INSTRUCTOR MANUAL

LNG-Steam Plant Simulator

(Version 1.4)

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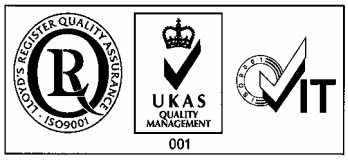

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We have made every effort to ensure the accuracy of this manual. However, the company cannot be held liable for the consequences of any errors or omissions contained herein.

Terminology and Symbols

ACC	- Automatic Combustion Control
AVR	- Automatic Voltage Regulator
BOTV	- Burner Oil Trip Valve
BR	- Boiler Room
D/A	- Diesel Alternator
DFO	- Diesel Fuel Oil
DO	- Diesel Fuel Oil, or Diesel Oil.
EDA	- Emergency Diesel Alternator
ER	- Engine Room
ESB	- Emergency Switchboard
FD	- Forced Draft
FO	- Fuel Oil, which may be either HFO or DFO
FW	- Fresh Water
FWG	- Fresh Water Generator
HFO	- Heavy Fuel Oil, or Heavy Oil
HO	- Heavy Fuel Oil, or Heavy Oil.
HP	- High Pressure
IP	- Intermediate Pressure
LO	- Lubricating Oil
LP	- Low Pressure
MOTV	- Main Oil Trip Valve
PF	- Power Factor
T/A	- Turbo Alternator
SW	- Salt Water, or Sea Water

Section
1

Introduction

The LNG-Steam Plant Simulator is a PC based simulator designed to reproduce the operational functions and reactions of a typical Marine Steam Turbine Propulsion Plant together with associated auxiliary plant and engine room machinery.

It provides training in the theory, safe operation, use, troubleshooting and maintenance of marine steam power plants and auxiliary machinery and is specifically designed to meet requirements of STCW Code Sections A-1/12 and Section B-1/12 and ISM Code sections 6 and 8 as applicable for PC based simulators.

Fidelity of Simulation Model

The mathematical models for the simulator are derived from a rigorous analysis of the physical characteristics of the simulated plant and are in accordance with design data provided by relevant machinery manufacturers. Such characteristics include the mechanical, thermodynamic, electrical and chemical properties and reactions.

Modeling is carried out in SI units but parameters are available graphically in either SI or ANSI (Imperial) units.

Virtual screen controls and graphic displays are used for system monitoring and control. Sound effects taken from real marine machinery add realism to the simulation.

Configuration

This version can be used for either stand alone (single-user) or group (networked) operation. Consequently each networked PC can operate in one of three ways:

- As part of a group under control of an instructor (group mode).
- Independently but under control of an instructor (individual group mode)
- Independently not under control of an instructor (stand-alone mode)

In group mode, the instructor can control and monitor the activity of each student. For example, the instructor is able to set exercise start-up conditions, monitor and record student activity, enter faults, change environmental conditions, alter fuel quality and request speed changes via the telegraph. Groups can contain only one PC - and in this case the student would work under instructor control but independently of others.

In stand-alone mode students are able to operate the system entirely by themselves, working through exercises at their own pace.

The networked system can be configured by the instructor to be a mix of multiple groups and/or stand-alone stations.

Simulated Ship Type

The simulator is not designed to simulate the performance of a specific vessel, but is typical for a vessel with steam turbine propulsion via fixed pitch propeller.

The vessel's systems are summarised below. Detailed descriptions and procedures can be found in the Machinery Operations Manual supplied.

Main Propulsion System

The ship derives power from steam generated by two boilers burning Diesel, Heavy Oil or Liquid Natural Gas and propels a Steam Turbine driving a fixed pitch propeller through a double reduction gearbox.

A service speed of 17 knots may be obtained at approximately 95 revs/min under the following conditions:

- Unlimited water (open sea)
- No current
- Clean hull
- Wind velocity and sea forces less than force 2
- Sea water temperature 15°C
- Both boilers operating

Steam Power Plant

The simulated marine steam power plant includes the following:

Two Water Tube boilers that provide superheated steam @ 950°F (510 °C) and 875 psig (6 MPa).

One 30,000 HP Main turbine comprising a High Pressure (HP) and Low Pressure (LP) Cross Compounded steam turbine set driving a single, fixed pitch, propeller through a double reduction gearbox. A 7000 HP Astern turbine is provided.

Fuel

Each boiler has two Oil (Diesel Oil or Heavy Oil) and two Gas Burners, individual burner management and combustion air control facilities. The burner control systems can be set for three modes: Oil, Gas or Dual Fuel.

Electrical Power Plant

Two Turbo Alternators (TAs), a Diesel Alternator (DA) and an Emergency Diesel Alternator (EDA) together with associated instrumentation, synchronization, distribution and protection equipment

Auxiliary Plant

The auxiliary equipment and systems include:

- Fuel System for Heavy Oil (HO) and Diesel Oil (DO) comprising bunkers and associated filling, transfer and supply systems to burners.
- Cooling System comprising Main Salt Water (SW) Circulation pumps and a Scoop for supplying the main condenser.

- Lubrication System comprising Lubricating Oil (LO) system for supplying oil to the bearings and gearing. This includes, sump, circulating pumps, coolers, gravity tank, filters and a centrifugal separator.
- Steam, Condensate and Feed Water (FW) systems together with associated pumps, heaters, feed re-circulation and feed storage system.
- Control Air System with Compressor
- Fresh Water Distiller
- Bilge System
- Fire System
- Steering Gear System

PCs and Network Configuration

PC Hardware

The minimum specification for each PC used to run the LNG-Steam Plant Simulator is as follows:

- CPU Pentium IV >= 1GHz
- 256 MB RAM
- 32 MB Video RAM
- 20 GB HDD
- CD ROM Drive x32 Speed
- Fast Ethernet LAN (100 MBs)
- 15" SVGA Monitor with 1280 x 1024 resolution with 24 or 32 bit colour
- Single Monitor - Dual Monitors of 17” or larger are recommended
- USB or Parallel Port for Software Security Device
- Printer Port (USB or parallel)
- Standard Keyboard
- Mouse
- Microsoft Windows NT, 2000 or XP

Dual Monitor Operation

The steam plant simulator is designed to function with single or dual monitors. The second monitor will be automatically configured for operation if present and will substantially enhance operation. Consequently PCs with dual monitors each with 1280 x 1024 resolution are recommended. Monitors must be set for colour resolution of at least 24 bit.

Network Requirements

A network supporting 100 MBs data transmission using TCPIP protocol is required for group mode operation. Stand Alone mode can be run on single PCs.

Software Security

A Software Security Device must be connected to the USB or Parallel port of all PCs before running the simulation software.

Section 2

Installation

Loading Software onto individual PCs

STEP 1 – Check all PCs meet the minimum specification (above) and set each display to 1280 x 1024 resolution with 24 bit or 32 bit colour depth. It is important to set the colour depth as described.

To install the LNG-Steam Plant software, proceed as follows

STEP 2 – Uninstall any previous versions of the LNG Steam Plant Simulator.

STEP 3 – Locate the Software Security License Device for the LNG-Steam Plant Simulator. (Note: If it is USB, do not yet plug it into the PC)

STEP 4 – Insert the LNG-Steam Plant Simulator CD into a CD Drive on your PC.

STEP 5 – Navigate to SetUp.exe in the Steam Sim LNG Vx.x Install folder on the CD

STEP 6 – Run SetUp.exe and install to the default folder (C:\Steam_Sim_LNG)

STEP 7 - Navigate to Sentinel Protection Installer 7.x.x.exe on the CD

STEP 8 – Run and install Sentinel Protection Installer 7.x.x.exe, choose “Complete” setup.

STEP 9 – Plug in the Software Security License Device to a free USB port on your PC if it is USB.

STEP 10 – Copy the Sentinel Superpro Medic folder from CD to your computer C:\.

STEP 11 – Repeat for all PCs.

The installation adds two shortcuts on the desktop as follows:

a) Steam Sim Stand-Alone (non-networked) mode

b) Steam Sim G Networked mode

STEP 12 – You can now run the simulator in Stand-Alone (non-networked) mode. To do this click the L-3 Sim icon labeled Steam Sim on your desktop.

