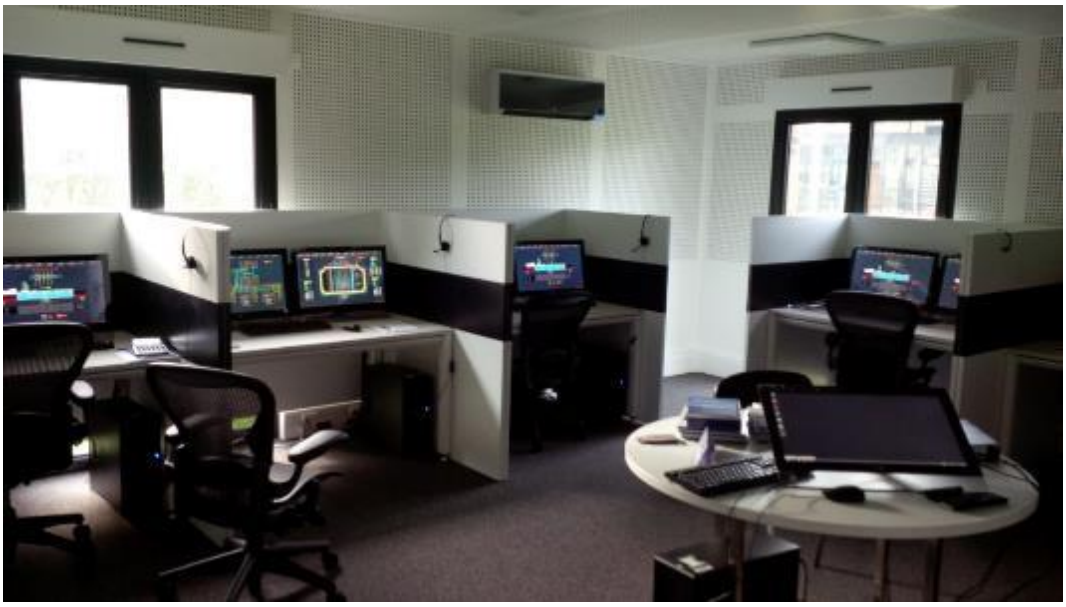
LNG Carrier Model - Operations Manual

# G-Sim
# Liquid Gas Handling Simulator (LGHS)



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# Contents

# Introduction

G-Sim provides the capability for training to be conducted using various system or ship models. This operations manual describes the details and capabilities of the LNG Carrier ship model along with how the various aspects of the specific model should be operated and controlled.
For details regarding the operation of the main G-Sim platform and the user interface reference should be made to the **'G-Sim Operations Manual'.**

# Model Description

The purpose of the LNG Carrier model is to provide the training provider or instructor with the capability to configure the ship to be the most suitable for use in the training session to be undertaken. The LNG Carrier model comprises all the systems that are installed on board the real vessel(s) associated with the cargo, and ballast, enabling the simulation of any operation related to the management of the cargo and stability that may be conducted on this type of vessel. The controls for the equipment and systems are designed to be as close to the controls that will be found on board the actual vessels as possible taking into account the different user interface.
The model is displayed to the operator via a set of graphical displays, each depicting a particular system or item of equipment, together with all the information and control mechanisms that are required o conduct the necessary operations. In addition to the graphical displays, the instructor may also be provided with a set of supporting instructor displays to he/she to interact with specific aspects of the model both during exercises and for scenario development purposes.
For the general operation of the graphical displays and user interface reference should be made to the relevant section in the G-Sim Operations Manual.
The following describes the specific features and their operating requirements for the LNG Carrier model and the various configurations.

## Model configuration

Although there are many LNG Carriers, with different types of tank and various sizes, many of the design features are common including:

- Tank arrangement
- Pipeline arrangements
- Equipment
- Operations that are conducted

The main change that has taken place on LNG Carriers since 2001 has been in the propulsion systems used on the vessels and the consequent changes in the way the boil off gas is handled. This has resulted in changes primarily to the equipment and arrangements within the machinery rooms, whilst most of the other arrangements are the same. Therefore, whilst the main training content will be similar, it may be necessary to use a different configuration of vessel to suit those being operated by a particular client, or to replicate a particular type of vessel to ensure the training delivered will be at its most effective.
The G-Sim LNG model has been designed to provide the operator with the flexibility to be able to select the configuration of the simulated 'vessel' that is to be used for the subsequent training session based on the following criteria:

- Vessel size
- Tank containment system
- Propulsion system
- Additional features

When installed, the software will be delivered with at least two configurations for the LNG Carrier model pre-defined. However, the operator may select other configurations as required using the Model Configuration utility as follows (a description is also available in the G-Sim Operations Manual).

Prior to starting the simulator, the model configurations that are to be available for selection by the instructor during the start process have to be defined. This may be done by using the 'Select Models' configuration tool which is accessed via the G-Sim Main Menu.


Up to 10 predefined model configurations may be defined. The above screen shot shows the situation with six configurations already defined with space for an addition four.

## To define a new model configuration

1) Click on one of the numbers in the list which does not have a model defined against it (ie #7). A new list will be displaying showing the model groups which can be used for the new model definition.

2) Click on the appropriate group (eg LNG Carrier). This will open the option selection dialogue for the model group selected.


3) Enter the title to be used for the new configuration (eg 170 NO96 Steam)
4) Enter a description (if required)
5) Enter the file name to be used for the appropriate stability module for the size of vessel selected
6) Using the radio buttons, select the options that you wish to be included in the model (one from each category).
7) Select if any of the additional options are required by checking the appropriate checkbox, if applicable (these are optional)

The above picture shows a model configured as a 138,000m$^3$, MarkIII containment, Steam propulsion using 2 x single stage LD compressors, fitted with a Regasification unit.

When you are happy with the choices, Click the 'Save' link.
This will return to the model list, showing the new model definition alongside the number previously selected.

The model definition is now available for use and when selected the appropriate graphics displays will be loaded accordingly.

## To add additional definitions

1) Repeat the above process for the various models configurations that you may use.
Click 'Menu' to return to the Main Menu.

## Configuration Options Available

The options available for selection by the operator for the LNG Carrier model are shown in the selection dialogue. As new options become available the displayed list will change to reflect the installed options. At the current time (May 2016), there are a minimum of twelve possible configurations for the model based on the following criteria:

- Vessel capacity: 138,000m$^3$ or 170,000m$^3$

- Containment system: GTT Mark III or GTT NO96
- Propulsion system: Steam or DFDE
- LD Compressor arrangement: 2 x single stage (steam only) or 2 x two stage (DFDE only)

Developments are currently in progress to add additional DFDE configurations, and a MEGI option which should be available in 2017.
When using the selection, if a selection is only applicable to one type of configuration, the other options will not be available

# Displays

## Navigation

### Graphics Displays

Access to the various graphics displays is provided via a two level menu system, the higher level comprising the overall groups, and the lower level comprising the various systems within each group. Access between displays is also achieved via hot links allowing changing between displays without using the menu.

The actual displays within each group will be different depending upon the model configuration selected. However, the general format is as follows:

| High Level Group | Lower Level Displays |
|---|---|
| Process Overview | Status |
| | ESD |
| | Pipeline displays for various operations |
| Gas Detection | Fixed detector |
| | Portable detectors |
| Cargo pipelines | Main pipelines |
| | Manifold |
| | Machinery room overview |
| Cargo tanks | Each cargo tank |
| | Temperature monitoring for each tank |
| | Glycol system |
| Compressors | HD Compressors |
| | LD Compressors |
| | Lub Oil |
| Heaters | Heaters |
| | Vaporisers |
| | Steam / heating medium |
| Nitrogen | Nitrogen supply |
| | Nitrogen distribution |
| Inert Gas | IG Generator |
| Engine Room | Engine room |
| Ballast | Ballast System |
| Auxiliary Tanks | Fuel & FW Tanks |

## Instructor Panels

The instructor is also provided with access to the following instructor displays

| General | |
|---|---|
| | Load Control (Port Side) |
| | Load Control (Stbd Side) |
| | Global Parameters |
| | Cargo Tanks |
| | Ballast Tanks |
| | Fuel & FW Tanks |
| | IG & N2 |
| | Gas Malfunctions |
| | Compressor Malfunctions |
| | Leaks |
| | Alarms |
| | Valves |

# Specific operating features

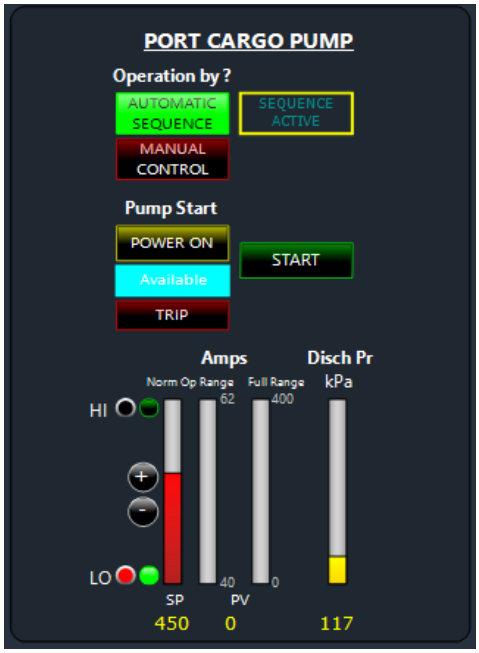
The following describes the operating procedures that need to be applied for specific items within the LNG model.

## Cargo Pumps

There are two cargo pumps provided in each cargo tank. They are of the single stage, electric driven, centrifugal, submerged type and can be operated in either Manual or Automatic mode. The method of operation is as follows

### To operate the pumps in manual mode:

1) Set 'Power' for the pump to 'ON' and indicator is illuminated
2) Check start available indicator is illuminated (based on power availability and liquid level)
3) Set discharge valve to approx. 10% - 15% open position (check cargo operations manual).
4) Set tank filling valve to 100% open
5) Start pump. Monitor pump amps
6) When pump running (amps steady), slowly open discharge valve and when discharge valve >30% open, begin to close in tank filling valve to control discharge rate.




### To operate pumps in automatic mode:

When in automatic mode the pump start and discharge start routines are based on a sequence controller. Full details of each of the respective sequences can be found in the pump descriptions within the Cargo Operations Manual. A description of the general sequences are shown below:

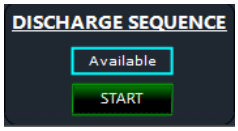
#### *To start first pump sequence:*

1) Set pump to stand-by to activate power.
2) Check 'Available' indicator is lit (indicating sufficient power and liquid level is above minimum level).
3) Check pump discharge, tank filling and tank isolating valves are closed.
4) Set pump to 'Automatic Control'
5) Start 'Pump Start' sequence by clicking 'Start' button and activating via the control bar.
6) Appropriate valves will open to the set positions, pump will then start, and once running filling valve will adjust to maintain pump load at minimum setting (60%).

*To start second pump sequence:*

1) Once first pump is running follow steps 1 – 5 above for second pump. As filling valve is already open, pump will start immediately the discharge valve has opened to the required set position.

*To start discharge sequence:*




1) Check at least one cargo pump is running.
2) Check 'Discharge Sequence Available' indicator is lit (indicating at least one pump is running).
3) Activate discharge sequence by clicking 'Start' button and then the control bar.
4) The tank isolating valve will now begin to open and after a set time period, the filling valve will close.

*To increase required motor load (capacity):*

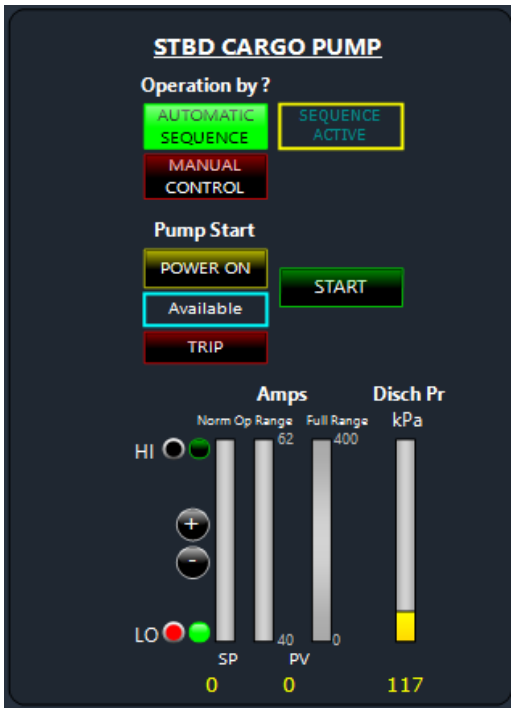
1) Check pump running and load equals set point (red bar).
2) Increase required load setting by placing cursor on '+' button and clicking on 'ON' on control bar. Setting will increase by 5% on each click.
3) To decrease required motor load setting place cursor on '-' button and click OFF on control bar. Setting will decrease by 5% on each click

*To stop pump in automatic mode:*

1) Click 'Start' button and then OFF on the control bar.

## Spray Pumps

There is one spray pump provided in each cargo tank. They are of the two stage, electric driven, centrifugal, submerged type and can be operated in either Manual or Automatic mode.




### To operate the spray pump in manual mode:

1) Set 'Power' for the pump to 'ON' and indicator is illuminated
2) Check start available indicator is illuminated (based on power availability and liquid level)
3) Set discharge valve to approx. 10% - 15% open position (check cargo operations manual).
4) Set spray return valve to 100% open
5) Start pump. Monitor pump amps
6) When pump running (amps steady), slowly open discharge valve and when discharge valve >30% open, begin to close in spray return valve to control discharge rate.

The positioning of the discharge and the spray return valves prior to starting the pump should be as indicated in the cargo operations manual.

### To operate pumps in automatic mode:

When in automatic mode the pump start and discharge start routines are based on a sequence controller.

*To start spray pump sequence:*

1) Open spray header isolating valve on the respective tank.
2) Set pump 'Power On' to activate power.
3) Check 'Available' indicator is lit (indicating sufficient power and liquid level is above the minimum required).
4) Check pump discharge, and spray return valves are closed.
5) Start 'Pump Start' sequence by clicking ON button and activating via control bar.
6) Appropriate valves will open to set positions, pump will then start and once running the spray return valve will adjust position to maintain pump load at minimum setting (60%)

*To increase required motor load:*

1) Check pump running and load equals set point (red bar).
2) Increase the required load setting by placing cursor on '+' button, located to the right of the controller display, and clicking on 'ON' on control bar. Setting will increase by 5% on each click.
3) To decrease required motor load setting place cursor on '-' button, located to the right of the controller display, and click OFF on control bar. Setting will decrease by 5% on each click

*To increase required spray header pressure:*

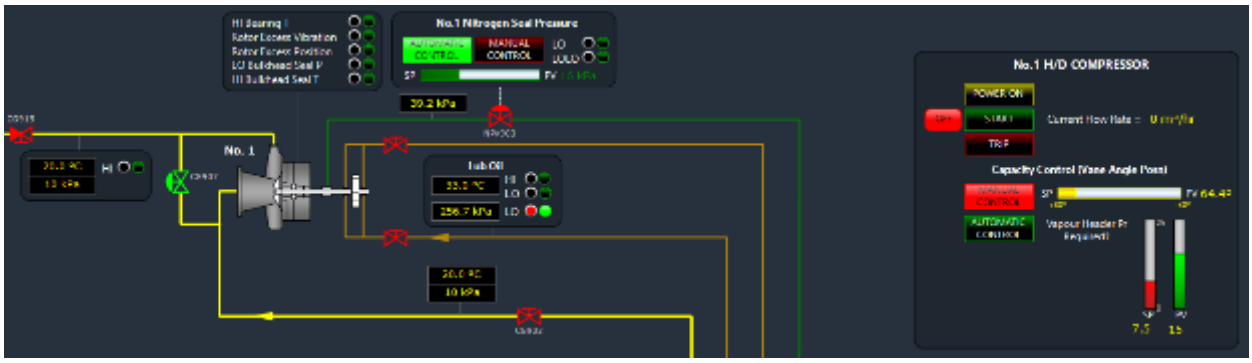
1) Check pump running and load equals set point (red bar).
2) Increase the required pressure setting by placing cursor on '+' button, located to the left of the controller display, and clicking on 'ON' on control bar. Setting will increase by 10kPa on each click.
3) To decrease required pressure setting place cursor on '-' button, located to the left of the controller display, and click OFF on control bar. Setting will decrease by 10kPa on each click

*To stop pump in automatic mode:*

1) Click 'Start' button and then OFF on control bar.

## HD Cargo Compressors

Two high duty (HD) compressors are provided. The H/D compressors are used for the movement of large volumes of vapour. The HD Compressors are single speed, with the capacity controlled by adjusting the vane angle in the compressor inlet. They can be operated in Manual or Automatic mode.




### To operate H/D compressors in Manual mode:

*Note: The compressors are always started and stopped manually. Automatic control is only applicable to the capacity control once the compressor is running.*

1) Check $N_2$ supply is open from Engine Room, the supply valve to compressor is open and there is sufficient pressure at seal.
2) Check the lubricating oil supply and return to/from compressor are open and the lub oil pump running and alarms extinguished.
3) Set the discharge valve to 100% open position (may not open immediately as non – return valve).
4) Open the compressor inlet valve 100% and check the suction pressure is positive.
5) Check the vane angle is set to minimum using the vane angle set point control.
6) Set 'Power On' for the compressor to activate power.
7) Start the compressor by selecting 'Start' indicator and clicking right hand end of control bar. Confirm compressor starts and flow rate increases and then becomes steady
8) Once running, increase the compressor capacity by increasing the position of the vane angle. Locate the cursor over the vane control indicator and using the control bar select the required % open for the vanes. Once selected the actual vane angle will gradually move to the selected position.

### To operate H/D compressors in Automatic Mode:

Once started the H/D compressors can be set so that the capacity will adjust automatically to maintain a set pressure within the vapour header.

1) Check the compressor running.
2) Set the required vapour header pressure that is to be maintained by locating the cursor on the red 'SP' column indicator to the left in the controller, and by using the control bar select the required pressure. The actual pressure selected will be displayed beneath the column and can be adjusted by selecting another position on the control bar.
3) When the required vapour pressure has been selected place compressor into automatic by selecting 'Automatic Control' indicator and then clicking on the control bar. Once in automatic model the vane angle will now adjust automatically dependent upon the actual vapour header pressure compared to the required set point.

### To stop H/D compressor:

1) Select 'Start' indicator then OFF on control bar.

### To operate Nitrogen Seal Supply in Automatic Mode:

The Nitrogen Seal Supply can also be set to operate in Automatic mode.

1) Set the required Nitrogen pressure for the compressor seal (usually > 30kPa). To do this locate the cursor on the green 'SP' bar located beneath the Automatic / Manual selection buttons, and then select the required pressure using the control bar. The actual pressure selected will be displayed to the right of the bar (PV).
2) When the required Nitrogen seal pressure has been entered place the supply valve into automatic by selecting either the 'Manual' buttons and the clicking OFF on the control bar. The supply valve will now adjust accordingly to maintain the pressure at or above the set point.

## LD Compressors

Usually two LD Compressors are provided for use as part of the Fuel Gas supply system to the engine room. However, the type, design and operating requirements differ depending upon the propulsion system selected. The following describes the various types that can be incorporated into the LNG Carrier model:

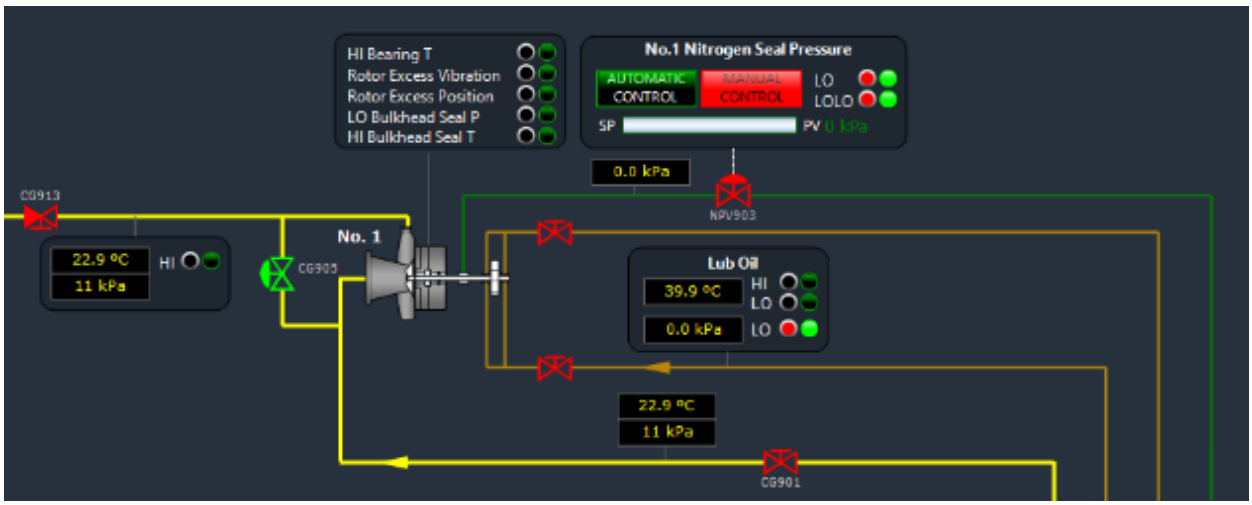
### Single Stage LD Compressors

Two single stage compressors are used when the steam propulsion system is selected. The single stage LD Compressors are variable speed, with the capacity controlled by adjustment of the vane angle in the compressor inlet, and motor speed. They can be operated in manual or automatic mode.

Capacity control:

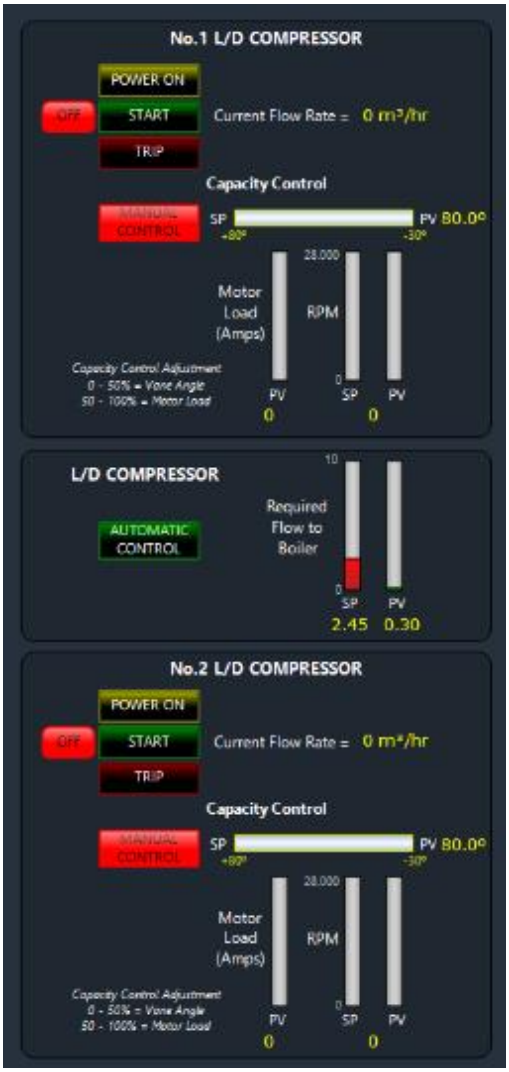
0 – 50% Fixed motor speed, adjustment of vane angle, min to max position
50 – 100% Vane angle set to maximum, increase motor speed

The LD Compressors can only be operated individually (one main, one standby)




*To operate L/D compressors in Manual mode:*

1) Check $N_2$ supply is open from Engine Room, the supply valve to compressor is open and there is sufficient pressure at seal (see below).
2) Check the lubricating oil supply and return to/from compressor are open and the lub oil pump running and alarms extinguished.
3) Set the discharge valve to 100% open position (may not open immediately as non – return valve).
4) Open the compressor inlet valve 100% and check the suction pressure is positive.
5) Check the vane angle is set to minimum using the vane angle set point control.
6) Set 'Power On' for the compressor to activate power.
7) Start the compressor by selecting 'Start' indicator and clicking right hand end of control bar. Confirm compressor starts and flow rate increases and then becomes steady
8) Once running, increase the compressor capacity by:
    a. Min – 50%
    Increasing the position of the vane angle. Locate the cursor over the vane control indicator and using the control bar select the required % open for the vanes. Once selected the actual vane angle will gradually move to the selected position.
    b. 50% - 100%
    Increasing the motor speed (load). Locate the cursor on the 'SP' column and using the control bar select the required motor load *(Note: when compressor starts initial load setting is always 50%).*




### *To operate L/D compressors in Automatic Mode:*

Once started the L/D compressors can be set so that the capacity will adjust automatically to maintain a set delivery rate to the engine room.

1) Check compressor running.
2) Set the required delivery rate to the engine room by locating the cursor on the 'SP' column alongside the 'Automatic Control' selection button, and using the control bar select the required pressure to be maintained in the vapour header. The actual pressure selected will be displayed beneath the column, and can be adjusted by selecting another position on the control bar.
3) When required delivery rate has been selected, place compressor into automatic by selecting 'Automatic Control' button and then ON on the control bar. The vane angle and motor load will now adjust automatically dependent upon actual vapour header pressure compared to the set point.

### *To stop L/D compressor:*

1) Select RUN indicator then OFF on control bar.

### *To operate Nitrogen Seal Supply in Automatic Mode:*

The Nitrogen Seal Supply can also be set to operate in Automatic mode.

1) Set the required Nitrogen pressure for the compressor seal (usually > 30kPa). To do this locate the cursor on the green 'SP' bar located beneath the Automatic / Manual selection buttons, and then select the

required pressure using the control bar. The actual pressure selected will be displayed to the right of the bar (PV).

2) When the required Nitrogen seal pressure has been entered place the supply valve into automatic by selecting either the ‘Automatic or Manual’ buttons and the clicking OFF on the control bar. The supply valve will now adjust accordingly to maintain the pressure at or above the set point.

