
	<b>SEAFARERS TRAINING CENTER</b>	<b>M-ERS(I)-36</b>
	<b>ENGINE ROOM SIMULATOR</b>	<b>REV. 01 -2016</b>

***SEAFARERS TRAINING CENTER***



***ENGINE ROOM  
SIMULATOR***

***In accordance with the STCW 78 Convention, as amended***

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### **AIMS**

This course consists in exercises structured around the operation of a ship Machinery installation and the teaching simulator of the engine room as starting up auxiliary and propulsion plants, setting the normal operation condition, trouble –shooting of faults, diagnosis and others.

### **OBJECTIVES**

To provide knowledge and skills to operate, supervise and monitor the safe operation and control of a ship’s machinery installation in accordance with provisions of Regulation III/1, VIII/2; Section A-III/1, A-VIII/2, B-VIII/2 and Table A-III/1.

Trainees should be competent to carry out:

- Use check list and plan for start engine.
- Watchkeeping duties and officer in charge of an engineering watch in engine room.
- Have knowledge of engine room equipment and connections.
- Have experience of engine room problems, detection and solve.
- Capacity for take decisions to carry out safe operations of the ship engine.
- Have knowledge of operations of auxiliary engines.
- Familiarization with the use of instrumentation and controls used in the engine room.

### **ENTRY STANDARS**

This course is open for trainees with basic engine knowledge.

### **COURSE CERTIFICATE**

A certificate after approved.


### **COURSE INTAKE LIMITATIONS**

The maximum number of participants should be 4

### **STAFF REQUIREMENT**

Instructors must be engine officers

### **TEACHING FACILITIES AND EQUIPMENT**


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An engine room simulator, that have basic equipment exist in engine merchant marine ship.

- Low speed main engine turbo-diesel.
- A boiler steam generator.
- A diesel engine economizer.
- A turbo generator.


#### **TEACHING AIDS**

- The Instructor Manual.
- Model Course 2.07
- STCW Convention
- An Engine Room Simulator.(UNITEST-MARINE TRAINING SOFTWARE)

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### COURSE TIME-TABLE

<b>Learning Objectives</b>	<b>(Lecture/Practical Work) Hours</b>
1. Course introduction	1
2. Familiarization: -Plant Arrangements -Instrumentation -Controls -Operation procedures	6
3. Operation -General procedures -Auxiliary system & units -Diesel generator -Steam boiler -Steam Turbo Generator -Steam Cargo Turbine -Main propulsion diesel engine	13
4. Main engine operation	10
5. Trouble-Shooting	20
6. Maintain a safe engineering watch -Duties associated with taking over and accepting a watch -Routine duties undertaken during a watch -Duties associated with handing over of a watch	30
<b>TOTAL</b>	<b>80</b>

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### DETAILED TEACHING SYLLABUS

LEARNING OBJETIVES	IMO REFERENCE	TEXTBOOK	TEACHING AID
<p>1. Course introduction (1 hour) The instructor:</p> <ul style="list-style-type: none"> <li>.1 Explains the objectives of the course.</li> <li>.2 Explains the different of this course and others relative same fields.</li> <li>.3 Explains that in course do personal and grupal activities.</li> <li>.4 Explians that necessary combine the course information with the experience.</li> <li>.5 Explains what knowledge is necessary for complete the learning objectives.</li> </ul> <p>2 Familiarization (6 hours)</p> <p>2.1 Engine components</p> <ul style="list-style-type: none"> <li>.1 List of Engine and equipments</li> </ul> <p>Components of the simulation installation:</p> <ul style="list-style-type: none"> <li>-Tanks</li> <li>-Valves</li> <li>-Piping system</li> <li>-Pumps</li> <li>-Interchambers</li> <li>-Fuel oil treatment installation</li> <li>-Strainers</li> <li>-Electric generators</li> <li>-Steam generators</li> <li>-Main propulsion system</li> <li>-Direct controls</li> <li>-Distance controls</li> </ul> <ul style="list-style-type: none"> <li>.2 Describes conection betwin engines and auxiliary sistems and prepare a block diagram.</li> <li>.3 Describes the block diagram and simulator.</li> </ul> <p>2.2 Instruments</p> <ul style="list-style-type: none"> <li>.1 Describes and mention the instruments</li> </ul>	<p>R1-ta:A-III/1 P:82 Operate main and auxilliary engines with controls</p> <p>R1Ta:A-III/1 P:83</p>	<p>B1</p>	<p>Unitest Marine Training.</p>


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<p>using in the simulator for measure:</p> <ul style="list-style-type: none"> <li>-Pressure</li> <li>-Temperature</li> <li>-Levels of fluid</li> <li>-Volume/mass</li> <li>-Flow indicator</li> <li>-Speed of rotation</li> <li>-Par/power</li> <li>-Voltage</li> <li>-Current</li> <li>-CO2 contents (exhaust gas)</li> <li>-Pressure/volume in the cylinder of the engine ("indicator diagram)</li> </ul> <p>.2 Description of the faults indicators</p> <p>.3 Use the p/v indicator to take a diagram.</p> <p>.4 Calculate:</p> <ul style="list-style-type: none"> <li>-Shaft power</li> <li>-Effective pressure in the cylinder</li> <li>-Power generate in the cilinders</li> <li>-Mechanic efficiency of the engine</li> </ul> <p>.5 Use the technical data for calculate the thermal balance.</p>	<p>Operate generators and controls systems</p>		
<p><b>2.3 Controls</b></p> <p>.1 Shows how control the engines can control from:</p> <ul style="list-style-type: none"> <li>- Engine side</li> <li>- Control engine room</li> <li>- Bridge control.</li> </ul>	<p>R1Ta:A-III/1 pp:81 Safe engine room watchkeeping</p>		
<p>.2 Show how to watch the propulsion unit from the instructors control room.</p>	<p>R1Ta:A-III/1 P:82 Operate main and auxiliary engine with controls</p>		








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<p>condition the steam turbogenerator.</p> <p>.2 Conect the turbogenerator to the main electric system, using controls for:</p> <ul style="list-style-type: none"> <li>-Voltage</li> <li>-Frecuency</li> <li>-Sincronization</li> </ul> <p>.3 Show how to distribute the load between turbogenerator and diesel generators.</p> <p>3.6 Steam turbine for load.</p> <p>.1 Prepare, start and put in normal working conditions the steam turbine for load</p> <p>.2 Operate the pump to discharge cargo.</p>	<p>Operate pumps system and controls</p> <p>R1Ta:A-III/1 p.:82</p>			
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3.7 Diesel main engine for propulsion.

.1 Procedures for prepare, including:


- Check the sea water circulation in the cooling system.
- Check the fresh water circulation in engine and in cooling system.
- Check the lube oil circulation in engine and in the cooling system.
- Confirm that the turning gear motor is disengage.
- Check the fuel oil circulation in heaters and in suction of injection pump.
- Check the pressure of air for start the engines.
- Confirm the circulation of lube oil in engine cylinders.
- Using starting air turn 1 round the main engine with the cocks open.

.2 Describe the procedure for prepare, including:

- Confirm all the cocks are close
- Confirm the fuel oil circulation
- Confirm the bridge order for move the engine.
- Apply the starting air for 3-4 revolutions
- Put the fuel oil control in desire position

.3 Fix a normal running position and follow the operational conditions including:


- lube oil temperature and refrigeration water.
- Exhaust gas temperature in each cylinder.
- Temperature of the entrance and outside of the turbocharger
- Engine speed and output power
- Maintenance of the supply of fuel oil (service tank)
- Maintenance of the fuel oil viscosity and temperature
- Change the engine speed according the

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bridge need and take notes of the change in the operational condition.

4 Main engine operation (10 hours)

- .1 Prepare, start and maintain running the main engine and auxiliary systems.
- .2 Fix the main units controls in ahead all the power, follow the bridge orders, or
- .3 Apply the manoeuvring procedures for get the output power required

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<p>5 Trouble –shooting (20 hours)</p>			
<p>5.1 Locate and apply remedial action for the following malfunctions or faults:</p> <ul style="list-style-type: none"> <li>.1 Regulate the fuel oil injection (advance/astern)</li> <li>.2 Incorrect function of piston plates in a cylinder</li> <li>.3 Fire in space of scavenging air</li> <li>.4 Incorrect function of the turbocharger (outside)</li> <li>.5 Incorrect function of the turbocharger (entrance)</li> <li>.6 Incorrect function of the air filters in the turbocharger</li> <li>.7 Incorrect function of the scavenging entrance or in the cooling scavenging air</li> <li>.8 Black out</li> <li>.9 Incorrect function of the oil filtering auxiliary engines</li> <li>.10 Overheating of the thrust bearing.</li> <li>.11 Dirt in coolers</li> <li>.12 Lube oil circulate pump fail</li> <li>.13 Bilges space in overflow</li> <li>.14 Bridge control fail</li> </ul> <p>6 Maintain a safe engineering watch (30 hours)</p> <p>6.1 Duties relatives to relieve watch and accept the watch</p> <ul style="list-style-type: none"> <li>.1 Arrive in engine room 15 minutes before relieve time</li> <li>.2 Inspect all the machineries, take notes of any incorrect function</li> <li>.3 Check boiler water level</li> </ul>			

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- .4 Check the bilge and space under deck
- 5. Notes the telegraph orders
- .6 Check levels in the fuel oil tanks
- .7 Check the person who is take the watch if is in condition
- .8 Fill engine record book
- .9 Recive the inform of the engineer whos live the watch
- .10 Notes abnormal operation during the inspection.
- .11 Accept the responsibility of the watch
- .12 Notes in the engine record book during the watch

6.2 During the watchkeeping  
Ping


- .1 During the watch in intervals take notes of the operatives conditions and correct according the normal function
- .2 Operate the oil centrifugals pump
- .3 Check the steam generate and adjust:
  - CO2 quantity in a exhaust gas
  - Temperature of entrance and out of the exhaust gas
  - Sea water temperature and adjust the cooling system
- .4 Check the lube oil pressure in cilindrs
- .5 Check the voltage in the electric system and load, verify the distribution of the load
- .6 Check pressure in the storage tanks of the compresed air and restaure
- .7 Check bilge system and space under deck
- .8 Show that in watch also must check :
  - Steering gear
  - Intermedial shaft
  - Fresh water consumption
  - Hydroforo

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<p>.9 Notes in the engine record book</p> <p>6.3 Duties relatives in a moment to change watch</p> <p>.1 Gives a oral inform to the relieve</p> <p>.2 Don't pass the watch if the person whos relieve is not in condition</p> <p>.3 Notes the details in the engine record book.</p>				
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## 1. Introduction

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4.4. BRIDGE CONTROL STATION (BCS)

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4.5.2 FRESH WATER COOLING SYSTEM

4.6. FUEL SYSTEM

4.6.1 FUEL FEED SYSTEM

4.6.2 STORAGE AND SEPARATING SYSTEM

4.7. LUBRICATING OIL SYSTEM

4.8. COMPRESSED AIR SYSTEM

4.9. STEAM SYSTEM

4.10. POWER PLANT

4.10.1 EMERGENCY GENERATOR

4.10.2 EMERGENCY SWITCH BOARD (ESB)

4.10.3 DIESEL GENERATOR

4.10.4 MAIN SWITCH BOARD

4.11. FRESH WATER GENERATOR


4.12. HYDROPHORE

4.13. BILGE SYSTEM

4.14. STEERING GEAR SYSTEM

4.15. SEWAGE TREATMENT PLANT



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4.15.1 VACUUM COLLECTING UNIT

4.15.2 BIOLOGICAL SEWAGE TREATMENT PLANT UNIT

4.16. WATER MIST SYSTEM

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6.4. STEAM AVAILABLE

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6.6. ME RUNNING

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Low Speed Engine Room Simulator ERS4000-TRANSAS– User’s manual

7. Software options description

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7.3. FAULT SIMULATION

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7.5. EVENT LOG


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7.7. INSTRUCTOR IP ADDRESS

8. Instructor station

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## 1. Introduction

### 1.1. General description and application

The Low Speed Engine Room Simulator Unitest Marin Training Software has been based on typical solutions, being presently used in medium-sized engine rooms (one two-stroke type main engine with fixed pitch propeller).

The simulator introduces 3D model of the Engine Room, based on the real equipment. In order to create the impression of working in the real environment, it provides 3D sound which can be listened on 2, 4 or more speakers.

This simulator is designated for training students of maritime academies as well as for different types of marine vocational training centres. The simulator has universal features and may be used both for training merchant and navy fleet crew.

The main purpose of the simulator is the practical preparation of the trainee for engine room operation, and more particularly:

- familiarization with the basic engine room installation (compressed air system, fresh and sea water cooling system, lubricating and fuel oil system etc.);
- Acknowledgment with main engines and auxiliary equipment operating procedures;
- propulsion system manoeuvring.


The software allows for the simulation of opening/closing of basic valves and auxiliary equipment operation in engine room installations. The software also generates the main engine room's sound.

The installation of the simulator's software is simple, it is performed by the user and does not require any manufacturer's installation services.

The software also enables to set up engine room resources and load or save setups.

The simulator software's language version is English.

The simulator has been developed in compliance with:

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- STCW Code: Section A-1/6
- ISM Code: Section 6 and Section 8.

Low Speed Engine Room Simulator Unitest Training Marine – User’s manual

### **1.2. Hardware requirements:**

PC – Intel Core 2 Duo, 2 GB RAM, 100,0 GB HDD, Graphic card 512 MB, CD-ROM drive, min. 17 ″, multimedia colour monitor, PS/2 mouse input for trackball connection, Windows XP.

### **1.3. Abbreviations**

ME – Main Engine  
 DG – Diesel generator  
 EM DG – Emergency diesel generator  
 LO – Lubricating oil  
 FW – Fresh water  
 SW – Sea water  
 HT – High temperature  
 LT – Low temperature  
 AUX PUMP – Auxiliary pump  
 PRESS – Pressure  
 TEMP – Temperature  
 RPM – Revolution per minute  
 MSB – Main Switchboard  
 ESB – Emergency Switchboard  
 PMS – Power Management System


### **1.4. Graphic symbols**

active pump – remote operation enabled, off status ( White)

active pump – remote operation enabled, on status (Green)

active pump – remote operation enabled, stand-by status (White-Green arrow)

active pump – remote operation disabled, off status (White-black arrow)

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pump status – off position (White-left arrow)

pump status – on position (Green )

active valve - closed (Green-black)

active valve - open Green)

active 3-way valve

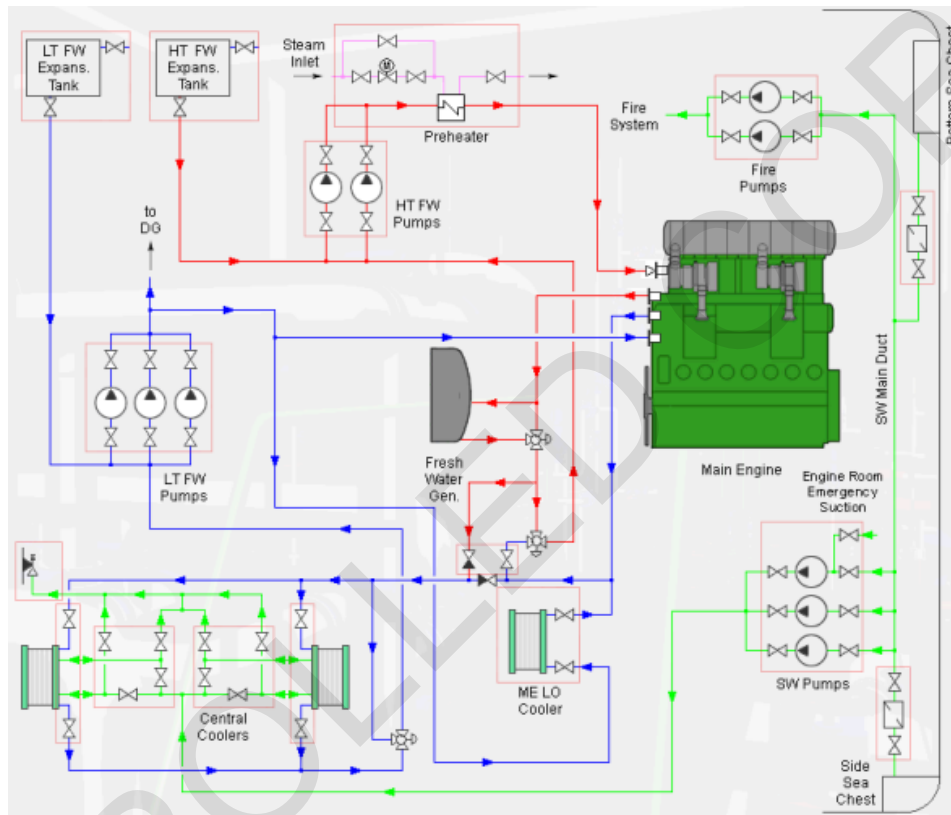
three-way valve status

automatically controlled valve

tank level indicator




### 1.5. Pipe identification



#### Piping system Painted strips

- 1.Sea Water(Green);
- 2.Fresh Water (Green-blue);
- 3.Fire Water (Red);
- 4.Steam (Grey);
- 5.Lubricating Oil (Black-yellow);
- 6.CO2 Extinguishing (yellow-red);
- 7.Fuel (black);
- 8.Hydraulic Oil (brown);
- 9 Oxygen Compressed Air (Blue-white);
- 10.Acetylene (Orange);
- 11. Bilge (Brown)..

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## 2. Installation

Please follow the installation software instructions.(see cd of Marine Training Software)

## 3. Simulator description

### 3.1. Simulation model

The simulator is based on an engine room composed of one low-speed diesel engine (ME), three diesel engine generators (DG).

#### **Main Engine**

Diesel engine, two-stroke type with direct injection, non-reversible with turbo-charger.

Nominal power 15820 kW

Nominal RPM 105 rpm

Number of cylinders 7

Cylinder Bore/stroke 600/2400 mm

ME is equipped with turning gear

ME is started with compressed air system

#### **Diesel Generator Engine**

Diesel engine, four stroke type, with direct injection, non-reversible, with turbo-charger.


Nominal power 700 kW

Nominal RPM 720 rpm

Number of cylinders 7

Piston diameter/stroke 280/320 mm



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Engine is started with compressed air system

### **Emergency Generator Engine**

Diesel engine, four stroke type, with direct injection, non-reversible.

Nominal power 240 kW

Nominal RPM 1500 rpm

Number of cylinders 8 (V)


Piston diameter/stroke 130/150 mm

Cylinders' cooling fresh water

Engine is started with electrical system or hydraulic system

The simulator is divided into the following modules:

- Main Engine
- Fuel System
- Cooling System
- Lubricating System
- Compressed Air System
- Power Plant
- Steam System
- Sanitary Water System
- Bilge System

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- Steering Gear
- Sewage Treatment Plant
- Water Mist System
- Refrigerating Plant
- AC Plant
- Incinerator
- CO2 Fire Extinguishing

### **3.2. User 3D interface**

The simulator introduces 3D model of the Engine Room, based on the real equipment. In order to create the impression of working in the real environment, it provides 3D sound which can be listened on 2, 4 or more speakers.

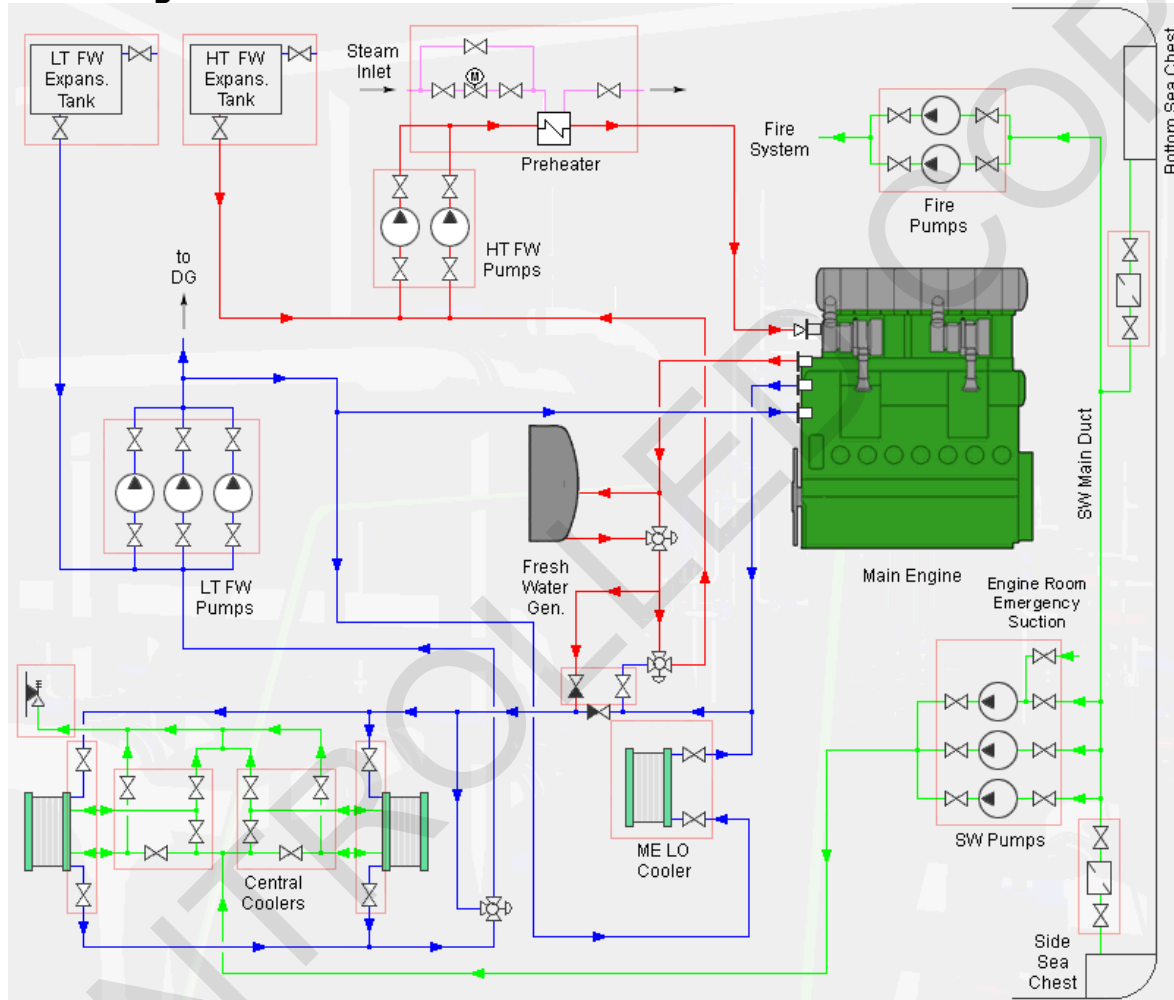
#### **3.2.1. System selection**

The ship's engine room comprises several functional systems. The Unitest Training Marine includes System selection menu for switching between them.

The System selection menu can be shown by clicking on the 'D' button. In order to hide menu, it is necessary to click the 'D' button again or press the right mouse button.




### 3.2.2. Diagram



The diagram provides possibility to zoom in the selected part of the engine room by moving mouse cursor above the red box surrounding the part (the box will be flashing), and then by clicking the left mouse button. The diagram will be closed and selected part will be shown in the 3D view.

### 3.2.3. Zooms

Zoom option allows navigation in 3D environment. Zoom of selected part of the engine room equipment is available when yellow box highlight. By mouse clicking

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on that box view bring closer to the selected object. To zoom out and go back to the Main View - click the right mouse button.

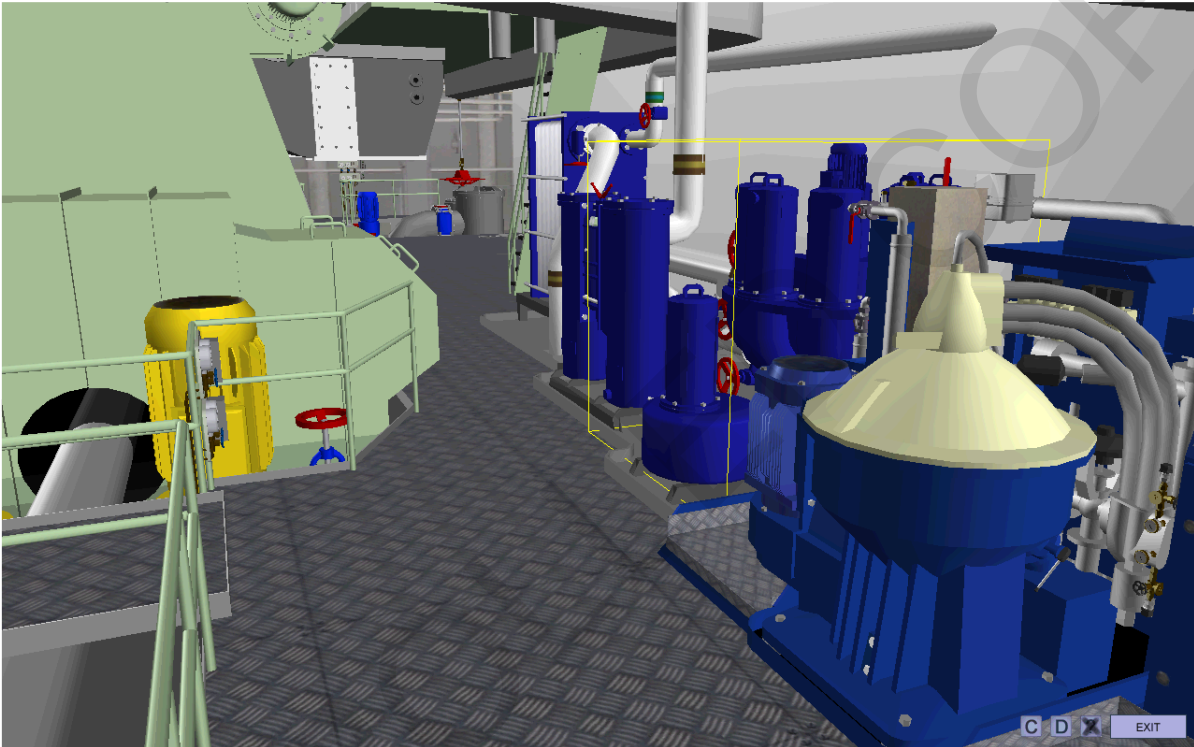


Fig. 3 Zoom (ME LO Automatic Filter)

### 3.2.4. Operating on the valves

When the mouse cursor is over an active valve – the selected valve lights up. In order to open / close the valve, please click the left mouse button on the valve lever. By selecting question mark button, it is possible to read valve description and to check current state of the valve (open / closed).


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Fig. 4 Valve description



### 3.2.5. Operating on the switches

When the mouse cursor is over an active region of switch – the selected switch lights up.

In order to change switch position, please click the left mouse button on the position you want to switch to.


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Fig. 5 Operating on the switch

### 3.2.6. Parts description

In order to get a short description about each of the engine room part, please check the question mark button and then point the part by the mouse cursor.

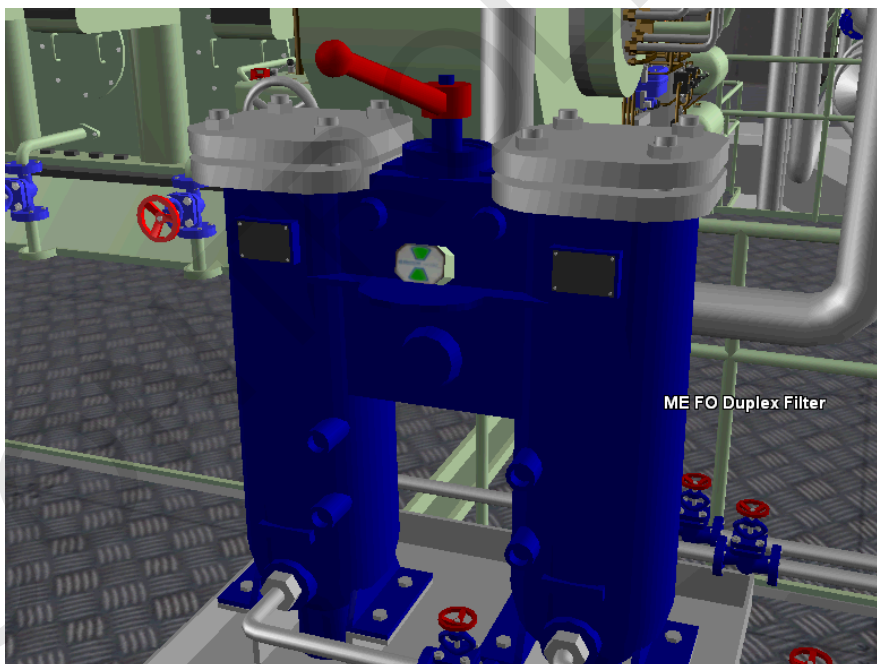



Fig. 6 Part description

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#### 4. Engine Room Specification

##### 4.1. Main Engine

The ME drives directly fixed pitch propeller. The ME can run on DO or HFO during manoeuvring.

The technical data for the ME simulated in Unitest Training Marine is given below:

- Type: 2 stroke, non-reversible with turbo-charger
- Nominal power 15820 kW
- Nominal RPM 110 rpm
- Number of cylinders 7
- Cylinder Bore/stroke 600/2400 mm

ME is equipped with turning gear and is started with compressed air system.

The ME mimic diagrams, displays and controls have been divided into software windows and consoles, each of which includes specific controls and gauges.

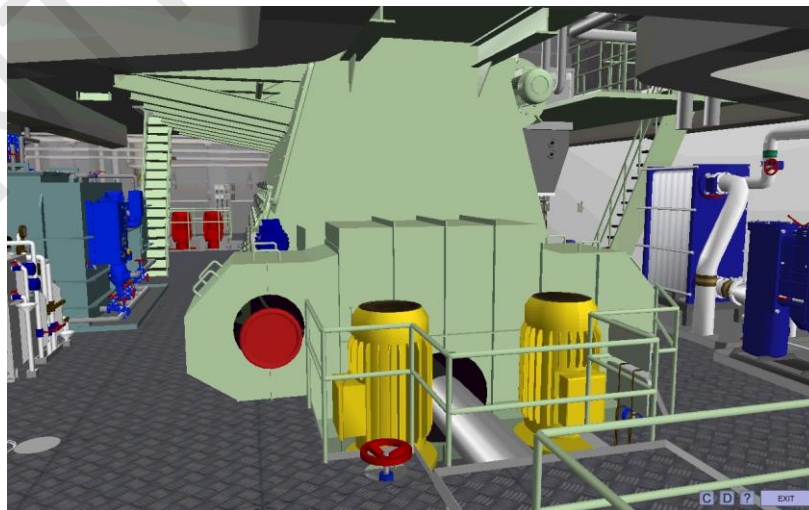



Fig. 7 Main Engine – General View

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#### **4.2. Engine Room Control Station (ECS)**

Engine Room Control Station is the manoeuvre station in the control room. ECS is a unit that has several functions. It is a control station for operation of the Main Engine remote control system.

ECS control station contains the following components:

- Control lever for engine speed demand
- Engine telegraph
- Gauges with display of Main Engine parameters
- Main Engine indication panel
- Main Engine safety system




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Fig. 9 Engine Room Control Station (ECS)

### 4.3. Local Control Station (LCS)

Engine Local Control Station is the manoeuvre station on the engine. It is a control station for emergency operation of Main Engine when the remote control system is damaged.

LCS contains the following components:

- Main Engine control panel with levers and switches
- Main Engine indication panel
- Local Engine Telegraph

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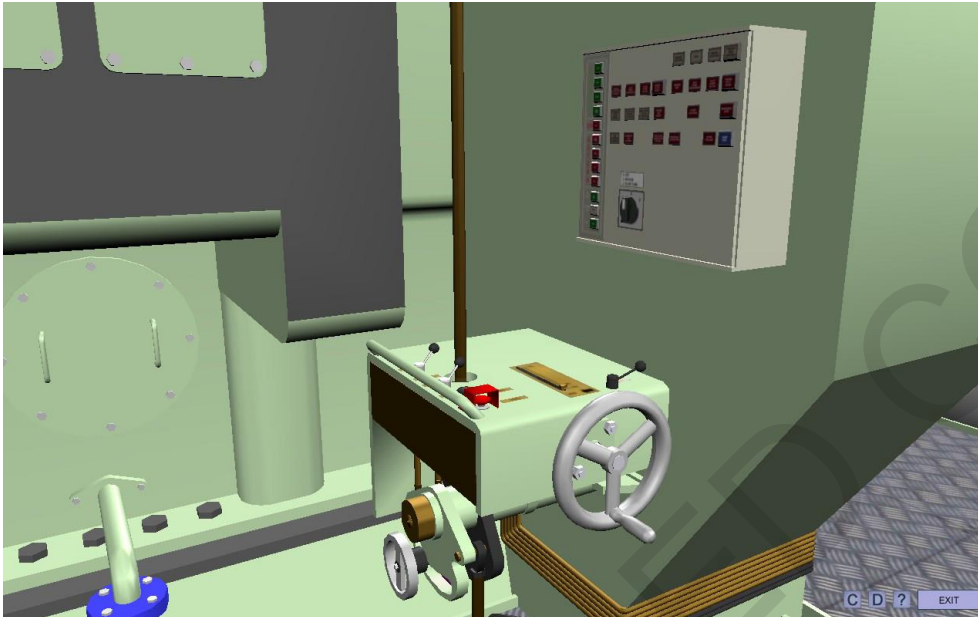



Fig. 10 Local Control Station

#### **4.4. Bridge Control Station (BCS)**

Bridge Control Station is the manoeuvre station on the bridge. BCS is a unit that has several functions. It is a control station for operation of the Main Engine remote control system and steering gear pumps.

