



**IMAGE SOFT**

**IS – Research Vessel MERSol Online Engine  
Room Simulator**

**Technical Documents – Instructor Manual**

**Version 2023.0.5**

<b>VERSION HISTORY</b>			
<b><i>Version</i></b>	<b><i>Date</i></b>	<b><i>Author</i></b>	<b><i>Version description</i></b>
	29.11.2021	PSa	Screen caps added
0.1	17.06.2022	SKe	Preliminary version for testing
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0.3	12.01.2023	PAr	Updated the quick closing valve system description. Added a chapter on alarm log. Added a new image for student station list and student action log.
0.4	14.04.2023	PAr	Updated screen captures.
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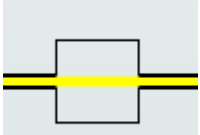

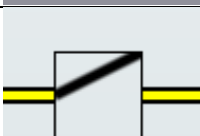


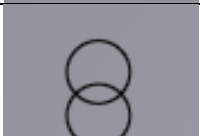
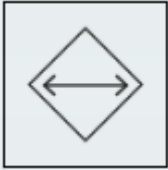
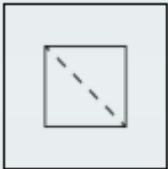
## Terms and Abbreviations

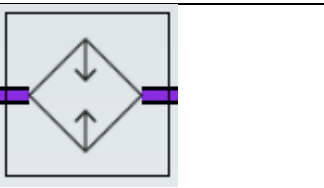
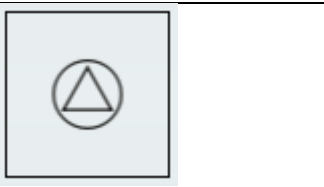
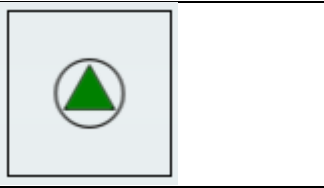

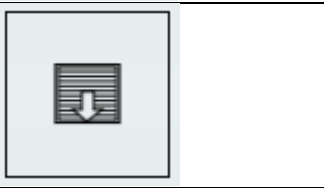
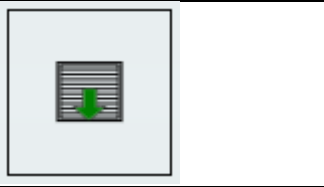
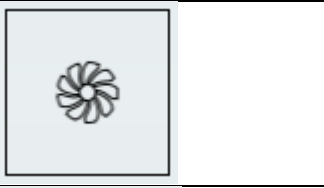
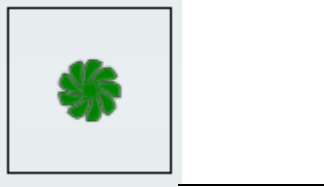
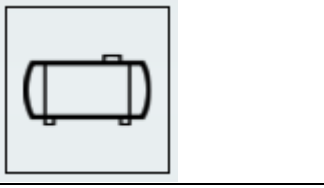
Table 1: Terms and abbreviations

<b>Term</b>	<b>Explanation</b>
CPP	Controllable Pitch Propeller
ERS	Engine Room Simulator
MS1P, MS1SB	Main Switchboard 1 Port, Main Switchboard 1 Starboard
ECR	Engine Control Room
CO2	Carbon Dioxide (fire extinguisher)
FO	Fuel Oil
MDO	Marine Diesel Oil
LO	Lubrication Oil
PB0211	Power board 0211
PB0212	Power board 0212
ME1, ME2	Main Engine 1, Main Engine 2
MCC0211, MCC0212	Motor Control Centre 0211, Motor Control Centre 0212
SW, FW	Sea Water, Fresh Water
HT, LT	High Temperature, Low Temperature
DG1, DG2	Diesel Generator
CL	Centre Line


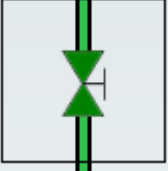

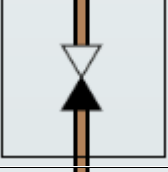
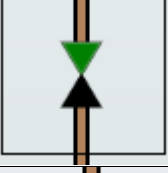
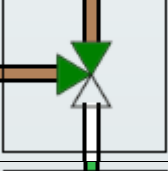
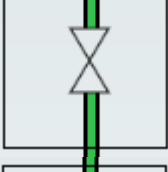
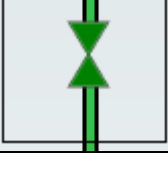
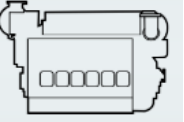
Table 1: Terms and abbreviations

Table 2: Icons and their descriptions

1. Electrical System Icons		
		<i>Closed breaker of type 1</i>
		<i>Closed breaker of type 2</i>
		<i>Open breaker of type 1</i>
		<i>Open breaker of type 2</i>
		<i>Inactive electrical source with label</i>
		<i>Active electrical source with label</i>
		<i>Transformer</i>
2. Hydraulic System Icons		
		<i>Cooler</i>
		<i>Filter</i>

		<p><i>Heater</i></p>
		<p><i>Inactive pump</i></p>
		<p><i>Active pump</i></p>
<p>3. Pneumatic System Icons</p>		
		<p><i>Air compressor</i></p>
		<p><i>Closed air vent</i></p>
		<p><i>Open air vent</i></p>
		<p><i>Inactive air fan</i></p>
		<p><i>Active air fan</i></p>
		<p><i>Pressure vessel</i></p>



4. Valve Icons		
		<i>Closed manual valve</i>
		<i>Opened manual valve</i>
		<i>Mixing valve</i>
		<i>Closed check valve</i>
		<i>Opened check valve</i>
		<i>Three-way valve</i>
		<i>Closed general valve</i>
		<i>Opened general valve</i>
5. Other Icons		
		<i>General icon indicating an engine</i>

	<p><i>Fuel oil tank with a venting pipe</i></p>
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## 1. Aims and Objectives

Research Vessel MERSol is a deep-sea fisheries research vessel.



*Illustration 1: Research Vessel Mersol at pier*

Aims and objectives of this document are to introduce the main operations of Research Vessel MERSol' engine room, familiarize the instructor with engine room functions and the simulator, which imitates the ship's engine room facilities, control panels, valves, and switches.

Research Vessel MERSol Engine Room Simulator (ERS) can be installed to a reasonably powerful Windows 10 computer. Windows 10 operating systems must be original and legal versions with the latest updates installed.

Research Vessel MERSol ERS can be interconnected with Image Soft Full Mission Bridge Simulator enabling comprehensive ship maneuvering exercises. A classroom version with e.g., six student workstations and one instructor workstation are also configurable.

Generally, in Engine Room simulator training the following universal objectives can be listed:

- Engine room equipment familiarization:
  - Familiarization with engine room systems, associated equipment and controls and simulation equipment.
  - Understanding the interdependency of the various machinery.
- System layout and flow diagrams:
  - Understanding the operations and intricacies of machineries.
  - Preliminary theoretical knowledge of day-to-day operations and piping systems.
- Monitoring and control systems:
  - Use of steering, controlling, and measuring systems in operation.
- Automation:
  - Introduction to remote control, alarm, and monitoring systems.
  - Practices for energy consumption and sustainable operations.
- Emergency operations:
  - Common safety practices and preparing for emergencies.
- Watchkeeping and troubleshooting:
  - Providing knowledge and skills to operate and monitor the safe operation and control of a ship's machinery installation.
- Vessel resource management:
  - Achieving safe engineering operations by managing personnel, equipment, and information by reviewing the team roles, human factors, and situational awareness.

## 2. Research Vessel MERSol specific ERS functions

### 2.1. Seawater Cooling System

The sea water is used as a cooling media in large seawater cooled heat exchangers to cool the fresh water of the closed circuit. Sea water is directly used in the machinery systems as a cooling media for heat exchangers.

Research Vessel MERSol is equipped with a seawater cooling system with three pumps for the two main engines' central coolers and two pumps for the two auxiliary engines' central coolers.

Training targets:

- Understanding the basics of cooling requirements of onboard machinery.
- Reducing and carrying away the heat energy to avoid malfunctioning or breakdown of machinery.

## 2.2. Freshwater Cooling System

Fresh water is used in a closed circuit to cool down the engine room machinery. The fresh water returning from the heat exchanger after cooling the machinery is further cooled by sea water in a sea water cooler.

Research Vessel MERSol is supplied with two combined LT/HT cooling systems. Both main engine cooling system consists of separate high temperature (HT) and low temperature (LT) circuits, which are cooled by sea water in the central coolers.

Training targets:

- Understanding the basics of cooling requirements for high efficiency run in long term.
- Reducing and carrying away the heat energy to avoid malfunctioning or breakdown of machinery.
- Research Vessel MERSol specific functions:
  - Main and auxiliary engines: Start-up procedure, normal running, and shut-down procedure of the cooling water systems.

## 2.3. Fuel System

Generally, fuel system comprises of MDO fuel tanks, fuel line pumps, gauges, pipes, and their pressure management.

Research Vessel MERSol is equipped with a fuel oil system with three feed pumps that feed marine diesel oil (MDO) to the main engines, and auxiliary diesel generators with built-in circulation pumps and filters. There are two MDO day tanks. Fuel oil transfer system is designed to pump MDO fuel onboard from storage tanks to day tanks and other storage tanks or ashore from storage and overflow tanks. One MDO separator is installed. Separation system is intended for constant flow, automated single stage purification of MDO.

Training targets:

- Start-up procedure, normal running and shut-down procedure of the separator and transfer pump.

## 2.4. Lubricating Oil Storage and Transfer

Lubricating oil (LO) storage and transfer system consists of bunkering, storage, transfer, and separation of LO.

Filling the LO of the main diesels is done by clean LO hand pump. Emptying of LO from main engines is provided by sludge oil pump. Both main engines have an independent LO separator that is automated, self-cleaning type.

