

ENGINE ROOM SIMULATOR ERS 4000

VESSEL MODEL “TANKER LNG” TRAINEE MANUAL

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PREAMBLE

This preamble provides general information for the work
with this document.

PRINTING HOUSE CONVENTIONS

Sample of notation	Usage comments
Control Panel	To highlight sections of a document
<F4>	To highlight names of keyboard keys
“POWER”	To highlight names of windows, pages, buttons, etc.

CHAPTER 1

Ship Steam Power Plant

This chapter contains a description of the simulator module designed for training the cargo ship engine room watch personnel in proper skills of operating the Ship Propulsion Plant (SPP).

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INTRODUCTION

Purpose

The simulator module is designed for training the cargo ship engine room watch personnel in proper skills of operating the ship propulsion plant (SPP), including:

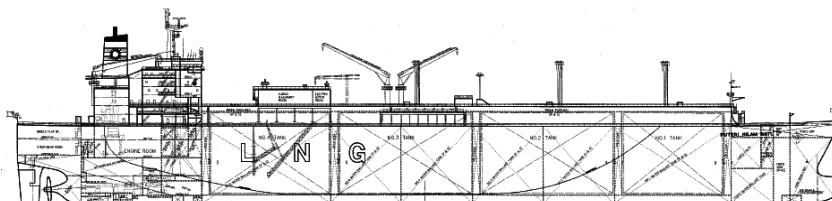
- preparing and putting into operation machinery and systems;
- monitoring their operation by measured parameters with the aid of the alarm system;
- trouble shooting;
- SPP control during vessel manoeuvring.

In addition to training in practical skills, the simulator allows the user to learn the basic principles of the structure, functions, and interaction of SPP components and systems.

The simulator composition corresponds to standard configuration of a LNG tanker SPP. Parameters and performance of the simulated mechanisms and systems correspond to the real ones because the simulator models all SPP basic processes (thermal, mechanical, gas/hydrodynamic, and electrical) in their interrelation.

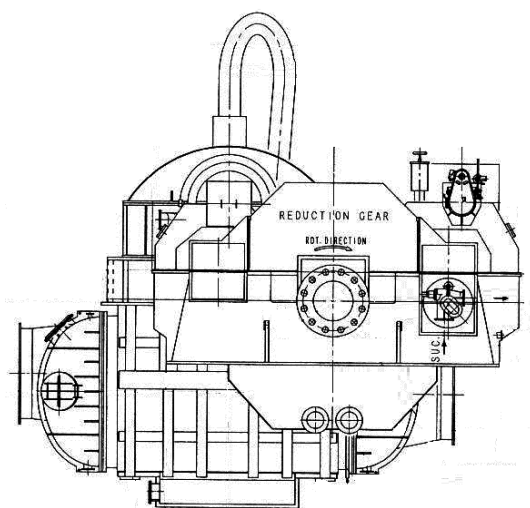
This is a LNG tanker (approx. 76.000 DWT) SPP ("LNG Carrier") with a steam turbine as the main engine, driving a fixed pitch propeller via a gearbox.

Ship



Length o.a., m	276.00
Breadth mld, m	43.40
Depth mld, m	25.50
Draught at design WL, m	11.01
Deadweight, t	76,134
Cargo tanks, m ³	137,585
Speed (service), knots	19.5

Main Engine



Type	Cross-compound, double reduction geared steam turbine (Kawasaki UA-400 as prototype)
Output MCR, kW	29,450
- H.P. turbine	5,075
R.P.M.: - L.P. turbine	3,350
- Propeller	90,0
Output NCR, kW	25,040 at 85,3 R.P.M.
Steam conditions at inlet	57.4 bar, 515 °C
Full astern conditions	70 % of ahead M.C.R. r.p.m. for period of at least two hours
Condenser vacuum at top (pump cooling)	722 mm Hg Vac. at M.C.R.
Main boiler	2 x Two-drum, water tube marine boiler with dual-fuel burners with internal Economizer (Mitsubishi MB-4E as prototype)
Superheated steam	61.5 bar/515 °C/ 63,500 kg/h at M.C.R. condition
Propeller	FPP

SIMULATOR MODULE SYSTEMS

Page MT – Main Turbine

Purpose

The page is designed for automated remote control (ARC) of the ship turbine and the turbine auxiliary systems from the Engine Control Room (ECR).

The page contains a main turbine remote control system as well as turbine system mnemonic diagrams and corresponding control panels:

- turbine/gearbox lub-oil system;
- turbine gland system;
- system for condensate removal from the turbine and the draining system.

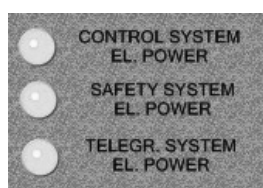
Turbine Remote Control Panel

The turbine remote control panel is shown in Fig. 1:



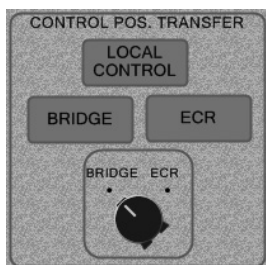
Fig. 1. Main turbine remote control panel

The control panel shown in figure, contains the following indicators:



- “CONTROL SYSTEM EL.POWER” – indicating control system power availability;
- “SAFETY SYSTEM EL.POWER” – indicating turbine protection system power availability;
- “TELEGR. SYSTEM EL. POWER” – indicating machine telegraph (MT) power availability.

The CONTROL POS. TRANSFER module is designed for selection of a turbine automatic remote control station, i.e. the Bridge or the ECR. The “LOCAL CONTROL” indicator specifies the local station the engine room as the current turbine control station.



The control station selector switch features two positions - “BRIDGE/ECR” and lights up the corresponding indicators, when changed over:

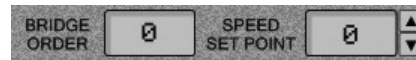
- the “BRIDGE” position means that the automatic remote control is performed directly from the Bridge;
- the “ECR” position means that the automatic remote control is performed from the ECR following Bridge orders.

The machine telegraph (MT) in the ECR is designed to receive orders (steaming bells) from the Bridge. At the same time, the engine telegraph serves as the turbine ARC system setter. The Bridge order is specified by the left-hand pointer of the engine telegraph. The engine telegraph lever is used to move the right-hand pointer to the desired position. Simultaneously, the order to change the RPM and turbine rotation directory is sent to the ARC system.



The “BRIDGE ORDER” indicator shows the Bridge order in a numeral format (% of the rated steam turbine RPM).

The “SPEED SET POINT” indicator shows the task given to the ARC system, and has the “More-Less” buttons to tune the task with $\pm 5\%$ steps.



In case of stand-alone ERS 4000 simulator operation, the instructor determines the Bridge order. In case of joint operation of the ERS 4000 and NTPro 4000 simulators the Bridge order is sent to the ERS 4000 simulator from NTPro 4000.

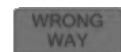
The auxiliary button telegraph is intended for sending fixed commands from the Bridge to the ECR or to the turbine local control panel in the ER:



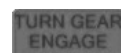
- “STAND-BY” – command to start the system operating and prepare the Main Engine (ME) for the start;
- “FINISH WITH ENGINE” – command to stop the ME and take the systems out of operation;
- “SEA MODE” – command to maintain the maximum ME rpm until the maximum ship speed is developed.

The auxiliary button telegraph is only used in the “ARC from ECR” mode or “Local control from ER” mode – control is accordance with commands given from the Bridge via the engine telegraph, but not in the mode of direct remote control – “ARC from Bridge”.

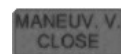
The “WRONG WAY” indicator advises that the ship movement direction (ahead/astern) sent to ER from the ECR engine telegraph doesn’t match the Bridge order.



The “TURN GEAR ENGAGE” indicator shows that the turn gear is ON.



The “MANEUV. V. CLOSE” indicator shows that the turbine manoeuvring valve is closed, steam not going to the turbine.



The “MANEUV. VALVE LIFT” indicator is used to view the rate of the turbine manoeuvring valve opening (% of the fully open position):



The dial face is divided into two parts AS/AH (Aster/Ahead) with division for each part from 0 to 100 %. The dial has also provided with a digital indicator of the manoeuvring valve opening rate.

The “SHAFT R.P.M.” point is designed to specify the propeller shaft RPM:

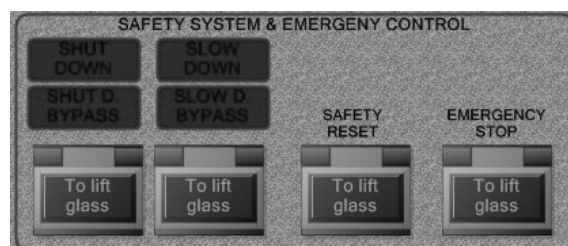


The dial-face is divided into two parts AS/AH (Aster/Ahead) with division for each part from 0 to 120 RPM. The dial has also provided with a digital indicator of propeller shaft RPM.

The RUDDER ANGLE panel is intended for determining the rudder blade turn angle:

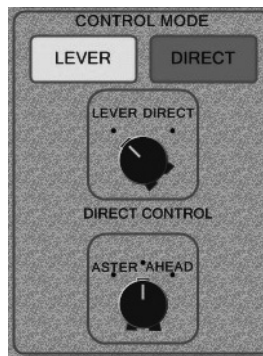


The SAFETY SYSTEM & EMERGENCY CONTROL module is the turbine protection module and the turbine emergency control module:



- “SHUT DOWN” indicator states of the fact of the turbine shutdown by the protection system;
- “SLOW DOWN” indicator advises on reduction of the turbine RPM by the protection system;
- “SHUT D. BYPASS” button allows cancel of the turbine shutdown by the protection system;
- “SLOW D. BYPASS” button allows cancel of the turbine slowdown by the turbine protection system;
- “SHUT D. BYPASS” indicator informs of the turbine shutdown cancel;
- “SLOW D. BYPASS” indicator informs of the turbine slowdown cancel;
- “SAFETY RESET” button – after actuation of the protection system, it has to be rearmed. This button serves the purpose;
- “EMERGENCY STOP” – this button is used for emergency turbine trip by way of closing the manoeuvring valve.

The CONTROL MODE module is used to select an ARC mode.



The "LEVER/DIRECT" switch is used for changeover between the control modes:

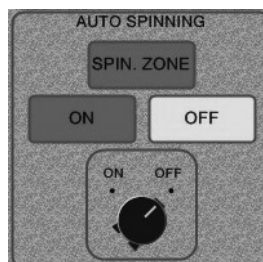
- "LEVER" – follow-up control from engine telegraph lever;
- "DIRECT" – non-follow-up control of the manoeuvring valve from the "AHEAD-ASTER" switch.

The WARMING THROUGH module is respective for the operation of the turbine warm-up program in the port mode.



The "WARMING THROUGH" button is used to launch the turbine warm-up program, provided the "LEVER/DIRECT" switch on the "CONTROL MODE" point is in the "DIRECT" position. When the program is running, the "WARMING THROUGH" indicator is ON.

The AUTO SPINNING module supports turbine readiness for immediate startup.



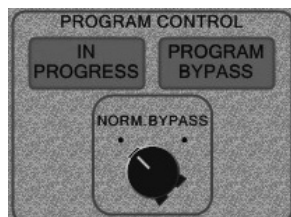
The program operation foresees regular automatic motoring of the turbine ahead and astern by temporary partial opening of the manoeuvring valve. When the turbine is supplied with a little volume of steam, it runs up to approximately 6 to 7 rpm. On closing the valve, the turbine continues to rotate because of momentum. When the turbine has been run up to 12-13 rpm, the "AUTO SPINNING OVERSPEED" alarm signal is actuated, and the turbine is stopped by the protection system.

The similar protection is provided in the mode of turbine breaking loose and warming up – i.e. the WARMING THROUGH mode.

The program can be enabled (by turning the switch to ON), if:

- the "LEVER/DIRECT" switch on the CONTROL MODE control panel is in the "LEVER" position;
- the engine telegraph lever is in the "STOP" position.

The PROGRAM CONTROL module is designed for selection or deselection of ARC operation in accordance with a program, which actuates engine telegraph orders not immediately, but according to a specified algorithm providing time delays:



The module selector switch has two positions – “NORM./BYPASS”:

- the “NORM.” position of within switch provides ARC operation in accordance with the program;
- turning the switch to the “BYPASS” position cancels the programmed ARC operation and turns on the “PROGRAM BYPASS” indicator denoting program cancellation.

Cancellation of the program run is possible only if the current value of the ARC control signal matches the engine telegraph order.

Module indicators:

- a lighted “IN PROGRESS” indicator means that ARC operated in accordance with the program;
- a lighted “PROGRAM BYPASS” indicator advises on cancellation of ARC programmed operation.

The OVERSPEED PREVENTER module relates to the ARC sub-program, which prevents the turbine RPM ceiling values actuating the “OVERSPEED” turbine protection system. When running, the program reduces (limits) the maximum RPM value specified by the engine telegraph (for example, in case of heavy seas, propeller exposure and possible turbine speeding-up).

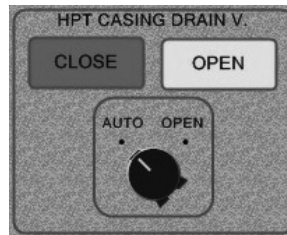


The module selector switch has two positions “ON/OFF” – turning the sub-program on and off. The “ON” indicator says that the sub-program is running. The “OFF” indicator says the program has finished its operation and the turbine RPM has been reduced.

The left-hand area of the panel concentrates the drain valve controls (condensate drain valves) from different parts of the turbine through part (casings):

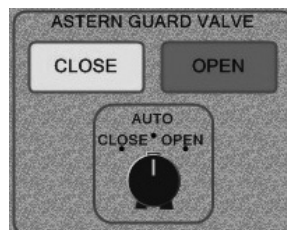
- HPT Casing Drain Valve – drain from the high-pressure turbine casing;
- HPT 2-nd Stage Drain Valve – drain from the 2nd stage turbine casing;
- HPT Bleeder Drain Valve – drain from the high-pressure turbine steam bleeder;
- HPT Steam Chest Drain Valve – drain from the high-pressure turbine stem chest;
- Manoeuvring valve Drain Valve – drain from the manoeuvring valve.

Each control module includes an “AUTO/OPEN” selector switch and the valve status indicators “OPEN” and “CLOSE”:



If the selector switch is in the “AUTO” position, then control of the valve and removal of condensate is performed by the automatic system. If the selector switch is changed into the “OPEN” position, the valve will open by a order in the manual control mode.

The ASTERN GUARD VALVE module is designed for manual and automatic remote control of the valve supplying steam the astern turbine.



- The “AUTO” position of the selector switch corresponds to the automatic mode of valve control;
- In case the valve is controlled manually, the “CLOSE” position of the switch corresponds to a closed valve, and the “OPEN” position denotes an open valve;
- The “OPEN” indicator denotes an open valve;
- The “CLOSE” indicator denotes closed valve.

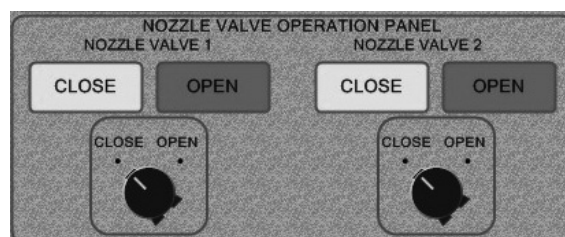
The “SPEED” gauge shows vessel knot speed:



The “POWER” gauge shows the developed power in kW:



The NOZZLE VALVE OPERATION PANEL module is used to manually control the additional steam-supplying valves NOZZLE VALVE 1 and NOZZLE VALVE 2.



The module includes two selector switches to control the valves, and valve status indicators “OPEN” and “CLOSE”.

Each selector switch has two positions:

- “CLOSE” – the valve is closed;
- “OPEN” – the valve is open.

Alarm Signals

- MT MANUAL TRIP – emergency manual stop of the turbine;
- TURN GEAR ENGAGED;
- MT OVERSPEED – turbine maximum rpm exceeded;
- AUTO SPINNING OVERSPEED – turbine maximum rpm in “AUTOSPINNING” mode exceeded;
- MT LO PRESS. LOW – low turbine and gear lubricating oil pressure;
- MAIN CONDENSER VACUUM LOW – low vacuum level in the Main Condenser (MC);
- MAIN COND. HOTWELL LEVEL LOW – low level in the MC hotwell;
- MB STEAM PRESS LOW – low boiler steam pressure.

Safety System

The turbine Shutdown and Slowdown protection is implemented. The Safety System panel is described above.

Shutdown protection system parameters:

- MT Overspeed – maximum turbine rpm exceeded (105 % of 96 rpm);
- Auto Spinning Overspeed – maximum turbine rpm in “AUTOSPINNING” mode exceeded (13 rpm);
- MT LO Pressure Low – low lubricating oil pressure (0.5 bar);
- MT Control Oil Pressure Low – low oil pressure in the control system (2 bars);
- Main Condenser Vacuum Low – low vacuum level in the Main Condenser (MC) – 330 mm of Mercury column (mm Hg);
- Main Condenser Level High – high water level in the MC (500 mm);
- MB Steam Drum Level High – high steam level in the main Boiler steam drum (250 mm);
- Main Boilers Trip – turbine stop because of the emergency shutdown of both main boilers;
- Steam Pressure Low – low steam level at the turbine inlet (50 bars);
- Vibration High – high turbine vibration (HPT – 130 mm/s, LPT – 180 mm/s).

Slowdown protection system parameters:

- STEAM PRESSURE LOW - low steam pressure at the turbine inlet (56 bars);
- MB STEAM DRUM LEVEL HIGH – high level in the Main Boiler steam drum (200 mm);
- MAIN CONDENSER VACUUM LOW – low vacuum level in the Main Condenser (MC) – 660 mm of Mercury column (mm Hg);
- MAIN CONDENSER LEVEL HIGH – high water level in the MC (500 mm);
- ONE BOILER TRIP – turbine stop because of the emergency shutdown of one boiler.

Faults Entered by Instructor

- Auto spinning automation fault – malfunction of Autospinning system automatics;
- Astern guard valve automation fault – faulty astern guard valve automatics;
- LPT blades wear;
- Main turboset breakdown;
- HP turbine breakdown;
- LP turbine breakdown;
- LPT blades breakdown.

Turbine and Gearbox Lubricating Oil System (Turbine LO System)

Purpose

The system is designed for lubrication of friction parts of the turbine and the gearbox.

System Components

See Fig. 2 for the lub-oil system mimic implemented in the simulator:

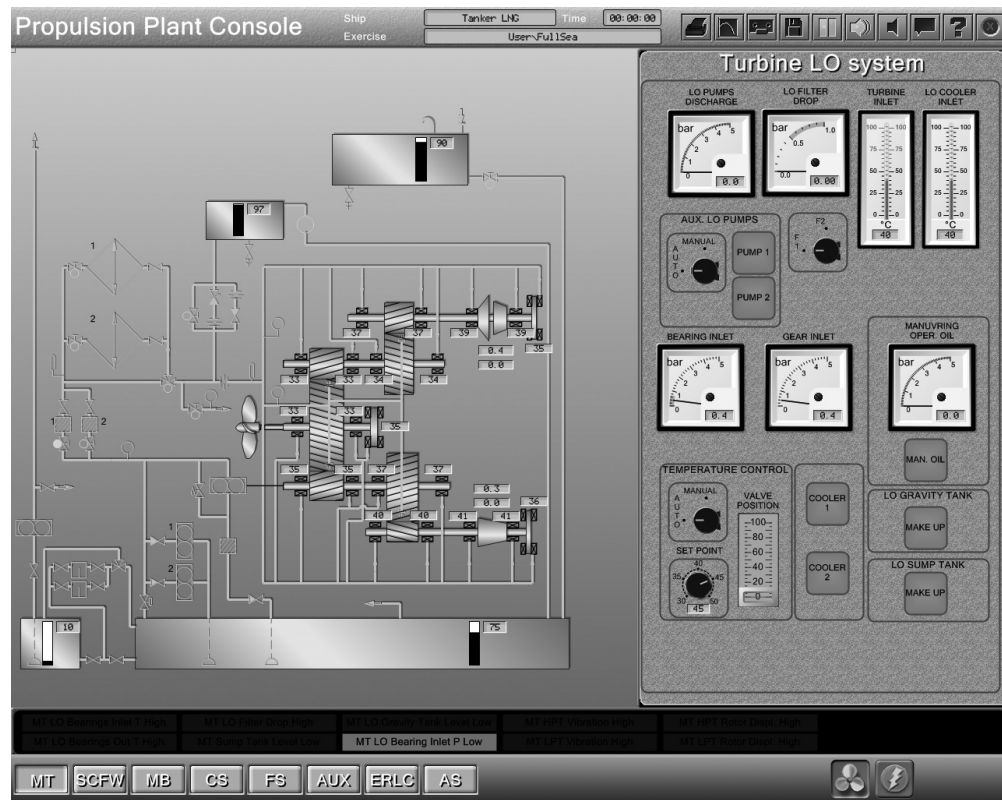


Fig. 2. Lub-oil system

Oil circulation in the system (pressure and flow-rate) is provided with a main LO pump driven from the turbine and two auxiliary (priming) electrically-driven pumps. A two-section oil filter provides oil filtration and allows filter sections to be switched over without a need to stop the turbine. Lube oil is cooled by two lube oil coolers. The working oil temperature is maintained using a temperature control controller (governor). The lube oil is supplied by pressure to all bearings, and also by splashing on the gearbox wheels.

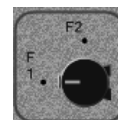
The “LO PUMPS DISCHARGE” pressure gauge is used to monitor pressure on the pump pressure side:



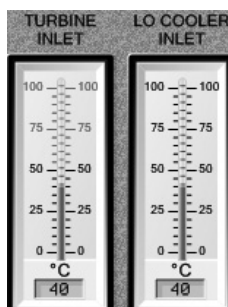
The “LO Filter Drop” pressure gauge monitors pressure drop through the oil filter.



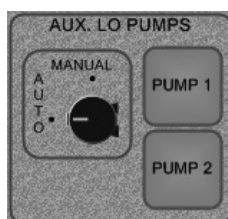
When pressure drop increases due to filter clogging, you can change over to the backup section of the oil filter using the “F1/F2” selector switch:



The thermometers TURBINE INLET and LO COOLER INLET are used to monitor oil temperature upstream of the turbine and oil coolers respectively:



The AUX. LO PUMPS module is designed for remote control of the electrically-driven auxiliary pumps. The control module includes:



- the “MANUAL/AUTO” remote mode switch shared by both pumps (AUTO – automatic pump control mode; MANUAL – manual pump control mode);
- the “PUMP 1” and “PUMP 2” buttons for manual start of the pumps. They are operative in manual mode only. (In the AUTO mode, the system starts up the pump automatically, when pressure in the system is low. The first to be started up is auxiliary Pump 1, and if this doesn’t result in pressure increase, Pump 2 is to be started up.)

The BEARING INLET pressure gauge is designed for indication of lube oil pressure at the inlet of the manifold supply ling oil to the bearing:



The GEAR INLET pressure gauge is designed for indication of lube oil pressure at the inlet of the manifold supply ling oil to the gearbox wheels (lubrication by splashing):

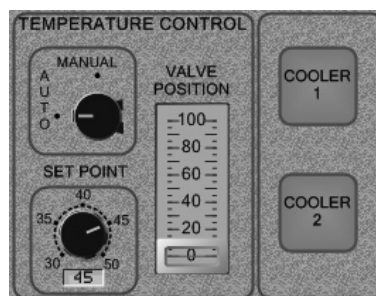


The MANOEUVRING OPER. OIL pressure gauge is designed for indication of lube oil pressure in the hydraulic control system.



The "MAN. OIL" button is used to open the valve for feeding oil into the hydraulic control system.

The TEMPERATURE CONTROL module is designed for automatic and manual adjustment of lub-oil temperature in the system:



The module includes:

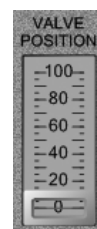
- "AUTO/MANUAL" selector switch for selection of a controller (governor) control mode;



- “SET POINT” oil temperature setting device for selecting oil temperature (30–50 °C) in the automatic control mode;



- Buttons enabling the coolers “COOLER 1” and “COOLER 2”;



- VALVE POSITION setter used to control the three-way valve in the manual control mode. The position “0” of the setter corresponds to a closed valve, in which case oil flow-rate through the cooler is zero, the “100” position corresponding to a wide-open valve, the oil flow-rate through the coolers being maximum.



The modules LO GRAVITY TANK and LO SUMP TANK are designed for remote replenishment of the lube oil tanks:

- Replenishment of the pressure tanks is performed by pressing the “MAKE UP” button;
- Replenishment of the oil collector is performed by pressing the “MAKE UP” button.



The system mnemonic diagram features also:

- digital indicators monitoring temperature of each bearing;
- indicators monitoring vibration and axial displacement of the high-pressure/low-pressure turbine rotors;
- fluid level indicators in each lube oil tanks.

Alarm Signals

- MT LO BEARINGS INLET T HIGH – high lub. oil temperature at the bearings inlet;
- MT LO BEARINGS OUTLET T HIGH – high lub. oil temperature at the bearings outlet;
- MT FILTER DROP HIGH – high pressure drop across the filter;
- MT SUMP TANK LEVEL LOW – low lub. oil level in the sump tank;
- MT LO GRAVITY TANK LEVEL LOW – low lub. oil level in the gravity tank;
- MT LO BEARING INLET P LOW – low lub. oil pressure at the bearings inlet;
- MT HPT VIBRATION HIGH – high level of High Pressure Turbine (HPT) vibration;
- MT LPT VIBRATION HIGH – high level of Low Pressure Turbine (LPT) vibration;
- MT HPT ROTOR DISPL HIGH – large axial displacement of the HPT rotor;
- MT LPT ROTOR DISPL HIGH – large axial displacement of the LPT rotor.

Faults Entered by Instructor

- LO Pump 1 (2) breakdown – breakdown of electrically driven lubricating oil pump 1 (2);
- LO Pump 1 (2) wear – wear of electrically driven lubricating oil pump 1 (2);
- LO Pumps autom. system failure – breakdown of lubricating pumps automatics (Stand-By mode fault);
- LO Drive Pump breakdown – breakdown of the mechanically driven lubricating oil pump;
- LO Drive Pump wear – wear of the mechanically driven lubricating oil pump;
- LO Filter 1 (2) fouling – fouling of oil filter 1 (2);
- LO system Temperature controller failure – faulty system temperature controller;
- LO system leakage – leakage from the lubricating oil system;
- LO system Cooler 1(2) fouling (LO side) – fouling of oil cooler 1 (2) on the lub. oil side;
- HPT fore bearing wear;
- HPT aft. bearing wear;
- HPT 1-st pinion fore bearing wear – wear of the fore bearing of the HPT primary pinion;
- HPT 1-st pinion aft. bearing wear – wear of the aft bearing of the HPT primary pinion;
- HPT 1-st wheel fore bearing wear – wear of the fore bearing of the HPT first gearwheel;
- HPT 1-st wheel aft. bearing wear – wear of the aft bearing of the HPT first gearwheel;
- HPT 2-nd pinion fore bearing wear – wear of the fore bearing of the HPT secondary pinion;
- HPT 2-nd pinion aft. bearing wear – wear of the aft bearing of the HPT secondary pinion;
- HPT thrust bearing wear;
- LPT thrust bearing wear;
- LPT fore bearing wear;
- LPT aft. bearing wear;
- LPT 1-st pinion fore bearing wear – wear of the fore bearing of the LPT primary pinion;
- LPT 1-st pinion aft. bearing wear – wear of the aft bearing of the LPT primary pinion;
- LPT 1-st wheel fore bearing wear – wear of the fore bearing of the LPT first gearwheel;
- LPT 1-st wheel aft. bearing wear – wear of the aft bearing of the LPT first gearwheel;
- LPT 2-nd pinion fore bearing wear – wear of the fore bearing of the LPT secondary pinion;
- LPT 2-nd pinion aft. bearing wear – wear of the aft bearing of the LPT secondary pinion;

- Main wheel fore bearing wear – wear of the main gearwheel fore bearing;
- Main wheel aft. bearing;
- Main thrust bearing wear;
- HPT thrust bearing no flow – no oil flow to the HPT bearing;
- LPT thrust bearing no flow – no oil flow to the LPT thrust bearing;
- Main thrust bearing no flow – no oil flow to the main thrust bearing;
- High Impurity contents – high fouling level of lub. oil;
- High Water contents – high water flooding level of lub. oil;
- Medium Water contents – medium water flooding level of lub. oil.

Turbine Gland System

Purpose

The sealing/gland system is designed to prevent steam breakthrough from the high-pressure turbine and into the low-pressure turbine. Along the mechanical labyrinth glands, the system features seals operating on the concept of diverting the breakthrough steam to the gland-steam condenser.

System Components

The system diagram implemented in the simulator, i.e. the system mnemonic, is shown in Fig. 3:

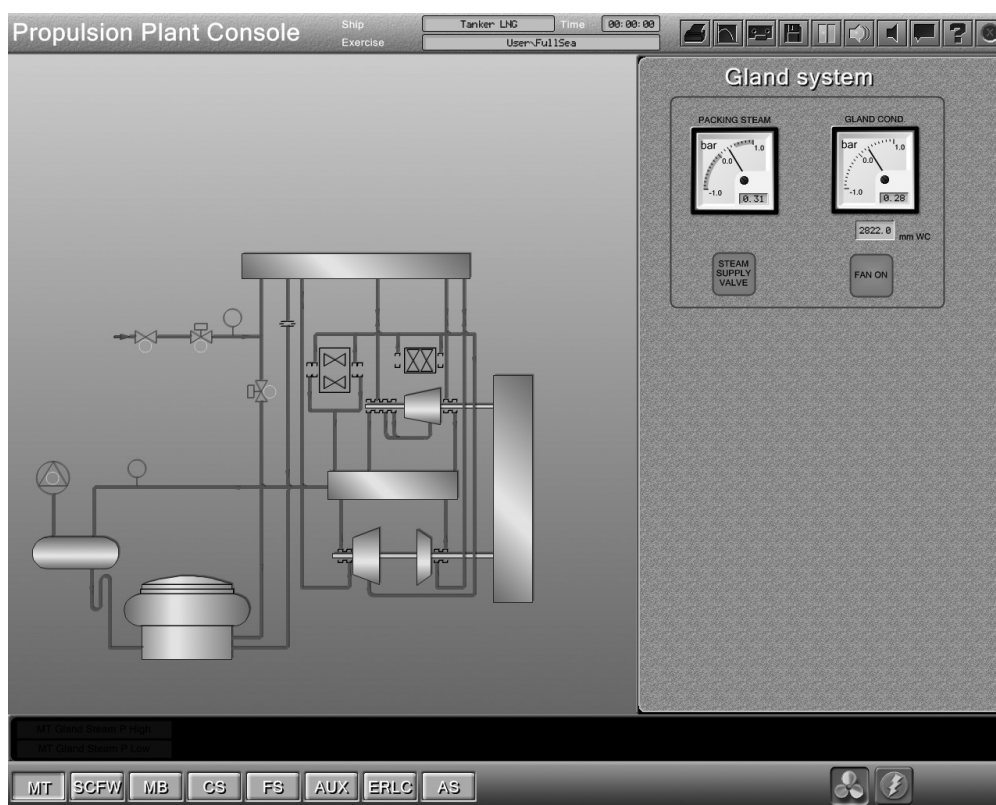
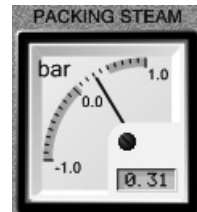


Fig. 3. Gland system

Control Panel

- PACKING STEAM pressure gauge monitoring steam introduced to the glands;
- GLAND CONDENSER pressure gauge monitoring pressure/vacuum in the gland steam condenser;
- Button for remote opening of the cutoff valve passing steam to the gland sealing system;
- “FAN ON” is used to launch the device creating vacuum in the gland steam condenser.



Alarm Signals

- MT GLAND STEAM P HIGH – high level of gland steam pressure;
- MT GLAND STEAM P LOW – low level of gland steam pressure.

Faults Entered by Instructor

- MT Package steam valve autom. fault – faulty automatics of the gland steam feed valve control;
- Gland Fan breakdown.

Bleed & Drain System

Purpose

The Bleed & Drain system is designed to extract condensate from the turbine (drainage) and to bleed surplus steam to the auxiliary systems to increase system efficiency. Normally, the system operates in within automatic mode. Manual operation of the draining valves is possible from the engine telegraph ARC panel in ECR, while manual control of the draining valves and steam extraction valves can be performed from the engine telegraph local control panel in the engine room.

System Components

The system diagram implemented in the simulator, i.e. the system mnemonic, is shown in Fig. 4:

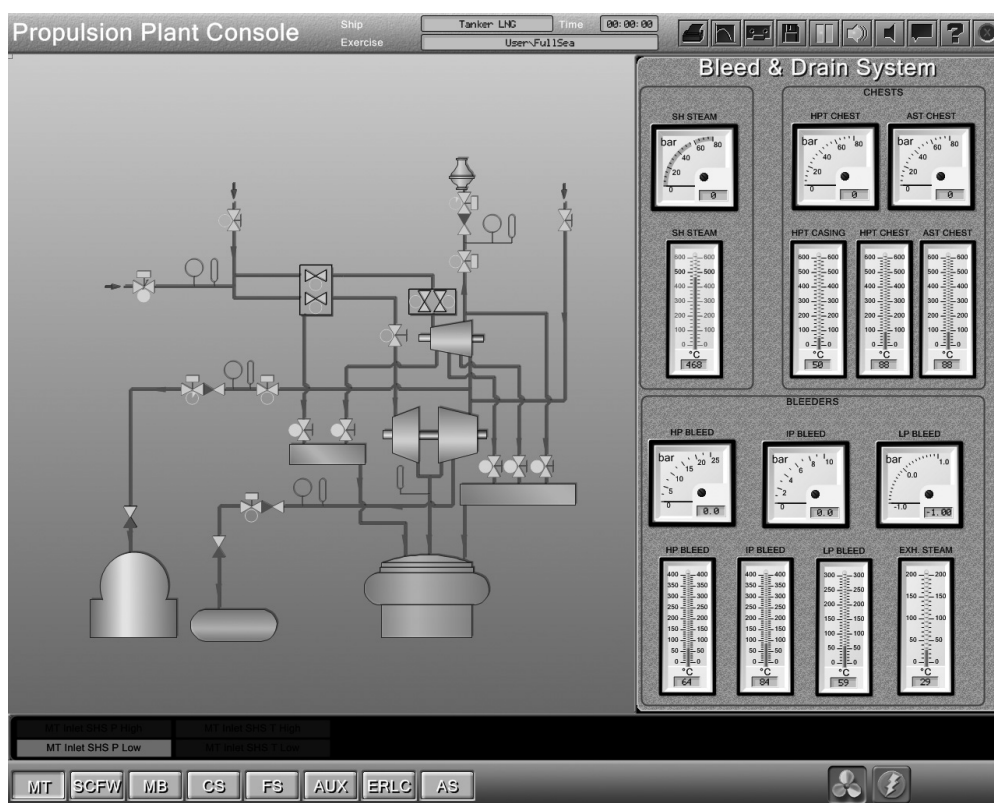
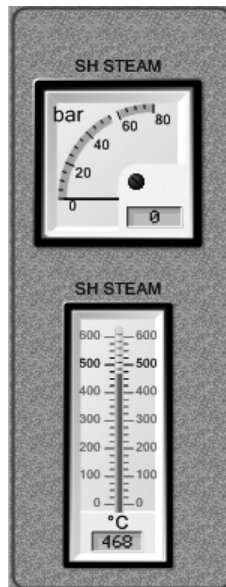


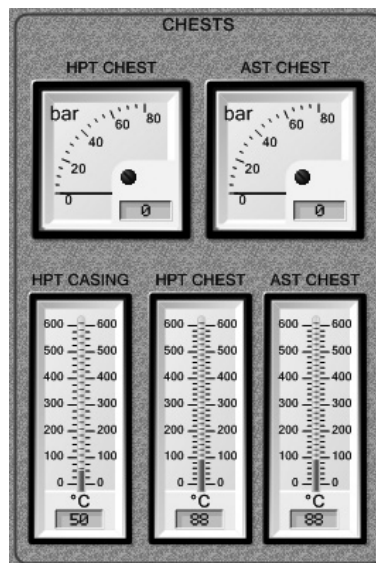
Fig. 4. Bleed and drain system

The cycle control panel includes indicating gages only.

The superheated steam parameters are indicated by the pressure gauge the temperature gauge located on the SH STEAM module:

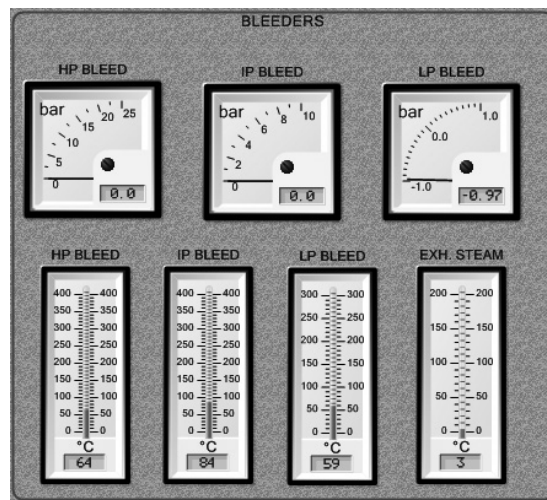


The CHESTS module includes:



- HPT CHEST pressure gauge indicates steam pressure in the HP turbine inlet chest;
- HPT CHEST temperature gauge indicates steam temperature in the HP turbine inlet chest;
- AST CHEST pressure gauge indicates steam pressure in the astern turbine inlet chest;
- AST CHEST temperature gauge indicates steam temperature in the astern turbine inlet chest;
- HPT CASING temperature gauge indicates HP turbine case temperature.

The BLEEDERS module includes:



- HP BLEED temperature/pressure gages are designed to indicate pressure/temperature of steam extracted from the HP turbine;
- LP BLEED temperature/pressure gages are designed to indicate pressure/temperature of steam extracted from the LP turbine;
- IP BLEED temperature/pressure gages are designed to indicate pressure of extracted steam entering the deaerator;
- EXH. STEAM temperature gauge is designed to indicate temperature of steam entering the main condenser.

Status of valves and the their rate of opening in shown in the mnemonic diagram.

Alarm System

- MT INLET SHS P HIGH – high superheated steam pressure at the inlet;
- MT INLET SHS P LOW – low superheated steam pressure at the inlet;
- MT INLET SHS T HIGH – high superheated steam temperature;
- MT INLET SHS T LOW – low superheated steam temperature.

Faults Entered by Instructor

- HPT casing drain valve automation fault – faulty automatics of the HPT casing drain valve;
- HPT bleeder drain valve automation fault – faulty automatics of the drain valve in the HPT steam bleeding system;
- HPT 2-nd stage drain valve automation fault – faulty automatics of the HPT second stage casing drain valve;
- HPT STM chest drain valve automation fault – faulty automatics of the HPT chest drain valve;
- Manoeuvring valve drain valve automation fault – faulty automatics of the manoeuvring valve drain valve.

Page SCFW – Steam, Condensate and Feed Water Systems

Purpose

Page SCFW shows external steam/water simulate of the ship boilers – the superheated/desuperheated steam distribution system, the steam condensate collection system and the ship boiler feed water system.

The page is represented in the form of an integrated mnemonic diagram of the systems and panels used for automatic remote control of the system from ECR, i.e.:

- superheated steam distribution system;
- desuperheated steam distribution system;
- steam condensate collection system;
- boilers feed water system.

See Fig. 5 for a integrated mnemonic diagram of the imitated systems:

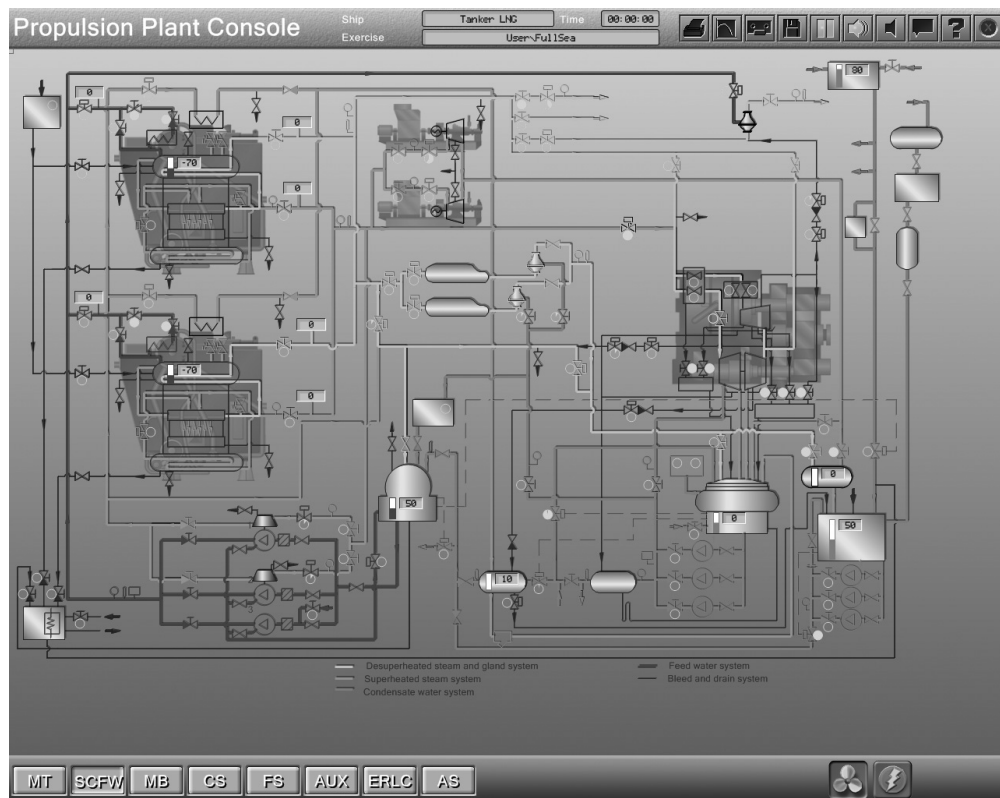


Fig. 5. Generalized mnemonic diagram

A press on the SCFW button results in appearance of an additional menu allowing the system of interest and the corresponding control panel to be chosen. The flow-rate values of feedwater, superheated steam and wet steam are shown in the system mnemonic diagram with the aid of digital indicators.

Superheated Steam Distribution Simulate

System Purpose

The system provides output of the superheated steam from boilers 1 and 2 and distribution between turbogenerators 1, 2 and feedwater pump turbine drives 1 and 2.

Control Panel

The “Superheated Steam System” control panel is shown in Fig. 6:

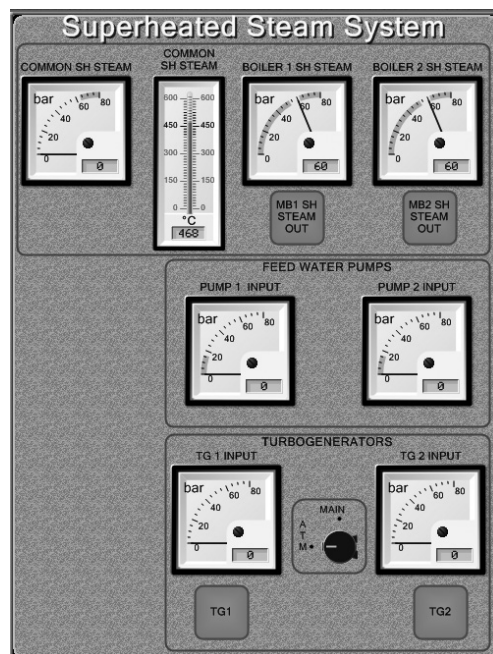
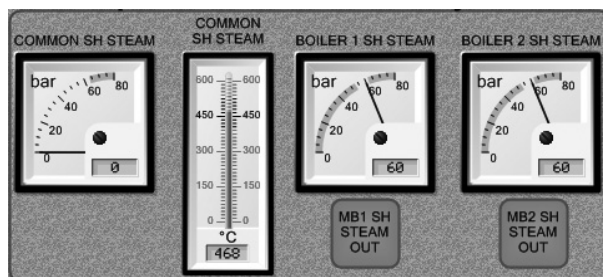


Fig. 6. “Superheated Steam System” control panel

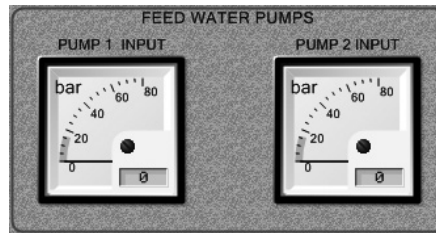
The panel is represented in three main modules:

The COMMON module includes the following monitoring instruments and controls:

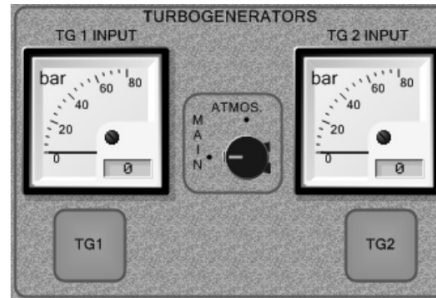


- COMMON SH STEAM pressure/temperature gauge shows pressure and temperature in the superheated steam main line;
- BOILER 1 SH STEAM pressure gauge shows superheated steam pressure at the superheater outlet of boiler 1;
- BOILER 2 SH STEAM pressure gauge shows superheated steam pressure at the superheater outlet of boiler 2;
- “MB1 SH STEAM OUT V” button is used for remote control of the cutoff valve delivering steam from boiler 1;
- “MB2 SH STEAM OUT V” button is used for remote control of the cutoff valve delivering steam from boiler 2.

The FEED WATER PUMPS module is designed for indication of superheated steam pressure at the inlet to the turbines driving feedwater pumps 1 and 2.



The TURBOGENERATORS module is designed for:



- remote control of valves delivering superheated steam to the turbines of turbogenerators 1 and 2;
- indication of superheated steam pressure at the inlet to the turbines of turbogenerators 1 and 2;
- remote control of the valves discharging dead steam downstream of the turbogenerators. The "MAIN/ATMOS" switch has two positions. "MAIN" opens the valve discharging dead steam to the main condenser. "ATMOS" opens the valve discharging dead steam to the atmospheric condenser.

Alarm Signals

- MB1 OUTLET SHS P HIGH – high pressure of superheated steam at the outlet from boiler 1;
- MB1 OUTLET SHS P LOW – low pressure of superheated steam at the outlet from boiler 1;
- MB2 OUTLET SHS P HIGH – high pressure of superheated steam at the outlet from boiler 2;
- MB2 OUTLET SHS P LOW – low pressure of superheated steam at the outlet from boiler 2;
- SHS T HIGH – high pressure of superheated steam;
- SHS T LOW – low pressure of superheated steam;
- FW TURBINE 1 P LOW – low steam pressure at the inlet to the turbine of feed water pump 1;
- FW TURBINE 2 P LOW – low steam pressure at the inlet to the turbine of feed water pump 2.

Faults Entered by Instructor

- MB1 SH Steam leakage – leakage of superheated steam from boiler 1;
- MB2 SH Steam leakage – leakage of superheated steam from boiler 2;
- Wet SHS steam in MB 1 – superheated steam in boiler 1 is damp;
- Wet SHS steam in MB 2 – superheated steam in boiler 3 is damp.

Desuperheated Steam Distribution System

System Purpose

The system provides consumers with desuperheated steam from boilers 1 and 2, and discharges surplus steam.

Control Panel

The “Desuperheated Steam & Dump System” control panel is shown in Fig. 7:

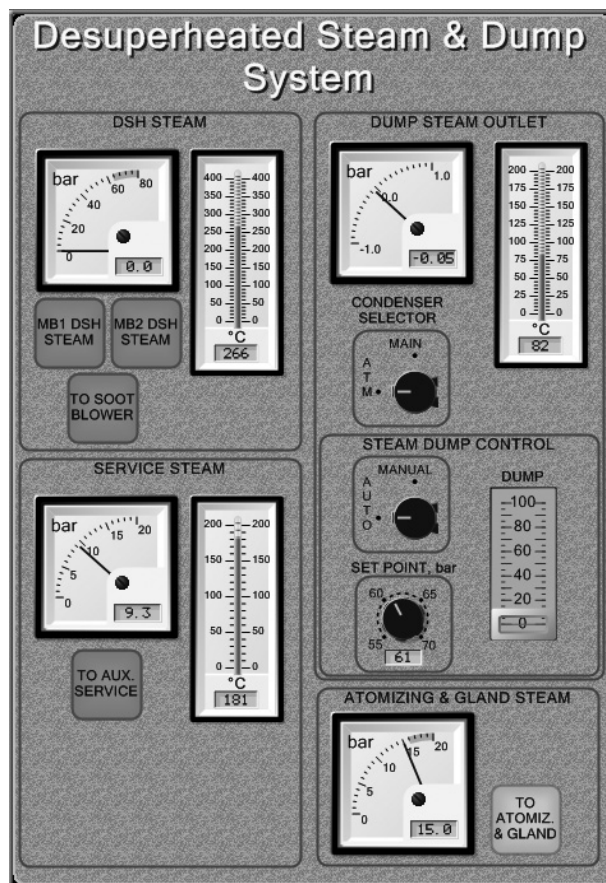
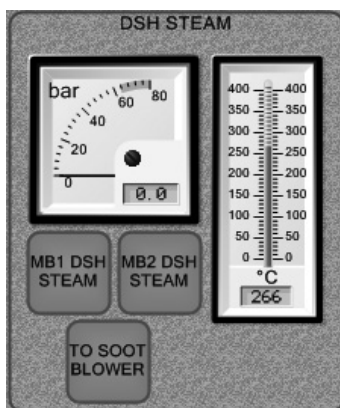


Fig. 7. “Desuperheated Steam & Dump System” control panel

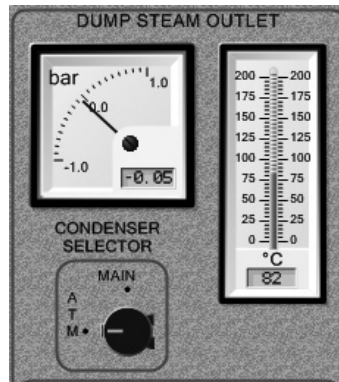
The panel is represented in four main modules:

The DSH STEAM module includes:



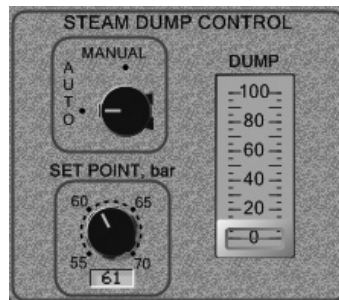
- DSH pressure gauge and the DSH temperature gauge indicating pressure and temperature of the desuperheated steam in the main line;
- “MB1 DSH STEAM” button for remote control of the valve delivering steam from boiler 1 to the main line;
- “MB2 DSH STEAM” button for remote control of the valve delivering steam from boiler 2 to the main line;
- “TO SOOT BLOWER” button for remote control of the valve delivering steam to the boiler soot blow system.

The DUMP STEAM module includes:



- The pressure/temperature gages indicating steam pressure/temperature at the outlet of the “DUMP SYSTEM” steam discharge system;
- The “CONDENSER SELECTOR” switch with two positions “MAIN/ATM.” is designed for remote control of the valves, providing selection of a condenser, to which steam is to be bled downstream of the DUMP system, i.e. the main condenser or the atmospheric condenser.

The “STEAM DUMP CONTROL” module



is designed for remote control of the steam discharge system, and includes:

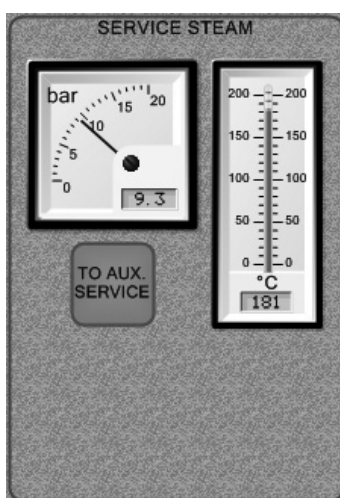
- “AUTO/MANUAL” selector switch to specify system operation mode;
- “SET POINT” setter for specifying a steam pressure threshold (55–70 bar), after which steam is to be discharged to the Dump system in the system automatic control mode;
- The DUMP V. setter is designed for control of the valve discharging steam to the Dump system in manual mode of system control. The “0” position of the slide corresponds to a fully closed valve, while its “100” position correspond to a wide-open valve.

The ATOMIZING & GLAND STEAM module includes:



- The “TO ATOMIZ. & GLAND” button which is used to remotely open the valve delivering steam to the gland system of the main turbine and to the system of steam introduction to boilers 1 and 2 for liquid fuel atomization;
- A pressure gauge for monitoring pressure of steam being delivered to the aforementioned systems.

The SERVICE STEAM module includes:



- The “TO AUX. SERVICE” button used to remotely open the valve delivering steam to the system;
- A pressure gauge and a temperature gauge to monitor parameter of the steam admitted to the aforementioned system.

Alarm System

- DUMP STEAM P HIGH – high pressure of dump steam;
- DUMP STEAM T HIGH – high temperature of dump steam;
- 10 BAR SYSTEM T HIGH – high temperature of steam of 10 bar pressure steam system.

Faults Entered by Instructor

- Dump Controller failure – faulty controller of the steam surplus dump system;
- Dump Piston valve Controller failed – faulty controller of the steam surplus dump system valve (the valve is closed);
- Aux. DSH Steam system pressure control valve failure;
- Aux. DSH Steam system temperature control valve failure.

Condensate Water Collection System

System Purpose

The system provides for control of the main steam condenser operation, extraction of condensate and condensate water, delivery of condensate water to the deaerator and for cooling the dump steam discharge system.

Control Panel

The “Condensate Water System” control panel is shown in Fig. 8:

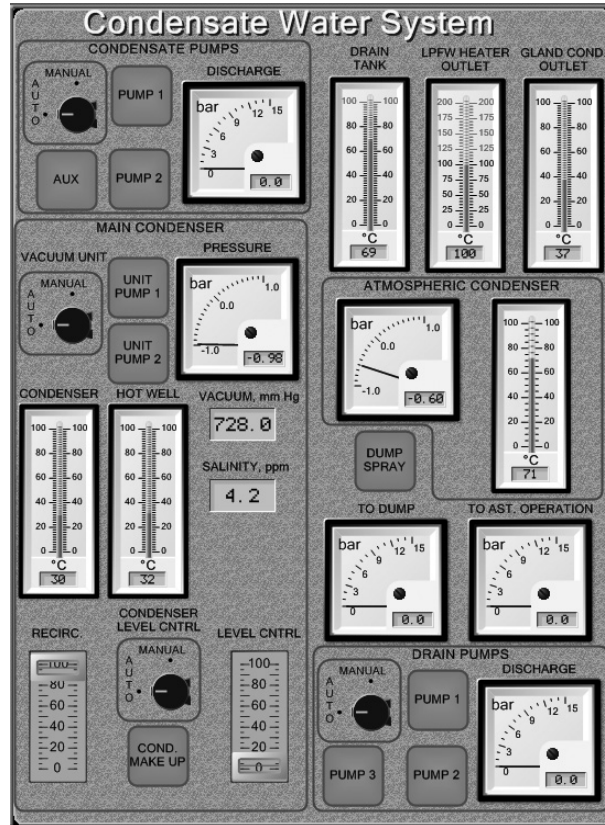
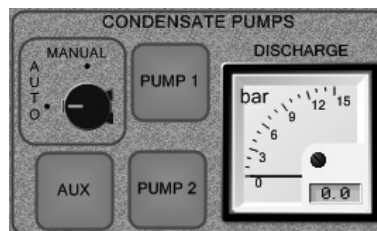


Fig. 8. Condensate and condensate water collection system

The system control panel includes a number of control modules.

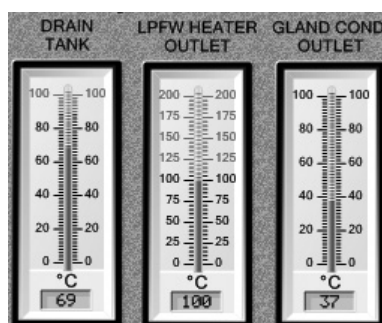
The CONDENSATE PUMPS module is designed to monitor and control the condensate water pumps in the manual and automatic modes of operation:



The module includes:

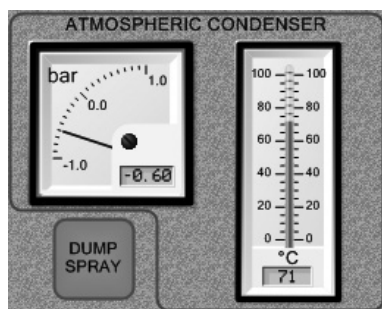
- “AUTO/MANUAL” modes of pump remote control selector;
- buttons “PUMP1”, “PUMP2”, “AUX” for starting two main pumps and an auxiliary pump in the mode of the manual remote control;
- the DISCHARGE pressure gauge designed for indication of pressure at the pump discharge side.

The temperature gauge module includes:



- DRAIN TANK temperature gauge for monitoring water temperature in the drainage tank;
- LPFW HEATER OUTLET temperature gauge for monitoring water temperature at the outlet of the low-pressure feedwater heater;
- GLAND COND. OUTLET temperature gauge for monitoring water temperature at the outlet of the Gland Condenser turbine sealing system.

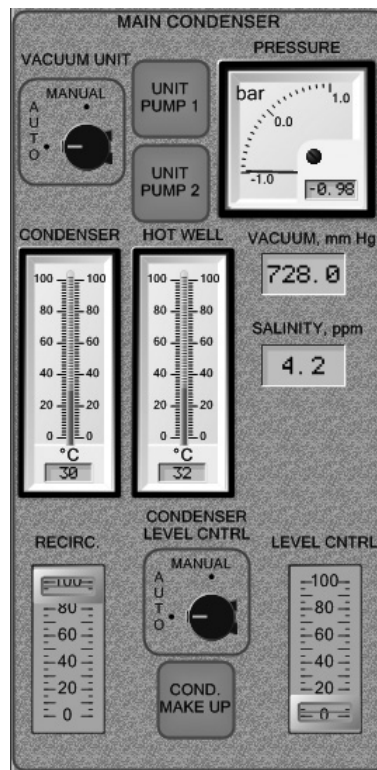
The ATMOSPHERIC CONDENSER module:



It includes indicators of atmospheric condenser parameters:

- pressure gauge for the lower part of the condenser;
- condenser water temperature gage.

The MAIN CONDENSER module:



It is designed for manual and automatic control of the main condenser operation. The module includes:

- the “AUTO/MANUAL” switch to select a condenser vacuum-pump operation mode;
- buttons “UNIT PUMP 1”, “UNIT PUMP 2” for launching the main vacuum-pumps in the manual remote operation mode;
- PRESSURE indicator to monitor vacuum in the condenser;
- the VACUUM digital indicator showing vacuum value in the condenser, in mm of mercury;
- digital water “SALINITY” displaying showing the current water salinity in ppm;
- CONDENSER temperature gauge for indication of temperature in the upper part of the condenser;
- HOT WELL temperature gauge for indication of temperature in the condenser hot well;
- “AUTO/MANUAL” switch to select a level regulator operation mode;
- “COND. MAKE UP” button to remotely control the condenser makeup valve;
- condensate level in the main condenser is adjusted in the manual remote control mode remotely with the aid of the valves RECIRC. and LEVEL CNTRL. The “0” setter position corresponds to a closed valve, while its “100” position corresponds to a wide-open valve.

The TO DUMP pressure gauge is designed for indication of pressure of water delivered to the steam discharge system.



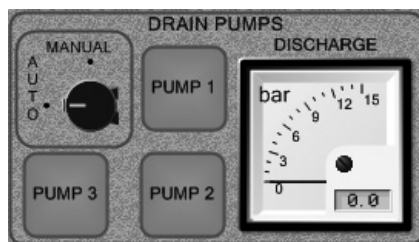
Below you can see the “DUMP SPRAY “ button used to remotely control the valve introducing water to the steam discharge system.



The TO AST. OPERATION pressure gauge is designed for indication of pressure of water delivered to the astern turbine.



The DRAIN PUMPS module is used for manual and automatic remote control of the drain pumps from ECR:



- “AUTO/MANUAL” switch to change between the automatic or manual mode of pump remote control from ECR;
- buttons “PUMP 1”, “PUMP 2”, “PUMP 3” for starting pumps in the manual remote control mode;
- DISCHARGE pressure gauge to show pressure on the pump discharge side.

Alarm System

- AUX. COND. P HIGH – high pressure in the auxiliary condenser;
- ATMOS DRAIN TK OUT T HIGH – high outlet temperature in the atmospheric drain tank;
- ATMOS DRAIN TK LEVEL HIGH – high level in the atmospheric drain tank;
- ATMOS DRAIN TK LEVEL LOW – low level in the atmospheric drain tank;
- MAIN CONDENSER LEVEL HIGH – high level in the main condenser;
- MAIN CONDENSER LEVEL LOW – low level in the main condenser;
- LP HEATER OUTLET T HIGH – high outlet temperature in the low pressure heater;
- MAIN COND VACUUM LOW – low vacuum level in the main condenser.

Faults Entered by Instructor

- Condensate Pump 1 Breakdown – breakdown of condensate water pump 1;
- Condensate Pump 2 Breakdown – breakdown of condensate water pump 2;
- Aux. Condensate Pump Breakdown – breakdown of auxiliary condensate water pump;
- Condensate Pump 1 Wear – wear of condensate water pump 1;
- Condensate Pump 2 Wear – wear of condensate water pump 2;
- Aux. Condensate Pump Wear – wear of auxiliary condensate water pump;
- Condensate Pump Autom. Control Failure – faulty condensate water pumps controller;
- Main Condenser Vacuum Unit Pump 1 Breakdown – breakdown of pump 1 of the Main Condenser (MC) vacuum unit;
- Main Condenser Vacuum Unit Pump 2 Breakdown – breakdown of pump 2 of the Main Condenser (MC) vacuum unit;
- Vacuum Unit Pump Autom. Control Failure – faulty controller of the MC vacuum unit pumps;
- Main Condenser Vacuum Failed – loss of vacuum in the MC;
- Main Condenser Level controller Failure – faulty MC level controller;
- Main Condenser – SW side leakage – sea water leakage in the MC (condensate salinity growth);
- Drain Pump 1 Breakdown – breakdown of drain pump 1;
- Drain Pump 2 Breakdown – breakdown of drain pump 2;
- Drain Pump 3 Breakdown – breakdown of drain pump 3;
- Drain Pumps Autom. control Failure – faulty drain pumps controller.

Feed Water System

System Purpose

The system is designed for providing boilers with feedwater. The system includes a deaerator, feedwater pumps, feedwater analysis system, and water treatment system.

Control Panel

The “Feed Water System” control panel is shown in Fig. 9:

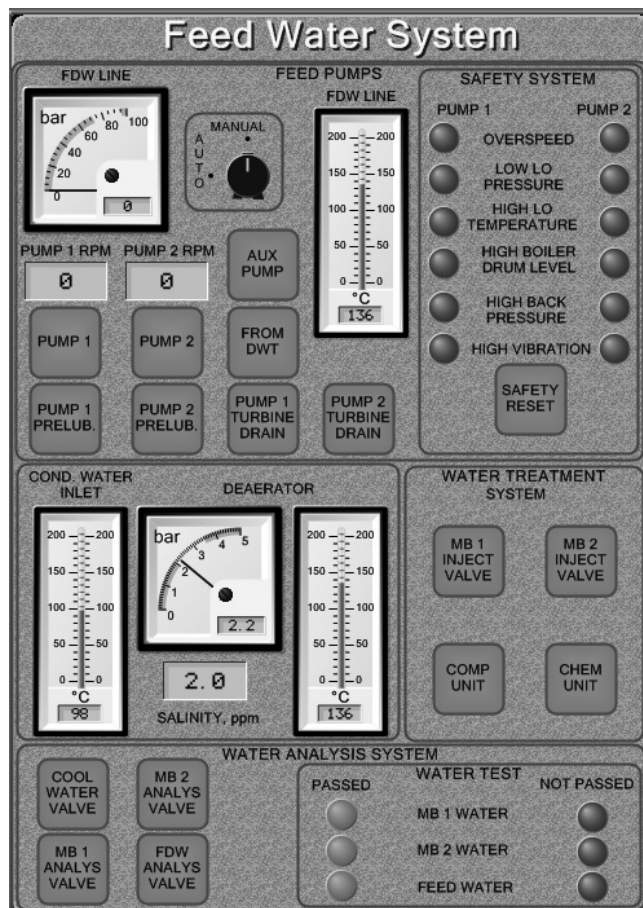
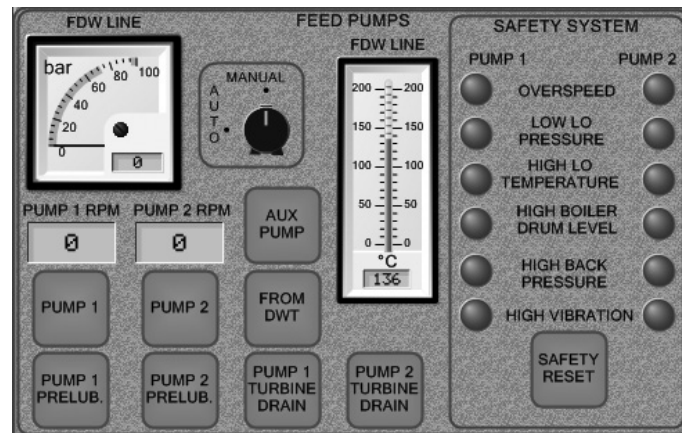


Fig. 9. Feedwater delivery system

The control panel includes the following modules:

The FEED PUMPS module is designed for remote control of the boiler feedwater pumps. Pumps 1 and 2 are driven by the steam turbine, while the auxiliary pump has an electric drive of its own.