BCS control station contains the following components:

- Engine telegraph
- Gauges with display of Main Engine parameters
- Main Engine alarm panel
- Control position indication panel

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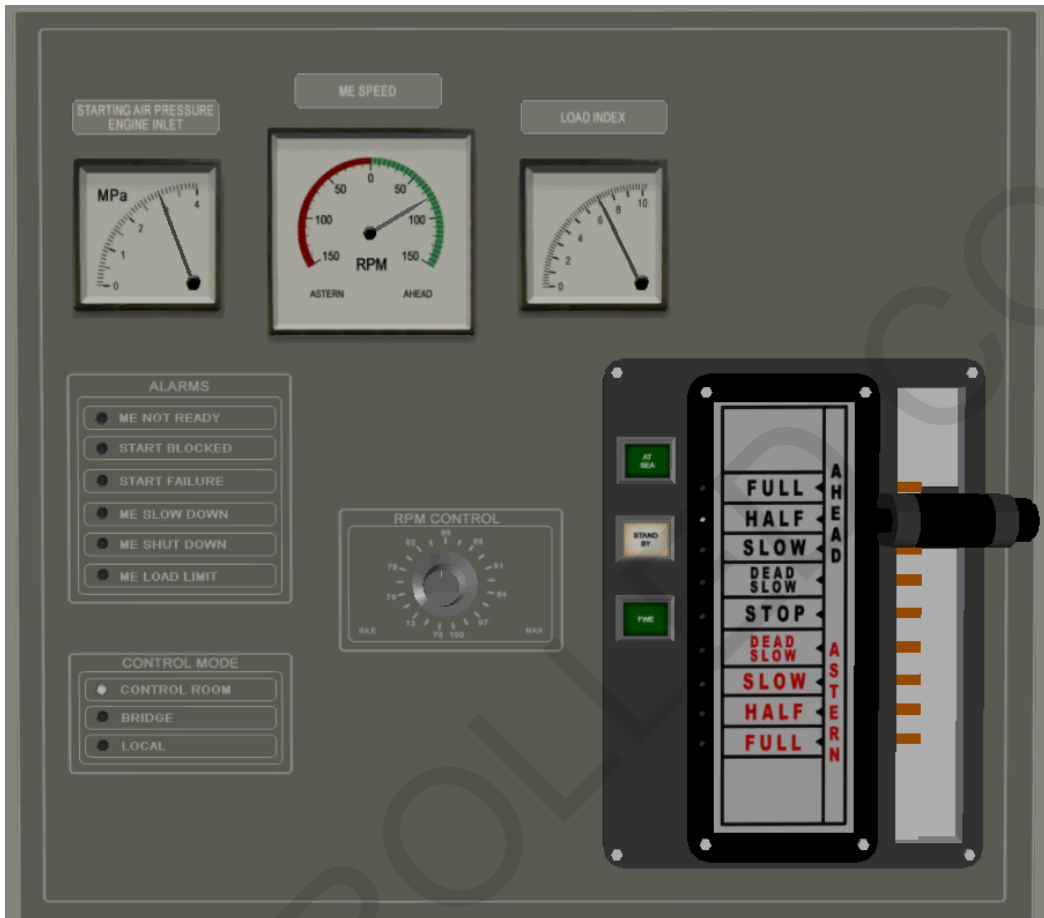


Fig. 11 Bridge Control Station

#### 4.5. Cooling System


The cooling system is divided into 3 sub-system: sea water cooling system, fresh water cooling system Low Temperature and fresh water cooling system High Temperature.

##### 4.5.1. Sea Water Cooling System

The purpose of this system is to cool LT FW coolers.

The system consists of the following elements:

- 2 central coolers

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- 3 SW pumps

- 1 side sea chest

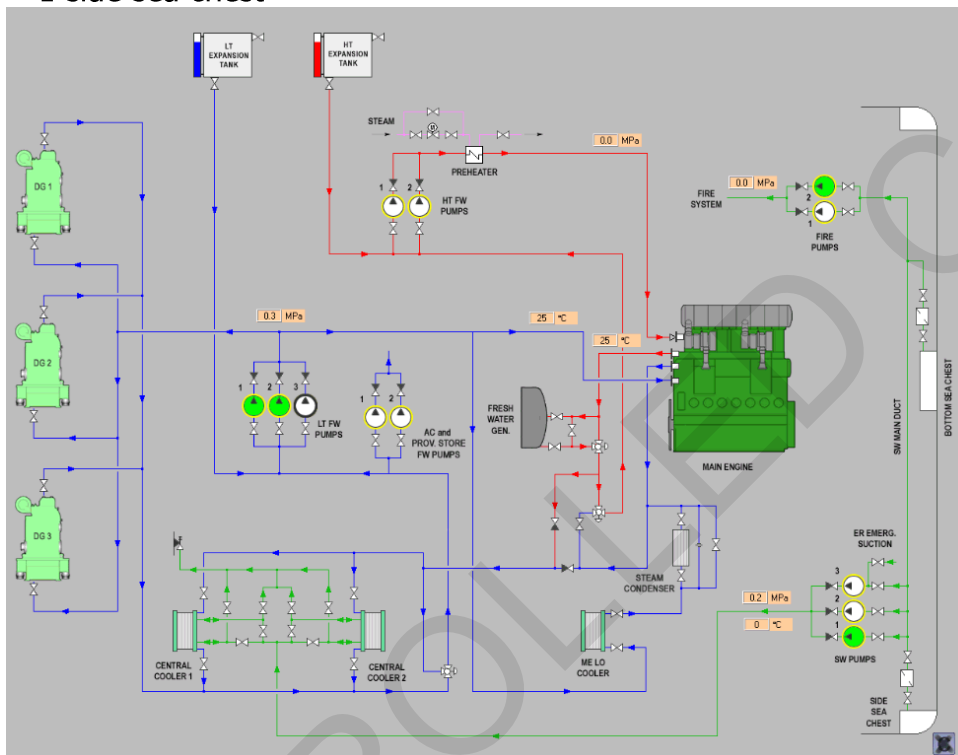


Fig. 12 Sea Water Cooling System Diagram (computer)

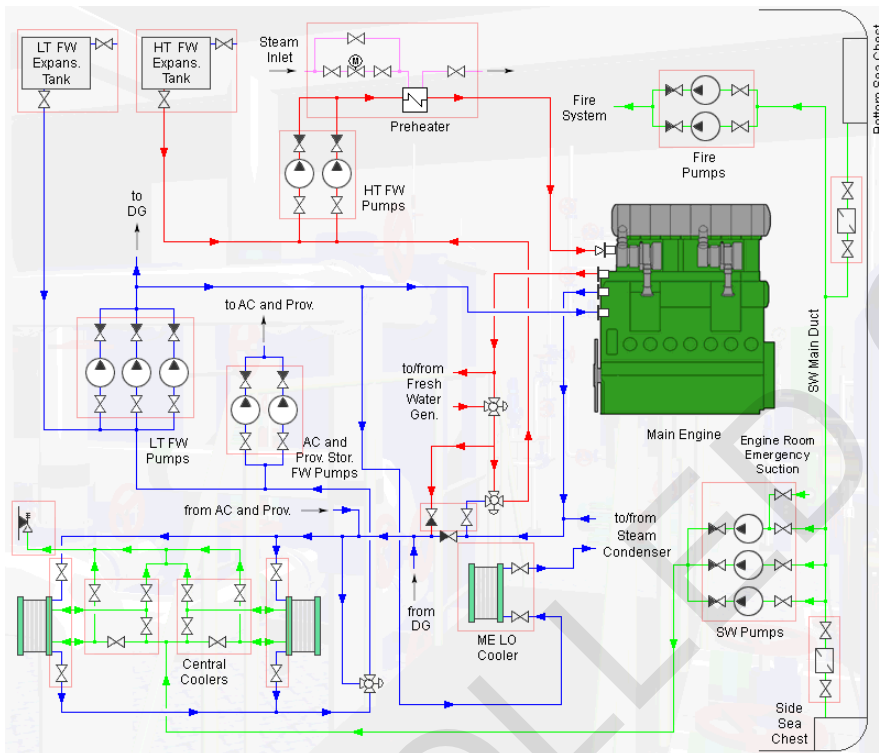


Fig. 13 Cooling System Diagram (3D navigation diagram)

#### 4.5.2. Fresh Water Cooling System


The fresh water cooling system is divided into high temperature (HT) and low temperature (LT) cooling system.

HT-water cools cylinders, cylinder heads, turbocharger and 1st stage of the charge air cooler. LT-water cools the 2nd stage of the air cooler, ME LO cooler and diesel generators.

As a standard, the Main Engine is equipped with a two-stage charge air cooler for increased heat recovery. The two-stage charge air cooler is built on the engine.

The LT-cooling and HT-cooling water circuit pumps are separately installed electrically driven pumps of centrifugal type.

The ME is also supplied with steam preheater.

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When preheating, the cooling water temperature for the engines should be kept as close as possible to the operating value.

To allow start on heavy fuel, the cooling water system should be preheated to a temperature as close to the operating temperature as possible, or min. 60oC.

#### **4.6. Fuel System**

The purpose of the fuel oil system is to conduct the fuel from the bottom tanks, through the centrifuge or transfer pumps, to the service tank and then to the ME, DG and Steam Boiler.

The ME and DG are designed for continuous heavy fuel operation. The engines can be started and stopped on heavy fuel provided that the engines and the fuel system are preheated to the operating temperature.

In ships intended for operation on heavy fuel, heating coils must be installed in the bunker tanks, so that it is possible to maintain a temperature of 40..50 oC when pumping the fuel to the settling tank.

The fuel system consists of two subsystems:

- fuel feed system
- storage and separation system


##### **4.6.1. Fuel Feed System**

The main task of the fuel feed system is to supply fuel to ME and DG with proper pressure and viscosity.

The system consists of the following elements:

- 1 DO service and 1 HFO service tanks
- 1 DO emergency service tank
- DO booster pump
- Fuel Conditioning Module

The Fuel Conditioning Module (FCM) is an automated two-stage pressurized fuel booster system used for ME and DG.

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FCM supplies clean filtered fuel to the engine at the flow rate, pressure and viscosity.

The feed pumps maintains the pressure in the fuel feed system. These pumps are high temperature resistant screw type.

The purpose of HFO booster pumps is to circulate the fuel in the system and maintain the correct pressure at the engine.


The heaters maintain an injection viscosity of 14 cSt at the maximum fuel consumption and a given day tank temperature.

For the control of heaters a viscosimeter is installed in the system. A thermostatic control is also fitted, to be used as safety when the viscosimeter is out of order.



Fig. 14 Fuel Conditioning Modular



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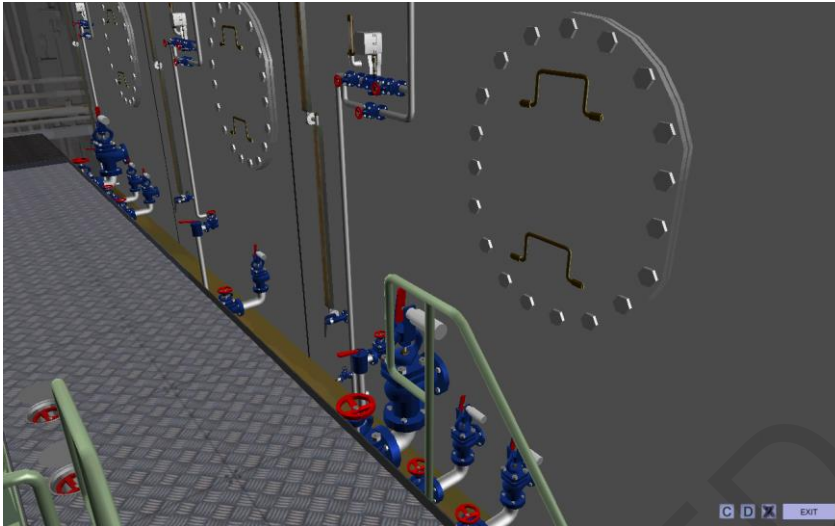


Fig. 15 HFO service tank with valves

The HFO service tank ensures fuel supply for about 24 operating hours.

DO booster pump is implemented in the fuel system for emergency situation. When there is no steam to heat the HFO, DO booster pump can be used to supply DG with DO.

In automatic operation DO booster pump starts automatically in case any of DG is switched to DO operation.

In case of blackout DG can be supplied with fuel from DO emergency service tank. Electromagnetic valve after this tank remains open when there are no voltage on bus bar and automatically close, after fuel pressure in normal supply will built up.



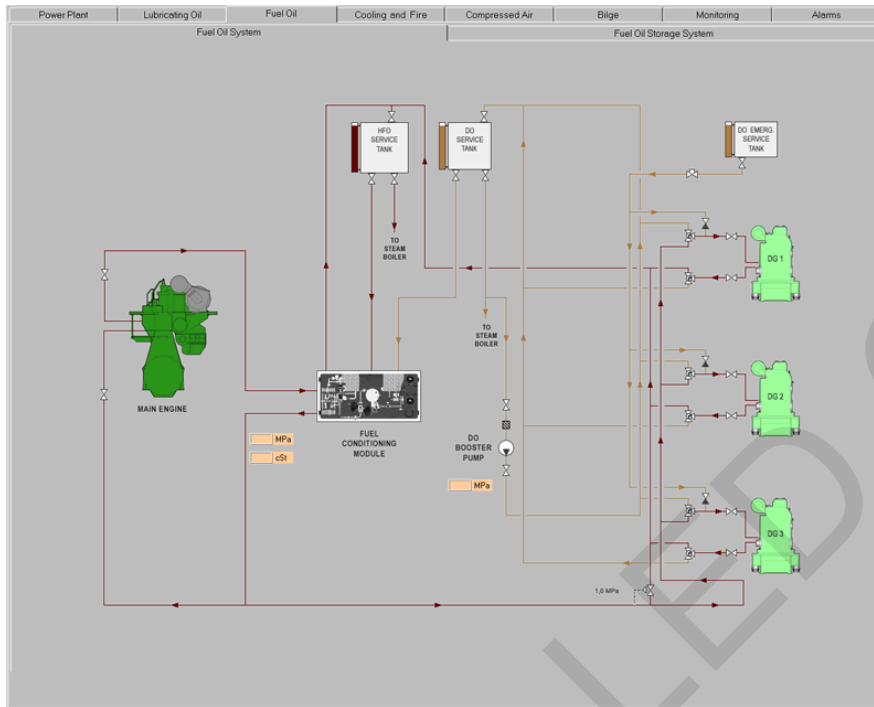


Fig. 16 Fuel System Diagram (computer)

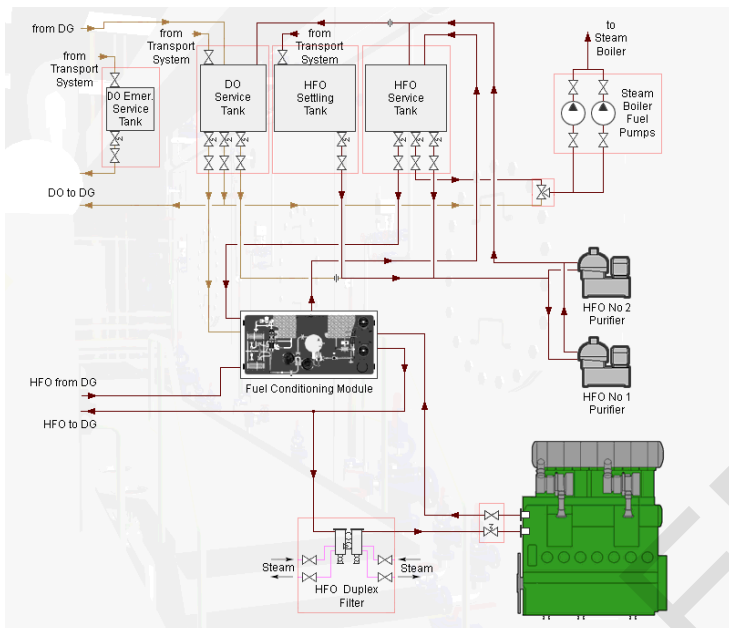



Fig. 17 Fuel System Diagram (3D navigation map)

Duplex fuel oil filter before ME and DG is of an active type, this means that after clicking on red filter handle, filter changed position (left, right, both). Filter is also equipped with contamination indicator Fig. 21, 22.

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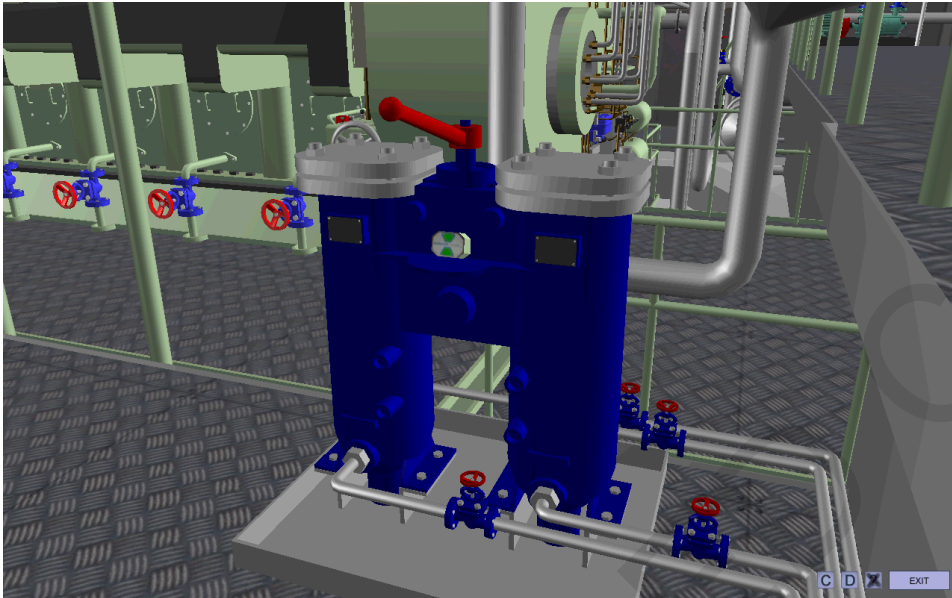


Fig. 18 Filter's contamination indicator ME

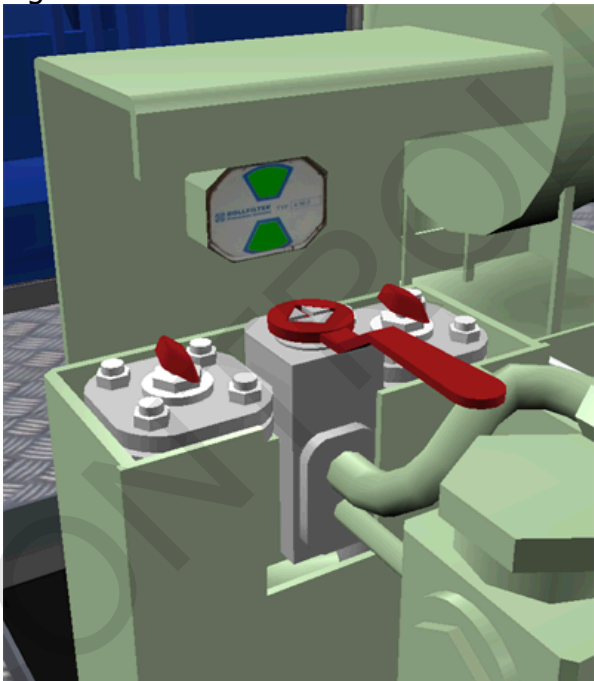



Fig. 19 Filter's contamination indicator DG

During simulation ME filters cleaning is performed by changing its position (from left to right filter etc.).

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DG filters cleaning is performed by rotating cleaning knobs located on the top of each filter.

#### 4.6.2. Storage and Separation System

The main task of this system is to transfer the fuel from storage tanks to service tank and to clean it in centrifugal separators.

This system comprises the following elements:

- HFO and DO storage tanks
- 1 HFO settling tanks
- 1 DO service and 1 HFO service tanks
- 1 DO and 1 HFO transfer pump
- 2 HFO purifiers

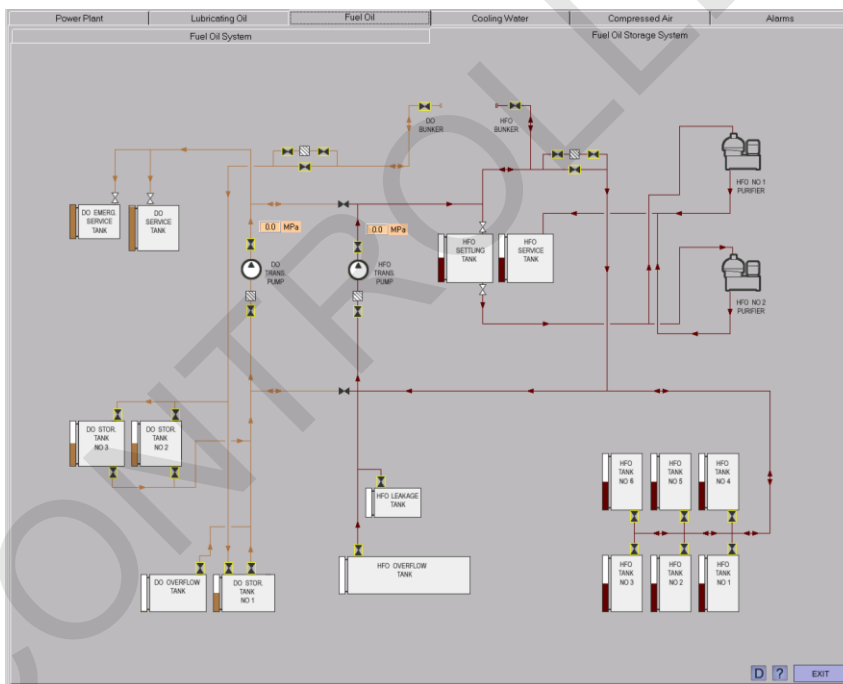


Fig. 20 Fuel Storage System Diagram (computer)

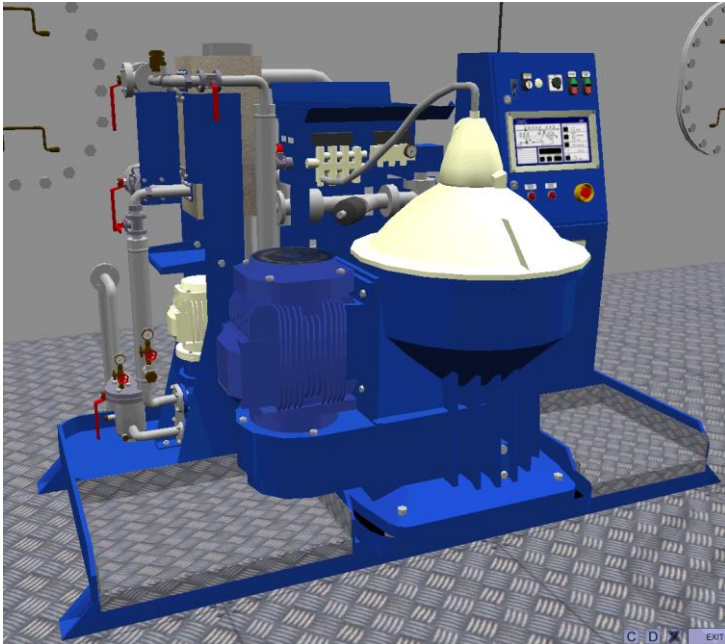


Fig. 21 HFO purifier

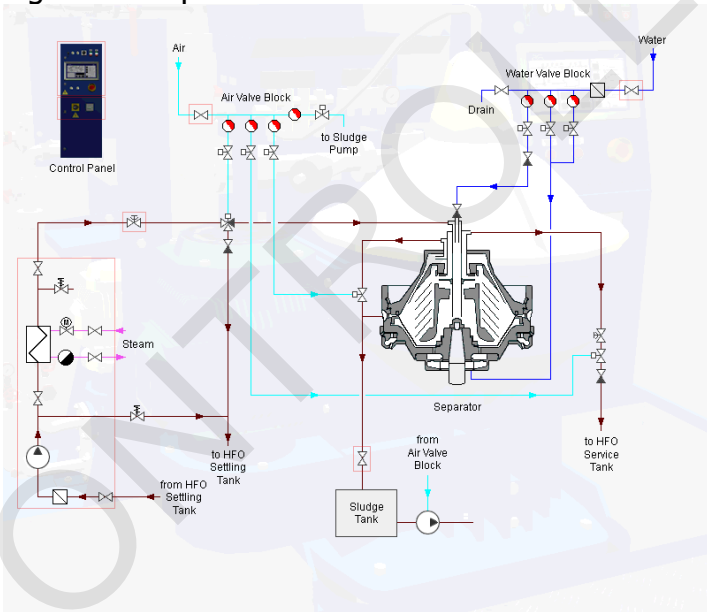



Fig. 22 HFO purifier (3D navigation map)

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#### 4.7. Lubricating Oil System

The lubricating oil system main task is the storage and delivery of lubricating oil for the ME and DG.

The lubricating oil system consists of the following elements:

- 2 ME LO circulating pumps
- Duplex filter (fitted on the engine)
- Automatic Filter

The lubricating oil pump is of screw type with an overflow valve.

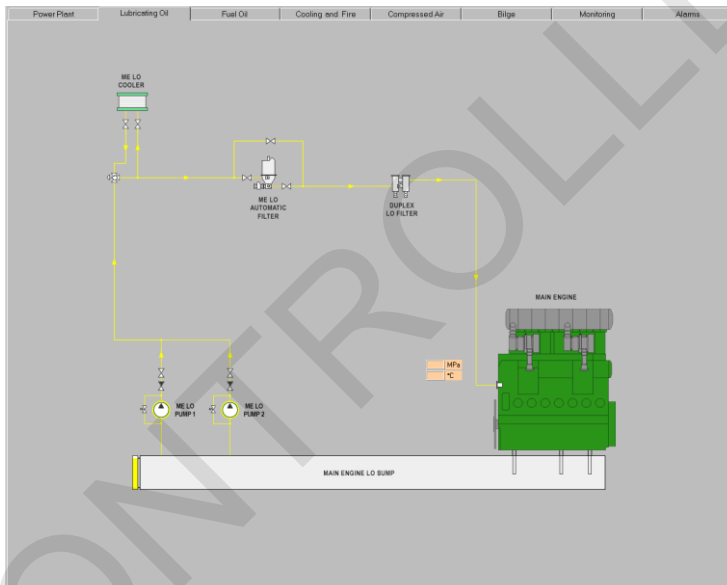



Fig. 23 Lubricating Oil System Diagram (computer)

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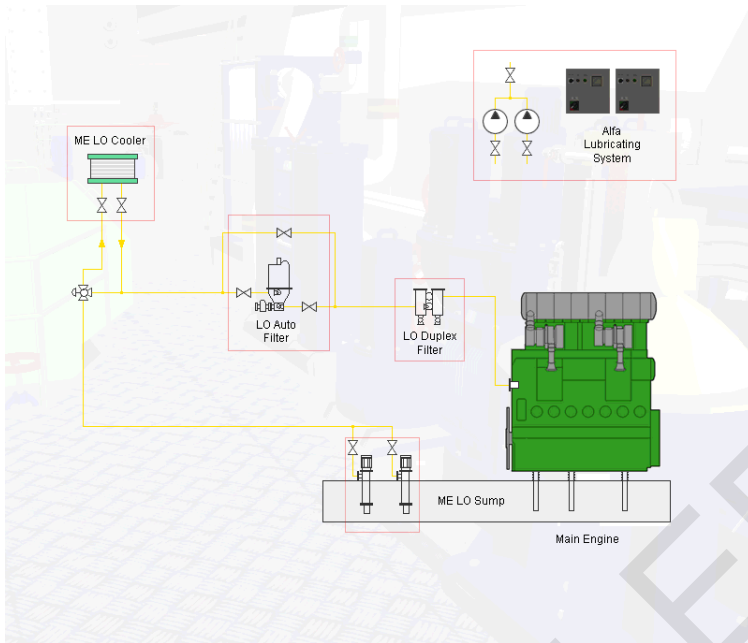


Fig. 24 Lubricating Oil System Diagram (3D navigation map)

Duplex lubricating oil filter before ME and DG is of an active type, this means that after clicking on red filter handle, filter changed position (left, right, both). Filter is also equipped with contamination indicator Fig. 21.

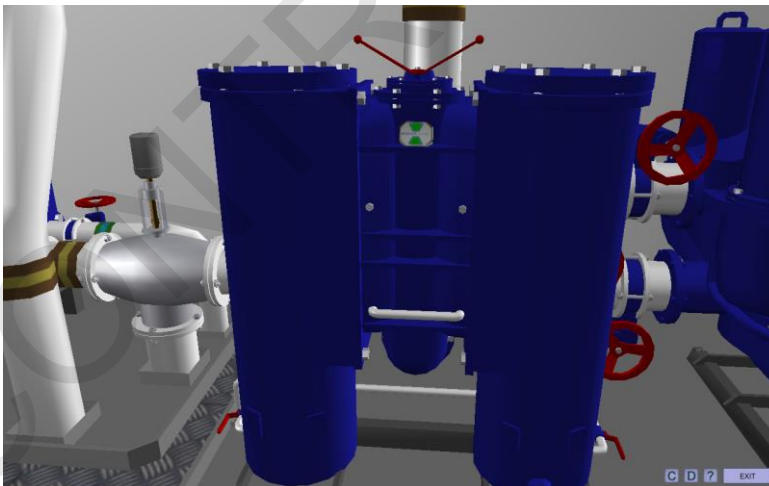


Fig. 25 Filter's contamination indicator ME


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Fig. 26 Filter's contamination indicator DG

During simulation filters cleaning is performed by changing its position (from left to right filter etc.)



Fig. 27 Alfa Cylinder Lubricating Oil System

### **Transport and Separation System**

The main task of this system is to transfer the lubricating oil from storage tanks to engine sumps and to clean it in centrifugal separators.

This system comprises the following elements:

- DG LO and ME LO storage tanks
- Dirty LO Tank





- 1 DG LO purifier
- 1 ME LO purifier
- 1 LO transfer pump
- LO engines' sumps

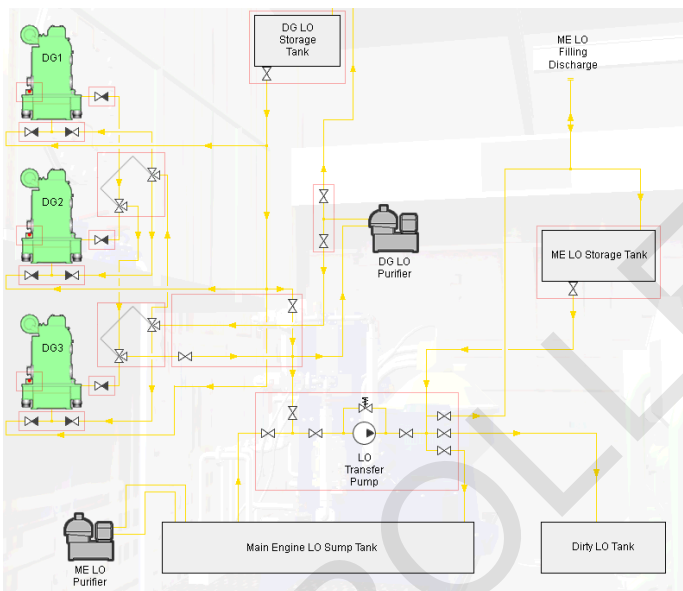


Fig. 28 Lubricating Oil Transport System Diagram (3D navigation map)


#### 4.8. Compressed Air System

ME and DG are started by means of compressed air with a nominal pressure of 3 MPa, the minimum recommended air pressure is 1,5 MPa (normally 1 MPa is still sufficient to start the engine).

The start is performed by direct injection of air into the cylinders through the starting air valve in cylinder head.

The purpose of compressed air system is the storage and supply of air for:

- ME starting
- DG starting

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- Control system
- Auxiliary purposes

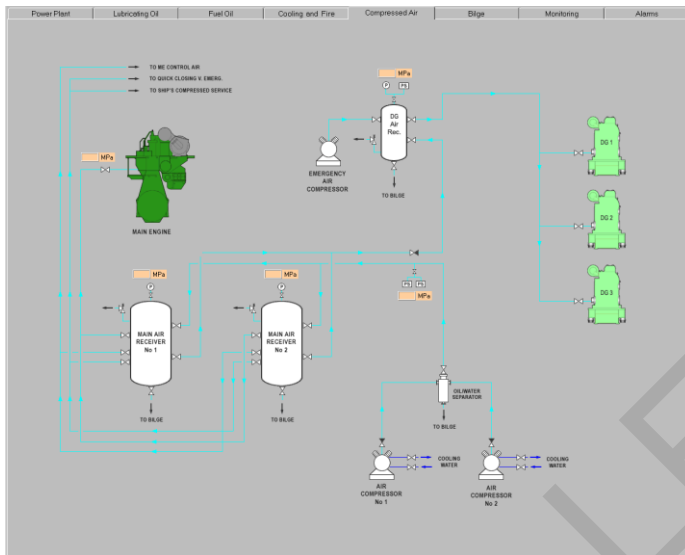


Fig. 29 Compressed Air System Diagram (computer)


The system consists of:

- 2 main air compressors
- 1 emergency compressor
- 2 main air receivers
- 1 DG air receiver

The main air compressor can be operated in manual or automated mode. In automatic mode compressors start and stop according to priority:

- lead: start - 2.6 MPa, stop - 3.0 MPa
- follow: start - 2.4 MPa, stop - 2.8 MPa

The compressed air for engine start is delivered directly from receivers. Air for control and auxiliary purposes is conducted through pressure reducing valves.

