeuvring speed to full sea speed.

Engine Safety Panel
To operate the main engine safely, all critical parameters must be monitored in order to activate alarm and, if required, initiate automatic slowdown and/or shutdown of the engine.

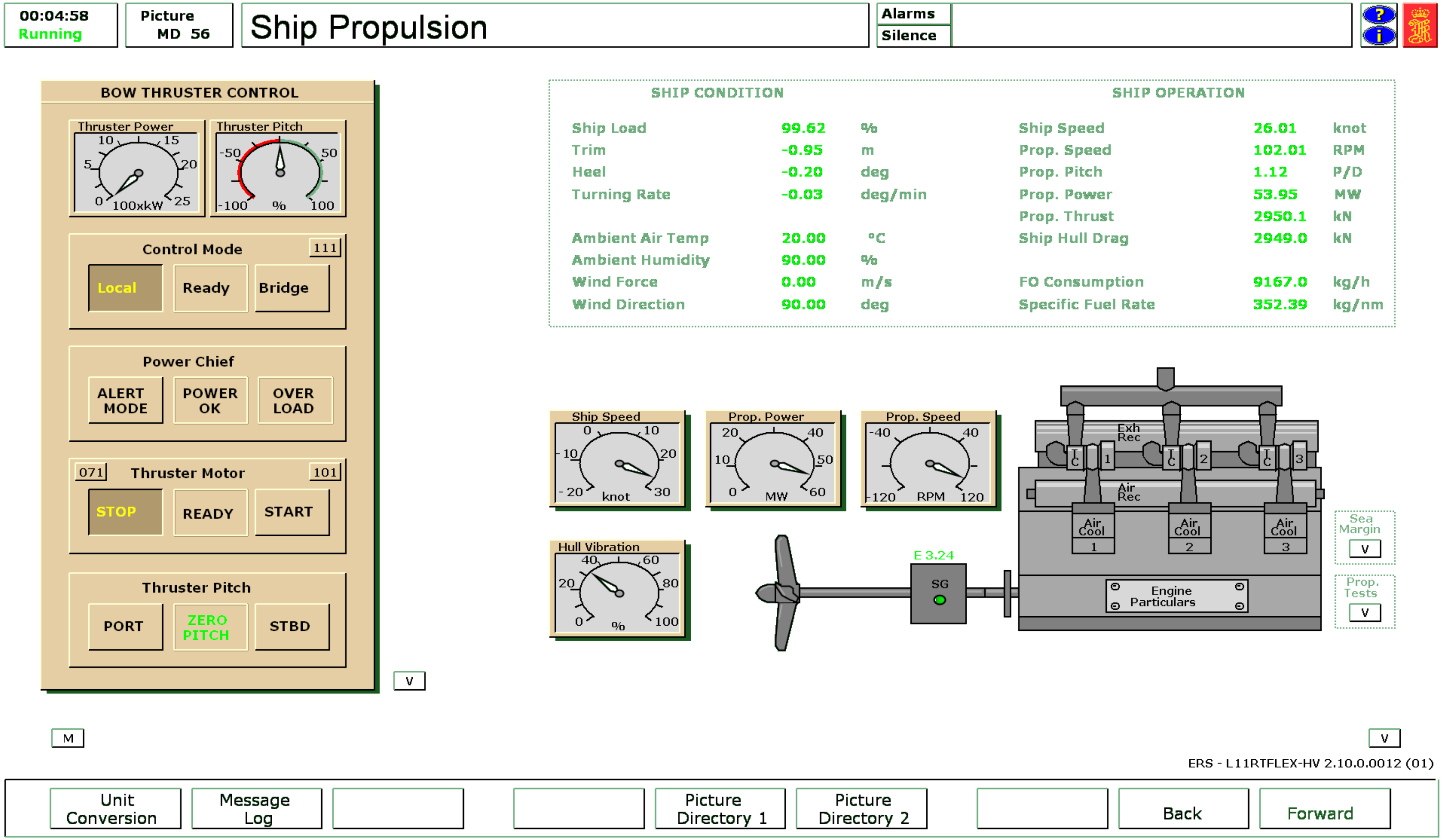
The engine safety indicator panel will inform the operator that an engine failure has occurred and the parameters or channel that has triggered this failure. Classification Rules dictate that an engine failure requires a dedicated alarm, and that the failure should be manually reset. Adjustments of the actual failure setpoints can be adjusted within the ME Control System screen on MD19.