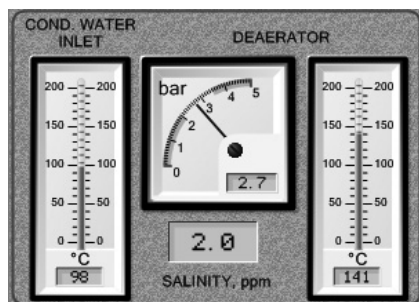
The module includes:

- the “AUTO/MANUAL” selector switch for choosing between automatic and manual mode of pump remote operation from ECR;
- the buttons “PUMP 1”, “PUMP 2”, “AUX PUMP” are designed to start the main/auxiliary pumps in the manual remote control mode;
- the pressure gauge is designed to indicate pressure downstream of the feedwater pipeline pumps;
- the RPM meters “PUMP 1 RPM” and “PUMP 2 RPM” show rotation velocity of the driving steam turbines;
- the buttons “PUMP 1 PRELUB.” and “PUMP 2 PRELUB.” Start the preliminary lube oil circulation through the driving steam turbines;
- the “PUMP1 TURBINE DRAIN”, “PUMP 2 TURBINE DRAIN” buttons are intended removing the drain accumulating during the operation of “PUMP 1”, “PUMP 2”;
- the “FROM DWT” button controls the valve allowing water to the pump inlet be fed directly from the distilled feedwater tank instead of the deaerator (the bypass valve);
- the temperature gauge is designed to show temperature in the feedwater pipeline downstream of the pumps.

The module also includes shutdown protection system indicators for the pumps 1 and 2 driven by the steam turbine drives:

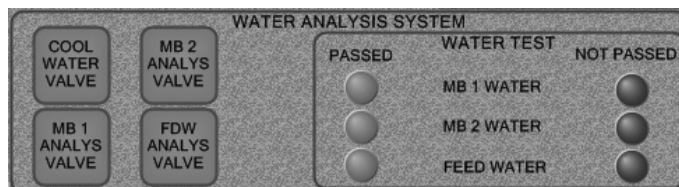
- “OVERSPEED” – pump 1/2 turbine overspeed;
- “LOW LO PRESSURE” – low lube oil pressure in the pipeline of pumps 1 or 2;
- “HIGH LO PRESSURE” – high lube oil temperature in the pipeline of pumps 1 or 2;
- “HIGH BOILER DRUM LEVEL” – high water level in the steam drum of the boiler;
- “HIGH BACK PRESSURE” – high back pressure at the steam outlet of the turbine drive for pumps 1 or 2;
- “HIGH VIBRATION” – high vibration level of pump 1 turbine or pump 2 turbine;
- The “SAFETY RESET” button is designed to re-arm the protection system after actuation.

The DEAERATOR unit is intended for monitoring water parameters in the deaerator and contains:

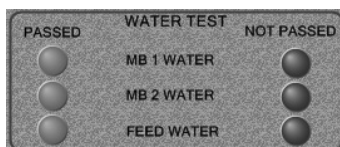


- “COND. WATER INLET” temperature gauge for showing water temperature at the deaerator inlet;
- pressure and Temperature gauge for showing the water pressure and temperature at the deaerator outlet;
- water “SALINITY” digital display showing the current salinity in ppm.

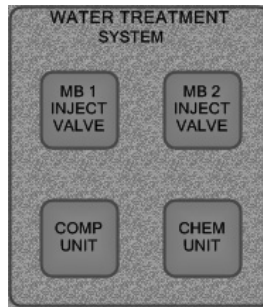
The WATER ANALYSIS SYSTEM unit is intended for the control of the water sampling system:



- “COOL WATER VALVE” is the button for opening/closing the valve feeding cooling water from the Central Fresh Water Cooling System to the coolers of the Water Analysis unit;
- “MB1 ANALYS VALVE” is the button for opening/closing the valve feeding water from the water drum of boiler 1 to the Water Analysis unit for cooling and sampling;
- “MB2 ANALYS VALVE” is the button for opening/closing the valve feeding water from the water drum of boiler 2 to the Water Analysis unit for cooling and sampling;
- “FDW ANALYS VALVE” is the button for opening/closing the valve supplying feedwater to the Water Analysis unit for cooling and sampling;
- Red and green indicator (lamps) imitating the passing of or a failure to pass the test – sample for water from boiler 1, boiler 2 and boilers feedwater.



The WATER TREATMENT SYSTEM unit is intended for the control of the water treatment system:



- “COMP. UNIT “ is the button for turning on/off the Boiler Compound Injection unit. After the switching on, the compound is batched, mixed with the water, and the treated water is fed by the pump;
- “MB1 INJECT VALVE”, “MB2 INJECT VALVE” are buttons for opening/closing valves for feeding treated water to the steam drum of boiler 1 and boiler 2;
- “CHEM. UNIT” is the button for turning on/off the Oxygen Scavenging Chemical unit. After the switching on, the chemical is batched, mixed with the water, and the treated water is fed by the pump to the Deaerator.

Alarm System

- DEAERATOR P LOW – low level of pressure in the deaerator;
- 2.7 BAR SYSTEM P HIGH – high pressure in 2.7 bar system;
- DEARATING HEATER LEVEL HIGH – high level in the heater;
- MAIN FEED WATER P LOW – low feedwater pressure in the main.

Faults Entered by Instructor

- Feed Water Pump 1 Governor Failure – faulty rpm governor (turbo drive governor) of feedwater pump 1;
- Feed Water Pump 2 Governor Failure – faulty rpm governor (turbo drive governor) of feedwater pump 2;
- Feed Water Pump 1 LO Pump Breakdown – breakdown of the oil pump in the drive of feedwater pump1;
- Feed Water Pump 2 LO Pump Breakdown – breakdown of the oil pump in the drive of feedwater pump 2;
- Feed Water Pump 1 LO Cooler Fouling – fouling of the oil cooler in the drive of feedwater pump 1;
- Feed Water Pump 2 LO Cooler Fouling – fouling of the oil cooler in the drive of feedwater pump 2;
- Feed Water Pump 1 Turbine not drained – condensate not drained from the drive turbine of feedwater pump 1;
- Feed Water Pump 2 Turbine not drained – condensate not drained from the drive turbine of feedwater pump 2;
- Feed Water Pump 1 Breakdown – breakdown of feedwater pump 1 drive;
- Feed Water Pump 2 Breakdown – breakdown of feedwater pump 2 drive;
- Feed Water Pumps Autom. control failure – faulty automatics of the feedwater pumps control;
- Feed Water leakage;

- Feed Water salinity High;
- MB 1 water poor – poor feedwater quality in boiler 1;
- MB 2 water poor – poor feedwater quality in boiler 2;
- Feed Water PH abnormal – high/low feedwater acidity beyond the recommended value range;
- Excess steam drain valve control failure – faulty steam drain valve in 2.5 bar system;
- DSH steam deaerator pressure control valve failed – faulty valves for supplying the desuperheated steam to the deaerator (2.5 bar system);
- Deaerator level control valve failed – faulty valve controlling level in the deaerator (the valve is closed);
- Bleeder steam pressure control valve failed – faulty valve for feeding steam to the deaerator from the turbine bleed-off.

Page MB – Main Boiler Control

Purpose

The system is designed for automated remote control (ARC) of the ship boiler from the Engine Control Room (ECR).

The page contains an integrated mnemonic diagram of the systems and a set of control panels for:

- boiler water-steam system;
- the system feeding fuel to the boiler burners controlling the combustion process;
- the system for purging fuel lines, burners and boiler furnaces with steam and nitrogen;
- the boiler soot blow system.

An integrated mnemonic diagram of the imitated systems is shown in Fig. 10:

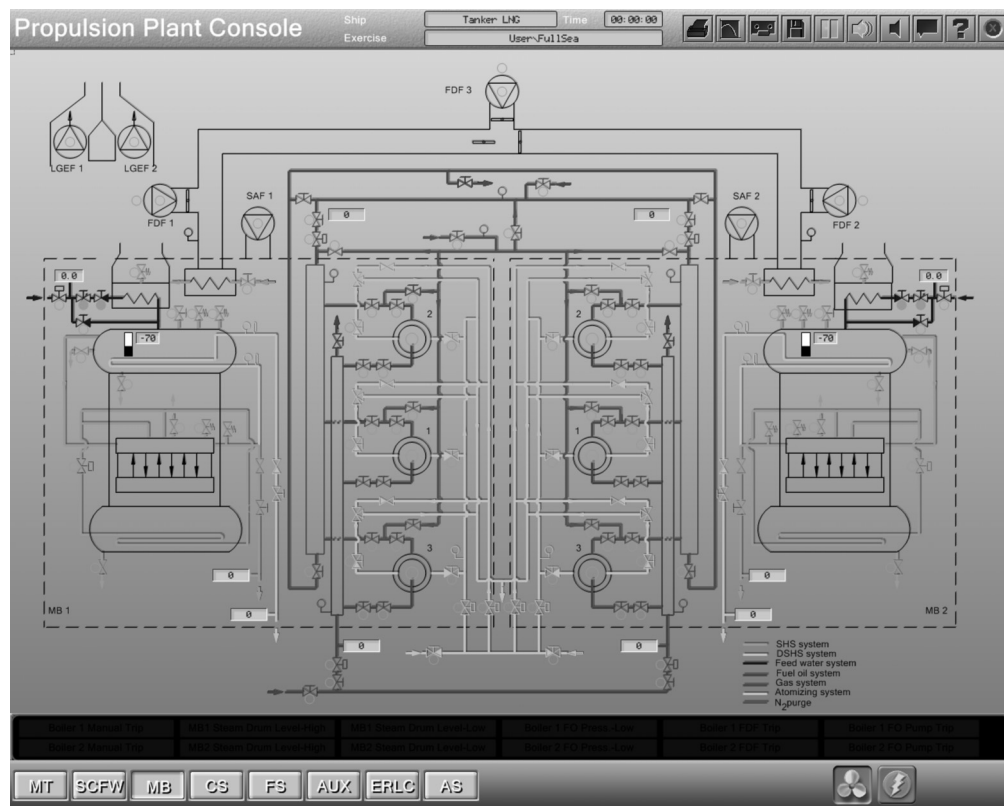


Fig. 10. Generalized mnemonic diagram

A press on the MB button opens an additional menu, which allows the desired sub-system and corresponding control panel to be chosen.

The system includes the following units imitated in the simulator:

- pipelines as hydro- and gas-dynamic objects;
- steam boilers as thermodynamic objects;
- remote control valves (pipeline fittings);
- boiler feed-water economizers heating water at the inlet of the upper boiler drum using the energy of the exhaust boiler gases;
- boiler air heaters heating air at the inlet of the boiler furnace;

- the main fans FDF1 (Forced Draft Fan) and FDF2 delivering air to the boiler furnaces, and the backup fan FDF3;
- the fans SAF1 (Sealing Air Fan) and SAF2 that provide surplus pressure preventing leakage of gas delivered to the boiler furnaces;
- the fans LGEF1 (Leak Gas Extraction Fan) and LGEF2 located in the flue and removing potential gas leakages;
- two-fuel boiler furnaces (1, 2 and 3 for each of the boilers).

The flow-rates of the feedwater, superheated steam and prime steam are represented by the system mnemonic diagram with the aid of the digital indicators.

Alarm and Safety System

- BOILER 1 MAN TRIP – manual trip of boiler 1;
- BOILER 2 MAN TRIP – manual trip of boiler 2;
- MB1 STEAM DRUM LEVEL HIGH – high level in the steam drum of boiler 1;
- MB2 STEAM DRUM LEVEL HIGH – high level in the steam drum of boiler 2;
- MB1 STEAM DRUM LEVEL LOW – low level in the steam drum of boiler 1;
- MB2 STEAM DRUM LEVEL LOW – low level in the steam drum of boiler 2;
- BOILER 1 TRIP – FO PRESS LOW – tripping of boiler 1 because of low pressure of fuel oil;
- BOILER 2 TRIP – FO PRESS LOW – tripping of boiler 2 because of low pressure of fuel oil;
- BOILER 1 TRIP – FDF1 – tripping of boiler 1 because of tripping of forced draft fan 1;
- BOILER 2 TRIP – FDF2 – tripping of boiler 2 because of tripping of forced draft fan 2;
- BOILER 1 TRIP – FO PUMP – tripping of boiler 1 because of tripping fuel oil pump;
- BOILER 2 TRIP – FO PUMP – tripping of boiler 2 because of tripping fuel oil pump.

Boiler Steam and Water System

System Purpose

The boiler steam and water system can be controlled both manually and automatically:

- by feedwater pressure/level in the upper boiler drum;
- by parameters of the produce steam (superheated and wet), i.e. by pressure/temperature.

Control Panel

The “Steam & Water System” control panel is shown in Fig. 11:

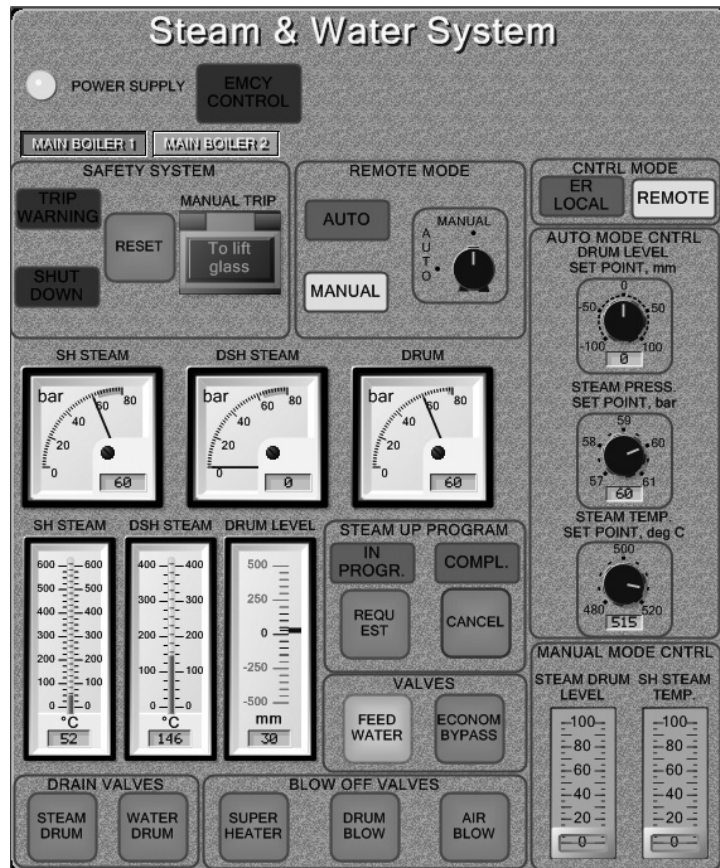
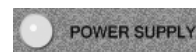


Fig. 11. “Steam & Water System” control panel

The control system power indicator is one for both boilers:



as well as the “EMCY CONTROL” indicator indicating whether the boilers are controlled from the engine room or from the local control panel:



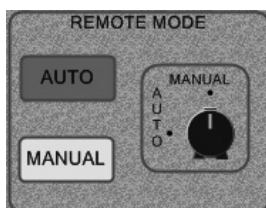
In the bottom area you can see the tabs “Main Boiler 1” and “Main Boiler 2”, which give access to the control panels of the boiler 1 and boiler and 2, respectively.

The boiler control panel (both 1 and 2) includes the following modules:

- ER LOCAL-REMOTE module of control mode indicators;

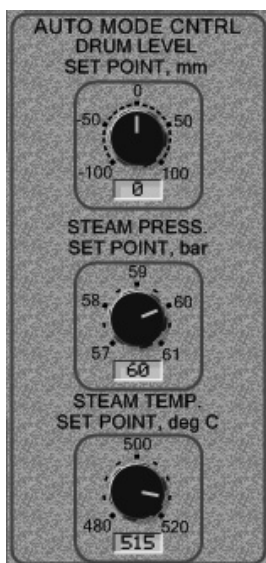


- "ER LOCAL" indicator informs that boiler is control from the local control panel in the engine room the "Remote" indicator informs that boiler control is transferred to ECR;
- the module for selection of a boiler remote control mode "AUTO/MANUAL".



The "AUTO/MANUAL" switch allows the boiler remote control mode to be specified as automatic or manual. Selection is confirmed by illumination of the corresponding indicator.

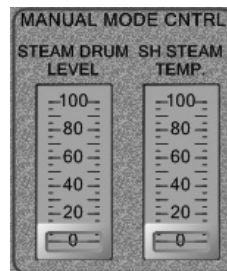
In the automatic remote control mode from ECR, the AUTO MODE CNTRL module allows the following superheated steam parameters to be specified:



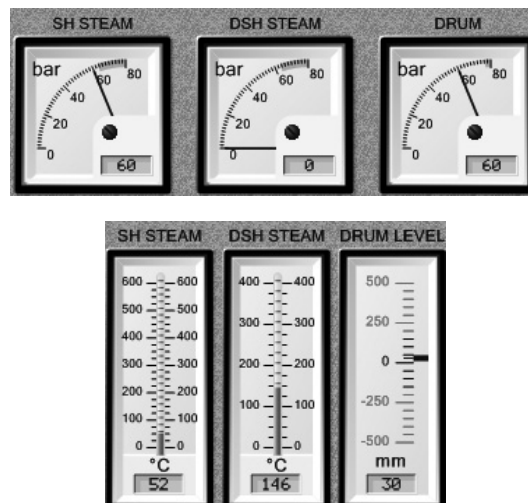
- pressure in the range 57–61 bar;
- temperature in the range 480–520 °C.

The water level in the upper boiler drum to be specified in relation to a average value in the range of -100 to +100 mm. The water level in the upper boiler drum can be adjusted by the rate of "Water Drum Level Control" valve opening, which is located on the feedwater delivery pipeline.

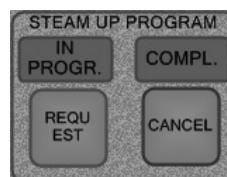
In the manual remote control mode from ECR, you can control the “Water Drum Level Control” valve and, respectively, the level in the upper boiler drum using the “Steam Drum Level Valve” slide, and also you can control the superheated steam temperature using the SH Steam Temperature Valve slide, which both are located in the “MANUAL MODE CONTROL” module:



The group of gauges contains pressure and temperature gauges of the superheated steam (SH STEAM) and desuperheated steam (DSH STEAM) and the DRUM gauge of the steam pressure and water level in the boiler top drum:

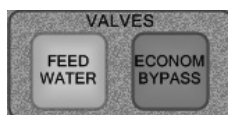


The STEAM UP PROGRAM group enables control of the program for raising the steam level in the boiler – control of burners and fuel feed depending on whether the boiler is cold or hot (Hot Program, steam pressure more than 10 bar).



The STEAM UP PROGRAM is run individually for each boiler by using the “REQUEST” button in the REMOTE CONTROL mode. If the program can be executed (no emergency condition for the burners and fuel oil system, and no emergency boiler tripping), the “IN PROGR.” indicator lights up, and the program is executed. After the end of the program, the “COMPL.” indicator light up, and the burners operate in accordance with the selected control in the standard steam pressure maintaining mode.

The VALVES module is designed for remote control of the valves:



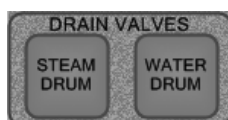
- “FEED WATER” button controls the feedwater delivery valve;
- “ECONOM. BYPASS” controls the valve bypassing economizer operation.

The BLOW OFF VALVES module is responsible for control of the blow-off valves:

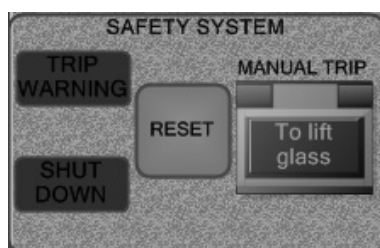


- “SUPER HEATER” – controls the superheater blow-off valve;
- “DRUM BLOW” – controls the boiler top drum blow-off valve;
- “AIR BLOW “ – controls the air blow-off valve, air blow-off from system.

The DRAIN VALVES module provides for remote control of the boiler drain valves located in the lower points of the upper boiler drum (“STEAM DRUM”) and those of the lower boiler drum (“WATER DRUM”):



The SAFETY SYSTEM boiler protection system module:



It includes the following indicators:

- “TRIP WARNING” – warning on a situation, when system parameters are close to an emergency, and the boiler shutdown protection is expected to actuate;
- “SHUT DOWN” – warning on an emergency shutdown of the steam boiler by the protection system.

There is a button for boiler emergency shutdown – “MANUAL TRIP”.

On actuation of the boiler protection system and boiler shutdown, re-start of the boiler is possible only after re-arming the protection system using the Reset function. The press on the Reset button results in re-arming and readiness of the protection system.

Safety System

The boiler shutdown safety system is actuated if at least one the following conditions (causes) is available:

- FUEL OIL PUMPS (1, 2) TRIP – tripping of fuel oil pumps supplying liquid fuel to the burners;
- MB1(2) STEAM DRUM LEVEL HIGH/LOW – high/low level in the top drum of boiler 1 (2);
- FUEL OIL PRESSURE LOW – low pressure of liquid fuel supplied to the burners;
- FDF TRIP – tripping of the boiler forced draft fan;
- FLAME FAILURE – burner flame-out.

Alarm System

- MB1 DRUM LEVEL HIGH – high level in the top drum of boiler 1;
- MB2 DRUM LEVEL HIGH – high level in the top drum of boiler 2;
- MB1 DRUM LEVEL LOW – low level in the top drum of boiler 1;
- MB2 DRUM LEVEL LOW – low level in the top drum of boiler 2.

Faults Entered by Instructor

- MB1 Remote Autom. control failure – faulty ARC system of boiler 1;
- MB2 Remote Autom. control failure – faulty ARC system of boiler 2;
- MB1 Economizer fouling – economiser fouling in boiler 1;
- MB2 Economizer fouling – economiser fouling in boiler 2;
- MB1 Steam Drum Level controller failure – faulty controller of level in the top drum of boiler 1;
- MB2 Steam Drum Level controller failure – faulty controller of level in the top drum of boiler 2;
- MB1 Steam Pressure controller failure – faulty controller of steam pressure in boiler 1;
- MB2 Steam Pressure controller failure – faulty controller of steam pressure in boiler 2;
- MB1 Steam Temperature controller failure – faulty controller of temperature in boiler 1;
- MB2 Steam Temperature controller failure – faulty controller of temperature in boiler 2;
- MB1 High Temp. gradient break – breakdown of boiler 1 (crack) due to the high temperature gradient in the furnace and other parts of the boiler;
- MB2 High Temp. gradient break – breakdown of boiler 2 (crack) due to the high temperature gradient in the furnace and other parts of the boiler;
- MB1 Economizer break – economizer breakdown (crack) in boiler 1;
- MB2 Economizer break – economizer breakdown (crack) in boiler 2.

Burner Fuel Supply System and Combustion Process Control (Fuel Oil, Gas & Atomizing)

Purpose

The system is designed to provide the combustion process in the boiler furnace.
The system supports:

- delivery of two kinds of fuel – fuel oil and gas – to the boiler furnaces;
- delivery of air to the boiler furnaces;
- operation of the boiler burners on fuel oil, gas or a fuel mixture (in manual and automatic modes);
- atomizing the oil fuel by the burners using compressed air or steam;
- delivery of air to the boilers to provide boiler tightness;
- removal of all kinds of leakages to the flues.

System Components

The system includes the following units imitated in the simulator:

- the pipeline system as a hydro- and gas-dynamic object, i.e. the pipelines carrying oil fuel, gas, steam, compressed air;
- the burners as a thermodynamic object. Each boiler has three burners – 1, 2 and 3. The central, 1 burner is the main, leading one. The burners 2 and 3 are the led ones, turning to operation depending on the boiler load (steam consumption);
- the boiler furnaces as a thermodynamic object;
- the forced draft fans FDF1, FDF2, and FDF3 that adjust air delivery to the boiler furnaces. The fan FDF 3 is a backup on being able to deliver air to both the furnace of the boiler 1 and the function of the boiler 2;
- the sealing air fans SAF1 and SAF2 creating surplus pressure to seal the boilers and to prevent gas leakage;
- the leak gas fans LGEF1 and LGEF2 preventing potential gas leakages to the flue;
- remotely controlled valves – pipeline fittings.

Control Panel

The “Fuel Oil, Gas & Atomizing” control panel is shown in Fig. 12:

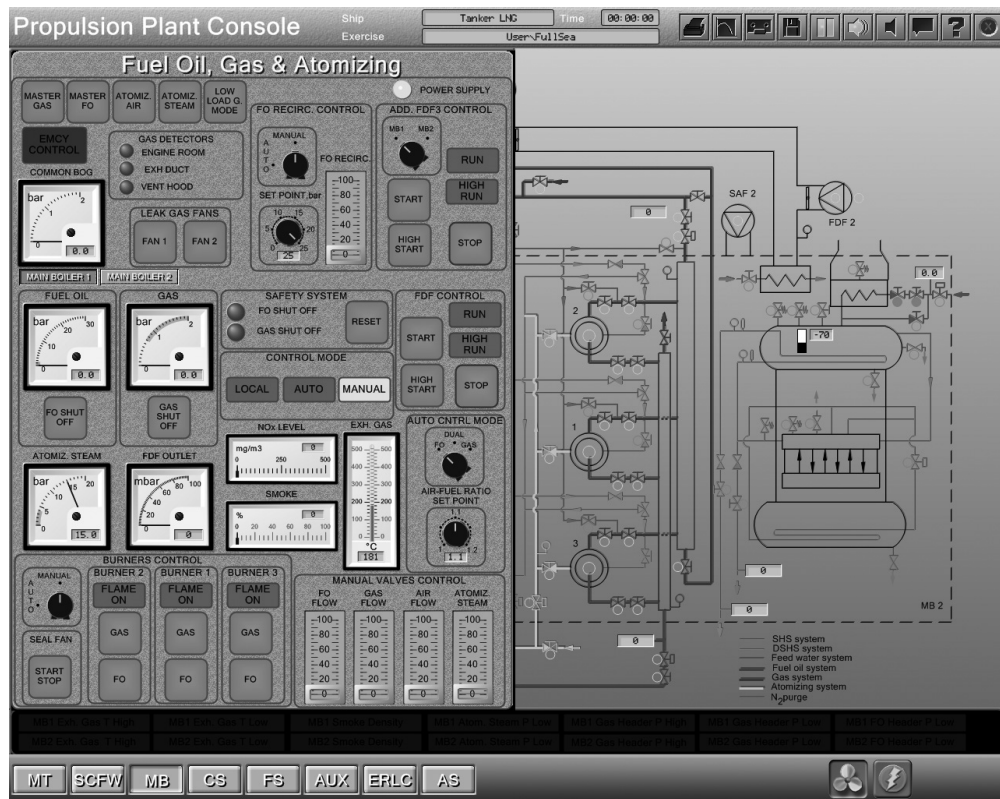
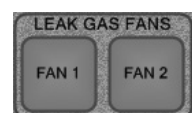
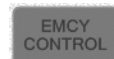
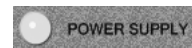


Fig. 12. “Fuel Oil, Gas & Atomizing” control panel

The following components are used by both boilers:

- Control system power indicator:
- “EMCY CONTROL” indicator identifying the emergency control panel in the engine room as the place of boiler control:
- Leak gas fan control module – “FAN 1” and “FAN 2”:
- COMMON BOG – pressure gauge showing common pressure for both boilers at the inlet of the boilers:



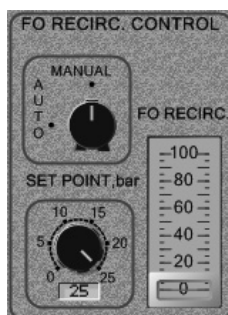
- The “MASTER GAS” button opens the master valve for gas supply to boilers 1 and 2:
- The “MASTER FO” button opens the master valve for fuel oil supply to boilers 1 and 2:



- The “ATOMIZ. AIR” button opens the valve for feeding compressed air for the liquid oil atomising (during boiler start):
- The “ATOMIZ. STEAM” button opens the steam feed valve for the fuel oil atomising:
- The “LOW LOAD GAS MODE” button turns on the mode of boiler operation on gas with the low boiler load (steam consumption):

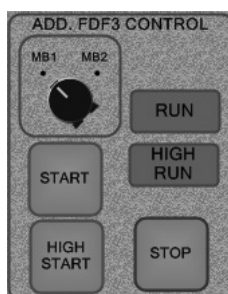


The FO RECIRC. CONTROL module is used to adjust oil fuel pressure at the inlet of the boilers:



Adjustment of the oil fuel pressure can be performed using one of the two modes – “AUTO” or “MANUAL”. In automatic mode, it will suffice to specify a desired fuel pressure turning the SET POINT knob (0...25 bar range). In the manual control mode, pressure is determined by the rate of the recirculation valve opening using the 0–100 setter. The position “0” of the setter corresponds to a closed recirculation valve (maximum fuel pressure at the inlet of the boilers), while the “100” position of the setter corresponds to a wide-open recirculation valve (minimum pressure).

The fan FDF3 is controlled from the ADD. FDF3 CONTROL module.



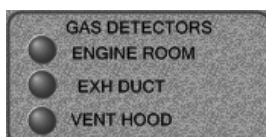
The top switch of the module has two positions – “MB1” and “MB2”. It denotes that the fan can be switched over to the first boiler or the second one, respectively.

The “START” button is used to turn on the fan at its usual rate. Fan operation at its usual rate is shown by the “RUN” indicator.

The “HIGH START” button is used to start the fan at an increased rotary velocity. Operation at an increased rotary velocity is shown by the “HIGH RUN” indicator.

The “STOP” button is used to turn the fan OFF.

The “GAS DETECTORS” indicators light up when the gas concentration is exceeded by 30 % of LEL (Lower Explosive Limit):



Checkpoints for gas concentration measurements are in the following places:

- in the top part of the engine room (“ENGINE ROOM”);
- in the exhaust ducts of the Fuel Gas Line in the main boilers (“EXH DUCT”);
- within the boiler vent hoods (“VENT HOOD”).

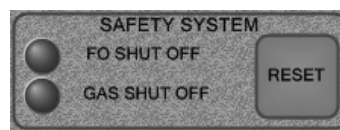
Indicators are actuated if:

- “LEAK GAS FANS” are not turned on;
- “SEAL FANS” are not turned on.

Change to the control panel of the boiler 1 or to the control panel of the boiler 2 is performed using the tabs:



The SAFETY SYSTEM group of indicators:



- “FO SHUT OFF” – fuel oil supply shut off;
- “GAS SHUT OFF” – gas supply shut off.

Mode of boiler operation is indicated by the indicator module CONTROL MODE:



where:

- “LOCAL” is boiler control from the engine room;
- “AUTO” automatic remoter control;
- “MANUAL” manual remote control.

If the automatic mode of boiler operation control has been selected, then the AUTO CNTRL MODE control module serves for selection of burner operation mode:



- switch position “FO” – operation on oil fuel only;
- switch position “GAS” – operation on gas only;
- switch position “DUAL” – simultaneous burner operation on oil fuel and gas (mixture).

Change to another fuel type is possible in the following order only:
FO ↔ DUAL ↔ GAS.

Control of the air-fuel mixture ratio (excess air factor) to provide efficient fuel combustion in the boiler furnace is performed by the “AIR-FUEL RATIO” setter.

The FUEL OIL module allows fuel oil to be fed to the boiler burners by opening the cut-off valve (the “FO SHUT OFF” button) and the fuel oil pressure to be monitored.



The GAS module allows gas to be fed to the boiler burners by opening the cut-off valve (“GAS SHUT OFF” button) and the gas pressure to be monitored.



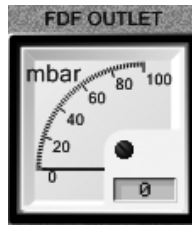
The “FDF CONTROL” module is designed for to control the Forced Draft Fan boiler fan. Its control is performed similar to the control of the “FDF3” fan, the “START” button being used to start the fan at its usual rate of turn. Fan operation at its usual rate is shown by the “RUN” indicator.



The “HIGH START” button is used to start the fan at an increased rotary velocity. Operation at an increased rotary velocity is shown by the “HIGH RUN” indicator.

The “STOP” button is used to turn the fan OFF.

Air pressure downstream of the FDF fan at the inlet of the boiler is monitored using the FDF OUTLET pressure gage:



Steam pressure introduced to the burners for the purpose of atomizing the oil fuel is monitored using the ATOMIZ. STEAM pressure gage:



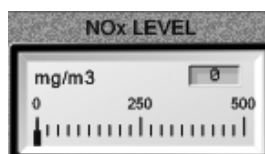
The EXH. GAS temperature gauge is designed to indicated exhaust gas temperature:



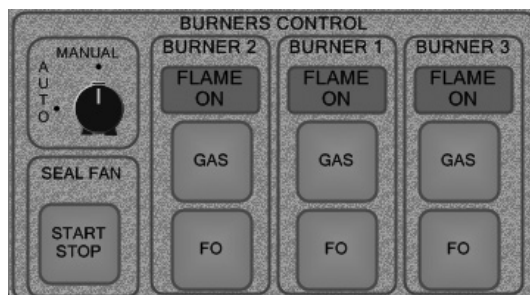
The quality of burning within the boiler by assessing smoke content in the exhaust gases (in per cent) is monitored with the aid of the SMOKE gauge:



The NOx LEVEL gauge shows the nitrogen oxide content (mg/m^3) in the boiler exhaust gases:



The BURNERS CONTROL module is designed for automatic remote control of the burners 1, 2, and 3:



The “AUTO/MANUAL” switch is designed for selecting the burners operating mode (automatic and manual).

For each of the burners:

- “FO” button – starts the algorithm of starting burner on oil fuel (opening the oil fuel delivery valve, ignition);
- “GAS” button – starts the algorithm of starting burner on gas (opening the gas delivery valve, ignition).

The “FLAME ON” indicator actuates from the inbuilt optical sensors showing the fact of flame presence and burner operation on the selected fuel.

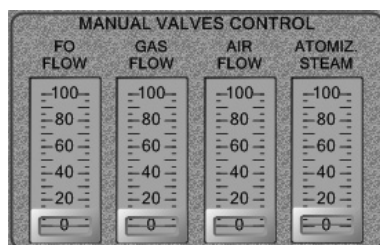
The Sealing Air Fan serves for preventing gas leakage – for the boiler sealing, for creating air overpressure in the gas pipeline area. The SEAL FAN control group contains this fan’s start/stop button.



In the Remote Manual control mode, control of the following valves:

- FO Flow Control Valve (oil fuel flow);
- Gas Flow Control Valve (gas flow);
- Air Flow Control Valve (air flow).

and the Atomizing Steam Pressure Valve (steam pressure adjustment) is performed from the MANUAL VALVES CONTROL module:



The FO FLOW CNTRL V. setter varies the rate of valve opening – delivery/flow-rate of oil fuel. The “0” position of the setter corresponds to a closed valve, when the fuel consumption is zero, and the pressure is at its maximum. The “100” position corresponds to a wide-open valve.

The GAS FLOW CNTRL V. setter adjusts the rate of valve opening – delivery/flow-rate of gas. The “0” position of the setter corresponds to a closed valve, when the fuel consumption is zero, and the pressure is at its maximum. The “100” position corresponds to a wide-open valve.

The AIR FLOW CNTRL V. setter adjusts opening of the shutters gates at the suction side of the FDF fan, i.e. air delivery to the boiler furnace. The “0” position of the setter corresponds to closed gates, when air supply is zero. The “100” position corresponds to wide-open gates.

The ATOMIZ. STEAM PRESS. V. setter adjusts the rate of opening of the valve supplying steam for oil fuel atomization. The “0” position of the setter corresponds to a closed valve, when steam consumption is zero, and the pressure is at its maximum. The “100” position corresponds to a wide-open valve.

Alarm System

- MB1 EXH GAS T HIGH – high temperature of exhaust gases in boiler 1;
- MB2 EXH GAS T HIGH – high temperature of exhaust gases in boiler 2;
- MB1 EXH GAS T LOW – low temperature of exhaust gases in boiler 1;
- MB2 EXH GAS T LOW – low temperature of exhaust gases in boiler 2;
- MB1 SMOKE DENSITY – high smoke concentration in boiler 1;
- MB2 SMOKE DENSITY – high smoke concentration in boiler 2;
- MB1 ATOM STEAM P LOW – low pressure level of steam supplied for fuel atomising in boiler 1;
- MB2 ATOM STEAM P LOW – low pressure level of steam supplied for fuel atomising in boiler 2;
- MB1 GAS HEADER P HIGH – high pressure in gas header of boiler 1;
- MB2 GAS HEADER P HIGH – high pressure in gas header of boiler 2;
- MB1 GAS HEADER P LOW – low pressure in gas header of boiler 1;
- MB2 GAS HEADER P LOW – low pressure in gas header of boiler 2;
- MB1 FO HEADER P LOW – low pressure in fuel oil header of boiler 1;
- MB2 FO HEADER P LOW – low pressure in fuel oil header of boiler 2.

Faults Entered by Instructor

- FO recirculation controller failure – faulty controller ensuring fuel oil recirculation;
- Forced Draft Fan 1 (2) breakdown – faulty fan of boiler 1 (2);
- Leak Gas Fan 1 (2) breakdown - faulty fan of boiler 1 (2);
- Sealing Air Fan 1 (2) breakdown - faulty fan of boiler 1 (2);
- Gas leakage;
- BOG supply failure (low pressure) – has supply failure, low gas pressure);
- MB1 Burner 1 (2, 3) breakdown – breakdown of burner 1 (2, 3) in boiler 1;
- MB2 Burner 1 (2, 3) breakdown – breakdown of burner 1 (2, 3) in boiler 2;
- MB1 (2) Burners controller failure – faulty burners controller in boiler 1 (2);
- MB1 (2) Firing mode controller failure – faulty controller for selecting the burners control mode in boiler 1 (2) “FO-Dual-Gas”;
- MB1 (2) Atomizing Steam pressure controller failure – faulty controller of steam pressure for the fuel atomising in boiler 1 (2);

- MB1 (2) Purge Steam pressure controller failure – faulty controller of steam pressure for purging boiler 1 (2);
- MB1 (2) FO Flow controller failure – faulty control of the fuel oil supply in boiler 1 (2);
- MB1 (2) BOG Flow controller failure – faulty controller of the gas supply in boiler 1 (2);
- MB1 (2) Feed Water Flow controller failure – faulty controller of feed water supply in boiler 1 (2);
- MB1 (2) Air Flow controller failure – faulty controller of air supply in boiler 1 (2);
- MB1 (2) SHS Temperature controller failure – faulty controller of the superheated steam temperature in boiler 1 (2);
- MB1 (2) Ignition controller failure – faulty controller of ignition in boiler 1 (2).

System for Purging Fuel Lines, Burners and Boiler Furnaces with Steam and Nitrogen (Steam and N2 Purge)

Purpose

The system (Fig. 13) is designed for manual and automatic control of:

- steam delivery to the boiler furnaces and burners as well as purging the gas manifold with nitrogen;
- nitrogen parameters;
- remote control of some valves.

Control Panel

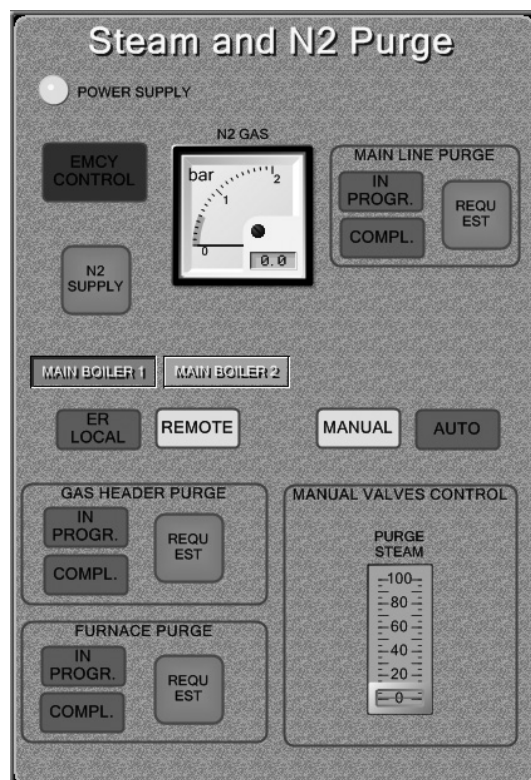
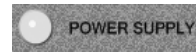


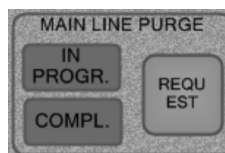
Fig. 13. System of purging fuel lines, boiler burners and furnaces with steam and nitrogen

The following indicators and buttons are common for both boilers:

- “POWER SUPPLY” – indicator of control system power ON;
- “EMCY CONTROL” – indicator informing when boiler control is performed from the emergency control panel in the engine room;
- The “N2 SUPPLY V.” button opens the “N2 Master Purge Valve” shutoff valve and provides for nitrogen supply;
- The “N2 GAS PRESSURE” pressure gauge located after the N2 Master Purge Valve monitors parameters of the supplied gas;



The MAIN LINE PURGE module represents indicators monitoring the system purge process.



Line purging from the Master Gas Valve to the Boiler Gas Valve is carried out automatically on closure of the Master Gas Valve, or manually on pressing the “REQUEST” button.

- “REQUEST” button actuates the main purge line in the manual remote control mode;
- “IN PROGR.” indicator illuminates, if the program is in progress;
- “COMPL.” indicator shows that the purge process is finished.

Change to the control panel of the boiler 1 or to the control panel of the boiler 2 is performed using the tabs:



The control panel of boiler 1 and boiler 2 includes the following modules.

The module of control mode indicators “ER LOCAL-REMOTE”:



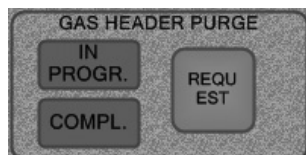
- “ER LOCAL” indicator informs that boiler control is performed from the local control panel in the engine room;
- “REMOTE” indicator informs that boiler control is transferred from the engine room to ECR.

The module of remote boiler control indicators “MANUAL” and “AUTO”:



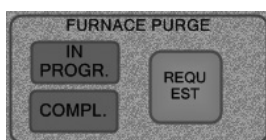
- “MANUAL” indicator informs that boiler control is performed in manual mode;
- “AUTO” informs that the remote boiler control is performed in automatic mode.

The GAS HEADER PURGE module represents the program of gas manifold purge control:



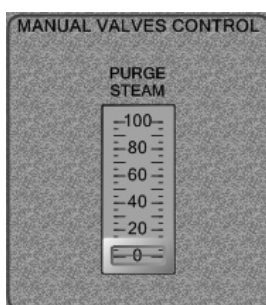
The program is started by using the “REQUEST” button. If program run is possible, and there is not reason for stopping operation of the purge system or for actuation of the protection system, the “IN PROGR.” indicator lights up. On completion of the program, the “COMPL.” indicator lights up.

The FURNANCE PURGE module represents the control program for purging gas-operated burners and furnaces.



The program is launched using the “REQUEST” button. If program run is possible, the “IN PROGR.” indicator lights up. On completion of the program, the “COMPL.” indicator lights up.

The module of Steam Purge Pressure Control MB1, 2 valve control in the manual remote control mode from ECR. The valve position being specified by the PURGE STEAM PRESS. V. setter.



The setter adjusts steam flow-rate through the valve. The “0” position of the setter corresponds to a closed valve, when the fuel consumption is zero, and the pressure is at its maximum. The “100” position corresponds to a wide-open valve.

Alarm System

SYSTEM INLET P LOW – low steam pressure at the inlet.

Faults Entered by Instructor

N2 missing – no nitrogen for purging.

Boiler Soot Blowers System

Purpose

The system is designed for manual and automatic control of:

- the boiler blow program;
- boiler blow mode selection;
- operation of any blow device;
- remote control of some valves.

System Components

The system diagram implemented in the simulator, i.e. the system mnemonic, is shown in Fig. 14:

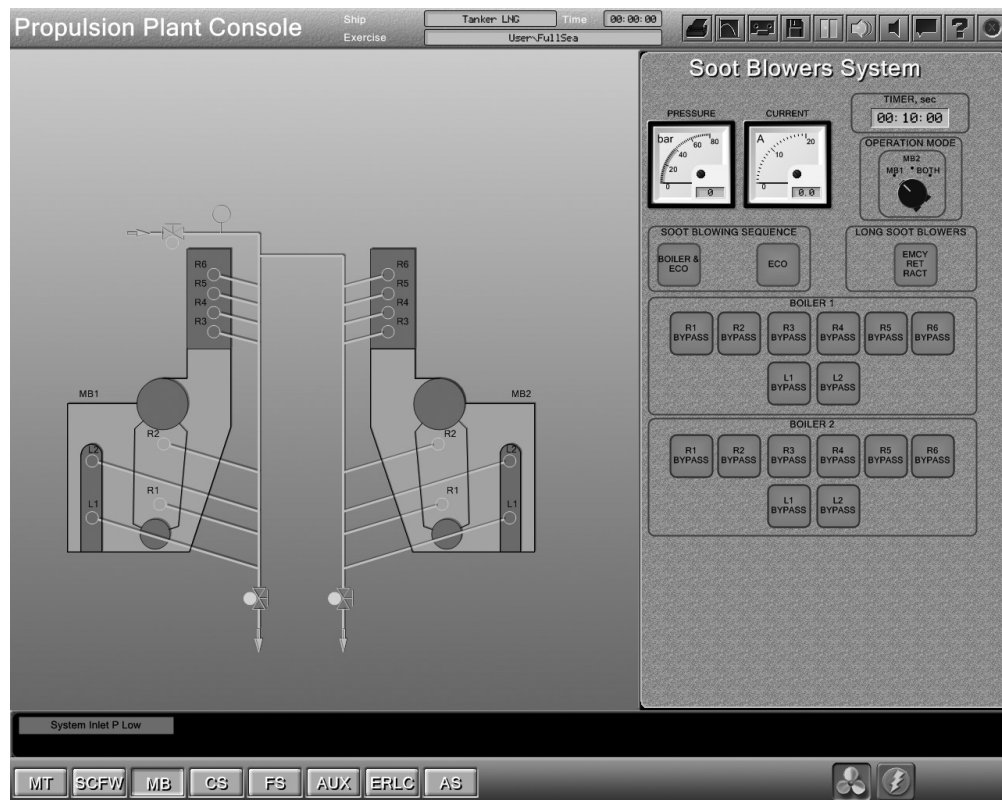


Fig. 14. Boiler soot blow system

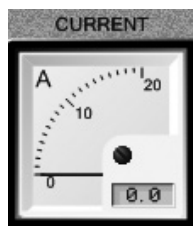
Control Panel

The control panel located in the right-hand part of the screen page is common for both boilers. It includes the following modules.

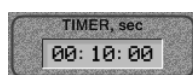
The pressure gauge indicates parameter of the steam supplied to the system.



The ammeter shows running current, 10 A, when voltage is applied to the blow devices. When changing over to R or L, the current sags by $\frac{1}{3}$.



The “TIMER, sec” indicator is designed to monitor the time of boiler blow program run. Time is counted quicker in this case, within 2 min, with indication 10 to 0 min for blowing a boiler.



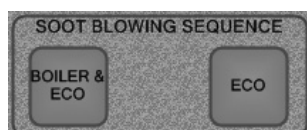
Within this period, all blowers should light up and then turn off sequentially, but those in the “bypass” mode. (If a blower is in the bypass mode, the time specified for boiler blow doesn’t change.) If only ECO is selected, the economizer will be blown, and in the beginning the time will just run without the boiler being blown.

The OPERATION MODE control module is designed for remote control of boiler blow mode selection:



- the “MB1” switch position – turning on the program of blowing the boiler 1;
- the “MB2” switch position – turning on the program of blowing the boiler 2;
- the “Both” position – launching the program of sequential blowing both boilers in automatic mode. When the “Both” mode is selected, the timer operates of 10 to 0 min, two times – the first time for blowing the boiler 1, and the second time – for blowing the boiler 2.

The SOOT BLOWING SEQUENCE module is designed for selection of the boiler blow automatic program.



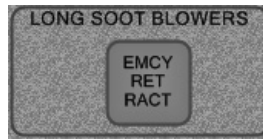
The “BOILER & ECO” button turns on the mode of blowing interior surfaces of the boiler proper and those of the economizer.

The “ECO” button provides for blowing the economizer only.

The blow procedure running time is shown by the timer. In the simulator, this time is limited down to:

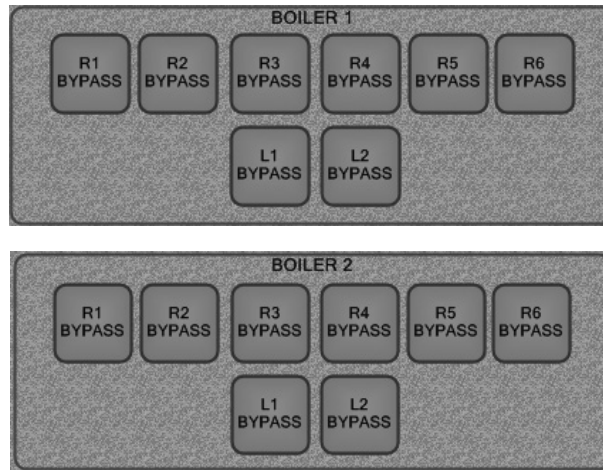
- soot blowing sequence/Boiler & ECO – 3 min;
- soot blowing sequence/ECO – 1 min.

The LONG SOOT BLOWERS module is designed for remote extraction of the blow device.



The “EMCY RETRACT” button is used for emergency enabling and extracting the Long Soot Blowers.

Below you can see the modules BOILER 1 and BOILER 2, which allow access to the blow device control buttons used for individual blowing of each of the boiler:



- in automatic control mode, operation of each blower can be bypassed in accordance with the selected operation program (Boiler & ECO/ECO) or in case of a fault signal from a blower;
- operation of any blower can be cancelled manually with the aid of the “BYPASS” buttons.

Alarm System

SYSTEM INLET P LOW – low steam pressure at the system inlet.

Faults Entered by the Instructor

- MB1 Rotary soot blower 1 (2, 3, 4, 5, 6) failure – faulty Rotary Soot Blowers 1 (2, 3, 4, 5, 6) in boiler 1;
- MB2 Rotary soot blower 1 (2, 3, 4, 5, 6) failure – faulty Rotary Soot Blowers 1 (2, 3, 4, 5, 6) in boiler 2;
- MB1 Long soot blower 1 (2) failure – faulty Long Soot Blower 1 (2) in boiler 1;
- MB2 Long soot blower 1 (2) failure – Long Soot Blower 1 (2) in boiler 2;
- MB1 (2) Soot on Economizer – large amount of soot on the economiser of boiler 1 (2);
- MB1 (2) Soot on Superheater – large amount of soot on the steam superheater of boiler 1 (2).

Page CS – Water Cooling System

System Purpose

The page CS represents the system of automatic remote control (ARC) of the sea/fresh water cooling systems from the Engine Control Room (ECR).

A press on the CS button results in additional menu appearance, allowing selection of a desired system and its control panel:

- seawater cooling system;
- freshwater cooling system.

The system includes the following units imitated in the simulator:

- pipeline system as a hydrodynamic object;
- cooler (of water, oil, etc.) as thermodynamic objects;
- water intake sea chests, the low and high ones, equipped with filters and stop valves);
- centrifugal electrically driven pumps;
- overboard valve.

Seawater Cooling System

Purpose

The system is designed for cooling the engine room equipment.

The system is composed of two subsystems and provides manual and automatic control of:

- the main circulation system;
- the seawater cooling system.

System Components

The mnemonic diagram and the generalized system control panel are shown in Fig. 15:

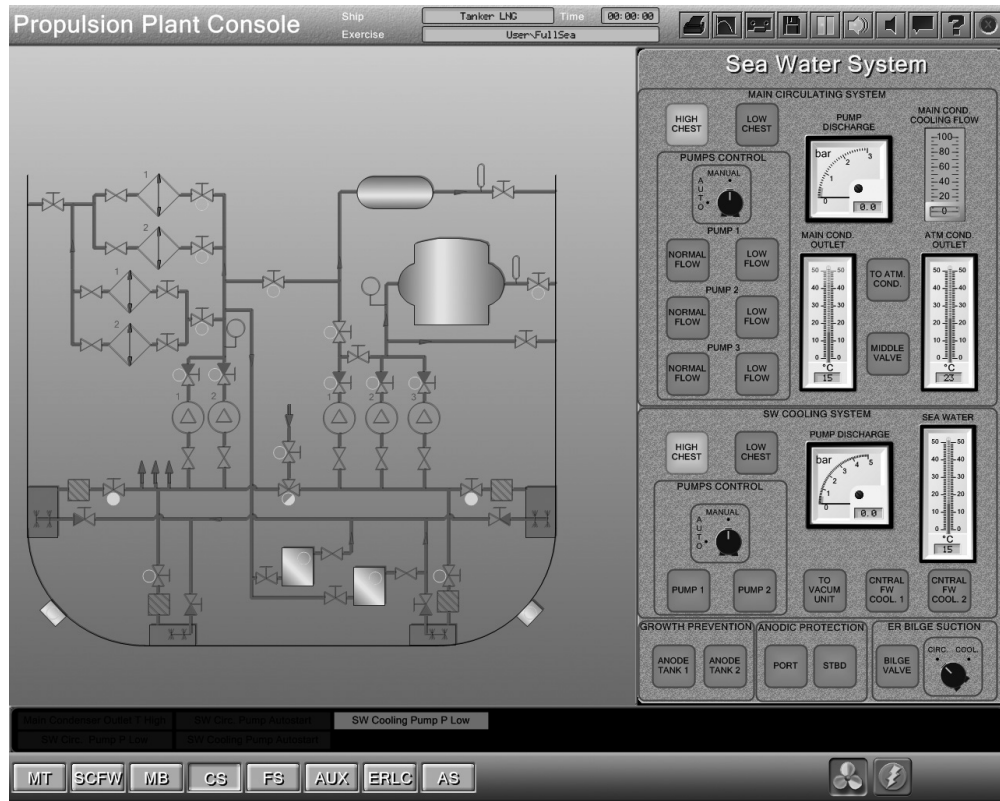


Fig. 15. The seawater cooling systems

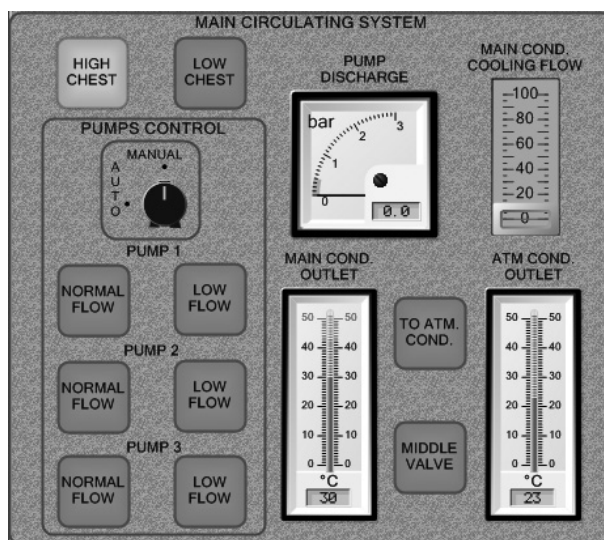
The system includes:

- for sea chests (two low ones and two high ones) equipped with filters and shutoff fittings;
- two pumps of the seawater cooling system, fresh water coolers (1 and 2) and coolers (1 and 2) of the device maintaining vacuum in the main condenser;
- three pumps of the main seawater circulation system, the main condenser the atmospheric condenser;
- the growth prevention system;
- the anodic hull protection system.

Control Panel

The control panel in the right-hand part of the screen page consists of two basic modules.

The MAIN CIRCULATING SYSTEM module is designed for remote control of the main circulation system:



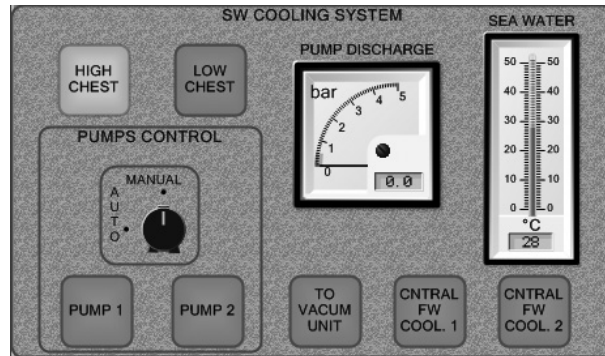
The PUMPS CONTROL module is designed for remote manual/automatic control of the circulating pumps “PUMP 1”, “PUMP 2” and “PUMP 3”.

The module includes:

- the pump mode selector switch “AUTO/MANUAL”;
- the buttons for tuning the pumps ON/OFF in the manual control mode (one or each of three pumps “PUMP 1”, “PUMP 2” and “PUMP 3”)
- “NORMAL FLOW” button is designed for remote start of the pump at its rated capacity (rotary velocity);
- “LOW FLOW” button is designed for remote start of the pump at a reduced capacity (rotary velocity);
- “HIGH CHEST” button is designed for remote control of the “High Sea Chest Valve” button and supply of seawater to the system from the high sea chest;
- “LOW CHEST” button is designed for remote control of the “Low Sea Chest Valve” button and supply of seawater to the low sea water change;
- PUMP DISCHARGE pressure gauge is designed to indicated pressure on the discharge side of the circulating pump;
- MAIN COND COOLING FLOW setter determines the rate of opening of the valve at the outlet of the main condenser (regulating the water flow-rate through the main condenser). The position “0” of the setter corresponds to a closed valve, in which case water flow-rate is zero, the pressure being maximum. The “100” position corresponds to a wide-open valve;
- MAIN COND OUTLET temperature gauge is designed for indication of temperature downstream of the main condenser;
- “TO ATM. COND.” button opens seawater supply to the atmospheric condenser;

- “MIDDLE VALVE” button is designed for remote control of the Middle Valve (merging of the two seawater systems in emergency);
- ATM. COND. OUTLET temperature gauge to indicate water temperature at the outlet of the main condenser.

The SW COOLING SYSTEM module is designed for remote control of the seawater cooling system:

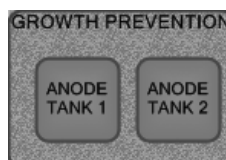


The “PUMPS CONTROL” module is designed for remote manual/automatic control of the cooling pumps “PUMP 1” and “PUMP 2”.

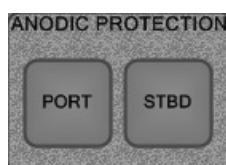
The module includes:

- the pump operation mode selector “AUTO/MANUAL”;
- the button for turning ON/OFF the pumps “PUMP 1”, “PUMP 2” in manual mode;
- “HIGH CHEST” button for remote control of the High Sea Chest Valve and seawater supply to the system from the high inlet sea box;
- “LOW CHEST” button for remote control of the Low Sea Chest Valve and seawater supply to the system from the low inlet sea box;
- PUMP DISCHARGE pressure gauge to indicate pressure on the discharge side of the pumps;
- SEA WATER temperature gauge to indicate seawater temperature;
- “TO VACUUM UNIT” button opens the seawater supply valve to the Vacuum Unit Cooling 1, 2 device coolers to maintaining vacuum in the main condenser;
- the buttons “CNTRL FW COOL. 1” and “CNTRL FW COOL. 2” control the valves supplying seawater to freshwater coolers 1 and 2.

The GROWTH PREVENTION module is designed for remote control of power supply to the growth prevention system located in the anodic tanks:



The ANODIC PROTECTION module is designed for remote control of power supply to the active anodic plates “PORT” and “STBD” that protect the ship hull against corrosion:



The ER BILGE SUCTION module is designed to connect the seawater system to the ER Bilge system making it possible to use the seawater pumps (cooling and circulating) to remove water from the engine room in case of flooding:



- “BILGE VALVE” button is designed for remote manual control of the valve used to connect to the engine room water removing system;
- “CIRC./COOL.” selector switch controls the three-position valve and provides connection of the engine room water removing system either to the circulating pumps (position “CIRC.”) or to the cooling system pumps (position “COOL.”).

Alarm System

- MAIN COND OUTLET T HIGH – high temperature at the condenser outlet;
- SW CIRC PUMP P LOW – low pressure of sea water circulating pump;
- SW CIRC PUMP AUTOSTART – automatic start of sea water circulating pump;
- SW COOL PUMP P LOW – low pressure of cooling sea water pump;
- SW COOL PUMP AUTOSTART – automatic start of cooling sea water pump.

Faults Entered by Instructor

- SW Circulating Pump 1 breakdown – breakdown of sea water circulating pump 1;
- SW Circulating Pump 2 breakdown – breakdown of sea water circulating pump 2;
- SW Circulating Pump 3 breakdown – breakdown of sea water circulating pump 3;
- SW Circulating Pump 1 wear – wear of sea water circulating pump 1;
- SW Circulating Pump 2 wear – wear of sea water circulating pump 2;
- SW Circulating Pump 3 wear – wear of sea water circulating pump 3;
- SW Circulating Pumps Atom. Mode failure – faulty automatics of the circulating pump control system;
- Cavitation in SW circ. system – cavitation in the circulating system;
- Upper chest fouling (circ. syst.) – fouling of the upper sea water chest (circulating system);
- Lower chest fouling (circ. syst.) – fouling of the lower sea water chest (circulating system);
- Main Condenser cooling fault – worsening of the cooling process, lower heat transfer due to the sedimentation on the surfaces of the Main Condenser cooler on the sea water side;
- Atmospheric Condenser cooling fault – worsening of the cooling process, lower heat transfer due to the sedimentation on the surfaces of the Atmospheric Condenser cooler on the sea water side;
- SW Cooling Pump 1 breakdown – breakdown of pump 1 of the sea water cooling system;
- SW Cooling Pump 2 breakdown – breakdown of pump 2 of the sea water cooling system;
- SW Cooling Pump 1 wear – wear of pump 1 of the sea water cooling system;
- SW Cooling Pump 2 wear – wear of pump 2 of the sea water cooling system;

- SW Cooling Pumps Atom. Mode failure – faulty automatics of the cooling system pumps control;
- Cavitation in SW cool. system – cavitation in the cooling system;
- Upper chest fouling (cool. syst.) – fouling of the upper sea water chest (circulating system);
- Lower chest fouling (cool. syst.) – fouling of the lower sea water chest (circulating system);
- FW Cooler 1 (2) fouling – fouling of fresh water cooler 1 (2);
- Anod. Tank 1 (2) power fault – faulty power supply of anode tank 1 (2).

Fresh Water Cooling System (FW System)

Purpose

The system is intended for cooling lubricating oil of the turbine, compressed air compressors and the diesel generator (DG).

In the system, fresh water which is in its turn cooled in the sea water cooler, is pumped in the closed loop.

System Components

The systems mnemonic diagram and generalised control panel are shown in Fig. 16:

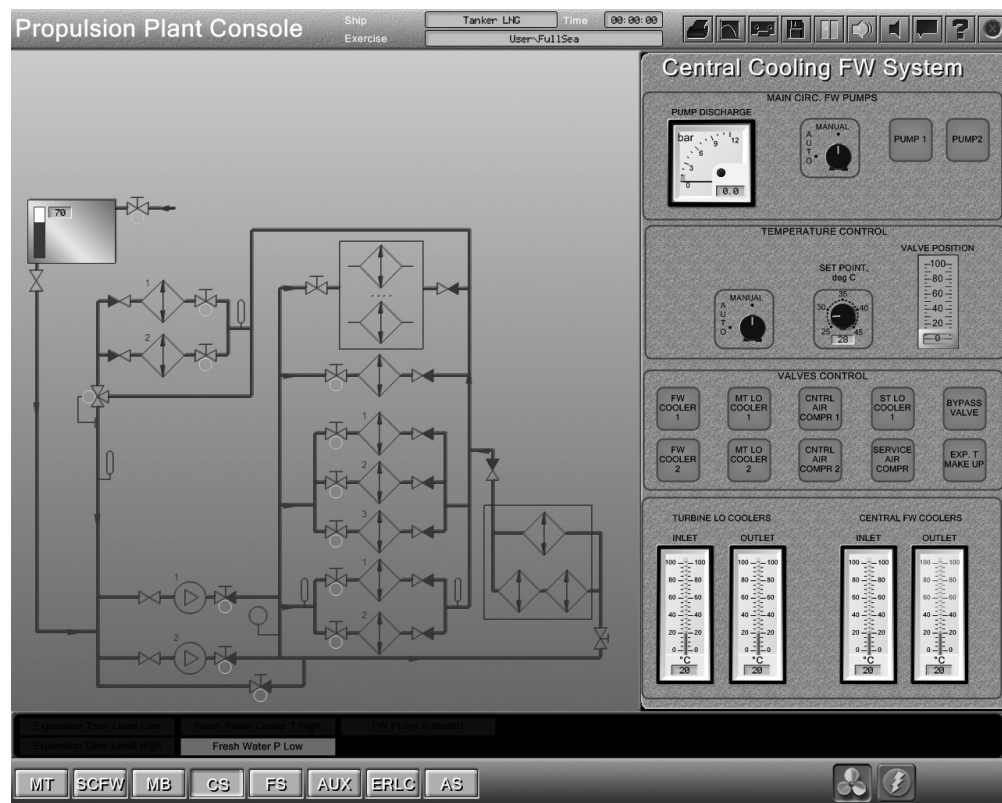
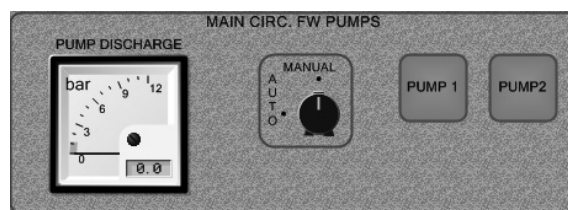


Fig. 16. "Central Cooling FW System"

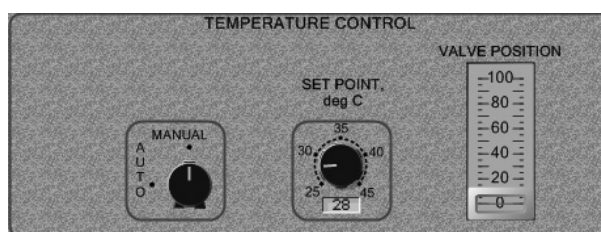
The MAIN CIRC. FW PUMPS group enables control of fresh water circulating pumps:



The group contains:

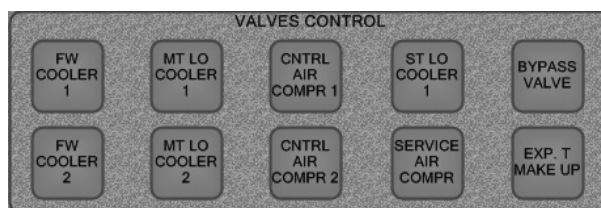
- PUMP DISCHARGE pressure gauge which shows the discharge pressures of pumps;
- pumps operating mode “AUTO/MANUAL” switch;
- “PUMP 1”, “PUMP 2” buttons for turning on/off Pump 1 and Pump 2.