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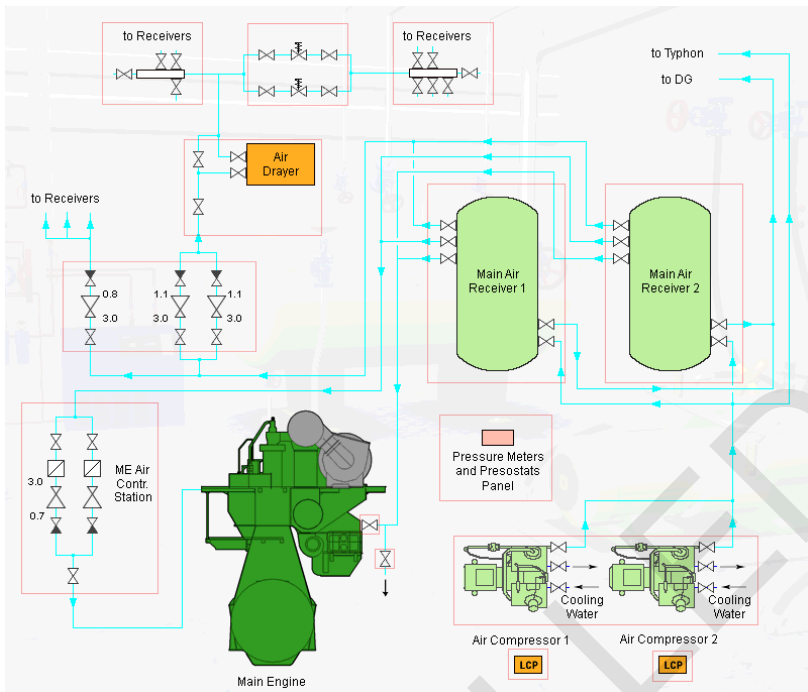


Fig. 30 Compressed Air System Diagram (3D navigation map)

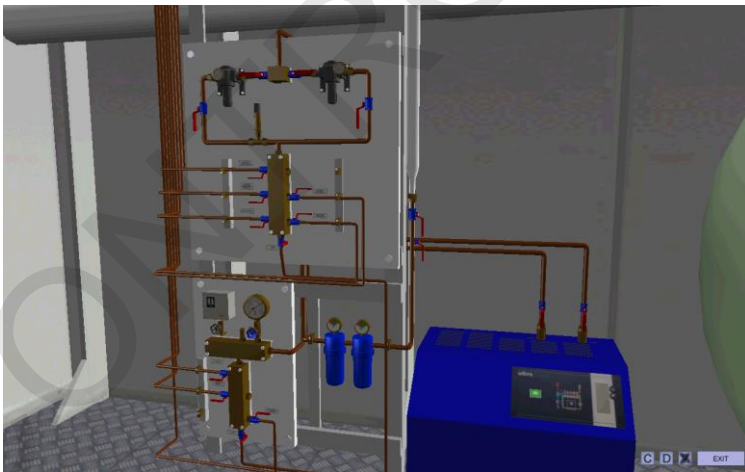



Fig. 31 Control Air Station

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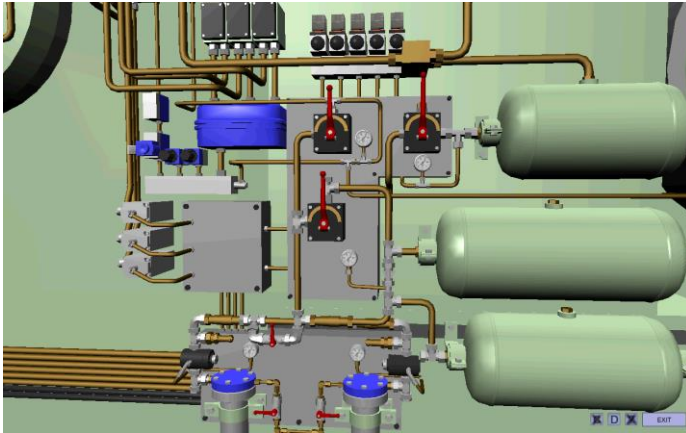


Fig. 32 ME Control Air Station

#### **4.9. Steam System**

The steam boiler is a combined vertical oil-fired (bare water tube) and exhaust gas (bare smoke tube) type.

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The boiler is equipped with the steam dump equipment designed for dumping excess steam generated by the boiler from the steam system to an atmospheric dump condenser.

It is essential that the condenser is dimensioned to be able to absorb the amount of steam generated in the exhaust gas part of the combined boiler.

The steam system consists of the following parts:

- Steam boiler
- Control panel
- Feed water pumps
- Fuel pumps
- Hot well with condenser
- Steam receivers collectors

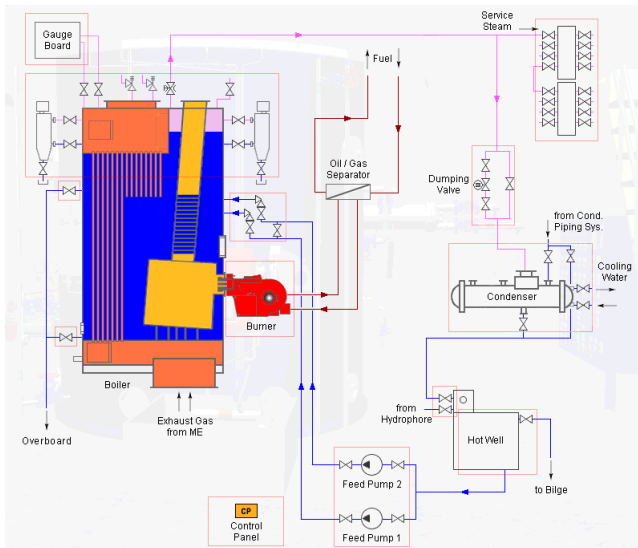


Fig. 33 Steam System (3D navigation diagram)

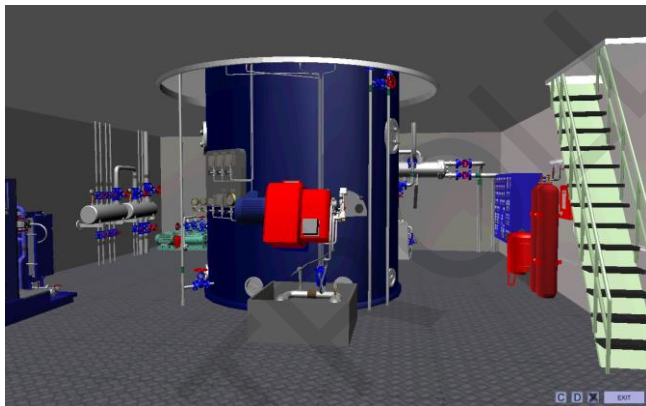


Fig. 34 Steam Boiler – main view

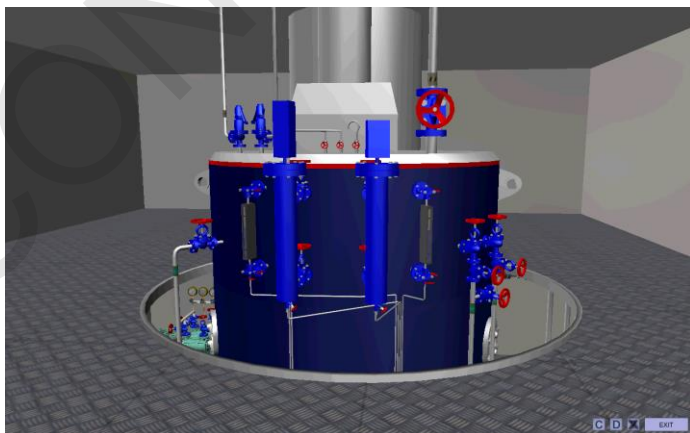


Fig. 35 Steam Boiler – valves



Fig. 36 Steam Boiler – control panel

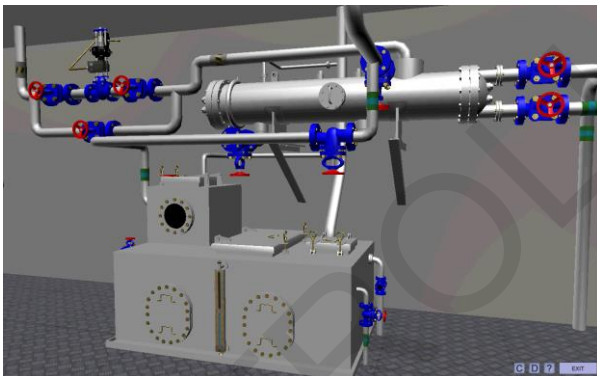


Fig. 37 Hot well and condenser

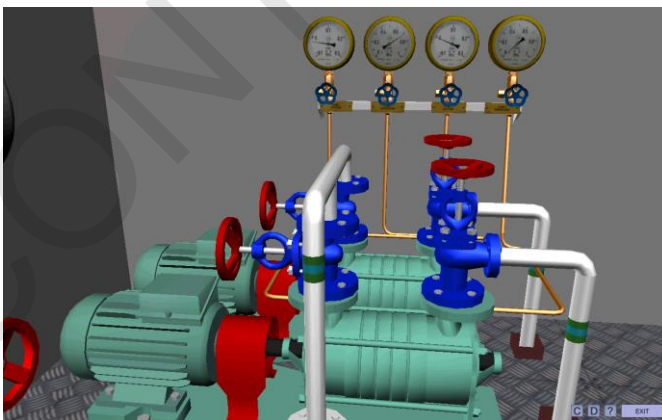



Fig. 38 Steam Boiler – feed water pumps



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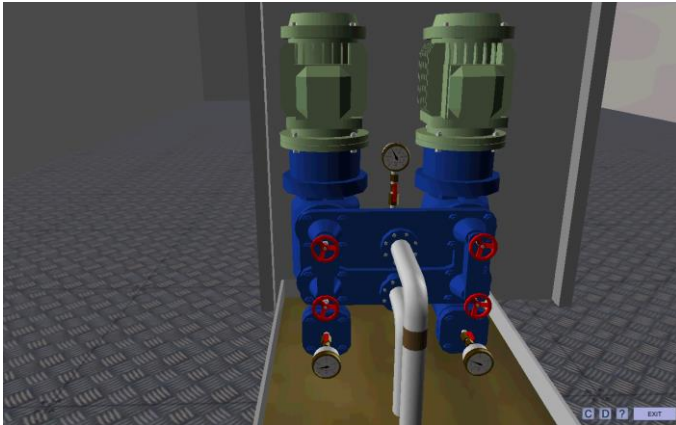


Fig. 39 Steam Boiler – fuel pumps

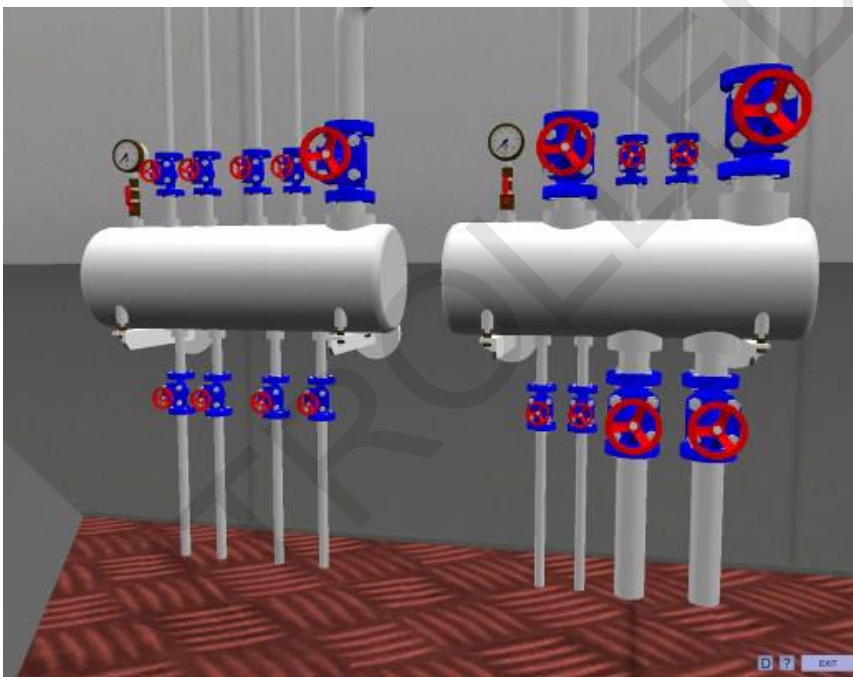



Fig. 40 Steam Boiler – receivers

#### 4.10. Power Plant

The electric power plant consists of three diesel generators and one emergency diesel generator. Shore supply is also simulated.

##### 4.10.1. Emergency Generator

The emergency diesel generator is very important part of ship electric power plant.

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The emergency generator is automatically connected to the emergency switchboard in case of failure of the main source of electric power, and within 45 s automatically supply emergency consumers.

The emergency generator shall not be used for supplying power during normal operation of the vessel.

Exceptionally, and for short periods, the emergency source of power may be used for blackout situations and for starting from dead ship.

In order to ensure ready availability of the emergency generator, non-emergency circuits are automatically disconnected from the emergency switchboard.

The emergency generator shall be sufficient to supply all services essential for safety in an emergency situations.

The emergency diesel generator is started with main electric and emergency hydraulic starting systems.

The emergency diesel generator consists of the following parts:

- Fuel Oil Tank
- Diesel Generator
- Diesel Generator Control Panel
- Emergency Transforms Box
- Battery Charger
- Emergency Switchboard
- Flaps Control Device




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Fig. 41 Emergency generator

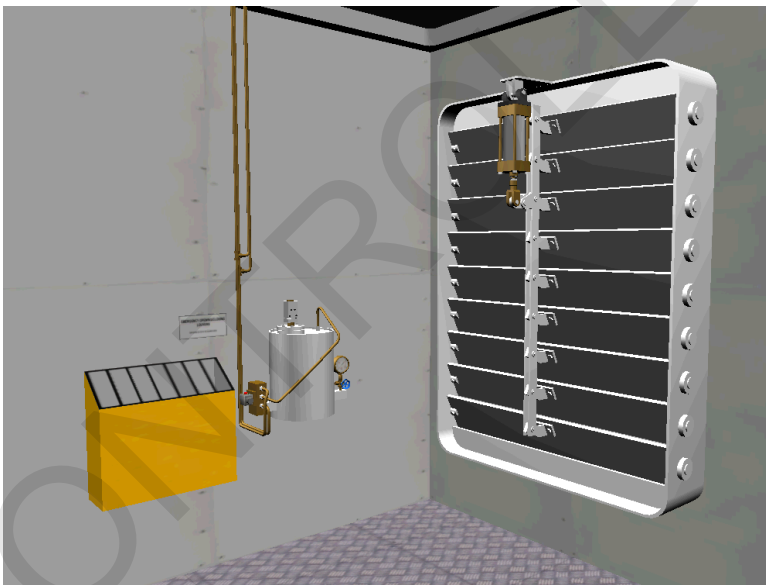



Fig. 42 Flaps of emergency generator

#### 4.10.2. Emergency Switchboard (ESB)

The emergency switchboard is located in the same space that emergency generator.

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In normal operation the emergency switchboard is supplied from the main switchboard by an interconnecting feeder.

This feeder is protected against overload and short circuit at the main switchboard, and is disconnected automatically at the emergency switchboard upon failure of the main source of electrical power.

The emergency switchboard is arranged for the supply of power back to the main distribution system, but shall be used only in emergency situation. Special key protected switch should be used for this purpose. The Emergency Switchboard consists of the following fields:

- Generator Panel
- Shore Supply Switch Panel
- Alarm Panel
- Shore Supply Control Panel
- Emergency Transformers Panel
- Emergency Consumers Panels




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Fig. 43 Emergency switchboard

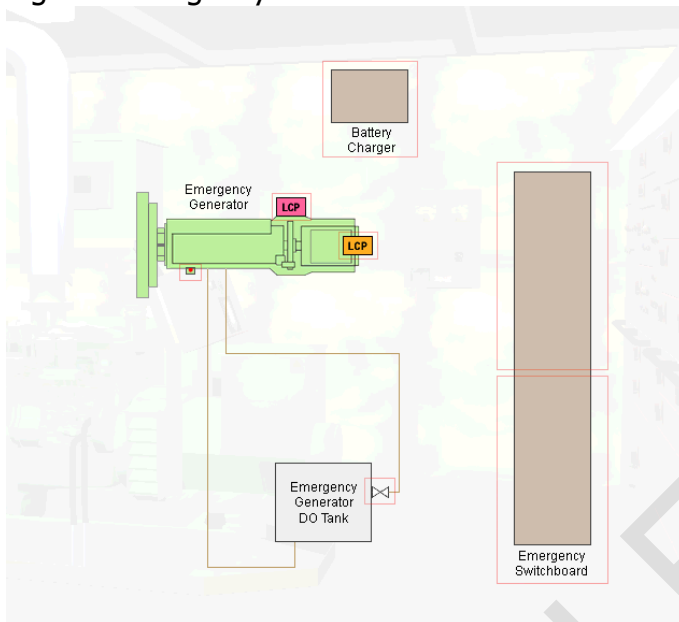
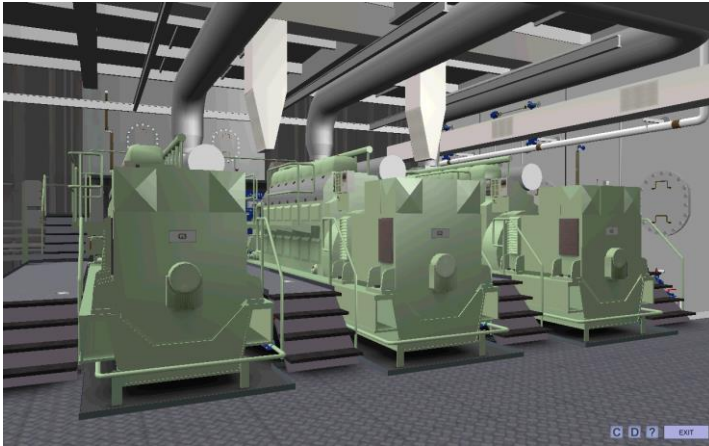


Fig. 44 Emergency generator (3d navigation diagram)

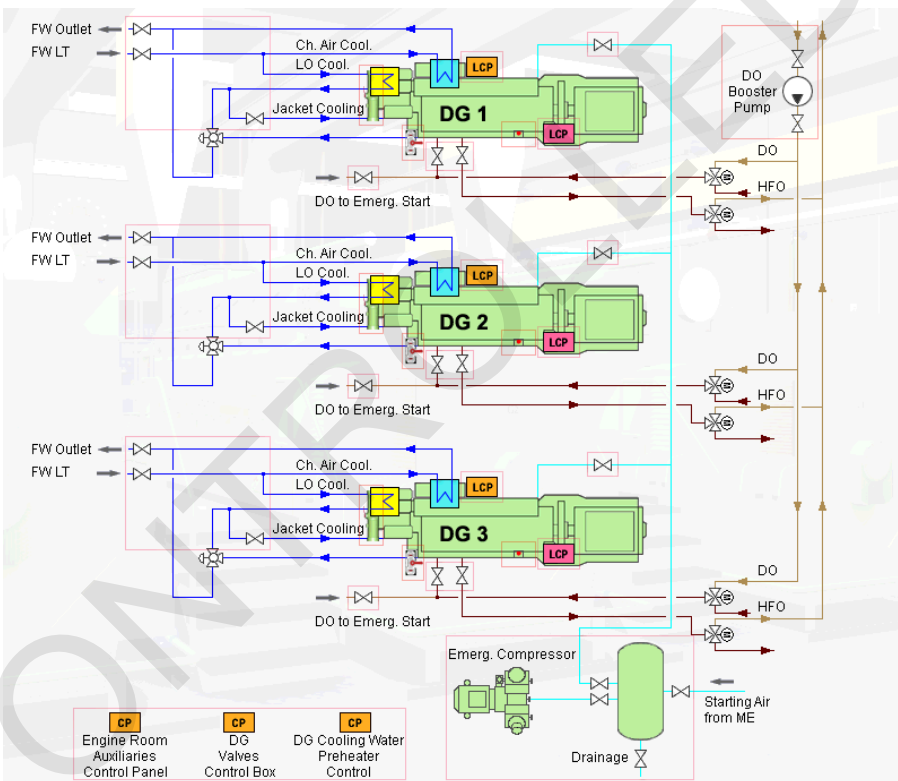
#### 4.10.3. Diesel Generators

The electric power plant consists of three diesel generators. One is used for the normal sea load, leaving two available to meet any unusually high loads or to provide security when maneuvering. Alternately, the third is retained as a standby set able to provide additional power.


The diesel generators are supplied with heavy fuel oil and diesel oil by means of booster pump. The diesel generators are started with compressed air and are provided for continuous parallel operation.



**Fig. 45 Diesel generators room**



**Fig. 46 Diesel generators room (3d navigation diagram)**

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#### 4.10.4. Main Switchboard

The main switchboard is one of the most important element of a marine electric distribution system. The system is generally designed such that under all normal conditions of operation, power is distributed from the main switchboard.

The main switchboard is generally located near the center of the distribution system and this is normally the main engine room or machinery control room. These locations are normally below the ship's waterline or below the uppermost continuous deck of the ship i.e. the bulkhead or main deck. Consequently, in the event of a fire or flooding it is likely that the main generators and switchboard would be disabled.

For shipboard installations specific protective systems are required to shut down all ventilation systems and all fuel oil systems in the event of fire.

The Main Switchboard consists of the following fields:

- Power Consumers – Fields 1, 2, 3 ,8, 9 ,10 ,11
- Diesel Generators Control Panels – Fields 4, 5, 7
- Synchronization Panel – Field 6

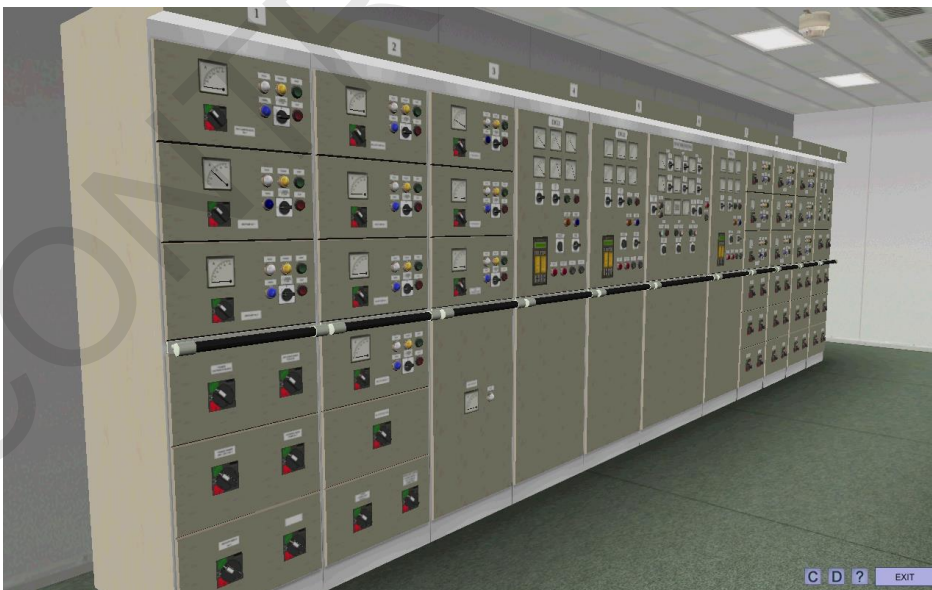



Fig. 47 Main Switchboard

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#### **4.11. Fresh Water Generator**

Conversion of sea water into fresh water, by vacuum distillation, is performed for the purpose of high quality fresh water supply for domestic and process utilization. Fresh Water Generator is designed for automatic operation with continuous control of freshwater quality.

The fresh water generator consists of the following main components:

1. Fresh water generator vessel with:
  - evaporator section /plate heat exchanger/,
  - demister,
  - condenser section /plate heat exchanger/,
  - fittings /air valve, safety valve, vacuum gauge, thermometer and sigh glass/.
2. Combined air/brine ejector.
3. Ejector pump.
4. Fresh water pump.
5. Control panel with salinometer and Engine Control Room's alarm block.
6. Mineralizer.

The feed water to be distilled is taken from the sea cooling water outlet of the condenser. It enters the evaporator where it evaporates at about 40-50°C as it passes between the plates heated by the heating medium.


The evaporating temperature corresponds to a vacuum of 90-95%, maintained by the brine/air ejector.

The vapours generated pass through a demister where any drops of sea water entrained are removed and fall due to gravity to the brine sump in the bottom of the generator chamber.

The clean fresh water vapours continue to the condenser, where they condense into fresh water as they pass between the cold plates cooled by the sea cooling water.

In order to check continuously the quality of the produced fresh water, a salinometer is provided together with an electrode unit fitted on the freshwater



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pump delivery side. If the salinity of the produced freshwater exceeds the permitted maximum value (2 ppm), solenoid valve and alarm are activated to dump automatically the produced fresh water to the bilge



Fig. 48 Fresh Water Generator

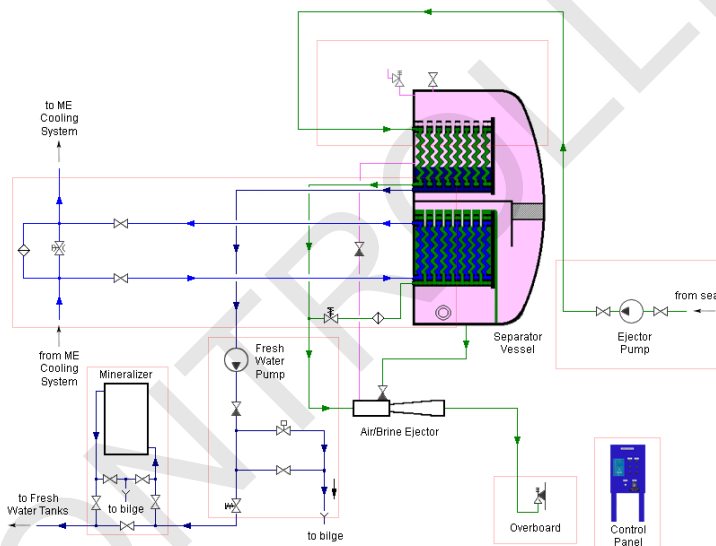



Fig. 49 Fresh Water Generator (3d navigation diagram)

#### 4.12. Hydrophore

The hydrophore set is designed for increasing water pressure in water supply systems.

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The hydrophore's aim is to supply fresh sanitary water to the receivers by keeping a determined pressure in the installation.

Sanitary water from hydrophore is used for:

- cooling water system (refilling gravity tank)
- separator operating tank
- bilge water separator
- cold water accommodation
- hot water accommodation

The hydrophore installation functions automatically. An electrically - driven centrifugal pump sucks water form tanks through a filter.

The pump forces the water into the pressure vessel, which is filled partly with water, partly with air.

The differential pressure control, installed in the upper part of the pressure vessel, cuts - off the electricity supply to A/C motor of the pump when the pressure in the vessel is at high value (0.6 MPa).


The current is connected again when the pressure in the vessel decreases to low value (0.3 MPa).

The water level in the pressure vessel should be related with pressure, it means that in the event the pressure is about low value (0.3 MPa) (the moment of pump starting), the water level should be at minimum ('MIN' marked on right part of the vessel).

In the event the pressure is about high value (0.6 MPa) the water level should correspond to maximum ('MAX').

From the pressure vessel /hydrophore/ water is conducted to the receivers.



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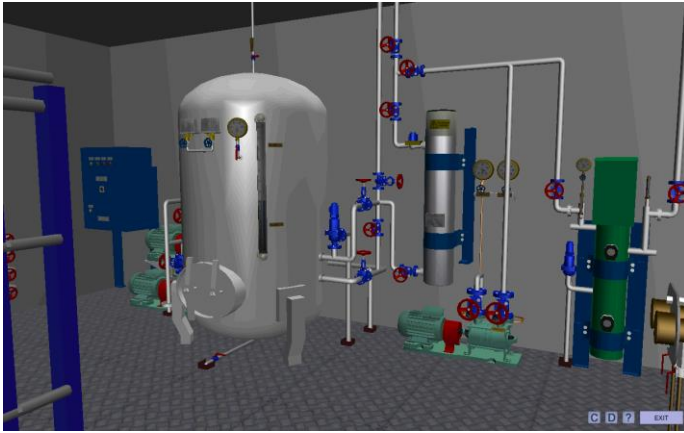


Fig. 50 Hydrophore installation

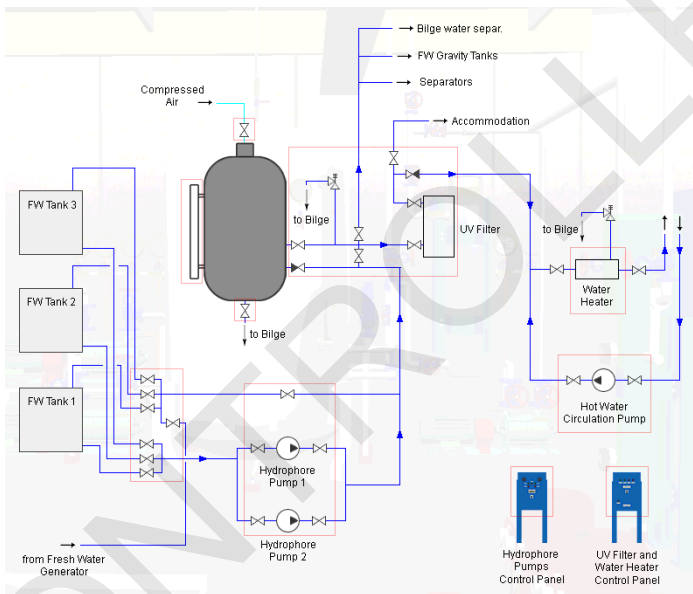



Fig. 51 Hydrophore (3d navigation diagram)

### 4.13. Bilge System

The bilge system consists of the following elements:

- Centrifugal bilge pumps
- Piston bilge pump

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- Bilge water tank
- Oily water separator
  
- 8 bilge wells

The bilge system includes following bilge wells:

- Propeller shaft
- ME Room SB
- ME Room PS
- Deck No 1 PS AFT
- Deck No 1 PS FWD
- Deck No 1 SB AFT
- Deck No 1 SB FWD
- Bow Thruster

Each bilge has a well and the related alarm controlled by the bilge level.


Bilge pumps have to be primed, this means that before starting the pump, it's suction side has to be filled by sea water.

The bilge water is collected in a separate tank and when the level in this tank reaches the upper limit, it has to be pumped out to the oily water separator. This is necessary because bilge water discharges must contain less than 15ppm of oil under the current IMO regulations.

The overboard discharge is sampled through an oil content meter. Prior to start-

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Up and shutdown the oily water separator must be flushed through with clean fresh water.

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This is done automatically when the separator operates in the automated mode and its operation is controlled by the level in the bilge water tank.

The separator can be also operated in the manual mode.

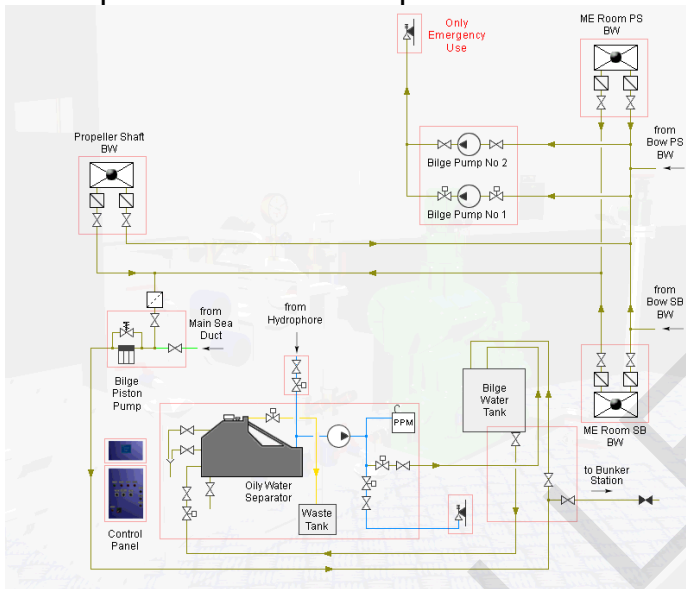


Fig. 52 Bilge System (3d navigation diagram)

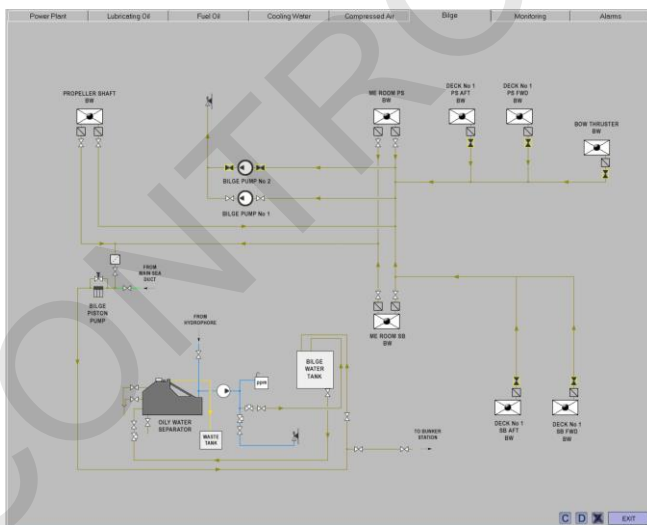



Fig. 53 Bilge System (computer)

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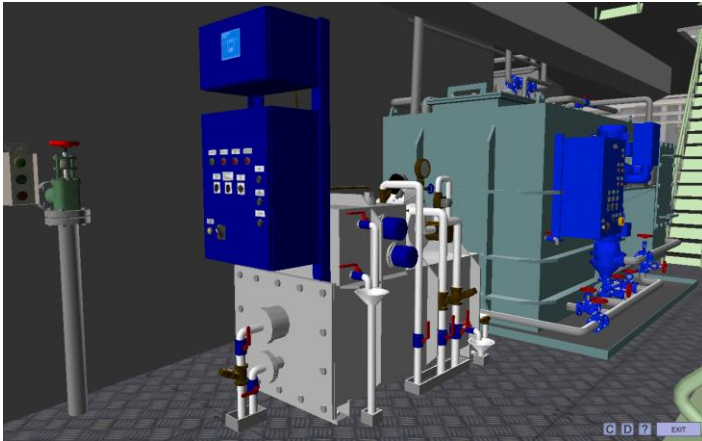


Fig. 54 Oily Water Separator

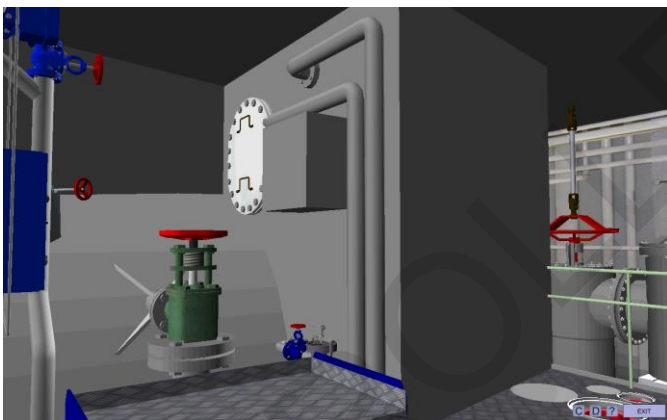


Fig. 55 Bilge Tank

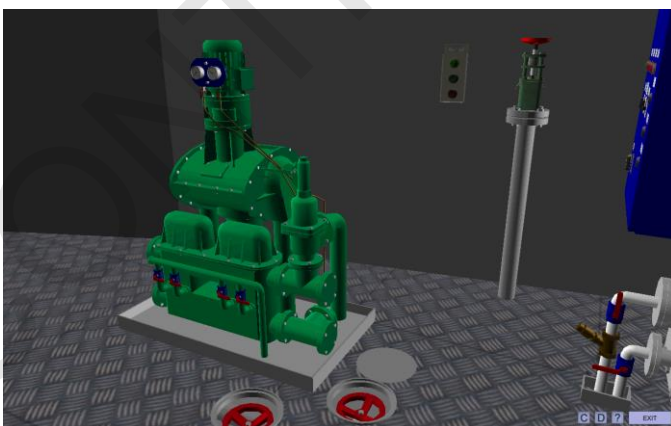



Fig. 56 Bilge Piston Pump

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#### **4.14. Steering Gear System**

The steering gear is composed of one hydraulic rotary vane actuator mounted directly on the rudder stock, served by two pump units delivering the necessary oil pressure for operating the rudder.

