KONGSBERG

User Manual

K-Spice® Generic Training Simulator

Kongsberg Oil & Gas Technologies AS

TABLE OF CONTENTS

1 Introduction

1.1 The Course

This course is intended to introduce the trainee to K-Spice® and a generic primary hydrocarbon process.

1.2 K-Spice®

K-Spice® is a high fidelity process simulation language

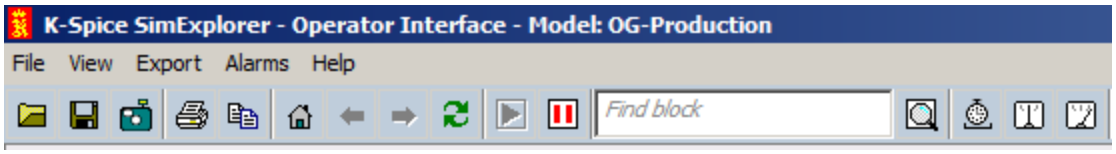
K-Spice® is Kongsberg Oil & Gas Technologies' next-generation dynamic process simulator, for detailed design and verification of oil and gas processes and control systems at all stages of the Lifecycle process.

Kongsberg Oil & Gas Technologies has been delivering dynamic process simulation models including multiphase pipeline simulation to the upstream oil & gas industry for over 25 years. We have delivered over 300 dynamic simulation studies, 100 customised Operator Training Simulators and over 40 online Production Management Systems to major oil & gas operators worldwide. This extensive and unique experience has been incorporated into K-Spice®, allowing us to provide field-proven, powerful dynamic process simulation solutions to the oil & gas market.

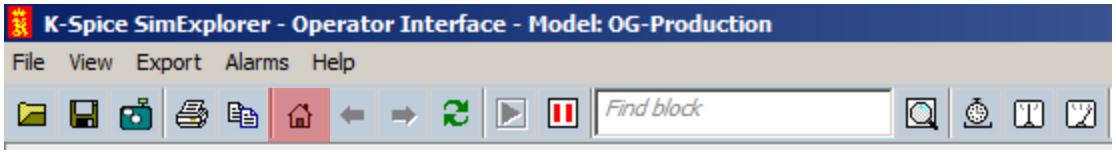
1.3 This document

Target areas are highlighted by a transparent target as show below, overlaying the item in question.

For example;



The K-Spice® tool bar, and below with the home key highlighted.



2 Generic Oil & Gas Production Model

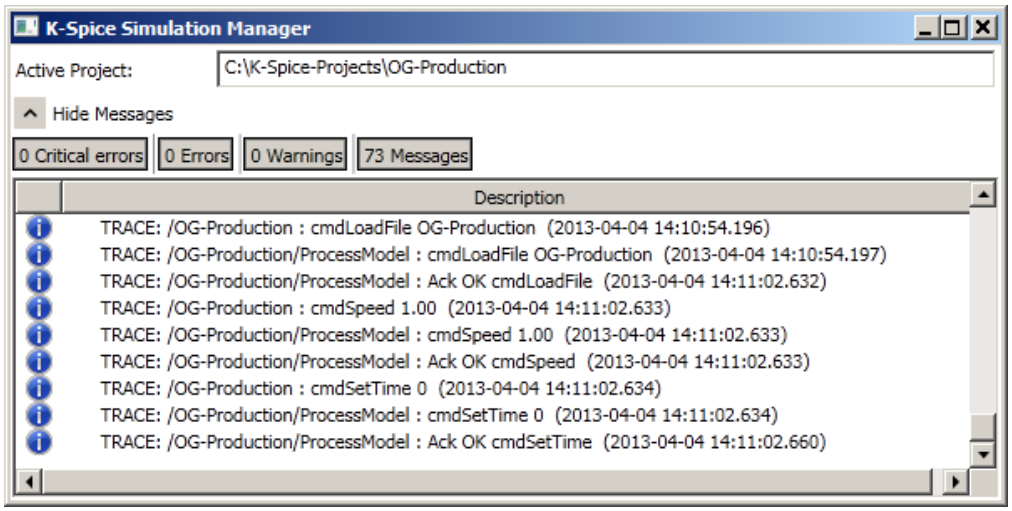
2.1 K-Spice® Environment

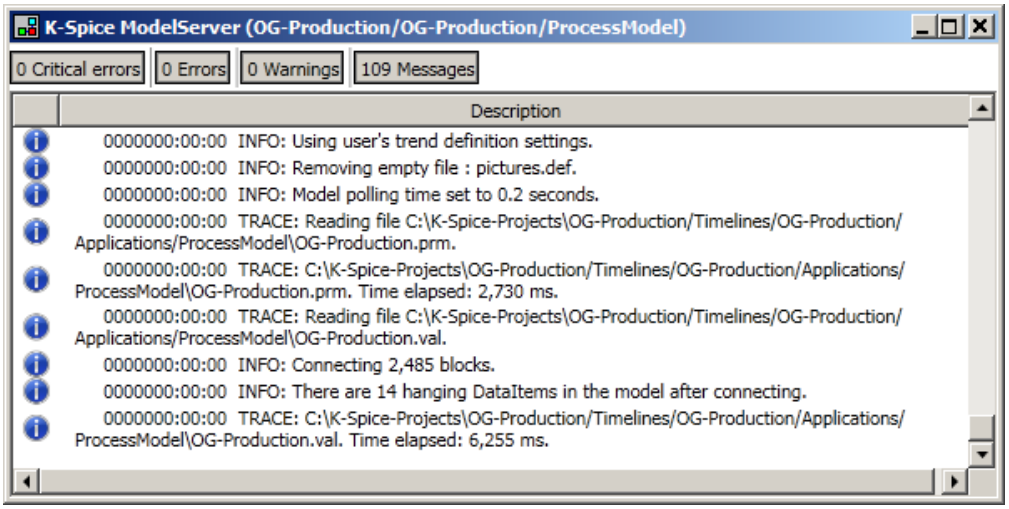
K-Spice® runs in the Microsoft Windows environment, and is accessible via desktop shortcuts.

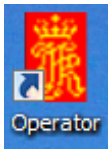
2.2 Starting the Oil & Gas Production Model

Desktop shortcut to start the simulator. (Double click).

This will open two windows, the K-Spice® simulation manager and the K-Spice® model server. These windows **MUST** remain open during the training sessions

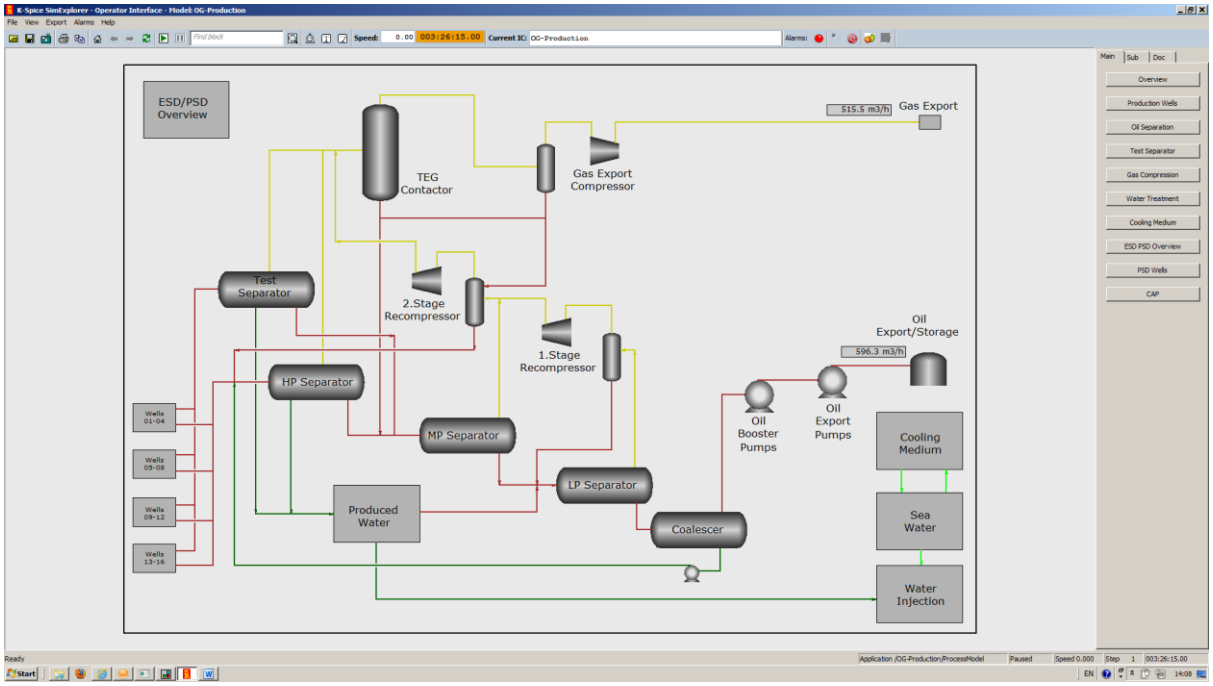






Desktop shortcut to launch the operator station. (Double click).

This launches the operator interface with the K-Spice® software, and has access to all the training functionality required.



3 The Process

The main operational features of the Generic Oil and Gas Production Process are:

- Production of stabilised (dead) crude for export to Storage Tanks
- Compression and treatment of associated gas for export via pipeline
- Treatment of Produced Water prior to disposal as a supply for the Water Injection
- Treatment of Sea Water prior to Water Injection

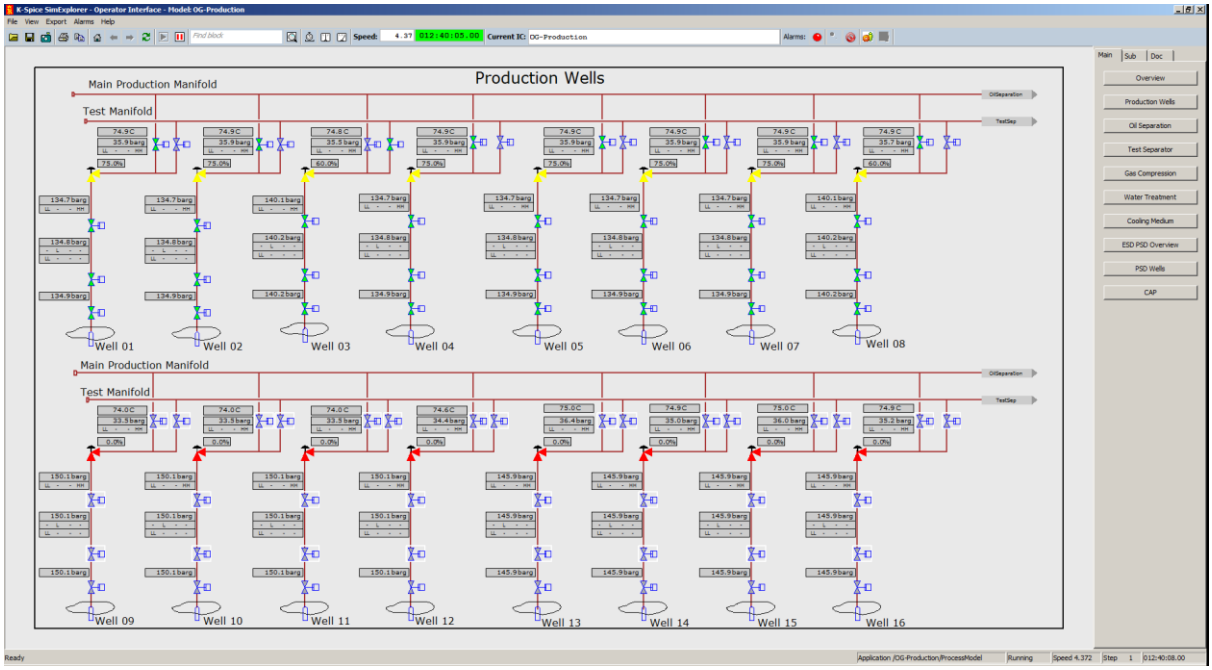
Primary Hydrocarbon Process

Process design consists of a three-stage, three-phase separation train. The three-phase flow from the production wells is routed to the High Pressure (HP) or Test Separator, for the initial separation into water, gas and hydrocarbon liquids. The hydrocarbon liquids are further degassed in the Medium Pressure (MP) Separator and then heated before the final degassing is done in the Low Pressure (LP) Separator. Stabilised crude from the Low Pressure (LP) separator is routed to an Electrostatic Coalescer for final dewatering prior to export. Water removed in the Coalescer is pumped back to the inlet of The associated gas from the Medium Pressure (MP) and Low Pressure (LP) stages are recompressed to High Pressure (HP) stage pressure. This done prior to the total gas stream being cooled for heavy hydrocarbon removal and then dehydrated by intimate contact with lean Tri Ethylene Glycol in the TEG Contactor in order to meet export specifications. The dried gas is compressed and then cooled for delivery into the Gas Export Pipeline. The rich TEG is returned to the Regeneration System.

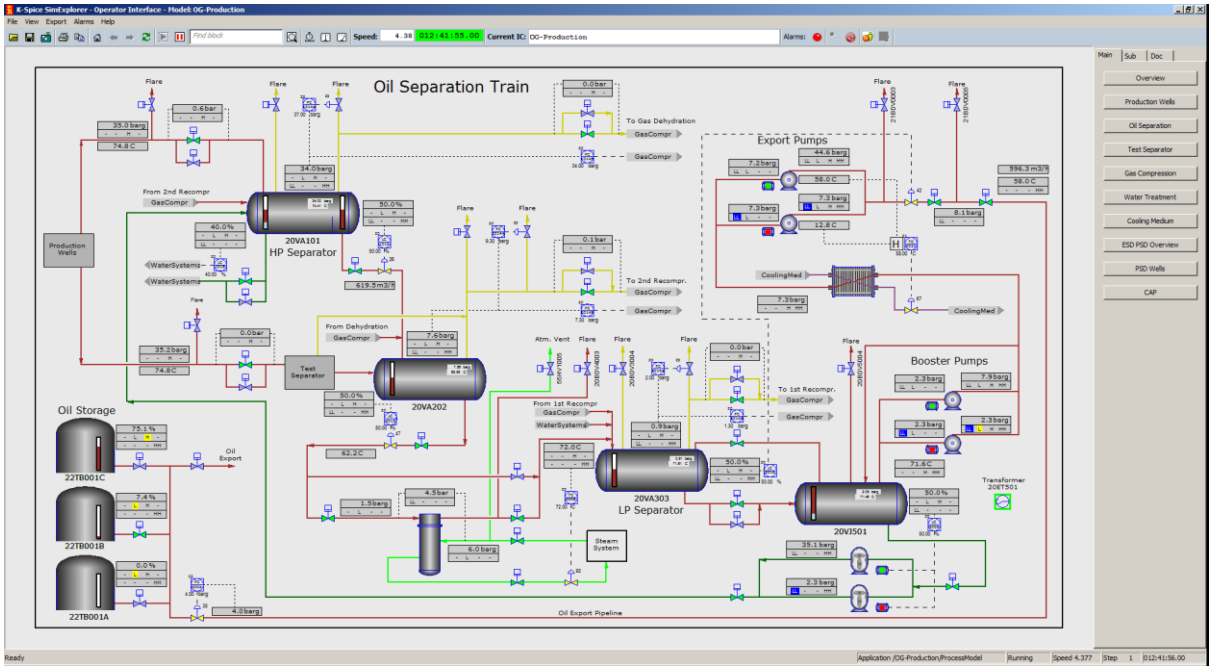
Produced Water leaving the HP and Test Separators is routed to their respective Hydrocyclones for de-oiling before final degassing in the Degassing Drum and onward pumping to the Water Injection System or disposal to sea.
A Test Separator, normally operating at the same pressure as the High Pressure Separator, caters for well testing.
To support the process operations a number of utility systems are provided. These utilities include:

- Cooling Medium
- Seawater
- Water Injection

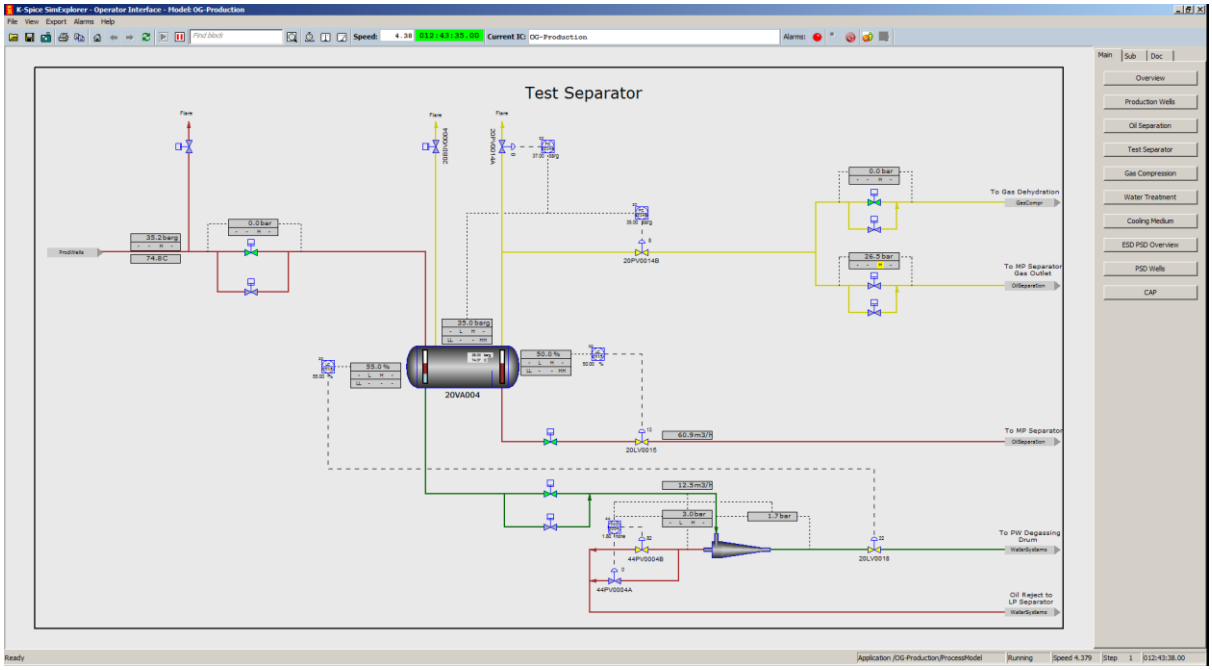
3.1 Production wells



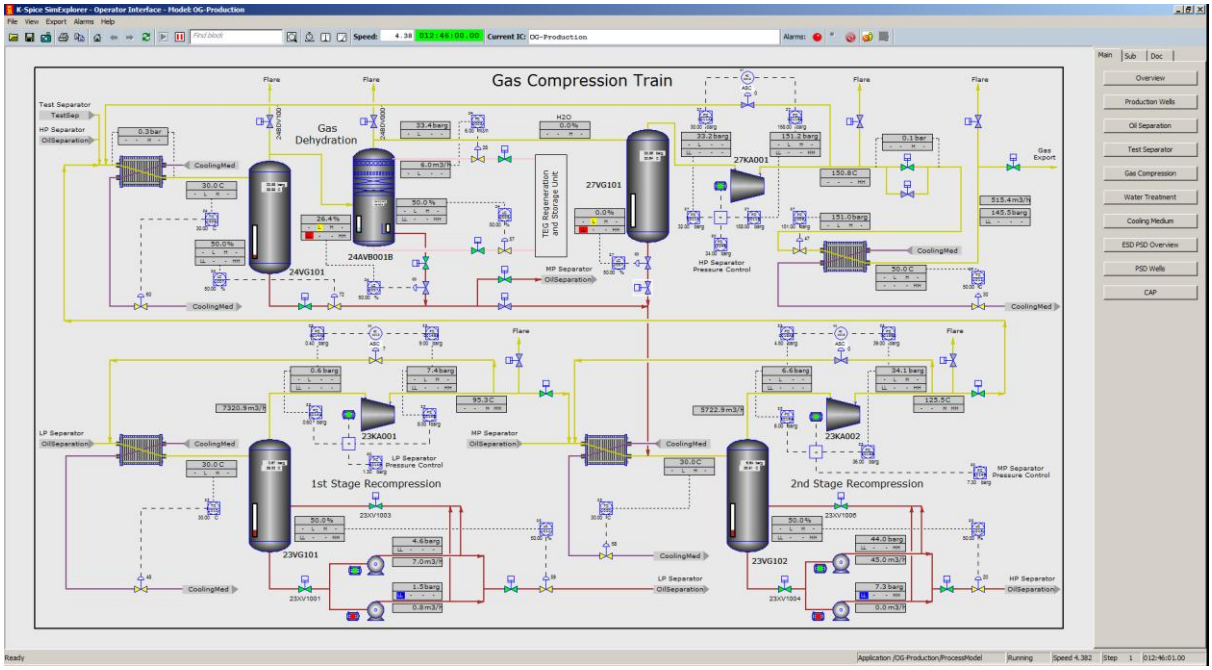
3.2 The oil system



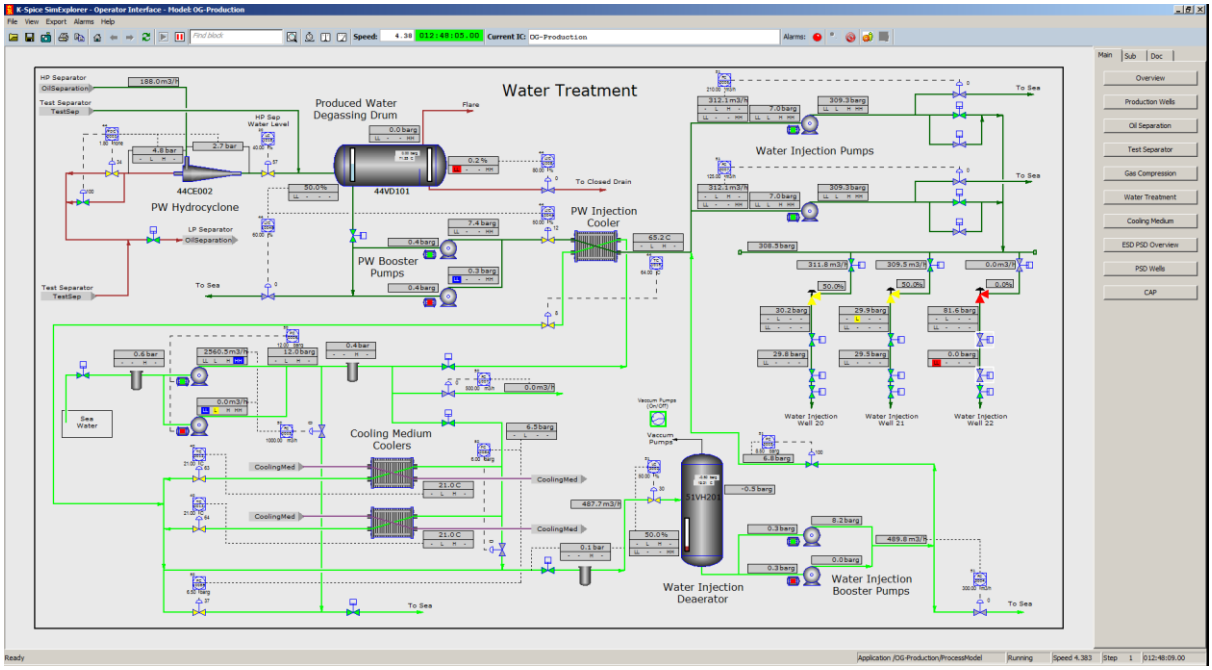
3.3 The test separator



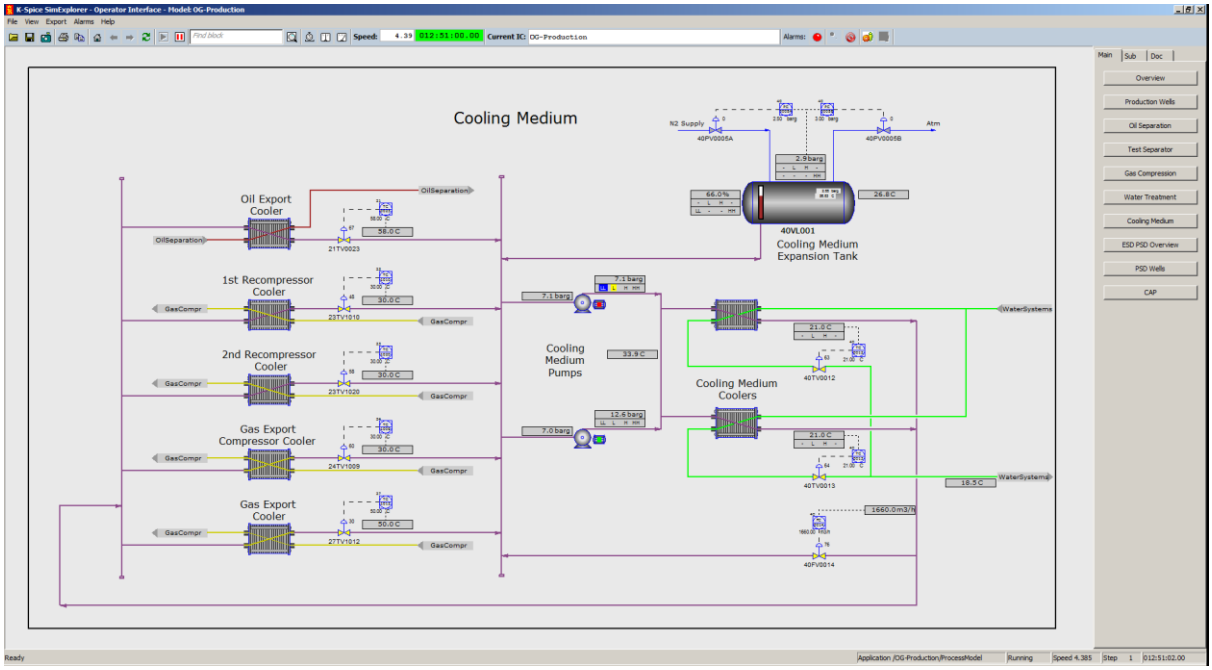
3.4 The gas compression train



3.5 Water treatment

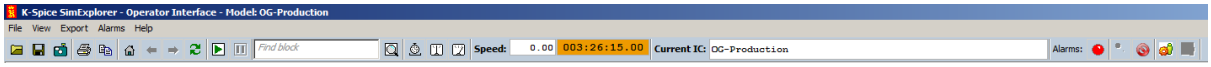


3.6 Cooling medium



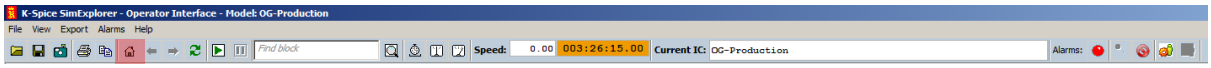
4 Operator Interface

4.1 Overview Menu

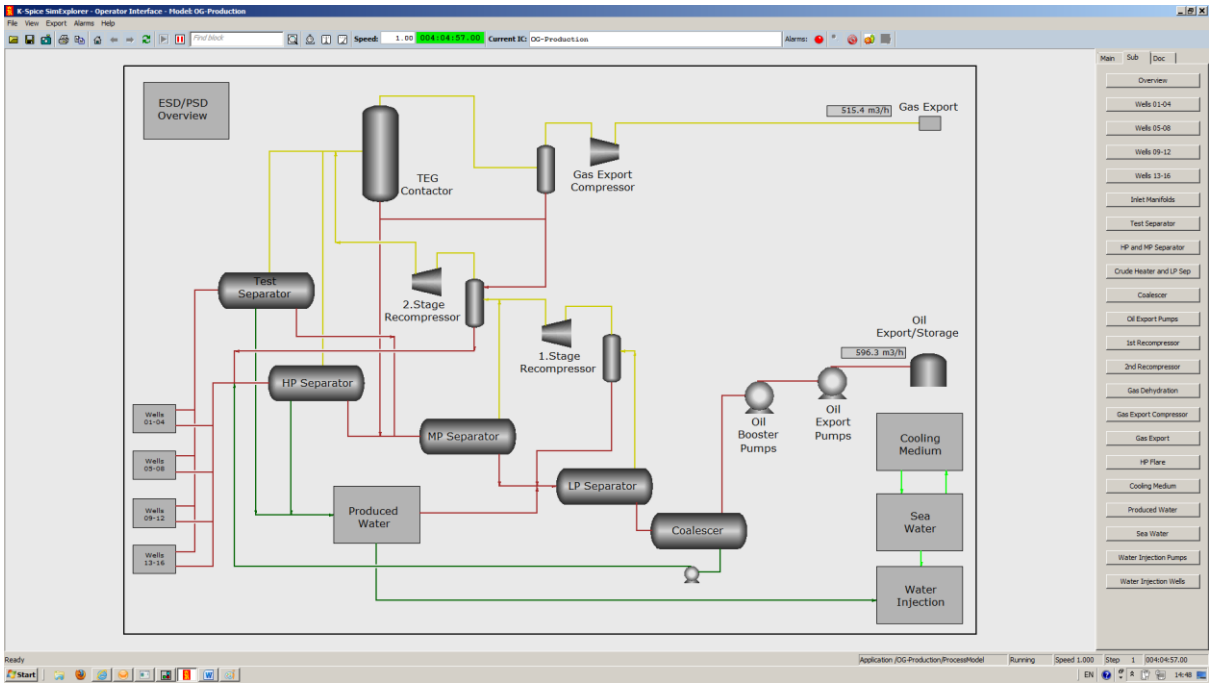


This menu bar gives full control over running a generic oil and gas simulator session.