The TEMPERATURE CONTROL group is used for the system temperature control (manipulating the Temperature Control Valve):



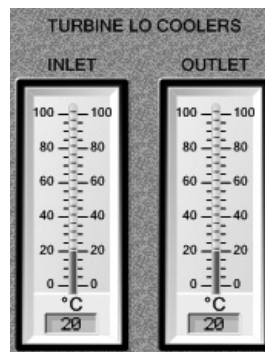
- the “AUTO/MANUAL” switch is used for switching the valve operating mode;
- in the automatic mode, the required water temperature is set with the aid of the “SET POINT” potentiometer;
- in the manual mode, the valve opening degree is set with the aid of the VALVE POSITION setter.

The VALVES CONTROL group enables control of:



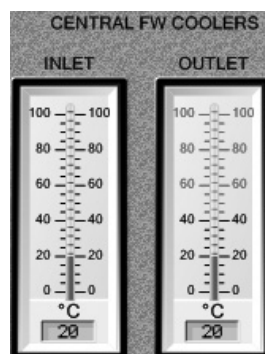
- valves for the supply of cooling water to fresh water coolers 1 and 2;
- valves for the supply of fresh water to the LO coolers of turbine 1 and 2;
- valves for the supply of fresh water to the coolers of the compressed control air system compressors 1 and 2 and of the service compressor;
- valves for the supply of fresh water to the oil cooler of the stern tube;
- “BYPASS VALVE”;
- valve (the Exp. Tank Make-Up Valve) for replenishing the expansion tank.

The TURBINE LO COOLERS group:



The group shows fresh water temperature at the inlet to and outlet from the oil coolers of the main turbine.

The CENTRAL FW COOLERS group:



The group shows fresh water temperature at the inlet and outlet to/from the fresh water coolers.

Alarm Signals

- EXPANSION TANK LEVEL LOW – low level in the expansion tank;
- EXPANSION TANK LEVEL HIGH – high level in the expansion tank;
- FRESH WATER COOLER T HIGH – high temperature in the fresh water cooler;
- FRESH WATER P LOW – low fresh water pressure;
- FW PUMP AUTOSTART – automatic fresh water pump start.

Faults Entered by Instructor

- FW pump 1(2) breakdown – breakdown of fresh water pump 1 (2);
- FW pump 1(2) wear – wear of fresh water pump 1 (2);
- FW pumps autom. control failure – faulty automatics of the fresh water pumps control;
- Cavitation in FW system – cavitation in the fresh water system;
- FW Cooler 1 (2) fouling – fouling of fresh water cooler 1 (2);
- Main Turbine LO Cooler 1 (2) fouling – fouling of main turbine oil cooler 1 (2);
- Control Air Compressor Cooler 1 (2) fouling – fouling of cooler 1 (2) of the Control Air Compressor;
- Service Air Compressor Cooler fouling – fouling of cooler of the Service Air Compressor;
- Stern Tube LO Cooler fouling – fouling of stern tube oil cooler;

- FW Water leakage – leakage from the fresh water cooling system;
- FW Temperature controller failure – faulty temperature controller of the fresh water cooling system.

Page FS – Fuel System

Purpose

The systems on page FS are used for storing heavy/diesel fuel, fuel transfer and treatment as well as supply of oil fuel to consumers. The systems are designed for automatic remote control (ARC) of the systems from the engine control room (ECR).

A press on the FS button results in additional menu appearance, allowing selection of the mnemonic and the control panel of the system of interest:

- Fuel supply system;
- Oil fuel storage system;
- Separation system.

The system includes the following units imitated in the simulator:

- pipelines as hydro- and gas-dynamic objects;
- onboard fuel consumers as thermodynamic objects;
- pumps as hydrodynamic objects;
- fuel/oil heaters;
- fuel/oil heaters separators;
- remotely controlled valves (pipeline fittings).

Fuel Oil Supply System

Purpose

The system is used for supply of heavy fuel oil and diesel oil from the service tank to the burners of the steam boilers 1 and 2. there is a possibility to take fuel from the heavy/diesel oil the purpose of supplying the diesel-generator.

The fuel is supplied:

- under necessary pressure ensuring fuel circulation through the system;
- at a certain temperature that ensures viscosity of 0 to 100 cSt, necessary for proper fuel atomization at the burners;
- through the filter that ensures removal of particles greater than 50 micron in order to prevent abrasive wear and jam of the fuel equipment components.

To make the heavy fuel less viscous, heating is provided: preliminary heating in the service tank and the pipelines (steam trace heating); and final heating in the fuel heater of the fuel viscosity regulator.

System Components

The system diagram implemented in the simulator, i.e. the system mnemonic, is shown in Fig. 17:

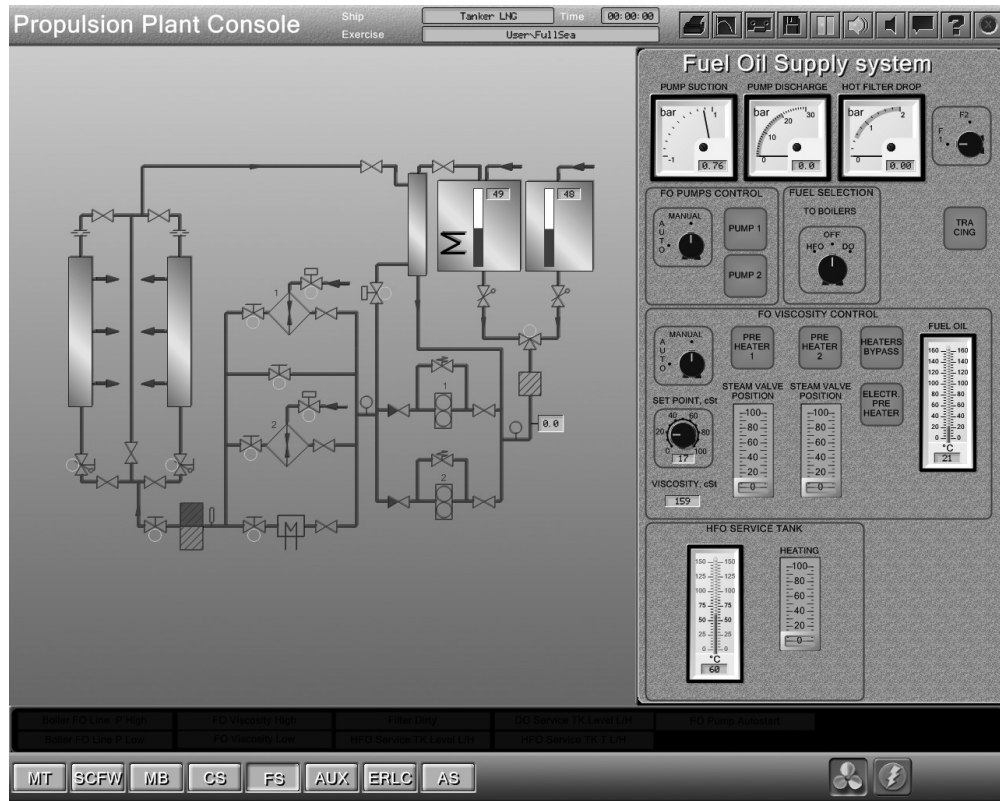


Fig. 17. Fuel oil supply system

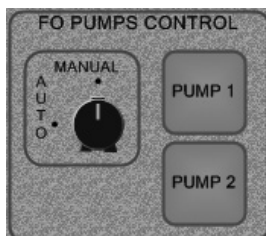
The system includes the following components:

- heavy oil service tank;
- diesel oil service tank;
- fuel supply pumps 1 and 2;
- fuel viscosity regulator controlling the steam fuel heaters 1 and 2 and an electrical fuel heater;
- primary and fine fuel purification filters;
- the pipeline system with all necessary fittings.

Control Panel

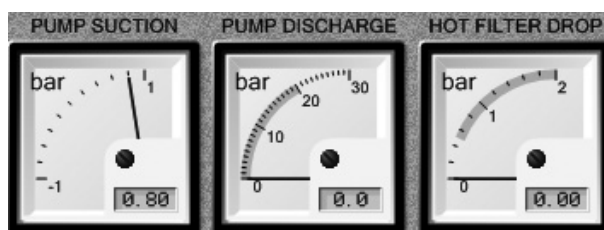
The control panel in the right-hand part of the screen page consists the following modules:

The FO PUMPS CONTROL module is designed for manual remote and automatic turning the fuel supply pumps ON and OFF:



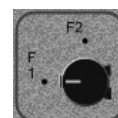
- “AUTO/MANUAL” switch for selection of fuel pump control mode;
- the buttons “PUMP 1”, “PUMP 2” are designed to remotely turn the fuel supply pumps 1 and 2 ON and OFF, respectively.

The pressure gauge module for pressure monitoring:



- PUMP SUCTION pressure gauge is designed to monitor pressure on the suction side of the fuel supply pumps;
- DUMP DISCHARGE pressure gauge is designed to monitor pressure on the discharge side of the fuel supply pumps;
- HOT FILTER DROP pressure gauge shows pressure drop through the two-section fine filter “FO FINE FILTER”.

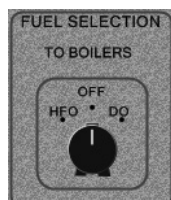
The selector switch “F1/F2”, located next to the pumps, is designed for remote change between the filter sections:



The “TRACING” button is used to supply steam for pipeline heating:



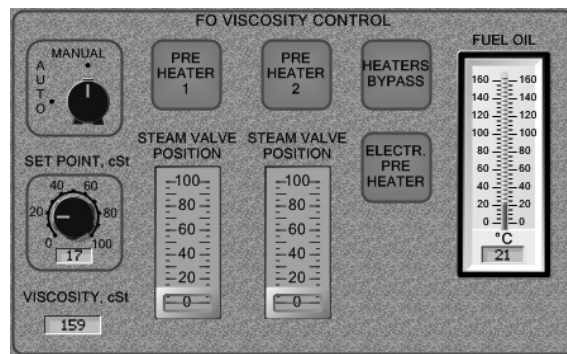
The FUEL SELECTION unit is intended for the manual remote control of the three-way valves for selecting the fuel oil type fed to the main boilers:



The TO BOILERS selector switch has three positions “HFO/OFF/DO”:

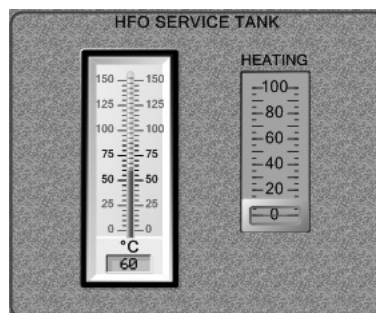
- “HFO” means that fuel is taken from the heavy oil service tank “HFO Service Tank”;
- “DO” means that fuel is taken from the diesel oil service tank “DO Service Tank”;
- “OFF” means that fuel supply of shut off.

The FO VISCOSITY CONTROL module is the fuel viscosity regulating module:



- the selector switch “AUTO/MANUAL” is designed for selection of viscosity regulator control mode;
- the buttons “PREHEATER 1” and “PREHEATER 2” are used for remote control of the valves providing fuel flow through the fuel heaters “FO Preheater 1 Valve” and “FO Preheater 2 Valve”;
- the setters STEAM VALVE POSITION are used to adjust the steam flow through the fuel heaters 1 and 2 in manual mode. The “0” position of the setter corresponds to a closed steam supply valve. The “100” position corresponds to a wide-open steam supply valve;
- SET POINT knob is used to specify a fuel viscosity value in viscosity regulator automatic control mode;
- VISCOSITY gauge shows the current fuel oil viscosity value;
- “HEATERS BYPASS” button is used for remote control of the viscosity regulator bypass valve;
- “ELECTR. PREHEATER” button is used for remote start of the electric preheater (opening the valve at the outlet of the heater and supplying voltage to the latter). The electric fuel heater is used for starting the steam boilers 1 and 2;
- “FUEL OIL TEMPERATURE” temperature gauge is used to monitor fuel temperature downstream of the heaters.

The HFO SERVICE TANK module is designed for to monitor fuel temperature in the heavy oil service tank:



- Temperature gauge is used to monitor fuel temperature in the tank;
- Heating setter is used for manual control of the valve supplying steam to the tank for the purpose of heating fuel in the latter. The “0” position corresponds to a disabled heater, while the “100” position means the maximum heater capacity.

Alarm Signals

- BOILER FO LINE P HIGH – high pressure in the fuel oil line;
- BOILER FO LINE P LOW – low pressure in the fuel oil line;
- FO VISCOSITY HIGH – high fuel oil viscosity;
- FO VISCOSITY LOW – low fuel oil viscosity;
- FILTER DIRTY – filter fouling;
- HFO SERVICE TK LEVEL L/H – low/high level in the heavy fuel oil service tank;
- DO SERVICE TK LEVEL L/H – low/high level in the diesel oil service tank;
- HFO SERVICE TK T L/H – low/high temperature in the heavy fuel oil service tank;
- FO PUMP AUTOSTART – fuel oil pump autostart.

Faults Entered by Instructor

- FO Pump 1(2) breakdown – breakdown of fuel oil pump 1 (2);
- FO Pumps autom. mode failure – faulty automatics of fuel oil pumps control;
- Preheater 1(2) fouling – fouling of fuel oil preheater 1 (2);
- Viscosity controller failure – faulty fuel oil viscosity controller;
- Filter 1(2) fouling – fouling of fuel oil filter 1 (2).

Fuel Oil Transfer System

Purpose

The system is intended for the storage, settling and transfer of the fuel oil (heavy and diesel) for its supply to the separation and service tanks.

System Components

The diagram of the system implemented in the simulator is shown on the mnemonic diagram in Fig. 18:

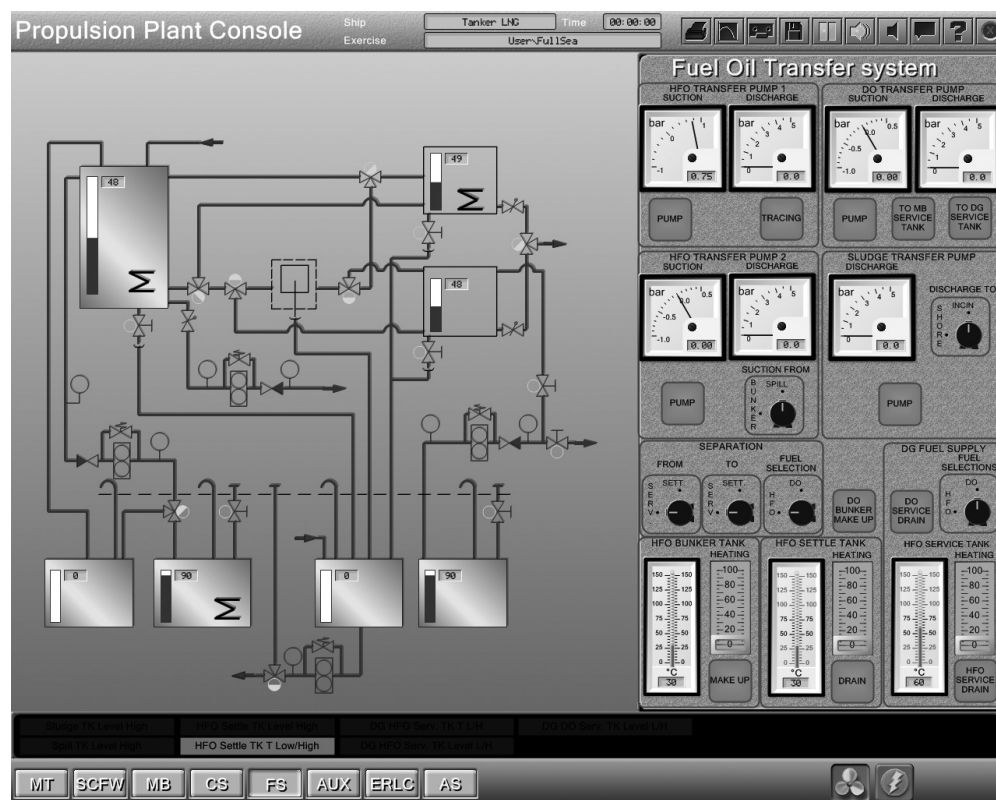


Fig. 18. Fuel treatment system (FS_FOT_System.bmp)

The system includes the following components modelled in the simulator:

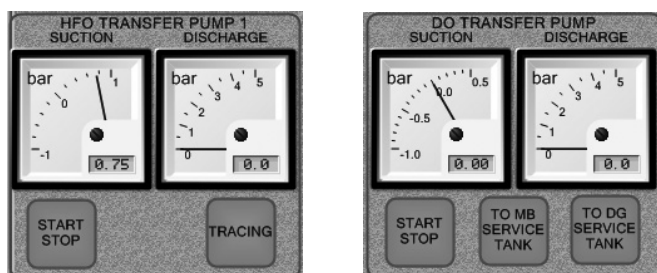
- heavy fuel oil bunker tank which serves for storing the stock of heavy fuel oil. Heating with steam coils is available;
- diesel oil bunker tank which serves for storing the stock of diesel oil;
- heavy fuel oil transfer pump which serves for replenishing the settle tank and for other fuel oil transfer operations;
- diesel oil transfer tank which serves for replenishing the diesel oil service tank and for other fuel oil transfer operations;
- heavy fuel oil and diesel oil service tanks. They serve for storing the stock of fuel oil enabling consumers operation;
- heavy fuel oil settle tank. It is replenished from the bunker with the heavy oil transfer pump. The settle tank overflow tube is connected with the overflow oil tank. The settle tank has a tap in the bottom part for draining the sludge to the sludge tank. The settle tank has steam coil heating. The fuel oil pipelines going to the tank are also heated with steam for reducing the transferred oil viscosity;

- the overflow tank serves as a guarantee against the overflowing of the settle and service tanks. When it is overfilled, fuel oil spills onto the deck through the “gooseneck” air tube (emergency). Fuel oil can be pumped from the overflow tank to the settle tank;
- dirty oil tank serves for collecting the separation waste, sludge and other dirty fuel and lubricating oil. There is a pump for transferring the tank contents on shore or supplying it to the incinerator.

Control Panel

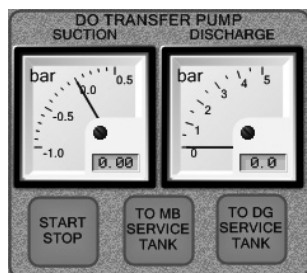
The control panel in the right-hand part of the screen page contains the following groups:

The HFO TRANSFER PUMP 1 and HFO TRANSFER PUMP 2 groups are intended for the control of the heavy fuel oil transfer pumps:



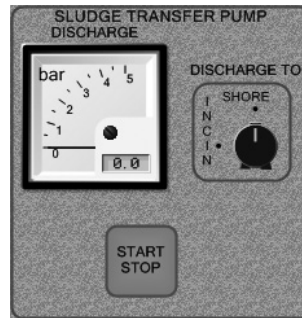
- SUCTION and DISCHARGE pressure gauge in each group shows the current pressure on the suction and discharge side of HFO Transfer Pump 1 and HFO Transfer Pump 2;
- HFO Transfer Pump 1 and HFO Transfer Pump 2 are turned on/off by using the “START/STOP” buttons;
- “TRACING” button in the HFO TRANSFER PUMP 1 group turns on steam heating of fuel oil lines for reducing viscosity of the transferred fuel oil;
- “SUCTION FROM BUNKER/SPILL” switch controls the Bunker – Spill valve. Depending on the position switch, the heavy fuel oil settle tank is replenished from the HFO Bunker Tank or the Spill Oil Tank.

The DO TRANSFER PUMP group is intended for the control of the diesel oil transfer pump:



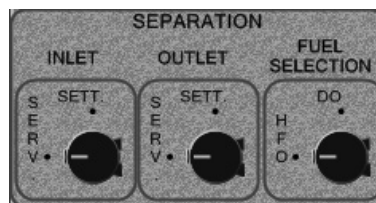
- SUCTION and DISCHARGE pressure gauges show the current pressure on the pump suction and discharge side;
- DO Transfer Pump is turned on/off by using the “START/STOP” button;
- “TO MB SERVICE TANK” button opens the valve for supplying fuel oil to the boiler service tank;
- “TO DG SERVICE TANK” button opens the valve for supplying fuel oil to the DG service tank.

Operation of the dirty fuel pump is controlled via the SLUDGE TRANSFER PUMP group:



- DISCHARGE pressure gauge is intended for displaying the fluid pressure on the “Sludge Pump” discharge side;
- “START/STOP” button turns on/off the dirty fuel transfer pump;
- “DISCHARGE TO INCIN./SHORE” switch is intended for selecting the transfer direction – to the shore or to the incinerator.

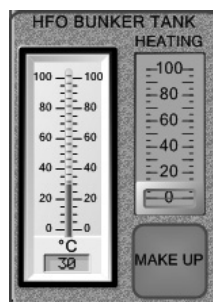
The SEPARATION group allows selection of the fuel (FO or DO) fed to the separation, of the place which the fuel is supplied to the separation from and the place where it will be supplied after the separation:



- INLET switch has two positions: “SERV.” and “SETT.”. Depending on the switch position, the fuel is fed to the separation either from the heavy fuel oil service tank or from the heavy fuel oil settle tank;
- OUTLET switch has two positions: “SERV.” and “SETT.”. Depending on the switch position, the separated fuel is returned either to the service tank or to the settle tank;
- FUEL SELECTION switch is intended for selecting the fuel grade supplied for separation;
- On the right-hand, the “DO BUNKER MAKE UP” button opens the tank make-up valve and imitates reception of fuel from the shore.

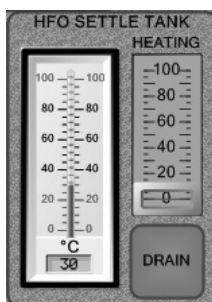


The HFO BUNKER TANK group includes:



- the temperature gauge which shows the current fuel oil temperature in the tank;
- HEATING setter allows control of the contents heating degree;
- “MAKE UP” button open the HFO Bunker Tank make-up valve.

The HFO SETTLE TANK group consists of:



- the temperature gauge shows the current fuel temperature in the tank;
- HEATING setter allows the degree of tank heating with steam coils to be controlled;
- “DRAIN” button opens the valve for draining sludge from the HFO Settle Tank.

The DG FUEL SUPPLY group:



- FUEL SELECTIONS switch is intended for selecting the fuel oil supplied to the DG – DO or HFO;
- “DO SERVICE DRAIN” button opens the drain valve of the diesel oil service tank.

The HFO SERVICE TANK group:

- the temperature gauge shows the current fuel oil temperature value in the HFO Service Tank;
- HEATING temperature setter allows the degree of heating the content of the service tank to be controlled;
- “HFO SERVICE DRAIN” button opens the valve for draining sludge from the heavy fuel oil tank.

Alarm System

- SLUDGE TK LEVEL HIGH – high level in the sludge tank;
- SPILL TK LEVEL HIGH – high level in the spill tank;
- HFO SETTLE TK LEVEL HIGH – high level in the HFO settle tank;
- HFO SETTLE TK T LOW/HIGH – low/high temperature of heavy fuel oil in the HFO settle tank;

- DG HFO SERV TK T LOW/HIGH – low/high temperature of fuel in DG HFO Service tank;
- DG HFO SERV TK LEVEL LOW/HIGH – low/high level of fuel in tank;
- DG DO SERV TK LEVEL LOW/HIGH – low/high level of fuel in tank.

Oil and Fuel Separators

Purpose

Separators serve for the fuel and lubricating oil treatment – for the removal of water and hard particles from them.

The separator can operate in two modes:

- Purification – treatment mode with the permanent removal of water from the separator drum. It is used for the treatment of products containing a large amount of water ($> 1\%$);
- Clarification – product refining mode with the regular removal (shoot-off) of the separated hard particles (sludge) and a small amount of water from the separator drum.

System Components

The diagram of the system implemented in the simulator, is shown in the mnemonic diagram in Fig. 19:

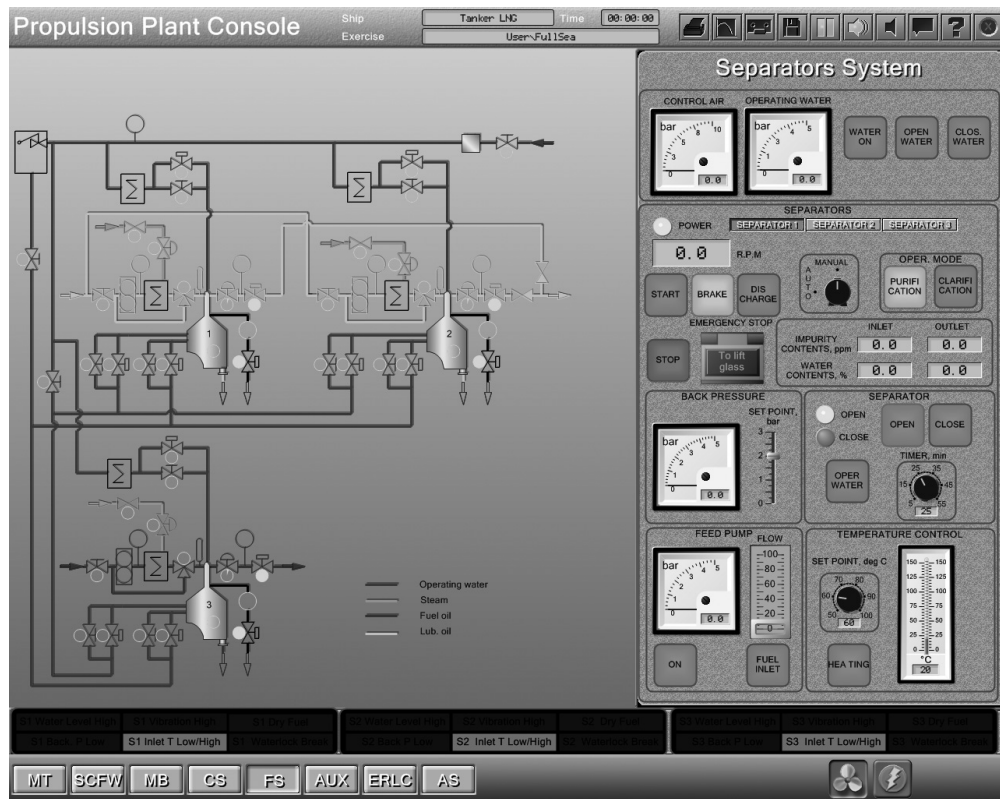


Fig. 19. Fuel and lubricating oil separation system (FS_Sep_System.bmp)

The system models three separators.

Separators 1 and 2 are intended for the treatment of the lubricating oil, whereas separator 3 is used for the fuel oil treatment.

Separators 1 and 2 operate in parallel; their serial operation is not provided for.

Control Panel

In the top part of the control panel incorporates controls common for all the three separators:

- CONTROL AIR pressure gauge for showing the control compressed air pressure;



- OPERATING WATER pressure gauge showing the operating water pressure;



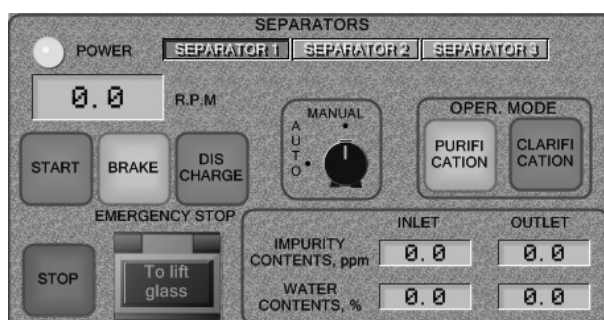
- “WATER ON” button opens the valve for supplying operating water to the system;
- “OPEN WATER” button opens the valve for supplying opening water to the system;
- “CLOS. WATER” button opens the valve for supplying the closing water to the system.



Selection of Separators 1, 2, or 3 is made with tabs:



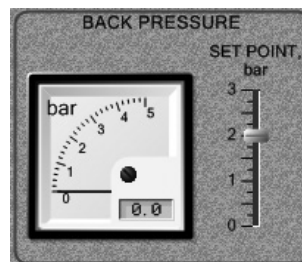
Arranged below are units for the control and monitoring of the selected separator:



- “POWER” on indicator;
- the separator “START” button;
- the separator “STOP” button;
- the separator “EMERGENCY STOP” button;
- the separator “BRAKE” on button;
- “DISCHARGE” button for turning on the separator unload mode (in the “AUTO” operating mode);

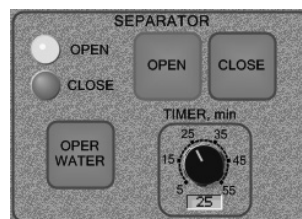
- “PURIFICATION” and “CLARIFICATION” buttons for imitating the selection of the separator operating mode (for separators 1 and 2);
- “AUTO/MANUAL” operation switch;
- the separator drum R.P.M. display;
- WATER CONTENTS, % INLET display of the water percentage at the separator inlet, and at the separator outlet – WATER CONTENTS, % OUTLET (for separators 1 and 2);
- INPURITY, ppm INLET display of hard particles content in the lubricating oil at the separator inlet, and at the separator outlet – INPURITY, ppm OUTLET (for separator 3).

Unit for the control of back pressure on the side of purified/clarified product issue from the separator:



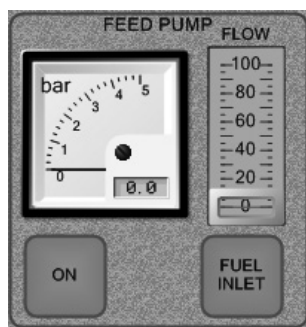
- the pressure gauge;
- SET POINT setter of the back pressure control.

The water and removal control group:



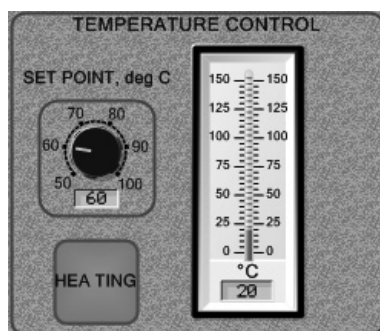
- the “OPER.WATER” button opening the valve for supplying the operating water to the separator (during the separator start and washing in the “MANUAL” mode, when the separator drum is replenishes and water is fed for the washing of the lubricating oil);
- the “OPEN” button opening the valve for supplying the separator opening ware (in the “MANUAL” separator operation mode), and the separator “OPEN” status indicator;
- the “CLOSE” button opening the valve for supplying the separator closing water (in the “MANUAL” separator operation mode), and the separator “CLOSE status indicator”;
- TIMER setter for when the sludge is drained from the separator by time in the automatic operation mode.

The FEED PUMP group for the control of the product supply to the separator:



- the pressure gauge which shows the product pressure after the feeding pump;
- “ON” button for starting the feeding pump;
- “FUEL INLET” button for supplying the product for purification/clarification;
- FLOW setter of opening the valve for fuel oil supply to the separator.

The TEMPERATURE CONTROL group:



- “HEATING” button opening the valve for supplying steam to the product and water heaters;
- SET POINT product temperature control setter;
- the temperature gauge showing the product temperature at the outlet from the heater/inlet to the separator.

Alarm Signals

- WATER LEVEL HIGH – high water level in the separator;
- BACK P LOW – low back pressure after the separator;
- VIBRATION – high vibration level;
- INLET T LOW/HIGH – low/high product temperature at the separator inlet;
- DRY FUEL – low water content in the fuel oil at the separator inlet;
- WATERLOCK BREAK – loss (break) of the water lock.

Safety System

The product outlet is closed if it contains a large amount of water, in the case of the water lock break and low back pressure (in the AUTO operating mode only).

Faults Entered by Instructor

- Separator drive breakdown;
- Separator bowl fouling – separator drum fouling, high vibration;
- Waterlock break;

- Pressostat fault;
- Closing Water solenoid valve fault;
- Opening Water solenoid valve fault;
- FO High water contents – high water content in the fuel oil (5 %);
- FO Medium water contents – medium water content in the fuel oil (3 %);
- LO High impurity – high content of hard particles in the lubricating oil (10000 ppm).

Work with System

Separators 1 and 2 are intended for the lubricating oil purification and clarification.

Separator 3 is intended for the fuel oil purification and clarification.

Separators 1 and 2 function in parallel, i.e., both separators operate independently.

Before the separator(s) start, feed operating water to the system (WATER ON) and open the supply of opening and closing water to the separators (Open Water and Closing Water valves).

Separator Start

1. In the simulator, the separator is started in the manual control mode: put the “AUTO/MANUAL” switch in the “MANUAL” position.
2. Select the clarification/purification operating mode – press the “PURIFICATION” or “CLARIFICATION” button (for separators 1 and 2).
3. Check the separator brake: the “BRAKE” button should be released.
4. Open the Water On valve, the Oper. Water and Clos. Water valves.
5. Run the separator electrical motor drive (the “START” button). Check that the drum is developed the required rpm (about 10000). At this stage, the drum is open, and the remains of water, product and sludge are removed from it.
6. Close the drum by supplying the closing water – the “CLOSE” button. Check that the “OPEN” button is released.
7. Open the product supply valve by using the “OIL INLET” button for Separators 1 and 2, or “FUEL INLET” for Separator 3.
8. Turn on the pump for feeding the product to the separator (the “FEED PUMP” button). As this is done, the Flow valve for feeding fuel oil to the separator is closed.
9. Turn on heating (the “HEATING” button) and set the required product temperature (SET POINT setter).
10. Use the “OPER. WATER” button to feed the operating water, and the drum is filled with water until the water appears in the indicator (spy hole) on the line of water drain from the separator (DRAIN).

11. Fill the drum with the product by opening slowly the FLOW valve for feeding the product to the separator (in doing this, it is necessary to check the required temperature product). The product pressure at the separator outlet ("BACK PRESSURE") is controlled by using the SET POINT setter. If the water lock is damaged by high back pressure, it is necessary to reduce the back pressure by 0.5–1 bar or increase the product supply. The safety solenoid valve is closed at the back pressure of more than 1 bar and is closed at the back pressure of less than 0.8 bar, or in an emergency when the "dirt" or water appear at the product outlet from the separator. Control of the back pressure is especially important in the manual control mode. In the separator automatic operation mode, the Water Drain valve is closed when the water level goes down in the drum.
12. Set the time (period) of removing sludge from the drum by using the "TIME, min" setter (in the Auto mode only).
13. Check the separation quality – content of water and hard particles in the product before and after the separator. This is simulated with the WATER CONTENTS, % – INLET/OUTLET and IMPURITY, ppm – INLET/OUTLET displays.
14. Check the separator operation parameters with the aid of indicators/displays on the control panel.

Separator Washing

1. The separator is operating in the "AUTO" mode.
2. Empty the drum (the "DISCHARGE" button).
3. Switch the separator to the "MANUAL" mode.
4. Feed the closing water – the "CLOSE" button.
5. Feed the operating water – the "OPER. WATER" button. The drum is filled with water and washed.
6. Empty the drum. Depending on the fouling degree, repeat the operation.

Separator Stop

1. The separator is operating in the "AUTO" mode.
2. Empty the drum (the "DISCHARGE" button).
3. Switch the simulator to the "MANUAL" mode.
4. Shut the water supply to the separator.
5. Stop the separator drive electrical motor (the "STOP" button).
6. Brake the separator (the "BRAKE" button).
7. In an emergency, use the "EMERGENCY STOP" button.

Page AUX – Auxiliary Systems

Compressed Air System

Purpose

The system is intended for the generation, storage and supply of the compressed air (to the control system, for service needs, to the boilers for the fuel oil atomising in the boiler burners, diesel generator start air system).

System Components

The diagram of the system implemented in the simulator is shown in the mnemonic diagram in Fig. 20:

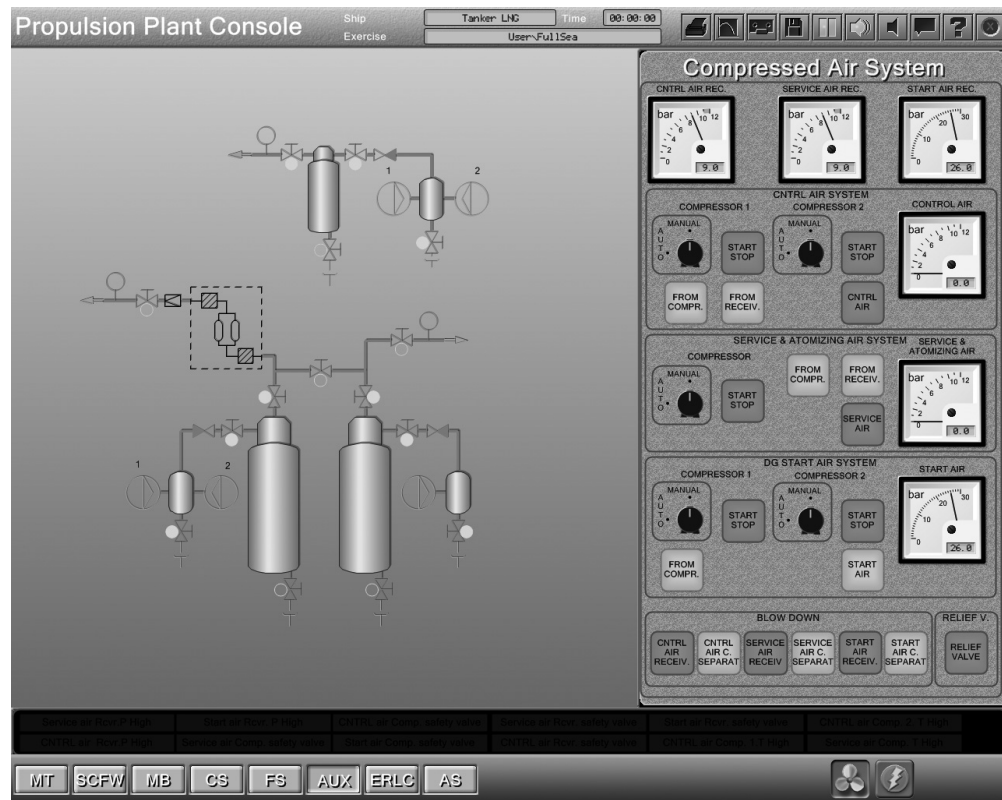


Fig. 20. Compressed air system

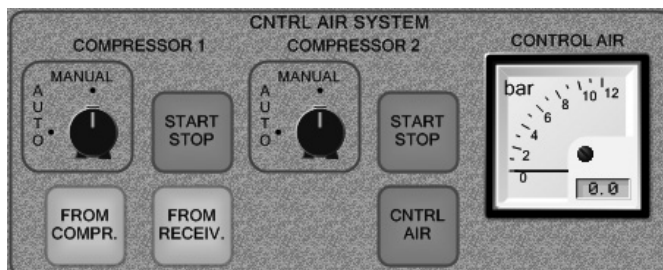
The system models:

- the system of pipelines and vessels (high pressure cylinders) as a gasdynamic object;
- the water-cooled Service Air Compressor provides compressed air with a pressure of 9 bars which is used in the ship compressed air system and is applied in the boilers for atomising fuel oil in the boiler burners (atomizing);
- water-cooled Control Air Compressor 1 and 2 provide compressed air with a pressure of 9 bars which is used in the electrical pneumatic remote control system;
- air-cooled DG Start Air Compressor 1 and 2 provide compressed air with a pressure of 25 bars which is use in the diesel generator start system;
- at the compressors outlet, the Oil and Water Separators are provided;
- Control Air Receiver, Service Air Receiver, DG Start Air Receiver are compressed air receivers (cylinders). Cylinder scavenging valves are provided for removing moisture from them.

Control Panel

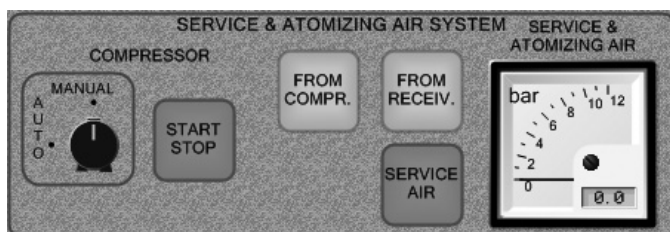
The control panel shown in the right-hand part of the screen page, contains the following groups.

The CNTRL AIR SYSTEM group is intended for the control of the control system compressed air subsystem:



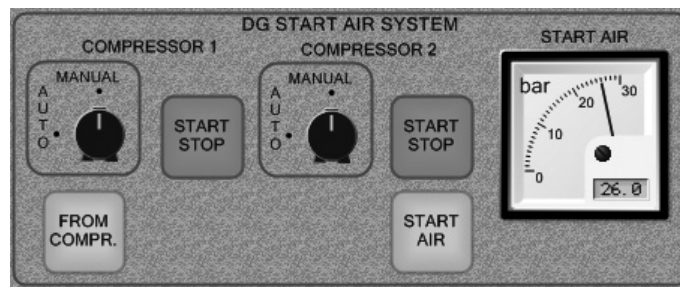
- the compressor 1 “AUTO/MANUAL” control mode selection switch – automatic control mode and manual control mode;
- the compressor 1 “START/STOP” button in the manual control mode;
- the compressor 2 “AUTO/MANUAL” control mode selection switch – automatic control mode and manual control mode;
- the compressor 2 “START/STOP” button in the manual control mode;
- “FROM COMPR.” button – control of the valve connecting the compressor to the compressed air receiver;
- “FROM RECEIV.” button opens the valve at the compressed air outlet from the receiver;
- “CNTRL AIR” button controls the shut-off valve for supplying compressed air to the control station via the reducing station;
- CONTROL AIR pressure gauge shows the compressed air pressure in the system.

The SERVICE & ATOMIZING AIR SYSTEM group:



- the compressor “AUTO/MANUAL” control mode selection switch – automatic control mode and manual control mode;
- the compressor “START/STOP” button in the manual control mode;
- “FROM COMPR.” button – control of the valve connecting the compressor to the compressed air receiver;
- “FROM RECEIV.” button opens the valve at the compressed air outlet from the receiver;
- “SERVICE AIR” button controls the shut-off valve for supplying compressed air to the system;
- SERVICE & ATOMIZING AIR pressure gauge – shows the compressed air pressure in the system.

The DG START AIR SYSTEM group:

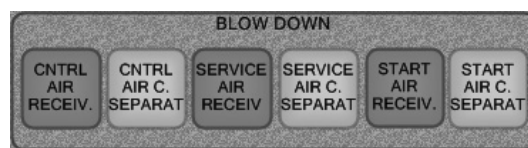


- the compressor 1 “AUTO/MANUAL” control mode selection switch – automatic control mode and manual control mode;
- the compressor 1 “START/STOP” button in the manual control mode;
- the compressor 2 “AUTO/MANUAL” control mode selection switch – automatic control mode and manual control mode;
- the compressor 2 “START/STOP” button in the manual control mode;
- “FROM COMPR.” button controls the valve connecting the compressor to the compressed air receiver;
- “START AIR” button controls the shut-off valve for supplying compressed air to the system;
- START AIR pressure gauge shows the compressed air pressure in the system.

The set of pressure gauges in the top part of the control panel shows pressure in the compressed air receivers:



The set of “BLOW DOWN” buttons serves for the control of valves for blowing down receivers and oil and water separators:



The relief valve from system to system serves for the deeper compressed air system redundancy. The relief valves are controlled by using the “RELIEF VALVE” button:



Alarm System

- SERVICE AIR RCVR. P HIGH – high pressure in the Service Air receiver;
- CNTRL AIR RCVR. P HIGH – high pressure in the Control Air receiver;
- START AIR RCVR. P HIGH – high pressure in the Start Air receiver;
- SERVICE AIR COMP. SAFETY VALVE – actuation of safety valve on the Service Air compressor;

- CNTRL AIR COMP. SAFETY VALVE – actuation of safety valve on the Control Air compressor;
- START AIR COMP. SAFETY VALVE – actuation of safety valve on the Start Air compressor;
- SERVICE AIR RCVR. SAFETY VALVE – actuation of safety valve on the Service Air receiver;
- CNTRL AIR RCVR. SAFETY VALVE – actuation of safety valve on the Control Air receiver;
- START AIR RCVR. SAFETY VALVE – actuation of safety valve on the Start Air receiver;
- CNTRL AIR COMP1. T HIGH – high temperature of the Control Air compressor 1;
- CNTRL AIR COMP2. T HIGH – high temperature of the Control Air compressor 2;
- SERVICE AIR COMP T HIGH – high temperature of the Service Air compressor.

Faults Entered by Instructor

- CNTRL Air Compressor 1 breakdown (motor) – breakdown of driving motor in Control Air compressor 1;
- CNTRL Air Compressor 2 breakdown (motor) – breakdown of driving motor in Control Air compressor 2;
- CNTRL Air Compressor 1 wear – wear of Control Air compressor 1;
- CNTRL Air Compressor 2 wear – wear of Control Air compressor 2;
- CNTRL Air Compressor 1 Autom. control failure – faulty automatics of the Control Air compressor 1;
- CNTRL Air Compressor 2 Autom. control failure – faulty automatics of the Control Air compressor 2;
- CNTRL Air system leakage – leakage from the Control Air system;
- Service Air Compressor breakdown (motor) – breakdown of the driving motor in the Service Air compressor;
- Service Air Compressor wear – wear of the Service Air compressor;
- Service Air Compressor Autom. control failure – faulty automatics of the Service Air compressor;
- Service Air system leakage – leakage from the Service Air system;
- DG Start Air Compressor 1 breakdown (motor) – breakdown of the driving motor of DG Start Air compressor 1;
- DG Start Air Compressor 2 breakdown (motor) – breakdown of the driving motor of DG Start Air compressor 2;
- DG Start Air Compressor 1 wear – wear of DG Start Air compressor 1;
- DG Start Air Compressor 2 wear – wear of DG Start Air compressor 2;
- DG Start Air Compressor 1 Autom. control failure – faulty automatics of the DG Start Air compressor 1;
- DG Start Air Compressor 2 Autom. control failure – faulty automatics of the DG Start Air compressor 2;
- DG Start Air system leakage – leakage from the DG Start Air system.

Stern Tube Lubricating Oil System

Purpose

The system ensures sealing of the propeller shaft and lubrication of the propeller shaft bearings.

System Components

The diagram of the system implemented in the simulator, is shown in the mnemonic diagram in Fig. 21:

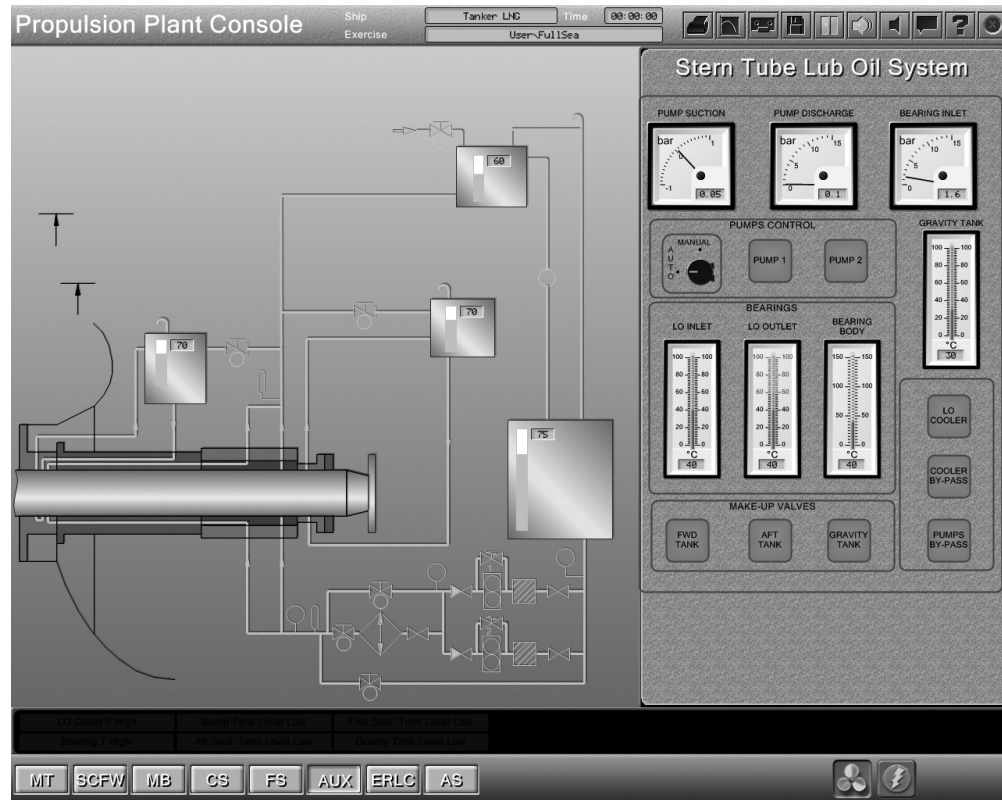


Fig. 21. Stern Tube Lub. Oil system

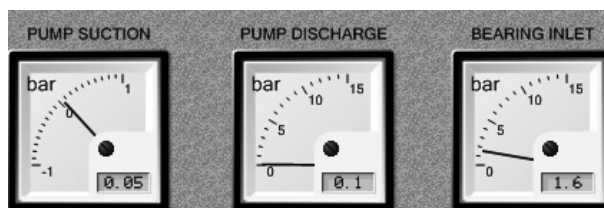
The system models:

- stern tube bearing unit as a hydro-dynamic and thermo-dynamic object;
- lubricating oil storage gravity tank (Sump Tank);
- fore and aft. lubricating oil tanks;
- main lubricating oil tank;
- circulating pumps 1 and 2;
- lubricating oil filters 1 and 2 before the circulating pumps;
- lubricating oil cooler;
- pipelines with necessary shut-off valves.

Control Panel

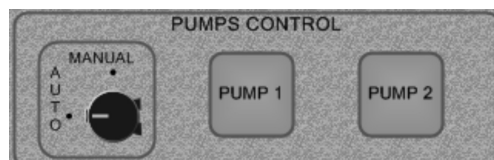
The control panel shown in the right-hand part of the screen page, contains:

Set of gauges:



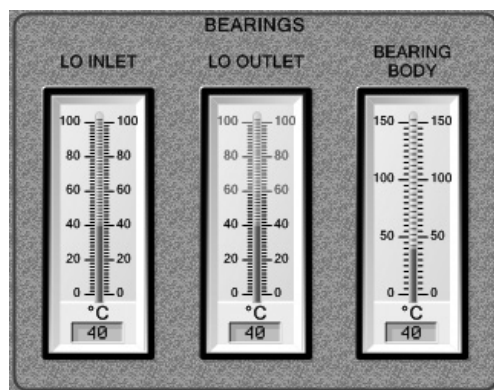
- PUMP SUCTION – pressure gauge which shows the lubricating oil pressure on the circulating pumps suction side;
- PUMP DISCHARGE – pressure gauge which shows the lubricating oil pressure on the circulating pumps discharge side;
- BEARING INLET – pressure gauge which shows the lubricating oil pressure at the inlet to the stern tube bearing.

The PUMPS CONTROL group contains controls of the circulating Stern Tube LO Pump 1, 2 in the manual and automatic control modes:



- “AUTO/MANUAL” pump control mode switch;
- “PUMP 1”, “PUMP 2” buttons for turning on/off the pumps in the manual control mode.

The BEARINGS group contains temperature gauges:

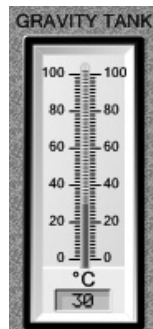


- LO INLET – temperature gauge of the cooling oil at the inlet to the stern tube bearing unit;
- LO OUTLET – temperature gauge of the cooling oil at the outlet from the stern tube bearing unit;
- BEARING BODY – temperature gauge which shows temperature of the stern tube bearing body.

The MAKE-UP VALVE group is intended for the control of the tank make-up valves:



- “FWD TANK” button opens/closes the fore tank make-up valve;
- “AFT TANK” button opens/closes the aft tank make-up valve;
- “GRAVITY TANK” button opens/closes the gravity tank make-up valve;
- GRAVITY TANK gauge – shows the lubricating oil temperature in the gravity tank:



- “LO COOLER” button – opens/closes the Stern Tube LO Cooler Valve:
- “COOLER BY-PASS” button – opens/closes Stern Tube LO Cooler By-pass Valve:
- “PUMPS BY-PASS” button – opens/closes Stern Tube Pumps By-pass Valve:



Alarm System

- LO OUTLET T HIGH – high lubricating oil temperature at the outlet from the bearing;
- BEARING T HIGH – high bearing temperature;
- SUMP TANK LEVEL LOW – low level in the sump tank;
- AFT SEAL. TANK LEVEL LOW – low level in the aft tank;
- FWD SEAL. TANK LEVEL LOW – low level in the fore tank;
- GRAVITY TANK LEVEL LOW – low level in the gravity tank.

Faults Entered by Instructor

- Leakage from LO system – lubricating oil leakage from the system;
- Leakage from FWD seal tank (seal ring wear) – leakage from the fore tank (shaft sealing wear);
- Leakage from AFT seal tank (seal ring wear) – leakage from the aft tank (shaft sealing wear);
- Stern tube pump 1 (2) breakdown– breakdown of pump 1 (2);
- Wear of Stern tube pump 1 (2) – wear of pump 1 (2);

- Bearing lubrication low (fouling) – deterioration of the bearing lubrication due to fouling;
- Filter 1 (2) fouling – fouling of filter 1 (2);
- Stern Tube LO Cooler fouling – fouling of cooler;
- Stern Tube bearing breakdown – bearing breakdown.

Distilling Plant

Purpose

The distilling plant modelled in the simulator, is intended primarily for the production of fresh water used in the boiler plant. The prototype is the unit by Alfa-Laval company.

System Components

The diagram of the system implemented in the simulator, is shown in the mnemonic diagram in Fig. 22:

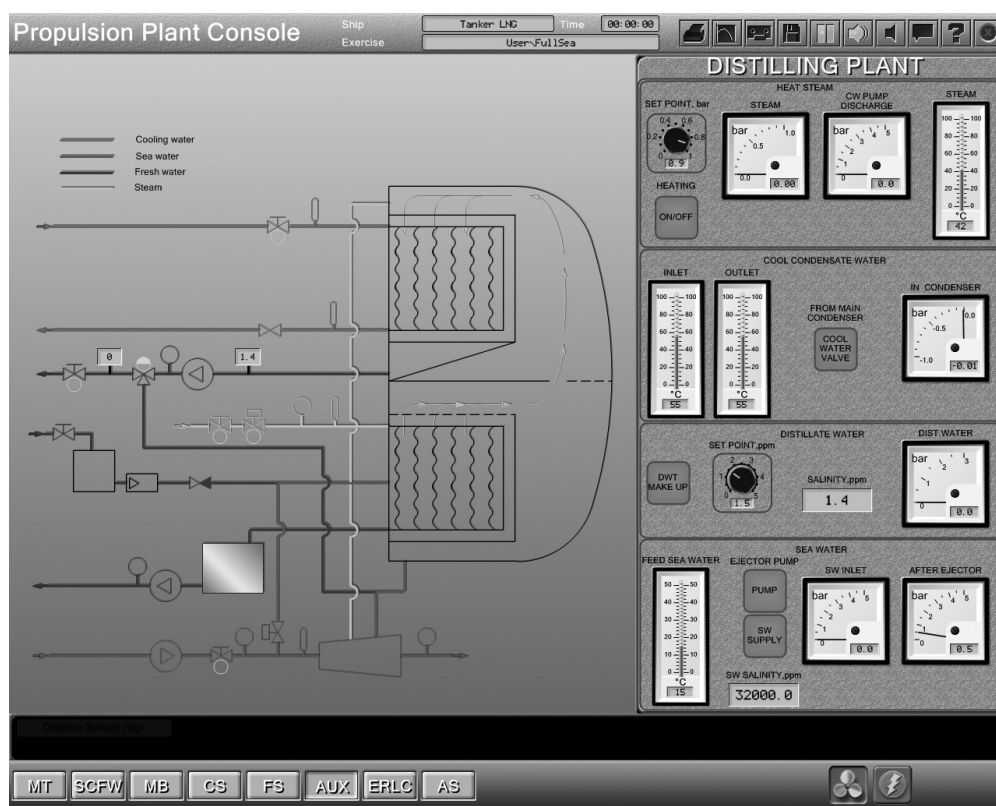


Fig. 22. Distilling plant

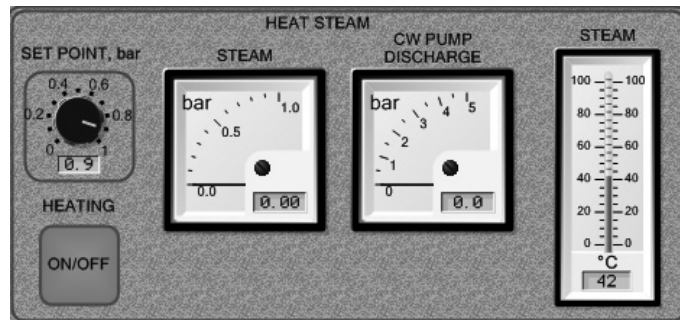
The system models:

- the distiller per se, whose body incorporates the Evaporator and the Condenser;
- sea water line containing pipelines with shut-off valves, sea water pump and the ejector;
- heating steam and condensate removal line which contains pipelines with shut-off valves, steam pressure control, condensate collection tank and the condensate pump;
- cooling water line containing pipelines with shut-off valves;
- distillate (distilled water) line containing pipelines with shut-off valves, salinity control, and FWD treatment dosage unit.

Control Panel

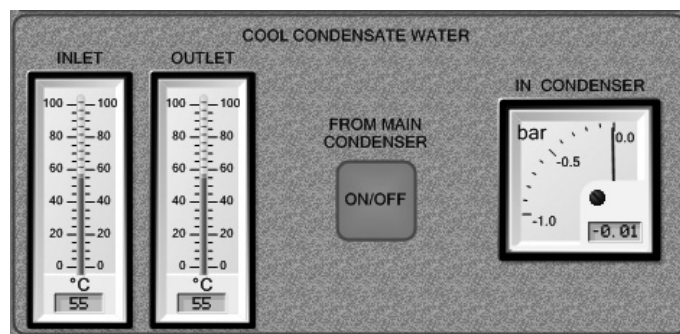
The control panel shown in the right-hand part of the screen page, contains:

The HEAT STEAM group is intended for the control of the heating steam line:



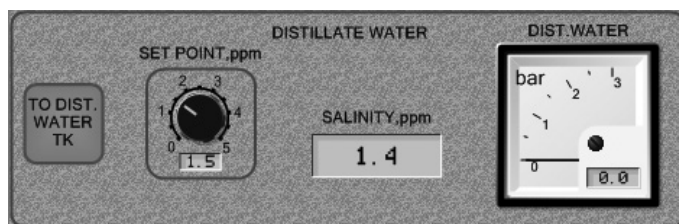
- HEATING – “ON/OFF” button opens/closes the cut-off valve on the line of steam supply to the evaporator;
- SET POINT setter is connected with the steam pressure controller and allows setting the required pressure of steam fed to the evaporator for the brine heating;
- STEAM pressure gauge is intended for showing the steam pressure at the evaporator inlet;
- STEAM temperature gauge is intended for showing the steam temperature at the evaporator inlet;
- CW PUMP DISCHARGE pressure gauge is intended for showing pressure on the Condensate Water Pump discharge side.

The COOL CONDENSATE WATER group is intended for control of the cooling water line:



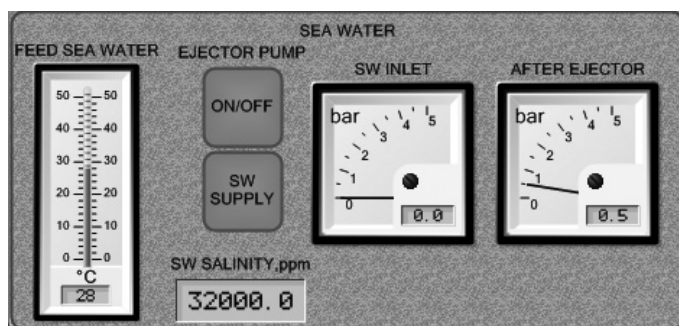
- FROM MAIN CONDENSER – “ON/OFF” button opens/closes the cut-off valve on the line feeding cooling water from the turbine Main Condenser;
- INLET temperature is intended for showing cooling water temperature at the condenser inlet;
- OUTLET temperature gauge is intended for showing cooling water temperature at the condenser outlet;
- IN CONDENSER pressure gauge is intended for showing vacuum in the condenser.

The DISTILLATE WATER group is intended for the distillate line control:



- “TO DIST. WATER TK” button opens/closes the cut-off valve on the line feeding distilled water to the distillate tank;
- SET POINT setter determines the distillate salinity setting for the salinity control;
- SALINITY display shows the distillate salinity;
- DIST. WATER pressure gauge is intended for showing pressure on the Dist. Water Pump discharge side.

The SEA WATER group is intended for the control of the sea water line:



- “ON/OFF” button is intended for turning on/off the Sea Water Pump;
- “SW SUPPLY” button opens/closes the valve for feeding sea water to the plant;
- SALINITY display shows the degree of the sea water salinity;
- FEED SEA WATER temperature gauge shows the sea water temperature at the ejector inlet;
- SW INLET pressure gauge is intended for showing pressure at the plant inlet on the Sea Water Pump discharge side;
- AFTER EJECTOR pressure gauge is intended for showing pressure after the ejector.

Alarm System

- DISTILLATE SALINITY HIGH – high distillate salinity degree.

Page ERLC – Local Control Stations in the Engine Room

The page ERLC provides:

- access to the local main steam turbine control panel;
- access to the local/emergency panels to control the steam boilers 1 and 2 in the engine room.

A press on the ERLC button results in additional menu appearance, allowing selection of the system of interest and the corresponding control panel.

Local Turbine Control Station in the Engine Room (MT Local Control System)

System Purpose

The local main turbine control station in the engine room is designed to start, shutdown and control the turbine from the engine room.

The local control station provides:

- turning ON/OFF the barring gear;
- slow turn of the turbine prior to starting it;
- turbine preheating
- turning turbine ON/OFF;
- turbine reverse;
- changing turbine RPM;
- control of drain valves (condensate drain valves) from various parts of the turbine through part (casings);
- control of a number of turbine parameters;
- control of the turbine in the emergency operation mode.

Control Panel

The control panel in Fig. 23 contains the following modules:



Fig. 23. Main Turbine Local Control panel

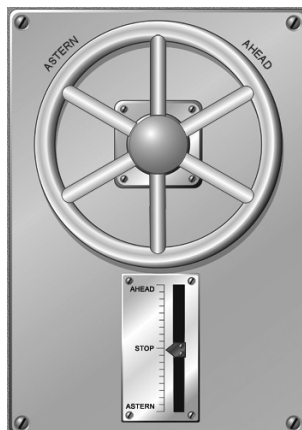
The CONTROL POS. TRANSFER module includes the selector switch to select a turbine control station:



- “LOCAL” position of the switch means that the turbine is operated from the local station in the engine room;
- “ECR” position of the switch means that the turbine is operated from ECR.

Control from the local control panel in the engine room is carried out, when the switching is in the “LOCAL” position.

Below you can see the device of direct non-follow-up control of the manoeuvring valve:



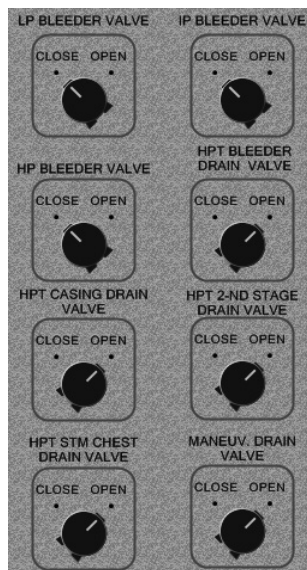
Control of the manoeuvring valve is imitated by moving the device allow in the ahead and astern zones using the mouse cursor.

Engine telegraph repeater:



The repeater features a circular dial divided into two parts – AHEAD and ASTERN graduated in accordance with the vessel motion speed (STOP, DEAD SLOW, SLOW, etc.). The pointer moves around the dial, its motion corresponding to the motion of the engine telegraph knowledge on the bridge (i.e., it indicates the Bridge order). As soon the pointer changes to another position, the engine telegraph starts to sound. The engine telegraph acknowledges lever is located coaxially to the pointer. Rotation of the acknowledge lever to the position matching the engine telegraph pointer by the watch engineer means the Bridge order has been accepted. The sounding ceases. The watch engineer changes turbine RPM in accordance with the table of correspondence of the vessel speed to the main turbine RPM.