Network Configuration

The Simulator Software uses a Local Area Network (LAN) to connect to other PCs. PCs can have any workgroup name and any network TCPIP address. However each PC running the simulator software needs to know the actual network addresses of all the other computers and the pathname to the simulator's executable (.exe file). To do this:

Navigate to the folder Eng_Sim_Network_Setup_Instal_Vx_x on the installation CD and run "setup.exe" and install to the default folder c:\Eng_Sim on all PCs

STEP 1
Go to the Instructor PC and run the program c:\Eng_Sim\EngSim_Network_Setup

STEP 2
Click the "Yes" box in response to the question "Is this the instructor PC?" – leave the program running

STEP 3
Enter the Logon password for the Instructor PC – This is the same password as that used when booting up the Instructor PC. You will be asked to repeat the password

STEP 4
Go to the first student PC run the program c:\Eng_Sim\EngSim_Network_Setup

STEP 5
Click the "No" box in response to the question "Is this the instructor PC?" – leave the program running

STEP 6
Repeat STEPS 4 and 5 on ALL student PC's

STEP 7
On each Student PC use the scroll up/down in the "Setup" frame to designate each PC number e.g. On PC01 "Setup this PC as PC number" and scroll to "1".

STEP 8
On the Student PC Click the blue box under "Configure" and you will see that the Instructor program will display "Yes" under the "Configured" column

STEP 9
Repeat STEPS 7 and 8 on ALL student PC's

STEP 10
On the Instructor PC click "Save Configuration"
Note: ALL Student PC programs close automatically

STEP 11
On the Instructor PC click "Exit"

You are now ready to run the simulator in a group (networked) configuration.

Important:

First run the Instructor program by double clicking the L-3 Sim icon labeled Steam Sim G on the Instructor PC desktop. After the “please wait” and progress-bar click “Accept”

Then run the Student programs by double clicking the L-3 Sim icon labeled Steam Sim G on each Student PC desktop. After the “please wait” and progress-bars have disappeared click “Accept”

Troubleshooting the Installation

Some virus checker programs will adversely affect the installation procedure. Try disabling such programs during installation.

If you have a problem running the SetUp program, create a temporary folder on your C drive, copy all files from the CD into this folder and repeat the installation steps - this time accessing the files on your C drive.

Updates to the Sentinel Protection Installer can be downloaded from www.safenet-inc.com

Section 3

The User Interface

The instructor and student displays are similar and both very easy to use. Common functions available to both Student and Instructor are displayed on the left and bottom of the display.

Functions for exclusive use by the instructor are shown at the top of the instructor screen only and are not visible on stations configured for student use only. All functions are accessed by simply pointing and clicking with the mouse.

The lower part of the screen displays valve and machinery controls, alarm data, exercise time and simulator run/halt status.

Instructor Functions

Instructor Functions are located at the top of the instructor display.

Initialize

It is essential that you initialize the simulator before the start of an exercise even if you intend starting with a pre-recorded snapshot – see later. This procedure prepares the simulator models and initializes the simulated vessel to a cold, dead ship state: There will be no electrical power available, valves will be closed and machinery stopped. Tanks will be part-filled or empty.

Halt

Clicking **Halt** will stop an exercise, inhibit operation of all valves and controls and silence the sounds. The exercise can be resumed by clicking Run.

Run

Clicking **Run** will resume an exercise that was previously halted.

Load Snap

The current state of the simulator can be saved at any time using the Snapshot Facility. Essentially, this allows an instructor to set a variety of initial conditions, environmental states etc. Typical examples are:

- Cold, dead ship with all tanks empty
- Vessel bunkered with the Diesel alternator running and coupled to the Bus.
- Vessel Boilers filled with water.
- Main propulsion turbines warmed through.
- Full away at sea

You can build a collection of snapshots and then select the most appropriate for each exercise. Once a snapshot is loaded all virtual controls and instrumentation are reset immediately to reflect the new operating state of the simulator.

Click on **Load Snap** to view a list of the snapshots available. Each snapshot listed includes the time and date at which it was taken, the instructor's name, class name, course name and a text description of the initial conditions Select one by clicking on its description then click the **Load Snapshot** button. After a brief delay the simulator will reflect the new operating state and an exercise will be underway.

Note that Snapshots 21 to 25 represent key stages in the vessel's preparation. These are reserved and cannot be overwritten.

Take Snap

Click **Take Snap** if you want to take a snapshot and you will see a list of currently saved snapshots. Select one by clicking on its description and then type a new description into the box available. Click the **Take Snapshot** button and, after a short delay, the current status will be saved - overwriting the original data.

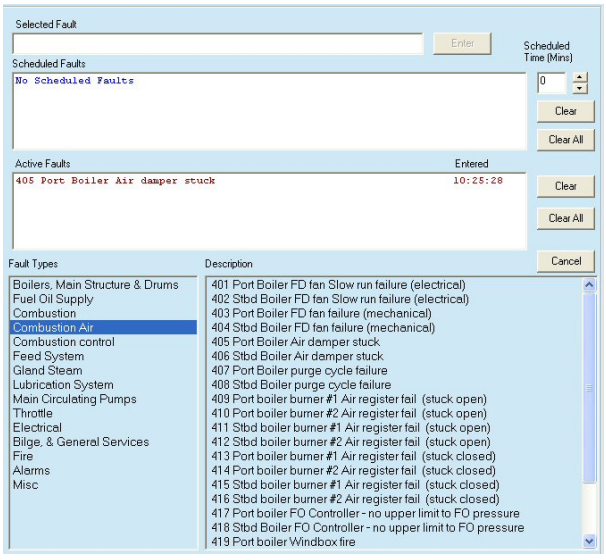
Note that Snapshots 21 to 25 represent key stages in the vessel's preparation. These are reserved and cannot be overwritten

Faults

The simulator can provide experience of the many fault conditions that may occur in the normal working environment. There are two types of fault routines that can be carried out on the simulator:

Faults introduced by the Student - When a student makes an error in an operational procedure, (such as having a valve closed when it should be open) the simulator model will respond accurately to this mistake. The Instructor does not have operational control over these mistakes as they are created by the trainee. The consequences of any such incorrect operation will be operationally valid.

Faults introduced by the Instructor - Over 200 faults are available for entry by the instructor covering all steam plant, propulsion, auxiliary and electrical systems. Some of these faults may be used in realistic combinations to create more complicated situations effectively increasing the number of faults available.



The **Faults** facility allows the instructor to enter one of a number of faults without the knowledge of the student who will only become aware of a problem if he notices subsequent changes in the system operation or if conditions develop to alarm levels. The student will have to decide what has changed and what fault may be causing these changes. The fault display is shown below:

To enter a fault, first select the Fault Type from the list of systems in the lower left pane. Next, select an individual fault relating to this system from then Description list. The selected fault will appear in the Selected Fault bar at the top of the menu.

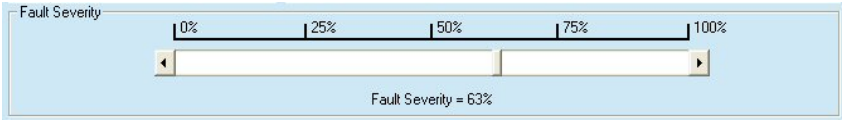
You can now enter the fault immediately by clicking **Enter** or, after a fixed delay, by setting the Scheduled Time to a value in minutes and then clicking Enter.

If you have entered a number of scheduled faults, the Scheduled Faults box will show all faults to be entered in chronological order. The Active Faults box shows all faults currently active and the time they were entered.

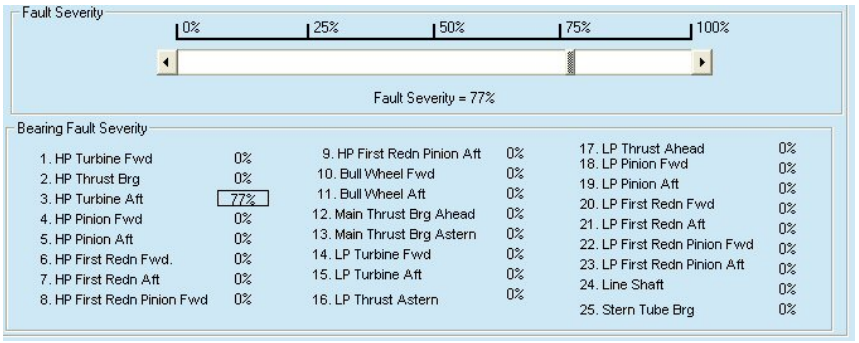
Clear individual faults by selecting the fault and clicking **Clear.**

Clear all faults by clicking **Clear All**

You can set the severity of some faults: for example you can set the amount of water leakage from a boiler tube between 0 and 100%. When you select such faults, a slider bar will automatically appear below the list of faults. Use the slider to set fault severity.