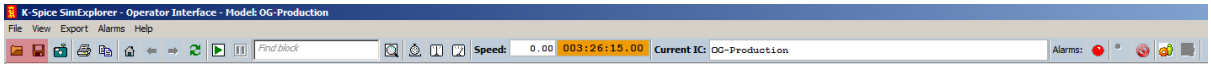
4.2 Home key



This button always brings up the overview screen



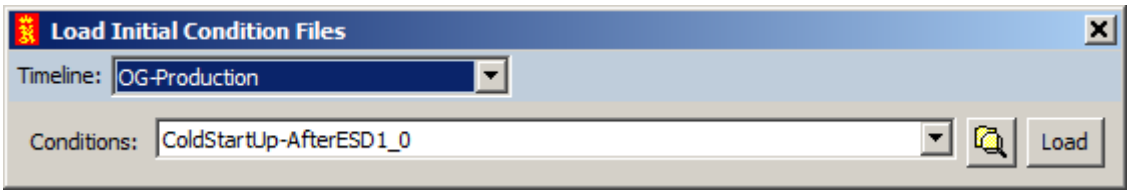
4.3 Load / Save Initial Conditions



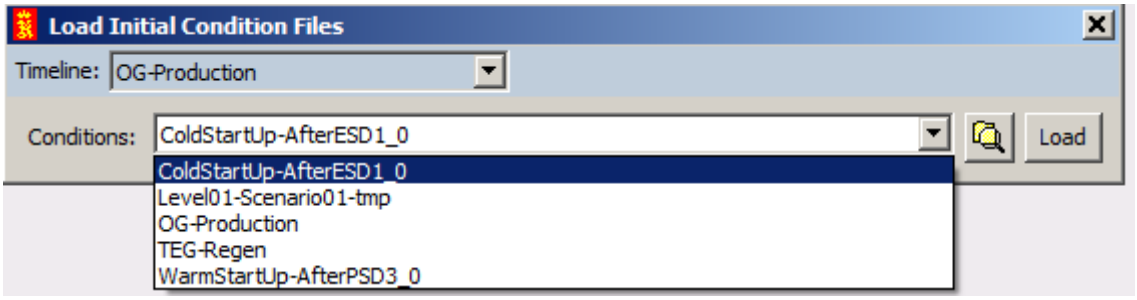
 Load and Save target icons

Clicking on the above icons gives the user the ability to load and save simulation scenarios

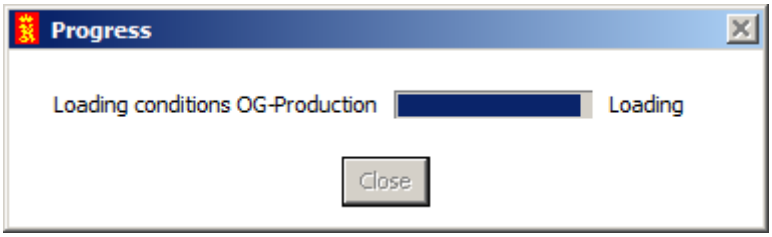
4.3.1 Loading an initial condition



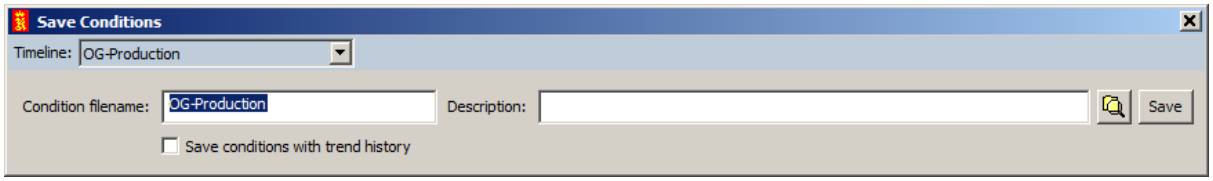
Load window; conditions are loaded from the drop down menu.



Select the desired initial condition and click load.



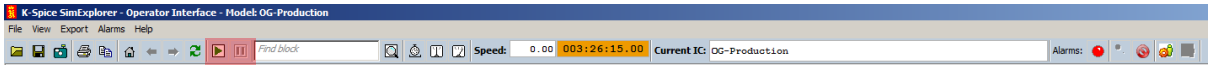
4.3.2 Saving an initial condition



Save window; conditions are saved by inputting the new data

Click on save.

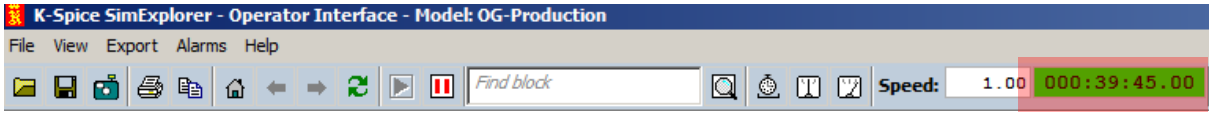
4.4 Run / Freeze Simulation



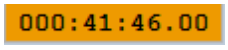
 Model paused, the ready to run icon is highlighted.

 Model running, the paused icon is highlighted.

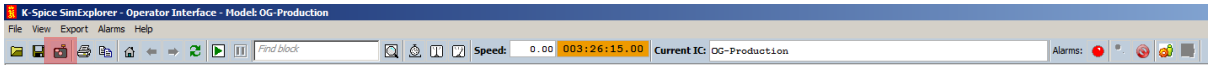
The simulation time is show in the menu bar



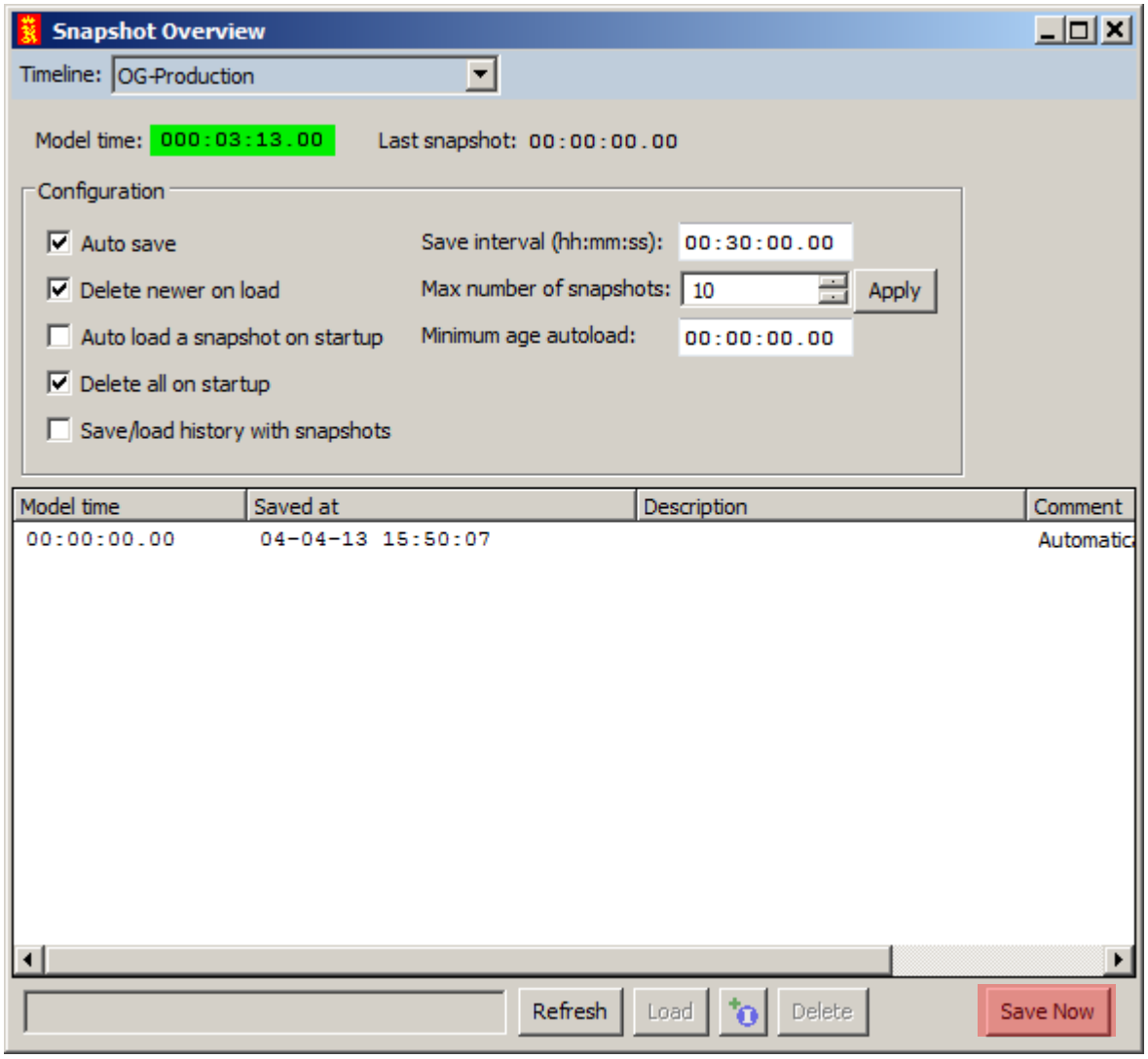
 model is running

 model is paused

4.5 Snapshot Overview



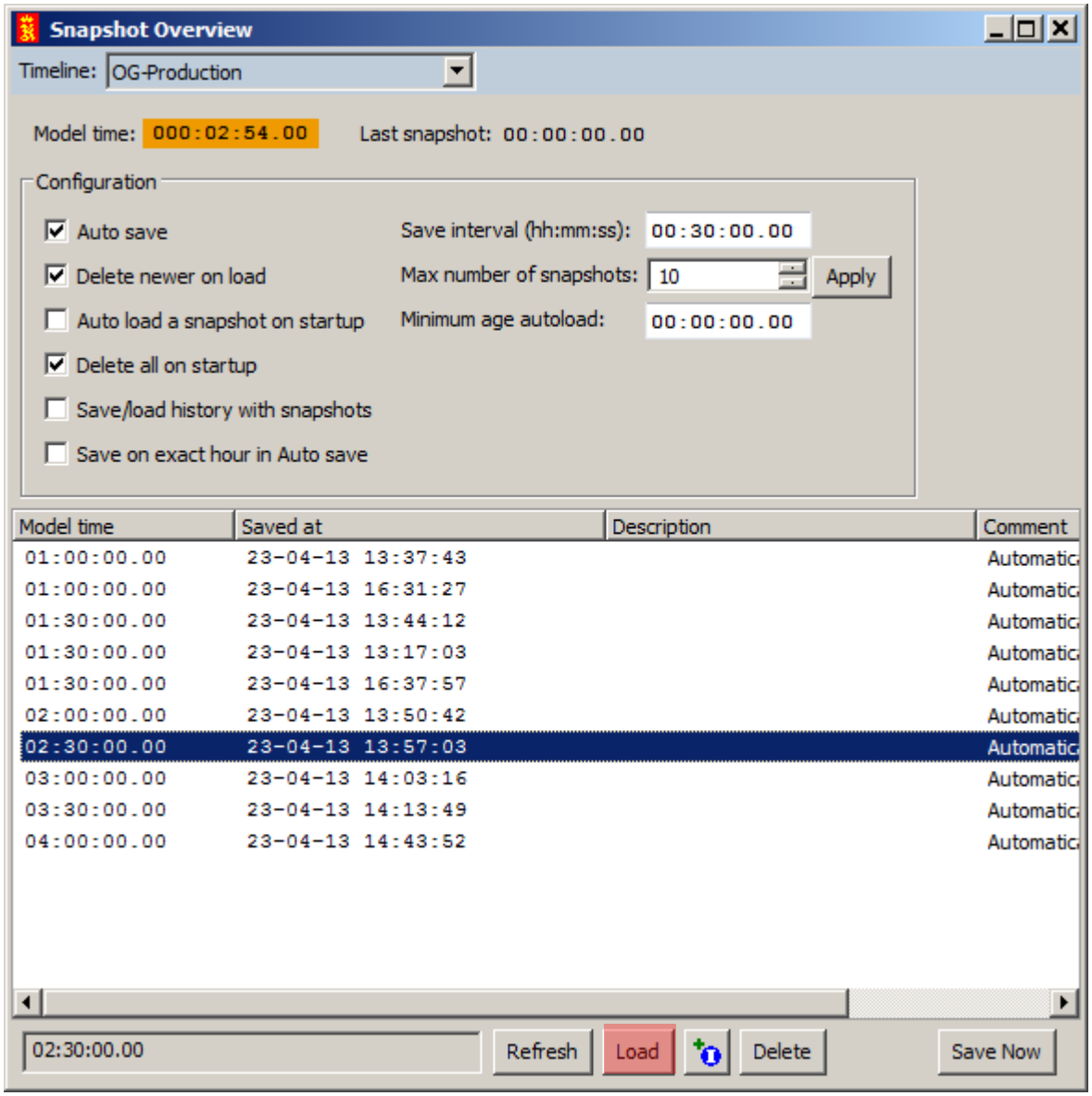
4.5.1 Saving a snapshot



Snapshot overview window.

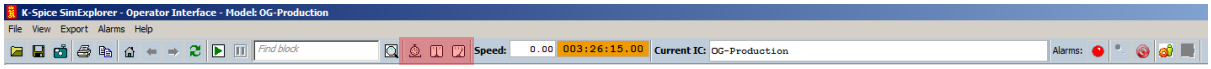
The snapshots can be turned off, saved at different periods of time, and a snap shot can be forced by clicking the Save Now button.

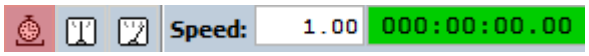
4.5.2 Loading a snapshot



Pause the model, select the snapshot, and click on Load.

4.6 Execution Speed Control

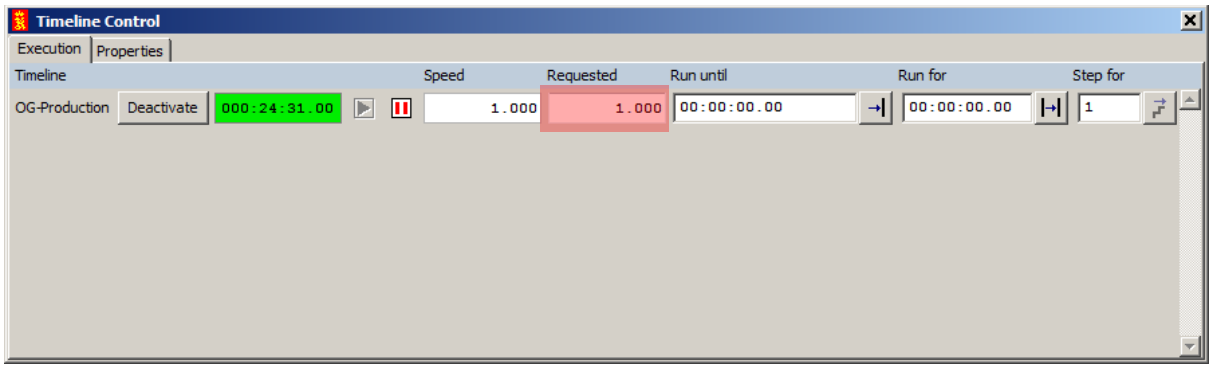




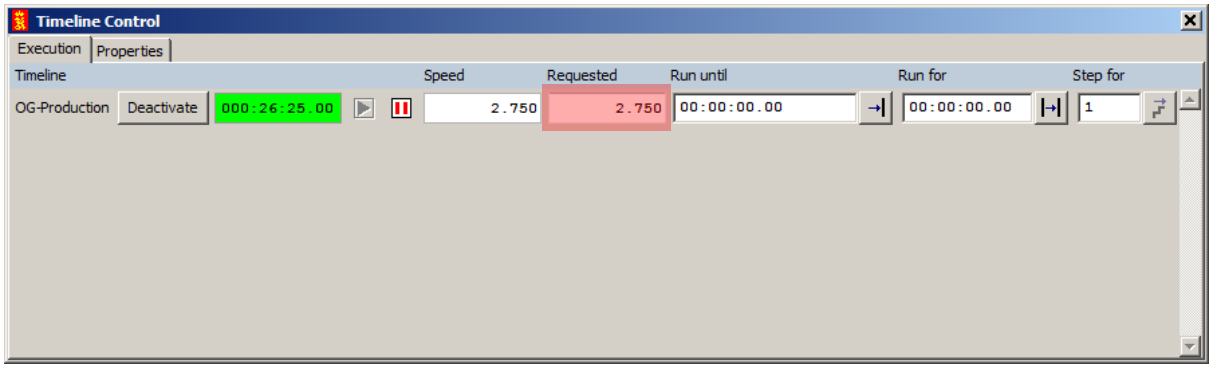
 Timeline control

 Set speed to x 1.0 (real time)

 Set speed to the maximum

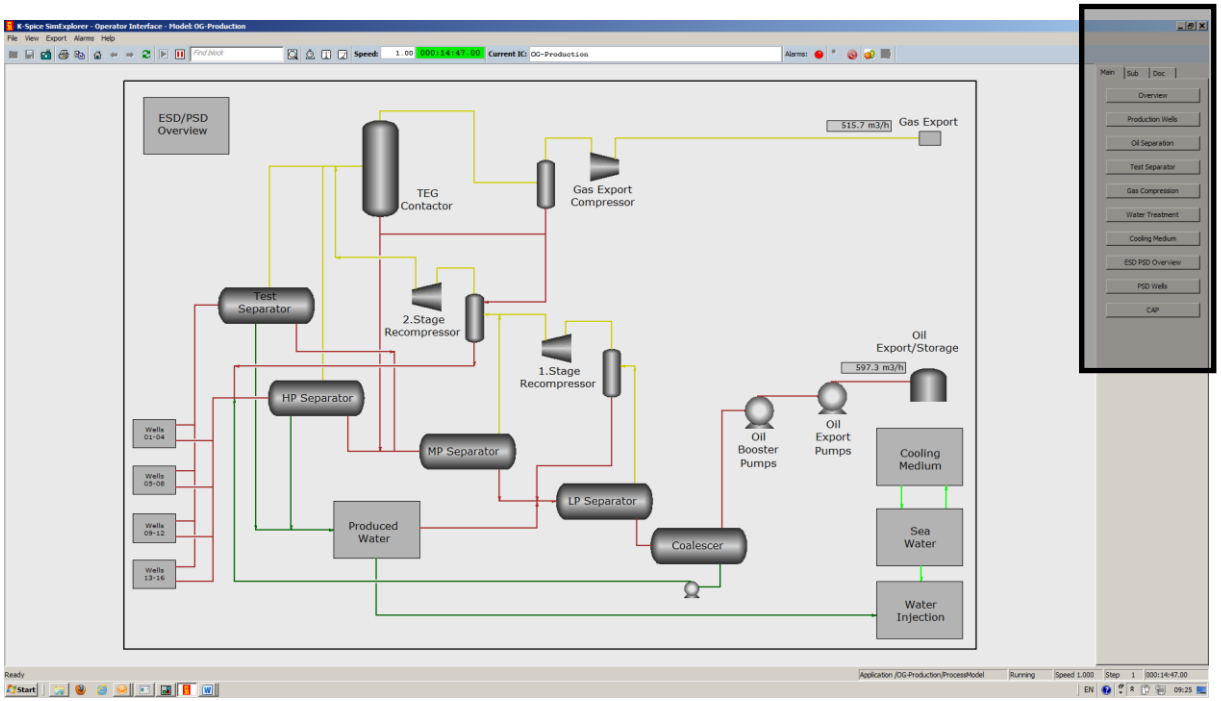


Set speed to desired value (within the limits of the model speed)

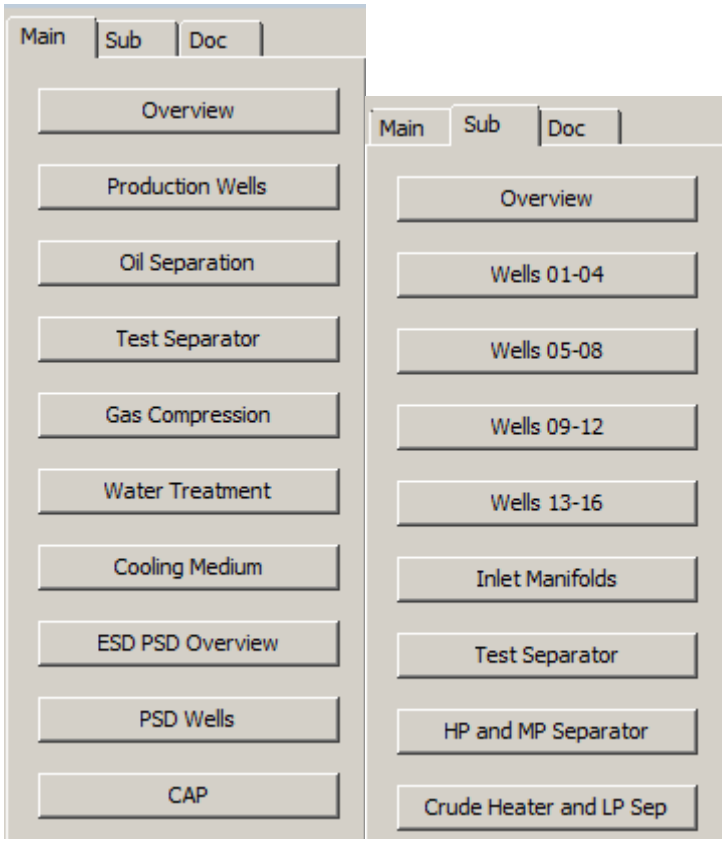


Speed request 2.750

4.7 Navigation

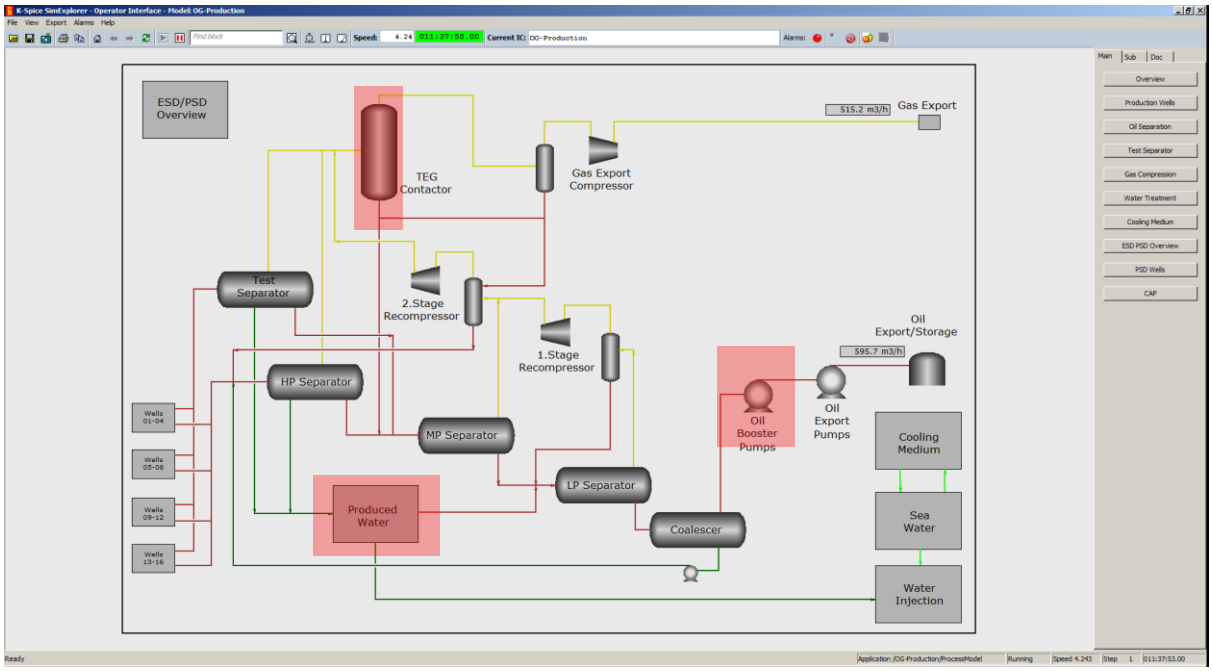


The model has two 'layers' of navigation, main and sub level. These are accessed from the tabulation on the main screen.