The various slowdown and shutdowns are monitored by the DataChief system, and transferred to AutoChief for initiation of the slowdown and /or shutdown. Each of the slowdown and shutdown parameters is grouped and represented by an indicator light on the AutoChief panel.

When the indicator light starts flashing, slowdown/shutdown procedures are initiated. The safety system gives the operator the possibility to override shutdowns and slowdowns by pressing the relevant override buttons.

The system will (depending on set-up) give the operator a warning on slow down and shut down. The default time delay for slowdown to be activated is 120 seconds. Within this period the operator may cancel the slowdown. The actual diode will flash as long as the trigger or cause for slowdown is present.
The default time delay for shut down to be activated is 30 seconds. Within this period the operator may cancel the shutdown (except for the overspeed, turning gear in and lube oil pressure). The actual diode will flash as long as the cause for shut down is present.

Note that slow turning should be performed if the main engine has stood still for more than 30 minutes. ME slow turning is carried out by manually pressing the Slow-Turn button.


00:04:58
Running
Picture
MD 56
Ship Propulsion
Alarms
Silence
BOW THRUSTER CONTROL
Thruster Power
100xkW
Thruster Pitch
Control Mode
111
Local
Ready
Bridge
Power Chief
ALERT MODE
POWER OK
OVER LOAD
071
Thruster Motor
101
STOP
READY
START
Thruster Pitch
PORT
ZERO PITCH
STBD
SHIP CONDITION
Ship Load 99.62 %
Trim -0.95 m
Heel -0.20 deg
Turning Rate -0.03 deg/min
Ambient Air Temp 20.00 °C
Ambient Humidity 90.00 %
Wind Force 0.00 m/s
Wind Direction 90.00 deg
SHIP OPERATION
Ship Speed 26.01 knot
Prop. Speed 102.01 RPM
Prop. Pitch 1.12 P/D
Prop. Power 53.95 MW
Prop. Thrust 2950.1 kN
Ship Hull Drag 2949.0 kN
FO Consumption 9167.0 kg/h
Specific Fuel Rate 352.39 kg/nm
Ship Speed
knot
Prop. Power
MW
Prop. Speed
RPM
Hull Vibration
%
E 3.24
SG
Exh Rec
Air Rec
Air Cool 1
Air Cool 2
Air Cool 3
Engine Particulars
Sea Margin
Prop. Tests
ERS - L11RTFLEX-HV 2.10.0.0012 (01)
Unit Conversion
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5.27 Ship Propulsion

General
Ship Propulsion displays information about:
Ship Conditions
- Ship Load
- Trim
- Heel
- Turning Rate

Ambient Conditions
- Air temperature
- Humidity
- Wind Force
- Wind Direction

Ship Operation
- Ship Speed
- Prop Speed
- Prop Pitch
- Prop Power
- Prop Thrust
- Ship Hull Drag

Fuel Consumption
- ME FO Consumption
- DG FO Consumption

Indication of hull vibration is given.

Local Control of the Bowthruster is available.

Alert Mode
Alert Mode is used to ensure sufficient electric power during operation of bow thruster.

If TG or SG in auto -> alert mode set to off.

If TG not in auto and SG not in auto -> possible to choose Alert Mode.

If Alert Mode is chosen, PowerChief control mode will be set to Equal Load.

If BT control mode is ready it is possible to transfer control from local to bridge. BT control mode is ready if alert mode, min 3 generators must be connected (DGs and TG) and power margin ok.

1. Bowthrust Operation

1.1 Select Local control
1.2 Select Alert Mode to prevent auto shutdown of generators on low load
1.3 Ensure that there is enough power reserve available. The ”Power OK” should be illuminated.
1.4 Press ’Start’ and the thruster motor will start
1.5 Adjust pitch as required.

5.28 Bridge – Main Engine Control

General
The Main Engine can be remotely controlled from the Bridge.

Indication of starting air pressure, propeller speed, fuel economy and ship speed is given.

Shut down, Slowdown and Start failure alarms are indicated and can be reset when the fault has been cleared.

1. To operate in Bridge Control

1.1 When the engine room has informed that the engine is ready select ERC standby and Bridge Control. The ECR should accept both situations.

1.2 The Engine should be in Manoeuvring mode with VIT and VEC selected.

1.3 The control lever should be moved to the required position and the engine should start.

1.4 As the engine accelerates the rate of change is governed by the load program and limits. These may be overridden in emergency to rapidly increase speed. SEVERE ENGINE DAMAGE may be caused by excessively fast acceleration.

