KONGSBERG

Kongsberg K-Chief 700

Operator Manual

Release 8.2

332618/B

Document history

Document number: 332618		
Rev. A	April 2009	First version.
Rev. B	January 2011	Changed description of section 3.7.8 Duty/Standby configuration.

The readers

This operator manual is intended as a reference manual for the system operator. The manual can contain information that is not relevant to your vessel.

Note

Warning

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment and/or injury to personnel. The user must be familiar with the contents of the appropriate manuals before attempting to operate or work on the equipment.
Kongsberg Maritime disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

Comments

To assist us in making improvements to the product and to this manual, we welcome comments and constructive criticism.
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Glossary

AIM	Advanced Integrated Multifunction system
ALC	Alarm & Control Panel
BIST	Built-In Self Test
BU-AUT	Business Unit Automation Panel
CAN	Controller Area Network
CPU	Central Processing Unit
CCR	Cargo Control Room
DFE	Dual Fuel Engine
DG	Diesel Generator
DO	Diesel Oil
DP	Dynamic Positioning
ECR	Engine Control Room
EMC	Electromagnetic Compatibility
EMD	European Union Maritime Directive
FBO	Forced Boil Off
FDS	Functional Design Specification
FO	Fuel Oil
FS	Field Station
FV	Forcing Vaporizer
GMS	Graphic Modelling System
GUI	Graphic User Interface
HFO	Heavy Fuel Oil
HH	High High alarm limit
HMI	Human Machine Interface
HS	History Station or High Speed
HTML	HyperText Markup Language
ICS	Integrated Control Systems
IMO	International Maritime Organization
INP	Input Panel
IO, I/O	Input/Output
IP	Ingress Protection
K-Bridge	Kongsberg Bridge System
K-Chief	Kongsberg Vessel Control System
KFDD	Kongsberg Functional Design Document

K-Gauge	Kongsberg Gauging System
K-Pos	Kongsberg Dynamic Positioning System
K-Pos DPM	Kongsberg Dynamic Positioning and Mooring System
K-Pos PM	Kongsberg Position Mooring System
K-Pro	Kongsberg Process System
K-Safe	Kongsberg Safety System
K-Thrust	Kongsberg Thruster Control System
LAN	Local Area Network
LBOG	Liquified Boil Off Gas
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LL	Low Low alarm limit
LS	Low Speed
MPxxxx	Marine PC model xxxx
MTBF	Mean Time Between Failure
NBO	Normal Boil Off
NCR	Navigation Control Room
NDU	Network Distribution Unit
OFAS	Operator Fitness Alarm System
OS	Operator Station
PC	Personal Computer
PDF	Portable Document Format
PDU	Power Distribution Unit
PID	Proportional Integral Derivative
PMS	Power Management System
PS	Process Station, process software package running on an RCU module
PU	Process Unit
RBUS	Remote I/O bus
RCA	Redundancy and Criticality Assessment system
RCU	Remote Controller Unit
RIO	Remote Input Output
RPM	Revolutions Per Minute
SS	SubSystem
UMS	Unmanned Machinery Space
UPS	Uninterruptible Power Supply

WBU	Watch Bridge Unit
WCS	Watch Call System
WCU	Watch Cabin Unit

1 System Description

1.1 Where to find K-Chief 700 user documentation

The K-Chief 700 user documentation is available as:

1 This K-Chief 700 Operator Manual

2 The electronic AIM user guide, which is available online.

The two documents describe the different parts of the K-Chief 700 system functions, as shown in the table below.

Table 1 Information division between the K-Chief 700 Operator Manual and AIM user guide

K-Chief 700 Operator Manual	K-Chief 700 automation applications - Basic monitoring and control, power management and other dedicated K-Chief 700 subsystems
	Log on/log off information
	Start-up and shutdown information
AIM user guide Configuration information for the basic AIM functions is included.	Alarms and events
	Report
	Trend system
	Time series system
	Command control system
	Access control system
	I/O system
	Various explorers for monitoring of system components and function modules.
	Information on the operator station, history station and field station
	Redundancy
	Various utility and auxiliary functions

You can view the online **AIM user guide** by doing either of the following:

a) From the main menu, choose`Help>User Guide`

b) Press the keyboard function key **F1**.

More information on the **AIM user guide** is provided in the User Interface section of this manual.

1.2 Overview K-Chief 700

The K-Chief 700 is a distributed monitoring and control system that can be used in a wide range of vessels and applications. K-Chief 700 monitors and controls the onboard functions such as power, machinery, fluid, cargo and thruster/propulsion management.

This K-Chief 700 can have basic functions, applications, and custom functions installed.

The basic functions are:

- Process control
- Remote control of field equipment e.g. valves, motors and pumps.
- Process and system monitoring
- Logging process value history
- Event and alarm monitoring
- Logging event and alarm history

The main applications are:

- Power management
- Thruster/propulsion control
- Redundancy and criticality assessment system
- Cargo and ballast control
- Extended alarm systems such as the watch calling system and the operator fitness alarm system.

Hardware components and application software modules can be combined as necessary, for a vessel's specific requirements.

The K-Chief 700 can operate as a standalone system or it can be seamlessly integrated with other K-line systems as part of a larger vessel management system. The K-line systems can be, for example:

- Safety system (K-Safe)
- Dynamic positioning systems (K-Pos)
- Position mooring (K-Pos DPM)
- Thruster control (K-Thrust)
- Bridge control (K-Bridge)
- Gauge systems (K-Gauge).

The integration can result in overlapping control functions between the systems. For example, you might be able to operate a thruster from the K-Chief 700, K-Thrust and K-Pos systems.

1.3 Distributed architecture

Operator stations provide the human machine interface (HMI), which allows you to interact with the K-Chief 700. One or many operator stations can be located in various control areas, such as the central control room (CCR), engine control room (ECR) and the bridge.

The process control system is made of intelligent remote control (RCU) and I/O (RIO) modules. They communicate with each other over a redundant, high-capacity process bus, the RBUS. All monitoring and automation functions are done by the RCUs.

The RIO module has a number of analogue and digital I/O channels. The individual channels are configured to match the field instruments.

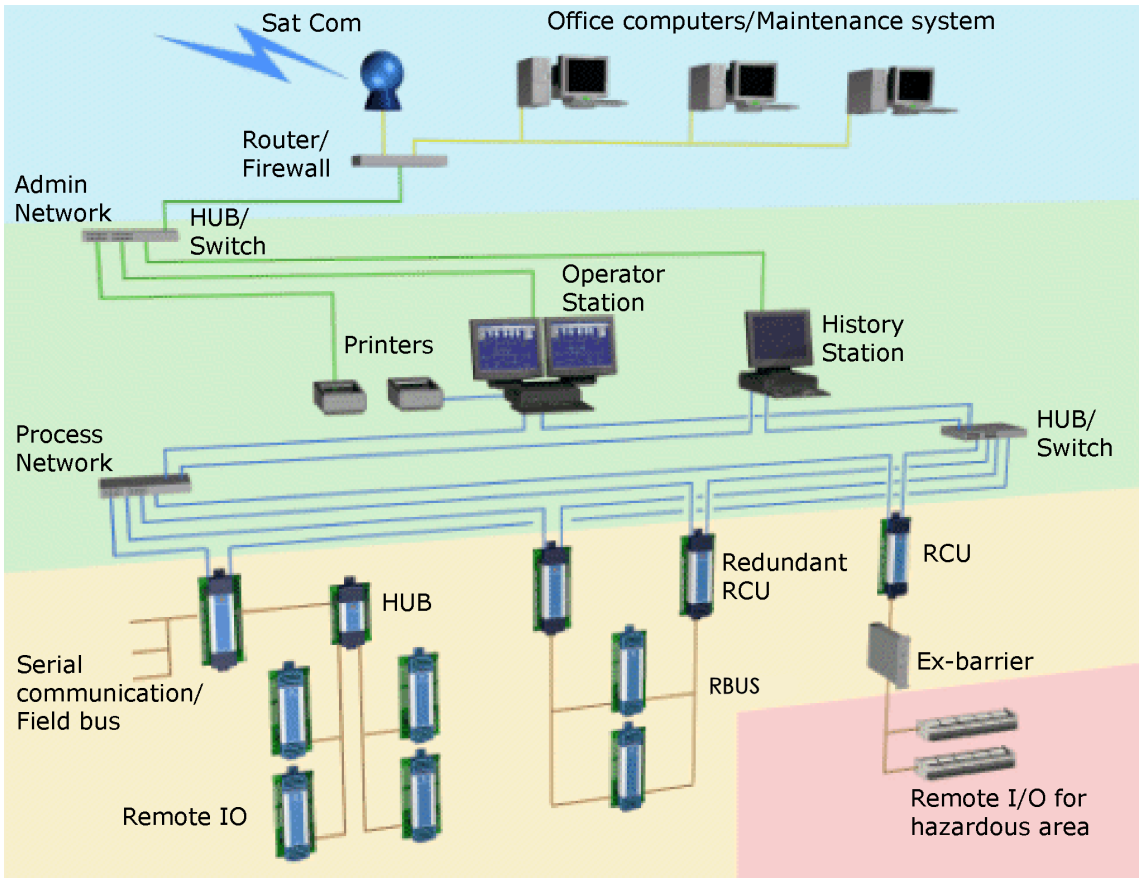
1.4 Main system components

The system is made of several basic components. Although, as an operator, you will primarily be concerned with the operator stations, it is useful to be aware of the other components in the system.

Also refer to the online AIM user guide.

The following figure shows a block diagram of the distributed control system.

Figure 1 Typical K-Chief 700 system configuration



The components of the ICS are described in the following sections.

1.4.1 Operator stations

The operator stations (OS) are the main interface between the operator and the processes.

An OS has three main parts:

- A colour monitor
- An operator panel with buttons and a trackball
- A graphics controller (computer).

These can be installed in a number of different ways, such as in a standard K-Chief 700 console, or as separate units for built-in or desktop operation. More than one OS is usually installed in a K-Chief 700. The OS is installed in locations such as the bridge, central control rooms (CCR) and engine control rooms (ECR).

1.4.2 Field stations

The field stations (FS) are combined field interface and processing units. They provide the interface between the ICS and the field equipment. A field station is associated with specific items of field equipment. The FS contains the software description of the field equipment that is connected to it. The FS is usually located near the field equipment and instrumentation.

Remote controller unit

The remote controller unit (RCU) executes the application program of a process control system and interfaces with different bus systems. It is also has dual network interfaces, called REDNET, for redundant RCU configurations.

Distributed processing

The ICS is a distributed processing system because the process control functions are done locally in the FS, not centrally in the OS. As the OS is independent of the process, it can be located anywhere on the vessel. Any OS can control any process, provided that it has control of the necessary command group, and the operator has sufficient access rights.

Every OS has a hard disk containing the software files for the ICS. These files are customized for the vessel. Process variable and parameter values shown in the OS are generated in the FS and transferred to any OS on request. The OS screen displays information collected from all the FS units.

1.4.3 Communication network

The communication network is a dual-redundant local area network (LAN) that interconnects the operator, history, and field stations. All communication between the operator and the equipment that is controlled, takes place over this network. The AIM network includes the distribution units, which are cabinets that contain a network switch or hub unit for the process network. Every distribution unit contains one or more network switch or hub units. Optionally, a patch panel can also be provided.

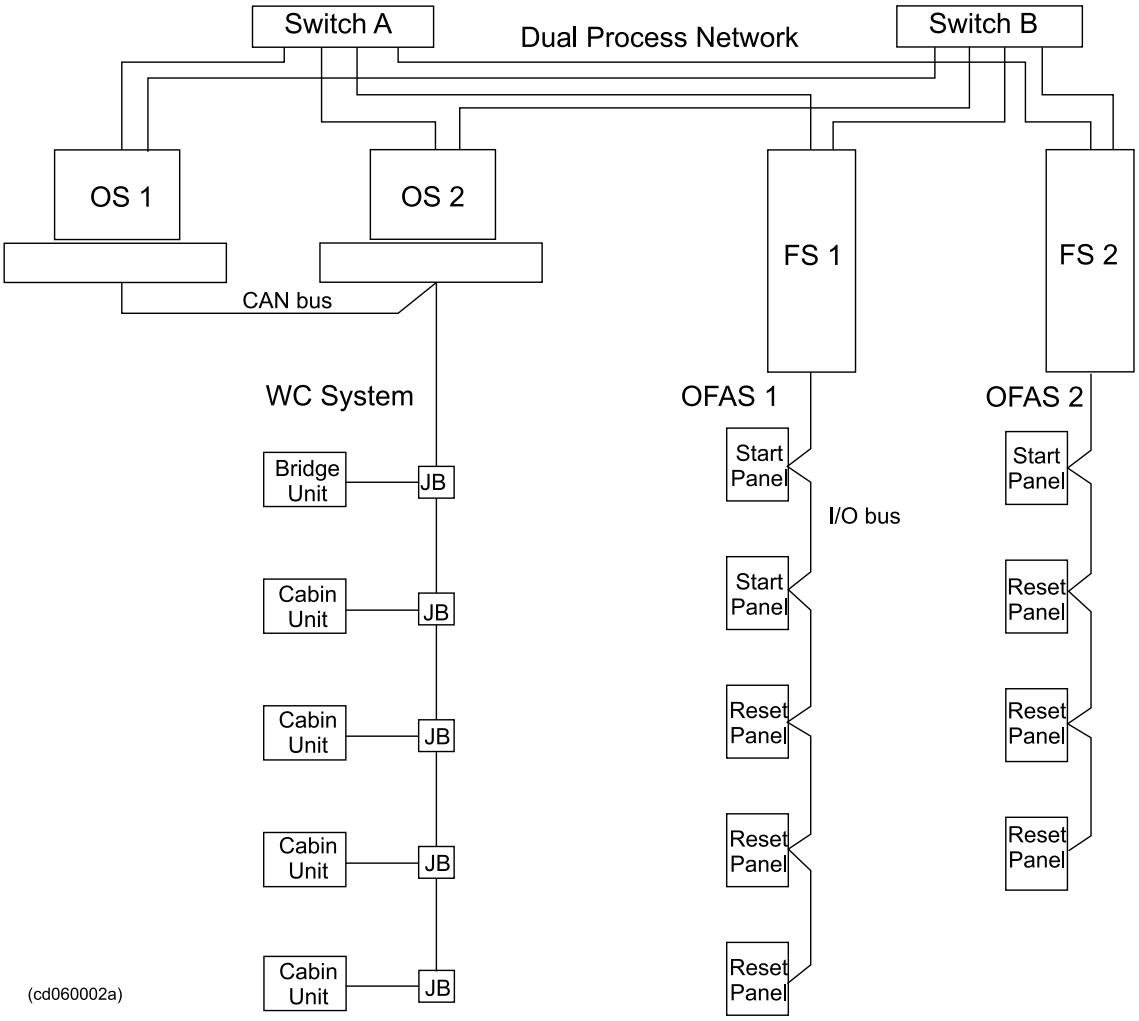
Operator stations and history stations can also be a part of an external network, which can have other systems and printers connected.

1.4.4 History station

A history station (HS) is a computer that is connected to the network. It contains the historical database that stores the process variables over time. This is called a time series, which is mainly used internally by the system, to show historical trends and reports in the operator stations.

1.4.5 Extended alarm systems

The watch call system (WCS) and operator fitness alarm system (OFAS) are extended alarm systems.



Watch call system

The WCS is part of the alarm and monitoring function of the K-Chief 700 system. It allows the engine room to be operated in unmanned mode. The WCS is compliant with classification society requirements for unmanned engine room operation.

The WCS consists of a number of panels that are installed at different locations throughout the vessel. It shows the roster for the various watches and alerts the applicable personnel when they have watch duties when an alarm condition occurs.

Refer to the section *Watch call system* on page 153 for details.

Operator fitness alarm system

The operator fitness alarm system (OFAS) is part of the alarm and monitoring function of the K-Chief 700 system. The OFAS panels are located in the machinery and cargo spaces.

OFAS is also known as dead man alarm system and patrol man alarm system.

Refer to the section *Operator fitness alarm system* on page 161 for details.

2 User Interface

2.1 Overview

The K-Chief 700 user interface consists of a colour monitor screen, an operator panel and an alphanumeric keyboard. The screen shows the K-Chief 700 images and the operator panel is used to interact with those images. The alphanumeric keyboard is used for setup and configuration purposes.

This section describes the interface. It describes the use of the operator panel and how to use the alphanumeric keyboard. it also gives an overview of the different images available.

Refer to the also *AIM user guide* on page 17 and the operator station topic in the online AIM user guide.

2.1.1 AIM user guide

The AIM user guide is an online reference for anyone who configures or operates the AIM-2000 system. The introduction section in the user guide contains all the necessary instructions for using the guide.

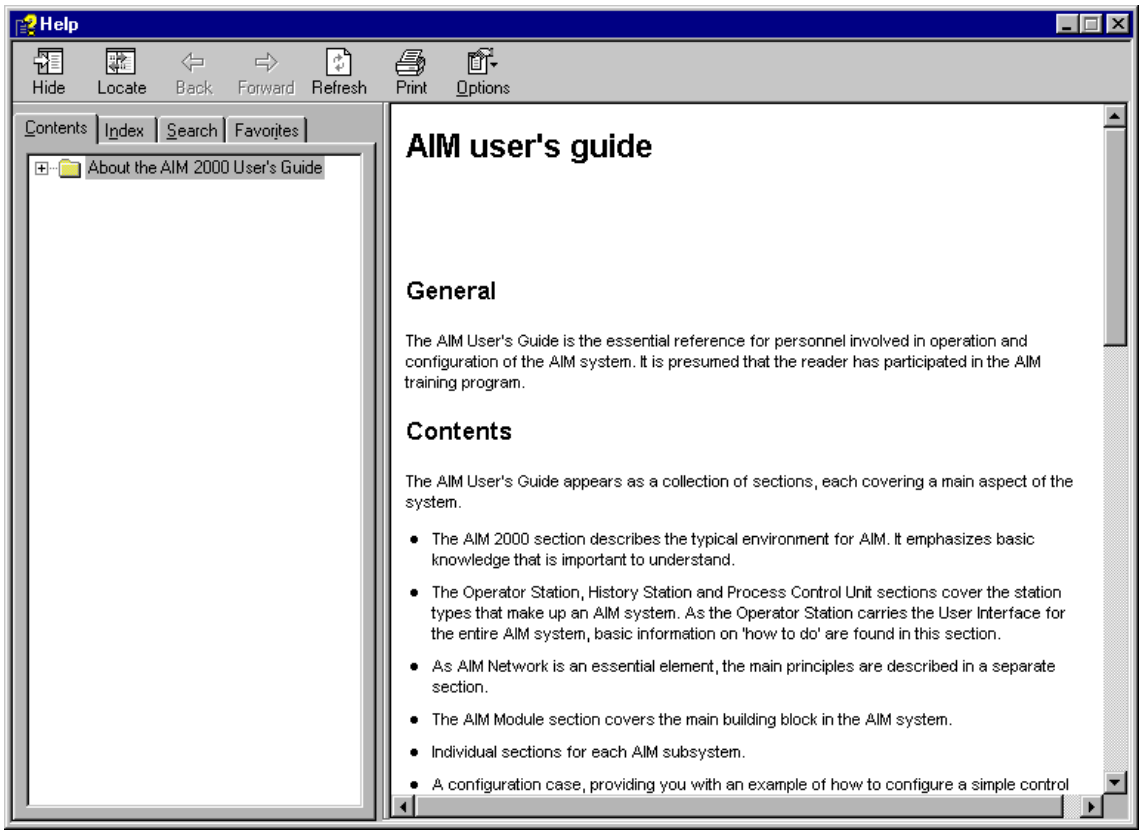
The AIM user guide can be viewed in two different ways, either by:

- Using the **Help** menu
- Pressing the keyboard **F1** function button.

2.1.1.1 Using the command on the Help menu

Choose the `User Guide` menu item in the **Help** menu to Refer to the AIM user guide.

Figure 2 The AIM user guide



You can find the information you require by either:

1 Selecting the →**Contents** tab and selecting the required table of contents entry

2 Selecting the →**Search** tab and typing a search string.

When the User Guide HTML help viewer is shown, a user guide button is added to the end of the toolbar of the currently displayed image. This button allows you to display or hide the viewer as necessary.

2.1.1.2 Using the keyboard F1 function button

Press **F1** function button on the keyboard to view the AIM user guide.

There are two display options.

- If you press the **F1** key when no dialog box has focus, the AIM user guide is shown.
- If you press the **F1** key when a dialog box has focus, the AIM user guide shows information about the dialog box. The AIM user guide navigation pane closes. The **Hide/Show** toggle button is in the **Show** mode. Click this button to open the navigation pane.

2.1.2 System version information

Choose the `About AIM OS` menu item in the **Help** menu to Refer to the information about the installed version of the K-Chief 700. The AIM user guide contains more details of the system information feature.

2.2 Operator station images

The operator station (OS) shows views of the process areas. These views, or images, show all or part of a process. They use standard symbols to represent the process equipment such as valves and motors. The parts of the process are shown using colours to show the present state of the process. Events such as alarms and messages are also shown in general views, as well as in specific views.

How processes are displayed and controlled

The number of images in a system depends on the amount of equipment that K-Chief 700 controls. The system is lets you select images that give varying levels of detail about a process.

When you select an image that shows an overall process (for example, Power Management), it is possible that there is not enough space to display all the detail on a single image. The K-Chief 700 system will therefore have a number of images, which are linked to the main image via hotspots or View panel buttons, that show this level of details.

Usually, no more than a maximum of two image levels will be used, although more can be used if required. Eventually you will reach a point where there is no more detail (i.e. at the level of a single function module).

The concepts behind images are central to understanding how a K-Chief 700 system works. They are briefly described in the User Interface section *User Interface* on page 17 and in more detail in the Basic Monitoring and Control section on page .

2.2.1 Image types

The various types of K-Chief 700 images are as follows:

- Process
- Flow Sheet
- List
- Trend
- Event List
- System Status
- I/O
- PDF
- Multiple.

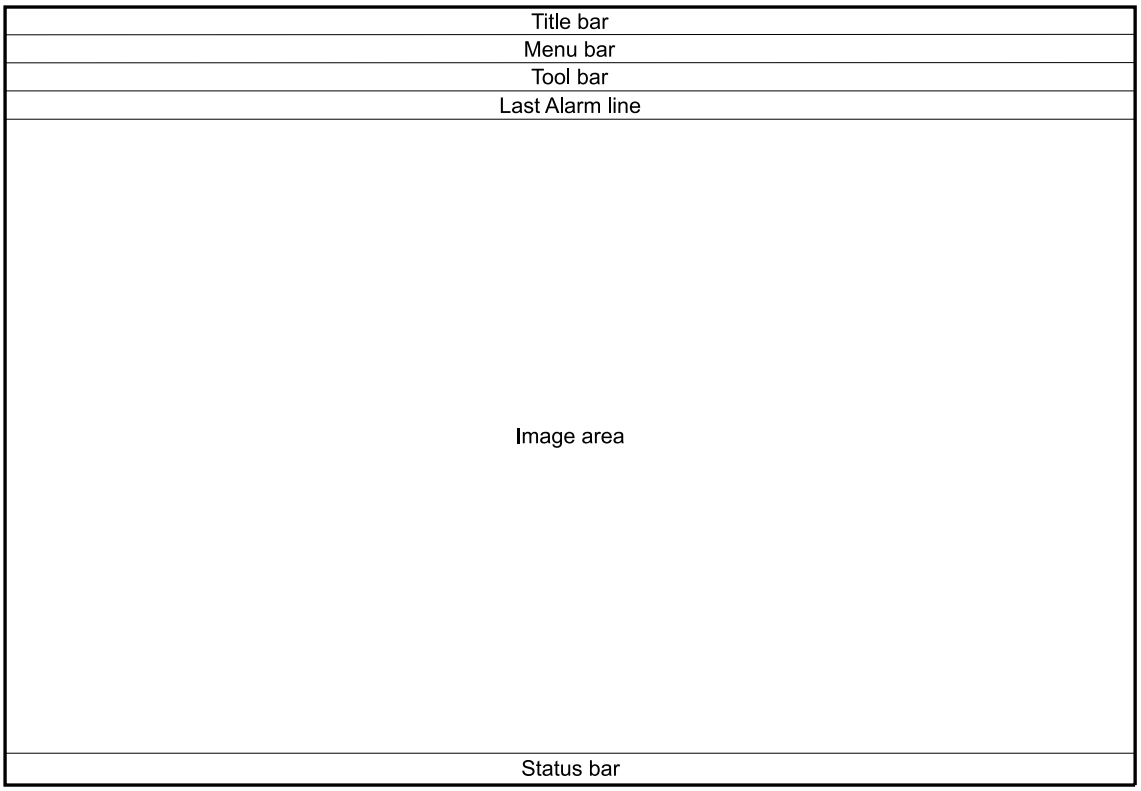
For more details on the various type of images, refer to the online AIM user guide.

2.2.2 Image layout

The K-Chief 700 images are displayed in a primary image window, that is divided into areas. Each of these areas has a different function, and is updated independently of the others. They contain information about the process, and information for the operator. The information displayed varies according to the type of command given, or the task being performed.

The arrangement of these areas is shown in the following figure.

Figure 3 K-Chief 700 view layout



(CD2338C)

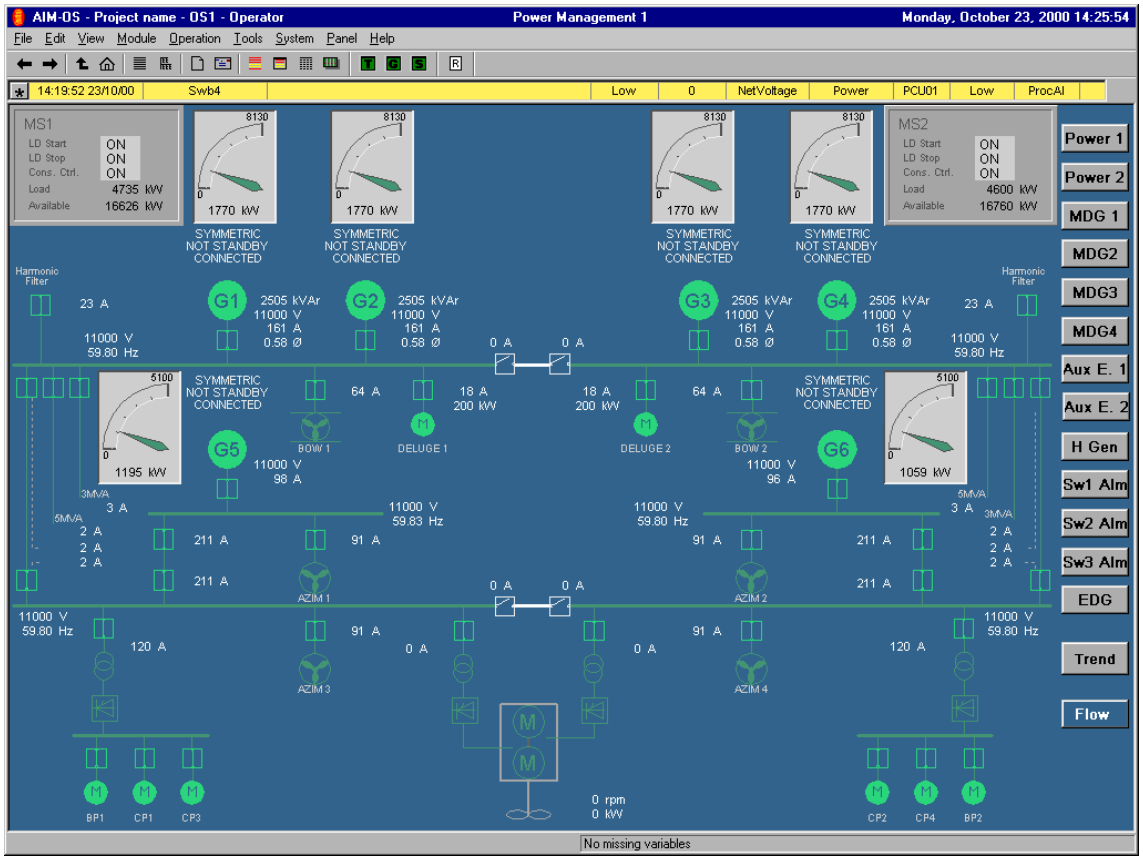
2.2.3 Process images

The process image offers enhanced graphical presentation of a process. The operator interacts with graphical elements using the various operation menus. Graphical elements represent process components such as pumps, motors, valves, or switches. Process values and alarms are displayed together with the element.