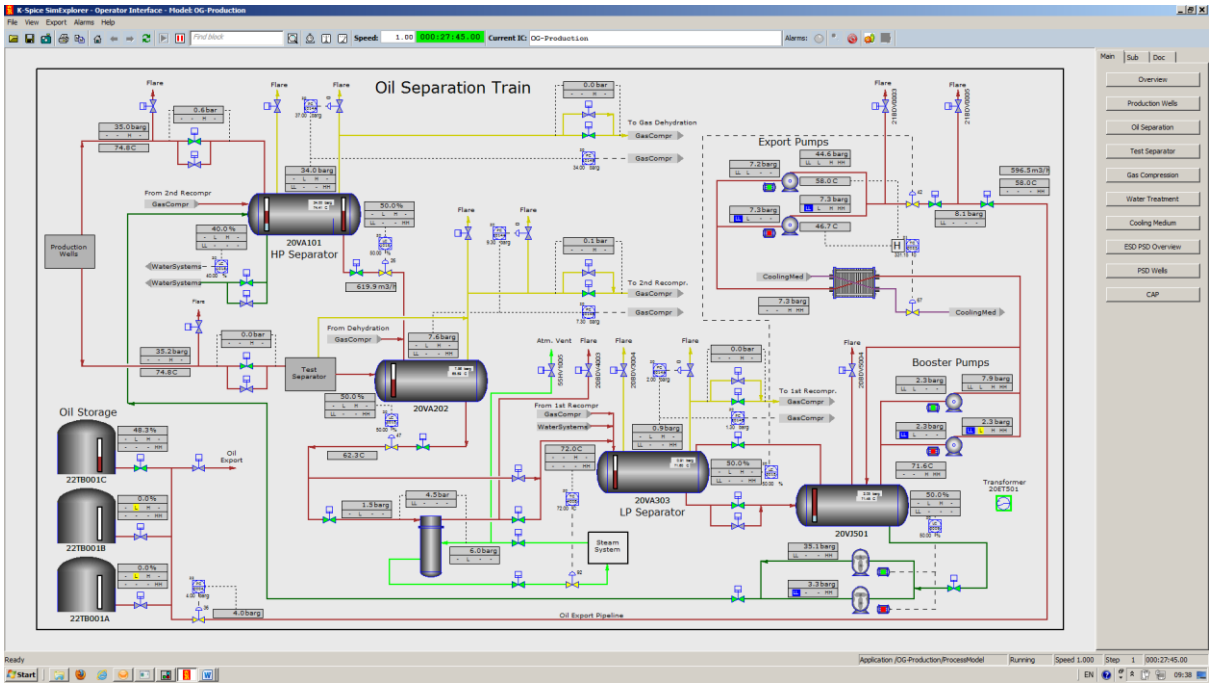
4.7.1 Navigational hotspots

Major pieces of equipment have navigational hotspots the call up a higher detailed graphic, (three are highlighted below).



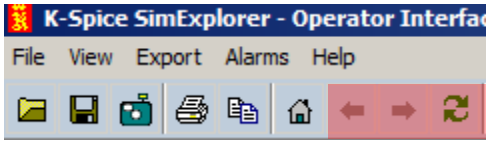
4.7.2 Main level graphics

The main graphics give an overview of the plant, and is broken down into ten graphics, including the shutdown system.



The plant can be controlled from these screens.

The graphic display history can be navigated from the arrow buttons on the tool bar



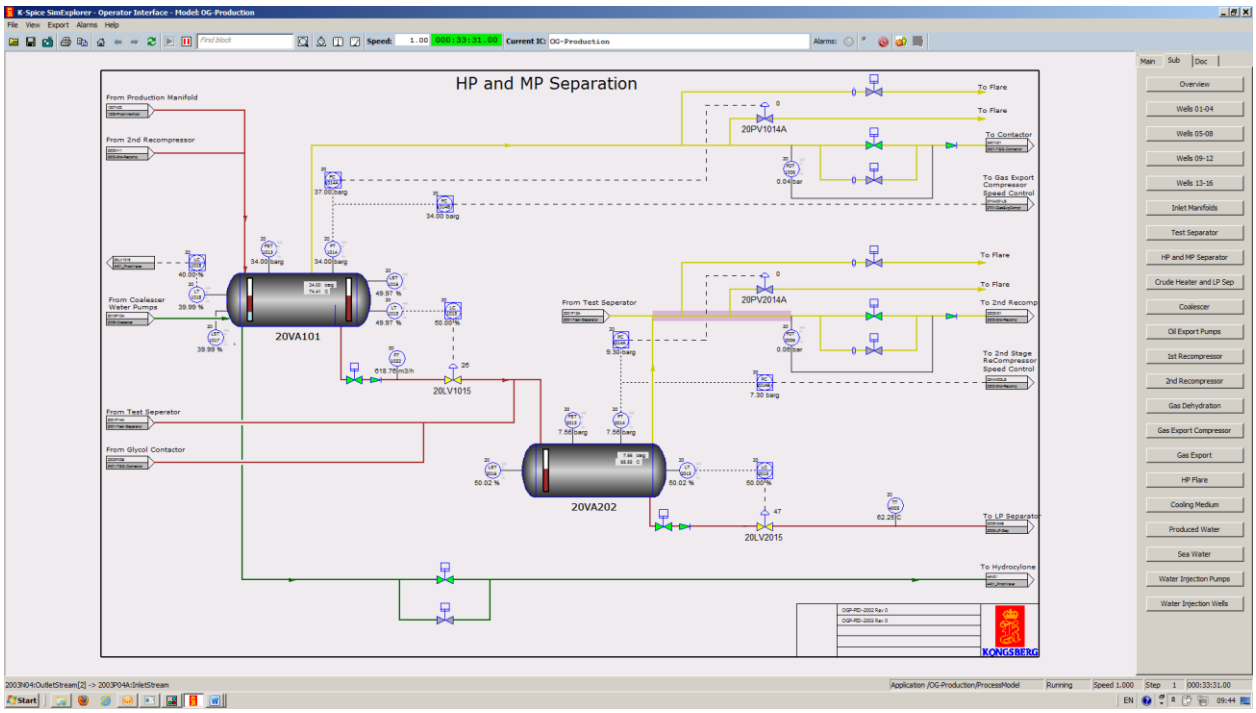
 Navigate back one graphic

 Navigate forward one graphic

The graphic can be redrawn using the  button

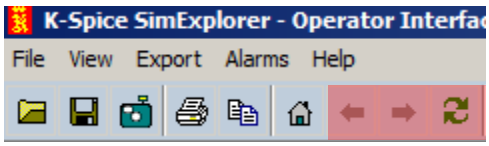
4.7.3 Sub level graphics

The sub level graphics give a more detailed view of the plant, and consist of twenty two graphics.



These graphics give a more detailed picture of the plant and also contain the field operator device (FOD) functionality.

As with the main level graphics graphic history can be navigated using the arrows on the tool bar.



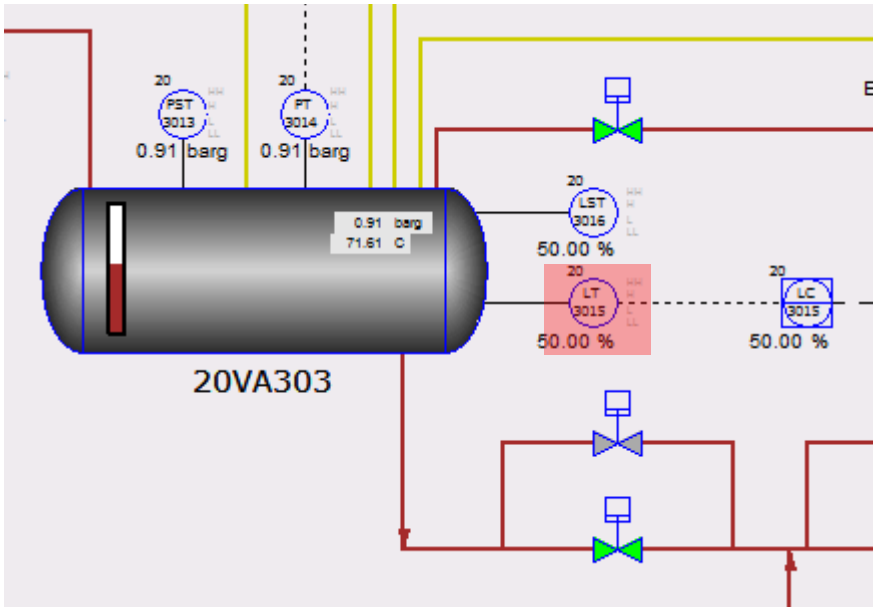
 Navigate back one graphic

 Navigate forward one graphic

The graphic can be redrawn using the  button

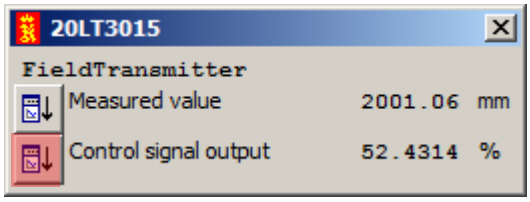
4.8 Trending

Values can be trended from transmitter windows and control windows

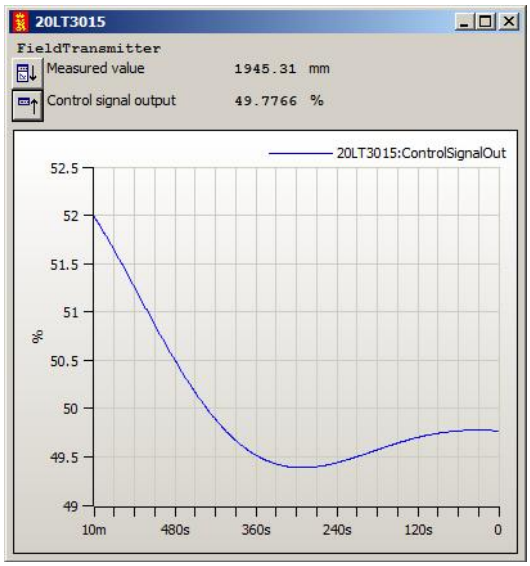


4.8.1 Trending from a transmitter.

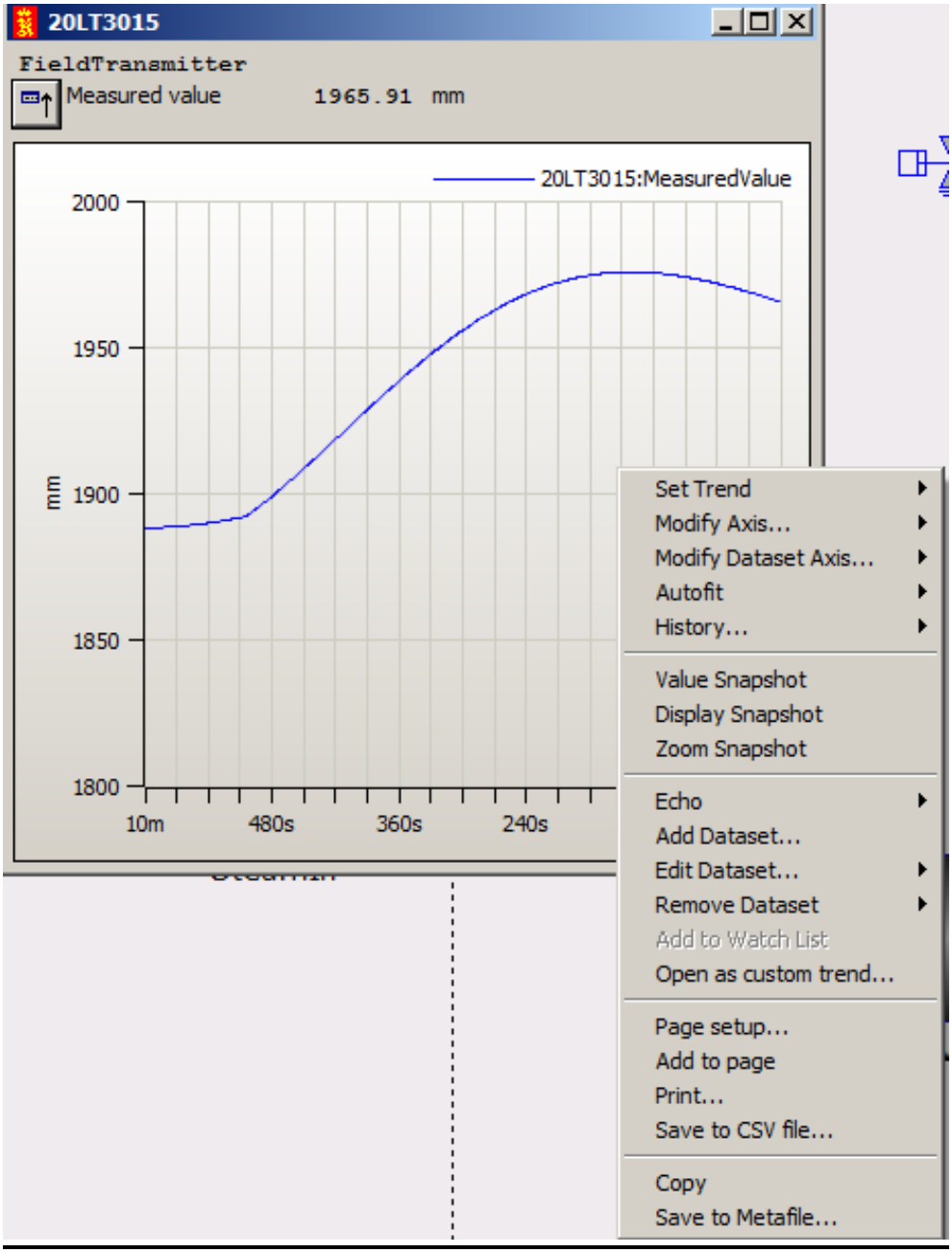
Selecting a transmitter (20LT3015) calls the following window



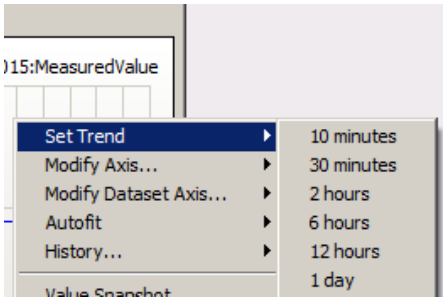
Selecting the trend tag displays a trend for that value



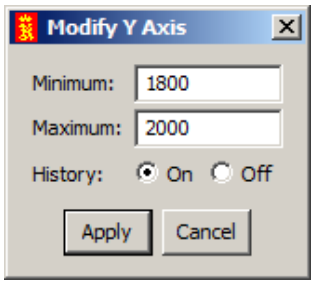
The properties of the trend can be changed by right clicking over the trend faceplate



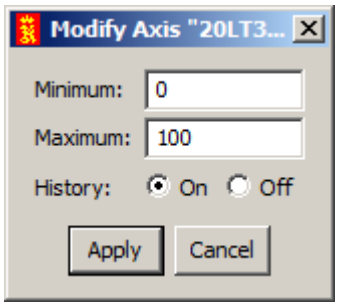
Set trend - changes the time scale



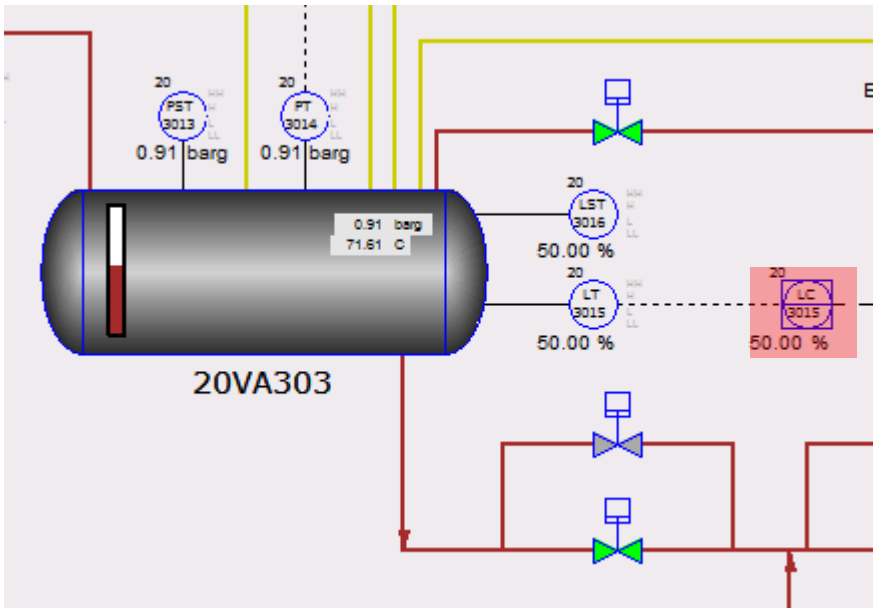
Modify Axis – alters the Y axis parameters



Modify Dataset Axis - modifies the data range

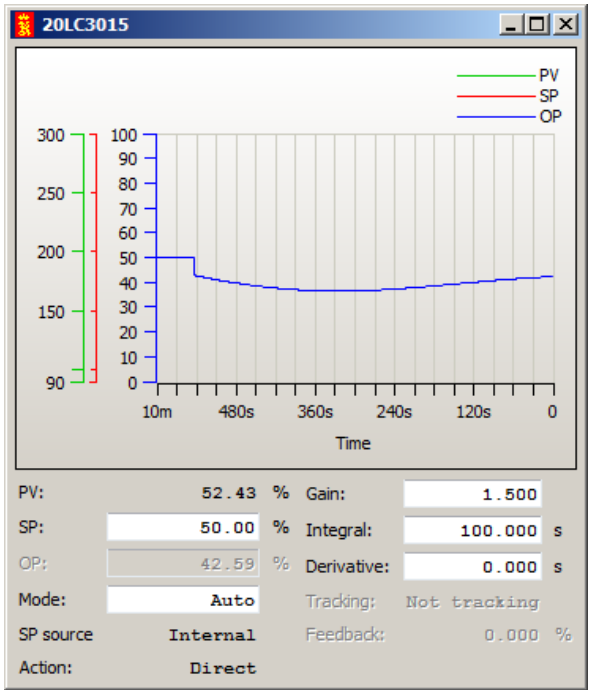


4.8.2 Trending from a controller



Trending from a controller brings up the controller faceplate

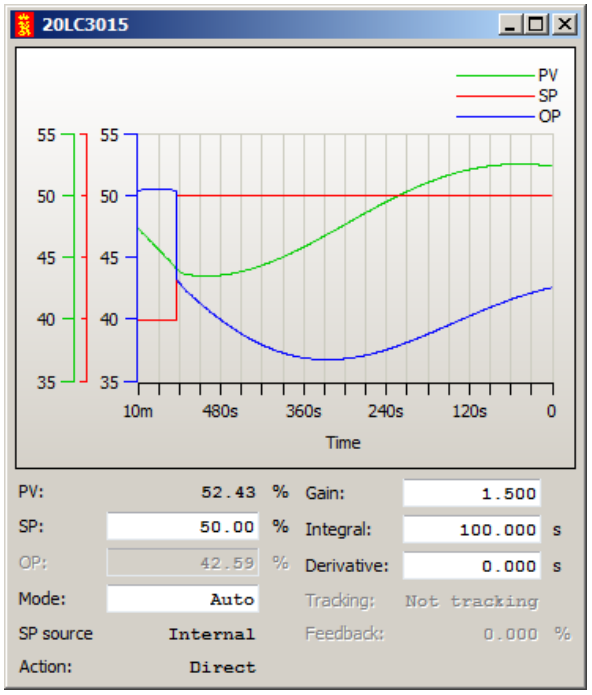
History – sets the trend to historise



Features are the same as the trend from a faceplate.

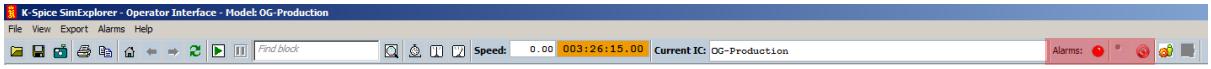
Autofit – automatically re ranges the x axis to fit the curves.

Below is 20LC3015 controller with autofit feature activated



Note that the set point, process value and output are all available to trend.

4.9 Alarms



alarm with sound off

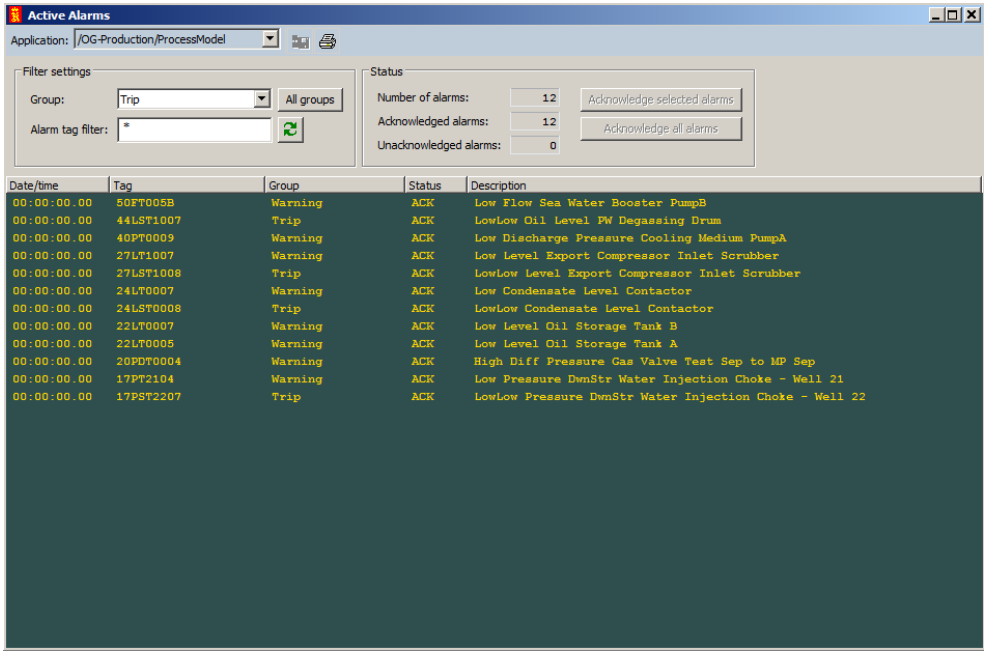
alarm with sound on

The alarm sound can be toggled on and off using the above buttons

4.9.1 Active Alarms

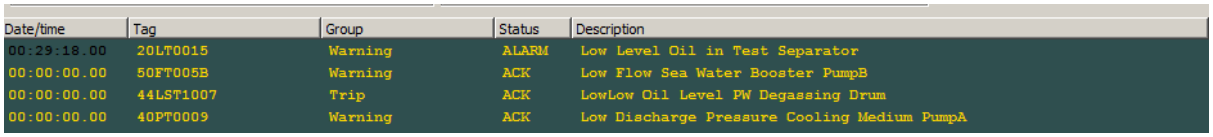
The alarm screen is called up by clicking the 

button.

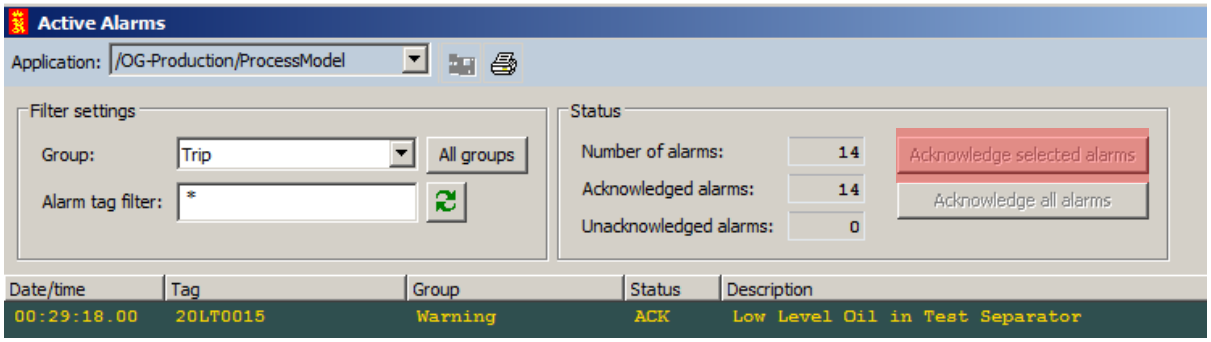


This page shows the alarms and trips (group column) that are active.

A new alarm 20LT0015 occurred at 00:29:18:00 its status is ALARM, it is a low level oil in the test separator.



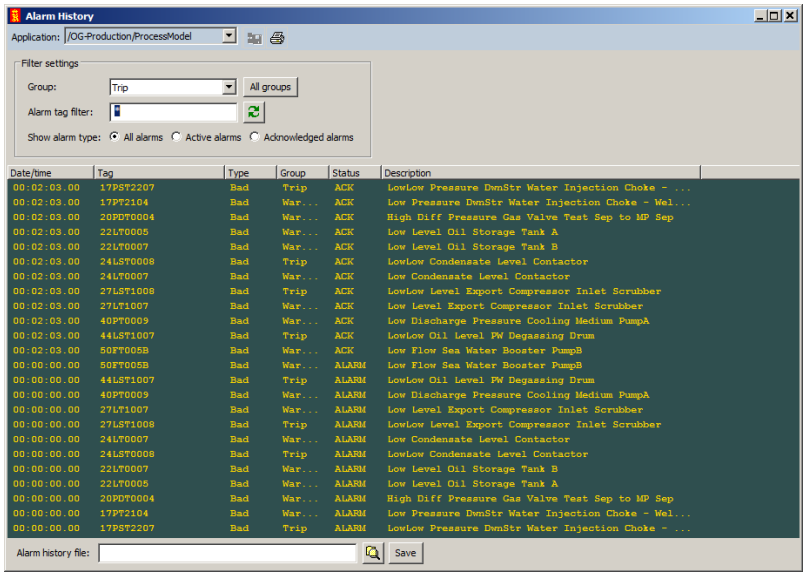
This can be acknowledged



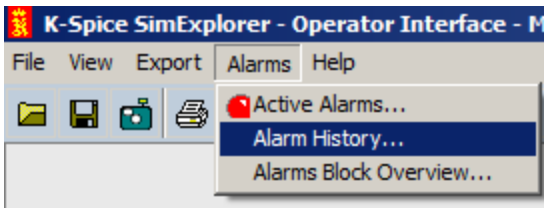
The status is now ACK.