1.5 When stand-by is over, the At Sea command should be given and the engine placed in Sea Mode.

1.6 Should the Shut Down or Slow Down conditions occur a prewarning is given. Should this be placing the vessel in danger the Shut Down and Slow Down may be overridden. This could cause SEVERE ENGINE DAMAGE.

1.7 With responsibility in Engine Control room the control lever indicates the desired speed and direction, the ECR should lever should then follow the Bridge lever.

1.8 With responsibility in Local then the Emergency Telegraph push buttons must be used to relay the command to the local control station.

5.29 Bridge – Ship Course Control

General
The vessel is piloted from Ship Course Control.

Indication is given for:

- Ship Speed
- Rudder Angle
- Sea Water Depth
- Draft

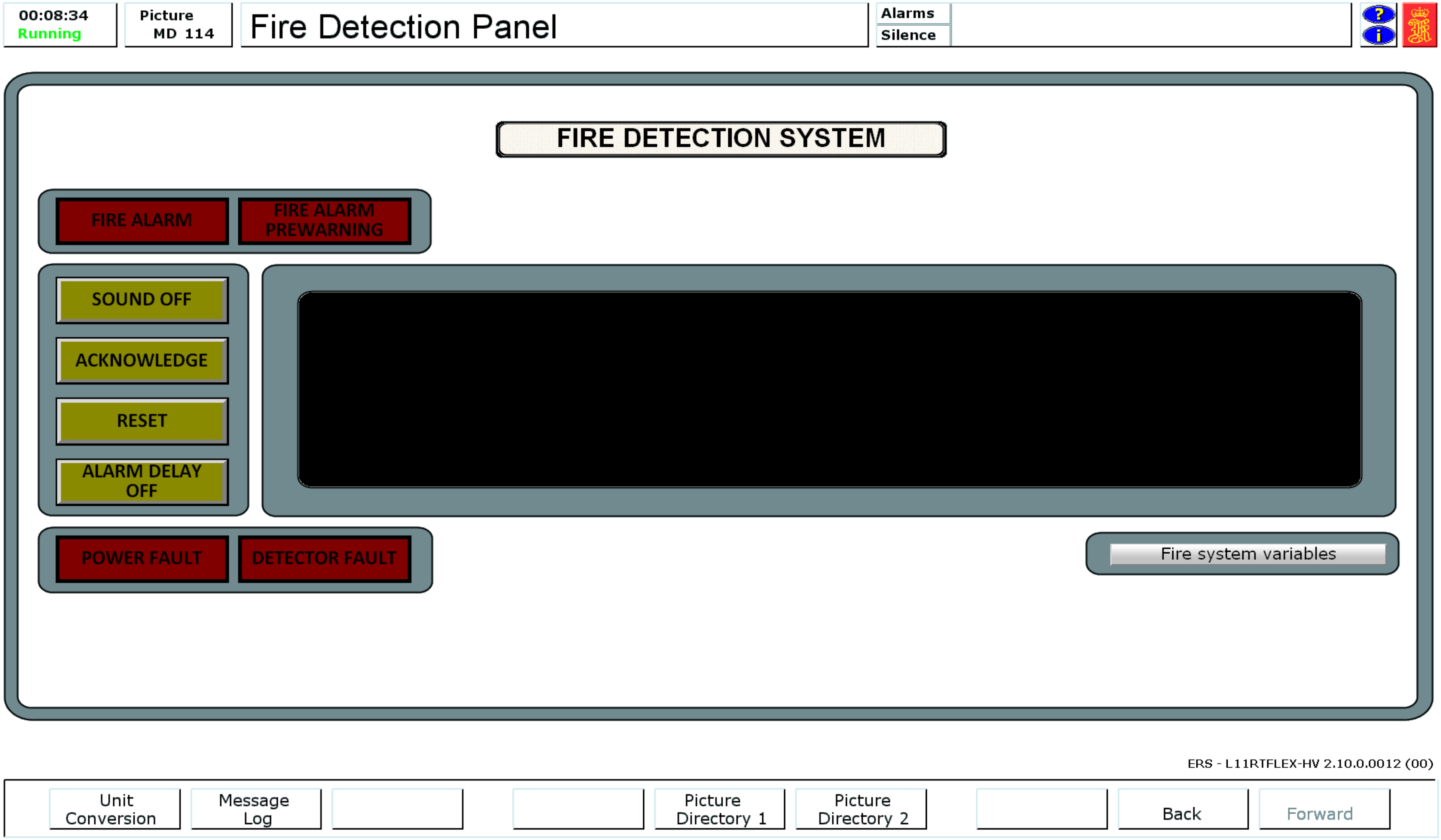
The vessels heading can be controlled by the auto-pilot by inputting a desired heading and turning the auto-pilot on.