Training targets:

- Monitoring of the lubrication oil level and pipeline valves.

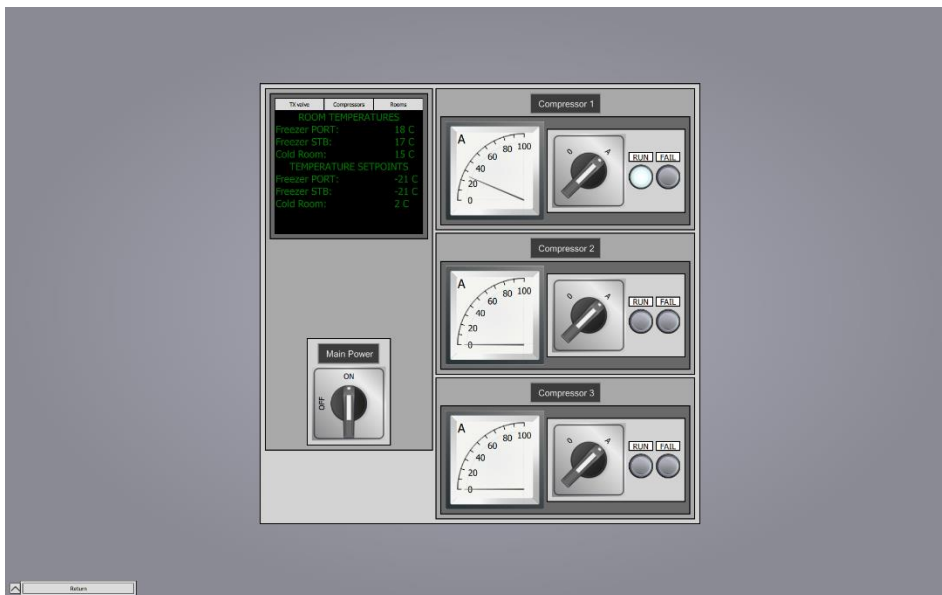
## 2.5. Air Conditioning System

The onboard air conditioning system is used to maintain the designed indoor temperature. The model ship has three separate air conditioning systems. One system controls the freezer and cold room cooling and the other two systems maintain the temperature at the technical spaces such as engine control room and wheelhouse.

The system is now simulated as heat producing load, which is connected to the seawater cooling system of the auxiliary equipment.

### 2.5.1. Refrigeration System

ERS simulates the freezer and cold room system by imitating the automated vapor-liquid compression cycle at the refrigeration plant's compressor, condenser, and evaporator. The refrigeration plant's compressor unit has a control panel that is located at engine room's second level at tween deck.



*Illustration 2: Refrigeration plant control panel*

The panel display lights up if the unit's main power switch is on and the unit receives power from the ship's electrical network. The compressor unit can be connected to the electrical network using the unit's breaker on MS1P.

The display shows data about the refrigerant compression cycle. Pressing the tabs at the top of the display inputs different measurement values on the screen. The unit has an inbuilt measurement device, that is, the expansion valve (TX Valve) which monitors refrigerant's saturated discharge temperature (SDT) and pressure at the plant's condenser. The expansion valve also measures the saturated suction temperature (SST) and pressure at the plant's evaporator.

The system consists of three compressors. Switching any of the three compressors to AUTO-mode (A) will initiate the automatic compression cycle at the full compression capacity and the refrigerant gas discharge temperature and pressure can be read from the unit's display. The air conditioning

system priorities the compressor with the lowest index that is on AUTO-mode and runs a single compressor at a time. If the running compressor fails or is shut down, the next compressor runs the compression cycle.

The compressor unit also displays the current cold and freezer room temperatures and setpoints. The setpoints can be modified using the thermostats in the cold and freezer rooms.

Training targets:

- Set the system on and monitor the output data on the control panel's display.

## 2.6. Ventilation, Operating Fans and Dampers

Ventilation of engine room: Two axial type supply fans are provided for ME-room, 11 m<sup>3</sup>/h each, 1500 RPM with frequency converters. Air dampers must be open in normal operation to avoid vacuum in ME room.

Ventilation of other machinery spaces are thermostat driven and adjustable as such. However, Research Vessel MERSol engine room simulator's focus on machinery ventilation is limited.

Training targets:

- Getting familiarized with the ventilation controls, such as the ventilation motor control centre and system diagram.

## 2.7. Start Air, Working Air, and Instrument Air Systems

Research Vessel MERSol is equipped with two fully automatic compressors that pressurize the two main starting air receivers (30 bar), which serve both the main engines and the auxiliary diesel generators. The compressors are equipped with built-in oil and water separators.

One working air compressor and one working air receiver (9 bar) are installed. Working air is led to e.g., ship maintenance purposes on engine compartments, workshops, to decks and vacuum ejectors of centrifugal pumps. Ballast/bilge pump ejectors and sea chests blowing are supplied from working air system.

One instrument air dryer and one emergency air vessel for remote controlled valves are installed in the engine room. Supply of instrument air to air dryer is provided from working air system. The air used must be cleaned, dry and oil-free to ensure that small lines, restrictions, and nozzles will not be plugged by dirt, oil, or water.

Training targets:

- Overview of the different compressed air systems on ship.
- Understanding the MANUAL and AUTO modes of start air, pressure indications and common alarms on display. Start-up procedures, normal and automated mode, and shut-down procedures.

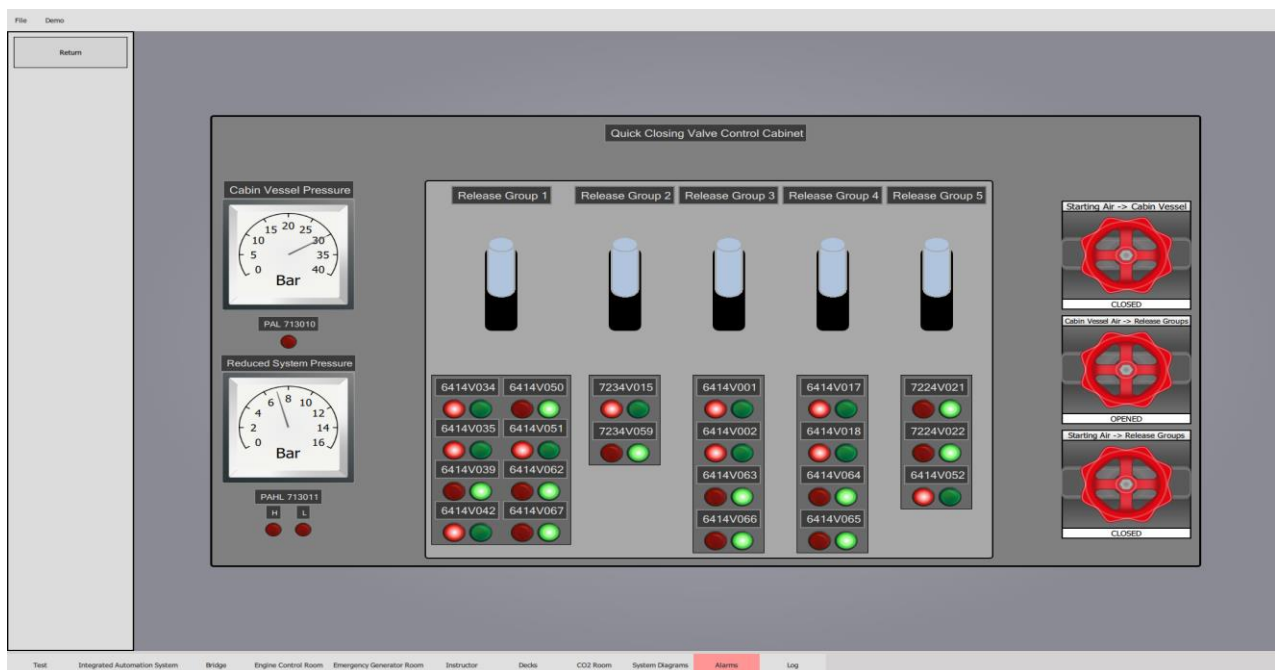
## 2.8. Quick Closing Valve System

The ship is equipped with a quick closing valve system. The purpose of the system is to quickly close critical valves on the ship's fuel and lubrication oil lines in case of an emergency. The quick closing valves are closed by releasing compressed air to the pipelines leading to quick closing valve pistons. The quick closing valves retain position after the actuation and must be opened manually.

The quick closing valves are grouped into separate release groups:

- The first control group consists of fuel oil inlet and outlet valves to and from the auxiliary engines.
- The second control group consists of valves on main engine, gear, and stern tube oil tanks.
- The third group consists of fuel oil inlet and outlet valves to and from the port main engine.
- The fourth group consists of fuel oil inlet and outlet valves to and from the starboard main engine.
- The fifth group consists of inlet and outlet valves to the fuel oil separator and the fuel oil inlet valve to the main engine blackout pump.

The emergency actuation of the release groups is controlled using the quick closing valve control cabinet on the ship's engine control room.



*Illustration 3: Quick closing valve cabinet*

The cabinet has an inbuilt emergency pressure vessel that is used as a reserve for compressed air used in the quick closing valve actuation. The pressure vessel is pressurized by allowing airflow to the cabinet from the ship's starting air system using the manual valves on the cabinet panel.

The pressure gauges on the cabinet panel indicate the vessel pressure and the reduced quick closing valve system pressure.

The activation handles control the inbuilt mechanical valves with integrated exhaust ports. When a handle is on downward position, the corresponding mechanical valve allows airflow from the cabinet to the quick closing valve pipelines. When a handle is on upward position, the valve directs airflow from the quick closing valve pipelines to the exhaust port and the pipeline pressure reduces to the surrounding room pressure.