The alarm will remain in the window until it has cleared.

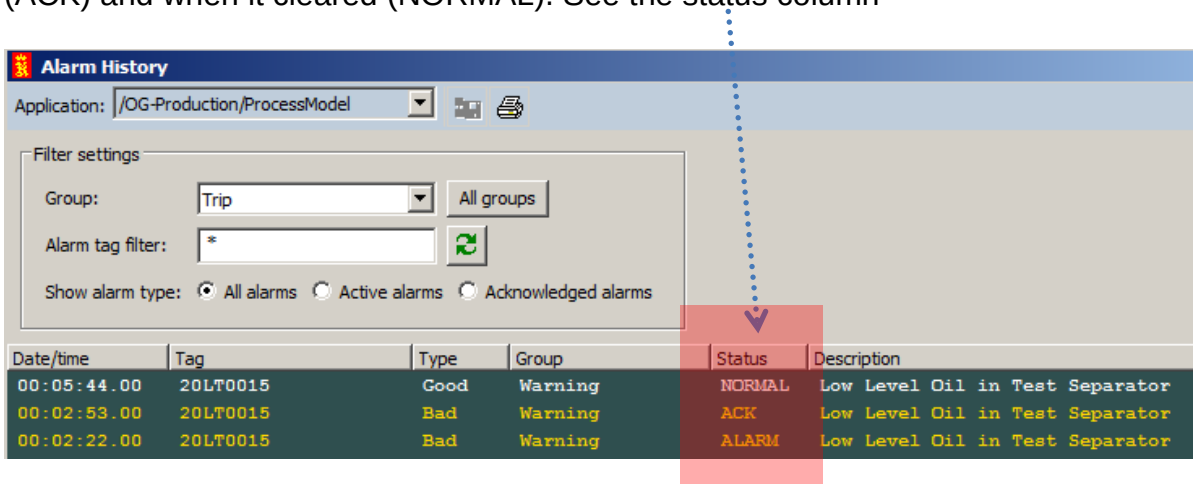
4.9.2 Alarm history



The alarm history is accessed via the menu

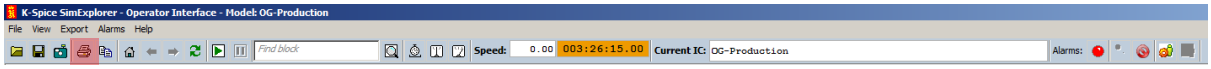


This the 'status' when an alarm occurred (ALARM), when it was acknowledged (ACK) and when it cleared (NORMAL). See the status column

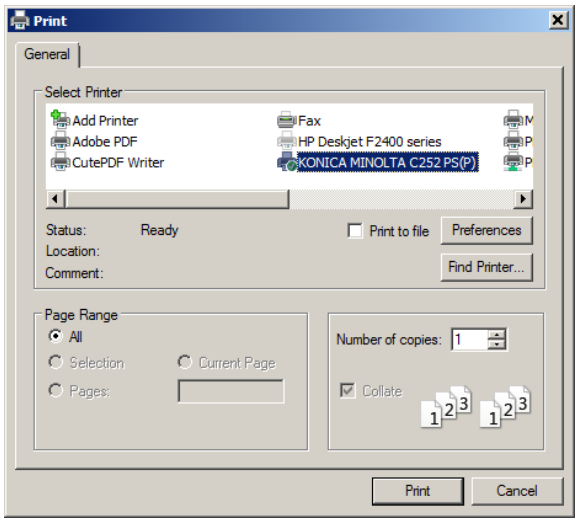


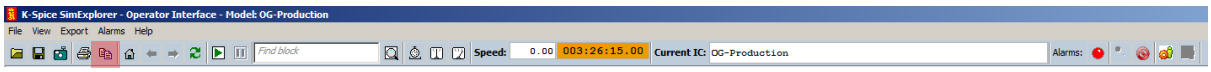
Again the alarm for the low level in the test separator (20LT0015) has occurred at 00:02:22:00 (ALARM), it was acknowledged at 02:53:00 (ACK), and went out of alarm at 00:056:44:00

4.10 Printing and copying graphics



 Allows you to print to your selected (attached) device as applicable. Including PDF writers for producing screen dumps.



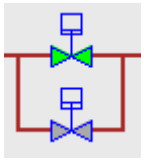


 Allows you to copy the graphic to the clipboard.

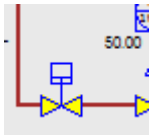
5 Process Equipment and Instrumentation Faceplates

5.1 Valves

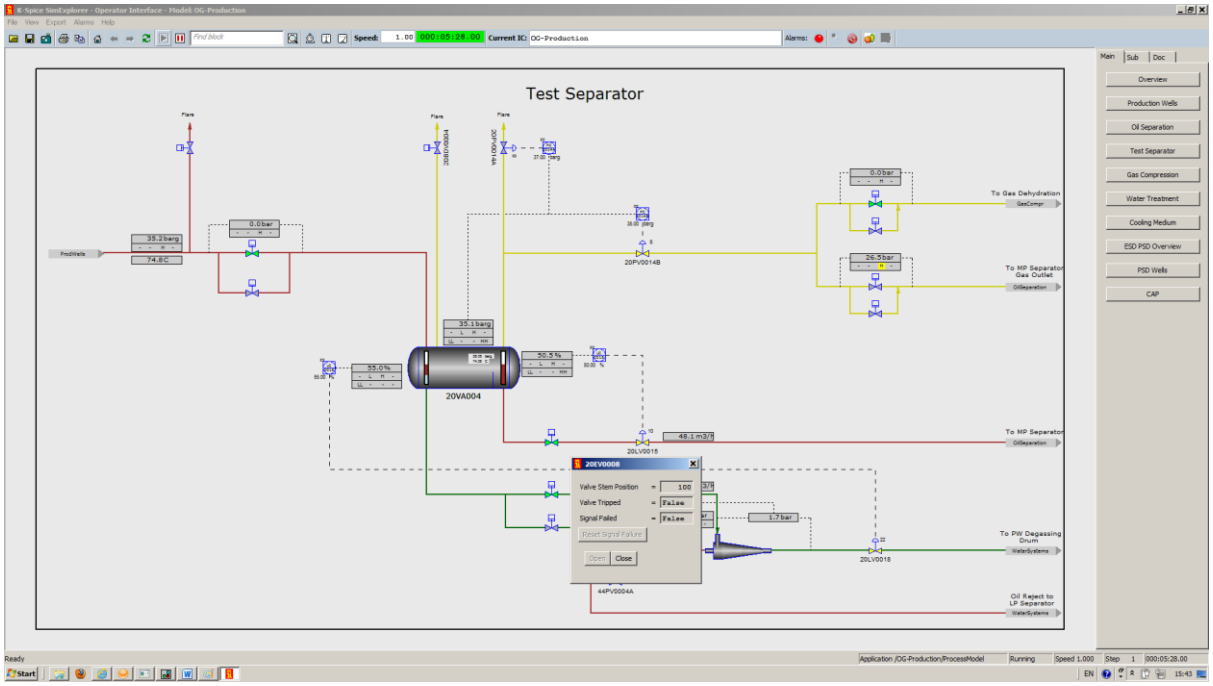
5.1.1 Shutdown Valves



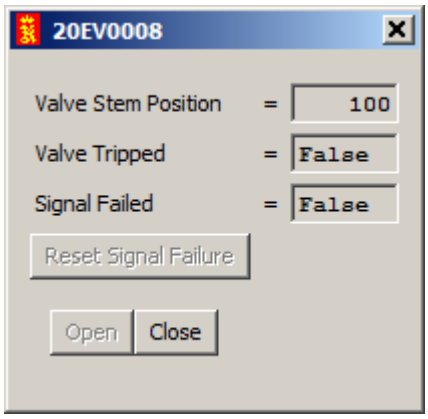
One open shutdown valve (green) and one closed shutdown valve (grey)



A shutdown ‘travelling’ between open and closed (yellow), this is a transient state for a shutdown valve.

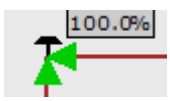


Shutdown valve faceplate for 20EV0008

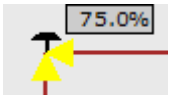


This valve can be opened or close, logic permitting.

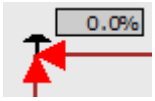
5.1.2 Choke Valves



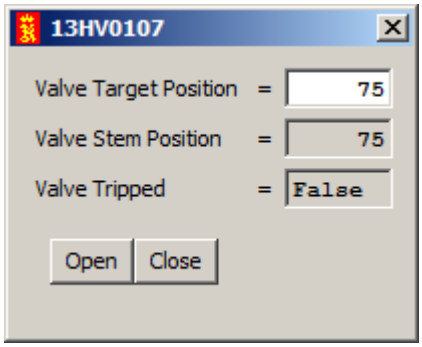
Open 100%



partially open



Closed 0%



Target position of the choke valve.

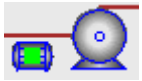
5.2 Motors

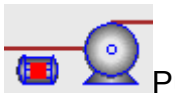
Running motor 

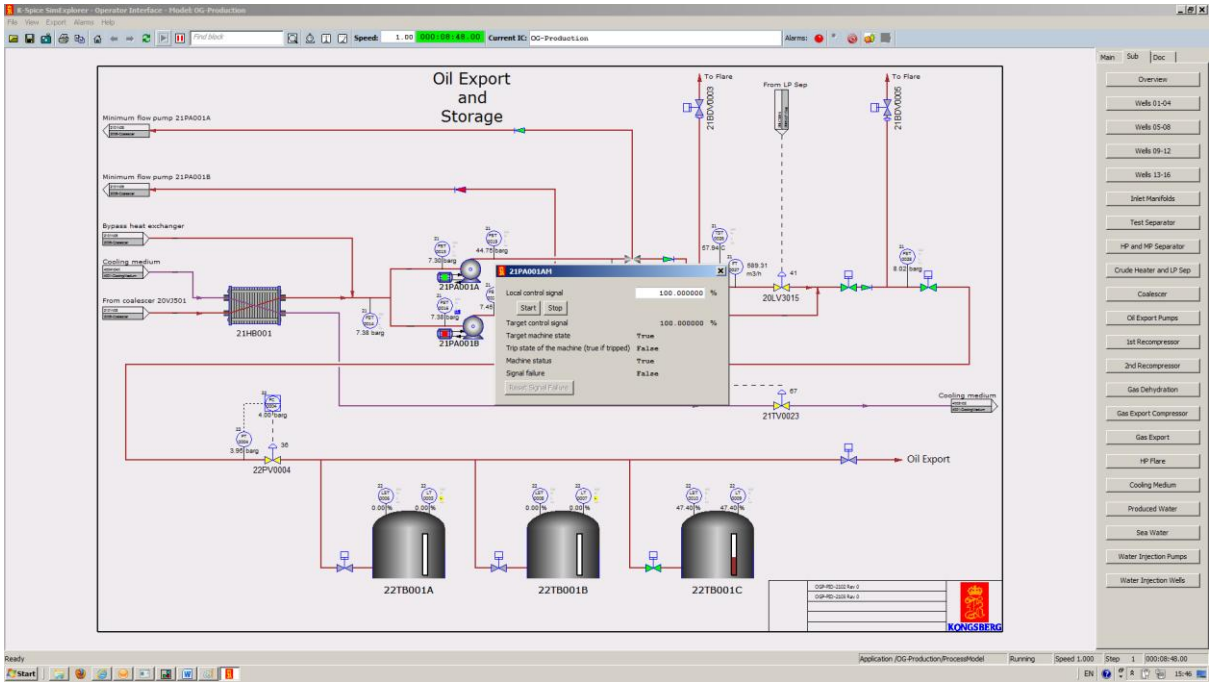
Stopped motor 

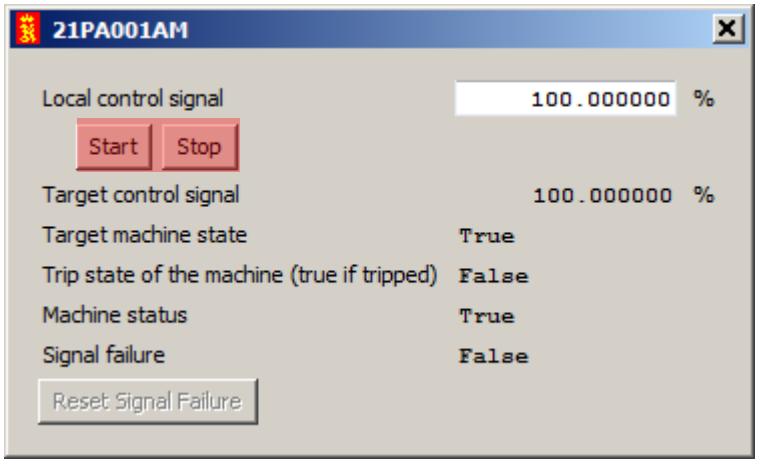
5.3 Pump

5.3.1 Centrifugal Pump


Pump with motor running


Pump with motor stopped

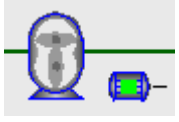




Pump start and stop faceplate, called up by a left click on the pump motor

The pump can be started and stopped from the control room via the Start and Stop buttons.

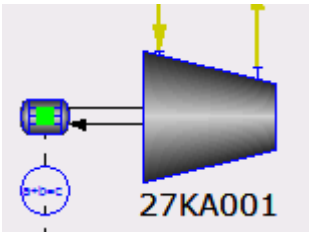
5.3.2 Displacement Pump

 Pump with motor running

 Pump with motor stopped

Start / Stop faceplate is the same as the centrifugal pump.

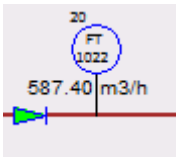
5.4 Compressor



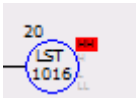
Centrifugal compressor

Start / Stop faceplate is the same as the centrifugal pump.

5.5 Field Transmitter

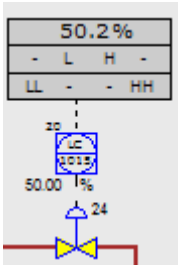


Flow transmitter (with non-return valve (check valve))

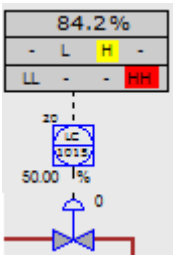


Trip transmitter with an active high alarm (backlit in red)

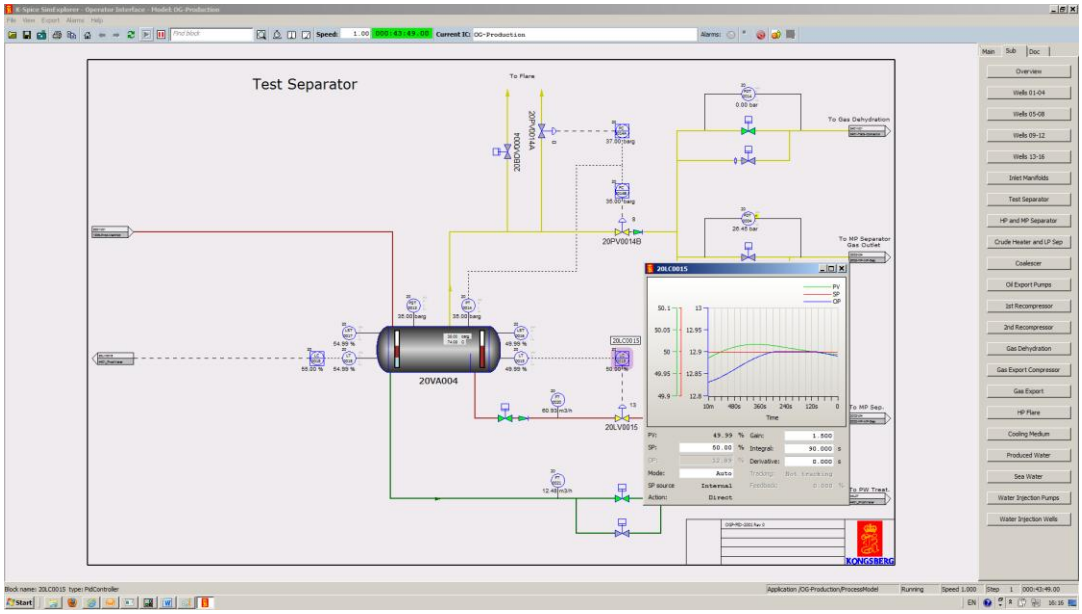
5.6 Controller



Controller with control valve active

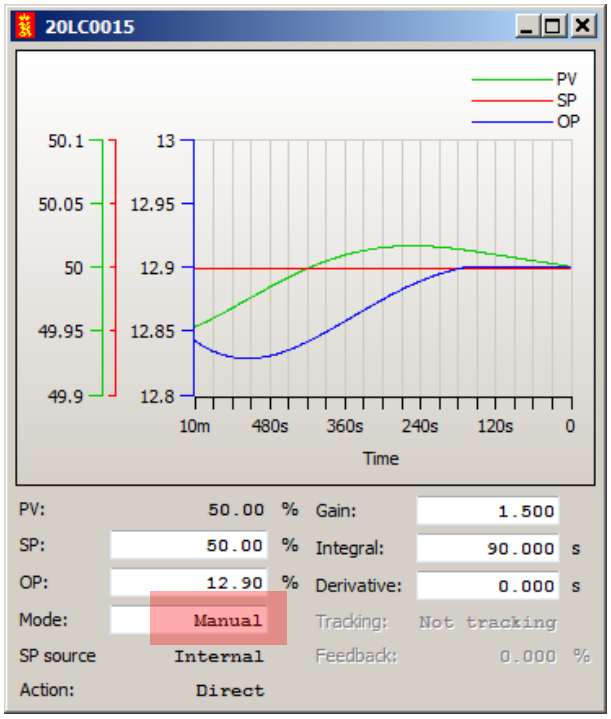


Controller with trips active and control valve closed

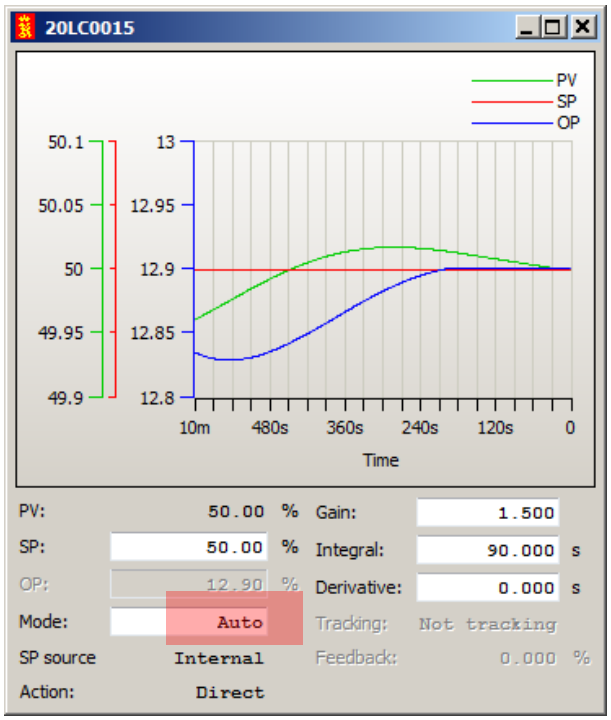


Controller faceplate called from 20LC0015

Controller faceplate modes of operation

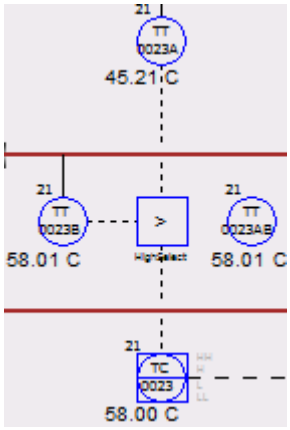


Controller in Manual (Output available), the operator can change the output of the valve



Controller in Automatic (Set Point available) , the operator can change the set point of the controller.

5.7 Selector



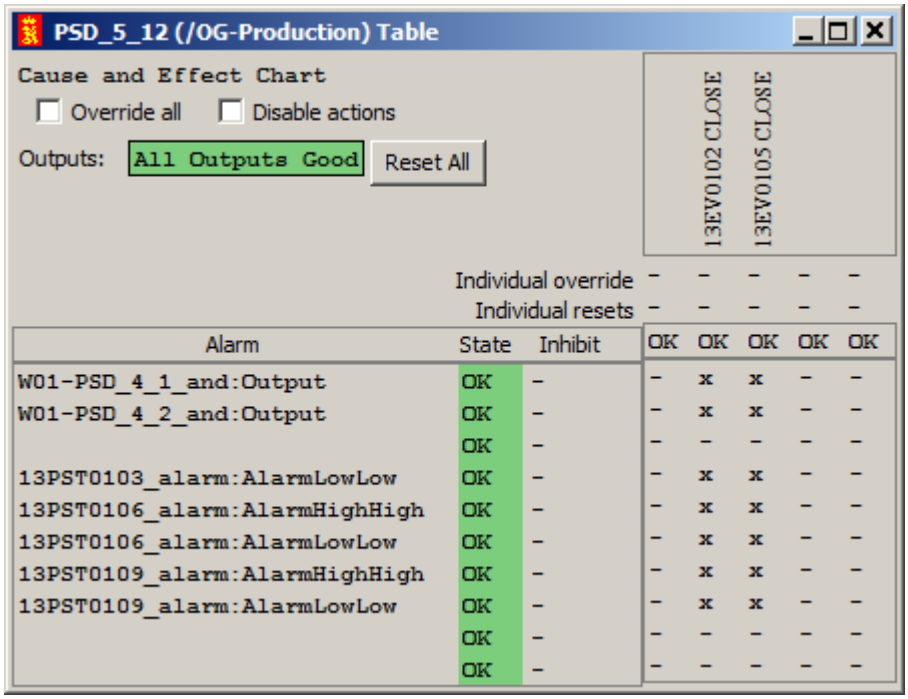
High selector takes the inputs 58'C and 45'C output to the controller (TC0023) is 58'C

5.8 Alarm

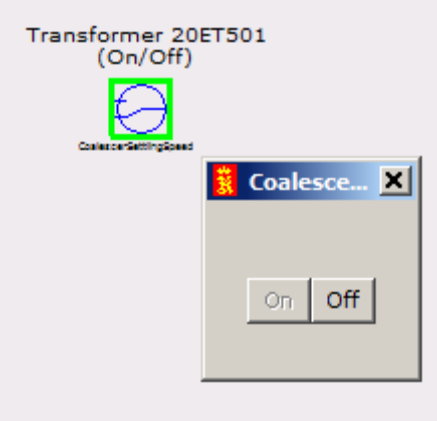
Low alarm highlighted blue on the transmitter

5.9 Cause & Effect

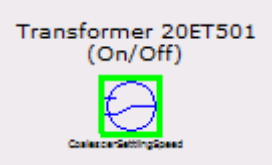
See section 8.3



5.10 On/Off Button



The Coalescer On/Off button, is displayed by left clicking on the switch.



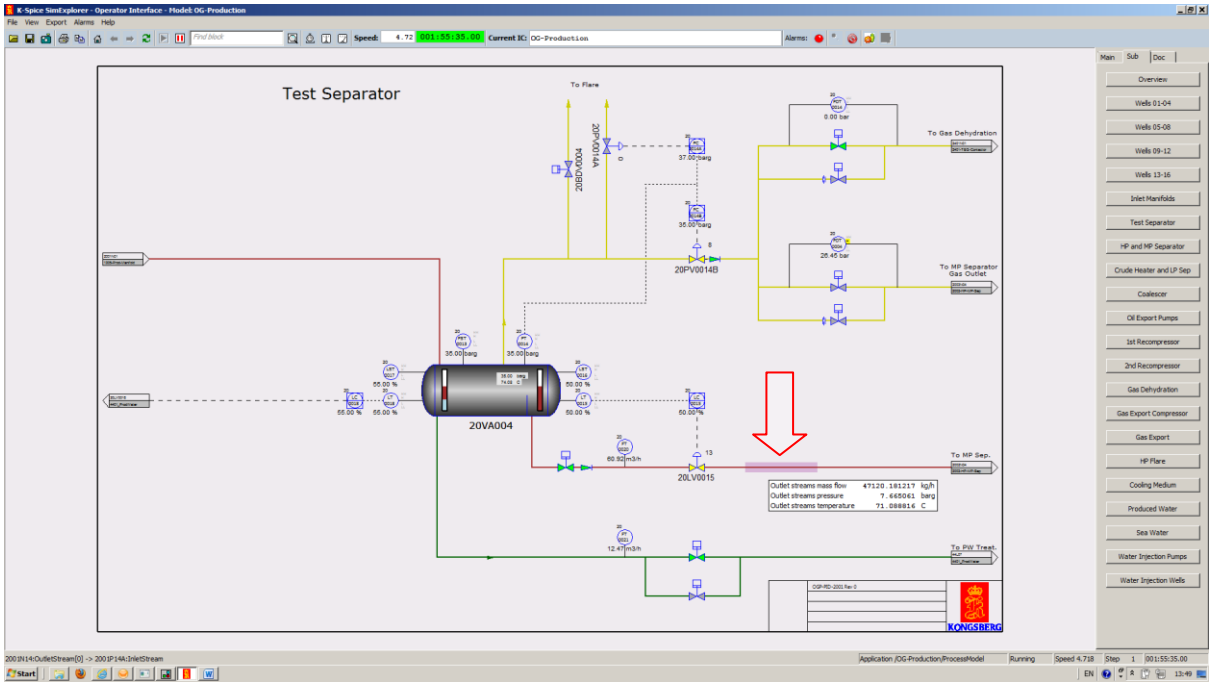
Switch

The switch can be toggled on or off.