The rudder angle can be manually adjusted with the auto-pilot off and inputting the required set point.

Emergency operation is by push button control.

The steering gear pumps can be stopped and started from this position.

The Bowthruster can be operated from this position, Bridge control must be selected at the local station on Ship Propulsion. The motor can be started, providing sufficient reserve power is available, and stopped. The Bowthruster is operated by inputting the desired set point.
All of the fire pumps can be remotely started from this position.


00:08:34
Running
Picture
MD 114
Fire Detection Panel
Alarms
Silence
FIRE DETECTION SYSTEM
FIRE ALARM
FIRE ALARM PREWARNING
SOUND OFF
ACKNOWLEDGE
RESET
ALARM DELAY OFF
POWER FAULT
DETECTOR FAULT
Fire system variables
ERS - L11RTFLEX-HV 2.10.0.0012 (00)
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5.30 Fire Detection

General
The fire detection system is a dedicated alarm and safety system that is used to give the earliest possible warning of the location of a fire on board the vessel.

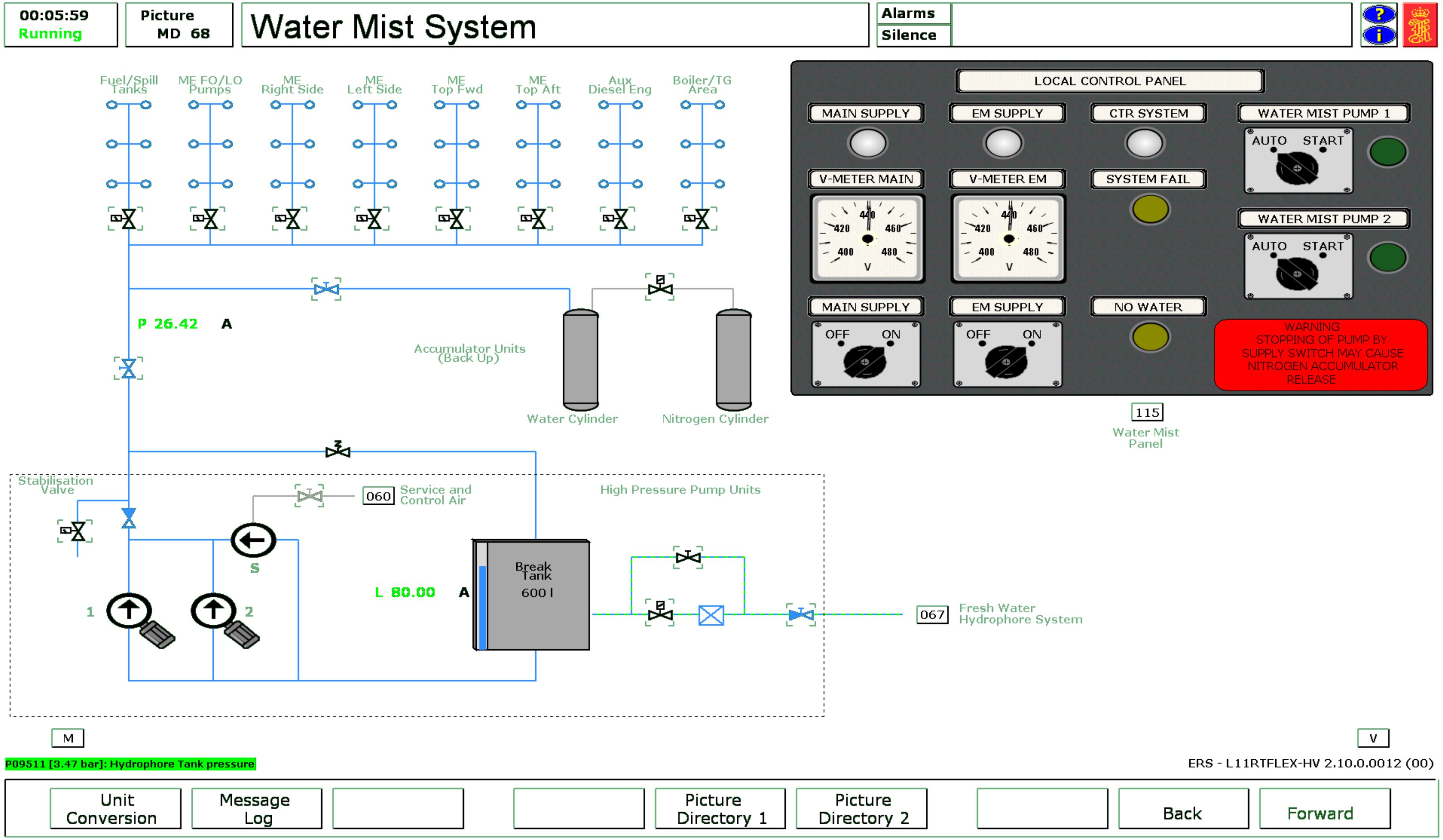
The detection system will give indication of a pre-alarm condition which will show that a preset threshold has been exceeded, indicating that a possible fire situation prevails.