In order to set the severity of a bearing fault, you must first select one or more bearings from the list that will appear below the slider bar. Click on one (or more) bearings to select and then move the slider. The selected bearings will be set with the same fault severity.



Start Log

This facility will record the sequence of actions carried out by the student such as opening/ closing valves, starting/stopping items of machinery. Each log entry is time stamped.

To start a log, click **Start Log**. Select a name for the log from the list or type a new name into the *File Name* box. By default, a suggested name made up from current date and time (eg L1708_Wed_18_05_2005.log) will appear in the File Name box but you can change this if required.

Click **Open** to start logging.

End Log

Click **End Log** to stop logging. A message appears stating the filename under which the log will be saved. You can view this at any time using Notepad or the View Log facility.

View Log

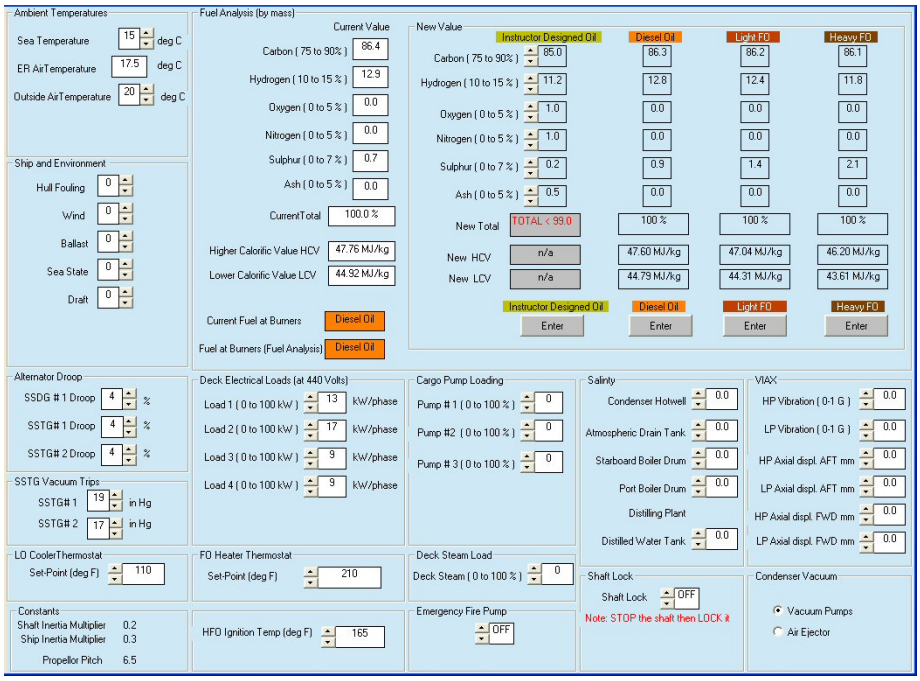
Click View Log and select the log you want to view from the list or type its name directly into the File Name box. Click Open to view the log.

Once displayed, you can print or exit. Log files are stored on the computer hard disk and may be viewed or printed at any time

Parameters

On a cold start, all parameters affecting plant performance are initialized to default working values. However you can change the value of any parameter before or during a simulator exercise using the Parameter display.

Parameters are saved during a snapshot and restored during Snapshot Load.



The Instructor can adjust or set a variety of parameters before or during an exercise using the Parameters display.

Ambient Temperatures – Sea Temperature and Outside Air Temperature will affect cooling efficiencies throughout the plant. Engine Room Temperature is calculated as a function of sea and air temperatures and the heat emitted by running machinery and plant.

Ship and Environment – Hull Fouling, Wind, Ballast, Sea State and Draft can each be set to values between 0 and 10. Each parameter has an appropriate effect on engine load.

Alternator Droop – Set the speed droop of each alternator between 0% and 10%.

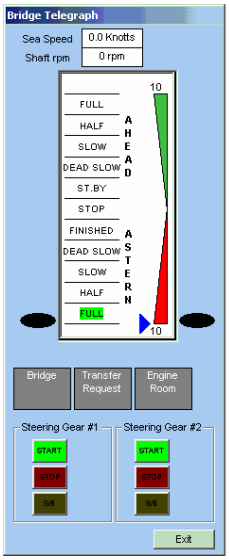
Turbo Alternator Vacuum Trip – Set the value of vacuum in (in Hg) for each turbo alternator above which the alternator will trip on low vacuum.

LO Cooler Thermostat – Set the set-point temperature for the Lubrication Oil Cooler Thermostat.

Fuel Analysis – The leftmost column of this section lists the current fuel constituents (Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur and Ash) along with their molecular concentrations in percentage terms. The Higher and Lower calorific values of this fuel are calculated and displayed.

The three rightmost columns in this section: Diesel Oil, Light Oil and Heavy Oil show the default composition of these standard fuels.

The column: Instructor Designated Oil, allows you to set the value of each constituent by clicking on the UP/DOWN arrows alongside each component.



Although varying oil quality in this way has limited visual effect on the running of the plant (as would be expected in real life), this feature enables consumption and fuel efficiencies to be calculated.

Deck Electrical Loads – This feature can be used to vary the electrical load of four items of deck machinery between 0 and 100 kW per phase. You can make such changes quickly to simulate the electrical characteristics of a winch or crane.

Fuel Oil Heater Thermostat – Set the operating temperature for the Fuel Oil Heater Thermostat.

HFO Ignition Temperature – Set the ignition temperature for Heavy Fuel Oil.

Cargo Pump Loads – This feature can be used to vary the steam consumption by changing the load on four cargo pumps between 0 and 100% of maximum load.

Deck Steam Load – This feature can be used to vary the deck steam consumption between 0 and 100% of maximum load

Emergency Fire Pump – The Emergency Fire Pump can only be started/stopped from the parameter display.

Salinity – This feature is used to vary the salinity at five locations throughout the plant: Condenser Hotwell, Atmospheric Drain Tank (ADT), Starboard and Port Boiler Drums and Distilled Water Tank (DWT)

Shaft Lock – The main prop shaft can only be locked or unlocked from the parameter display.

VIAX – This feature is used to set the amplitude of mechanical vibration in the HP and LP Turbines, axial displacement of the HP and LP Turbines for'd and aft. Introducing a high value at any of these locations will cause a VIAX alarm.

Condenser Vacuum – This feature allows you to choose either vacuum pumps of air ejectors as a source of condenser vacuum. The relevant displays will show only the system chosen.

Advanced Mode

The simulator model calculates the value of many parameters that are not available or easily accessible on real plant. For this reason, they are not normally presented to the student. However, for advanced exercises, you can include these additional values by clicking **Advanced**.

Telegraph

In group mode, the instructor station is used to provide the inputs that, on real plant, would come from the bridge.

Click **Telegraph** to display a virtual bridge telegraph and throttle control with indication of sea speed, shaft rpm and the station in command controls: Bridge, Transfer Request and Engine Room. There are also remote controls for both steering gear motors.

Students have a similar display available representing the Engine Room throttle, telegraph and station in command controls.

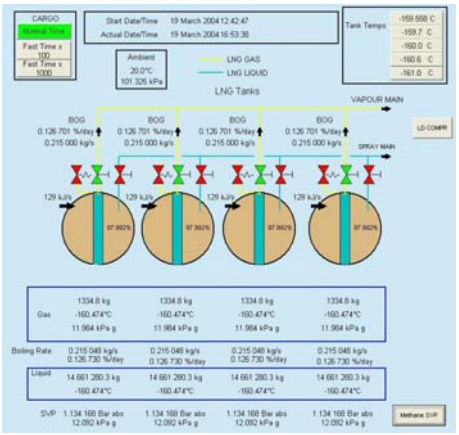
The instructor display becomes active when the plant is in Bridge control mode.

Actual telegraph and throttle positions are indicated by green and blue markers respectively. The telegraph and throttle control levers are represented by movable controls to the left and right.

The two telegraph displays are interactive so the instructor can follow the students response to bridge requests and vice versa. The instructors display can also be used to directly control the engine speed when bridge control is in use.