A graphical element represents detailed information about a software function module. The software function module represents a process component such as an instrument, an electrical motor, a valve or a pump.

An example of a process image for the power management application is shown in the following figure:

Figure 4 Process view



2.2.4 Flow sheet images

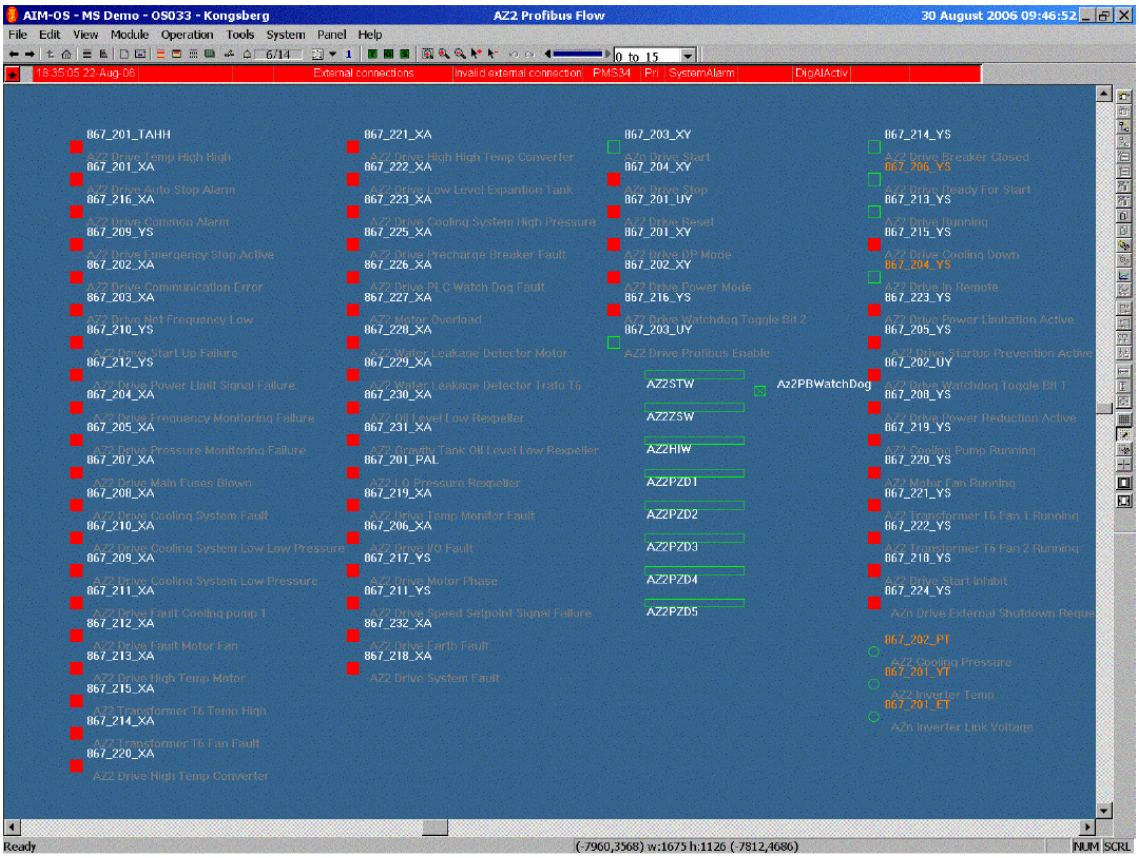
Flow sheet images have the standard K-Chief 700 image layout. They are similar to process images, as they are graphic representations of physical parts of the vessel process.

The main difference between a flow sheet image and a process image is the way they are created, and the way in which vessel process information is shown in the image area.

In addition, the flow sheet image supports zoom and information display functions that are not found in process images. There are also scroll bars on the image area for viewing the flow sheet process map.

An example of a flow sheet image for the power management application is shown in the following figure.

Figure 5 Flow sheet image

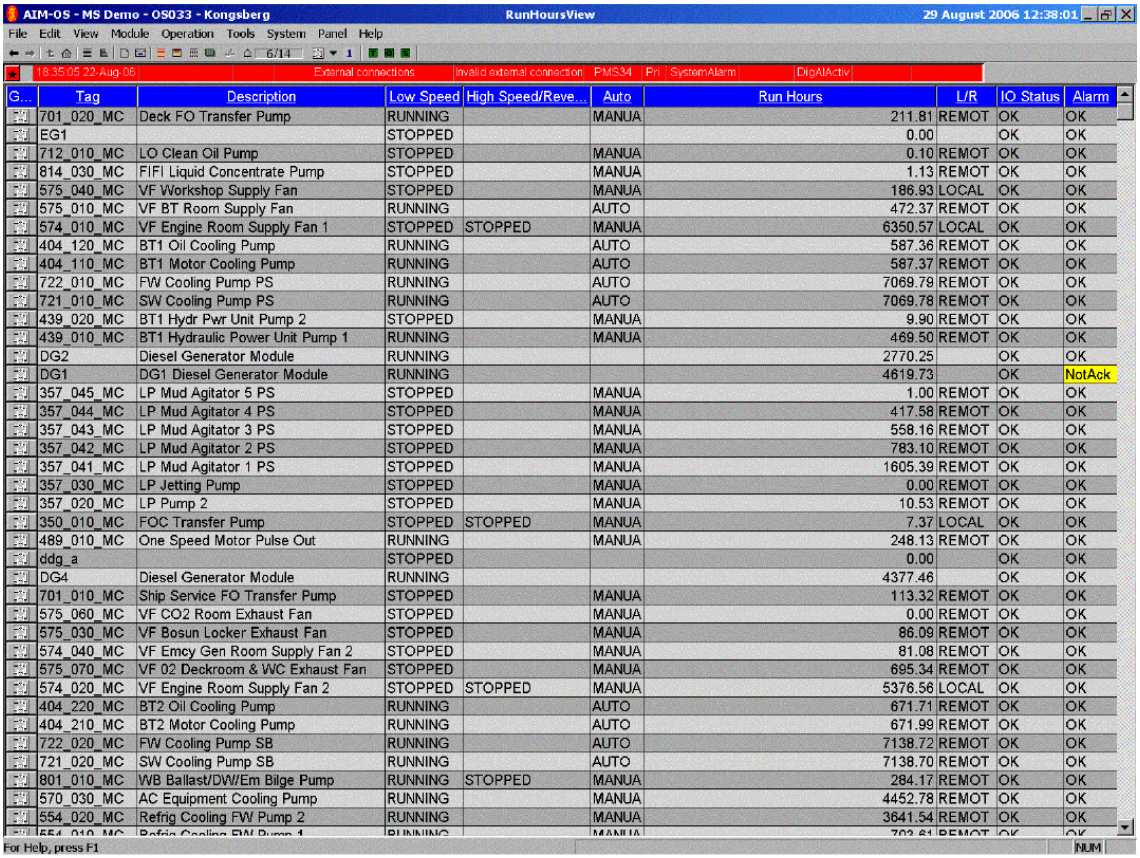


2.2.5 List images

The list image lets you easily make views containing selected information from the modules, or tags. These views can be seen by clicking on the tabs at the top of the screen.

The following figure shows an example of motor status and running hours.

Figure 6 List image



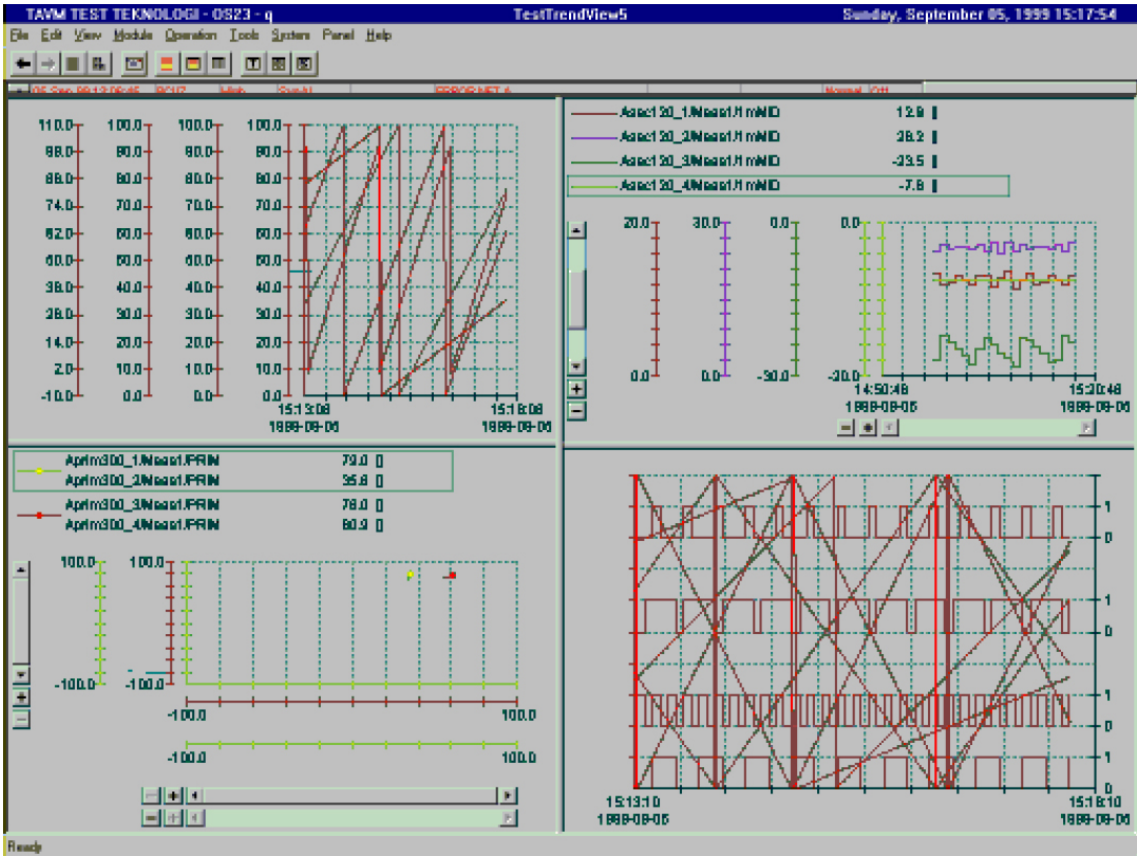
G...	Tag	Description	Low Speed	High Speed/Reve...	Auto	Run Hours	L/R	IO Status	Alarm
	701_020_MC	Deck FO Transfer Pump	RUNNING		MANUA	211.81	REMOT	OK	OK
	EG1		STOPPED			0.00		OK	OK
	712_010_MC	LO Clean Oil Pump	STOPPED		MANUA	0.10	REMOT	OK	OK
	814_030_MC	FIFI Liquid Concentrate Pump	STOPPED		MANUA	1.13	REMOT	OK	OK
	575_040_MC	VF Workshop Supply Fan	STOPPED		MANUA	186.93	LOCAL	OK	OK
	575_010_MC	VF BT Room Supply Fan	RUNNING		AUTO	472.37	REMOT	OK	OK
	574_010_MC	VF Engine Room Supply Fan 1	STOPPED	STOPPED	MANUA	6350.57	LOCAL	OK	OK
	404_120_MC	BT1 Oil Cooling Pump	RUNNING		AUTO	587.36	REMOT	OK	OK
	404_110_MC	BT1 Motor Cooling Pump	RUNNING		AUTO	587.37	REMOT	OK	OK
	722_010_MC	FW Cooling Pump PS	RUNNING		AUTO	7069.79	REMOT	OK	OK
	721_010_MC	SW Cooling Pump PS	RUNNING		AUTO	7069.78	REMOT	OK	OK
	439_020_MC	BT1 Hydr Pwr Unit Pump 2	STOPPED		MANUA	9.90	REMOT	OK	OK
	439_010_MC	BT1 Hydraulic Power Unit Pump 1	RUNNING		MANUA	469.50	REMOT	OK	OK
	DG2	Diesel Generator Module	RUNNING			2770.25		OK	OK
	DG1	DG1 Diesel Generator Module	RUNNING			4619.73		OK	NotAck
	357_045_MC	LP Mud Agitator 5 PS	STOPPED		MANUA	1.00	REMOT	OK	OK
	357_044_MC	LP Mud Agitator 4 PS	STOPPED		MANUA	417.58	REMOT	OK	OK
	357_043_MC	LP Mud Agitator 3 PS	STOPPED		MANUA	558.16	REMOT	OK	OK
	357_042_MC	LP Mud Agitator 2 PS	STOPPED		MANUA	783.10	REMOT	OK	OK
	357_041_MC	LP Mud Agitator 1 PS	STOPPED		MANUA	1605.39	REMOT	OK	OK
	357_030_MC	LP Jetting Pump	STOPPED		MANUA	0.00	REMOT	OK	OK
	357_020_MC	LP Pump 2	STOPPED		MANUA	10.53	REMOT	OK	OK
	350_010_MC	FOC Transfer Pump	STOPPED	STOPPED	MANUA	7.37	LOCAL	OK	OK
	489_010_MC	One Speed Motor Pulse Out	RUNNING		MANUA	248.13	REMOT	OK	OK
	ddg_a		STOPPED			0.00		OK	OK
	DG4	Diesel Generator Module	RUNNING			4377.46		OK	OK
	701_010_MC	Ship Service FO Transfer Pump	STOPPED		MANUA	113.32	REMOT	OK	OK
	575_060_MC	VF CO2 Room Exhaust Fan	STOPPED		MANUA	0.00	REMOT	OK	OK
	575_030_MC	VF Bosun Locker Exhaust Fan	STOPPED		MANUA	86.09	REMOT	OK	OK
	574_040_MC	VF Emcy Gen Room Supply Fan 2	STOPPED		MANUA	81.08	REMOT	OK	OK
	575_070_MC	VF 02 Deckroom & WC Exhaust Fan	STOPPED		MANUA	695.34	REMOT	OK	OK
	574_020_MC	VF Engine Room Supply Fan 2	STOPPED	STOPPED	MANUA	5376.56	LOCAL	OK	OK
	404_220_MC	BT2 Oil Cooling Pump	RUNNING		AUTO	671.71	REMOT	OK	OK
	404_210_MC	BT2 Motor Cooling Pump	RUNNING		AUTO	671.99	REMOT	OK	OK
	722_020_MC	FW Cooling Pump SB	RUNNING		AUTO	7138.72	REMOT	OK	OK
	721_020_MC	SW Cooling Pump SB	RUNNING		AUTO	7138.70	REMOT	OK	OK
	801_010_MC	WB Ballast/DW/Em Bilge Pump	RUNNING	STOPPED	MANUA	284.17	REMOT	OK	OK
	570_030_MC	AC Equipment Cooling Pump	RUNNING		MANUA	4452.78	REMOT	OK	OK
	554_020_MC	Refrig Cooling FW Pump 2	RUNNING		MANUA	3641.54	REMOT	OK	OK

2.2.6 Trend images

The trend image can contain several trends, such as a mixture of x-y, and time trends. A trend can contain several trend curves.

An example of a trend image containing four trends is shown in the following figure.

Figure 7 Trend image

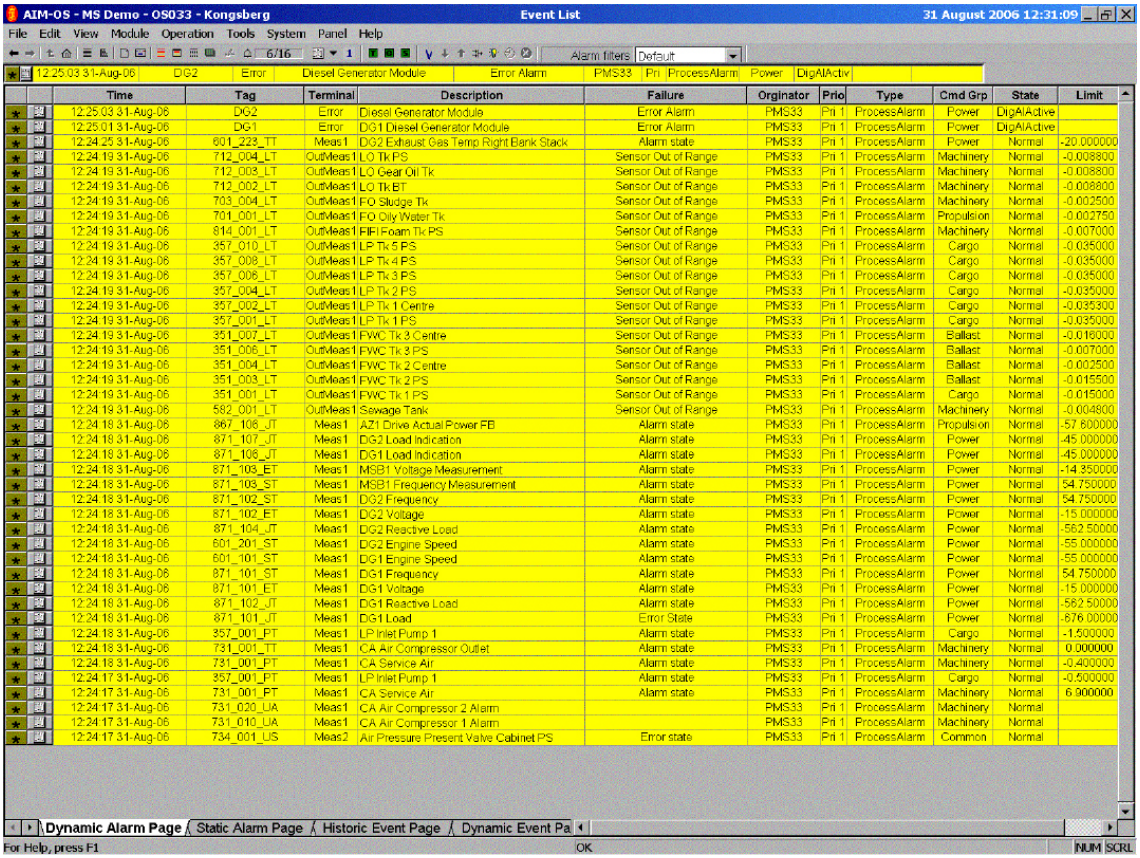


2.2.7 Event list images

An event notifies you of some condition in the system, or the process, that needs your attention. The events are notified, depending on the list that is displayed, and the selected filter.

An example of an event image is shown in the following figure.

Figure 8 Event list image

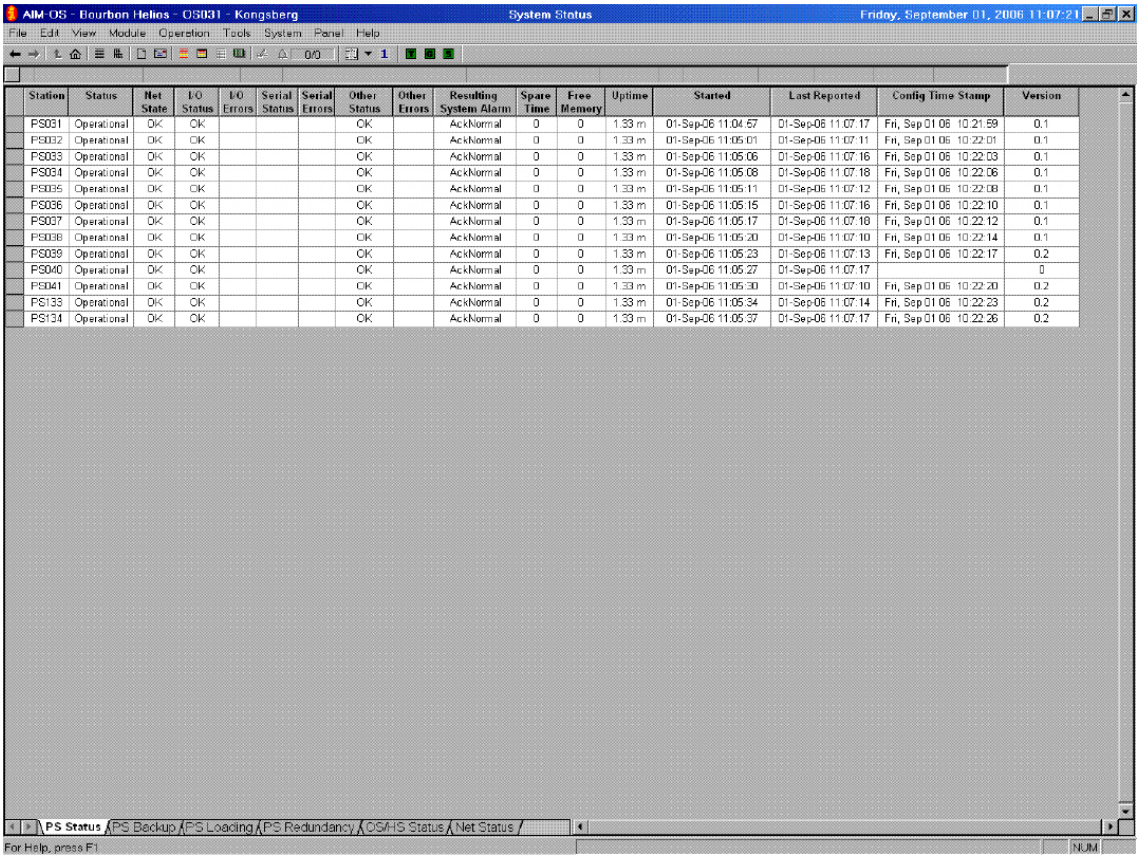


2.2.8 System status images

The system status images show operational status information about the process stations (PS), the history stations (HS) and the operator stations (OS). They also show information about communication with other equipment that are connected to the communication network.

An example of a system status image is shown in the following figure.

Figure 9 System status image



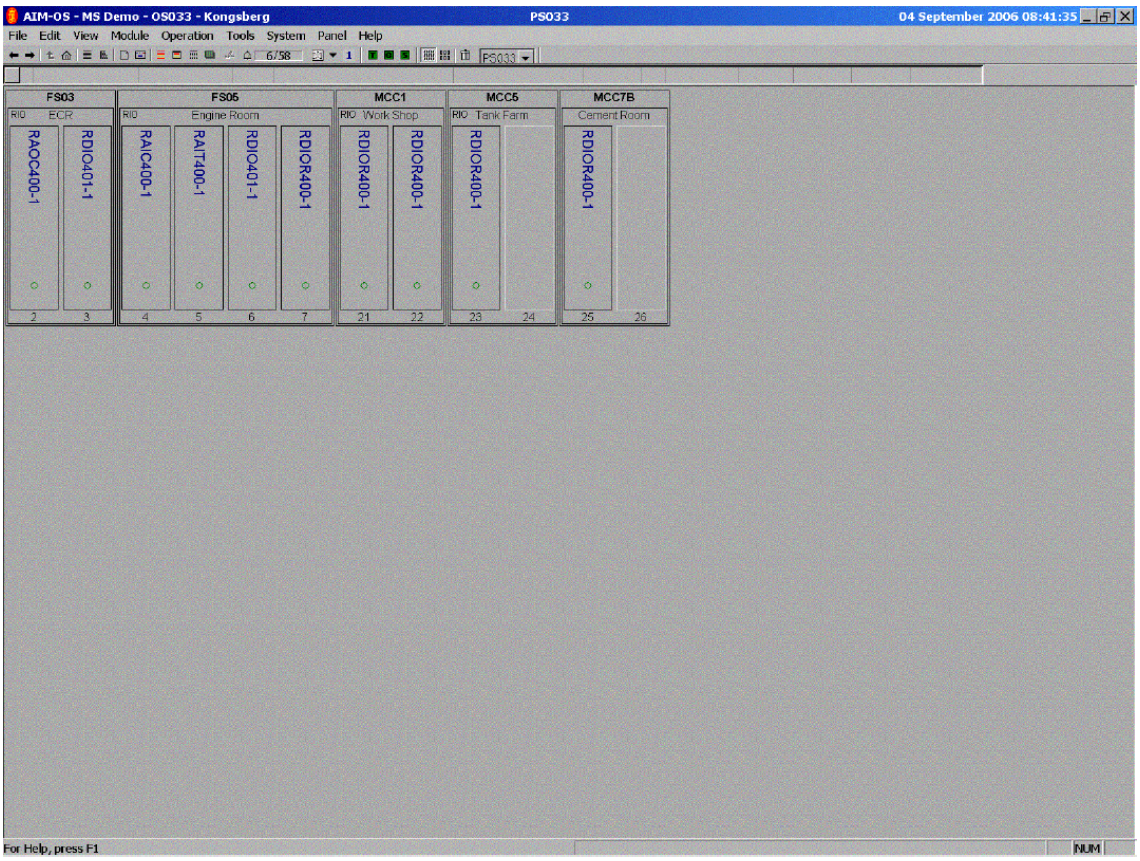
2.2.9 I/O images

The I/O image shows you the I/O configuration of the system. You can drill down into the individual channels to inspect the I/O connections.

The following figure shows an example of an I/O image.

Refer to the online AIM user guide for more information on the I/O images.