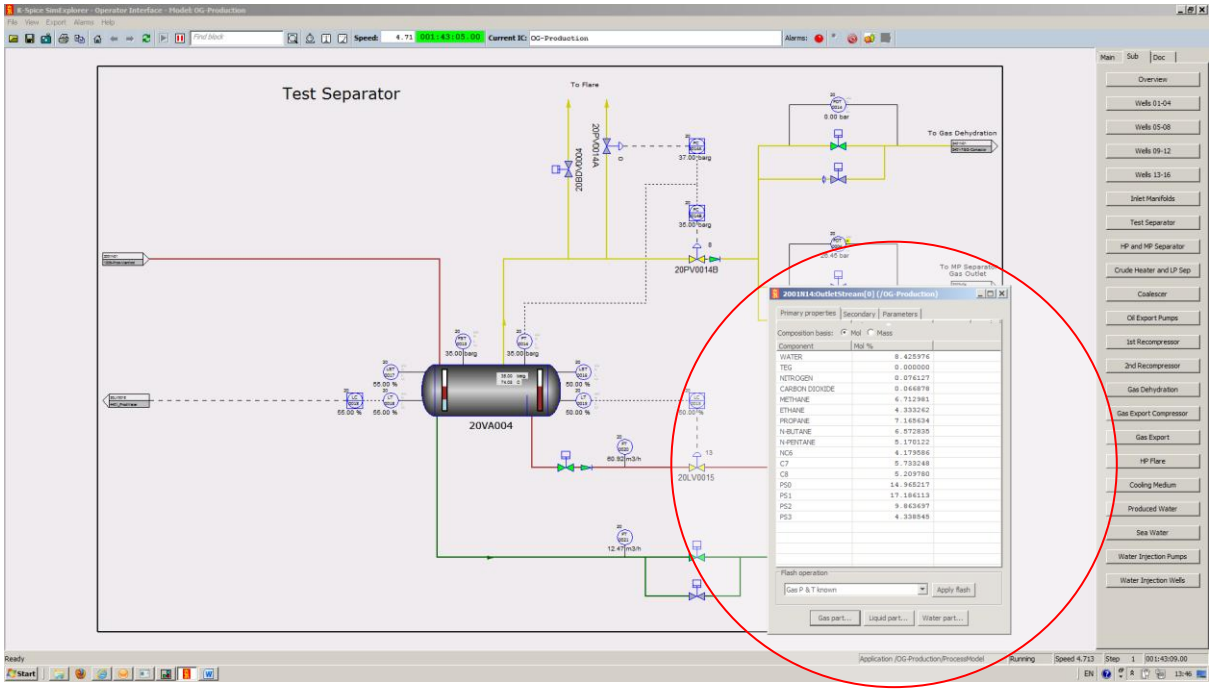
Toggle button

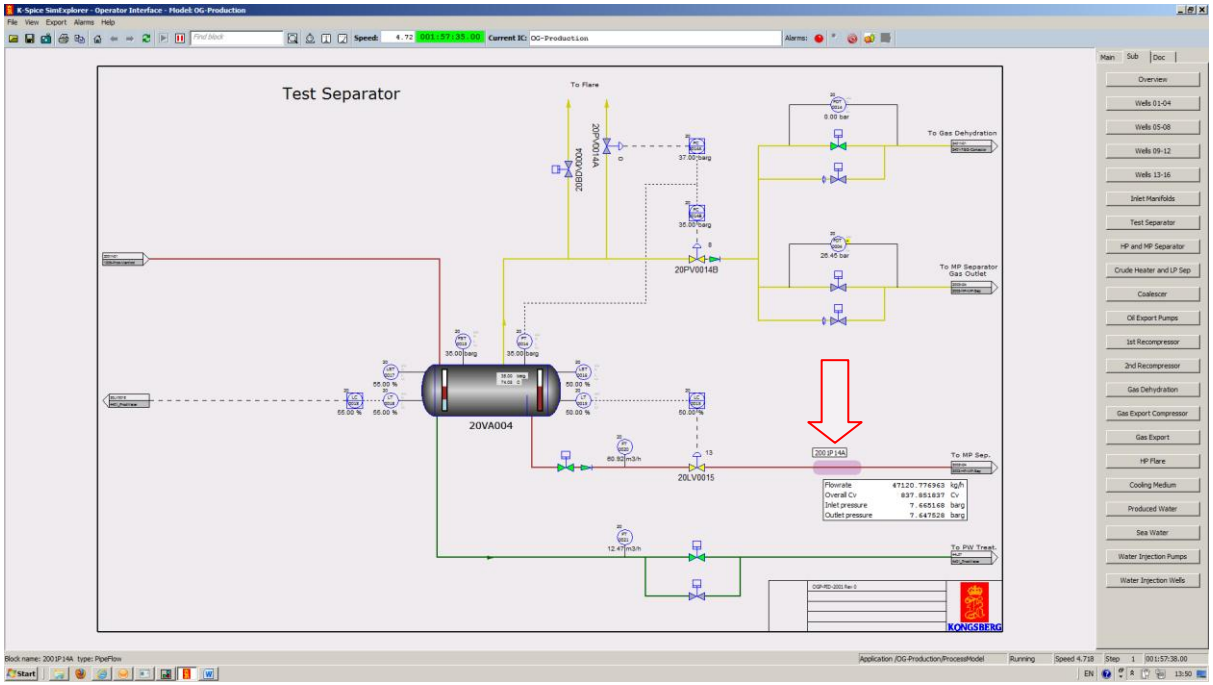
5.11 Stream Properties

By left clicking the mouse on the process stream you can access the stream properties and the line properties.

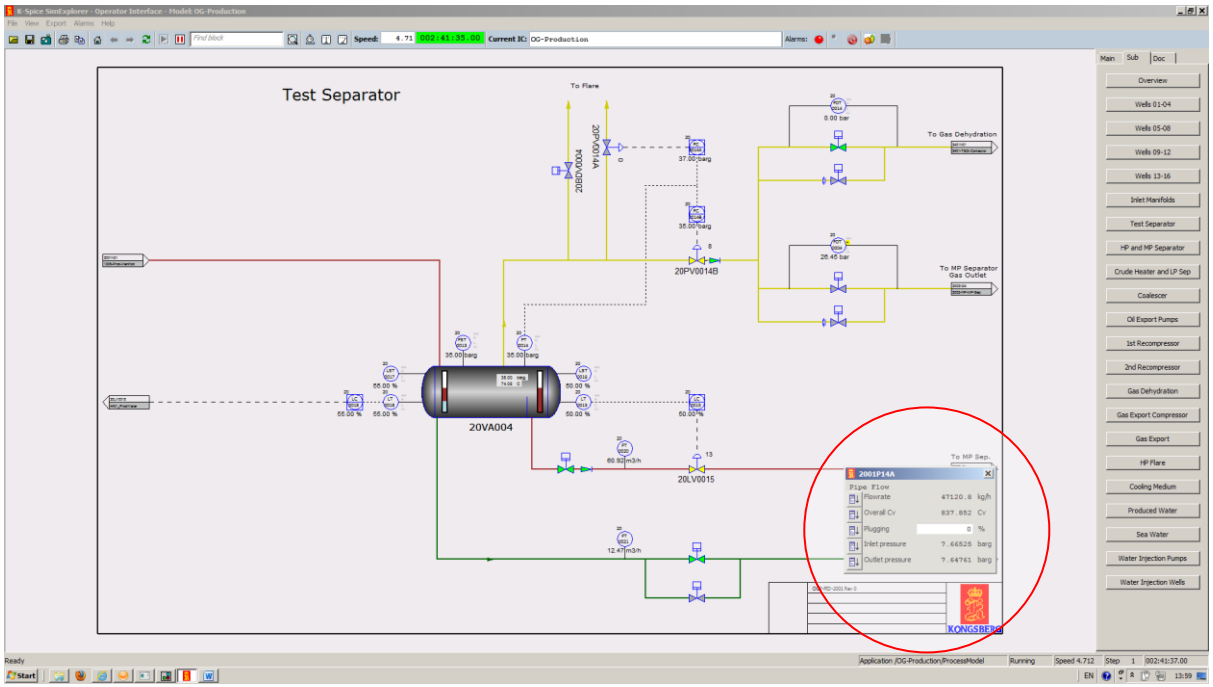


Note highlighted section in the above diagram.





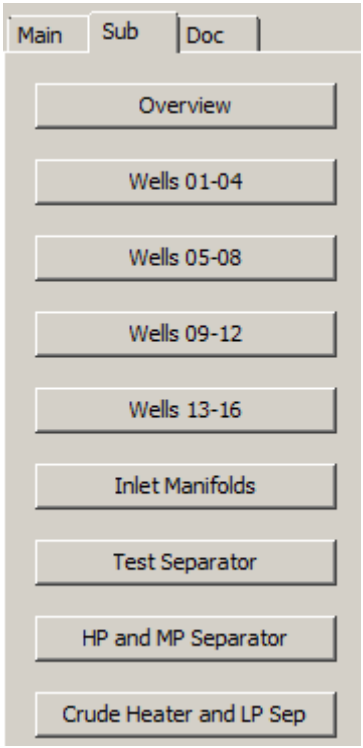
Note highlighted section the above diagram.

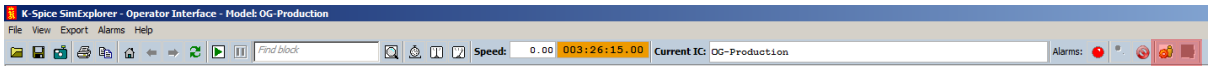


6 Field Operator Duties (FOD)

6.1 FOD Interface

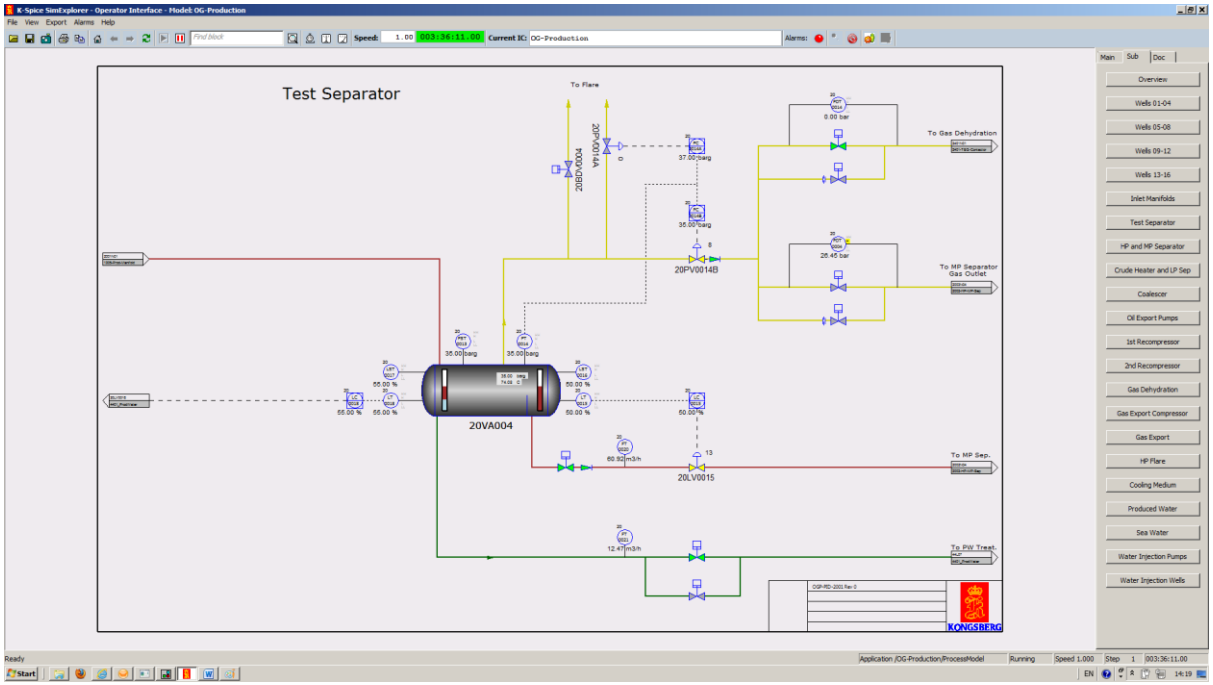
The field operator interface is accessed only from the graphics on the sub menu tab as shown;



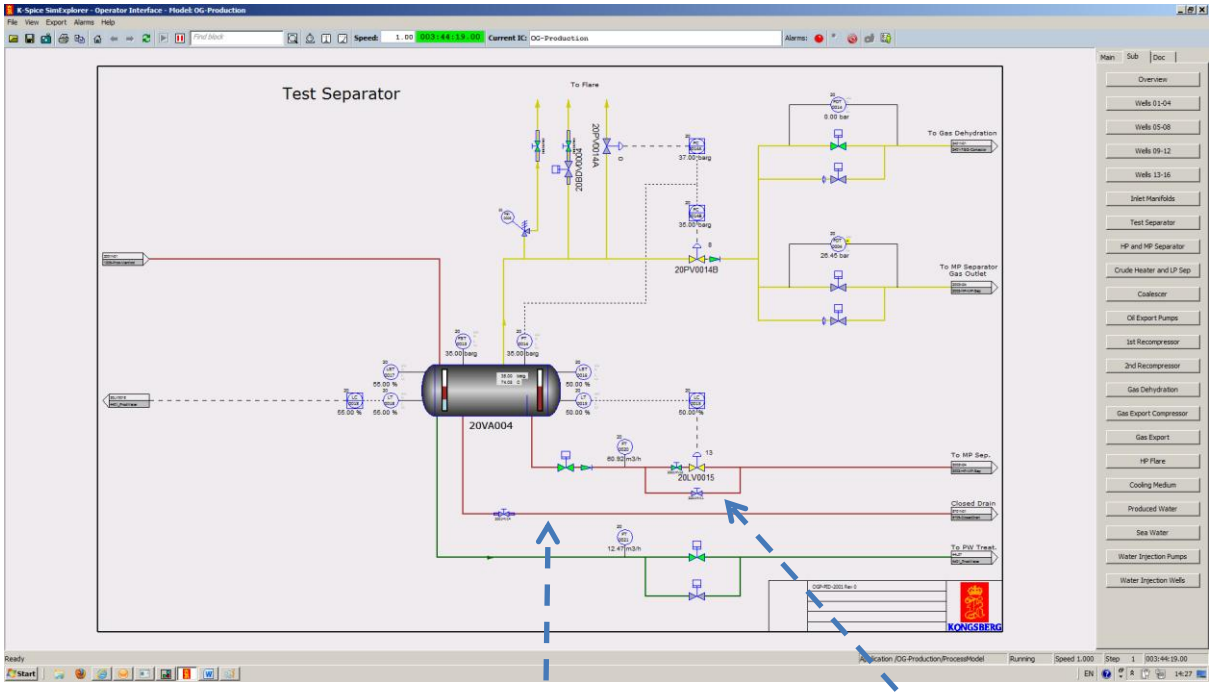


 Activates the FOD 'layer' by overlaying FOD equipment.

 Turns off the FOD information.



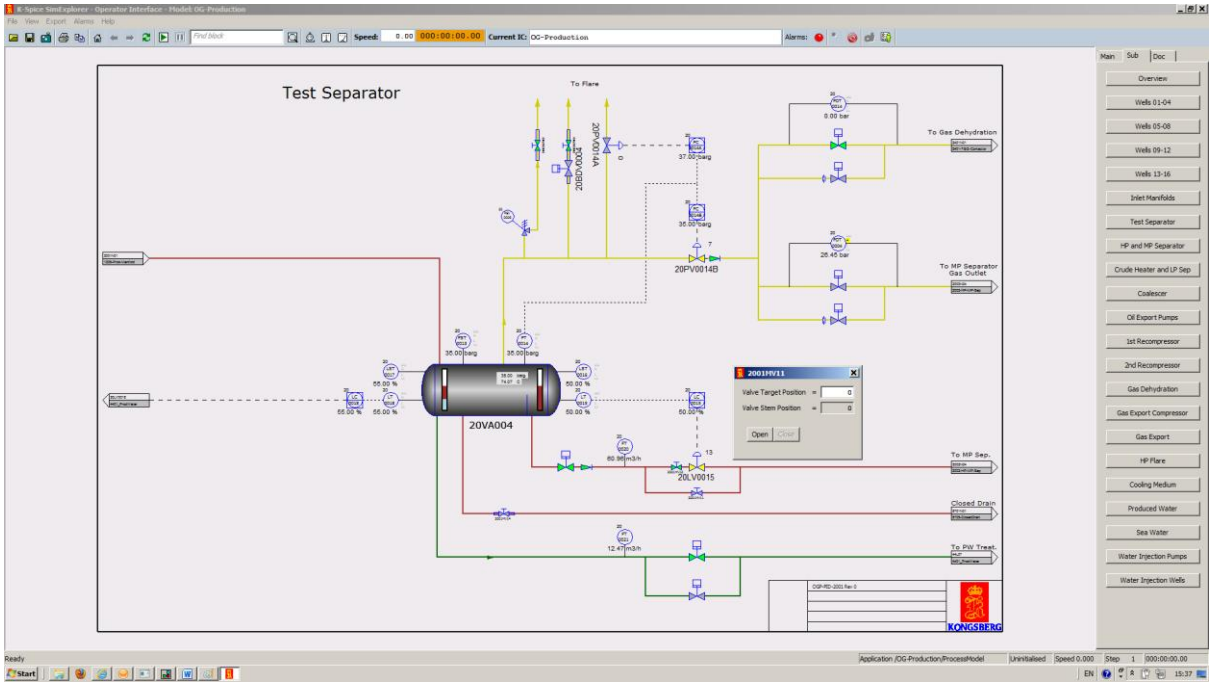
 Click the FOD button and this reveals the duties available as seen in the graphic below.

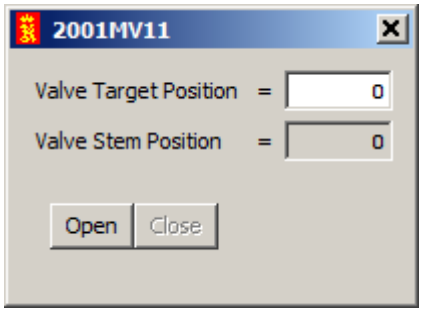


Note the extra lines, such as the vessel drain line and the control valve bypass

6.2 Operation of FOD equipment

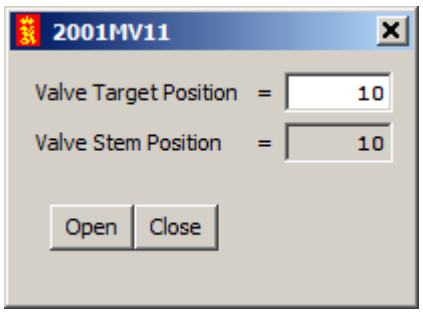
Block valve





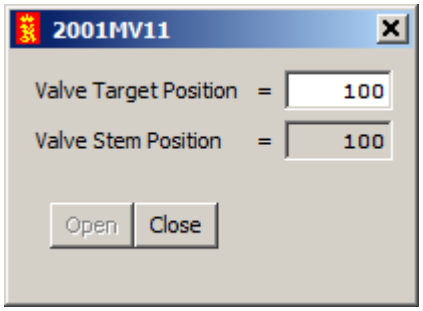
Valve body will be grey, when closed.

Input a value to partially open the valve, below is 10%. **NOTE: DO NOT CLICK OPEN** enter the required stem position, clicking open, opens the valves to 100%



Valve body will by yellow (when not 0% or 100%)

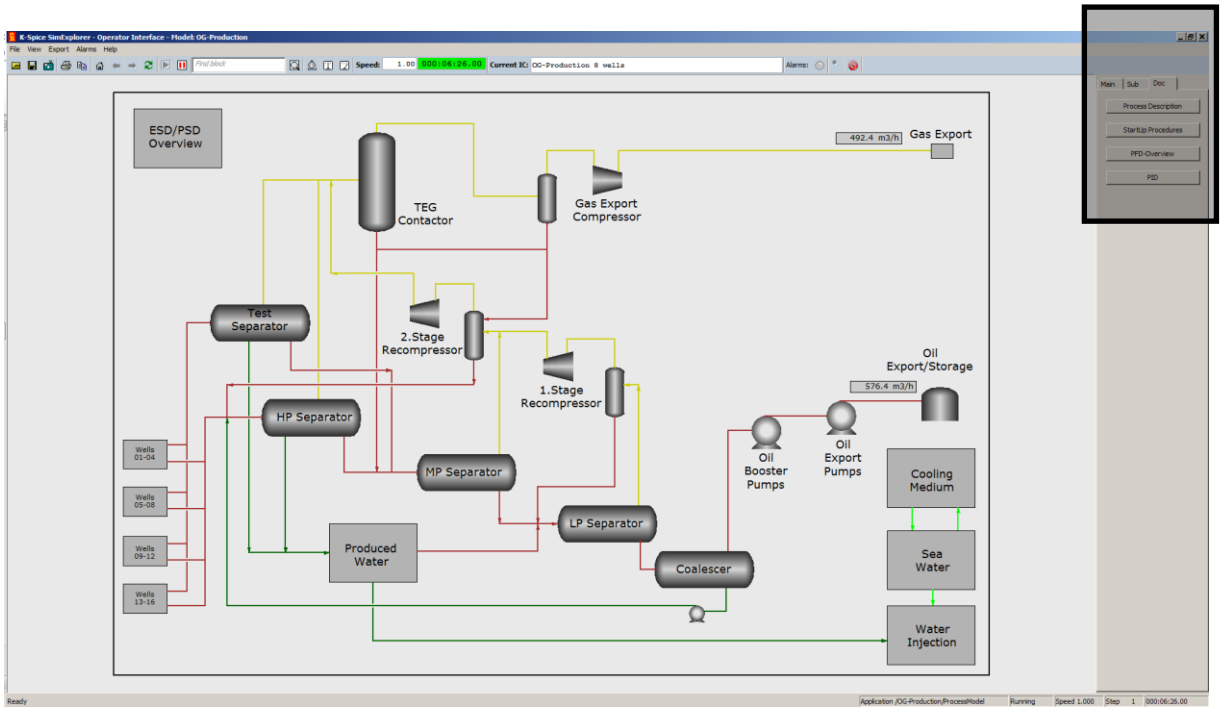
Or click Open to give 100% output

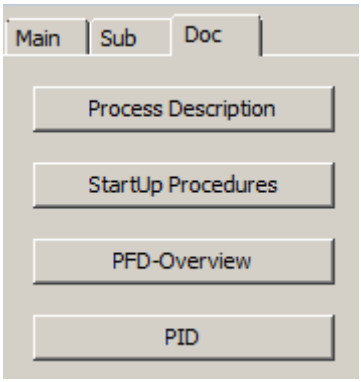


Valve body will be solid green when 100% open

7 Online Information and Documentation

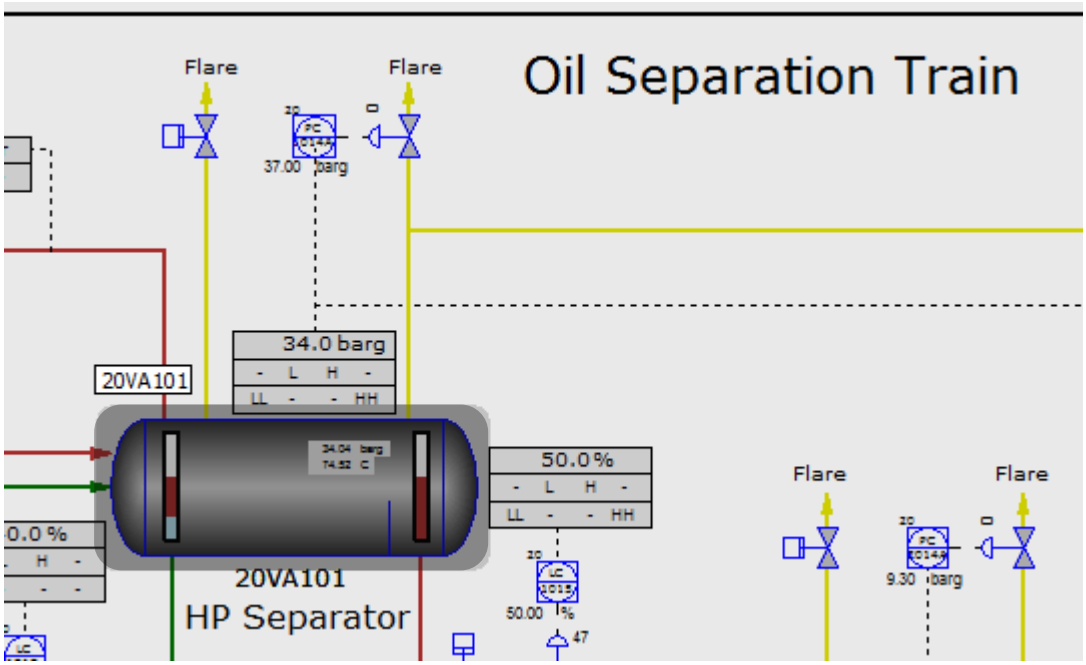
The following sections are accessed via the ‘tabs’ on the operator screen.



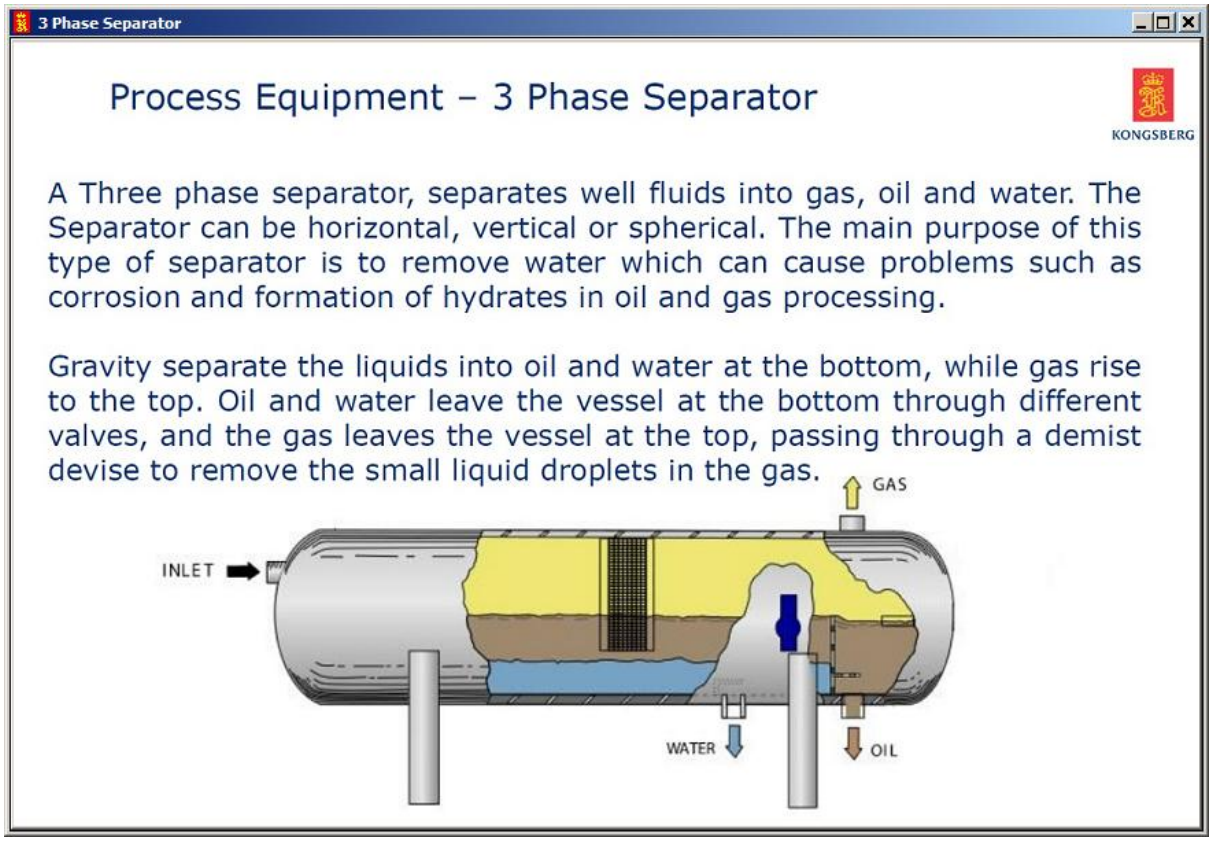


Documentation tab.