The left-hand part of the panel has grouped controls of the turbine valves for steam bleeding and draining (condensate drain valves) from various parts of the turbine through part (casings):



The “CLOSE” position of the switch corresponds to a closed valve, and the “OPEN” position denotes an open valve.

The SAFETY SYSTEM module is represented by the following buttons and indicators:



- “SHUT DOWN” indicator states of the fact of the turbine shutdown by the protection system;
- “SHUT DOWN BYPASS” indicator informs of the interlocking the protection system shutdown actuation by the watch;
- “SHUT DOWN BYPASS” button allows protection system shutdown actuation to be interlocked;
- “SAFETY RESET” button is designed to re-arm the protection system after actuation;
- “EMERGENCY STOP” – this button is used for emergency turbine shutdown.

The MANEUVR. VALVE LIFT indicator is used to show the rate of opening of the manoeuvring valve (% of the fully open position) for the forward and backward speeds:



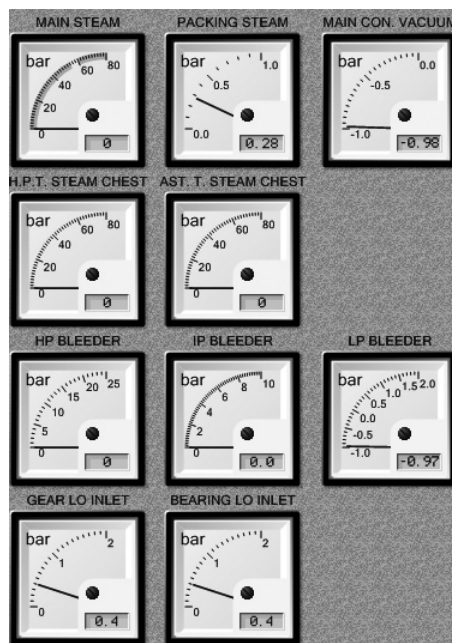
The dial face is divided into two parts AS/AH (Aster/Ahead) with division of each part from 0 to 100 %. The dial has also a degraded indicator of the manoeuvring valve opening rate.

The SHAFT R.P.M. indicator is designed to specify the propeller shaft RPM.



The dial-face is divided into two parts AS/AH (Aster/Ahead) with division for each part from 0 to 120 RPM. The dial has also provided with a digital indicator of propeller shaft RPM.

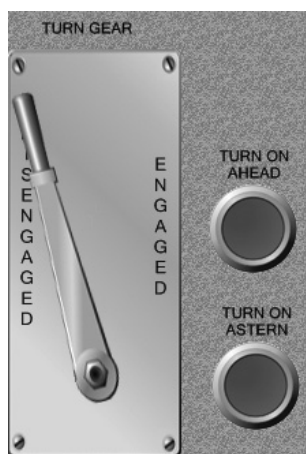
The right-hand part of the control panel houses the pressure indicator module:



- “MAIN STEAM” pressure gauge showing steam pressure in the system main line upstream of the main manoeuvring valve;
- PACKING STEAM pressure gauge showing steam pressure introduced to the gland sealing system;
- MAIN COND VACUUM pressure gauge showing negative pressure in the main condenser;

- H.P.T. STEAM CHEST pressure gauge showing steam pressure at the HP turbine inlet receiver;
- AST. STEAM CHEST pressure gauge showing steam pressure in the inlet receiver of the astern turbine;
- HP BLEEDER pressure gauge showing steam pressure in the bleeding flow from the high-pressure turbine;
- LP BLEEDER pressure gauge showing steam pressure in the bleeding flow from the low-pressure turbine;
- IP BLEEDER pressure gauge showing steam pressure at the inlet to the deaerator;
- GEAR LO INLET pressure gauge showing lube oil pressure at the inlet of the line supplying lube oil to the turbine set gearbox wheels (splash lubrication);
- BEARING LO INLET pressure gauge showing lube oil pump at the inlet of the line supplying oil to the turbine set bearings.

The TURN GEAR selector switch is designed for barring gear engagement, it has two positions – device engaged and device disengaged:



The buttons “TURN ON AHEAD” and “TURN ON ASTERN” specify direction of turbine rotation, when the barring gear is engaged.

The “WARM UP VALVE” button opens the manoeuvring valve for preheating the turbine in the port mode.



Boilers Local Control

Purpose

The boilers local control post in the Engine Room (ER) is intended for starting, stopping and controlling boilers 1 and 2 from the ER.

The local control post enables:

- control of the fuel oil, gas and steam supply for the fuel atomising to the boiler burners;
- control of fuel oil circulation in the system;
- preparation of the system for the boilers start;
- control of the boiler burners operation;
- boilers start;

- monitoring of a number of the boilers operation parameters;
- control of boilers in the emergency operation mode.

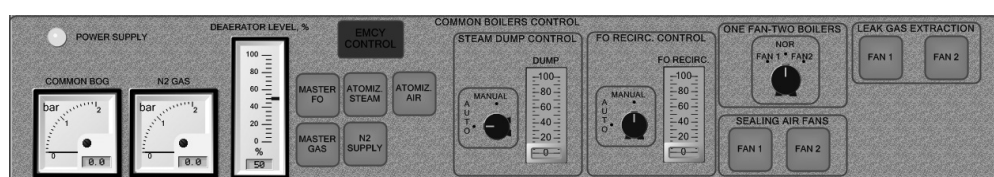
Control Panel

The control panel shown in Fig. 24, contains the following groups:



Fig. 24

The top part of the panel incorporates monitoring and control units common for both boilers:



- the control system “POWER SUPPLY” ON indicator;
- the “EMCY CONTROL” indicator shows that control is exercised from the EG, from the local control post;
- COMMON BOG pressure gauge is intended for showing the gas pressure in the main line;
- N2 GAS pressure gauge shows the nitrogen pressure in N2 Purge line;
- DEAERATOR LEVEL display shows the water level in the deaerator;
- The “MASTER FO”, “MASTER GAS”, “ATOMIZ. STEAM”, “ATOMIZ. AIR” and “N2 SUPPLY” buttons are intended for opening/closing cut-off valves on the lines feeding fuel oil, gas, steam, air, and nitrogen to the boilers lines;

- STEAM DUMP CONTROL group is intended for the control of the steam dump system in the manual and automatic modes. The control mode is selected by using the “AUTO/MANUAL” switch, the degree of the valve opening for steam dumping in the manual mode is set via the DUMP setter;
- FO RECIRC CONTROL group is intended for the control of the fuel oil circulation system. The control mode is selected by using the “AUTO/MANUAL” switch, the degree of the recirculation valve opening in the manual control mode is set via the FO RECIRC. setter;
- ONE FAN – TWO BOILERS group is intended for the control of boiler fans in the emergency mode. If one of the boiler fans fails, the “FAN 1/NORMALFAN 2” switch is used for selecting a fan in good operating order which will alone operate for both boilers. In the standard mode, when both fans are in good operating order, the switch should be in the “NORMAL” position;
- SEALING AIR FANS group: the “FAN 1” button is intended for turning on/off the fan of boiler 1 sealing system, whereas the “FAN 2” button is intended for turning on/off the fan of boiler 2 sealing system;
- LEAK GAS EXTRACTION group: the “FAN 1” button is intended for turning on/off fan 1 for the gas leakage extraction, whereas the “FAN 2” button is intended for turning on/off fan 2 for the gas leakage extraction.

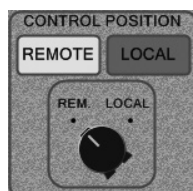
Located below are control panels of boiler 1 and boiler 2.

The boiler for control is selected with “MAIN BOILER 1” and “MAIN BOILER 2” tabs:



The control panel of each boiler includes:

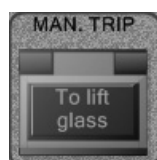
The CONTROL POSITION group – the “REMOTE-LOCAL” two-position switch allows selection of the control mode for the boiler. The selected mode is shown with the “REMOTE” or “LOCAL” indicator:



Liquid fuel oil, gas and feed water are supplied to the boiler via the cut-off valves. These valves can be opened and closed by using the following buttons:



The “MAN. TRIP” button is intended for the boiler emergency stop.

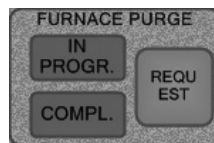


The group of STEAM UP indicators shows the operation of the program of raising steam in the boiler.



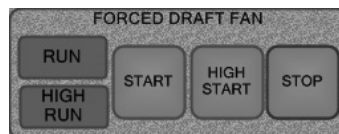
- "IN PROGR." indicator shows that the program is in the execution stage;
- "COMPL." indicator shows that the program has been completed.

The FURNACE PURGE group is intended for the control of the furnace purge program:



The program is started by using the "REQUEST" button. During the program operation the "IN PROGR." indicator is lighted, and after the end of the program operation the "COMPL." indicator light up.

The FORCED DRAFT FAN group is intended for the control of the boiler fan:



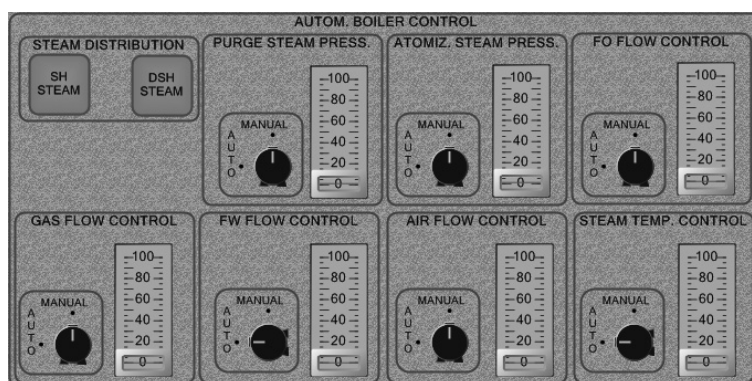
- "START" button is intended for starting the fan at the first rotation speed. The fan operation in this mode is confirmed by the lighted "RUN" indicator;
- a press on the "HIGH START" button switches the fan to the second rotation speed (high output mode). The fan operation in this mode is confirmed by the lighted "HIGH RUN" indicator;
- "STOP" button is intended for stopping the fan.

Control of boiler burners 1, 2, and 3 is concentrated in the BURNER 1, BURNER 2 and BURNER 3 groups:



- "FO" button is intended for starting the liquid fuel oil burner;
- "GAS" button is intended for starting the gas burner;
- "FLAME ON" indicator shows the burner operation on the selected fuel by checking the availability of flame.

The AUTOM. BOILER CONTROL group is intended for the automated boiler control:

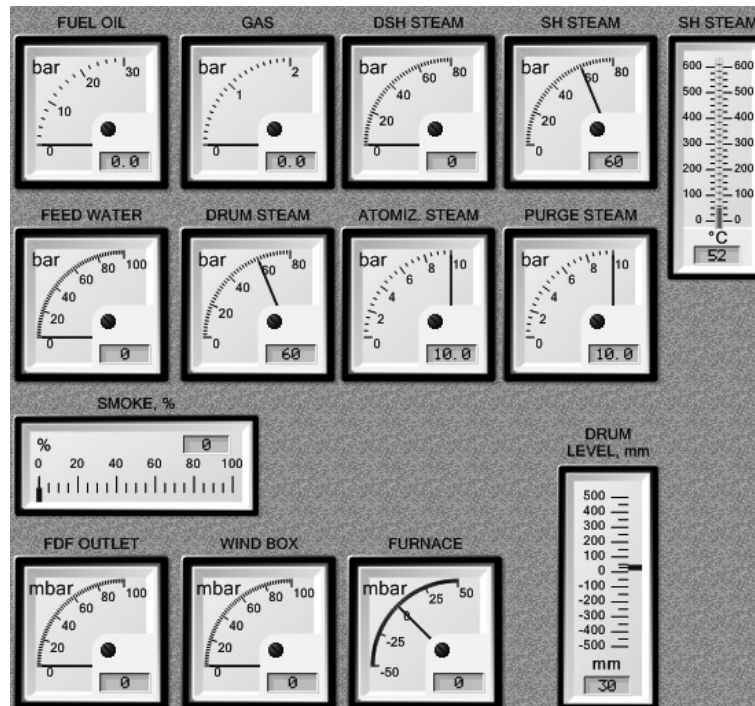


Control of steam output from the boiler is exercised by using buttons in the “STEAM DISTRIBUTION” group: the “SH STEAM” button opens the valve for producing the superheated steam from the boiler, and the “DSH STEAM” button open the desuperheated steam valve.

Next come groups for the control of a number of parameters: pressures, flows, and temperatures. The two-position “AUTO/MANUAL” switch is used for selecting the parameter control mode. In the manual mode, the parameter is controlled by varying the opening degree of the valve in question by suing the 0–100 % setter.

- PURGE STEAM PRESSURE group is intended for controlling the pressure of the steam supplied for purging;
- “ATOMIZ. STEAM PRESSURE group is intended for controlling the pressure of the steam fed for the fuel oil atomising in the boiler burners;
- FO FLOW CONTROL group is intended for controlling the flow of fuel oil fed to the burners;
- GAS FLOW CONTROL group is intended for controlling the flow of gas fed to the burners;
- FW FLOW CONTROL group is intended for controlling the flow of the boiler feed water;
- AIR FLOW CONTROL group is intended for controlling the air flow to the boiler furnace;
- STEAM TEMP. CONTROL group is intended for controlling the steam temperature at the boiler output.

The boiler operation parameter gauges are arranged in the left-hand part of the control panel:



- FUEL OIL pressure gauge is intended for showing the fuel oil pressure at the boiler inlet;
- GAS pressure gauge is intended for showing the gas pressure at the boiler inlet;
- DSH STEAM pressure gauge is intended for showing the desuperheated steam pressure at the boiler outlet;
- SH STEAM pressure gauge is intended for showing the superheated steam pressure at the boiler outlet;
- SH STEAM temperature gauge is intended for showing the superheated steam temperature at the boiler outlet;
- FEED WATER pressure gauge is intended for showing feed water pressure at the boiler inlet;
- DRUM STEAM pressure gauge is intended for showing steam pressure in the boiler upper drum;
- DRUM LEVEL gauge shows the water level in the boiler upper drum;
- ATOMIZ. STEAM pressure gauge is intended for showing pressure of the steam supplied to the burners for the fuel oil atomising
- PURGE STEAM pressure gauge is intended for showing pressure of the steam supplied for the boiler furnace purging;
- SMOKE gauge is intended for showing the smoke content in the boiler exhaust gases;
- FDF OUTLET pressure gauge is intended for showing pressure on the boiler fan discharge side;
- WIND BOX pressure gauge is intended for showing pressure in the boiler purge chamber;
- FURNACE pressure gauge is intended for showing pressure in the boiler furnace.

Boilers Emergency Panel

Purpose

The control panel is intended for the manual emergency control of boiler burners in emergencies.

Control Panel

The system diagram and control panel are shown in Fig. 25:

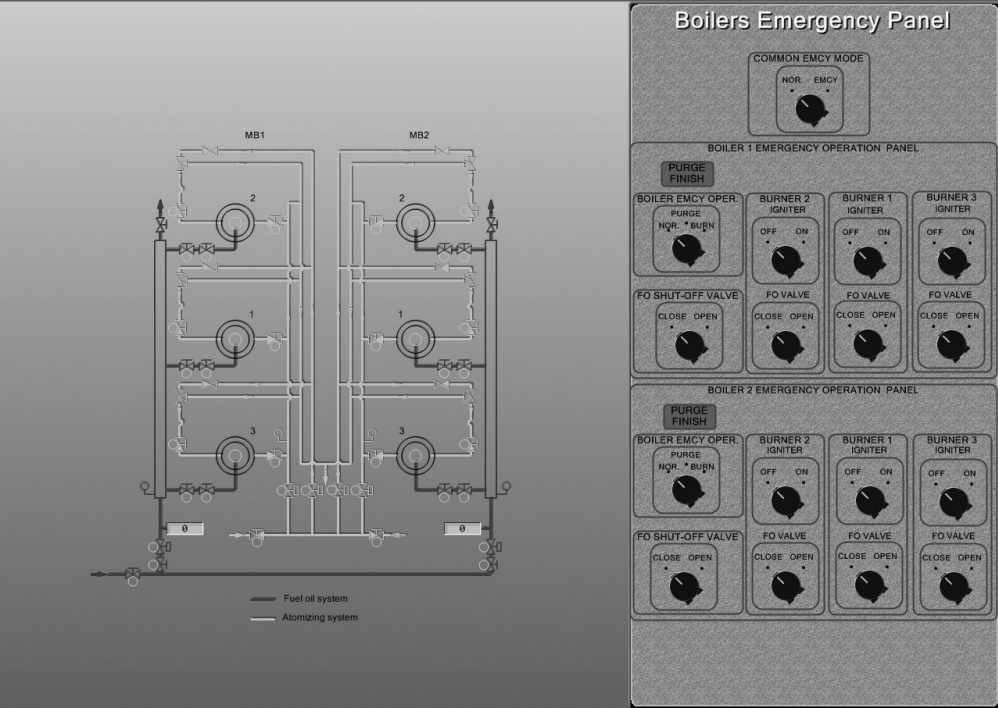
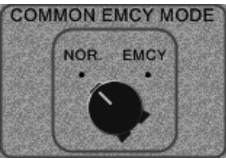


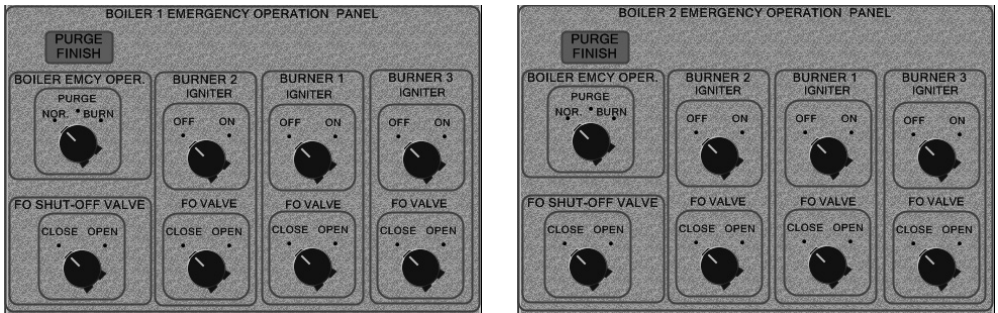
Fig. 25. Emergency boiler control post in the ER

The emergency control mode is selected by using the COMMON EMCY MODE switch:



The switch’s “NOR.” position corresponds to the standard control mode. To switch boilers to the emergency control mode, put the switch in the “EMCY” position.

The BOILER 1 EMERGENCY OPERATION PANEL and BOILER 2 EMERGENCY OPERATION PANEL are identical to each other:



The boilers emergency control panel contains the following groups:

- **BOILER EMCY OPER.** group contains the “NOR./PURGE/BURN” three-position switch. In the standard control mode, the switch is, by default, in the “NORMAL” position. The switching to the “PURGE” position runs the boiler purge program before the start. After the end of purging, the “PURGE FINISH” indicator lights up. The switching to the “BURN” position allows the manual start of the boiler burners on the fuel oil;
- **FO SHUT OFF VALVE** group is intended for controlling the fuel oil supply cut-off valve. The group contains the two-position “CLOSE/OPEN” switch;
- **BURNER 1, BURNER 2, BURNER 3** groups are intended for the control of boiler burners. The opening of the valve for feeding fuel oil to the burner is made by putting the two-position “FO VALVE” switch from the “OFF” position to the “ON” position. The burner igniter unit is turned on by putting the two-position “IGNITER switch from the “OFF” position to the “ON” position.

Page AS – Group Alarm Panel

Purpose

The group Alarms panel is intended for notifying about faults in the simulator module systems and machinery.

System Panel

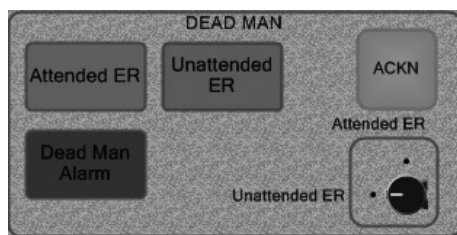
The Alarm Panel is shown in Fig. 26:



Fig. 26. Group alarm panel

All the Alarm Signals are grouped by systems presented on the simulator module pages.

The Group Alarm Panel also incorporates the DEAD MAN system group:



The DEAD MAN system performs the function of monitoring the watch engineer during his/her stay in the ER.

The system is turned on:

- manually by the watch engineer before he goes to the ER by putting the two-position switch from the “Unattended ER” position to the “Attended ER” position;
- automatically if in some modelled system the Local control mode is selected – control from the local control post in the ER.

The system status is shown with relevant indicators: “Attended ER” and “Unattended ER”.

After the system has been turned on, the time is started (the countdown, 20 min by default, the value can be corrected by the instructor). The task of the watch engineer in the ER is to regularly press the “ACKN” button notifying the system that he/she is on watch. Each press on the acknowledgement button stops the time countdown and restarts the timer.

If the watch engineer failed to press the acknowledgement button during the timer operation, the system forms a “Dead Man Alarm” signal within the ER. If the watch officer has not responded to the signal failed to acknowledge, after a certain time interval (2 minutes by default, the value can be corrected by the instructor the system sends an alarm signal to the bridge (the “Dead Man alarm not acknowledged” message is formed in the Event Log at the ERS simulator instructor workplace).

EXAMPLES OF WORK WITH A NUMBER OF SIMULATOR MODULE SYSTEMS

Situation 1

The Steam Propulsion Plant module only is started, "Default" exercise – there is steam in the boilers but the boilers (boiler burners) do not operate

AUX Page, Compressed Air System

1. Check that the compressed air cylinders are filled, replenish them as required;
2. Supply compressed air to the control system and for fuel oil atomising by opening the compressed air supply valves: Control Air Distribution Valve and Service & Atomizing Air Distribution Valve.
3. Put the compressor operation control mode selection switches to the "AUTO" position.

MT Page, Lubrication Oil System

Preparation of the lubricating system and hydraulic control system:

1. In the lubricating oil temperature controller group set the lubricating oil temperature in the system at 40–45 °C.
2. In the Manual control mode turn on PUMP 1 and put the control mode selection switch to the "AUTO" position.
3. Put Lubricating Oil Cooler 1 into operation and put the temperature control selection mode to the "AUTO" position.
4. Open the valve for feeding oil to the Man. Oil control system.
5. Monitor the oil level in the gravity tank (see the spy-hole), oil temperature and pressure at the turbine inlet.

CS Page, Sea Water System

1. Check opening of sea chests at the pumps suction.
2. In the Manual control mode, switch main sea water circulation PUMP 1 to LOW FLOW and put the pump operation mode switch to the "AUTO" position.
3. Open the cooling water supply valves:
 - to the Main Condenser (open the Main Condenser Cooling Flow valve);
 - to the atmospheric condenser (with the "TO ATM. CONDENSER" button);
4. Monitor pressure after the pumps and water temperature at the condenser outlet;
5. In the Manual control mode, turn on Sea Water Cooling Pump 1 by using the "PUMP 1" button and put the pump operation mode switch to the "AUTO" position;
6. Open the valves for supplying cooling water to Central FW Cooler 1 and Vacuum Unit Cooler;
7. Monitor pressure after the pumps;
8. Connect power supply to anodic tank 1 or 2;
9. Turn on the ship hull anodic protection by using the "PORT" and (or) "STBD" button.

CS Page, Central Fresh Water Cooling System

1. In the Manual control mode, turn on the main fresh water circulation pump (PUMP 1) and put the pumps operation mode switch to the "AUTO" position.
2. Open the cooling water supply pumps:
 - to the fresh water cooler (by opening the FW COOLER 1 valve);
 - to the turbine lubricating oil cooler (by pressing the "MT LO COOLER 1" button);
 - to the control air compressor cooler (by pressing the "CNTRL AIR COMPR. 1" button);
 - to the stern tube bearing cooler (by pressing the "ST LO Cooler 1" button);
 - to the service air compressor cooler (by pressing the "SERVICE AIR COMPRESSOR" button).
3. Monitor pressure after the pumps and water temperature at the FW cooler outlet;
4. Set the temperature controller at 28–35 °C and put the temperature controller mode switch to the Auto mode.

SCFW Page, Condensate Water System

1. In the Manual control mode, turn on condensate water Pump 1 and put the pumps operation mode switch to the "AUTO" position.
2. Check the operation of the Vacuum Pump Unit of Main Condenser – and put the vacuum pumps operation mode switch to the "AUTO" position, monitor the pressure, temperature and level in the Condenser.
3. In the Manual control mode, turn on Drain Pump 1 and put the pumps operation mode switch to the "AUTO" position.
4. Monitor pressure on the pump discharge side.
5. Open the Dump Spray Valve for the steam dump system.
6. Set the CONDENSER LEVEL CNTRL switch in the "AUTO" position.

SCFW Page, Desuperheated Steam System

1. Press the "MB1 DSH STEAM" and "MB2 DSH STEAM" buttons to open the valves for letting out desuperheated steam from the boilers.
2. Press the "TO SOOT BLOWER" button to open the valve for supplying steam to the boiler blowing system.
3. Press the "TO AUX. SERVICE" button to open the valve for the supply of steam to the ship "10 bars" steam system.
4. Press the "TO ATOMIZ. & GLAND" button to open the valve for supplying steam to the Main turbine sealing system and to the system for feeding steam for the fuel oil atomising in the boiler burners.
5. Set the STEAM DUMP CONTROL switch in the "AUTO" position.

MT Page, Gland System

1. Press the “FAN ON” button to turn on the fan creating vacuum in the Gland Condenser.
2. Monitor the vacuum in the gland condenser by using the Gland Condenser pressure gauge.
3. Press the “STEAM SUPPLY VALVE” button to open the valve supplying steam to the sealing system.
4. Monitor the sealing system steam pressure by using the PACKING STEAM pressure gauge.

SCFW Page, Superheated Steam System

1. Press the “MB1 SH STEAM OUT V.” and “MB2 SH STEAM OUT V.” buttons to open valves for letting out superheated steam from the boilers.
2. Press the “TG 1” button to open the valve for supplying superheated steam to Turbo generator 1.

SCFW Page, Feed Water System

1. Press the “PUMP 1 TURBINE DRAIN” и “PUMP 2 TURBINE DRAIN” to open the valves for draining the condensate from the feed water pump turbines.
2. Press the “PUMP 1 PRELUB.” and “PUMP 2 PRELUB.” buttons to turn on the pumps for the fed water pump turbines pre-lubrication.
3. Press the “PUMP 1” button to start feed water pump 1.
4. After the end of the low feed water pressure alarm, set the feed water pumps operation mode selection switch to the “AUTO” position.
5. Monitor the deaerator parameters – pressure, temperature and salinity.

MT Page, Bleed & Drain System

Assess readings of pressure and temperature gauges on the system control panel – check that the parameters of steam in the system are within the operating range.

To prevent steam pressure drop in the boilers, it is necessary to quickly put the boilers into operation. To do this you should:

FS Page, Fuel Oil Supply System

1. Select the type of fuel oil which the boiler burners will be operating on, e.g., heavy fuel oil. To do this, set the FUEL SELECTION switch for the boilers to the “HFO” position.
2. In the Manual control mode, turn on fuel oil pump 1 and put the pumps operation mode switch to the “AUTO” position.
3. If the heavy fuel oil is selected, to control its viscosity, press the “PREHEATER 1” button in the Manual viscosity control mode and set the viscosity control operation mode switch to the “AUTO” position. Set the required fuel oil viscosity value by using the SET POINT setter, monitor the fuel oil viscosity value by using the relevant gauge.
4. Turn on the supply of steam for heating fuel oil lines by pressing the “TRACING” button.

MB Page, Local Control Panel

Let us consider the control of boilers from the local control post in the ER:

1. Turn on the boiler sealing system fans (Sealing Air Fans) by pressing “FAN 1” and “FAN 2” buttons.
2. Turn on the gas leakage extraction system fans (Leak Gas Extraction) and press “FAN 1” and “FAN 2” button.
3. Open the valves for supplying the following to the boilers:
 - fuel oil – press the “MASTER FO” button;
 - steam for fuel oil atomising – press the “ATOMIZ. STEAM” button (in case of low steam pressure feed compressed air for the fuel oil atomising – press the “ATOMIZ. AIR” button);
 - gas – press the “MASTER GAS” button;
 - nitrogen for blowing off boiler pipelines and burners – press the “N2 SUPPLY” button.
4. Set the steam dump system operation mode switch (Steam Dump Control) to the “AUTO” position.
5. Set the circulating fuel oil system operation mode switch (FO Recirc. Control) to the “AUTO” position.

Note: The further control of boilers, separate for boiler 1 and boiler 2 is exercised by selecting “MAIN BOILER 1” and “MAIN BOILER 2” tabs.

6. Select the mode of boiler control from the local post in the ER – set the Control Position operation mode switch to the “LOCAL” position.
7. Turn on the boiler Forced Draft Fan – press the “START” button.
8. Open the valve for feeding fuel oil to the boiler burners – press the “FO SHUT OFF” button.
9. For the PURGE STEAM PRESSURE control, select the Auto control mode.
10. For the control of steam pressure for the fuel oil atomising (ATOMIZ. STEAM PRESSURE), select the Auto control mode.
11. For the FO FLOW CONTROL, select the Auto control mode.
12. For the GAS FLOW CONTROL, select the Auto control mode.
13. For the FW FLOW CONTROL, select the Auto control mode.
14. For the AIR FLOW CONTROL, select the Auto control mode.
15. For the STEAM TEMPERATURE CONTROL, select the Auto control mode.
16. Press the “FO” button to start fuel oil burner 1: at first the furnace purging procedure will be performed (PURGE), the IGNITER will then be turned on on the burner, and fuel oil will be fed to the burner.
17. Check that the “FLAME ON” indicator of the fuel oil burning on the burner has lighted up and that the burner is operating.
18. Repeat items 6–17 as required for the second boiler.
19. Monitor the steam parameters (pressure and temperature) and levels in the boiler steam drums (STEAM DRUM).
20. Before starting the Main Turbine, transfer the boiler control to the ECR by setting the CONTROL POSITION switches to the “REMOTE” position.

A similar algorithm is used for starting the boilers from the ECR in the ARC mode.

AUX Page, Stern Tube LO System Control Panel

Start the propeller shaft lubricating and sealing system:

1. In the Manual control mode, turn on lubricating oil circulating PUMP 1 and put the pumps operation mode switch to the “AUTO” position.
2. Open the system lubricating oil cooler valve.

Turning Main Turbine and its Preheating before the Start

To turn the turbine with the shaft turning gear (STG):

1. Before turning the turbine, it is necessary to provide lubrication of the turbine and reduction gear. Set the control mode switch of the auxiliary electrically driven pumps (AUX. LO PUMPS) to the “MANUAL” position, run Pump 1 by pressing the “PUMP 1” button, put the pumps operation mode switch to the “AUTO” position. Monitor the lubricating system parameters by using the gauges.
2. Check that steam has been supplied to the turbine sealing system: this will ensure its heating before the turning.
3. On the MT LOCAL CONTROL, set the mode of the turbine control from the local post in the ER – set the CONTROL POS. TRANSFER switch to the “LOCAL” position.
4. Having checked that the manoeuvring valve is closed and that the turbine rpm is at zero, put the TURN GEAR handle to the “ENGAGED” position – engage the STG.
5. Turn on the STG electrical motor for turning the turbine ahead – press the “TURN ON AHEAD” button and keep it depressed. The turbine should be spinned for 5-6 minutes.
6. Use a similar procedure to turn the turbine in the reverse direction.
7. Disengage the STG – put the TURN GEAR handle to the “DISENGAGED” position.
8. Set the mode of controlling the turbine from the ECR – set the CONTROL POS. TRANSFER switch to the “ERC” position.

The turbine automatic breakaway with steam and its periodic turning is possible from the ERC from the MT REMOTE CONTROL panel:

1. Turn on the turbine Auto Spinning program – set the AUTO SPINNING switch to the “ON” position. If the conditions for the Auto Spinning program operation are fulfilled (the Engine Telegraph handle is in the “STOP” position, the CONTROL MODE switch is in the “LEVER” position and there are no reasons for the Shut Down safety system actuation, the “SPIN ZONE” indicator lights up, and after a 20-second delay the turbine will start rotating in the astern direction. The turbine rpm may rise to 9–11 during the Auto Spinning program operation (at 13 rpm, the Shut Down protection is actuated).
2. Monitor the steam parameters on the “Bleed & Drain System” panel.
3. During the execution of the Auto Spinning program, monitor the vibration and axial shift values on the “Lubrication Oil System” panel.
4. After the end of the turbine preheating you will only have to put the Engine Telegraph handle in the necessary position to get it started.

Situation 2

Steam Propulsion Plant module only is started. Boiler “cold” start – steam-up-in-boiler procedure.

Preparatory operations

CS Page, Sea Water System

Put the water cooling system into operation – open the sea water chests, start the cooling pumps, open flows through the coolers in the system.

CS Page, Central Fresh Water Cooling System

Fill in the expansion tank in the system as required, run the system cooling pump, open the flow through “Fresh Water Cooler 1” or “Fresh Water Cooler 2”.

AUX Page, Compressed Air System

1. Check that the compressed air cylinders are filled, replenish them as required;
2. Supply the compressed air to the control system and for the fuel oil atomising – open the Control Air Distribution Valve and Service & Atomizing Air Distribution Valve.

FS Page, Fuel Oil Supply System

Check that the diesel oil and heavy fuel oil tanks are filled in. replenish them as required.

ATTENTION!

The boiler is started on the diesel oil (DO)!

Boiler replenishment with feed water

1. On the boiler “Steam & Water System” panel, open the Blow Off Valves – press the “SUPER HEATER”, “DRUM BLOW” and “AIR BLOW” buttons;
2. On the boiler “Steam & Water System” panel, open the valve for filling the boiler with water bypassing the economizer – press the “ECONOMIZER BYPASS” button
3. On the “Feed Water System” panel open the valve for feeding water from the distilled fresh water store tank by pressing the “FROM DWT” button and run the auxiliary feed water pump by pressing the “AUX PUMP” button. Switch the feed water pump control to the Auto mode;
4. On the boiler “Steam & Water System” panel, monitor the boiler filling with water process by the “DRUM LEVEL” water indicator.
5. After the boiler has been filled in, on the boiler “Steam & Water System” panel release the “ECONOMIZER BYPASS” button (close the Economizer By-pass Valve) and open the main valve for supplying feed water to the boiler by pressing the “FEED WATER” button;
6. Select the boiler control mode “AUTO”.

CS Page, Sea Water System

Provide the sea water flow through the Main Condenser:

1. On the MAIN CIRCULATION SYSTEM panel of the “Sea Water System”, start the circulating pump (1, 2 or 3) in the manual control mode.
2. Use the MAIN COND. COOLING FLOW setter to control the sea water flow through the Main Condenser.

SCFW Page, Condensate Water System

1. Open the condenser make-up valve by pressing the “COND. MAKE UP” button and replenish the Main Condenser checking the level within it;
2. In the manual control mode, turn on the “Condensate Pumps” in the circulating mode – open the circulating pump with the RECIRC. setter and in the Manual mode of controlling level in the Main Condenser partly close the level control valve by using the LEVEL CNTRL setter;
3. Select the control mode for pumps “Drain Pumps” – “AUTO”.
4. Select the control mode for pumps “Vacuum Unit Pump” – “AUTO”.

MB Page, Fuel Oil, Gas & Atomizing

1. Open the valves for supplying fuel oil and air for the fuel oil atomising by pressing the “MASTER FO” and “ATOMIZ. AIR” buttons.
2. Turn on Leak Gas Fans 1 and 2;
3. In the FO RECIRC. CONTROL group select the Manual control mode and open slightly the fuel oil recirculation valve by using the FO RECIRC. setter, thus ensuring the low fuel oil pressure;
4. Turn on the FDF fan – in the FDF CONTROL group press the “START” button;
5. Open the fuel oil supply valve – press the “FO SHUT OFF” button;
6. Turn on the Seal Fan – press the “START/STOP” button;
7. In the BURNERS CONTROL group, select the Manual burners control mode and turn on fuel oil burner 1 by pressing the “FO” button;

MB Page, Steam & Water System

1. In the REMOTE MODE group, switch the boiler control to the Auto mode;
2. In the STEAM UP PROGRAM group, run the steam-up program – press the “REQUEST” button: the “IN PROGRESS” program operation indicator should light up.

Control of the fuel oil flow is in accordance with the temporal program of pressure build-up in the boiler Steam Drum.

Further operations

1. After the start of the steam rising in the boiler, on the “Desuperheated Steam & Dump System” panel, press the “MB 1(2) DSH STEAM” button – open the valve for letting out the desuperheated steam from the boiler.
2. Put the turbine sealing system into operation (the “Gland System” panel).
3. Starting from the steam overpressure in the order of 1.5–2 bars (the arrow on the mnemonic diagram will turn from blue to orange) you can close the boiler AIR BLOW valve (the BLOW OFF VALVES group on the “Steam & Water System” panel).

4. The fuel Atomizing Steam instead of the compressed air is used starting from the desuperheated steam pressure of 8 bars.
5. In the BLOW OFF VALVES group of the “Steam & Water System” panel, close the blow-off valve of the SUPER HEATER.
6. As the pressure grows to 10 bars in the boiler “Steam Drum”, turn on the fuel oil preheating and switch to the heavy fuel oil by increasing its supply pressure with the aid of the recirculation valve;
7. As the pressure reaches 15 bars in the boiler “Steam Drum”, open the valve for letting out the superheated steam from the boiler – the “MB 1(2) SH STEAM OUT V.” button on the “Superheated Steam System” panel;
8. With the lowering of the water level in the boiler steam drum, in the BLOW OFF VALVES group of the “Steam & Water System”, close the blow-off Drum Blow valve of the steam drum.
9. Run the turbo-driven feed water pump of boiler 1 (2).
10. Supply steam to the turbo generator 1 by pressing the “TG1” panel on the “Superheated Steam System” panel;

The steam is raised, providing the minimum water flow through the economiser and draining the surplus as required to the atmospheric tank via the STEAM DRUM valve.

The steam raising can be considered completed when the pressure of about 57 bars is gained. On the “Fuel Oil, Gas & Atomizing” panel, in the BURNERS CONTROL group switch the boiler burner control to the Auto mode.

After the steam-up in one boiler, you can run the main turbine in the preheating mode or in the low rpm operation mode.

ATTENTION!

For the steam-up in the second boiler, steam from the first boiler is used. As this is done, the MB SH STEAM OUT V. superheated steam supply valve of the second boiler should be closed until the steam raising in it is completed. If you open this valve (in the Auto mode of controlling both boilers), the control system will start equalizing the steam pressure in both boilers, which will result in the pressure drop in the first boiler.

The blow-off valve of the second boiler steam superheater (the “SUPER HEATER” button in the BLOW OFF VALVES group on the “Steam & Water System” panel) should be permanently opened as the steam is rising within it.

CHAPTER 2

Ship Electrical Power Plant

This chapter contains the description of the Ship Electrical Power Plant simulator module for training the watch personnel of a cargo ship engine room in skills of proper operating the ship Electrical Power Plant.

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INTRODUCTION

The Ship Electrical Power Plant simulator module is designed for training the cargo ship engine room watch personnel in skill of proper operating the ship electrical power system (SEPS), including:

- preparation of equipment/systems for their operation, startup, and shutdown;
- monitoring of operation using variable parameters;
- trouble shooting.

In addition to training in practical skills, the simulator allows the user to learn the basic principles of the structure, functions, and interaction of SEPS components and systems.

The simulator composition corresponds to SEPS standard setup. Parameters and performance of the simulated mechanisms and systems correspond to the real ones.

This is a SEPS simulation of a liquid natural gas carrier ship (hereinafter referred to as “LNG Carrier”) with a steam turbine main engine and transmission to a fixed pitch propeller (FPP) via a reducing gearbox.

SHIP ELECTRICAL POWER SYSTEM (SEPS)

Purpose

The ship electrical power system (SEPS) is designed to meet the ship's electrical power demands in standard and emergency conditions.

System Components

SEPS consists of the ship electrical power plant (EPP), ship electrical network and power consumers. The ship electrical network in turn consists of switchboards (SB) and electric cables (feeders).

The EPP includes: one diesel generator (DG), two turbogenerators (TG), emergency diesel generator (EDG), main switchboard (MSB), emergency switchboard (ESB), shore supply switchboard (SSS), and power transformers.

The ship's EPP has one 3200 kW DG (6.6 kV, 60 Hz, $n = 720$ RPM), two 3150 kW turbogenerators (6.6 kV, 60 Hz, $n = 1800$ rpm), and 580 kW EDG (440 V, 60 Hz, $n = 720$ RPM), shore supply of 440 V, 1000 A, transformers T_1 – T_9 .

Structurally, the SEPS consists of a set of control panels for monitoring and control of the drives and the power plant in the Engine Control Room (ECR), a set of MSB control panels, and a MSB monitoring/control set of panels.

SEPS composition is represented by the main current circuit, see Fig. 1:

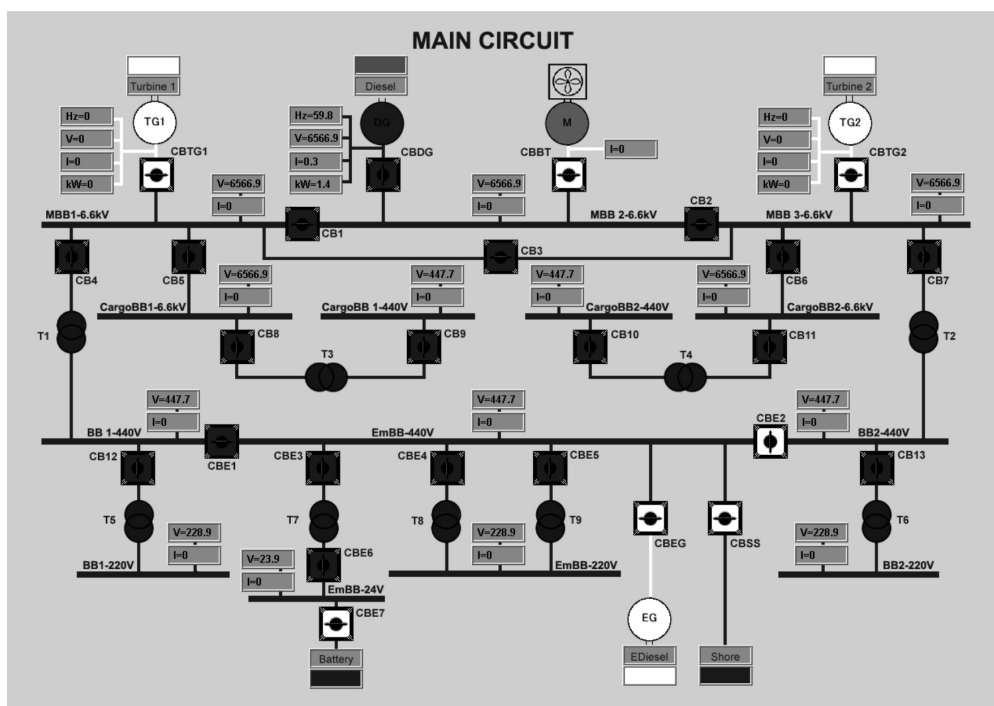


Fig. 1. Main current circuit

EPP Control

EPP control is provided in both the manual and automatic modes, for standard and emergency situations.

In the manual mode, the watch engineer can use a standard or emergency procedure to start and stop the DG, TG and EDG, switch the generators to the parallel operation, switch to the shore supply via the power plant de-energising, or switch from the shore supply to the DG.

ATTENTION!

Parallel operation of DG and TG is allowed, while preliminary operation of DG and TG with EDG is not provided for.

The EPP enables the generators to be switched to the parallel operation both manually and automatically (generator synchronising). The automatic generator synchronising is possible with both manual and automatic EPP control modes. In case of automatic generator synchronising, the “matching” (equalization) of generator frequencies is carried out, so that the synchronised generator’s frequency is higher than the network frequency by a certain value, which depends on the EPP load and does not exceed 0.3 Hz (differential frequency). At the moment of closing the generator onto the MSB buses, the following conditions are provided: the phase difference of the MSB and the synchronised generator is below 20°; whilst the synchronised generator’s frequency deviation (the differential frequency taken into account) from the MSB frequency should not exceed 0.1 Hz. Connection of the generator to the MSB buses is performed in advance, in consideration of the generator circuit breaker (GCB) sluggishness.

In the automatic mode, EPP operates with one, two, or three generators (DG, TG1, and TG2).

The following automatic modes of operation are provided:

- equal DG power mode (Equal);
- optimal DG load mode (Optimal);
- cyclic DG load mode (Cyclic);
- constant frequency maintenance mode (Const Freq.).

In the equal power mode, all generators closed onto the buses have identical loads.

In the optimal load mode, one of the generators takes a larger part of the load, the other ones taking less. Two cases are possible:

- 2 generators onto the buses:
 - if the total load is up to 95 % of the generator rated value, the lower-priority generator takes 15 %, the remaining part being taken by the higher-priority one;
 - if the total load is over 95 % of the generator rated value, but below 160 %, the higher-priority generator takes 80 % of the load, the remaining part being taken by the lower-priority one (15...80 %);
 - if the total load amounts to more than 160 % of the generator’s rated value, the load is distributed equally.

- 3 generators onto the buses:
 - if the total load is up to 110 % of the generator rated value, the lower-priority generators take 15 % of the load each, the remaining part being taken by the higher-priority generator;
 - if the total load exceeds 110 % of the generator rated value, but below 240 %, the higher-priority generator takes 80 %, and the lower-priority generators take the remaining part in equal shares (15...80 %);
 - if the total load exceeds 240 % of the generator rated value, the load is distributed equally.

In the cyclic load distribution mode, the load is distributed between the working generators as in the optimal load mode, but the generators' priorities change at predetermined intervals.

In the constant frequency mode, the load is divided between the operating generators with a more accurate stabilisation of the current frequency within 59-60 Hz. In this mode, the RPM governor of the higher-priority DG provides for frequency stabilisation, while the RPM governors of the other DG's take care of load distribution.

In case of complete de-energizing of the EPP buses, the automatic mode provides first of all for starting the higher-priority DG and its connection to the network.

ATTENTION!

There can be no operation in parallel with the shore supply. Switching to and from the shore supply involves de-energising of the plant. With the generator circuit breaker switched on, the shore supply cannot be switched on. In case of a phase wire break or a wrong phase order, the shore supply cannot be switched on either. The specified values of consumers' power demand are fixed and do not change with the change of the vessel's motion mode (running, manoeuvring, stay at a port).

Protection System

The protection system of the ship electrical power plant includes several levels of protection: disconnection in case of overload of specific consumers, disconnection in case of overload of consumer groups, protection of generator circuit breakers (GCB), protection of generators and generator drive protection system. See Tab. 1.1–1.4 for protection system parameters.

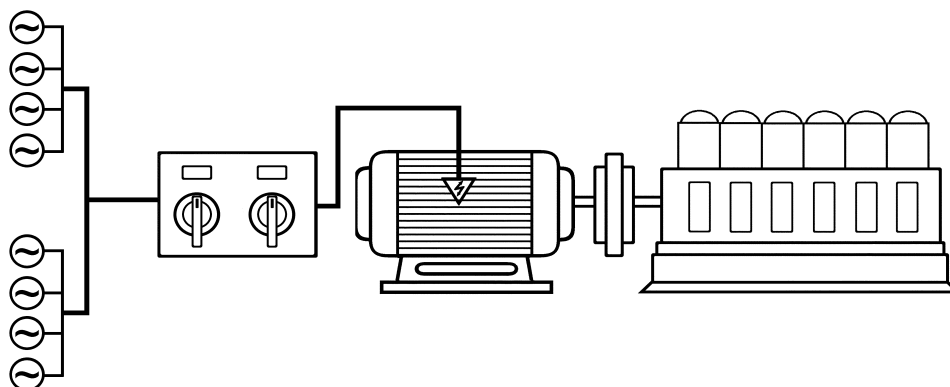


Fig. 2. Electrical Power Plant Circuit Breaker and Protection system

Protection system parameters with a DG operating:

Table 1.1

Electrical network protection	GCB protection settings	Generator protection	Diesel protection
Disconnection of consumers	GCB tripping		Stopping the diesel engine, GCB tripping
$I > I_{nom}$ 1st turn 5 s*	$U < 5280 \text{ V}$ 5 s (0.8 U_{nom}) 60 s $I > 1.21 I_{nom}$	$U < 5280 \text{ V}$ 3 s (0.8 U_{nom}) 3 s $U > 7260 \text{ V}$ (1.1 U_{nom})	Cooling water temperature (outlet) $> 95^\circ\text{C}$
2nd turn 15 s**	$I > 3 I_{nom}$ 0.4 s $I > 10 I_{nom}$ 0 s $I_{rev.} > 0.1 I_{nom}$ 10 s	$I > 1.21 I_{nom}$ 40 s $I > 3 I_{nom}$ 0.2 s $I_{rev.} > 0.08 I_{nom}$ 6 s $f < 54 \text{ Hz}$ 4 s (0.9 f_{nom})	Oil pressure $< 1.1 \text{ bar}$ RPM $> 110 \%$

Protection system parameters with a TG operating:

Table 1.2

Electrical network protection	GCB protection settings	Generator protection	Diesel protection
Disconnection of consumers	GCB tripping		Stopping the diesel engine, GCB tripping
$I > I_{nom}$ 1st turn 5 s*	$U < 5280 \text{ V}$ 5 s (0.8 U_{nom}) 60 s $I > 1.21 I_{nom}$	$U < 5280 \text{ V}$ 3 s (0.8 U_{nom}) 3 s $U > 7260 \text{ V}$ (1.1 U_{nom})	Cooling water temperature (outlet) $> 95^\circ\text{C}$
2nd turn 15 s**	$I > 3 I_{nom}$ 0.4 s $I > 10 I_{nom}$ 0 s $I_{rev.} > 0.1 I_{nom}$ 10 s	$I > 1.21 I_{nom}$ 40 s $I > 3 I_{nom}$ 0.2 s $I_{rev.} > 0.08 I_{nom}$ 6 s $f < 54 \text{ Hz}$ 4 s (0.9 f_{nom})	Oil pressure $< 1.1 \text{ bar}$ Rpm $> 110 \%$

Protection system parameter with the shore power supply (SS) connected:

Table 1.3

Electrical network protection	CB protection settings	SS switchboard protection
-	CB tripping	CB tripping
-	$U < 300 \text{ V}$ 5 s $I > 1.21 I_{nom}$ 60 s $I > 3 I_{nom}$ 0.38 s $I > 10 I_{nom}$ 0.19 s Phase break protection	Wrong phase connection

* – The breaking capacity of the higher-priority consumers is 427 kW.

** – The breaking capacity of the lower-priority consumers is 3415,8 kW.

PS parameters during emergency diesel generator operation (EDG):

Table 1.4

Electrical network protection	GCB protection settings	Generator protection	Diesel protection
-	GCB tripping		Stopping the diesel engine, GCB tripping
-	$U < 300 \text{ V}$ 6 $I > 1.2 I_{\text{nom}}$ 120 s $I > 10 I_{\text{nom}}$ 0.19 s	-	Oil pressure $< 0.8 \text{ bar}$ RPM $> 110 \%$

All disconnectable power plant consumers are ranked in three priorities in accordance with degree of their significance, taking into account their power demand – 1st, 2nd, and Auto Run. Consumers are disconnected as follows: after 5 seconds the first priority consumers will be switched off; if the generator remains overloaded, in another 15 seconds the second priority consumers will be switched off.

Power of the disconnected first- and second-priority consumers are:

- First priority – 427 kW;
- second priority – 3415.8 kW.

There are also some automatically started (auto run) fixed consumers on board, enabling operation of the main power plant and a group of fixed consumers on the ship, powered from the emergency switchboard (ESB) in case of power plant de-energising.

Consumers' circuit breakers have shorter time lags as compared to the generator automatic circuit breakers, which insures disconnection of faulty consumers loading the plant without turning off the generator automatic circuit breaker. This is the way the selective protection of the electrical power plant is arranged.

Faults Introduced by the Instructor

- Automated Control Fault;
- "Equal" mode fault;
- "Cyclic" mode fault;
- "Optimal" mode fault;
- "Const. frequency" mode fault;
- Autom. Synchronizing fault;
- Transformer N fault, $N = (1 \dots 9)$;
- 24 V DC supply fault – no 24 V DC for power plant automatic equipment control.

SHIP ELECTRICAL NETWORK AND CONSUMERS

Purpose

The ship electrical network is designed for delivering electrical power from the ship EPP to the consumers. The ship electrical network provides consumers with 6,6 kV, 440 V, 220 V, 3 phase, 60 Hz, and 24 V DC.

System Components

The ship electrical network consists of switchboards (SB) and electrical cables (feeders). All SB's and feeders are provided with automatic circuit breakers.

See Tab. 2.1 for parameters of electrical power consumers:

Table 2.1. Parameters of electrical power consumers

N	Consumer designation	Voltage, V	Disconnection turn number	MSB section (ESB)	Power demand, kW
1	Bow Thruster	6600	2	MBB2	1830
2	Warp Winch	440	2	BB2-440	112
3	Ballast Pump No 1	6600	Auto Run	MBB1	194
4	Ballast Pump No 2	6600	Auto Run	MBB3	194
5	Boiler Forced Draft Fan No 1	440	Auto Run	BB1-440	125.4
6	Sealing Air Fan No 1	440	Auto Run	BB1-440	3.7
7	Leak Gas Extr. Fan No 1	440	Auto Run	BB1-440	3.5
8	Main Turbine Lub. Oil Pump No 1	440	Auto Run	BB1-440	55
9	Boilers Fuel Oil Pump No 1	440	Auto Run	BB1-440	22
10	Drain Tank/Drain Pump No 1	440	1	BB1-440	22
11	Main Condensate Pump No 1	440	Auto Run	BB1-440	75
12	Main Cooling SW Pump No 1	440	Auto Run	BB1-440	90
13	Main Circulation SW Pump No 1	440	Auto Run	BB1-440	200
14	Central Cooling FW Pump No 1	440	Auto Run	BB1-440	65
15	CNTRL Air Compressor No 1	440	2	BB1-440	58
16	Fire Pump No 1	440	Auto Run	BB1-440	75
17	Vacuum unit Pump No 1	440	Auto Run	BB1-440	30
18	Lub. Oil Separator No 1	440	2	BB1-440	58
19	Boilers Aux. Forced Draft Fan No 3	440	2	BB1-440	125.4
20	Aux. Feed Water Pump	440	Auto Run	BB1-440	280
21	Ranges (galley)	440	1	BB1-440	40
22	Heavy Fuel Oil Transfer Pump No 2	440	2	BB1-440	25
23	Diesel Oil Transfer Pump	440	2	BB1-440	6
24	Water-desalinating plant	440	1	BB1-440	84
25	Provision Store Ref. Plant	440	2	BB1-440	25
26	Switchboard No 4	440	1	BB1-440	100
27	Boiler Forced Draft Fan No 2	440	2	BB2-440	125.4
28	Sealing Air Fan No 2	440	Auto Run	BB2-440	3.7
29	Leak Gas Extraction Fan No 2	440	Auto Run	BB2-440	3.5
30	Main Turbine Lub. Oil Pump No 2	440	2	BB2-440	55
31	Boilers Fuel Oil Pump No 2	440	2	BB2-440	22
32	Drain Tank/Drain Pump No 2	440	1	BB2-440	22

N	Consumer designation	Voltage, V	Disconnection turn number	MSB section (ESB)	Power demand, kW
33	Main Condensate Pump No 2	440	2	BB2-440	75
34	Main Cooling Sea Water Pump No 2	440	2	BB2-440	90
35	Main Circulation SW Pump No 2	440	2	BB2-440	200
36	Central Cooling FW Pump No 2	440	2	BB2-440	65
37	CNTRL Air Compressor No 2	440	2	BB2-440	58
38	Steering Gear Pump No 2	440	Auto Run	BB2-440	84
39	Fire Pump No 2	440	Auto Run	BB2-440	75
40	Vacuum unit Pump No 2 (stand-by)	440	Auto Run	BB2-440	30
41	Lub. Oil Separator No 2	440	2	BB2-440	58
42	FO Electro Heater (Boiler Start-up)	440	2	BB2-440	100
43	Main Circulation SW Pump No 3	440	2	BB2-440	200
44	Aux. Main Condensate Pump	440	Auto Run	BB2-440	75
45	Main Turbine Turn Gear Motor	440	Auto Run	BB2-440	11
46	Fuel Oil Separator	440	2	BB2-440	28
47	Bilge Water Pump	440	Auto Run	BB2-440	30
48	Switchboard No 5	440	1	BB2-440	24
49	Ship Ventilation	440	1	BB2-440	120
50	MBs CNTRL Main	230	Auto Run	BB1-220	6.6
51	Common Lights	230	2	BB1-220	100
52	MBs CNTRL Reserve	230	Auto Run	BB2-220	6.6
53	Switchboard No 6	230	1	BB2-220	15
54	Service Air Compressor	440	Auto Run	EmBB-440	8
55	Steering Gear Pump No 1	440	Auto Run	EmBB-440	84
56	Radio Equipment	440	Auto Run	EmBB-440	5
57	Machinery Space (MS) Ventilation	440	Auto Run	EmBB-440	140
58	Cargo & Ballast machinery	440	Auto Run	EmBB-440	120
59	Battery Charger	440	Auto Run	EmBB-440	1
60	Cargo Pump Cp 10	440	Auto Run	EmBB-440	50
61	Cargo Pump Cp 20	440	Auto Run	EmBB-440	50
62	Cargo Pump Cp 30	440	Auto Run	EmBB-440	50
63	Cargo Pump Cp 40	440	Auto Run	EmBB-440	50
64	Navigational equipment & intercom	230	Auto Run	EmBB-220	10
65	Navigational lights	230	Auto Run	EmBB-220	3.4
66	Machine Telegraph system	230	Auto Run	EmBB-220	1.5
67	Gas Detection systems	230	Auto Run	EmBB-220	10
68	Emergency Lights	230	Auto Run	EmBB-220	120
69	Switchboard No 7	230	Auto Run	EmBB-220	15
70	Main Turbine Automation	24	Auto Run	EmBB-24	1
71	Main Turbine Safety System	24	Auto Run	EmBB-24	1
72	Turbo- and DG Automation	24	Auto Run	EmBB-24	1
73	Switchboard No 8	24	Auto Run	EmBB-24	1
74	Cargo Pump Cp 11	6600	Auto Run	CargoBB1-6.6	380
75	Cargo Pump Cp 21	6600	Auto Run	CargoBB1-6.6	380
76	Cargo Pump Cp 31	6600	Auto Run	CargoBB1-6.6	380
77	Cargo Pump Cp 41	6600	Auto Run	CargoBB1-6.6	380

N	Consumer designation	Voltage, V	Disconnection turn number	MSB section (ESB)	Power demand, kW
78	Cargo High Duty Compressor 1	6600	Auto Run	CargoBB1-6.6	760
79	Cargo Pump Cp 12	6600	Auto Run	CargoBB2-6.6	380
80	Cargo Pump Cp 22	6600	Auto Run	CargoBB2-6.6	380
81	Cargo Pump Cp 32	6600	Auto Run	CargoBB2-6.6	380
82	Cargo Pump Cp 42	6600	Auto Run	CargoBB2-6.6	380
83	Cargo High Duty Compressor No 2	6600	Auto Run	CargoBB2-6.6	760
84	Cargo Low Duty Compressor No 1	440	Auto Run	CargoBB1-440	330
85	Inert Gas Plant/Fuel Pump lpf1	440	Auto Run	CargoBB1-440	3
86	Inert Gas Plant/N2 Compressor lc1	440	Auto Run	CargoBB1-440	37
87	Inert Gas Plant/Compressor lcom1	440	Auto Run	CargoBB1-440	40
88	Inert Gas Plant/Blower lb1	440	Auto Run	CargoBB1-440	158
89	Inert Gas Plant/Pump Hip1	440	Auto Run	CargoBB1-440	50
90	Inert Gas Plant/Blower lb3	440	Auto Run	CargoBB1-440	35
91	Cargo Pump Cps1	440	Auto Run	CargoBB1-440	16
92	Cargo Pump Cps3	440	Auto Run	CargoBB1-440	16
93	Cargo Low Duty Compressor No 2	440	Auto Run	CargoBB2-440	330
94	Inert Gas Plant/Fuel Pump lpf2	440	Auto Run	CargoBB2-440	3
95	Inert Gas Plant/N2 Compressor lc2	440	Auto Run	CargoBB2-440	37
96	Inert Gas Plant/Compressor lcom2	440	Auto Run	CargoBB2-440	40
97	Inert Gas Plant/Blower lb2	440	Auto Run	CargoBB2-440	158
98	Inert Gas Plant/Compressor lref	440	Auto Run	CargoBB2-440	132
99	Cargo Pump Cps2	440	Auto Run	CargoBB2-440	16
100	Cargo Pump Cps4	440	Auto Run	CargoBB2-440	16

AUTOMATIC CIRCUIT BREAKERS

Consumers' Circuit Breakers

Circuit breakers can be used for supplying and disconnecting power to/from the SB's and feeders of individual consumers.

See table 2.2 for automatic circuit breakers parameters:

Table 2.2.

Consumer designation	Rated current, A
Bow Thruster	250
Warp Winch	200
Ballast Pump No 1	25
Ballast Pump No 2	25
Boiler Forced Draft Fan No 1	250
Sealing Air Fan No 1	6
Leak Gas Extr. Fan No 1	6
Main Turbine Lub. Oil Pump No 1	100
Boilers Fuel Oil Pump No 1	40
Drain Tank/Drain Pump No 1	40
Main Condensate Pump No 1	125
Main Cooling SW Pump No 1	160
Main Circulation SW Pump No 1	400
Central Cooling FW Pump No 1	125
CNTRL Air Compressor No 1	100
Fire Pump No 1	125
Vacuum unit Pump No 1	50
Lub. Oil Separator No 1	100
Boilers Aux. Forced Draft Fan No 3	250
Aux. Feed Water Pump	500
Ranges (galley)	80
Heavy Fuel Oil Transfer Pump No 2	50
Diesel Oil Transfer Pump	10
Water-desalinating plant	160
Provision Store Ref. Plant	50
Switchboard No 4	200
Boiler Forced Draft Fan No 2	250
Sealing Air Fan No 2	6
Leak Gas Extraction Fan No 2	6
Main Turbine Lub. Oil Pump No 2	100
Boilers Fuel Oil Pump No 2	40
Drain Tank/Drain Pump No 2	40
Main Condensate Pump No 2	125
Main Cooling Sea Water Pump No 2	160
Main Circulation SW Pump No 2	400
Central Cooling FW PumpNo 2	125
CNTRL Air Compressor No 2	100
Steering Gear Pump No 2	160
Fire Pump No 2	125
Vacuum unit Pump No 2 (stand-by)	50
Lub. Oil Separator No 2	100

Consumer designation	Rated current, A
FO Electro Heater (boiler start)	200
Main Circulation SW Pump (3)	400
Aux. Main Condensate Pump	125
Main Turbine Turn Gear Motor	20
Fuel Oil Separator	50
Bilge Water Pump	50
Switchboard No 5	40
Ship Ventilation	200
MBs CNTRL Main	25
Common Lights	320
MBs CNTRL Reserve	25
Switchboard No 6	50
Service Air Compressor	13
Steering Gear Pump No 1	160
Radio Equipment	9
Machinery Space (MS) Ventilation	250
Cargo & Ballast machinery	200
Battery Charger	2
Cargo Pump Cp 10	100
Cargo Pump Cp 20	100
Cargo Pump Cp 30	100
Cargo Pump Cp 40	100
Navigational equipment & intercom	32
Navigational lights	11
Machine Telegraph system	5
Gas Detection systems	32
Emergency Lights	400
Switchboard No 7	50
Main Turbine Automation	32
Main Turbine Safety System	32
Turbo- and DG Automation	32
Switchboard No 8	32
Cargo Pump Cp 11	50
Cargo Pump Cp 21	50
Cargo Pump Cp 31	50
Cargo Pump Cp 41	100
Cargo High Duty Compressor 1	100
Cargo Pump Cp 12	50
Cargo Pump Cp 22	50
Cargo Pump Cp 32	50
Cargo Pump Cp 42	50
Cargo High Duty Compressor 2	100
Cargo Low Duty Compressor 1	630
Inert Gas Plant/Fuel Pump lpf1	5
Inert Gas Plant/N2 Compressor lc1	63
Inert Gas Plant/Compressor lcom1	80
Inert Gas Plant/Blower lb1	320
Inert Gas Plant/Pump Hip1	100
Inert Gas Plant/Blower lb3	63

Consumer designation	Rated current, A
Cargo Pump Cps1	32
Cargo Pump Cps3	32
Cargo Low Duty Compressor 2	630
Inert Gas Plant/Fuel Pump lpf2	5
Inert Gas Plant/N2 Compressor lc2	63
Inert Gas Plant/Compressor lcom2	80
Inert Gas Plant/Blower lb2	320
Inert Gas Plant/Compressor lref	250
Cargo Pump Cps2	32
Cargo Pump Cps4	32

Faults Introduced by the Instructor

For each consumer, the instructor can introduce the following faults:

- Over current – overload (jamming of a mechanism on the electric motor shaft);
- Short Circuit – consumer short-circuit failure;
- Low Insulation – low insulation resistance;
- Sticking of contact – switch failure, stuck/welded contacts, no possibility to switch the consumer off;
- No contacting – switch failure, contacts not closing.

Diesel/Turbo Generator Automatic Circuit Breakers (Generator Circuit Breakers)

The automatic circuit breakers (generator circuit breakers) are used for protection of generators.