Figure 10 I/O image

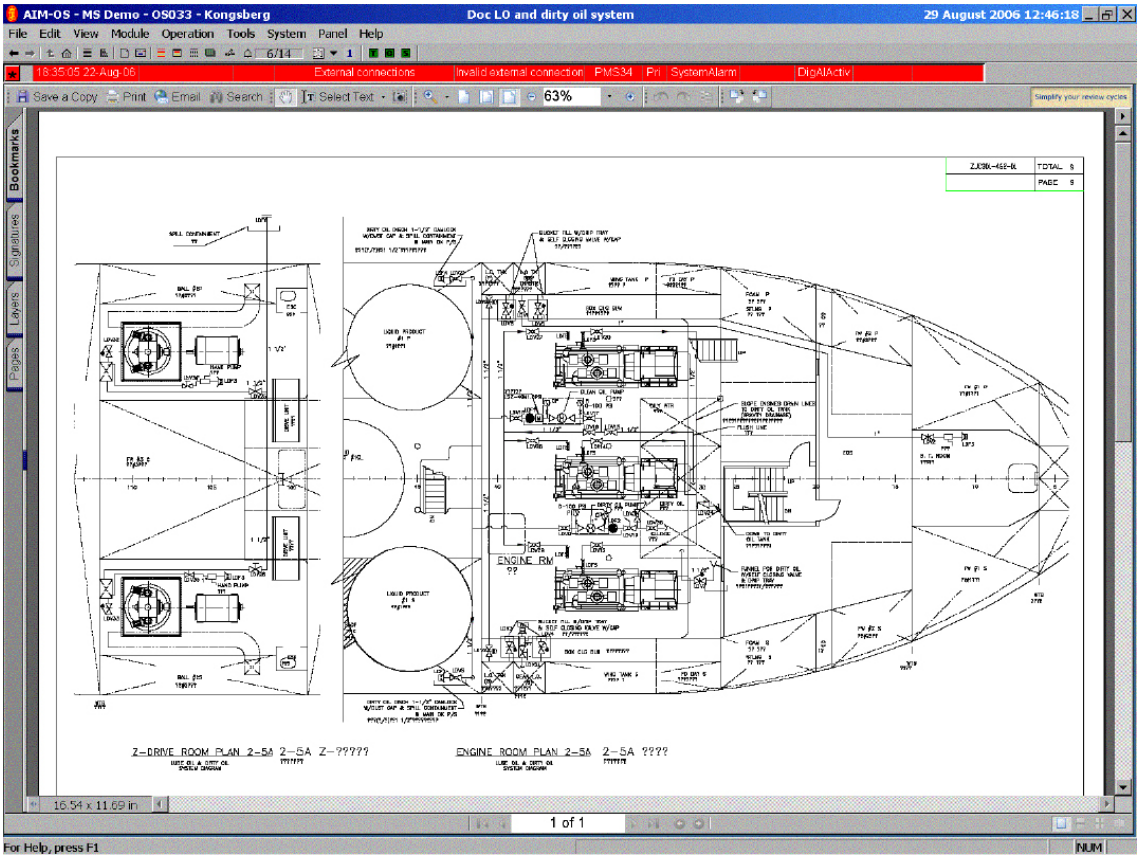


2.2.10 PDF images

The Portable Document Format (PDF) is a file format created for document exchange, by Adobe Systems. PDF images are used to display PDF documents.

An example of a PDF image is shown in the following figure.

Figure 11 PDF image

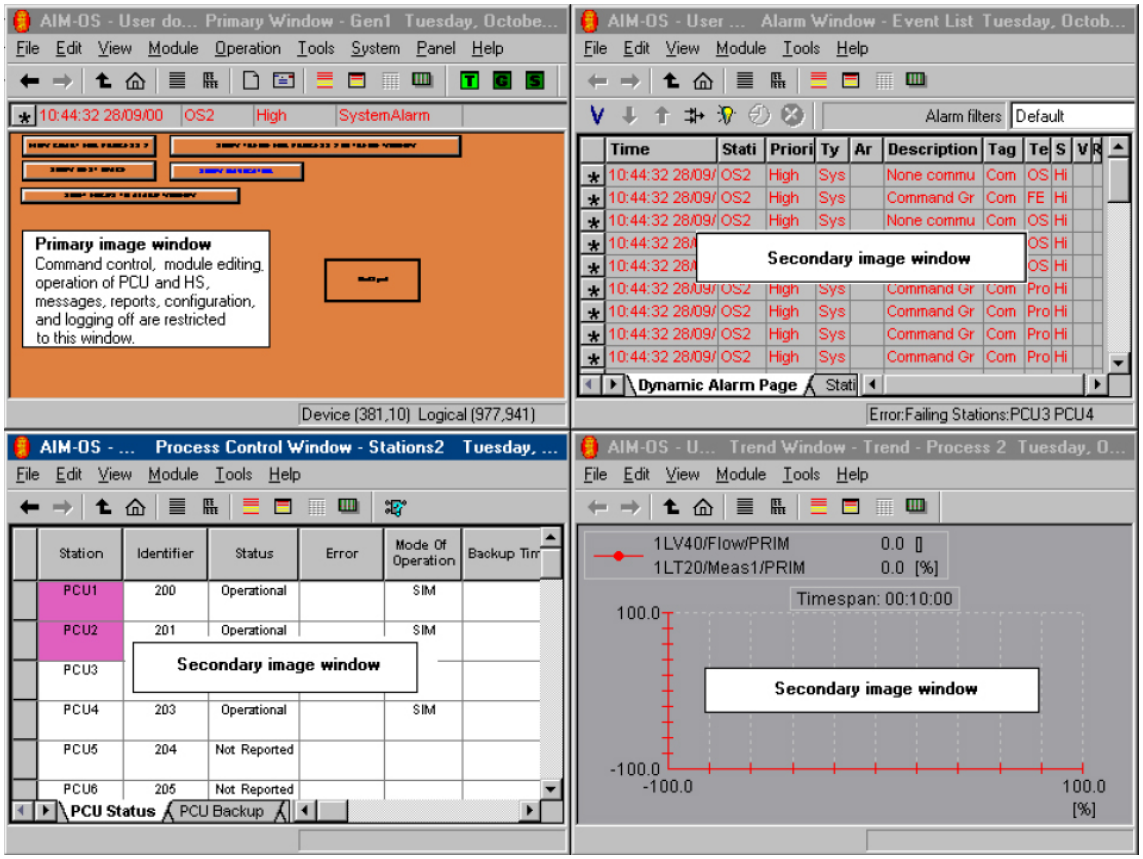


2.2.11 Multiple images

Multiple images are used to display several images on the screen simultaneously.

An example of multiple images is shown in the following figure.

Figure 12 Multiple image



2.3 OS operator panel

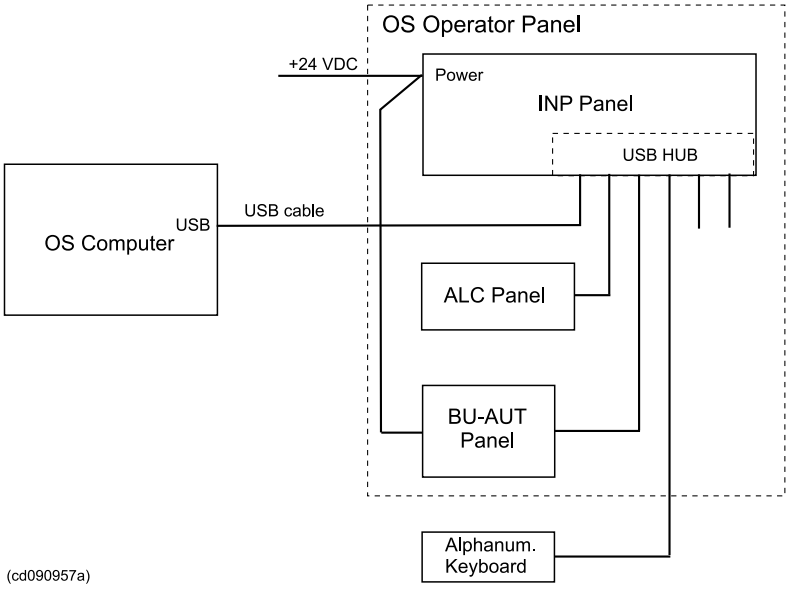
The OS (operator station) operator panel comprises the following sub-panels:

- Input Panel (INP)
- Alarm and Control Panel (ALC)
- Automation Panel (BU-AUT)

They are used to interact with the view, and control the process. This is normally done using the trackball and mouse buttons to point at and click on symbols and menus.

The OS operator panel with its sub-panels communicate with the operator station computer using USB links. See the following figure for communication principles.

Figure 13 Inter-panel communication



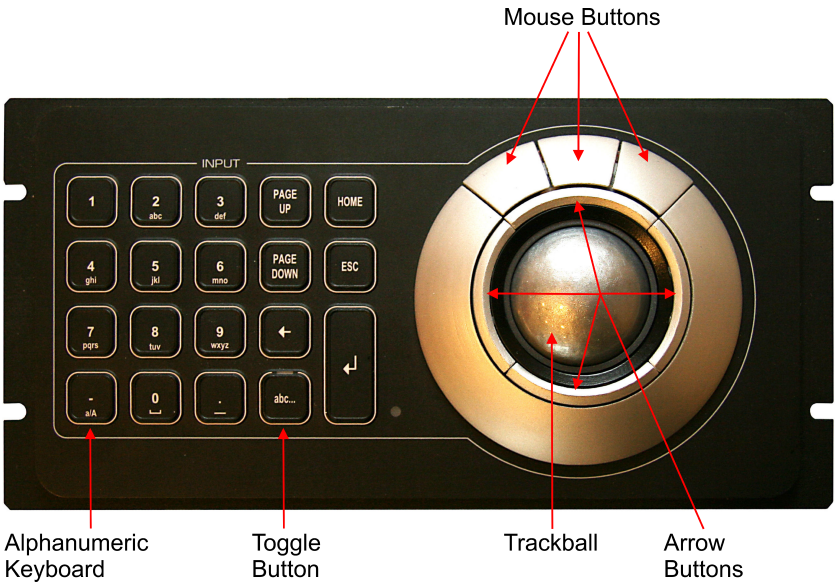
2.3.1 Input Panel (INP)

2.3.1.1 Understanding the INP

The INP is a keyboard which provides easy access to the operator functions.

The following illustration shows the layout of the INP. The buttons and keys on the panel are explained in the following sections.

Figure 14 Input Panel layout



2.3.1.2 Input group buttons and lamp(s)

The input group contains 19 buttons. One of these has a lamp. This is the **abc...** (toggle) button.

The buttons and keys are:

- **2 / abc**

  If you press the button when the panel is in numeric mode, the number 2 is entered. When the panel is in alphanumeric mode the letter A is entered. You should press the button two times to enter the letter B and three times to enter the letter C.

- **abc...** (toggle button)
  - Toggles between numeric and alphanumeric mode
  - The numeric mode is the default
  - You can press the button for one second to toggle the mode
  - A short beep confirms that the mode is changed
  - The lamp is lit green when the panel is in alphanumeric mode (letters) and not lit when in numeric mode (numbers).
- **PAGE UP**
  - Same function as the **PAGE UP** button in a standard keyboard.

You can adjust the brightness of the lamp from the computer.

2.3.1.3 Trackball

The trackball has one trackball and three mouse buttons. The other four buttons are arrow buttons, located around the trackball. Refer to the *Input Panel layout* on page 32.

- Trackball
  - This is used for navigation onscreen
- Mouse buttons
  - The mouse buttons have the same functions as an ordinary three-button mouse
- Arrow buttons
  - Use the arrow buttons to move the cursor up, down, left or right.

2.3.1.4 Backlight

A yellow backlight is built into the panel. You can adjust the brightness of the lamp from the computer.

2.3.1.5 Temperature sensor

A temperature sensor is provided in the panel, to sense the temperature. If the temperature increases above a specified limit (70 °C), a system alarm is given.

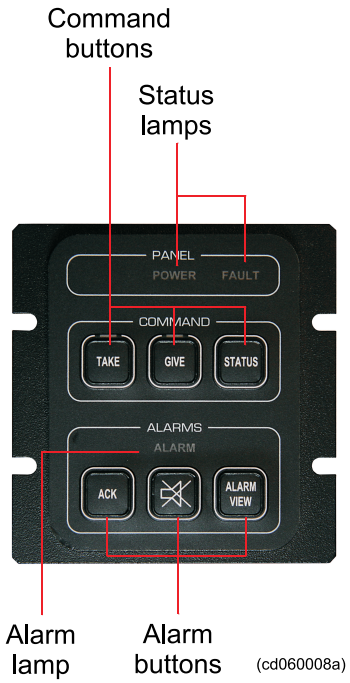
2.3.2 Alarm and Control Panel (ALC)

2.3.2.1 Understanding the ALC

The ALC is a specially designed keyboard which provides easy access to the operator functions.

The following illustration shows the layout of the ALC. The lamps and buttons in the panel are explained in the following sections.

Figure 15 Alarm & Control Panel (ALC) layout



2.3.2.2 Panel group lamps

The panel group contains two lamps.

- **POWER**
  - The lamp is lit green when power is OK
- **FAULT**
  - The lamp is lit red when the connection to the computer is lost, otherwise it is not lit.

2.3.2.3 Command group buttons and lamps

The command group contains two buttons with lamps and one button without a lamp.

- **TAKE**
  - Press this button quickly twice to take operator control, the lamp is then lit green
- **GIVE**

  - Press this button to give control to another operator station, the lamp is then lit green

- **STATUS**
  - When you press this button, the control status is shown in the operator station screen.

2.3.2.4 Alarm group buttons and lamps

The alarm group contains one lamp, and three buttons without lamps.

- **ALARM**
  - The lamp flashes red when an alarm occurs
  - The lamp is continuously lit when the ACK button is pressed, and the alarm is still active
- **ACK**
  - Press this button to acknowledge an alarm.

- **SILENCE**

  Press this button to silence the buzzer.

- **ALARM VIEW**

  Press this button to view the active alarms in the operator station screen.

2.3.2.5 Backlight

A yellow backlight is integrated in the panel. The brightness can be adjusted from the computer.

2.3.2.6 Buzzer

The buzzer sounds an alarm at the following incidents. Refer also to the Figure 13 on page 32.

- Alarm created by the system
- Loss of communication between the OS computer (MPxxxx) and the OS operator panel
- Loss of power to the OS operator panel (sound duration limited by HW)

The buzzer will be silenced at loss of power, or can be silenced by pressing button on local panel or by executing a system command (manually or automatically).

2.3.2.7 Temperature sensor

A temperature sensor in the alarm panel senses the temperature. If the temperature increases more than a specified limit (70 °C), a system alarm is given.

2.3.3 Automation Panel (BU-AUT)

2.3.3.1 Understanding the BU-AUT

The BU-AUT is a specially designed keyboard which enables easy access to the operator functions.

The following illustration shows the layout of the BU-AUT. The buttons in the panel are explained below.

Figure 16 Automation panel layout

2.3.3.2 Views group buttons and lamps

The views group contains 28 buttons and lamps. You can assign functions to these buttons and lamps.

When you press a button, a signal is sent to the computer to activate, or enable the function that is assigned with the button. Buttons that are not configured do not report anything when pressed.

If an alarm occurs, the associated lamp is lit.

2.3.3.3 Backlight

A yellow backlight is integrated in the panel. The brightness can be adjusted from the computer.

2.3.3.4 Temperature sensor

A temperature sensor in the alarm panel senses the temperature. If the temperature increases more than a specified limit (70 °C), a system alarm is given.

3 Basic Monitoring and Control

Standard software modules do the basic monitoring and control. These are used universally by the various applications in K-Chief 700.

The basic function modules are:

- Operation menu buttons
- Analogue measurement modules
- Digital measurement modules
- Pulse measurement modules
- Motor/Pump control modules
- Valve control modules
- PID controller modules
- Sequence control modules.

3.1 Image construction

All process and flow sheet images are made from a set of standard function modules. You can Refer to the symbols associated with these function modules onscreen, such as measurements, valves, and motors.

Descriptions of the standard function modules are given in this section. The descriptions give details of the behaviour of the function modules, and the commands that can be given. Although the symbols on the screen can look the same, it is the internal parameter values of the function module's that determine their behaviour.

The different function modules often behave in very similar ways, because of the nature of the standard functions. For example, most valves will open and close. The real differences are where a function module has logic interlocks implemented, that override its normal functions under certain conditions. A typical example is that a pump motor start is inhibited when its output flow control valve is closed.

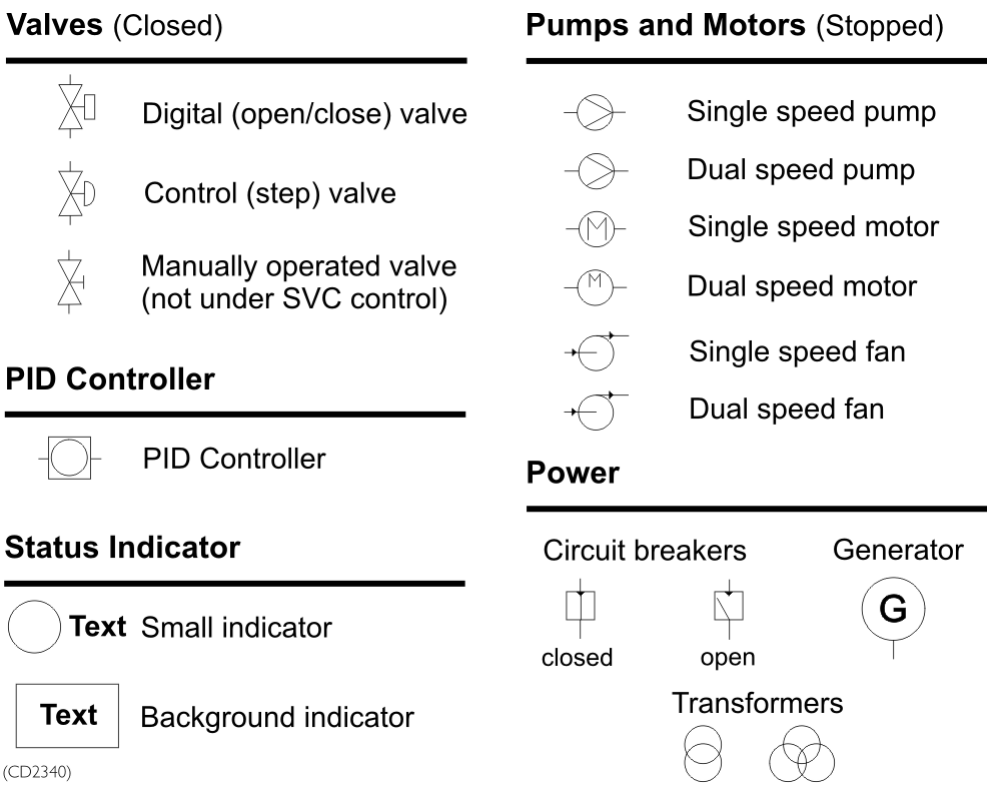
You do not set parameter values for function modules when you use the K-Chief 700 system. The configuration of your system is described in the vessel's K-Chief 700 functional design specification.

3.1.1 Function module symbols

The function module symbols show the operational mode and condition, using tag mark characters and changes in colour and appearance.

Some of the most common function module symbols used in K-Chief 700 are shown in the following figure.

Figure 17 Common function module symbols



3.1.1.1 Operation menu

Press the left trackball button when the cursor is over a function module symbol to open the operation menu, if it has one. The layout of this menu is similar to that shown in the following figure.

Figure 18 Module operation menu

The tag name of the equipment is shown in the title bar of the module operation menu.

Note

The operation menu may vary, depending on the software version of the function module.

The module operation menu is used to operate function modules, and the equipment they represent, from an image. The commands in the menu give the operations that can be done.

The **Acknowledge** button is enabled when alarms are active for the function module, that are not acknowledged. Click this button to acknowledge all active alarms for the module.

Click the **Pin** button to anchor the operation menu to a fixed location on the screen. Click it again to move the operator menu elsewhere.

The **Arrowhead right** and **Arrowhead down** are used to expand the operation menu in the horizontal and vertical direction respectively. Not all operation menus can be expanded.

Figure 19 Module operation menu horizontally expanded

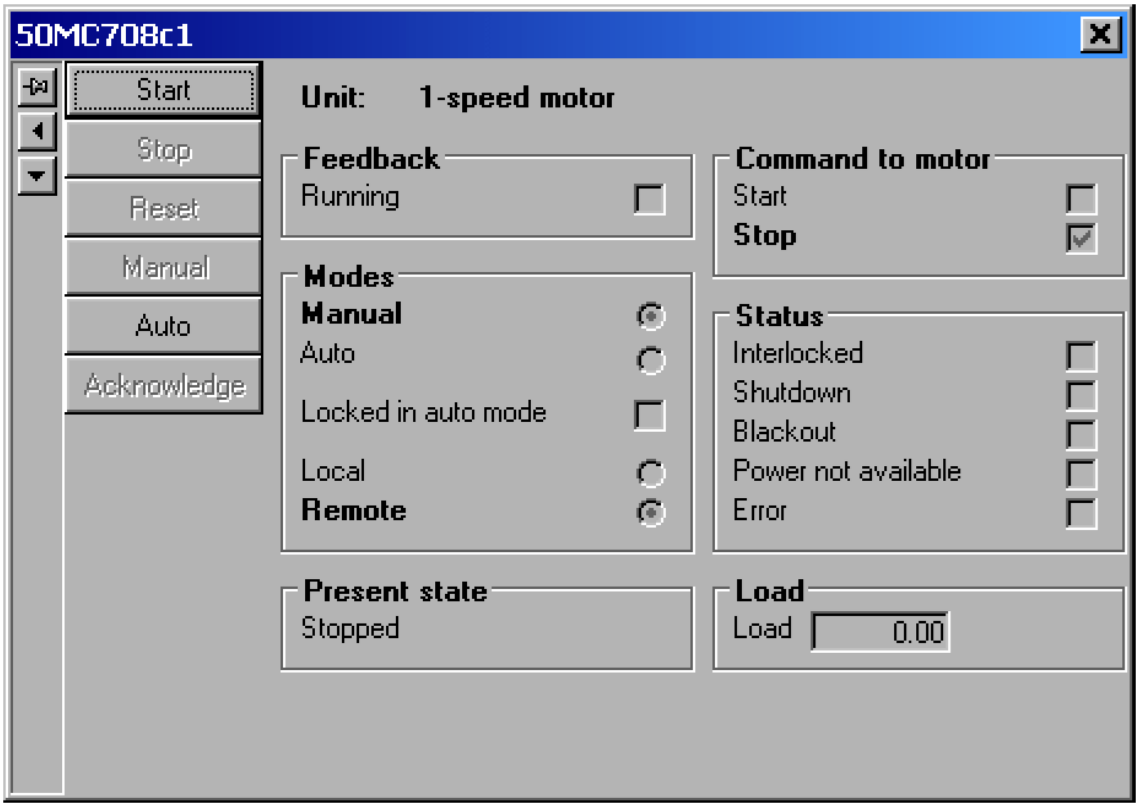
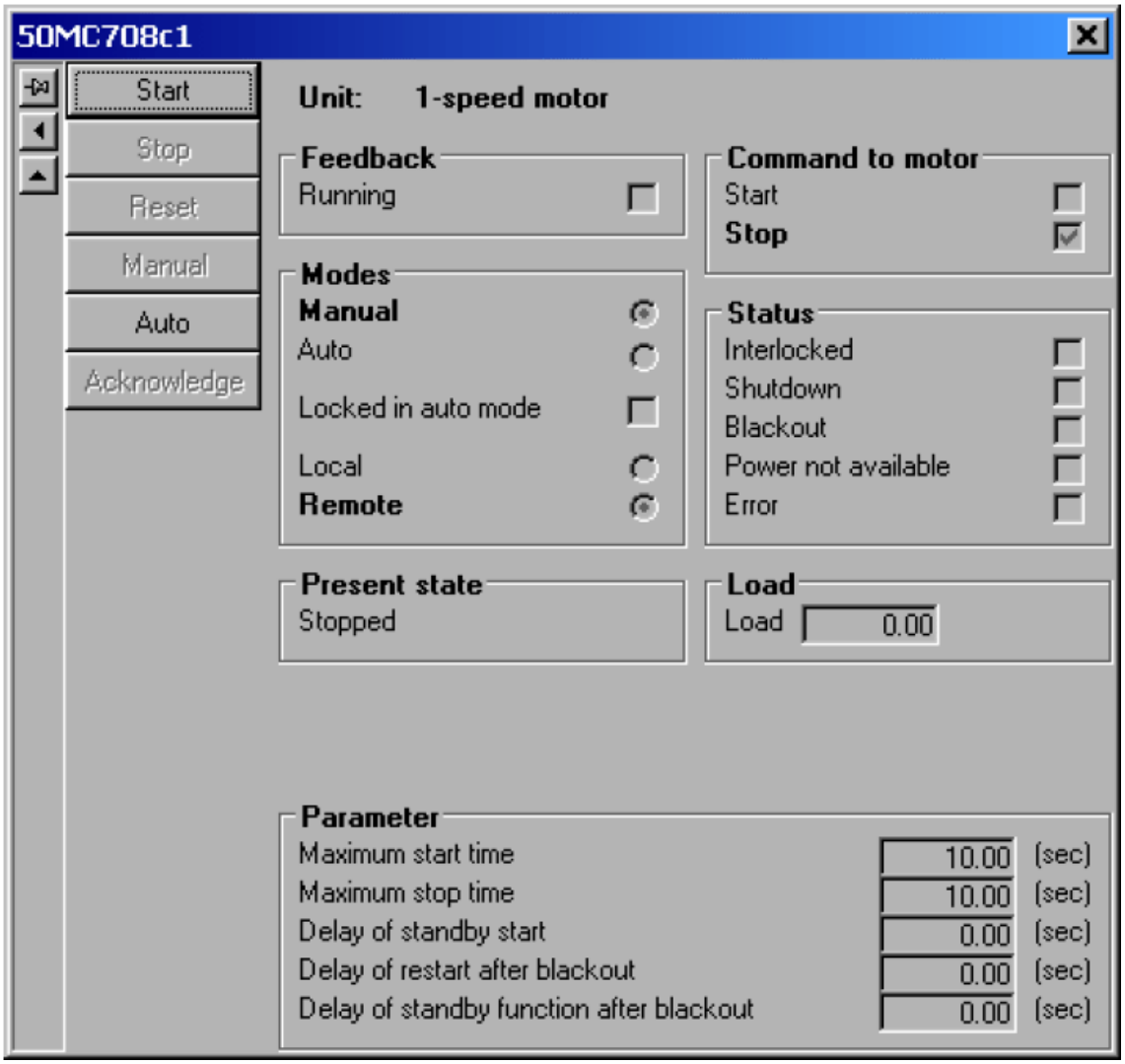


Figure 20 Module operation menu horizontally and vertically expanded



If a command cannot be used because of the current operational status of the equipment, the command button in the module operation menu is disabled. For example, if a motor is automatically controlled, i.e. in the Auto mode, the stop and start commands are not available. The **STOP** and **START** buttons are disabled, as shown in the following figure.

Figure 21 Module operation menu with unavailable commands disabled

If you select the manual mode, by clicking the **MANUAL** button, the **STOP** and **START** buttons are enabled.