The indication lights on the cabinet indicate whether the corresponding quick closing valve is open or closed. Green light indicates a closed quick closing valve, and red light indicates an opened quick closing valve.

Training targets:

- Learn the physical quick closing valve locations on the ship.
- Redirect compressed air from the starting air system to the quick closing valve cabinet and fill the emergency air vessel.
- Isolate the quick closing valve system from other air systems and keep the emergency vessel pressure high even if the other air systems lose air pressure.
- Redirect compressed air from the cabinet's vessel to the mechanical valves controlling the emergency actuation.
- Pull the mechanical valve handles and initiate the emergency actuation of the quick closing valve release groups. Observe how the cabinet's vessel pressure changes. Notice how the indication lights behave as the quick closing valves close.
- Observe how the emergency release group actuation of each release group affect the ship's overall state.
- Monitor and react to the quick closing valve system pressure alarms.

## **2.9. Reduction Gear and CPP**

Main engines are set to run in default RPM, and reduction gear acts as a switch to transmit the power to the shaft generator and the propeller at a desired rpm. CPP further enables the finetune of the propeller blade pitches to reach a desired speed. To keep the ship positioned in changing wind and current, the ship's dynamic positioning (DP) system takes over the control of reduction gear and CPP.

Training targets:

- Learn the control locations of reduction gear and CPP.

## **2.10. Preheating of Engines**

The starting procedure of marine engines requires several points related to electricity, air pressure and pumps that need to be taken into consideration in enabling a safe and sound start. One of them,



preheating of engines, relates to fuel oil, cooling water and lubricating oil cycles, which all must be set to required temperatures before start to avoid possible malfunctions and damages to engines.

Training targets:

- Understand start-up procedures and the purpose of pre-heating in the total concept.

## **2.11. Electricity**

Electricity is generated by generators at sea. On Research Vessel MERSol, diesel operated auxiliary engines and shaft generators produce the electricity onboard, both for technical and utility purposes.

Training targets:

- Adopting an overview of the IAS and electrical systems on the ship. Learn how to read and operate the control panels and generators.

## **2.12. Shore Power and Emergency Generator**

Shore power is the source for electricity when the ship is docked, reducing air emissions, and improving the local air quality, but also saving fuel costs.

Energy on the sea is generated by auxiliary engines and shaft generators. In case the main power generation system on the ship fails, an emergency power system or a standby system is also present. Research Vessel MERSol has a diesel operated emergency power generator.

Training targets:

- Learn and rehearse situations, at which emergency power is needed. Learn the emergency generator starting procedure and controls.

### **2.12.1. Main and Emergency Switchboards**

Main switchboard (MS) is an assembled unit of electrotechnical components. It is used for receiving, measuring and distribution of electrical energy, and protects the network from overload, short-circuit and current leak.

Emergency switchboard is a switchboard which, if the main system of electrical power supply fails, is directly supplied by the emergency source of electrical power to the emergency services. Emergency power supply should prioritize the essential systems of the ship such as

- Steering gear system
- Emergency bilge and fire p/p
- Watertight doors
- Firefighting system
- Ships navigation lights and emergency lights
- Communication and alarm system

Training targets:

- Learn and adopt the operations of the main and emergency switchboard controls.

### **2.12.2. Auxiliary Engines**

Auxiliary engines' function is to drive generators that generate electricity to the engine room and other electricity driven functions on the ship such as the deck machines, navigation equipment, and the daily life demands of the crew onboard.

Training targets:

- Auxiliary engines' controls, manual and automatic use, synchronization, and drive modes.

### **2.12.3. Shaft Generator**

Shaft generator is attached to the main engine shaft to generate electricity without a dedicated auxiliary diesel engine. As such, it is an environmentally friendly technique to produce electricity, provided that the main engine(s) is(are) running. In Research Vessel MERSol the two shaft generators supply power to the ship's network or bow thruster motor (driven by electricity only).

Training targets:

- Embracing the controls, operational principles and options of the shaft generator use at sea, and at harbour.

### **2.12.4. Earth Fault**

Earth fault is considered very critical on board a ship. Research Vessel MERSol features 24, 230 and 440V distribution circuits. At high 440 voltages earth faults are potentially highly dangerous to the crew, so they must be dealt with high priority. The source of the leakage must be identified, located, and isolated, to which the ship's IAS (Integrated Automation System) system offers tools. The ship's IAS also helps manage situations where critical maneuvering units must stay operational to avoid emergencies on the sea.

Training targets:

- Understand the phenomena of earth fault.

## **2.13. Bow Thruster**

Research Vessel MERSol is equipped with one 450kW bow thruster with controllable pitch propeller (CPP). This controllable pitch propeller installation consists of a hub, propeller blades hydraulics and a remote-control system. Electrically driven hydraulic pump adjusts the propeller blade pitches by oil pressure. Bow thruster must be started with pitches at zero position (lever is in neutral position) and shifting the pitch shall be done gradually avoiding sudden changes in BT movement.

Training targets:

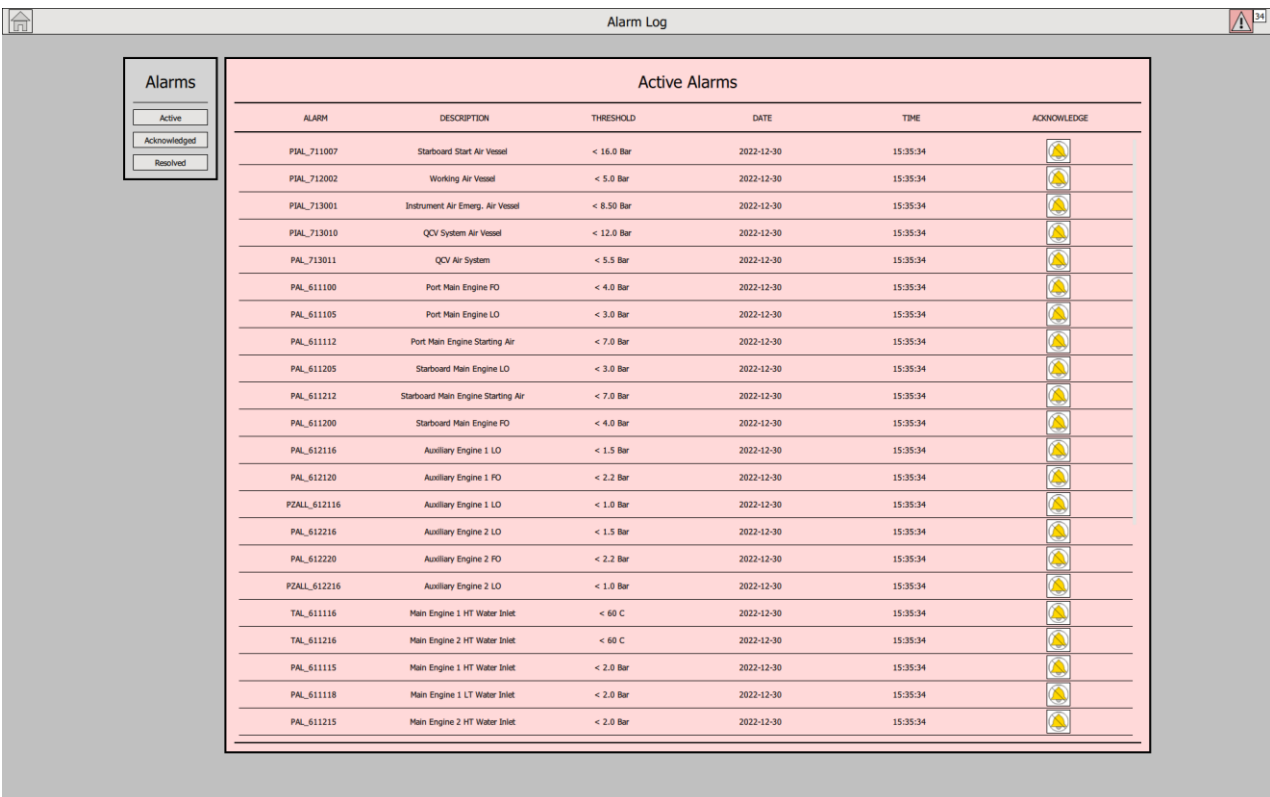
- Adopting bow thruster operations, electrical interconnections, controls, and use.

## 2.14. Alarm Log

Alarm log displays the alarm information emitted from the ship systems to the integrated automation system. Alarm log has layouts for active, acknowledged and resolved alarms.

### 2.14.1. Active Alarms

Alarms become active if the alarm's abnormal state is triggered. The number of active alarms is displayed in the simulator's header menu, and they are logged on the alarm menu. The alarm menu displays the alarm's name, description, threshold, date, and time.

