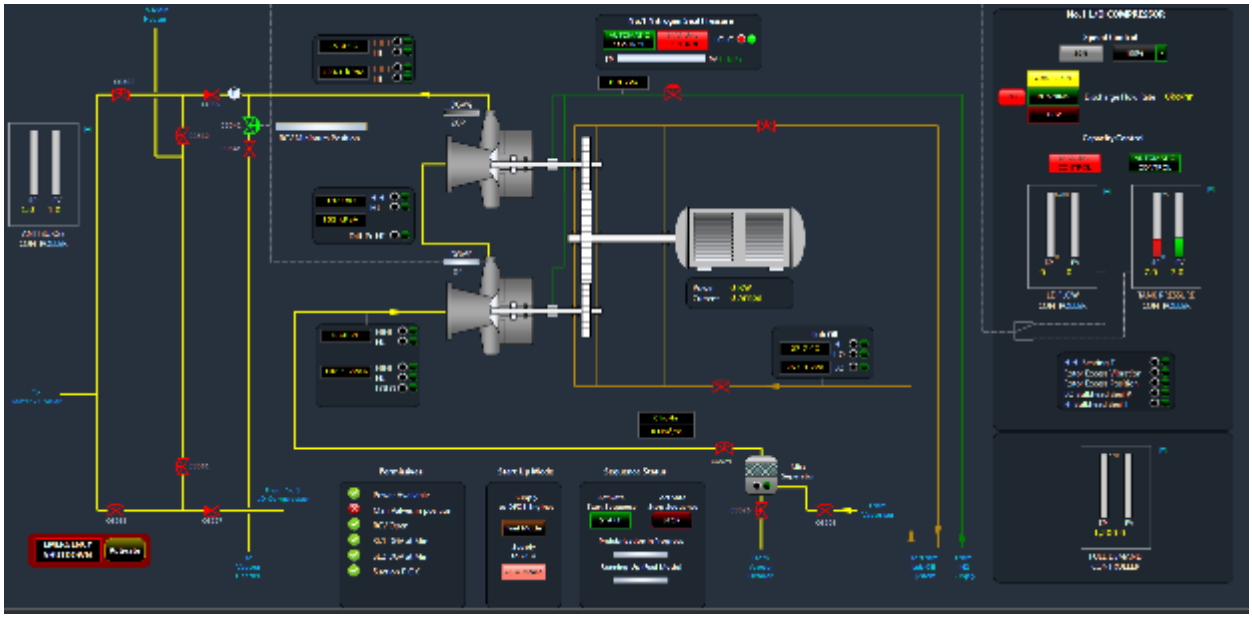
## Two stage LD Compressors

When the DFDE option is selected there are a number of possible configurations of LD Compressors that are in common use. Currently, within the LNG Carrier model the following options are selectable:

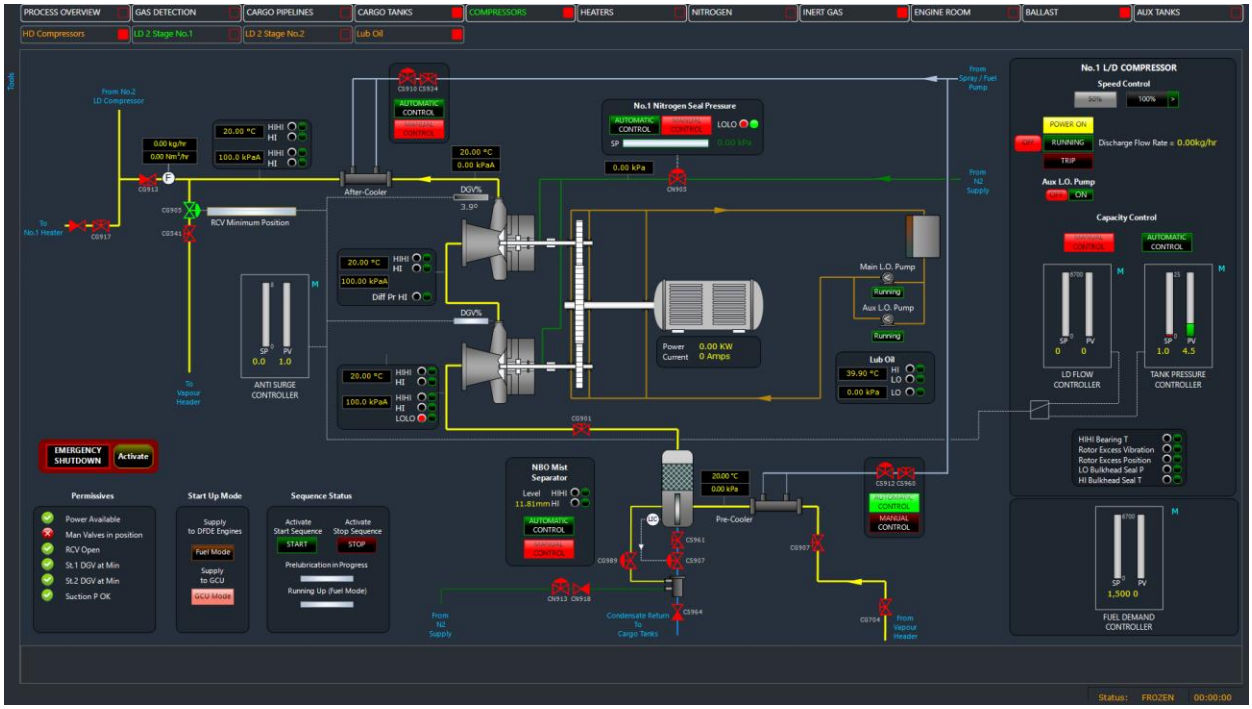
- Two, two stage LD compressors (version 1 – applicable to the standard LNG & 170k models)
- Two, two stage LD compressors (version 2 – applicable to the Asia Vision model)

For full details about the compressors see the LNG Carrier Cargo Operations Manual.

Version 1



Version 2



The prime differences between the two versions of compressor relate to the positioning of the pre and after coolers. The following descriptions explain the operating principles for each.

**The following is applicable to both versions 1 & 2:**
The LD Compressor forms part of the Fuel Gas Management System that regulates the flow of gas to the dual fuel engines. Consequently, once setup, its operation is usually in automatic mode. The following provides a description of the various controllers and the general operation of the compressors.

### *Control logic*

All the process control elements (Valves, Compressor, compressor Diffuser Guide Valves, motor..) are manipulated by PID controllers. The basic target of the process control system has two functions

1) To manipulate the final control element in order to bring the process measurement to the set point whenever the set point is changed
2) To hold the process measurement at the set point by manipulating the final control element

The PID control algorithm does not "know" the correct output that will bring the process to the set point. Instead the PID algorithm continues to move the output in the direction that should move the process toward the set point until the process reaches the set point. So the PID controller must have a feedback (Process Variable "PV"), a set Point (SP) and an output Processing signal (OP) in order to perform.
A PID controller can work in three modes

- MAN: Operator manipulates the output of the controller directly, or a Program manipulates the output (P-MAN)
- AUTO: PID algorithm acts a directly on the control element by processing the OP signal
- CASCADE: PID algorithm acts directly on the control element by processing the OP signal but in this case the SP of the controller is proved by second controller known as primary controller. The secondary controller is in AUTO mode and Primary in CASCADE

During the process of starting-up all the controllers perform with all loops in manual. In the Plant the following indications are donating the status of the controller.

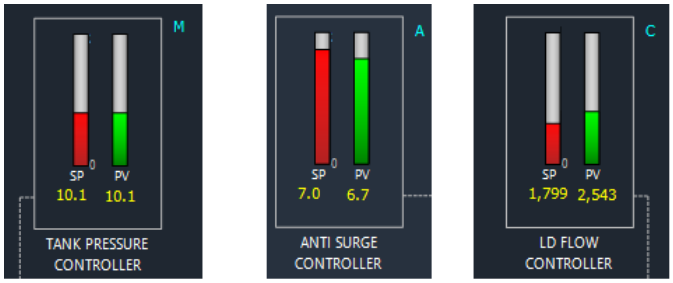



*Figure 1. Controllers in action (The letter M denotes the Manual mode, A the auto mode, and C the cascade mode)*

In Man Mode, the SP value of the controller is equal to the PV value.

### *Controllers in the system*

**Tank Pressure Controller**
The "Tank Pressure Controller" is responsible for maintaining the tank pressure at the required set point. It has two modes of operation 1) manual 2) auto.
In manual mode, output signal of the controller is not active (it is not controlling any element). In auto mode, the output signal of the controller is used to produce the Set Point of the flow controller.

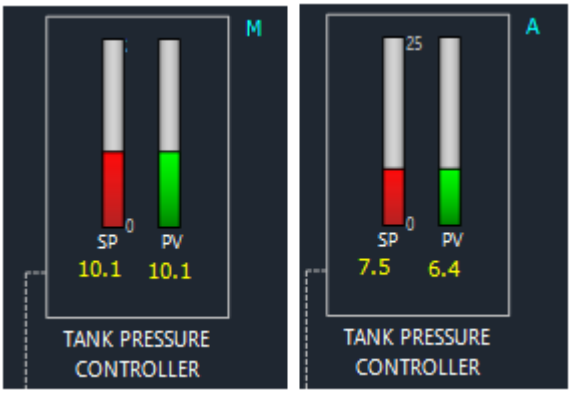



*Figure 2 Tank Pressure Controller (Tank pressure controller in M mode and AUTO mode).*

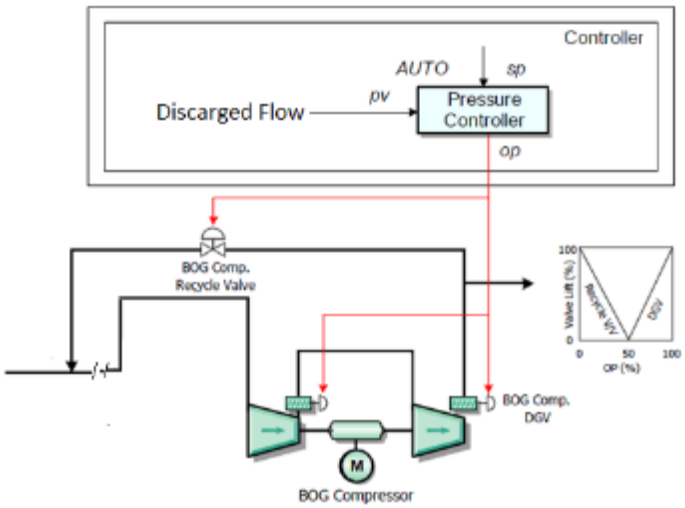
The mode of the controller can be switched though the "Capacity Control Panel", when AUTOMATIC CAPACITY is active, the controller performs in AUTO mode and in M mode under "MANUAL CONTROL".

**LD Flow Controller**

The "LD Flow Controller" is responsible for controlling the compressor discharge flow. The output signal of the controller acts on

1) The diffuser Guide Vane of 1st stage
2) The diffuser Guide Vane of 2nd stage
3) Recycling compressors Valve

A simple schematic presentation of the OP actions is as follows:




*Note: The output signal Flow controller is not acting directly on the DGVs (Diffuser Guide Vanes), but first the signal is corrected by 1) Motor load Controller 2) Isentropic Corrective Controller . These two controller have been modelled, but they are not visible on the graphics displays as no manual action is required for their operation.*

It has three modes of operation 1) manual 2) auto 3) cascade mode

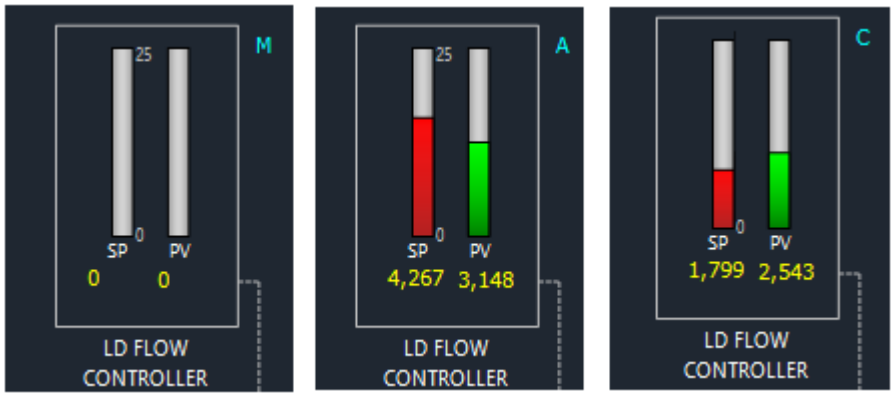



*Figure 3 LD Flow Controller modes.*

During the start-up, the controller is in manual mode. When the compressor's motor reaches full speed during the start up the controller becomes active.

**Anti-Surge Controller**

The "Anti-Surge Controller" is a pressure ratio controller. As it is a safety controller, it is activated only at extreme operating conditions under normal operation, its task is to keep the compressor from surging. Like the other controllers can work in Auto or MAN mode.

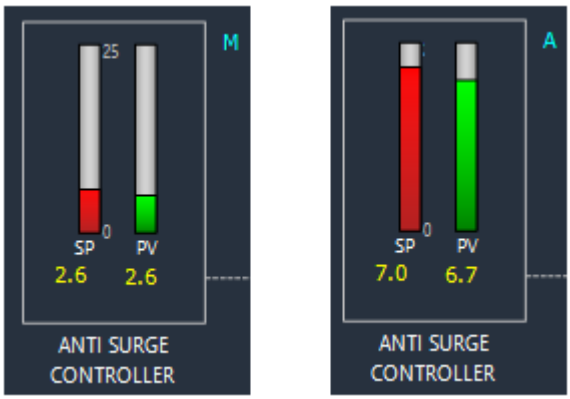



*Figure 4 Anti-Surge Controller*

The Anti-surge controller work in manual when compressor is not running or during the start up. During, the start up the output signal of the controller on the Recycle valve is done P-MAN (a manual output controlled by a program). At all times, the output signal of the controller (PID loop) is compared with P-Man output before action. The Program Output (P-Man) differs between the FUEL/GCU modes.

- Under FUEL mode, the P-MAN is targeting to keep recycle valve open.
- Under GCU mode, the P-MAN is targeting to move RCV at a closed position as pre-cooling is not available under GCU mode.

As "anti-surge controller is safety controller" will override any signal from P-MAN when PV starts to get higher than SP.

**FUEL Demand Controller**

The "FUEL Demand Controller" is a Flow Indicator and Controller with the main purpose to

1) Adjust the flow to GCU
2) Correct the Set Point of LD Flow controller
3) increase/decrease burning capacity within the engines.

When Flow is higher than the demand the extra amount of BOG is diverted to GCU. The output of the "Fuel demand controller" is compared to the output of a Pressure indicator and controller[1]. Both controllers can act on the "Flow diversion" mechanism, the signal of Pressure controller overrides the signal of the flow controller when there is risk of acute pressure drop which can lead to knocking/damage of the engines.

The "Flow diversion mechanism" acts on the Valve CG-615 and the request to DFDE engines for increasing/decreasing burning capacity.

When Valve CG-615 is under automatic control, the status of the Valve changes to "A" from "M". During the GCU mode, the "FUEL Demand controller" remains under Manual mode at all times. Under the FUEL MODE, the "FUEL Demand controller" switches to AUTO mode when the delivery to Engines is started. The Delivery to engines is started after the activation of the "FULL SPEED mode"

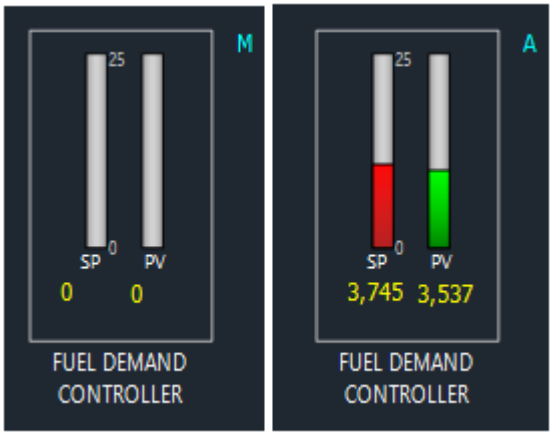



*Figure 5 Fuel Demand Controller*

### *Operational Modes*

The discharge pressure control mode of each LD compressor can be selected between fuel gas supply pressure control and GCU supply pressure control. Change between the two discharge pressure control modes is only possible during compressor stand still.


*Figure 6 Control Panel for switching between Fuel/GCU mode.*

**Fuel gas supply pressure control**

[1] The Pressure indicator and controller is not shown on the Graphics.

Under the fuel gas supply pressure control, the LD compressor (two-stage centrifugal compressor) will compress the BOG to maintain the fuel gas supply pressure at a constant level (6.5bara) by modulating the recycle valve and DGVs. In this mode, a BOG temperature at the compressor inlet between -140° and -120°C is required. The LD compressor gets started in the "50% Speed Mode" and it is locked to this speed. When the compressor has been running in low speed for more than 5 minutes with gas inlet temperature below -100°C, the high speed interlocked is removed. And operator activates the High speed mode. During, the low speed mode BOG is directed to GCU. With the activation of High speed mode and the discharge BOG at correct Temperature/Pressure, the delivery to DFDE engine is commenced.

**GCU supply pressure control**

If GCU supply pressure control is selected, the LD compressor is operated in 50% speed mode at all times. Pre-cooling is not required and no interlock exists on the inlet Temperature.
The Recycle valve remains open most of the time and capacity control is done though Diffuser Guide Vanes by the LD Flow Controller.

*Version 1 - Operation procedures in GCU Mode -*

**Preparations of Compressors for condition "ready to start"**

**1)** Prepare compressors auxiliaries
- Align the supply of Lube- oil to the Skid
- Align the supply of N2 sealing gas to the skid

**2)** For a successful start of the LD compressor, all the Permissives should be fulfilled. When the required conditions for a permissive to be true are valid, the permissive is displayed as  otherwise displayed as  .

In order the "Man Valves in position to be shown as TRUE, the discharge, suction, recycle and any block valve should be open.
Power permissive is ON given the compressor is at stby and sufficient power availability.

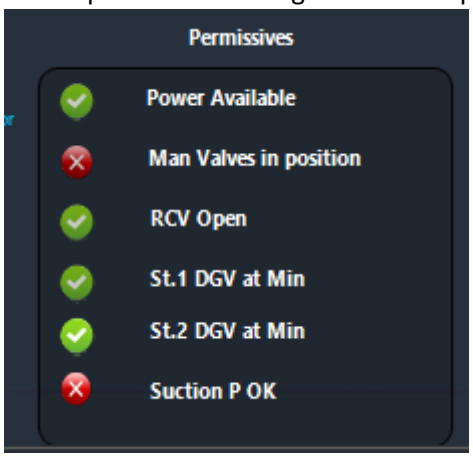



*Figure 7. Compressor panel for Permissives.*

**3)** Start the GCU plant
**4)** Align the Flow Path to GCU

**Condition "ready to start"**

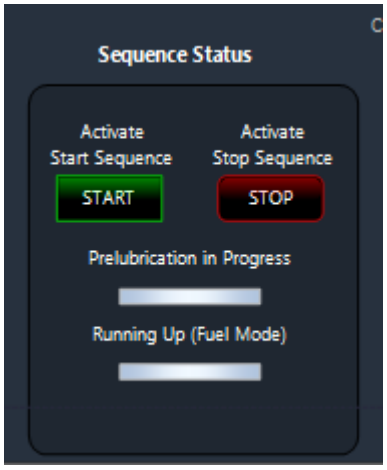
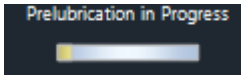
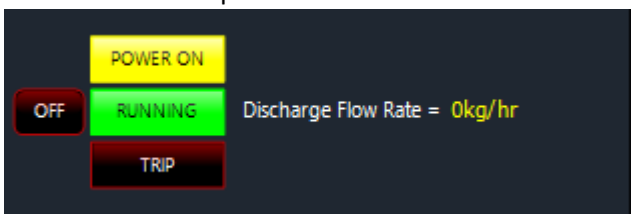



*Figure 8 Compressor Start Sequence Status*

The compressor gets started though the activation of the START SEQUENCE. With the activation of the sequence the pre-lubrication will be started. The pre-lubrication takes two minutes to complete. The Indicator Pre-lubrication in Progress shows the status of the Pre-lubrication.




With the pre-lubrication in place the start signal to the motor will be given and the Running indicator under the control panel will become lit.

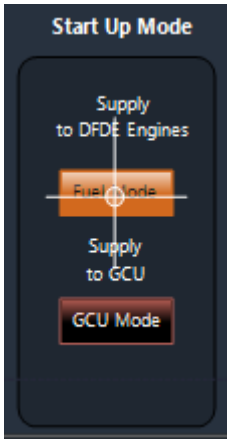



The controllers will continue to operate under the M mode till the compressor's motor reaches full speed. With reaching the desired speed at the 50% speed mode the compressors controllers will get active in AUTO mode.

The control logic will bring the recycle valve in closed position. With the RCV at closed position the operator can increase/decrease the set point of LD flow Controller.

### *Version 1 - Operation procedures in FUEL Mode*

Select FUEL mode operation




**Preparations of Compressors for condition "ready to start"**

**1)** Prepare compressors auxiliaries
- Align the supply of Lube- oil to the Skid
- Align the supply of N2 sealing gas to the skid

**2)** For a successful start of the LD compressor, all the Permissives should be fulfilled. When the required conditions for a permissive to be true are valid, the permissive is displayed as  otherwise displayed as  .
In order the "Man Valves in position to be shown as TRUE, the discharge, suction, recycle and any block valve should be open.

Power permissive is ON given the compressor is at stby and sufficient power availability.


*Figure 9. Compressor panel for Permissives.*

**3)** Start the DFDE /GCU plant
**4)** Align the Flow Path to GCU and DFDE

**Condition "ready to start"**

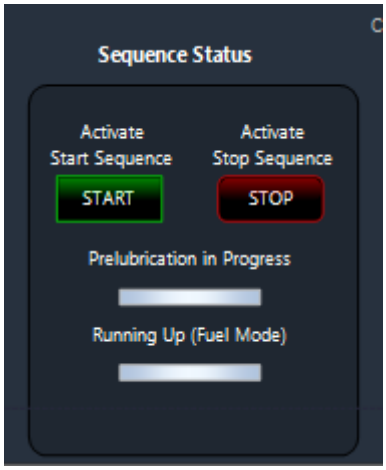
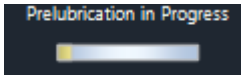
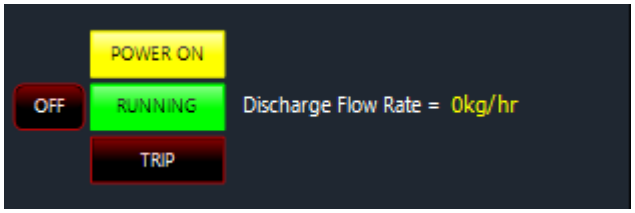



*Figure 10 Compressor Start Sequence Status*

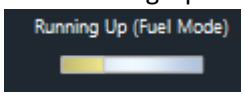
The compressor gets started though the activation of the START SEQUENCE. With the activation of the sequence the pre-lubrication will be started. The pre-lubrication takes two minutes to complete. The Indicator Pre-lubrication in Progress shows the status of the Pre-lubrication.



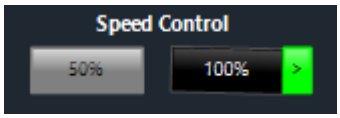

With the pre-lubrication in place the start signal to the motor will be given and the Running indicator under the control panel will become lit.



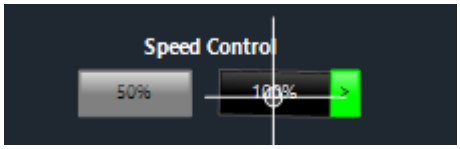

The “running Up” indicator will start counting for the speed interlock release.




During the interlock time the activation indicator for full speed mode appears dark. When all the conditions are met, the activation indicator becomes green.




Then operator can start the BOG delivery to DFDE engines by switch to 100% speed.

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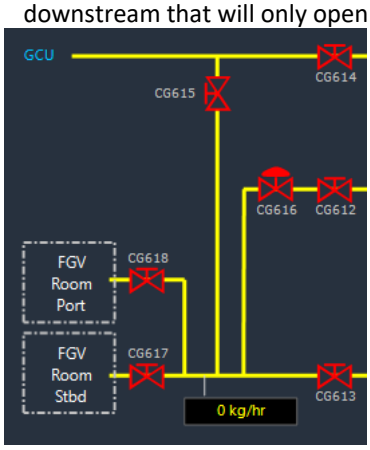
*Version 1 Detailed instructions - To Start LD Compressor*

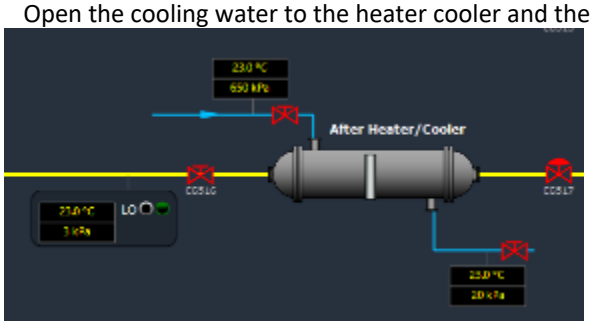
The compressor can be started in GCU or Fuel mode. GCU is straight forward it just goes to the GCU

**Starting in Fuel mode**

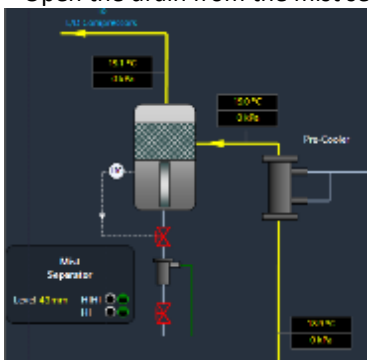
1) Start the spray pump to supply the pre-cooler, (suggested initial pressure approx 2 barg).
2) Note:
   a) *the pre-cooler is required to maintain the inlet temperature into the LD Compressor <-120°C*
   b) *Note the auto valve is only available in manual when the compressor is stopped and would be used for cooling the line down.*
3) Open the 2 valves to the engines CG617 & 618. Nothing will go to the engine as there is an invisible valve downstream that will only open when the pressure reaches 550kPa.




4) Open the valve to the GCU CG615 (this will also open automatically when the LD starts)
5) Open the cooling water to the heater cooler and the inlet and outlet valves.

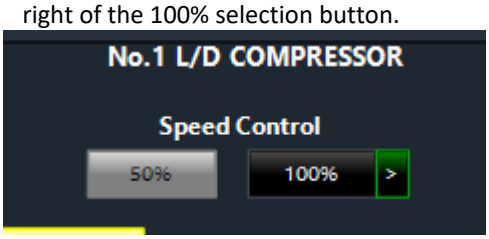



6) Open the drain from the mist separator. This returns back to tank 3 or 4




7) On the compressor set up the lub oil and nitrogen as usual. Using number 1 for this example.
8) Using LD Compressor #1 as the example, open the surge isolation valve CG541 and discharge valves CG556 and CG562
9) Open compressor suction valve and CG704 from the vapour header.
10) Check permissives are all green


11) On the 'Start Up Mode' select 'Fuel mode'
12) On the 'Sequence Status' activate the Start Sequence. The progress of the start sequence is indicated by the yellow progress bars. Initially, the start sequence involves pre-lubrication which runs for 2mins.
13) When pre-lubrication is completed (progress bar = 100%) the compressor starts on 50% speed and the GCU valve (CG615) operation changes to automatic and opens (if not already open).
14) On starting the LD flow controller SP is automatically set at '1500' which is the minimum for the engines.
15) The start sequence will now continue with progress indicated on the lower progress bar. For a period of 5 mins the compressor is fixed at 50% speed. Note the recycle valve remains partially open at this time due to the low flow rate is so low the DGV are on minimum settings.
16) Once this period is over, speed increase to 100% is available indicated by the 'green >' indicator to the right of the 100% selection button.




17) The LD cannot increase to 100% speed until the inlet T has been less than -120(?) for 5 minutes.
18) Increase speed to 100% by selecting the 100% button. Discharge pressure from the compressor will now increase. When the pressure is 550 kPa the inlet valves to the engines open and the flow will increase. At the same time the GCU valve will close.

**Running in manual**

1) When the speed has been increased to 100% the setting for the LD flow controller can also be increased. This increases the flow through the compressor.
   *Note: The fuel demand is separate. If the fuel demand is still set to 1500 and the LD flow controller is set to 3000 then 1500 goes to the engine and 1500 to the GCU.*
2) If the fuel demand exceeds the LD flow controller setting the LD flow controller SP changes to match the Fuel demand. i.e. if fuel demand and LD flow controller are at 1500 and the fuel demand is increased to 2000 the LD flow controller also increases to 2000.
3) If the Fuel demand controller is reduced the LD flow controller remains the same and the excess goes to the GCU unless the LD flow controller is brought down as well. The LD flow controller cannot be brought down less than the Fuel demand.

**Running in Auto**

1) When the capacity controller is in automatic the Tank pressure controller goes to Automatic mode and the LD flow controller is in cascade mode. The system tries to calculate the flow based on the tank pressure SP and the PV and adjusts the flow accordingly. If the Tank pressure controller SP is reduced the flow controller will increase the flow. It then calculates how quickly the tank pressure will fall in response to the flow so takes time to settle.

2) The tank pressure controller will set the LD flow control SP in order to achieve the tank pressure demanded. The fuel demand can be set independently and if the LD flow controller is greater than the fuel demand then the excess goes to the GCU. If the LD flow control set point is less than the fuel demand the Forcing vaporiser is started. This would be automatic on the real vessel but is manual on the simulator.