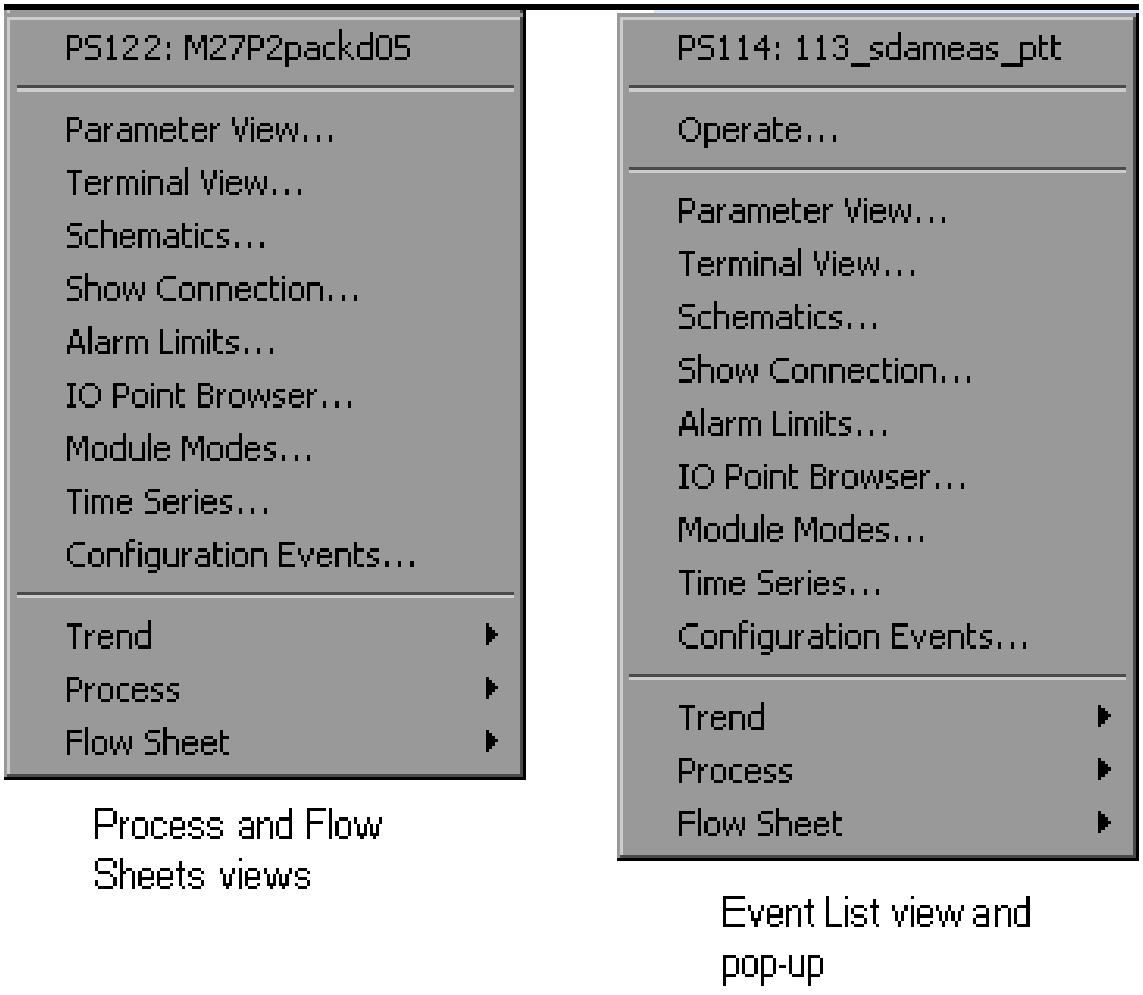
3.1.1.2 Shortcut menu

Press the right trackball button when a function module is selected, to open the shortcut menu. This menu lets you access the settings for the function module, and any other images in which the function module is configured.

The `Module` command in the popup shortcut menu of an event list view or popup page, can give a slightly different version of the module shortcut menu when it is generated by a process variable.

Examples of the two versions of the module shortcut menus are shown in the following figures.

Figure 22 Module shortcut menus



The commands available in these menus are given in the table below:

Command	Description	Comments
`Operate`	Shows the operation menu for the selected function module.	Refer to the section *Operation menu* on page 39. This command is only available in the event list view and event list popup.
`Parameter View`	Allows you to view and change the configuration parameters of the selected function module.	Refer to the *Module Editor* topic in the online AIM user guide.

Command	Description	Comments
`Terminal View`	Allows you to view and change the signal values for the terminals of the selected function module.	Refer to the *Flow system* topic in the online AIM user guide.
`Schematics....`	Allows you to view function modules and the connections between them	Also refer to the `Show Connections` command below. Refer to the *Schematics* chapter in the online AIM user guide.
`Show Connection`	Allows you to view and trace the connections to and from the function module input and output terminals	Refer to the *Show connections* topic in the online AIM user guide
`Alarm Limits`	Allows you to view and change the alarm limits for the terminals of the selected function module.	You can change alarm limits only if you are logged in as an authorised user. Refer to the *Alarm Limits* topic in the online AIM user guide.
`IO Point Browser`	Allows you to gather and display information on any IO point related to the browse criteria entered on the selected station	Refer to the *IO system* topic in the online AIM user guide.
`Module Modes`	Allows you to view and change the operational mode of the function module.	You can change the operational mode only if you are logged in as an authorised user. Refer to the *Module Editor* topic in the online AIM user guide.
`Time Series`	Allows you to display, create, delete and edit time series from a function module terminal, or log-variable of a function module running in a FS.	Refer to the *Time series* topic in the online AIM user guide.
`Configuration Events`	Allows you to view events generated by changes to the configuration of the selected function module.	Refer to the *Event system* and *Version control* topics in the online AIM user guide.

Command	Description	Comments
`Trend`	Displays, if available, a submenu containing the names of the trend images that link to the selected function module is.	Refer to the *Trend system* topic in the online AIM user guide)
`Process`	Displays, if available, a submenu containing the names of the other process images that link to the selected function module.	
`Flow Sheet`	Displays the flow sheet image linked to the selected function module.	Refer to the *Flow system* topic in the online AIM user guide.

Different commands that are enabled in the menu, depending on the selected function module, and your user group.

If you login as a member of the *Users* group, the `Alarm Limits` and `Module Status` commands are unavailable.

3.1.1.3 Mode indication

The K-Chief 700 process control has parts called function modules, that can be operated in various modes. These parts are called function mdules, at the A tag mark character next to the symbol of the function module shows the mode. The characters used, and their colours, are given in the table below.

Tag Mark Character	Tag Mark Colour	Mode
m	Blank space or white	Manual mode
a	Green	Auto mode
d	Cyan	Disabled
e	Green	External
f	Cyan	Follow or Freeze mode
i	Cyan	Interlocked
l or **L**	Cyan	Local mode
o	Cyan	Override
t	Magenta	Tripped

3.1.1.4 Module status indication

The status of a function module is shown by a small coloured square that is located near, or inside, the module symbol. The various module states are given in the following table.

Table 2 Module status indication

Module State	Indicator State
Unacknowledged alarm	Flashing indicator. The colour changes according to the alarm priority.[1]
Acknowledged alarm	Indicator colour changes according to the alarm priority.[2]
Suppressed alarm	*Cyan* indicator.
Disabled alarm	*Cyan* indicator.[3])
Disabled input	*Cyan* indicator.[4].)
Disabled output	*Cyan* indicator.[5].)
Passive module (not active)	Continuously lit *Brown* indicator.[6].)

3.1.1.5 Process status indication

Changes in the process are shown in the process image by changing the colour of the module symbols. For example, the colour of a motor symbol is white when the motor stops. It flashes green when the motor starts, flashes white when the motor shuts down. The symbol becomes green when the motor runs and is fully operational.

More information about showing the module status using colours are given later in this section and in other sections.

Note

You can specify the process status colours that are used.

3.1.2 Pipes

The lines in images, that represent pipes carrying fluids, can be colour coded.

The standard colour coding is given in the following table.

Table 3 Standard pipe colour code

Pipe Colour	Fluid
Blue	Fresh water or condensate
Brown	Heavy fuel oil or crude oil

1. Refer to the Station Status topic in the online AIM user guide
2. Refer to the Station Status topic in the online AIM user guide
3. Refer to the Module Editor topic in the online AIM user guide
4. Refer to the Module Editor topic in the online AIM user guide
5. Refer to the Module Editor topic in the online AIM user guide
6. Refer to the Module Editor topic in the online AIM user guide

Table 3 Standard pipe colour code (cont'd.)

Pipe Colour	Fluid
Cyan or Light Blue	Compressed air
Green	Sea water, ballast water or bilge water
Red	Steam
White	Chemicals, inert gas or methanol
Yellow	Lubrication oil, hydraulic oil or diesel oil

3.1.3 Process changes

As an option, lines representing electrical lines and pipes can be made to change colour to show a change in the process.

The standard colours used to show process change are listed in the following table:

Table 4 Standard process colour code

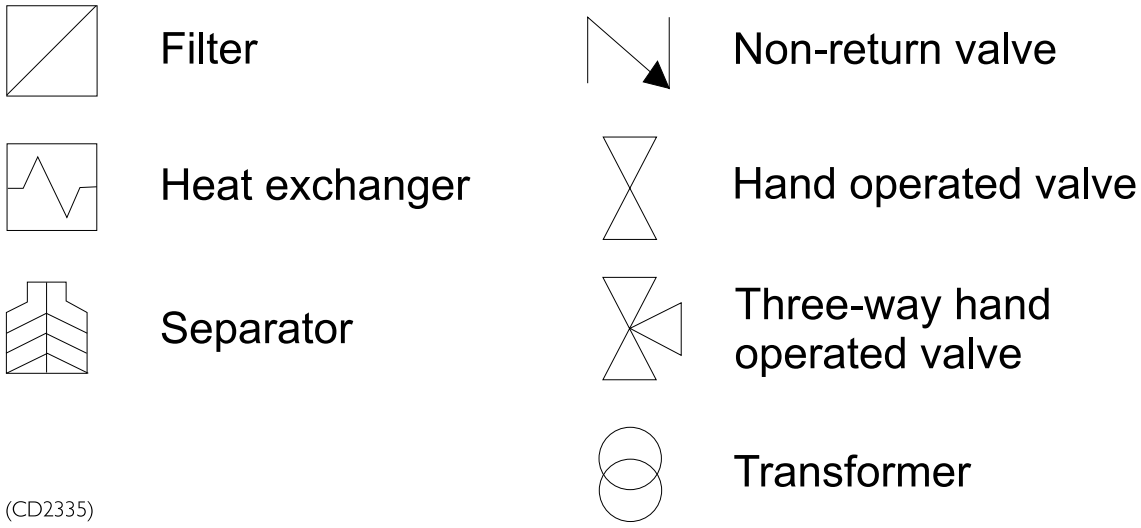
Process	Colour	Status
Power Plant	Light Grey	Bus bar dead
	Green	Bus bar live
Ballast System	Light Grey	No flow in the pipe
	Green	Flow in the pipe
Cargo System	Light Grey	No flow in the pipe
	Brown	Flow in the pipe

3.1.4 Static symbols

You cannot interact with static symbols. They are usually used to represent passive elements in the process such as heat exchangers and filters.

Some common static symbols are shown in the following figure.

Figure 23 Common static symbols



3.1.5 Alarm indicators

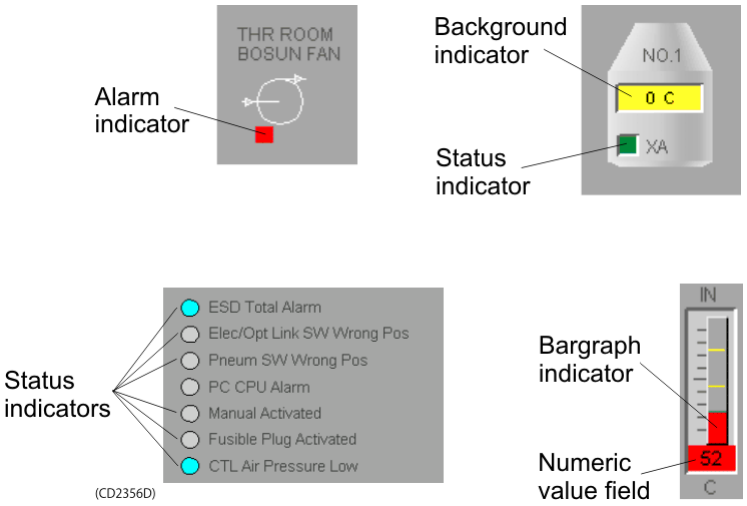
Alarms are shown in the process view as:

- A square alarm indicator next to a symbol.
- The background colour of a numeric or text box.
- A circle status indicator to the left of a label.
- The colour of a bar graph indicator and the background colour of the numeric value box.

Examples of the four types of indicators are shown in the following figure.

If an alarm condition occurs, the colour of the corresponding alarm indicator flashes until the alarm is acknowledged.

Figure 24 Alarm indicators



3.2 Operation menu buttons

There are two types of operation menu buttons:

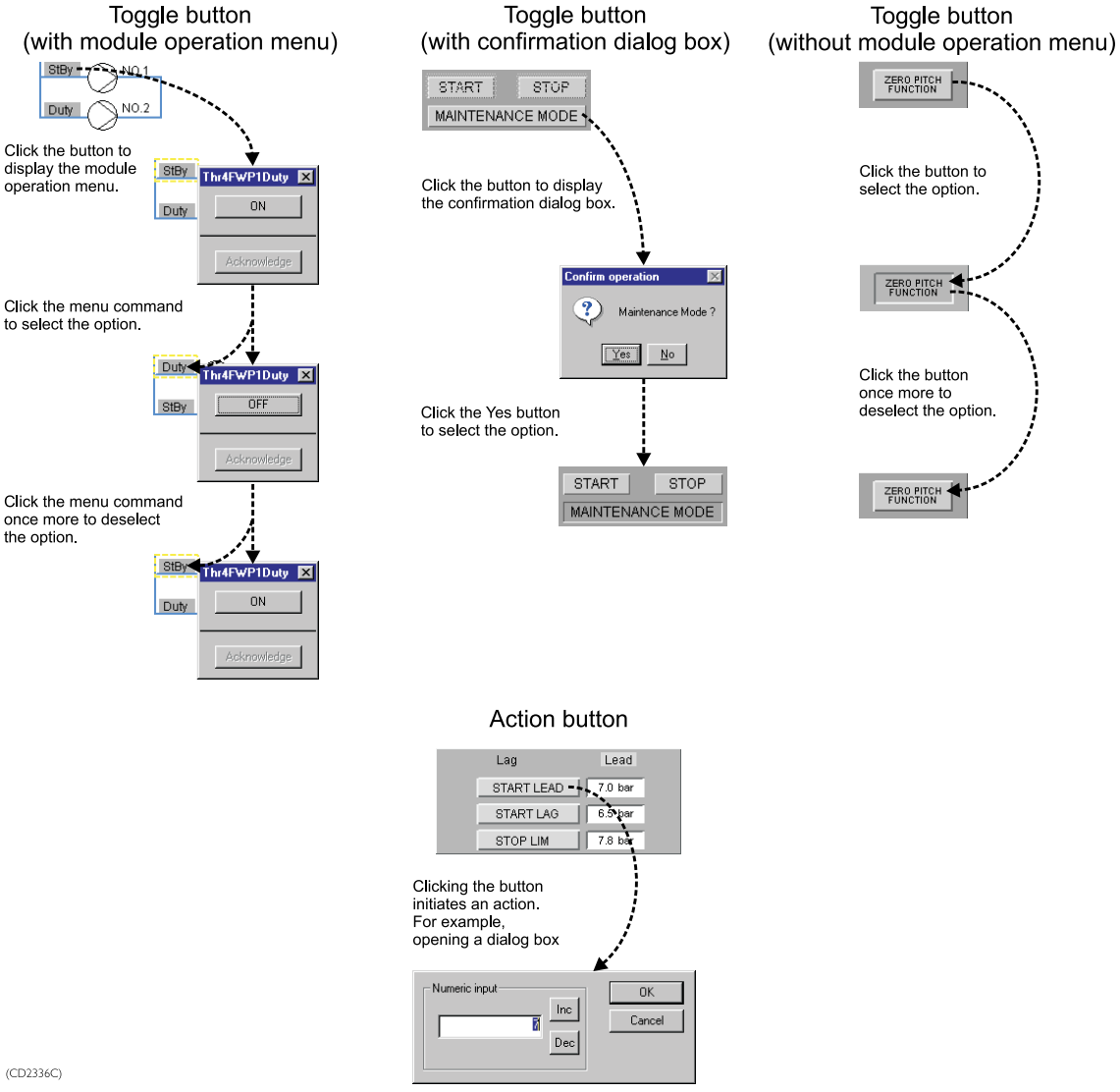
- Toggle button which selects or cancels an option.
- Action button which does an action when you click it.

The toggle button may or may not, depending on the configuration, have an operation menu. Refer to the *Operation of Toggle and Action buttons* on page 50.

The action button does not have an operation menu.

The operation of these buttons is shown in the following figure.

Figure 25 Operation of Toggle and Action buttons



3.3 Analogue measurements

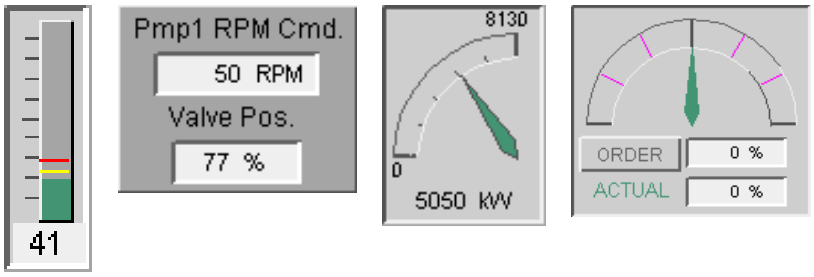
Analogue measurements are often used in the K-Chief 700. They can be shown in ways such as a simple numeric field displaying a single value, or a multiple bar chart showing the deviation from a mean value.

Analog measurement modules are used to display measured analogue process values such as temperatures, pressures, power consumption and setpoints.

3.3.1 Symbols

The following figure shows some ways in which analogue measurements are displayed.

Figure 26 Analogue measurement symbols



3.3.2 Status indication

If the signal limit function is inhibited or alarm suppression is enabled, the numeric value box is *cyan* in colour. This box can also show an alarm status.

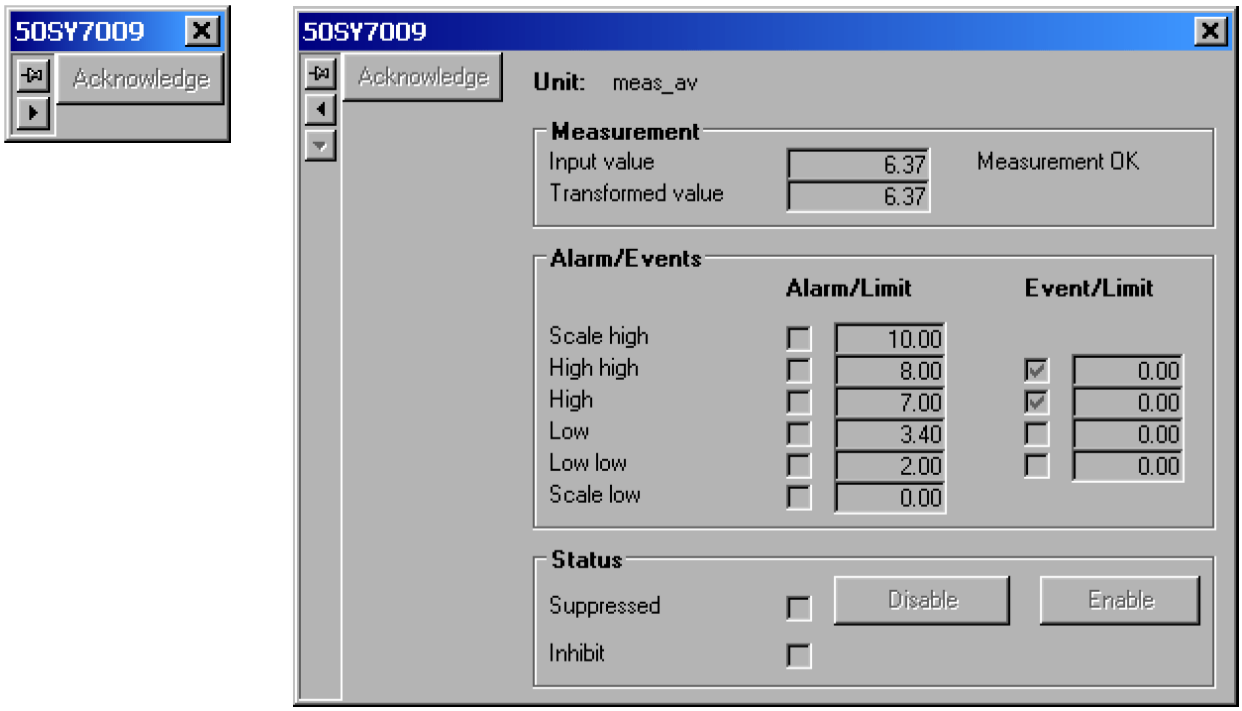
3.3.3 Operation menu

Note

The operation menu varies according to the software version of the function module.

An example of the operation menu of an analogue measurement module is given in the figure below.

Figure 27 Analogue measurements operation menu



Click the command buttons to **Enable** or **Disable** the alarm suppression function. When you disable the alarm suppression, it is automatically enabled again after 10 minutes.

3.3.4 Configuration options

One or more of the following functions can be added the analogue measurement modules.

- Input signal limits
- Alarm suppression
- IO failure
- Event generation.

You can view and change the status of these functions using the commands in the module shortcut menu. Refer to the section *Shortcut menu* on page 43..

3.3.4.1 Input signal limits

Analogue measurement modules have the following limits for the input signals:

- High High
- High
- Low
- Low Low

If these limits are exceeded, digital limit signals are given. The input signal limits can be individually enabled or disabled.

3.3.4.2 Alarm suppression

Analog measurement modules have an alarm suppression function that can be activated and reset by other modules. It is normally used to prevent alarms being given by equipment that is not operational. The reset for this function can be delayed. You can specify the duration of the delay. Refer to the *Event system* and *Alarms and messages* topics in the online AIM user guide.

3.3.4.3 IO failure

When an IO failure is sensed, an error handler controls the value shown in the numeric value field, which is then either:

- Frozen at the last legal input value (default)

  or

- Corrected to a fixed value, which you specify

  or

- The input value, the IO failure status is ignored.

Refer to the *IO system* and *Alarms and messages* topics in the online AIM user guide.

3.3.4.4 Event generation

Analogue measurement modules generate an event whenever the input value increases above the limit, or an IO failure occurs. Refer to the *Event system* topic in the online AIM user guide.

3.4 Exhaust gas monitoring module

The exhaust gas monitoring module is used for internal combustion engines. It is used to show the exhaust gas temperature for each cylinder, and the deviation from the calculated mean temperature.

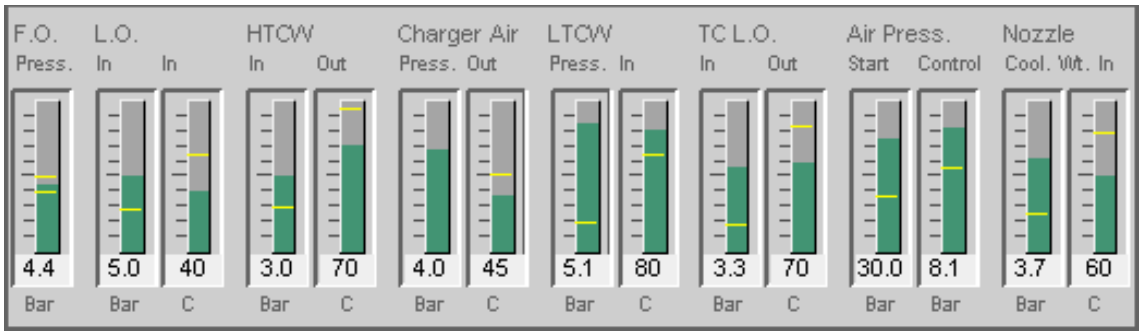
3.4.1 Symbols

Measured analogue values are used to give the exhaust gas temperatures of the cylinders, as shown in the following figure.

Figure 28 Exhaust gas temperatures

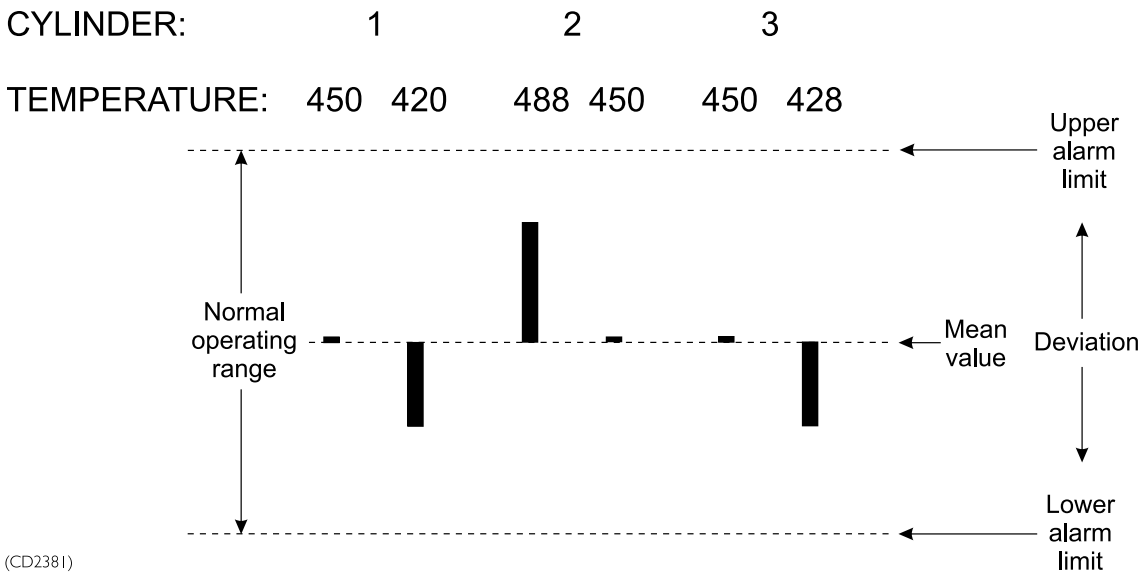
Bar graphs are used to show the deviation from the calculated mean temperature, for every cylinder. Refer to the following figure for an example.

Figure 29 Exhaust gas temperature deviation



The following figure explains how to interpret the bar chart.

Figure 30 Deviation alarm limit indications



3.5 Digital measurement modules

Digital measurement modules are normally used to indicate digital alarms. They can also be used to indicate the status of equipment such as pumps, motors, valves and switches.

3.5.1 Symbols

The following figure gives an example of a digital measurement module.

Figure 31 Digital measurement module symbols

A digital measurement module can also be shown as a symbol that changes colour to give the status. Refer to section *Process status indication* on page 47.

3.5.2 Status indications

When a digital measurement module is inhibited, or alarm suppression is enabled, the colour of the status indicator in the module symbol is *Cyan*.

3.5.3 Operation menu

Note

The operation menu varies according to the software version of the function module.

The commands in the operation menu are shown in the example on the left.

The command buttons let you:

- Test the value and give the digital measurement status to show in the process image. The function module and the field station must be in the simulation mode. Refer to the **Module Editor** topic in the online AIM user guide.
- Toggle the module inhibit function on or off. When the module operation menu is open, the button text shows the condition that can be selected.

3.5.4 Configuration options

One or more of the following functions can be enabled for the digital measurement modules:

- Alarm delay
- Alarm suppression
- Text string
- Module inhibit.

You can view and change the status of these functions using the commands in the module shortcut menu. Refer to the *Shortcut menu* on page 43.

3.5.4.1 Alarm delay

Digital measurement modules have an alarm delay to prevents short-duration signal changes from generating alarms. You can specify the duration of the delay.

3.5.4.2 Alarm suppression

Digital measurement modules have an alarm suppression function that is enabled or disabled by other modules. The reset for this function can be delayed. You can specify the duration of the delay. Refer to the *Event system* and *Alarms and messages* topics in the online AIM user guide.

3.5.4.3 Text string

Digital measurement modules can display one of two text strings. You can specify the text strings. The text string is displayed according to the logical state of the module's output signal.

3.5.4.4 Module inhibit

You can use the `INHIBIT ON/INHIBIT OFF` button in the operation menu to toggle the module inhibit function. The inhibit can also be toggled by other function modules.