The two pump units may be operated together or separately.


Each pump unit will provide oil with sufficient pressure to develop the specified rudder torque.

In normal operation at sea, only one pump unit is in operation while the other is acting as a stand-by unit.

During maneuver of the vessel, when the shortest possible steering time is required, it is possible to run both pump units simultaneously and in such case the rudder rate will be doubled.

The pump units are equipped with solenoid valves, which are normally operated by means of signals from the bridge steering controls.

The pump is submerged in the oil tank. The tank is divided into three chambers, one for each pump unit and one for the integrated storage tank, with one low level alarm-switch in each of the pump unit chambers.

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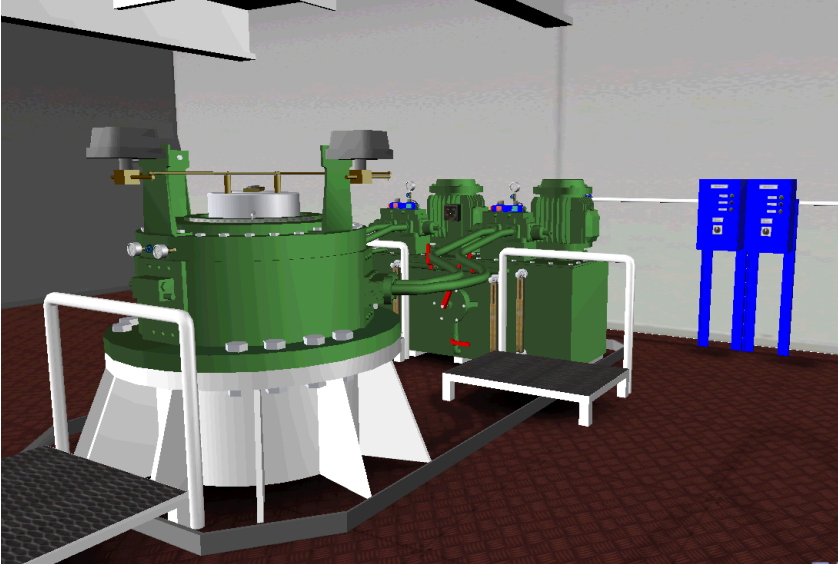



Fig. 58 Steering Gear



Fig. 59 Steering Gear – Bridge Panel

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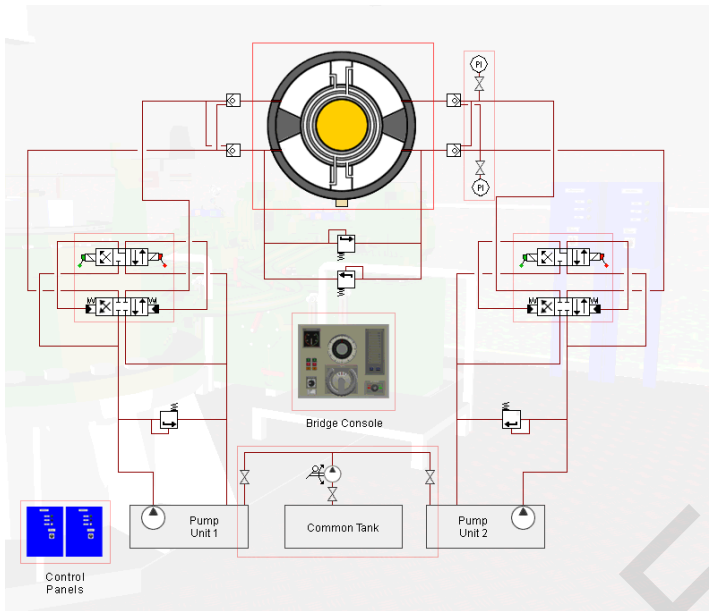


Fig. 60 Steering Gear (3d navigation diagram)

#### 4.15. Sewage Treatment Plant

Sewage treatment plant is a vacuum type toilet system. The toilet system receives, treats and discharges sewage waste.

All waste water, both black water (toilets, urinals, hospital) and grey water (galley, showers and sinks) can be treated in the plant. Sewage treatment plant consists of vacuum collecting unit and biological sewage treatment plant unit.

##### 4.15.1. Vacuum Collecting Unit

The vacuum collecting unit has following functions:

- Vacuum generation for vacuum toilets
- Tank discharge operations
- Alarms, indications and connections to the engine monitoring system

The vacuum collecting unit consists of:

1. Sewage atmospheric tank



- 2. Ejector
- 3. Ejector pump
- 4. Pressure switch
- 5. Vacuum gauge
- 6. Discharge valve (motor valve)
- 7. High level switch
- 8. Low level switch
- 9. Shut-off valve

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- 10. Control panel

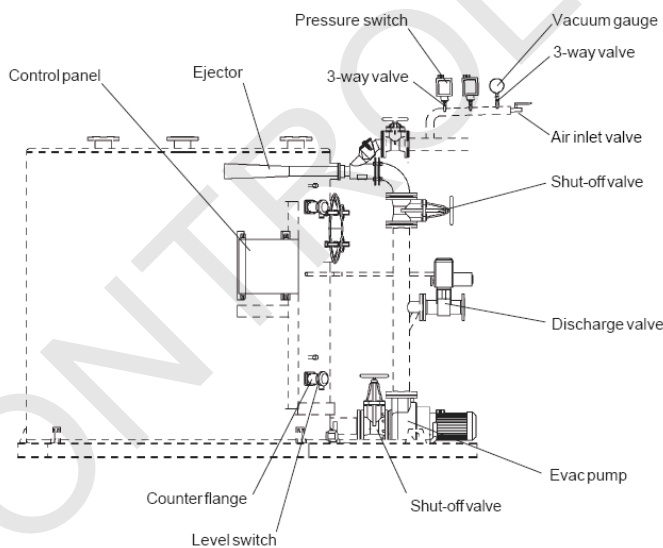



Fig. 61 Vacuum Collecting Unit

### Vacuum generation

Vacuum is generated by an ejector pump circulating water.



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Vacuum is generated only to the vacuum piping and the sewage collecting tank itself is under atmospheric pressure.

The vacuum level is controlled by the vacuum switch, which is located on the manifold of the vacuum piping.

Vacuum switch is set to start pump at – 35 kPa and stop the pump at –60 kPa.

### **Discharge operation**

The ejector pump together with motor valve is used for discharging of collecting unit.

The discharge operation can be manually or automatically controlled.

The automatic discharge operation is either timer or level controlled.

In level controlled discharging, process starts when liquid level has reached the high level switch in the sewage tank and continues until liquid level is below the low level switch.

During timer-controlled discharging, process is controlled by a timer.

Timer-controlled discharging starts with work operation.

After discharging starts the pause time.

The discharging will stop, if sewage level in the tank reaches low level switch.

If the sewage level in the tank reaches the high level switch, the discharge starts immediately and stops as soon as the high level switch has fallen to its down-position.

### **4.15.2. Biological Sewage Treatment Plant Unit**

In biological sewage treatment plant biopopulation converts organic substances existing in waste water to carbon dioxide and water without danger of methane gas production.

The biological sewage treatment plant has four chambers (two aeration chambers, a settling Chamber and a disinfection chamber).

The biological aerobic process takes place in two aeration chambers.

In the settling chamber sludge is separated from waste water and in the disinfection chamber discharged effluent is neutralized.

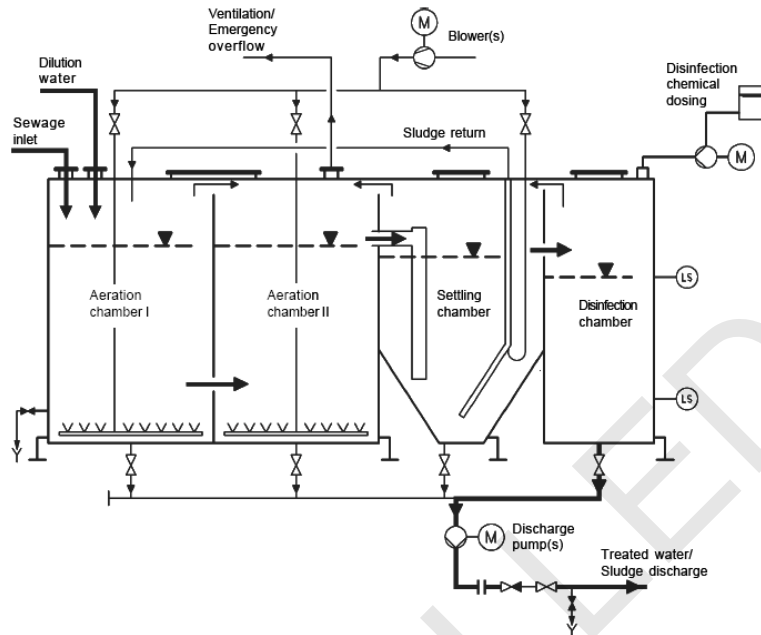


Fig. 62 Biological Sewage Treatment Plant

**Biological sewage treatment process**


All waste water is led to the aeration chamber I by gravity or vacuum. Bacterial growth is stimulated by oxygen of air.

Required air is produced by the air blower and led to aeration chambers I and II via air distributors.

The aerobic treatment process starts in the aeration chamber I and continues in the aeration chamber II.

An activated sludge is separated in the settling chamber by gravity and clarified water floats to the disinfection chamber. The activated sludge is pumped back to the aeration chamber I by and air driven ejector.

A chlorine based disinfection chemical is added by the dosing pump into the clarified water in the disinfection chamber to meet IMO's requirements regarding presence of coliform bacterias in treated water.

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Treated water is pumped to sea or ashore by a discharge pump.

Disinfection can be also done by UV on special request.

A mineralized sludge from activation chambers I and II is pumped at given intervals to sea, to on shore facilities or to the vessel's sludge storing tank.

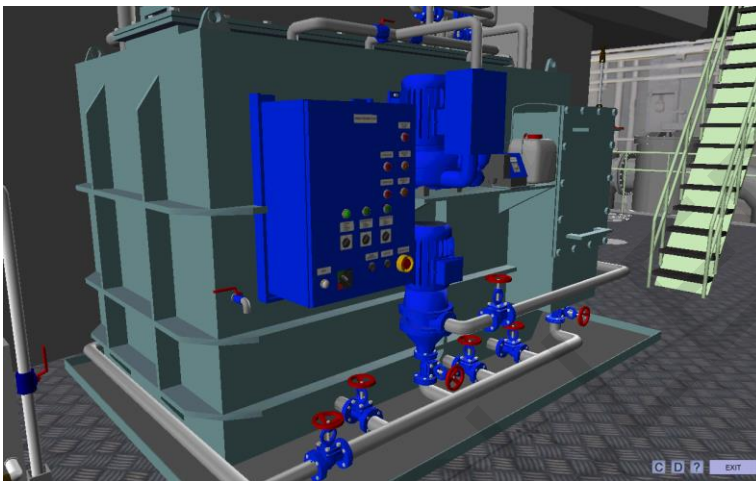


Fig. 63 Sewage Treatment Plant

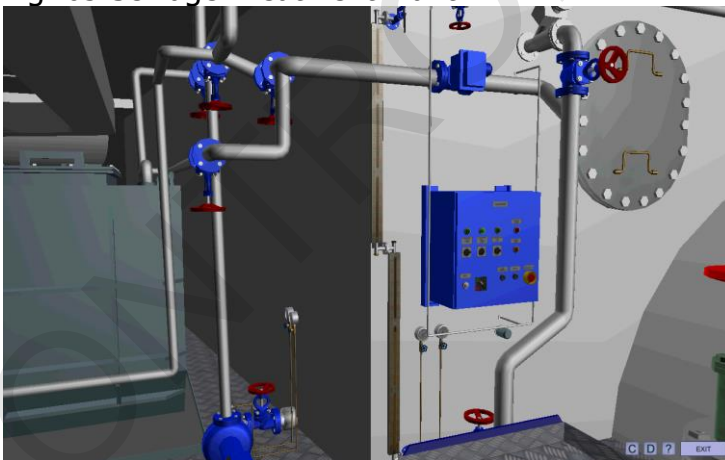



Fig. 64 Vacuum Collecting Unit

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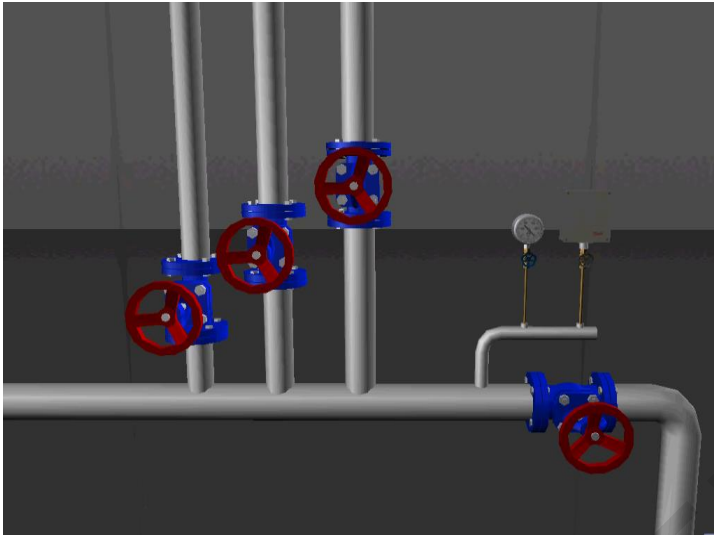


Fig. 65 Sewage Treatment Plant – Sewage Collector

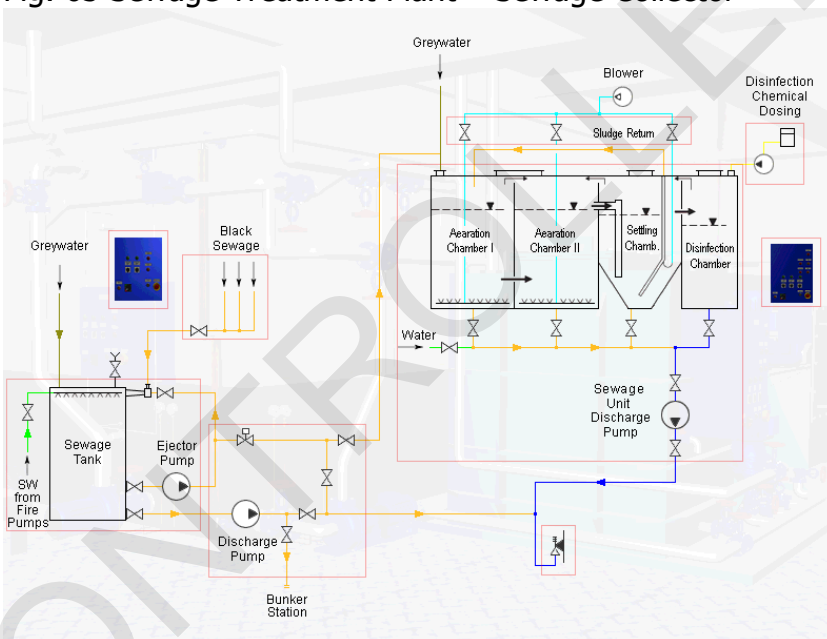



Fig. 66 Sewage Treatment Plant (3d navigation diagram)

#### 4.16. Water Mist System

The water mist system is fixed fire fighting system. A high-pressure water mist system protect high risk areas in engine room.

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The water mist fire fighting system is supplied for automatic and manual operation.

The system covers the following objects in the engine room:

- Main engine (4 nozzles)
- 3 Diesel generators each (2 nozzles)
- FO purifiers (2 nozzles)
- Steam boiler (1 nozzle)

Each of the above 4 sections, having its own section valve and is therefore protected individually.

### **System activation**

The system is designed for automatic, remote and emergency activation.

Automatic operation is initiated by the vessels fire detection system.

The water mist system has built-in interface relays for incoming signals, from the fire detection system.

By remote activation the system is operated from the valve operation panel located in the Engine Control Room.

### **Emergency operation**

In case of error in the operation system, the section valves can be operated by opening the by-pass valve located at each section valve, and the high-pressure pump can be started by operation the pump start switch located on the front of the local control panel.

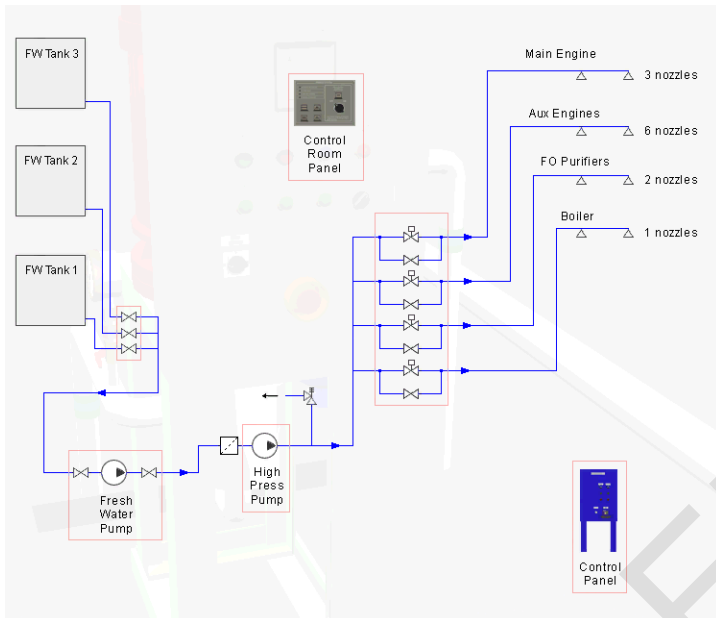


Fig. 67 Water Mist System (3d navigation diagram)

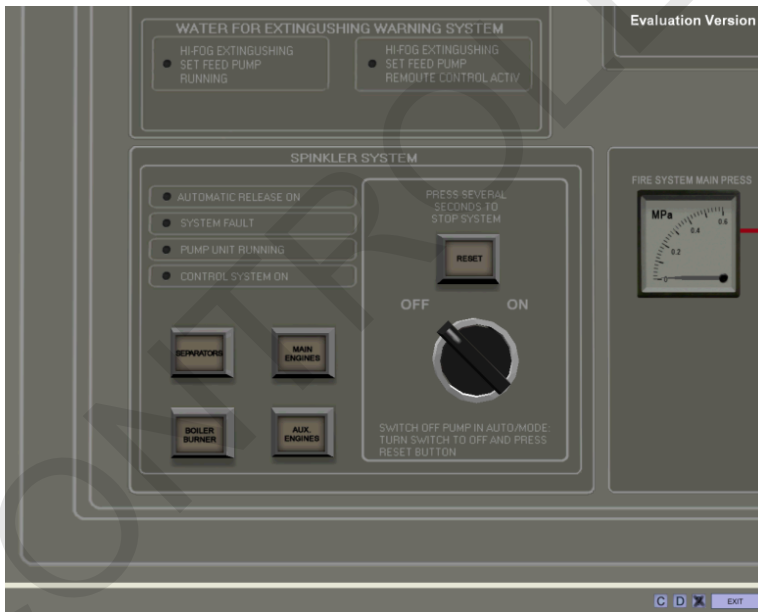



Fig. 68 Valve Operation Panel

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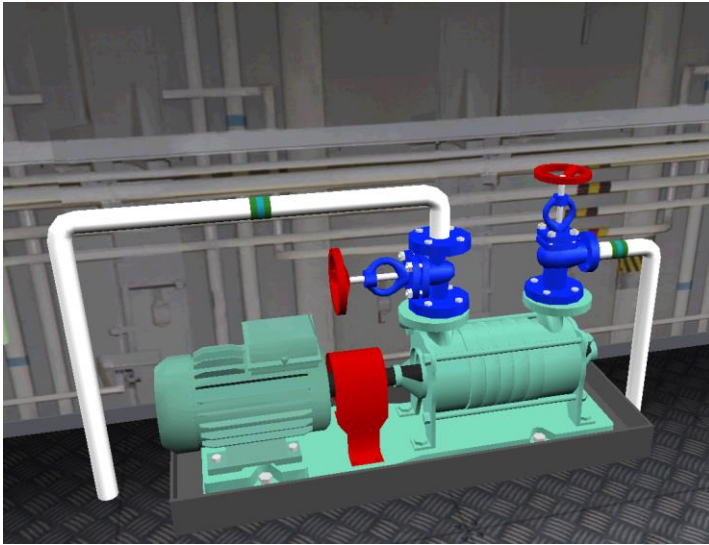



Fig. 69 Water Supply Pump



Fig. 70 High Pressure Pump with Control Panel

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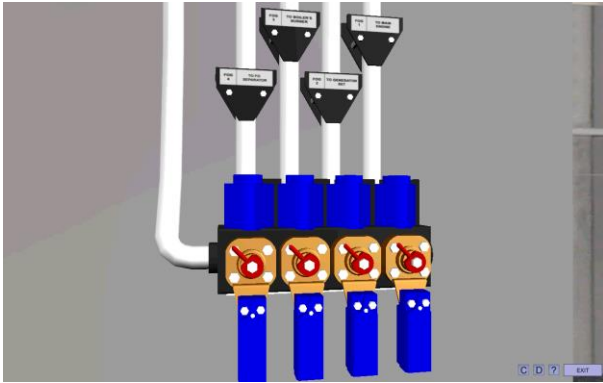


Fig. 71 Section Valves

#### 4.17. Air Conditioning System

The system consists of the following elements:

1. Air Handling Unit (AHU)
2. Refrigerating Condensing Unit
3. Steam valves block
4. Control panel

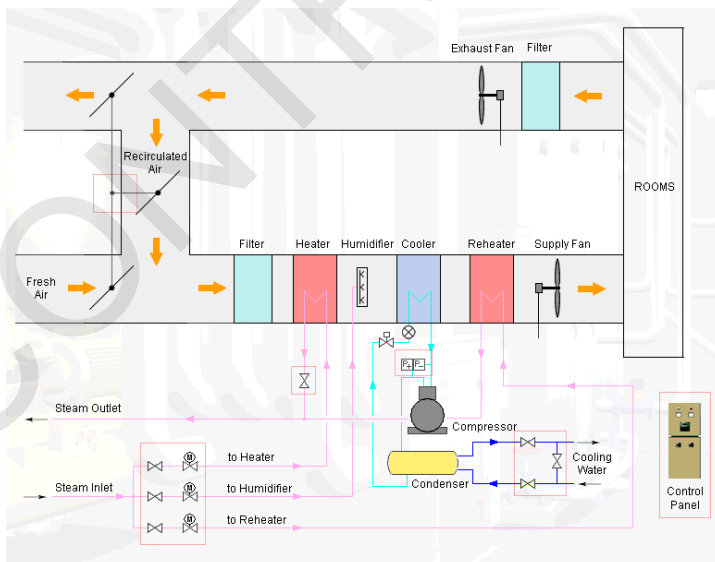


Fig. 72 Air Conditioning System (3d navigation diagram)





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Fig. 73 Air Handling Unit



Fig. 74 Refrigerating Condensing Unit

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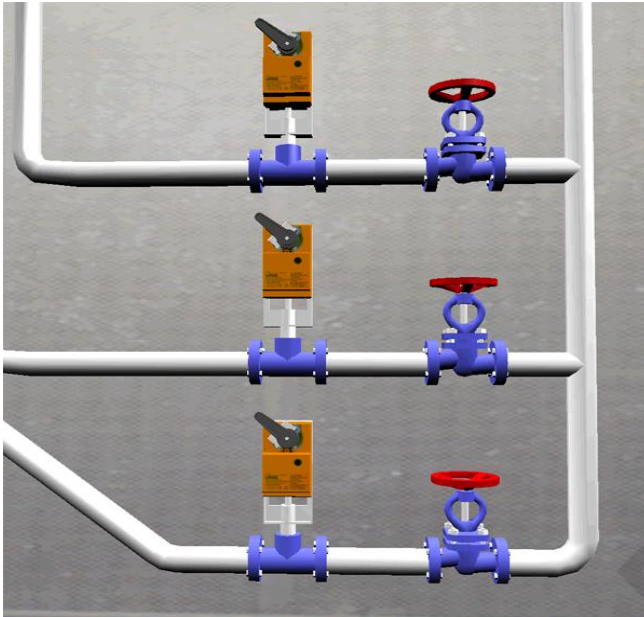


Fig. 75 Steam valves block



Fig. 76 Control panel

#### 4.18. Refrigeration System

The system is based on a refrigerating plant with four cold chambers:

- Meat/Fish – temp:  $-25\text{ }^{\circ}\text{C}$
- Vegetables – temp:  $+4\text{ }^{\circ}\text{C}$
- Dairy – temp:  $+4\text{ }^{\circ}\text{C}$



••Dry provision – temp: +10 oC

The chambers are serviced by two compressors.

The refrigerant medium is freon R 404A.

The system consists of the following elements:

1. Refrigerating compressors
2. Condensers
3. Cold chambers
4. Control panel

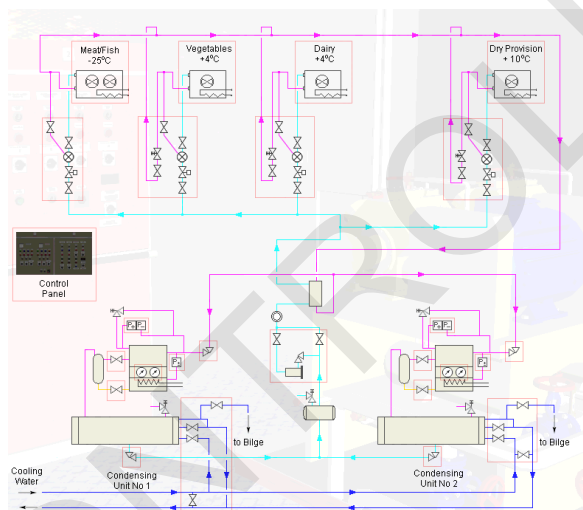



Fig. 77 Refrigeration System (3d navigation diagram)

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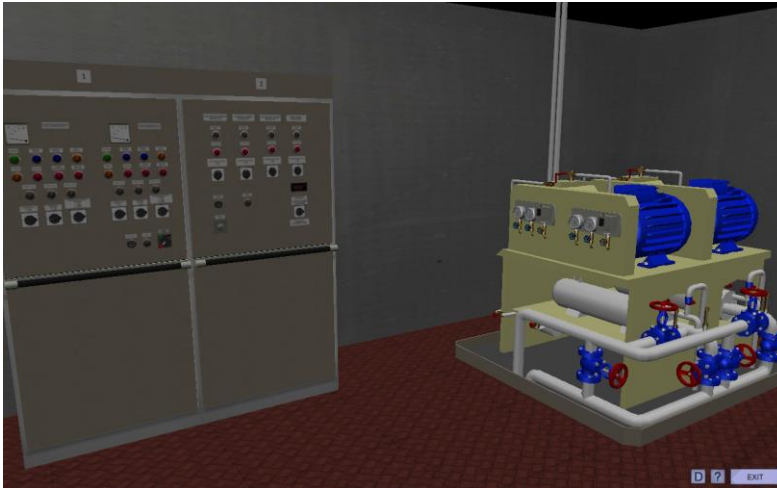


Fig. 78 Refrigeration System General View

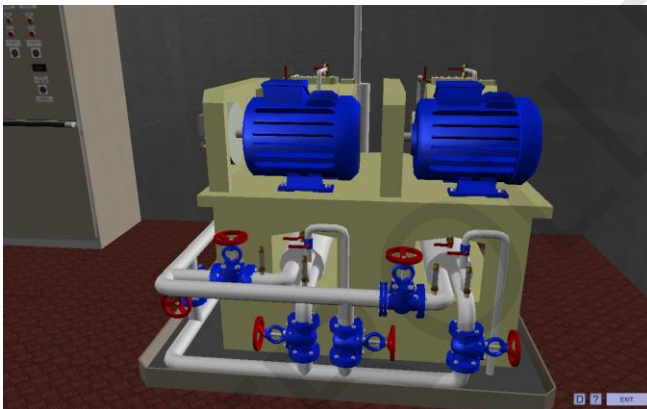



Fig. 79 Compressors with Condensers



Fig. 80 Cold Chambers General View

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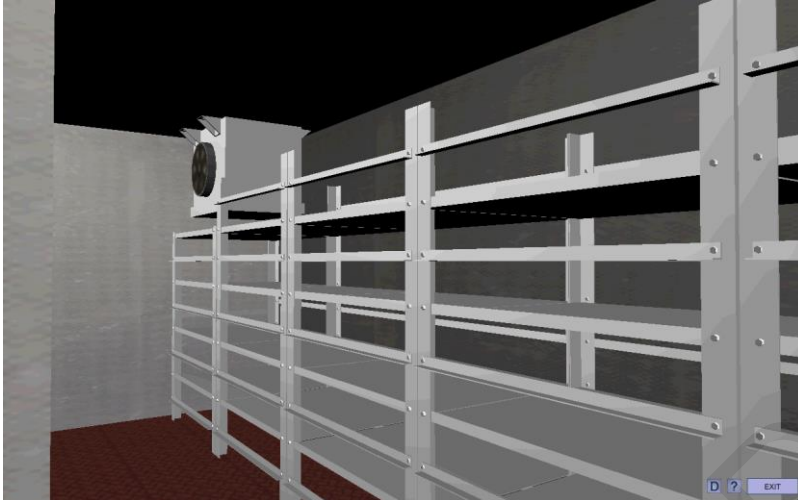


Fig. 81 Cold Chamber

#### **4.19. Incinerator**

##### ***System function description***


The Incinerator is designed for on board incineration of ship's waste oil and solid refuse.

The incinerator consists of five main parts:

- Combustion chamber with diesel oil burner, sludge burner, pilot fuel heater and electric control panel
- Flue gas fan
- Flue gas damper
- Sludge tank with circulating pump and heater
- Diesel oil tank

##### **Combustion chamber**

The combustion chamber is two circular chambers.

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The right chamber is for burning solids.

The revolving sluice for manually feeding is mounted on top of this chamber.

The trash falls down on a grate in the chamber and is ignited by radiant heat from the burner in the secondary chamber.

The combustion chamber is equipped with an inspection door and an ash door, which can be opened only while the incinerator is not burning.

The control system will prevent the doors from being opened before the set temp for cooling is passed.

A manual secondary combustion air damper is located in ash door below the inspection door.

The flue gas outlet is located at the top of the secondary chamber for most efficient use of the flames.

The flames from the burner follow a corkscrew pattern towards the bottom and continue rotation upwards in the centre of the combustion chamber.

The trash is ignited by radiant heat from the burner.

The gas flow goes from the trash chamber to secondary where oxygen is added.

Remnants of particulate matters in the gas flow are neutralized by the burner so it is ecologically safe.

As the fumes leaves the chamber, cooling air drawn from the lower part of the casing is mixed with the flue to bring the temperature down to approx.


340°C before it sucked out by the flue gas fan and blown out the stack.

The burning process is monitored by the PLC and scanned by a photo resistor.

The temperatures are also monitored/regulated automatically by the PLC control system.

A sight glass in the inspection door is equipped for the operator to be able to watch the amount of trash in the chamber and the function of the system.



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The combustion chamber is equipped with a two-stage diesel oil burner and a steam atomising nozzle for sludge.

The DO burner has 2 stages, which are automatically regulated by the PLC.

### **Flue gas fan**

The purpose of the flue gas fan is transportation of the flue gas from the combustion chamber and the fan creates negative pressure in the furnace.

The same fan draws ambient air through the cooling jacket on the combustion chamber and the hot gas from the furnace is diluted with the cooling air at the flue gas outlet on the combustion chamber in order to reduce the temperature to approx. 340°C.

### **Sludge tank with steam heater**

The Sludge tank is meant to function as a daily service tank for sludge to the incinerator.


A transfer pump can be used to fill the tank, and be connected to the "high level" switch, which stops the pump when the tank is full.

A heater, controlled by a thermostat, will keep the sludge temperature around the set point (60 to 90°C).

Two drain valves (sample points) are mounted on the tank to check the sludge level in the tank. The lowest one is meant to use for draining of the water.

A circulating pump is mounted on the tank. The pump transports the sludge to the incinerator and as a return line to the tank is provided, a good mixing of the sludge and water is guaranteed.

A low level switch on the tank will stop the circulating pump and heating when the level has reached a minimum.