Either station can request control by clicking the **request for transfer**. This will cause the same **request** button in both engine room (student) and bridge (instructor) to flash. The request is acknowledged at the other station by first aligning both telegraph and throttle settings and then **clicking Transfer request.** This action causes the Transfer Request lamps to stop flashing. Next, click the **Bridge (or Engine Room)** button. Corresponding lamps on both stations will illuminate and the other two revert to gray - thus completing the transfer.

LNG Tanks



The initial volume and temperature of LNG cargo in the tanks is set by the instructor -usually by loading a pre-recorded snapshot.

The subsequent boil-off rate and pressure will be typical for a generic tank system and reacts to changes in flow. Conditions within the cargo tanks vary as a consequence of student actions and environmental conditions, for example; using too much or insufficient gas.

This display and the ability to set boil-off gas parameters are restricted to the instructor. To change LNG temperature in the tanks, click on one of the tank **Temps buttons** at the top right of the display.

Click Methane SVP (bottom right) to display the LNG vapour pressure at the selected temperature.

You can accelerate the boil-off rate by a factor of 100 or 1000 by clicking on Fast Time (top left).

This function is not simulated in detail but intended to provide a supply of gas at a specific temperature.

Sounds

Click **Sounds** to enable or disable simulated sound effects. When highlighted, sound output is enabled.

Sound Mixer

Click **Sound Mixer** to display a virtual sound mixer with volume controls for each simulated sound. Use the check boxes (left column) to enable / disable individual sounds and the volume controls to adjust individual sound intensity.

Mixer controls are initialized automatically to default settings with all sounds enabled.

SI Units

Click **SI Units** to display all variables in SI (Metric) units. Alternatively, values can be displayed in Imperial units – see next.

Imperial

Click **Imperial** to display all variables in SI (Metric) units. Alternatively, values can be displayed in Metric (SI) units – see above.

Common Functions

Common Functions available to both students and instructor are located at the left and bottom of the display.

System Displays

On the left is a menu in vertical column format listing the displays available - grouped according to system. Just point and click to display. All displays are full-screen size.

For dual monitor systems, the vertical menu is duplicated on the second monitor allowing you to view two different displays at the same time.

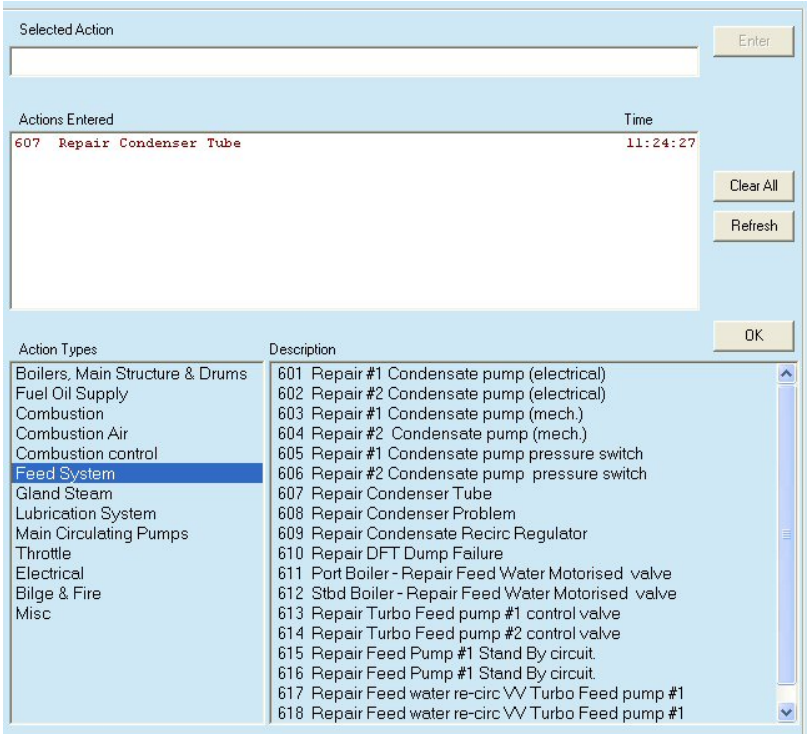
Shortcuts

Shortcuts allow you to move quickly from one system to another and are an alternative method of navigation to using the menu. Shortcuts appear on displays as yellow buttons with a text description of the destination.

Icon Menu
At the bottom of the display is a row of icons relating to commonly used functions: Student Actions, Alarm Log, Alarm Display, Printing, Plotting and Exit.

Actions

This allows you to select and carry out actions that are otherwise not possible using the simulator's displays. Such actions are often required to correct a problem that has developed and is often prompted by an alarm condition; for example to repair a seal, or to repair a pump.



In all cases the plant must be properly prepared before any action will take effect and the action will be ignored if the plant is not prepared. For example, before replacing a shaft bearing it is obviously necessary to first stop rotation and apply the shaft lock. If this is not done the entered action will have no effect.

To enter an action, click on the Action Icon and select the relevant system (Action Types) from the list displayed in the left pane. A list of actions relating to this system will be displayed in the right pane (Description). Select the appropriate action and click **Enter**.

Most actions are automatically removed but some will remain active until you remove them manually. To remove an action, select the action you wish to remove from the Entered Actions box and click **Clear.**

To clear all entered actions at once, click **Clear All.**

Alarm Log

This shows a historical log of all alarms in chronological sequence including the time they became active.

Alarms

All parameters that have an associated alarm are displayed in a box that is coloured either Red (in Alarm) or Green (Out Of Alarm). Parameters that do not have an associated alarm are displayed in White Boxes

When a new alarm occurs the Red Alarm Bell Icon at the bottom of the display flashes. Click on it to display a list of all currently active Critical and Non-Critical alarms. A flashing asterisk alongside an alarm description means that this alarm has not yet been acknowledged. Each entry comprises; time alarm became active, alarm ID, description and the current alarm trip point (if any).

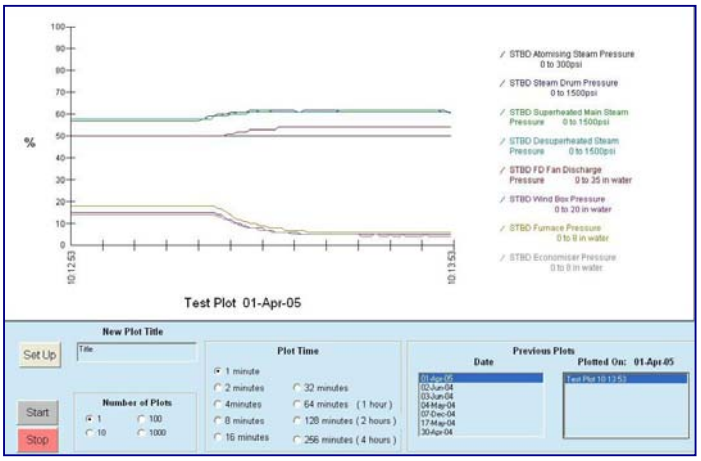
The three buttons at the top of the display: Silence, Accept and Reset have the following functions:

Silence – Silences the alarm bell
Accept – Acknowledges the alarm condition and stops flashing.
Reset – Removes the alarm from the list if it is no longer active.

Critical alarms may cause a throttle trip or speed reduction.

Print

Clicking **print** will print the current display. The background will automatically be set to white in order to save ink and produce the clearest result. You can select printer, paper size, type etc in the normal way.



Plot

This allows you to monitor selected parameters such as temperatures, pressures, levels, flows, ship speed, etc over a period of operation.

Up to eight such parameters may be plotted simultaneously.

Click **SetUp** to view a complete list of all the parameters that can be plotted. Click on those that you wish to plot and they will be automatically allocated a pen colour – see example.

The **Plot Time** setting determines the time for the plot to cover the display area - the higher the plot time, the slower the plot. You can select plot times of between 1 and 256 minutes.

By default only one plot is taken. For multiple sequential plots, set the **Number of Plots** to 10,100 or 1000.

All plots are automatically saved as files using a name you can set using the **New Plot Title** box.

Start plotting by clicking the **Start** button. Stop plotting by clicking **Stop**.

View previously stored plots by clicking a filename in the **Previous Plots** list.