3.6 Pulse measurement modules

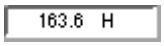
Pulse measurement modules are used to read pulse signals and calculate accumulated values and frequency. These modules are used to read pulse signals for applications such as engine speed or fluid flow. They can also be used to read other analogue measurements and count running hours.

Accumulated values are calculated on raw input, and total accumulated values are calculated from the previous reset. Last day and last hour values are calculated for both the current day and hour, and previous day and hour.

3.6.1 Symbols

The following example shows the display of a pulse measurement module.

Figure 32 Pulse measurement module



3.6.2 Operation menu

Note

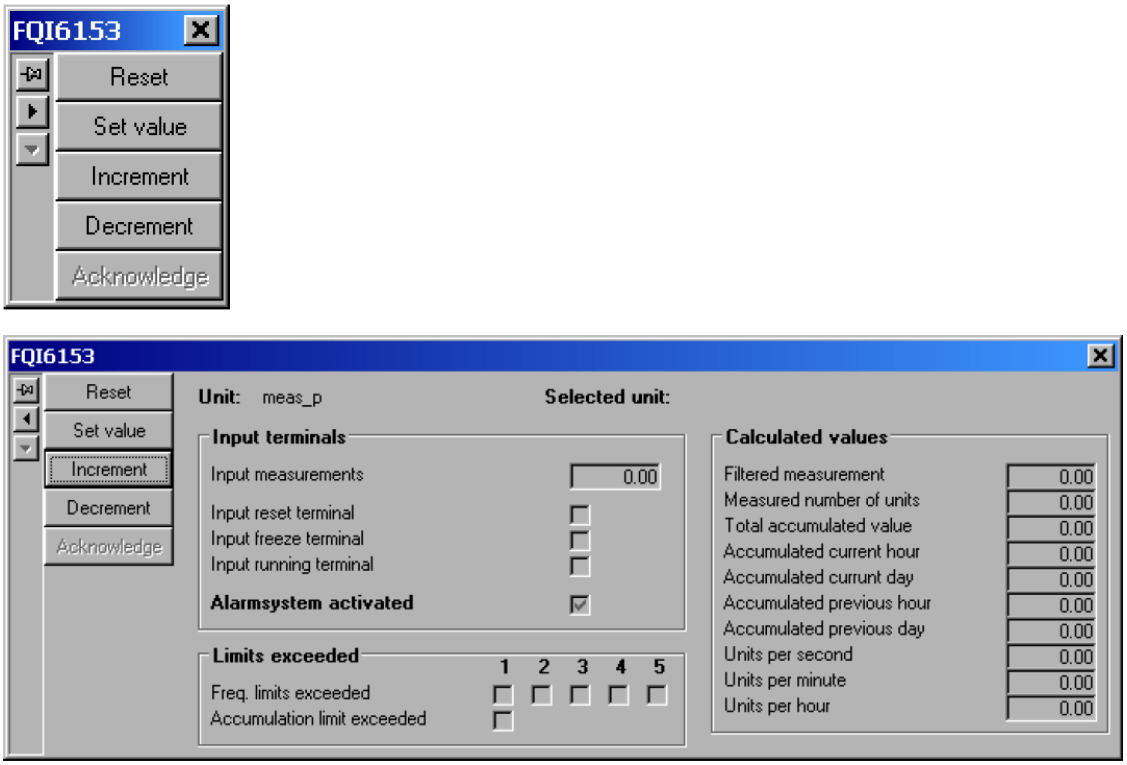
The operation menu varies according to the software version of the function module.

The command buttons allow you to:

- Reset the accumulated value to zero
- Give a value to the function module. The value is given from the numeric input dialog box. The command is only available in the manual mode
- Increase or decrease the total accumulated value by 1.

The commands in the operation menu of a pulse measurement module are shown in the figure below.

Figure 33 Pulse measurements operation menu



3.6.3 Configuration options

One or more of the following functions can be enabled for the pulse measurement modules:

- Pulse counting
- Block operation
- Count running hours.

You can view and change the status of these functions using the commands in the module shortcut menu. Refer to the section *Shortcut menu* on page 43.

3.6.3.1 Pulse counting

Pulse measurement modules read pulse signals from modules such as the RDIOR4xx, for example. The number of pulses for each sample is filtered, and the frequency calculated.

The number of pulses per unit, gain and bias are used to calculate the number of units per sample. The frequency is expressed in the number of units per second, minute and hour, based on a filtered value. The frequency is also compared with five different limits, and if any of these limits are exceeded over a specified period, a corresponding digital output is set to 1.

3.6.3.2 Block operation

The operation menu commands can be blocked. If this option is selected the RESET, INCREMENT and DECREMENT command buttons in the operation menu become unavailable. The SET VALUE command is disabled.

3.6.3.3 Count running hours

Pulse measurement modules count running hours when the input value is set to either 1.0 or 0.0. This depends on whether or not the system is running. The pulse per unit is set to 3600, the gain is set to 1 and the module cycle time is set to 1 second.

3.7 Motor and pump control modules

All the motors and pumps are controlled by function modules. These modules can control single- and dual-speed electrical motors and pumps, and hydraulically-driven pumps. The function modules are interfaced to the local starter panel of their respective motor or pump.

The function modules can do the following basic functions:

- Auto and manual control
- Local or remote control
- Control logic interlocking
- Power demand
- Standby start
- Restart after blackout and shutdown.

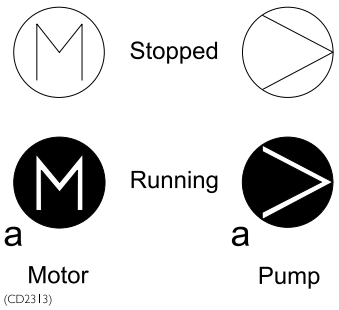
3.7.1 Symbols

A Motor/pump control function module is shown as a symbol and a tag mark character, which gives the current operational mode.

3.7.1.1 Single speed electrical motor/pump

The symbols for single speed electrical motor and pump modules are shown in the following figure:

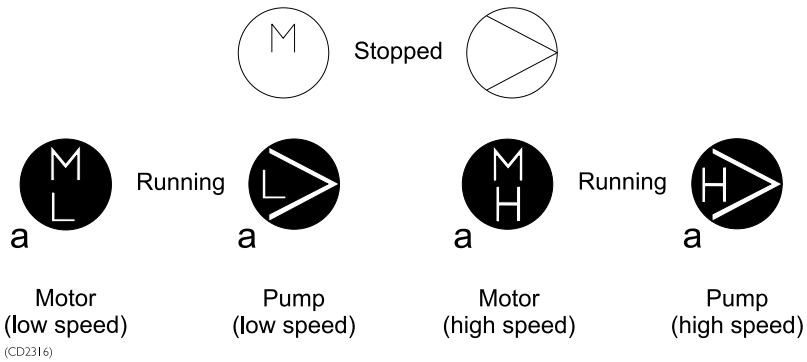
Figure 34 Single speed electrical motor/pump module symbols



3.7.1.2 Dual speed electrical motor/pump

The symbols for dual speed electrical motor and pump modules are shown in the following figure.

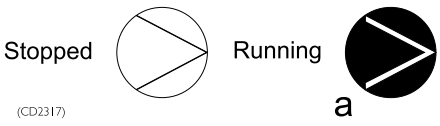
Figure 35 Dual speed electrical motor/pump module symbols



3.7.1.3 Hydraulic-driven pump

The symbols for hydraulic-driven pump modules are shown in the following figure:

Figure 36 Hydraulic-driven pump module symbols



3.7.2 Mode indication

The operational mode of a motor or pump is shown by the tag mark character. It is displayed at the bottom left-hand corner of the function module symbol.

The tag mark characters used for motors/pumps are given in the table below.

Tag mark character	Colour	Meaning
Blank Space		Manual mode
m	White	Manual mode

Tag mark character	Colour	Meaning
a	Green	Automatic mode
i	Cyan	Interlocked
l	Cyan	Local mode
t	Magenta	Pump or Motor Tripped

3.7.3 Status indication

The operational status of a motor or pump is shown by the colour of the function module symbol.

The colours used to show the operational status of a motor or pump are given in the table below.

Colour	Meaning
Green	The motor or pump is running.
White	The motor or pump is stopped.
Flashing green	The motor or pump is starting.
Flashing white	The motor or pump is stopping.

3.7.4 Single speed electrical motor/pump operation menu

Note

The operation menu varies according to the software version of the function module.

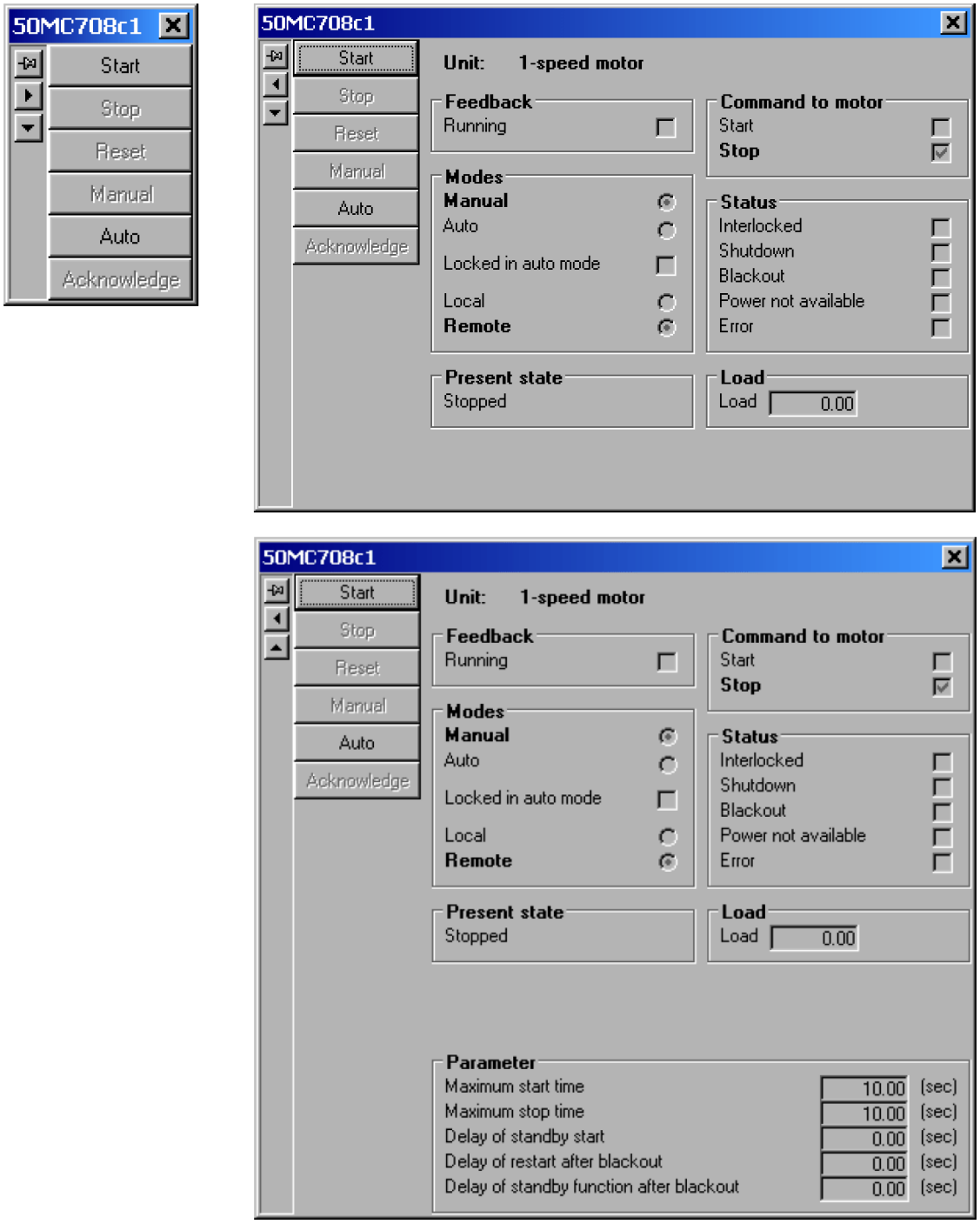
Single speed electrical motor/pump operation menu on page 62 shows the commands in the operation menu.

The command buttons allow you to:

- **Start** a motor or pump.
- **Stop** a motor or pump.

  The two commands given above can also be used to cancel a start or stop operation. These commands are only available in the *Manual* mode.
- **Reset** the applicable timeout counters, to recover from failed start or stop operations.
- Select the ***Automatic*** or ***Manual*** mode for the motor or pump.

Figure 37 Single speed electrical motor/pump operation menu



3.7.5 Dual speed electrical motor/pump operation menu

Note

The operation menu varies according to the software version of the function module.

Dual speed electrical motor/pump operation menu on page 63 shows the command buttons in the operation menu.

The command buttons are given below.

- **Stop**

  Click this button to stop a running motor/pump, or cancel a start operation. The command is only available in the *Manual* mode.

- **Start_LS**

  Lets you start a pump or motor in low speed.

- **Start_HS**

  Lets you start a pump or motor in high speed.

  If the motor or pump is already running, you can use the commands to change the speed. For example, you can click the **Start_LS** button to slow down a motor running at high speed. These commands are only available in the manual mode.

- **Reset**

  Click this button to reset the applicable timeout counters, to recover from failed start or stop operations.

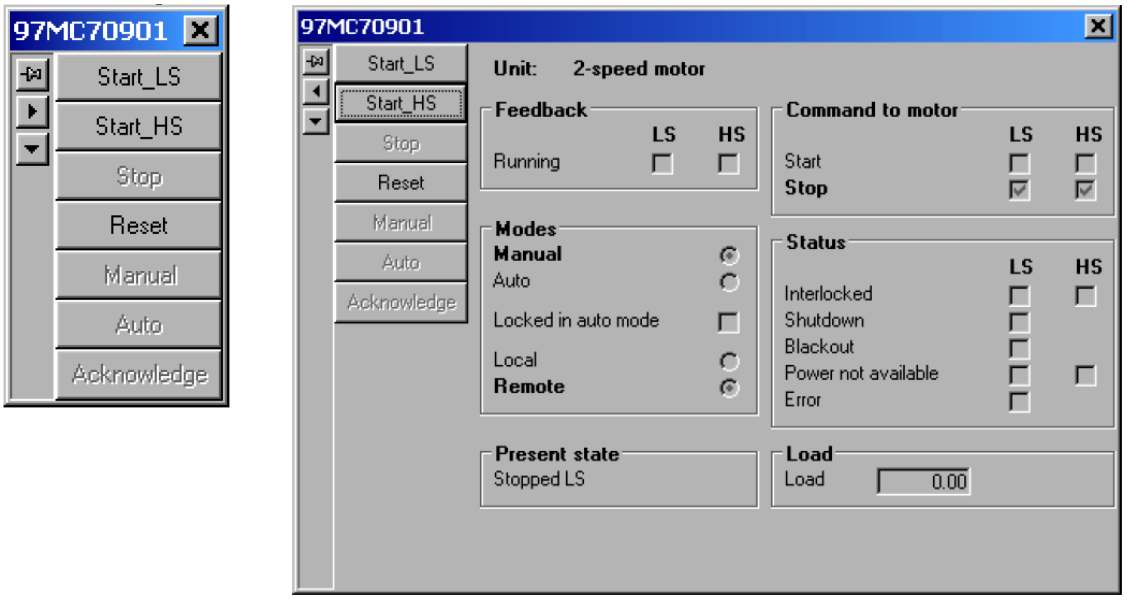
- **Automatic**

  Click this button to select the automatic mode for the motor/pump.

- **Manual**

  Click this button to select the manual mode for the motor/pump.

Figure 38 Dual speed electrical motor/pump operation menu



3.7.6 Hydraulically-driven pump operation menu

Note

The speed of a hydraulically-driven pump is controlled using a regulator valve to adjust the hydraulic pressure.

Note

The operation menu varies according to the software version of the function module.

The commands in the operation menu for a hydraulically-driven pump are shown in *Hydraulic-driven pump operation menu* on page 65.

The following command buttons are available:

- **Setpoint**

  Click this button to decrease or increase the setpoint (control signal), for the valve that regulates the hydraulic pressure to the motor. The setpoint can range from 0% to 100%. This causes the valve to fully close or fully open, decreasing or increasing the hydraulic pressure, to stop or run the pump. The setpoint can also specify the operating speed of the pump. These commands have no effect on a stopped hydraulic pump. They are only available in the Manual mode.

- **Reset**

  Click this button to reset the applicable timeout counters, after a failed start or stop operation.

- **Freeze**

  Click this button to lock the setpoint at its present value. The command is only available in the Manual mode. applicable timeout counters.

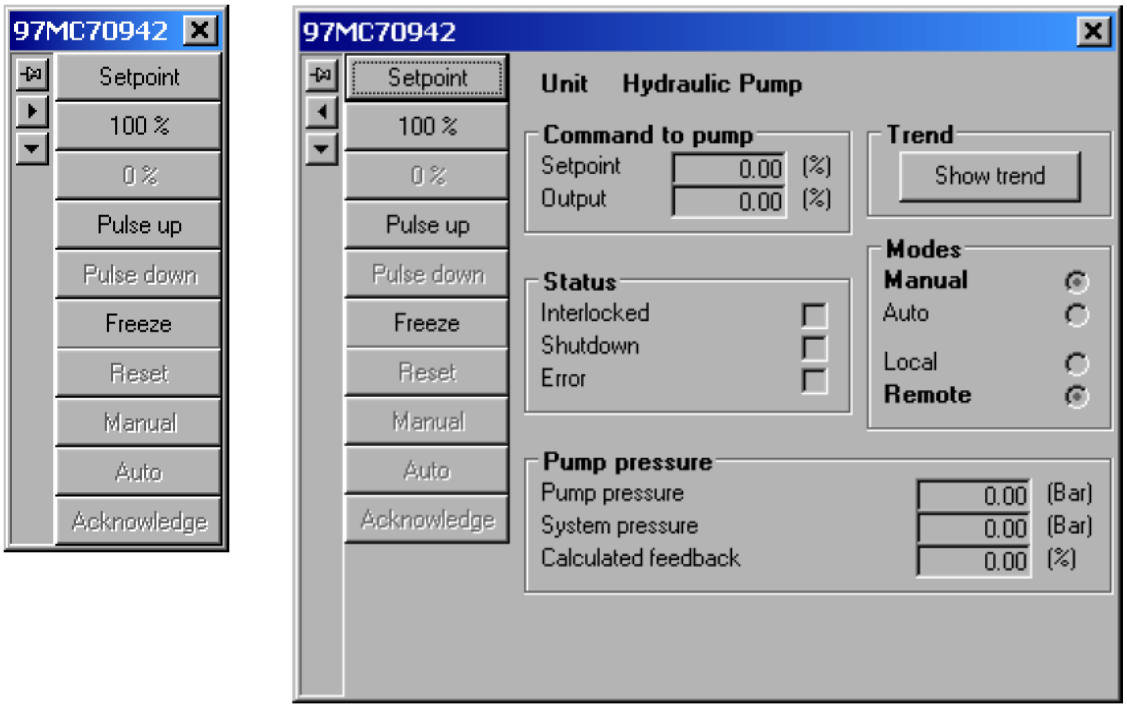
- **Auto**

  Click this button to select the automatic operation mode.

- **Manual**

  Click this button to select the manual operation mode.

Figure 39 Hydraulic-driven pump operation menu



3.7.7 Configuration options

One or more of the following functions can be enabled for the hydraulically-driven motor or pump control modules:

- Local/Remote mode
- Control logic interlocks
- Power demand
- Standby start
- Blackout restart
- Shutdown.

You can view and change the status of these functions using the module shortcut menu. Refer to the section *Shortcut menu* on page 43.

3.7.7.1 Local/Remote mode

All motor/pump control modules can be put in *Local* or *Remote* mode. In the *Local* mode, you control the motor or pump from the local panel. In the *Remote* mode, it is controlled by K-Chief 700. You can change between local and remote control from the local panel.

3.7.7.2 Control logic interlocks

All motor/pump control modules have interlocks to prevent damage to the motor/pump.

The interlock functions are:

- Inhibit the **Stop** command when the interlock condition occurs
- Inhibit the **Start** command when the interlock condition occurs
- Execute the **Stop** command when the interlock condition occurs
- Execute the **Start** command when the interlock condition occurs.

For hydraulic pumps, the interlock functions are:

- Inhibit all commands when the interlock condition occurs.

3.7.7.3 Power demand

Both types of electrical motor/pump control module have a power interlock function. This prevents the motor/pump from starting if there is insufficient power available. This function is only used for major consumers.

3.7.7.4 Standby start

Both types of electrical motor/pump control module have a standby start function. This lets up specify a duty/standby sequence with up to a maximum of three electrical motors/pumps.

A standby motor/pump can be started as follows:

- In the *Manual* mode. It will continue to run when put into the *Automatic* mode.
- Automatically, if another pump in the sequence stops due to a failure.
- Automatically, if a specific condition occurs. For example, a pressure switch can be used to start up additional pumps if the lubrication oil pressure for a generator is low.

3.7.7.5 Blackout restart

Both types of electrical motor control module have a blackout restart function. This automatically restarts a motor that stopped because of a blackout, when power becomes available. You can specify a delay for the motors that start, to prevent many motors starting simultaneously.

3.7.7.6 Shutdown

All motor/pump control modules have a shutdown function. It overrides all other control inputs and does an emergency stop.

3.7.8 Duty/Standby configuration

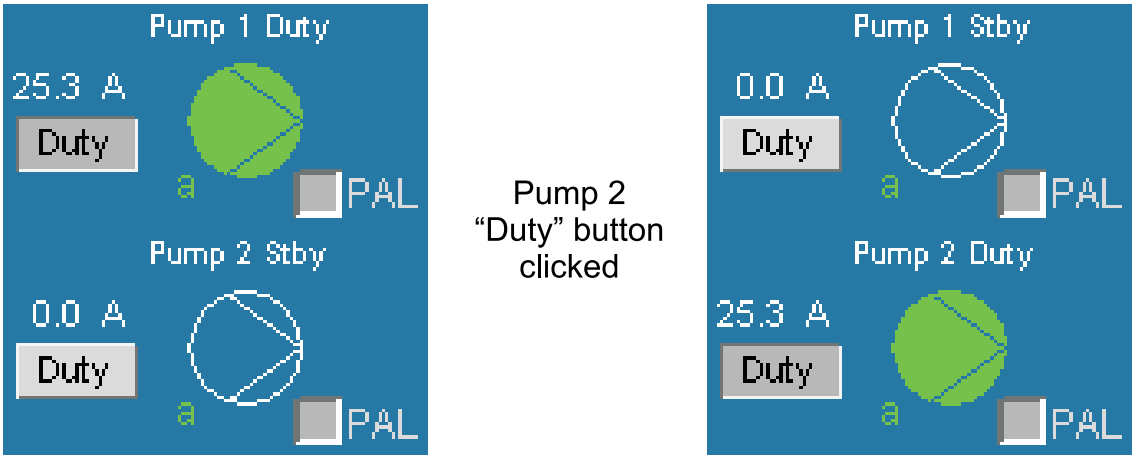
Motor/pump control modules can be connected in either of two duty/standby configurations.

One configuration uses the *Standby start* function. Refer to the section *Standby start* on page 66. The duty motor/pump and the standby motor/pump are in the *Automatic* mode. The standby motor/pump automatically starts when additional capacity is necessary. This happens, for example, when the discharge pressure of a duty pump decreases below a set limit.

You can also operate the motors/pumps in the *Automatic* mode. You can select the duty/standby mode by clicking the toggle buttons.

The following figure shows two single speed pumps in a duty/standby configuration.

Figure 40 Two single speed electrical pumps in a redundant configuration



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3.8 Valve control modules

Valve control modules are used to control valves. The basic module functions are:

- Auto/manual control
- Local/remote control
- Control logic interlocking
- Shutdown.

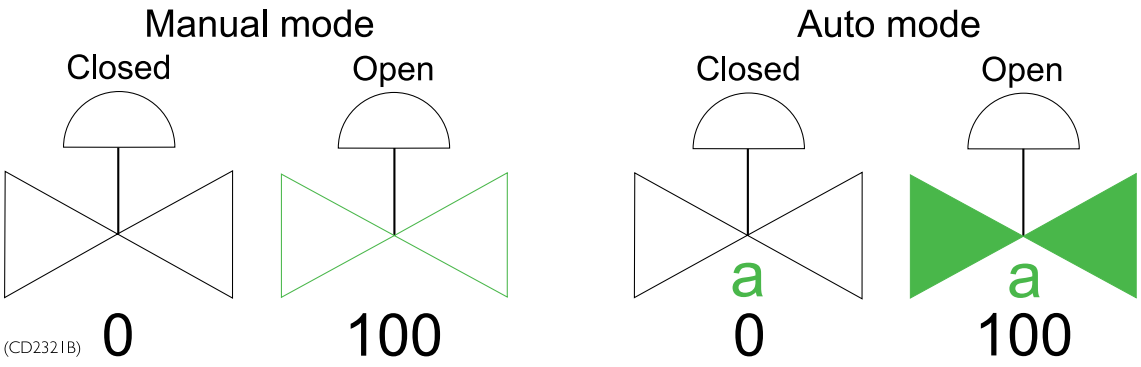
3.8.1 Symbols

The valve control module is represented by the valve symbol. A tag mark character shows the operational mode. A number below the tag mark either gives the position of the valve, or the setpoint of the valve as a percentage.

3.8.1.1 Control and Throttle Valves

The symbols for control and throttle valve modules are shown in the following figure.

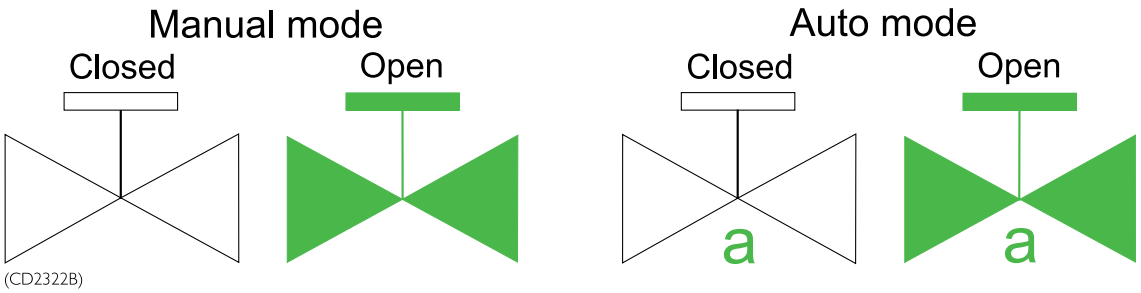
Figure 41 Control and throttle valve module symbols



3.8.1.2 Digital valve

The symbols for digital valve modules are shown in the following figure.

Figure 42 Digital Valve module symbols



3.8.2 Mode indication

The tag mark characters used for valves are given in the table below.

Tag mark character	Colour	Mode
Blank space		Manual
m	White	Manual
a	Green	Automatic
i	Cyan	Interlocked
l	Cyan	Local
t	Magenta	Tripped

3.8.3 Status indication

The operational status of a valve is shown by the colour of the symbol. The colours are given in the table below.

Colour	Meaning
Green	The valve is open.
Flashing green	The valve is opening.
Flashing white	The valve is closing.
White	The valve is closed.

3.8.4 Control valve operation menu

Note

The operation menu varies according to the software version of the function module.