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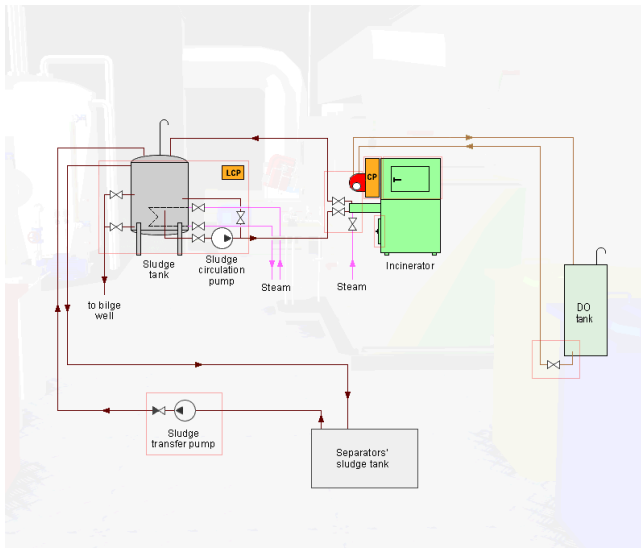



Fig. 82 Incinerator (3d navigation diagram)



Fig. 83 Incinerator General View



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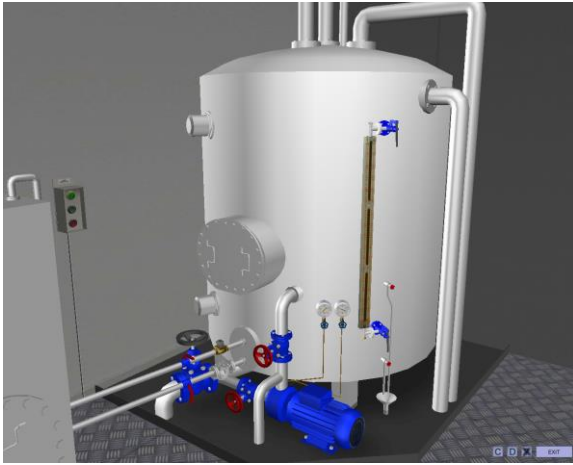


Fig. 84 Sludge Tank

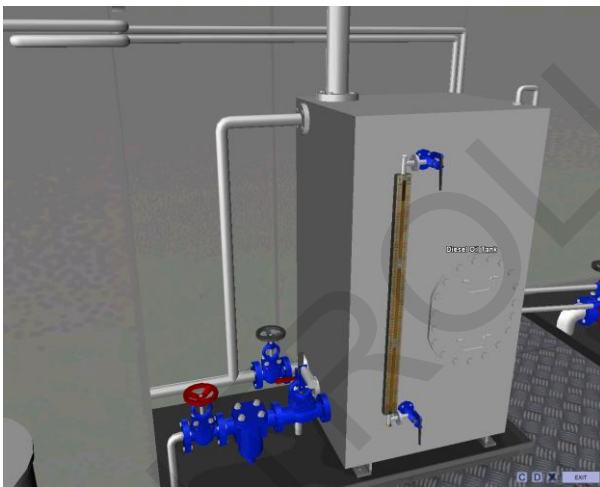



Fig. 85 Diesel Oil Tank

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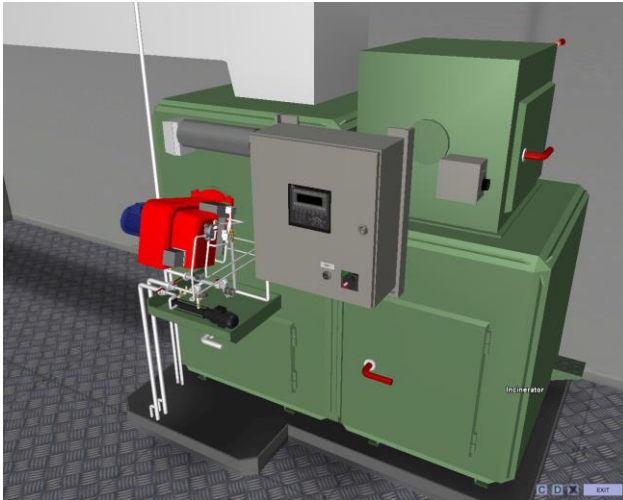


Fig. 86 Incinerator

### ***Program description***

#### **Stop**


Stop any selected program. Green LED above the function key is lit.

If the combustion chamber temperature is above 220°C [CCTFS], the flue gas fan will continue running until the temperature decrease below 170°C [CCTFS] - [HCCTFS] At stop of fan the door can be opened.

#### **Slagging**

Green LED above the function key is lit.

1. **SLAGGING** display for 5 sec.
2. Closing flue gas damper for 30 sec. and the display will show: **DAMPER CLOSING.**
3. After 30 sec. The flue gas fan start.
4. The display will show: **SLAGGING.**
5. This mode will run until the STOP key is pushed.

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## Solid Waste

Push the key: **SOLID WASTE**. Green LED above the function key is lit.

1. **SOLID WASTE** will display for 5 sec.
2. **WTG FOR D OIL TEMP** will display until the temperature switch open at set point for diesel oil temp.
3. **SOLID WASTE** will display.
4. Flue gas fan start and the chamber under pressure are controlled at 35 mm WC [CCPS].

The burner start up as described in section for burner control. Flue gas fan, burner, and running indicated with green LED.

5. When normal flame is detected in the chamber the display will show **BURNER STAGE NO 3**.


Burner nozzle 1+2 and the burner damper at max. position. Combustion chamber pressure is controlled at 10 mm WC [SPSW].

6. When the combustion chamber temperature exceeds 700oC [CCTWF] the door lock on sluice door is energized and feeding of solid waste can start.
7. If the flue gas temperature increase above 330°C [FGTCCP] or the combustion chamber temperature increase above 1000°C [CCTCCP] Combustion chamber negative pressure is controlled gradually up to 28mm WC [SPMAX] by step of 2mm [PU] at a 60 sec. interval [FGTTR].

8. If the flue gas temperature increase above 340°C [FGTMAX] or combustion chamber temperature increase above 1150°C [CCTMAX] the control logic will start stepping down the burner stage at a 60 sec.

Interval [FGTTR] At stage 0 the burner motor stops and the display will show **BURNER STAGE NO 0**.

At temperature below 335°C [FGTMAX] - [HFGT] or 1140°C [CCTMAX] - [HCCT] the controller can step up again.

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9. When normal flame is detected in the chamber the display will show **BURNER STAGE NO 1**.

Burner nozzle land the burner damper at min. position. Combustion chamber pressure controlled at 10 mmWC [SPSW].

10. Further control of burner is depending on temperature in chamber and flue gas duct.

11. If temperature rising is less than 25°C [CCTR] in 60 sec. [CCTTR] burner control will step one stage up.

12. Step no. 1: **BURNER STAGE NO 2** Burner change from nozzle 1 to nozzle 2 and burner damper open at 50% opening.

13. Step no. 2: **BURNER STAGE NO 3** Burner nozzle no 2 is added and the burner damper open 100%.

14. The burner program is running until the key STOP is pushed, or elapsed pre-set burning time.

### **Sludge**

Push the key SLUDGE. Green LED above the function key is lit.

1. **SLUDGE** display for 5 sec.


2. If the sludge tank level is low the display will show: **LOW LEVEL SL TANK** for 5 sec and return to: **READY**.

3. If the sludge temperature is below 80°C [SLTN] WTG FOR SLUDGE TEMP will display. Sludge tank heater and circulation pump starts (if not started manually previously).

4. **WTG FOR D OIL TEMP** show in the display until temperature switch open at set point for diesel oil.

5. **SLUDGE** display at the panel.

6. Flue gas fan start and the chamber negative pressure control at 35 mmWC [CCPS] the burner start up as described in the section for burner control. Flue gas

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fan, burner, air fan, sludge heater, sludge circ. pump and running indicated with green LED.

7. At detection of flame the display will show **BURNER STAGE NO 3**.

Burner nozzle no.1 and no 2, the burner and damper at max.

Opening.

Chamber pressure control at 10 mm WC [SPSS].

8. When the combustion chamber temperature is above 650°C [CCTSS] the sludge dosing pump starts at 400 rpm.

[RPMST] diesel nozzle no.1 closes and nozzle no. 2 opens. Sludge control counter set at 2.

**BURNER STAGE NO 4** show in the display.

9. If the flue gas temperature increase above 330°C [FGTCCP] or chamber temperature increase above 1000°C [CCTCCP] the chamber under pressure control will gradually control to the level of 28 mm WC [SPMAX].

10. If the flue gas temperature increase above 340°C [FGTMAX] or combustion chamber temperature above 1150°C [CCTMAX] the sludge pump will slow down to reduce the sludge and bring the temperature down below max. level.

When temperature decrease below 335°C [FGTMAX] - [HFGT] or 1140°C [CCTMAX] - [HCCT] the sludge can be increased again.


11. Burner program will run until the **STOP** key is pushed, or the pre-set burner time has elapsed.

### **Sludge circulation pump**

Push the key SLUDGE PUMP. Green LED above the function key is lit.

1. The sludge circulating pump starts indicated with green LED.

2. If there is low sludge tank level, the display will show **LOW LEVEL SL TANK** at line 4 and the pump stop.

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3. To stop the Pump, (if the pump is started manually) push the **SLUDGE PUMP** key. The pump also stop if the key "STOP "is used.

4. If the pump is started manually, and then incinerator continue burning at a pre selected burning time, the pump will continue running after elapsed time and burner stop.

### **Sludge tank heater**

Push the key SLUDGE HEATER. Green LED above the function key is lit.

1. The sludge heater starts indicated with green LED.
2. If the sludge tank level is low, display will show **LOW LEVEL SL TANK** at line 4 and the heater switches off.
3. To stop the Heater, (if the heater is started manually) push the SLUDGE HEATER key. The heater also stop if the key "STOP "is used.
4. If the heater is started manually, and the incinerator continue burning at a pre selected burning time, the heater will not be switched off at end of the preset burning time.

### **4.20. CO2 Fire Extinguishing System**


The engine room is protected by the CO2 central system consists of 168 CO2 cylinders, each containing 45 of CO2 gas.

The system is pressure operated from the release cabinet located in the fire control station.

CO2 Fire Extinguishing System consists of the following main parts:

- CO2 Room
- Fire Control Station

CO2 Fire Extinguishing System protects the following areas:

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- Engine Room
- Emergency Generator
- ME Scavenge Air Duct

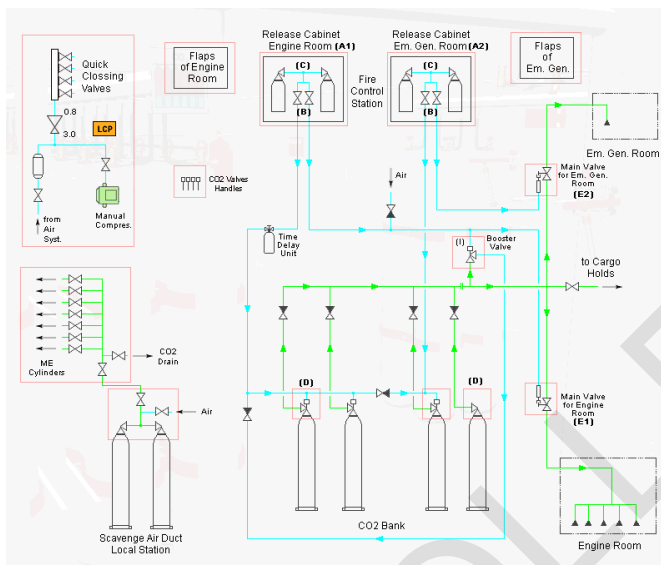



Fig. 87 CO2 System (3d navigation diagram)



Fig. 88 Control Station (release cabinets)

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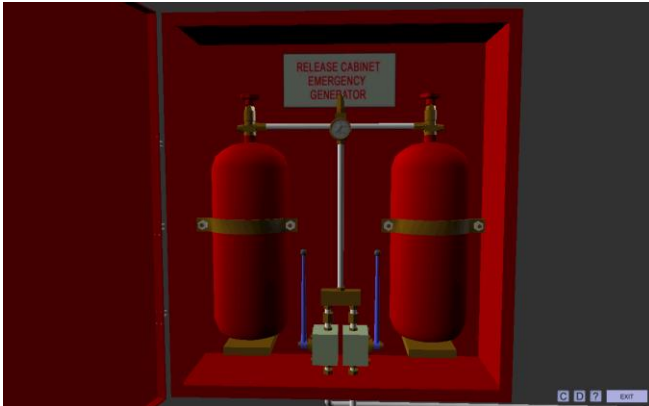


Fig. 89 Release Cabinet Engine Room

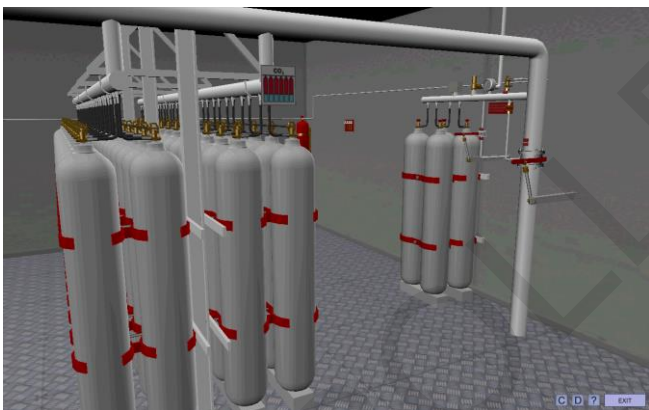



Fig. 90 CO2 Room



Fig. 91 Quick Closing Valves Release Station



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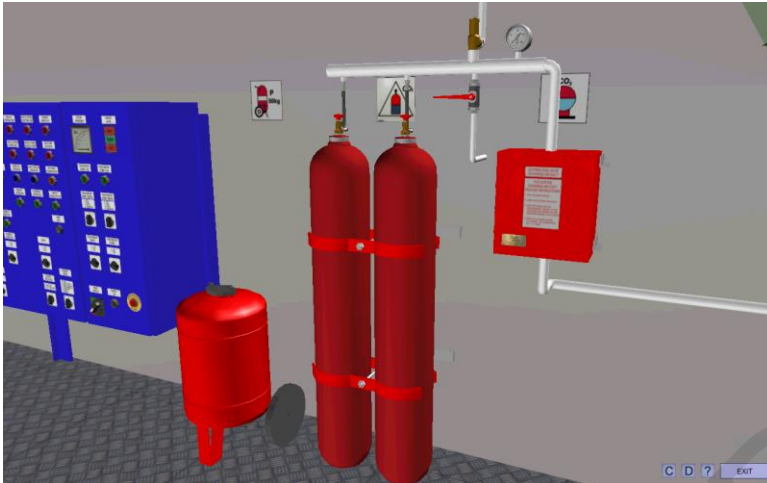


Fig. 92 Scavenge Air Duct CO2 Local Station

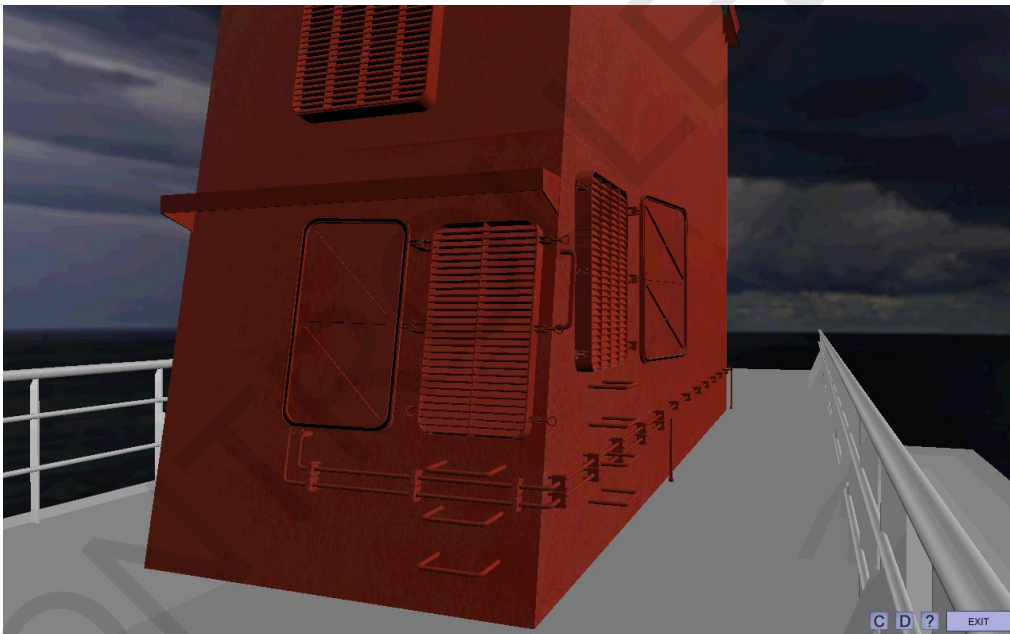



Fig. 93 Flaps of Engine Room

## 5. Power Management System

### 5.1. Introduction

The PMS system for control and protection of generator plants is able to combine the following functions into one interactive system:

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- Power management system (PMS) functions
- control of generator set(s)
- supervision of tie breaker
- an extensive number of integrated protective functions
- measurement of all relevant AC-values
- system logic
- serial communication interface

The PMS system is able to carry out control of several generator sets within the interactive system.

The PMS system consists basically of a Generator Unit (called DGU) and a corresponding Control Panel, (called CP) for each generator set.

Each DGU may have as many as 3 corresponding control panels.


The internal communication between the DGU and the corresponding control panel(s) are carried out by local area network.

By using a network for communication between the DGUs, very high transmission rates and maximum flexibility regarding placement of the DGUs is achieved.

If more than one DGU are included in the system the network is used for exchange information between the DGUs regarding e.g. PMS commands, system status, DGU status as well as communication between the DGU and the corresponding CP(s).

DGU no. 1 (Master DGU) contains the Power management system (PMS) software unit. All DGUs (incl. the Master DGU) in the PMS system contain the generator control software unit and a PMS interface.

The PMS software unit controls and supervises all common PMS functions in the PMS system according to the functionalism of the selected plant mode, e.g. the SEMI-AUTO or the AUTOMATIC plant modes.

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The PMS interface forms a bi-directional communication link between the PMS software unit and the generator set control software units.

The PMS software unit transmits e.g. PMS start/stop commands and selected plant mode via the PMS interface.

The generator set control software unit(s) transmits signals such as the generator sets operational status (e.g. running or stand-by), relevant measured and calculated values, and the status of the selected control mode (PMS control or SWBD control) for the generator set.

The generator set control software unit controls and supervises all local operations of the generator set.

The received PMS commands may initiate e.g. start and stop of the generator

Set but the generator set control software unit carries out the actual control, protection and supervision of the generator set.

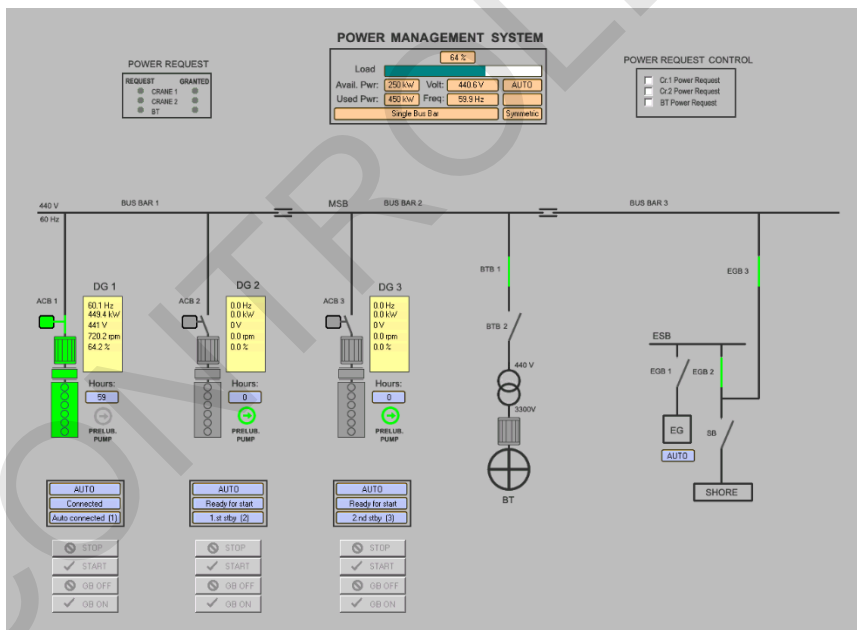




Fig. 94 Power Management System

## The PMS functions

The following functions are implemented in the PMS system:

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- Plant modes:
    - SEMI-AUTO
    - AUTO
  - User-programmable start priority
  - Load dependent star/stop function incl.:
    - Transmission of PMS star/stop commands.
    - Safety start of stand-by generator sets due to expected stop of a running generator set.
    - Transfer of PMS start command in case of failed engagement of the generator set.
  - Common black-out detection and subsequently black-out start of two generator sets
  - Load sharing:
    - Symmetrical load sharing
    - Asymmetrical load sharing
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- Conditional connection of 3 heavy consumers with fixed or variable load
  - Supervision of the shore connection position
  - Bi-directional serial interface (MODBUS ATU, standard communication protocol) offers remote control or supervision of the PMS system:
    - Access to system control commands
    - Access to set-point and timers

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- measured and calculated values
- system status feedback

- alarm status feedback

### **The generator set functions**

The following Generator set functions are implemented in the PMS system:


- Internal system supervision comprising:
  - I/O error; supervision of hardware configuration
  - Breaker position feedback signal
  - Supervision of ARC-network communication
  - Supervision of the power supply
  - Cable supervision
- Selection of local control for each generator set
  - PMS control; the generator set is included in the PMS functions
  - SWBD control, the generator set is excluded from all automatic functions and is controlled manually (protection functions are still active).
- Automatically start sequence
  - Programmable start prepare output
  - Programmable number of start attempts
  - Programmable pause stop during the start sequence
  - Programmable priming output
- Automatically stop sequence
  - Programmable cooling down time

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- Programmable stop time
- GB ON sequence; dynamical synchronisation of the generator set to the busbar
- Programmable dynamical synchronisation parameters (concerning voltage and frequency)
- Supervision of positive sequential order of the phase before synchronization
- Supervision of generator voltage and frequency before synchronization
- Programmable closing time of the breaker
- GB OFF sequence:

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- Deloading the generator set before opening the generator breaker
- Generator set load control
- load share supervision
- Generator protection:
- Supervision of generator voltage and frequency
- Overcurrent,  $I >$  (two step protection)
- Overload,  $P >$  (both protection and supervision)
- Reverse power,  $-P >$  (protection)
- Busbar supervision and protection:
- Undervoltage,  $U_{BB} <$  (both protection and supervision)
- Overvoltage,  $U_{BB} >$  (both protection and supervision)

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- Underfrequency,  $f_{BB} <$  (both protection and supervision)
- Overfrequency,  $f_{BB} >$  (both protection and supervision)
- 5 different alarm sequences
- DG warning (only information for operator)
- DG blocked (inhibit of automatic functions of the DG)
- Safety stop (expected stop when DG has been replaced by another unit)
- Trip of the generator breaker
- Shutdown of entire generator set
- Trip of two non-essential loads groups in case of:
  - Trip of the generator breaker
  - High load at the generator set
  - Low frequency at the busbar
- User setup of all relevant parameters of the DG and the entire plant from the control panel
- Cable supervision for digital and analogue inputs
- Alarm test function of all implemented alarm
- "Test mode" function for indication of any used timer when status "running" is achieved
- Operator programmable binary alarm input function:
  - Programmable selection of designated alarm sequence
  - Programmable alarm delay

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- Programmable status for alarm detection
- Programmable connection to the alarm inhibit function
- Running hour indication on display of the Control Panel
- Indication of rpm at the Control Panel in case of analogue running feedback
- Differential protection of each generator.

### The control panels




Fig. 95 Control panel - front layout

The 5 push-buttons located at the top of the control panel (CP) are designated for control of the display view and programming of setup values.

PUSH-BUTTON



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**DESCRIPTION**

*Left arrow push-button:*

Moves display view to the left (1)



Moves the cursor to the left (2)

*Down arrow push-button:*



Moves display view down (1)

Degrades a value or toggle a selection (2)

*Up arrow push-button:*

Moves display view up (1)



Upgrades a value or toggle a selection (2)

*Right arrow push-button:*

Moves display view to the right (1)



Moves the cursor to the right (2)

*Programming function control button:*




Selection of Master CP (3)

- 1) When the programming function is inactive
- 2) When the programming function is active
- 3) Only active when a DGU has more than one corresponding CP

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Each Control Panel is provided with 10 push-buttons (S1-S10) located at the bottom of the CP which are designated for alarm handling and control of the PMS system.

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DGU  
No.

PUSH-BUTTON

S1

S2

S3

S4

S5

S6

S7

S8

S9

S10

1

START

GB

ACK

STOP

GB

1 ST

NEXT

LAMP

ON

ALARM

OFF

PRIOR

ALARM

TEST

2

START

GB

ACK

STOP

GB


1 ST

NEXT

LAMP

ON

ALARM

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OFF  
 PRIOR  
 ALARM  
 TEST  
 3  
 START  
 GB  
 ACK  
 STOP  
 GB  
 1 ST  
 NEXT  
 LAMP  
 ON  
 ALARM  
 OFF  
 PRIOR  
 ALARM  
 TEST  
**PUSH-BUTTON**

**DESCRIPTION**

**"START"**

Initiates the automatic start sequence  
 (Only active in semi-auto mode)

**"STOP"**

Initiates the automatic stop sequence  
 (Only active in semi-auto mode)

**"GB ON"**


Initiates the GB ON sequence  
 (Only active in semi-auto mode)

**"GB OFF"**

Initiates the GB OFF sequence  
 (Only active in semi-auto mode)

**Not used**

**"1st PRIOR"**

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Moves DG up having first start priority

**"ACK ALARM"**

Used for acknowledgement of alarms.

The display view moves to the next un-acknowledged.

**"NEXT ALARM"**

Alarm (1)

The display view jumps to the top of the alarm stack (2)

**Not used**

**"LAMP TEST"**

Lamp test of all LEDs

1) When the display view is located in the alarm stack.

2) When the display view is located outside the alarm stack.

**The control panel LEDs**

The PMS control panel has altogether 16 status LEDs (H1-H16).

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**Left side LEDs**

The 8 LEDs (H1-H8) located in the left side are basically used for identification of the operational status of the generator set.

**LED  
COLOR  
DESCRIPTION**

**H1**

**READY**


*Green*

Indication that the auxiliary engine is ready for start.

**H2**

**START**

*Green*

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*Yellow*

Indicates ON status of the "START" output.  
Indicates an active "START PREPARE" output previous  
To the automatic start sequence and the START OFF  
Time during the automatic start sequence.

**H3  
RUNNING**

*Green*

*Yellow*

Indication of running feedback signal from the auxiliary  
engine.

Indication of tacho failure.

**H4  
GB ON**

*Green*

*Yellow*

*Dark (turned oft)*

Indication of a closed generator breaker feedback signal.  
The generator set is currently carrying out the GB ON  
sequence.

Indication of an open generator breaker feedback signal.

**H5  
COOLING DOWN**

*Green*


Indication that the auxiliary engine is running cooling  
down.

**H6  
STOP**

*Yellow*

Indication of an active "STOP" output during the stop  
sequence.

**H7  
FREQUENCY  
CONTROL**

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*Green*

Indicates that the DGU in question is carrying out frequency control.

**H8**

**PMS CONTROL**

*Green*

*Yellow*

*Dark (turned oft)*

The DGU is selected to be under *PMS control* and the Generator set is ready to respond to PMS commands.

Indicates that the DGU is actually selected to be under PMS Control but is *forced* into SWBD control.

The DGU is selected to be under SWBD control.

**Right side LEDs**

The 8 LED's (H9-H16) located on the right side of the control panel are, with exception of the "1st START PRIORITY" LED, used by the alarm handling function for identification of alarm status etc.

LED

**COLOR**

**DESCRIPTION**

**H9**

**ALARM MESSAGE**

**SEE DISPLAY**

*Flashes red*

*Red*

Indication of one or more un-acknowledged alarms in the alarm stack.

Indication that the alarm stack only contains acknowledged but still active alarm(s).

**H10**

**ALARM INHIBIT**


*Green*

Indicates that the alarm inhibit function is active.

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**"ALARM MESSAGE"**

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**No:xxx F:Y U-ACK**

**H11**

**SHUTDOWN**

*Red*

Indicates that the shutdown alarm sequence for the corresponding generator set has been activated.

**H12**

**GB TRIPPED**

*Red*

Indicates that the trip of GB alarm sequence for the corresponding generator set has been activated.

**H13**

**SAFETY STOP**

*Red*

Indicates that the safety stop alarm sequence has been activated for the generator set in question.

**H14**

**BASE LOAD**

*Green*

*Yellow*

Indicates that asymmetrical load sharing is selected and this DG is running base load.

Asymmetrical load sharing is selected but it is automatically canceled due to the load situation at the busbar.

**H15 \*)**

**SCB ON**

*Green*

*Dark (turned off)*

Indicates of a closed shore breaker feedback signal.


Indicates of an open shore breaker feedback signal.

**H16**

**1st START PRIORITY**

*Green*

Indicates that the generator set is designated with

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1st start priority.

\*) Only active on CP 1/DGU 1

## **5.2. Alarm system**

### **5.2.1. Alarm handling**

The alarm handler is a software function, which handles all alarms registered by the PMS system.

The alarm handler may be activated by:

- External alarm signals
- Internal DGU system supervision
- Internal generator set supervision
- Internal PMS supervision

The alarm handler will examine every registered alarm, activate the designated alarm sequence and display the corresponding alarm message.

When a new alarm is registered:

- the LED "**ALARM MESSAGE SEE DISPLAY**" will start flashing red.
- the corresponding alarm message will be displayed at the CP.
- the corresponding alarm sequence will be carried out.

#### **Display of alarms**


The alarm messages are displayed at the text line.

All alarm messages concerning a specific generator set (DGU) will be displayed at the corresponding CP.

All alarm messages concerning common PMS functions will only be displayed at the corresponding CP for the Master DGU.

### **5.2.2. Alarm types**



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The alarm handler distinguishes between System alarms and PMS alarms.

### **System alarms (system supervision)**

A system alarm indicates a failure, which may prevent the DGU to operate as expected. A system alarm may be caused by communication error, power supply failure or in/output error and similar.

A registered system alarm will be indicated by:

- an active **SYSTEM ALARM** output

### **PMS alarms**

A PMS alarm may be considered to be caused by a "normal" event meaning that the PMS system is fully operational and handling the event(s) as expected.

A registered PMS alarm will be indicated by:


- an active **PMS ALARM** output

### **5.2.3. Alarm sequences**

The alarm sequences are designed to take appropriate action according to the severity of the event which caused the alarm.

The PMS system is implemented with several different alarm sequences:

- Warning
- DG Block
- Safety stop
- Trip of GB
- Shutdown

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## Warning

The purpose of the warning sequence is to inform the operator of "nice to know" events.

The PMS system will not take any action but only display an alarm message.

Activation of the **warning sequence** will:

- start flashing the LED "**ALARM MESSAGE SEE DISPLAY**" red
- display the designated alarm message at the CP
- activate the horn output
- set one of the alarm type outputs (SYSTEM or PMS)

The operator is able to reset the horn output by pressing the "**RESET HORN**" push-button.


This will not have any influence on the further alarm handling.

## DG Block

The DG block alarm sequence is used for blocking any further automatic functions, which will lead to connection of the generator set, if a situation (electrical or mechanical) occurs due to which it is inadmissible to connect the generator set to the busbar.

Activation of the DG block sequence will:

- Carry out the warning sequence.
- block all automatic functions which will lead to a connection of the generator set.
- Block closing of the generator breaker in question.  
(the DG block sequence will not open or trip the generator breaker if it is already closed, when the block alarm becomes active).

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- transfer the PMS start command to the next stand-by DGU.

### **Safety Stop**

The safety stop sequence is used to carry out a previous intervention and stop a defective engine, instead of waiting until a critical condition becomes fatal for the engine.

Furthermore, the safety stop alarm sequence can prevent a possible black-out situation at the busbar as it replaces the defective generator set before a shutdown occurs on a running generator set.

The safety stop sequence starts and connects the next stand-by generator set to the busbar according to the chosen start priority.

When sufficient available power is measured at the busbar the defective generator set is disconnected and stopped (incl. cooling down etc.).

Activation of the safety stop sequence will:


- carry out the warning sequence (alarm message causing the situation)
- transmit a PMS start command to the next stand-by generator set
- connect the next stand-by generator set to the busbar
- display alarm "**Safety Stop**" on the CP for the defective DG
- disconnect and stop the defective generator set (incl. cooling down etc.) block for a new start of the defective DG
- carry out the blocking alarm sequence

An active safety stop alarm sequence is indicated by:

- a red "**SAFETY STOP**" LED at the CP corresponding to the defective DGU

If the defective DGU is not ready for PMS stop the alarm message "Safety Stop" is not displayed and the DG is not stopped either.

### **Trip of GB**

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The trip of Generator Breaker sequence is carried out in order to protect the generator set from critical electrical conditions on the busbar, or to protect the busbar from critical electrical conditions in the generator set.

Activation of the trip of GB sequence will:

- immediately open the generator breaker
- disconnect the non essential load groups (NEL)
- carry out the warning sequence
- transmit a PMS start command to the next stand-by generator set
- continue idle run of the defective generator set
- block a re-connection of the defective generator set to the busbar until the alarm is acknowledged

An active trip of generator breaker alarm sequence is indicated by:

- a red "**GB TRIPPED**" LED at the CP corresponding to the defective DGU


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### **Shutdown**

The shutdown alarm sequence may be carried out when a fatal condition has occurred in the generator set.

Activation of the **shutdown sequence** will:

- immediately open the generator breaker
- shutdown the engine immediately after disconnecting the breaker from the busbar
- disconnect the non essential load groups (NEL)
- carry out the warning sequence

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- transmit a PMS start command to the next stand-by generator set
- block a new start of the detective generator set until the alarm is acknowledged

An active shutdown alarm sequence is indicated by:

- a red "**SHUTDOWN**" LED at the CP corresponding to the detective DGU

### **SC Block**

The SC block alarm sequence is used for blocking any further automatic functions which will lead connection of the shore connection, if a situation (electrical or mechanical) occurs due to which it is inadmissible to connect it.

Activation of the SC block sequence will:

- Carry out the warning sequence.
- block all automatic functions which will lead to a connection (the SC block sequence will not open or trip the breaker if it is already closed, when the block alarm becomes active)

### **Trip of SC**


The trip of Shore Connection sequence is carried out in order to protect the shore connection from critical electrical conditions on the busbar, or to protect the busbar from critical electrical conditions in the shore connection.

Activation of the **trip of SC sequence** will:

- immediately open the shore connection breaker
- carry out the warning sequence
- block for a re-connection of the shore connection to the busbar

An active trip of shore connection alarm sequence is indicated by:

- a red "**SCB ON**" LED at the CP corresponding to the Master DGU

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### **TB Block**

The TB block alarm sequence is used for blocking any further automatic functions which will lead to connection of the tie breaker, if a situation (electrical or mechanical) occurs due to which it is inadmissible to close it.

Activation of the TB block sequence will:

- carry out the warning sequence.

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ALARM STACK

XXX ALARM(S)

ALARM MESSAGE 1

No:xxx F: U-ACK

ALARM MESSAGE 2

No:xxx F: U-ACK


- block for all automatic functions which will lead to closing the breaker
- (the TB block sequence will not open or trip the breaker if it is already closed, when the block alarm becomes active)

### **Trip of TB**

The trip of Tie Breaker sequence is carried out in order to protect the tie breaker from critical electrical conditions on the busbar.

Activation of the trip of TB sequence will:

- immediately open the tie breaker
- carry out the warning sequence
- block a re-connection of the tie breaker

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An active trip of tie breaker alarm sequence is indicated by:

- a red "**TB ON**" LED at the CP corresponding to the Master DGU

#### **5.2.4 Alarm registration**

All alarm messages are registered and stored in the alarm stack with statement of:

- status as first or not first received alarm
- status as an un-acknowledged or acknowledged alarm

#### **Alarm stack**

The alarm handler stores all registered alarm messages in chronological order (as registered by PMS) in the alarm stack.

The received alarms will be stored with the first (oldest) alarm at the top of the stack.