*Version 2 - Operation procedures in GCU Mode –*

**Preparations of Compressors for condition "ready to start"**

**1) Prepare compressors auxiliaries**

- Start the Lube- oil System, by turning ON the aux pump.


-Align the supply of N2 sealing gas to the skid, setting the required sealing Pressure above 30 kPa.

**2) Prepare for "Permissives in place".**

For a successful start of the LD compressor, all the Permissives should be fulfilled. When the required conditions for a permissive to be true are valid, the permissive is displayed as  otherwise displayed as  .

In order for the "Man Valves in position to be shown as TRUE, the following valves need to be open:

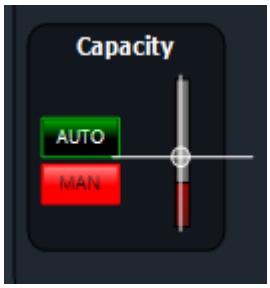
- Compressor discharge
- Compressor suction,
- Compressor recycle
- Any block valves related to the above

Power permissive is ON given the compressor is at "stby" and sufficient power availability.

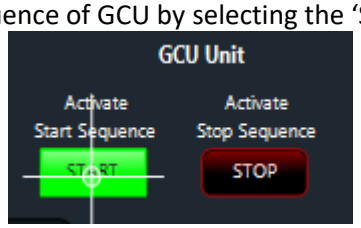
**3) Start the GCU plant**

-Set Capacity Mode on MAN mode


-Set Capacity at 30%




- Align the supply of N2 sealing gas to the skid (valves:CN915, CN901)
- Align the BOG Flow Path to GCU to allow free flow of BOG though a BOG heater at a temperature of 20°C.
-Activate the Start Sequence of GCU by selecting the 'START' button

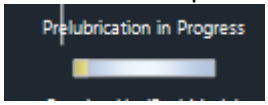



**Condition "ready to start"**

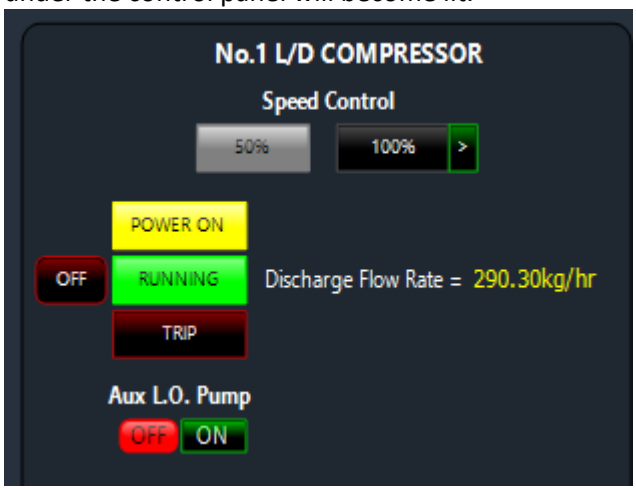
The compressor is started though the activation of the START SEQUENCE.



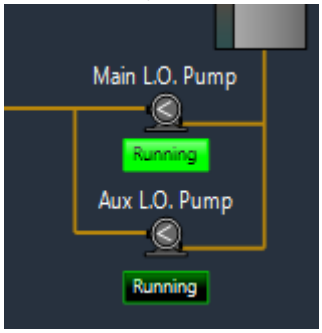
With the activation of the sequence the pre-lubrication will be started. The pre-lubrication takes two minutes to complete. The Indicator Pre-lubrication in Progress shows the status of the Pre-lubrication.



With the pre-lubrication in place the start signal to the motor will be given and the Running indicator under the control panel will become lit.

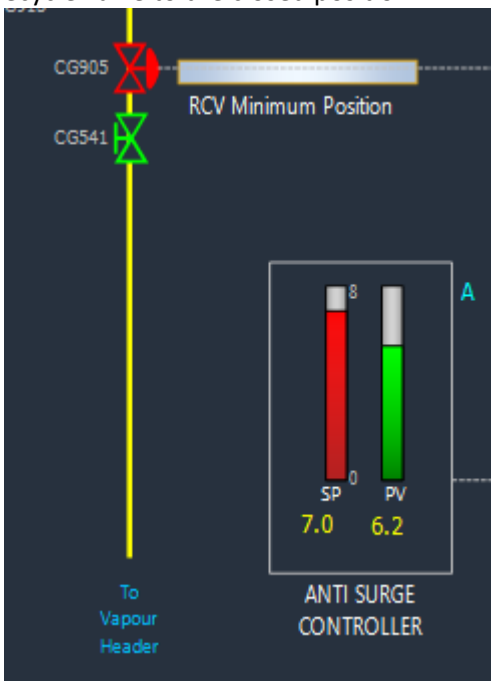



At the same, the Main Lub Oil pump will start automatically and Aux will stop.

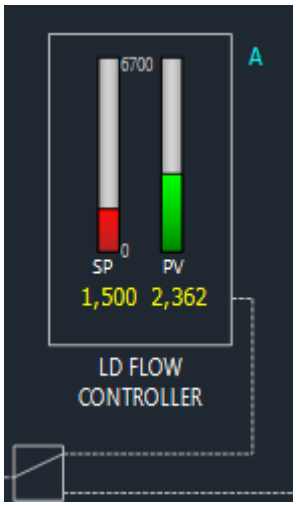



The controllers will continue to operate under the M mode till the compressor's motor reaches full speed. When reaching the desired speed at the 50% speed mode, the compressors controllers will become active in AUTO mode.

The control logic will bring the recycle valve to the closed position.

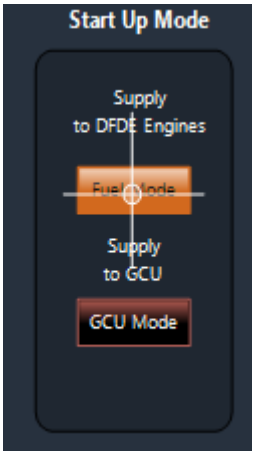


With the RCV in the closed position the operator can increase/decrease the set point of LD flow Controller.




*Version 2 - Operation procedures in FUEL Mode*

Select FUEL mode operation




**Preparations of Compressors for condition "ready to start"**

**1) Prepare compressors auxiliaries**

- Start the Lube- oil System, by turning ON the aux pump.


-Align the supply of N2 sealing gas to the skid, set sealing Pressure to be above 30 kPa.

**2) Prepare for "Permissives in place".**

For a successful start of the LD compressor, all the Permissives should be fulfilled. When the required conditions for a permissive to be true are valid, the permissive is displayed as  otherwise displayed as  .

In order for the "Man Valves in position to be shown as TRUE, the following valves need to be open:

- Compressor discharge
- Compressor suction,
- Compressor recycle

- Any block valves related to the above

Power permissive is ON when the compressor is in “stby” and there is sufficient power availability.


**3) Start the GCU plant**

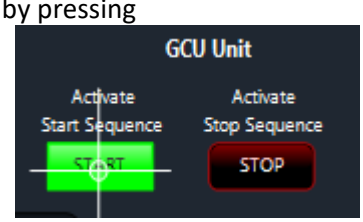
-Set Capacity Mode on MAN mode


-Set Capacity at 30%

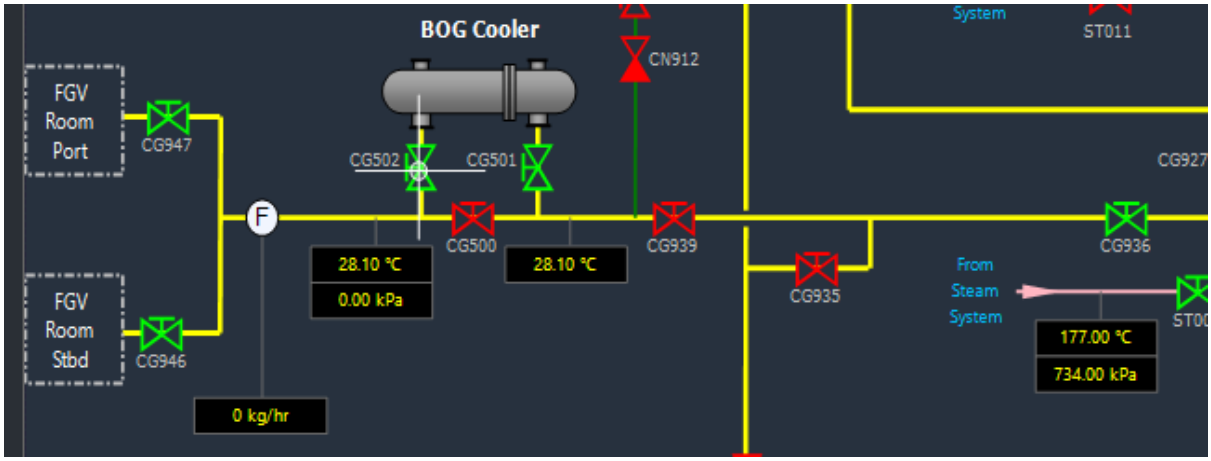

- Align the supply of N2 sealing gas to the skid (valves:CN915, CN901)

- Align the BOG Flow Path to GCU for having free flow of BOG though a BOG heater at a temperature of 20°C.

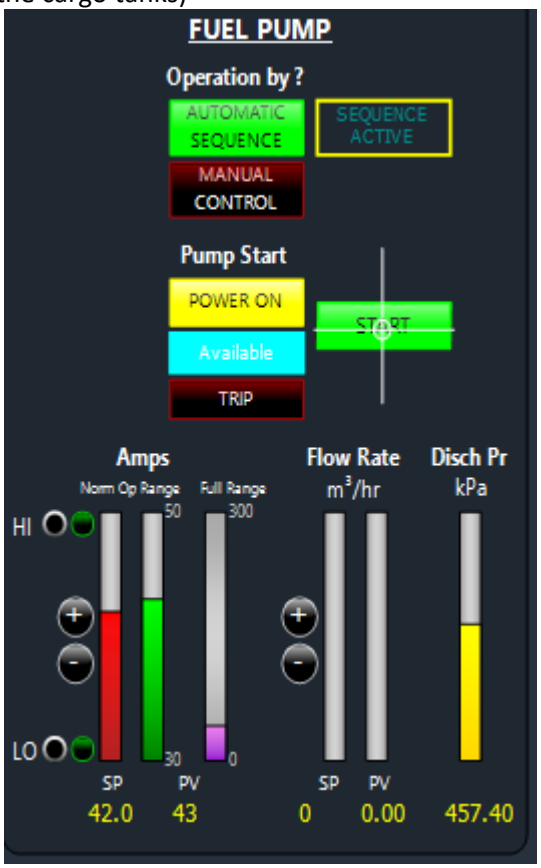
-Activate the Start Sequence of GCU by pressing




-Align BOG Flow path DFDE Engines though BOG Cooler

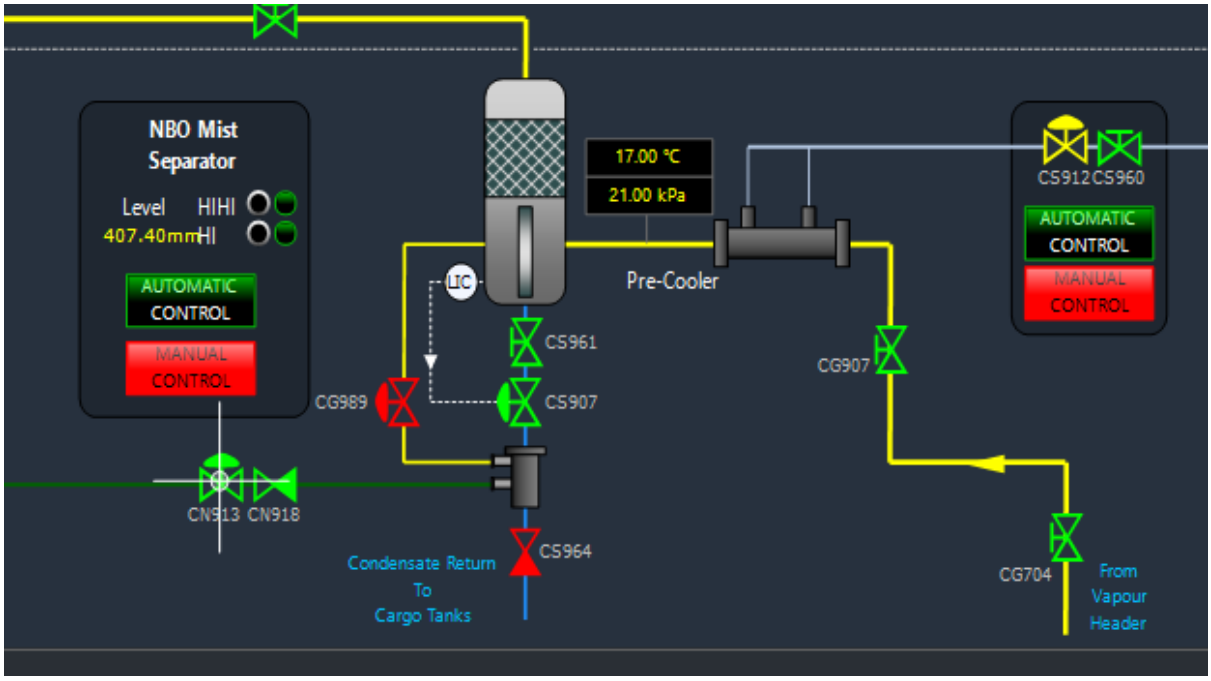



-Start a Fuel Pump (in one of the cargo tanks)

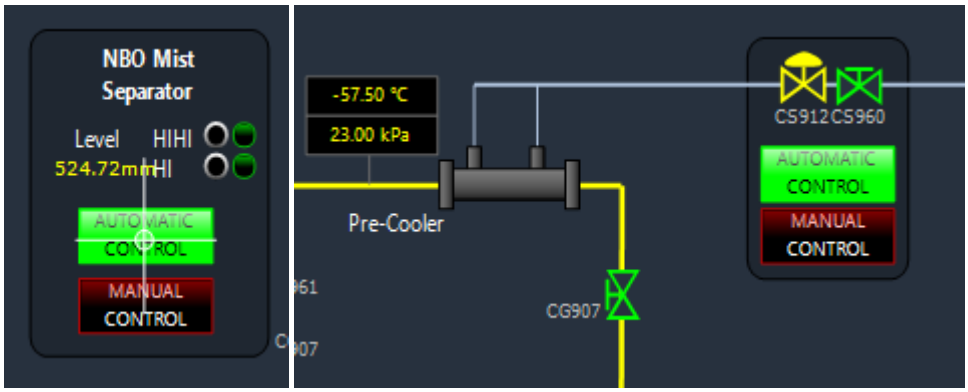



-Start the cooling down of the Fuel header (by opening valve: CSi12, CS706, CS971,CS972 and condensate return valve

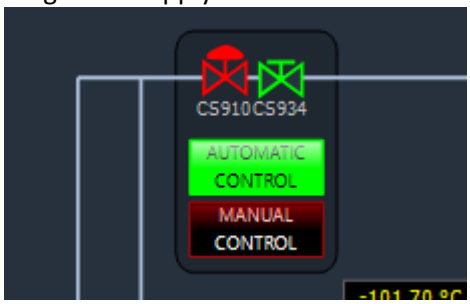
-After some time, align flow path though the LD pre-cooler.




For being able to supply LNG to pre-cooler set Pre-cooler TCV to manual mode. Then set LCV and TCV on Automatic.

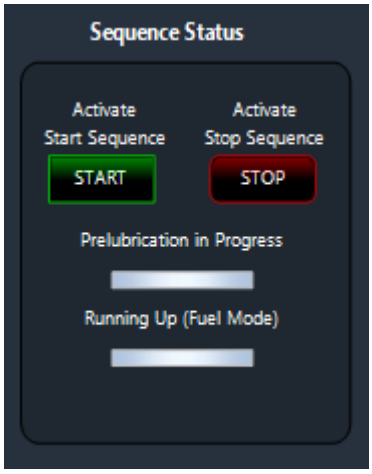



-Align LNG supply to LNG in LINE cooler (by opening manual Valve) and set TCV on Auto

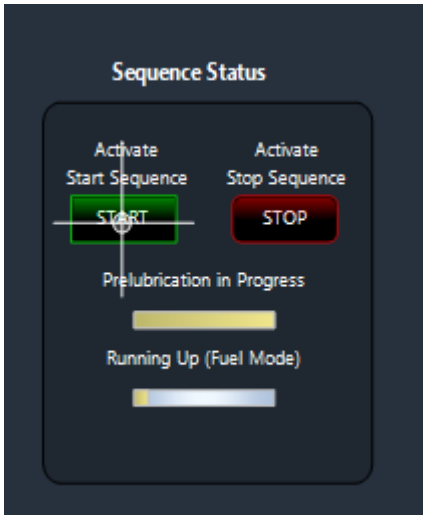


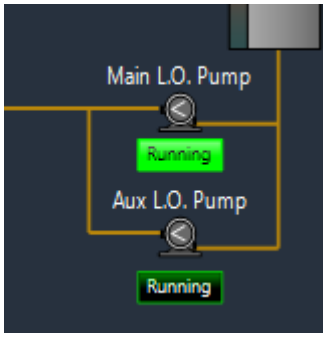

**Condition "ready to start"**

The compressor gets started though the activation of the START SEQUENCE

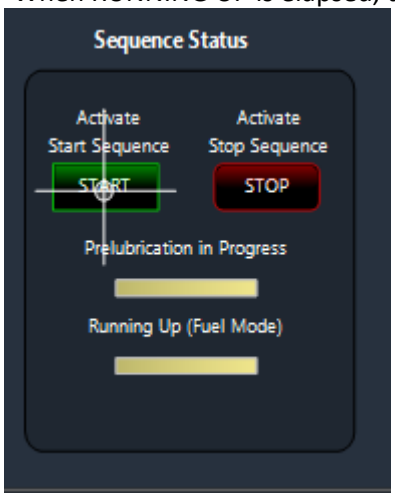


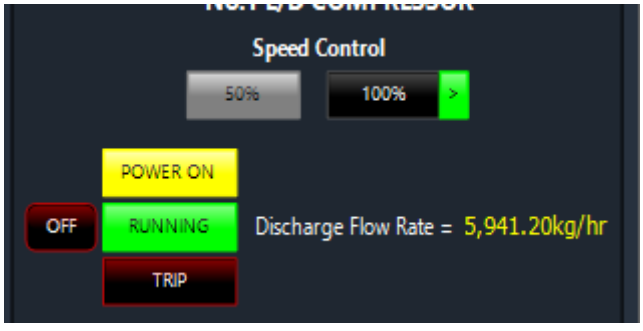

-Follow the pre-lubrication status of LD compressor, at the end of this phase the running phase in FUEL Mode will become active and Main Lub Oil Pump will take over.



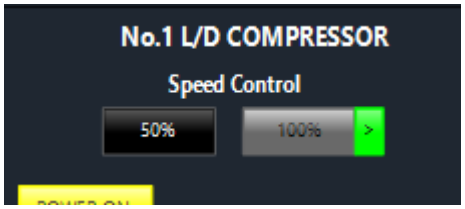



-When RUNNING UP is elapsed, the compressor's motor is in FULL speed at 50%,

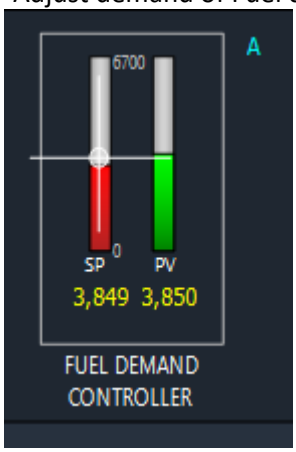





The indication for starting in 100% speed will become lit.
-Switch to 100% speed



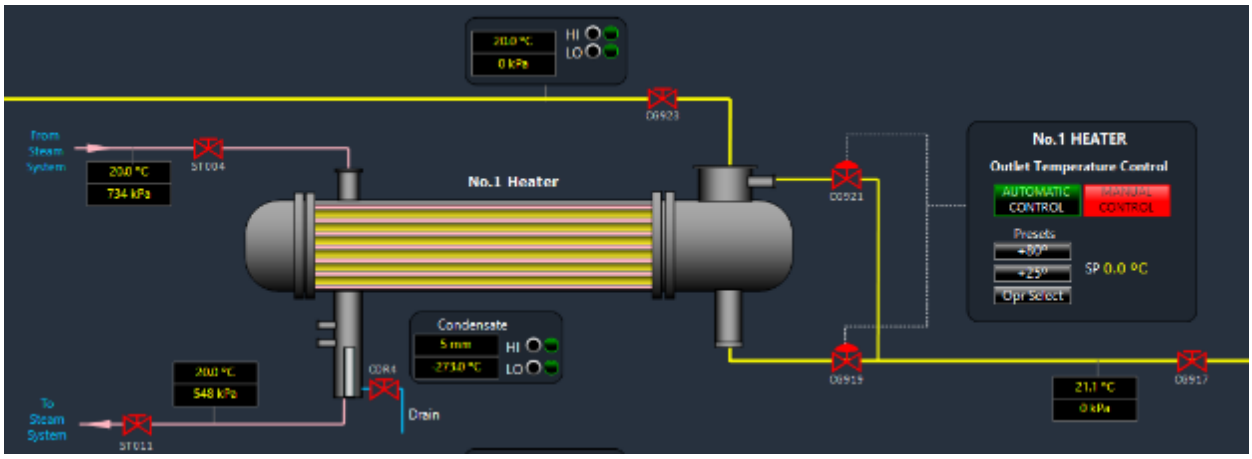

-Adjust demand of Fuel controller as Required



## Cargo Heater(s)

One or two main cargo heaters are provided depending upon the fuel gas management system arrangement that is implemented in the configuration selected. They are used for heating large volumes of vapour when warming up, or they may be also used as part of the fuel gas supply system.

The outlet temperature from the heaters can be maintained either in Manual or Automatic mode.




### Heater Operation

*To operate heaters in Manual Mode:*

1) Open steam inlet and outlet valves.
2) Check steam supply is on (inlet pressure > 700kPa) and that steam outlet pressure from heater is > 100kPa.
3) Open the condensate drain valve
4) Open the inlet valves to heater (Note: Heater inlet valve will not open unless steps 1 & 2 have been completed due to a steam supply interlock)
5) Open the heater outlet valve.
6) Start the flow through heater and monitor outlet temperature. Outlet temperature can be adjusted by initially opening the temperature control valve (top) to reduce the outlet temperature. If this is insufficient the heater inlet valve should be closed in. The required outlet temperature is obtained and then maintained by adjusting both inlet valves together.

*To operate heaters in Automatic Mode:*

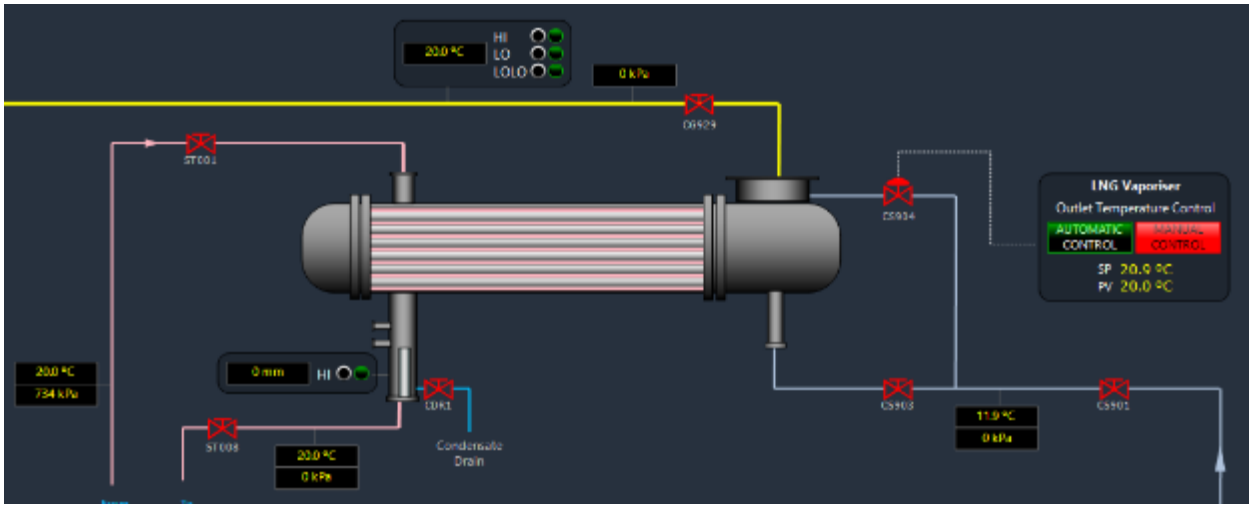
The 'Automatic' mode controller for the heater is designed to maintain an outlet temperature already set up, not achieve the setup from start (due to the wide temperature range). To place into automatic mode:

1) Carry out steps 1 – 6 above to obtain the required outlet temperature. (This should be done prior to placing into Automatic mode)
2) When the required outlet temperature has been obtained, select ''Automatic Control' mode.
3) When Automatic Control mode has been selected the required temperature can be adjusted by selecting one of the three buttons located below the Automatic / Manual Control buttons. To maintain the temperature at either +80 or +25 select the appropriate button and then click 'ON' on the control bar.
4) To select a different temperature, select the 'Opr Select' button. When this is selected the current temperature of the outlet vapour is transferred to become the new set point for the automatic control. To change the temperature, place back into Manual Control, adjust the valves and when the correct temperature is achieved, place back into Automatic control.

   For each of the above the temperature selected will now be displayed by the indicator and the inlet and temperature control valves will now adjust automatically to maintain the set temperature.

## Vaporisers

Two vaporisers are provided. The LNG Vaporiser has a large capacity and is used to produce large volumes of cargo vapour, or Nitrogen vapour. The smaller Forcing Vaporiser is used as part of the fuel gas supply system. Both vaporisers are operated in a similar way, with the outlet temperature capable of being maintained either in Manual or Automatic mode.




### Vaporiser Operation

*To operate the LNG or Forcing Vaporiser in Manual Mode:*

1) Open steam inlet and outlet valves.
2) Check steam supply is on (inlet pressure > 700kPa) and that steam outlet pressure from heater is > 100kPa.
3) Open the condensate drain valve
4) Open the inlet valves to heater (Note: Heater inlet valve will not open unless steps 1 & 2 have been completed due to a steam supply interlock)
5) Open Vaporiser outlet valve.
6) Start flow of liquid to the vaporiser and monitor outlet temperature. The outlet temperature is controlled by adjusting the position of the temperature control valve (into heater outlet) to reduce the outlet temperature. If this is insufficient the flow rate into the vaporiser should be reduced. The required outlet temperature is obtained and then maintained by adjusting the position of the temperature control valve.