A pneumatically operated valve is a type of control valve.

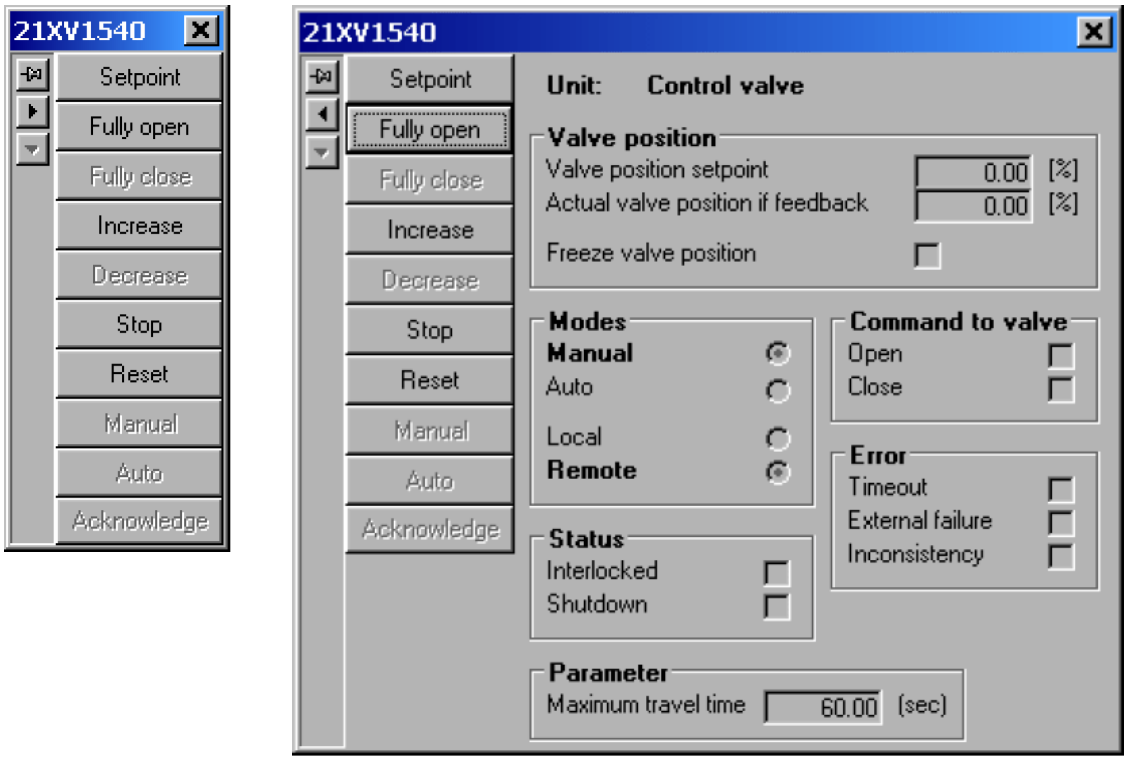
An example of the commands in the operation menu of a control module for the control valve is shown in *Control valve operation menu* on page 70.

The command buttons are given in the following table.

Command button	Function	Description
Setpoint	Lets you give the setpoint position for the valve.	You give the setpoint from the **Numeric input** dialog box. The command is only available in the *Manual* mode.
Fully Open	Fully opens the valve.	This command can be used to cancel a close operation. It is only available in the *Manual* mode.
Fully Close	Fully closes the valve.	
Increase	Increase the setpoint by a predefined value, when the valve is in the *Automatic* mode.	When the Control valve is in the *Manual* mode, this commands increases the output value <of what?>.
Decrease	Decrease the setpoint by a predefined value, when the valve is in the *Automatic* mode.	When the Control valve is in the *Manual* mode, this commands decreases the output value <of what?>.
Stop	Immediately stops the operation of the valve.	The command is only available in the *Manual* mode.
Reset	Reset the applicable timeout counters.	Use this button to reset the timeout counter after a failed start or stop <there is only a maximum travel time counter for a valve?>.

Command button	Function	Description
Manual	Place the valve under manual control.	
Auto	Place the valve under automatic control.	
Acknowledge	Click this button to acknowledge alarms for the valve.	

Figure 43 Control valve operation menu



3.8.5 Throttle valve operation menu

A hydraulically operated multi-position valve is an example of a throttle valve. The throttle valve gives information about its position, and moves steplessly between the open and closed position.

Note

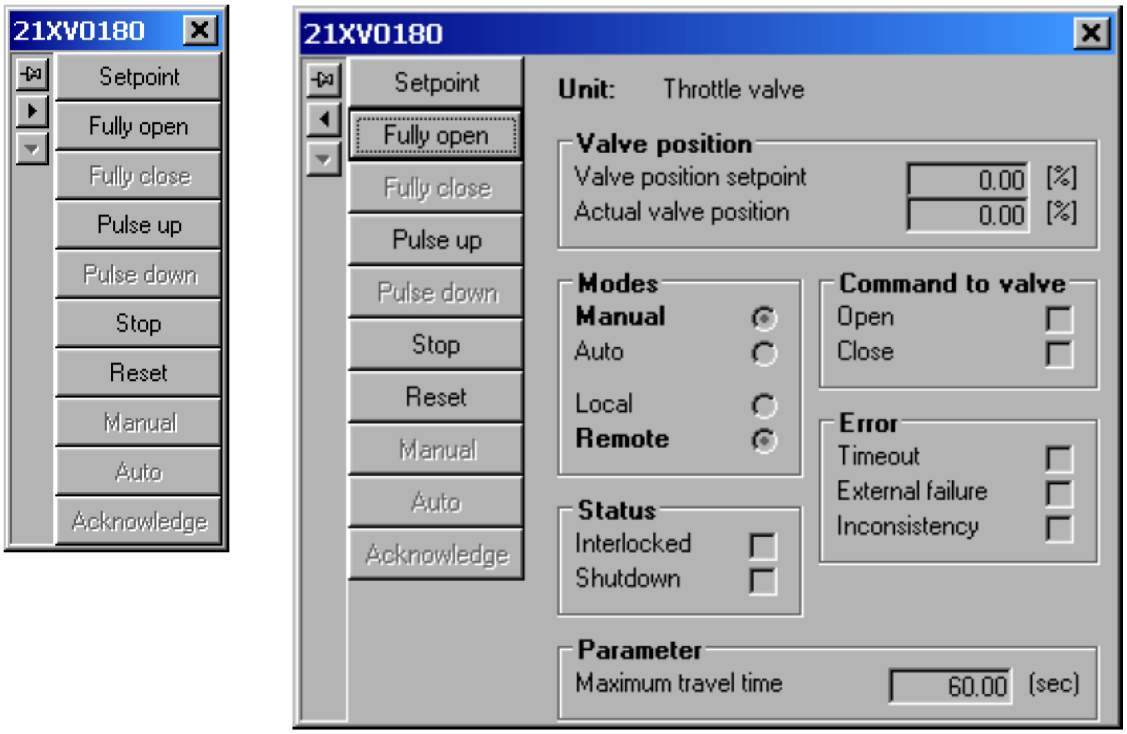
The operation menu varies according to the software version of the function module.

The command buttons in the throttle valve operation menu are shown in *Throttle valve operation menu* on page 72.

The command buttons are given in the following table.

Command button	Function	Description
Setpoint	Lets you give the setpoint position for the valve.	You give the setpoint from the **Numeric input** dialog box. The command is only available in the *Manual* mode.
Fully Open	Fully opens the valve.	This command can be used to cancel a close operation. It is only available in the *Manual* mode.
Fully Close	Fully closes the valve.	This command can be used to cancel an open operation. It is only available in the *Manual* mode.
Increase	Increase the pulse length by a predefined value, when the valve is in the *Manual* mode.	When the Control valve is in the *Manual* mode, this commands increases the output value <of what?>.
Decrease	Decrease pulse length by a predefined value, when the valve is in the *Manual* mode.	When the Control valve is in the *Manual* mode, this commands decreases the output value <of what?>.
Stop	Immediately stops the operation of the valve. The valve remains in the same position.	The command is only available in the *Manual* mode.
Reset	Reset the applicable timeout counters.	Use this button to reset the timeout counter after a failed start or stop <there is only a maximum travel time counter for a valve?>.
Manual	Place the valve under manual control.	
Auto	Place the valve under automatic control.	
Acknowledge	Click this button to acknowledge alarms for the valve.	

Figure 44 Throttle valve operation menu



3.8.6 Digital valve operation menu

Note

The operation menu varies according to the software version of the function module.

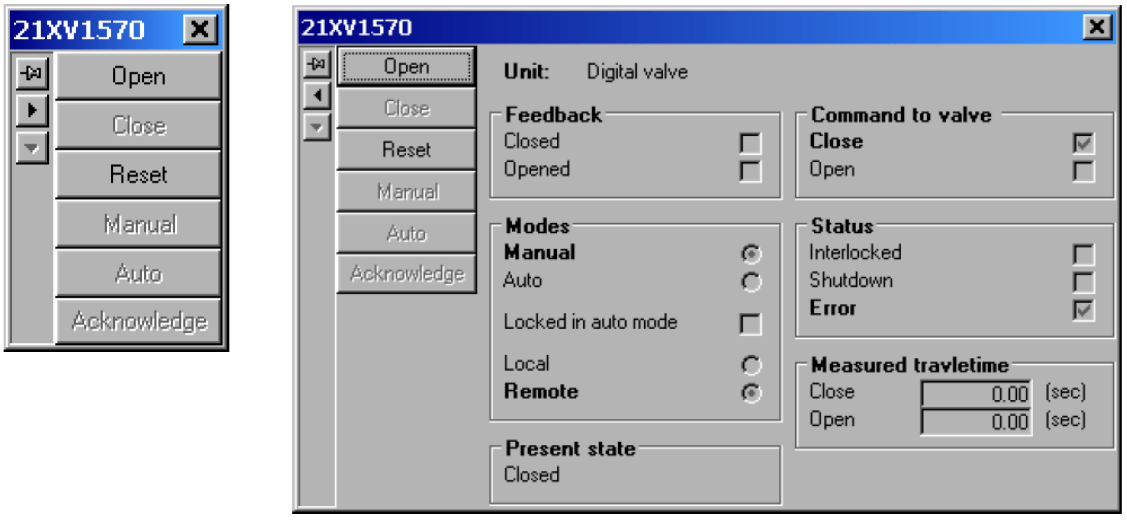
The commands in the operation menu are shown in *Digital valve operation menu* on page 73.

The command buttons are given in the following table.

Command button	Function	Description
Setpoint	Lets you give the setpoint position for the valve.	You give the setpoint from the **Numeric input** dialog box. The command is only available in the *Manual* mode.
Fully Open	Fully opens the valve.	This command can be used to cancel a close operation. It is only available in the *Manual* mode.

Command button	Function	Description
Fully Close	Fully closes the valve.	This command can be used to cancel an open operation. It is only available in the *Manual* mode.
Increase	Increase the pulse length by a predefined value, when the valve is in the *Manual* mode.	When the Control valve is in the *Manual* mode, this commands increases the output value.
Decrease	Decrease pulse length by a predefined value, when the valve is in the *Manual* mode.	When the Control valve is in the *Manual* mode, this commands decreases the output value.
Stop	Immediately stops the operation of the valve. The valve remains in the same position.	The command is only available in the *Manual* mode.
Reset	Reset the applicable timeout counters.	Use this button to reset the timeout counter.
Manual	Place the valve under manual control.	
Auto	Place the valve under automatic control.	
Acknowledge	Click this button to acknowledge alarms for the valve.	

Figure 45 Digital valve operation menu



3.8.7 Configuration options

One or more of the following functions can be enabled for the valve control modules:

- Local/Remote mode
- Control logic interlocks
- Shutdown.

The status of these functions can be viewed and changed using the commands on the module shortcut menu (Refer to *Shortcut menu* on page 43) that gives you access to the module setup facilities.

3.8.7.1 Local/Remote mode

You can set any valve in *Local Remote*mode. In the *Local* mode, you control the valve from a local panel. In the *Remote* mode, K-Chief 700 controls the valve. You can change the mode from the local panel.

3.8.7.2 Control logic interlocks

All valve control modules have interlocks to prevent damage to the valve.

The interlock functions are:

- Inhibit the **Close** command when the interlock condition occurs
- Inhibit the **Open** command when the interlock condition occurs
- Execute the **Close** command when the interlock condition occurs
- Execute the **Open** command when the interlock condition occurs.

3.8.7.3 Shutdown

The shutdown function quickly shuts the valve. It overrides all other commands to the function module. This function is used to close the valve in an emergency.

3.9 PID controller modules

The proportional integral derivative (PID) controller is a function module that controls various process equipment. .

These controller modules are used for:

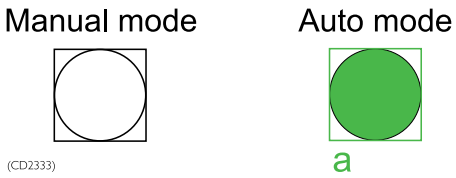
- Temperature control in lubrication oil systems
- Temperature control in water cooling systems
- Temperature control of heavy fuel oil supplied to main and auxiliary engines
- Temperature control of fuel oil storage and cargo tanks
- Viscosity control of heavy fuel oil
- Level and feed control of boiler water
- Servo control of thruster and propulsion pitch/azimuth.

3.9.1 Symbols

PID controllers are shown in many ways, such as a box, or a bar chart with many values.

The standard symbols for a PID controller are shown in *Standard PID controller symbols* on page 75.

Figure 46 Standard PID controller symbols



3.9.2 Mode indications

The operational mode of a PID controller is shown by the tag mark character, located below the left-hand side of the module symbol.

Tag mark character	Colour	Mode
Blank space		Manual
m	White	
a	Green	Automatic
e	Green	External
f	Cyan	Freeze or Follow
o	Cyan	Override

3.9.3 Operation menu

Note

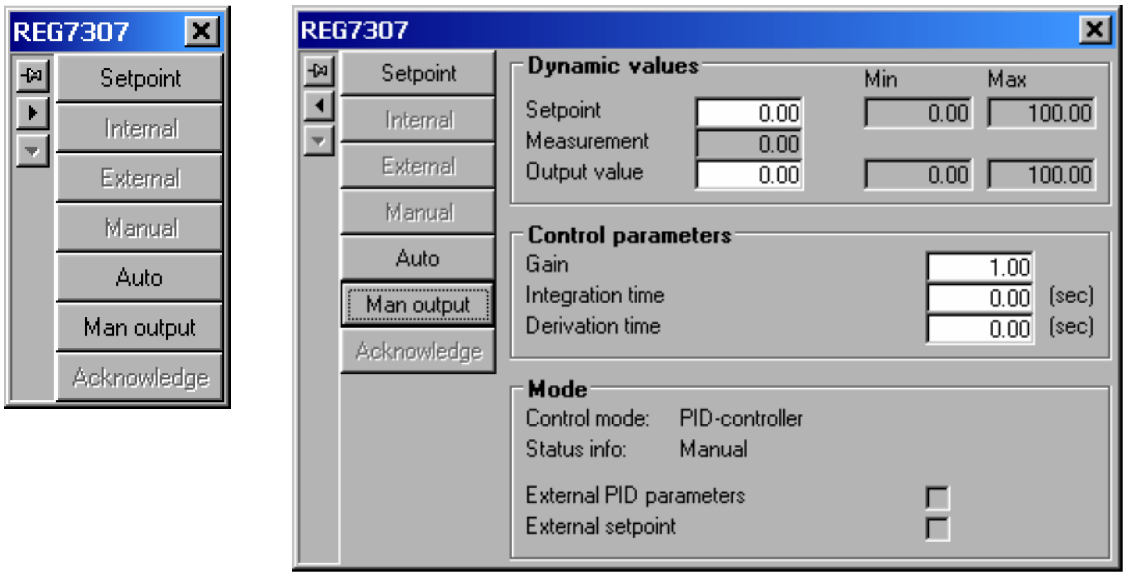
The operation menu varies according to the software version of the function module.

The operation menu of a PID controller is given in *PID controller operation menu* on page 76.

The command buttons are given in the following table.

Command button	Function	Description
External	Select the external control inputs (setpoint and controller parameters).	When external control inputs are selected, the PID controller gets the setpoint and controller parameters from the output signals of other function modules.
Internal	Select the internal control inputs (setpoint and controller parameters).	When internal control inputs are selected, the *Automatic* mode is automatically selected.
Manual	Place the PID controller under manual control.	
Auto	Place the PID controller under automatic control.	
Man output	Click this button to give a manual output value for the PID controller. You give the output value from the numeric input dialog box.	The command is only available in the *Manual* mode.
Acknowledge	Click this button to acknowledge alarms for the PID controller.	Alarms are given if the module is in an alarm condition.

Figure 47 PID controller operation menu



3.9.4 Configuration options

During system configuration, one or more of the following functions may have been configured for the PID controller modules:

- Follow mode
- Freeze mode
- Control logic interlocks.

The status of these functions can be viewed and changed using the commands on the module shortcut menu (Refer to *Shortcut menu* on page 43) that gives you access to the module setup facilities.

3.9.4.1 Follow mode

All PID controller modules have a *Follow mode* function. In this mode, the controller output follows the value of the Follow A input.

3.9.4.2 Freeze mode

All PID controller modules have a Freeze mode function. In this mode, the controller output is frozen at either the current or a predefined value. If the Manual mode is selected, the controller output value may be changed using the `UP`, `DOWN` and `MAN OUTPUT` commands.

3.9.4.3 Control logic interlocks

All PID controller modules have interlock functions in the control logic, to protect the process from damaging conditions.

These interlock functions are:

- No mode change if interlocked. The controller output is set to a preset value.
- *Manual* mode selected if interlocked. The controller output is set to a preset value.
- *Auto* mode selected if interlocked.
- External control inputs are selected if interlocked. The controller output is set to a preset value.

3.10 Sequence control modules

Sequence control modules are used to specify and control a set of actions that are executed in a predefined sequence.

A typical example of the use of sequence control modules is when starting a thruster, where several subsystems must be started in the correct sequence. There must be delays between each action, or step. When all the steps are successfully completed, and all the subsystems are in the necessary states, the thruster can be started.

If a subsystem fails to get the necessary state, or something else fails, the sequence is normally terminated. You must then stop the subsystems that are started. In critical applications, a new sequence can be initiated to bring the equipment to a safe state.

Multiple (top level) control sequences are also available. These are normally used to change the operational mode of the vessel. For example, when transferring the vessel to the DP control mode, these sequences configure the power management system and start the necessary thrusters.

The sequence control module group contains the following main modules:

- Sequence step module
- Sequence administrator module
- Sequence recipe module.

A control sequence for the operation of a system, such as a thruster, can be made of several sequence step modules under the control of a sequence administrator module. Up to a maximum of 100 sequence step modules can be chained in a single sequence.

3.11 Sequence step module

The sequence step module defines the actions to be performed by one subsystem and the conditions expected on completion of the actions. Time delays can also be given to allow sufficient time for the equipment to do the necessary actions.

Note

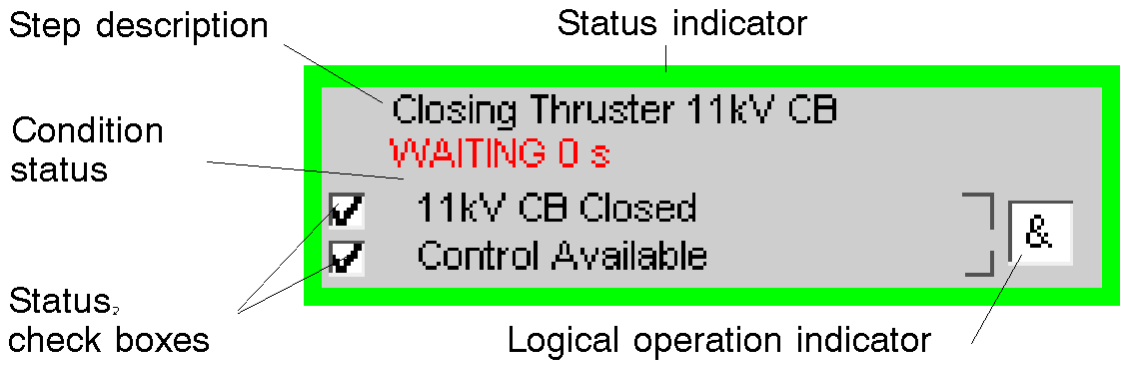
The sequence step module does not have an operation menu.

3.11.1 Symbol

The appearance of the symbol for the sequence step module depends on the actions done in the step.

An example of a sequence step module symbol is shown in the following figure.

Figure 48 Sequence step module symbol



The following table describes the parts of the sequence step module symbol.

Step description	A text field that describes the action done.	
Status indicator	A coloured rectangular border to indicate the status of the step.	
	Colour	**Status**
	Red	Failed
	Green	Active
	Yellow	Hold
	White	Completed
	Background	Not active
Condition status	A red condition status text field, together with a list of conditions. The condition is preceded by a status check box and followed by a collective logical operation indicator. A status check box with a tick shows that the condition is achieved. The collective logical operation indicator shows the logical relationship between the conditions. & (AND) — all the given conditions must be available for the step to complete. > (OR) — one of the given conditions must be available for the step to complete.	

The symbol for a sequence step module can be shown in an application process image. It is normally only shown in a dedicated sequence process image.

3.11.2 Configuration options

One or more of the following functions can be enabled for the sequence step modules during system configuration:

- Allow stop in step

- Allow force in step.

3.11.2.1 Allow stop in step

All sequence step modules have an `Allow stop` function. When the **Allow stop in step** parameter is set to 0, the `TERMINATE` and `HOLD` commands in the operation menu of the sequence administrator module are disabled. The step continues to run, regardless of the status. When the parameter is set to 1, the `TERMINATE` and `HOLD` commands are enabled.

3.11.2.2 Allow force in step

All Sequence Step modules have an `Allow force` function. When the **Allow force in step** parameter is set to 0, the `FORCE NEXT` command in the operation menu of the sequence administrator module is disabled. When the parameter is set to 1, the `FORCE NEXT` command is enabled.

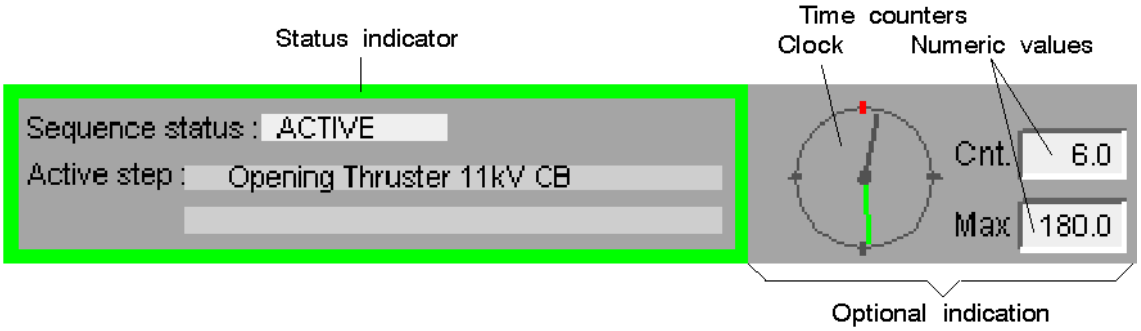
3.12 Sequence administrator module

The sequence administrator module contains the control logic for doing the steps in a control sequence. It specifies the steps and the order in which the steps are to be done. It is also the interfaces with the operator and external logic for controlling the sequence.

3.12.1 Symbol

The symbol for a sequence administrator module is shown in the following figure.

Figure 49 Sequence administrator module symbol



<table>
<tr><td>Status indicator</td><td colspan="2">A coloured rectangular border around the symbol to show the status of the sequence.</td></tr>
<tr><td></td><td>Colour</td><td>Status</td></tr>
<tr><td></td><td>Red</td><td>Failed</td></tr>
<tr><td></td><td>Green</td><td>Active</td></tr>
<tr><td></td><td>Yellow</td><td>Hold</td></tr>
<tr><td></td><td>White</td><td>Completed/not active (sequence process images)</td></tr>
<tr><td></td><td>Light Grey</td><td>Completed/not active (application process images)</td></tr>
<tr><td>Sequence status:</td><td colspan="2">A text field that shows the status of the control sequence as:
ACTIVE
NOT ACTIVE
HOLD</td></tr>
<tr><td>Active step:</td><td colspan="2">A two-line text field.
The top line describes the action of the currently active step.
If a step fails, the bottom line shows the error condition that caused the failure.</td></tr>
<tr><td>Time counters</td><td colspan="2">A clock with dark grey and green hands, and two numeric value fields that give:
The time currently used by the sequence (dark grey hand on the clock and the Cnt. numeric value).
The time taken to complete the sequence, the last time it was run (green hand on the clock).
The maximum time allowed for completion of the sequence (Max. numeric value).</td></tr>
</table>

The function module symbol for the Sequence Administrator module is normally included as part of a relevant K-Chief 700 application Process image and as part of a dedicated Sequence Process image.

The symbol for a sequence step module can be shown in an application process image. It is normally only shown in a dedicated sequence process image.

3.12.2 Operation menu

Note

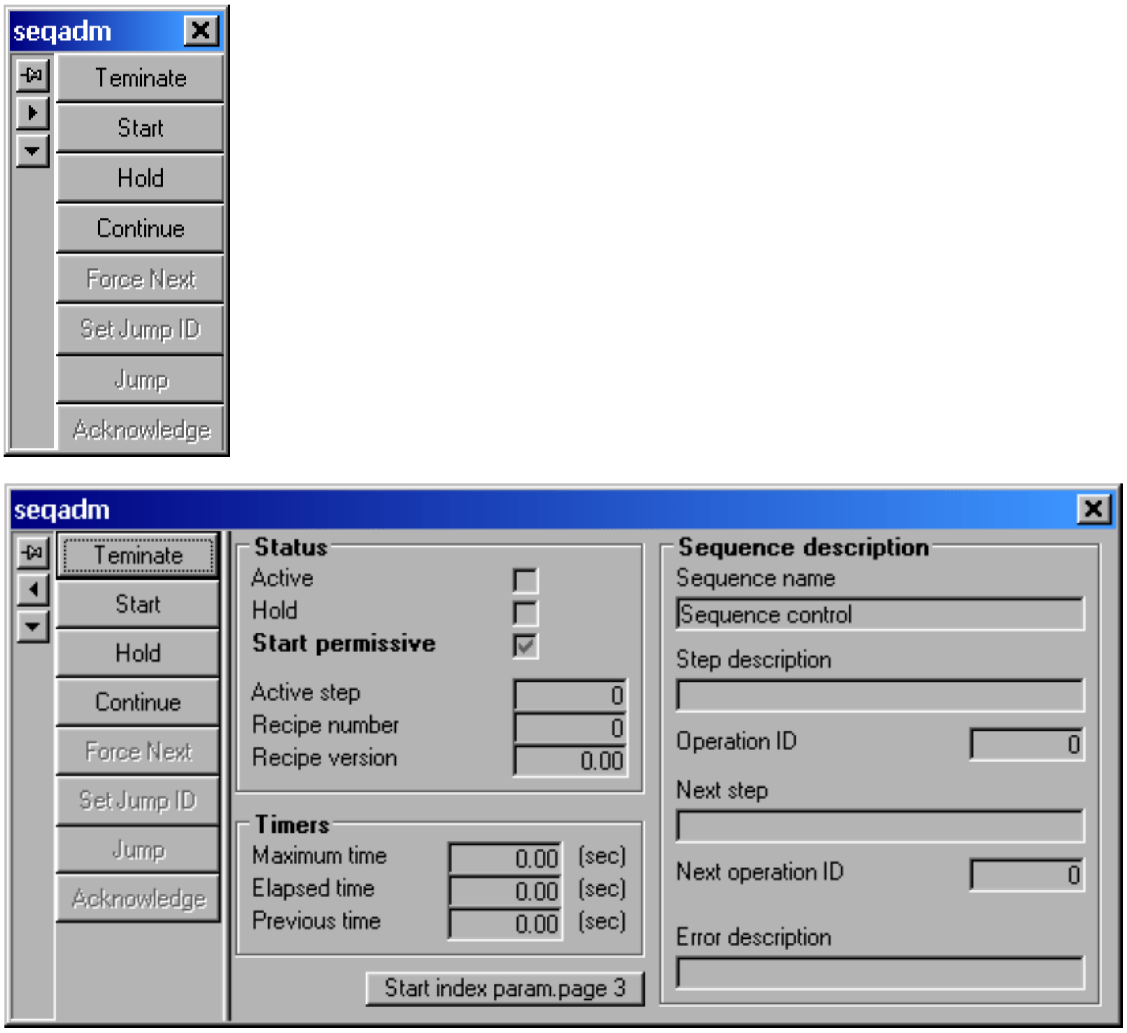
The operation menu varies according to the software version of the function module.