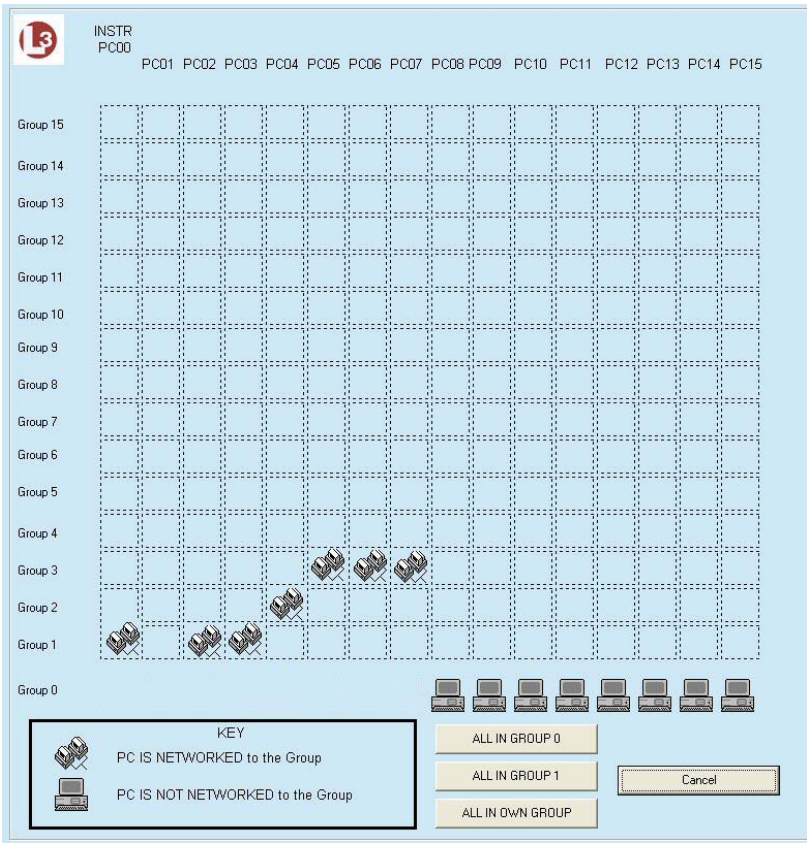
Exit

Clicking exit will (after a check prompt) terminate the exercise and return you to Windows. In group mode, the instructor has control over the operation of student PCs and this option is not available.

PC Config

Use this feature to arrange students into groups when in group (network) mode.

A display similar to the following will appear:



Student PCs available for group exercises are shown as network icons. Those not networked (and therefore unavailable) are shown as PCs.

Consider the display matrix as comprising columns for the instructor and student PCs, with a row for each group. To move a PC into a group, click on the appropriate row/column intersection. Groups can contain one or more student PCs. By default, all student PCs are in a single group.

Note that once an exercise has started it is not possible to change the configuration of student PCs within any group. The instructor however can join any group ant any time in order to monitor and control an exercise within that group. This means that once he has joined a particular group, all the instructor facilities (snapshot, fault entry etc) are available and will affect that particular group exercise.

Section

4

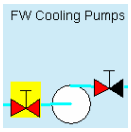
Plant Control

Control of the simulated plant is through virtual controls accessed directly from the system displays. These include:

- Opening or Closing Valves
- Starting & Stopping Pumps or Machinery
- Opening Closing Circuit Breakers
- Changing Alarm Set-Points
- Adjusting Automatic (PID) Controller Set-Points
- Boiler Combustion Control
- Boiler Auxiliary Controllers

Valve Operation

To operate a valve, first click on its symbol. When selected, the valve will be highlighted in yellow:



A control box will appear at the bottom of the screen along with a text description of the valve.

FW Cooling Pump #1 Suction Valve

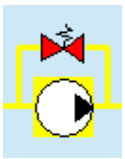
The actual valve position is shown by a black arrow against a red-green bar. For a fully closed valve, the arrow will be at the extreme left side (red). For a fully open valve, the arrow will be at the extreme right side (green). Valves that are continuously variable may have an intermediate position.

To open the valve click on the **OPEN** button. The time taken to open will depend on the type of valve and its travel time. Solenoid type valves will appear to operate almost instantly. You can set continuously variable valves to an intermediate position by using the **STOP** button during operation.

To Close a valve, click the **CLOSE** button.
To deselect the valve, either click **Exit** or select another valve.

Pump and Machinery Operation

To operate a pump or item of machinery, first click on its symbol. When selected, the item will be highlighted in yellow:



A control box will appear at the bottom of the screen with controls for START and STOP and (if available) additional controls for STANDBY, AUTO or MANUAL operation.

Click the control you require then click **Exit**

Circuit Breaker Operation

To operate a circuit breaker, click on its symbol and the breaker will immediately change state. Paddle type circuit breakers are ON when the paddle is in the up position.

A red indicator alongside the breaker will illuminate if the breakers has tripped. In this case reset the breaker by clicking the square Trip Reset button marked with a “T”.

Changing Alarm Set-Points

Every alarm has at least one of the following set-points:

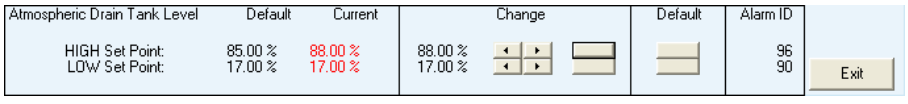
- LO (Low)
- LO-LO (Low-Low)
- HI (High)
- HI-HI (High-High)

Each alarm has a default set-point that may be changed by instructor or student. These new values can be stored for subsequent exercises using the snapshot facility.

All parameters that have an associated alarm are shown on the system displays in a box that is coloured either Red (in Alarm) or Green (Out Of Alarm). Parameters that do not have an associated alarm are displayed in White Boxes.

To change an alarm setpoint, click on the alarm box. An alarm setpoint control box will appear at the bottom of the display allowing you to adjust all setpoints associated with this alarm between pre-defined limits.

In this example you can see the Atmospheric Drain Tank Level HIGH setpoint is currently 88% and the the default is 85%.

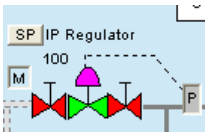


To change a setpoint, click the right or left arrows to increase or decrease the new sepoint value shown in the Change section. When the value matches that required, click the button alongside the right arrow. The current value will change to the new value.

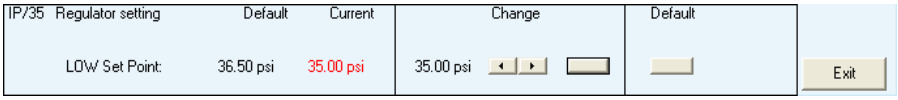
Click the button in the Default section to restore the default value.

Changing set-points of Proportional controllers

Proportional controllers (regulators) are used for a variety of purposes throughout the plant such as reducing steam pressure to a value of (say) 150 psi (1035 kPa). Controllers of this type are shown on a system displays as follows:



To change the set point, click the SP button. A proportional controller set point box will appear at the bottom of the display.

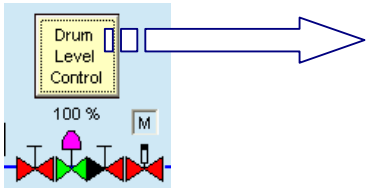


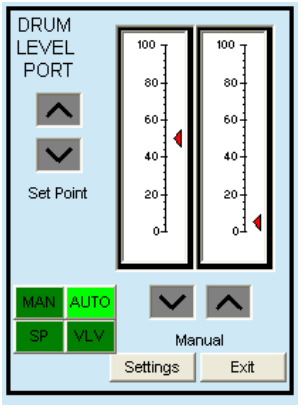
To change a set point, click the right or left arrows to increase or decrease the new set point value shown in the Change section. When the value matches that required, click the button alongside the right arrow and the current value will change to the new value.

Click the button in the Default section to restore the default value.

Changing PID controller set-points

PID Controllers are represented graphically in a similar way to the proportional controllers. However each PID controller has a virtual control panel that can be displayed by clicking on the yellow square shortcut.

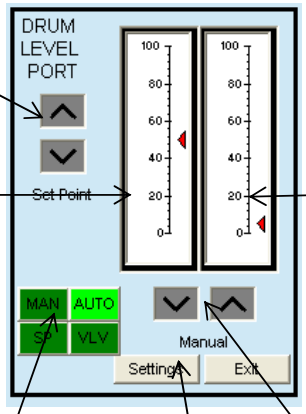




For PID controllers that are part of the Combustion cascaded system, clicking on the shortcut displays the entire set of related controllers. This allows the user to see individual controller settings in the context of the overall control system.