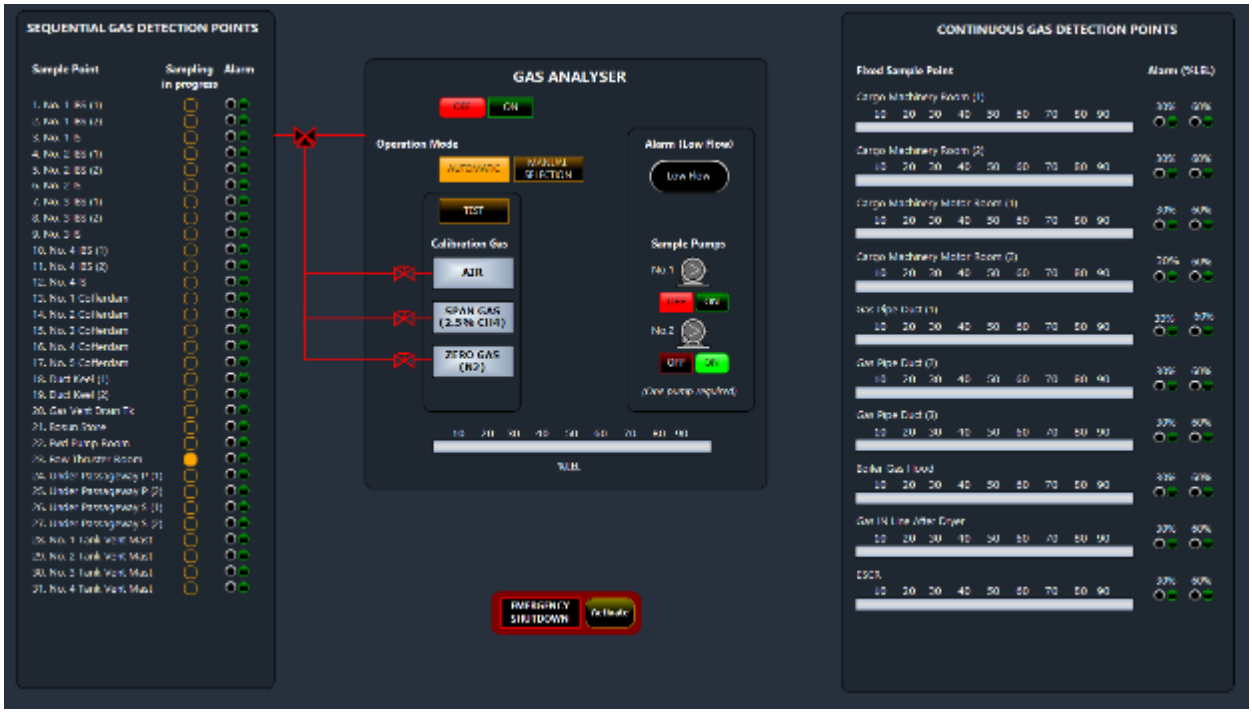
*To operate LNG or Forcing Vaporiser in Automatic Mode:*

The 'Automatic' mode controller for the heater is designed to maintain an outlet temperature already set up, not achieve the setup from start (due to the wide temperature range). To place into automatic mode:

1) Carry out steps 1 – 6 above to obtain the required outlet temperature. (This should be done prior to placing into Automatic mode)
2) When the required outlet temperature has been obtained, select ''Automatic Control' mode. When this is selected the current temperature of the outlet vapour is transferred to become the new set point for the automatic control. To change the temperature, place back into Manual Control, adjust the valves and when the correct temperature is achieved, place back into Automatic control.

## Fixed Gas Detection System

The vessel is fitted with an automatic, sequential and constant hydrocarbon gas detection system for the cargo and engine room spaces. Details of the system can be found in the Cargo Operations Manual. Depending upon the space there are two alarm settings. If the gas level exceeds the 30% LEL alarm setting the alarm for the particular space will illuminate and remain on until the gas level has been checked to reduce below the alarm setting. Where the spaces are monitored constantly a 60% alarm is also provided which initiates various shutdowns if activated.




The system has three modes of operation:

- Automatic
  Sequentially tests each sample point so that all points are tested at least once every 30 minutes as per IGC requirements

- Manual
  This stops the auto sampling mechanism and allows the operator to select a particular sample point for testing by clicking on the orange sample point indicator. The gas level within that space will then be displayed until another sample point is selected.

- Test
  Allows the instrument to be calibrated for zero using Nitrogen, for accurate reading using a 'Span' (test) gas or purged using Air.

### Gas Detector Operation

*To Operate in Automatic (normal) mode:*

1) Place Gas Analyser to 'ON'
2) Start one of the sample pumps. If pump not started low flow alarm will be activated.
3) Select 'Automatic' mode.
4) Check orange indicator moves sequentially through the sample points.

*To Operate in Manual mode:*

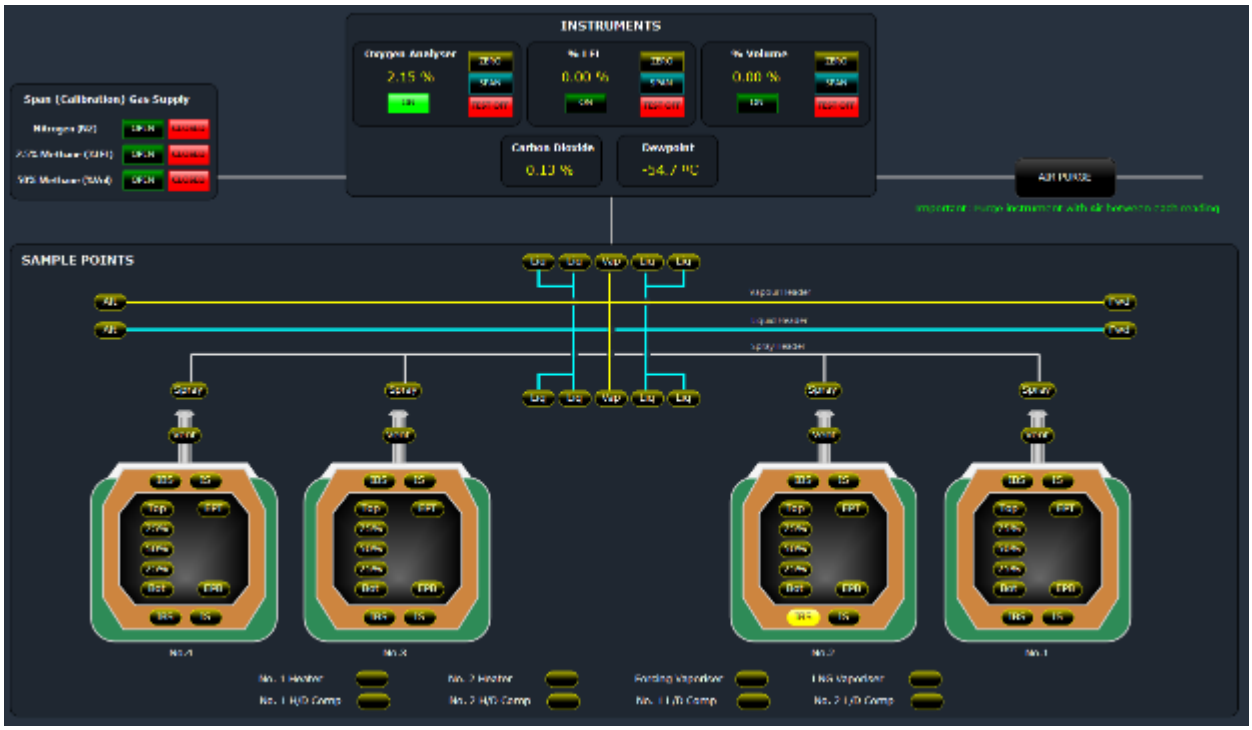
1) Place Gas Analyser to 'ON'
2) Start one of the sample pumps. If pump not started low flow alarm will be activated.
3) Select 'Manual' mode
4) Select the required sample point to be tested by clicking on the orange sample point

*To Operate in Test mode:*

1) Place Gas Analyser to 'ON'
2) Start one of the sample pumps. If pump not started low flow alarm will be activated.
3) Select 'Test' mode
4) Open valve on 'Span' Gas supply. Check instrument reading
5) Close valve on 'Span' Gas supply.
6) Open valve on 'Zero' Gas supply. Check instrument reading
7) Close valve on 'Zero' Gas supply.
8) Select either 'Automatic' or 'Manual' mode.

## Portable Gas Detection

The operator is provided with three portable gas instruments which may be operated, together with $CO_2$ and dewpoint readings which are provided automatically for the sample point selected. Located beneath the instruments are the sample points that may be monitored.




### Instruments provided:

- Oxygen Meter
- Explosimeter (measures %LFL in air)
- Tankscope or Gas Meter (measures % volume in inert atmospheres)
- $CO_2$ (Carbon Dioxide) ppm
- Dewpoint (T in °C)

The method of operation of the instruments on the model has been set up so that the correct procedures have to be followed, as if using the real instruments. Readings are provided automatically on the $CO_2$ and Dewpoint instruments whenever the operator selects any of the other three instruments.

### Operating Procedures:

Although instruments are of different types the operation of each is the same as follows:

1) Switch on instrument to be used. (If one instrument is already on it will automatically switch off if another chosen).
2) Purge instrument with air by locating cursor on AIR supply indicator and touching right hand end of control bar. Light will indicate as purging undertaken.
3) When AIR indicator extinguished, turn on span gas supply, located beneath the respective instrument.
4) Test instrument for correct span reading by operating 'SPAN' indicator.
5) Check reading corresponds with that expected.

6) Check 'ZERO' by first purging instrument with AIR (Explosimeter and Tankscope) or Nitrogen (Oxygen Meter). If not correct, locate cursor on 'ZERO' indicator and touch right hand end of control bar. Reading should change to 0.00.

*Note: If ZERO indicator is operated whilst instrument is not being purged with the 'zero' calibration gas, there is the possibility that an error is introduced into the instrument. Consequently, 'ZERO' should only be operated after the correct zero gas has been purged through the instrument.*

7) When calibration complete, re-purge instrument with AIR.
8) Locate cursor on required sample point and touch right hand end of control bar. Sample point chosen will light up and appropriate readings will be displayed on the actual instrument being used and on the $CO_2$ and dewpoint monitors.
9) Check readings.
10) PURGE instrument with AIR.

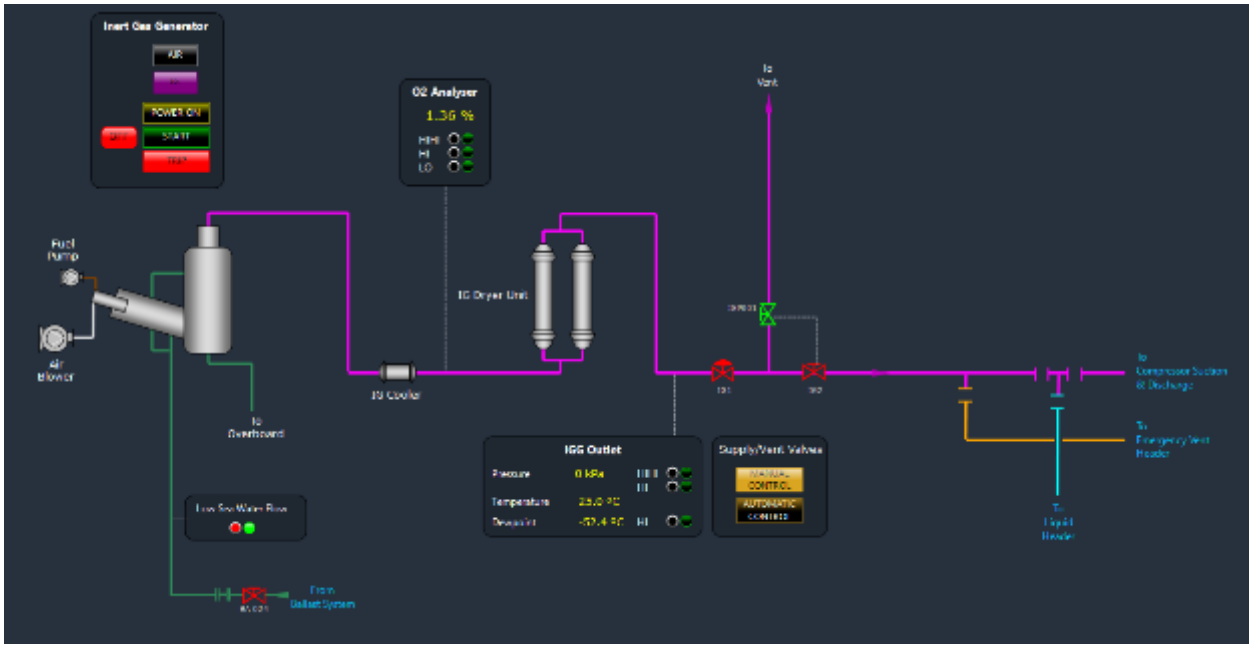
*Note: The instrument has to be purged with air before a new sample point is chosen. If this operation is not undertaken the readings will not change.*

11) Locate next sample point and check readings.

*Note: The displayed reading indicates the amount of gas in the sample point at the time of the sample being taken. It will only change if another sample of the same space is undertaken.*

## Inert Gas Generator

A single Inert Gas Generator is provided which can be used to supply both Inert Gas and Dry Air.




### Operating procedure

*To operate in Dry Air mode:*

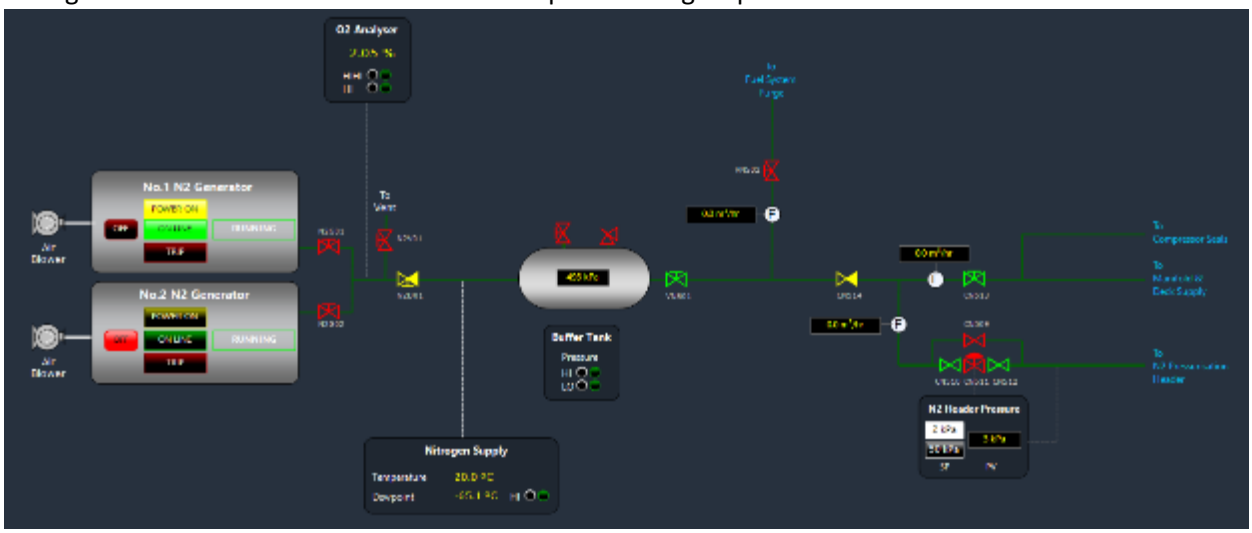
1) Insert spool piece in SW supply line from ballast system
2) Line up and start ballast pump to supply SW to the IG Generator. Confirm Low Sea Water alarm is extinguished
3) Select 'Air' supply button
4) Select 'Power On' to activate power supply
5) Start Generator by selecting 'Start' button
6) The supply valves to the deck can be operated in manual or automatic mode.
   To operate the valves in Manual mode select the 'Manual Control' button located beneath the valves and then click 'ON' on the control bar. The main supply, deck supply and vent valves can then be operated manually as required.
   To operate the valves in Automatic mode select the 'Automatic Control button. The main delivery valve to the deck will open once the dewpoint of the air is below the set point for the required. At the same time the vent valve will close.

*To operate in IG mode:*

1) Insert spool piece in SW supply line from ballast system
2) Line up and start ballast pump to supply SW to the IG Generator. Confirm Low Sea Water alarm is extinguished
3) Select 'IG' supply button
4) Select 'Power On' to activate power supply
5) Start Generator by selecting 'Start' button
6) The supply valves to the deck can be operated in manual or automatic mode.
   To operate the valves in Manual mode select the 'Manual Control' button located beneath the valves and then click 'ON' on the control bar. The main supply, deck supply and vent valves can then be operated manually as required.
   To operate the valves in Automatic mode select the 'Automatic Control button. The main delivery valve to the deck will open when both the Oxygen and dewpoint levels are below the set values. At the same time the vent valve will close.

## Nitrogen Generator

Two Nitrogen Generators are provided, together with a buffer supply tank. Details regarding the Nitrogen Generators can be located in the respective Cargo Operations Manual.

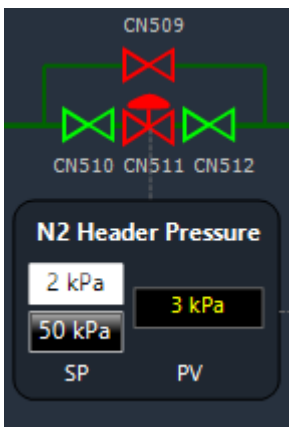



### Operating procedure

1) Open the discharge valves from the generator and line up into the buffer tank
2) Select 'Power On' to activate power supply
3) Start the generator by selecting the 'On Line' button.
   Once one of the Nitrogen Generators has been started, if the pressure within the buffer tank is below 300kPa, the generator will start running (shown by the running indicator) and the delivery valve into the buffer tank will adjust automatically to maintain the pressure within the buffer tank > 300kPa and below 800Kpa. Once the required pressure in the buffer tank has been achieved the 'Running' indicator will extinguish but the generator will remain 'OnLine' in standby mode. Only one generator is normally required to be operating but two will be required when cooldown operations in progress.

### Supply to Pressurisation Header & Insulation Spaces

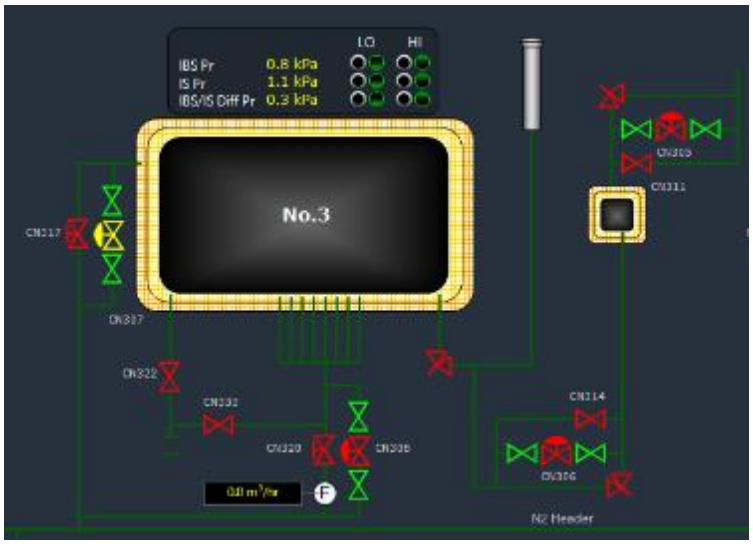
The nitrogen supply to the pressurisation header is controlled via a control valve. This valve is able to control the pressure in the pressurisation header to either 2kPa (normal mode) or 50kPa (cooldown mode). To maintain the correct pressure using the control valve:




1) Open the control valve inlet and outlet valves.

2) Select the required pressure button and then click ‘ON’ on the control bar. Valve position will now automatically adjust to maintain the required pressure in the supply header (PV value).
3) The control valve can be bypassed by opening the bypass valve.

### To operate the Nitrogen purging of the Insulation or Interbarrier spaces:

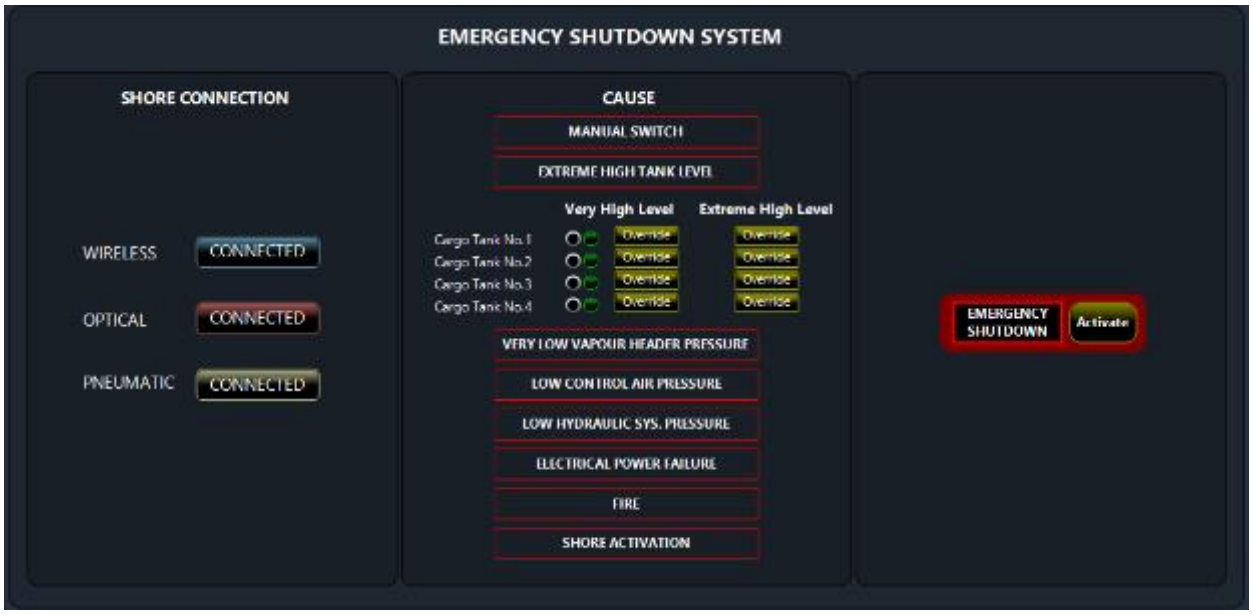



1) Open the inlet and outlet valves for the appropriate control valve for the Insulation space or Interbarrier space $N_2$ supply.
2) Open the inlet and outlet valves for the appropriate control valve for the Insulation space or Interbarrier space $N_2$ exhaust (from vapour dome).

The control valves will operate automatically to maintain the defined pressure in each space and the correct differential pressure between the two spaces (see Cargo Operations Manual)

## Emergency Shutdown System

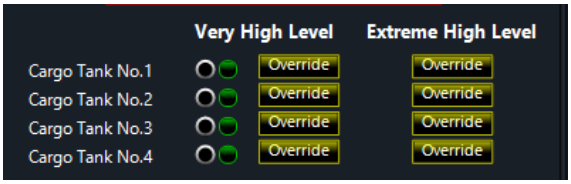
The vessel is equipped with a sophisticated Emergency Shutdown System that can be activated by various conditions. Indication lights are provided which show the cause of the ESD if one should occur.




When alongside a terminal the vessels ESD system should be connected into the shore system using one of the methods provided (Optical Fibre, Pneumatic, Wireless) by selecting the relevant indicator.

To operate the system manually, select the yellow box located to the right of the ESD indicator which is displayed on most of the graphics pages, and then select ‘ON’ on the control bar.

The operator is also provided with the ability to disable the alarms and subsequent actions related to the Very High, and Extreme High level alarms.




When the appropriate ‘Override’ button is illuminated the effects of the alarm (shutting of the cargo tank filling valve or ESD activation) are disabled respectively.

## Loading Rate Control

Using the appropriate 'Loading Control' instructor panel the instructor is able to set up the appropriate shore connections and control the flow rates in to and out of the vessel on all the manifolds.


### Control of loading / liquid flow rates

When acting as the 'dummy jetty' (normal situation) the instructor can control the flow rates in and out of the trainee's vessel. This can be done line by line, or by entering a total value that the model then distributes across the lines that are open. Flow rates out of the model are controlled by the machinery being used within the model, but the instructor can alter the flow rate by increasing or decreasing the external pressure.

All flow rates within the model are dependent upon the pressure difference between the source and final destination. Consequently, a loading rate is controlled by gradually increasing the external supply pressure, which creates a pressure difference with the pressure within the lines in the vessel, causing a flow. To enable this increase to be linear a routine is used within the model.

The set the loading rates, perform the following steps:

a) Check that students manifold valve is open. This can be seen by the current flow indicating non zero on the respective line.
b) Check the shore valve for the respective line is open (can be seen via the graphical symbol on the page)
c) Check the arm has been connected – indicated by 
d) Check the blank on the respective line is not in place – indicated by 
e) Set the 'Change increment' to be at a suitable value (usually 0.005 – 0.05). The change increment is the amount the actual shore pressure will increase or decrease every time step (0.5s) until the actual

pressure = required pressure. By changing this value, the speed of increase/decrease in flow can be controlled. (Note: a smaller value means the pressure will change more slowly causing 'hunting' but slower approach to the required value).

f) Set the 'Maximum allowed' value > 1.00. The maximum allowed value indicates the maximum pressure to which the shore pressure will increase in absolute. Consequently, if the maximum value is set at 1.0 (0.0 gauge) this will be the same as the pressure within the model so there will not be any flow allowed. Usually the value should be set to a normal maximum line operating pressure (9.0 or 10.0) which will allow the line pressure to increase as required to maintain the requested flow.

g) To set flow rate line by line:

   a. Change 'Set flow rate on separate manifolds to =  (Set total flow rate =  )
   b. Enter a required flow in m3/hr for the appropriate line either by clicking on the value and entering a new value and clicking OK, or by clicking on the indicator bar and increasing the value using the control bar slider control
   c. Check external pressure on the line begins to increase
   d. Check actual flow on the line begins to increase and is inward flowing (Flow direction = 1)
   e. When actual flow = required flow check shore pressure remain stable
   f. To change flow rate, enter new required flow
   g. Repeat on the remaining lines

h) To set a total flow rate:

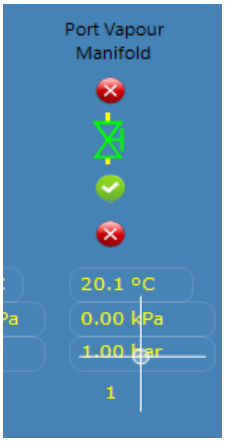
   a. Change 'Set total flow rate =  (Set flow rate on separate manifolds =  )
   b. Enter the required 'total' maximum flow rate (all lines combined) either by clicking on the value and entering a new value and clicking OK, or by clicking on the indicator bar and increasing the value using the control bar slider control
   c. Check external pressure on the lines begins to increase (Model calculates the required flow on each line to achieve the total dependent on the back pressure within the line so different flow rates may apply to different lines)
   d. Check actual flow on all the lines begins to increase and is inward flowing (Flow direction = 1)
   e. When actual flow = required flow check shore pressure remain stable

## Control of vapour flow rate

Flow through the vapour manifold is determined purely by the pressure difference between the internal pressure, either directly from the vapour header or via the compressors, and the external vapour manifold pressure. When the manifold is being used as a vapour return to the shore there is no need to change the default external pressure setting.

To simulator shore gas return during a discharge operation:

a. Locate the cursor on the external pressure applicable to the vapour manifold (center)

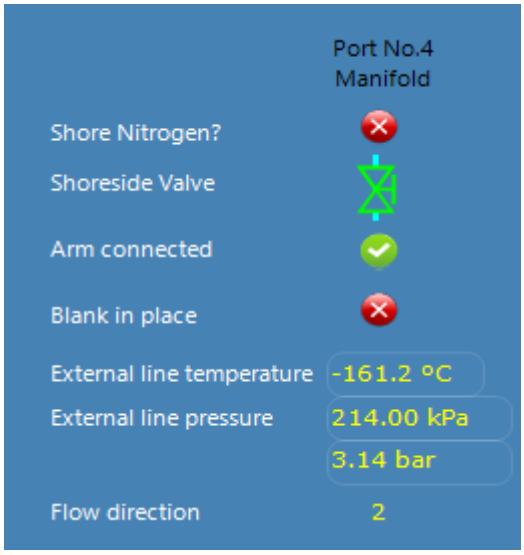



b. Enter an external pressure between 1.000 & 1.300 bar.
c. As the value is entered monitor the gas flow rate into the vessel. To maintain the pressures within the vapour header steady the inflow should be slightly higher than the liquid outflow.