Active Alarms					
ALARM	DESCRIPTION	THRESHOLD	DATE	TIME	ACKNOWLEDGE
PIAL_711007	Starboard Start Air Vessel	< 16.0 Bar	2022-12-30	15:35:34	
PIAL_712002	Working Air Vessel	< 5.0 Bar	2022-12-30	15:35:34	
PIAL_713001	Instrument Air Emerg. Air Vessel	< 8.50 Bar	2022-12-30	15:35:34	
PIAL_713010	QCV System Air Vessel	< 12.0 Bar	2022-12-30	15:35:34	
PAL_713011	QCV Air System	< 5.5 Bar	2022-12-30	15:35:34	
PAL_611100	Port Main Engine FO	< 4.0 Bar	2022-12-30	15:35:34	
PAL_611105	Port Main Engine LO	< 3.0 Bar	2022-12-30	15:35:34	
PAL_611112	Port Main Engine Starting Air	< 7.0 Bar	2022-12-30	15:35:34	
PAL_611205	Starboard Main Engine LO	< 3.0 Bar	2022-12-30	15:35:34	
PAL_611212	Starboard Main Engine Starting Air	< 7.0 Bar	2022-12-30	15:35:34	
PAL_611200	Starboard Main Engine FO	< 4.0 Bar	2022-12-30	15:35:34	
PAL_612116	Auxiliary Engine 1 LO	< 1.5 Bar	2022-12-30	15:35:34	
PAL_612120	Auxiliary Engine 1 FO	< 2.2 Bar	2022-12-30	15:35:34	
PZAL_612116	Auxiliary Engine 1 LO	< 1.0 Bar	2022-12-30	15:35:34	
PAL_612216	Auxiliary Engine 2 LO	< 1.5 Bar	2022-12-30	15:35:34	
PAL_612220	Auxiliary Engine 2 FO	< 2.2 Bar	2022-12-30	15:35:34	
PZAL_612216	Auxiliary Engine 2 LO	< 1.0 Bar	2022-12-30	15:35:34	
TAL_611116	Main Engine 1 HT Water Inlet	< 60 C	2022-12-30	15:35:34	
PAL_611216	Main Engine 2 HT Water Inlet	< 60 C	2022-12-30	15:35:34	
PAL_611115	Main Engine 1 HT Water Inlet	< 2.0 Bar	2022-12-30	15:35:34	
PAL_611118	Main Engine 1 LT Water Inlet	< 2.0 Bar	2022-12-30	15:35:34	
PAL_611215	Main Engine 2 HT Water Inlet	< 2.0 Bar	2022-12-30	15:35:34	

Illustration 4: Active alarms








### 2.14.2. Acknowledged Alarms

Active alarms can be acknowledged using the icon on the active alarm layout. Acknowledged alarms are not treated as active alarms on the header menu or action log. The time of the alarm acknowledgement is logged in the alarm log. Acknowledged alarms can be reactivated using the icon on the acknowledged alarm view.

Alarm Log 22

**Alarms**

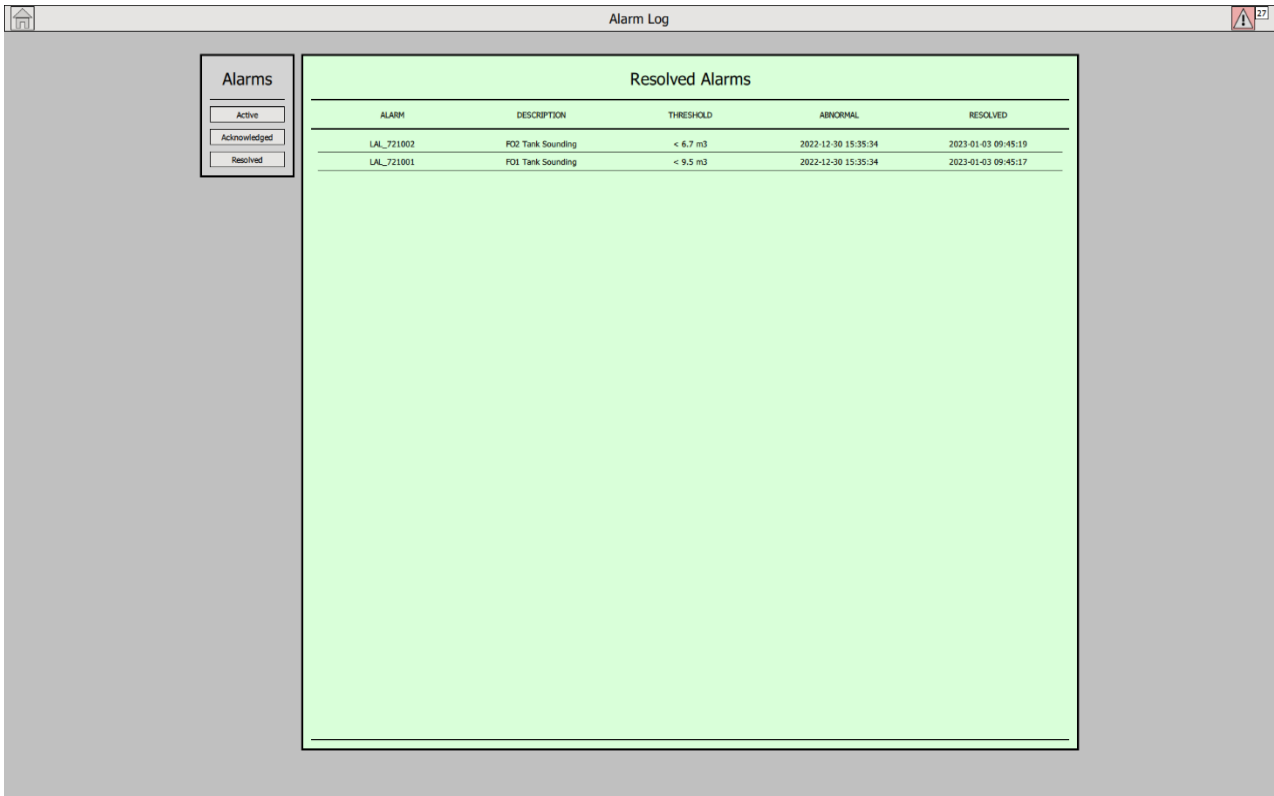
**Acknowledged Alarms**

ALARM	DESCRIPTION	THRESHOLD	ABNORMAL	ACKNOWLEDGED	ACTIVATE
PAL_61118	Main Engine 1 LT Water Inlet	< 2.0 Bar	2022-12-30 15:35:34	2023-01-03 09:44:47	
PAL_61115	Main Engine 1 HT Water Inlet	< 2.0 Bar	2022-12-30 15:35:34	2023-01-03 09:44:46	
TAL_61216	Main Engine 2 HT Water Inlet	< 60 C	2022-12-30 15:35:34	2023-01-03 09:44:45	
TAL_61116	Main Engine 1 HT Water Inlet	< 60 C	2022-12-30 15:35:34	2023-01-03 09:44:44	
PAL_61212	Starboard Main Engine Starting Air	< 7.0 Bar	2022-12-30 15:35:34	2023-01-03 09:44:21	
PAL_61112	Port Main Engine Starting Air	< 7.0 Bar	2022-12-30 15:35:34	2023-01-03 09:44:18	
PIAL_711007	Starboard Start Air Vessel	< 16.0 Bar	2022-12-30 15:35:34	2023-01-03 09:44:12	

*Illustration 5: Acknowledged alarms*

### 2.14.3. Resolved Alarms

Active and acknowledged alarms become resolved if the alarm's abnormal state returns to normal. The time when abnormality returns to normal is logged in the alarm log. Resolved alarms are removed from the log if they become active again.



*Illustration 6: Resolved alarms*

#### 2.14.4. Alarm Names

The alarm name is a combination of a code and an identifier number. The following codes are used in the simulator:

Code	Meaning
EA	Voltage Alarm
PIAL	Pressure Indicator Alarm Low
PIAH	Pressure Indicator Alarm High
PAL	Pressure Alarm Low
PAH	Pressure Alarm High
TAH	Temperature Alarm High
PZALL	Shut Down Alarm on Low Pressure
TZAHH	Shut Down Alarm on High Pressure
TAL	Temperature Alarm Low
LAL	Level Alarm Low

LAH	Level Alarm High
-----	------------------

Some alarm codes depend on context. The alarm description in alarm log will clarify the meaning in these cases.

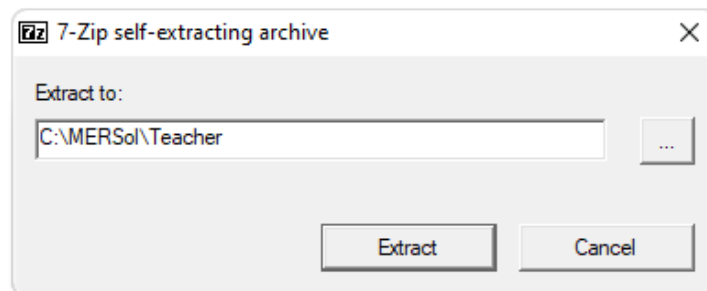
Code	Meaning
XAH	General High Threshold Alarm
XA	General Alarm
UA	Universal Alarm

## 3. Using the Online Engine Room Simulator

### 3.1. Installing the simulator

The installation package for this simulator is provided as a self-extracting installation package. The package can be installed by double clicking it on any modern Windows environment.

After clicking the installation package, the package needs to be extracted:



*Figure 1: Installation dialog*

Select a folder, for example `C:\MERSol\Teacher` as presented in the figure, and extract the package.

### 3.2. Running the Simulator

To start the simulator, open the folder where the simulator was extracted.

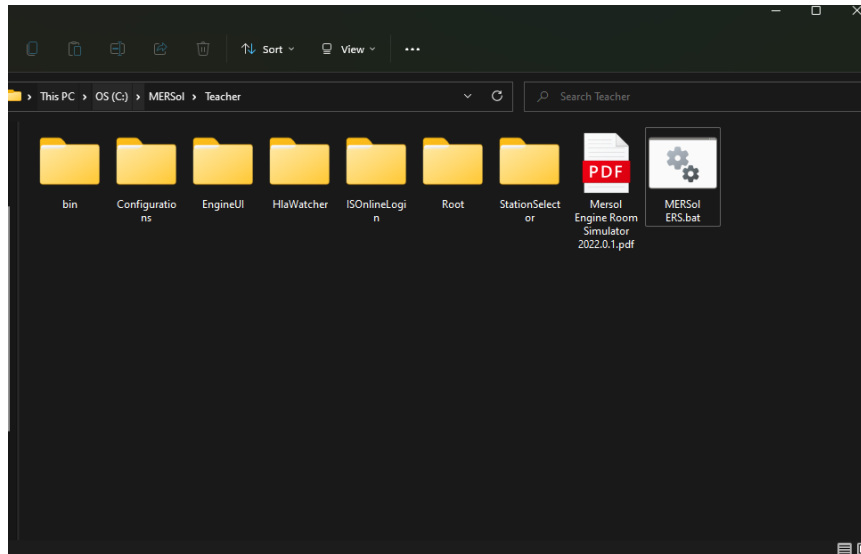


Figure 2: Contents of the MERSol installation folder

Start the simulator by double clicking the **MERSol ERS.bat** icon.