Fire Detection
The following events occur in the event of fire detection with regard to the operator panel:

a) The fire alarm prewarning indicator starts to blink.
b) The location of the activated detector is displayed on the panel's monitor.
c) The audible buzzer will sound.
d) After approximately 1 minute, the main fire alarm goes off and an alarm signal is transmitted to the the PA system.
e) Resetting of the alarm on the panel is to be done only when the alarm has been acknowledged and after the cause of the alarm has been determined and dealt with accordingly
f) The buzzer and PA alarm sounds are silenced by the push button SOUND OFF.

In the event of a sensor fault occurring, the following will take place at the panel:

a) The DETECTOR FAULT lamp will be lit when the detector has a faulty sensor that will fail to detect any fire.
b) A fault message for the particular loop is displayed on the panel's monitor.
c) Any false detection will activate prewarning and fire alarm as a real fire should take place.
d) Resetting of the fault alarm on the panel is to be done only when the alarm has been acknowledged and after the cause of the alarm has been determined and dealt with accordingly.


00:05:59
Running
Picture
MD 68
Water Mist System
Alarms
Silence
Fuel/Spill Tanks
ME FO/LO Pumps
ME Right Side
ME Left Side
ME Top Fwd
ME Top Aft
Aux Diesel Eng
Boiler/TG Area
P 26.42 A
Accumulator Units (Back Up)
Water Cylinder
Nitrogen Cylinder
LOCAL CONTROL PANEL
MAIN SUPPLY
EM SUPPLY
CTR SYSTEM
WATER MIST PUMP 1
AUTO START
V-METER MAIN
V-METER EM
SYSTEM FAIL
WATER MIST PUMP 2
AUTO START
MAIN SUPPLY
EM SUPPLY
NO WATER
OFF ON
OFF ON
WARNING
STOPPING OF PUMP BY SUPPLY SWITCH MAY CAUSE NITROGEN ACCUMULATOR RELEASE
115
Water Mist Panel
Stabilisation Valve
060
Service and Control Air
High Pressure Pump Units
S
1
2
L 80.00 A
Break Tank
600 l
067
Fresh Water Hydrophore System
M
V
P09511 [3.47 bar]: Hydrophore Tank pressure
ERS - L11RTFLEX-HV 2.10.0.0012 (00)
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5.31 Water Mist

General

The Water Mist Pump Unit is designed to supply high pressure water to a water mist distribution system used for fire protection. The system uses water under high pressure from a common manifold dispersing it to the selected areas. The water under pressure flows through spray heads, which cause the water to enter the space as fine fog (mist) at high velocity.

Another component of the extinguishing method of the water mist system is by oxygen displacement. The expanding water vapour displaces the air and in doing so reduces the amount of oxygen in the vicinity of the fire. If the water vapour is directed against the fire, flammable vapour concentrations and free oxygen levels at the fuel surface will be reduced and the fire extinguished or reduced in intensity.

Main Data

No. of sets: (Main System)	1 pump module with 2 pump units
Water cylinders:	1 rack containing 10 cylinders (Back-Up)
Water cylinder rating:	50 litres each, 300/450 bar
Nitrogen cylinders:	1 rack containing 10 cylinders (Back- Up)
Nitrogen cylinder rating:	50 litres each, 300/450 bar
Pump motor rating:	15.5kW each
System pressure:	25 bar (standby) 140 bar (operating)
Breake Tank:	600 litres (Main System)

Emergency Water Mist Back-up Unit

The water mist pump module has been backed up with pressurised nitrogen and water cylinders. The system comprises ten water cylinders each containing 50 litres of fresh water and ten high pressure nitrogen cylinders, each containing 50 litres of nitrogen. If the Hi-fog system has been activated and the pressure in the discharge line drops below 30 bar for 15 seconds or more, or in the event of a loss of power that will prevent the pumps from starting, a signal will be automatically given to release the water accumulator unit. The nitrogen gas will then be released and pressurise the inlet line to the water cylinders and force the water out under pressure.