GCB Components

The generator circuit breaker (GCB) consists of:

- an electric motor for the automatic winding of springs;
- electric magnets for remote switching on, and a trip for remote GCB disconnection;
- switch-on springs;
- contacts (main, preliminary, arc suppressing);
- arc suppressing chambers;
- time relay;
- current release, zero uncouplers, maximum uncouplers;
- GCB switch on/off buttons;
- manual spring winding lever;
- GCB power supply switch.

The automatic circuit breakers are actuated in two stages: winding of the springs and switching on. The winding of the springs is done manually by using a handle or by means of an electric motor (automatic winding), with the GCB turned off by pressing "DISCONNECT" button. In the initial state, the springs are in the wound up state. The GCB is turned on by pressing "CONNECT" button, but only after the GCB has been connected to the power supply and the spring has been armed. When the GCB is tripped for protection, the springs would arm automatically, i.e., to turn on the circuit breaker again, it is necessary to wind the springs manually. In case of power break during GCB operation, GCB will be off, and the springs will not be wound up.

GCB is provided with the following types of protection:

- zero protection ($U_0 = 4950 \text{ V} = 0.75 U_{nom}$, actuated after 5 s);
- generator current overload protection ($I = 1.21 I_{nom}$, actuated after 60 s);
- generator current overload protection ($I = 3 I_{nom}$, actuated after 0.4 s);
- short circuit protection ($I = 10 I_{nom}$, actuated without any time delay);
- reverse power protection (reverse current $> 0.1 I_{nom}$, actuated after 10 s).

GCB Controls

GCB controls are arranged in a MSB section and include:

- GCB power supply switch;
- Illuminated button "CONNECT" for switching GCB on;
- Illuminated button "DISCONNECT" for switching GCB off;
- Lever for manual winding of the power supply springs.

Emergency Generator Circuit Breakers

The GCB under consideration is used to protect the emergency diesel generator (EDG) and the shore power supply.

GCB Components

The GCB consists of a thermal relay which operates (indirectly via the minimum voltage release) the uncoupling shaft of the switch, fast-operating uncoupler, mechanical retarder, independent uncoupler, switch-on springs, electric motor for their winding, GCB switch on/off buttons and GCB power switch.

GCB is switched on automatically when the voltage on the generator terminals reaches the value of $0.85 U_{nom}$. The springs are wound up by the electric motor automatically, when GCB is switched on. GCB is switched off by the independent uncoupler, when voltage appears on the MSB's buses.

The emergency diesel generator has the following protections:

- zero protection (line voltage is below 300 V ($0.75 U_{nom}$), actuated after 6 s);
- generator current overload protection ($I = 1.2 I_{nom}$, actuated after 120 s);
- short circuit protection ($I = 10 I_{nom}$, actuated after 0.19 s).

Shore supply GCB has the following protections:

- zero protection (line voltage is below 300 V ($0.75 U_{nom}$), actuated after 5 s);
- generator current overload protection ($I = 1.21 I_{nom}$, actuated after 60 s);
- generator current overload protection ($I = 3 I_{nom}$, actuated after 0.38 s);
- short circuit protection ($I = 10 I_{nom}$, actuated after 0.19 s);
- phase break protection (actuated without any time delay).

GCB controls

GCB controls are located on the ESB section:

- GCB power supply switch;
- Illuminated button “CONNECT” for switching GCB on;
- Illuminated button “DISCONNECT” for switching GCB off.

INSULATION MONITORING

Purpose

The insulation monitoring instruments are designed for checking the insulation of consumer SB's: 6.6 kV, 440 V, 220 V, sections DG, TG1, TG2, EDG, and synchronization section.

COMPOSITION

- Insulation resistance control of each MSB/ESB section is performed with a megohmmeter:
 - MSBD 6600 – 1, 2, and 3-section megohmmeters;
 - SBD 440 – 1 and 2-section megohmmeters;
 - SBD 220 – 1 and 2-section megohmmeters;
- Two switchable megohmmeters are also provided for insulation resistance control of:
 - TG1 section, TG2 section, and DG section;
 - EDG section and synchronization section.

Control of insulation resistance for each cargo switchboard section is provided using an individual megohmmeter for each section:

- Cargo SBD 6600 – 1, 2-section megohmmeters;
- Cargo SBD 440 – 1, 2-section megohmmeters.

Monitored Parameters and Indicators

The subject of monitoring is the insulation resistance, which should be between 0.1–0.5 MOhm.

DIESEL GENERATOR

Purpose

Diesel generator is designed for generating electrical power onboard the ship.

Composition

For power generation, the ship EPP uses a brushless three-phase synchronous generator with an implicit-pole rotor (6 kV, 60 Hz, $\cos \varphi = 0.8$, $n = 720$ rpm). The synchronous generator has a three-phase current exciter with external poles, a rotating rectifier unit, electronic excitation and regulating device for the exciter, voltage limiter and harbor heating. The harbor heating is switched off automatically, when the generators get closed onto the buses. Harbor heating is switched off automatically upon closing the generator onto the buses.

The diesel generator power capacity is 3200 kW.

DG Control System

The DG control system located in the MSB's generator section, includes:

- controller of the automatic voltage regulator (AVR), which allows varying the generator voltage between 5680 V and 7450 V;
- buttons (more/less) for changing specified engine rpm, which allows changing RPM within $\pm 10\%$ of their rated value;
- "demagnetisation" button for "damping" the electromagnetic field (automatic field-damping device) protected against an accidental depressing;
- "HEATING" button for switching on the electrical heating of the interior DG section space for the purpose of removing possible condensate.

DG Monitoring System

The DG control system includes the following instruments:

- ammeter with a phase selector switch;
- voltmeter with line voltage switch;
- frequency meter;
- active-power wattmeter;
- reactive-power meter.
- The monitoring system also includes the following indicator lamps:
- Diesel engine status indicator ("STOP", "RUN" – engine rpm above 80 % of its rated value);
- Indicator of voltage type (power supply type) on the MSB buses (standard: DG or TG are operating; emergency: EDG is operating; and shore supply: MSB is powered from ashore).

DG Alarm System

The DG alarm system includes the following indicators:

- LOW VOLTAGE – indicator of voltage drop on the generator terminals (line voltage below 5280 V ($0.8 U_{nom}$) for 1 s (time delay));
- OVER CURRENT – generator overload (generator current above I_{nom} for 1 s);
- HIGH STATOR TEMPERATURE – high stator temperature (the stator hardware temperature is higher than 65 °C for 30 s);
- SHORT CIRCUIT – short circuit of the generator windings, generator current exceeds 3 I_{nom} , the generator has changed to the motor mode (the generator reverse current above 0.08 P_{nom} for 1 s);
- DIESEL NOT WARM-UP – the diesel engine is not warmed up (freshwater temperature after engine is below 35 °C).

DG Protection System

The DG protection system switches off the GCB in case:

- the generator changes to the motor mode and loads the EPP (the generator's reverse power is above 0.08 P_{nom} for 6 s);
- line voltage is below 5280 V ($0.8 U_{nom}$) for more than 3 s.;
- line voltage is higher than 7260 V ($1.1 U_{nom}$) for more than 3 s.;
- generator overload (generator current above 1.21 I_{nom} for 40 s);
- generator short circuit (generator current above 3 I_{nom} for 0.2 s);
- the generator rpm is reduced (the electrical current frequency is below 55 Hz without time delay).

DG is also protected by the GCB own protection system.

ATTENTION!

DG GCB cannot be turned on, when MSB is energized from ashore.

Faults Introduced by the Instructor

- Voltage control feedback breaking – generator overvoltage, AVR feedback break;
- Low insulation – low generator insulation resistance;
- Circuit breaker fault – GCB fault;
- Voltage control fault – AVR fault;
- RPM governor control fault – RPM governor fault, generator frequency change;
- Generator short circuit – short circuit in the generator;
- High generator stator temperature.

TURBOGENERATOR

Purpose

The turbogenerator (TG) is designed for production of electric power aboard.

Composition

For power generation, the ship EPP uses brushless three-phase synchronous implicit-pole rotor generators (6 kV, 60 Hz, $\cos \varphi = 0.8$, $n = 720$ rpm).

The synchronous generator has a three-phase current exciter with external poles, a rotating rectifier unit, electronic excitation and regulating device for the exciter, voltage limiter and harbor heating. The harbor heating is switched off automatically, when the generators closes onto the buses.

The total turbogenerator power capacity is 3150 kW.

TG Control System

The TG control system located in the MSB's generator section includes:

- controller of the automatic voltage regulator (AVR), which allows varying the generator voltage between 5680 V and 7450 V;
- buttons (more/less) for changing specified engine rpm, which allows changing RPM within ± 10 % of their rated value;
- "demagnetisation" button for "damping" the electromagnetic field (automatic field-damping device) protected against an accidental depressing.
- "HEATING" button for switching on the electrical heating of the interior TG section space for the purpose of removing possible condensate.

TG Monitoring System

The TG control system includes the following instruments:

- an ammeter with a phase selector switch;
- a voltmeter with line voltage switch;
- a frequency meter;
- active-power wattmeter;
- reactive-power meter.

The monitoring system also includes the following indicator lamps:

- diesel engine status indicator ("STOP", "RUN" – engine rpm above 80 % of its rated value);
- indicator of voltage type (power supply type) on the MSB buses ("NORMAL" – DG or TG operation, "EMERGENCY" – EDG operation, or "SHORE" – shore power supply).

TG Alarm System

The TG Alarm System includes the following indicators:

- LOW VOLTAGE – indicator of voltage on the generator terminals (line voltage below 5280 V ($0.8 U_{nom}$) for 1 s (time delay));
- OVER CURRENT – generator overload (generator current above I_{nom} for 1 s);
- HIGH STATOR TEMPERATURE – high stator temperature (the stator hardware temperature is higher than 65 °C for 30 s);
- SHORT CIRCUIT – short circuit of the generator windings, generator current exceeds $3 I_{nom}$, the generator has changed to the motor mode (the generator reverse current above $0.08 P_{nom}$ for 1 s).

TG Protection System

TG protection system switches off the GCB in case:

- the generator changes to the motor mode and loads the EPP (the generator's reverse power is above $0.08 P_{nom}$ for 6 s);
- line voltage is below 5280 V ($0.8 U_{nom}$) for more than 3 s;
- line voltage is higher than 7260 V ($1.1 U_{nom}$) for more than 3 s;
- generator overload (generator current above $1.21 I_{nom}$ for 40 s);
- generator short circuit (generator current above $3 I_{nom}$ for 0.2 s);
- the generator rpm is reduced (the electrical current frequency is below 55 Hz without time delay).

TG is also protected by the GCB own protection system.

ATTENTION!

GCB cannot be turned on, when MSB is energized from ashore.

Faults Introduced by the Instructor

- "Voltage control feedback breaking" – generator overvoltage, AVR feedback break;
- "Low insulation" – low generator insulation resistance;
- "Circuit breaker fault" – GCB fault;
- "Voltage control fault" – AVR fault;
- "RPM governor control fault" – RPM governor fault, generator frequency change;
- "Generator short circuit" – short circuit in the generator;
- "High generator stator temperature".

EMERGENCY DIESEL GENERATOR

Purpose

The emergency generator (EDG) is designed for generating electric power on the ship in an emergency (in case of basic source failure, i.e., DG, TG1, and TG2).

Composition

For an EDG, the ship EPP uses a brushless three-phase synchronous generators with an implicit-pole rotor 450 V, 60 Hz, $\cos \varphi = 0.8$, $n = 720$ rpm). The synchronous generator has a three-phase current exciter with external poles, a rotating rectifier unit, electronic excitation and regulating device for the exciter, voltage limiter, and harbor heating. The harbor heating is switched off automatically when the generators are connected to the buses.

EDG power capacity is 580 kW.

Control System

The EDG control system located on the emergency switchboard includes GCB control buttons.

Monitoring System

The EDG monitoring system includes the following instruments:

- ammeter with a phase selector switch;
- voltmeter with line voltage switch;
- frequency meter.

Alarm System

The EDG alarm system includes the following indicators:

- LOW VOLTAGE AB – indicator of voltage drop on the starting accumulator battery (below 21.5 V);
- LOW VOLTAGE EG – voltage drop on the generator terminals (line voltage below 320 V ($0.8 U_{nom}$) for 1 s (time delay);
- OVER CURRENT – generator overload (generator current above I_{nom} for 1 s);
- HIGH STATOR TEMPERATURE – high stator temperature (the stator hardware temperature is higher than 65 °C for 30 s);
- SHORT CIRCUIT – short circuit of the generator windings (generator current is above $3 I_{nom}$).

Protection System

EDG protection is provided by automatic switching off of the GCB. EDG GCB is also switched off by an independent release without time delay at an external signal when voltage appears on the MSB ($U > 6.6$ kV) without any time delay.

Faults Introduced by the Instructor

- Low insulation – low generator insulation resistance;
- Circuit breaker fault – GCB fault;
- Generator short circuit – short circuit in the generator;
- High generator stator temperature.

SHORE SUPPLY SWITCHBOARD

Purpose

Shore power supply can be used for energizing a part of ship consumers during her stay at the pier.

Shore Power Supply Components

The shore power supply consists of the shore supply switchboard and electrical cables for shore connection.

The vessel EPP is provided with a 1000 A shore power supply switchboard.

Controls

The shore power supply controls are arranged on the shore supply switchboard and include:

- shore supply circuit-breaker “CONNECT” and “DISCONNECT” buttons with illumination;
- “SUPPLY” switch of the shore supply circuit breaker power supply.

ATTENTION!

In case of voltage on MSB buses, the shore supply is interlocked against connection.

Control System

The shore supply monitoring system includes the following instruments and indicators:

- an ammeter with a phase selector switch;
- a voltmeter with line voltage switch;
- “RIGHT” and “WRONG” correct shore connection indicator lamps;
- indicator of voltage on the MSB buses (“POWER ON”).

DG Alarm System

The alarm system switches on the following indicators:

- phase wire break indicator;
- short circuit indicator.

Protection System

The shore supply protection is provided by interlocking the shore supply circuit breaker in the following cases:

- incorrect phase connection;
- voltage on MSB (voltage on the MSB buses is higher than 6.6 kV).

The shore supply circuit breaker can also be switched off due to its own protection.

Faults Introduced by the Instructor

- Shore Supply Phase breaking;
- Shore Supply Wrong phase;
- Shore Supply disable;
- Shore Supply Circuit Breaker fault.

MAIN SWITCHBOARD (MSB)

Purpose

MSB is the central point of control and power distribution among the onboard power consumers.

MSB Components

MSB consists of the generator sections DG, TG1, TG2, synchronization section, and consumer's section 6.6 kV, 440 V and 220 V.

Cargo System Switchboard (Cargo)**Purpose**

The switchboard is a point of power distribution among the onboard power cargo consumers.

Switchboard Components

The switchboard consists of the 6.6 kV/440 V consumer section.

EMERGENCY SWITCHBOARD (ESB)

Purpose

ESB is designed for providing a certain part of onboard consumers with power from EDG in case of main power source failure, i.e. DG, TG1, and/or TG2.

ESB Components

ESB is composed of the EDG generator section (EDG), 440 V, 220 V and 24 V DATA CONTAINER emergency consumer sections, and an accumulator battery (AB) charging unit section.

AB Charging Unit Controls

AB charging unit controls:

- switches for connection of batteries 1, 2, 3, and 4 to the charging unit;
- battery room fan on/off switch;
- battery charging-current adjustment knob.

AB Charging Unit Monitoring System

The AB charging unit monitoring system includes:

- voltmeter with a switch for monitoring capacity of batteries 1, 2, 3, and 4;
- ammeter with a switch for checking the charging-current value through batteries 1, 2, 3, and 4.

AB Charging Unit Alarm System

The alarm system includes a short circuit current indicator.

Faults Introduced by the Instructor

Charging unit:

- Charger (batteries) fault – failure of the charger current regulator.

AUXILIARY DIESEL ENGINE

Purpose

The auxiliary diesel engine is the generator's drive motor and is designed to rotate the generator rotor. The generator is driven by a four-stroke non-reversible medium RPM turbo charged diesel engine operating on light or heavy diesel fuel.

Control System

The auxiliary diesel engine control consists of:

- auxiliary engine automatic remote control system (ARC), providing engine preparation for start, and engine start/stop;
- RPM governor;
- diesel protection system;
- emergency warning protection system (alarm system).
- the ARC system provides:
 - warming up of the inactive engine;
 - prestart lubrication of the inactive engine;
 - standard or emergency (accelerated) start/stop of the diesel engine.

Prestart warm-up of the auxiliary diesel engine is performed by switching on a special power pump, which circulates engine cooling water through the electrical heater.

The prestart lubrication of a non-operating diesel engine is effected by means of permanent (Run mode) or periodic (Auto mode) run of the electric oil priming pump.

A standard start of the diesel engine can be effected under condition that the oil pressure is not below 2 bar. When the oil pressure is below 2 bar, the oil priming pump is switched on. With the oil pressure of not below 2 bar and freshwater and lube oil temperature of not below 20 °C, the start air is supplied. As the diesel engine gains 20 % of the rated RPM, fuel is fed and RPM grow to 80 % of its rated value (warming-up idling revolutions). At this rate the cooling water and engine lube oil are heated to 35 °C. When this temperature is reached, the RPM is brought to the rated value, and the engine is ready to accept 50 % of load. After another 2 minutes the engine is ready for 100 % load.

In case of an emergency start, no check of oil pressure and freshwater temperature is performed at the start stage. For an emergency start, no oil priming or engine warm-up at the intermediate rate is effected either.

After three successive start failures, the automatic start is locked. A start attempt is assumed to be a failure, if:

- the engine does not develop 20 % of its rate rpm within 15 seconds, when operating on start air;
- the engine stops after fuel is supplied;
- the engine does not develop 80 % of its rated rpm in 15 seconds after the fuel is supplied.

A standard shutdown of the diesel engine cannot be effected, unless the GCB is ON. In case of a standard engine shutdown, the engine is brought down to 80 % of its rated RPM and is kept at these RPM for 2 minutes. The engine is then stopped by cutting off the fuel supply.

In case of an urgent engine shutdown, GCB switches off immediately and the fuel is cut off. The engine will stop without any time delay.

Monitoring System

The auxiliary diesel monitoring system includes the following instruments:

- Diesel RPM meter;
- LO pressure gage at the last lubrication point;
- pressure gauge in the start air line upstream of the engine;
- fresh water pressure gage in the diesel cooling system;
- pressure gauge for the fresh-water cooling line;
- temperature gage showing fresh cooling water temperature downstream of the diesel.

Alarm System

The alarm system includes the following indicators:

- HIGH FW TEMPERATURE – cooling freshwater temperature downstream of the engine above 90 °C;
- HIGH LO TEMPERATURE – lube oil temperature upstream of the oil cooler above 75 °C;
- LOW LO PRESSURE – lubricating oil pressure below 1.5 bar;
- HIGH EXH. GAS TEMPERATURE – exhaust gas temperature downstream of the turbocompressor above 465 °C;
- LOW START AIR PRESSURE – start air pressure below 8 bar;
- START FAULT – diesel start failure (3 failed attempts of start);
- LOW LO LEVEL – low lube oil level;
- LOW FO LEVEL – low fuel oil level in the service tank;
- SYNC. FAULT – synchronization failure.

The latter signal arrives to the auxiliary engine alarm system from the fuel system of the propulsion plant module.

Protection System

The protection system (PS) activates stopping the auxiliary diesel on the following signals from the protection system sensors:

- HIGH FW TEMPERATURE – freshwater temperature above 95 °C after engine;
- LOW LO PRESSURE – lubricating oil pressure below 1.1 bar;
- OVERSPEED – diesel RPM above 110 % of its rated value.

On tripping, the protection system switches the GCB off and stops the engine by cutting off the fuel supply; in case of a stop caused by the excessive RPM, the air supply is also stopped. Arming of the protection system is performed automatically, when the engine achieves 60 % of its rated RPM, which results in actuation of the "ON" indicator. Pressing on the Reset button performs PS reset.

Faults Introduced by the Instructor

- Fuel feed breaking – fuel feed is interrupted, the engine wouldn't start;
- RPM Governor jamming – jamming of the diesel engine RPM governor, engine overspeed;
- Exhaust valve jamming – jamming of the exhaust valve, exhaust gas temperature rising;
- Lub. oil pump is sucking-up the air – lube oil pump failure, oil pressure drop;
- Lub. oil cooler obstructed – oil cooler clogged, lube oil temperature rising.
- Low fuel level – low fuel level in the tank;
- Low oil level – low lube oil level in the tank.

TURBOGENERATOR DRIVE

Purpose

The turbogenerator drive is a steam turbine designed to rotate the generator rotor.

The turbogenerator control system consists of the following:

- Steam turbine automatic remote control (ARC) system providing preparation of the turbine for start, its start and stop;
- Turbine RPM governor;
- Turbine protection system;
- Alarm system.

ARC allows the following operations to be performed:

- automatic preliminary warm-up of the turbine;
- preliminary, intermittent or constant lubrication of the non-operating turbine;
- standard start and standard or emergency stop of the turbine.

The preliminary lubrication of a non-operating turbine is effected by means of permanent (Run mode) or periodic (Auto mode) switching on of the electric oil priming pump.

The warm-up mode is switched on automatically after turbine start and the Warm-Up indicator on the turbine control panel comes on. The turbine runs up to 400 rpm and operates approx. 2 min. Then, within approx. 1 min, the turbine runs up to 1100 rpm. Achieving 1100 rpm, the turbine runs up to its rated speed of 1800 RPM within approx. 5 s.

Standard turbine stop is possible with GCB off only. For a standard stop, the turbine smoothly decreases its speed until full stop, which takes about 20 s.

In case of an emergency turbine stop, GCB is off, and steam is cut at the maneuvering valve inlet.

Monitoring System

TG drive monitoring system includes the following instrument:

- Generator rpm meter;
- Steam pressure gage at the maneuvering valve inlet;
- Steam monitoring at the maneuvering valve inlet;
- Lube oil pressure gage at the turbine inlet;
- Lube oil temperature gage at the turbine outlet;
- Turbine vibration indicator;
- Turbine rotor axial displacement indicator.

Turbine Protection System

Protection system (PS) activates stopping the turbogenerator on the following signals from the protection system sensors:

- OVERSPEED – turbine overspeed;
- LOW LO PRESSURE – low lube oil pressure;
- HIGH LO TEMPERATURE – high lube oil temperature;
- HIGH VIBRATION – high level of turbine rotor vibration;
- ROTOR DISPLACEMENT – excessive turbine rotor displacement;
- HIGH CONDENSER LEVEL – high level in the condenser;
- CONDENSER VACUUM – loss of vacuum in the condenser.

The protection system is armed automatically during turbine acceleration, the “ON” indicator coming on. Press the “RESET” button to reset the protection system after tripping.

Faults Introduced by the Instructor

- Turbine overspeed – turbine overspeed;
- Turbine low LO pressure – low lube oil pressure;
- Turbine high LO temperature – high lube oil temperature;
- Turbine high vibration – high level of turbine rotor vibration;
- Turbine rotor high displacement – excessive turbine rotor displacement;
- High level in Condenser – high level in the condenser;
- Condenser vacuum loss – loss of vacuum in the condenser.

EMERGENCY DIESEL ENGINE

Purpose

Emergency diesel engine is designed to drive the emergency generator. A four-stroke non-reversible medium RPM turbocharged diesel engine operating on light fuel is used as the emergency diesel engine.

Components

The diesel engine of the emergency unit consists of the diesel engine per se and the engine systems, which include:

- engine control system;
- lubrication system;
- fuel oil system;
- cooling system.

All these systems are self-sustained.

Control System

The diesel control system consists of:

- remote automatic control (ARC) system controlling the start/stop subsystems;
- RPM governor;
- protection system;
- alarm system.

The unit is installed in a heated room with a minimum temperature of 25–30 °C. No preliminary warming up or regular lubricating oil priming is required.

The engine is started automatically on voltage disappearance on MSB (below 4950 V ($0.75 U_{nom}$) for more than 3 s). The engine can be started/stopped manually, using the buttons “START” and “STOP”. An electric starter is used for starting the emergency generator engine. A fully charged accumulator battery provides 5 successive starts. The engine stops after the switching off of the GCB, which is switched off when the voltage appears on the MSB buses (voltage above 5900 V). When being stopped, the engine is brought down to 80 % of its rated RPM and is maintained at this RPM for 1 minute. The engine is then stopped by cutting off the fuel supply. After three successive start failures, the automatic start is locked.

A start attempt is assumed to be a failure, if:

- the engine does not develop 20 % of its rate rpm within 15 seconds;
- the engine stops after fuel is supplied;
- the engine does not develop 80 % of its rated rpm within 15 seconds after fuel is supplied.

Monitoring System

The diesel engine monitoring system includes the following instruments:

- RPM meter;
- lube oil pressure gage at the final lubrication point;
- cooling water pressure gage at the diesel engine inlet;
- cooling seawater pressure gage.

Alarm System

The Alarm System includes the following indicators:

- START FAULT – diesel start failure (3 failed attempts of start);
- LOW LO LEVEL – low lube oil level;
- LOW LO PRESSURE – lubricating oil pressure below 1.5 bar;
- LOW FO LEVEL – low fuel oil level in the service tank;
- HIGH FW TEMPERATURE – temperature of cooling freshwater at the engine outlet above 90 °C;
- HIGH EXH. GAS TEMPERATURE – exhaust gas temperature upstream of the turbocompressor turbine above 465 °C;
- 24 V FAULT – voltage in the automatic system below 21 V;
Start readiness (accumulator battery voltage above 21.5 V).

Protection System

The protection system (PS) activates stopping the diesel on the following signals from the protection system sensors:

- OVERSPEED – engine speed above 110 % of its rated RPM;
- LOW LO PRESSURE – lubricating oil pressure below 0.8 bar.

At the signal from these sensors, the protection system switches the GCB off and stops the engine by cutting off the fuel supply; in case of a stop caused by the excessive RPM, the air supply is also stopped. The protection system is turned on as the engine RPM grows to 60 % of its rated value. To reset the protection system after its actuation, press “RESET” button.

Faults Introduced by the Instructor

- Fuel feed breaking – no fuel, engine start failure;
- Low fuel level – low fuel level in the tank;
- Exhaust valve jamming – jamming of the exhaust valve, exhaust gas temperature rising;
- RPM Governor jamming – jamming of the diesel engine RPM governor, engine overspeed;
- LO pump is sucking-up the air – lube oil pump failure, oil pressure drop;
- Low LO level – low lube oil level;
- LO cooler obstructed – oil cooler clogged, lube oil temperature rising.

SIMULATOR CONTROL PANELS

SEPS controls, indicators, and alarms are distributed on several simulator screen pages according to the systems they belong to; in addition, some pages contain the main current circuit and the summary information on alarm actuation for all systems. See Fig. 3 for a structural diagram of screen panels.

Simulator controls	
Panels for monitoring and control of machinery and systems	PP control panel
Page leaf-over buttons	

Fig. 3. Screen panel structural diagram

See Fig. 4–6 for appearance of some panels.

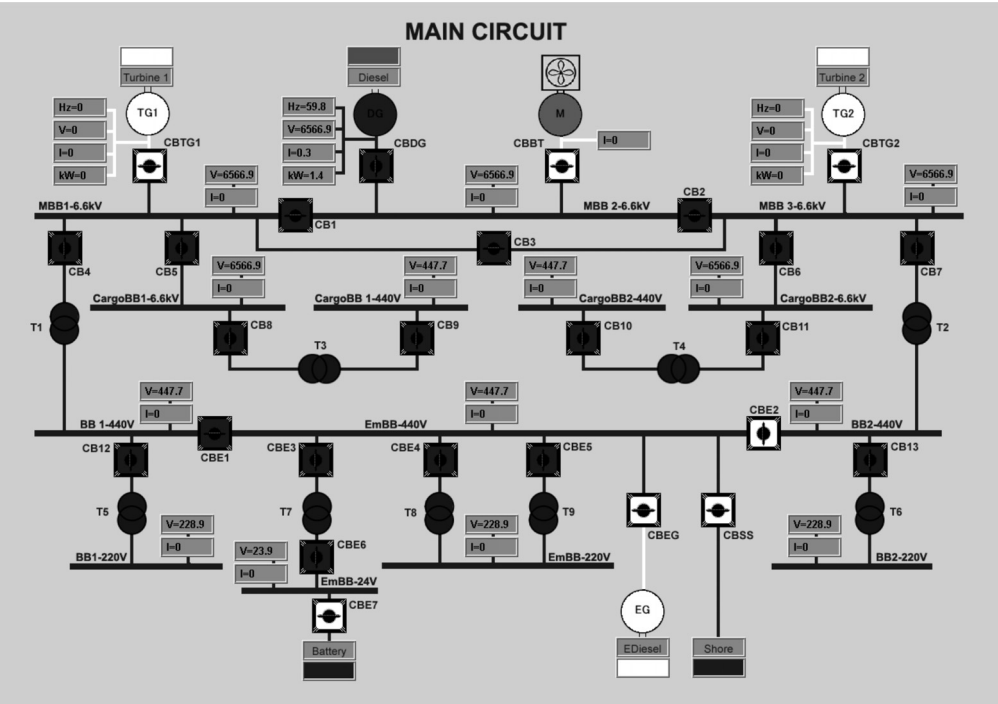


Fig. 4. Main current circuit

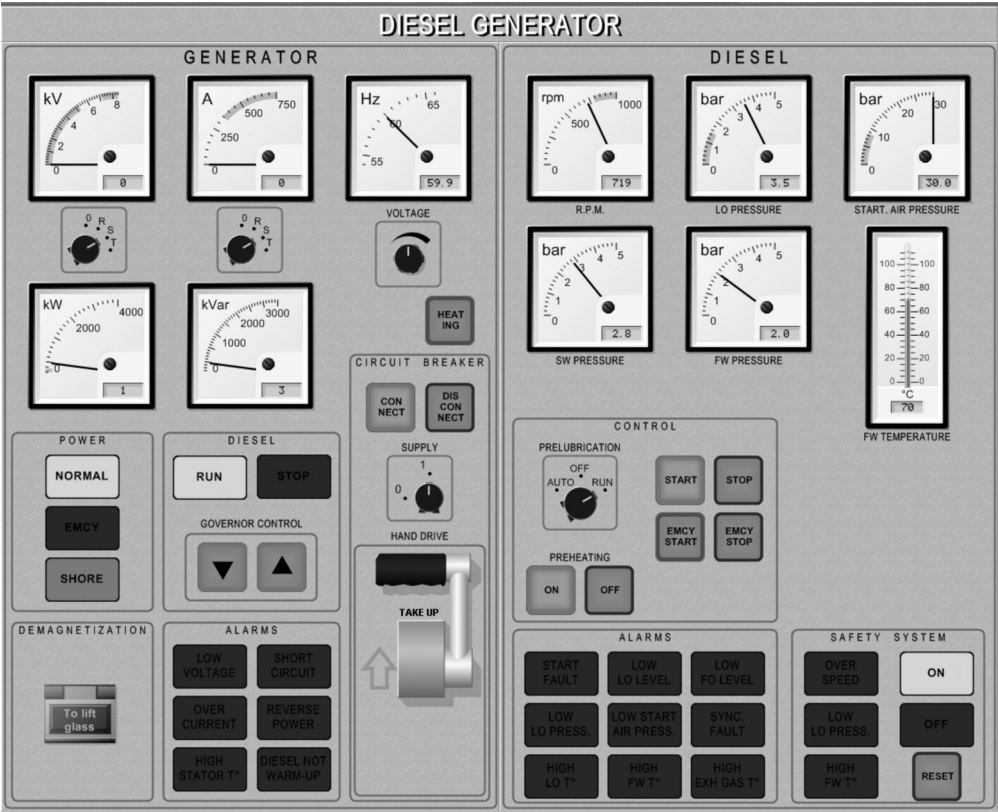


Fig. 5. Panel for DG1 and power plant control

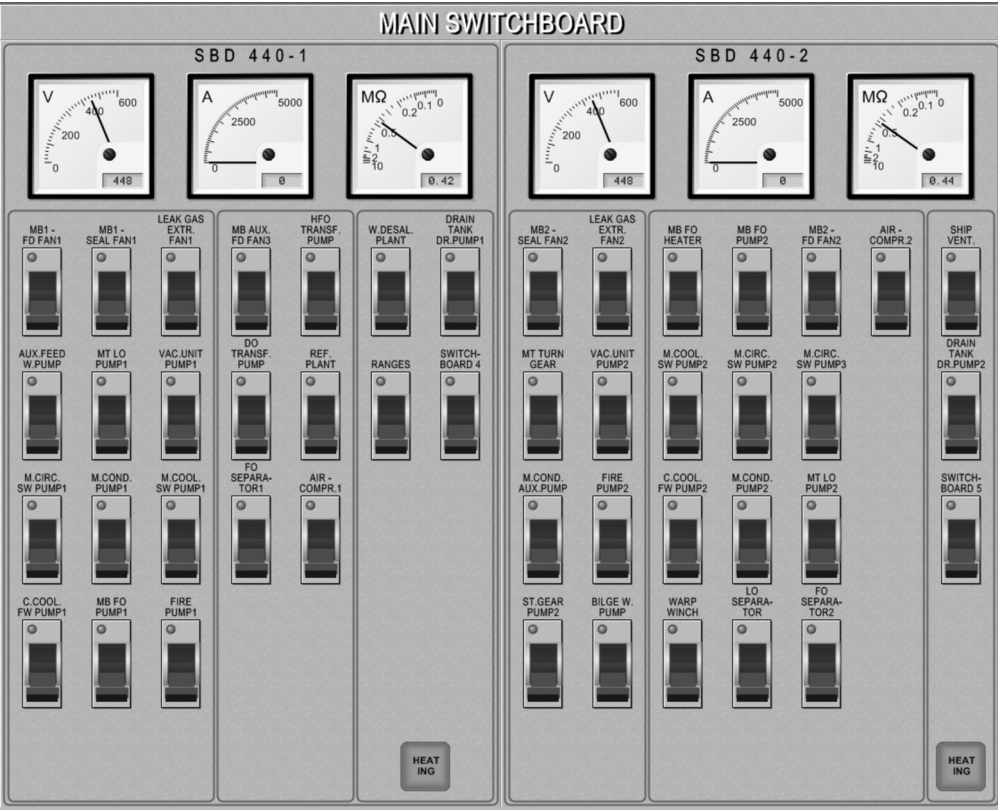


Fig. 6. MSB. Load distribution and insulation monitoring panels

SEPS Control Panel

The SEPS control panel is designed to assign a SEPS operation mode (see Fig. 7).

The control panel includes:

- Control mode switch (CONTROL MODE);
- Generator priority switch (PRIORITY);
- SEPS operation submode selection buttons, when in the automatic control mode (AUTO MODES – “EQUAL”, “OPTIMAL”, “CYCLIC”, “CONST FREQ”).

The power plant status switch (CONTROL MODE) is designed to switch between the manual and automatic control of SEPS.

The “CONTROL MODE” switch has two positions:

- “AUTO” – automatic mode of power plant control;
- “MANUAL” – manual mode of power plant control.

The priority switch (PRIORITY) for diesel generators is designed to select the priority (first to start) diesel generator (DG, TG1 or TG2), when SEPS is in the automatic mode. The “PRIORITY” switch has two positions:

- “DG” – the higher-priority generator is DG;
- “TG1” – the higher-priority generator is turbogenerator 1;
- “TG2” – the higher-priority generator is turbogenerator 2.

The SEPS automatic control mode selection buttons (AUTO MODES) are designed to select a generator load mode in the automatic mode (i.e., the buttons are active only in case SEPS is in the automatic mode).

The PP automatic operation system can be in one of the following modes:

- EQUAL – equal power mode, i.e. the mode, when the generators closed onto the buses are loaded uniformly;
- OPTIMAL – the best DG load mode. In this mode, the higher-priority generator is loaded more than the others. Two cases are possible:
 - two generators closed onto the buses:
 - if the total load is up to 95 % of the generator rated value, the lower-priority generator takes 15 %, the remaining part being taken by the higher-priority one;
 - if the total load is over 95 % of the generator rated value, but below 160 %, the higher-priority generator takes 80 % of the load, the remaining part being taken by the lower-priority one (15...80 %);
 - if the total load amounts to more than 160 % of the generator’s rated value, the load is distributed equally.
 - three generators onto the buses:
 - if the total load is up to 110 % of the generator rated value, the lower-priority generators take 15 % of the load each, the remaining part being taken by the higher-priority generator;
 - if the total load exceeds 110 % of the generator rated value, but below 240 %, the higher-priority generator takes 80 %, and the lower-priority generators take the remaining part in equal shares (15...80 %);
 - if the total load exceeds 240 % of the generator rated value, the load is distributed equally.

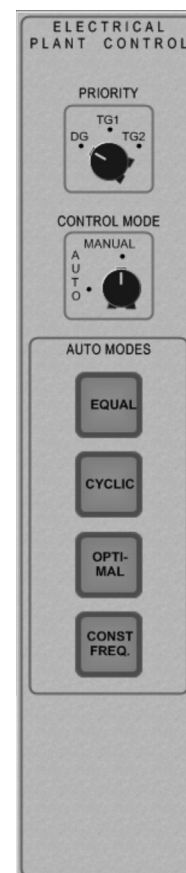


Fig. 7. SEPS control panel

- CYCLIC – the cyclic load distribution mode, when the load is distributed between the operating generators the same as in the optimal load mode, the generator priority, however, being changed in a preset interval;
- CONST FREQ. – constant frequency mode. In this mode the load is divided between the operating DG's in equal parts with a more accurate stabilization of the current frequency within 59-60 Hz limits. In this mode the RPM governor of the higher-priority DG ensures the frequency stabilization, whilst the RPM governor of the other DG's provides for load distribution.

Auxiliary Diesel Control Panel

The auxiliary diesel generator control panel is designed for:

- monitoring driving diesel engine parameters;
- preheating the diesel engine;
- starting preliminary oil circulation in the engine
- starting the diesel engine (standard and emergency procedures);
- stopping the diesel engine (standard and emergency procedures);

To perform these functions, the panel includes:

- engine controls;
- diesel engine condition indicating meters;
- alarm system;
- protection system (PS).

See Fig. 8 for the auxiliary diesel engine control panel.

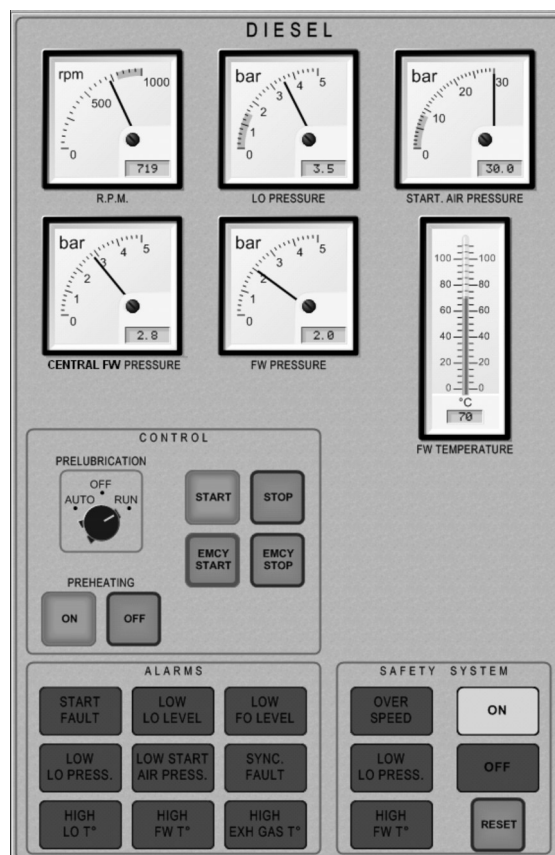


Fig. 8. Auxiliary diesel control panel

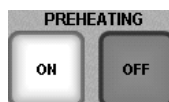
Auxiliary Diesel Engine System Control Panel

The diesel engine system control panel:

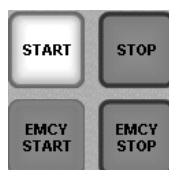
- Oil priming control mode switch (PRELUBRICATION) – “OFF/AUTO/RUN” modes;



- diesel engine warm-up control buttons (PREHEATING) – “ON-OFF”;



- “START” and “EMCY START” buttons, and “STOP” and “EMCY STOP” buttons.



The oil priming control mode switch (PRELUBRICATION) is designed for establishing a mode of operation for the electric oil-priming pump, it has three positions: “OFF”, “RUN”, and “AUTO”. To establish a mode of operation for the oil-priming pump, set the switch to the required position using the mouse:

- OFF mode – the oil priming pump doesn't run;
- RUN mode – the oil priming pump starts and brings the oil pressure to 2.5 bar;
- AUTO mode – the oil-priming pump runs intermittently (pumping oil for 5 minutes after each 20-minute break).

The diesel engine warm-up control buttons (PREHEATING) are designed for control of diesel engine preheating. The “ON” button activates the electrical heater and the electrical pump, which circulates diesel cooling freshwater through the heater. The “OFF” button is used to stop the circulating pump and de-energize the electrical heater.

Diesel engine startup and shutdown is performed using four buttons.

For a standard (regular) diesel engine startup, press the “START” button. In this case, if pressure in the lubrication system is below 2.0 bar, the electric oil-priming pump will be switched on prior to air supply. When the pressure reaches a specified value, the engine will be started.

To start the engine in emergency, press the “EMCY START” button. In this case, the engine will be started without a check of initial pressure of oil, gaining its rated RPM in minimum time.

The diesel engine is stopped using the “STOP” button, only if the generator circuit breaker (GCB) is OFF. In case of a standard engine stop, the diesel engine is brought down to 80 % of its rated RPM and is maintained at this RPM for 2 minutes. The engine is then stopped by cutting off the fuel supply.

In case of an emergency engine stop, for which the “EMCY STOP” button is used, the GCB is switched off automatically and the fuel supply is cut off immediately.

The “EMCY START” and “EMCY STOP” buttons have the first priority. If the engine is started by using first the “START” button, and then “EMCY START” button, it will be started according to the Emergency Start program from the moment of pressing the “EMCY START” button. In this case, no return to the standard start program is possible. The “STOP” and “EMCY STOP” buttons have a similar way of operation.

Diesel Engine Protection System Panel

The diesel engine protection system (or SAFETY SYSTEM) is designed to protect the engine against damage.

The protection system becomes armed after engine crankshaft speed has reached a level of 60 % of the rated value. The protection system state is monitored by the "ON" indicator (the system is armed and ready) and the "OFF" indicator (the system is off or has been actuated). On actuation, the protection system performs an emergency engine shutdown procedure. This is accompanied by an acoustic signal, after which the system locks any attempt to start the engine again. The protection system can be unlocked after actuation, using the "RESET" button.

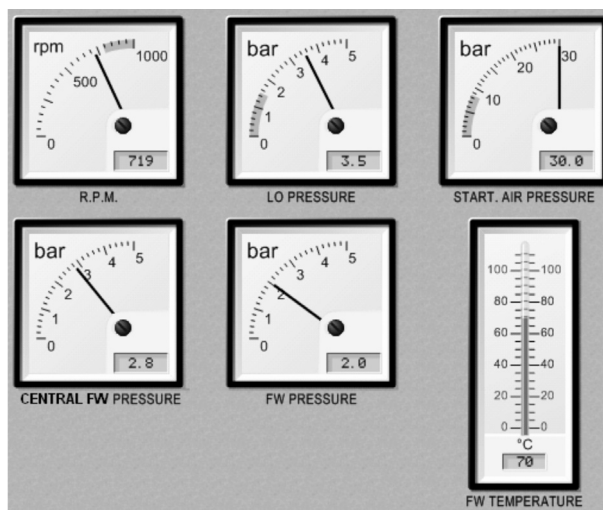


Protection system activates under the following conditions:

- Auxiliary diesel engine RPM is above 110 % of its rated value ("OVER SPEED" indicator);
- The oil pressure in the final lubrication point is below 1.5 bar ("LOW LO PRESS" indicator);
- cooling system freshwater downstream of the diesel above 95 °C ("HIGH FW T⁰" indicator).

Diesel Engine Condition Indicating Meters

The diesel engine status indicating meters are used for monitoring the most important parameters of the running or stopped engine, among them being:



- R.P.M meter – showing diesel speed (revolutions per minutes);
- LO PRESSURE gage – showing oil pressure in the final lubrication point (bar);
- START. AIR PRESSURE gage – showing pressure in the start air line upstream of the engine (bar);

- CENTRAL FW PRESSURE gage – showing pressure in the central freshwater cooling line (bar);
- FW PRESSURE gage – showing freshwater pressure upstream of the engine;
- FW TEMPERATURE gage – showing cooling freshwater temperature downstream of the engine (°C).

Diesel Engine Alarm System Indicator Panel

The alarm indicators signal to the user that some parameters have exceeded their operational range.



The engine alarm system functions only during engine operation (except the start air minimum pressure indicator), actuating the following indicators:

- SYNC. FAULT – synchronization failure in the automatic mode for more than 2 min (coming from the automatic synchronization control system);
- LOW LO PRESS. – lube oil pressure below 2 bar;
- LOW START AIR PRESS. – start air pressure below 8 bar;
- HIGH LO T° – lubricating oil pressure above 75 °C downstream of the engine and upstream of the lubricating oil cooler;
- HIGH EXH. GAS T° – exhaust gas temperature downstream of the turbocharger turbine above 465 °C;
- LOW LO LEVEL – low lubricating oil level in the service tank;
- LOW FO LEVEL – low fuel oil level in the service tank (the signal coming to the engine alarm system from the simulator module of the diesel propulsion plant);
- START FAULT – engine start failure (the engine does not develop 20 % of its rated rpm in 15 s operating on the start air; the engine stops after fuel is supplied; the engine does not develop 80 % of its rate rpm in 15 s);
- HIGH FW T° – freshwater temperature at the engine outlet above 90 °C.

When the monitored parameters exceed the working range, the respective indicators start flashing simultaneously with the sound alarm, reporting on alarm system signals that have arisen but not acknowledged yet. The sound alarm is silenced by acknowledgement, while the indicators either change for continuous light, if the alarm cause is still present (the parameter is still outside the operational range), or turn off, if the alarm cause has disappeared (the parameter has returned to its operational range).

TG Drive Control Panel

The turbogenerator (TG) drive control panel, see Fig. 9, is designed control of turbine/gearbox status. The control panel includes:

- indicators and meters for monitoring the turbine/gearbox status;
- alarm indicators;
- system protection panel.

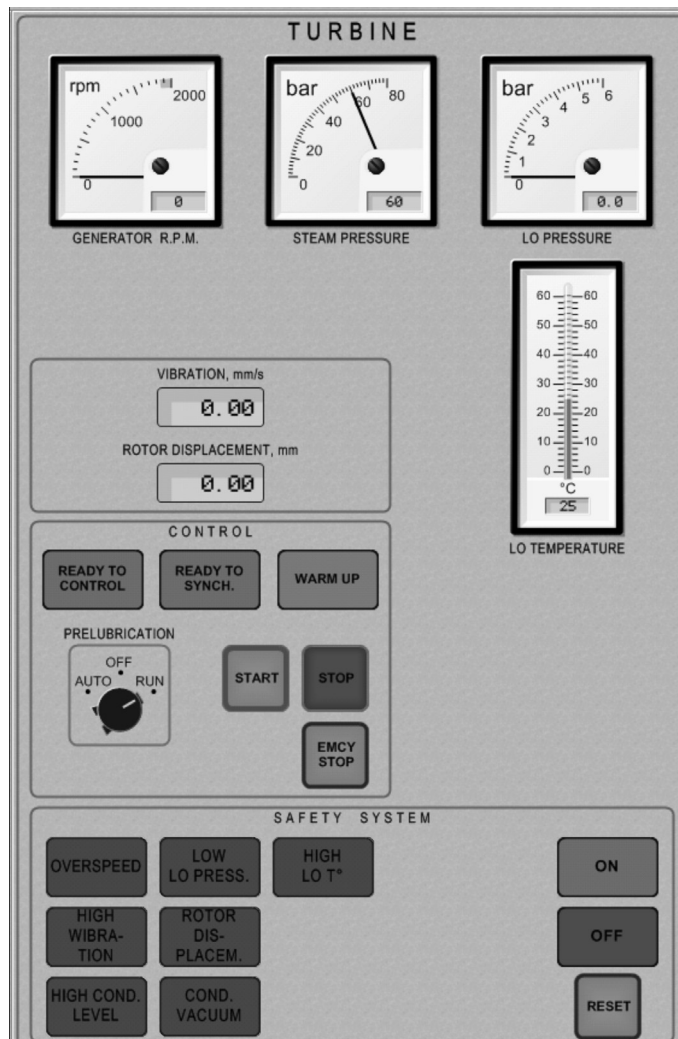
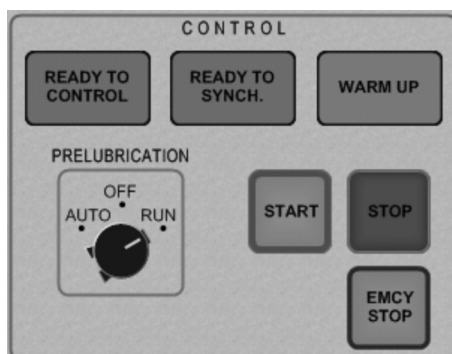


Fig. 9. TG drive control panel

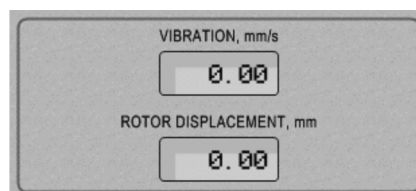
Control panel

TG drive control panel includes:



- “READY TO CONTROL” indicator – control readiness;
- “READY TO SYNCH.” indicator – TG readiness for synchronization;
- “WARM UP” indicator – prestart turbine warm-up mode;
- “OFF/AUTO/RUN” switch – oil priming control mode (PRELUBRICATION);
- “START TG” button – normal mode start;
- “STOP TG” button – normal mode stop;
- “EMCY STOP” button – TG emergency stop.

The digital indicators of turbine rotor vibration and its axial displacement are located above the control panel:



System Protection Panel

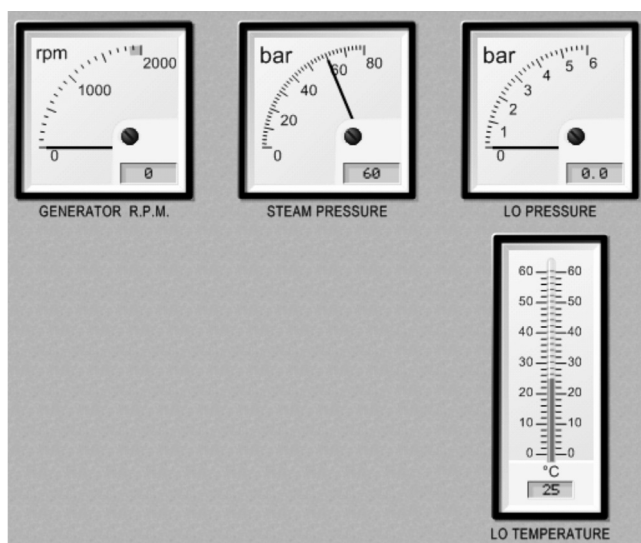
Turbogenerator turbine protection panel contains indicators specifying the reason for turbine shut down by the protection system:



- OVERSPEED – turbine overspeed;
- LOW LO PRESSURE – low lube oil pressure;
- HIGH LO TEMPERATURE – high lube oil temperature;
- HIGH VIBRATION – high level of turbine rotor vibration;
- ROTOR DISPLACEMENT – excessive turbine rotor displacement;
- HIGH COND. LEVEL – high water content in the steam condensate;
- COND. VACUUM – loss of vacuum in the steam condensate.

The panel contains also “ON-OFF” indicators of system activity and the button for re-arming the protection system after its tripping.

Turbogenerator Drive Status Instruments



The turbogenerator drive meters are designed for monitoring the basic parameter values; they include:

- GENERATOR R.P.M meter – showing generator/gearbox rpm;
- STEAM PRESSURE gage – showing steam pressure upstream of the maneuvering valve (bar);
- LO PRESSURE gage – showing lube oil pressure in the lubrication system (bar);
- LO TEMPERATURE gage – showing lube oil temperature (°C).

Emergency Diesel Generator Engine Control Panel

The emergency diesel generator engine control panel is designed for controlling/monitoring engine operation.

To perform these functions, the panel includes:

- engine controls;
- diesel parameter indicating meters;
- alarm panel;
- system protection panel (PS).

See Fig. 10 for the emergency diesel generator engine control panel.

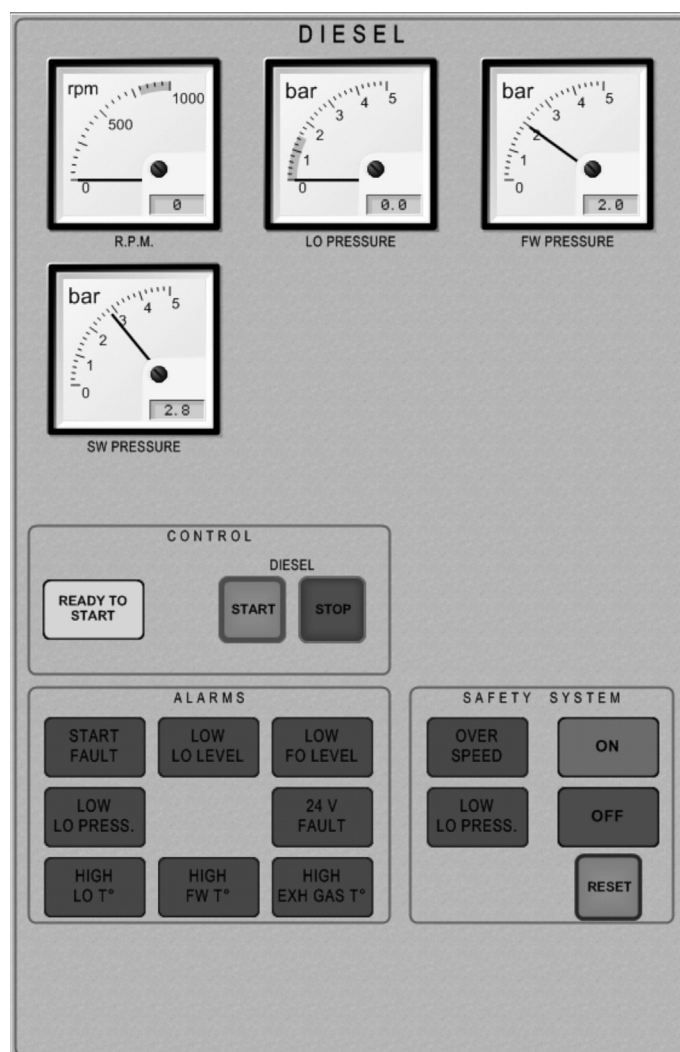


Fig. 10. Emergency diesel generator engine control panel

Control panel

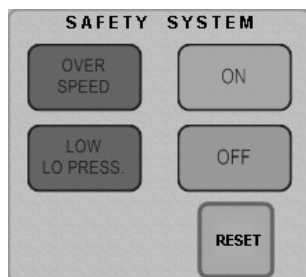
The emergency diesel generator engine control panel includes:

- “START/STOP” – engine start/stop buttons;
- READY TO START – indicator of the emergency generator engine readiness for start.

The diesel generator engine readiness-for-start indicator is actuated, when the start battery value exceeds 21.5 V.

Diesel engine protection system panel

Diesel PS (SAFETY SYSTEM) is designed to guard the diesel engine against damage during its operation.



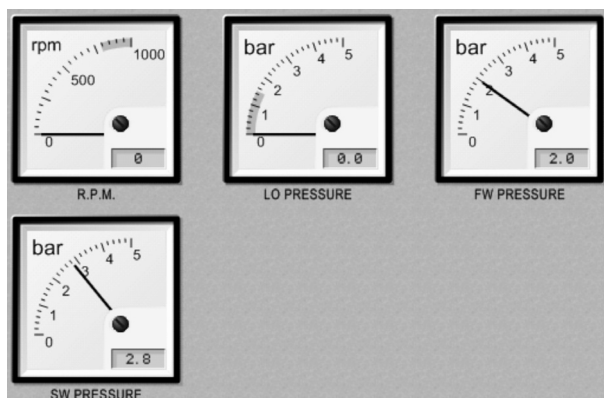
The protection system becomes armed after engine speed has reached a level of 60 % of the rated value. The protection system state is monitored by the “ON” indicator (the system is armed and ready to work) and the “OFF” indicator (the system has been turned off or actuated). On actuation, the protection system provides a diesel engine emergency stop. This is accompanied by an acoustic signal, after which the system locks any repeated attempts to start the diesel engine. The protection system can be relocked after actuation by the “RESET” button.

The protection system trips under the following conditions:

- Auxiliary diesel engine RPM have exceeded 110 % of the rated value (“OVER SPEED” indicator);
- The oil pressure in the final lubrication point is below 0.8 bar (“LOW LO PRESS” indicator).

Engine Parameter Indicating Meters

The instruments are designed for monitoring the basic parameters of the running or stopped engine; they include:



- R.P.M meter – showing diesel crankshaft speed (revolutions per minute);
- LO PRESSURE gage – showing oil pressure in the final lubrication point (bar);
- FW PRESSURE gage – showing freshwater pressure at the diesel inlet;
- SW PRESSURE gage – showing pressure in the seawater cooling line (bar).

Diesel Alarm System Panel

The alarm indicators signal to the user that some parameters have exceeded their operational range.



The diesel engine alarm system is active during diesel engine operation only (except the indicator of the start battery minimum voltage); it includes the following indicators:

- 24 V FAULT – automation system voltage below 21V;
- LOW LO PRESS. – lube oil pressure below 2 bar;
- HIGH LO T° – lube oil temperature before the oil cooler below 75 °C;
- HIGH EXH. GAS T° – exhaust gas temperature above 465 °C after the turbocharger turbine;
- LOW LO LEVEL – low lubricating oil level in the service tank;
- LOW FO LEVEL – low full oil level in the service tank;
- START FAULT – diesel engine start failure (three attempts failed). An attempt is regarded as a failure, if the engine doesn't gain 20 % of the RPM rated value after its starting by the electric starter for 15 s, or the engine stops after the fuel is supplied; or the engine does not develop 80 % of its rated RPM in 15 s);
- HIGH FW T° – freshwater temperature at the engine outlet above 90 °C.

When the monitored parameters exceed the working range, the respective indicators start flashing simultaneously with the sound alarm, reporting on alarm system signals that have arisen but not acknowledged yet. The sound alarm is silenced by acknowledgement, while the indicators either change for continuous light, if the alarm cause is still present (the parameter is still outside the operational range), or turn off, if the alarm cause has disappeared (the parameter has returned to its operational range).

MSB Generator Sections

MSB generator section contains the Diesel Generator, Turbogenerator 1, and Turbogenerator 2.

MSB generator section is designed for:

- connecting the generator to the MSB buses;
- electric current frequency regulation;
- generator voltage control.

To perform these functions, the panel includes:

- controls of the generator and the auxiliary generator;
- emergency controls for the generator;
- electric parameter indicating meters and the ON/OFF button for heating of the section interior space;
- generator alarm panel;
- generator PS panel.

See Fig. 11 for MSB generator section.

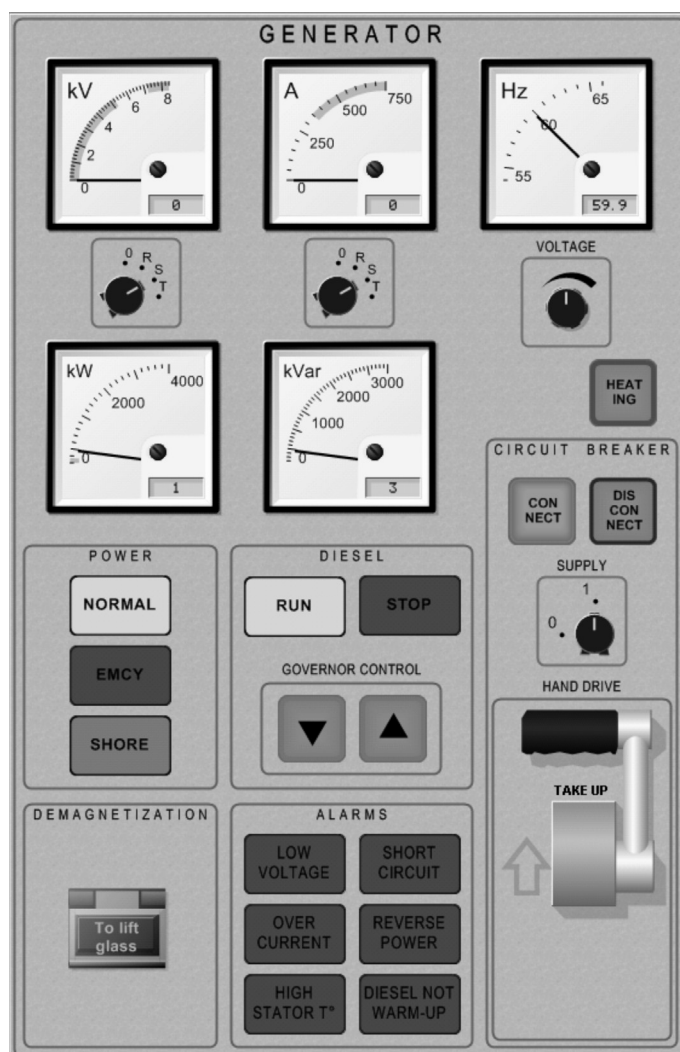


Fig. 11. Generator section

Generator Circuit Breaker

Generator circuit breaker (GCB) is designed for closing the generator onto the SEPS buses and for generator protection. GCB controls include the GCB power supply switch (SUPPLY) and highlighted GCB on/off buttons ("CONNECT", "DISCONNECT") and the GCB spring hand drive. The GCB power supply switch (SUPPLY) can be in one of two positions:

- "0" – no power supply to the generator circuit breaker;
- "1" – power supply to the generator circuit breaker on.

CB on/off buttons ("CONNECT" and "DISCONNECT") are active only in case the power supply switch is in position "1", otherwise, the "DISCONNECT" illuminates. Turning the CB power supply switch (SUPPLY) from position "1" to position "0" results in CB disconnection ("DISCONNECT" button illuminates).



ATTENTION!

DG GCB cannot be turned on (interlocked), when MSB is energized from ashore.

In case of SEPS operating in the automatic mode, the manual switching of GCB is locked, the generator connection to the buses being performed by the automatic system only (GCB being energized).

GCB is actuated in two stages: spring winding and switching on.

The winding of the springs is done either automatically using the integrated electric motor (automatic winding) after turning GCB off by the “DISCONNECT” button, or manually using the HAND DRIVE handle after actuation of the integrated GCB protection system. In the initial state, the GCB springs are not in the unwound state, which requires manual winding.

The GCB can be turned on by pressing “CONNECT” button, but only after the GCB is connected to the power supply and the springs are wound.

Controls

The controls for the generator and the auxiliary diesel engine include:

- the automatic device (DEMAGNETIZATION) for “damping” the electromagnetic field as a component of emergency control;



- buttons “more”/”less” for drive (diesel or turbin) RPM governor control;



- “VOLTAGE” button for controller of the automatic voltage regulator (AVR);
- “HEATING” button for turning on the interior electrical heating for the purpose of condensate removal from the section.



The automatic electromagnetic field damping device (DEMAGNETIZATION) is designed for urgent reduction of generator voltage by short-circuiting the excitation winding. The device switch is provided with a protecting cover (against unintentional depressing), which can be opened by a mouse left-hand button click (to lift glass). You can press the switch, and in this case, the excitation winding will be short-circuited, which results in the fall of the magnetic excitation field.

Governor control (GOVERNOR CONTROL) is designed for setting and changing the driving engine crankshaft speed (revolutions per minute), and, subsequently, the generator rotor speed. This control is also used by the system of active power distribution between the generators operating in parallel. The monitoring of speed change is performed using the frequency indicator (Hz) on the generator section. The engine speed can be changed (manual distribution of the active power) using the arrow buttons:

- ▼ – smooth reduction of engine RPM down to the minimum value ($0.9 \omega_{nom}$);
- ▲ – smooth increase of engine RPM up to the maximum value ($1.1 \omega_{nom}$).

ATTENTION!

Governor control using these buttons is locked in case the power plant operates in the automatic mode, or if the automatic synchronization mode is selected while the power plant is in the manual mode.

The automatic voltage regulator (AVR) is designed for voltage control of the working generator. Voltage is monitored using the voltmeter (V) on the MSB generator panel. The voltage controller knob mounted on the generator panel too allows the generator voltage to be changed from the minimum value ($0.93 U_{nom}$) to the maximum one ($1.07 U_{nom}$) and/or can be used for manual distribution of the reactive load.

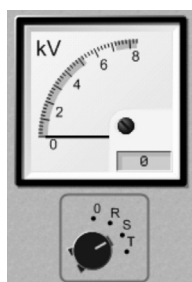
ATTENTION!

AVR manual control is disabled, if the power plant is in the automatic mode.

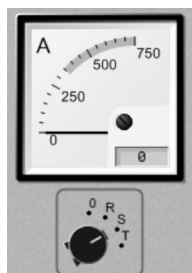
Instruments for Monitoring Generator Parameters

Generator parameter indicating meters are used for measuring the basic electric parameters of the generator. They are as follows:

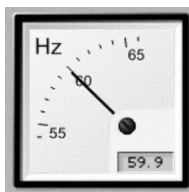
- voltmeter V – showing the voltage between generator phases depending on the position of the phase switch, R/S/T;



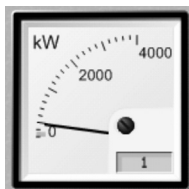
- ammeter A – showing the current value for each generator phase depending on the position of the phase switch, R/S/T;



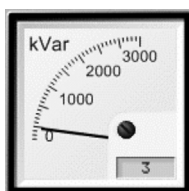
- frequency indicator Hz – showing the generator current frequency;



- wattmeter kW – showing the active power of the power consumers;



- reactive-power meter kVar – showing the reactive power of the power consumers.