The commands in the operation menu of a sequence administrator module are shown in the following figure.

The command buttons are given in the following table.

Command button	Function	Description
Terminate	Stop and reset the running control sequence	This command, which has the highest priority, can be disabled for individual steps using the **Allow stop** option.
Start	Start a control sequence.	If the *External* mode is selected, the command button is disabled
Hold	Pause the running control sequence at the present step.	This command, has a higher priority than the FORCE NEXT command. It can be disabled for individual steps using the **Allow stop** option.
Continue	Resume the control sequence after it is stopped by giving the HOLD command.	
Jump	Jump to the next step in the control sequence.	You can jump to a new step although the current step is not completed

Figure 50 Sequence administrator operation menu



3.12.3 Configuration options

During system configuration, one or more of the following functions can be enabled:

- External mode
- Start permissive.

3.12.3.1 External mode

You can enable the *External* mode function to control the function module using external control logic. The `START` command in the operation menu becomes disabled.

3.12.3.2 Start permissive

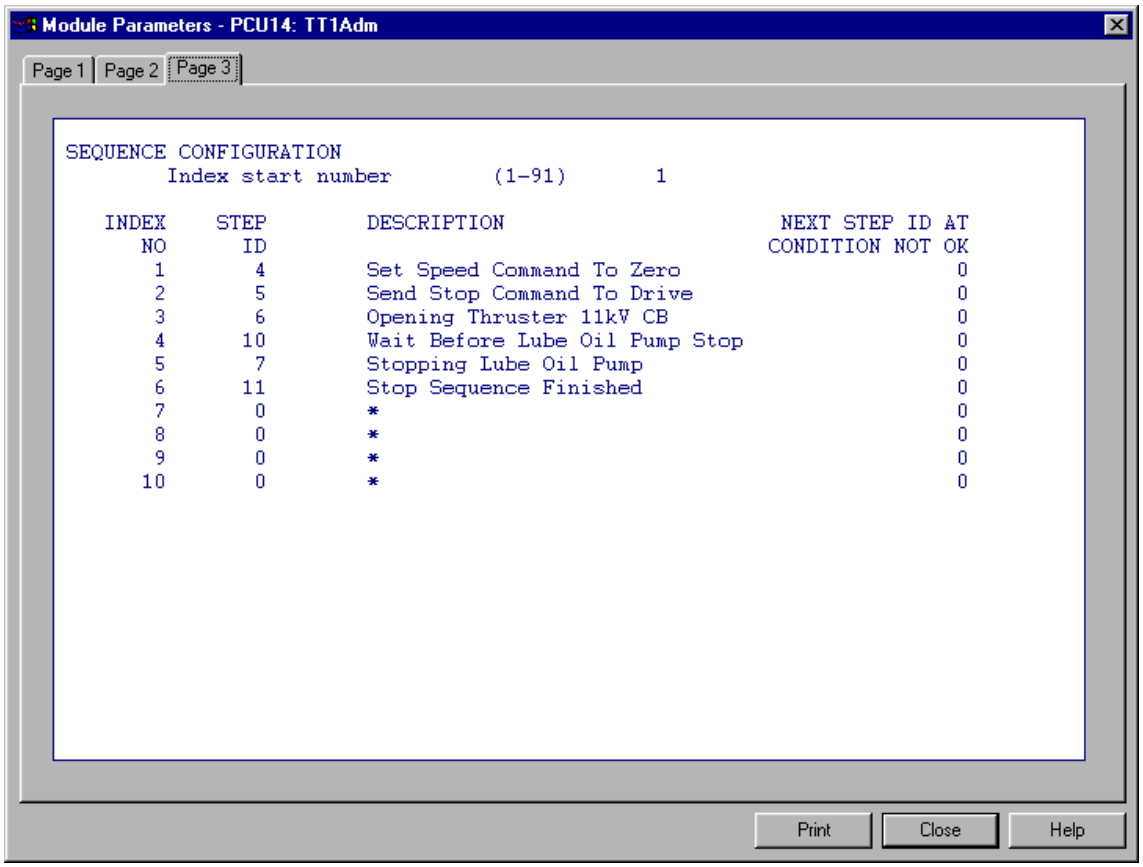
If you connect the start permissive terminal and set it to 0, the `START` command in the operation menu becomes disabled. If you connect the terminal and set it to 1, the `START` command becomes enabled.

3.12.4 Control sequence overview

You can view a list of the steps in the currently active or most recently run control sequence. The **Page 3** tab of the *Module Parameters* window shows this information. For more details, refer to *Module Editor* topic for the sequence administrator module, in the online AIM user guide.

An example of the **Page 3** tab, showing the sequence configuration for stopping a tunnel thruster, is given in the following figure.

Figure 51 Module parameters window for a sequence administrator module



3.13 Sequence recipe module

The sequence recipe module specifies the steps in a control sequence and the order in which they are done. You can use it to replace the available set of steps in a sequence administrator module with your own set of steps.

For example, if a control sequence starts and stops a thruster, you can use the same sequence administrator module to control two sets of sequence step modules, one for start and one for stop, by means of two sequence recipe modules.

3.13.1 Symbol

The symbol for the sequence recipe module, which is only shown in flow sheet views, is given in the following figure.

Figure 52 Sequence recipe module symbol

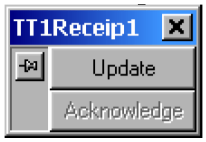
3.13.2 Operation menu

Note

The operation menu varies according to the software version of the function module.

The commands in the operation menu of a sequence recipe module can as given in the following figure.

Figure 53 Sequence recipe operation menu



The command buttons are given in the following table.

Command	Function	Description
`Update`	Update the sequence recipe module with a new sequence configuration.	The `Update`command is usually disabled because the *External* mode is usually selected. If this happens, transfer the contents of the sequence recipe module to the sequence administrator module before starting the sequence.

3.13.3 Configuration options

One or more of the following functions can be enabled for the sequence recipe modules during system configuration:

- External mode
- Interlock
- Freeze.

3.13.3.1 External mode

Sequence recipe modules have an *External* mode function. In this mode, the function module is controlled by external control logic. The `UPDATE` command in the operation menu becomes disabled.

3.13.3.2 Interlock

Sequence recipe modules have an *Interlock* function. When set, this function the sequence administrator module is not updated.

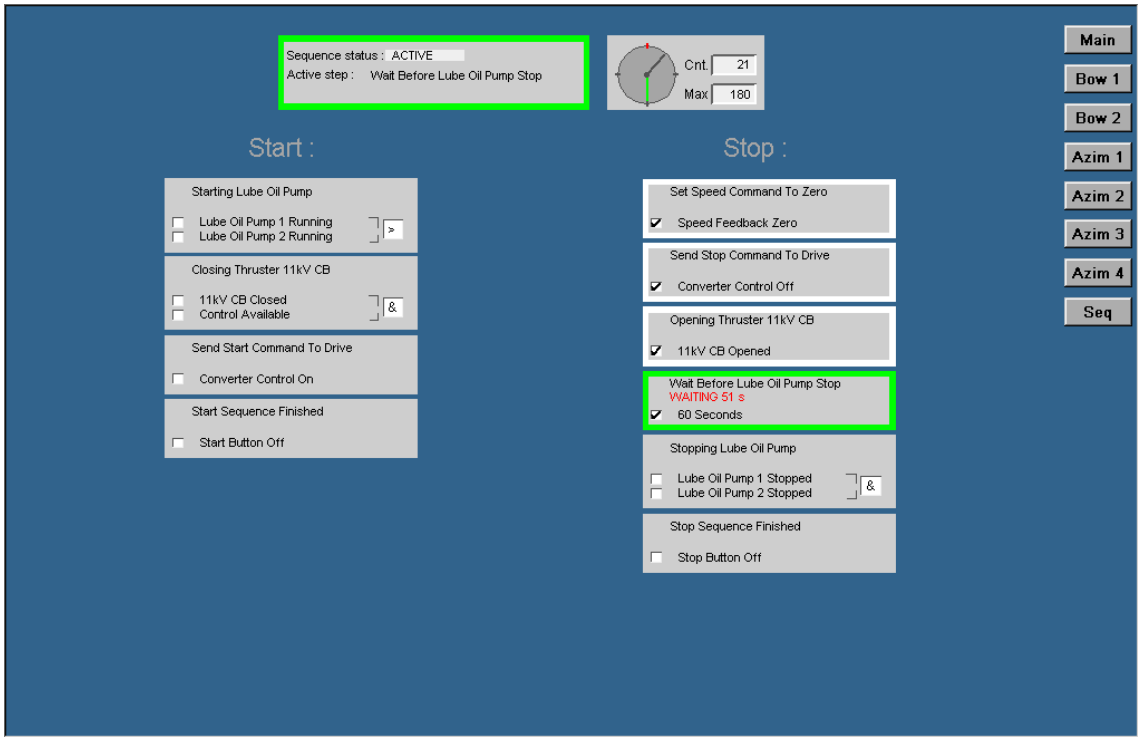
3.13.3.3 Freeze

Sequence Recipe modules have a *Freeze* function. When you set the **Freeze recipe data** parameter to zero, recipe data can be changed. If you set the parameter to 999, the recipe data is frozen. When the recipe data is frozen, it cannot be changed from the function module.

3.14 Sequence process image

An example of a typical sequence process image for stopping a tunnel thruster is shown in the following figure.

Figure 54 Sequence process image for tunnel thruster



When a step in a control sequence is started, a record is created in the event database. You can view these events can by opening the **Historic Event Page** of the Event List view, with the **Universal** event filter selected (Refer to the **Event system** topic in the online AIM user guide).

An example of the events that occur when a tunnel thruster stops is shown in the following figure.

Figure 55 Sequence events for stopping a tunnel thruster

Time	Tag	Description	State	Value	Terminal	Cmd Group	Station	Priority	Type	Red
09:28:28 18/07/01	TT1Adm	End of sequence	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:28:21 18/07/01	TT1Adm	Step active ID : 11	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:28:19 18/07/01	Thr1_LubeOil	OPERATION OK -> READY	Void	0		RCA	PCU14	UnPri	ProcMsg	
09:28:15 18/07/01	TT1Adm	Step active ID : 7	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:27:14 18/07/01	TT1Adm	Step active ID : 10	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:27:10 18/07/01	H12	Breaker opened	Void	0		Power	PCU09	UnPri	ProcMsg	
09:27:08 18/07/01	TT1Adm	Step active ID : 6	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:27:07 18/07/01	69PSL330054	Suppressed	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:27:06 18/07/01	Thr1_Misc	OPERATION OK -> READY	Void	0		RCA	PCU14	UnPri	ProcMsg	
09:27:06 18/07/01	Thr1_Temp	OPERATION OK -> READY	Void	0		RCA	PCU14	UnPri	ProcMsg	
09:27:06 18/07/01	TT1RpmFail	Suppressed	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:27:06 18/07/01	TT1RpmMismatch	Suppressed	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:27:04 18/07/01	TT1Adm	Step active ID : 5	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:27:01 18/07/01	TT1Adm	Step active ID : 4	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:27:01 18/07/01	TT1Adm	Sequence started	Void	0		Thruster	PCU14	UnPri	ProcMsg	
09:27:00 18/07/01	TT1Receip2	Sequence updated, Recipe No 2	Void	0		Thruster	PCU14	UnPri	ProcMsg	

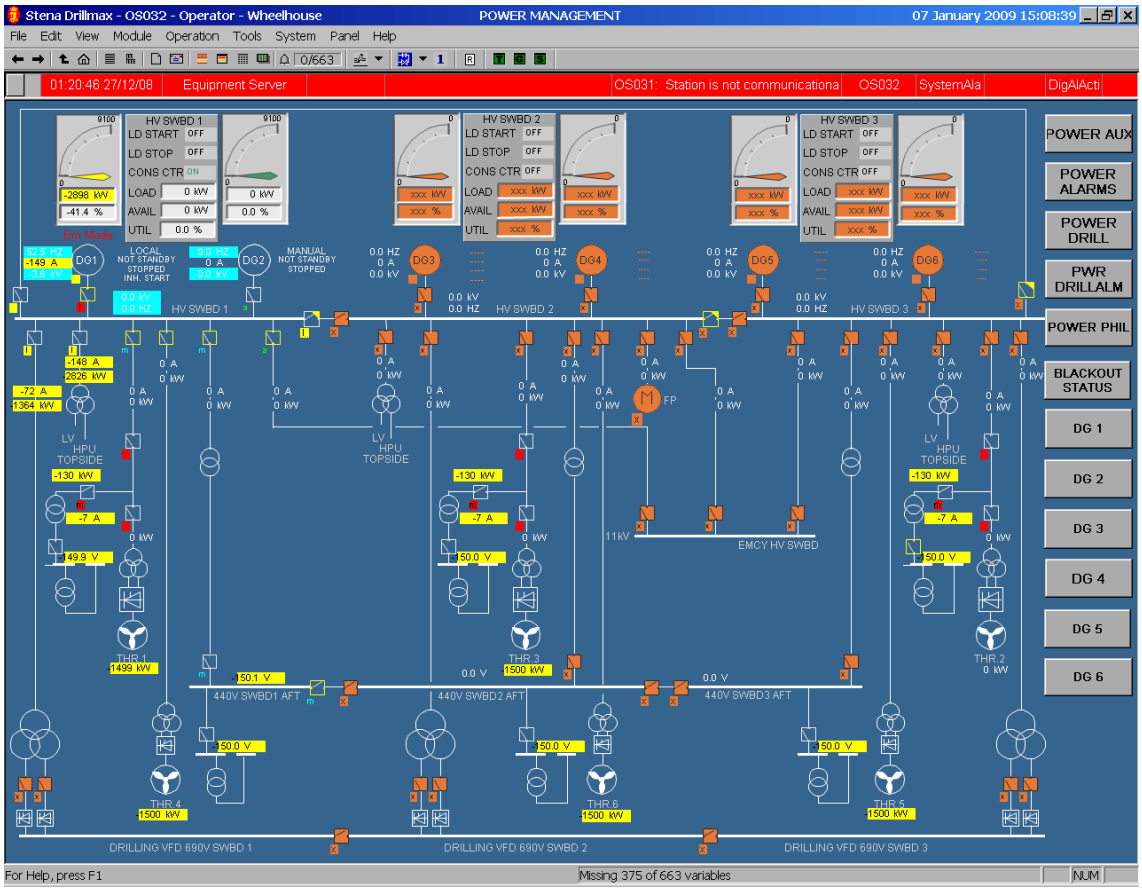
4 Power management

The power management application provides monitoring, control and safety functions for the power generating systems.

The power management process image shows the power generation system and consumers. From this image, you can monitor the power network and operate the generators, switchboards and circuit breakers. Heavy consumers are usually shown in the power management image.

A typical power management process image is shown in the following figure.

Figure 56 Power management process image



You can view some of the equipment in more detail by selecting a lower-level process image. The contents of the lower-level process images depends on the equipment installed in the vessel. For specific information on a device, refer to the user documentation for the device. For example, you can click the DG1 button at the right of the top-level power management screen to view the generator set process image for diesel generator 1.

The power management application contains the following basic functions:

- Generator control (for diesel, turbine and shaft driven generators)
- Switchboard control
- Circuit breaker control.

Only the main basic functions and the associated sub-functions are described in the following sections, although other functions can be implemented for special applications.

4.1 User interface

The top level process image for power management shows the complete electrical power production and distribution system. The condition of each generator set is shown, together with the status of all switchboards, breakers and connections. The process image also shows the supply voltage and load status.

The power management process image has various lower level process images that allow you to:

- View a separate process image for every generator engine and electrical generator
- Alternatively, to view a separate process image for every generator set
- View a separate process image for each switchboard, if not already shown in the top-level power management process image
- View optional process images showing detailed information about the low voltage distribution system and/or safety systems.

You can use the power management images to monitor and control the power generation system.

The generator engine process image gives you more detailed information about the status and condition of the generator engine. It also gives you information about exhaust gas temperatures if applicable, and the engine auxiliaries. The amount of data shown depends on the type of engine and the installation.

If there is a separate electrical generator process image, it shows information and alarms related to the electrical generator.

A generator set process image usually shows the generator engine and electrical generator status, condition, measurements and alarm information for a complete generator set in a single image, if there is sufficient space.

A switchboard process image shows the selected mode for load dependent start/stop and consumer control, together with any relevant electrical measurements.

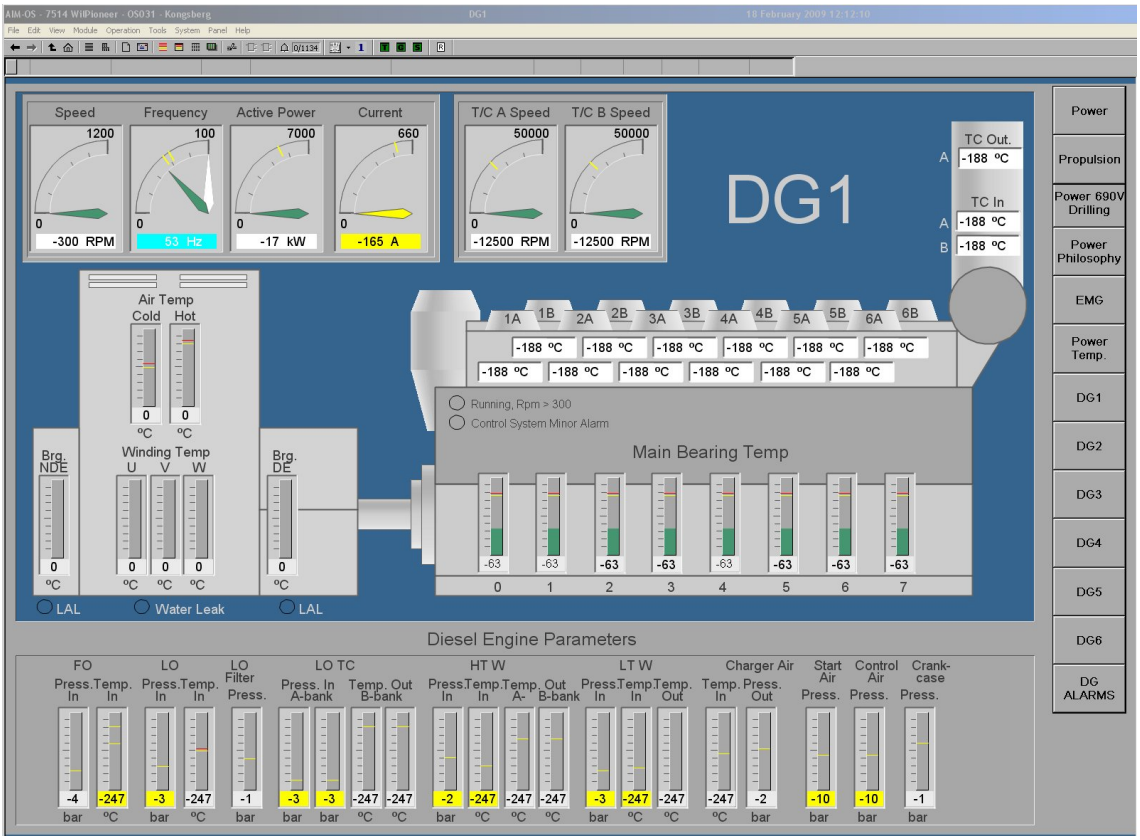
You can see the lower-level process images by:

- Clicking on a hot spot in the power management process image or, where applicable, in one of the lower-level process images.
- Selecting the necessary image in the navigator. Refer to the **Toolbars** section in the operator station topic, in the online AIM user guide.
- Clicking the **NAVIGATOR (VIEW MAP)** button in the operator panel. Refer to *Automation panel layout* on page 36.
- Opening the **History** mimics.

4.2 Generator set process image

An example of the generator set process image is shown in the following figure.

Figure 57 Generator set process image



This process image is divided into areas that show information about the different parts of the generator set. The information shown in the process image depends on the type of engine and generator.

4.3 Generator control module

Module symbols represent generators in the power management process images.

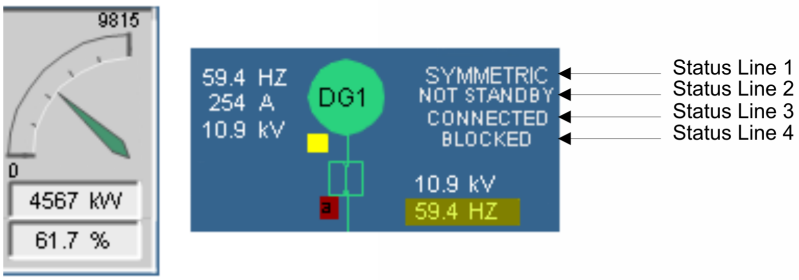
The generator module symbol is used to show the operational status of a generator and control the operation of the generator.

4.3.1 Symbols

The module symbol of a generator has an analog dial that shows the load on the generator. The generator symbol has four lines of status text that show the state of the generator.

An example of the generator symbols are given in the following figure. The information shown by the symbol can vary in different vessels.

Figure 58 Generator control module symbols



Optional information such as the power factor, output voltage, load current and frequency of the generator can also be shown near the generator symbol.

4.3.2 Status indication

The colour of the symbol and the four lines of status text show the state of the generator. See Figure 58.

The colours used to show the operational state of the generator are given in the table that follows.

Colour	Meaning
White	The generator is stopped.
Yellow	The generator is either starting or stopping.
Green	The generator is running and operates correctly.

The status text varies according to the operational conditions, and the commands given from the generator module operation menu. Refer to section *Operation menu* on page 94.

Line 1 shows whether the generator is controlled from a local panel, or by the power management application. If the power management application controls the generator, the selected load mode is shown. See *Generator control module symbols* on page 91.

The following table below gives other text that can be shown in Line 1.

Status text	Meaning
LOCAL	K-Chief 700 does not control the generator.
EXTERNAL LOADSHARING	*External Load sharing* mode is selected. K-Chief 700 does not control the load sharing.
MANUAL	*Manual* mode is selected.
FIX LOAD	*Fixed Load* mode is selected.
SYMMETRIC	*Symmetric* mode is selected.
ASYMMETRIC	*Asymmetric* mode is selected.
ASYMMETRIC MAIN	*Asymmetric* mode is selected. This generator is now the main generator.
DIESEL LOCAL	The diesel engine is set in **Local** mode.
BREAKER LOCAL	The generator breaker is set in **Local** mode.
MANUAL ISOCH.	The generator is in the **Manual Isochronous** mode.
SYMM ISOCH.	The generator is in the **Symmetric Isochronous** mode.
ASYMM ISOCH.	The generator is in the **Asymmetric Isochronous** mode.
TRACK MODE	The generator is in the **Track** mode.

Line 2 shows the control mode for the generator.

The following table gives the text that can be shown in Line 2.

Status text	Meaning
NOT STANDBY	The K-Chief 700 system cannot start, connect, disconnect or stop the generator.
STANDBY #	The K-Chief 700 system can start, connect, disconnect or stop the generator. The hash symbol # stands for the standby number (from 1 to 15), which determines the order of automatic operation.

Line 3 gives the current state of the generator engine.

The following table below gives the text that can be shown in Line 2.

Status text	Meaning
STOPPED	Engine is stopped
START HELP SYSTEM	

Status text	Meaning
START ENGINE	Start the engine
START ENGINE WAIT	Start engine wait
RUN IDLE	Running at idle speed
RUN RATED	Running at rated speed
SYNCHRONISING	The generator is synchronising the phase with the bus
DEAD BUS CLOSE	The generator circuit breaker is closing
CONNECTED	The generator is connected to the bus
REDUCE LOAD	The load on the generator is being reduced
DISCONNECTING	The generator is disconnecting from the bus
RUNNING COOLING DOWN	The engine is running in the cool down sequence This sequence is used to cool the engine before shutdown
RUNNING CLEANING UP	Running and cleaning up the status
STOPPING	Generator stopping
SHUT DOWN	Shutdown This can be due to various reasons, which are shown in the process image that gives the generator shutdown information

Line 4 gives the condition of the generator.

The Line 4 text alternatives are:

INTERNAL BLOCKED	The generator is shut down and must be reset before starting
INHIBIT DISCONNECT	The generator is not allowed to disconnect from the bus
INHIBIT STOP AND CONNECT	Inhibit the Stop and Connect processes
INHIBIT CONNECT	The **Breaker Ready** signal not present, the breaker is not ready
INHIBIT STOP	The Stop process is inhibited
INHIBIT START	Starting is inhibited because at least one of the measured values are missing or out of range. The value(s) in error are shown in the Process image containing generator start-inhibit information
FIRST TO STOP	The generator is set as the first generator to stop.
FIRST TO START	The generator is set as the first generator to start.
FIRST STBY. START	The generator is set as the first generator to standby start.
FIRST LDEP. START	The generator is set as the first generator for a load dependent start.

4.3.3 Operation menu

Note

The operation menu varies according to the software version of the function module.

The commands given in the operation menu of a generator control module can be as shown in *Generator control operation menu extended* on page 96.

The command buttons allow you to:

- `Stop` or `Start` the generator. The generator can be started either manually by the operator or automatically by the system logic.

  Note

  The `Stop` and `Start` commands are not available for shaft generators.

- `Disconnect` or `Connect` the generator to the bus. The generator can be connected or disconnected either manually by the operator or automatically by the system logic.

  If you give the `Disconnect` command to a **Not standby** generator, the generator is disconnected from the bus but not stopped. If you give the `Disconnect` command to a **Standby** generator, the generator is disconnected from the bus and stopped.

  You can only disconnect the generator if it is supplying sufficient power to the switchboard.

  You must manually start a **Not standby** generator before you give the `Connect` command.

  If you give the `Connect` command to a **Standby** generator, the generator is automatically started, synchronised and connected to the bus.

- Set the generator to the **Standby** mode, or in **Not standby** mode, which acts on a single generator, and can only be activated manually. The commands are given from the **Numeric** dialog box.