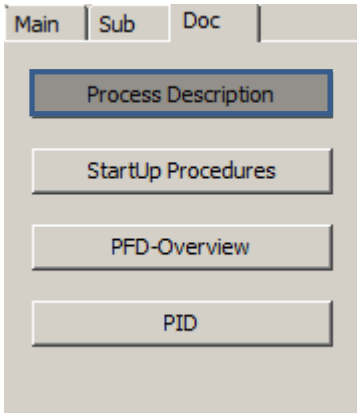
7.1 Process Equipment Description

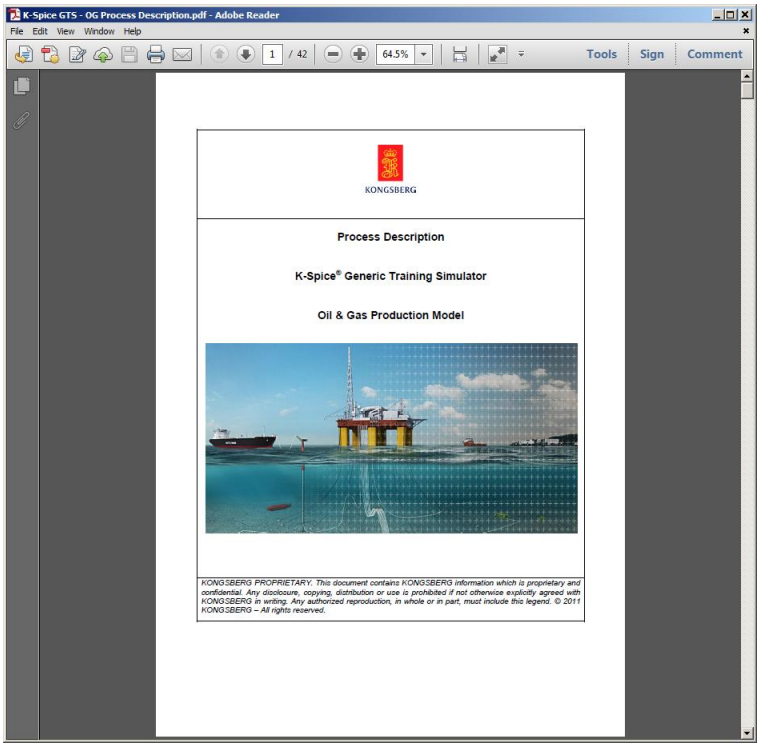


Left click on the equipment (grey box) to detail the process description below. This can be done on all types of equipment.



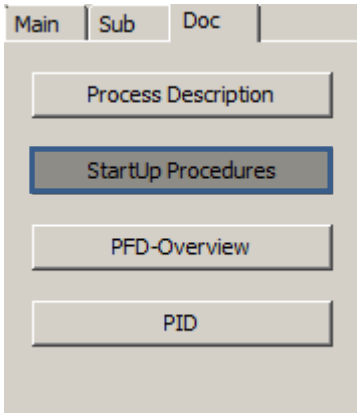
7.2 Process Description

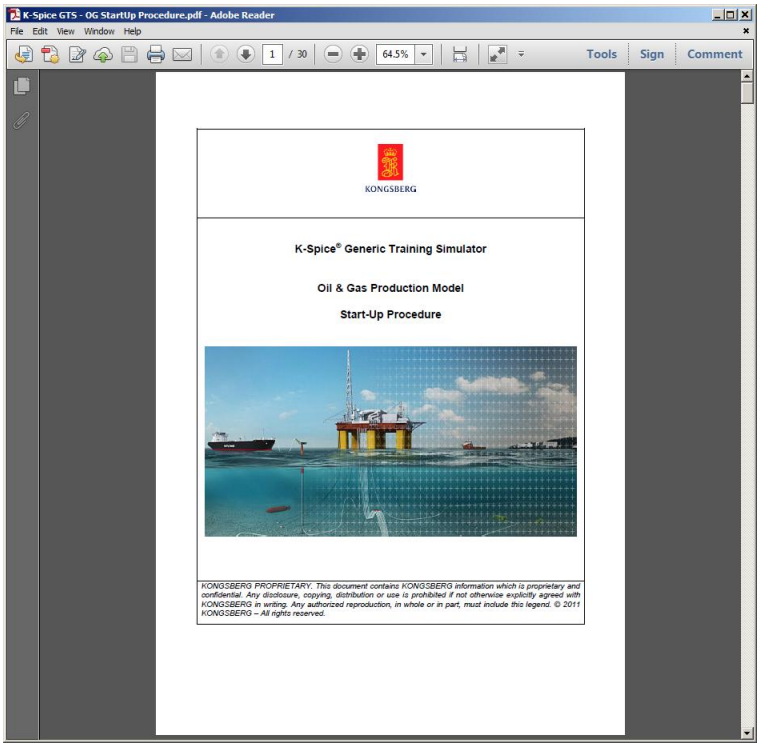




Double click on the process description target

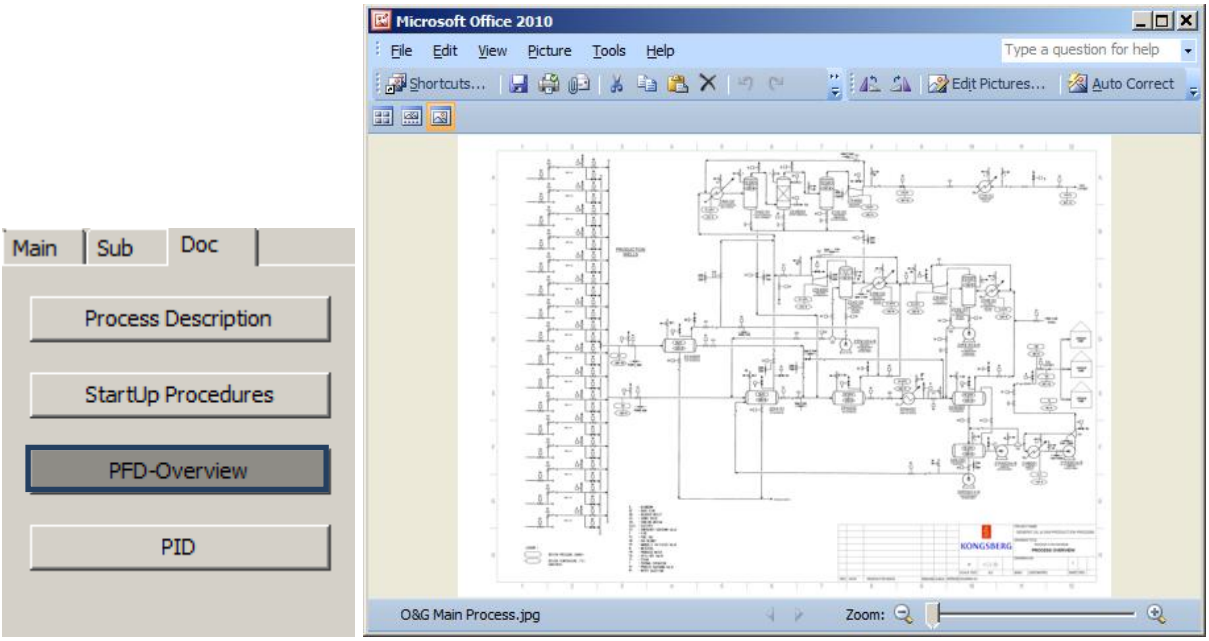
7.3 Operational Procedures





7.4 Process Flow Diagrams (PFD's)

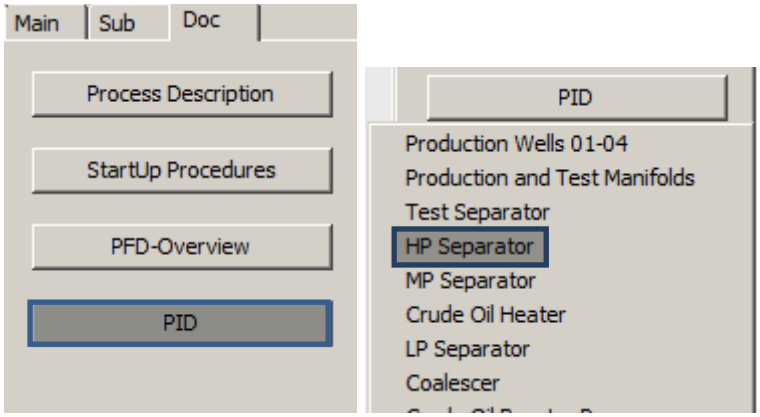
Select PFD-Overview

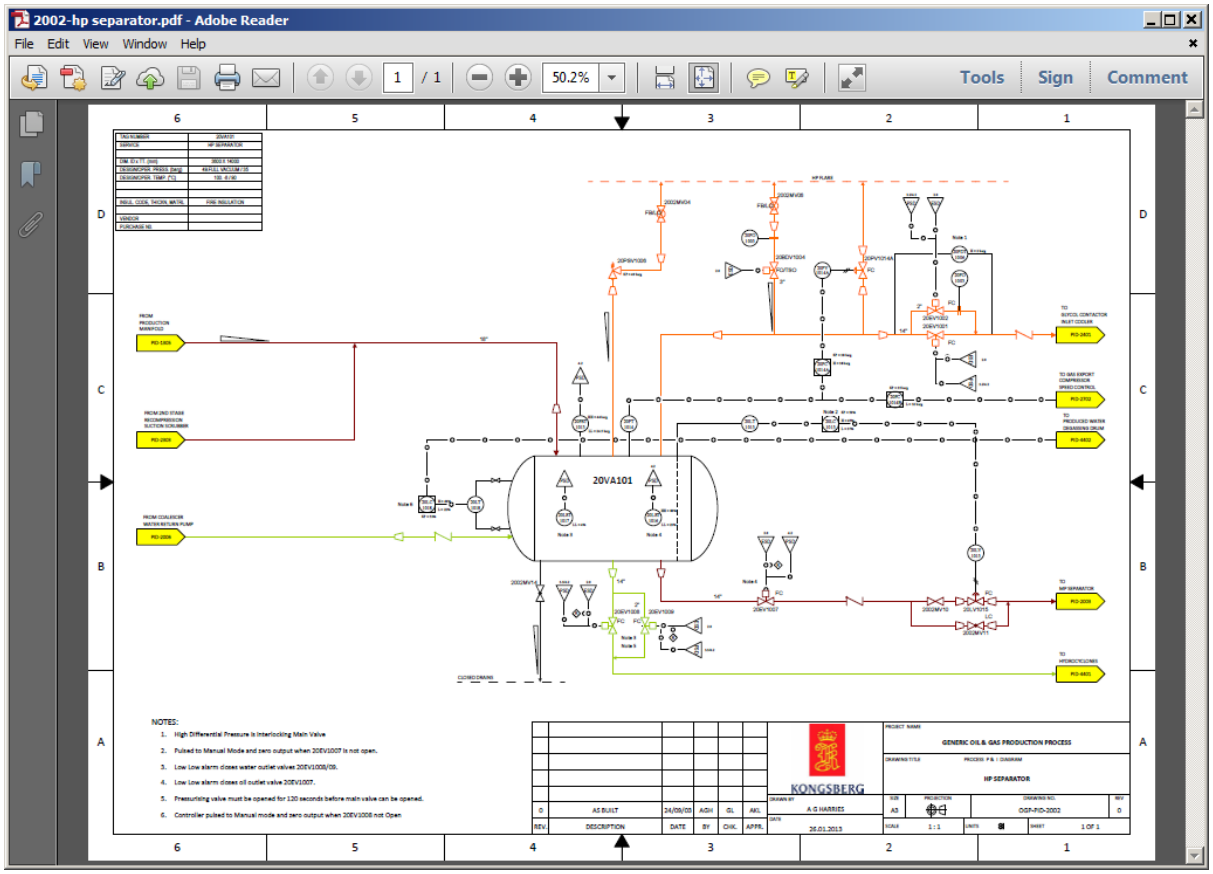


A PFD overview of the whole plant

7.5 Piping and Instrumental Diagrams (P&ID's)

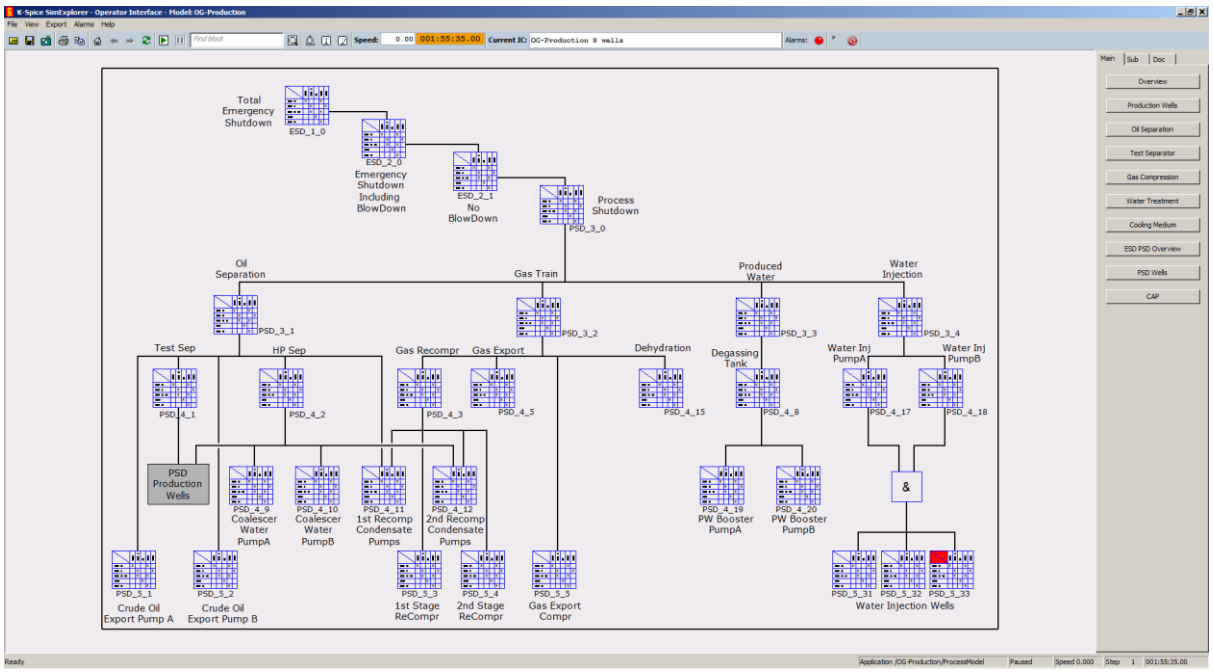
Select PID, HP Separator to display the P&ID for the information.

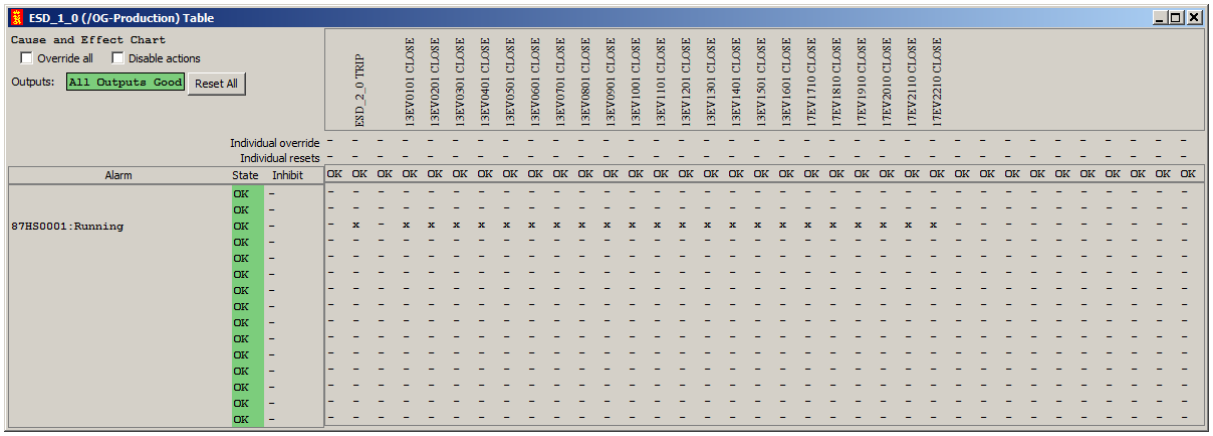




8 Shutdown Systems (ESD/PSD)

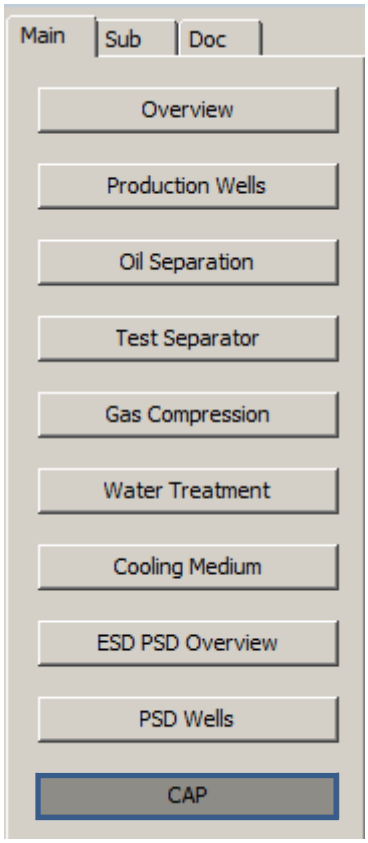
8.1 Shutdown Hierarchy

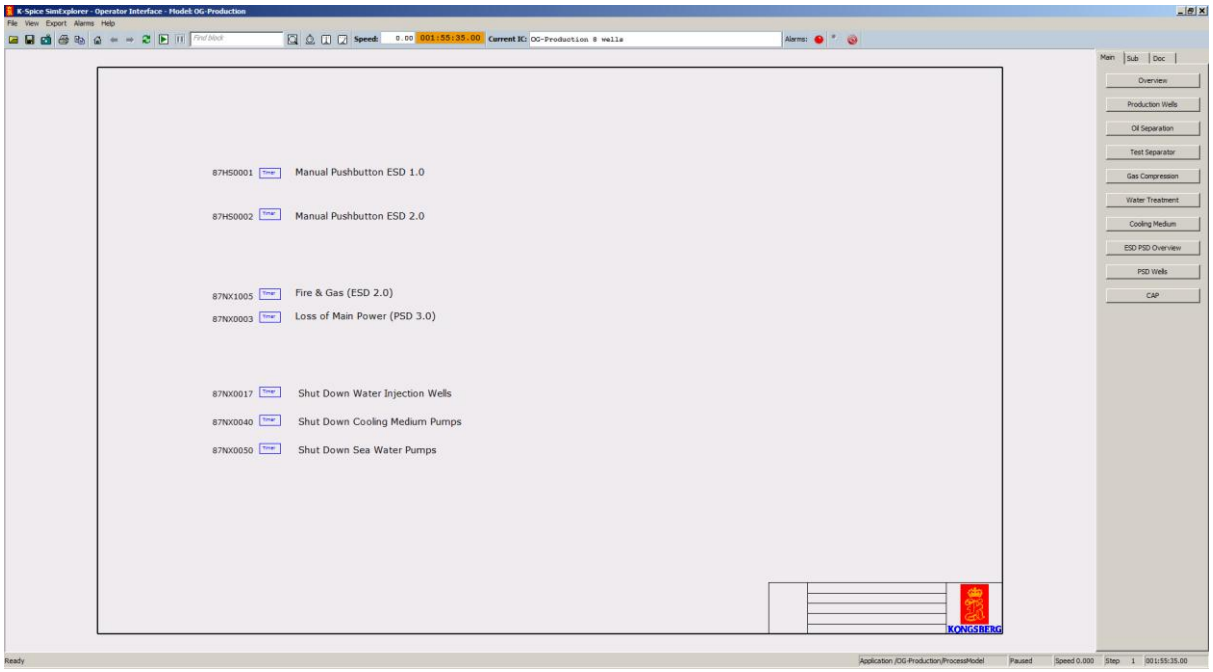




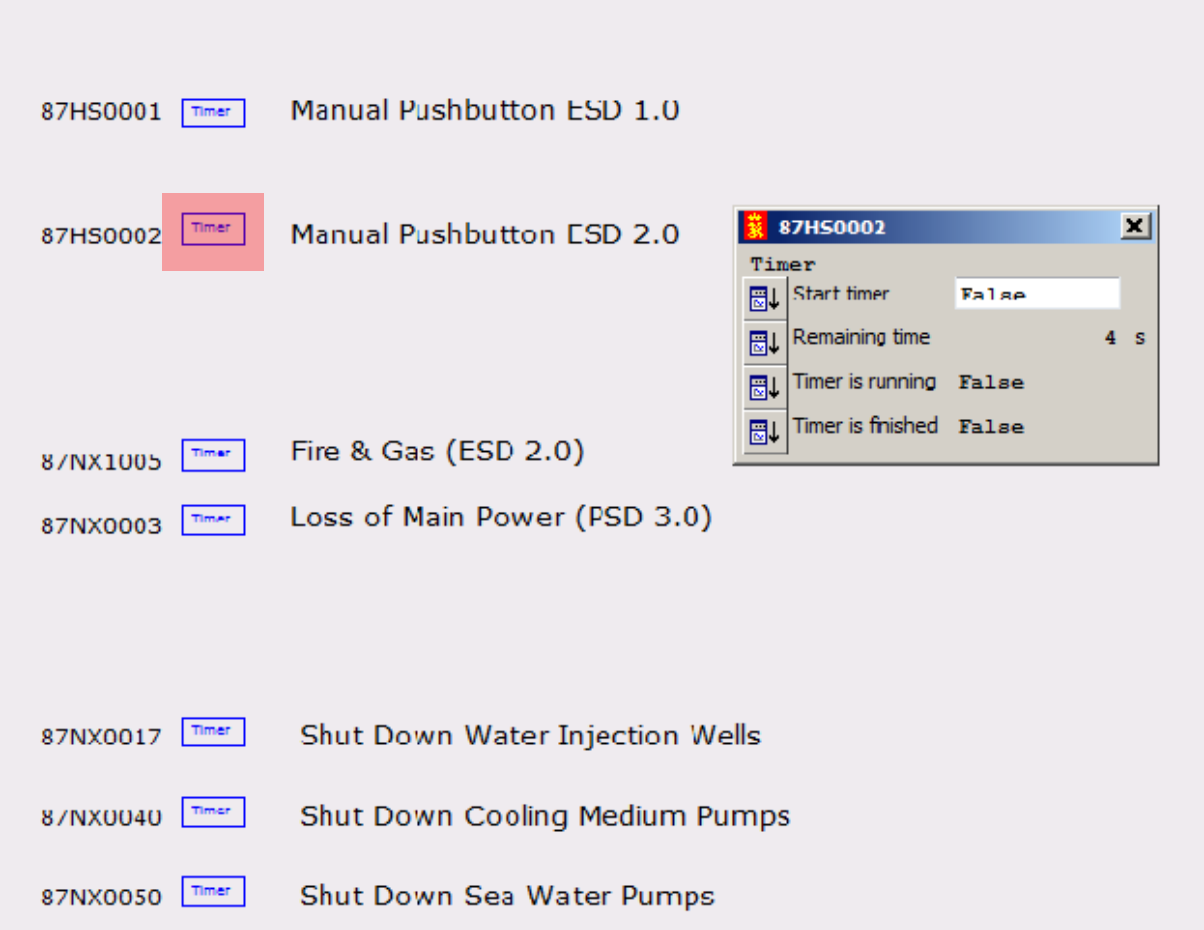
8.2 Shutdown buttons

Accessed from the main tab CAP button

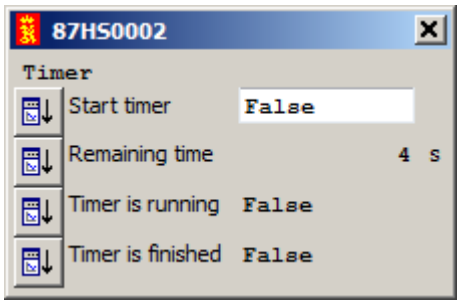




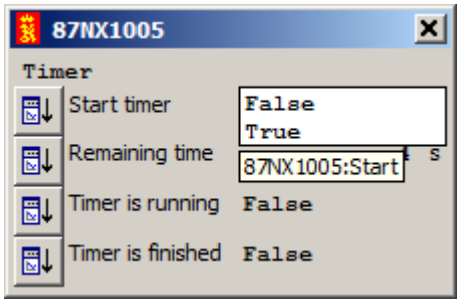
A shut is initiated by changing the false timer setting to true