### 3.3. Activating the Simulator

The first time a new installation of ERS is opened, the program must be activated by the Image Soft Oy staff. Activation window is pictured below:

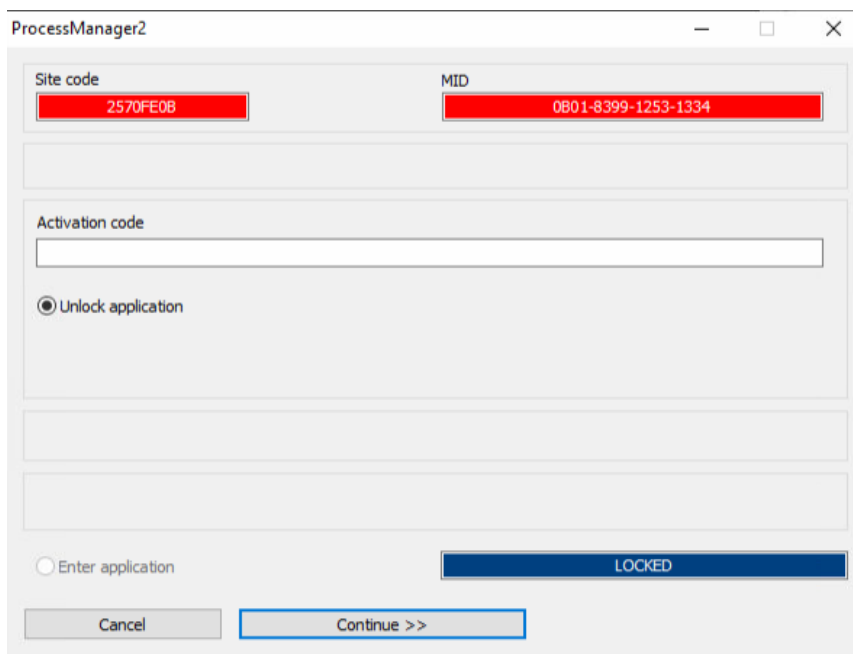
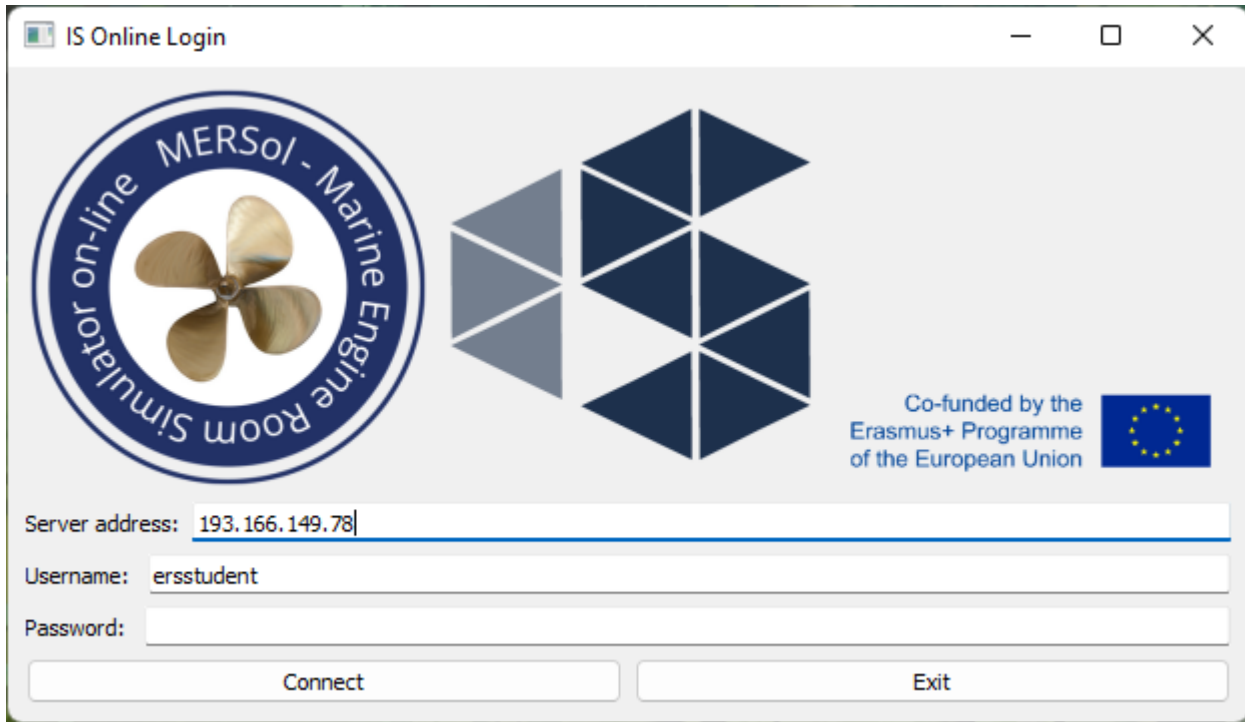


Figure 3: Activation dialog

To get the correct Activation Code for the installation, copy the Site code and MID into an email message and send it to [sami.ketola@imagesoft.fi](mailto:sami.ketola@imagesoft.fi) with the information that you have installed either instructor's or student's MERSol ERS client to your machine.

### 3.4. Logging In

After clicking the **MERSol ERS.bat** icon and successfully activating the product, you'll be presented with the following dialogue:



*Figure 4:IS Online Login dialogue for logging in to the simulator*

Here you need to input the Server address, username and password that have been given to you by the training organization. You may also use the default values if they are provided automatically by your custom installation package.

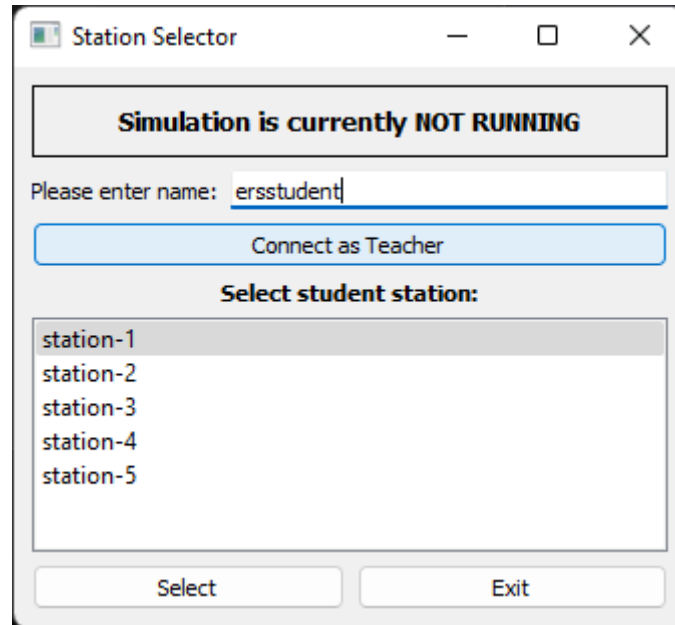
After inputting the correct information on the form, you should be able to access the simulator.

### 3.5. Selecting the User Station

After clicking “Connect” on the IS Online Login form, the simulator’s Station Selector is shown as pictured below.

Students must input their name on the station selector’s text field before selecting a station and joining the simulation. Instructors may choose the “Connect as Teacher”- option without entering a name. This option is not available for the students.





*Figure 5: Interface of the Station Selector application*

After using the “Connect as Teacher”- option as an instructor or selecting a station as a student, you’ll be presented with the main view of the Engine Room Simulator.

### 3.6. EngineUI Main View

When a user is logged in as an instructor, the main view looks like this:

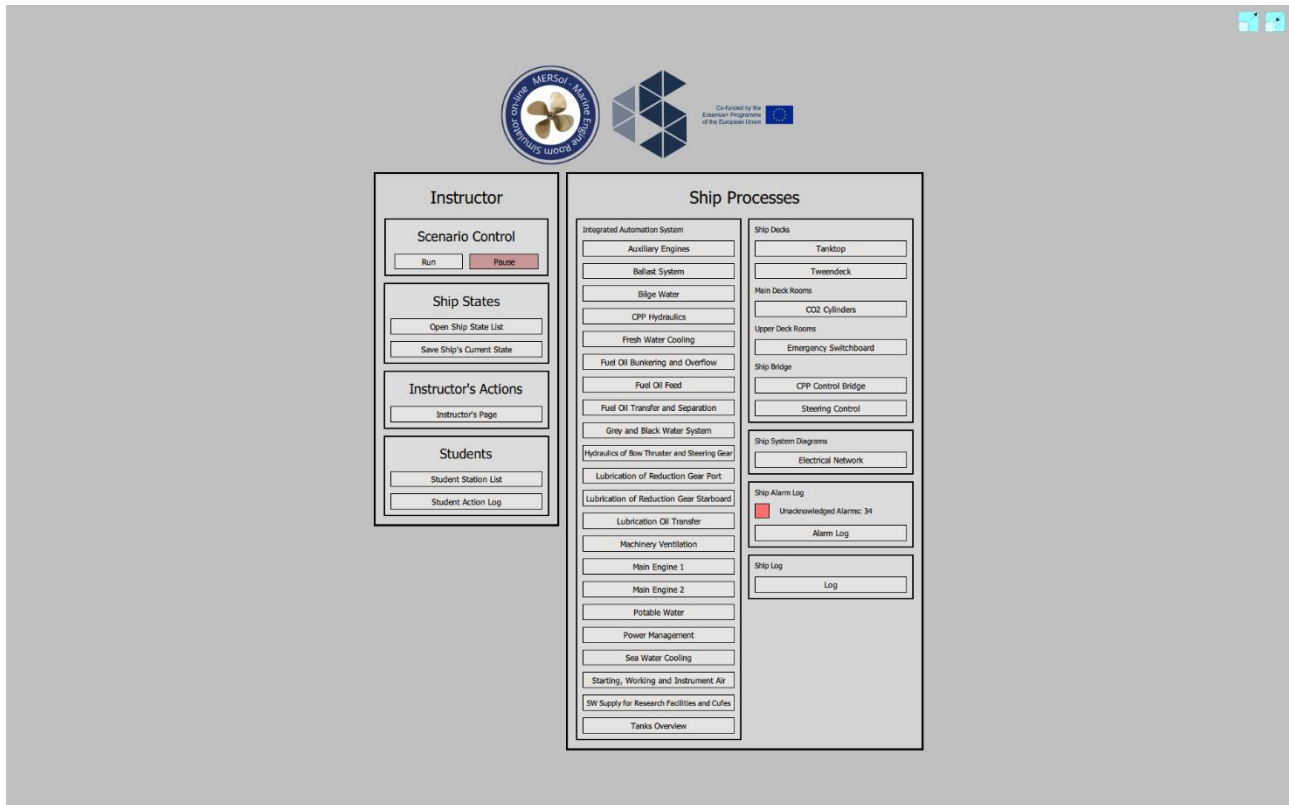


Figure 6: Main instructor view

On left, instructors have the **Scenario Controls** that allow the instructor to start or pause the scenario, **load new states**, go through **instructor actions**, and **manage student stations**.

On right, there are the ERS MERSol ship controls and menus, allowing the use of the ship's functions. Instructors may also override functions using the right click command menus on many occasions.

If a user has logged in as a student the view looks like this:

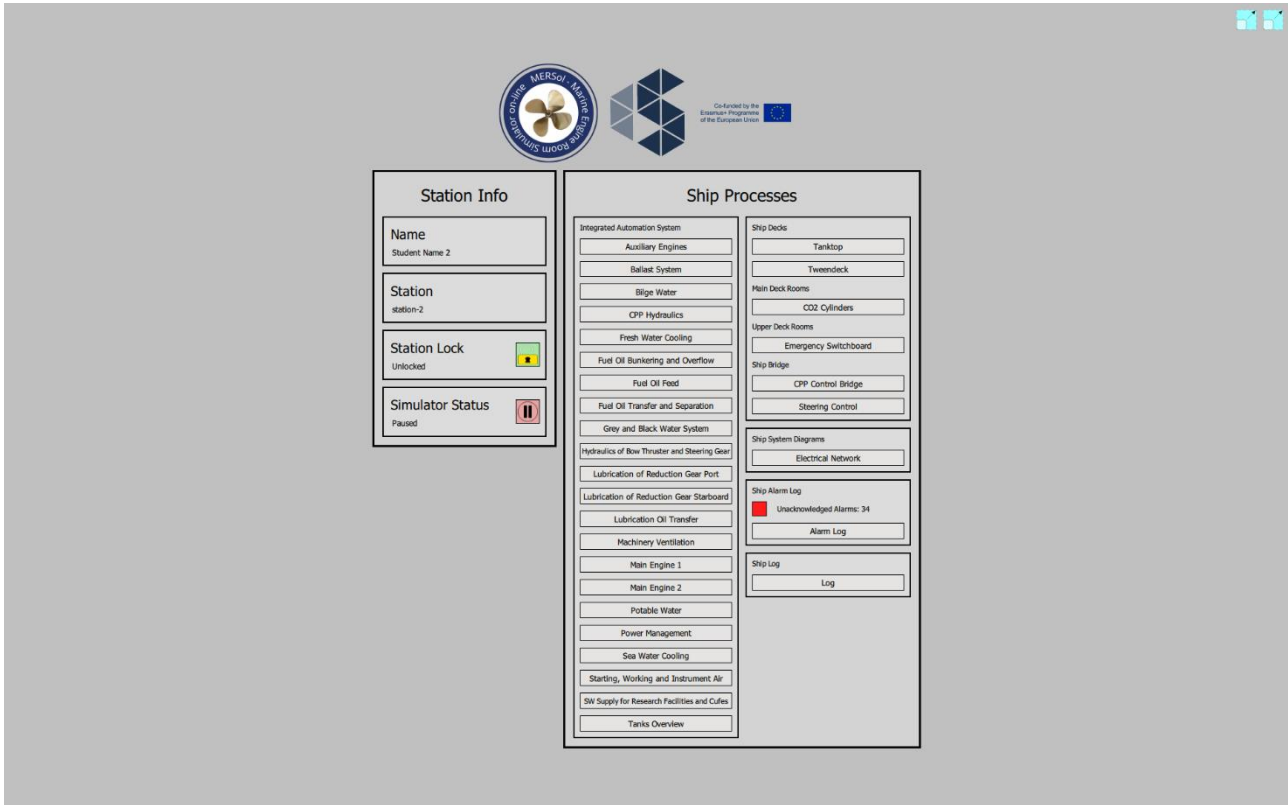
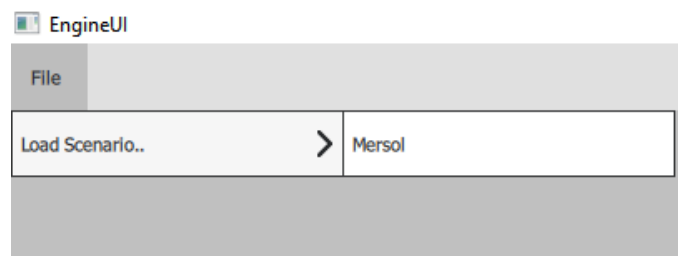


Figure 7: Main student view

Student has the **basic information** of the entered station on the left and on the right the same ERS MERSol controls the instructors have without the extra functions that allow the instructor to override the ship functions.

### 3.7. Instructor Specific Features

If the scenario is not running and student positions are not available, start the Research Vessel MERSol ERS scenario by pressing the Load Scenario button on the instructor's EngineUI program.



Simulator then loads the ship to an initial state. Pressing Run Simulation after the initial loading will start the simulation and all connected stations, that are not locked, will be able to manipulate the controls of the Research Vessel MERSol ERS.

Ship States can be saved and loaded using Save state and Load state buttons. Loading the default state defaults the ship to the initial state.

After the scenario has been loaded, teacher can open the **Instructor's page**, **Student Station List** and **Student Action Log** pages from the main page.

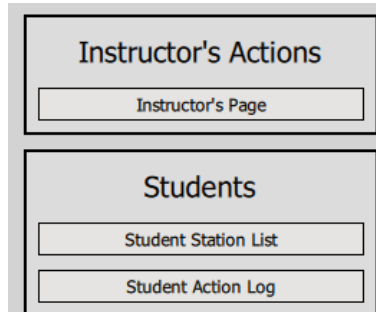


Figure 8: Instructor specific actions

### 3.7.1. Instructor's Page

Depending on the ship model, Instructor's page lists instructor specific special actions and events that can be triggered on the ship. In this current version of MERSol ERS the available actions are Engine Room Fire Alarm and switching on and off the shore power availability.



### 3.7.2. Student Station List

Student station list shows the students currently logged in the scenario. Instructor can edit, lock and empty student stations.



Figure 9: Student station list

### 3.7.3. Student Action Log

Student action log displays the actions the online students have made in the simulator session, allowing instructors to monitor the learning and state of the ship more easily.

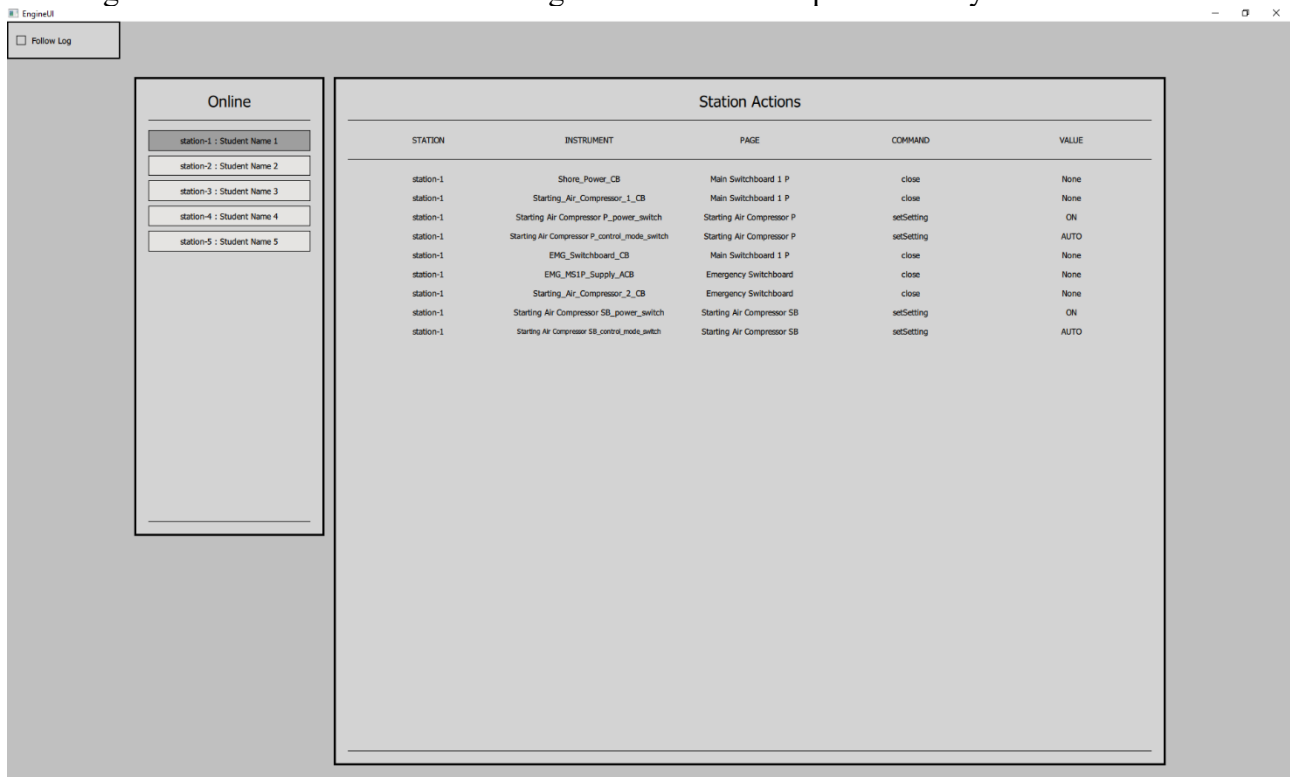


Figure 10: Student action log

## 4. Fishing Vessel MERSol ERS Training

This engine room simulator is designed to imitate Research Vessel MERSol engine room main functions and operations, and their corresponding control panels in the ship engine room and other premises within.