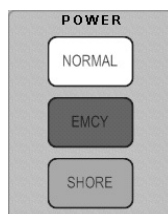
Status Indicators for the Diesel Engine and Power Supply for SEPS Buses

The indicators are designed for monitoring the status of the generator drive and power on the SEPS buses.

The drive check indicators switch on two indicators, i.e. “RUN” and “STOP”. The RUN indicator comes on, when the generator RPM reach 80 % of its rated value, otherwise the STOP indicator comes on.



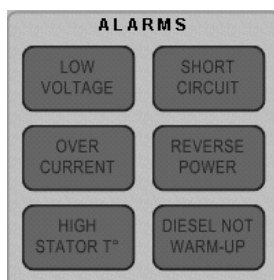
The “POWER” indicator shows the MSB bus power supply source and includes three indicators – “NORMAL”, “EMCY”, and “SHORE” (just one of the three illuminating at a time).



- “NORMAL” indicator shows that MSB buses are powered from the diesel generators or the shaft generator;
- “EMCY” indicator shows that only ESB buses are powered from EDG;
- “SHORE” indicator shows that power supply is from ashore (shore supply).

Panel of Generator Alarm/Protection Indicators

The indicators signal to the user that some generator parameters have exceeded their operational range. The generator alarm/protection systems are armed, when the generator gains 90 % of the rated RPM with a 25s delay.



The generator alarm system includes the following indicators:

- LOW VOLTAGE – voltage on generator buses below $0.8 U_{nom}$ for 1 s;
- OVER CURRENT – generator current above I_{nom} for 1 s;
- SHORT CIRCUIT – short circuit (generator current above $3 I_{nom}$ for 0.1 s);
- HIGH STATOR T° – stator temperature above 65°C for 30 s;
- REVERSE POWER – reverse power above $0.08 P_{nom}$ for 1 s;
- DIESEL NOT WARM-UP – for DG only, indicating that the diesel has been started without preliminary warming up, freshwater temperature at the diesel outlet is below 35°C .

The generator protection system trips GCB, when the parameters exceed their set range.

When the monitored parameters exceed the working range, the respective indicators start flashing simultaneously with the sound alarm, reporting on alarm system signals that have arisen but not acknowledged yet. The sound alarm is silenced by acknowledgement, while the indicators either change for continuous light, if the alarm cause is still present (the parameter is still outside the operational range), or turn off, if the alarm cause has disappeared (the parameter has returned to its operational range).

Synchronization Section

The synchronization section is designed for:

- selection of a generator to be synchronized (DG, TG1, or TG2);
- checking phase differences at MSB and at the terminals of the generator to be connected;
- switching generators to the parallel operation.

To perform these functions, the panel includes:

- controls;
- indicating meters for checking voltage and frequency at MSB and generator terminals;
- synchronoscope.

See Fig. 12 for the synchronization section.

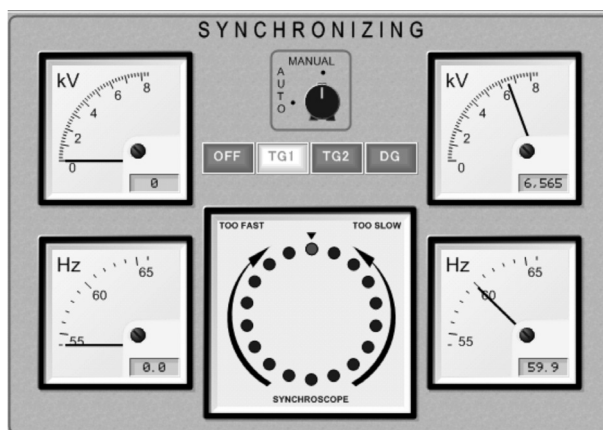


Fig. 12. Synchronization section

Controls

Synchronization section controls include:

- Synchronization mode switch (“MANUAL/AUTO”);



- generator-to-be-synchronized selection buttons.



The synchronization mode switch is designed for setting synchronization system operational mode, having two positions:

- “AUTO” – automatic synchronization mode;
- “MANUAL” – manual synchronization mode.

The generator-to-be-synchronized selection buttons (“OFF”, “DG1”, “DG2” and “SG”) are designed for selection of a generator to be connected to the parallel operation. GCB of the selected generator (DG1, DG2, or SG) should be energized. Then the switching of the automatic synchronization mode on (“AUTO”) will result in automatic synchronization of the selected generator with its connection to the buses. After this operation, the synchronization mode selector will automatically return to “MANUAL” position.

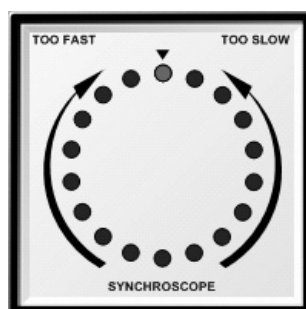
Indicating Meters

Instruments provide for checking the MSB voltage and frequency (right-hand instruments) on the connected generator too (left-hand instruments).

Synchroscope

The synchronization section includes a synchroscope. The red-colour synchroscope indicators are positioned in a circle; their operation is implemented on the “running wave” principle – alternating illumination of the indicators is possible both clockwise and counterclockwise.

If synchronization conditions are fulfilled (allowing the generator to be connected to the parallel operation), the upper indicator of the synchroscope illuminates only (“12 o'clock”). The indicators illuminate at the left side, or the light wave, consisting of illuminating in turn indicators, runs counterclockwise in case the synchronization conditions are not provided for, i.e., frequency of the synchronized generator is below that on MSB (TOO SLOW). The indicators illuminate at the right side, or the light wave, runs clockwise in case the synchronization conditions are not provided for, i.e., frequency of the synchronized generator is greater than that on MSB (TOO FAST).



Insulation Monitoring Board

A separate insulation monitoring board is designed for checking insulation of the generator section and the synchronization section; it includes two megohmmeters ($M\Omega$) with 4-position switches. The left-hand megohmmeter checks insulation of the sections of the diesel-generator and turbogenerators 1 and 2, the right-hand megohmmeter is designed for checking insulation of the synchronization section and the emergency generator section. See Fig. 13 for the insulation monitoring board.

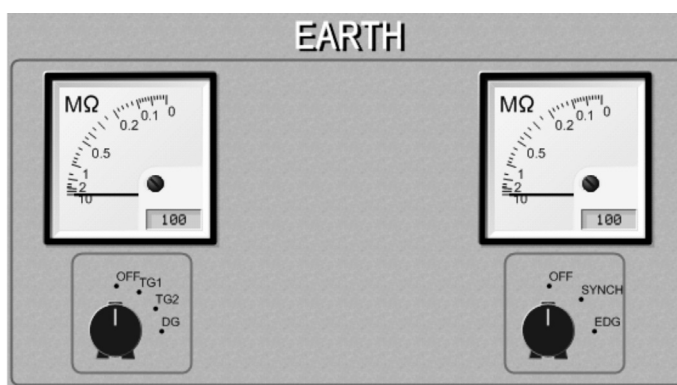


Fig. 13. Insulation monitoring board

Shore Supply Switchboard

The shore supply switchboard is designed for connection of the ship power plant to the shore power network.

To perform these functions, the shore supply switchboard includes:

- controls;
- indicating meters;
- indicators of shore supply phase sequence;
- alarm system.

See Fig. 14 for the shore supply switchboard.

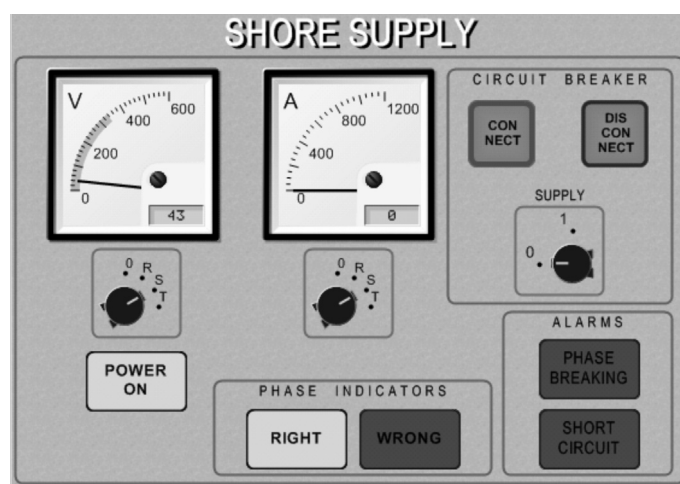
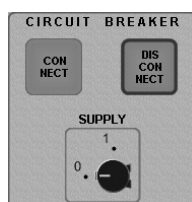


Fig. 14. Shore supply switchboard

Circuit Breaker

The circuit breaker is designed to connect shore power to the EPP buses and to protect EPP against wrong connection. In addition, the circuit breaker (CB) assures protection of the shore power network against overload and short circuit (SC). The circuit breaker controls consist of the power switch (SUPPLY) and illuminated GCB on/off buttons ("CONNECT", "DISCONNECT"). The power switch (SUPPLY) can be in one of two positions:



- "0" – circuit breaker not energized;
- "1" – circuit breaker energized.

CB on/off buttons ("CONNECT" and "DISCONNECT") are active only in case the power supply switch is in position "1", otherwise the "DISCONNECT" illuminates. Turning the CB power supply switch (SUPPLY) from position "1" to position "0" results in CB disconnection ("DISCONNECT" button illuminates).

The shore supply CB cannot be switched on, if MSB is energized, because of the interlock. The shore supply CB switches off automatically (i.e. shore supply is disconnected from MSB) in the following cases:

- shore supply line voltage below the rated value for 5 s;
- current overload (CB current above $1.21 I_{nom}$ for 60 s);
- short circuit (CB current above $3 I_{nom}$ for 0.38 s);
- short circuit (CB current above $10 I_{nom}$ for 0.19 s);
- phase break.

Indicating meters

The shore supply indicating meters are designed for measuring the basic parameters of the shore supply, they switch on the following:

- “POWER ON” indicator – showing that MSB is energized from ashore;
- voltmeter V – showing voltage between shore supply phases depending on R/S/T switch position;
- ammeter A – showing current for each shore supply phase depending on R/S/T switch position.



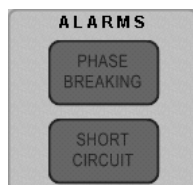
Indicators of Shore Supply Phase Sequence

The indicators (PHASE INDICATORS) are designed for checking the phase sequence during shore supply connection. “RIGHT” indicator illuminates in case of proper phase connection, otherwise – the “WRONG” indicator illuminates. When shore supply is unavailable, the voltage value being zero, neither “RIGHT” nor “WRONG” indicator illuminates.



Alarm Indicator Panel

The shore supply alarm indicators (ALARMS) are designed for to check SEPS operation from the shore supply. The “PHASE BREAKING” indicator denotes wrong phase sequence. The “SHORT CIRCUIT” indicator points at the fact that the shore supply CB has tripped from overloading or short circuiting (SC).



Emergency Diesel Generator (EDG) Section

The section is used for:

- connection of the emergency diesel generator (EDG) to the ESB buses;
- monitoring EDG operation.

To perform these functions, the section includes:

- EDG status indicating meters;
- Alarm system indicators and EDG protection systems.

See Fig. 15 for the EDG section.

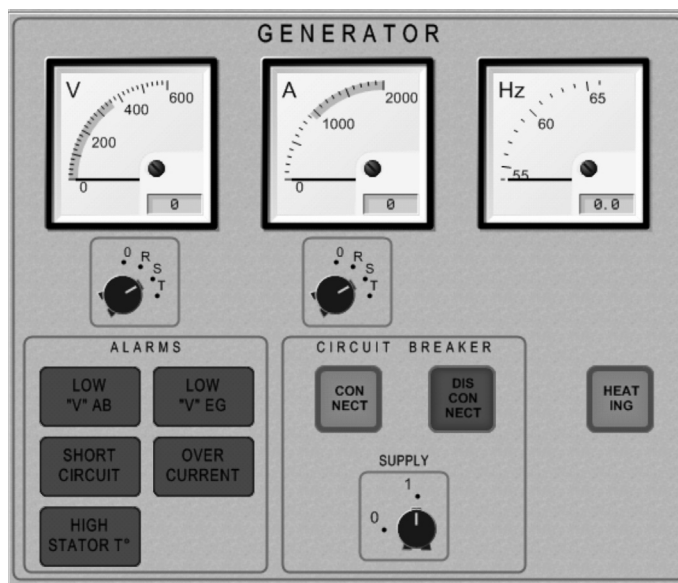
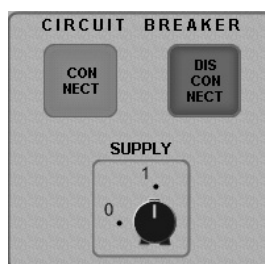


Fig. 15. EDG section

Generator Circuit Breaker

GCB (CIRCUIT BREAKER) is designed for closing the generator onto the SEPS buses and for generator protection against breakage. GCB controls include the GCB power supply switch (SUPPLY) and highlighted GCB on/off buttons (“CONNECT”, “DISCONNECT”).



The GCB power supply switch (SUPPLY) can be in one of two positions:

- “0” – generator circuit breaker energized;
- “1” – generator circuit breaker not energized.

CB on/off buttons (“CONNECT” and “DISCONNECT”) are active only in case the power supply switch is in position “1”, otherwise, the “DISCONNECT” illuminates. Turning the CB power supply switch (SUPPLY) from position “1” to position “0” results in CB disconnection (“DISCONNECT” button illuminates).

GCB is disconnected automatically (i.e., EDG is disconnected from the buses) in the following cases:

- line voltage on generator terminals is below the rated value for 6 s;
- generator overload (generator current above $1.21 I_{nom}$ for 120 s);
- generator short circuit (generator current above $10 I_{nom}$ for 0.19 s).

The EDG automatic control system, if GCB is energized, connects EDG to ESB buses in case MSB voltage disappears and disconnects GCB, when MSB buses become energized. GCB is locked against switching on under condition of voltage presence on MSB buses.

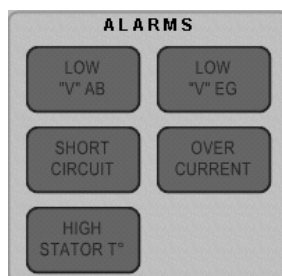
Emergency Generator Indicating Meters

EDG indicating meters are designed for determination of the generator major parameters and include the following:

- Voltmeter V – showing voltage between the generator phases depending on R/S/T switch position;
- Ammeter A – showing the current value for each generator phase depending on the position of the R/S/T phase switch;
- Frequency indicator Hz – showing the generator current frequency (Hz).

Panel of Alarm/Protection Support Indicators

The indicators of the generator alarm and protection systems (ALARMS) signal to the user that some generator parameters have exceeded their operational range or the protection system has tripped. The generator alarm/protection systems are armed, when the engine crankshaft gains 90 % of the rated RPM with a 25s delay, and becomes unarmed, when the emergency engine is stopped.



EDG alarm system includes the following indicators:

- LOW "V" CB – voltage at the battery terminals below 21 V;
- LOW "V" EG – voltage on generator buses below 320 V ($0.8 U_{nom}$) within 1 s;
- OVER CURRENT – generator current above I_{nom} within 1 s
- SHORT CIRCUIT – short circuit (generator current above $3 I_{nom}$ within 0.1 s);
- HIGH STATOR T° – stator temperature above 65 °C for 30 s.

The generator protection system trips GCB, when the parameters exceed their set range.

When the monitored parameters exceed the working range, the respective indicators start flashing simultaneously with the sound alarm, reporting on alarm system signals that have arisen but not acknowledged yet. The sound alarm is silenced by acknowledgement, while the indicators either change for continuous light, if the alarm cause is still present (the parameter is still outside the operational range), or turn off, if the alarm cause has disappeared (the parameter has returned to its operational range).

Consumer Switchboards MSB – MSB 1, MSB 2, and MSB 3

Page “MSB 1” (Main Switch Board 1) contains MSB 6.6 kV consumer switchboards:

- Switchboard MSBD 6600-1;
- Switchboard MSBD 6600-2;
- Switchboard MSBD 6600-3.

See Fig. 16 from MSB 1 page:

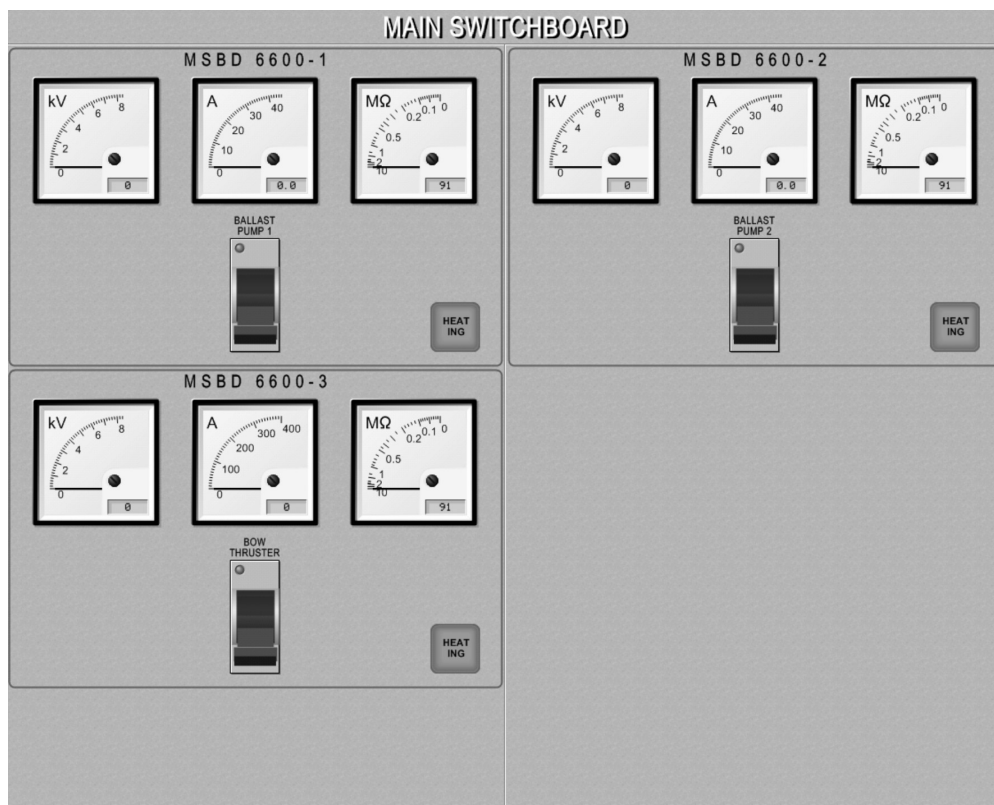


Fig. 16. MSB 1 page

Page “MSB 2” (Main Switch Board 2) contains MSB 440 V consumer switchboards:

- Switchboard SBD 440-1;
- Switchboard SBD 440-2.

See Fig. 17 for MSB 2 page:

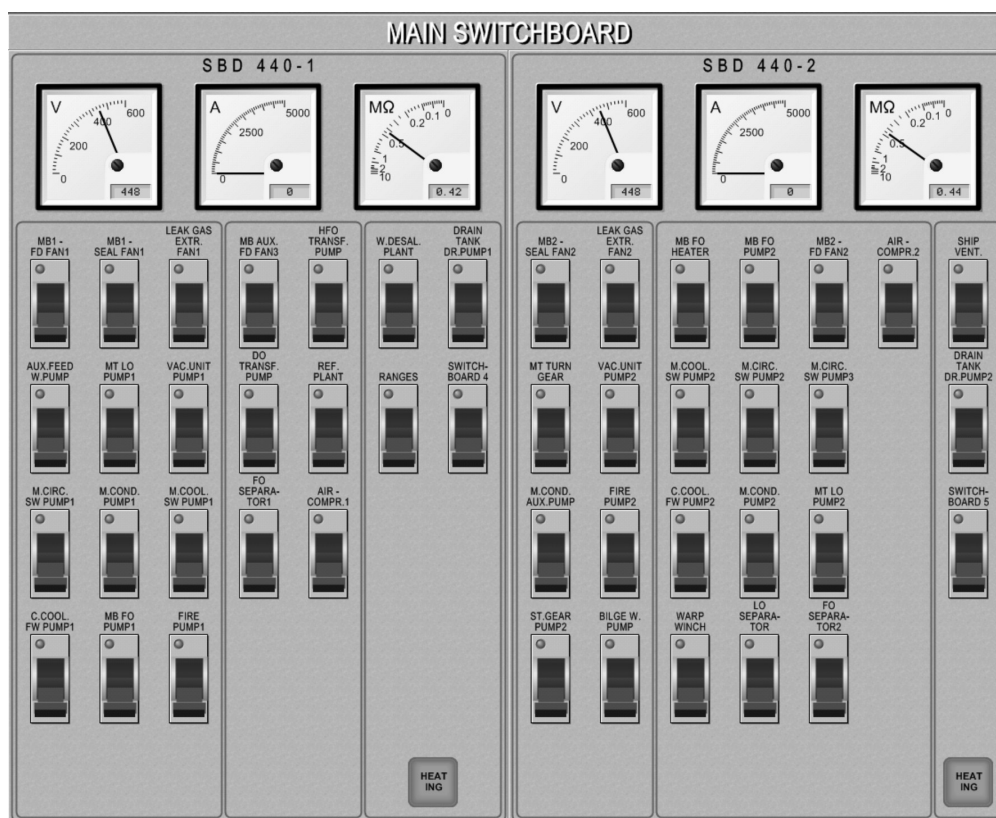


Fig. 17. MSB 2 Page

Page “MSB 3” (Main Switch Board 3) contains MSB 220 Valve consumer switchboards:

- Switchboard SBD 220-1;
- Switchboard SBD 220-2.

See Fig. 18 for MSB 3 page:

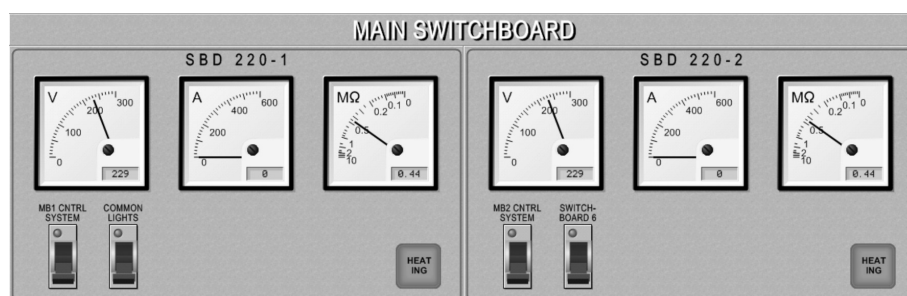


Fig. 18. MSB 3 Page

The switchboards are designed for control of 6.6 kV, 440 V, 220 V networks and connection/disconnection supply to/from the consumers connected to these switchboards.

To perform these functions, the switchboards include:

- controls – switches for supplying power to consumers, and buttons for switching on interior heaters (“heater pads”) designed for condensate removal from the switchboards;
- indicating meters – ammeters and insulation control meters (megohmmeters).

Controls

The controls are represented by switches, which are used to supply power to consumers. The switches on switchboards SBD 440-1 and SBD 440-2 are grouped: critical/non-critical consumers, heavy-duty/low-duty consumers, for whom selective protection is implemented too. The switches are provided with integrated protection against overloading. When protection trips, the consumer is disconnected. Each switch features a red-colour indicator in its upper left corner, which confirms the fact of the integrated protection tripping

Indicating Meters

The indicating meters are used to check the mains voltage, the current draw, and insulation. The switchboards are provided with:

- voltmeters V – showing the line voltage on the switchboard;
- ammeters A – showing current drawn by the consumers connected to the switchboard;
- megohmmeter $M\Omega$ – showing switchboard insulation resistance.

Emergency Switchboard (ESB)

Page “ESB” (Emergency Switch Board) contains ESB consumer switchboards:

- Switchboard ESBD 440;
- Switchboard ESBD 220;
- Switchboard ESBD 24 V DC;
- Battery Charging switchboard, 24 V DC.

See Fig. 19 for page ESB:

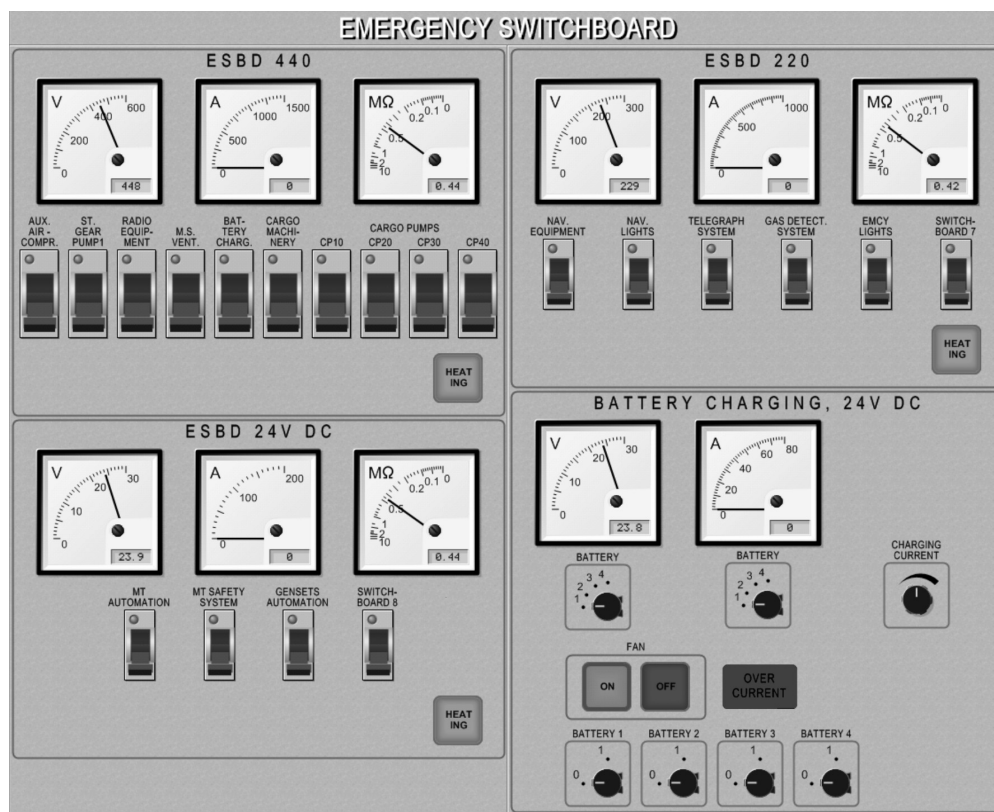


Fig. 19. “ESB” page

The switchboards are designed for control of 440 V DC, 220 V DC, 24 V DC and connection/disconnection supply to/from the consumers connected to these switchboards.

To perform these functions, the switchboards include:

- controls – switches for supplying power to consumers, and buttons for switching on interior heaters (“heater pads”) designed for condensate removal from the switchboards;
- indicating meters – ammeters and insulation control meters (megohmmeters).

In addition, there is a 24 V DC charger panel there.

Accumulator Battery (AB) Charging Unit

The charging unit is designed for monitoring the battery charge level and for charging 24 V DC batteries.

For realization of these functions, the charging unit panel includes:

- controls;
- indicating meters.

See Fig. 20 for the charging unit panel.

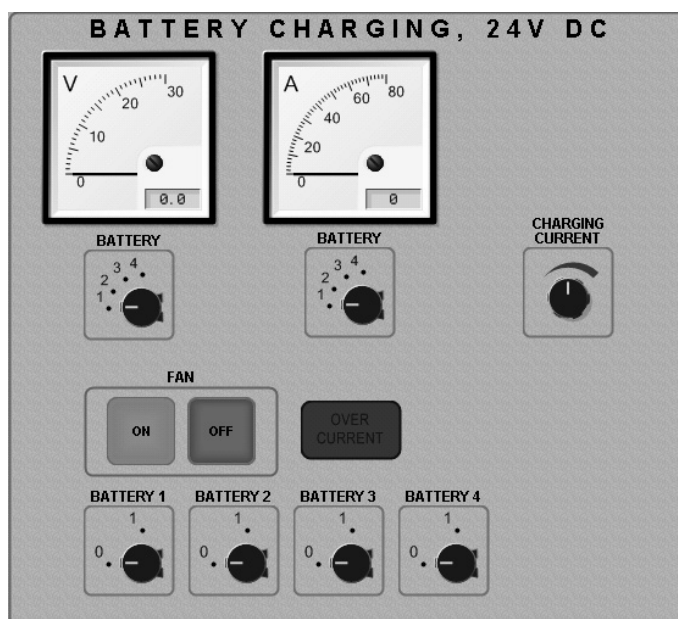


Fig. 20. Charging unit panel

Controls

Switches for connection of a certain battery to the charging unit.



Ventilation "ON-OFF" buttons of the accumulator battery room.



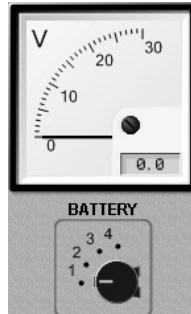
Battery charging current adjustment knob.



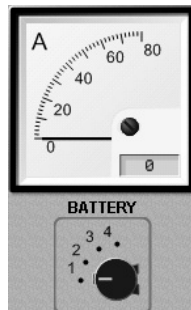
Indicating Meters

The charging unit panel includes:

- voltmeter V with a 1/2/3/4 switch – showing line voltage of the corresponding battery;

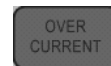


- ammeter A with a 1/2/3/4 switch – showing the charging current for the corresponding battery.



Alarm Indicator Panel

The charging unit alarm system is designed for monitoring the battery charging current. The “OVER CURRENT” indicator shows charging current rushes.



Cargo Switchboards (CSB)

Page “CSB” (Cargo Switch Board) contains tanker cargo system consumer switchboards:

- Switchboard CSBD 6600-1;
- Switchboard CSBD 6600-2;
- Switchboard CSBD 440-1;
- Switchboard CSBD 440-2.

See Fig. 21 for page ESB:

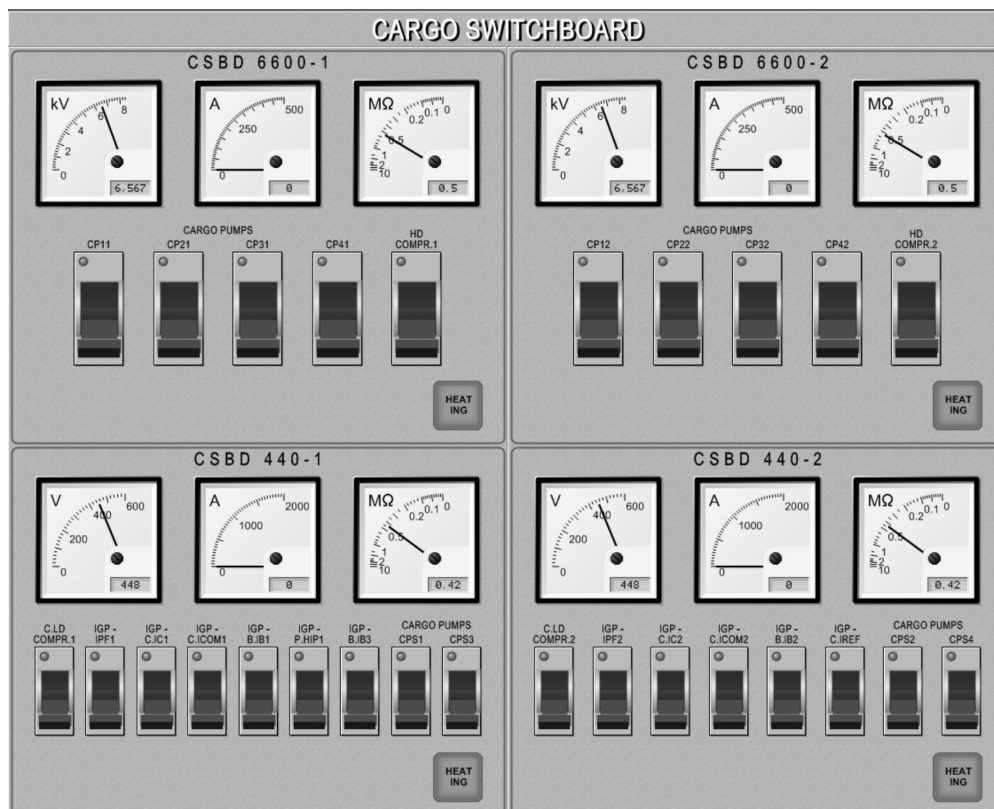


Fig. 21. “CSB” page

The switchboards are designed for control of 6.6 kV, 440 V, 220 V networks and connection/disconnection supply to/from the consumers connected to these switchboards.

To perform these functions, the switchboards include:

- controls – switches for supplying power to consumers, and buttons for switching on interior heaters (“heater pads”) designed for condensate removal from the switchboards;
- indicating meters – ammeters and insulation control meters (megohmmeters).

Controls

The controls are represented by switches, which are used to supply power to consumers. The switches are provided with integrated protection against overloading. When protection trips, the consumer is disconnected. Each switch features a red-colour indicator in its upper left corner, which confirms the fact of the integrated protection tripping.

Indicating Meters

The indicating meters are used to check the mains voltage, the current draw, and insulation. The switchboards are provided with:

- voltmeters V – showing the line voltage on the switchboard;
- ammeters A – showing current drawn by the consumers connected to the switchboard;
- megohmmeter MΩ – showing switchboard insulation resistance.

Main Circuit Diagram

For the modern ship control and monitoring systems, the summary information on the power plant, i.e., its configuration, generator statuses, basic electrical parameters, etc., are displayed on the system monitor being referred to as the main circuit diagram.

See Fig. 22 for appearance of the page containing the main current circuit realized in the simulator:

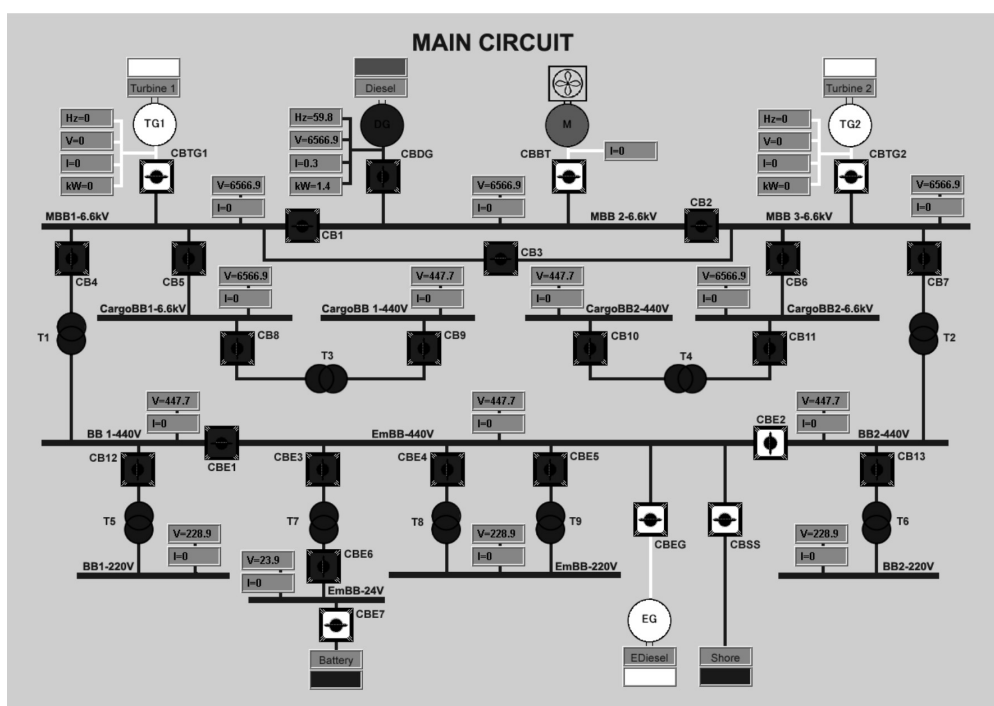


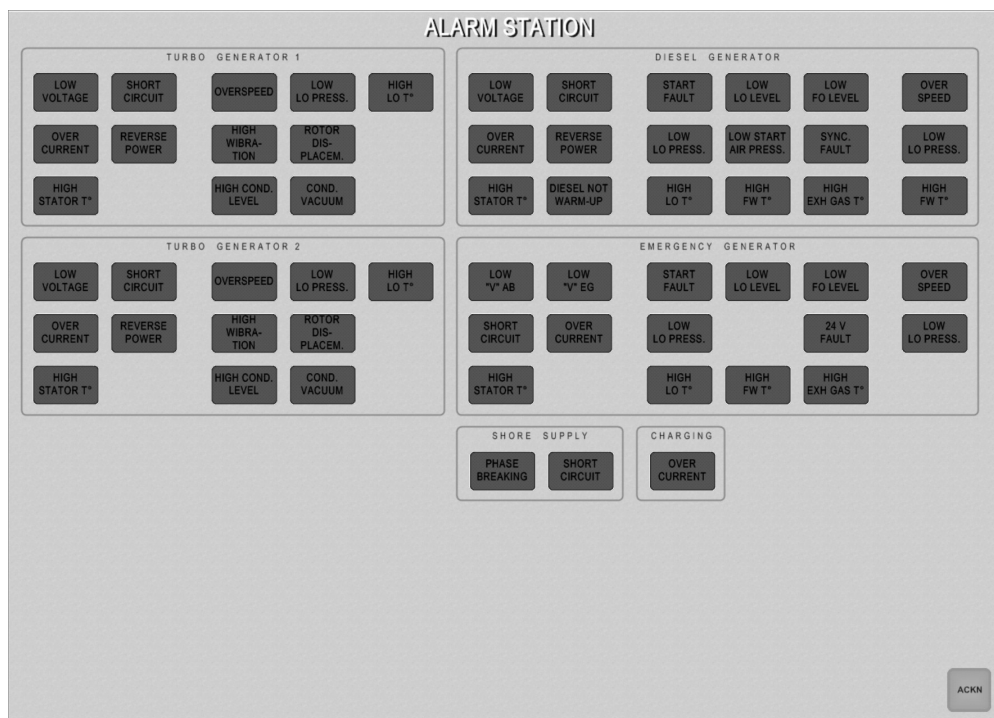
Fig. 22. Main circuit diagram

The active (live) elements (buses, feeders, closed switches) in the circuit are highlighted in blue. Special waste windows are provided for indication of electrical parameters, i.e. voltage, current, frequency, and power.

In addition to the informative component of the page, the simulator features a possibility to use the mouse to control some MSB/ESB switches, which are not presented on the simulator control panels.

Group Alarm Panel

Page AS of the simulator contains the group alarm panel:



Alarm signals of the power plant, i.e. from the power plant generators (DG, TG1, TG2 and EDG), and from the shore supply section, and the battery charging unit panel are routed to the single group alarm panel. Appearance of an alarm signal is accompanied by blinking of the corresponding panel and the buzzer sound. Signal acknowledgement is possible using the “ACKN” button. After acknowledgement, the buzzer sound is off, and the panel is constantly lit. The panel goes out after elimination of the alarm reason.

SEPS OPERATION INSTRUCTIONS

This section provides recommendations for SEPS preparation for operation, setting to work and operation.

SEPS Control

SEPS Manual Control Mode

1. Turn the CONTROL MODE switch to the "MANUAL" position.
2. Control of generators and consumers on the switchboards should be performed in the Manual mode.

SEPS Control in the Automatic Mode

1. Turn the CONTROL MODE switch to the "AUTO" position.
2. Apply power to the diesel generator GBC's (turn the CIRCUIT BREAKER SUPPLY switch to position "1").
3. Select an automatic control mode for SEPS ("EQUAL", "CYCLIC", "OPTIMAL" or "CONST FREQ.").
4. Control of consumers on the switchboards should be performed in the Manual mode.

Auxiliary Diesel Engine Control

Startup Preparation

1. Turn on the oil priming pump (set the PRELUBRICATION switch to "RUN").
2. Turn on engine preheating (depress the "PREHEATING ON" button)

Standard Start

Depress the "START" button. At this moment, if pressure in the lubrication system is below 2.0 bar, the electric oil-priming pump will be switched on prior to air supply. When the pressure reaches the specified value, the diesel engine will be started. The engine is brought down to 80 % of its rated RPM and is maintained at this RPM for 35 seconds for heating the cooling water and lube oil. Then the RPM is brought to the rated value, and the engine is ready to accept 50 % of load. After another 2 minutes the engine is ready for 100 % load.

Emergency Start

Press the "EMCY START" button. In this case, the engine will be started without checking the initial oil pressure, and come to its rated RPM in minimum time.

Standard Stop

1. Remove the generator from MSB buses using the "DISCONNECT" button of the GCB.
2. Depress the "STOP" button. In case of a standard stop, the engine is brought down to 80 % of its rated RPM and is maintained at this RPM for 1 minute. The engine is then stopped by cutting off the fuel supply.

Emergency Stop

Press the “EMCY STOP” button, which will result in automatic disconnection of the generator circuit breaker and fuel supply cutting off.

The “EMCY START”, “EMCY STOP” buttons are of higher priority. If the engine is started by using first the “START” button and then the “EMCY START”, it will be started according to the emergency start procedure from the moment of pressing the “EMCY START” button. In this case, no return to the standard start program is possible. The “STOP” and “EMCY STOP” button have a similar way of operation.

Turbogenerator Turbine Control

Startup Preparation

1. The turbine can be started only if steam pressure at the maneuvering valve inlet is not lower than 60 bar.
2. Turn on the oil priming pump (set the PRELUBRICATION switch to “RUN”).

Standard Start

Press the “START” button. The prestart warming up of the turbine will start automatically, meaning that the turbine will be run up to 400 RPM and continue working in this mode for about 2 min. The warming up mode is accompanied by the “WARM UP” indicator lit. After warming up, the turbine is run up to 1100 RPM, is operated for about 1 minute maintaining this permitted value, and then is speed up to the rated 1800 RPM within 5 s. When the turbine reaches its rated RPM, the “WARM UP” panel goes out, and the “READY TO SINCHRO” lamp comes on. Now the turbogenerator is ready to take a load.

Standard Stop

1. Remove the generator from MSB buses using the “DISCONNECT” button of the GCB.
2. Press the “STOP” button. For standard stop, the turbine reduces its RPM smoothly within, approximately 20 s (the maneuvering valve operating).

Emergency Stop

Press the “EMCY STOP” button, this will result in automatic disconnection of the generator circuit breaker with subsequent cut of steam to the maneuvering valve.

Closing Generator onto the De-Energized MSB Buses

1. Start the generator drive.
2. Check that generator frequency has reached 60 Hz and generator voltage has reached its rated value.
3. Supply power to GCB (CIRCUIT BREAKER SUPPLY in position "1").
4. Arm GCB if required (move the HAND DRIVE handle to the upper position).
5. Press the "CONNECT" button.

Setting to the Parallel Operation (MSB Energized)

1. Start the generator drive.
2. Check that generator frequency has reached 60 Hz, and generator voltage has reached its operating value.
3. Supply power to GCB (CIRCUIT BREAKER SUPPLY in position "1").
4. Arm GCB, if applicable (move the HAND DRIVE handle to the upper position).
5. Synchronize the generator to be connected to MSB buses manually or automatically.

Manual synchronization:

1. Use the "more/less" buttons of the DG frequency regulation system (GOVERNOR CONTROL 2) to adjust the frequency of the generator to be closed onto the MSB frequency. The frequency of the generator to be closed should slightly exceed the MSB frequency. Monitoring is performed using the frequency meters on the synchronization section.
2. Use the "more/less" buttons of the DG frequency regulation system (GOVERNOR CONTROL) to reduce the phase difference (phase displacement) between voltage of the generator to be connected and the MSB voltage; Monitoring is performed using the synchronoscope.
3. At the moment of the zero phase difference (the "12 o'clock" indicator illuminates at the synchronoscope) or a minimum phase difference, press the GCB "CONNECT" button for the shaft generator.

Automatic synchronization:

1. Press the selection button for the generator to be synchronized at the synchronization section (DG, TG1, TG2).
2. Move the synchronization mode switch to the "AUTO" position.

ATTENTION!

The moment of moving the synchronization mode switch to the AUTO position is the synchronization process starting moment

On completion of the synchronization process, the synchronized generator will be closed onto the MSB buses. Then the synchronization mode selection switch will automatically return from the "AUTO" position to the "MANUAL" position.

Active Power Distribution in Parallel Operation

Use the “more/less” buttons of the generator frequency regulation system (GOVERNOR CONTROL) to change the generator active power. The active load increases with frequency. Monitoring of the active load is performed using the wattmeter on the MSB generator section.

Reactive Power Distribution in Parallel Operation

Adjust generator voltage using the handle of the automatic voltage regulator controller (VOLTAGE). The reactive load increases with voltage. Monitoring of the reactive load is performed using the reactive-power meter on the MSB generator section.

Taking Generator Out of Parallel Operation

1. Use the “more/less” buttons of the DG frequency regulation system (GOVERNOR CONTROL) to decrease generator load down to approx 50 kW. The active load decreases with frequency. Monitoring of the active load is performed using the wattmeter on the MSB generator section.
2. Press the “GCB DISCONNECT” button.

Emergency Diesel Generator Control

Automatic Mode of Operation

Automatic Start and Closing onto ESB Buses

1. EDG is started under condition of MSB voltage disappearance for a duration above 3 seconds.
2. Closing onto the buses is carried out automatically, when voltage is supplied to the EDG circuit breaker.

Automatic Disconnection from ESB Buses and Stopping EDG

1. GCB is disconnected from the buses automatically, when voltage is supplied to the MSB buses.
2. The engine stops after the generator circuit breaker is switched off. When being stopped, the engine is brought down to 80 % of its rated RPM and is maintained at this RPM for 1 minute. Then the engine is stopped.

Manual Mode of Operation

Diesel Engine Start

Press the “START” button at the emergency diesel engine control panel. The engine can be started, if the EDG’s “READY TO START” indicator illuminates.

Closing onto ESB Buses

1. Supply power to the EDG circuit breaker (move the CIRCUIT BREAKER SUPPLY switch to position “1”).
2. Switch on the EDG circuit breaker – i.e., press the “CONNECT” button.

Disconnection from ESB Buses

1. Turn off the EDG circuit breaker (press the “DISCONNECT” button).
2. Remove power supply from the EDG circuit breaker (CIRCUIT BREAKER SUPPLY).

Stopping the Diesel Engine

Press the “STOP” button at the emergency diesel engine control panel. This will bring the diesel engine down to 80 % of its rated RPM and maintain it at this RPM for 1 minute. Then the engine is stopped.

Control of MSB Shore Power Supply

Closing Shore Supply onto ESB Buses

1. Check the voltage value of the shore power supply using the voltmeter (rated value is 440 V) on the SHORE SUPPLY section.
2. Check phase sequence. The “RIGHT” indicator should illuminate. If the “WRONG” indicator illuminates, change phase sequence (apply to the simulator Instructor).
3. Supply power to the shore supply circuit breaker (CIRCUIT BREAKER SUPPLY).
4. Connection to the shore supply is possible only in case of complete ship de-energizing. Switch off generator circuit breakers on the generator section for all generators closed onto MSB.
5. Switch on the circuit breaker on the shore supply switchboard (press the “CONNECT” button).

Disconnection of Shore Supply from MSB

1. Press the “DISCONNECT” button on the shore supply switchboard.
2. Remove power from the shore supply circuit breaker (CIRCUIT BREAKER SUPPLY).

CHAPTER 3

Ship Auxiliary Machinery and Systems

This chapter contains description of the “Ship auxiliary systems and machinery” simulator module designed for training cargo-ship engine-room watch personnel in skill of proper operation of ship auxiliary machinery and systems.

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INTRODUCTION

The “Ship auxiliary machinery and systems” module is designed for training the cargo-ship engine-room watch personnel in skills of proper operation of ship auxiliary machinery and systems, including:

- preparing and putting the systems into operation;
- monitoring the system operation using measured parameters with the aid of the alarm system;
- trouble shooting.

In addition to training in practical skills, the simulator allows the basic principles of the structure, functions, and interaction of components and systems to be learned by the user.

The composition of the simulator systems corresponds to a standard onboard configuration. Parameters and performance of the simulated mechanisms and systems correspond to the real ones, because the simulator models all basic processes (heat exchange, mechanical, steam-dynamic and hydrodynamic) in their interrelation.

The module simulates auxiliary machinery and systems of an LNG carrier (LNG Tanker).

SIMULATOR MODULE SYSTEMS

Bilge Water System (BW Page)

Purpose

The system is designed to collect, treat, and remove oil-bilge water. The system is in full compliance with requirements of MARPOL and SOLAS.

System Components

The system scheme realized in the simulator, can be seen in Fig. 1 as its mimic diagram.

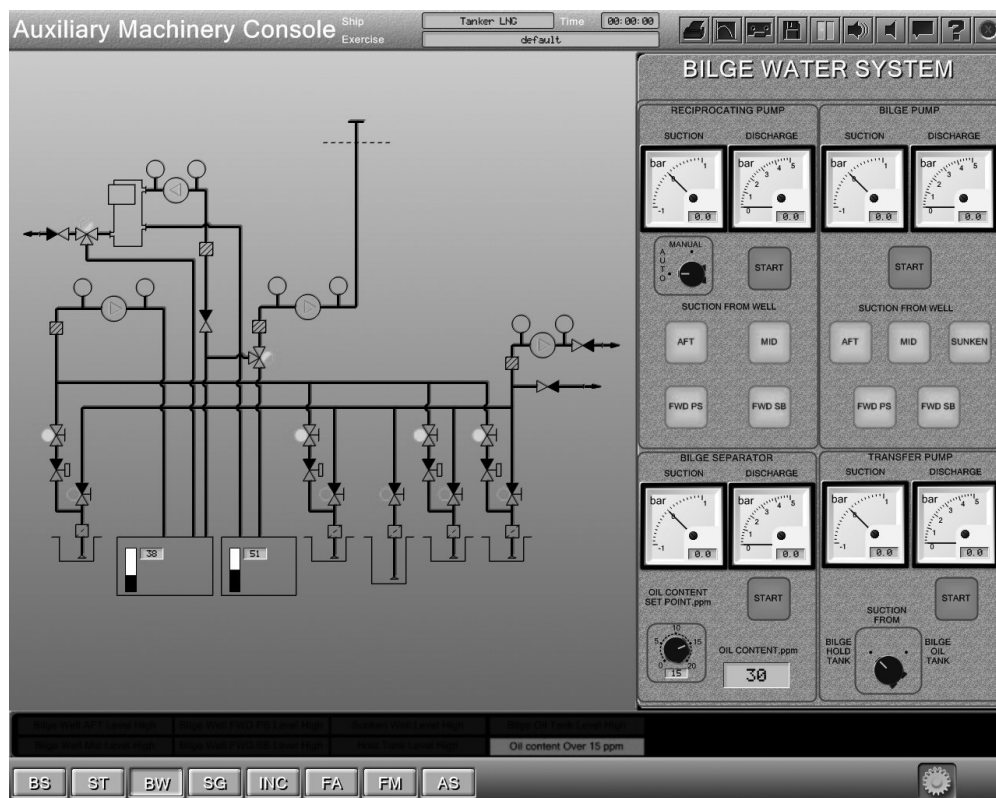


Fig. 1

The system includes:

- Bilge wells:
 - AFT bilge well;
 - Middle bilge well;
 - FWD-PS bilge well;
 - FWD-SB bilge well;
 - Sunken well, bilge will under ME.
- Bilge hold tank;
- Separator bilge oil tank;
- Reciprocating bilge pump;
- Bilge separator service pump;
- Transfer pump;

- Engine room bilge pump;
- Pipeline system including filters and stop valves.

The bilge water is collected in the wells. The wells are provided with high-level alarm sensors. Suction pipelines with mud boxes running to each bilge well. Contents of the bilge well are pumped out to the bilge hold tank using the reciprocating bilge pump. The tank is provided with a steam heater for its contents; their temperature and level being monitored.

The pipelines running from each well to the bilge pump are provided with special air piston valves, which close automatically when the well and the pump suction line are empty. Manual control valves designed to manually exclude one or another well from pumping-out operation are installed in sequence with the air piston valves. The manual control valves are in the “Open” status by default.

Reciprocating bilge pump can be operated in manual and automatic modes (Manual/Auto). Pressure is monitored at the suction and discharge sides of the pump. If the Auto mode is selected, the pump is started automatically when receiving a “Bilge well high level” signal from a well. In the Auto mode, the pump stops automatically when the well empties out.

In the manual mode, the pump can be started/shutdown using the Pump button.

In a case of emergency, the engine room being flooded (when the high-level alarm comes from the sunken well) it is possible to discharge water from the engine room overboard. The emergency discharge is performed using a high capacity bilge pump in the manual mode (using the pump button to start/stop the pump). Pressure is monitored at the suction and discharge sides of the pump. The wells to be pumped out using the Bilge Pump can be selected by opening the corresponding valves in the pump suction line. If the Bilge Pump is faulty or its capacity is not sufficient, there is a possibility to connect the Bilge water system pipeline to the Main Cooling Sea Water pump suction line (refer to Sea Water Cooling system in the propulsion plant module).

Separation of the Bilge hold tank contents and discharge of the treated overboard is performed using the Bilge separator.

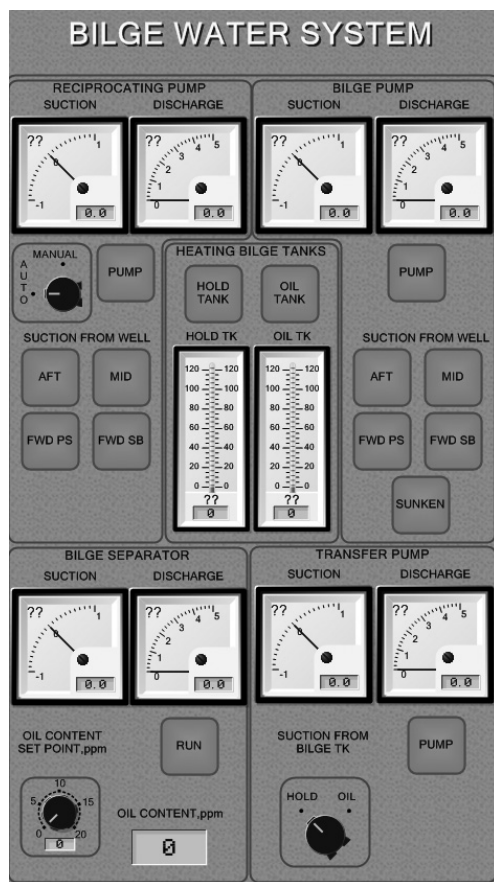
The separator runs in an automatic mode, its start/stop being controlled using the Run button. The separator is fed by the Bilge separator service pump. Pressure is monitored at the suction and discharge sides of the pump.

The separator automatic system determines oil product content in water (setting 5 to 15 ppm is assigned using the “Oil content set point” pot) and controls the three-way valve of water discharge from the separator. If the oil product content at the separator outlet does not exceed the set point, water may be discharged overboard. If the oil product content at the separator outlet exceeds the set point – discharge is performed back to the bilge hold tank. Separation wastes are directed to the bilge oil tank. The tank is provided with a steam heater for its contents; their temperature and level being monitored.

The Transfer pump is used to pump out the contents of the separation wastes from the separator bilge oil tank and the bilge hold tank. The tank to discharge to is selected using the three-way valve controlled by the switch “Suction from Bilge hold tank/Bilge oil tank”. The pump can be controlled in the manual mode too (using the pump button to start/stop the pump). Pressure is monitored at the suction and discharge sides of the pump. The pump is stopped on achieving the low level in the tank, from which the contents are being pumped out.

Control Panel

The right-hand part of the screen page houses the system control panel:



The control panel includes the following modules:

- “RECIPROCATING PUMP” – bilge pump control module;
- “BILGE PUMP” – engine room drainage control module;
- “HEATING BILGE TANKS” – control module for heating the Bilge hold tank and the Separator bilge oil tank;
- “BILGE SEPARATOR” – separator control module;
- “TRANSFER PUMP” – control module for the pump discharging the tank contents ashore.

Reciprocating Pump Control Module

The control mode is selected using the Manual/Auto selector switch. In the manual control mode the pump is started/stopped by pressing the “PUMP” button. One or another well can be cut from the bilge pump by closing the corresponding remote control valve using the respective button (AFT, MID, FWD PS, or FWD SB). By default, each valve is open. Pressure is monitored at the suction side and the discharge side of the pump.

ER Bilge Pump Control Module

The only control module for the pump is manual. Starting/stopping the pump is performed by a press on the “PUMP” button. One or another well can be connected to the bilge pump by opening the corresponding remote control valve using the respective button (AFT, MID, FWD PS, or FWD SB, SUNKEN). By default, each valve is closed. Pressure is monitored at the suction side and the discharge side of the pump.

Heating Bilge Tanks Control Module

The contents of the Bilge hold tank and the Separator bilge oil tank is stem-heated. Steam is fed to the heaters by opening the remote control valves. This is performed using the buttons "HOLD TANK" and "OIL TANK". Tank contents temperature is monitored using the temperature gages "HOLD TANK" and "OIL TANK".

Transfer Pump Control Module

The only control module for the pump is manual. Starting/stopping the pump is performed by a press on the "PUMP" button. The pumping direction (from which tank) is determined by the position of the three-way valve, which is remotely controlled by the "SUCTION FROM BILGE TK" switch featuring two positions - "HOLD" and "OIL". Pressure is monitored at the suction side and the discharge side of the pump.

Bilge Separator Control Module

The separator can be started by pressing the "RUN" button. Pressure is monitored at the suction side and the discharge side of the Bilge separator service pump. Setting of the oil product content in water (5 to 15 ppm) is assigned using the "OIL CONTENT SET POINT" pot. The content of oil product in water downstream of the separator is shown by the "OIL CONTENT" indicator.

Alarm Signals

- BILGE WELL AFT LEVEL HIGH – high level in the aft bilge well;
- BILGE WELL MID LEVEL HIGH – high level in the mid bilge well;
- BILGE WELL FWD PS LEVEL HIGH – high level in the port side forward bilge well;
- BILGE WELL FWD SB LEVEL HIGH – high level in the starboard;
- SUNKEN WELL LEVEL HIGH – high level in the sunken well (under ME);
- HOLD TANK LEVEL HIGH – high level in the bilge well hold tank;
- BILGE OIL TANK LEVEL HIGH – high level in the bilge water separation waste tank;
- OIL CONTENT OVER 15 PPM – oil product content limit downstream of the separator.

Protection System

Automatic interruption of water discharge overboard in case the set oil product content in water is exceeded.

System Faults Introduced by the Instructor

- Bilge Pump Failure (Break) – failure of ER drainage pump;
- Reciprocating Pump Failure (Break) – failure of bilge pump;
- Reciprocating Pump Auto Failure – failure of the bilge pump automatic control system;
- Transfer Pump Failure (Break) – failure of the transfer pump;
- Service Pump Failure (Break) – failure of the separator pump;
- Filter of Transfer Pump Fouling – filter clogging at the transfer pump suction side;
- Filter of Reciprocating Pump Fouling – filter clogging at the bilge pump suction side;
- Filter of Bilge Pump Fouling – filter clogging at the ER drainage pump suction side;

- Flooding – flooding of the engine room, water in the Sunken well;
- Separator Ineffective – separator capacity not sufficient for full treatment of the bilge water, high oil product content in the bilge water;
- Bilge Air Piston Break Well Aft – valve failure in the aft well, the valve cannot close automatically, when the well empties out;
- Bilge Air Piston Break Well Middle – valve failure in the middle well, the valve cannot close automatically, when the well empties out;
- Bilge Air Piston Break Well FWD SB – valve failure in the starboard fore well, the valve cannot close automatically, when the well empties out;
- Bilge Air Piston Break Well FWD PS – valve failure in the port side fore well, the valve cannot close automatically, when the well empties out.

Steering Gear (Page SG)

Purpose

The system is designed to provide rudder displacement bet -35° to $+35^{\circ}$ in accordance with ship maneuvering needs. The steering gear (SG) design complies with the SOLAS requirements for tankers – it is of the two-circuit type, i.e. having two individual hydraulic drives able to operate together or autonomously.

Control of the steering machine is controlled remotely from the bridge or from the local control station in the SG room.

System Components

The system scheme realized in the simulator can be seen in Fig. 2.

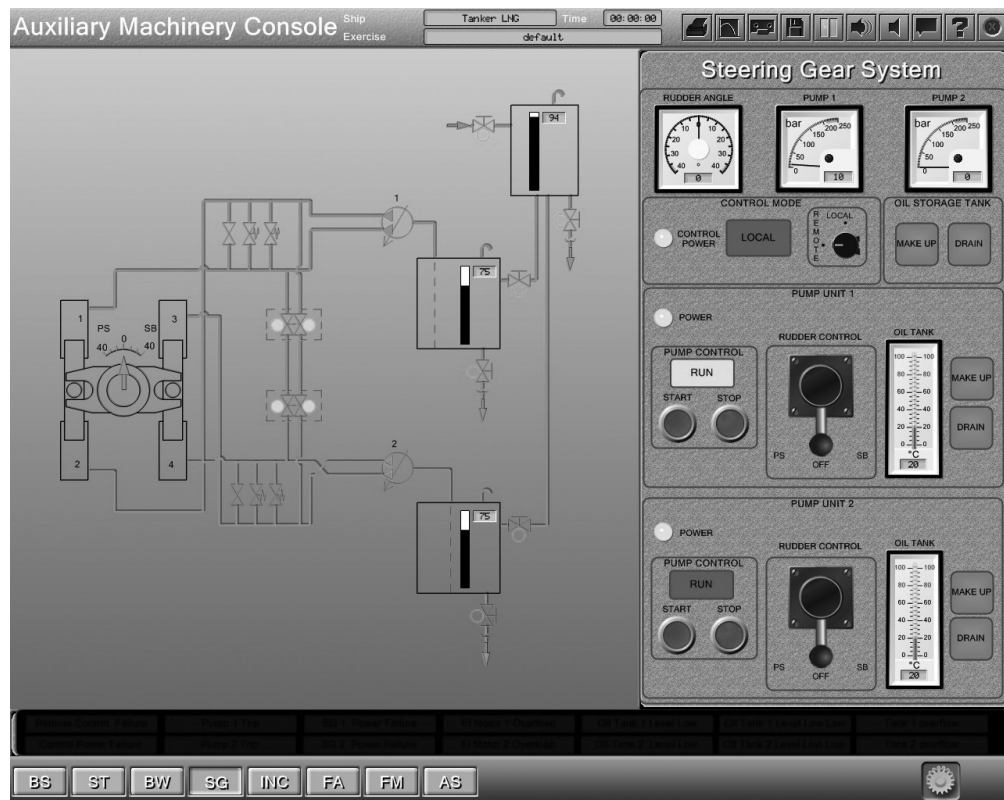


Fig. 2

The system has the following components reproduced in the simulator:

- Electrohydraulic unit 1 (Janney Pump 1) with the control valve chest (By-Pass Valve, Safety Valves) and isolation valves (Isolation Valves 1, 2);
- Electrohydraulic unit hydraulic oil tank 1 (Oil Tank1);
- Electrohydraulic unit 2 (Janney Pump 2) with the control valve chest (By-Pass Valve, Safety Valves) and isolation valves (Isolation Valves 1, 2);
- Electrohydraulic unit hydraulic oil tank 2 (Oil Tank2);
- Steering gear 1 – plungers and hydraulic cylinders 1 and 2;
- Steering gear 2 – plungers and hydraulic cylinders 3 and 4;
- Hydraulic oil storage tank (Oil Storage Tank);
- Hydraulic pipelines as hydrodynamic objects;
- System of local manual control and remote automatic control.

SG circuit operation principle:

the electrohydraulic unit (Janney Pump) raises hydraulic oil pressure and directs it to the steering gear through the hydraulic pipelines. The steering gear has a plunger and two hydraulic cylinders. One hydraulic cylinder receives oil, the other one removes it. This provides plunger longitudinal motion, which is converted with the aid of the SG gear to the rotational motion of the rudder stock. A change of oil direction feeding to/removing from the cylinders brings about a change of rudder rotation direction. The electrohydraulic unit has two outlets, being connected simultaneously to two pipelines. The control system makes it possible to interchange pipeline purposes – one of them becomes the feeding one, and the other-a removing one, and vice versa.

Availability of two SG circuits and respectively four hydraulic cylinders doubles the drive capacity and its reliability.

The both SG circuits (pipelines) and combined with the aid of two couples of automatic isolation valves, i.e. Isolation valves 1, 2 and Isolation valves 3, 4.

In the normal operation mode (SG circuits are connected, the isolation valves being open) the following variants of SG operation are possible:

1. Only Janney Pump 1 operates rising pressure, which is directed to all cylinders- 1, 2, 3, and 4.
2. Only Janney Pump 2 operates rising pressure which is directed to all cylinders - 1,2, 3, and 4.
3. The both Janney Pumps, 1 and 2, operate rising pressure which is directed to all cylinders – 1, 2, 3, and 4. Pressure in the system is increased with subsequent increase of rudder displacement rate.

If hydraulic oil leakage is detected in a circuit (determined by drop of level in the corresponding hydraulic oil tank), then the isolation valves close, cutting of the faulty circuit.

The level is monitored in all hydraulic oil tanks, if necessary oil can be drains from the tanks using the Drain valves or added to the tanks using the Make-Up valves.

Hydraulic oil temperature in the hydraulic oil tanks is monitored.