## To select LNG or N2 supply

At times it is necessary to change the liquid or gas that is in the external node (shore) for supply into the vessel. Depending upon the vessel configuration selected the operator can select between:

- LNG (default)
- N2 vapour
- N2 liquid




To change from LNG to N2 vapour click on the 'Shore Nitrogen? Symbol and change to = 

*To purge the lines with N2:*

- Select N2 supply as above
- Set manifold valves in correct positions (closed)
- Set flow rate control to be on individual manifolds
- Set 'Maximum allowed' parameter = 5.000 bar (4 bar / 400kPa gauge)

- Set required flow rate for the connection to be purged > 0 (usually 100). Check external pressure will begin to increase, and actual flow remains at 0 (If flow rate > 0 check valves are closed)
- When external pressure = maximum allowed (5.00 bar) open manifold valves. External pressure will now decrease.
- Repeat until line clear of methane.

## Berth Control

The model is capable of being used in two modes:

a) Normal mode – where the instructor acts as the jetty operator and the model is linked to a 'dummy berth' (this is the normal mode)

b) Connected mode – where two models are connected directly together to enable the transfer of cargo from one model to the other (one station to the other). This mode is used when wishing to simulate direct ship to ship operations


### Normal Mode

The screen shot above shows the model in 'Normal' Mode. To set the model in this mode:

1) Open the 'Global Parameters' instructor panel
2) Set the 'BERTH' parameter = -1
3) Set the 'Side Moored' parameter to = 'P' or 'S' depending upon the side you wish to be connected

### Connected Mode

To connect two models together

1) Load the required scenarios into the two stations to be used (e.g. loaded on one, empty on the other)
2) Open the 'Global Parameters' instructor panel.
3) Set the berth number = a number between 1 and 5 (numbers larger than 5 are ignored). The number needs to be the same on both stations (ie if you decide to use #1, enter '1' into both models
   *Notes:*
   *a) The number you enter indicates a 'berth' number on the interface, not a station number. So on any station you should enter a number between 1 & 5.*
   *b) The number has to be the same in both the models that you are linking. Ie if you wish to use berth 1, you enter '1' into both models indicating they are connected via interface No.1*
4) You then decide which of the models is going to be the master (usually the one discharging) and which is the slave. For the master you set the 'Interface Side' = 2 and on the slave set it = 1
5) You then set the connection arrangements by assigning the 'Conn Flag' or Connection No. to a value between 1 & 4 where:-

1 = P/S
2 = P/P
3 = S/P
4 = S/S

6) The 'Side Moored' parameter is not used when using the connected interface. It is only used along with the dummy berth (ie Berth = -1) when the instructor operates as the jetty.
7) When the above has been completed on both models you have to set the connection flags for the lines to be used on the appropriate side as you defined in (e) = T.

The models should now be linked and cargo will transfer from one to the other in the normal way.

## Tank Contents Control

### Cargo Tanks

The contents within the cargo tanks can be adjusted by the instructor via the 'Cargo Tanks' instructor display


Basic operation of the display is described within the G-Sim Operations Manual. Specific items relating to the cargo are described below:

1) Liquid Level
   The liquid level is shown as a % full, and a sounding (in m) for each tank. To adjust the level select either the slider control and adjust as required or input a new % full. The sounding will adjust accordingly when the model is next run.

   Note: Before the level in the tank can be adjusted there must be liquid present (ie a level already existing) in the tank concerned.

2) Two vapour phases
   This indicates if there are two different vapours present in the vapour phase within the tank space. For example, if there is one gas already within the tank and another is introduced, this indicator will show if the gases are mixing (one mixed vapour) or separating (two vapour phases). This can be used to provide a quick indication as to whether inerting and gassing up operations are being conducted correctly (two vapour phase should = true)

3) Vapour phase properties
   Information showing the current temperature, pressure, molecular weight and density of the current vapour phase

4) Liquid phase properties
5) Information showing the current temperature, pressure, molecular weight and density of the current liquid phase together with the makeup of the current composition of the liquid. The composition can comprise of:
    a. IG
    b. H20
    c. CH4 (methane)
    d. C2H6 (Ethane)
    e. C3H8 (Propane)
    f. O2
    g. CO2

    The composition will be dependent upon the liquid loaded into the vessel from the external node and the temperature and pressure within the tank.

    Note: The composition cannot be changed directly via this display. To change the composition please refer to the separate section in the Operations Manual.

## Ballast Tanks


The contents within the ballast tanks can be adjusted by the instructor via the ‘Ballast Tanks’ instructor display. The instructor is able to change the following:

- Liquid density within the tank
- Liquid level (% full)

To change either of the above the model has to be in the ‘Freeze’ mode. The new values can be entered and when the model is next placed into the ‘Run’ mode the tank contents will update accordingly.

Using the above the instructor can adjust the tank levels to suit the required draft and trim for the proposed exercise situation.

## Fuel & FW Tanks


To ensure the draughts and stability for the vessel are calculated and displayed correctly, the fuel and fresh water tanks need to have appropriate contents for the condition being simulated. The Fuel & FW tank instructor display allows the instructor to input and change the contents of the tanks as required. For each of the tanks the instructor may change:

- Liquid density within the tank
- Liquid level (% full)

To change either of the above the model has to be in the 'Freeze' mode. The new values can be entered and when the model is next placed into the 'Run' mode the tank contents and stability criteria will update accordingly.

The facility is also provided to allow the simulation of the tanks being filled or emptied as part of the simulation (ie bunkering operations in progress) by defining the filling /emptying rate for that tank in $m^3$/min

- To fill a tank
  Enter a positive number (ie > 0.000) into the 'Fill/Empty' column (100$m^3$/hr = enter 1.667/min)
- To empty a tank
  Enter a negative number (ie <0.000) into the 'Fill/Empty' column (-100$m^3$/hr = enter -1.667/min)

## Alarms

The following is a list of the alarms that exist within the LNG Carrier models, together with their respective ID #.

| Alarm ID | Description |
|---|---|
| 31066 | LO Level Tk.1 |
| 31067 | LO Level Tk.2 |
| 31068 | LO Level Tk.3 |
| 31069 | LO Level Tk.4 |
| 31070 | HI Level Tk.1 |
| 31071 | HI Level Tk.2 |
| 31072 | HI Level Tk.3 |
| 31073 | HI Level Tk.4 |
| 31074 | HIHI Level Tk.1 |
| 31075 | HIHI Level Tk.2 |
| 31076 | HIHI Level Tk.3 |
| 31077 | HIHI Level Tk.4 |
| 31078 | VHI Level Tk.1 |
| 31079 | VHI Level Tk.2 |
| 31080 | VHI Level Tk.3 |
| 31081 | VHI Level Tk.4 |
| 31082 | HIHI Pres Tk.1 (P >22 kPa) |
| 31083 | HIHI Pres Tk.2 |
| 31084 | HIHI Pres Tk.3 |
| 31085 | HIHI Pres Tk.4 |
| 31086 | EHI Pres Tk.1.(P >25 Kpa |
| 31087 | EHI Pres Tk.2 |
| 31088 | EHI Pres Tk.3 |
| 31089 | EHI Pres Tk.4 |
| 31090 | LO Pres Tk.1 |
| 31091 | LO Pres Tk.2 |
| 31092 | LO Pres Tk.3 |
| 31093 | LO Pres Tk.4 |
| 31094 | LOLO Pres Tk.1 |
| 31095 | LOLO Pres Tk.2 |
| 31096 | LOLO Pres Tk.3 |
| 31097 | LOLO Pres Tk.4 |
| 31098 | CTS Failure Tk.1 |
| 31099 | CTS Failure Tk.2 |
| 31100 | CTS Failure Tk.3 |
| 31101 | CTS Failure Tk.4 |
| 31102 | LO Tnk.1 Bottom Aft Centre IBS |
| 31103 | LO Tnk.2 Bottom Aft Centre IBS |
| 31104 | LO Tnk.3 Bottom Aft Centre IBS |
| 31105 | LO Tnk.4 Bottom Aft Centre IBS |
| 31106 | LO Tnk.1 Bottom Centre IBS T |
| 31107 | LO Tnk.2 Bottom Centre IBS T |
| 31108 | LO Tnk.3 Bottom Centre IBS T |
| 31109 | LO Tnk.4 Bottom Centre IBS T |
| 31110 | LO Tnk.1 Port Lower IBS T |
| 31111 | LO Tnk.2 Port Lower IBS T |
| 31112 | LO Tnk.3 Port Lower IBS T |
| 31113 | LO Tnk.4 Port Lower IBS T |
| 31114 | LO Tnk.1 Stbd Lower IBS T |
| 31115 | LO Tnk.2 Stbd Lower IBS T |
| 31116 | LO Tnk.3 Stbd Lower IBS T |
| 31117 | LO Tnk.4 Stbd Lower IBS T |
| 31118 | LO Tnk.1 Port Mid IBS T |
| 31119 | LO Tnk.2 Port Mid IBS T |
| 31120 | LO Tnk.3 Port Mid IBS T |
| 31121 | LO Tnk.4 Port Mid IBS T |
| 31122 | LO Tnk.1 Stbd Mid IBS T |
| 31123 | LO Tnk.2 Stbd Mid IBS T |
| 31124 | LO Tnk.3 Stbd Mid IBS T |
| 31125 | LO Tnk.4 Stbd Mid IBS T |
| 31126 | LO Tnk.1 Port Upper IBS T |
| 31127 | LO Tnk.2 Port Upper IBS T |
| 31128 | LO Tnk.3 Port Upper IBS T |
| 31129 | LO Tnk.4 Port Upper IBS T |
| 31130 | LO Tnk.1 Stbd Upper IBS T |
| 31131 | LO Tnk.2 Stbd Upper IBS T |
| 31132 | LO Tnk.3 Stbd Upper IBS T |
| 31133 | LO Tnk.4 Stbd Upper IBS T |
| 31134 | LO Tnk.1 Top Centre IBS T |
| 31135 | LO Tnk.2 Top Centre IBS T |
| 31136 | LO Tnk.3 Top Centre IBS T |
| 31137 | LO Tnk.4 Top Centre IBS T |
| 31138 | LO Tnk.1 Bottom Aft Centre IS |
| 31139 | LO Tnk.2 Bottom Aft Centre IS |
| 31140 | LO Tnk.3 Bottom Aft Centre IS |
| 31141 | LO Tnk.4 Bottom Aft Centre IS |
| 31142 | LO Tnk.1 Bottom Centre IS T |
| 31143 | LO Tnk.2 Bottom Centre IS T |
| 31144 | LO Tnk.3 Bottom Centre IS T |

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| 31145 | LO Tnk.4 Bottom Centre IS T |
| 31146 | LO Tnk.1 Fwd Centre IS T |
| 31147 | LO Tnk.2 Fwd Centre IS T |
| 31148 | LO Tnk.3 Fwd Centre IS T |
| 31149 | LO Tnk.4 Fwd Centre IS T |
| 31150 | LO Tnk.1 Top Centre IS T |
| 31151 | LO Tnk.2 Top Centre IS T |
| 31152 | LO Tnk.3 Top Centre IS T |
| 31153 | LO Tnk.4 Top Centre IS T |
| 31154 | LO Tnk.1 Top Fwd IS T |
| 31155 | LO Tnk.2 Top Fwd IS T |
| 31156 | LO Tnk.3 Top Fwd IS T |
| 31157 | LO Tnk.4 Top Fwd IS T |
| 31158 | LO Tnk No.1 Fwd Top Rt Bhd T |
| 31159 | LO Tnk No.2 Fwd Top Rt Bhd T |
| 31160 | LO Tnk No.3 Fwd Top Rt Bhd T |
| 31161 | LO Tnk No.4 Fwd Top Rt Bhd T |
| 31162 | LO Tnk No.1 Fwd Top Lt Bhd T |
| 31163 | LO Tnk No.2 Fwd Top Lt Bhd T |
| 31164 | LO Tnk No.3 Fwd Top Lt Bhd T |
| 31165 | LO Tnk No.4 Fwd Top Lt Bhd T |
| 31166 | LO Tnk No.1 Fwd Bot Lt Bhd T |
| 31167 | LO Tnk No.2 Fwd Bot Lt Bhd T |
| 31168 | LO Tnk No.3 Fwd Bot Lt Bhd T |
| 31169 | LO Tnk No.4 Fwd Bot Lt Bhd T |
| 31170 | LO Tnk No.1 Fwd Bot Rt Bhd T |
| 31171 | LO Tnk No.2 Fwd Bot Rt Bhd T |
| 31172 | LO Tnk No.3 Fwd Bot Rt Bhd T |
| 31173 | LO Tnk No.4 Fwd Bot Rt Bhd T |
| 31174 | LO Tnk No.1 Fwd Bot Rt Bhd T |
| 31175 | LO Tnk No.2 Fwd Bot Rt Bhd T |
| 31176 | LO Tnk No.3 Fwd Bot Rt Bhd T |
| 31177 | LO Tnk No.4 Fwd Bot Rt Bhd T |
| 31178 | LO Tnk No.1 Aft Top Rt Bhd T |
| 31179 | LO Tnk No.2 Aft Top Rt Bhd T |
| 31180 | LO Tnk No.3 Aft Top Rt Bhd T |
| 31181 | LO Tnk No.4 Aft Top Rt Bhd T |
| 31182 | LO Tnk No.1 Aft Top Lt Bhd T |
| 31183 | LO Tnk No.2 Aft Top Lt Bhd T |
| 31184 | LO Tnk No.3 Aft Top Lt Bhd T |
| 31185 | LO Tnk No.4 Aft Top Lt Bhd T |
| 31186 | LO Tnk No.1 Aft Bot Lt Bhd T |
| 31187 | LO Tnk No.2 Aft Bot Lt Bhd T |
| 31188 | LO Tnk No.3 Aft Bot Lt Bhd T |
| 31189 | LO Tnk No.4 Aft Bot Lt Bhd T |
| 31190 | LO Tnk No.1 Aft Bot Rt Bhd T |
| 31191 | LO Tnk No.2 Aft Bot Rt Bhd T |
| 31192 | LO Tnk No.3 Aft Bot Rt Bhd T |
| 31193 | LO Tnk No.4 Aft Bot Rt Bhd T |
| 31194 | LO Tnk No.1 Aft Bot Rt Bhd T |
| 31195 | LO Tnk No.2 Aft Bot Rt Bhd T |
| 31196 | LO Tnk No.3 Aft Bot Rt Bhd T |
| 31197 | LO Tnk No.4 Aft Bot Rt Bhd T |
| 31198 | LO Press IBS 1 |
| 31199 | LO Press IBS 2 |
| 31200 | LO Press IBS 3 |
| 31201 | LO Press IBS 4 |
| 31202 | LO Press IS 1 |
| 31203 | LO Press IS 2 |
| 31204 | LO Press IS 3 |
| 31205 | LO Press IS 4 |
| 31206 | LO Press IS/IBS 1 |
| 31207 | LO Press IS/IBS 2 |
| 31208 | LO Press IS/IBS 3 |
| 31209 | LO Press IS/IBS 4 |
| 31210 | HI Press IBS 1 |
| 31211 | HI Press IBS 2 |
| 31212 | HI Press IBS 3 |
| 31213 | HI Press IBS 4 |
| 31214 | HI Press IS 1 |
| 31215 | HI Press IS 2 |
| 31216 | HI Press IS 3 |
| 31217 | HI Press IS 4 |
| 31218 | HI Press IS/IBS 1 |
| 31219 | HI Press IS/IBS 2 |
| 31220 | HI Press IS/IBS 3 |
| 31221 | HI Press IS/IBS 4 |
| 31222 | No.1 Tk. Filling Valve stuck |
| 31223 | No.2 Tk. Filling Valve stuck |
| 31224 | No.3 Tk. Filling Valve stuck |
| 31225 | No.4 Tk. Filling Valve stuck |
| 31226 | HI Vapour Header Pres |
| 31227 | LO 1/P Crg.Pmp Amps |
| 31228 | LO 2/P Crg.Pmp Amps |
| 31229 | LO 3/P Crg.Pmp Amps |
| 31230 | LO 4/P Crg.Pmp Amps |
| 31231 | LO 1/S Crg.Pmp Amps |
| 31232 | LO 2/S Crg.Pmp Amps |

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| 31233 | LO 3/S Crg.Pmp Amps |
| 31234 | LO 4/S Crg.Pmp Amps |
| 31235 | LOLO 1/P Crg.Pmp Amps |
| 31236 | LOLO 2/P Crg.Pmp Amps |
| 31237 | LOLO 3/P Crg.Pmp Amps |
| 31238 | LOLO 4/P Crg.Pmp Amps |
| 31239 | LOLO 1/S Crg.Pmp Amps |
| 31240 | LOLO 2/S Crg.Pmp Amps |
| 31241 | LOLO 3/S Crg.Pmp Amps |
| 31242 | LOLO 4/S Crg.Pmp Amps |
| 31243 | HI 1/P Crg.Pmp Amps |
| 31244 | HI 2/P Crg.Pmp Amps |
| 31245 | HI 3/P Crg.Pmp Amps |
| 31246 | HI 4/P Crg.Pmp Amps |
| 31247 | HI 1/S Crg.Pmp Amps |
| 31248 | HI 2/S Crg.Pmp Amps |
| 31249 | HI 3/S Crg.Pmp Amps |
| 31250 | HI 4/S Crg.Pmp Amps |
| 31251 | HIHI 1/P Crg.Pmp Amps |
| 31252 | HIHI 2/P Crg.Pmp Amps |
| 31253 | HIHI 3/P Crg.Pmp Amps |
| 31254 | HIHI 4/P Crg.Pmp Amps |
| 31255 | HIHI 1/S Crg.Pmp Amps |
| 31256 | HIHI 2/S Crg.Pmp Amps |
| 31257 | HIHI 3/S Crg.Pmp Amps |
| 31258 | HIHI 4/S Crg.Pmp Amps |
| 31259 | LO 1/P Crg.Pmp Disch. P |
| 31260 | LO 2/P Crg.Pmp Disch. P |
| 31261 | LO 3/P Crg.Pmp Disch. P |
| 31262 | LO 4/P Crg.Pmp Disch. P |
| 31263 | LO 1/S Crg.Pmp Disch. P |
| 31264 | LO 2/S Crg.Pmp Disch. P |
| 31265 | LO 3/S Crg.Pmp Disch. P |
| 31266 | LO 4/S Crg.Pmp Disch. P |
| 31267 | 1/P Crg.Pmp Disch. Valve stuck |
| 31268 | 2/P Crg.Pmp Disch. Valve stuck |
| 31269 | 3/P Crg.Pmp Disch. Valve stuck |
| 31270 | 4/P Crg.Pmp Disch. Valve stuck |
| 31271 | 1/S Crg.Pmp Disch. Valve stuck |
| 31272 | 2/S Crg.Pmp Disch. Valve stuck |
| 31273 | 3/S Crg.Pmp Disch. Valve stuck |
| 31274 | 4/S Crg.Pmp Disch. Valve stuck |
| 31275 | LO No.1 Spray Pmp Amps |
| 31276 | LO No.2 Spray Pmp Amps |
| 31277 | LO No.3 Spray Pmp Amps |
| 31278 | LO No.4 Spray Pmp Amps |
| 31279 | LOLO No.1 Spray Pmp Amps |
| 31280 | LOLO No.2 Spray Pmp Amps |
| 31281 | LOLO No.3 Spray Pmp Amps |
| 31282 | LOLO No.4 Spray Pmp Amps |
| 31283 | HI No.1 Spray Pmp Amps |
| 31284 | HI No.2 Spray Pmp Amps |
| 31285 | HI No.3 Spray Pmp Amps |
| 31286 | HI No.4 Spray Pmp Amps |
| 31287 | HIHI No.1 Spray Pmp Amps |
| 31288 | HIHI No.2 Spray Pmp Amps |
| 31289 | HIHI No.3 Spray Pmp Amps |
| 31290 | HIHI No.4 Spray Pmp Amps |
| 31291 | LO Vapour Header Pres |
| 31292 | LO No.2 Glycol Return T |
| 31293 | LO No.1 Glycol Return T |
| 31294 | LO No.2 Glycol Pmp BackP |
| 31295 | LO No.1 Glycol Pmp BackP |
| 31296 | LO No.2 Steam/Glycol Diff.P |
| 31297 | LO No.1 Steam/Glycol Diff.P |
| 31298 | LO No.2 Steam P |
| 31299 | LO No.1 Steam P |
| 31300 | HI No.2 Steam P |
| 31301 | HI No.1 Steam P |
| 31302 | HI No.2 Heater Outlet T |
| 31303 | HI No.1 Heater Outlet T |
| 31304 | HiHi No.2 Heater Outlet T(>105 C) |
| 31305 | HiHi No.1 Heater Outlet T(>105 C) |
| 31306 | Gas Detection Group Alarm |
| 31307 | LOLO H/D Comp.1 L.O. P |
| 31308 | LOLO H/D Comp.2 L.O. P |
| 31309 | HIHI H/D Comp.1 L.O. T |
| 31310 | HIHI H/D Comp.2 L.O. T |
| 31311 | LO H/D Comp.1 L.O. T |
| 31312 | LO H/D Comp.2 L.O. T |
| 31313 | HI H/D Comp.1 Bearing T |
| 31314 | HI H/D Comp.2 Bearing T |
| 31315 | HIHI H/D Comp.1 Bearing T |
| 31316 | HIHI H/D Comp.2 Bearing T |
| 31317 | H/D Comp.1 Rotor Excess Vibr. |
| 31318 | H/D Comp.2 Rotor Excess Vibr. |
| 31319 | H/D Comp.1 Rotor Axis Excess P |
| 31320 | H/D Comp.2 Rotor Axis Excess P |

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| 31321 | H/D: Comp.1 N2 Seal Gas P --LO |
| 31322 | H/D: Comp.2 N2 Seal Gas P --LO |
| 31323 | H/D: Comp.1 N2 Seal Gas P --LOLO |
| 31324 | H/D: Comp.2 N2 Seal Gas P --LOLO |
| 31325 | LO H/D Comp.1 Bulkhead Seal P |
| 31326 | LO H/D Comp.2 Bulkhead Seal P |
| 31327 | LOLO H/D Comp.1 Bulkhead Seal |
| 31328 | LOLO H/D Comp.2 Bulkhead Seal |
| 31329 | HI H/D Comp.1 Bulkhead Seal T |
| 31330 | HI H/D Comp.2 Bulkhead Seal T |
| 31331 | HIHI H/D Comp.1 Bulkhead Seal T |
| 31332 | HIHI H/D Comp.2 Bulkhead Seal T |
| 31333 | HI H/D Comp.1 Disch. T |
| 31334 | HI H/D Comp.2 Disch. T |
| 31335 | HIHI H/D Comp.1 Disch. T |
| 31336 | HIHI H/D Comp.2 Disch. T |
| 31337 | LOLO L/D Comp.1 L.O. P |
| 31338 | LOLO L/D Comp.2 L.O. P |
| 31339 | HIHI L/D Comp.1 L.O. T |
| 31340 | HIHI L/D Comp.2 L.O. T |
| 31341 | LO L/D Comp.1 L.O. T |
| 31342 | LO L/D Comp.2 L.O. T |
| 31343 | HI L/D Comp.1 Bearing T |
| 31344 | HI L/D Comp.2 Bearing T |
| 31345 | HIHI L/D Comp.1 Bearing T |
| 31346 | HIHI L/D Comp.2 Bearing T |
| 31347 | L/D Comp.1 Rotor Excess Vibr. |
| 31348 | L/D Comp.2 Rotor Excess Vibr. |
| 31349 | L/D Comp.1 Rotor Axis Excess P |
| 31350 | L/D Comp.2 Rotor Axis Excess P |
| 31351 | LO L/D Comp.1 N2 Seal Gas P |
| 31352 | LO L/D Comp.2 N2 Seal Gas P |
| 31353 | LOLO L/D Comp.1 N2 Seal Gas P |
| 31354 | LOLO L/D Comp.2 N2 Seal Gas P |
| 31355 | LO L/D Comp.1 Bulkhead Seal P |
| 31356 | LO L/D Comp.2 Bulkhead Seal P |
| 31357 | LOLO L/D Comp.1 Bulkhead Seal |
| 31358 | LOLO L/D Comp.2 Bulkhead Seal |
| 31359 | HI L/D Comp.1 Bulkhead Seal T |
| 31360 | HI L/D Comp.2 Bulkhead Seal T |
| 31361 | HIHI L/D Comp.1 Bulkhead Seal |
| 31362 | HIHI L/D Comp.2 Bulkhead Seal |
| 31363 | HI L/D Comp.1 Disch. T |
| 31364 | HI L/D Comp.2 Disch. T |

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| 31365 | HIHI L/D Comp.1 Disch. T |
| 31366 | HIHI L/D Comp.2 Disch. T |
| 31367 | LO No.2 Heater Disch. T |
| 31368 | LO No.1 Heater Disch. T |
| 31369 | HI No.2 Heater Disch. T |
| 31370 | HI No.1 Heater Disch. T |
| 31371 | HIHI No.2 Heater Disch. T |
| 31372 | HIHI No.1 Heater Disch. T |
| 31373 | HI No.2 Heater Condensate Leve |
| 31374 | HI No.1 Heater Condensate Leve |
| 31375 | LO No.2 Heater Condensate T |
| 31376 | LO No.1 Heater Condensate T |
| 31377 | LOLO No.2 Heater Condensate T |
| 31378 | LOLO No.1 Heater Condensate T |
| 31379 | LO LNG Vapouriser Disch. T |
| 31380 | LO Forcing Vapouriser Disch. T |
| 31381 | HI LNG Vapouriser Disch. T |
| 31382 | HI Forcing Vapouriser Disch. T |
| 31383 | HI LNG Vapouriser Condensate L |
| 31384 | HI Forcing Vapouriser Condensa |
| 31385 | LO Forcing Vapouriser Mist Sep |
| 31386 | LO BOG line P |
| 31387 | LO Seal Water P |
| 31388 | HI IG O2 content |
| 31389 | HIHI IG O2 content |
| 31390 | LO IG O2 content |
| 31391 | HI IG Delivery P |
| 31392 | HIHI IG Delivery P |
| 31393 | HI IG dew-point |
| 31394 | HI N2 O2 content |
| 31395 | HIHI N2 O2 content |
| 31396 | HI N2 dew-point |
| 31397 | LO N2 Buffer Tank P |
| 31398 | HI N2 Buffer Tank P |
| 31399 | HI IBS/IS Pressurisation Line |
| 31400 | LO IBS/IS Pressurisation Line |
| 31401 | LO Sample Flow (Fail) |
| 31402 | HI % LEL Cargo Mach.Room (1) |
| 31403 | HI % LEL Cargo Mach.Room (2) |
| 31404 | HI % LEL Cargo Mach.Motor Room |
| 31405 | HI % LEL Cargo Mach.Motor Room |
| 31406 | HI % LEL Fuel Gas Main Pipe Du |
| 31407 | HI % LEL Fuel Gas Main Pipe Du |
| 31408 | HI % LEL Fuel Gas Main Pipe Du |