For PID controllers that operate individually (not part of a cascade), clicking on the shortcut displays the controller on the same system display as the control valve.

Controller functions are as follows:



Controls to Raise/Lower the set point

In AUTO the LH Scale shows the set point as an absolute value as listed in the chart below. In MAN mode the scale shows the manual setting as 0-100%

The RH Scale shows the Measured Value scaled as listed in the chart below in both AUTO and MAN modes

Controls to select:
MAN – Manual Operation
AUTO – Automatic Operation
SP – Automatic Operation with set point adjustment disabled
VLV - Manual Operation with manual adjustment disabled

Controls to Raise/Lower the Manual setting

Access the Proportional, Integral and Derivative Settings

	Stbd			Port		
	Man/Auto	LH Scale	RH Scale	Man/Auto	LH Scale	RH Scale
Drum Level	M	0 to 100%	-230 to +230 mm	M	0 to 100%	-230 to +230 mm
Steam Temperature	M	0 to 100%	93 to 815°C	M	0 to 100%	93 to 815°C
Fuel	A	0 to 2.02 kg/s	0 to 2.02 kg/s	A	0 to 2.02 kg/s	0 to 2.02 kg/s
Air	A	0 to 25 kg/s	0 to 25 kg/s	A	0 to 25 kg/s	0 to 25 kg/s
Master	M	0 to 100%	0 to 130 Bar	M	0 to 100%	0 to 130 Bar

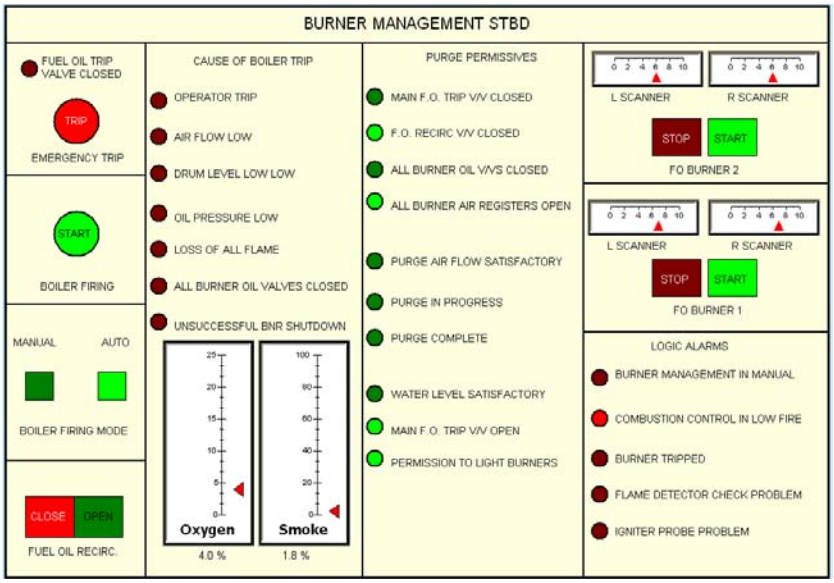
	Man/Auto	LH Scale	RH Scale
Plant Master	A	0 to 104 Bar	0 to 104 Bar

Click **Status** on the Plant Master to view the above summary of all controller settings and scales. This display is dynamic and will change according to whether controllers are selected to manual or automatic operation.

Boiler Control

Fuel Oil Burner Control

The procedure for Fuel Oil burning (including purge and ignition) is controlled from a virtual oil burner management panel. There is one such control panel for each boiler. View by clicking **Bnr Mgt Port** or **Bnr Mgt Stbd** on the list of displays



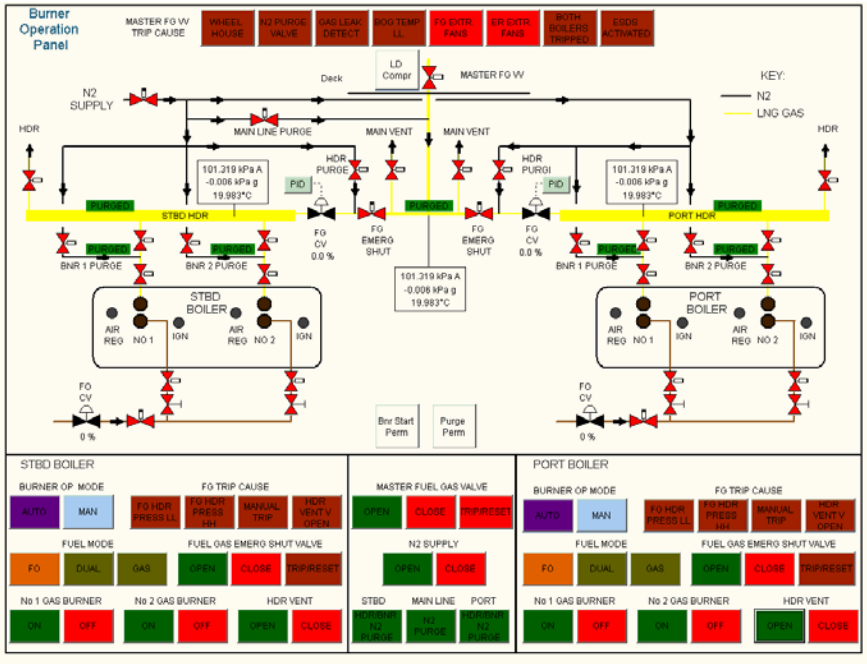
All purge permissives must be cleared and no boiler trips can be present for ignition to occur. Thee panel supports Emergency Trip, Manual Boiler Start and Fuel Oil Recirculation controls.

Two flame scanners per burner show the status of the oil flame at each burner. Virtual analog gauges show oxygen and smoke concentrations.

If the drum pressure is below 650 psi (4.4 MPa) the burners will operate in a Low Fire mode that restricts the volume of fuel and air – as in the example above. However this mode can be overridden by placing the Fuel or Air controllers into Manual Mode.

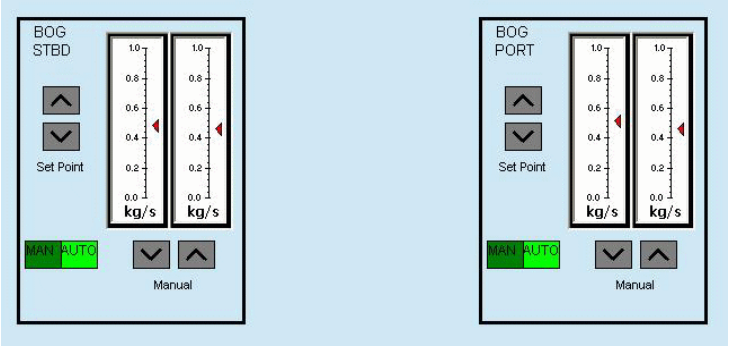
Gas Burner Control

The procedure for Gas burning including purge and ignition is controlled from a virtual gas burner management panel. This panel also controls the mode of operation: Oil, Gas or Duel Fuel. You can view the Gas Burner Control Panel by clicking **Bnr Operation** on the list of displays.



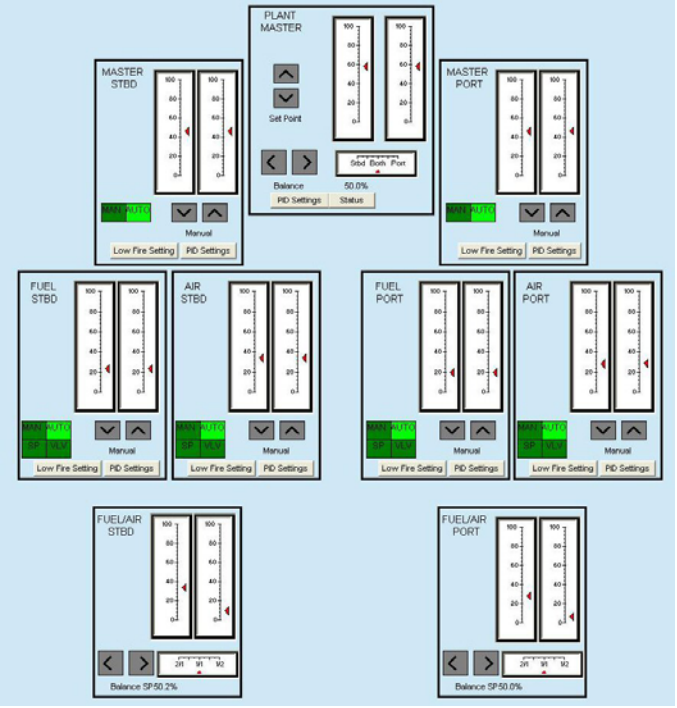
Gas Combustion Control

Gas Combustion control is by a pair of virtual, PID controllers.