The SG can be controlled either remotely from the bridge (Remote) or locally from the local SG station (Local). The control mode is selected on the SG local panel using the “Local/Remote” selector switch.

The SG system sends to the bridge a feedback signal, i.e. the actual value of the rudder angle.

The control can be follow-up and non-follow-up.

The follow-up control is the remote automatic control from the bridge. The command of turning the rudder is generated either by the autopilot or by the helmSGan. The follow-up mode compares the values of helm turn command and the feedback signal. The automatic device generates the helm angle command basing of the difference between the command value and the feedback signal value.

Then non-follow-up control is performed remotely as manual control from the bridge or as local manual control from the SG local station. In this mode, the command to turn the helm is determined by the watch office basing on the rudder angle indicator reading.

The remote manual control from the bridge is reserved as an emergency mode.

When ERS 4000 is in the autonomous mode, the helm turn commands are simulated by the instructor, who specifies them in the degrees of the helm turn, while during combined operation of the simulators ERS 4000 and NTPro 4000, the commands (tasks) are coming from the NTPro 4000 simulator.

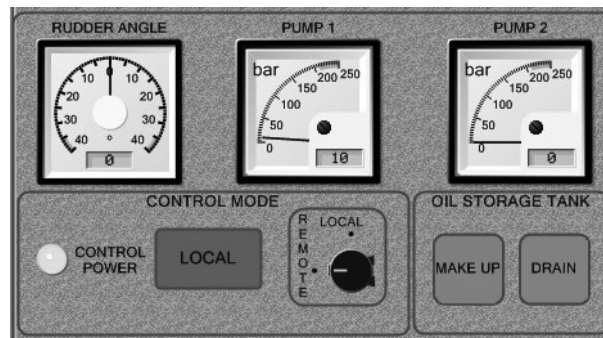
The SG allows operation with one hydraulic circuit (unit) only, if the vessel speed is up to 7 knots. If this value is surpassed, the rudder force and respectively the resistance to SG plunger motion increases to a level, when the Janey Pump motor get overloaded, and then it is necessary to operate two SG units.

Control Panel

The control panel simulated the local SG station, it includes three modules:

- system control module;
- pump unit 1 control module;
- pump unit 2 control module.

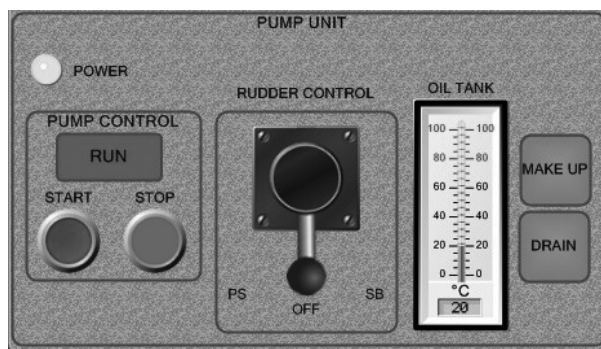
System Control Module



The panel includes:

- power on indicator for the control system – CONTROL POWER;
- operation mode selector switch – LOCAL/REMOTE;
- indicator – LOCAL display – confirming selection of the control mode from the local SG station;
- double rudder angle indicator – RUDDER ANGLE;
- pressure indicator for hydraulic circuit 1;
- pressure indicator for hydraulic circuit 2;
- control buttons for drain valve (“DRAIN”) and replenishment of the hydraulic oil (“MAKE UP”) hold tank.

Content Modules for Pump Units 1 and 2



The panel includes:

- power on indicator for the unit – POWER;
- pump control module – PUMP CONTROL: the “START” button, the “STOP” button, and the Run display indicator;
- spring-loaded SG “RUDDER CONTROL” handle. Its motion to portside or starboard results in helm motion to the specified side. The rudder turn is monitored using the “RUDDER ANGLE” indicator, and when the handle is released, it automatically goes to the OFF position, the rudder stopping in the required position;
- temperature gage for the hydraulic oil in the pump unit tank – OIL TANK;
- control button for the drain valve of the pump unit tank – DRAIN;
- control button for replenishment of the pump unit hydraulic oil tank – MAKE UP.

Alarm Signals

- POWER 1 FAILURE – no power at unit 1;
- POWER 2 FAILURE – no power at unit 2;
- CONTROL POWER FAILURE – no power at the control system;
- REMOTE CONTROL FAILURE – a fault in the control system;
- OIL TANK 1 LEVEL LOW – low level of hydraulic oil in the tank for unit 1, tank replenishment required;
- OIL TANK 1 LEVEL LOW LOW – very low level of hydraulic oil in the tank for unit 1 resulting in actuation of the protection system and closing of the isolation valves of the circuit;
- OIL TANK 2 LEVEL LOW – low level of hydraulic oil in the tank for unit 2, tank replenishment required;
- OIL TANK 2 LEVEL LOW LOW – very low level of hydraulic oil in the tank for unit 1 resulting in actuation of the protection system and closing of the isolation valves of circuit 2;
- OIL TANK 1 OVERFLOW – overflow of the circuit 1 tank;
- OIL TANK 2 OVERFLOW – overflow of the circuit 2 tank;
- EL. MOTOR 1 OVERLOAD – overload of the unit 1 motor 1 (vessel speed over 7 knots, SG has in operation only unit 1);
- EL. MOTOR 2 OVERLOAD – overload of the unit 2 motor (vessel speed over 7 knots, SG has in operation only unit 2);
- PUMP 1 TRIP – emergency shutdown of unit 1;
- PUMP 2 TRIP – emergency shutdown of unit 2.

Protection System

A leakage from the hydraulic circuit results in actuation of isolation valves and shutdown of the faulty circuit.

System Faults Introduced by the Instructor

- Remote Control Failure – a fault in the control system;
- SG Pump 1 Trip – emergency shutdown of unit 1;
- SG Pump 2 Trip – emergency shutdown of unit 2;
- SG Pump 1 Power Failure – failure of power for unit 1;
- SG Pump 2 Power Failure – failure of power for unit 2;
- SG Pump 1 Wear – tear and wear of unit 1 pump, reduction of discharge pressure;
- SG Pump 2 Wear – tear and wear of unit 2, reduction of discharge pressure;
- SG Tank 1 Leakage – leakage in hydraulic circuit 1;
- SG Tank 2 Leakage – leakage in hydraulic circuit 2;
- Ship Speed over 7 knots – vessel speed over 7 knots (used for simulator module autonomous mode).

Ballast System (Page BS)

Purpose

The ballast system is designed for taking and removal of isolated ballast (seawater) for the purpose of necessary ship stability (list/trim control, draft change).

System Components

The ballast pumps are located in the dedicated pump section next to the engine room. The pipelines are laid according to the line principle, the pipes running via a special tunnel in the lower part of the hull, their connection to the ballast tanks executed at the lower points of the tanks. The ballast tanks are placed uniformly along the vessel length and symmetrically at the vessel width along the both sides.

The system scheme realized in the simulator can be seen in Fig. 3:

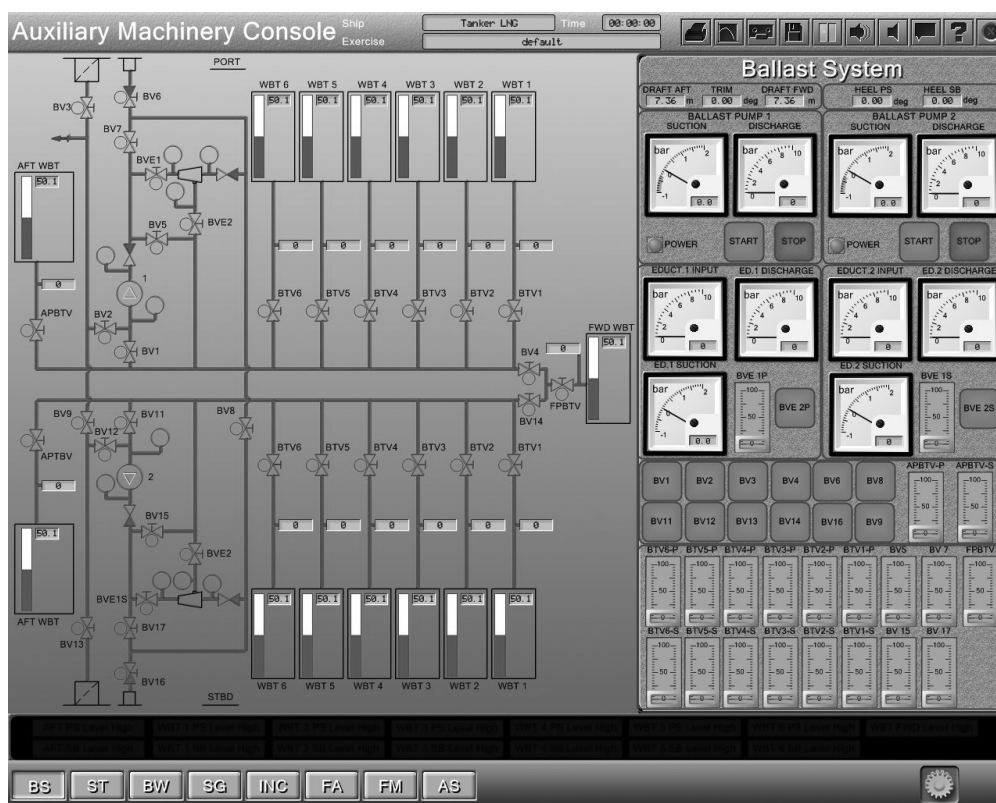


Fig. 3

The system has the following components reproduced in the simulator:

- Sea chests BV3 (port side – side sea chest, below the water-line) and BV13 (starboard – lower chest at the ship bottom) for sea water intake. The sea chests are provided with filters;
- Discharging valves (non-return) BV6 and BV16 for discharging water overboard are located above the water line;
- Pipeline system with fittings as a hydrodynamic object;
- Ballast pumps Pump 1 and Ballast Pump 2 – electrically driven centrifugal pumps;
- Ballast Strip Eductors are used for stripping the ballast tanks;
- Side (port side and starboard) ballast tanks Ballast Tank (BT) 1...6;
- Afterpeak tanks (2 pes., port side and starboard) and the afterpeak;

- Stop valves – remote-operated valves “Open/Close” with status indication;
- Regulating valves (rotary gates) – remote-operated valves with opening rate indication of 0 to 100%.

The system mimic shows liquid levels in tanks (%), water flow rates (m^3/h) for each tank, stop valve opening indicators and regulating valve opening rate indicators.

Using various combinations of stop/regulating valve statuses, the system allows for transfer of current volumes of water between tanks at different flow rates.

The movable masses create vertical forces, longitudinal and transverse moments affecting the ship hull trim and draft.

The following values are calculated in the process of the mathematical model operation:

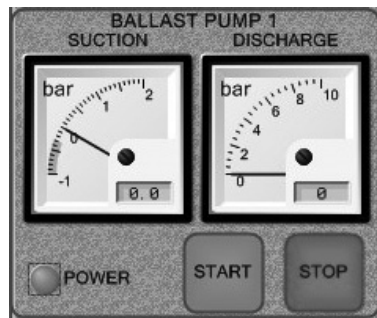
- water volumes in each tank and corresponding masses;
- total and net water masses in tanks;
- vertical forces from the masses;
- total moments of masses along the “X” axis and the “Y” axis of the ship.

The mentioned data are processed and used for calculation of the vessel list, draft (fore, aft), and trim.

Control Panel

The buildings and structures system control panel includes the following modules:

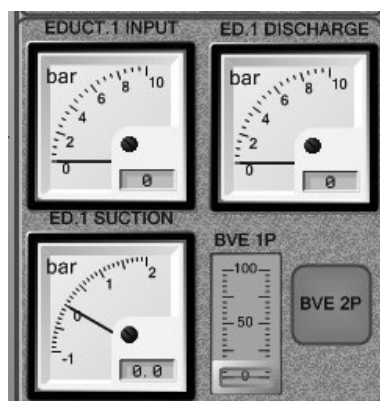
Ballast Pump 1/2 Control Modules



The module includes:

- pump power indicator;
- pump start button – “START”;
- pump shutdown button – “STOP”;
- pump suction pressure indicator – “SUCTION”;
- pump discharge pressure indicator – “DISCHARGE”.

Eductor 1/2 Control Modules



The module includes:

- remote control button BVE 2P(S) (open/close) for the stop valve opening the pipeline at the eductor suction end;
- slide BVE 1 P(S) to remotely control the opening rate of the valve regulating sea water flow from the ballast pump to the eductor;
- sea water pressure indicator at the eductor 1 (2) inlet;
- sea water pressure indicator at the eductor 1 (2) outlet;
- suction pressure indicator at the eductor 1(2) suction side.

Stop Valve Control Module



The module includes:

- buttons for remote control (closing-opening) of the valves BV1, BV2, BV3, BV4, and BV6 located in the system at the port side;
- buttons for remote control (closing-opening) of the valves BV11, BV12, BV13, BV14, and BV16 located in the system at the starboard side;
- buttons for remote control (closing-opening) of the valves BV8 and BV9, which ensure connection of the port side/starboard pipelines.

Operating the aforementioned valves, one can achieve a required configuration of the system pipelines in order to provide necessary intakes, overflows, and discharges in the system.

Alarm Signals

For each of the ballast tanks, the “Ballast Tank Level High” alarm is foreseen.

System Faults Introduced by the Instructor

- Ballast Pump 1 Break – ballast pump 1 emergency shutdown;
- Ballast Pump 2 Break – ballast pump 2 emergency shutdown 2;
- Ballast High Chest PS Fouling – obstruction in the ballast system sea chest at the port side;
- Ballast High Chest SB Fouling – obstruction in the ballast system sea chest at the starboard.

Sewage Treatment and Storage System (Page STS)

Purpose

The system is designed for collection and treatment of sewage water in accordance with requirements of MARPOL.

System Components

The system scheme realized in the simulator, can be seen in Fig. 4.

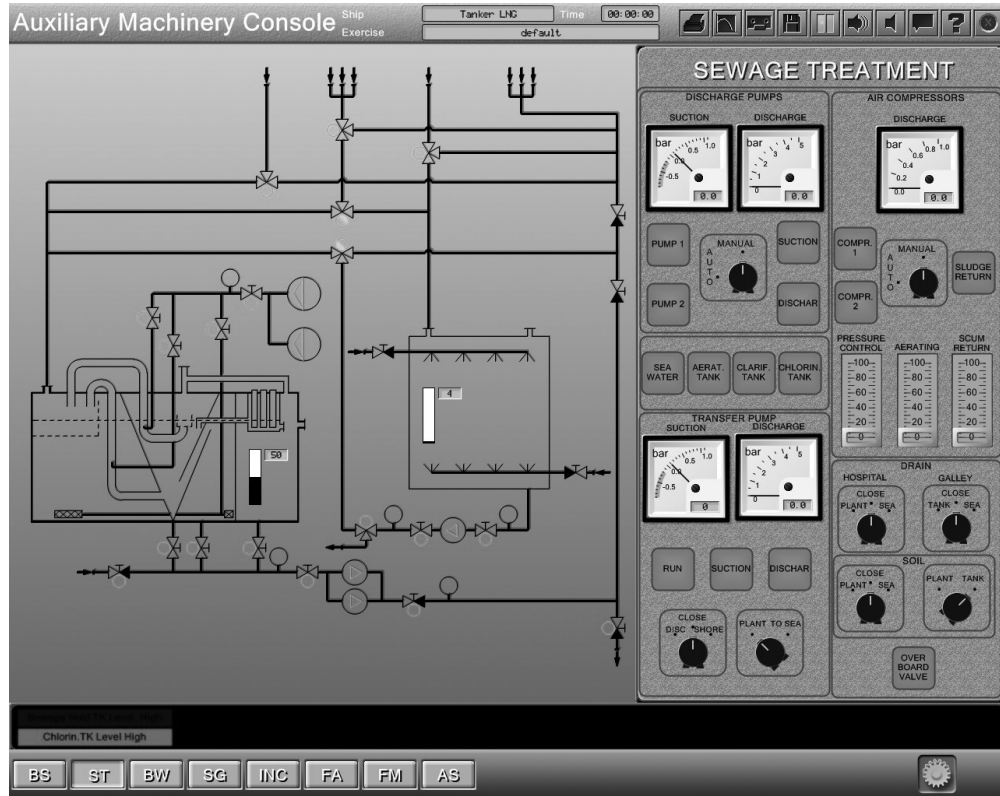


Fig. 4

The system has the following components reproduced in the simulator:

- Sewage pipelines with stop valves;
- Sewage treatment plant;
- Discharge pumps 1 and 2 of the sewage treatment plant;
- Air compressors 1 and 2 of the sewage treatment plant;
- Sewage hold tank;
- Sewage transfer pump.

Sewage water of different origin is gathered in collector. The ship has a multibranch network of collectors and a number of valves for discharging collectors overboard. The simulator has just one valve “Overboard storm valve” for discharging overboard, which is located below the water line.

The dedicated “Sewage hold tank” allows sewage be collected and stored for subsequent transfer to shore storages or to the water treatment plant again, or to discharge it overboard.

The sewage treatment plant is a container divided into three inner spaces – Aeration tank, Clarification tank, and Chlorination tank. Sewage water enters the aeration tank, where it is subjected to action of the aerobic bacteria, which life activity is supported by the atmospheric oxygen. The atmospheric oxygen enters the tank due to blowing the tank with compressed air. The compressed air is generated by air compressors. Then the water comes to the clarification tank, where the solids (sludge) formed as a result of bacteria action precipitate. They accumulated there for about 2 to 3 months, and then are discharged overboard with the aid of the sewage treatment plant discharge pumps (only in areas permitted). The clarification tank and the aeration tank are connected with transparent scum return branches and sludge return branches to provide for circulation of the contents between the aeration tank and the clarification tank in the process of system operation. These branches are used to feed compressed air from the plant compressors. The water cleared of the solids is directed to the Chlorination tank for killing bacteria by chlorine treatment. Chlorine is introduced into special cartridges in a form of pills (Chlorinator). With consumption the pills are added.

According to the type and pollution level, the sewage is divided into a number of groups.

Group 1 – sewage water “WB”, “Drains”, and “Disposer” are discharged directly overboard.

Group 2 – the “Galley” sewage is directed to the Sewage hold tank, but there is an option of discharging overboard. Control is performed using the three-position valve “Galley/Close/Sea/Tank”.

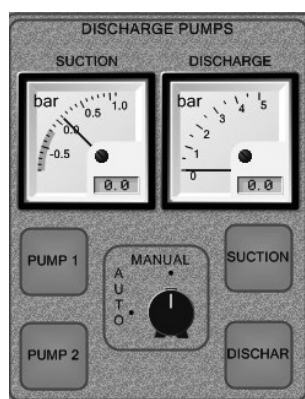
Group 3 – the sewage waters “WC”, “Lav. Scupper” and “Soil” are directed either to the water treatment plant or to the sewage hold tank. There is an option of discharging overboard. Control is performed using the three-position valve “Soil - Close/Sea/Plant” the two-position valve “Treatment – Tank”.

Group 4 – the “Hospital” sewage is directed to the water treatment plant. There is an option of discharging overboard. Control is performed using the three-position valve “Hospital – Close/Sea/Plant”.

Control Panel

The control panel contains the following modules:

Discharge Pump Control Module



The pumps can operate in two control modes, i.e. Manual mode and Auto mode with the Stand-By function.

In the manual mode, the pumps are started/stopped using the buttons Pump 1 and Pump 2. The pump inlets and outlets feature valves controlled using the buttons “SUCTION” and “DISCHARGE”. Pump inlet/outlet pressure is monitored using the pressure gages “SUCTION” and “DISCHARGE”.

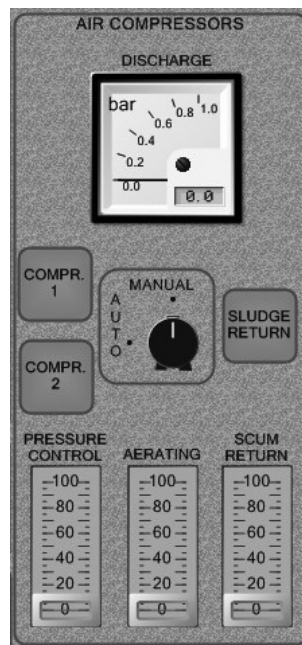
Valve Control Module



The module is used to control the sewage treatment plant valves. The valves are closed/opened by pressing the corresponding buttons on the module.

The Sea Water valve is used to direct seawater to the sewage treatment plant. The Aeration Tank valve is used to direct seawater to the aeration tank and to discharge its contents therefrom. The pumping-in of seawater and the pumping-out of the contents from the clarification tank are performed through the Clarification tank valve, while the pumping-in of seawater and the pumping-out of the contents from the chlorination tank is done using the Chlorination tank valve.

Air Compressors Control Module

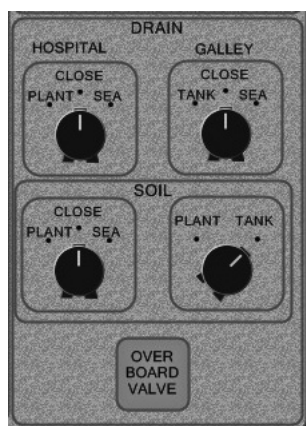


Compressed air for the sewage treatment plant is provided by a couple (Stand-By) compressors, i.e. Air Compressor 1 and Air Compressor 2. The compressors operate in two control modes, i.e. Manual mode and Auto mode with the Stand-By function. Compressor start/shutdown in the manual mode is performed using the buttons Compressor 1 and Compressor 2.

Pressure at the outlet of the operating compressor is adjusted using the "PRESSURE CONTROL" valve, being monitored by the "DISCHARGE" pressure gauge.

Entry of compressed air to the aeration tank is regulated using the Aerating valve ("AERATING SLIDE"). Compressed air introduced to the scum return branch is regulated with the aid of the Scum return valve ("SCUM RETURN" slide). Compressed air is introduced to the sludge return branch by opening the Sludge return valve (the Sludge return button).

Plant Discharge Valve Control Module



Discharge of sewage overboard is done through the “OVERBOARD VALVE”.

The Hospital three-position valve for discharging hospital sewage has three positions:

- The valve is closed, the valve control selector switch is in the CLOSE position;
- The valve control selector switch is in the PLANT position, sewage entering the sewage treatment plant;
- The valve control selector switch is in the SEA position, sewage goes overboard.

The GALLEY three-position valve for discharging galley waters:

- The valve is closed, the valve control selector switch is in the CLOSE position;
- The valve control selector switch is in the TANK position, sewage going to the sewage hold tank;
- The valve control selector switch is in the SEA position, sewage goes overboard.

Discharge of polluted SOIL waters is control by combination of the three-position valve and two-position valve.

- The three-position valve SOIL has three positions:
- The valve is closed, the valve control switch is in the CLOSE position;
- The valve control selector switch is in the PLANT position, sewage entering the sewage treatment plant;
- The valve control selector switch is in the SEA position, sewage goes overboard.

The two-position valve SOIL has two positions:

- The valve control selector switch is in the PLANT position, sewage entering the sewage treatment plant;
- The valve control selector switch is in the TANK position, sewage going to the sewage hold tank.

Transfer Pump Control Module



- to shore terminal;
- to treatment unit;
- to sea.

Discharge of tankage is control by combination of two valves:

- the first three – position valve has three positions:
 - CLOSE position;
 - SHORE position (discharge to shore);
 - DISCHARGE position (discharge to second valve).
- the second valve has two position:
 - PLANT position (discharge to treatment unit);
 - SEA position (discharge to sea).

The suction and discharge valves must be opened (SUCTION and DISCHARGE push buttons) before pump start.

Pump start/stop is performed using the button RUN. Pressure at the inlet and outlet of the operating pump being monitored by the SUCTION and DISCHARGE pressure gauges.

Alarm Signals

- SEWAGE HOLD TANK LEVEL HIGH;
- CHLORINATION TANK LEVEL HIGH.

System Faults Introduced by the Instructor

- Air Compressor 1 Trip – emergency stop of the compressed air compressor 1;
- Air Compressor 2 Trip – emergency stop of the compressed air compressor 2;
- Discharge Pump 1 Trip – emergency stop of the discharge pump 1;
- Discharge Pump 2 Trip – emergency stop of the discharge pump 2;
- Discharge Pump Auto Start Failure – failure of the discharge pump automatic system, fail of automatic pump start;
- Discharge Pump Auto Stop Failure – failure of the discharge pump automatic system, fail of automatic pump start;
- Sewage Hold Tank High Level – tank overflow;
- Sewage Hold Tank Level Sensor Failure – failure of the level sensor in the tank;
- Chlorination Tank Level Sensor Failure – failure of the level sensor in the tank.

System Operation

Initial Sewage Treatment Plant Startup

1. The Aeration and Clarification tanks are not filled up. Sewage feed to the plant is cut.
2. The Discharge pumps land 2 are the stand-by ones, able to operate in the modes “MANUAL” and “AUTO”. The pumps are in the stationary status, and the operation mode selector for discharge pumps 1 and 2 is set to the “MANUAL” position.
3. Fully open the air valves “Pressure control valve”, “Aeration valve” and “Scum return valve”, open the “Sludge return valve” (no adjustment needed, being adjusted by the manufacturer). The compressors are stand-by units, able to operate in the modes “Manual” and “Auto”. Set the compressor operation mode switching to the “Manual” position and start up one of the compressors. Make sure that air pressure is in the range of 0.15 to 0.5 bar. Turn over the compressor operation mode switch to the “Auto” position.
4. The Clarification and Chlorination tank valves are closed.
5. Open the Aeration tank valve.
6. Open the Sea water valve and fill the plant with seawater until its level increase in the Chlorination tank (see the Chlorination tank level indicator) or inspect to make sure that there is flow through the “Scum return” and “Sludge return” vinyl tubes (the flow is simulated as arrows on the mimic).
7. Close the Aeration tank valve and the Sea water valve.
8. Ensure there are chlorine pills in the “Chlorinator” (not simulated).
9. Direct “Soil” and “Hospital” group discharges to the plant.
10. Open the Chlorination tank valve and the Overboard valve.
11. Turn the operation mode switch for Discharge pumps 1 and 2 to the “Auto” position. Depending on the liquid level in the Chlorination tank, the discharge pump will start up and shutdown, automatically removing liquid from the Chlorination tank overboard.

Sewage Hold Tank Operation

A maximum rise of level in the tank activates the “SEWAGE HOLD TANK LEVEL HIGH” alarm signal.

The tank is supplied with seawater to make spray, and compressed air; it is shown on the mimic, but not realized in the simulator.

The tank can be emptied out using the Transfer pump. Before starting the pump, make sure the valves at the pump suction/discharge sides are in the open position.

The pump operates in the manual mode only, the Run button being used to start/stop it.

Pressure at the both sides of the pump is monitored using the pressure gauges “Suction” and “Discharge”.

The tank contents can be pumped out ashore (the first valve in the “Shore” position), or to the sewage treatment plant (the first valve in the “Discharge” position, the second one in the “Plant” position), or overboard (the first valve in the “Discharge” position, the second one in the “To Sea” position). Selection of the ship side from which transfer ashore is to be performed is not foreseen in this simulator.

When working in the system, one should check the “Overboard valve” status, i.e. make sure it is open, when pumping out from the tank or when discharging sewage water overboard.

Incinerator (Page INC)

Purpose

The plant is designed for disposal of the oil product and solids by burning. The system is designed in accordance with MARPOL requirements.

The incinerator is to be operated from the local control station.

System Components

See Fig. 5 for the system screen.

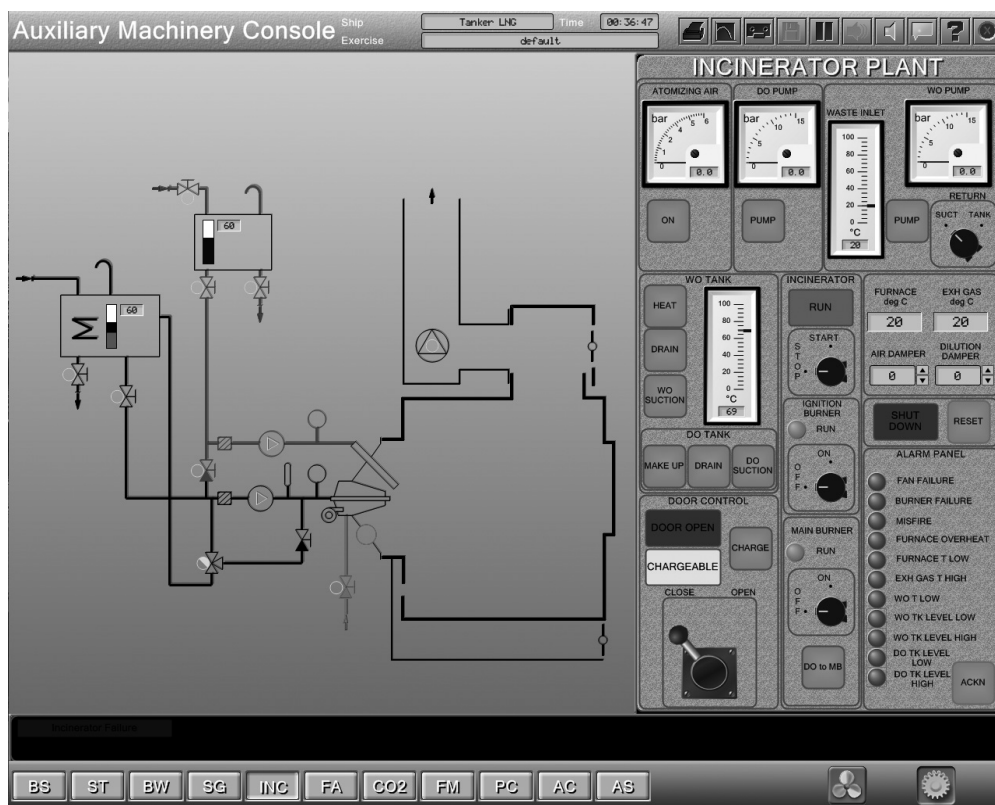


Fig. 5

The system includes:

- incinerator proper with integrated fuel pumps, burners, and automatic control devices;
- tank for settling oil product sediments – Waste Oil settling tank;
- Diesel Oil tank;
- pipelines with necessary fittings as a hydrodynamic object.

The Waste Oil settling tank includes:

- WO suction valve for feeding sediments to the incinerator;
- drain valve;
- heating valve to introduce tank heating steam;
- tank contents temperature indicator;
- tank level indicator.

Oil product sludge come to the tank from the Fuel Oil Transfer system (FOT) through the Sludge discharge pump.

The Diesel Oil tank includes:

- DO Suction valve to supply fuel to the incinerator;
- Drain valve;
- Make Up Valve;
- Tank level indicator.

The diesel fuel from the Fuel Oil Transfer system (FOT) gravitates to the diesel fuel tank.

Diesel oil is supplied to the Incinerator by the integrated DO pump (manual control).

Supply of oil product sludge to the Incinerator is provided by the integrated WO pump (manual control). A pressure reducing valve and a Return valve are installed at the outlet of the WO pump. The Return valve makes it possible to direct part of fuel back to the Waste Oil settling tank or back to the WO pump inlet.

To provide for combustion process, the Incinerator furnace has two burners:

- electrical ignition burner using diesel oil only.
- main burner (Rotary cup type) using both the diesel oil and the oil product sludge. Diesel oil is supplied through the non-return DO supply valve.

The Main burner is provided with an integrated Primary air fan. Fuel is atomized by the compressed atomizing air supplied to the burner from the ship's compressed air system.

To charge solid wastes, the incinerator is provided with a door equipped with an open-status sensor. When open, the charging door disables the starting of the non-operating incinerator.

Combustion air is supplied to the furnace through a manually operated air damper.

The exhaust gas fan ensures air draught in the furnace and discharge of exhaust gases.

Exhaust gas temperature is monitored using the Exhaust Gas indicator. Exhaust gas temperature can be reduced by injection of atmospheric air to the smoke chamber. It is done by opening the dilution damper (manual control of its position). Working range of the exhaust gas temperature is 310 °C to 320 °C.

Combustion process (flame availability) in the furnace can be checked using the "Flame eye". Temperature in the furnace can be monitored using the Furnace temperature indicator (working temperature range is 1000 °C to 1100 °C).

The incinerator is equipped with the local automatic system and overheat protection. The operational principle is based on the monitoring of the exhaust gas temperature and the furnace temperature.

Monitoring the exhaust gas temperature:

- If the exhaust gas temperature increases up to 320 °C, oil supply to the burner nozzles will be cut automatically. After temperature reduction down to 310 °C, it will be resumed;
- If the exhaust gas temperature increases up 350 °C, the dilution damper will open completely and automatically for the purpose of cooling down the exhaust gases and protecting the flue and the exhaust gas fan against overheating.

Monitoring the furnace temperature:

- If the furnace temperature reaches 1100 °C, oil supply to the burner nozzles will be cut automatically. When temperature drops down again to 1050 °C, oil supply will be resumed;
- If the furnace temperature reaches 1200 °C, oil supply to the burner nozzles will be cut automatically, and the WO/DO fuel pumps will be shutdown;
- While furnace temperature is above 220 °C, the charging door opening is disabled. When temperature in the furnace drops below 220 °C, the “Chargeable” indicator illuminates indicating that the door can be opened for charging solid wastes to the Incinerator;
- After Incinerator is shutdown, and temperature in the furnace drops below 60 °C, the exhaust gas fan will stop automatically.

Control Panel

The control panel contains the following modules:

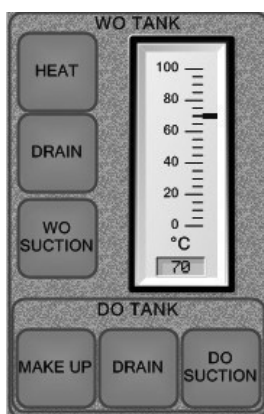
Atomizing Air Control Module



The compressed air pressure is checked using the “ATOMIZING AIR” pressure gauge.

Compressed air is supplied by pressing the button “ON”.

WO/DO Tank Control Modules



A tank for settling oil product sediments -Waste Oil settling Tank (WO Tank).

The contents of the “WO TANK” are heated by introducing heating steam using the “HEAT” button, while the contents temperature is checked using a temperature gage.

Discharge of waste oil from the tank is possible by opening the “DRAIN” valve using the button of the same name.

Feeding the tank contents to the fuel pump inlet is possible after opening the "WO SUCTION" valve by pressing the button of the same name.

Tank replenishment is performed from the Fuel Oil Transfer system (FOT) using the "SLUDGE"; the tank level is checked against the indicator on the mimic.

Diesel Oil tank:

Tank replenishment is performed after opening the "MAKE UP" valve by pressing the button of the same name.

Discharge of waste oil from the tank is possible by opening the "DRAIN" valve using the button of the same name.

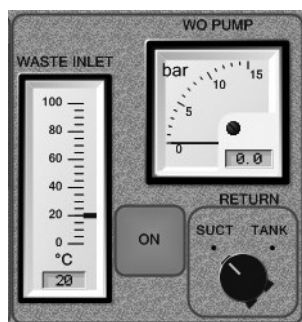
Feeding the tank contents to the fuel pump inlet is possible after opening the "DO SUCTION" valve by pressing the button of the same name.

DO Pump Control Module



The pump can be started by pressing the "ON" button. Discharge pressure is monitored against a pressure gauge.

WO Pump Control Module



Liquid temperature at the "WO PUMP" inlet is checked against the "WASTE INLET" temperature gage. The pump can be started by pressing the "ON" button. Discharge pressure is monitored against a pressure gauge.

The return valve is controlled using the two-position "RETURN" selector switch – liquid surplus after the pump pressure reducing valve is directed either back to the Waste Oil settling tank (selector switch position "Tank") or back to the WO pump (position "Suction").

Incinerator Control Module

The "IGNITION BURNER" is started (oil supply to the nozzle, switching on of the electrical ignition) using the "ON/OFF" selector switch. Turning the switch "ON" switches on the to the "RUN" indicator.

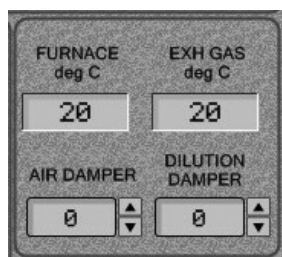
The "MAIN BURNER" is started (oil supply to the nozzle, switching on of the integrated fan) using the "ON/OFF" selector switch. Turning the switch ON switches on the to the "RUN" indicator.

The valve supplying diesel fuel to the main burner is opened with a press on the "DO to MB" button.

Incinerator start/shutdown is performed using the "START/STOP" selector switch. Setting the switch to the "START" position will automatically start the Exhaust Gas Fan and activate the protection system. The "RUN" display indicator turns on with the Incinerator start.



Temperature/Air Damper Control Module

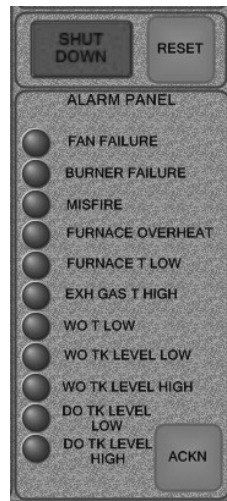


Temperature in the furnace is checked against the "FURNACE" digital temperature gage, while the exhaust gas temperature is checked against the "EXH GAS" digital temperature gage.

The "AIR DAMPER" is opened/closed using the arrows More/Less. Damper position is shown by the degraded indicator.

The Dilution air Damper is opened/closed using the arrows More/Less. Damper position is shown by the degraded indicator.

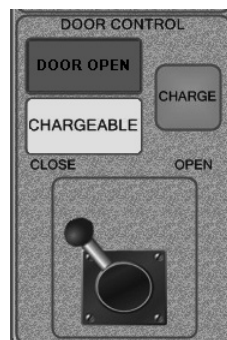
Alarm Panel Module



The Incinerator emergency shutdown status (Incinerator Trip) is indicated with the aid of the “SHUT DOWN” display indicator. After tripping and fault elimination, the protection system is armed by a press on the “RESET” button.

The Incinerator local control station panel includes a module of group alarm with alarm indicators (alarm light and alarm designation). An alarm is acknowledged by a press on the “ACKN” button.

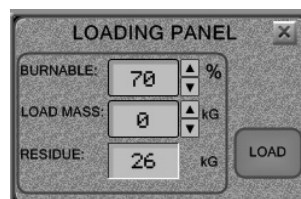
Incinerator Door/Solids Charge Control



The opening/closing of the Incinerator door is simulated by turning the module handle to the “OPEN/CLOSE” position. If the door is open, the Door display indicator is ON.

The “CHARGEABLE” display indicator informs the user the furnace temperature is below 220 °C, which means a possibility to safely charge the solid waste for incineration.

Loading of solid waste to the incinerator is simulated by a press on the “CHARGE” button. A click on it results in appearance of the “LOADING PANEL” window:



The weight of the loaded solid waste is specified using the “LOAD MASS” selector.

Using the “BURNABLE” selector, you can specify a percentage of combustible materials in the solid waste to be loaded.

The value of remaining solid waste in the furnace (not burnt) is shown in the "RESIDUE" field.

Confirm loading by a click on the "LOAD" button.

Cancel loading by a click on the crossed button.

Alarm Signals

Alarm signals on the local station panel:

- FAN FAILURE – failure of the exhaust gas fan due to overheating;
- BURNER FAILURE – failure of the main burner;
- MISFIRE – flame-out, fire extinction in the furnace;
- FURNACE OVERHEAT – furnace overheating (over 1200 °C);
- FURNACE TEMPERATURE LOW – low temperature in the furnace (below 800 °C);
- EXHAUST GAS TEMPERATURE HIGH – high temperature of exhaust gases (over 350 °C);
- WO TEMPERATURE LOW – low temperature in the oil product sludge settling tank (below 80 °C);
- WO TANK LEVEL LOW – low level in the oil product sludge settling tank;
- WO TANK LEVEL HIGH – high level in the oil product sludge settling tank;
- DO TANK LEVEL LOW – low level in the diesel oil tank;
- DO TANK LEVEL HIGH – high level in the diesel oil tank.

A consolidate alarm signal is indicated on the alarm simulator module:

- INCINERATOR FAILURE – failure of the incinerator.

Protection System

The unit protection system is a component of the local control system.

Its operational logic is based on the monitoring of the furnace temperature, exhaust gas temperature, and the flame availability in the furnace.

Depending on the situation (see above), the protection system cuts oil supply to the burner nozzles and shuts down the fuel pumps.

System Faults Introduced by the Instructor

- Exhaust Fan failure – failure of the exhaust gas fan, no intensive removal of exhaust gases, rise of temperature in the furnace and rise of exhaust gas temperature;
- Main burner failure – failure of the main burner, furnace flame-out;
- Ignition burner failure – failure of the ignition burner, furnace flame-out;
- Furnace temperature controller failure – fail of the furnace temperature regulator, rise of furnace temperature;
- Exhaust gas temperature controller failure – failure of the exhaust gas temperature regulator, rise of gas temperature;
- DO pump failure – failure of the diesel oil pump, no fuel supply; flame-out, when operating on the diesel fuel;
- WO pump failure – failure of the oil product waste pump, no fuel supply; flame-out, when operating on the oil product waste.

System Operation

Startup Preparation

1. Make sure the WO Settling tanks and the diesel oil tank are filled, there is no alarm signal related to a low level of the tanks requiring replenishment of the tank contents.
2. Heat up the WO Sett. Tank contents up to 90 °C by opening the heating valve and introducing tank heating steam.
3. Discharge water (bottoms) from the WO Sett. Tank by opening the Drain valve.
4. Make sure that compressed air is available ("ATOMIZING AIR" panel) and introduce compressed air to the unit using the "ON" button.
5. If there are solid waste to be incinerated, open the furnace door, "load" the solid waste (Charge button), close the door, and make sure the "DOOR OPEN" display is "OFF".

Unit Startup and Heating-Up

1. Supply diesel oil to the main burner – the "DO SUCTION" valve is open, the "DO SUPPLY" valve is open, the "WO SUCTION" valve is closed.
2. On the WO Pump module, set the "RETURN" selector switch to the "SUCTION" position.
3. Set the "INCINERATOR" switch to the position "START", it will start up the Exhaust gas fan automatically.
4. Partially open the Air damper (approx. 15 %).
5. Start up the DO and WO fuel pumps.
6. Set the "IGNITION BURNER" selector switch to the position "ON", which will result in activation of the ignition burner pilot light.
7. The combustion process will be started in the furnace, which can be determined by appearance of fire in the Flame eye. Wait approx. 3 min to get the furnace heated up.
8. Partially open the Air damper (approx. 35 %).
9. Set the "MAIN BURNER" selector switch to the "ON" position, which results in activation of the main diesel oil burner.
10. Set the "IGNITION BURNER" selector switch to the "OFF" position, which will shutdown the burner. The unit starts to be heated up by operation of the main diesel oil burner. The furnace is to be heated up to 800 °C. Monitor the furnace temperature and the exhaust gas temperature handling the "AIR DAMPER" and the "DILUTION DAMPER".

Incineration of Oil Product Waste

1. The unit is started and heated up.
2. Set the "RETURN" selector switch in the "WO PUMP" module to the "TANK" position.
3. Close the DO supply valve, open the "WO SUCTION" valve. The main burner starts to operate on the oil product waste.
4. Control the process handling the "AIR DAMPER" and the "DILUTION DAMPER".

Pipeline Purging (Between the WO Sett. Tank and the Main Burner)

1. After prolonged operation of the installation, the pipeline superheated be cleaned, when within installation is not operated.
2. Supply diesel oil to the main burner – the “DO SUCTION” valve is open, the “DO SUPPLY” valve is open.
3. Set the “Return” selector switch in the “WO PUMP” control module to the “TANK” position.
4. Start up the WO fuel pump. The diesel oil will start circulating through the WO pump discharging into the WO Sett. Tank. Be careful! It is easy to pump over all diesel oil to the WO Sett. Tank, so make sure the operation is quite short.

Incineration of Solid Waste

1. It is possible to open the Incinerator door and load some solid waste, if the “CHARGEABLE” indicator is ON, denoting temperature in the furnace below 220 °C.
2. Load the solid waste to the furnace.
3. Start up the “IGNITION BURNER” for ignition of the solid waste. When the furnace temperature reaches approx. 300 °C, the “IGNITION BURNER” may be switched on.

Unit Shutdown, Cooling

1. Set the working burner to the “OFF” position.
2. Close the “WO SUCTION” valve and the “DO SUCTION” valve and turn off the fuel pumps. Cut the “Atomizing Air” supply.
3. Set the “INCINERATOR” switch to the “STOP” position.
4. The fire in the furnace will diesel away, the furnace temperature and the exhaust gas temperature dropping gradually.
5. The “Exhaust gas” fan will continue operating until the moment, when furnace temperature lowers down to 60 C, and then shuts down.

Central Fire Station (Page FA)

Purpose

The central fire station (CFS) is designed for permanent monitoring of the fire situation aboard the ship, remote control of the fire fighting systems, fire doors, ventilation, and cut valves of the fuel pipelines.

System Components

See Fig. 6 for the system screen.

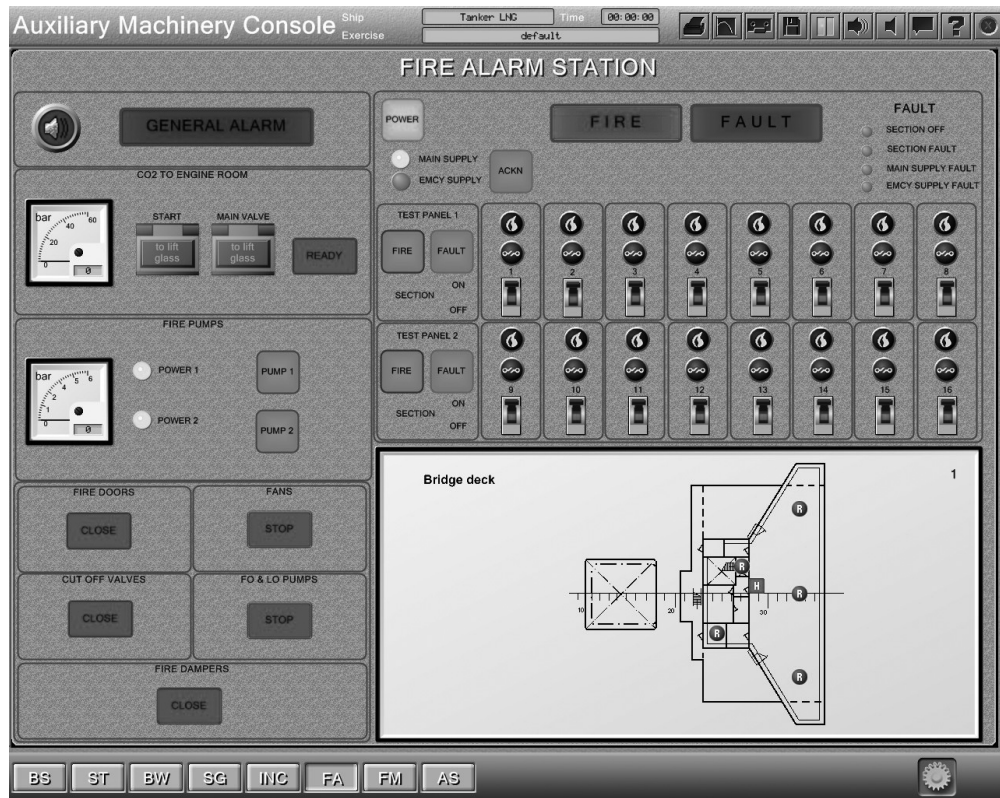


Fig. 6

The system includes:

- ship fire alarm module;
- remote control module for carbon dioxide extinguishing system in the engine room;
- remote control module for fire pumps 1 and 2;
- module indicating statuses of the following mechanisms:
 - closing the fire doors;
 - turning off the fans;
 - closing the cut valves of the fuel/oil systems;
 - shutting down the fuel/oil pumps;
 - closing the fan fire dampers.

The fire alarm system is arranged as a radial one. Each of the system radii provides for monitoring of one or another ship room.

Control Panel

The Ship Fire Alarm Module

The module occupies a major part of the page and consists of the following three panels:

- main control panel;
- fire alarm group panel;
- window showing detector layout in the protected rooms.

Main Control Panel

The fire alarm system gets armed with connection to power using the “POWER” button. Power availability and its source are indicated by the indicator lights “MAIN SUPPLY” (from MSB) and EMCY SUPPLY (from ESB), located under the button.



The central part of the module features to display indicators “FIRE” and “FAULT”.

A lit “FIRE” indicator means a tripped fire detector in a protected room.

A lit “FAULT” indicator means a fault in the system, for example, a faulty detector in the ray, a short circuit or a break in the electrical circuit.

Operation of visual indicator is accompanied by an audible alarm signal.

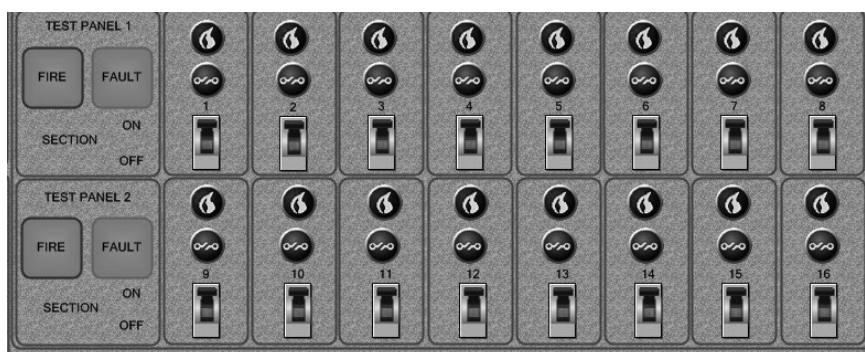
A fire alarm signal is acknowledged by a click on the “ACKN” button.

The indicator lights in the right-hand part of the module indicate the following faults:

- SECTION OFF – disconnection of a radius;
- SECTION FAULT-a fault in a radius;
- MAIN SUPPLY FAULT – absence of system main power;
- EMCY SUPPLY FAULT – absence of system emergency power.

Fire Alarm Group Panel

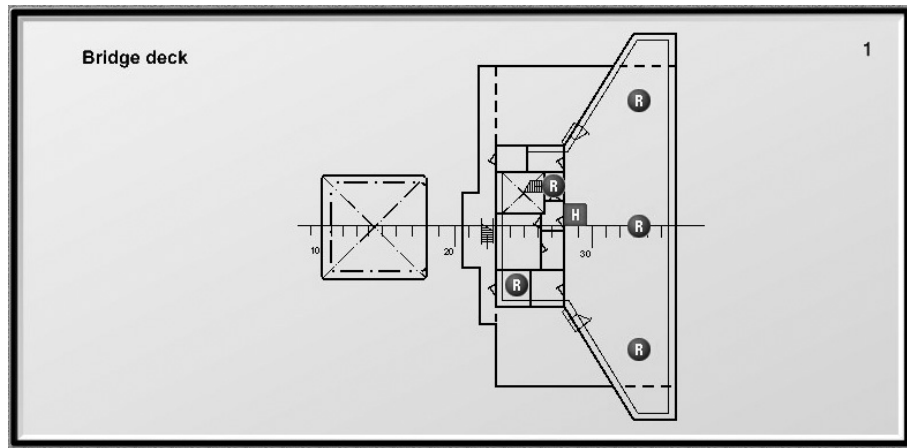
The panel contains numbered switches of the fire alarm radii (1...16), indicator lights (“FIRE”) indicating the tripping of detectors in the radii, indicator lights (“FAULT”) indicating faults in the radii, and buttons for testing the indicator lights.



On actuation of a detector in the protected room, a signal from this detector is directed to the panel, where the “FIRE” indicator illuminates on the corresponding radius. At the same time, the “FIRE” indicator lights up on the main alarm panel accompanied by an audible signal. In a similar manner, a detector fault, a short circuit, or a break in the circuit radius results in activation of the “FAULT” indicator.

Window Showing the Layout of Detectors in the Protected Rooms

The window is located below the fire alarm group panel.



If a radius warning lamp has activated on the fire alarm group panel, select it using your mouse – the window will show the layout of the protected room with indication of positions of the fire detectors belonging to the respective radius.

Detector (detector indicators) legend:

- smoke detector (optical);
- watertight smoke detector (optical);
- manual alarm;
- watertight manual alarm;
- temperature detector;
- watertight temperature detector;
- smoke detector (ionization probe);
- watertight smoke detector (ion probe).



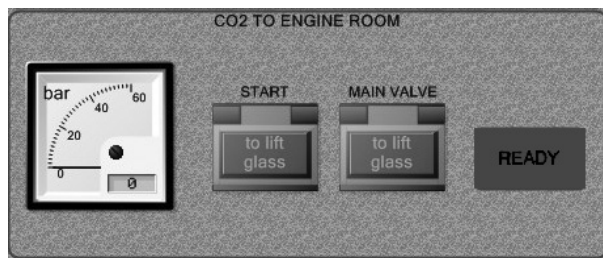
The detector indicators might be in one of three states:

- gray-color indicator – no power;
- green-color indicator – no power, detector has not tripped;
- red-color indicator – the detector has tripped, fire danger situation exists.

Remote Control Module for Carbon Dioxide Extinguishing System in the Engine Room

The simulator has the facility of remote activation of the dioxide extinguishing system (refer to a separate chapter in this description dedicated to the system).

The controls for the function are integrated in the “CO2 TO ENGINE ROOM” module.



The system is started with a click on the “START” button. The click results in activation of the launching CO₂ cylinder designed for delayed disruption of the main system cylinders. Pressure at the main CO₂ cylinders is monitored against the pressure gauge. When the gas from the main cylinders enters the pipeline, the pressure gauge shows pressure increase, and the warning activates, i.e. the “READY” red-color indicator lights up.

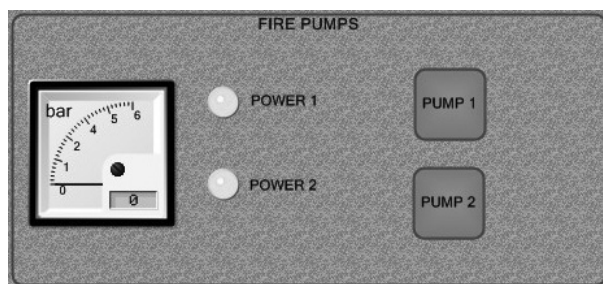
Then the main valve opens to remotely introduce gas to the protected rooms. It can be opened/closed using the “MAIN VALVE” button.

The buttons “START” and “MAIN VALVE” are protected against inadvertent press with “transparent” safety cups. To get an access, click on the “to lift glass” wording.

Module for Remote Starting the Fire Pumps in the Engine Room

The simulator has the facility of remote activation of the fire pumps (refer to a separate chapter in this description dedicated to the main fire water system).

The controls for the function are integrated in the FIRE PUMPS module:

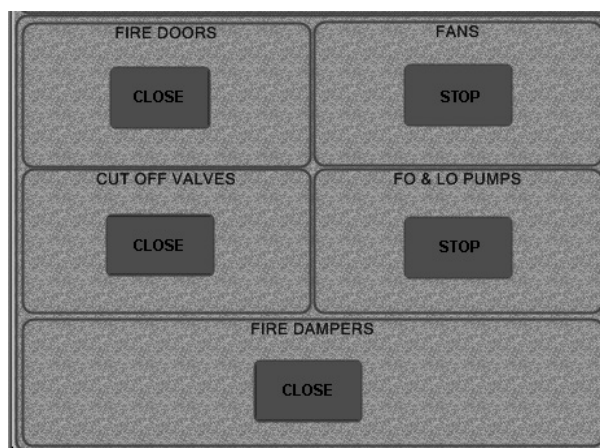


The indicators “POWER 1” and “POWER 2” show availability of power for fire pumps 1 and 2.

The fire pumps are started using the buttons “PUMP 1” and “PUMP 2”.

Pressure downstream of the pumps can be checked against the pressure gauge.

Device status indication module



- Closing the FIRE DOORS – when the fire doors close due to appearance of the FIRE signal, the “CLOSE” indicator lights up;
- Shutting down the “FANS” – when the fans stop due to appearance of the FIRE signal, the “STOP” indicator lights up. This action will shutdown the following fans:
 - All forcing and exhaust fans in the engine room;
 - The air conditioning system fan;
 - All forcing and exhausting fans in the service rooms and crew quarters.
- Closing of the shut off valves of the fuel/oil tanks – when the CUT OFF VALVES close due to appearance of the FIRE signal, the “CLOSE” indicator will light up on the fire alarm panel;
- Shutting down of the “FO & LO PUMPS” – when these pumps shutdown due to appearance of the FIRE signal, the “STOP” indicator will light up on the fire alarm panel. This will result in shutdown of the following pumps:
 - FO transfer pump;
 - DO transfer pump;
 - FO burner supply pump 1;
 - FO burner supply pump 2;
 - LO transfer pump;
 - Purifiers feed pumps.
- Closure of the FIRE DAMPERS – when the fire dampers close in the air ducts of the forcing and exhausting fans of the engine room, the “CLOSE” indicator will light up.

Panel of General/Fire Alarm Signalization

The general /fire alarm signalization is activated on the bridge. The simulator has the facility of turning on the alarm signalization using the red-color “GENERAL ALARM” button.

Alarm Signals

- FIRE ALARM – alarm signal indicating fire in one or more rooms (tripping of a detector);
- GENERAL ALARM – general ship alarm signal.

Protection System

Not simulated.

System Faults Introduced by the Instructor

- Fire near Fuel tanks – fire next to the fuel tanks;
- Fire near Diesel generator – fire next to the diesel generator;
- Fire near economizer Port Side – fire next to the port side economizer;
- Fire near economizer Star Side – fire next to the starboard economizer;
- Fire near Boilers – fire next to the boilers;
- Fire in Separator room – fire in the separator room;
- Fire in Pump room – fire in the pump room;
- Main Power Failure – loss of power (mains);
- Battery failure – loss of backup power (batteries).

Carbon Dioxide Extinguishing System (Page CO₂)

Purpose

Carbon dioxide extinguishing system is designed to fight fires of complicated categories in the ship engine room, boiler rooms, cargo rooms, etc.

The control of the system activation can be performed both at the local carbon dioxide extinguishing station ("CO₂ CONTROL PANEL", page "CO₂"), and remotely at the Central fire station (CO₂ to Engine Room, page "FA").

System Components

See Fig. 7 for the system mimic.

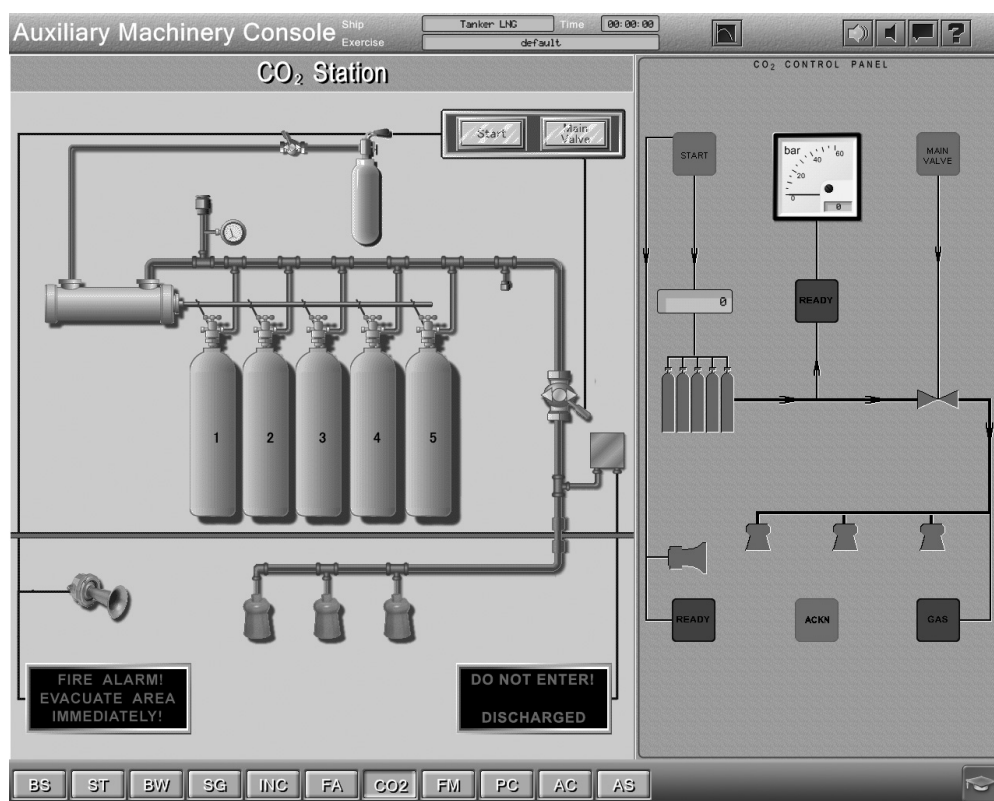


Fig. 7

The system has the following components reproduced in the simulator:

- main set of CO₂ cylinders;
- launching CO₂ cylinder;
- servocylinder;
- main valve;
- pipeline equipped with non-return valves;
- remote control and alarm system.

The set of main CO₂ cylinders can be composed of a number of cylinder groups. The cylinder outlets are provided with non-return valves to supply CO₂ further down the pipeline into the protected rooms. The main cylinder valves can be opened ("disrupted") both manually and remotely.

Remote opening of the main cylinders is performed by the launching CO₂ cylinder shown in the upper part of the mimic. The outlet of the launching CO₂ cylinder is also provided with a non-return valve.



In case of a manual activation, the valves of the main CO₂ cylinders get open using the system launch lever (above the main CO₂ cylinders on the mimic).

After activation of the launching cylinder, the gas is supplied through the non-return valve at the outlet to the servocylinder. The servocylinder is designed for providing a delay before the disruption of the main cylinder valves.



The system launched and the main CO₂ cylinders disrupted, the gas enters the pipeline through the non-return valves. To introduce CO₂ to the protected room, it is sufficed to open the main valve.



The pipeline running from the main cylinders to the main valve is provided with a safety valve of the diaphragm type, which serves to discharge gas, if the set pressure (> 120 bar) is exceeded. Such a situation is possible, for example, in case of a fire at the CO₂ station. Then, when the safety valve has tripped, the escaping gas extinguishes fire at the CO₂ station.



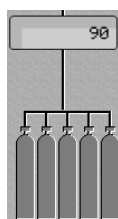
Control Panel

The launching of CO₂ cylinder is started with a press on the START button (there is a similar button at the central fire station).



A press on the START button results in the lighting-up of the red-color READY indicator and the launching of timer (about 2 minutes in the simulator) for the opening of the main CO₂ cylinders.

At the same time the audible and visual fire warning turn on in the room – “FIRE ALARM! EVACUATE AREA IMMEDIATELY!”



Pressure at the main CO₂ cylinders is monitored using the pressure gauge.

The system launched and the main CO₂ cylinders disrupted, the gas enters the pipeline through the non-return valves, pressure gauge reading starts to rise, and the red -color “READY” indicator lights up under the pressure gauge.

The main valve can be opened using the “MAIN VALVE”.



When the main valve is open, the display indicator “DO NOT ENTER! CO₂ DISCHARGED” lights up, and the “GAS” indicator lights up on the control panel.

The simulator foresees a spontaneous disruption of the main CO₂ cylinders. In this case the pressure gauge shows pressure increase upstream of the main valve, the alarm activates lighting the red-color “READY” indicator.

Any alarm signal superheated be acknowledged by a click on the “ACKN” button.



Alarm Signals

- GO AWAY FROM ER, CO₂ RELEASE – the fire fighting system has been activated, gas supply time count-down has started;
- CO₂ MAIN VALVE OPEN – the main valve is open;
- CO₂ IN MANIFOLDS – gas has been introduced to the protected rooms.

Protection System

Not simulated.

System Faults Introduced by the Instructor

- CO₂ cylinder accidental release – spontaneous activation, gas cylinder disruption.

Water Fire System and Foam Fire System (Page Fm)

Purpose

Water fire system is designed for firefighting in all superstructure rooms and in the engine room. On the open deck, the water fire system can be used for deck protection in case of cargo leakage. The water sprinkling system is designed for preventing fire to the adjacent rooms. Sprinkling is applied to the cargo pump rooms, life-boat boarding places, top surfaces of the cargo tanks, spaces around the cargo valves, and spaced around the cargo manifolds.

The foam fire system is used jointly with the water fire system for firefighting (in the simulator, it is used for firefighting in the rooms containing separators, boiler, and cargo pumps). The high-expansion foam (1:1000) is used for firefighting in the engine room and the pump room. The basic equipment and the foam fire system controls are located in the foam fire station room.

System Components

See Fig. 8 for the system mimic.