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| 31409 | HI % LEL Boiler Hood |
| 31410 | HI % LEL IG Line after Drier |
| 31411 | HI % LEL ESCR |
| 31412 | HI % No.1 IBS (1) |
| 31413 | HI % LEL No.1 IBS (2) |
| 31414 | HI % LEL No.1 IS |
| 31415 | HI % LEL No.2 IBS (1) |
| 31416 | HI % LEL No.2 IBS (2) |
| 31417 | HI % LEL No.2 IS |
| 31418 | HI % LEL No.3 IBS (1) |
| 31419 | HI % LEL No.3 IBS (2) |
| 31420 | HI % LEL No.3 IS |
| 31421 | HI % LEL No.4 IBS (1) |
| 31422 | HI % LEL No.4 IBS (2) |
| 31423 | HI % LEL No.4 IS |
| 31424 | HI % LEL No.1 Cofferdam |
| 31425 | HI % LEL No.2 Cofferdam |
| 31426 | HI % LEL No.3 Cofferdam |
| 31427 | HI % LEL No.4 Cofferdam |
| 31428 | HI % LEL No.5 Cofferdam |
| 31429 | HI % LEL Duct Keel (1) |
| 31430 | HI % LEL Duct Keel (2) |
| 31431 | HI % LEL Gas Vent Drain Tnk |
| 31432 | HI % LEL Bosun Store |
| 31433 | HI % LEL Fwd Pump Room |
| 31434 | HI % LEL Bow Thruster Room |
| 31435 | HI % LEL Underdeck Passage (Fw |
| 31436 | HI % LEL Underdeck Passage (Af |
| 31437 | HI % LEL Underdeck Passage (Fw |
| 31438 | HI % LEL Underdeck Passage (Af |
| 31439 | HI % LEL No.1 Vent Disch |
| 31440 | HI % LEL No.2 Vent Disch |
| 31441 | HI % LEL No.3 Vent Disch |
| 31442 | HI % LEL No.4 Vent Disch |
| 31443 | LO Level Forepeak WB |
| 31444 | LO Fwd P WB Tank P |
| 31445 | LO Fwd S WB Tank P |
| 31446 | LO No.1 P WB Tank P |
| 31447 | LO No.1 S WB Tank P |
| 31448 | LO No.2 P Fwd WB Tank P |
| 31449 | LO No.2 S Fwd WB Tank P |
| 31450 | LO No.2 P Aft WB Tank P |
| 31451 | LO No.2 S Aft WB Tank P |
| 31452 | LO No.3 P Fwd WB Tank P |

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| 31453 | LO No.3 S Fwd WB Tank P |
| 31454 | LO No.3 P Aft WB Tank P |
| 31455 | LO No.3 S Aft WB Tank P |
| 31456 | LO No.4 P WB Tank P |
| 31457 | LO No.4 S WB Tank P |
| 31458 | LO E/R P WB Tank P |
| 31459 | LO E/R S WB Tank P |
| 31460 | LO Aft Peak WB Tank P |
| 31461 | HI Level Forepeak WB |
| 31462 | HI Fwd P WB Tank P |
| 31463 | HI Fwd S WB Tank P |
| 31464 | HI No.1 P WB Tank P |
| 31465 | HI No.1 S WB Tank P |
| 31466 | HI No.2 P Fwd WB Tank P |
| 31467 | HI No.2 S Fwd WB Tank P |
| 31468 | HI No.2 P Aft WB Tank P |
| 31469 | HI No.2 S Aft WB Tank P |
| 31470 | HI No.3 P Fwd WB Tank P |
| 31471 | HI No.3 S Fwd WB Tank P |
| 31472 | HI No.3 P Aft WB Tank P |
| 31473 | HI No.3 S Aft WB Tank P |
| 31474 | HI No.4 P WB Tank P |
| 31475 | HI No.4 S WB Tank P |
| 31476 | HI E/R P WB Tank P |
| 31477 | HI E/R S WB Tank P |
| 31478 | HI Aft Peak WB Tank P |
| 31479 | HI Eductor Suct. P |
| 31480 | HI Fuse T (Fire) |
| 31481 | LO Hydraulic P |
| 31482 | LO Control Air P |
| 31483 | P.1 Burst Pipe Setp |
| 31484 | P.2 Burst Pipe Setp |
| 31485 | P.3 Burst Pipe Setp |
| 31486 | P.4 Burst Pipe Setp |
| 31487 | S.1 Burst Pipe Setp |
| 31488 | S.2 Burst Pipe Setp |
| 31489 | S.3 Burst Pipe Setp |
| 31490 | S.4 Burst Pipe Setp |
| 31491 | No.1 Spray Pmp Disch. Valve st |
| 31492 | No.2 Spray Pmp Disch. Valve st |
| 31493 | No.3 Spray Pmp Disch. Valve st |
| 31494 | No.4 Spray Pmp Disch. Valve st |
| 31495 | No.1 Spray Return Valve stuck |
| 31496 | No.2 Spray Return Valve stuck |

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| 31497 | No.3 Spray Return Valve stuck |
| 31498 | No.4 Spray Return Valve stuck |
| 31499 | HI Mooring Load |
| 31500 | Min Flow flagged if shut again |
| 31501 | LOLO BOG Supply P |
| 31502 | HIHI % LEL Cargo Mach.Room (1) |
| 31503 | HIHI % LEL Cargo Mach.Room (2) |
| 31504 | HIHI % LEL Cargo Mach.Motor Ro |
| 31505 | HIHI % LEL Cargo Mach.Motor Ro |
| 31506 | HIHI % LEL Fuel Gas Main Pipe |
| 31507 | HIHI % LEL Fuel Gas Main Pipe |
| 31508 | HIHI % LEL Fuel Gas Main Pipe |
| 31509 | HIHI % LEL Boiler Hood |
| 31510 | HIHI % LEL IG Line after Drier |
| 31511 | HIHI % LEL ESCR |
| 31512 | LO H/D Comp.1 L.O. P |
| 31513 | LO H/D Comp.2 L.O. P |
| 31514 | HIHi H/D Comp.1 L.O. T |
| 31515 | HIHi H/D Comp.2 L.O. T |
| 31516 | LO L/D Comp.1 L.O. P |
| 31517 | LO L/D Comp.2 L.O. P |
| 31518 | HI L/D Comp.1 L.O. T |
| 31519 | HI L/D Comp.2 L.O. T |
| 31520 | LOLO LNG Vapouriser Disch. T --MC |
| 31521 | LOLO Forcing Vapouriser Disch. --MC |
| 31522 | LOLO Level Tk.1 --MC |
| 31523 | LOLO Level Tk.2 --MC |
| 31524 | LOLO Level Tk.3 --MC |
| 31525 | LOLO Level Tk.4 --MC |
| 31526 | VHI Pres Tk.1(P>23 kPa) |
| 31527 | VHI Pres Tk.2 |
| 31528 | VHI Pres Tk.3 |
| 31529 | VHI Pres Tk.4 |
| 31530 | HI Pres Tk.1(P>20 kPa) |
| 31531 | HI Pres Tk.2 |
| 31532 | HI Pres Tk.3 |
| 31533 | HI Pres Tk.4 |
| 31534 | LOLO Press Tk.1 (P<2 kPa) |
| 31535 | LOLO Press Tk.2 (P<2 kPa) |
| 31536 | LOLO Press Tk.3 (P<2 kPa) |
| 31537 | LOLO Press Tk.4 (P<2 kPa) |
| 31538 | LOLO Vap Header Press (P<2 kPa) |
| 31539 | GCU Trip Indicator (Tk.1 P<4 kPa) |
| 31540 | GCU Stop Indicator (Tk.2 P<4 kPa) |

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| 31541 | GCU Stop Indicator (Tk.3 P<4 kPa) |
| 31542 | GCU Stop Indicator (Tk.4 P<4 kPa) |
| 31543 | LO LO Tank Press diff Tank/IBS1 (<0.5 kPa) |
| 31544 | LO LO Tank Press diff Tank/IBS2 (<0.5 kPa) |
| 31545 | LO LO Tank Press diff Tank/IBS3 (<0.5 kPa) |
| 31546 | LO LO Tank Press diff Tank/IBS4 (<0.5 kPa) |
| 31547 | VLO Vap. Header Pressure(<0.3) |
| 31548 | SP for High Vapour header Pressure( >0.92*SP) |
| 31549 | BOG Compr.1 Suction P -HiHi |
| 31550 | BOG Compr.2 Suction P -HiHi |
| 31551 | BOG Compr.1 Suction P -Hi |
| 31552 | BOG Compr.2 Suction P -Hi |
| 31553 | BOG Compr.1 Suction P -LoLo |
| 31554 | BOG Compr.2 Suction P -LoLo |
| 31555 | BOG Compr.1 Suction T -HiHi |
| 31556 | BOG Compr.2 Suction T -HiHi |
| 31557 | BOG Compr.1 Suction T -Hi |
| 31558 | BOG Compr.2 Suction T -Hi |
| 31559 | BOG Compr.1 Diff P at Stage1 -Hi |
| 31560 | BOG Compr.2 Diff P at Stage1 -Hi |
| 31561 | BOG Compr.1 Interstage T -Hi |
| 31562 | BOG Compr.2 Interstage T -Hi |
| 31563 | BOG Compr.1 Interstage T -HiHi |
| 31564 | BOG Compr.2 Interstage T -HiHi |
| 31565 | BOG Compr.1 Discharge P -Hi |
| 31566 | BOG Compr.2 Discharge P -Hi |
| 31567 | BOG Compr.1 Discharge P -HiHi |
| 31568 | BOG Compr.2 Discharge P -HiHi |
| 31569 | BOG Compr.1 Discharge T -Hi |
| 31570 | BOG Compr.2 Discharge T -Hi |
| 31571 | BOG Compr.1 Discharge T -HiHi |
| 31572 | BOG Compr.2 Discharge T -HiHi |
| 31573 | BOG Compr.1 Bearing T-HiHi |
| 31574 | BOG Compr.2 Bearing T-HiHi |
| 31575 | BOG Compr.1 Bearing Vibr.-HiHi |
| 31576 | BOG Compr.2 Bearing Vibr.-HiHi |
| 31577 | BOG Compr.1 Shaft Displacement-HiHi |
| 31578 | BOG Compr.2 Shaft Displacement-HiHi |
| 31579 | BOG Compr.1 N2 Seal Gas P -LoLo |
| 31580 | BOG Compr.1 N2 Seal Gas P -LoLo |

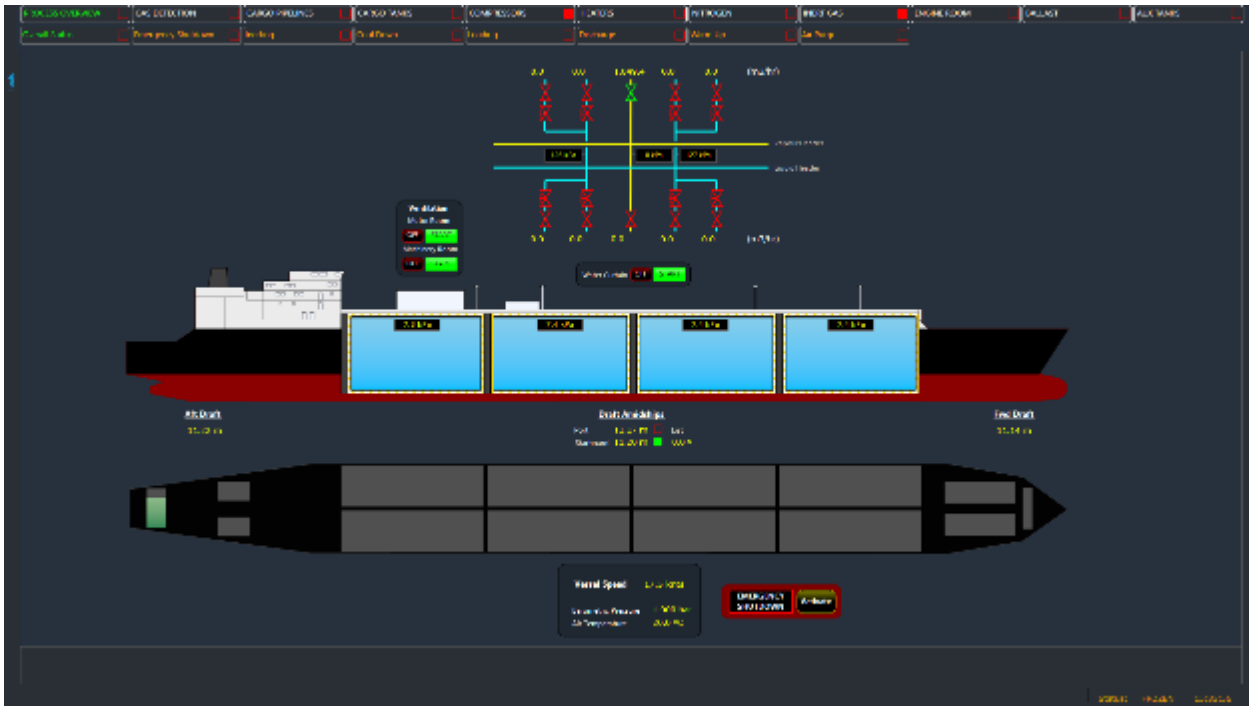
| | |
|---|---|
| 31581 | BOG Compr.1 Bulkhead Seal P-LoLo |
| 31582 | BOG Compr.2 Bulkhead Seal P-LoLo |
| 31583 | BOG Compr.1 Bulkhead Seal T -HiHi |
| 31584 | BOG Compr.2 Bulkhead Seal T -HiHi |
| 31585 | BOG Compr.1 L.O. P-LoLo |
| 31586 | BOG Compr.2 L.O. P-LoLo |
| 31587 | BOG Compr.1 L.O. T -HiHi |
| 31588 | BOG Compr.2 L.O. T -HiHi |

| | |
|---|---|
| 31589 | BOG Compr.1 L.O. T -Hi |
| 31590 | BOG Compr.2 L.O. T -Hi |
| 31591 | After Cooler/Heater Outlet T-Lo |
| 31592 | Separaror Level-Hi |
| 31593 | Separaror Level-HiHi [483] |
| 31594 | DFDE: Low Methane Number at Separator Exit |

# Listing of Graphics Displays

## Process Overview

### Status



This provides the operator with access to the overall status of the vessel at any time including the following:

- Manifold Status – Provides indication of the position status of the manifold valves and the current flow rates on each manifold
- Cargo and Ballast Tank Status – The level within each tank is displayed, (Blue for Liquid Cargo, Green for ballast). The level indicators update automatically as the appropriate tanks are filled or emptied.
- Draught Information – Draughts fwd, aft and amidships are displayed. The amount of list is indicated in degrees with the red or green light indicating if list is to port or stbd.
- Machinery Room Ventilation Controls – If the fans for the cargo machinery room are not operating, or are stopped, the ESDS will be activated
- Weather Status
- Emergency Shutdown System Activation.

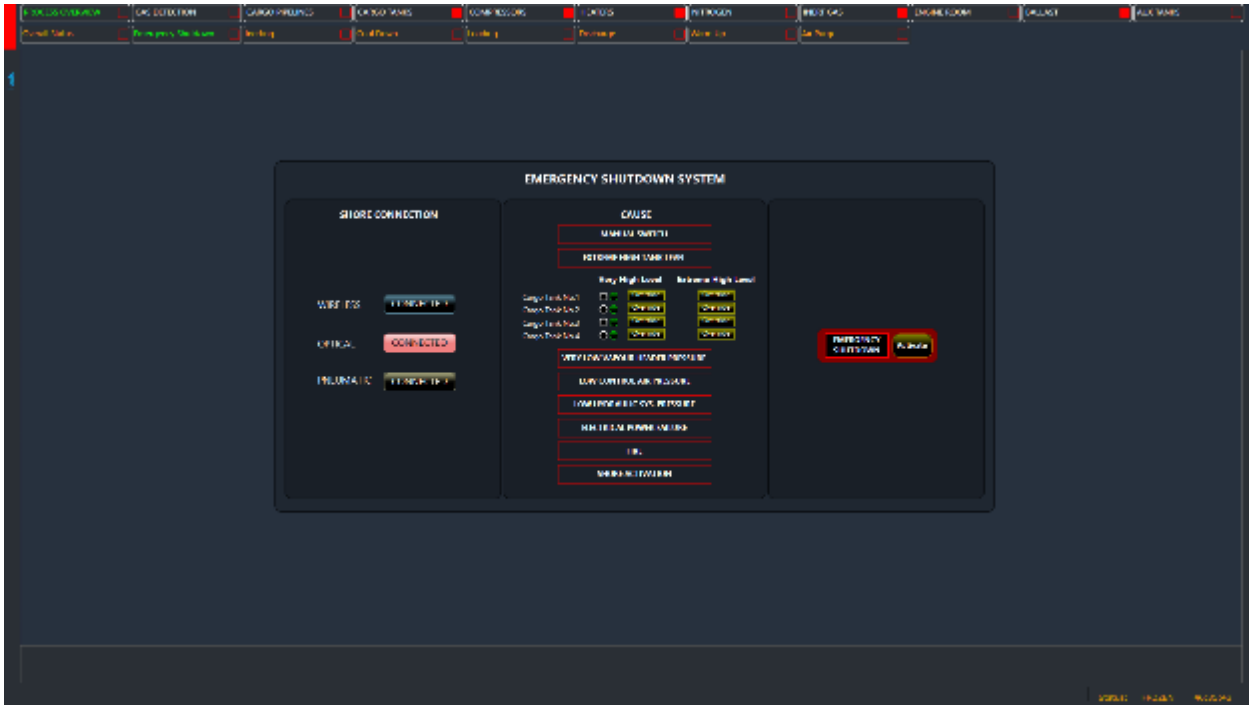
Hot links are located as follows:

- Manifold – links to manifold display
- Cargo tanks – link to the appropriate cargo tank display
- Ballast – links to ballast system display

Model parameters or malfunctions that can be accessed directly via the Status display include:

- Speed
- Flow control
- Weather conditions

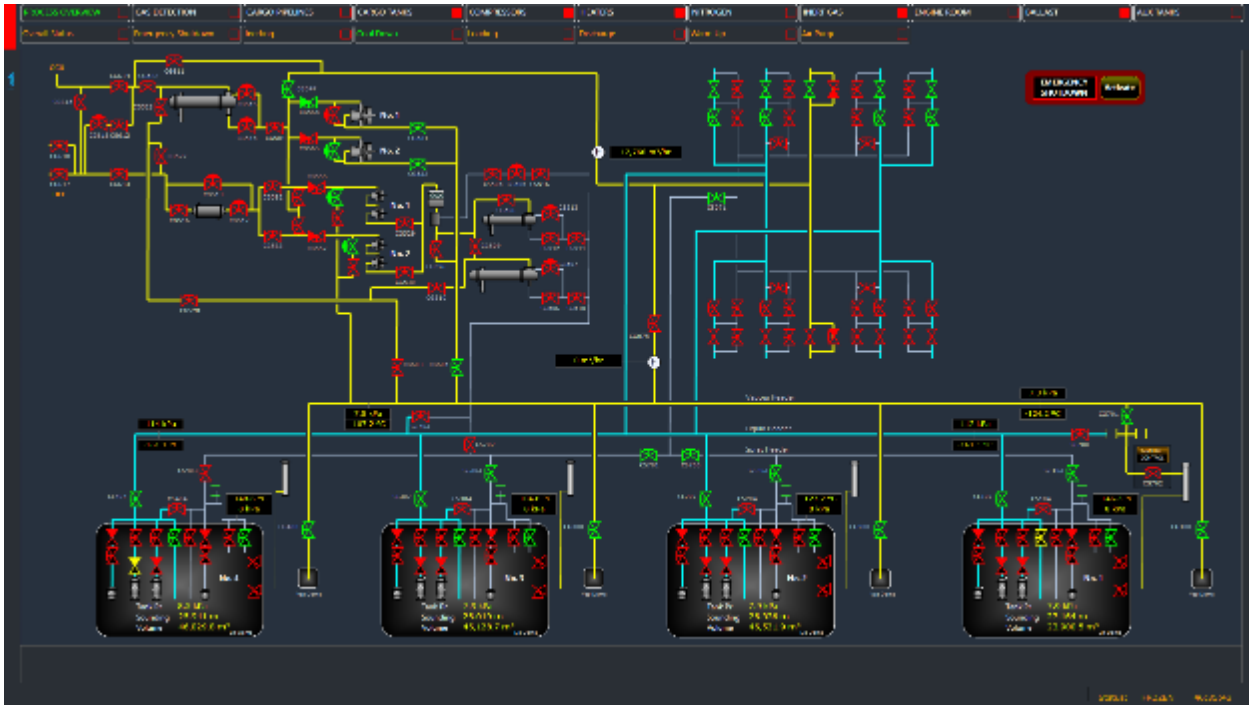
## Emergency Shutdown




Provides access to the controls related to the Emergency Shutdown System including:

- Selection of shore connection
- Indication of activation cause
- Tank Protection System (TPS) trigger override for Very high cargo tank level
- ESD trigger override for Extreme high cargo tank level
- Manual ESD activation point

## Operation Mimics



A number of displays based on the main cargo pipeline display but adapted so that only the pipelines and equipment that will be used to undertake the operation concerned are displayed.
The relevant displays include:

- Inerting
- Cooldown
- Loading
- Discharge
- Warm Up
- Air Purge

Hot links are located as follows:

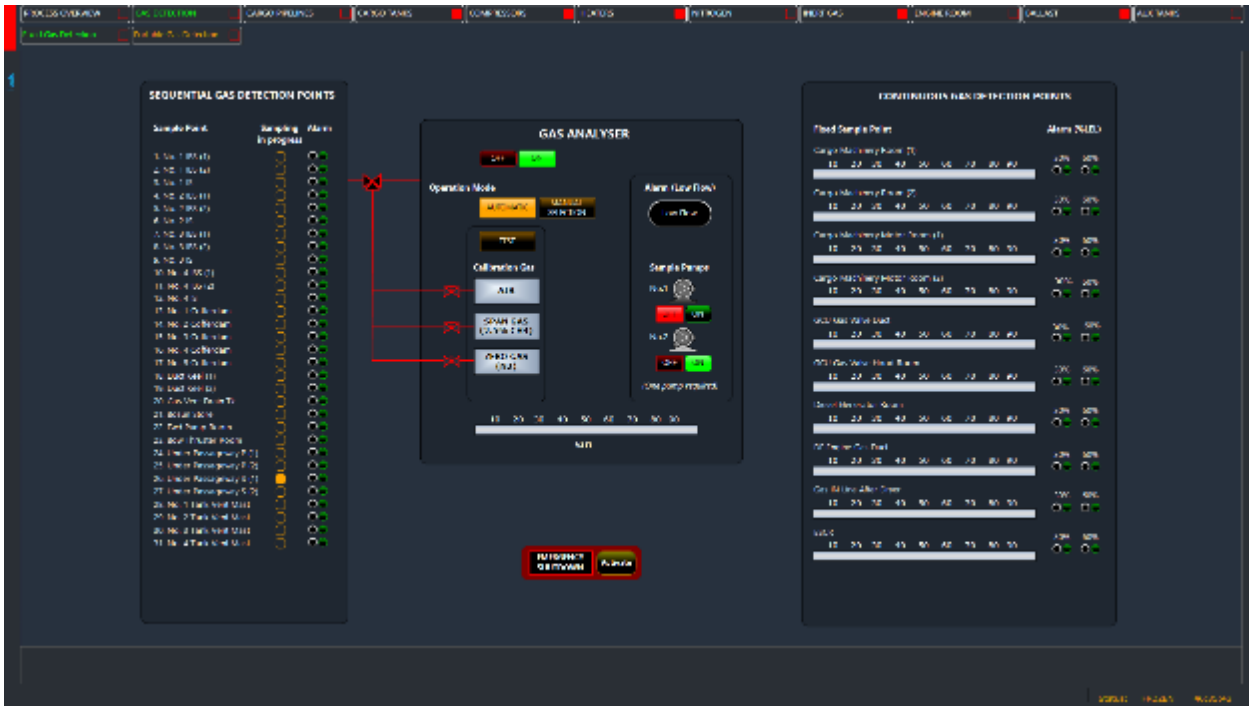
- Cargo tanks
- Vaporisers
- LD & HD Compressors
- Heaters
- Manifold

Model parameters or malfunctions that can be accessed directly via these displays include:

- Valve malfunctions
- Tank level malfunctions

## Gas Detection

### Fixed Gas Detection



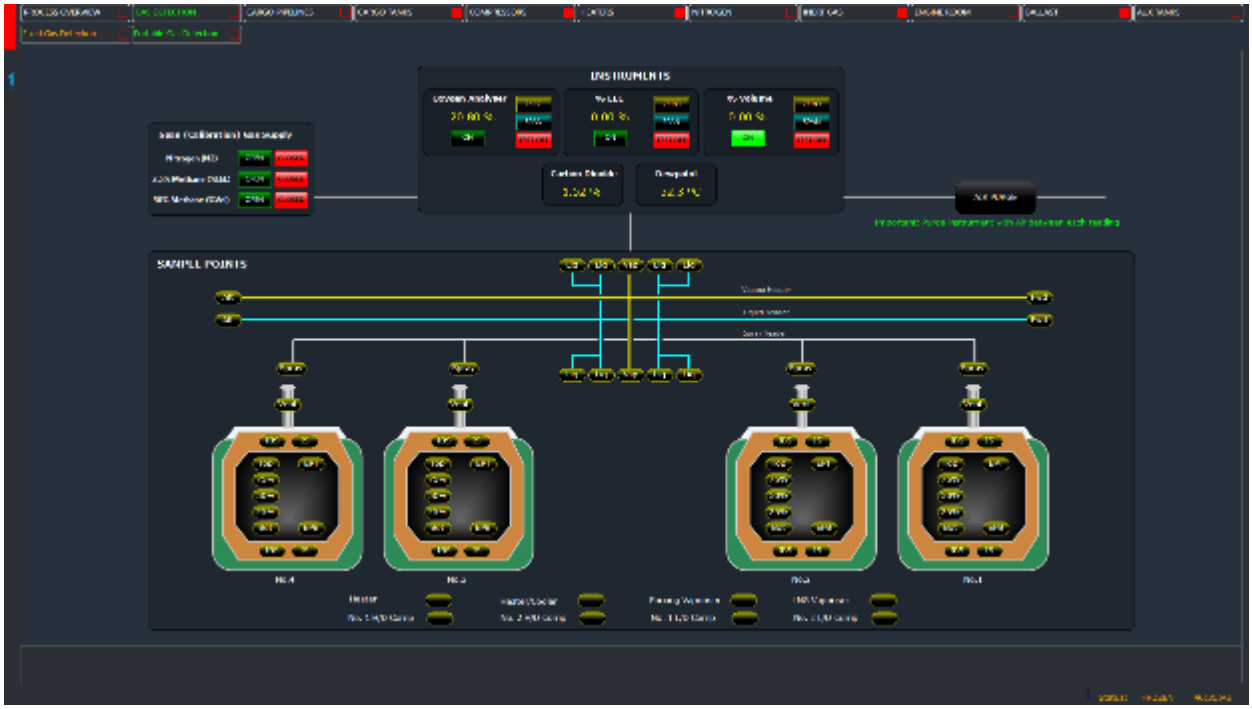

The automatic gas detector enables samples to be taken automatically on a sequential basis from all the defined points every 30 minutes (all samples have to be sampled at least once within that time period), or by the operator manually selecting specific points.

The operation of the system is described in the 'Fixed Gas Detection System' section earlier in this document.

Model parameters or malfunctions that can be accessed directly via this display include:

- Alarm settings
- Gas Malfunctions in non-cargo spaces

## Portable Gas Detection




The operator is provided with three portable gas instruments which may be operated manually. When any of the three instruments is operated the $CO_2$ and dewpoint readings for the space selected are provided automatically.