Operating

The system has three modes of operation and these are as follows:

- Standby Mode: This is the normal mode of operation when the system is switched ON and the pump switches on the local control panel are turned to position ‘A’.
- Operating Mode: This mode is when the system has been activated
- Off: This is when the system has been shut down for maintenance or repair

System In Stand-by Mode

In normal use the system must be left in the stand-by mode which requires the following:

- The SPU must be connected to the electric supply and the main power switch turned ON
- Working air is supplied to the stand-by pump and the pump is operational
- The system pressure is within the set limits
- The control system is operational

In standby mode, a pressure of 25 bar is maintained in the pipe lines up to the solenoid operated release valves. When a fire is detected by the fire alarm system, and with the SPU switched to automatic, the relevant section valve(s) will be (manually) opened and water will start to flow from the spray heads. The flow monitor will then detect a flow and will start the SPU. The SPU can also be started manually, either locally by turning the start switches on the control cabinet to ‘Start’, or remotely by Manual Emergency Start from the Water Mist Panel.

When the SPU is activated, the pump modules are automatically started in sequence with a few seconds delay between each start to reduce electric loads. If the flow of water required is less than the output of the unit, the un-loader valves will open and route the extra water back to the ‘break’ tank. High pressure water will now be fed to the system forming the Hi-fog mist.

After the SPU has been stopped it must be reset. The stabilisation phase takes a few minutes, during which the system pressure drops to the stand-by level and then the unit returns to the standby mode.

Automatic Start

The SPU will automatically start to operate if it detects a water flow and/or if the water pressure drops below 17 bar for more than 10 ~ 20 seconds. The redundant motor, will automatically start if one of the motors fails to start or if it suddenly stops operating. To stop the unit, after confirming that the fire has been extinguished, press and hold the RESET button for one second. If there is still a flow in the system after the reset period, the unit will restart. Isolate the sections where there is flow.

Manual Start

Turn the pump activation switches on the pump control cabinet to the ‘Start’ position to switch the pumps on. Stop the pumps by pressing reset from the Water Mist remote control panel (MD115).

A manual start from the slave panel is activated by pressing the button of the zone to be activated.

Pump Unit in Operation

When the pump unit has received a start signal it will maintain the required pressure and flow in the system until a stop signal is given or the pumps run out of water.

Note: The low level switch in the break tank or a pressure switch in the feed water line will prevent the unit from starting, or will stop the motors to prevent them from running dry.