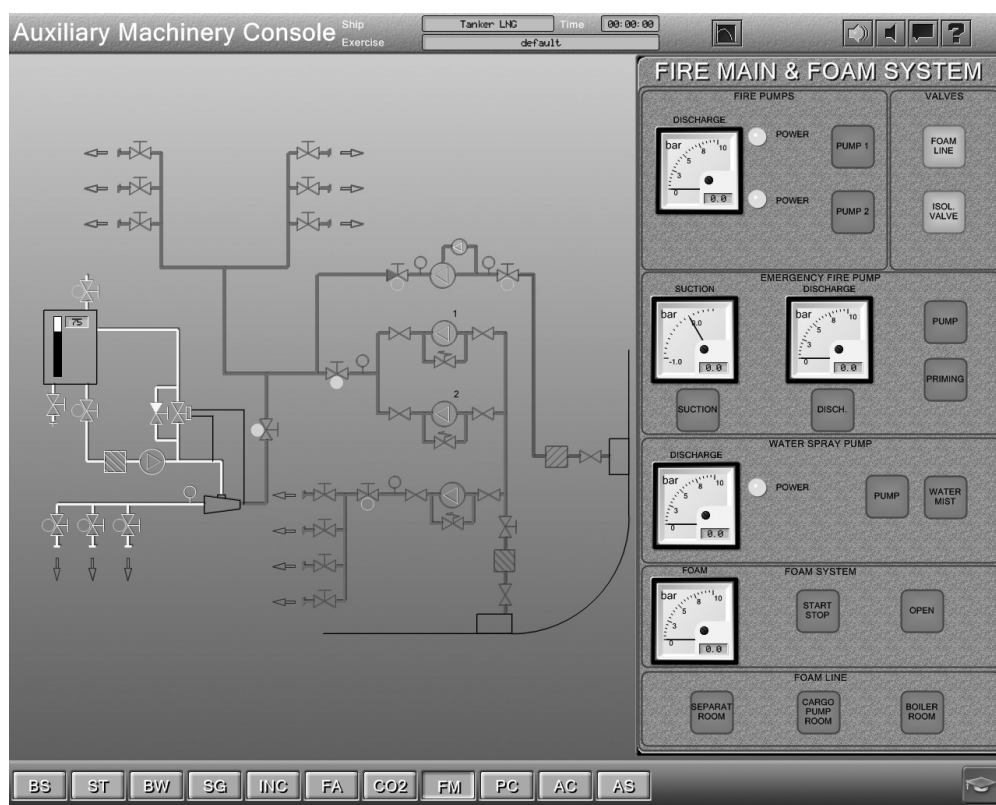


Fig. 8

The system has the following components reproduced by the simulator:

- pipeline system as a hydrodynamic object;
- electrically driven fire pump 1 and fire pump 2;
- emergency fire pump independently driven by an internal-combustion engine;
- electric sprinkling system pump;
- sea chests;
- foam preparation supply system.

Fire pumps 1 and 2 are located below the water line outside the protected rooms.

The pump delivery pipes are equipped with non-return and safety valves, while the suction pipelines have shutoff valves.

There is an isolation valve, cutting off the engine room in case of fire, on the fire water main at its exit from the engine room. In case of fire in the engine room, the isolation valve is closed, the water main being supplied by the emergency fire pump.

The emergency fire pump has a diesel drive and a priming pump, water intake being from an individual sea chest. The pump is installed in a separate room. To operate the emergency pump, open the shutoff valves at the discharge/suction sides, start the pump and turn on the priming pump. The priming pump can be turned on, only if the emergency fire pump is operating.

The main fire pipeline provides water supply from the pumps to the fire location. It covers the entire area of the ship so that each potential fire zone could be subjected to action of at least two water jets. The main is equipped with the fittings for international standard shore connection.

The foam fire system is used for firefighting jointly with the water fire system.

The protected room houses a stationary foam extinguishing installation.

The installation consists of the following:

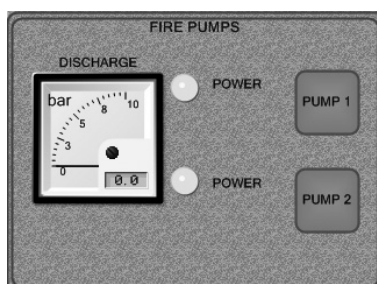
- Tank containing the foaming agent. The level in the foaming agent tank (%) can be checked against the level indicator;
- Pump – for introduction of the foaming agent from the tank to the mixer. The suction side of the pump is equipped with a shutoff valve and a filter;
- Mixer. The foaming agent comes from the operating pump to the mixer. Water from the fire pumps is supplied to the other side of the pump, via the pipeline including the open valve. The mixer is equipped with a metering pilot valve, an automatic diaphragm dispenser and a bypass valve.

At the exit from the foam fire station, shutoff valves are installed to control foam supply to the rooms aboard having points of fire outbreak.

Control Panel

The control panel is on the screen right to the mimic and includes the following control modules:

Main Fire Pump Control Module



Availability of power for the fire pumps is indicated button the “POWER” lamps.

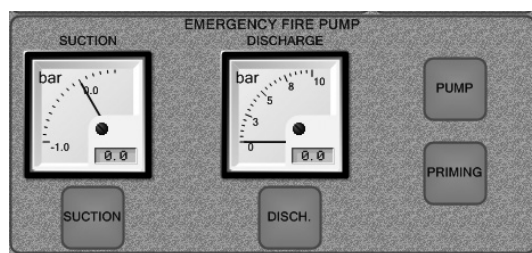
The main fire pumps 1 and 2 in the engine room can be started/shut down in the engine room using the buttons “PUMP 1” and “PUMP 2”, respectively.

Pressure in the pump discharge line can be checked against the pressure gauge.

The isolation valve to cut off the engine room in case of fire can be opened using the “ISOL. VALVE” button located in the “VALVES” control module.



Emergency Fire Pump Control Module

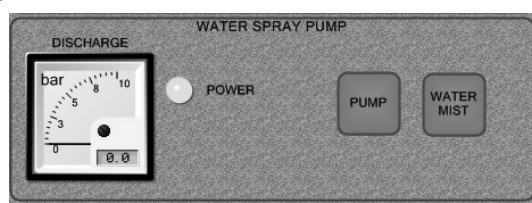


The shutoff valve in the suction/discharge lines of the emergency fire pump can be opened with a push on the buttons “SUCTION” and “DISCH.”.

The emergency fire pump start/shutdown can be performed using the “PUMP” button. The priming pump can be turned on, only if the emergency fire pump is operating, with a press on the “PRIMING”.

Pressure in the suction/discharge lines of the emergency fire pump can be checked against the pressure gauges “SUCTION” and “DISCH.”.

Water Spray Pump Control Module



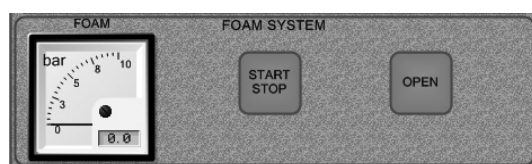
Availability of power for the pump is indicated by the “POWER” lamp.

Pump start/shutdown can be performed using the “PUMP” button.

Pressure in the discharge line of the pump can be checked against the “DISCHARGE” pressure gauge.

Supply of water to the spray system is started using the “WATER MIST” valve. Press the corresponding button to open it.

Foam System Control Module



Water from the fire main to the installation is performed using the Foam Line valve, which can be opened by a press on the “FOAM LINE” button in the “VALVES” module.

The installation is started/stopped with the aid of the “START/STOP” button, which opens the tank air valve and starts up the system pump.

Supply of the foaming agent to the installation pump is carried out after a press on the “OPEN” button, which results in the opening of the corresponding valve.

Foam pressure can be checked against the “FOAM” pressure gauge.

Foam Line Module



The foam line module is provided in the simulator to control foam supply to a number of rooms. This module is used to control the following shutoff valves:

- “SEPARAT ROOM” – foam supply to the separator room;
- “CARGO PUMP ROOM” – foam supply to the pump room;
- “BOILER ROOM” – foam supply to the boiler room.

Alarm Signals

Not simulated.

Protection System

Not simulated.

System Faults Introduced by the Instructor

- Fire Pump 1 Breakdown – failure of fire pump 1;
- Fire Pump 2 Breakdown – failure of fire pump 2.

Provision Cooling System (PC Page)

Purpose

The automatic Provision Cooling System is intended for creating and maintaining the set temperature conditions for the storage of food in two groups of provision stores.

System Components

The system mnemonic diagram is shown in Fig. 9:

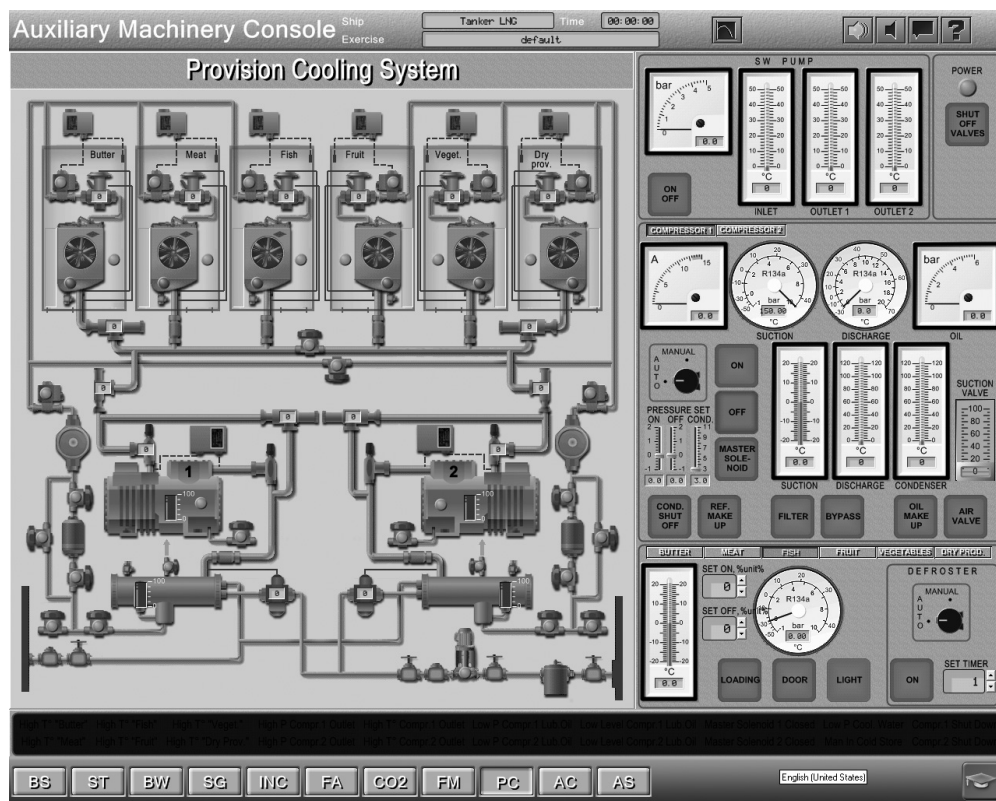


Fig. 9

The following components are included in the system and modelled in the simulator:

- provision stores as a thermodynamic object;
- refrigeration plants 1 and 2;
- gas and liquid lines with valves as hydro- and gas dynamic objects;
- cooling seawater pump.

The provision stores are divided into groups proceeding from the level of temperature maintained in them.

The first group includes three provision storerooms for the storage of frozen foods:

- Butter – storage of butter at a temperature of -2°C ;
- Meat – storage of meat at a temperature of -15°C ;
- Fish – storage of fish at a temperature of -15°C .

The other group includes three provision storerooms for the storage of chilled food:

- Fruit – storage of fruit at a temperature of +2°C;
- Vegetables – storage of vegetables at a temperature of +2°C;
- Dry prov. – storage of dry provisions at a temperature of +8°C.

Each of the refrigeration plants operates for its group of consumers. However, the refrigeration performance of each refrigerator is sufficient for the supply of both storeroom groups if required. This capability is ensured by the availability of connecting lines with cut-off valves. Freon R134a has been selected for the main liquid refrigerant, there is a capability to switch to R401b.

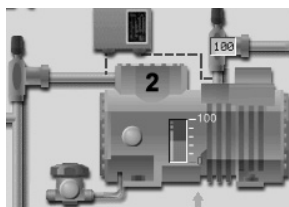
The sea water pump which is in the right bottom corner of the mnemonic diagram, supplies water for the cooling of condensers 1, 2.



Condensers 1 and 2 are located in the bottom part of the mnemonic diagram. Shown here is the liquid refrigerant level in the condenser collector. The sea water flow for the condenser cooling is controlled by using the condensing pressure governor (water control valves) installed on the water supply lines to condensers 1 and 2.



Compressor 1 maintains the required temperature conditions in the frozen food stores (Butter, Meat, Fish), compressor 2 maintains the required temperature in the chilled product storerooms (Fruit, Vegetables, Dry prov.).



When the compressors are operating, indicators of the compressor operation light up on the mnemonic diagram. Also shown here is oil level in the compressor case and the degree of openness of the compressor suction valve.

Automatic adjustment of the compressor refrigeration performance is provided in two ways: compressor STAR/STOP and bypassing. Adjustment by bypassing is performed by using the performance suction pressure governor control. On the mnemonic diagram, the regulator is set on the compressor bypass line. The current position (extent of openness) is shown on the digital indicator of the performance regulator on the mnemonic diagram.



The sight glass located on the liquid line on the mnemonic diagram shows the state of the liquid refrigerant and moisture content.



The air temperature in the storerooms is maintained with the air coolers. The thermo switch monitors the temperature in the pertinent provision storeroom and controls operation of the solenoid valves in the refrigeration chamber, as well as the operation of the air cooler valve. As the solenoid valve is opened, its OPEN indicator lights up on the mnemonic diagram (above the air cooler).

Operation of the air cooler fan is reflected on the mnemonic diagram.



Liquid refrigerant is supplied to the air cooler by the thermostatic expansion valve (above the air cooler on the mnemonic diagram). The current status degree of openness is shown on the digital indicator of the thermostatic expansion valve on the mnemonic diagram.

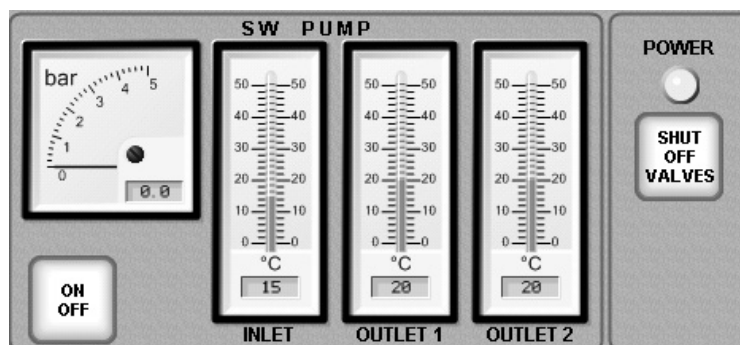


Control Panel

The control panel located in the right-hand part of the screen page contains the following groups:

- Control of seawater supply;
- Control of pipeline cut-off valves;
- Control of compressors;
- Control of provision storerooms.

SW PUMP Group – Control Of Seawater Supply

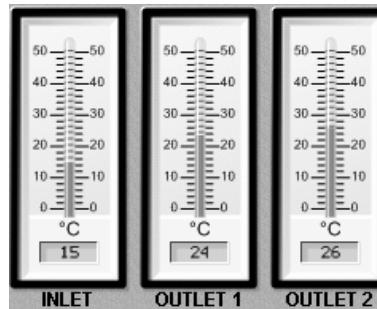


The sea water pump is turned on/off by using "ON/OFF" button. When the pump is on, the button indicator is backlit, and the pump "ON" indicator lights up on the mnemonic diagram.



Set above the buttons on the control panel is the digital pressure gauge, which shows the pump's charging pressure.

To the right of the pressure gauge on the control panel, there are three temperature gauges showing sea water temperature at the system inlet – INLET and temperature of the water after condensers 1 and 2 – OUTLET 1 and OUTLET 2 respectively.

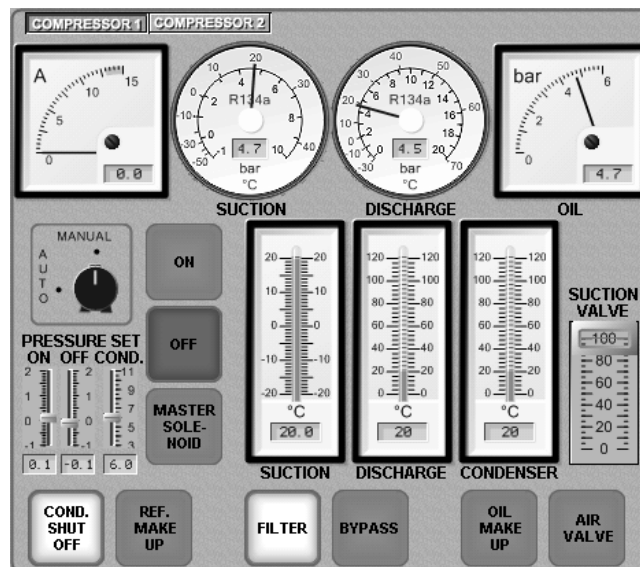


Group for the Control of Pipeline Cut-off Valves

The “POWER” indicator shows that the system is powered.

The “SHUT OFF VALVES” button serves for the control of cut-off valves on the vapour and liquid connection lines on the mnemonic diagram. A press on the button opens the valves, thus ensuring the interchange ability of the compressors. When the valves are opened, the valve Open indicators light up on the mnemonic diagram and the button on the control panel is backlit.

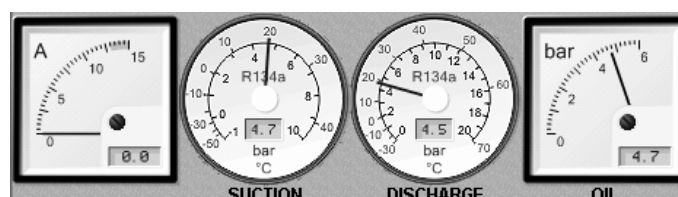
Compressor Control Group



There are two tabs in the group: “COMPRESSOR 1” and “COMPRESSOR 2” which are used for selecting the parameter monitoring instruments and controls of the required compressor:



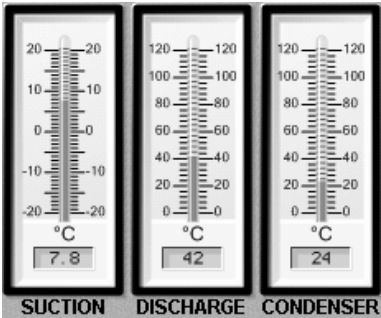
Installed on the control panel are amperemeter (shows electrical current), SUCTION vacuum gauge (shows suction pressure), and two pressure gauges (DISCHARGE shows charging pressure, OIL pressure gauge shows pressure in the compressor lubricating system).



With a high charging pressure in the compressor, an alarm is generated: appropriate lamps start flickering in the bottom part of the screen.

The alarm is also generated in case of lows pressure in the compressor lubricating system.

In the centre of the control, panel there are three temperature gauges for determining the liquid refrigerant temperature on the suction line – SUCTION, on the charging line – DISCHARGE, and in the condenser – CONDENSER.



With a high compressor discharge temperature, an alarm is generated, and appropriate lamp starts flickering in the bottom part of the screen.

In the left-hand part of the control panel, “AUTO/MANUAL” compressor operating mode switch is located. As the switch is set to “AUTO” position, control of the compressor motor operation and solenoid valves is exercised automatically.



Adjustment of water control valves for maintaining the set condensing pressure value (0.6-0.7 MPa) is made on the control panel.

In the left-hand part of the control panel, there is “PRESSURE SET COND.” condensation pressure controller.



The current condition of the condensation pressure control (degree of openness) is shown on the controller digital indicator on the mnemonic diagram.



If the switch is set to “MANUAL” position, to turn the compressor on, it is first necessary to open the master solenoid by pressing “MASTER SOLENOID” button on the control panel.



The button indicator is backlit, and the valve open status indicator lights up on the mnemonic diagram.



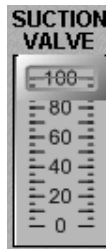
Then the compressor is turned on by using “ON” button on the control panel.



“OFF” button serves for turning the compressor off.



The suction valve of the compressor is opened via SUCTION VALVE setter in the right-hand part of the control panel.



Adjustment of the compressor refrigeration performance is provided in two ways: compressor Star/Stop and bypassing.

The compressor is started in stopped automatically by the lows pressure switch. The switch is adjusted by using PRESSURE analog setter.

On "OFF" scale, set the suction pressure value whereupon the compressor cylinders will turn off.



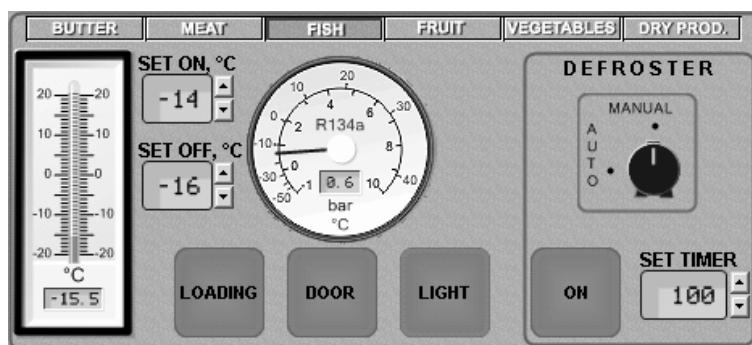
On "ON" scale, set the pressure value whereupon the compressor will turn on.

System valve control buttons are in the bottom part of the group. The lighted button indicator corresponds to the valve's open status. As a valve is opened, the valve Open indicator lights up on the mnemonic diagram.

- Button for the control of the shut-off valves on the liquid refrigerant drain from the condenser;
- Button for the control of the valve for the system replenishment with liquid refrigerant;
- Button for the control of the moisture eliminator shut-off valve;
- Button for the control of the moisture eliminator bypass valve (used when the moisture eliminator is replaced);
- Button for the control of the valve for the supply of oil into the compressor;
- Button for the control of the valve used in the procedure of releasing air from the system.



Control of Provision Storerooms Group



In the top part of the group, there are tabs for switching monitoring tools and controls of different provision storerooms:



Set to the left on the control panel is a thermometer showing the current temperature in the provision storeroom.

With a high temperature in the cooled space (3 °C higher than the set value) an alarm is generated – a lamp starts flickering in the bottom part of the screen indicating the pertinent provision storeroom, e.g. that for the storage of butter: High T° “Butter”.

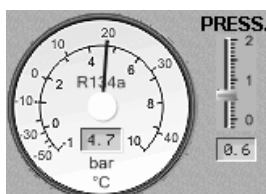


To the right of the temperature gauge on the control panel, there is a digital controller of the thermostatic monitoring the temperature in the pertinent provision storeroom and controlling operation of the solenoid valves in the refrigeration chamber, as well as the operation of the air cooler valve.

As the solenoid valve is opened, its “OPEN” indicator lights up on the mnemonic diagram (above the air cooler).



In the centre of the control unit, there is a pressure gauge showing the pressure and boiling point in the pertinent air cooler.



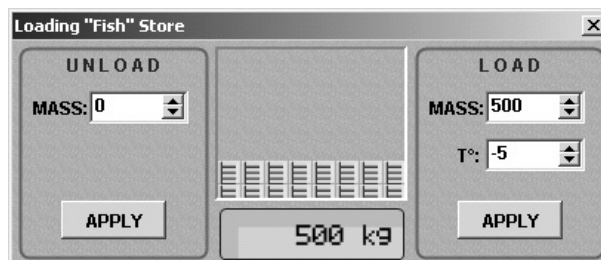
To the right of the pressure gauge on the control panel for butter (Butter) and dry provisions (Dry prov.) storerooms, there is a setter of “PRESS.” evaporation pressure control.

The control's current state is shown on the digital indicator on the mnemonic diagram (below the air cooler of the pertinent storeroom).



Arranged in the bottom part of the control panel are buttons:

Storeroom loading/unloading control button. It is first necessary to open the storeroom door by using “DOOR” button (see below). Then press “LOADING” button to open the following dialogue window on the screen:



The window heading indicates which storeroom will be loaded/unloaded. The central part of the dialogue window displays an open storeroom door and the amount of goods in kg which is currently stored there.

Enter the amount of products to be unloaded in “MASS” box in the left-hand part of the dialogue window (UNLOAD) and press “APPLY” button.

To load the storeroom, enter the required amount of goods in “MASS” box in the left-hand part of the dialogue window (LOAD), enter temperature in “T°” box and press “APPLY”.

The procedure for loading provisions in the chamber can be performed from the instructor workplace as well. In “Data Monitor” window, enter the amount of goods in kg in the selected chamber. If there were no goods in the chamber at the loading time, the provisions which are being loaded will be stored in the chamber with the temperature equal to the refrigeration chamber temperature. If there were some goods in the chamber at the loading moment, the provisions which are being loaded will have a temperature of the provisions already stored in the chamber.

Door control button. It is used for the loading and unloading of goods into/from the storeroom. When the door is opened, the button is lighted, and an open door is shown on the mnemonic diagram (in the bottom part of the storeroom). The door will not close as long as the light in the storeroom is on.



Storeroom lighting button. The lighted button corresponds to ON status. The light cannot be turned on unless the storeroom door is open.



In the right bottom corner of the control panel, there is “DEFROSTER” unit which includes “AUTO/MANUAL” switch for the control of the refrigeration equipment defrosting system.



In the right bottom corner of the control panel, there is “DEFROSTER” unit which includes “AUTO/MANUAL” switch for the control of the refrigeration equipment defrosting system.



Button for the control of the evaporator defrosting process when the switch is in “MANUAL” position.



During the defrosting the button is backlighted, and a red coloured indicator lights up on the mnemonic diagram (next to the air cooler).



Alarm Signals

- HIGH T° “BUTTER” – temperature setting in the storeroom exceeded (by 3° C);
- HIGH T° “MEAT” – temperature setting in the storeroom exceeded (by 3° C);
- HIGH T° “FISH” – temperature setting in the storeroom exceeded (by 3° C);
- HIGH T° “FRUIT” – temperature setting in the storeroom exceeded (by 3° C);
- HIGH T° “VEGETABLES” – temperature setting in the storeroom exceeded (by 3° C);
- HIGH T° “DRY PROVIS.” – temperature setting in the storeroom exceeded (by 3° C);
- HIGH PRESS. COMPR. 1 OUT – high pressure at the outlet of Compressor 1;
- HIGH T°. COMPR. 1 OUT – high temperature at the outlet of Compressor 1;
- LOW PRESS. COMPR. 1 OIL – low oil pressure in Compressor 1;
- LOW LEVEL. COMPR. 1 OIL – low oil level in Compressor 1;
- SOLENOID 1 CLOSED – solenoid valve in Compressor 1 closed;
- COMPRESSOR 1 SHUT DOWN – Compressor 1 stopped automatically;
- HIGH PRESS. COMPR. 2 OUT – high pressure at the outlet of Compressor 2;
- HIGH T°. COMPR. 2 OUT – high temperature at the outlet of Compressor 2;
- LOW PRESS. COMPR. 2 OIL – low oil pressure in Compressor 2;
- LOW LEVEL. COMPR. 2 OIL – low oil level in Compressor 2;
- SOLENOID 2 CLOSED – solenoid valve in Compressor 2 closed;
- COMPRESSOR 2 SHUT DOWN – Compressor 2 stopped automatically;
- LOW PRESS. COOL WATER – low pressure of cooling sea water;
- MAN IN COLD STORE.

Safety System

No available as an individually implemented subsystem, provided by the system automatics.

System Faults Introduced by the Instructor

- Ref. Power fault – system power supply fault;
- SW Reg. Valve 1 Fault – faulty sea water valve 1;
- SW Reg. Valve 2 Fault – faulty sea water valve 2;
- Air in System 1;
- Air in System 2;
- Excessive moisture Filter 1;
- Excessive moisture Filter 2;
- Condenser 1 Fouling;
- Condenser 2 Fouling;
- Compressor 1 breakdown;
- Compressor 2 breakdown;
- Refrigerant leakage from System 1;

- Refrigerant leakage from System 2;
- Oil leakage from Compressor 1;
- Oil leakage from Compressor 2;
- Term. Exp. Valve Fouling (Fish) – fouling of temperature valve in the storeroom;
- Term. Exp. Valve Fouling (Meat) – fouling of temperature valve in the storeroom;
- Term. Exp. Valve Fouling (Butter) – fouling of temperature valve in the storeroom;
- Term. Exp. Valve Fouling (Fruit) – fouling of temperature valve in the storeroom;
- Term. Exp. Valve Fouling (Vegetables) – fouling of temperature valve in the storeroom;
- Term. Exp. Valve Fouling (Dry Prov.) – fouling of temperature valve in the storeroom;
- Snow Coat (Fish) – growth of snow coat in the storeroom;
- Snow Coat (Meat) – growth of snow coat in the storeroom;
- Snow Coat (Butter) – growth of snow coat in the storeroom;
- Snow Coat (Fruit) – growth of snow coat in the storeroom;
- Snow Coat (Vegetables) – growth of snow coat in the storeroom;
- Snow Coat (Dry Prov.) – growth of snow coat in the storeroom;
- Thermostat Fault (Fish);
- Thermostat Fault (Meat).

Directions for the Plant Operation and Maintenance

Procedure for Starting the Plant in Manual Mode

1. Turn on the sea water pump. Monitor its operation by the pressure gauge.



2. Set the compressor operating mode switch to "MANUAL" position.



3. Open the shut-off valves on the liquid refrigerant circulation lines.



4. If the refrigeration plant is expected to operate for its own group of storerooms only, shut-off valves on the connecting steam and liquid pipelines are closed. If one of the refrigeration plants operates for both groups of consumers (the second plant is not turned on), the shut-off valves should be closed.

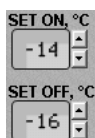
5. Adjust the low pressure switch.

On “OFF” scale, set the pressure value whereby the compressor is turned off. By the moment of the compressor stop, the temperature in all the cooled storerooms should achieve the set value.

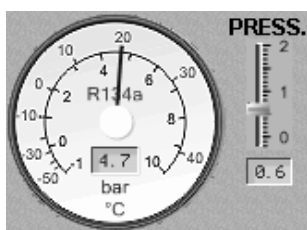


On “ON” scale, set the pressure value whereby the compressor is turned on. By this moment, temperature in at least one room has grown to more than the set value.

6. Adjust thermostats for each storeroom.



7. For “BUTTER” and “DRY. PROV.” storerooms. Adjust the evaporation pressure control.



8. Open the master solenoid valve.



9. Start the compressor.



10. Set the operating mode switch of the equipment defrosting system to “AUTO” position.

11. Set the time interval (in hours) at which the defrosting of refrigeration equipment will be performed in each cooling space.

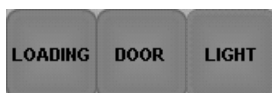


12. Set the defrosting system control switch to “AUTO” position.



13. Monitor the plant operation parameters maintaining their values within the standard range. You will be advised about all the faults by the alarm system. As a monitored parameter reaches the maximum permissible value, the safety system is actuated: an appropriate alarm is turned on in the bottom part of the screen.

14. Load (unload) as necessary the set mass of goods (products) into/from the storerooms.



Defrosting of Refrigeration Equipment in Manual Mode

This is used in case of excessive growth of hoar frost on the surface of refrigerating units.

If the thickness of the hoar frost layer is 5 mm or more, and the equipment defrosting process has not been started automatically, then it is necessary to:

1. Set the defrosting system control switch to "MANUAL" position.



2. Press "ON" button under the switch.



Replenishment of Liquid Refrigerant

This is performed if the refrigerating plant operating mode indicates the insufficiency of liquid refrigerant in the system (low level of liquid refrigerant in the condenser receiver part, gas bubbles in the sight glass, low suction pressure, extensive overheating on the suction line, and high charging temperature):

1. Set the compressor operating mode switch to "MANUAL" position.



2. Close the shut-off valve on the liquid line after the condenser.



3. Open the make-up valve.



4. Monitor the liquid refrigerant level by using the sight glass on the receiver part of the condenser.
5. After the end of the process, close the make-up valve (the liquid refrigerant level on the condenser sight glass is 0.4-0.5 H).
6. Open the shut-off valve after the condenser.
7. Turn the compressor on.
8. Set the operating mode switch to "AUTO".



9. Monitor the refrigerating plant operation parameters.

In case of the system overfilling with liquid refrigerant, there may be "damp" compressor operation.

Compressor Replenishment with Oil

This is performed if the oil level in the sight glass on the compressor sump has dropped to below 1/2 H mark. The oil should best be added with the compressor not running (the oil level is clearly visible in the sight glass):

1. Set the compressor operating mode switch to "MANUAL" position.



2. Close the compressor suction valve.
3. After the suction pressure (in the sump) has dropped to a value below the atmospheric pressure (≈ -0.5 bars), stop the compressor.



4. Open the oil make-up valve.



5. After the end of the process (oil level is not higher than 2/3 of the sight glass), close the valve.
6. Turn the compressor on.
7. Set the operating mode switch to AUTO position.



8. Monitor the refrigerating plant operating parameters.

Where the compressor cannot be stopped (e.g. loading of a considerable amount of goods with rather high temperature) at the moment of oil replenishment, it is necessary:

1. To re-adjust the low pressure switch – on "OFF" scale make $\approx -0.5 \dots -0.3$ setting.



2. After the pressure has dropped below the atmospheric pressure, open the oil make-up valve.
3. After the end of the process, close the valve.
4. Re-adjust the low pressure switch to the operating mode.
5. Monitor the refrigerating plant operating parameters.

If oil is added to the operating compressor, the replenishment will be either excessive or incomplete.

Air Discharge

This is performed if the pressure gauge needle on the charging line makes jerking oscillatory motions, and the charging pressure exceeds the optimum value by 0.2 MPa and more:

1. Set the compressor operating mode switch to “MANUAL” position.



2. Turn the compressor off.



3. Adjust the condensation pressure control to 100 % opening (see fig.).



4. After the water temperature drops at the condenser outlet (OUTLET temperature gauge) down to the sea water temperature (INLET temperature gauge), open the valve for the discharge of air from the system.



5. As the charging pressure drops to the value corresponding to the optimum condensation temperature, i.e. as the temperature readings in DISCHARGE pressure gauge and DISCHARGE temperature gauge are equalised, close the air discharge valve.
6. Monitor the level of liquid refrigerant by using the sight glass on the condenser (there should be no lowering of the level).
7. Adjust the condensation pressure control for the maintaining of the set pressure value (0.6-0.7 MPa).

8. Turn the compressor on.



9. Set the operating mode switch to “AUTO” position.



As this is done, the indicator colour will change from the yellow colour to green, i.e. there will be an imitation of the filter drain replacement:

1. Open the shut-off valves of the filter drain.
2. Close the bypass valves of the filter drain.

Compressor Breakdown

In case of failure of one of the compressors, the other compressor will maintain the required temperature in all the six provision storerooms:

1. Re-adjust the low pressure switch of the operating compressor (N2) as required (in case of breakdown of compressor N1).
2. Set the operating mode switch of the stopped (broken) compressor to "MANUAL" position.

Replacement of Filter Drain

This is done when the colour of the sight glass indicator changes. The indicator colour changes from green to yellow as the moisture penetrates in the liquid refrigerant system:

1. Close the shut-off valves of the filter drain.
2. Open the bypass valve of the filter drain.



As this is done, the indicator colour will change from the yellow colour to green, i.e. there will be an imitation of the filter drain replacement:

1. Open the shut-off valves of the filter drain.
2. Close the bypass valves of the filter drain.

Compressor Breakdown

In case of failure of one of the compressors, the other compressor will maintain the required temperature in all the six provision storerooms:

1. Re-adjust the low pressure switch of the operating compressor (N2) as required (in case of breakdown of compressor N1).
2. Set the operating mode switch of the stopped (broken) compressor to "MANUAL" position.



3. Close the master solenoid valve on the refrigerating plant which is not operating.
4. Open the shut-off valves on the steam and liquid connecting lines.



Air Conditioning System (AC Page)

Purpose of the System

The central straight flow twin-channel high-pressure conditioning system is designed for the year-round moisture and temperature treatment of the air in the accommodation spaces, mess room, and other rooms on the ship.

System Components

The system mnemonic diagram implemented in the simulator, is shown in Fig. 10:

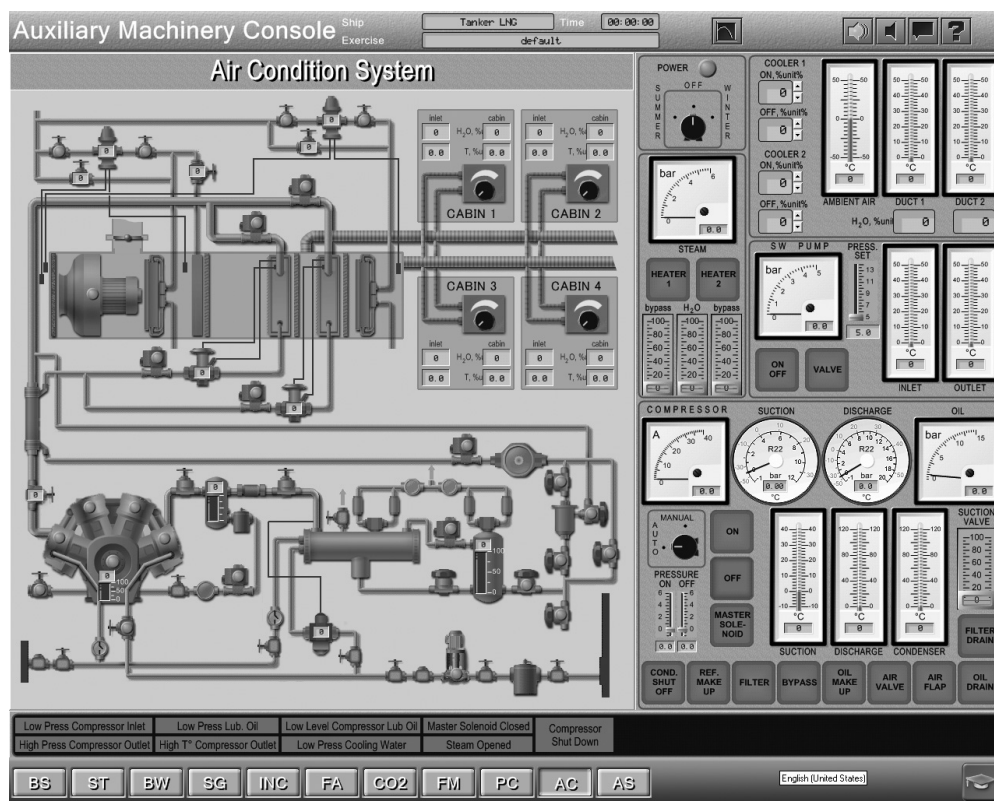


Fig. 10

The following components are included in the system and modelled in the simulator:

- system of pipelines as a hydro- and gas dynamic object;
- refrigeration plant;
- cooling seawater pump;
- steam air heaters;
- air coolers;
- centrifugal straight flow blower with an air filter;
- moisture control unit.

The modes of year-round operation are available for AC plant:

- summer, air temperature over +25 °C;
- transition, air temperature between +15 °C and +25 °C;
- winter, air temperature less than +15 °C.

The air is propelled through the conditioner by the centrifugal straight flow blower with an electric motor and air filter. When the blower is operating, its operation indicator lights up on the mnemonic diagram.



In case of the air blower breakdown, the air is supplied to the conditioning system from the air blower of the conditioner on the other side, through the shutter on the mnemonic diagram.

The plant has two steam air heaters of the first level BH₁ (after the air blower) and of the second level BH₂ (at the conditioner outlet), shown the top part of the mnemonic diagram.



The air temperature after the first and second levels of heaters is controlled automatically by varying the water steam feed with the use of steam control valves (direct acting temperature controls). In this case, the first stage control is adjusted for maintaining constant temperature in the first duct, whereas the setting of the second stage control varies automatically with the ambient temperature.



In case of automatic steam control valve failure, the steam supply is controlled by using manual control valves.

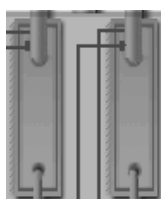


The current status of the steam control and manual control valves (degree openness) is shown on the valves' digital indicators on the mnemonic diagram.

At an ambient temperature of below 5°C, the treated air is saturated with water steam. The air saturator along with the demister are located after the first stage of the air heater on the mnemonic diagram.



The plant has two air coolers of the first (BO₁) and second (BO₂) stages of direct cooling. The air coolers are located in the top part of the mnemonic diagram. Installed after the air coolers are demisters.



The liquid refrigerant is supplied to the air coolers via the thermostatic expansions valves – TPB (below the air coolers on the mnemonic diagram). The current status (degree of openness) is shown on the TPB digital indicator.



As the solenoid valves are opened, their open status indicators light up on the mnemonic diagram (above and below air coolers).



The right hand part of the mnemonic diagram shows part of ship compartments serviced by the conditioner where it maintains desirable air temperature and humidity. The air parameters are controlled by using a cabin air distribution switch set in the room.

The sea water pump supplies water to the condenser and compressor cooling.



The sea water flow for the condenser cooling is controlled by using the condensing pressure control (water control valve) set on the water supply line to the condenser.

The current position (degree of openness) is shown on the digital condensing pressure indicator on the mnemonic diagram.

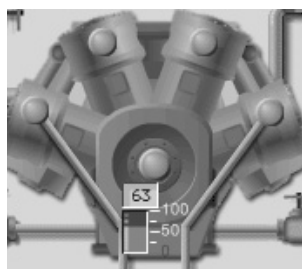


Flow indicators are set on the mnemonic diagram on the pipelines for the water discharge from the condenser and compressor.



At an ambient temperature of 25 and more degrees, the conditioning system switches to "SUMMER" operating mode. In this case, it is serviced by the refrigerating plant using Freon 22.

The piston eight-cylinder compressor is located in the left bottom part of the mnemonic diagram.



When the compressor motor is operating, an indicator in the centre lights up, as the cylinders are brought into operation, indicators light up showing the operation of corresponding cylinder pairs in the compressor. The bottom part of the compressor on the mnemonic diagram shows the oil level in the sump.

The compressor refrigeration performance is controlled by taking its cylinders out of operation, pair by pair, on the account of electromagnetic pushing of suction valve plates with the drop of the suction pressure which varies with the change of the air coolers' thermal load.

Electromagnetic pushing devices are controlled by the low pressure switch by means of a control system which includes a time switch.

On the charging side of the compressor, there is an oil separator with an automatic float valve for the return of oil to the compressor sump. The oil separator shows the oil level in the device.



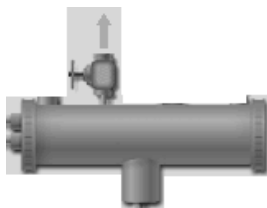
Installed on the oil line for the return of oil to the compressor sump, are a filter, oil flow indicator and a solenoid valve which opens up at a command from the thermal switch as the temperature in the oil separator grows to 60 °C.



As the solenoid valve opens up, its indicator on the mnemonic diagram lights up.



The condenser is situated in the central part of the mnemonic diagram. The device has an air release valve; the valve open status is shown by an indicator on the mnemonic diagram: a highlighted arrow.



The receiver is located on the mnemonic diagram next to the condenser. Here the level of the liquid refrigerant in the container is shown. Installed on the equalising steam pipeline between the condenser and receiver is a solenoid valve which is opened as the compressor is started and closed when the compressor is stopped.



When it is open, the solenoid valve open status indicator lights up on the mnemonic diagram.



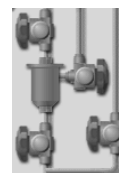
Safety release valves are installed on the receiver and condenser. As the pressure in the device (container) grows to above the maximum admissible value of 20 bars (excessive pressure), the safety valves are actuated and the device (container) is connected to the pipeline for the emergency discharge of refrigerating fuel overboard.



The actuation of the safety valve is shown on the indicator installed on the emergency pipeline, in addition an arrow lights up showing the discharge of liquid refrigerant overboard.



Moisture is removed from the liquid refrigerant system by using the moisture eliminator located in the left hand part of the mnemonic diagram. To control the moisture eliminator during its replacement procedure, use the buttons installed in the bottom part of the control group. The backlighted button indicator corresponds to the valve open status. As the valve is opened, the valve open status indicator lights up on the mnemonic diagram.



For the monitoring of moisture content in the liquid refrigerant and its condition, a sight glass is installed on the fluid line (moisture indicator).



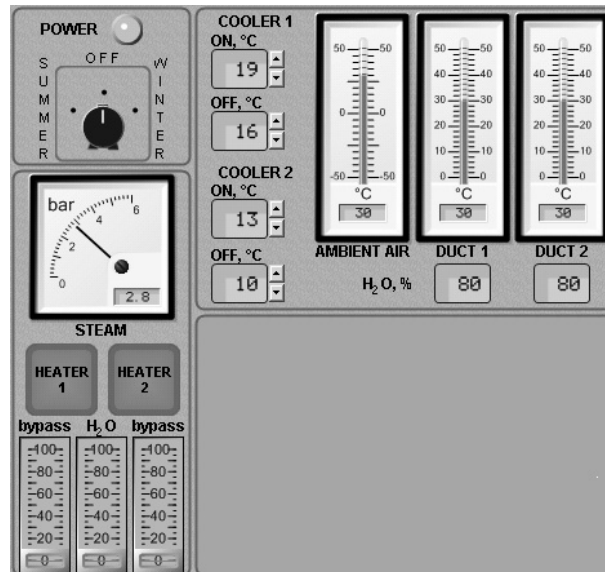
In the left hand part of the mnemonic diagram, above the compressor, a oil/heat exchanger is installed.



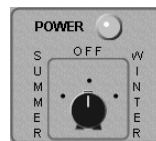
Control Panel

The control panel located in the right hand part of the screen page, contains the conditioning system monitoring and control units:

Monitoring and Control of Conditioner



In the top left part of the control unit there is “POWER” indicator lamp which shows that the system is powered.



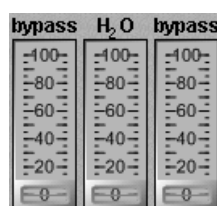
Below the indicator lamp, there is “SUMMER/OFF/WINTER” conditioner operating mode switch. If the switch is set to “SUMMER” position, the conditioner operates in the summer mode providing the cooling and drying of the air. With the switch set to “OFF”, the motors of the compressor, sea water pump and fan are disconnected from the power supply. When the switch is set to “WINTER” position, the conditioner operates either in the winter mode whereby the air is heated and saturated with moisture, or in the transient ventilation mode whereby there is no treatment of the air (air heaters and saturator are turned off).

The heaters are turned on by using “HEATER1”, “HEATER2” buttons, in this case the buttons are backlit. The buttons are installed in the left hand part of the control panel.



The air temperature after the first and second levels of heaters is controlled automatically by varying the water steam feed with the use of steam control valves (direct acting temperature controls). In case of automatic steam control valve failure, the steam supply is controlled by using manual control valves.

Controls of manual “bypass Y in the left bottom part. “bypass 2” valves are installed on the control panel.



The automatic humidity control is performed by the steam control valve of the first stage air heater. To attain this, during the switch to the winter operating mode, the system re-adjustment is performed, i.e. the setting of the necessary ratio of the air flow to the air heater BH₁ and saturator by using the manual control valve located above the air saturator on the mnemonic diagram. The air saturator control valve is adjusted by using “H₂O” setter located on the control panel next to “bypass 1” and “bypass 2”.

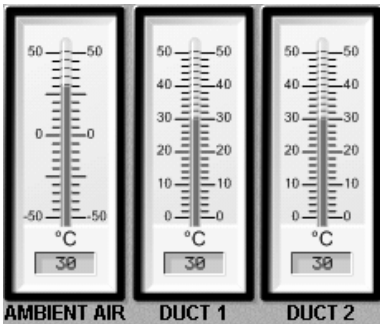
The current valve status is shown on the digital indicator on the mnemonic diagram.



Below the conditioner operating mode switch on the control panel, there is a digital pressure gauge which shows pressure of the water steam fed to the system.



In the right-hand part of the control panel, there are three temperature gauges for the display of ambient temperature – AMBIENT AIR, air temperature in the first duct – DUCT 1, and in the second duct – DUCT 2.



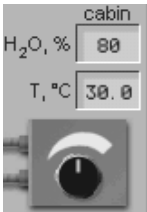
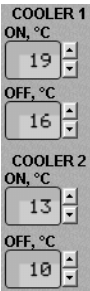
Located below the temperature gauges are devices for the display of the air relative humidity in the first and second ducts.



To the left of the thermostatic controls installed on the control panel, are digital setters of thermal switches monitoring the air temperature after the first and second air coolers and controlling the operation of solenoid valves at the supply and return of liquid refrigerant from the air coolers.

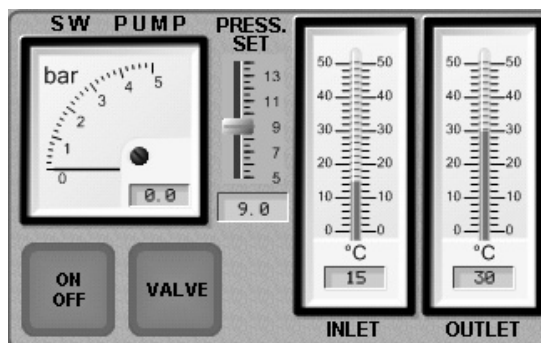
The air parameters are controlled by using a cabin air distribution switch set in the room.

The current air temperature and humidity in the room is shown on the indicator set above the switch on the mnemonic diagram.



Monitoring and Control of Sea Water Supply

The sea water pump supplies water to the condenser and compressor cooling.



To start the system operating it is first necessary to press “VALVE” button in the bottom part of the panel in order to open the valve for the supply of water to the compressor cooling.



As the valve is opened, the button indicator is backlighted and the valve open status indicator lights up on the mnemonic diagram (below the compressor).



Then turn on the sea water pump by using “ON/OFF” button on the control panel: the button indicator is backlighted. The pump “ON” indicator lights up on the mnemonic diagram.



Set above the buttons on the control panel is the digital pressure gauge which shows the pump's charging pressure.



With the pump's charging pressure low, an alarm is generated, and an appropriate lamp starts flickering in the bottom part of the screen.

To the right of the pressure gauge on the control panel, there are temperature gauges showing sea water temperature – INLET and temperature of the water removed from the condenser – OUTLET.

The sea water flow for the condenser cooling is controlled by using the condensing pressure control (water control valve) set on the water supply line to the condenser.

The PRESS. SET unit for the control of the water control valve for maintaining a certain condensing pressure (8-11 bars) is in the centre of the control panel.

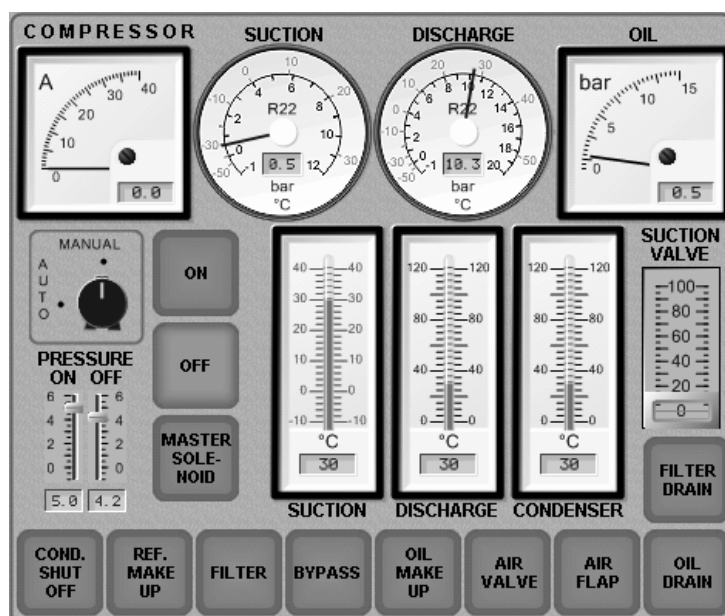


The current position (degree of openness) is shown on the digital condensing pressure indicator on the mnemonic diagram.



Monitoring and Control of Refrigeration Plant

At an ambient temperature of 25 and more degrees, the conditioning system switches to “SUMMER” operating mode. In this case, it is serviced by the refrigerating plant.



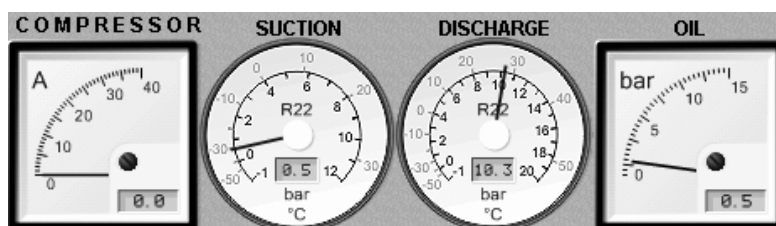
The compressor refrigeration performance is controlled by taking its cylinders out of operation, pair by pair, on the account of electromagnetic pushing of suction valve plates with the drop of the suction pressure which varies with the change of the air coolers' thermal load. Electromagnetic pushing devices are controlled by the low pressure switch by means of a control system which includes a time switch.

The pressure switch is adjusted by using PRESSURE analog setter.



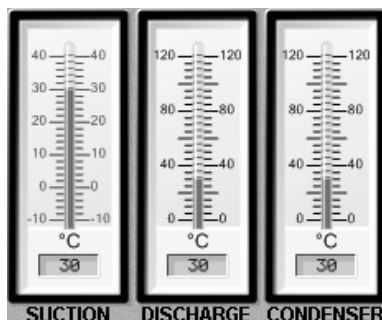
“OFF” scale is used for setting suction pressure; as this pressure is reached, the compressor cylinders start to turn off. “ON” scale is used for setting the pressure value; as this value is reached, the compressor cylinders will start to turn on.

The following gauges are installed in the top part of the control panel: amperemeter (shows electrical motor current), SUCTION pressure/vacuum gauge (shows suction pressure), DISCHARGE pressure gauge (shows charging pressure), OIL pressure gauge (shows pressure in the compressor lubricating system).



With a high charging pressure, low suctions pressure or low pressure in the compressor lubricating system, an alarm is generated: appropriate lamps start flickering in the bottom part of the screen, and the compressor is stopped (Shut Down).

In the centre of the control panel, there are three pressure gauges for determining the liquid refrigerant temperature on the suction line – SUCTION, on the charging line – “DISCHARGE”, and condensation pressure – CONDENSER.



With a high charging temperature of the compressor, an alarm is generated, and appropriate lamp starts flickering in the bottom part of the screen, the compressor stops (Shut Down).

In the left-hand part of the control panel, “AUTO/MANUAL” compressor operating mode switch is located.



As the switch is set to AUTO position, control of the compressor operation, master solenoid valve and solenoid valves of the evaporators is exercised automatically.



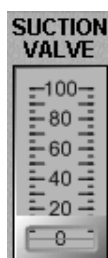
If the switch is set to MANUAL position, to turn the compressor on, it is first necessary to open the master solenoid by pressing “MASTER SOLENOID” button on the control panel. The button indicator is backlighted, and the valve open status indicator lights up on the mnemonic diagram.



In MANUAL mode, the compressor’s suction shut-off valve is closed, the charging valve is open, the electromagnetic pushing devices which raise the suction valve plates are on, taking the cylinders out of operation and thus creating the compressor’s idle running. Then use “ON” button on the control panel to turn the compressor on.



After the compressor has been started, the evaporator solenoid valves open up, in several seconds the pushing devices are activated, and its cylinders start operating. On the mnemonic diagram, cylinder operation indicators light up. The suction valve of the compressor is opened via “SUCTION VALVE” setter in the right-hand part of the control panel.



The current position (degree of openness) is shown on the digital indicator of the suction valve on the mnemonic diagram.



- “OFF” button on the control panel serves for turning the compressor off when the operating mode switch is set to MANUAL. As this is done, evaporator solenoid valves are closed;
- The air valve is controlled via “AIR VALVE” button. The backlighted button indicator corresponds to the valve’s open status;
- “FILTER DRAIN” button serves for the control of the valve on the liquid refrigerant exhaust line from the moisture eliminator;
- “FILTER” button serves for the control of the moisture eliminator shut-off valve;
- “BYPASS” button serves for the control of the moisture eliminator bypass valve.



For the monitoring of moisture content in the liquid refrigerant and its condition, a sight glass is installed on the fluid line (moisture indicator).



In the bottom part of the unit valve control buttons are located.

The backlighted button indicator corresponds to the valve’s open status. As the valve opens, the valve open status indicator lights up on the mnemonic diagram.

- Button for the control of the shut-off valves on the liquid refrigerant drain from the receiver;
- Button for the control of the valve for the system replenishment with liquid refrigerant;
- Button for the control of the valve for the supply of oil into the compressor;
- Button for the control of the air flap.



Alarm Signals

- LOW PRESS. COMPR. INLET – low compressor suction pressure;
- HIGH PRESS. COMPR. OUTLET – high compressor charging pressure;
- LOW PRESS. LUB. OIL – low pressure of compressor lubricating oil;
- HIGH T COMPR. OUTLET – high temperature on the compressor charging side;
- LOW LEVEL COMPR. OIL – low lubricating oil level in the compressor;
- LOW PRESS. COOL. WATER – low pressure of cooling (Sea) water;
- SOLENOID CLOSED – master solenoid is closed;
- STEAM OPENED – steam supply is open;
- COMPRESSOR SHUT DOWN.

Safety System

No available as an individual device (system). It is implemented owing to the system automatics: shutdown of the refrigerating plant compressor in case of e.g. high charging pressure and temperature, low suction pressure of lubricating oil pressure.

System Faults Introduced by the Instructor

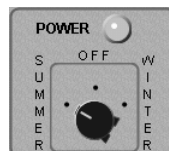
- Condenser Fouling;
- Term. Exp. Valve 1 Fouling;
- Term. Exp. Valve 2 Fouling;
- Excessive moisture Filter;
- Air in System;
- Ref. Power fault;
- Refrigerant leakage;
- Ventilation fault – air blower will not start;
- Air Filter fouling;
- Water Steam Reg.1 fault – faulty control 1, full opening of steam valve;
- Water Steam Reg.2 fault – faulty control 2, full opening of steam valve;
- Automatic Oil drain fault – faulty oil separator, air supply is reduced;
- High Pressure Pressostat fault – faulty pressostat, high pressure protection does not operate;
- Oil Leakage – oil leakage from the compressor;
- SW Reg. Valve Fault – faulty sea water valve, control for maintaining pressure in the condenser does not operate.

Directions on the Plant Operation and Maintenance

Procedure to Bring the Air Conditioning System into Operation in Summer Mode

The air conditioning system is switched to the summer more as the ambient temperature grows to +25 °C:

1. Set the conditioner operating mode switch to “SUMMER” position.



2. Open the valve for feeding water to the compressors cooling.



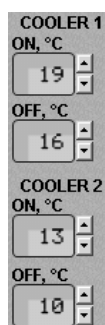
3. Turn on the sea water pump.



4. Open the shut-off valves on the liquid refrigerant circulation lines.



5. Adjust temperature switches.



6. Set the compressors operating mode switch to "MANUAL" position.



7. Adjust the low pressure switch.

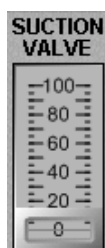


On "OFF" scale, set the suction pressure value whereupon, with some delay, the compressor cylinders will start to turn off. On "ON" scale, set the pressure value whereupon the compressor cylinders will start to turn on, by the timer, too.

8. Open the master solenoid valve.



9. Check if the compressor suction valve is closed.



10. Run the compressor.



As this is done, the electromagnetic actuators which raise the suction valve plates are ON, taking the cylinders out of operation and thus creating the compressor's idle running.

After the compressor has been run, the pushing devices are turned off in several seconds, and its cylinders start operating:

1. Partly open (to 5–10%) the compressor suction valve.



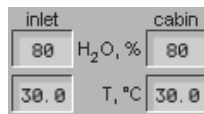
2. Check pressure in the compressor lubricating system.



3. With normal oil pressure value, continue opening the suction valve observing safety precautions.
4. Set the compressor operating mode switch to “AUTO” position.
5. Use manual switches to set the desired air temperature in the cabins.



Values of temperature and humidity in the cabin are shown on indicators.



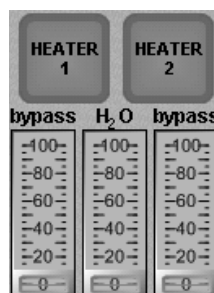
6. Monitor the plant operating parameters maintaining their values within a standard range. The alarm system will signal about all the possible faults.

As a monitored parameters reaches its limit value, and appropriate alarm lights up in the bottom part of the screen. Where no steps are made to normalise the compressor operation, SHUT DOWN protection is actuated, and the compressor is stopped, whereafter it can be brought back into operation in MANUAL mode only.

Procedure to Bring the Air Conditioning System into Operation in Transient Mode

The air conditioning system is switched to the transient mode at the ambient temperature of +15 °C to +25 °C.

Set the conditioner operating mode switch to “WINTER” position, turn off the heaters and humidifier: the fan only will remain operating.



Procedure to Bring the Air Conditioning System into Operation in Winter Mode

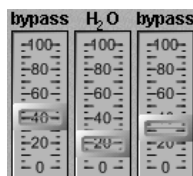
The air conditioning system is switched to the winter operating mode when the ambient temperature drops to +15 °C:

1. Set the conditioner operating mode switch to "WINTER" position.
2. Depending on the ambient temperature (t_{a}), tune on the first and second stage heaters.



Ambient temperature after the first and second stage heaters as well as relative humidity of the treated air is maintained automatically by using the direct-acting temperature controls (steam control valves). In this case, the first stage control maintains constant temperature at the first duct outlet, whereas the second stage control maintains temperature at the second duct outlet in accordance with its setting changed automatically with the ambient temperature.

3. To control the air humidity, it is first necessary to turn on "H₂O" valve manually monitoring the air humidity values in the first and second ducts. After it has been set, humidity is controlled automatically in accordance with the ambient temperature by the first duct temperature control.



4. Use manual switches in the cabin to set the desired temperature in the cabin.
5. Monitor the air conditioned operation parameters maintaining their values within the standard range.



Refrigerant Replenishment

The operation is performed if the refrigeration plant operating mode indicates insufficient refrigerant in the system (low refrigerant level in the receiver, gas bubbles in the sight glass, low suction pressure, excessive heating in the suction line, and high temperature on the charging line):

1. Set the compressor operating mode switch to "MANUAL" position.



2. Close the shut-off valve on the liquid line after the receiver.



3. Open the make-up valve.



4. Monitor the refrigerant level by the sight glass on the receiver.
5. After the end of the process, close the make-up valve (the refrigerant level on the receiver sight glass is 50 %).
6. Open the shut-off valve after the receiver.

7. Set the operating mode switch to “AUTO” position.



8. Monitor the refrigerating plant operation parameters.
9. In case of the system overfilling with liquid refrigerant, there may be “damp” compressor operation.

Compressor Replenishment with Oil

This is performed if the oil level in the sight glass on the compressor sump has dropped to below 1/2 height mark. The oil should best be added with the compressor not running (oil level is clearly visible in the sight glass):

1. Set the compressor operating mode switch to “MANUAL” position.



2. Close the compressor suction valve.
3. After the suction pressure (in the sump) has dropped to a value below the atmospheric pressure (≈ -0.5 bars), stop the compressor.



4. Open the oil make-up valve.



5. After the end of the process (oil level is not higher than 2/3 of the sight glass), close the valve.

6. Turn the compressor on.



7. Open the compressor suction valve.



8. Set the operating mode switch to AUTO position.



9. Monitor the refrigerating plant operating parameters.

Air Discharge from the Refrigerant System

This is performed if the pressure gauge needle on the charging line makes jerking oscillatory motions, and the charging pressure exceeds the optimum value by 2 bars or more:

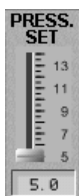
1. Set the compressor operating mode switch to "MANUAL" position.



2. Close the compressor suction valve.
3. Turn the compressor off.



4. Adjust the condensation pressure control to 100% opening (which corresponds to the setter's position "5").



5. After the water temperature drops at the condenser outlet (OUTLET temperature gauge) down to the seawater temperature (INLET temperature gauge), open the valve for the discharge of air from the system.



6. As the charging pressure drops to the value corresponding to the optimum condensation temperature, i.e. as the temperature readings in DISCHARGE pressure gauge and DISCHARGE temperature gauge are equalised, close the air discharge valve.
7. Monitor the level of refrigerant by using the sight glass on the condenser (there should be no lowering of the level).
8. Adjust the condensation pressure control for the maintaining of the set pressure value (9-10 bars).



9. Turn the compressor on.



10. Open the compressor suction valve.
11. Set the operating mode switch to AUTO position.



Replacement of Moisture Eliminator

This is done when the colour of the sight glass indicator changes. The indicator colour changes from green to yellow as the moisture penetrates in the refrigerant system:

1. Close the moisture eliminator shut-off valves.
2. Open the moisture eliminator bypass valve.
3. Open the valve for drawing off refrigerant from the moisture eliminator for several minutes (1-2 minutes).
4. Close the valve for drawing off refrigerant from the moisture eliminator.
5. Open the moisture eliminator shut-off valves.
6. Close the moisture eliminator bypass valve.

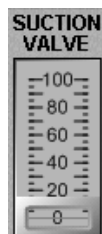


As this is done, the indicator colour will change from the yellow colour to green, i.e. there will be an indication of the moisture eliminator replacement.

Elimination of Compressor Damp Operation

This is performed if there is a sharp drop of temperature on the charging line (down to +10...0°C), overheating decreases, the compressor noise changes to dull the cylinder walls and sump are covered with ice (if there is considerable flooding with liquid refrigerant), rattling noise appears, and the amperemeter needle goes beyond the red line:

1. Close the compressor suction valve leaving it 5–10% open.



2. After the indications of damp operation disappear, open the compressor suction valve slowly.
3. Check oil level in the sump replenish the compressor with oil as required.

Breakage of Conditioner Fan

If a fan is broken, air is supplied to this conditioner by the fan of the conditioner on the other board through the air flap.

To do this, press the air flap control button.

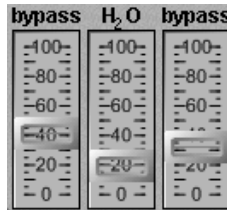


You can act in much the same way in case of the fan air filter fouling until it is "replaced" (the fault is eliminated from the instructor workplace).

Breakage of Automatic Steam Control Valve

If the automatic steam control valve is broken:

1. Close the shut-off valves “bypass 1” and “bypass 2” of the steam control (for the time of the repairs).



2. Open the manual control valve on the bypass line, adjusting its flow by the readings of temperature gauges at the outlets of the first and second ducts.