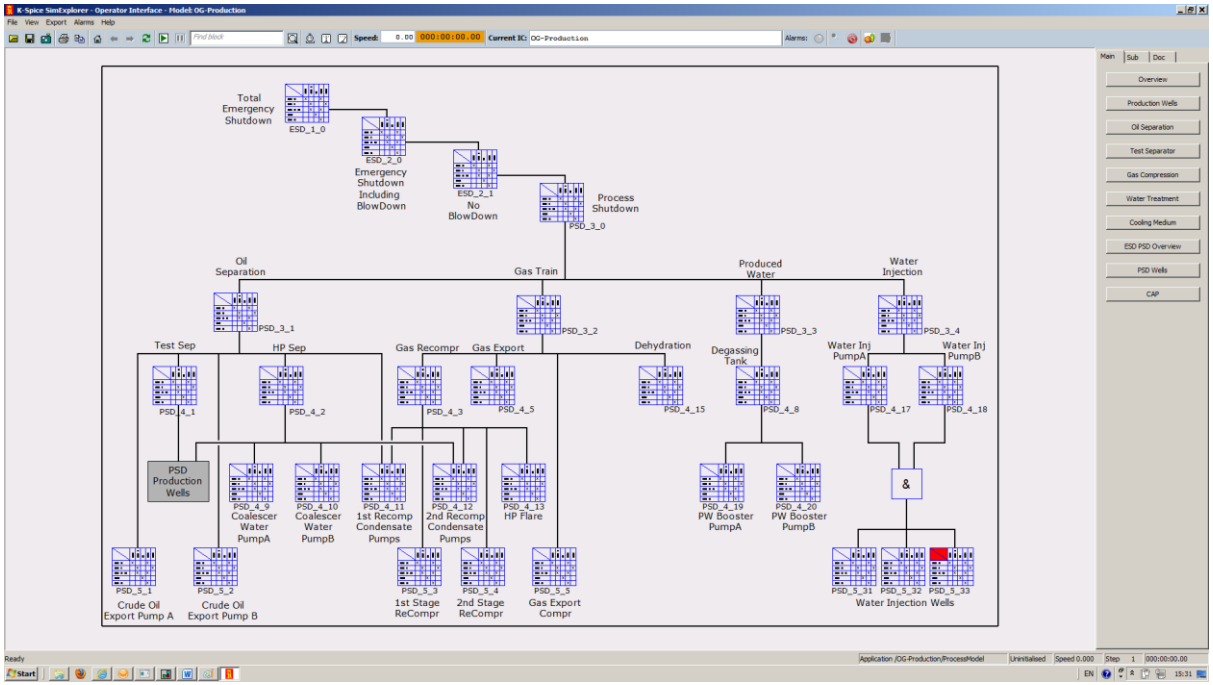
Left click on 87HS0002 Timer target

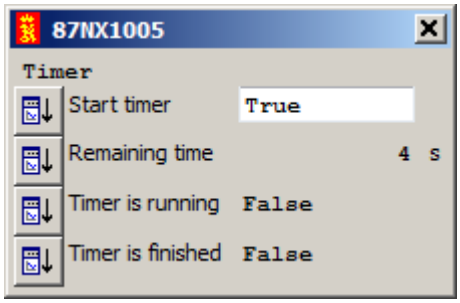


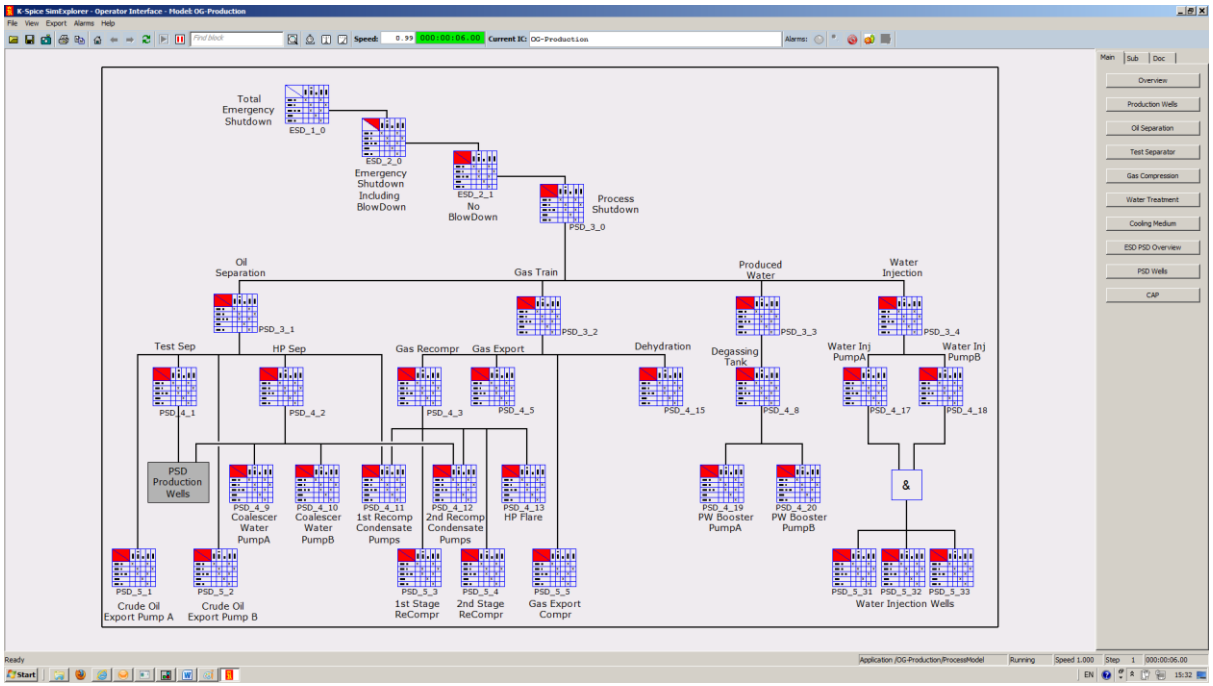
Shutdown faceplate



Initiate by changing False to True

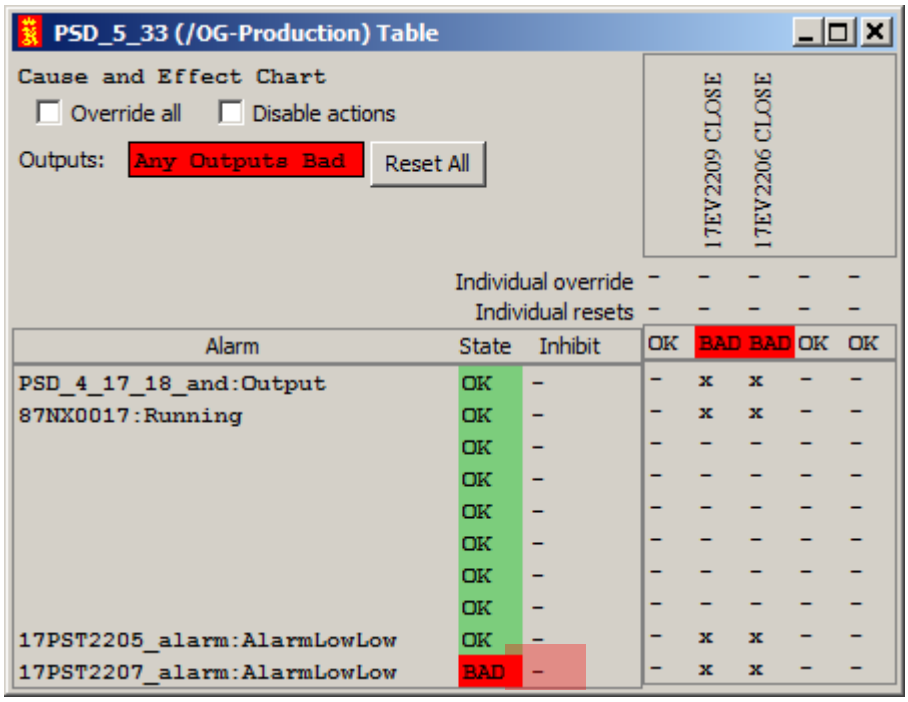

Total Emergency Shutdown
ESD_1_0
ESD_2_0
Emergency Shutdown Including BlowDown
ESD_2_1
No BlowDown
Process Shutdown
PSD_3_0
Oil Separation
Gas Train
Produced Water
Water Injection
PSD_3_1
PSD_3_2
PSD_3_3
PSD_3_4
Test Sep
HP Sep
Gas Recompr
Gas Export
Dehydration
Degassing Tank
Water Inj PumpA
Water Inj PumpB
PSD_4_1
PSD_4_2
PSD_4_3
PSD_4_5
PSD_4_15
PSD_4_8
PSD_4_17
PSD_4_18
PSD Production Wells
PSD_4_9 Coalescer Water PumpA
PSD_4_10 Coalescer Water PumpB
PSD_4_11 1st Recomp Condensate Pumps
PSD_4_12 2nd Recomp Condensate Pumps
PSD_4_13 HP Flare
PSD_4_19 PW Booster PumpA
PSD_4_20 PW Booster PumpB
&
PSD_5_1 Crude Oil Export Pump A
PSD_5_2 Crude Oil Export Pump B
PSD_5_3 1st Stage ReCompr
PSD_5_4 2nd Stage ReCompr
PSD_5_5 Gas Export Compr
PSD_5_31
PSD_5_32
PSD_5_33
Water Injection Wells


87NX1005
Timer
Start timer
True
Remaining time
4 s
Timer is running
False
Timer is finished
False

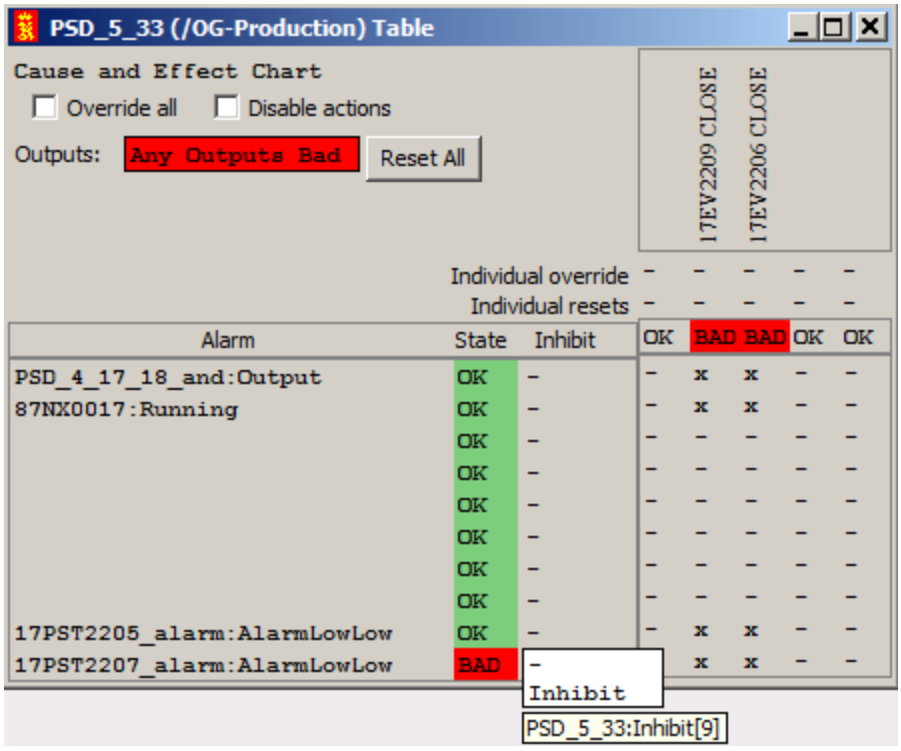

Total Emergency Shutdown
ESD_1_0
ESD_2_0
Emergency Shutdown Including BlowDown
ESD_2_1
No BlowDown
Process Shutdown
PSD_3_0
Oil Separation
Gas Train
Produced Water
Water Injection
PSD_3_1
PSD_3_2
PSD_3_3
PSD_3_4
Test Sep
HP Sep
Gas Recompr
Gas Export
Dehydration
Degassing Tank
Water Inj PumpA
Water Inj PumpB
PSD_4_1
PSD_4_2
PSD_4_3
PSD_4_5
PSD_4_15
PSD_4_8
PSD_4_17
PSD_4_18
PSD Production Wells
PSD_4_9 Coalescer Water PumpA
PSD_4_10 Coalescer Water PumpB
PSD_4_11 1st Recomp Condensate Pumps
PSD_4_12 2nd Recomp Condensate Pumps
PSD_4_13 HP Flare
PSD_4_19 PW Booster PumpA
PSD_4_20 PW Booster PumpB
&
PSD_5_1 Crude Oil Export Pump A
PSD_5_2 Crude Oil Export Pump B
PSD_5_3 1st Stage ReCompr
PSD_5_4 2nd Stage ReCompr
PSD_5_5 Gas Export Compr
PSD_5_31
PSD_5_32
PSD_5_33
Water Injection Wells

8.3 Override / Suppression

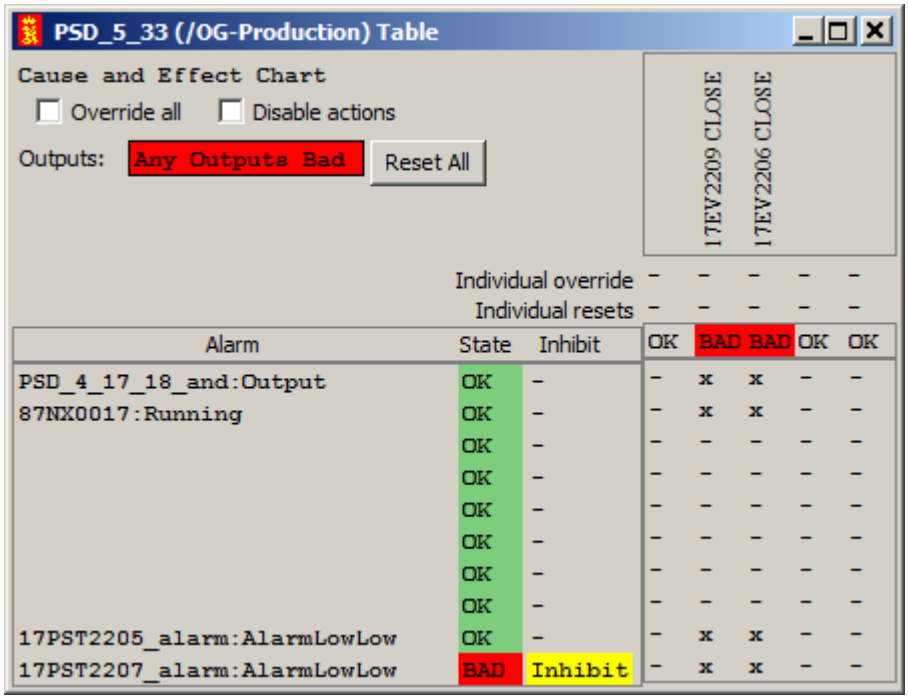
8.3.1 Override

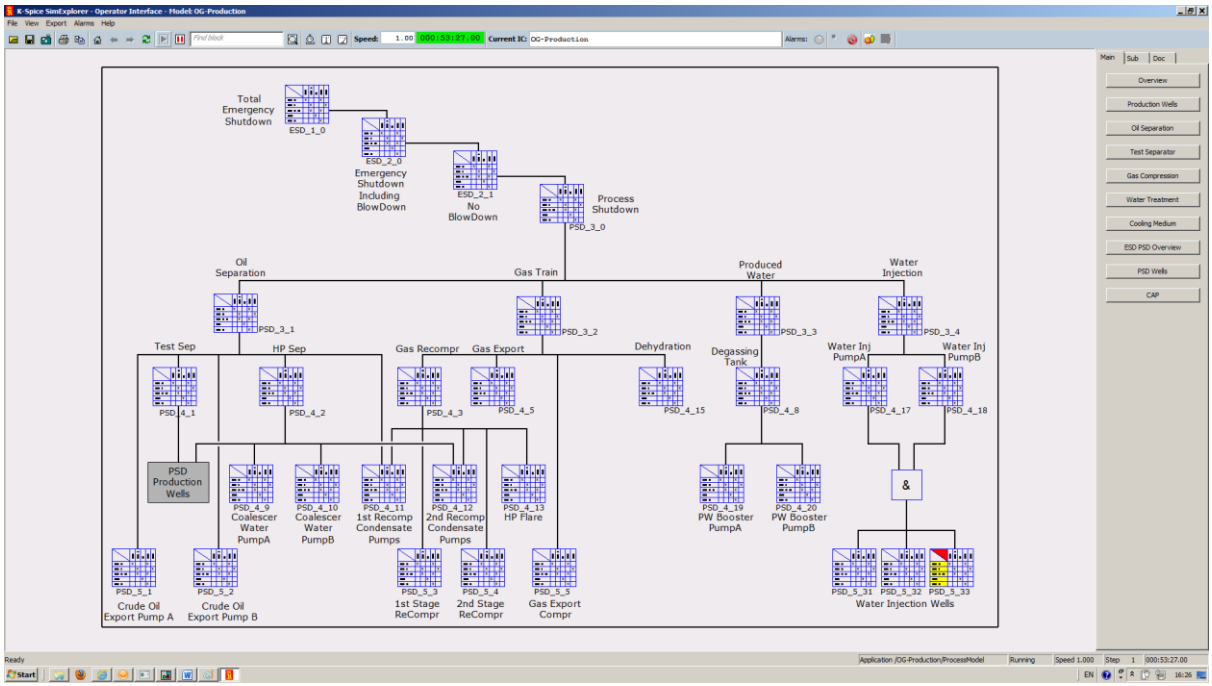


By clicking on the highlighted area above an inhibit can be applied

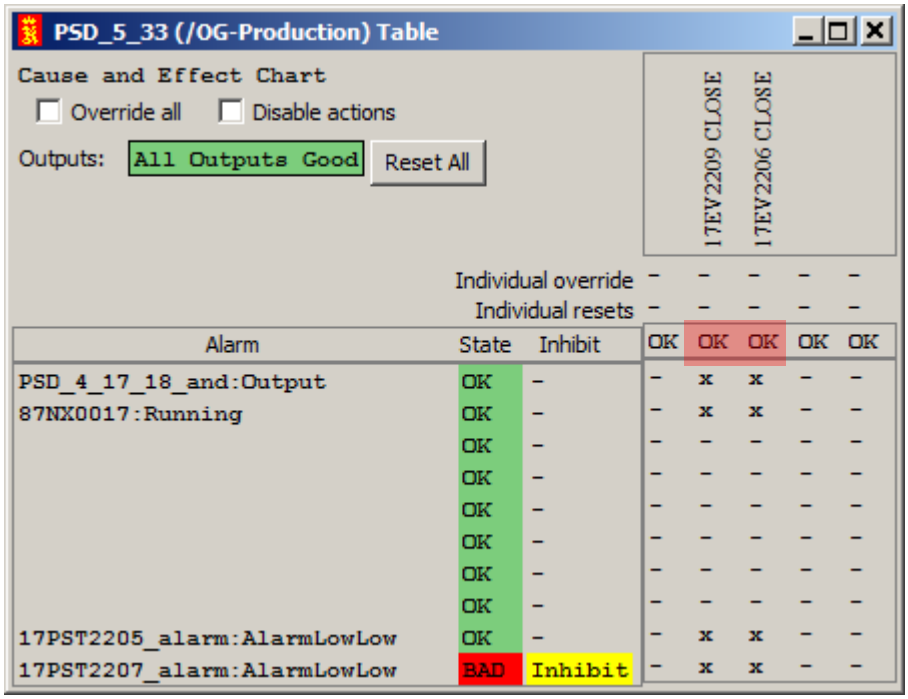


Click in inhibit





ESD overview table PSD_5_33 shows an inhibit present by a yellow input notification.



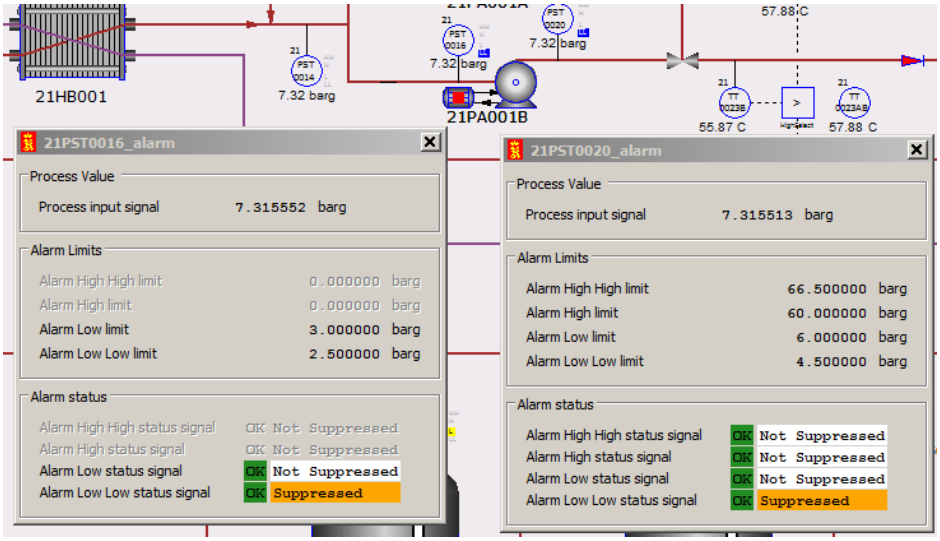
The inhibit allows the tripped outputs to be reset.

8.3.2 Suppression

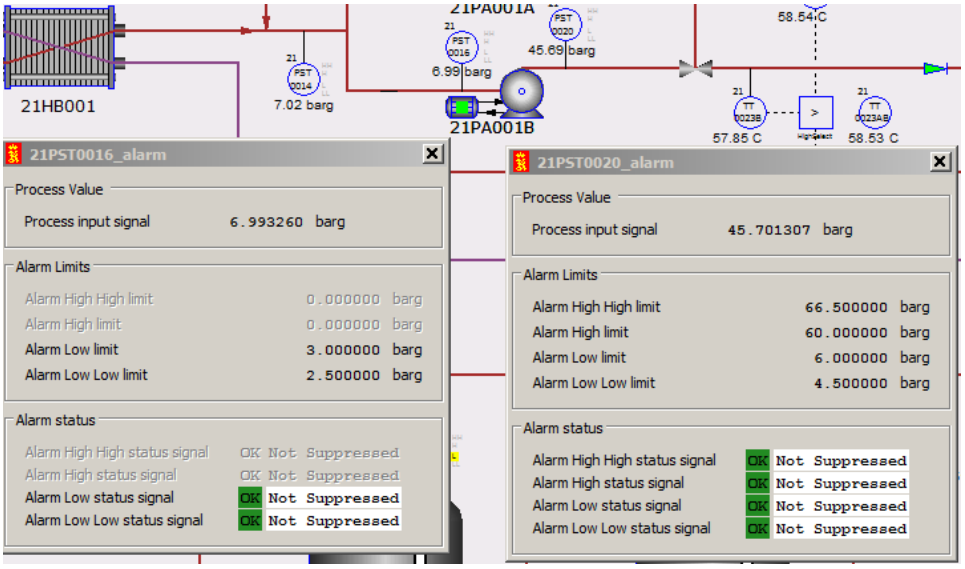
In some cases trips are automatically suppressed to allow the safe start-up of machinery.

Example

21PA001B, has a low pressure trip which is activity when the pump is running at speed and pressure. To allow the pump to start the low level trips are automatically suppressed, to allow the pump to start. The trip is highlighted blue on the graphic and shown as suppressed on the alarm faceplate.



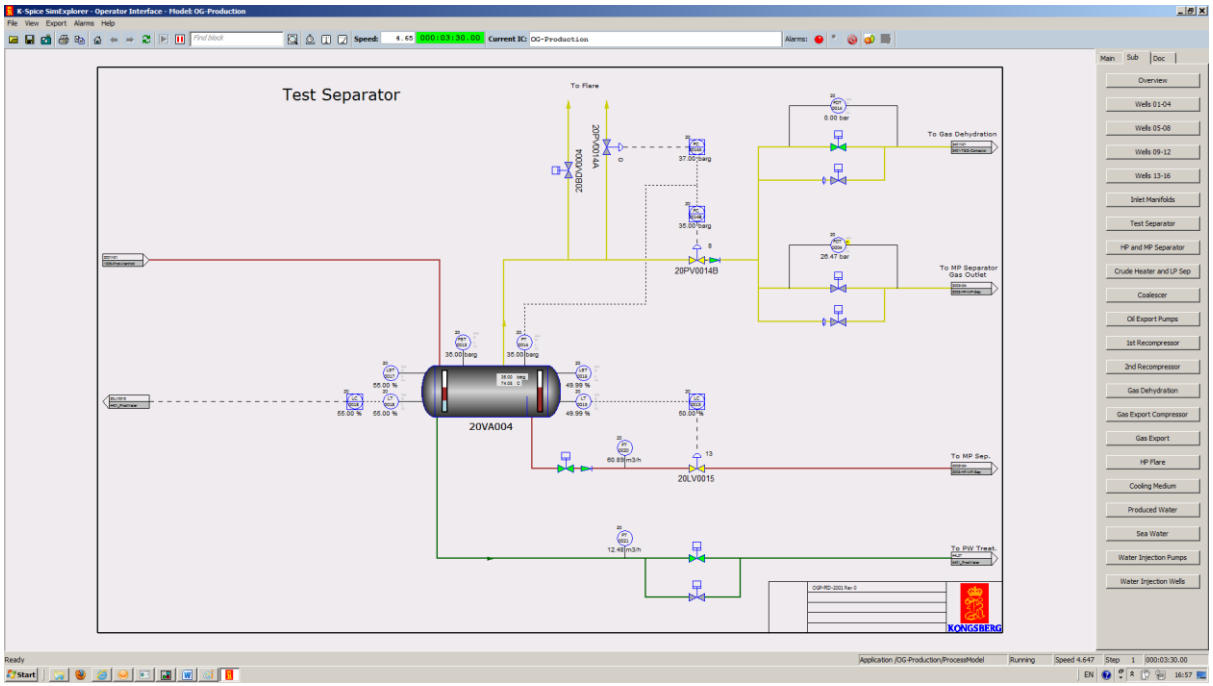
After a given time post pump start the suppression is automatically removed leaving protection for the pump in the case of a malfunction.