The heading of the alarm stack is indicated by the following text at the CP display:

The total number of un-acknowledged and acknowledged alarms stored in the alarm stack, is displayed at the bottom line of the alarm stack heading.

The operator is able to jump to the top of the alarm stack from any location (outside the alarm stack) in the PMS sub-menu structure by pressing the "NEXT ALARM" push-button.

The operator is able to browse through the alarm stack by using the "." and "." push-buttons on the CP:

Press "."


LOW SUPPLY VOLT.

No: 8 F:Y U-ACK

ALARM MESSAGE

No:xxx F:Y U-ACK

ALARM MESSAGE

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No:xxx F:N U-ACK

### **Alarm ID. No**

Every alarm in the PMS multi-function system is identified by an alarm identification number.

### **First alarm**

The first alarm status is designated to the first new alarm received by the PMS.

Some events may cause a chain reaction of further events, each generating an alarm.

The first alarm status may indicate which event was the first.

The alarm handler software is sequentially executed, which means that the status of the internal alarm signals is examined once in every program scan.

One program scan has an approximate duration of 60 ms. If the PMS receives several internal alarm signals within one program scan, the alarm signals which were "scanned" first will be designated with the first alarm status.

If the alarm stack contains only acknowledged alarms the next new alarms registered will be designated with the first alarm status.

This means several "first alarms" may be registered in the alarm stack simultaneously.

The first alarm is identified by the following code in the status line of the alarm message:


F:Y (First: Yes)

Any other alarms (registered later than the first alarm) are identified by the following code in the status line of the alarm message:

F:N (First: No)

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ALARM MESSAGE

No:xxx F:N **U-ACK**

ALARM MESSAGE

No:xxx F:N **-ACK**

### **Acknowledgement of alarms**

Any alarm registered by the PMS system must be acknowledged by the operator, in order to reset the action taken by the alarm sequence.

At the same time the operator becomes aware of any occurring abnormal events, even though the condition which caused the alarm may have disappeared as a result of the action taken by the PMS alarm sequence.

Each un-acknowledged alarm is identified by:

- a flashing **LED "ALARM MESSAGE SEE DISPLAY"** (red flash)
- the following status line in the display:

Un-ACKnowledged

An active alarm is acknowledged by pressing the "**ACK ALARM**" push-button on the CP.

Acknowledgement of a still active alarm is confirmed by the following status line in the display:


--Acknowledged

The operator is able to jump to the next un-acknowledged alarm when viewing the alarm stack by pressing the "NEXT ALARM" push-button.

When only acknowledged alarms are present in the alarm stack then:

- the LED "**ALARM MESSAGE SEE DISPLAY**" will turn to a steady red light

### **Acknowledgement of active alarms**

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An active alarm means that the condition(s) which caused the alarm are still present or active.

The acknowledgement results in a change of status for the alarm in question, from un-acknowledged to Acknowledged.

When the alarm condition(s) for an alarm with acknowledged status disappears, the alarm message will be removed from the alarm stack and any actions made by the alarm sequence are disabled without further notice.

### **Acknowledgement of in-active alarms**

An in-active alarm means that the condition(s) which caused the alarm disappeared before acknowledgement of the alarm.

### **An empty alarm stack**

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When there are no un-acknowledged alarms and no more active alarms:

- the LED "ALARM MESSAGE SEE DISPLAY" will turn off
- the alarm output(s) will be de-activated (PMS or DGU alarm outputs)

When the alarm stack is empty, it will no longer be possible to enter the alarm stack. Furthermore the push-button "NEXT ALARM" becomes inactive.


### **5.2.5. Alarm list**

The alarm list contains all alarm messages (listed in numerical order) in the PMS system.

*Note!* Some of the alarm messages mentioned in this chapter may correspond to functions, which may not be available in your specific PMS system.

The alarm list constitutes a very helpful and fast approach for the operator, in order to locate a desired piece of information in the PMS technical documentation based on an actual alarm text.

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The alarm list contains the following information:

- the alarm ID no
- the specific alarm text
- a brief description of the event(s) which activated the Alarm, and the status after the alarm handling
- which alarm sequence is dedicated to the actual alarm
- the references indicate in which chapter to find detailed information about any set-points, timers and alarm conditions, which have influence on the generation of the alarm message in question

**ID no.**

**ALARM TEXT**

**DESCRIPTION**

**ALARM SEQ.**

**REFERENCES**

Arc Net error no:

06: Dupl. ID

The control panel has detected another CP with the same LAN ID and the same group number on the ARC-network.


The corresponding DGU will, if possible continue operation.

System alarm

18.

Arc Net error no.:

08: No Token

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The control panel has not received the data transmission token on the ARC-network.

The corresponding DGU will, if possible continue operation.

System alarm

18.

Arc Net error no:

12: DGU Missing

The control panel is without communication with the corresponding DGU (with the same ID no.) on the ARC-network.

The corresponding DGU will, if possible continue operation.

System alarm

18.

Arc Net error no:

13: No Activity

The control panel is not able to measure

satisfactory activity at the ARC-network.

The corresponding DGU will, if possible

continue operation.

System alarm


18.

DELOMATIC-3

CP SW 1.XX

The control panel has not been updated by

the corresponding DGU (with the same ID

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no.) since the last power up.

The corresponding DGU will, if possible continue operation.

System alarm

18.

1...3

MEASURE ERROR

The SCM module with the I/O addr.

(n;0..2) has repeatedly measured an abnormal voltage or frequency.

The DGU is *forced* into SWBD control and is as such not included in the automatic PMS control.

System alarm

18.

**ID no.**

**ALARM TEXT**

**DESCRIPTION**

**ALARM SEQ.**

**REFERENCES**


4

CB O POS. FAIL.

A conflicting ON and OFF status has been detected on the position feedback signals from the generator breaker controlled by the SCM-1 module in question.

The DGU is *forced* into SWBD control and is as such not included in the automatic PMS control.

System alarm

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18.  
5...6  
CB n POS. FAIL

A conflicting ON and OFF status has been detected at the position feedback signals tram circuit breaker no. n; controlled by a SCM-2 module.

The DGU is *forced* into SWBD control and is as such not included in the automatic PMS control.  
System alarm  
18.

*I/O ERROR #-##:##*  
An I/O hardware configuration error has been detected in the DGU by the system supervision function.


*Please refer to the description in the technical documentation for detailed information about the defective module type and location. Notice that only one failed module at the time is shown.*  
The DGU is *forced into* SWBD control and is as such not included in the automatic PMS control.

System alarm  
18.

8  
LOW SUPPLY VOLT.

The supply voltage to the DGU has continuously been below 18 VDC (24 VDC - 25%).

The DGU is *forced into* SWBD control and is as such not included in the automatic PMS control.

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System alarm

18.

9...11

CP n COM. ERROR

A communication error has been detected between control panel n (n;1..3) and corresponding DGU.

a) The alarm message is displayed at the detective CP when the communication between CP and DGU *is reestablished*.

b) If a DGU have *more than one* corresponding CP the alarm message is displayed at all other operational CPs.

System alarm

18.

**ID no.**

**ALARM TEXT**

**DESCRIPTION**

**ALARM SEQ.**

**REFERENCES**

COM. ERROR DGU 1

The DGU in question is unable to communicate with the Master DGU (no. 1).

The DGU is *forced into* SWBD control and is as such not included in the automatic PMS control.

System alarm

18.

13...19


COM. ERROR DGU n

The Master DGU (no.1) is unable to communicate with DGU no. n (n;2...8).

The Master DGU *excludes* DGU no. from the automatic PMS control.

System alarm

18.

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#### CABLE FAIL X:C##

The cable supervision function has detected a cable failure at the IPM-1 Channel no. ##. The detective module is located at I/O address X in the corresponding DGU.

*Notice that only one failed channel is shown at the time.*

System alarm  
18.

#### f-DG TOO LOW

The *generator frequency* has continuously been below the programmed limit for busbar under frequency during idle run (GB open).

The detective generator set will not attempt to synchronise to the busbar.

*A PMS start command has been transferred to the next stand-by generator set.*

DG Block  
18.

#### f-DG TOO HIGH

The *generator frequency* has continuously exceeded the programmed limit for busbar overfrequency during idle run (GB open).

The defective generator set will not attempt to synchronise to the busbar.

*A PMS start command has been transferred to the next stand-by generator set.*


DG Block  
18.

#### U-DG TOO LOW

The *generator voltage* has continuously been below the *programmed limit for busbar undervoltage* during idle run.

The detective generator set will not attempt



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to synchronise to the busbar.

*A PMS start command has been transferred to the next stand-by generator set.*

DG Block

18.

#### U-DG TOO HIGH

The *generator voltage* has continuously exceeded the programmed *limit for busbar overvoltage* during idle run.

The detective generator set will not attempt to synchronise to the busbar.

*A PMS start command has been transferred to the next stand-by generator set.*

DG Block

18.

#### **ID no.**

#### **ALARM TEXT**

#### **DESCRIPTION**

#### **ALARM SEQ.**

#### REFERENCES

#### START FAILURE

The *auxiliary engine is not running* after execution of the programmed number of start attempts.

The detective generator set will not be "*ready for PMS start*" until the alarm has been acknowledged.


*The PMS start command has been transferred to the next stand-by generator set.*

DG Block

#### TACHO FAILURE

The running feedback signal is missing.

*The generator set will continue normal operation but will not be able to synchronise to the busbar.*

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DG Block

**DGB PHASE SEQ.**

A negative sequential order of phases has been detected at the generator with Regards to the busbar.

The detective generator set will not attempt to synchronise to the busbar.

*The PMS start command is transferred to the next stand-by generator set.*

DG Block

**DG SYNC. FAILURE**

The generator set has failed to synchronise to the busbar within the programmable *max. sync. time.*

*The PMS start command has been transferred to the next stand-by generator set.*

NOTE ! The "DG SYNC. FAILURE" alarm is automatically acknowledged in case of blackout at the busbar.

DG Block

**DGB ON FAILURE**

The DGU has failed to turn the generator breaker into ON position.


A command to open the breaker is transmitted.

*A PMS start command is transferred to the next stand-by generator set.*

DG Block

**DGB OFF FAILURE**

The DGU has failed to turn the generator breaker into OFF position.

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The generator set remain connected to the busbar and is included in the load share and load depending start / stop function.

*A PMS stop command is transmitted to the next generator set which is to be stopped (according the programmed start/stop priority).*

DG Block

DG STOP FAILURE

The DGU has been unable to stop the auxiliary engine.

The aux. engine continues idle run

*DGU keeps the stop output activated until the auxiliary engine is stopped.*  
DG Block


**ID no.**  
**ALARM TEXT**  
**DESCRIPTION**  
**ALARM SEQ.**  
**REFERENCES**

DG SAFETY STOP

The safety stop alarm sequence has been activated on this DG.

*The next stand-by generator set is started and connected to the busbar.*

*When sufficient available power is measured at the busbar the defective generator set is disconnected and stopped (incl. cooling*

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*down etc.).*

Safety stop

**U-DIFF. MAX FAIL**

The synchronisation of the generator set to the busbar has failed due to a too *high voltage deviation*.  
DG Block

**OVERSPEED**

The max. value for overspeed detection regarding the analogue input function has been achieved meaning that the generator set has been *shutdown* due to Aux. engine overspeed.

The aux. engine remains blocked for automatic start until the alarm becomes inactive.

*A PMS start command has been transmitted to the next stand-by generator set.*  
Shutdown

**DG OVERCURRENT**

The generator breaker has been tripped because generator current has exceeded the programmed limit for *overcurrent* continuously during the programmed delay.

*A PMS start command has been transmitted to the next stand-by generator set.*

Trip of GB


**DG HIGH LOAD**

The load on the generator set has exceeded the programmable limit for *DG high load* continuously during the programmed delay.

Warning

**DG OVERLOAD**

The generator breaker has been tripped due to the real power load on the generator set has exceeded the programmed limit for

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overload continuously during the programmed delay.  
*A PMS start command has been transmitted to the next stand-by generator set.*

Trip of GB

DG REVERSE POWER

The generator breaker has been tripped due to the reverse power at the generator set continuously has exceeded the programmed limit for reverse power during the programmed delay.

*A PMS start command has been transmitted to the next stand-by generator set.*  
 Trip of GB

**D no.**  
**ALARM TEXT**  
**DESCRIPTION**  
**ALARM SEQ.**  
**REFERENCES**

GB SHORT CIRCUIT


The generator breaker has been *tripped* due to detection of a short circuit above the setpoint (external or internal detection).

*A short circuit alarm blocks for black-out Start.*

Trip of GB

DG DIFF. CURRENT

The generator breaker has been *tripped* due to detection of a differential current above the setpoint (external or internal detection).

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Trip of GB

f-BB LOW WARN.

The *frequency at the busbar* has continuously been below the *programmed limit for underfrequency*.

*This alarm is also used during supervision of the shore supply when the shore connection breaker is closed.*

Warning

f-BB HIGH WARN.

The *frequency at the busbar* has continuously exceeded the *programmed limit for overfrequency*.

*This alarm is also used during supervision of the shore supply when the shore connection breaker is closed.*

Warning

U-BB LOW WARN.

The *busbar voltage* has been continuously below the *programmed limit for busbar undervoltage*.

*This alarm is also used during supervision of the shore supply when the shore connection breaker is closed.*

Warning

U-BB HIGH WARN.

The *busbar voltage* has been continuously above the *programmed limit for busbar overvoltage*.


*This alarm is also used during supervision of the shore supply when the shore connection breaker is closed.*

Warning

f-BB TOO LOW

The generator breaker has been *tripped* due to the fact that frequency at the busbar continuously has been below the programmed *limit for underfrequency*.

Trip of GB

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**f-BB TOO HIGH**

The generator breaker has been *tripped* due to the fact that the frequency at the busbar has continuously exceeded the programmed *limit for overfrequency*.

Trip of GB

**U-BB TOO LOW**

The generator breaker has been *tripped* due to the voltage at the busbar has been continuously below the programmed *limit for undervoltage*.

Trip of GB

**ID no.**

**ALARM TEXT**

**DESCRIPTION**

**ALARM SEQ.**

**REFERENCES**

**U-BB TOO HIGH**

The generator breaker has been *tripped* due to fact that *the voltage at the busbar* has continuously exceeded the programmed *limit for overvoltage*.

Trip of GB

**P LOADSHARE FAIL**


The *power* produced by the generator set has continuously *deviated* more than the max. acceptable limit from the power setpoint.

DG Block

**DG-I NEL 1 TRIP**

Non Essential Load group no. 1 has been tripped due to one of the below mentioned causes:

- a) The *current* of the generator set has been continuously above the programmed *limit for trip of NEL 1*.

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b) A shutdown or trip of GB alarm sequence has disconnected the generator set from the busbar.

Warning

#### DG-I NEL 2 TRIP

Non Essential Load group no. 2 has been tripped due to one of the below mentioned causes:

a) The *current* of the generator set has been continuously above the programmed *limit for trip of NEL 2*.

b) A shutdown or trip of GB alarm sequence has disconnected the generator set from the busbar.

Warning

#### DG-f NEL 1 TRIP

Non Essential Load group no. 1 has been tripped due to the *frequency* at the busbar has been continuously below the programmed *limit for trip of NEL 1*.

Warning

#### DG-f NEL 2 TRIP

Non Essential Load group no. 2 has been tripped due to the *frequency* at the busbar has been continuously below the programmed *limit for trip of NEL 2*.

Warning

#### DG DELOAD FAIL


The DGU has been unable to deload the generator set below the programmed power limit for opening of the GB.

The generator set remains connected to the busbar and is included in the load share and load dependent start / stop calculation.

*A PMS stop command is transmitted to the next generator set which is to be stopped (according the programmed start/stop priority).*

DG Block



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**ID no.**  
**ALARM TEXT**  
**DESCRIPTION**  
**ALARM SEQ.**  
**REFERENCES**

DG SHORT CIRCUIT  
ALARM

The *custom binary alarm input channe/1..6* has detected the programmed alarm status.

The designated/selected alarm sequence is carried out \*).

The entered alarm text is displayed at the corresponding CP. *Please notice custom alarm inputs can have a customized alarm text.*

\*) Selected alarm sequence

DG ALARM 1


L.O.P. LOW ALARM

H.T. WATER OUTLET  
TEMP. ALARM

MICRO SWITCH TURN  
GEAR ALARM

GEN. WIND/BEARING  
ALARM

GS OVERSPEED  
ALARM

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By detection of over speed the requested alarm sequence will be executed.  
Shutdown

ASYM.LD.SH.CANC.

The asymmetrical load share function is automatically cancelled due to the load situation.

The connected DGU's *forced back to* symmetrical load share.

Warning

TB POS. OFF

By detection of TB position = OFF the system will be forced into SWBD mode.

Warning

SCB POS. ON !

The shore connection breaker is closed and at the same time one or more generator breakers are closed, meaning The DG is running in parallel with the mains.

*No DG is running frequency control.*

Warning


### **5.3. Menu system**

The PMS menu systems, which are operated via the control panel(s), provide access to all programmable set-points/timers, system selections and read-out of selected measured values.

#### **5.3.1. The menu structure**

The PMS menu structure is based on 4 main sections. Each main section contains a number of sub-menus.

- The system setup section contains e.g. sub-menus for programming of set-points and delays used for control of the PMS system.

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- The data readings section contains read-out sub-menus for display of actual measured values.
- In the system selections section, a number of system selections are available (only visible on the CP for the Master DGU).
- The alarm stack contains the alarm messages for all alarms.

The operator is able to browse through the PMS menu system via the CP push buttons:

- Moves the focus to the left in the menu structure
- Moves the focus down in the menu structure
- Moves the focus up in the menu structure
- Moves the focus to the right in the menu structure

### **The programming function**

The programming function (P-function) must be active whenever the operator wishes to change set points and timer values through the PMS menu system.


SYSTEM  
 SETUP CP-MASTER  
 MAIN MENU  
 DATA READINGS  
 SYSTEM  
 SELECTION  
 ALARM STACK  
 XXX ALARM(S)

### **5.3.2. Data readings**

The data readings section is divided into 3 or more subsections:

The data readings DG section contains measured values such as:

- generator phase-phase voltage
- generator phase currents
- generator frequency
- generator active and re-active power

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The data readings SG section contains measured values such as:

- generator phase-phase voltage
- generator phase currents
- generator frequency
- generator active and re-active power

The common data readings section contains measured values such as:

- busbar voltages
- busbar frequency
- available power at the busbar
- consumed power at the busbar

The aux. data readings section contains a number of miscellaneous measured values such as:

- the measured supply voltage at the supply terminals (PSM-1)
- the total running hours of the generator set

SYSTEM

SETUP CP-MASTER

MAIN MENU


DATA READINGS

SYSTEM

SELECTION

ALARM STACK

XXX ALARM(S)

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## DATA READINGS

DG  
DATA READINGS  
SG

DATA READINGS  
COMMON

DATA READINGS  
AUX

- the number of running hours since last reset of the trip counter
- value present at the analogue alarm input channels
- actual rpm at the engine
- the power consumed by any HC with analogue power feedback signal
- the software ID number

### **5.3.3. System selections**

Through the system selection sections, the operator is able to program and activate common system function such as:

- selection of start priority (the PMS system may handle several generator sets)
- selection of asymmetrical load share (only possible if the asymmetrical load share function is available in the PMS system)


#### **NOTE !**

The system selection menus are only visible on CP(s) corresponding to the Master DGU.

### **5.3.4. Alarm stack**

In the alarm stack, all registered and active alarm messages are available for read-out.

If there are no active or un-acknowledged alarms registered in the PMS system, the alarm stack is empty.

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SYSTEM

SETUP CP-MASTER

MAIN MENU

DATA READINGS

SYSTEM

SELECTION

ALARM STACK

XXX ALARM(S)

START PRIORITY

X-X-X-n

ASYMM. LOAD SH.

SELECTED: YES/NO

#### **5.4. PMS – functions**


The PMS unit controls all functions regarding superior or common control of the entire power plant by means of PMS commands.

The PMS system operates as an integrated unit in the Master DGU.

The PMS interface in each DGU carries out distributed control of the generator sets according to the received PMS commands and PMS status feedback signals.

Only generator sets (DGUs) selected to be under PMS control are included in the automatic PMS functions.

#### **Plant modes**

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The PMS system operates according to the functionalism of the selected plant mode.

The plant modes combine the automatic functions in the PMS system according to the desired functionalism of each plant mode. This means some of the automatic functions may not be used in all plant modes.

The system is able to handle the following plant modes:

••**SEMI-AUTO MODE**

••**AUTOMATIC MODE**

Selection of the plant mode for the entire power plant is done by a switch located on MSB.

x = active

- = inactive

(1) = Push-button activated

**SWBD**

**CONTROL**

**PMS CONTROL**

**PLANT MODES**

**AUTOMATIC PMS FUNCTIONS**

**SEMI-AUTO**

**MODE**


**AUTOMATIC**

**MODE**

1. Load depending start/stop


-

-

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- X
- 2. Selection of start/stop priority
- 
- 
- X
- 3. Frequency control
- 
- X
- X
- 4. Symmetrical load share
- 
- X
- X
- 5. Asymmetrical load share
- 
- 
- X
- 6. Black-out start
- 
- X
- X
- 7. Shore connection supervision
- X
- X
- X
- 8. Conditional connection of heavy consumers
- 
- X
- X
- 9.
- 10.
- GENERATOR SET FUNCTIONS
- 11. Automatic start sequence
- (1)
- X
- X
- 12. GB ON sequence
- (1)
- X
- X



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13. Frequency/load control

X

X

X

14. Manual control of freq./load

-

-

-

15. GB OFF sequence

(1)

X

X

16. Automatic stop sequence

(1)

X

X

GENERATOR SET PROTECTION

17. Internal system supervision

X

X

X

18. Engine supervision

X

X

X

19. Busbar supervision

X

X

X

20. Generator protection

X

X

X

21. Short circuit protection

X


X

X

22. Trip of non essential load groups

X

X

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X  
23. Binary alarm inputs

X

X

X

24. Analogue alarm inputs

X

X

X

### **SEMI-AUTO plant mode**

The SEMI-AUTO plant mode is an operator dependent AUTO mode.

In this mode the automatic sequences are carried out only on request of the operator, via the push-buttons at the CP-Master for the DGU; the automatic start sequence, the GB ON sequence incl. dynamical synchronisation, the GB OFF sequence and the automatic stop sequence.

Selection of SEMI-AUTO plant mode will have no effect on running generator sets.

Following push buttons at the CP-Master's are only active when SEMI-AUTO mode is selected.

#### **PUSH-BUTTON DESCRIPTION "START"**

Start of engine; the programmed automatic start sequence is carried out.

#### **"STOP"**


Stop of engine; the programmed automatic stop sequence is carried out.

#### **"GB ON"**

Closing of GB; the programmed automatic GB ON sequence is carried out.

#### **"GB OFF"**

Opening of engine; the programmed automatic GB OFF sequence is carried out. 1)

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NOTE ! Any auxiliary engines, which carry out idle run when SEMI-AUTO mode is cancelled, are automatically stopped by the function for stop of non connected DGs.

### **AUTO plant mode**

During this full-automatic mode, called AUTO mode, the automatic control is carried out by all generator sets, which are selected to be under PMS control.

The PMS system carries out automatic frequency and load control during the AUTOMATIC plant mode.

Load depending start and stop of the generator is carried out according to the actual power demand at the busbar with respect to: the programmed start/stop priority and the programmed limits for start and stop.

If the PMS system detects a blackout situation at the busbar, a conditional blackout start of two generator sets is carried out.

### **Load dependent start/stop function**


The load dependent start/stop function is active when the AUTO or SPLIT plant mode is selected and shore connection is not closed.

The start/stop functions transmits PMS start and stop commands, which are based on a calculation of how many generator sets are needed in order to satisfy the actual power demand at the busbar.

The PMS start/stop commands cause the individual generator sets to carry out respectively start and stop according to the programmed start/stop priority.

Furthermore, during SEMI-AUTO mode, the load depending start/stop functions operate as hidden load supervision. The load depending start/stop function will only allow a push-button initiated semi-auto disconnection of a generator breaker, if the generator set is expandable at the busbar (the predicted available power > the nominal power of the generator set).

Calculation of the load depending PMS start/stop commands is based on a comparison of the programmed start and stop limits and a special PMS value called the predicted available power.

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### **Selection of Start/Stop priority**

Depending on the programmed priority sequence and the operational status of the generator sets, the start/stop priority function continuously designates each generator set with respectively a PMS start priority and a PMS stop priority.

Fig. 96 Operating principle for determination of the start/stop priority.

The load depending start/stop function uses this information when the PMS start/stop commands are to be transmitted.

NOTE: The start/stop priority function keeps account with which DGUs are "ready for PMS start", and which DGUs are "ready for PMS stop". Any running DGU, which during operation, becomes not "ready for PMS stop" are not accepted as the next generator to be stopped.

### **Programming of the start/stop sequence**

Programming and read-out of the start/stop priority sequence are carried out for all generator sets through the CP corresponding to the Master DGU.

The PMS multi-function will not accept the start/stop priority sequence if:

- two or more generator sets are programmed to the same start/stop priority number

- a generator set is programmed to have several start/stop priority numbers

The example below shows a start/stop priority sequence for a 4 generator set power plant, programmed to start priority 2-3-1-4.  
DGU no.

START PRIORITY 1st 2nd 3rd 4<sup>th</sup>


PROGRAMMABLE

START/STOP PRIORITY

LOAD DEPENDING

START/STOP

FUNCTION

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DGU 1

DGU 2

DGU 3

PMS START

PMS STOP

START DGU No. X

STOP DGU No.

READY FOR PMS STOP

READY FOR PMS START

READY FOR PMS STOP

READY FOR PMS START

READY FOR PMS STOP

READY FOR PMS START

PMS START/STOP COMMANDS


START PRIORITY

2 - 3 - 1 - 4

**NOTE!**

The PMS system is able to control the start/stop priority for as many as 6 generator sets.

When the operator changes the priority sequence, the generator sets automatically re-arrange according to the new start/stop priority, any stand-by generator sets which have been designated with a higher start priority than any running generator sets, will automatically substitute these.

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### **Determination of the start priority**

The Master DGU continuously designates each generator set with a PMS start priority number according to the programmed priority sequence.  
The priority sequence 2 - 3 - 1 - 4 in the display designates:

- DGU no. 2 with start priority no. 1 (to be started first) .
- DGU no. 3 with start priority no. 2
- DGU no. 1 with start priority no. 3
- DGU no. 4 with start priority no. 4 (to be started last)

The DGU designated with start priority no. 1 is indicated by:

- a green "**1ST START PRIORITY**" LED

### **Determination of the stop priority**

The Master DGU continuously designates each generator set with a PMS stop priority number according to the programmed priority sequence.

A priority sequence 2 - 3 - 1 - 4 in the display designates:


- DGU no. 4 with stop priority no. 1 (to be stopped first)
- DGU no. 1 with stop priority no. 2
- DGU no. 3 with stop priority no. 3
- DGU no. 2 with stop priority no. 4

### **"1st PRIOR" push-button**

The operator is able to designate the highest start priority to any generator set via the corresponding CP by pressing the:

- "**1st PRIOR**" push-button

The example below shows how the start priority changes if the operator presses the "**1st PRIOR**" push-button at the CP corresponding to DGU no. 4:

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The start priority sequence before as read-out on the CP:  
2-3-1-4 meaning:

- DGU no. 2 is designated with start priority no. 1 (to be started first)
- DGU no. 3 is designated with start priority no. 2
- DGU no. 1 is designated with start priority no. 3
- DGU no. 4 is designated with start priority no. 4 (to be started last)

Then the push-button "1st PRIOR" on the CP corresponding to DGU no. 4 is pressed!

The start priority sequence after as read-out on the CP:  
4-2-3-1 meaning:

- DGU no. 4 is designated with start priority no. 1 (to be started first)
- DGU no. 2 is designated with start priority no. 2
- DGU no. 3 is designated with start priority no. 3
- DGU no. 1 is designated with start priority no. 4 (to be started last)


The load depending start/stop function will subsequently re-arrange the running generator sets according to the new start priority.

### **Black-out function**

The blackout function is active whenever one of the following plant modes are selected:

- SEMI-AUTO mode
- AUTO mode

The blackout function consists of two separate functions:

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- a common detection of "dead busbar" status
- the black-out start sequence

An individual detection of "dead busbar" status is made by all DGUs in the system.

The blackout start sequence is initiated once the Master DGU receives the internal "dead busbar" status from all DGUs in the PMS system.

### **Dead busbar detection**

The individual "dead busbar" internal signal is transmitted when the following conditions have been continuously registered by a DGU during the programmable delay.

- the largest measured busbar phase-phase voltage (UL-L) is below 20 % of nominal value
- the corresponding generator breaker is in OFF position
- no short circuit alarm is active in the DGU \*)

\*) A short circuit alarm at any of the DGUs will block the entire blackout start sequence.

***In such cases, the operator must acknowledge the short circuit alarm(s) in order to enable the blackout start sequence.***


If one or several of the above mentioned initiating conditions disappear, the "dead busbar" detection is immediately disabled.

*A synchronisation-alarm is automatically acknowledged (reset) in case of an active "dead busbar" status in the DGU. This allows the generator set in question to attempt to connect to the busbar.*

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### **The blackout start sequence**



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If the Master DGU is unable to communicate with a DGU (indicated by a communication alarm message) the signal from the defective DGU is not required in order to initiate the blackout start sequence.

NOTE! Activation of the blackout start sequence is only possible, if at least one of the DGUs selected to be in PMS control and "ready for PMS start".

Fig. 97 Operating principle of the black-out function

The blackout start sequence carries out the following step-by-step sequence:

a) A PMS start command (activates the automatic start sequence in the DGUs) is transmitted to the DGUs with the highest and second highest start priority, which at the same time are "ready for PMS start".

b) The DGU which first obtains normal running feedback and normal generator voltage/ frequency will close the breaker immediately (after receiving an acknowledge-signal from the Master DGU).

If this does not result in the closing of the generator breaker, the other black-out started generator set will (after approx. 2 sec. delay) be requested to close this breaker without synchronisation.

c) The second black-out started DGU initiates synchronisation of the generator breaker, approx. 2 s, after satisfactory voltage and frequency have been detected at the busbar.


d) If any of the two chosen generator sets fails during the start sequence, the PMS start command is transferred to the next stand-by generator set as long as the blackout situation is present.

e) When one generator set is successfully connected to the busbar, the black-out function is considered to be completed. The PMS system switch back to "normal" operation again.

BLACK-OUT

FUNCTION

PROGRAMMABLE

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START/STOP

PRIORITY

DGU 1

DGU 2

DGU 3

BLACK-OUT

DEAD BUSBAR

READY FOR PMS START

DGU No. X DGU No.

DEAD BUSBAR

READY FOR PMS START

DEAD BUSBAR

READY FOR PMS START

BLACK-OUT

START


### **Conditional connection of heavy consumers**

The conditional connection of Heavy Consumers function is able to handle 3 heavy consumers (HCs).

When requested by a heavy consumer, the function for conditional connection of heavy consumers reserves the programmed max.

Power at the busbar and blocks engagement of the heavy consumer until sufficient predicted available power is present at the busbar.

After achieving sufficient predicted available power, the heavy consumer is subsequently blocked until the programmed delay runs out.

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The heavy consumers (HC) are connected according to their priority.

This means, if two or more heavy consumers request for start acknowledgement at the same time, the HC with the highest priority is handled first, subsequently HCs with lower priority etc.

HC 1 is designated the highest priority e.g.; HC 1 is handled before HC 3, if they request for start at the same time. If there are any preferential HCs, these must be connected to the hardware interface for HC 1 in order to ensure 1st priority handling.

The PMS system carries out the following step-by-step sequence, in case of a HC request for start acknowledgement:

- a) The programmed "HC n MAX POWER" value is reserved at the busbar.
- b) A PMS start command is transmitted to the next stand-by generator set if the predicted available power is below the programmed "LOAD START LIMIT",  
*If the predicted available power at the busbar is below 0 kW, the timer "DELAY ACK. HC n" is blocked until the stand-by generator set is connected and sufficient predicted available power is present at the busbar.*  
*The timer "DELAY ACK. HC n" starts running at this point if the predicted available power at the busbar is above 0 kW.*
- c) When sufficient predicted available power is present at the busbar, the timer "DELAY ACK. HC n" starts running.
- d) The start acknowledge signal is transmitted to the HC in question, when the timer "DELAY ACK. HC n" runs out and sufficient available power is still measured at the busbar.


### **5.5. Generator set control**

Generator set control is handled by the DGUs according to a number of automatic sequences.

The automatic sequences form jointly a complete cycle of operation for a generator set.

The Master DGU is able to initiate a complete cycle of operation for a generator set by means of the PMS start command and the PMS stop command.

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A DGU "ready for PMS start" will respond to the PMS start command by carrying out:

- the automatic start sequence
- the automatic GB ON sequence.

All generator sets in operation which are "ready for PMS stop" respond to the PMS stop command by carrying out:

- the automatic GB OFF sequence
- the automatic stop sequence.

During an active SEMI-AUTO plant mode, the initiation of the automatic sequences is carried out step-by-step (sequence by sequence) according to the operator commands via the push-buttons at the CP(s).

Fig. 98 The automatic sequences contained in the cycle of operation for a generator set

All the above mentioned automatic sequences are controlled according to a number of programmable set-points and timers - this enables the operator to adjust the automatic operation of the generator set.

### **DGU operational modes for the generator set**

Each generator set is controlled according to the selected DGU operational mode.

Each generator set may be selected to be under either:


- Switchboard (SWBD) control  
AUTOMATIC

START

SEQUENCE

GB ON

SEQUENCE;

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SYNCHRONISATION

PMS START

COMMAND  
"GB ON"

SEMI-AUTO  
"START"

SEMI-AUTO

AUTOMATIC  
STOP

SEQUENCE  
GB OFF

SEQUENCE;  
DELOADING  
PMS STOP  
COMMAND  
"GB OFF"

SEMI-AUTO  
"STOP"


SEMI-AUTO

OPERATION:

FREQUENCY/LOAD  
CONTROL  
"READY FOR  
PMS START"  
"READY FOR  
PMS STOP"

Or

•• Power management system (PMS) control

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### **Switchboard control (DGU operational mode)**

Generator sets under switchboard control (SWBD control) are only to be operated manually.

A generator set under SWBD control is excluded from all automatic PMS functions.

SWBD control is strictly local; all other generator sets operating under selected PMS control will not be affected.

The synchronising unit in the SCM-1 module turns into SWBD control, when SWBD control is selected on the DGU.