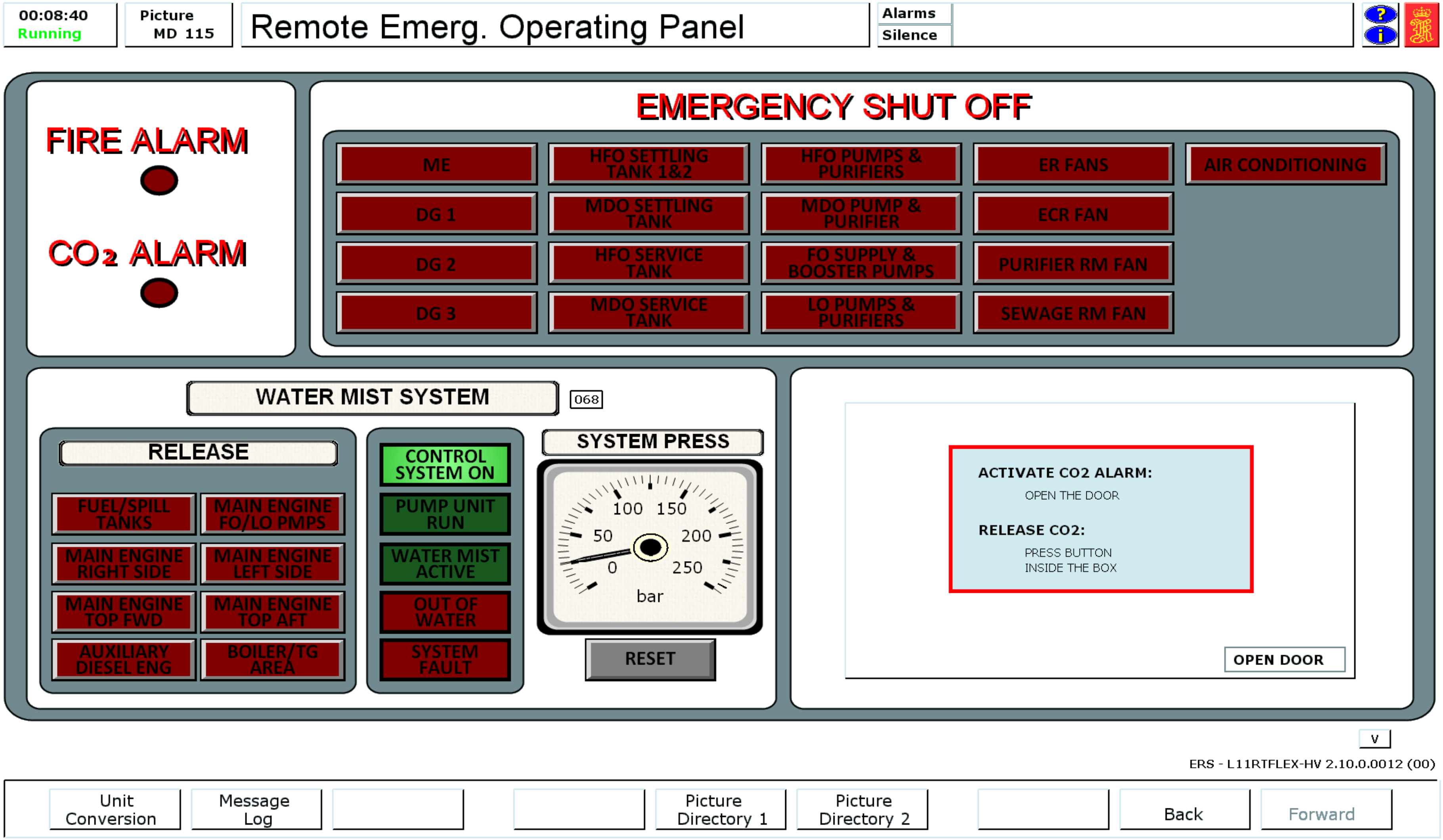
If the system has been activated and the pressure drops below 30 bar for 15 seconds or more, or if there is a power cut, or the motors cannot be started for some reason, a signal will be automatically given to release the water accumulator unit.

Stopping and Resetting the System

Make sure that the fire has been extinguished before stopping the unit and ensure that any released spray heads are isolated with the section valves closed. Press and hold down the RESET button for one second on the pump's control panel. If started automatically, the pump motors will stop and the stabilization valve will open decreasing the system pressure, and the alarms will clear.

The stabilisation valve will close when the pressure in the system has dropped to 22 bar. After that, the pneumatically operated standby pump in the module will automatically increase the pressure in the system to the 25 bar standby pressure.

A restart is prevented during the stabilisation period which is recognised by the RESET light flashing on and off. When the reset phase has been completed, the pump will automatically switch to the standby mode.


00:08:40
Running
Picture
MD 115
Remote Emerg. Operating Panel
Alarms
Silence
FIRE ALARM
CO2 ALARM
EMERGENCY SHUT OFF
ME
HFO SETTLING TANK 1&2
HFO PUMPS & PURIFIERS
ER FANS
AIR CONDITIONING
DG 1
MDO SETTLING TANK
MDO PUMP & PURIFIER
ECR FAN
DG 2
HFO SERVICE TANK
FO SUPPLY & BOOSTER PUMPS
PURIFIER RM FAN
DG 3
MDO SERVICE TANK
LO PUMPS & PURIFIERS
SEWAGE RM FAN
WATER MIST SYSTEM
068
RELEASE
FUEL/SPILL TANKS
MAIN ENGINE FO/LO PMPS
MAIN ENGINE RIGHT SIDE
MAIN ENGINE LEFT SIDE
MAIN ENGINE TOP FWD
MAIN ENGINE TOP AFT
AUXILIARY DIESEL ENG
BOILER/TG AREA
CONTROL SYSTEM ON
PUMP UNIT RUN
WATER MIST ACTIVE
OUT OF WATER
SYSTEM FAULT
SYSTEM PRESS
0
50
100
150
200
250
bar
RESET
ACTIVATE CO2 ALARM:
OPEN THE DOOR
RELEASE CO2:
PRESS BUTTON
INSIDE THE BOX
OPEN DOOR
V
ERS - L11RTFLEX-HV 2.10.0.0012 (00)
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5.32 Emergency Operating Panel

General
The Remote Emergency Operating Panel consists of three (3) main systems:
-Emergency Shut Off
-Water Mist Control Panel
-CO_2 release cabinet

The **Emergency Shut Off** system enables emergency shutdown of
a) main and aux. diesel engines by quick closing valves.
b) emergency stop of DO/FO and LO pumps
c) tank shut off by quick closing valves
d) ventilation shut down

Reset any activated Shut Off by releasing the actual button and re-open/re-start valves/pumps/fans.