The current Research Vessel MERSol ERS (version 2023.0.5) is, as the name indicates, limited to RV Research Vessel MERSol's technical design. The future evolution of this Research Vessel MERSol specific ERS will aim at covering all main engine room functions of the ship, and eventually integrate ERS with the ship bridge simulator.

The first release of Research Vessel MERSol ERS will focus on the following limited engine room topics of the ship, familiarizing the students with the basic engine room operations.

### 4.1. Exercises

The following exercise set is designed for engine room simulator training using Research Vessel MERSol as a model ship. The exercise set assumes the Research Vessel MERSol has had a longer idle period at pier. The ship is now at harbour and shore connection is available. The ERS default state, which is loaded when the simulator is started, corresponds to this ship state. The goal of the exercise

set is to start the ship's auxiliary and main engines. The exercises progress gradually and should be completed in order. The exercise set is divided into seven categories:

- Air Systems
- Fuel Systems
- Cooling Systems
- Oil Systems
- Auxiliary Engines
- Electrical Network
- Main Engines

#### **4.1.1. Air Systems**

- **Exercise 1.1:** The ship's starting air vessels are pressurized using the starting air compressors.
- **Exercise 1.2:** After the starting air receivers are pressurized, compressed air is directed to the quick closing valve system. The emergency air vessel is pressurized.
- **Exercise 1.3:** The working air compressor is started, and the system's pressure vessel is pressurized.
- **Exercise 1.4:** Engine room ventilation is set into motion.
- **Exercise 1.5:** Refrigeration cycle for the ship's freezer and cold rooms is initiated.

##### **4.1.1.1. Exercise 1.1**

The port side main compressor unit is connected to the port side main busbar. The starboard main compressor is powered using the emergency switchboard. In the first exercise, the necessary breakers are closed to power the compressors. The compressors are then set to automated control mode.

**Step 1:** Go to the engine control room and open the port side main switchboard. Close the following breakers:

- SHORE CONNECTION
- STARTING AIR COMPRESSOR UNIT
- EMERGENCY SWITCHBOARD ES11 400V

**Step 2:** Open the emergency switchboard. Find the air circuit breaker that connects the emergency switchboards to the main switchboards and close the breaker by pressing "ON" on the control panel. Next, close the following circuit breaker:

- STARTING AIR COMPRESSOR UNIT 2

**Step 3:** Open the engine room layout and find the main compressor icons. Open the starter panels and switch the compressor power on. Set the control mode to automatic.

Compressors now fill the main air receivers, until the pressure setpoint (28 bars) is reached.

#### 4.1.1.2. Exercise 1.2

Quick closing valve system cabinet is connected to the starting air system. The emergency air vessel is pressurized by opening the relevant air inlet valves.

**Step 1:** Open the quick closing valve cabinet in the engine control room. Open the valve directing air flow from the starting air system to the cabinet.

**Step 2:** Open the starting air diagram. Open the main air receiver valves V01 and V02.

Compressed air now flows to the emergency vessel.

#### 4.1.1.3. Exercise 1.3

Working air compressor is connected to the starboard main busbar.

**Step 1:** Open the synchronization panel and close the bus-tie breaker connecting the two main switchboards.

**Step 2:** Open the starboard main switchboard and close the following breaker:

- WORKING AIR COMPRESSOR

**Step 3:** Find the working air compressor's control panel on the tween deck's engine room. Turn the power on and choose the automatic control mode.

Compressor now fills the working air receiver until the pressure setpoint (9 bar) is reached.

#### 4.1.1.4. Exercise 1.4

Engine room supply fans ES03 and ES04 are started using the ventilation motor control centre. The corresponding dampers should open automatically when the fans run. The damper icons can be located at the machinery ventilation mimic page.

**Step 1:** Close the following breaker on the starboard main switchboard:

- VMC-UNIT FOR VENT IN MACHINERY SPACES

**Step 2:** Open the ventilation motor control centre and start the supply fans.

The main supply fans now ventilate the engine room.

#### 4.1.1.5. Exercise 1.5

The refrigeration unit cools the ship's two freezer rooms and one cold storage. The thermostats are powered on the ship's starboard main switchboard MS 2 STBD.

**Step 1:** Open the port main switchboard and close the following breaker:

- FREEZER ROOMS COMPRESSOR UNIT

**Step 2:** Open the starboard main switchboard and close the following breaker:

- LIGHTING TRANSFORMER LTR2

**Step 3:** Open the starboard main switchboard MS 2 STBD and close the following breakers:

- TRANSFORMER SUPPLY LTR2
- THERMOSTAT PANEL 1

**Step 4:** Enter the freezer and cold rooms and use the thermostats to set the temperature setpoints. Use, for example, - 20 Celsius for freezer rooms and 4 Celsius for the cold room.

**Step 5:** Find the freezer room compressor unit on the tween deck's engine room. Turn the power on and set one of the compressors to automated mode.

Refrigeration plant now cools the storage rooms until the thermostat setpoints are reached.

#### 4.1.2. Fuel Systems

- **Exercise 2.1:** The ship's bunkering station is used to fill two of the ship's marine diesel oil (MDO) storage tanks.
- **Exercise 2.2:** Fuel oil separator is started, and fuel is transferred to the ship's day tanks.
- **Exercise 2.3:** Fuel oil transfer pump is started, and fuel oil is transferred to the ship's day tanks.
- **Exercise 2.4:** Fuel oil transfer from storage tanks to day tanks is stopped and separator separates the fuel oil in day tanks.

##### 4.1.2.1. Exercise 2.1

The bunkering pump is used to fill the ship's fuel oil storage tanks. It is assumed that the pump is ashore, and tank filling happens very quickly.

**Step 1:** Open the fuel oil bunkering mimic page. Open the following valves:

- V01, V02 and V08

**Step 2:** Start the bunker station pump by double clicking the pump icon. Wait until the storage tank levels are sufficiently high, stop the pump and close the bunkering valves.

##### 4.1.2.2. Exercise 2.2



The fuel oil separator and feed pump are started. Fuel oil is then transferred to the ship's day tanks.

**Step 1:** Open the fuel oil transfer and separation mimic page. Open the following valves:

- V01, V02, V09, V12 and V13

**Step 2:** Open the port main switchboard on the engine control room and close the following breaker:

- FO SEPARATOR MODULE

**Step 3:** Open the engine room layout and find the fuel oil separator module icon. Open the control panel and turn the separator module and the feed pump on.

Separated fuel oil now flows to the day tanks.

#### 4.1.2.3. Exercise 2.3

Fuel oil transfer pump can be started using the ship's starboard motor control centre.

**Step 1:** Open the starboard main switchboard and close the following breaker:

- MOTOR CONTROL CENTRE MCC0212

**Step 2:** Find the motor control centre 2 icon in the engine control room and open the control panel. Close the following breaker:

- FO TRANSFER PUMP

Once the breaker is closed, start the pump.

**Step 3:** Open the fuel oil transfer and separation page. Open the following valves:

- V10 and V11

Day tank levels raise.

#### 4.1.2.4. Exercise 2.4

Once the day tank levels are sufficiently high, the storage transfer valves are closed, and the quick closing valves allowing fuel flow from day tanks to the separator are opened:

**Step 1:** Open the fuel oil transfer and separation page and close the following valves:

- V10 and V11

**Step 2:** Power down the fuel oil transfer pump using the icon on the fuel oil transfer and separation mimic page.

**Step 3:** Open the ship's tween deck layout and find the day tank icons. Open the tank layouts and find the tab labelled "QCV Valves". On port tank layout, open the following quick closing valve:

- V021 MDO TO SEPARATOR

Similarly on starboard tank layout, open the following quick closing valve:

- V022 MDO TO SEPARATOR

**Step 4:** Return to the fuel oil transfer and separation mimic page and close the remaining transferring valves:

- V01, V02 and V13

The fuel oil now circulates between the fuel oil separator and the day tanks. The fuel oil no longer transfers from storage tanks to day tanks.

### 4.1.3. Cooling Systems

- **Exercise 3.1:** Sea water is run through the ship's central coolers.
- **Exercise 3.2:** Fresh water-cooling systems for auxiliary equipment is initialized.

#### 4.1.3.1. Exercise 3.1

Sea water cooling pumps for main engines and auxiliary equipment are powered using the ship's motor control centres. The pipeline valves to the central coolers are opened.