SWBD control enables manual control of the speed governor via the synchronising unit in the SCM-1 module. The speed governor may be manually decreased and increased by means of two binary inputs.

All supervision and protective functions regarding the generator set are still active for generator set(s) under SWBD control e.g.:

- generator protection
- busbar supervision

### **PMS control (DGU operational mode)**


Generator sets under PMS control are automatically controlled by the PMS system according to the selected plant mode.

### **Automatic start sequence**

The automatic start sequence starts the corresponding auxiliary engine and detects if the start is completed successfully.

A successfully completed start sequence initiates the GB ON sequence.

The automatic start sequence is carried out when a DGU receives a PMS start command. The PMS start command may e.g. be generated by the load depending on start/stop or by the blackout function.

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An operator dependent initiation (push-button) of the automatic start sequence may take place in SEMI-AUTO mode (this will not initiate the GB ON sequence).

The start sequence is initiated when the DGU receives a PMS start command.

Each DGU in the PMS system is able to carry out the automatic start sequence, which includes:


- continuous supervision of "ready for PMS start" status
- programmable time for the "START PREPARE" output
- programmable ON time for the "START" output
- programmable OFF time for the "START" output
- programmable activation of the stop output during OFF time
- programmable number of start attempts
- detection of start failure
- supervision of generator voltage and frequency during idle run
- transfer of the PMS start command to the next stand-by generator set in case of:
  - start failure
  - generator voltage or frequency failure

#### **Automatic GB ON sequence**

The GB ON sequence is automatically initiated (except during SEMI-AUTO mode) when the automatic start sequence has been successfully completed.

The automatic GB ON sequence includes:

- detection of "ready for PMS synchronisation" status for the generator set

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- programmable dynamical synchronisation
- generator breaker ON control
- transfer of the PMS start command to the next stand-by generator set in case of:
  - a failed synchronisation
  - a generator breaker ON failure

When the GB ON sequence is initiated it is indicated at the CP corresponding to the DGU by:

- a yellow "GB ON" LED

#### **Automatic GB OFF sequence**

The GB OFF sequence is initiated when the DGU receives a PMS stop command from the Master DGU (or a SEMI-AUTO initiated GB OFF) and the PMS stop command is only accepted by the DGU if the generator set is "ready for PMS stop". The GB OFF sequence deloads the generator set and will finally open the generator breaker.

#### **Automatic stop sequence**


The automatic stop sequence is carried out when the DGU has successfully completed the GB OFF sequence.

The stop sequence is automatically initiated when the GB OFF sequence has been completed.

The DGU in the DELOMATIG system is able to carry out the automatic stop sequence, which includes:

- Automatic stop sequence incl.:
- programmable cooling down time
- "STOP" output with programmable extended ON time



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- Semi-auto stop of engine incl.:
- programmable cooling down time
- "STOP" output with programmable extended ON time

### **5.6. Generator set supervision and protection**

The DGU in the PMS system is able to handle local supervision and protection of the corresponding generator set.

Each DGU is implemented with the protective and supervision functions.


NOTE! All local supervision and protective functions are also active during SWBD control.

#### **Internal system supervision**

The DGUs in the PMS system are implemented with an extensive number of internal system supervision functions for supervision of their ability to carry out safe and correct operation.

Each DGU continuously carries out the following system supervision functions:

- CP-1 supervision of the ARC-network
- CM-2 supervision of ARC-network and internal communication
- supervision of the generator breaker position feedback signals
- supervision of I/O configuration (hardware)
- power supply supervision
- supervision of the multi-transducer unit in SCM modules
- cable supervision

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### **Engine supervision**

Engine supervision is handled by the PMS system according to the status on a number of alarm inputs.

Each DGU in the PMS system is able to carry out the following engine supervision functions:

- •tacho feedback
- •6 user programmable alarms

The engine supervision functions are disabled when the engine is not running (stand-by). Disabling of the engine supervision means that no alarms are generated by the supervision functions.

The engine supervision functions are furthermore disabled during the automatic start sequence until the auxiliary engine has obtained running status.

Each DGU is implemented with the hardware interface, which is used in coherence with the engine supervision functions.

### **Busbar supervision and protection**

The PMS busbar supervision and protective functions are activated whenever a generator set is connected to the busbar.


Busbar supervision is also activated at the Master DGU when a shore connection is supplying the busbar (only if shore connection is present).

Each DGU carries out busbar supervision and protection according to individual programmable set points and delays.

This means the DGUs may be programmed differently, but it is highly recommended to program the busbar supervision functions with set points and delays common for the entire PMS system.

Each DGU implements the following busbar supervision (warning) and protective (trip of GB) functions:

- •2 level undervoltage, UBB<

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- 2 level overvoltage, UBB>
- 2 level underfrequency, fBB <
- 2 level overfrequency, fBB >

### **Generator protection**

The PMS generator set protection is separated into two parts:

- supervision of the generator during an idle run (the breaker is open)
- a set of protective functions which are active when the breaker is closed

The following generator supervision and protective functions are implemented in each DGU in the PMS system:

- supervision of generator voltage and frequency during idle run
- protection against overcurrent;  $I >$  (2 steps; slow and fast)
- protection against reverse power;  $-P >$
- protection against overload;  $P >$  (2 steps; high load and overload)


Each DGU carries out the generator protection according to individual programmable set points and delays.

This means that the protective functions in the DGUs may be programmed differently according to different characteristic values.

### **5.6.5. Trip of non essential load groups**

The trip of **Non Essential Load (NEL)** groups is carried out in order to protect the busbar against an imminent black-out situation due to either a high load on a generator set or a low busbar frequency.

The trip of NEL groups function is implemented in each DGU.

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This means each DGU executes the trip of NEL groups according to individual settings. But it is highly recommended to program all DGUs with identical settings in order to obtain a uniform operation.

Each DGU is able to trip two NEL groups due to:

- the measured load of the generator set
- and
- the measured frequency at the busbar

The load groups are tripped as two individually load groups. Thus, the trip of load group no. 1 has no direct influence on the trip of load group no. 2.

Only the measurement of either the busbar frequency or the load on the generator set is able to trip the load groups.

### **Trip of NEL groups due to high load**

Trip of the NEL groups due to the load of a running generator set will reduce the load on the busbar and thus reduce the load percentage on the running generator set.

This may prevent a possible black-out at the busbar caused by an overload on the running generator sets.

NOTE ! Furthermore, both steps of NEL groups are tripped at the same time by the DGU if the corresponding generator breaker is tripped.

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6. Operating procedures

## **6.0. Shore Supply**

### **Normal Supply**

*(Emergency Generator)*

1. Shore supply switch should be set to ON
2. Shore supply On button should PRESSED for a few seconds

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## **MSB Emergency Supply**

*(Emergency Generator)*

1. Control of EG breaker and tie breaker to MSB switch should be set to MANUAL
2. Control of tie breaker to MSB switch should be set to emergency supply of MSB

### **6.1. Emergency generator**

#### **Start with hydraulic starter**

*(Emergency Generator)*

1. Shore supply Off button should PRESSED for a few seconds
2. Shore supply switch should be set to OFF
3. Emergency generator DO tank outlet valve should be OPEN
4. Emergency generator LO sump level should be checked
5. Emergency generator operation switch should be set to MANUAL
6. Hydraulic starter hand pump should be PRESSED until pressure is about 30 MPa
7. Starting lever should be PRESSED for a few seconds


#### **Start with electric starter**

*(Emergency Generator)*

1. Emergency generator DO tank outlet valve should be OPEN
2. Emergency generator operation switch should be set to MANUAL
3. Emergency generator START/STOP button should be PRESSED for a few seconds

#### **Connect to ESB**

*(Emergency Generator)*


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1. Control of EG breaker and tie breaker to MSB switch should be set to MANUAL
2. Emergency generator breaker ON button should be PRESSED for a few seconds

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**6.2 DG operational**  
**Prepare Cooling Water System**  
*(Cooling System)*

1. Side sea chest valve before the filter should be OPEN
2. Side sea chest valve after the filter should be OPEN
3. SW pump no 3 suction valve should be OPEN
4. SW pump no 3 discharge valve should be OPEN
5. LT FW pump no 3 suction valve should be OPEN
6. LT FW pump no 3 discharge valve should be OPEN
7. Central cooler no 1 SW inlet valve (basic) should be OPEN
8. Central cooler no 1 SW outlet valve should (basic) be OPEN
9. Central cooler no 1 FW inlet valve should be OPEN
10. Central cooler no 1 FW outlet valve should be OPEN
11. Central cooler no 2 SW inlet valve (basic) should be OPEN
12. Central cooler no 2 SW outlet valve should (basic) be OPEN
13. Central cooler no 2 FW inlet valve should be OPEN
14. Central cooler no 2 FW outlet valve should be OPEN
15. Main SW overboard outlet valve should be OPEN

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16. LT expansion tank outlet valve from should be OPEN  
(Diesel Generators)

17. DG1 LT cooling water inlet valve should be OPEN

18. DG1 LT cooling water outlet valve should be OPEN

19. DG1 HT cooling water inlet valve should be OPEN

20. DG2 LT cooling water inlet valve should be OPEN

21. DG2 LT cooling water outlet valve should be OPEN

22. DG2 HT cooling water inlet valve should be OPEN

23. DG3 LT cooling water inlet valve should be OPEN

24. DG3 LT cooling water outlet valve should be OPEN

25. DG3 HT cooling water inlet valve should be OPEN

26. DG1 preheater should be switched ON

27. LT FW pump no 3 should be switched ON

**Prepare Compressed Air System**

(Diesel Generators)

1. Emergency air compressor mode switch should be set to LOCAL

2. DG starting air receiver refilling valve should be OPEN


3. Emergency air compressor should be switched ON

4. Wait until DG starting air receiver pressure is higher than 2.5 MPa

5. Emergency air compressor should be switched OFF

6. DG starting air receiver drain valve should be OPEN

7. DG starting air receiver drain valve should be CLOSED

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8. DG starting air receiver main discharge valve should be OPEN

9. DG1 starting air inlet valve should be OPEN

10. DG2 starting air inlet valve should be OPEN

11. DG3 starting air inlet valve should be OPEN

### **Prepare Fuel Oil System**

*(Fuel System)*

1. DO service tank outlet valve to DG & steam boiler should be OPEN

2. DO emergency service tank outlet valve should be OPEN  
*(Diesel Generators)*

3. DO booster pump suction valve should be OPEN

4. DO booster pump discharge valve should be OPEN

5. DG1 fuel inlet valve should be OPEN

6. DG1 fuel outlet valve should be OPEN

7. DG2 fuel inlet valve should be OPEN

8. DG2 fuel outlet valve should be OPEN

9. DG3 fuel inlet valve should be OPEN

10. DG3 fuel outlet valve should be OPEN


11. DG1 fuel inlet valve from emergency service tank should be OPEN

12. DG2 fuel inlet valve from emergency service tank should be OPEN

13. DG3 fuel inlet valve from emergency service tank should be OPEN

14. DO booster pump should be switched ON



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### **DG Local Start**


*(Diesel Generators)*

1. Check oil level in DG1 LO Sump
2. DG1 prelubricating pump should be switched ON
3. Wait few minutes for prelubricating
4. DG1 prelubricating pump should be switched OFF
5. DG1 LOCAL button should be PRESSED for a few seconds
6. DG1 START button should be PRESSED for a few seconds  
*(Control Room)*
7. DG1 Standstill heating should be switched ON
8. DG1 gen. breaker button should be PRESSED for a few seconds
9. SW pump no 3 should be switched ON
10. Transformers (400/230) mode switch should be set to position 1
11. DG1 preheater should be switched OFF  
*(Emergency Generator)*
12. Control of EG breaker and tie breaker to MSB switch should be set to AUTO
13. Emergency generator START/STOP button should be PRESSED for a few seconds
14. Emergency generator operation switch should be set to AUTO

### **Start PMS**

*(Diesel Generators)*

1. DG1 prelubricating pump switch position should be set to PMS


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2. Check oil level in DG2 LO Sump
3. Check oil level in DG3 LO Sump
4. DG2 prelubricating pump switch position should be set to PMS
5. DG3 prelubricating pump switch position should be set to PMS
6. DG1 REMOTE button should be PRESSED for a few seconds  
*(Control Room)*
7. PMS mode switch position should be set to AUTO
8. DG1 Switchboard/PMS control switch position should be set to PMS
9. DG2 Switchboard/PMS control switch position should be set to PMS
10. DG3 Switchboard/PMS control switch position should be set to PMS

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**6.3. Voltage available**  
**Prepare compressed air system**  
*(Compressed Air System)*

1. Main air receiver no 1 refilling valve should be OPEN
2. Main air receiver no 2 refilling valve should be OPEN
3. Air compressor no 1 outlet valve should be OPEN
4. Air compressor no 2 outlet valve should be OPEN
5. Air compressor no 1 cooling water inlet valve should be OPEN
6. Air compressor no 1 cooling water outlet should be OPEN
7. Air compressor no 2 cooling water inlet valve should be OPEN
8. Air compressor no 2 cooling water outlet should be OPEN

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*(Control room, computer)*


9. Air compressor no 1 should be set to STAND BY/AUTO
10. Air compressor no 2 should be set to STAND BY/AUTO  
*(Compressed Air System)*
11. Main air receiver no 1 drain valve should be OPEN
12. Main air receiver no 1 drain valve should be CLOSED
13. Main air receiver no 2 drain valve should be OPEN
14. Main air receiver no 2 drain valve should be CLOSED
15. Main air receiver no 1 main discharge valve should be OPEN
16. Main air receiver no 1 outlet valve to ME air station should be OPEN
17. Main air receiver no 1 outlet valve to DG should be OPEN
18. Main air receiver no 1 outlet valve to air reductors should be OPEN
19. Air reductor (3.0-1.1 MPa) inlet valve should be OPEN
20. Air reductor (3.0-1.1 MPa) outlet valve should be OPEN
21. Air reductor (3.0-0.8 MPa) inlet valve should be OPEN
22. Air reductor (3.0-0.8 MPa) outlet valve should be OPEN
23. Air control station inlet valve should be OPEN
24. Air dryer inlet valve should be OPEN
25. Air dryer outlet valve should be OPEN
26. Air dryer should be switched ON
27. Air station reductor (1.1/07 MPa) inlet valve should be OPEN

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28. Air station reductor (1.1/07 MPa) outlet valve should be OPEN
29. Air to Fuel Unit and LO Filter should be OPEN
30. Air to Fuel and LO Separators should be OPEN
31. Air to Boiler Control should be OPEN
32. Air to DO 3-way valves should be OPEN
33. Air to Bilge Water Separator should be OPEN
34. ME control air inlet valve should be OPEN
35. ME control air main inlet valve should be OPEN
36. ME control air valve should be OPEN
37. ME air supply to exhaust valve air springs valve should be OPEN
38. ME safety air valve should be OPEN  
*(Diesel Generators)*
39. DG Starting Air Receiver inlet valve from main air receivers valve should be OPEN

**Start hydrophore**  
*(Hydrophore)*

1. Fresh water tank no 1 outlet valve should be OPEN
2. Hydrophore pump no 1 suction valve should be OPEN
3. Hydrophore pump no 1 discharge valve should be OPEN
4. Hydrophore pump no 2 suction valve should be OPEN
5. Hydrophore pump no 2 discharge valve should be OPEN

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6. Hydrophore inlet valve should be OPEN
7. Hydrophore pumps control switch should be set to 1
12. Wait until water level in hydrophore tank reaches MIN value
13. Hydrophore pumps control switch should be set to 0
14. Hydrophore air inlet valve should be OPEN
15. Wait until pressure in hydrophore tank reaches 0.3 Mpa
16. Hydrophore pumps control switch should be set to 1
17. Hydrophore outlet valve should be set to OPEN
18. Fresh water receivers inlet valve should be set to OPEN
19. UV filter inlet valve should be set to OPEN
20. UV filter outlet valve should be set to OPEN
21. Fresh water to accommodations inlet valve should be set to OPEN
22. Fresh water to hot water circulation system inlet valve should be set to OPEN
23. Hot water circulation pump suction valve should be set to OPEN
24. Hot water circulation pump discharge valve should be set to OPEN
25. Fresh water heater inlet valve should be set to OPEN
26. Fresh water heater outlet valve should be set to OPEN
27. Hot water circulation pump main switch should be set to ON
28. Fresh water heater control switch should be set to position 1 (step I)
29. UV filter control switch should be set to position 1 (lamp I)

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**Prepare water mist system**

*(Water Mist System)*

1. Water supply pump suction valve should be OPEN
2. Water supply pump discharge valve should be OPEN
3. Main Switch on high pressure pump local panel should be set to ON
4. Main Switch on Control Room Panel should be set to ON


**Start steam boiler**

*(Fuel System)*


1. DO service tank outlet valve to DG & steam boiler should be OPEN
2. Boiler fuel pump no 1 suction valve should be OPEN
3. Boiler fuel pump no 1 discharge valve should be OPEN
4. Boiler fuel pump no 2 suction valve should be OPEN
5. Boiler fuel pump no 2 discharge valve should be OPEN

*(Steam System)*

6. Air valve on top of the boiler should be OPEN
7. Valve to gauge board 1 should be OPEN
8. Valve to gauge board 2 should be OPEN
9. Right float switches chamber upper valve should be OPEN
10. Right float switches chamber lower valve should be OPEN
11. Left float switches chamber upper valve should be OPEN
12. Left float switches chamber lower valve should be OPEN
13. Feed water inlet angular valve - pump 1 should be OPEN


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14. Feed water inlet valve - pump 1 should be OPEN
15. Feed water inlet angular valve - pump 2 should be OPEN
16. Feed water inlet valve - pump 2 should be OPEN
17. Boiler feed pump no 1 suction valve should be OPEN
18. Boiler feed pump no 1 discharge valve should be OPEN
19. Boiler feed pump no 2 suction valve should be OPEN
20. Boiler feed pump no 2 discharge valve should be OPEN
21. Boiler main switch position should be set to ON
22. Feed water pump no 1 power switch should be set to ON
23. Feed water pump no 1 mode switch should be set to AUTO
24. Feed water pump no 2 power switch should be set to ON
25. Feed water pump no 2 mode switch should be set to STAND BY
26. Fuel pump no 1 power switch should be set to ON
27. Fuel pump no 1 mode switch should be set to RUN
28. Fuel pump no 2 power switch should be set to ON
29. Fuel pump no 2 mode switch should be set to STAND BY
30. Reset switch position should be set to ON
31. Burner operation mode switch should be to Nozzle 1 Aut.
32. Air valve on top of the boiler should be CLOSED
33. Boiler main steam valve should be OPEN to 20 %

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34. Steam receivers collector no 1 drain valve should be OPEN
35. Steam receivers collector no 1 steam inlet valve should be OPEN
36. Steam receivers collector no 1 drain valve should be CLOSED
37. Boiler main steam valve should be slowly OPENED to 100 %
38. Steam receivers collector no 1 and LO Separators valve should be OPEN
39. Steam receivers collector no 1 steam outlet to collector no 2 valve should be OPEN
40. Steam receivers collector no 1 FO Service and Settling Tanks valve should be OPEN
41. Steam receivers collector no 1 FO Storage Tanks valve should be OPEN
42. Steam receivers collector no 1 Fuel Unit valve should be OPEN
43. Steam receivers collector no 2 drain valve should be OPEN
44. Steam receivers collector no 2 steam inlet valve should be OPEN
45. Steam receivers collector no 2 drain valve should be CLOSED
46. Steam receivers collector no 2 LO Settling Tank should be OPEN
47. Steam receivers collector no 2 Emergency Sea Chest should be OPEN
48. Steam receivers collector no 2 ER Sea Chest Tank should be OPEN
49. Steam receivers collector no 2 LO Bilge Water Tank should be OPEN
50. Steam receivers collector no 2 Waste Oil Tank should be OPEN
51. Steam receivers collector no 2 Fuel Oil Drain Tank should be OPEN
52. Steam receivers collector no 2 Fuel Oil Overflow Tank should be OPEN



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53. Steam Condenser cooling water inlet valve should be OPEN
54. Steam Condenser cooling water outlet valve should be OPEN
55. Valve from condensate piping system to condenser should be OPEN
56. Condenser outlet valve to hot well should be OPEN
57. Steam heating valves on DO service tank should be OPEN
58. Steam heating valves on HFO service tank should be OPEN


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59. Steam heating valves on HFO settling tank should be OPEN

#### **Start air conditioning plant**

*(Cooling system)*


1. AC and Prov. Store FW Pump No 1 inlet valve should be OPEN
2. AC and Prov. Store FW Pump No 1 inlet valve should be OPEN
3. AC and Prov. Store FW Pump No 2 inlet valve should be OPEN
4. AC and Prov. Store FW Pump No 2 inlet valve should be OPEN  
*(Control room, computer)*
5. AC and Prov. Store FW Pump No 1 should be set to ON  
*(A/C Plant)*
6. Cooling water inlet valve to condenser should be OPEN
7. Cooling water outlet valve from condenser should be OPEN
8. Condenser cooling water by-pass valve should be CLOSED
9. Steam inlet valve to humidifier should be OPEN
10. Steam inlet valve to heater should be OPEN

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11. Steam inlet valve to reheater should be OPEN
12. Humidifier outlet valve should be OPEN
13. Air recirculation should be set to position 25% open
14. Manual reset on compressors high press safety cut-out switch should be pressed  
*(Control Panel)*
15. AHU main switch should be set to ON
16. Compressor main switch should be set to ON
17. Compressor should be set to automatic operation:
  - a) COMPR F1 button on PLC MENU should be pressed
  - b) AUTO F3 button on PLC MENU should be pressed
18. Air Handling Unit AHU should be switch On:
  - a) Main button on PLC MENU
  - b) AHU F2 button on PLC MENU should be pressed
  - c) START F1 button on PLC MENU should be pressed

**Start refrigerating plant**  
*(Refrigerating Plant)*


1. Condenser No 1 cooling water inlet valve should be OPEN
2. Condenser No 1 cooling water outlet valve should be OPEN
3. Condenser No 1 vent valve should be OPEN
4. Condenser No 1 vent valve should be CLOSED
5. Refrigerating compressor No 1 discharge valve should be OPEN

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6. Refrigerating compressor No 1 oil return valve should be OPEN
7. Dehydrator inlet valve should be OPEN
8. Dehydrator outlet valve should be OPEN
9. Dehydrator by-pass valve should be CLOSED
10. All valves before meat/fish chamber should be OPEN
11. All valves before vegetables chamber should be OPEN
12. All valves before dairy chamber should be OPEN
13. All valves before dry provision chamber should be OPEN

*(Control Panel)*

14. Main switch on refrigerating plant control panel should be OPEN
15. Compressor No 1 standstill heating switch should be set to ON
16. Compressor No 1 capacity control switch should be set to AUTO
17. Compressor No 1 switch should be set to ON
18. Manual reset on compressors high press safety cut-out switch should be pressed
19. Meat and fish chamber freezing fan switch should be set to ON
20. Vegetables chamber freezing fan switch should be set to ON
21. Dairy chamber freezing fan switch should be set to ON
22. Dry provision chamber freezing fan switch should be set to ON

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23. Refrigerating compressor No 1 suction valve should be slowly OPEN

24. Condenser No 1 refrigerant outlet valve should be OPEN

#### **6.4. Steam available**

##### **Start Oily Water Separator (OWS)**

*(Bilge System)*

1. Bilge tank outlet to oily water separator valve should be OPEN

2. OWS water inlet valve should be OPEN

3. OWS water discharge valve – bilge tank should be OPEN

4. OWS water discharge valve – overboard should be OPEN

5. OWS oil discharge valve should be OPEN

6. OWS bilge water suction valve should be OPEN

7. OWS overboard valve should be OPEN

*(Oily Water Separator – Control Panel)*

8. OWS Main switch should be switched ON

9. OWS Alarm confirmation button should be PRESSED for a few seconds

10. OWS Control mode switch should be set to position AUTO

11. OWS heater should be switched ON


12. OWS Reset button should be PRESSED for a few seconds

##### **Start Sewage Treatment Plant**

*(Sewage Treatment Plant)*

1. Ejector pump inlet valve should be OPEN


2. Ejector inlet valve should be OPEN

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3. Black water inlet valve to sewage tank valve should be OPEN
4. All black water outlet valves from system should be OPEN
5. Ejector pump outlet valve to sewage unit should be OPEN  
*(Sewage Treatment Plant - Collecting Unit Control Panel)*
6. Main switch should be switched ON
7. Alarm confirmation button should be PRESSED for a few seconds
8. Ejector pump control switch should be set to position AUTO  
*(Biological Sewage Treatment Plant - Control Panel)*
9. Main switch should be switched ON  
*(Cooling System)*

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10. Fire pump no 1 suction valve should be OPEN
11. Fire pump no 1 discharge valve should be OPEN
12. Fire pump no 1 should be switched ON  
*(Sewage Treatment Plant)*
13. Aeration chamber 1 valve should be OPEN
14. Water from fire pumps inlet valve should be OPEN
15. Wait until Below low level indication lamp turn OFF
16. Aeration chamber 1 valve should be CLOSED
17. Water from fire pumps inlet valve should be CLOSED
18. Disinfection chamber valve should be OPEN

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19. Discharge pump inlet valve should be OPEN
20. Discharge pump outlet valve should be OPEN
21. Sewage overboard valve should be OPEN
22. Settling chamber air inlet valve should be OPEN
23. Aeration chamber 1 air inlet valve should be OPEN
24. Aeration chamber 2 air inlet valve should be OPEN  
(*Sewage Treatment Plant - Control Panel*)
25. Blower control switch should be set to position AUTO
26. Discharge pump control switch should be set to position AUTO
27. Chlorination pump control switch should be set to position AUTO

### **Start Incinerator**

#### *Selecting Program*


Following programs are available:

- Slagging
- Solid Waste Burning
- Sludge Burning

Prior to start

(*Incinerator*)

1. Diesel Oil Tank Outlet Valve should be OPEN
2. Sludge Tank Heater Inlet Valve should be OPEN
3. Sludge Tank Heater Outlet Valve should be OPEN

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4. Sludge Circulation Pump Suction Valve should be OPEN
  5. Incinerator Sludge Inlet Valve should be OPEN
  6. Incinerator Sludge Return Valve should be OPEN
  7. Regulating Valve for Atomising Steam should set to 50 % OPEN
  8. Main switch on the control panel is switched to position "ON"
- Slagging


1. Check that there are no flames in the incinerator
2. Push the "SLAGGING" key, the flue gas damper will close for 30 sec. and the flue gas fan will start. LED for "SLAGGING", "FG FAN" and "RUNNING" are lit
3. Open the ash doors and remove ashes and slag, partly burned cans, can remain. These will burn out eventually

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NOTE! Combustion air inlet openings at "floor" level must be cleaned. This is important for a free air flow to the combustion chamber.

Solid Waste

1. Press the "SOLID WASTE" button. Wait for the temperature to reach 700 oC. The green control lamp / push button will be lit
2. Press and hold the green button and open the sluice door
3. Put the trash bag into the sluice
4. Close the sluice door
5. Rotate the sluice arm for emptying the garbage into the incinerator
6. Return the sluice back in position
7. After 3 minutes, the control lamp will be lit and a new load can be fed into the incinerator. Operate the pusher handle before each load - if pusher is fitted

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8. After all garbage is incinerated, activate the "STOP" button  
Sludge

1. Prior to burning sludge, heat the sludge to 80 oC
2. Heating is activated by pressing the "SLUDGE HEATER" button. (Should be heated over night) The circulating pump must not be started at preheating
3. Next morning, drain off as much water as possible from the sludge tank
4. Press "SLUDGE" button
5. Adjust the sludge oil pressure to 0,2 bar with the sludge tank reg. valve
6. The incinerator will stop automatically when the sludge tank is empty, or by pressing the "STOP" button


**Start Steering Gear**  
(*Steering Gear*)

1. Pump unit no 1 control model switch should be set to position REMOTE CONTROL
2. Pump unit no 2 control model switch should be set to position REMOTE CONTROL  
(*Bridge*)
3. START/RUN PUMP 1 button on Bridge Console should be PRESSED for a few seconds

**Start ME cooling**  
(*Cooling system*)

1. LT FW pump no 1 suction valve should be OPEN
2. LT FW pump no 1 discharge valve should be OPEN
3. ME LO cooler LO inlet valve should be OPEN




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4. ME LO cooler LO outlet valve should be OPEN
5. ME LO cooler FW inlet valve should be OPEN
6. ME LO cooler FW outlet valve should be OPEN
7. LT FW to HT FW system inlet valve should be OPEN
8. LT FW to HT FW system outlet valve should be OPEN
9. HT expansion tank suction valve should be OPEN
10. HT FW pump no 1 suction valve should be OPEN
11. HT FW pump no 1 discharge valve should be OPEN
12. HT FW pump no 2 suction valve should be OPEN
13. HT FW pump no 2 discharge valve should be OPEN
14. LT FW pump no 1 should be switched to ON

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15. LT FW pump no 2 should be switched to STAND BY/AUTO
16. LT FW pump no 3 should be switched to OFF
17. HT FW pump no 1 should be switched to ON
18. HT FW pump no 2 should be switched to STAND BY/AUTO
19. ME heater automatic regulating valve steam inlet should be OPEN
20. ME heater automatic regulating valve steam outlet should be OPEN
21. ME heater steam outlet valve should be OPEN

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### **Start ME lubricating**

*(Lubricating System)*

1. ME LO circulating pump no 1 discharge valve should be OPEN
2. ME LO circulating pump no 2 discharge valve should be OPEN
3. ME LO automatic filter inlet valve should be OPEN
4. ME LO automatic filter outlet valve should be OPEN
5. ME LO circulating pump no 1 should be switched to ON
6. ME LO circulating pump no 2 should be switched to STAND BY/AUTO


*(Alfa Lubricating System)*

1. Alfa unit no 1 suction valve should be OPEN
2. Alfa unit no 2 suction valve should be OPEN
3. Main discharge valve should be OPEN
4. Alfa unit no 1 main switch should be set to ON
5. Alfa unit no 1 mode switch should be set to AUTO


### **Start ME LO Purifier**

*(ME LO Purifier)*


1. Purifier feed pump suction valve should be OPEN
2. Heater inlet valve should be OPEN
3. Heater outlet valve should be OPEN
4. Steam inlet valve should be OPEN
5. Steam outlet valve should be OPEN
6. Purifier water supply shut-off valve should be OPEN

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7. Purifier air supply shut-off valve should be OPEN
  8. Sludge valve should be OPEN
  9. Inlet regulating valve should be set to 50 % OPEN
  10. Purifier main switch should be set to ON
  11. Oil feed pump should be set to On
  12. Heater button should be PRESSED for a few seconds
  13. Separation button should be PRESSED for a few seconds
  14. "-" button should be PRESSED for a few seconds
  15. Separator should be set to On
  16. Wait for "STANDBY" info on LCD display
  17. Separation button should be PRESSED for a few seconds
- Start FCM DO supply**  
(Fuel System)
1. DO Service tank outlet valve to FCM should be OPEN
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- (FCM)
2. Supply pump no 1 suction valve should be OPEN
  3. Supply pump no 1 discharge valve should be OPEN
  4. Supply pump no 2 suction valve should be OPEN
  5. Supply pump no 2 discharge valve should be OPEN
  6. Flow transmitter inlet valve should be OPEN
  7. Flow transmitter outlet valve should be OPEN

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8. Manual deaeration valve on the top of the mixing tube should be CLOSED
9. Circulation pump no 1 suction valve should be OPEN
10. Circulation pump no 1 discharge valve should be OPEN
11. Circulation pump no 2 suction valve should be OPEN
12. Circulation pump no 2 discharge valve should be OPEN
13. Fuel heater no 1 fuel inlet valve should be OPEN
14. Fuel heater no 1 fuel outlet valve should be OPEN
15. Fuel heater no 1 steam inlet valve should be OPEN
16. Fuel heater no 1 steam outlet valve should be OPEN
17. Viscosity transmitter inlet valve should be OPEN
18. Viscosity transmitter outlet valve should be OPEN
19. Steam regulating inlet valve should be OPEN
20. Steam regulating outlet should be OPEN
21. Steam trap inlet valve should be OPEN
22. Steam trap outlet should be OPEN
23. Automatic filter control switch should be set to AUTO position. In this position the filter is hard wired to start when the respective pump is started (supply pump if filter is after the supply pumps, or circulating pump if filter is after the circulating pumps)
24. Regulating valve control switch should be set to EPC position
25. Heating tracing control switch should be set to 1 position
26. Automatic filter main switch should be set to the On position


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27. Circulation pump no 1 main switch should be set to the On position
28. Circulation pump no 2 main switch should be set to the On position
29. Supply pump no 1 main switch should be set to the On position
30. Supply pump no 2 main switch should be set to the On position
31. Circulation pump no 1 control switch should be set to the EPC position
32. Circulation pump no 2 control switch should be set to the EPC position
33. Supply pump no 1 control switch should be set to the EPC position
34. Supply pump no 2 control switch should be set to the EPC position
35. Press "Start" on the EPC. A question will appear in the display, "Start?" + = Yes - = No" (fig. 31). Pressing the "+" button will start the system. Pumps and heating will be started according to the module starting sequence.
36. DG1 HFO supply control button should be PRESSED for a few seconds
37. DG2 HFO supply control button should be PRESSED for a few seconds
38. DG3 HFO supply control button should be PRESSED for a few seconds
39. DO booster pump should be switched OFF

### **6.5. ME stopped Prepare ME**

*(Main Engine)*

1. ME indicator valve no 1 should be OPEN
2. ME indicator valve no 2 should be OPEN
3. ME indicator valve no 3 should be OPEN
4. ME indicator valve no 4 should be OPEN
5. ME indicator valve no 5 should be OPEN

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6. ME indicator valve no 6 should be OPEN
7. ME indicator valve no 7 should be OPEN
8. ME turning gear should be ENGAGED
9. ME turning gear motor switch position should be set to On
10. ME turning gear motor switch position should be set to OFF
11. ME turning gear should be DISENGAGED
12. ME indicator valve no 1 should be CLOSED
13. ME indicator valve no 2 should be CLOSED
14. ME indicator valve no 3 should be CLOSED
15. ME indicator valve no 4 should be CLOSED
16. ME indicator valve no 5 should be CLOSED
17. ME indicator valve no 6 should be CLOSED
18. Main Starting Valve should be OPEN


**Start ME**  
(Fuel System)

1. ME fuel oil outlet valve should be OPEN  
(Bridge)

1. SLOW AHEAD button on bridge telegraph should be PRESSED for a few seconds  
(Control Room)

1. SLOW AHEAD button on control room telegraph should be PRESSED for a few seconds

2. AUX BLOWERS mode switch position should be set to AUTO

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3. SLOW DOWN RESET button should be PRESSED for a few seconds
4. SHUT DOWN RESET button should be PRESSED for a few seconds
5. ME Start Blocked Alarm should be confirmed on computer alarm system
6. ME starting lever should be set to position START until ME achieve 30 RPM
7. ME starting lever should be set to position 3

**6.6. ME running**  
**Start HFO Supply**  
*(Fuel System)*

1. HFO Service tank outlet valve to FCM should be OPEN  
*(FCM)*
2. Press the DO / HFO button
3. A question appears in the display. "Change oil mode? + = yes, - = no"
4. Press "+" to start the charge over


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**Start Exhaust Boiler Equipment**  
*(Steam System)*

1. Steam valve before dumping regulating valve should be OPEN
2. Steam valve after dumping regulating valve should be OPEN

**Start HFO Purifier**  
*(Fuel system)*

18. HFO settling tank outlet valve to purifiers should be OPEN  
*(HFO Purifier)*
19. Purifier feed pump suction valve should be OPEN

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20. Heater inlet valve should be OPEN
21. Heater outlet valve should be OPEN
22. Steam inlet valve should be OPEN
23. Steam outlet valve should be OPEN
24. Purifier water supply shut-off valve should be OPEN
25. Purifier air supply shut-off valve should be OPEN
26. Sludge valve should be OPEN
27. Inlet regulating valve should be set to 50 % OPEN
28. Purifier main switch should be set to ON
29. Oil feed pump should be set to On
30. Heater button should be PRESSED for a few seconds
31. Separation button should be PRESSED for a few seconds
32. "-" button should be PRESSED for a few seconds
33. Separator should be set to On


**Start Fresh Water Generator (FWG)**

*(Fresh Water Generator)*

1. Ejector pump suction valve should be OPEN
  2. Ejector pump discharge valve should be OPEN
  3. FWG overboard valve should be OPEN
  4. FWG air valve should be CLOSED
- (Fresh Water Generator – Control Panel)*

5. FWG main switch should be switched ON



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6. Ejector pump start button should be PRESSED for a few seconds

7. Wait until vacuum in FWG is 90 %  
(*Fresh Water Generator*)

8. FWG heating water inlet valve should be OPEN

9. FWG heating water outlet valve should be OPEN

10. FWG heating water by-pass valve should be CLOSED to 50 %

11. FW to bilge manual valve to bilge should be OPEN  
(*Hydrophore*)

12. FWG outlet valve to FW tanks should be OPEN

13. Fresh water tank no 3 inlet valve should be OPEN

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(*Fresh Water Generator*)

14. Mineralizer inlet valve should be OPEN

15. Mineralizer outlet valve should be OPEN

16. Fresh water pump start button should be PRESSED for a few seconds

17. Wait until water salinity will be less than 1 ppm


18. FW to bilge manual valve to bilge should be CLOSED

### **6.7. Fire Fighting**

#### **CO2 Fire Extinguishing System Engine Room In case of fire-operatin from release cabinet**

1. Open the Engine Room Release Cabinet **(A1)** marked engine room on fire. The CO2 alarm will now sound in the protected space.