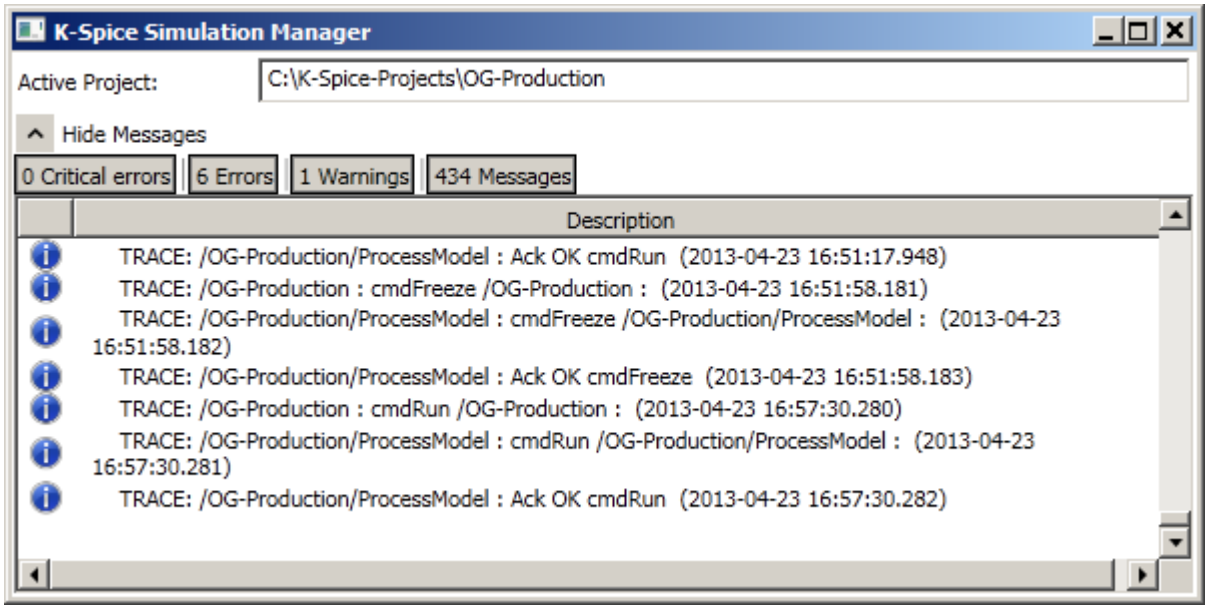
9 Shutting down the simulator

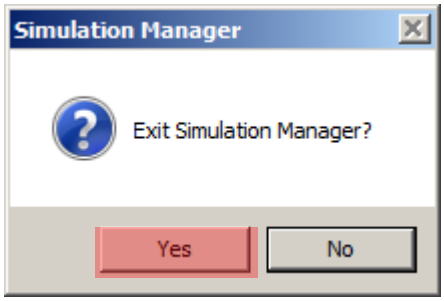
Save any work needed before shutting down.

Close down the operator screen, by clicking the x in the top right hand corner.



Close the simulation manager by clicking the x in the top right hand corner.





Click yes

Note: - the K-Spice® model server closes automatically.

The K-Spice® simulator has now stopped.

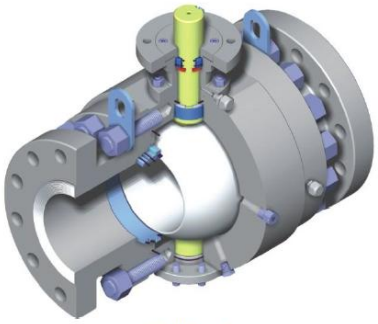
10 Appendix A: Process Equipment Description

10.1 Valves

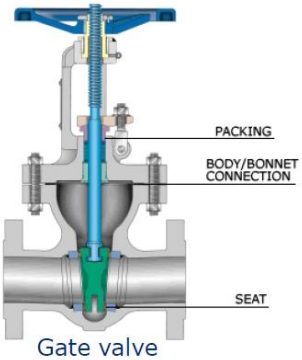
Ball valve, for on/off control without pressure drop, and ideal for quick shut-off since a 90º turn offers complete shut-off angle, compared to multiple turns required on most manual valves.

Gate valve, mainly for on/off control, with low pressure drop.

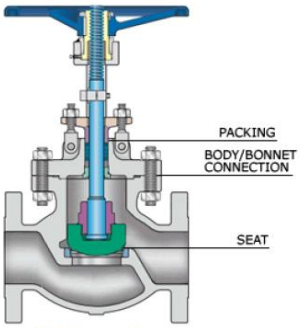
Globe valve, good for regulating flow.



Ball valve



Gate valve



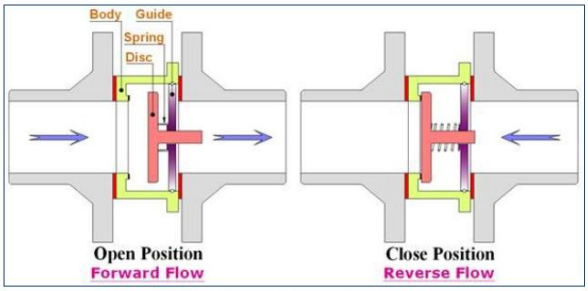
Globe valve

Butterfly valve, for flow regulation in large pipe diameters.

Check valve or non-return valve, allows the fluid to pass in one direction only.

Choke valve, a valve that raises or lowers a solid cylinder which is placed around or inside another cylinder which has holes or slots. Used for high pressure drops found in oil and gas wellheads.

Butterfly valve



Check valve (Disk)

Choke valve

10.2 Automatic Recirculation Valves

Minimum flow protection for the pumps is provided by automatic recirculation valves on the individual pump discharge lines.

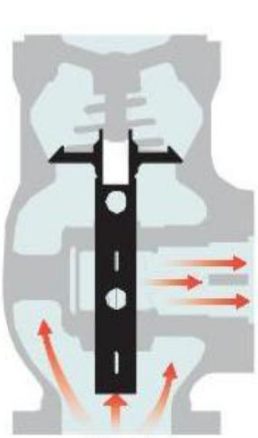


Figure 1
No Process Flow
Full Recirculation

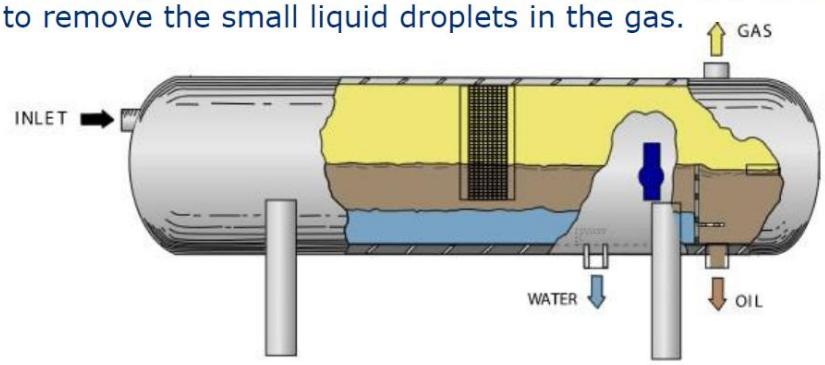
Figure 2
Changing Process Flow
Controlled Recirculation

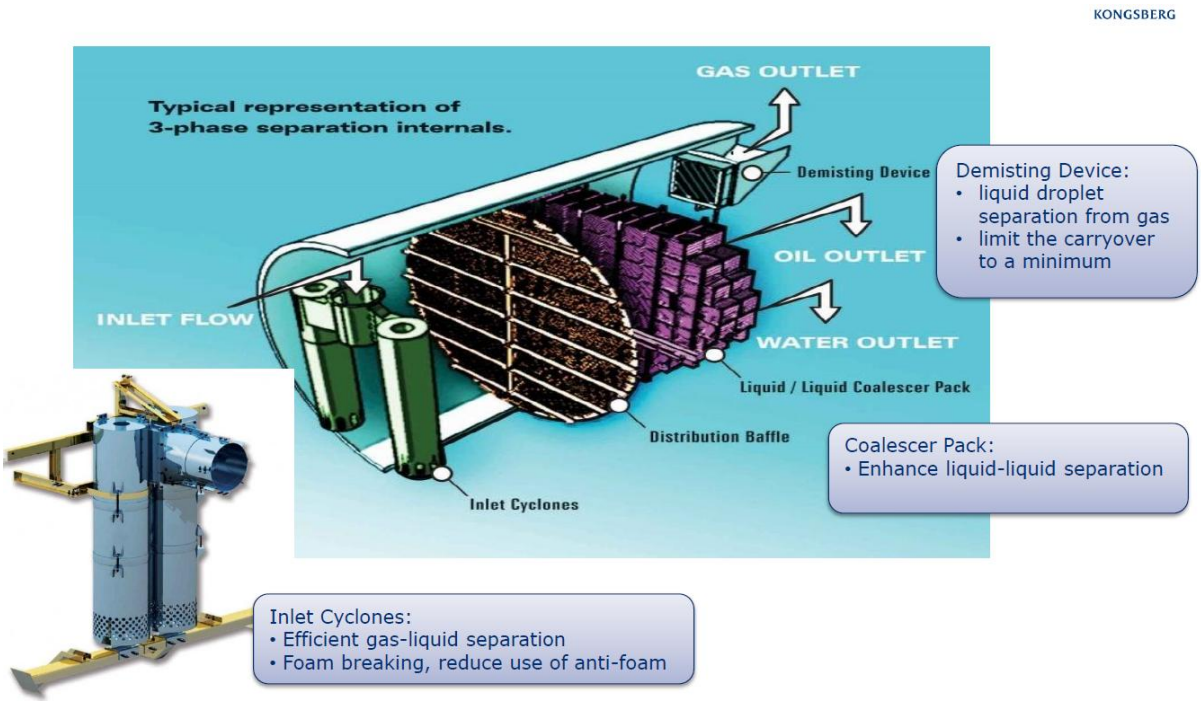
Figure 3
Increased Process Flow
No Recirculation

10.3 3-Phase Separator

A Three phase separator, separates well fluids into gas, oil and water. The Separator can be horizontal, vertical or spherical. The main purpose of this type of separator is to remove water which can cause problems such as corrosion and formation of hydrates in oil and gas processing.

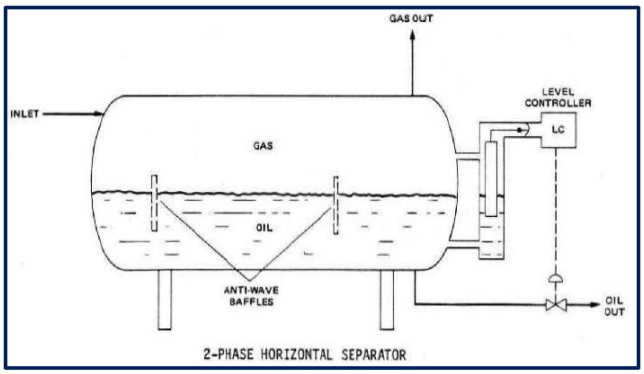
Gravity separate the liquids into oil and water at the bottom, while gas rise to the top. Oil and water leave the vessel at the bottom through different valves, and the gas leaves the vessel at the top, passing through a demist devise to remove the small liquid droplets in the gas.





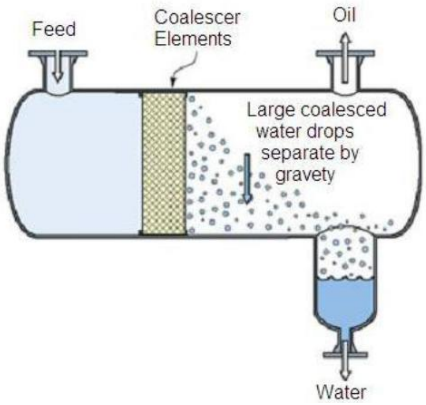
10.4 2-Phase Separator

A Two Phase Separator is a vessel that separates the well fluids into gas and total liquid. The vessel can be horizontal, vertical or spherical. The liquid leaves the vessel at the bottom through a level-control or dump valve. The gas leaves the vessel at the top, passing through a mist extractor to remove the small liquid droplets in the gas.



10.5 Coalescer

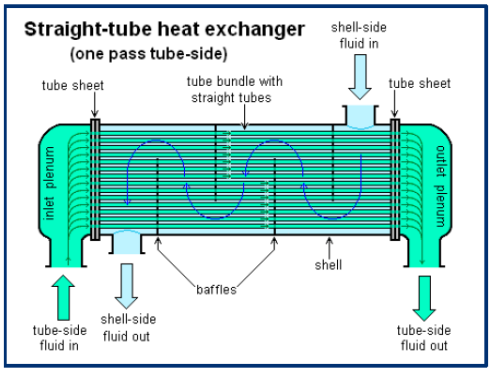
An electrostatic coalescer is a liquid/liquid separator. The vessel operates liquid full at all times. The prime purpose of the vessel is to provide final dewatering of the crude oil before storage. The process is achieved using the principle of coalescing in which small water droplets are encouraged to coalesce into larger droplets. The large droplets will separate more readily from the oil due to gravitational effects. The migration of the water droplets towards each other is produced by the application of an electric potential between sets of plates immersed in the oil.

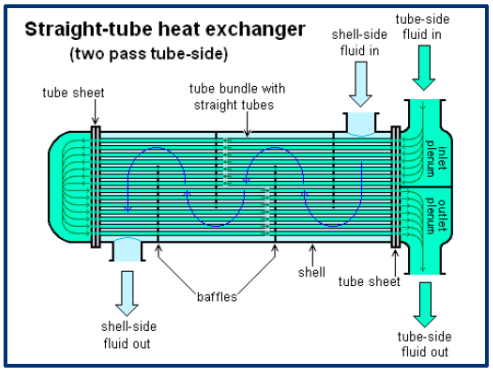


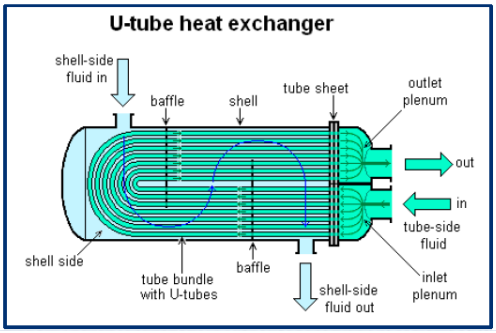
10.6 Shell and Tube Heat Exchanger

Shell and tube heat exchangers is the most common type of heat exchanger in oil refineries and other large chemical processes, and is suited for higher-pressure applications. This type of heat exchanger consists of a shell (a large pressure vessel) with a bundle of tubes inside it. Two fluids with different starting temperatures flow through the heat exchanger. One flows through the tubes (tube side) and the other flows outside the tubes but inside the shell (shell side). Heat is transferred from one fluid to the other through the tube walls. The fluids can be either liquids or gases on either the shell or the tube side. In order to transfer heat efficiently, a large heat transfer area should be used, leading to the use of many tubes.

KONGSBERG



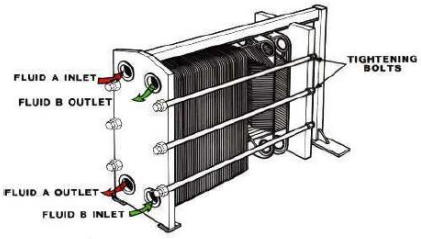




10.7 Plate Heat Exchanger

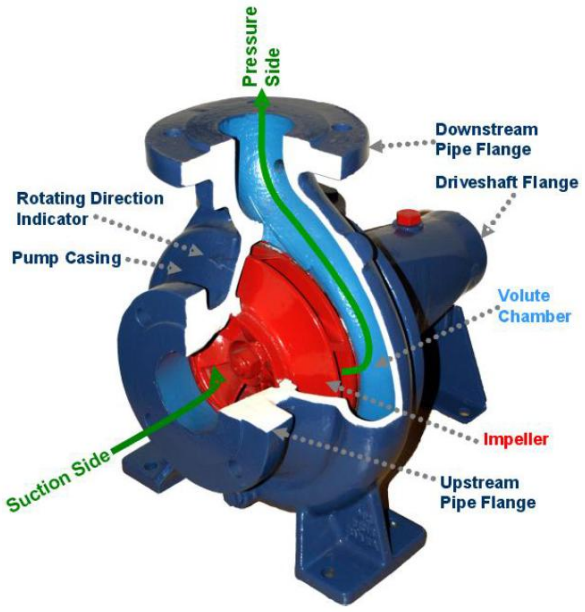
A plate heat exchanger is a type of heat exchanger that uses metal plates to transfer heat between two fluids. The plates used in a plate heat exchanger are obtained by one piece pressing of metal plates. Stainless steel is a commonly used metal for the plates because of its ability to withstand high temperatures, its strength, and its corrosion resistance. The plates produce an extremely large surface area, which allows for the fastest possible heat transfer. Making each chamber thin ensures that the majority of the volume of the liquid contacts the plate. A plate heat exchanger consists of a series of thin plates which are compressed together in a rigid frame to form an arrangement of parallel flow channels with alternating hot and cold fluids.

PLATE AND FRAME HEAT EXCHANGER



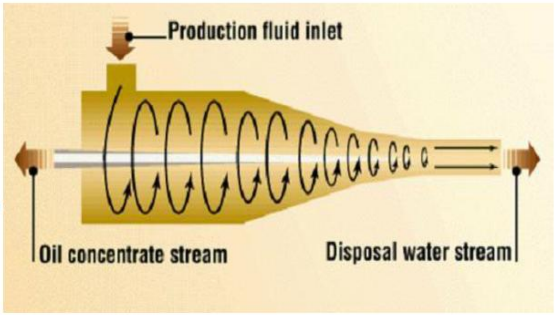
10.8 Centrifugal Pump

A centrifugal pump uses a rotating impeller to increase the pressure of a fluid. Centrifugal pumps are commonly used to move liquids through a piping system. The fluid enters the pump impeller along or near to the rotating axis and is accelerated by the impeller, flowing radially outward into a diffuser or volute chamber, from where it exits into the downstream piping system. Centrifugal pumps are used for large discharge through smaller heads.



10.9 Hydrocyclones

Hydrocyclones are extremely efficient wastewater treatment devices. The primary variable which dictates performance and separation efficiency is inlet flow rate, since high velocity is required to generate the very high g-forces needed to create the oil and water separation.



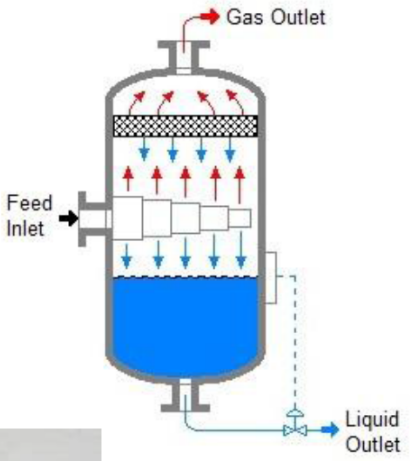
Control of the ratio of the pressure differentials between oily water inlet and the two product streams is used to control separation efficiency of the hydrocyclones.

Pressure differential measurement is used as an inferential method of determining flow rates. The efficiency of the separation is based on what is known as the reject ratio, which is defined as the ratio of the reject stream to inlet flow. Below a critical minimum ratio the hydrocyclones will not function

10.10 Gas Scrubber

Gas Scrubbers are used to remove dirt, water, foreign matter, or undesired liquids that are part of the gas flow stream, to protect downstream rotating equipment. They are also used to recover valuable liquids from gas.

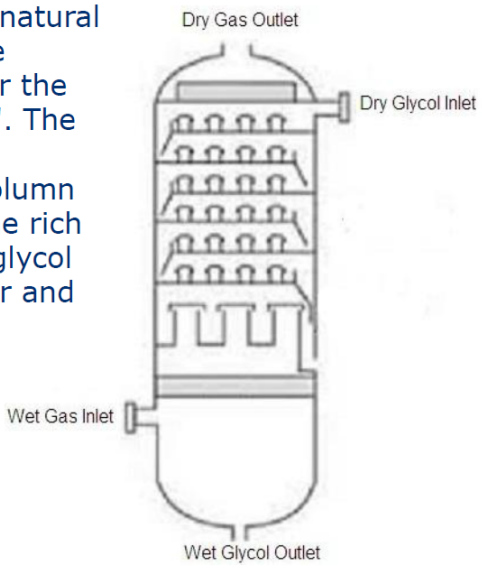
Droplets that are in the scrubber inlet gas are separated from the outlet gas stream by means of a demisting device. The collected liquid leaves the vessel at the bottom through a level-control or dump valve.



10.11 Glycol Contactor

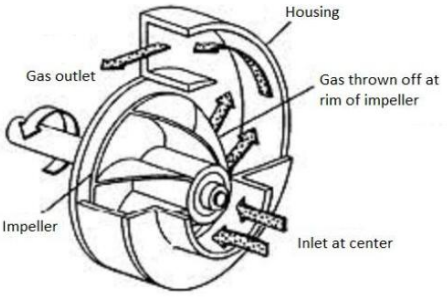
The purpose of a Glycol Contactor is to remove water from natural gas. When produced from a reservoir, natural gas usually contains a large amount of water and is typically completely saturated or at the water dew point. This water can cause several problems for downstream processes and equipment. At low temperatures the water can either freeze in piping or, as is more commonly the case, form hydrates with CO_2 and hydrocarbons (mainly methane hydrates). Depending on composition, these hydrates can form at relatively high temperatures, plugging equipment and piping. Without gas dehydration, a free water phase (liquid water) could also drop out of the natural gas as it is either cooled or the pressure is lowered through equipment and piping. This free water phase will contain some portions of acid gas (such as H_2S and CO_2) and can cause corrosion.

Lean, water-free glycol is fed to the top of the glycol contactor where it is contacted with the wet natural gas stream. The glycol removes water from the natural gas by physical absorption and is carried out the bottom of the column. Upon exiting the absorber the glycol stream is often referred to as "rich glycol". The dry natural gas leaves the top of the absorption column. A Glycol Contactor can be either tray column or packed column. After leaving the absorber, the rich glycol is fed to a Glycol Regeneration Unit. The glycol is thermally regenerated to remove excess water and regain the high glycol purity.



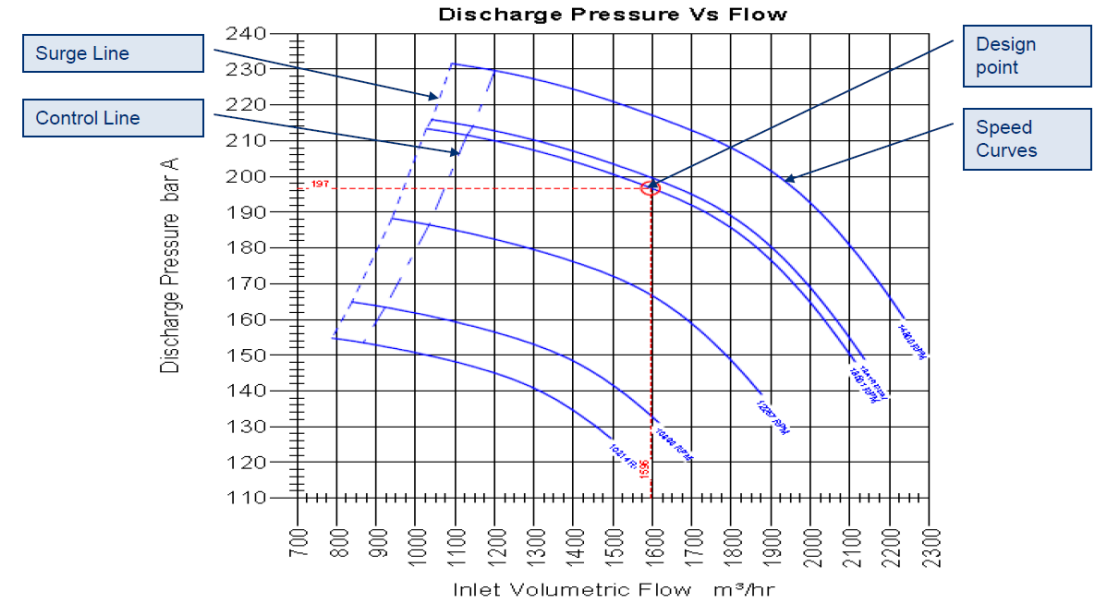
10.12 Centrifugal Compressor

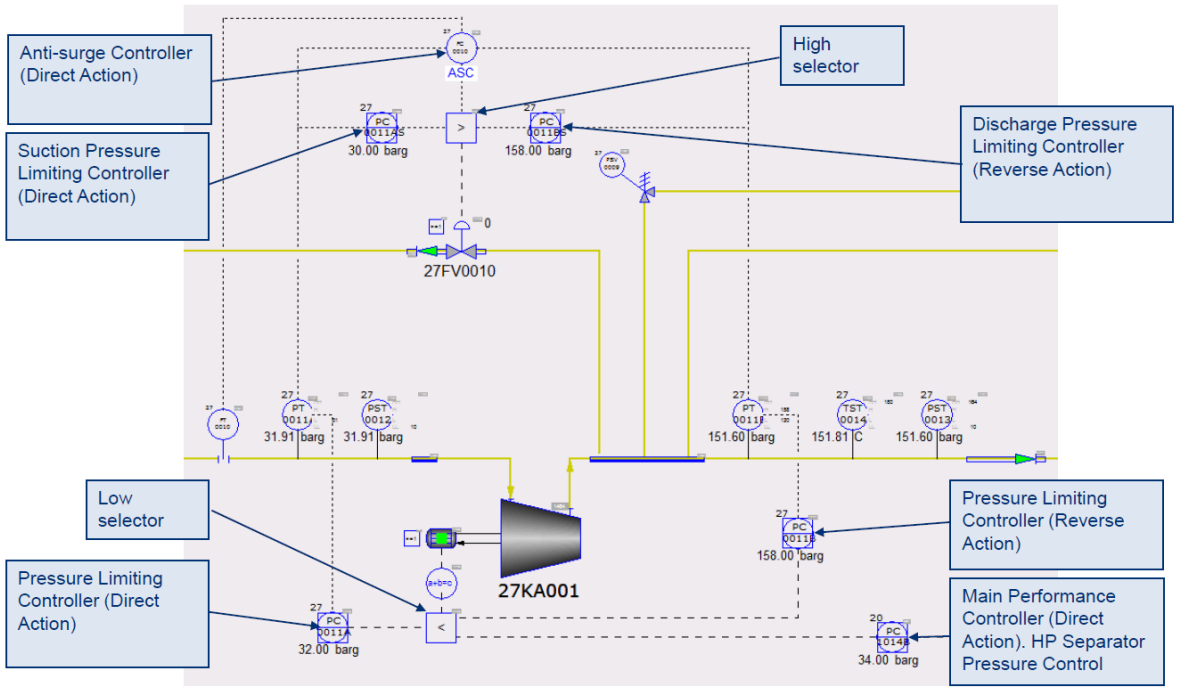
A gas compressor is a mechanical device that increases the pressure of a gas by reducing its volume. Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. As gases are compressible, the compressor also reduces the volume of a gas.



Centrifugal compressors use a rotating disk or impeller in a shaped housing to force the gas to the rim of the impeller, increasing the velocity of the gas. A diffuser (divergent duct) section converts the velocity energy to pressure energy. They are primarily used for continuous, stationary service in industries such as oil refineries, chemicl and petrochemicl plants and natural gas processing plants.

10.13 Compressor Protection System





10.14 Seawater Deaerator

Secondary recovery by means of water injection is frequently an essential feature of crude oil production. It is often a crucial factor in achieving and sustaining economically viable production rates.
The source of the water is dependant on the location of the production facility and could be from a subsurface source such as produced water or an aquifer, or from a surface source such as the sea or a river. The latter two sources, as with most surface waters, normally contain substantial levels of dissolved oxygen. In order to control corrosion rates in downstream plant and to inhibit bacterial growth this oxygen must be removed before the water is used for injection. This normally takes place in a Deaerator.