Located beneath the instruments are the sample points that may be monitored:

- Manifolds
- Main headers, fore & aft
- Spray headers on each tank
- Vent masts on each tank
- Cargo tank contents
- IBS & IS spaces
- Emergency pump column (EPT, EPB)
- Equipment

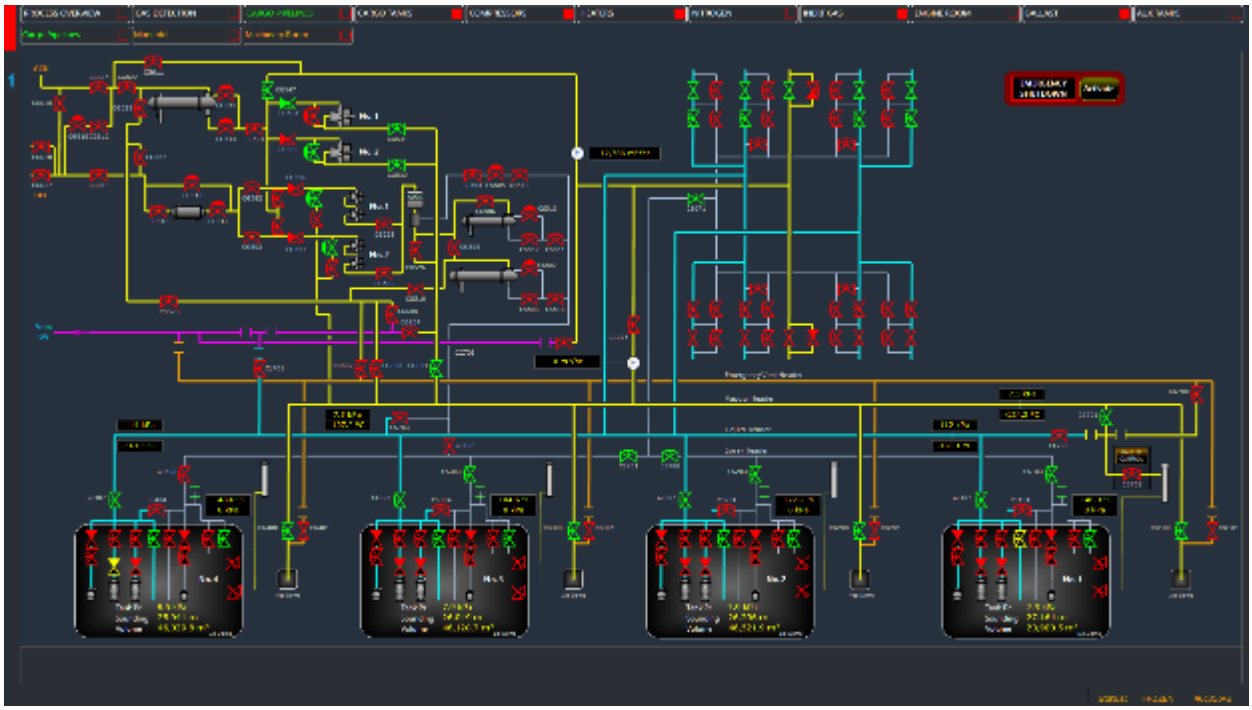
Full details of the instruments and their operation can be found in the Portable Gas Detection section earlier in this document.

Model parameters or malfunctions that can be accessed directly via this display include:

- Instrument malfunctions to introduce an error into the readings displayed

## Cargo Pipelines

### Cargo Pipelines



Provides overview of main pipelines associated with liquid and vapour on deck. Information is also provided on:

- Spray header pressure and temperature for all tanks
- Liquid header pressure and temperature
- Vapour header pressure and temperature
- Cargo tank information
- Manual ESD activation

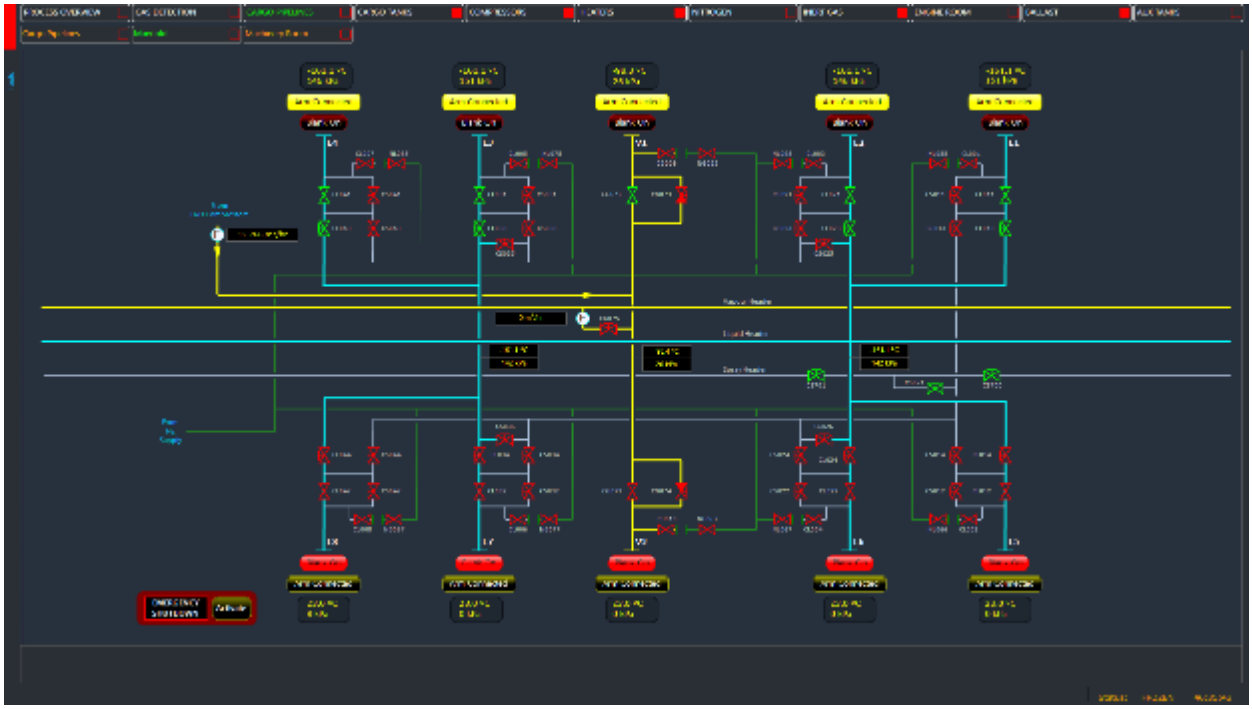
Hot links are located as follows:

- Cargo tanks
- Vaporisers
- LD & HD Compressors
- Heaters
- Manifold

Model parameters or malfunctions that can be accessed directly via these displays include:

- Valve malfunctions
- Tank level malfunctions

## Manifold



This display provides access to the manifold connections for all liquid and vapour lines.

Each manifold is provided with the control to allow the line to be blanked or connected to the shore. The appropriate status is applied when the indicator is illuminated

For each manifold there are three options:

- Blank off, arm not connected – in this position the manifold is open to the atmosphere so if the valves are opened and contents will flow into the atmosphere. Used during inerting and gas freeing
- Blank on, arm not connected – line is blanked so no flow
- Blank off, arm connected – line is connected to the shore

Above screen shot show the port lines connected to the shore arms, and stbd lines blanked and not connected.

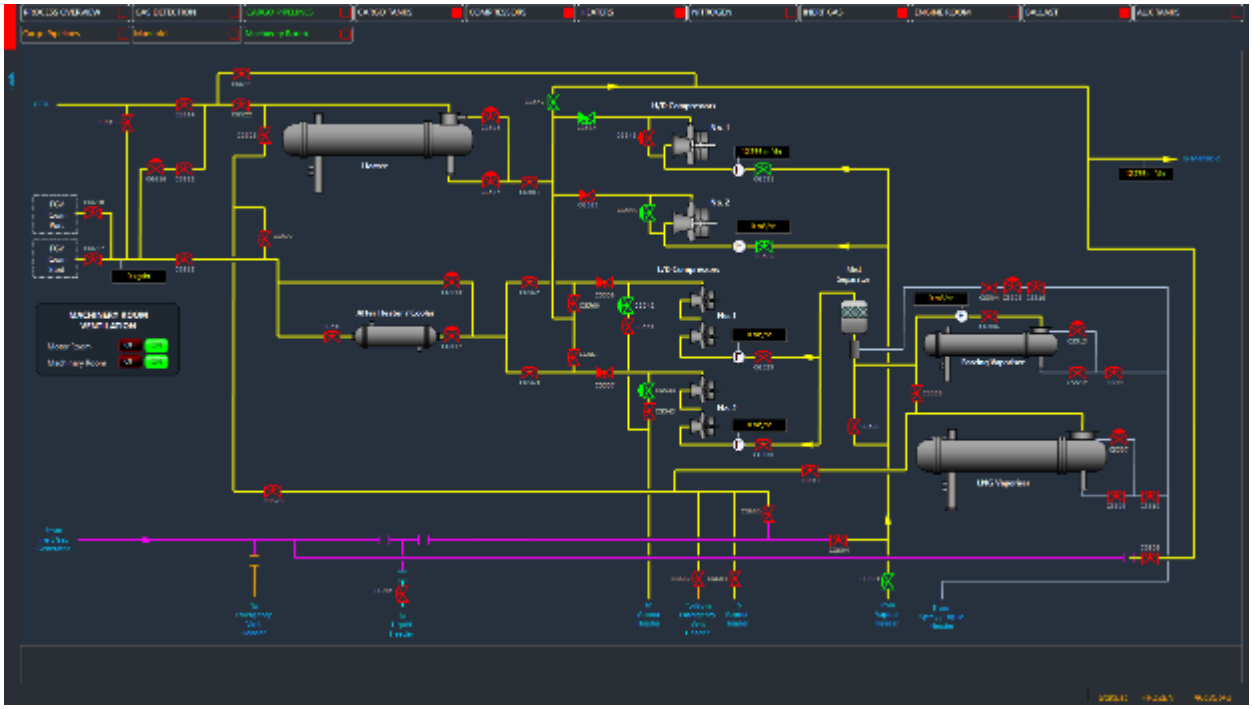
Hot links are located as follows:

- HD Compressors
- N2 Supply

Model parameters or malfunctions that can be accessed directly via these displays include:

- Required flow rate for each liquid manifold (accessed by right clicking on external pressure display for the particular manifold)
- Valve malfunctions

## Machinery Room



Provides overview of pipelines and connections between the various items of machinery and the main deck. The layout of the machinery room will change to reflect the different propulsion system selected for the model arrangement to be used (the above shows the arrangement for the 2 stage DFDE).

Controls are also shown for the machinery room ventilation.

Hot links are located as follows:

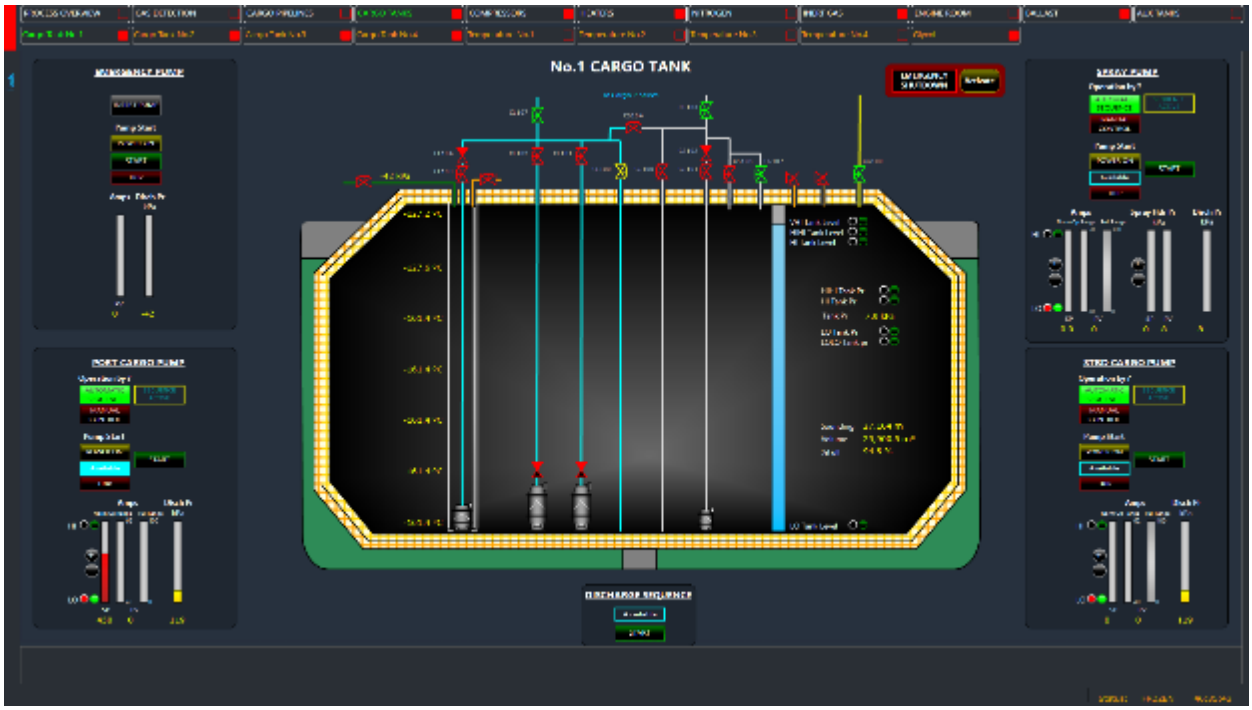
- GCU (Engine Room)
- IG Generator
- Cargo pipelines

Model parameters or malfunctions that can be accessed directly via these displays include:

- Valve malfunctions

## Cargo Tanks

### Cargo Tank No.1 (2,3,4)




Provides the pipeline arrangement within each of the cargo tanks together with the cargo, spray and emergency pump controls depending on the display selected. Details regarding the operation of the controls can be found earlier in this document in the following sections:

Cargo Pumps
Spray Pumps

Additional information displayed includes:

- Cargo tank alarms
- Sounding, volume and % full information
- Cargo tank pressure and temperatures

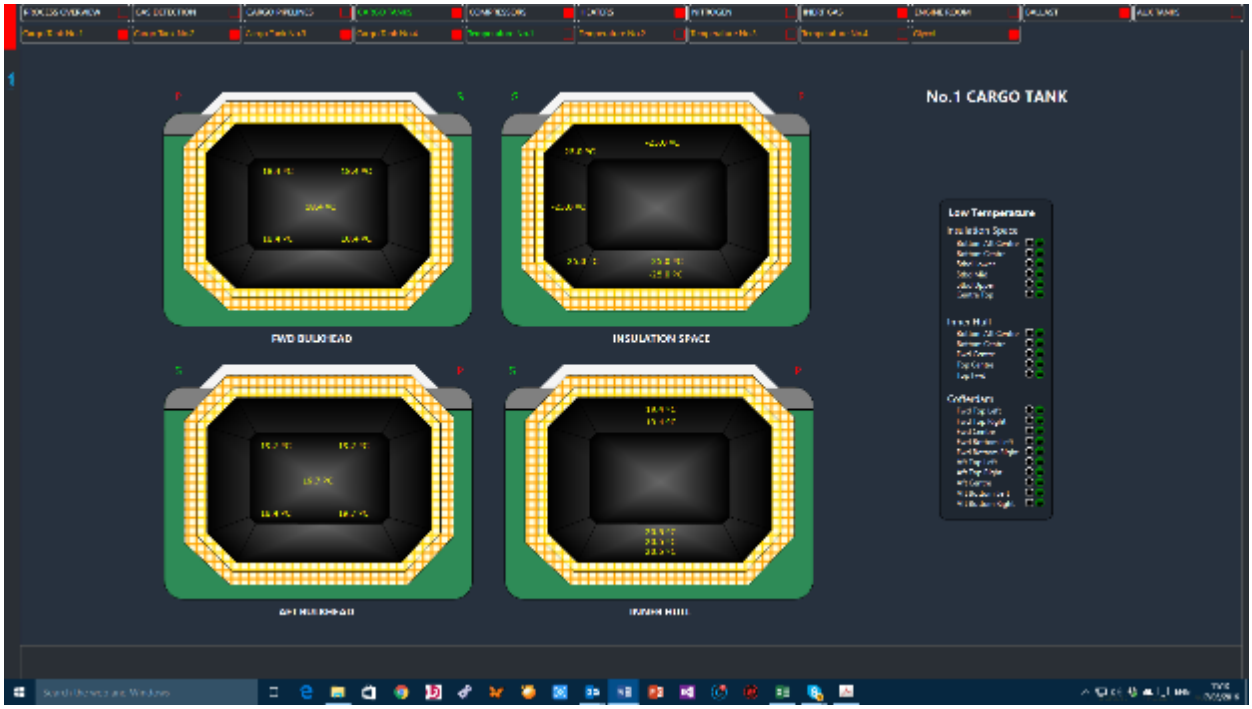
Hot links are located as follows:

- Cargo Pipelines

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Level malfunctions
- Valve Malfunctions
- Alarm settings and malfunctions

## Temperature No.1 (2,3 4)

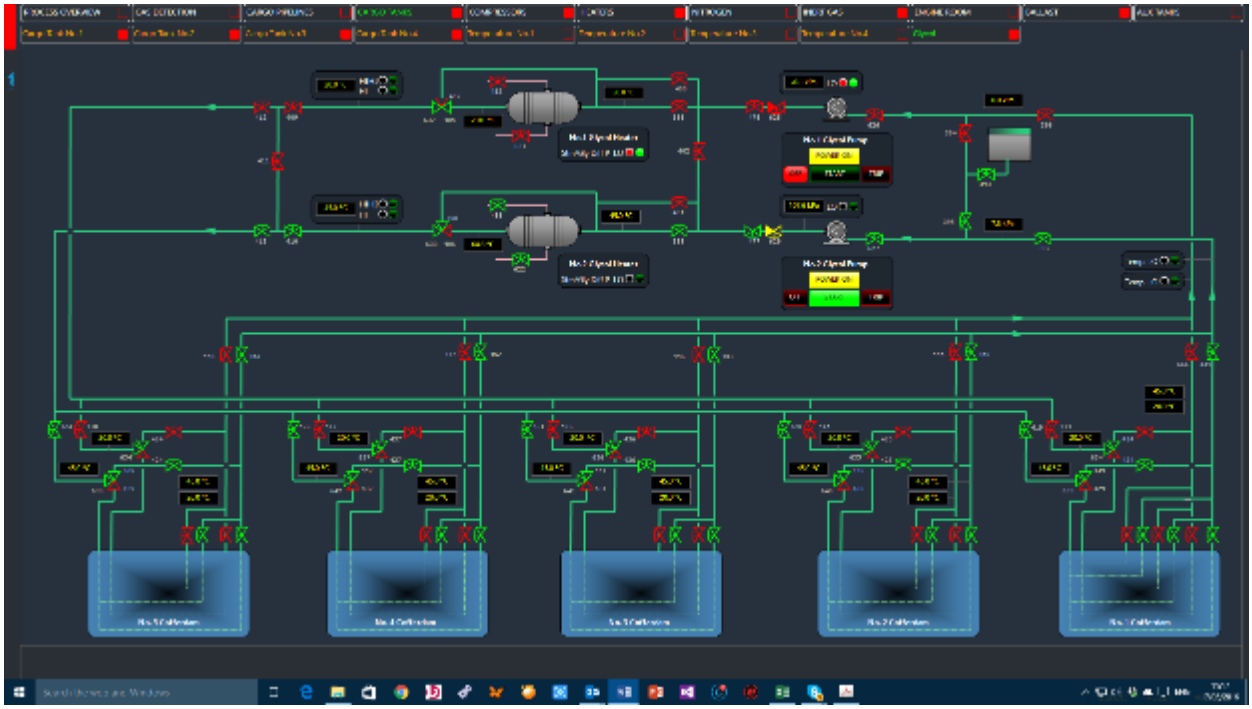



These displays show the temperature monitoring points within the Interbarrier and Insulation spaces surrounding the appropriate cargo tank. The displays are arranged on the basis that the operator is standing within the cargo tank at the centre and then looking at the respective bulkhead.

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Alarm settings and malfunctions

## Glycol System



The controls, equipment and pipeline arrangements for the Glycol Heating System. Both heaters are supplied from the 'Steam Supply' and the pumps are operated using the standard 'Combined Logical Controllers' as described in the G-Sim Operations Manual (above shows No.1 pump stopped, and No.2 pump in operation).

The coils within the cofferdams are supplied via three way valves which are automatic in operation so the position cannot be set by the operator.

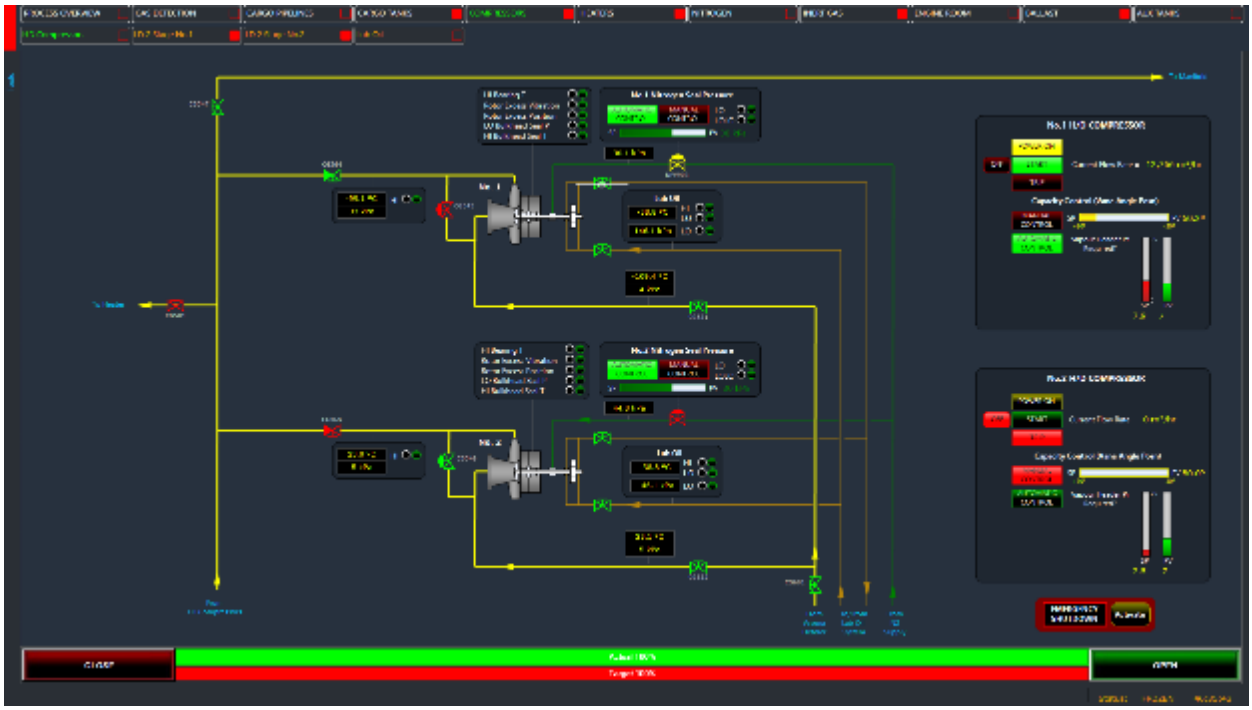
Note: all the outlet return valves from the three way valves need to be open to allow full circulation when the three way valve inlet to the cofferdam coil is closed.

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions

## Compressors

### HD Compressors



Provides access to all the controls and information related to the High Duty (H/D) Compressors. Details about the operation of the various items of machinery or equipment can be found in the HD Compressor section earlier in this document.

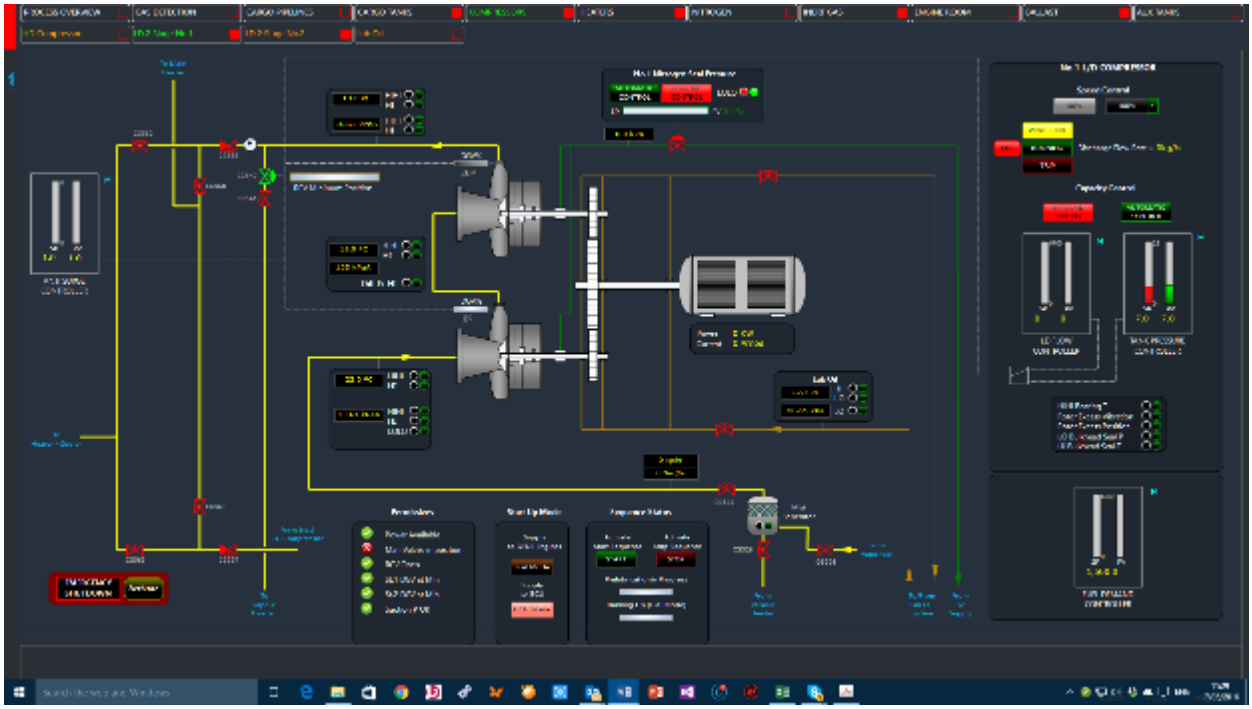
Hot links are located as follows:

- Heaters
- Manifold
- Cargo pipelines
- Lub oil system
- N2 System

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Level malfunctions
- Valve Malfunctions
- Alarm settings and malfunctions

## LD Compressors



Provides access to all the controls and information related to the Low Duty (L/D) Compressors. The controls displayed will change dependent of the propulsion system that has been selected. The above shows the arrangement for the 2 stage DFDE.

Details about the operation of the various items of machinery or equipment can be found in the LD Compressor section earlier in this document.

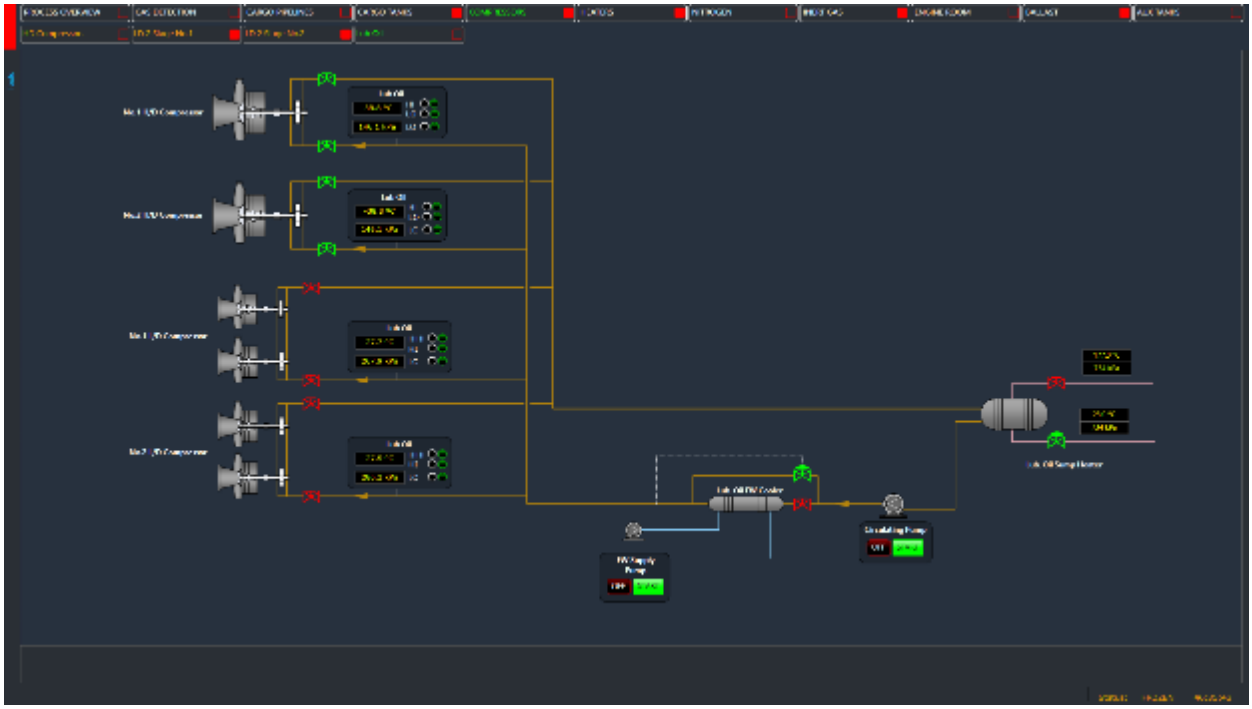
Hot links are located as follows:

- Heaters
- Vaporisers
- Cargo pipelines
- Lub oil system
- N2 System

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Level malfunctions
- Valve Malfunctions
- Alarm settings and malfunctions

## Lub Oil System



The controls and equipment comprising the lubricating oil system for the compressors. The pumps are operated using a simple logical controller.