2. Be sure that all personnel are avacuated from the protected space.

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3. Before operating the system, close all openings to the protected space, stop engines, close quick-closing valves for fuel, stop fuel pumps and purifiers, shut down the ventilation.

4. Pull down both ball valve handles (**B**).

5. Open the screw down valve (**C**) on one pilot cylinder.

6. The system is now operated.

7. The Main Valve (**E1**) will be open immediately, a time delay unit will delay the operation of the CO<sub>2</sub> cylinder top valves (**D**). After a pre-set time (60-90 sec.) the CO<sub>2</sub> gas will be discharged into the engine room.

#### **Emergency operation from CO<sub>2</sub> room**

In case of failure in the operation of the system from the release cabinet, the system can be manually operated according to the following procedure:

1. Open the main valve (**E1**) for the engine room on fire.

2. Be sure that all personnel are evacuated from the protected space.


3. Before operating the system, close all openings to the protected space, stop engines, close quick-closing valves for fuel, stop fuel pumps and purifiers, shut down the ventilation.

4. Take the CO<sub>2</sub> handles from handles bank.

5. Open one or two CO<sub>2</sub> pressure operated cylinder top valves (**D**) in the CO<sub>2</sub> bank by putting the handle into the top of valve and pulling.

6. Open the booster valve (**I**) by putting the handle into the top of valve and pulling. All the pressure operated CO<sub>2</sub> cylinder top valves will now open automatically.

7. The system is now operated. The CO<sub>2</sub> gas will be discharged into the engine room.

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### **Warning: CO2 gas suppresses oxygen**

When the fire is out, ventilate the space thoroughly, and person re-entering the space should wear breathing apparatus until it is certain that the oxygen content is normal.

### **CO2 System Scavenge Air Duct**

1. Stop the Main Engine.

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2. Open the distribution valve.
3. Open CO2 scavenge air duct main valve.
4. Open proper scavenge air box valve and the neighbouring valves to the scavenge air chamber on fire.
5. Open the release valves on CO2 bottles.


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7. Software options description

#### **7.1. Engine room resources**

Resources option allows for the adjustment of the following liquid level in tanks and pressure settlement.

This option is available from **Options | Resources.**

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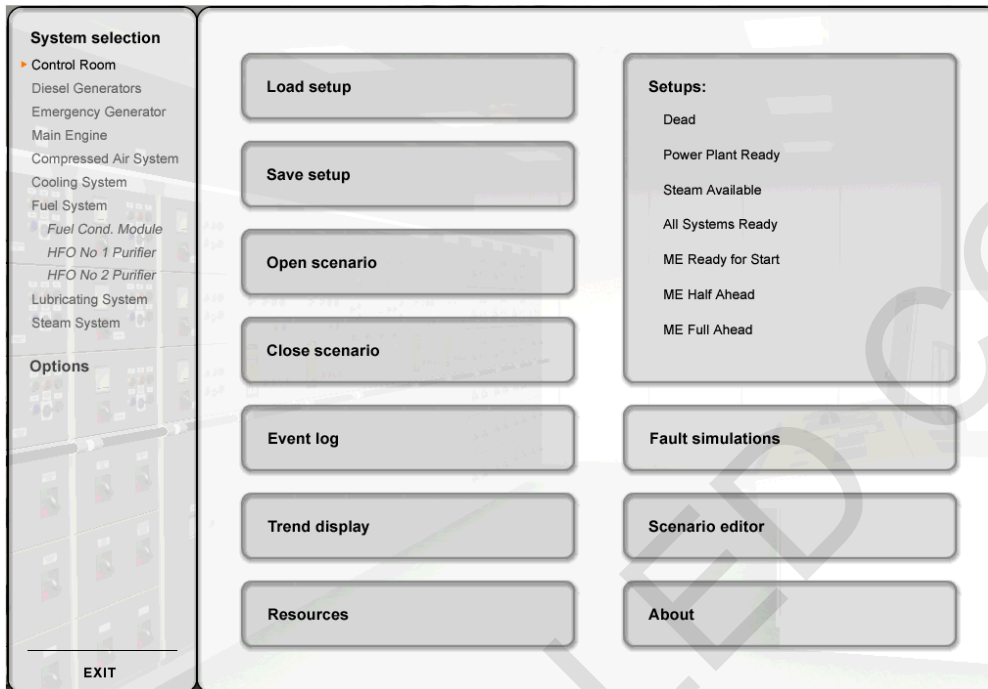


Fig. 99 Resources

The levels of resources are changed by moving the suitable Track Bar in Resources Dialogue Box.

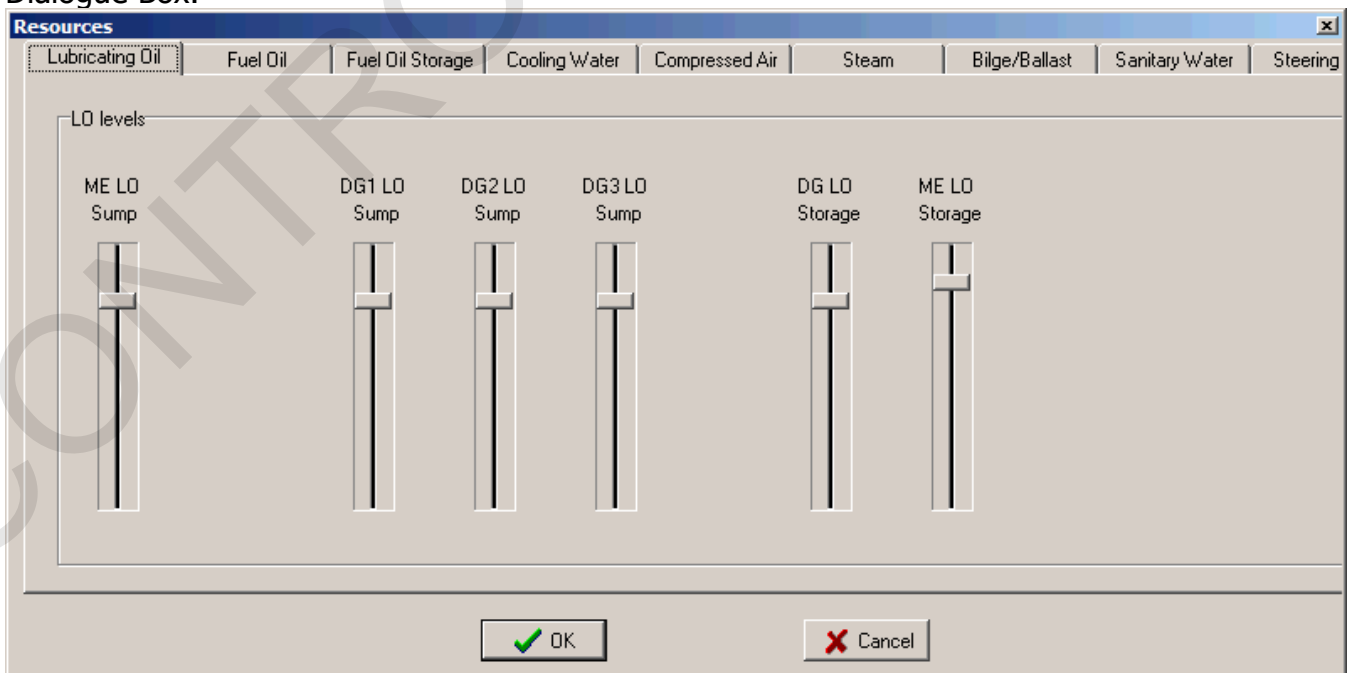



Fig. 100 Resources levels

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## 7.2. Setup

There are 7 standard setup options available in Low Speed Engine Room Simulator by **Options | Setup**:

- a. Dead (*cold engine room*)
- b. Power Plant Ready (*DG1 is in operation and connected to bus bur, all DG systems ready*)
- c. Steam Available (*main air compressors ready, hydrofore in operation, steam boiler at working pressure*)
- d. All Systems Ready (*all auxiliary systems ready*)
- e. ME Ready for Start (*Main Engine and its systems ready for operation*)
- f. ME Half Ahead (*Main Engine at half ahead on diesel oil*)
- g. ME Full Ahead (*Main Engine at full ahead on heavy fuel oil, exhaust boiler in operation*)

It is also possible to save any state of engine room on hard drive. For this purpose there is an option in **Main Menu |**

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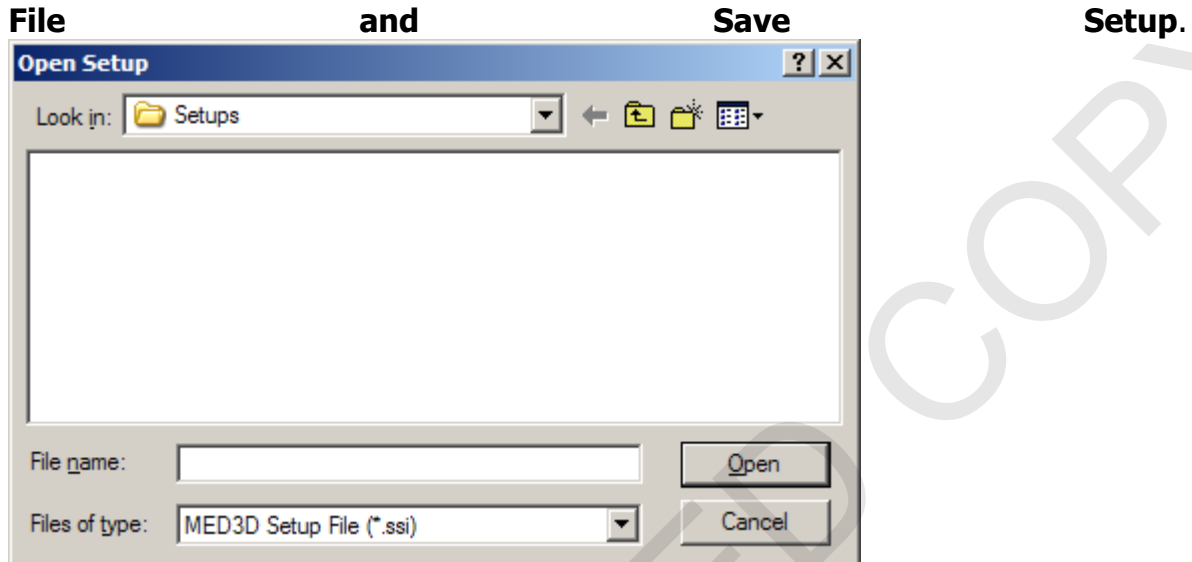


Fig. 101 Setup loading Dialogue Box

### 7.3. Fault simulation

To open Fault Simulation window '**Options / Fault simulation**' command should be selected.

The Fault Simulation window contains a list of all available simulations and their status can be monitored and changed.


There are two possible states for each fault simulation:

- a. 'OFF' - No fault i.e. default technical state.
- b. 'ON' - Described fault is simulated.

The fault status will change when clicking at the Fault column of the selected simulation.

The 'Scenario status' in the 'Fault Simulation' window shows if the scenario is currently running or not.

When the Fault Simulation window opens, it shows the current engine room fault status. All currently active faults are also shown in the smaller window below the list. The fault status

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Changed at the list by clicking, does not change component status immediately. Only when the OK button is pressed all the introduced changes become active.

However, clicking at the Cancel button will cancel all changes and close the Fault Simulation window.

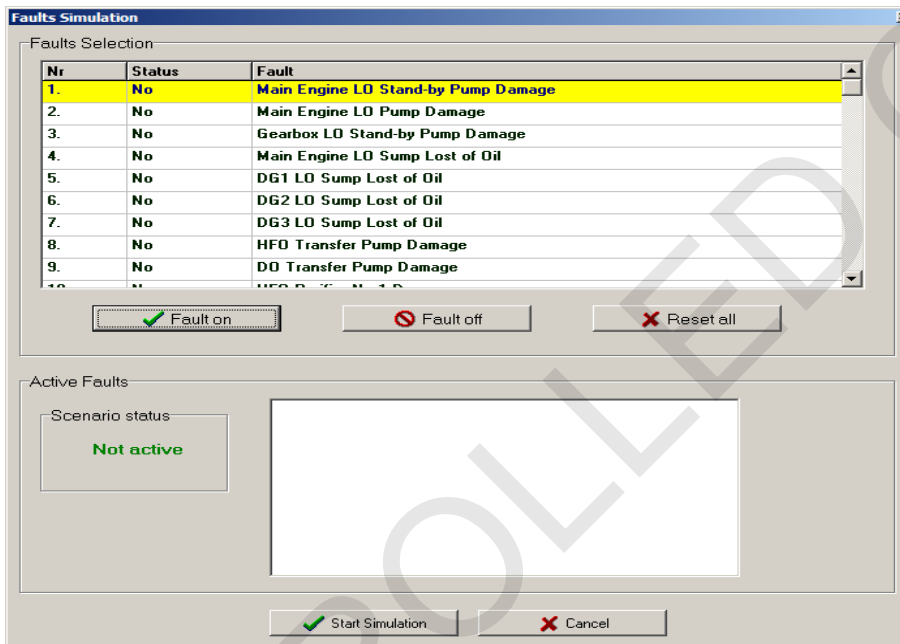



Fig. 102 Faults simulation window

## 7.4. Scenarios

A scenario is a chain of events that introduces or removes faults from the engine room operation. Each scenario is described by the following properties:

- Fault name (selected from the given list).
- Fault delay (the delay in seconds between the prior event and the current one). The scenario is stored as a file with (\*.scm extension). The scenario file can be used in the way specified below:
- The scenario can be opened using '**File | Open scenario**' item from the main menu. When opened; the scenario will run in the background introducing events stored in scenario file. The 'Open scenario' item is disabled and 'Close scenario'

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item is enabled in the main menu, and in the 'Fault simulation' window Scenario status shows 'Active' state.

- The scenario can be closed using 'File | Close scenario' item from the main menu. This means that the scenario event execution is stopped immediately even if not all scenario events have been executed.

The open scenario will close automatically when the last event stored in the file is executed.

All scenario events (fault simulation) that are still active will remain in the simulator after scenario is closed.

The present faults status can be checked and edited when using 'Options | Fault simulation' option from

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The main menu. The Fault Simulation window includes Reset All Faults button which will remove all faults introduced during the scenario run, but only if the OK. button is pressed.

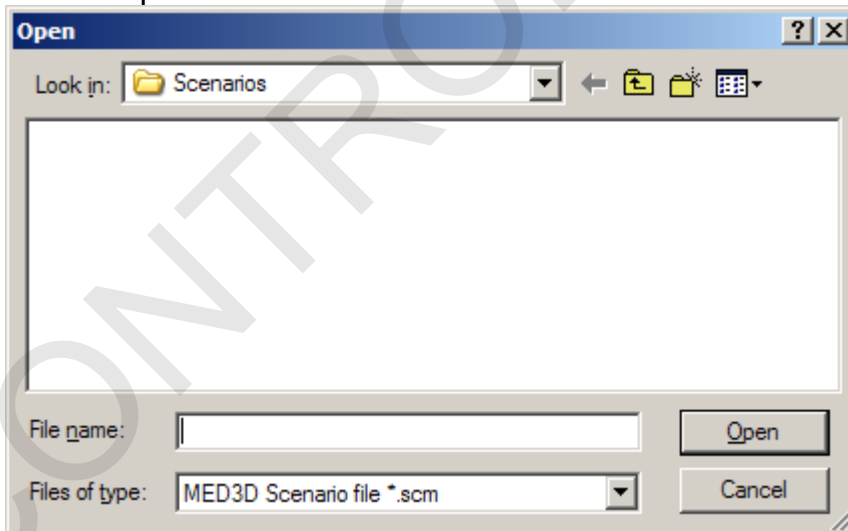



Fig. 103 Open scenario

Please keep in mind that when you load or save the setup this does not include currently present faults. Additionally when you load the setup all faults will be reset.



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However, before a scenario file can be used it has to be created as a new file or edited as an existing file. The procedure for the creation of a scenario file is described below.

### Scenario Editor

The scenario editor will pop up when 'Options | Scenario Editor' - item from the main menu is selected.

When invoked, the Edit scenario window opens and is empty as shown on the picture below.

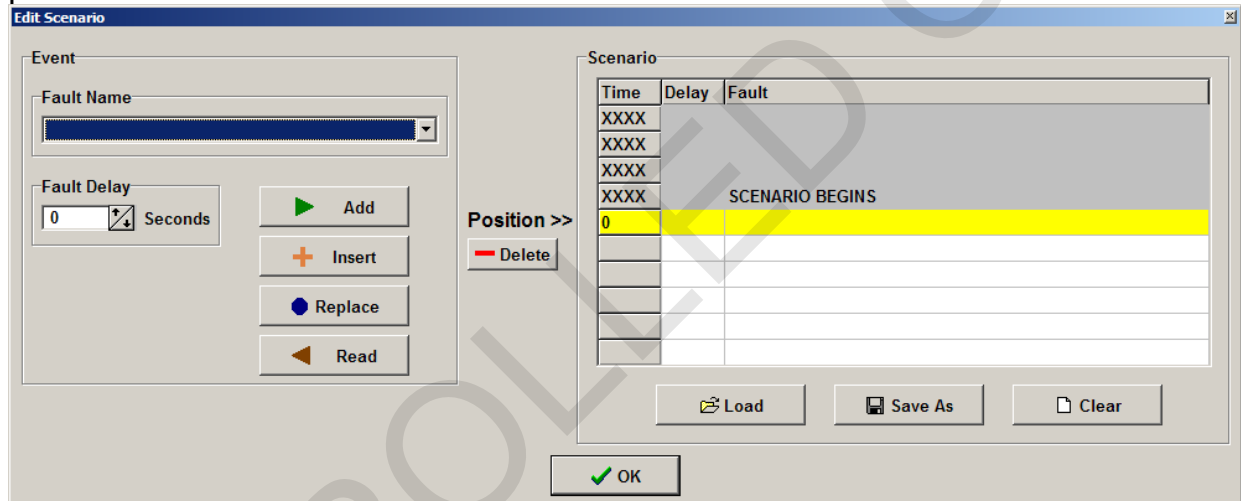


Fig. 104 Empty Scenario editor

The left part of the window includes the event editor, the right part includes the grid with the complete list of the events belonging to the edited scenario.

The event highlighted in yellow is

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the current event i.e. event being currently edited. The buttons can be used for the events manipulation in scenario file:

- “Add” adds the currently edited event to the end of the events list.

Typically, this button will be used when adding a new event.

- “Insert” inserts the currently edited event just before the highlighted position. Typically, this button will be used when inserting a new event between the other events.

- “Replace” writes over the currently edited event at the highlighted position. Typically, this button will be used together with Read button when editing an existing event.

- “Read” reads the event being highlighted in the scenario into the event editor. Typically, this button will be used together with Write when editing an existing event.

- “Delete” deletes the event currently highlighted in the scenario.

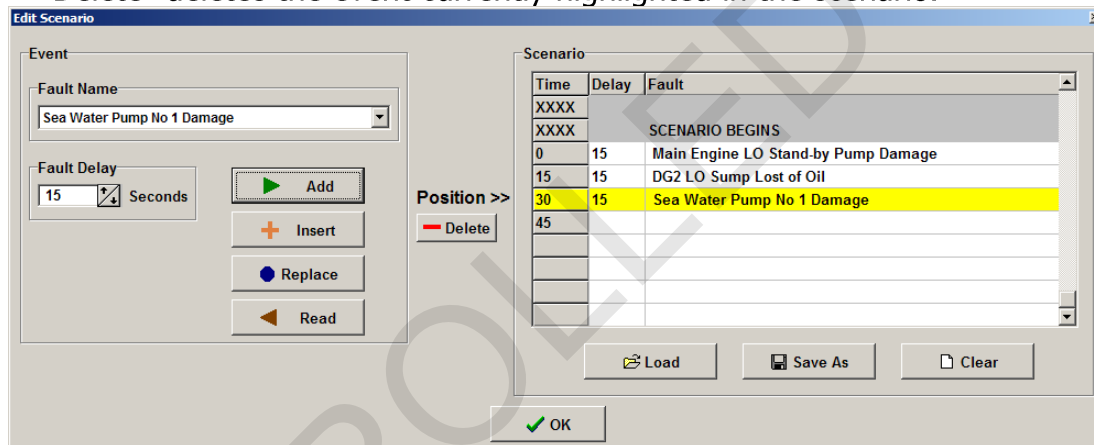



Fig. 105 Scenario editor with some scenario example

The three buttons below the scenario grid are dedicated for the scenario file manipulation: “Load”; loads the existing scenario file from disc. This will replace completely the scenario being currently edited.

“Save As”: saves the scenario being currently edited in the scenario file.

“Clear”: clears the scenario being currently edited. This means that all events will be cleared.

Please keep in mind that when the Edit Scenario window closes, all edited scenarios will be lost unless saved.

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## 7.5. Event Log

The Event Log window can be used to get an overview of the alarms (activated and removed) and user activities. This window can be opened by mouse clicking on the **View | Event log** item from the main menu.

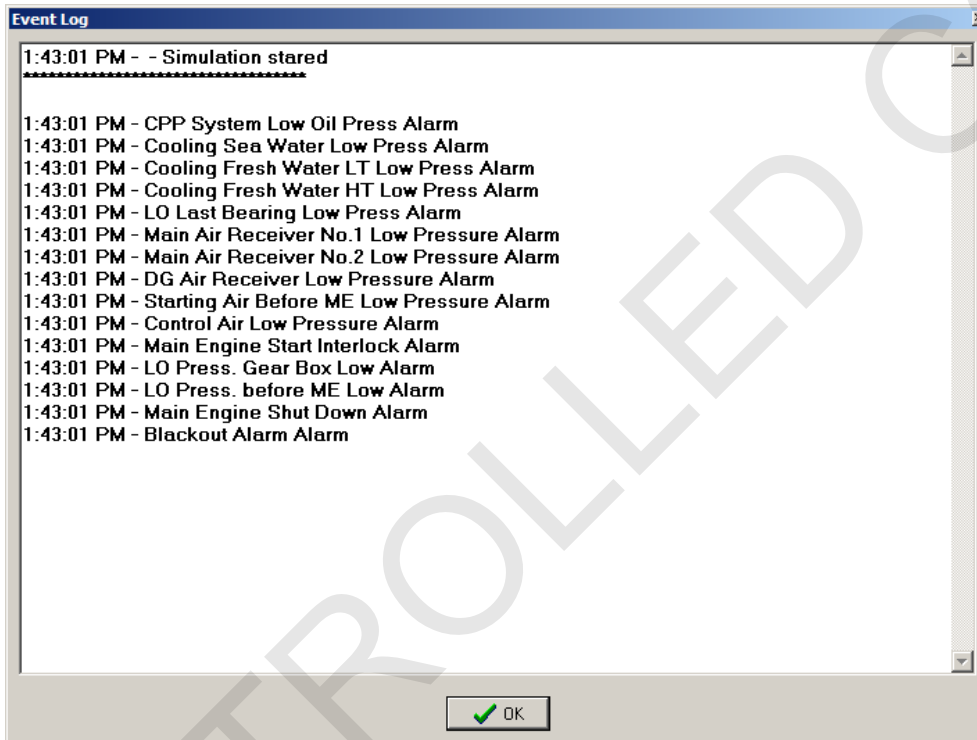



Fig. 106 Event Log Window

## 7.6. Trend Display

The Trend display window shows the trend curves of up to four selected engine room parameters. This window can be opened by mouse clicking on the **View | Trend display** item from the main menu.

Each parameter can be selected and each curve can be switched off.

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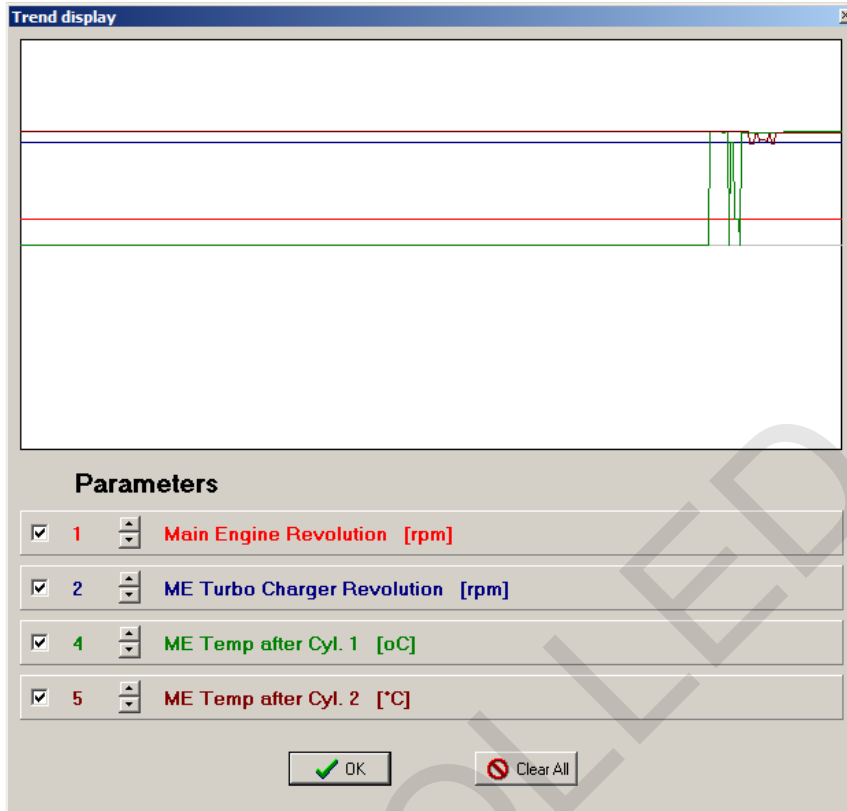


Fig. 107 Trend display window

### 7.7. Instructor IP address

LER3D simulator needs instructor IP address for communication with instructor station. The simulator communication protocol requires static IP address. The IP address can be set in Configuration/Set instructor IP address.

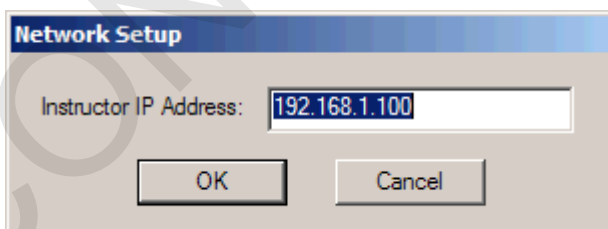



Fig. 108 Instructor IP address

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## 8. Instructor station


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Instructor station software is a utility program designated for the instructor monitoring and remote control over the students working with LER3D in the local area network. Instructor software does not require any hardlock and should be installed separately from the installation CD on the instructors computer only. The following options are available from the instructor station:

- setups
- resources
- faults simulation
- scenario editor

Station enables also the observation of the following student's station indications Fig. 80:

- systems alarm
- shaft revolution
- event log

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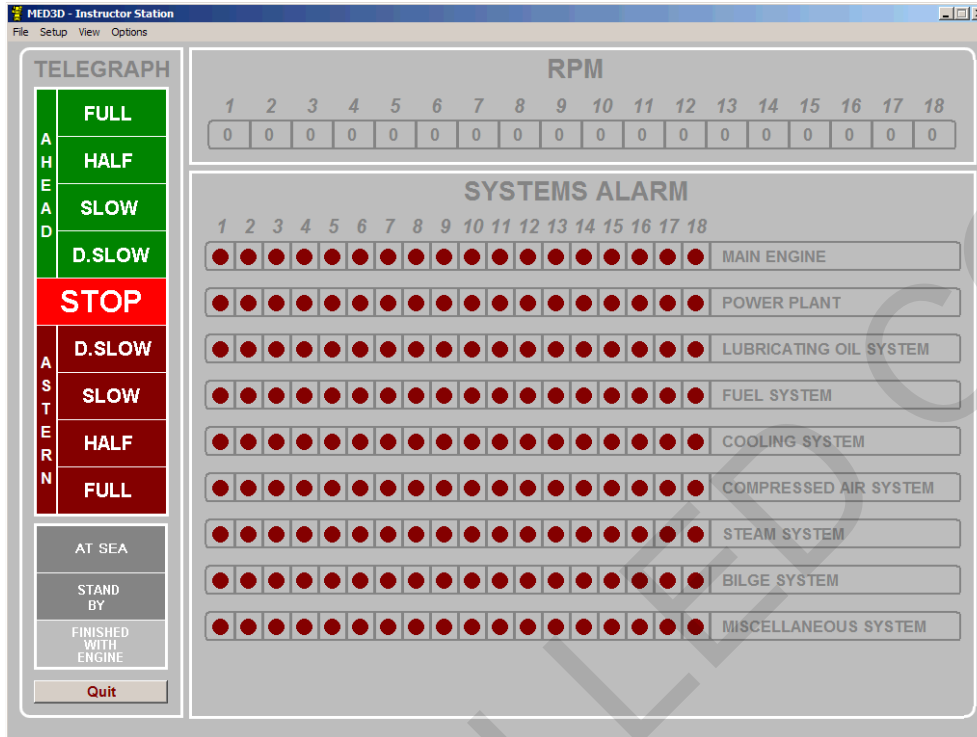

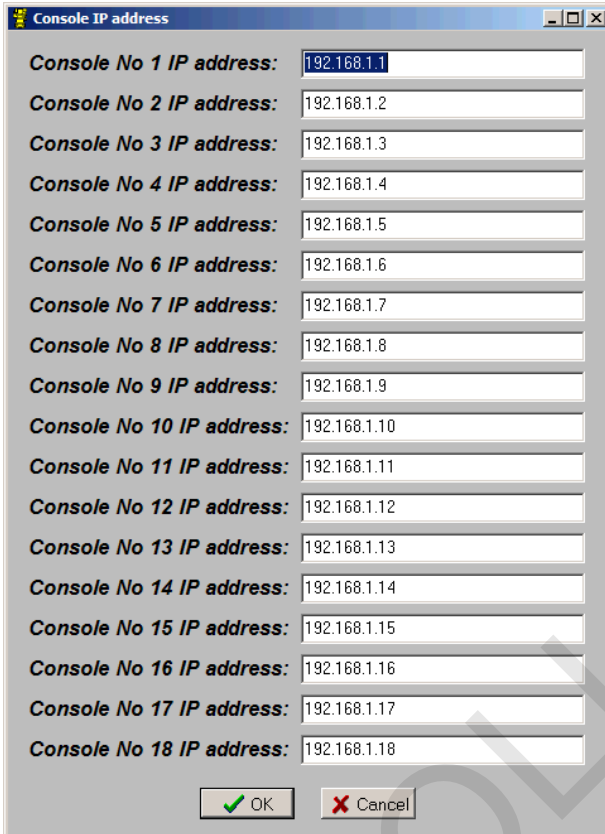


Fig. 109 Instructor station software

To establish network connection with the students stations is necessary to set IP addresses of all students consoles (Options/Configuration/Console IP address).

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Console No	IP address
1	192.168.1.1
2	192.168.1.2
3	192.168.1.3
4	192.168.1.4
5	192.168.1.5
6	192.168.1.6
7	192.168.1.7
8	192.168.1.8
9	192.168.1.9
10	192.168.1.10
11	192.168.1.11
12	192.168.1.12
13	192.168.1.13
14	192.168.1.14
15	192.168.1.15
16	192.168.1.16
17	192.168.1.17
18	192.168.1.18

Fig. 110 Consoles IP address

Instructor station is connected by phone with the trainee station.