There is one gas control valve per boiler. Its function is to regulate the flow and pressure of gas in the burner header and control the number of burners in operation. The control systems for both FO and Gas burning are shown and described below.

Fuel Oil Combustion Control



Fuel Oil Combustion control is by a set of virtual, PID controllers. It is a cascaded system beginning at the highest level with the Plant Master that ultimately controls the fuel oil and air to each boiler. To view all controllers click on **Comb Ctrlls** on the display menu

FO Mode - In **AUTO** mode, the FO Control valve is controlled from the Boiler Master signal. The number of burners in operation is also set automatically. In **MAN** mode, both FO flow and number of burners is set manually. There is no Gas flow.

Gas Mode – In **AUTO** and **MAN** modes FO is re-circulated (a mandatory requirement) and kept hot. This is achieved by setting the FO control valve at 50% and re-circulating all resulting flow. During the switchover from DUAL to GAS mode, the “Min” element ensures a very low set-point is used in order to reduce the flame before shut-off.

Dual Mode – AUTO During normal AUTO operation the actual Gas Flow is first subtracted from the Boiler master FO signal. This has the effect of making the gas the “master” signal in that if the gas flow increases for any reason then FO flow will decrease.

During the transient condition of igniting a first or second burner, a proportion (either 18% or 35%) of the full Boiler master signal is used. Control reverts to normal after 5 secs. The High element preserves a minimum FO Flow during normal burn conditions.

The PID is standard and can itself operate in Manual or Auto modes – see separate section .

Dual Mode – MAN FO flow is set manually.

GAS Control

FO Mode – There is no gas flow.

Gas Mode – AUTO This mode not allowed

Gas Mode – **MAN** Gas flow and number of burners is set manually without limit (apart from supply capacity). There is no FO flow into boiler.

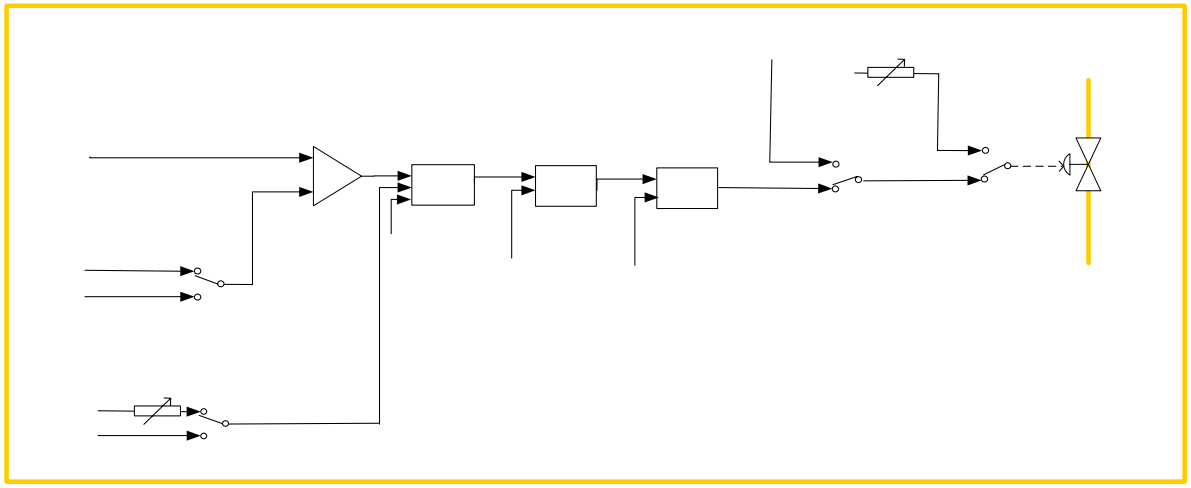
Dual Mode – AUTO During normal automatic operation the min FO flow is first subtracted from the Boiler master signal. This is a small value so essentially, gas flow tracks the boiler master signal. (*Note that in dual mode, FO flow will seek to make up difference between gas flow and that required by boiler master. This effectively makes gas flow the master and FO flow the slave)*.

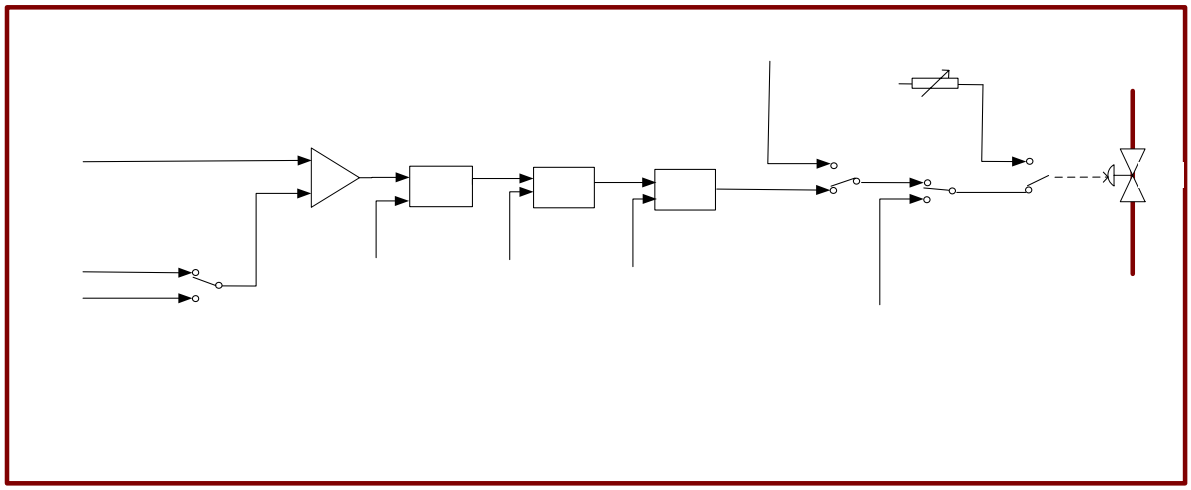
The Min element will use the lower signal of either (the slightly modified) boiler master or BOG setting. In this way, the BOG setting places an upper limit on the amount of gas that can be used. An exception to this occurs when the gas is to be extinguished (eg during DUAL to FO changeover) when a very small signal is used

The PID is standard and can itself operate in Manual or Auto modes – see separate section

A High element ensures a gas dP is maintained between header & burner. This parameter is alarmed & can result in shutdown.

Dual Mode – MAN Gas flow and number of burners is set manually. PID output is still calculated from Boiler Master less Actual FO flow which prepares PID for bump less transfer if required.





Section 4

Faults

Faults Defined

The following faults may be entered by the instructor and can be directed at individual students or group.

There are appropriate student actions to recover from these faults provided they are entered correctly, at the appropriate time and with proper preparation of the systems.

FAULTS (CASUALTIES)

Faults are entered by the instructor and directed at individual students or groups.

There are appropriate student actions to recover from these faults provided they are entered correctly, at the appropriate time and with proper preparation of the systems.