The lub oil FW cooler bypass valve is automatically controlled. This also applies to the steam supply valve to the Sump Heater. The operator is not able to set the position of these two valves.

Hot links are located as follows:

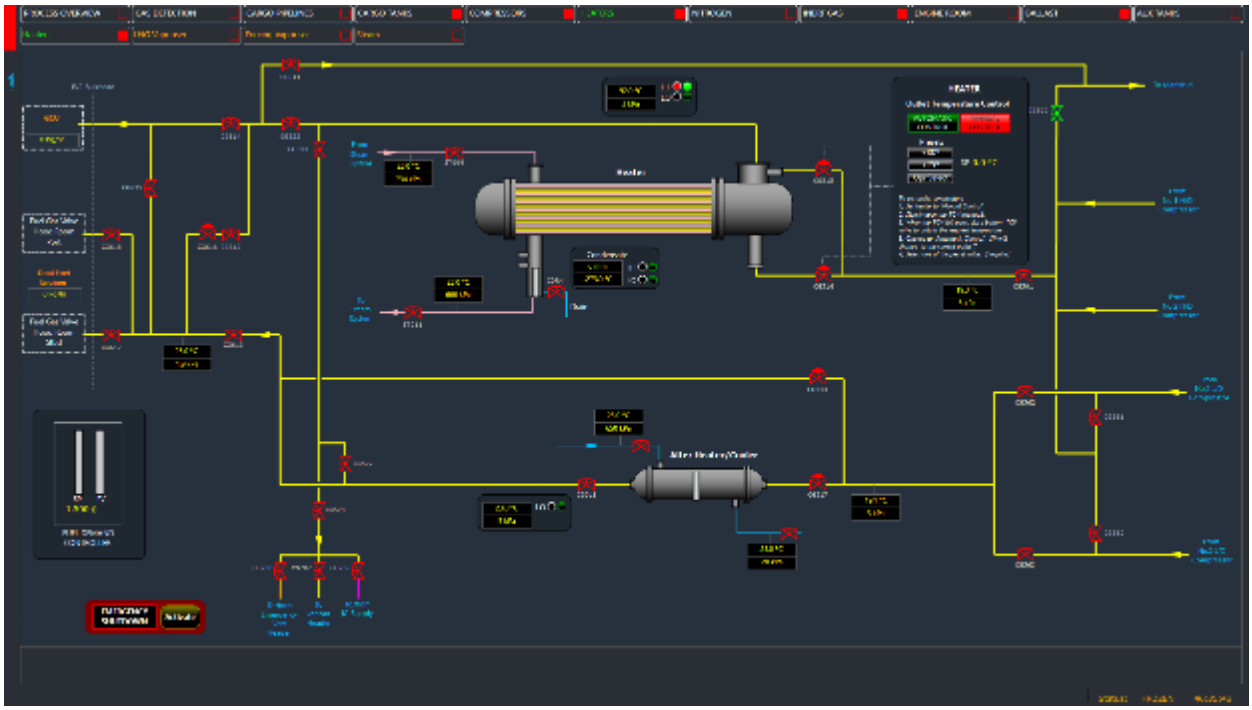
- HD Compressors
- LD Compressors
- Steam system

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions

## Heaters

### Heaters



Provides access to all the controls and information related to the heaters. Details of the operation of the various items of equipment can be found in the Cargo Heaters section earlier in this document. The controls displayed will change dependent of the propulsion system that has been selected.

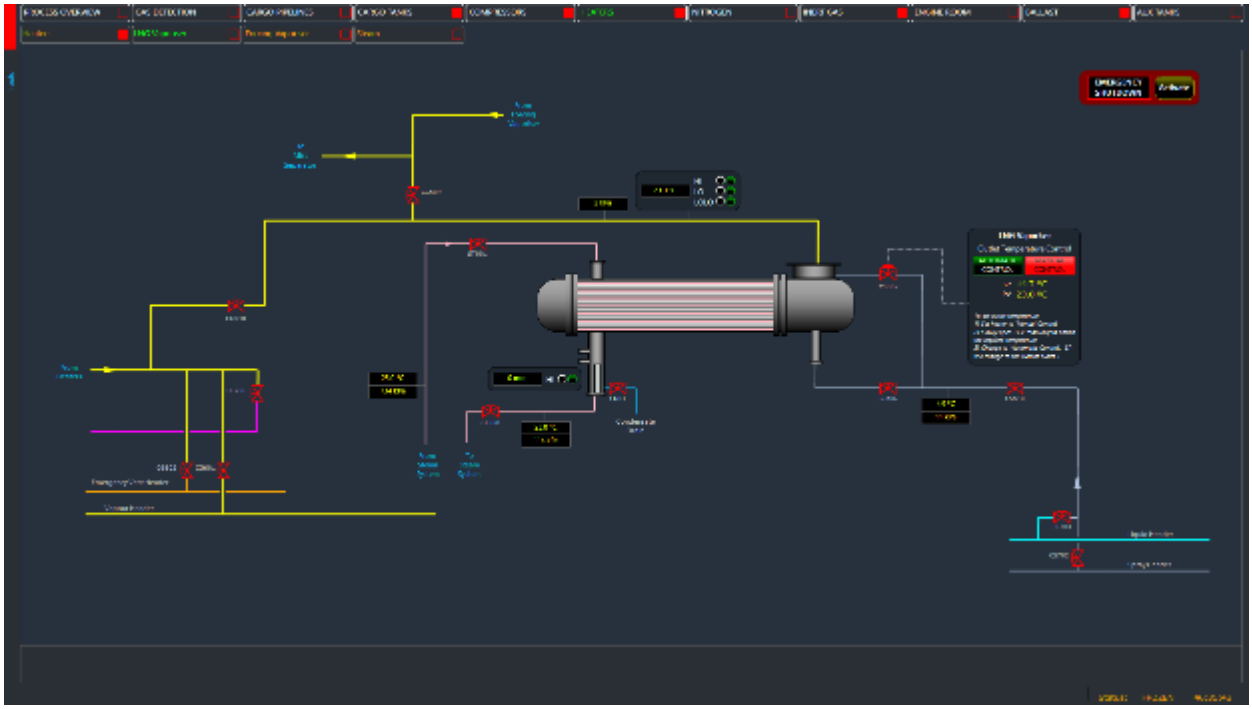
Hot links are located as follows:

- HD Compressors
- LD Compressors
- Steam system
- Cargo pipelines

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions

## LNG Vaporiser



Provides access to all the controls and information related to the LNG Vaporisers. Details about the operation of the vaporiser can be found in the Vaporisers section earlier in this document.

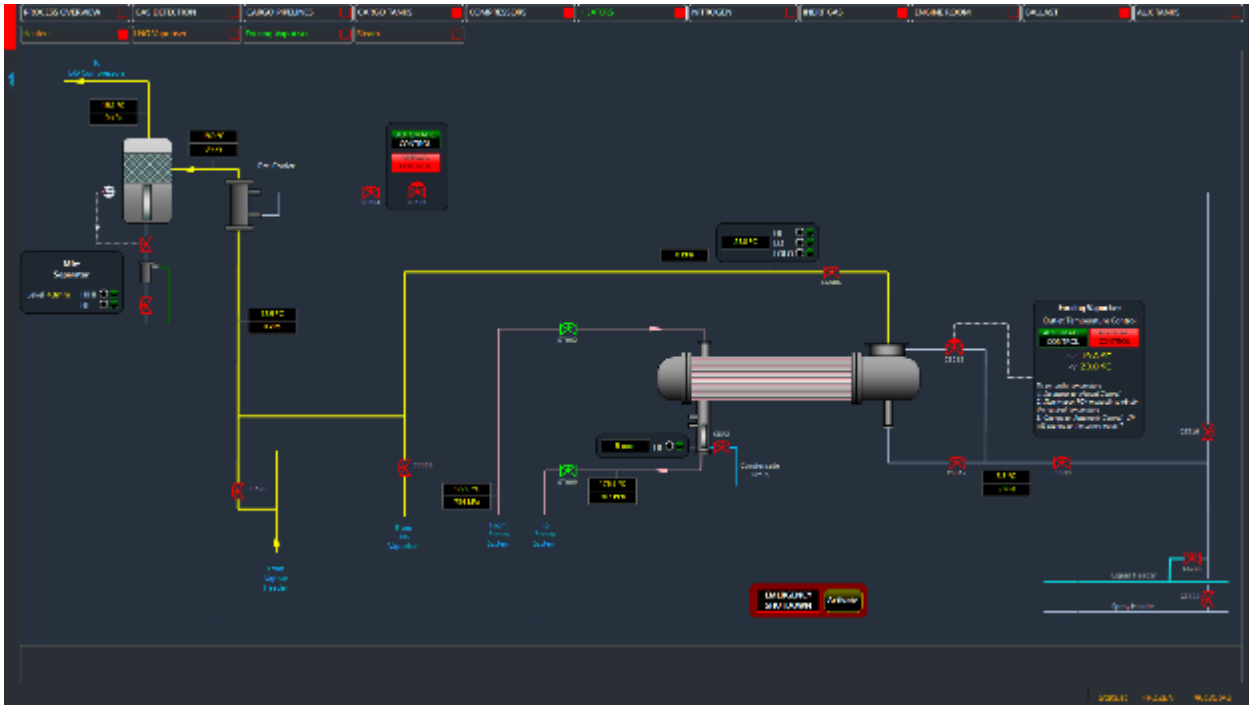
Hot links are located as follows:

- Forcing Vaporiser
- Mist Separator
- Steam system
- Cargo pipelines

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions

## Forcing Vaporiser



Provides access to all the controls and information related to the LNG Vaporisers. Details about the operation of the vaporiser can be found in the Vaporisers section earlier in this document. The arrangement displayed will be dependent upon the propulsion system selected.

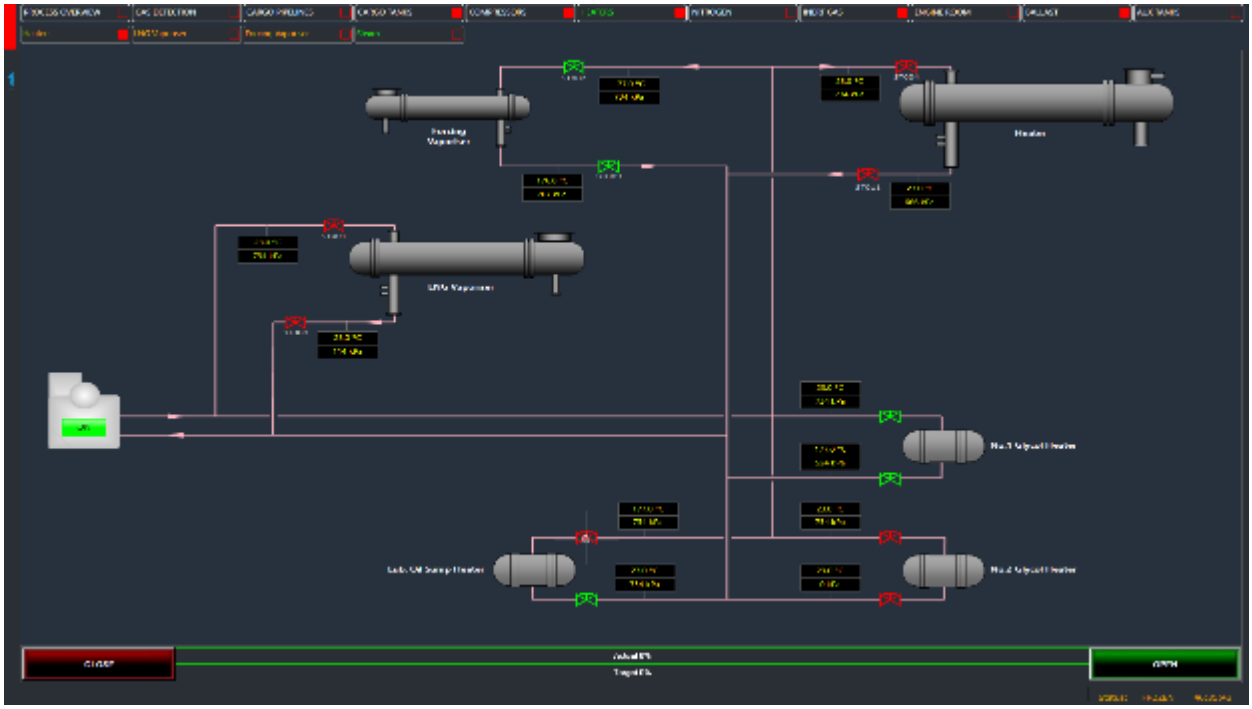
Hot links are located as follows:

- LNG Vaporiser
- LD Compressors
- Steam system
- Cargo pipelines

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions

## Steam System



The steam supply is activated via the on/off control on the boiler. Interlocks are incorporated into the heaters and vaporisers to ensure the supply valves remain closed unless the steam supply has been opened.

Hot links are located as follows:

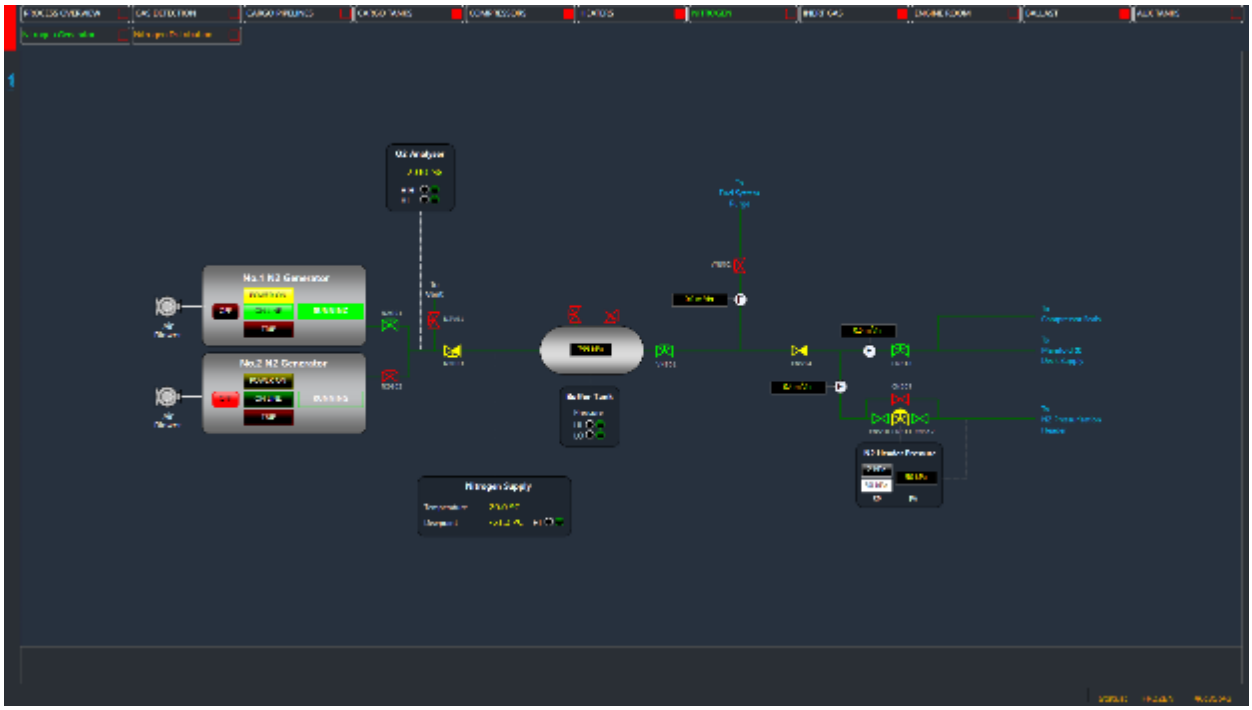
- LNG Vaporiser
- Forcing Vaporiser
- Heater(s)
- Glycol system
- Lub oil system

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions

## Nitrogen

### Nitrogen Generator



Controls and arrangement related to the Nitrogen generation and supply system.  Details regarding the operation of the generators can be found in the Nitrogen Generator section earlier in this document.

Hot links are located as follows:

- Engine Room
- Machinery Room
- Cargo pipelines
- N2 pressurisation system

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions
- N2 properties
    - Oxygen & dewpoint settings
    - Delivery pressure
    - Delivery Temperature

## Nitrogen Distribution

Controls and arrangement related to the Nitrogen supply system to the spaces surrounding the cargo tanks. The arrangement displayed will be dependent upon the cargo containment type selected for the model being used. The above shows the arrangement for the Mark III system. Details regarding the operation of the system can be found in the Nitrogen Generator section earlier in this document.

Hot links are located as follows:

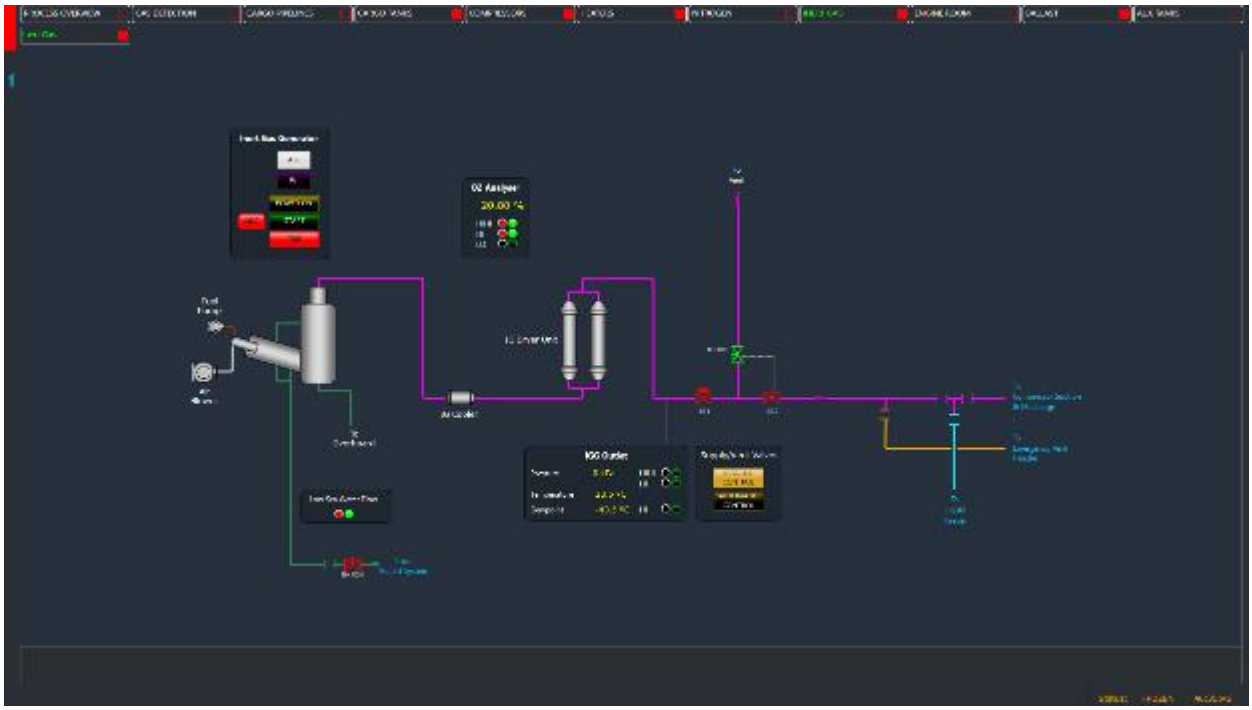
- Engine Room
- Machinery Room
- Manifold
- N2 Generator

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions

## Inert Gas

### Inert Gas



Controls and arrangement related to the Dry Air and Inert Gas generation and supply system.  Details regarding the operation of the system can be found in the IG Generator section earlier in this document.

Water for the IG scrubber is supplied via the Ballast System

Hot links are located as follows:

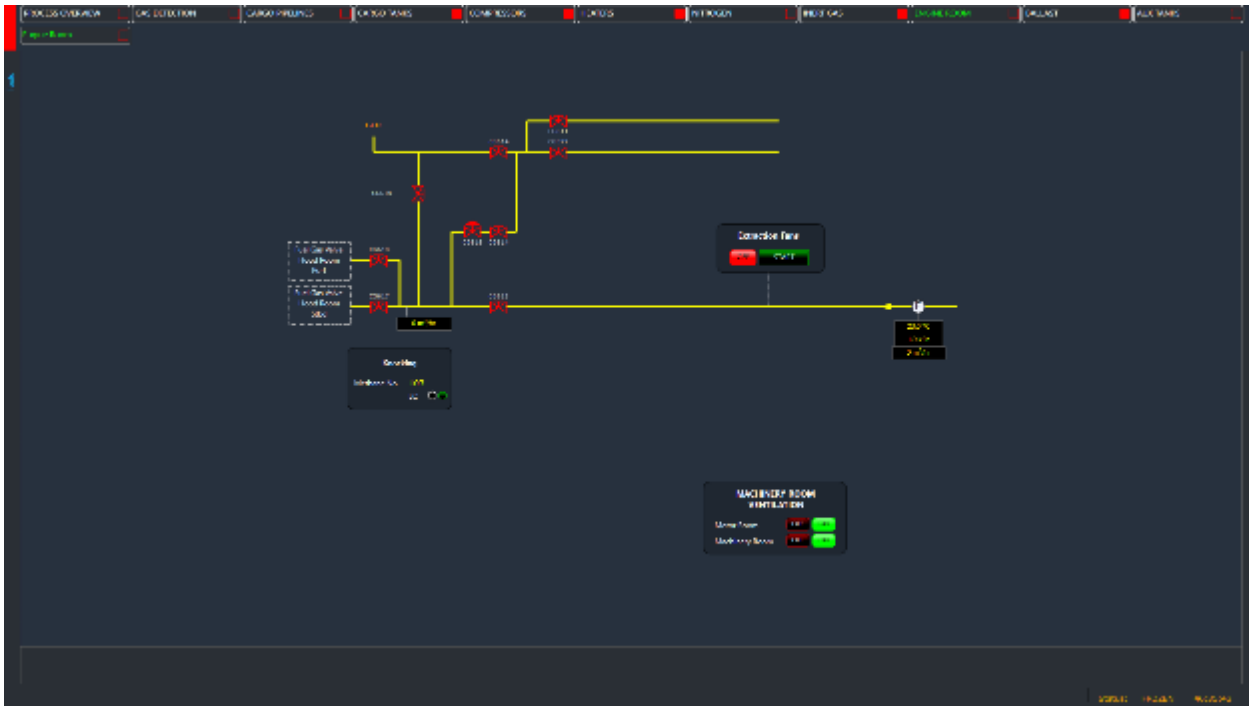
- Machinery Room
- Cargo pipelines
- Ballast System

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions
- IG properties
    - Oxygen & dewpoint settings
    - Delivery pressure
    - Delivery Temperature

## Engine Room

### Engine Room



Controls and arrangement related to the supply of gas to the engine room for use in the propulsion system.  The arrangement displayed will be dependent upon the propulsion system selected.

Hot links are located as follows:

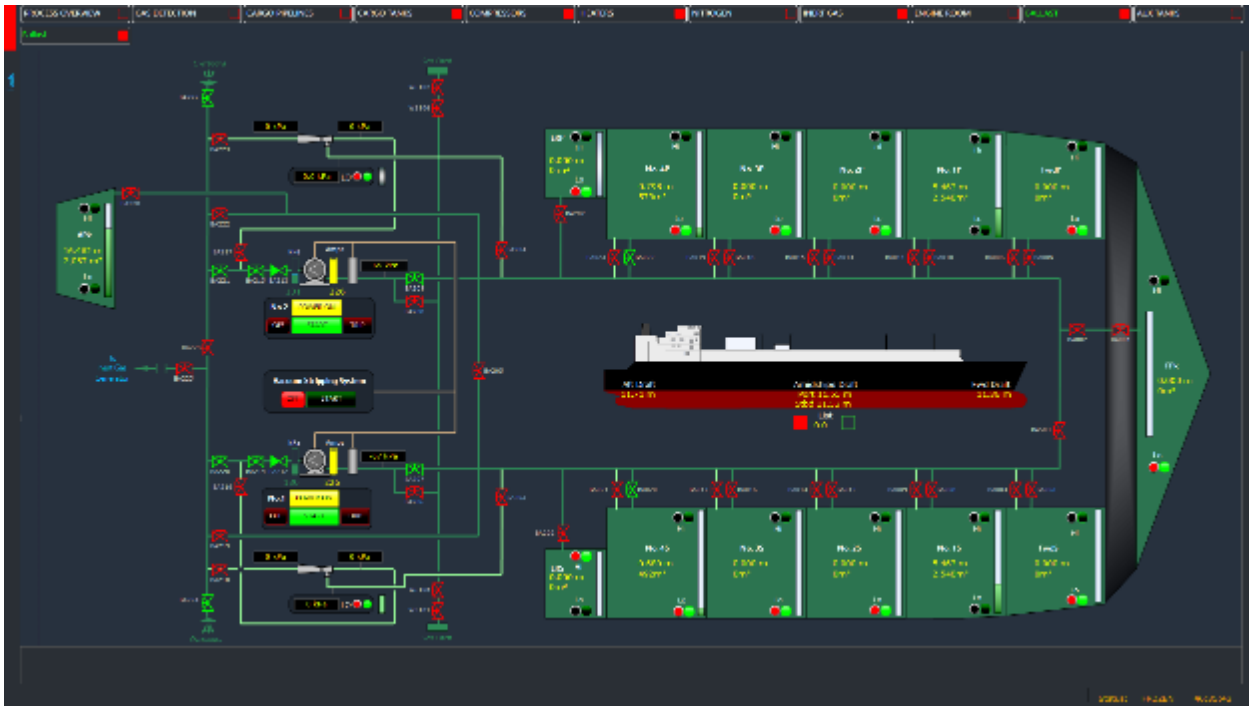
- Machinery Room

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions

## Ballast

### Ballast System



Provides access to all the controls and information relating to the ballast system. Depending upon the vessel arrangement selected the system comprises of either:

- Three electric, centrifugal pumps together with a small stripping eductor that is driven by water taken from the water spray pump. No. 3 pump is used to supply cooling water to the Inert Gas Generator when in required.
- Two electric, centrifugal ballast pumps, incorporating a vac-strip system, together with two stripping eductors.

Hot links are located as follows:

- IG Generator

Model parameters or malfunctions that can be accessed directly via the cargo tank displays include:

- Valve Malfunctions
- Alarm settings and malfunctions

## Aux Tanks

### Ancillary Tanks


This display shows the current status of the Fuel oil and Fresh water tanks within the model to the operator. The levels and contents of these tanks is controlled by the instructor via the appropriate instructor portal display. See section earlier in this document.