**Step 1:** Open the sea water cooling mimic page and open the following valves allowing flow from the sea chests to the ship's double bottom tank:

- V01, V02, V03, V04, V05, V06

**Step 2:** Open the auxiliary equipment cooling pump inlet and outlet valves:

- V07, V08, V09, V10

**Step 3:** Open the main engine cooling pump inlet and outlet valves:

- V14, V17, V16, V18

**Step 4:** Go to engine control room, open the port main switchboard, and close the port motor control centre breaker:

- MOTOR CONTROL CENTRE MCC0211

**Step 5:** Using motor control centre 1 in engine control room, close the necessary breakers and start the following pumps:

- SW COOLING PUMP FOR ME PUMP 1
- SW COOLING PUMP FOR ME PUMP 3
- SW COOLING PUMP FOR AUXILIARIES 1

**Step 6:** Similarly, go to motor control centre 2 and start the following pump:

- SW COOLING PUMP FOR AUXILIARIES 2

Cooling pumps are now operating.

#### 4.1.3.2. Exercise 3.2

The auxiliary equipment freshwater cooling is supported by two low temperature cooling pumps and one freshwater transfer pump.

**Step 1:** Open the freshwater cooling mimic page. Make sure the cooling water tank is not empty.

**Step 2:** Open the motor control centre 1 and start the following pumps:

- COOLING WATER TRANSFER PUMP
- LT COOLING WATER PUMP FOR AUX PUMP 1

**Step 3:** Open the motor control centre 2 and start the following pump:

- LT COOLING WATER PUMP FOR AUX PUMP 2

Fresh cooling water is now available for the auxiliary equipment.

#### 4.1.4. Oil Systems

- **Exercise 4.1:** Check the lubrication oil tank levels and valves.
- **Exercise 4.2:** Start the lubrication oil separator.

##### 4.1.4.1. Exercise 4.1

The ship has lubrication oil tanks for engines, CPP, and reduction gear. The tank levels can be inspected using the lubrication oil transfer mimic page and the valves can be examined at the respective tank locations.

**Step 1:** Open the lubrication oil transfer mimic page and check the lubrication oil tanks are full.

**Step 2:** Open the engine room layout and find the main engine and stern tube lubrication oil tank. Open the tank layout and check that the outlet quick closing valve is open.

**Step 3:** Open the tween deck's engine room layout and find the CPP and gear lubrication oil tank. Open the tank layout and check that the outlet quick closing valve is open.

##### 4.1.4.2. Exercise 4.2

The main engine lubrication oil separator has two modules, which are connected to the ship's power boards.

**Step 1:** Open the port main switchboard in the engine control room and close the following breakers:

- LO SEPARATOR 1 HEATING

- POWER BOARD PB0211 400V

**Step 2:** Open the starboard main switchboard in the engine control room and close the following breakers:

- LO SEPARATOR 2 HEATING
- POWER BOARD PB0212 400V

**Step 3:** Find the lubrication oil separator icon on engine room layout and switch the separator modules and feed pumps on.

The main engine lubrication oil is now being separated.

#### 4.1.5. Auxiliary Engines

The ship has two auxiliary engines. They are the prime movers for the ship's diesel generators.

- **Exercise 5.1:** The ship's auxiliary engines are started.

##### 4.1.5.1. Exercise 5.1

The fuel oil circulation valves and the auxiliary engine sea water cooling water valves are opened.

**Step 1:** Go to the tween deck and open the day tank layouts. First, the following valves on port side tank need to be opened:

- V034 MDO TO AEs
- V067 MDO FROM AES

Similarly, on starboard side, open the following quick closing valves:

- V035 MDO TO AEs
- V062 MDO FROM AEs

**Step 2:** Go to the tween deck's engine room and find the auxiliary engine icons. First, open the port engine layout and open the fuel circulation quick closing valves:

- V042 MDO OUT
- V051 MDO IN

Second, open the starboard auxiliary port engine layout and open the fuel circulation quick closing valves:

- V039 MDO OUT
- V050 MDO IN

**Step 3:** Open the sea water cooling mimic page and open the valves allowing inflow to auxiliary engine coolers. These valves are:

- V12 and V13

The auxiliary engine sea water cooling pumps operate automatically when the engines run. They cannot be started using the mimic page icons.

**Step 4:** Return to tween deck's engine room and open the auxiliary engine starter layouts. Use the engine starter panels to start the engines.

Auxiliary engines are now running.

#### 4.1.6. Electrical Network

The ship's electrical network consists of port and starboard subnetworks, that can be divided into separate networks using the ships main bus-tie breaker, thus allowing a degree of redundancy. The network can be supported by shore connection, diesel generators and shaft generators. The ship's two diesel generators can run in parallel and share the electrical load if the main bus-tie is closed.

- **Exercise 6.1:** Diesel generator 1 is synchronized with the shore power, and after synchronization, the shore connection is disconnected. The diesel generator then supports the ship's electrical load alone.
- **Exercise 6.2:** Diesel generator 2 is synchronized with the first generator and connected to the network. Generators run in parallel.
- **Exercise 6.3:** The ship's electrical network is split into port and starboard subnetworks by opening the main bus-tie breaker. Generators then support the subnetworks individually.

##### 4.1.6.1. Exercise 6.1

The ship's diesel generator 1 is synchronized with shore power using the synchronization panel in engine control room.

**Step 1:** Find the diesel generator 1 control panel in the engine control room. The panel can be found using the main switchboard 1 icon and choosing the tab labelled "DG1". Make sure the control location switch is set to manual and the air circuit breaker spring is charged. If the spring is charged, there is a yellow indicator on the air circuit breaker reading "CHARGED SPRING".

**Step 2:** Find the synchronization panel in engine control room. The panel can be found using the main switchboard 1 icon and choosing the tab labelled "Synchronization".

**Step 3:** Use the source selector switch and select "DG1". Match the generator frequency with the network using the diesel generator 1 speed controller. The speed controller is labelled "DG1 SPEED CONTROL".

**Step 4:** When the phase angles are equal, synchroscope flashes green at the pointer's top position. At this moment, close the generator breaker using the button labelled "DG1 BREAKER CLOSE" on the synchronization panel.

**Step 5:** Disconnect the shore connection by pressing the button labelled “SC BREAKER CLOSE” button on the synchronization panel.

Diesel generator 1 now supports the ship’s electrical load.

#### 4.1.6.2. Exercise 6.2

The ship’s diesel generators are synchronized and set to run in parallel.

**Step 1:** Find the diesel generator 2 control panel in the engine control room. Check the control mode is set to manual and the air circuit breaker spring is charged.

**Step 2:** Open the synchronization panel and set the source selector to “DG 2”. Match the generator frequency with the network. Use the “DG2 SPEED CONTROL” switch to adjust the generator frequency.

**Step 3:** Once the generator and network frequencies are the same and synchroscope indicates the phase match, press the synchronization panel button labelled “DG2 BREAKER CLOSE” to connect the generator to the network.

Both generators now support the ship’s electrical load. Load is shared between the generators.

#### 4.1.6.3. Exercise 6.3

The main bus-tie breaker is opened, and the ship’s electrical network is divided into two subnetworks.

**Step 1:** Open the synchronization panel and find the main bus-tie breaker. Press the button labelled “Push OFF” to open the breaker.

Both generators now support individual subnetworks.

### 4.1.7. Main Engines

The ship has two main propulsion engines. The main engines are also prime movers for the ship’s shaft generators.

- **Exercise 7.1:** Start the main engine preheating units and pre-lubrication pumps.
- **Exercise 7.2:** Open the main engine fuel circulation valves and start the fuel circulation pumps.
- **Exercise 7.3:** Power on the CO2 exhaust fan and open the starting air inlet valves.
- **Exercise 7.4:** Check the starting air, lubrication oil, and fuel oil pressures. Start the engines.

#### 4.1.7.1. Exercise 7.1

**Step 1:** Go to engine control room and open the port side main switchboard. Close the following breakers:

- PREHEATING UNIT ME1
- PRELUB PUMP FOR ME1
- LO STBY PUMP FOR ME 1

Similarly, open the starboard main switchboard and close the following breakers:

- PREHEATING UNIT ME2
- PRELUB PUMP FOR ME2
- LO STBY PUMP FOR ME 2

**Step 2:** Go to engine room and find the engine preheating unit icon. First, open the preheating unit control panel and set both units to automated mode. Second, find the port and starboard pre-lubrication pump starter icons and start the pumps. Set both pumps to automated control mode. Finally, find the port and starboard lubrication oil stand-by pump icons. Set the stand-by pumps to automated control mode.

#### 4.1.7.2. Exercise 7.2

**Step 1:** Return to tween deck and open the day tank fuel circulation valves. On port side day tank, these quick closing valves are:

- V001 MDO TO ME P
- V017 MDO TO ME STBD
- V063 MDO FROM ME P
- V064 MDO FROM ME STBD

On starboard tank, open the following valves:

- V002 MDO TO ME P
- V018 MDO TO ME STBD
- V066 MDO FROM ME P
- V065 MDO FROM ME STBD

**Step 2:** Return to engine control room and start the fuel oil circulation pumps. Open motor control centre 1 and start the pump labelled “FO CIRCULATION PUMP FOR ME1”. Next, open motor control centre 2 and start the pump labelled “FO CIRCULATION PUMP FOR ME2”.

#### 4.1.7.3. Exercise 7.3

**Step 5:** Open the ventilation motor control centre. Start the following exhaust fan:

- EE05 MAIN ENGINE ROOM CO2 EXHAUST FAN

**Step 6:** Open the starting air diagram. Open the following valves:

- V06 and V07

#### **4.1.7.4. Exercise 7.4**

**Step 1:** Open the main engine mimic pages. Make sure there are no pressure alarms on starting air and fuel oil pressure indicators. Also, make sure the lubrication oil pressure is sufficient for the engine start. The pressure should be above two bars.

**Step 2:** Go to engine room. Open the main engine starters. Start the engines.

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