Boiler & Drum Faults

101	Port Boiler water level controller failure (fully open)
102	Stbd Boiler water level controller failure (fully open)
103	Port Boiler water level controller failure (stuck)
104	Stbd Boiler water level controller failure (stuck)
105	Port Boiler – Drum Water level transmitter failure
106	Stbd Boiler – Drum Water level transmitter failure
107	Port Boiler major tube leak
108	Stbd Boiler major tube leak
109	Port Boiler minor tube leak
110	Stbd Boiler minor tube leak
111	Port Boiler Soot blower failure (stuck on)
112	Stbd Boiler Soot blower failure (stuck on)
113	Port Boiler De-superheater Leak
114	Port Boiler De-superheater Leak

115	Port boiler Attemporator Valve Fail – Stuck
116	Stbd Boiler Attemporator Valve Fail – Stuck
117	Port boiler Attemporator leak & water into S/H steam
118	Stbd boiler Attemporator leak & water into S/H steam
119	Port Boiler Steam flow transmitter failure
120	Stbd Boiler Steam flow transmitter failure

Fuel Oil Supply Faults

201	Fuel oil supply pumps suction strainer – part blocked
202	Hot Fuel oil strainer – part blocked
203	#1 Fuel oil service pump failure (electrical)
204	#2 Fuel oil service pump failure (electrical)
205	#1 Fuel oil service pump failure (mechanical)
206	#2 Fuel oil service pump failure (mechanical)
207	Inhibit STBY for #1 Fuel service oil pump
208	Inhibit STBY for #2 Fuel service oil pump
209	FO heater tube failure
210	Failure of Thermostat control to FO heater
211	Failure of Fuel Flow control valve

Combustion Faults

301	Port boiler #1 Electrode tip burn out (Igniter)
302	Port boiler #2 Electrode tip burn out (Igniter)
303	Stbd boiler #1 Electrode tip burn out (Igniter)
304	Stbd boiler #2 Electrode tip burn out (Igniter)
305	Port boiler burner #1 Burner oil trip valve sticks open
306	Port boiler burner #2 Burner oil trip valve sticks open
307	Stbd boiler burner #1 Burner oil trip valve sticks open
308	Stbd boiler burner #2 Burner oil trip valve sticks open
309	Port boiler burner #1 Igniter Drive failure

310	Port boiler burner #2 Igniter Drive failure
311	Stbd boiler burner #1 Igniter Drive failure
312	Stbd boiler burner #2 Igniter Drive failure
313	Port boiler burner #1 Flame sensor failure (Photo-cell)
314	Port boiler burner #2 Flame sensor failure (Photo-cell)
315	Stbd boiler burner #1 Flame sensor failure (Photo-cell)
316	Stbd boiler burner #2 Flame sensor failure (Photo-cell)
317	Port boiler burner #1 Flame failure
318	Port boiler burner #2 Flame failure
319	Stbd boiler burner #1 Flame failure
320	Stbd boiler burner #2 Flame failure
321	Atomising steam supply failure (Valve stuck)

Combustion Air Faults

401	Port Boiler FD fan Slow run failure (electrical)
402	Stbd Boiler FD fan Slow run failure (electrical)
403	Port Boiler FD fan failure (mechanical)
404	Stbd Boiler FD fan failure (mechanical)
405	Port Boiler Air damper stuck
406	Stbd Boiler Air damper stuck
407	Port Boiler purge cycle failure
408	Stbd Boiler purge cycle failure
409	Port boiler burner #1 Air register fail (stuck open)
410	Port boiler burner #2 Air register fail (stuck open)
411	Stbd boiler burner #1 Air register fail (stuck open)
412	Stbd boiler burner #2 Air register fail (stuck open)
413	Port boiler burner #1 Air register fail (stuck closed)
414	Port boiler burner #2 Air register fail (stuck closed)
415	Stbd boiler burner #1 Air register fail (stuck closed)

416	Stbd boiler burner #2 Air register fail (stuck closed)
417	Port boiler FO Controller - no upper limit to FO pressure
418	Stbd Boiler FO Controller - no upper limit to FO pressure
419	Port boiler Windbox fire
420	Stbd Boiler Windbox fire
421	Stbd Boiler Air heater fire
422	Port Boiler Air heater fire
423	Port Boiler Air heater motor failure
424	Stbd Boiler Air heater motor failure

Combustion control Faults

501	Port Boiler Master fail (high)
502	Stbd Boiler Master fail (high)
503	Port Boiler Master fail (low)
504	Stbd Boiler Master fail (low)
505	Port Air/Fuel ratio controller failure
506	Stbd Air/Fuel ratio controller failure
507	Port F.O regulator failure (high)
508	Stbd F.O regulator failure (high)

Feed System Faults

601	Condensate pump #1 failure (Electrical)
602	Condensate pump #1 failure (Electrical)
603	Condensate pump #1 failure (Mech.)
604	Condensate pump #2 failure (Mech.)
605	Condensate pump #1- failure of standby operation
606	Condensate pump #2- failure of standby operation
607	Condenser tube failure.
608	Loss of vacuum in condenser

609	Condensate Recirc Regulator failure
610	DFT Dump fail
611	Port Boiler Feed water motorised valve failure
612	Stbd Boiler Feed water motorised valve failure
613	Turbo Feed pump #1 control valve failure (fully-open)
614	Turbo Feed pump #2 control valve failure (fully-open)
615	Turbo Feed pump #1 Stand by failure
616	Turbo Feed pump #2 Stand by failure
617	Turbo Feed pump #1 Feed water Re-circulation valve stuck
618	Turbo Feed pump #2 Feed water Re-circulation valve stuck
619	Make up Feed water regulator failure
620	Fresh Water Generator Condenser Tube Failure
621	Oil in the Contaminated Drain Tank
622	Feed Pump # 1 TRIP
623	Feed Pump # 2 TRIP

Gland Steam Faults

701	Gland steam regulator failure.
702	Gland steam to LP poorly regulated (inadequate pressure)

Lubrication System Faults

801	Lubricating oil pump #1 failure (electrical)
802	Lubricating oil pump #2 failure (electrical)
803	Lubricating oil pump #1 failure (mechanical)
804	Lubricating oil pump #2 failure (mechanical)
805	Lubricating oil pump #1- failure of standby operation
806	Lubricating oil pump #2- failure of standby operation
807	Lubricating oil leak
808	LO Coolers choked (waterside)

809	LO cooler thermostatic regulator failed.
810	LO cooler tube failure
811	Gear box bearing fault.
812	Gearbox sprayer faulty.
813	Main Line Shaft bearing running hot
814	LO Centrifugal separator drive failure
815	LO Centrifugal separator seal failure
816	LO Centrifugal separator water supply header tank low level.
817	LO Centrifugal separator drive failure (electric motor)

Main Circulating Pumps Faults

901	Main Circulating Pump #1 Fail electrically
902	Main Circulating Pump #2 Fail electrically
903	Main Circulating Pump #1 Fail (mechanical)
904	Main Circulating Pump #2 Fail (mechanical)
905	Main Circulating Pump #1- failure of standby operation
906	Main Circulating Pump #2- failure of standby operation

Throttle Faults

1001	Bridge Throttle control failure
1002	Engine Room throttle control failure
1003	Engine Room EOT failure
1004	Hydraulic throttle booster pump failure

Electrical Faults

1101	#1 TG - governor speed control failure
1102	#2 TG - governor speed control failure

1103	#1 TG - governor failure - full open
1104	#2 TG - governor failure - full open
1105	#1 TG - LO pump drive shaft failure
1106	#2 TG - LO pump drive shaft failure
1107	#1 TG - LO cooler choked
1108	#2 TG - LO cooler choked
1109	#1 TG - alternator air cooler leakage
1110	#2 TG - alternator air cooler leakage
1111	#1 TG - excitation failure
1112	#2 TG - excitation failure
1113	#1 TG - AVR failure
1114	#2 TG - AVR failure
1115	#1 TG - Low Vacuum
1116	#2 TG - Low Vacuum
1140	Main busbar - short circuit
1150	DG - LO pump drive shaft failure
1151	DG - LO leak from sump
1152	DG - LO cooler fouling
1153	DG - Charge air cooler fouling (SW side)
1154	DG - JCW cooler fouling (SW side)
1155	DG - JCW pump gland leak
1156	DG - JCW pump failure
1157	DG - clogged injector
1158	DG - alternator air cooler water leak
1159	DG - governor speed control failure
1160	DG - governor failure - full open
1161	DG - excitation failure
1162	DG - AVR failure
1163	Synchroscope failure

1164	Earth leakage (medium)
1165	Earth leakage (serious)
1166	Inhibit auto start emergency alternator
1167	Shore supply phase reversal

Bilge, & General Services

1204	Bilge pump - electrical fault
1205	Bilge suction strum blocked Port Forward
1207	Bilge suction strum blocked Port Aft
1208	Bilge suction strum blocked Stbd Forward
1210	Bilge suction strum blocked Stbd Aft
1211	Bilge level high Port Forward
1213	Bilge level high Port Aft
1214	Bilge level high Stbd Forward
1216	Bilge level high Stbd Aft
1217	OWS high oil content in discharge
1218	GS pump - electrical fault

Fire

1219	Fire pump - electrical fault
1223	Fire in Engine Room