Water Mist: If a fire is present in one of the zones, a prewarning will occur in the display followed by a fire alarm. The fire can be extinguished by release of the related water mist section valves by pushing the section valve button.
When water mist is released all the valves in this section will open and the main pump will start due to the pressure drop.

There are two pumps in the system, the aux pump keeps normal standby pressure between 20-26 bar while the main pump kicks in when the pressure drops below 15 bar and drives it up to 150 bar which is the pressure required to create a water mist for firefighting.

After a release, the pressure should be drained down to normal standby pressure by pushing the reset button.

Fire can be set in each section from MA Alfa page 5917-5918. The fire can only be extinguished by use of water mist or CO_2.

If a fire is set in one section, the fire will spread throughout the other sections in engine room if no action is taken.
- After 60 seconds all zones in the same section is on fire.
- After 180 seconds the fire will spread out thorough out the entire engine room and is now only possible to extinguish with CO_2.
 Refer also to own chapter.

CO_2 release:
The engine room is protected by a CO_2 system with remote release. When you open the CO_2 Cabinet Door the CO_2 alarm is activated and ventilation fans MD 40 will stop.

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6 SIMULATOR AND SHIP MODEL PARTICULARS

6.1 Auto Pulsar System

Description
To facilitate easy test of controller performance in various systems, the auto pulsar system is included. The auto pulsar enables auto-change of set point in intervals. The engine room systems with auto pulsar functionality vary with the simulator model but are found under the SIM CONTROL variable pages.

The following settings are typical for a low speed engine model:

Sea water temp control:	Default = 20 ºC	Auto pulsar = 16 ºC
Low temp fresh water temp control:	Default = 34 ºC	Auto pulsar = 30 ºC
High temp fresh water temp control:	Default = 85 ºC	Auto pulsar = 80 ºC
Lubrication oil temp control:	Default = 45 ºC	Auto pulsar = 41 ºC
Main engine command:	Default = 100 %	Auto pulsar = 70 %
FO Viscosity control:	Default = 16 cSt	Auto pulsar = 12 cSt
Boiler steam load	Default = 50 %	Auto pulsar = 0%
Boiler level control:	Default = 0 mm	Auto pulsar = -100mm
Boiler pressure control:	Default = 7 bar	Auto pulsar = 6.6 bar

Operation
Select SIM CONTROL variable page.
Set Pulsar system active (1).
Set one or more of available systems to auto pulsar active (1).
Observe that controller instantly changes set-point and the counter starts counting down from default time setting (seconds).
To switch off auto pulsar, type 0.

The following settings in seconds are typical for the low speed models:

Sea water system	Default = 180 seconds ON/180 seconds OFF
Low temp fresh water temp control:	Default = 180 seconds ON/180 seconds OFF
High temp fresh water temp control:	Default = 480 seconds ON/480 seconds OFF
Lubrication oil temp control:	Default = 480 seconds ON/480 seconds OFF
Main engine command:	Default = 600 seconds ON/600 seconds OFF
FO Viscosity control:	Default = 180 seconds ON/180 seconds OFF
Boiler steam load	Default = 480 seconds ON/480 seconds OFF
Boiler level control:	Default = 180 seconds ON/300 seconds OFF
Boiler pressure control:	Default = 480 seconds ON/240 seconds OFF

Useful Info
Changing ON and OFF time is done by typing desired time as a negative value.
Note that some simulator models may have counter range 0-99, this means that any number is multiplied by 10 to get the time in seconds (setting 12 is equal to 120 seconds).

600 70 % 100 %	ECR lever position
480 80 ºC 85 ºC	HTFW temp control
180 30 ºC 34 ºC	LTFW temp control
480 41 ºC 45 ºC	LO temp control
180 12 cSt 16 cSt	FO viscosity control
120 94 ºC 98 ºC	HFO purifier temp control
120 84 ºC 88 ºC	LO purifier
120 58 ºC 62 ºC	DO purifier
480 0 % 50 %	boiler steam load (deck steam valve pos)
480 6,6 bar 7,0 bar	boiler press set point
180 -100 mm 0 mm	boiler level set point