  Note

  *The **Standby** mode is not available for shaft generators. Shaft generators are always in **Not standby** mode.*

- `Reset` a blocked operation, whenever a generator is shut down.
- Set the generator to the **Manual** mode. This mode is one of four available load sharing modes. The others three are automatic load sharing modes:
  - **Fixed Load**
  - **Symmetric**
  - **Asymmetric**

  To leave the **Fixed Load** mode, set the generator to the **Manual**, **Symmetric** or **Asymmetric** mode.

Note

*Selecting the **Manual** mode for a generator that is in **Standby** mode sets the generator to **Not standby** mode.*

- Set the generator to the **Fixed Load** mode, which is only available for generators that are connected to the switchboards of the power distribution network.

  You cannot stop a generator when it is operating in the **Fixed Load** mode.

  To leave the **Fixed Load** mode, set the generator to the **Manual**, **Symmetric** or **Asymmetric** mode.

  Note

  *You cannot select the **Fixed Load** mode for a generator that is set to the **Standby** mode.*

- Select the **Symmetric** mode.

  To leave this mode, set the generator to the **Fixed Load**, **Manual** or **Asymmetric** mode.

  Note

  *Setting a generator to the **Symmetric** mode can affect the load sharing with other generators that are in the **Symmetric** or **Asymmetric** modes.*

- Set the generator to the **Asymmetric** mode.

  In the **Asymmetric** mode, the load is shared in the following ways:

  - One generator in **Asymmetric** mode is set as the main generator. The load on the main generator correlates with the optimum load value for the generator. The optimum load value is typically between 70 and 80% of the nominal load.

  - The other load sharing generators in **Symmetric** and **Asymmetric** mode are called the topping up generators.

  They share the remaining load as equal percentages of their nominal load.

  The load shared by the topping up generators is the total load on the switchboard, excluding fixed loads, manual loads and the main asymmetric load.

  To leave this mode, set the generator to the **Fixed Load**, **Manual** or **Symmetric** mode.

  Note

  *The **Asymmetric** mode is not available for shaft generators.*

- Click the **Increase** or **Increase** button to increase or decrease the load on the generator by a preset amount. These commands are only available when the generator is running in the **Manual** or **Fixed Load** mode.
- Click the **Isochronous** button to set the speed governors in isochronous mode. Click **Droop** to set the speed governors in droop mode.

In compensated droop mode, PMS supports a the following load sharing options:

- Symmetric load sharing
- Asymmetric load sharing

- Fixed load
- Manual load sharing

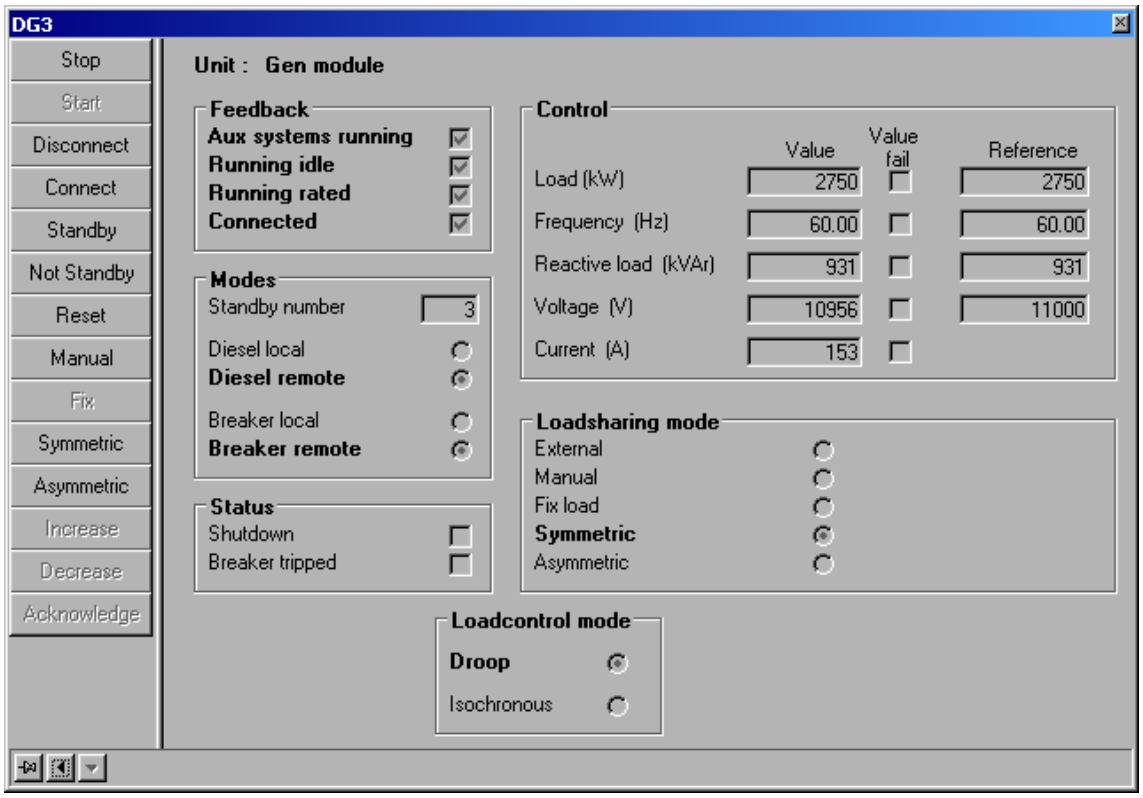
Isochronous load sharing does automatic proportional division of the total load between the generator sets, while maintaining a fixed frequency on the bus. All the generators share the load equally. PMS monitors the load on all the connected generators. It gives an alarm if the load between the connected generators deviates from a defined limit, when in the isochronous control mode. This function can be turned on or off, and the limits adjusted from the main power mimic. The load sharing functions can be selected individually for each generator. PMS controls the active load sharing using the speed governor when the speed governors are in droop load sharing mode. The engine speed is controlled by the speed controller. The normal operation mode is symmetric load sharing. The speed governors are set up with equal droop setting, to manage proportional load sharing.

In **Isochronous** mode, you can select the following load sharing modes:

- Symmetric
- Asymmetric
- Fixed

If you want to set a generator in **Isochronous** mode to **Asymmetric** of **Fixed** load sharing mode, the external generator controller must have Base Load/MW control enabled. Otherwise, only the **Symmetric** mode can be set.

Figure 59 Generator control operation menu extended



4.4 Switchboard module

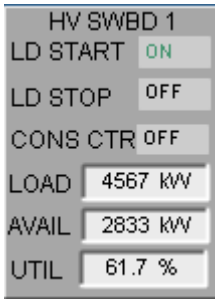
Use the switchboard module to operate the load and consumer control function of the switchboard, and to see the current load and spare capacity.

4.4.1 Symbol

The switchboard module symbol shows the identification name of the switchboard, the status of the load and consumer controls, the current power loading on the switchboard and the available unused power (spare capacity).

An example of a switchboard module symbol is shown in the following figure.

Figure 60 Switchboard symbol



You can switch the **Load Start**, **Load Stop** and **Consumer Control** on or off from the module operation menu. To open this menu, use the left trackball button to click the **ON/OFF** label in the **Load and Consumer Control** status field.

4.4.2 Operation menu

Note

The operation menu varies according to the software version of the function module.

An example of the commands available in the operation menu for a switchboard module is shown in *Switchboard module operation menu and window* on page 99.

The command buttons allow you to:

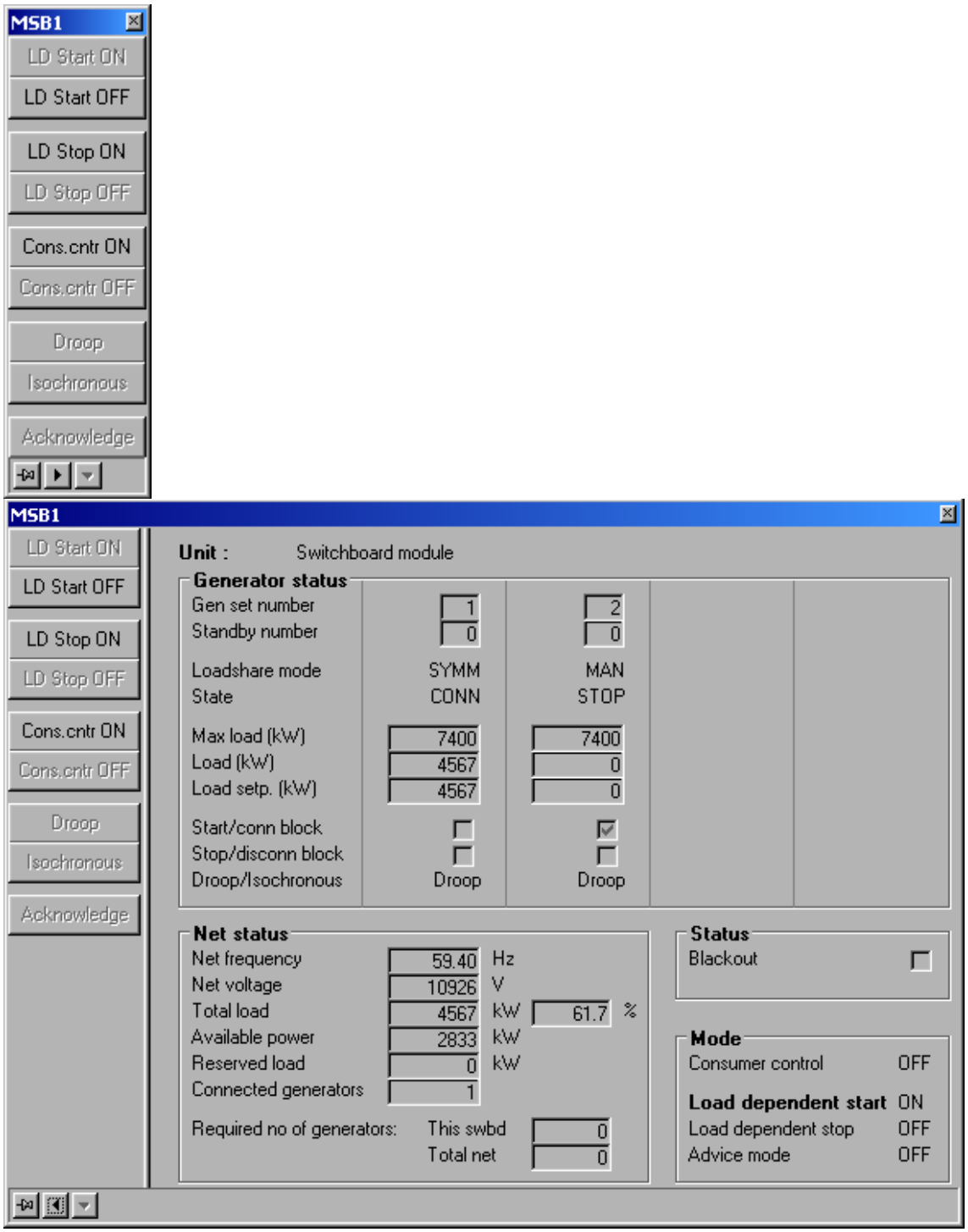
- Set the **Load Dependent Start On**. This setting acts on **Standby** generators that are in the **Asymmetric** or **Symmetric** mode. Selecting this command starts the **Next standby** generator.
- Select the **Load Dependent Start Off** . This setting acts on **Standby** generators that are in the **Asymmetric** or **Symmetric** mode. Selecting this command inhibits the **Next standby** generator from starting automatically due to variations in symmetrically or asymmetrically shared loads.
- Select the **Load Dependent Stop On** . This setting acts on all **Standby** generators connected to the switchboard, that are in the **Asymmetric** or **Symmetric** mode. Selecting this command stops the running generators in descending order of their standby number.
- Select the **Load Dependent Stop Off** , which applies to all **Standby** generators that are in the **Asymmetric** or **Symmetric** mode and connected to the switchboard. Selecting this command inhibits the automatic stop of any of the **Standby** generators due to variations in symmetrically or asymmetrically assigned loads.
- Set the **Consumer Control On** , which applies to all **Standby** generators that are currently not connected to the switchboard. If you select this command, the spare capacity is checked when a heavy consumer gives a start request.

  Note

  Heavy consumers are usually the thrusters, main hydraulics and large pumps.

- Set the **Consumer Control Off** , which applies to all **Standby** generators that are connected to the switchboard. If you select this command, any consumer demand causes a generator to start, whether spare capacity is available or not. The number of generators connected or simultaneous start attempts from other consumers also do not have any effect on the attempt to start.
- Toggle between **Isochronous** and **Droop** mode. Click the **Isochronous** button to set the generator to isochronous mode. Click the **Droop** button to set the generator to isochronous mode.

Figure 61 Switchboard module operation menu and window



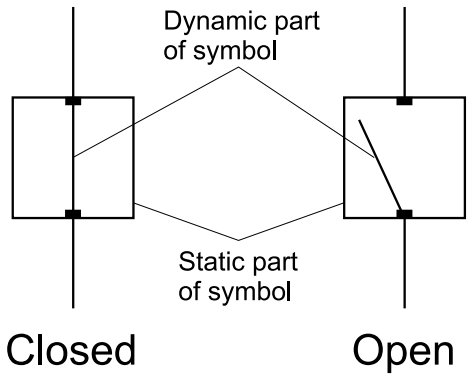
4.5 Circuit Breaker module

Circuit breakers are used to connect and disconnect the generators and consumers to the power distribution network. The circuit breaker module is used to interact with the circuit breaker.

4.5.1 Symbol

A circuit breaker module is represented by the following symbols.

Figure 62 Circuit breaker module symbols



4.5.2 Mode indications

The operational mode of a circuit breaker is shown by the tag mark character that appears next to its symbol.

The tag mark characters used in circuit breakers are given in the table below:

Tag mark character	**Colour**	**Mode**
Blank		Manual
m	White	
a	Green	Automatic
i	Cyan	Interlocked
l	Cyan	Local

4.5.3 Status indications

The colour of the symbol is changed to show the operational state of the circuit breaker.

Status Colour	**Status**
White	The circuit breaker is open.
Green	The circuit breaker is closed.
Yellow	The circuit breaker is in a transient or unknown state.

4.5.4 Operation menu

The commands given in the module operation menu depend on the system configuration, such as the configuration of the circuit breaker. If it is configured as remote (**rem**) the commands are available. If the circuit breaker is configured as monitoring (**mon**) or automatic (**auto**), the commands are not available.

Typical circuit breakers are those fitted on both sides of transformers. The circuit breaker between a generator and a switchboard is controlled from the generator control module.

Note

The operation menu varies according to the software version of the function module.

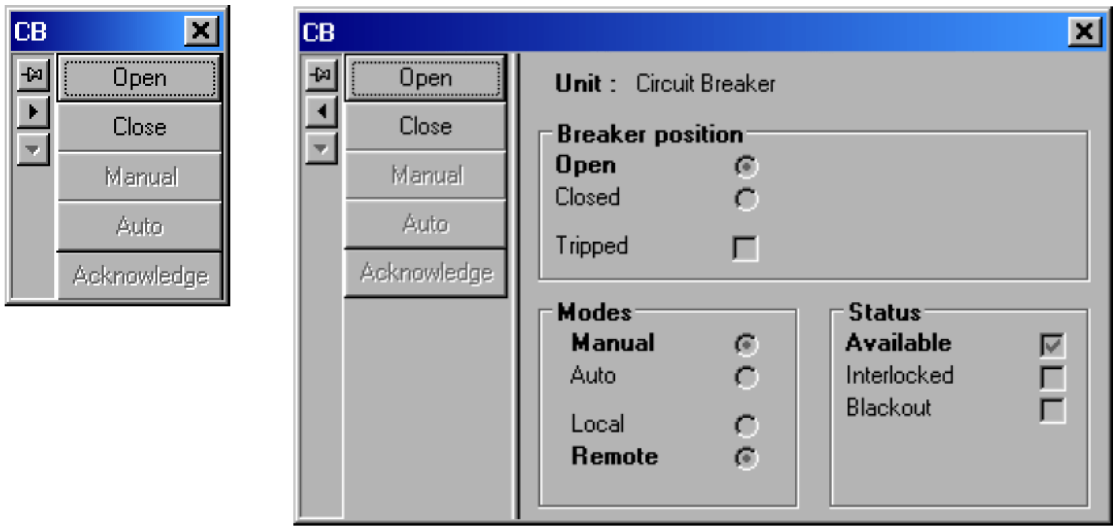
An example of the command toolbar of a circuit breaker module is shown in the figure below.

The command buttons allow you to:

- **Open** or **Close** the circuit breaker.
- Set the circuit breaker to **Auto** or **Manual** operation.

An inconsistency check compares the flow through the breaker against the breaker status signal. If the breaker status signal reports the breaker open while a flow is measured across the breaker, the status indication is changed to **Breaker closed**. If the breaker status signal reports the breaker closed while no flow is measured across the breaker, the status indication is changed to **Breaker open**.

Figure 63 Circuit breaker operation menu



4.6 Consumers

Although the major consumers are shown in the power management process images, they are usually controlled from process images within other applications. For example, the thrusters are controlled from the thruster/propulsion process images.

The colours used to indicate the operational status of consumers are as follows:

Status Colour	Status
Green	The consumer is running.
White	The consumer is stopped.
Yellow	The consumer is in a transient state such as starting, stopping or changing speed.

4.7 Typical procedures

The following procedures are examples and only intended to illustrate the interaction between the operator and the power management application for doing typical tasks.

Note

The operation menu varies according to the software version of the function module.

4.7.1 Set a generator as standby generator

The following procedure describes how to set a generator as standby generator.

It is assumed that the generator is stopped and in the **Manual** mode, and that the generator or the switchboard are not in the alarm condition.

1 Open the power management process image.

The image shows the status of the power plant.

2 Note the information given for the generator.

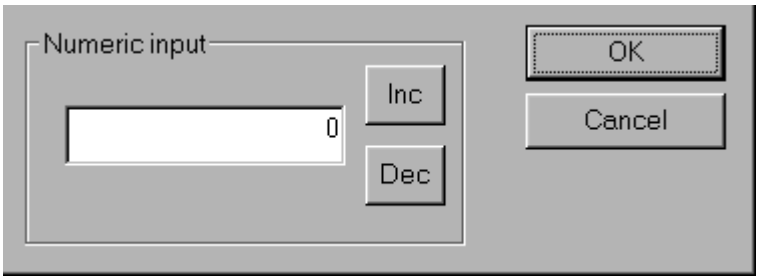
3 Move the cursor over the generator symbol and click the left trackball button.

A selection box appears around the generator symbol and the generator operation menu appears. See Figure 59.

4 Click the `Standby` button.

The numeric input dialog box appears. See Figure 64.

Figure 64 Numeric input dialog



5 Type the necessary value for the standby number in the **Numeric input** field and click **OK**. You can also click the **Inc** or **Dec** button to increase or decrease the value by 1.

The Line 2 status text of the generator symbol changes to show the new standby status.

4.7.2 Connecting a generator

This section tells you how to set a generator in the **Symmetric** mode, do a manual start and connect the generator to the switchboard bus.

It is assumed that the generator is stopped and in the **Manual** mode, and that the generator and the switchboard are not in the alarm condition.

1 Open the power management process image.

The image shows the status of the power plant.

2 Note the information given for the generator.

3 Move the cursor over the generator symbol and click the left trackball button.

A selection box appears around the generator symbol and the generator operation menu appears. See Figure 59.

4 Click the **Symmetric** button.

The generator is set in the **Symmetric** load sharing mode. The Line 1 status text of the generator symbol changes from **MANUAL** to **SYMMETRIC**.

5 Click **Start**.

The Line 3 status text of the generator symbol changes from **STOPPED** to **START ENGINE**. The colour of the generator symbol changes from white to yellow. ***Check this.***

The Line 3 status text of the generator symbol changes from **START ENGINE** to **RUN RATED**. The colour of the generator symbol changes from yellow to green.

6 Click **Connect**.

The Line 3 status text of the generator symbol changes from **RUN RATED** to **SYNCHRONISING**, then to **CONNECTED**. When the generator is connected to the switchboard bus, the circuit breaker symbol changes from white to green.

7 Close the module operation menu.

4.7.3 Failed generator start and reset

This section tells you the events that occur when a generator fails to start. It tells you how to reset the blocked condition after the generator is repaired. You can also use these procedures after an automatic start fails.

It is assumed that a generator has failed to start and one of the remaining generators, set as a **Standby** generator, is not connected to the switchboard.

1. The Line 3 status text of the generator symbol changes. The maximum number of start attempts allowed is set by the parameter **Max. no. of start trials**.
2. When the last start attempt fails, a **Start fail** alarm is given. The Line 3 status text of the generator symbol changes to **STOPPED**. The Line 4 status text of the generator symbol changes to **BLOCKED**. The colour of the generator symbol changes to white.
3. The blocked generator is excluded from the standby starting sequence.
4. The **Next standby** generator is started and connected to the switchboard power bus.
5. After the **Next standby** generator is connected, the Line 3 status text of the generator symbol changes to **CONNECTED**.

   The colour of the generator symbol changes to green.

   The bus circuit breaker symbol shows the breaker is closed.

To reset the blocked generator:

1. Open the necessary generator and/or safety process image.
2. Look at the information given in the images as this can give the reason why the generator failed to start.
3. When recovery or repair of the generator is complete, open the power management process image.
4. Open the module operation menu for the blocked generator.
5. Click **Reset**.

   The Line 4 status text of the generator symbol changes from **BLOCKED** to blank.

You can start and connect the generator to the bus and/or set it as a **Standby** generator. Refer to *Connecting a generator* on page 103.

4.7.4 Alarm start

The following sequence tells you the events that happen when a generator that is online enters the alarm condition. The generator in the alarm condition is stopped. A **Standby** generator is started and connected.

No operator action is required if the generator that enters the alarm condition is set in the **Standby** mode.

If the generator is set in **Not Standby** mode, the generator engine must be stopped manually, using the `Stop` command.

When a generator that is online enters the alarm condition, the following events happen:

1. An alarm condition occurs in the connected generator.
2. The **Next standby** generator is started and connected to the switchboard.

3 The load on the generator in the alarm condition is reduced.

4 The Line 3 status text of the generator symbol for the generator in the alarm condition changes from **CONNECTED** to **REDUCE LOAD**.

5 The Line 3 status text of its generator symbol changes to **CONNECTED** and the colour of the generator symbol changes to green. The bus circuit breaker symbol shows that the circuit breaker is closed.

6 The Line 3 status text of the generator symbol for the generator in the alarm condition changes from **CONNECTED** to **REDUCE LOAD**.

7 When the load is less than n% (where n is the value of the parameter **Max. rel. load to disconnect**), the bus circuit breaker opens and the generator is disconnected from the switchboard.

8 The Line 3 status text of the generator symbol changes from **REDUCE LOAD** to **DISCONNECT**. The circuit breaker symbol shows that the circuit breaker is open and changes from green to white colour. The generator symbol changes from green to yellow colour.

9 The generator in the alarm condition is stopped.

10 The Line 3 status text of the generator symbol changes from **DISCONNECT** to **STOPPING** and then to **STOPPED**. The generator symbol changes from yellow to white colour. The Line 4 status text of the generator symbol changes to **BLOCKED**.

11 The blocked generator is removed from standby duty.

When the generator in the alarm condition is repaired, reset the blocked state. Refer to *Failed generator start and reset* on page 104

4.7.5 Fixed load operation

The following procedure tells you how to set the generator for fixed load operation. It also tells you about the effects of this action on the other generators.

It is assumed that three generators that are set in the **Symmetric** load sharing mode are connected to the switchboard.

1 Open the module operation menu for the first **Standby** generator.

2 Click **Fix**.

The Line 2 status text changes from **STANDBY 1** to **NOT STANDBY**. The Line 3 status text of the generator symbol changes from **SYMMETRIC** to **FIX LOAD**.

The load setpoint for the generator is set as the present value of the generator load.

3 Click **Decrease**.

The load setpoint of the generator is decreased by a predefined amount.

4 Observe the changes in load for all three generators.

The load on the generator decreases until the load setpoint, and the remaining load is shared symmetrically between the other two generators.

If the result of the load reduction on the generator with fixed load causes 100% loads on the other two generators, the **Fixed** load mode is bypassed and the load total is distributed symmetrically between all the three generators.

5 Close the module operation menu.

4.7.6 Asymmetric load sharing

The following procedure tells you how to set **Asymmetric** load sharing with three generators. Two generators are in the **Symmetric** mode and one in the **Fixed Load** mode. All three generators are connected to the switchboard.

The procedure also tells you about the effects on the load of each generator because of changes in the total load.

1 Open the module operation menu for the generator in the **Fixed Load** mode.

2 Click **Asymmetric**.

The Line 3 status text of the generator symbol changes from **FIX LOAD** to **ASYMMETRIC**

The load setpoint for the generator is preset at typically between 70 and 80% of the generator's load capacity.

The other two generators share the remaining load symmetrically.

3 Close the module operation menu.

4 Decrease the total load on the switchboard by disconnecting a consumer.

Initially, the load shared by the two **Symmetric** mode generators is reduced while the load on the **Asymmetric** mode generator remains constant. If the load on two **Symmetric** mode generators reduces below a predefined limit (typically 25%), the load on these two generators remains unchanged while the load on the generator in **Asymmetric** mode is reduced.

5 Increase the total load by connecting more consumers.

The asymmetric load limit increases. If the increase in the total load continues, and the two generators in **Symmetric** mode reach the same load limit, the additional load is shared symmetrically between all three generators.

4.7.7 Load dependent start

This section tells you about the effect of an increase in the total load when load dependent start is selected, with at least three generators in the **Symmetric** mode.

It is assumed that one of these generators is running and connected to the switchboard and the other two are set in **Standby** mode.

1 Open the module operation menu for the switchboard.

2 Click `LDSTRT ON`.

3 Close the module operation menu.

4 Increase the total load on the switchboard by connecting more consumers.

The load on the connected generator increases.

When the load on the generator increases above the Start 1 (or Start 2) limit and remains above these limits for a time period greater than the Start 1 (or Start 2)

limit delay, the **Next standby** generator is automatically started and connected to the switchboard.

5 When the **Next standby** generator is connected, the Line 3 status text of the generator symbol changes to **CONNECTED**. The colour of the generator symbol changes to green. The circuit breaker symbol shows the bus circuit breaker closed.

The total switchboard load is shared symmetrically between the two connected generators.

When the load on the generator increases above the Start 1 (or Start 2) limit and remains above these limits for a time period greater than the Start 1 (or Start 2) limit delay, the **Next standby** generator is automatically started and connected to the switchboard.

To turn off the load dependent start, do the following procedure:

1 Open the module operation menu for the switchboard.

2 Click `LDSTRT OFF`.

The text in the switchboard module symbol changes from **ON** in green colour to **OFF** in black.

3 Close the module operation menu.

4.7.8 Load dependent stop

To turn on the load dependent stop, do the following procedure:

1 Open the module operation menu for the switchboard.

2 Click **LDSTOP ON**.

The text in the switchboard module symbol changes from **OFF** in black colour to **ON** in green.

3 Close the module operation menu.

To turn off the Load Dependent stop, proceed as follows:

1 Display the module operation menu for the switchboard.

2 Click **LDSTOP OFF**.

The text in the switchboard module symbol changes from **ON** in green colour to **OFF** in black.

3 Close the module operation menu.

4.7.9 Consumer control

To set the consumer control on, proceed as follows:

1 Open the module operation menu for the switchboard.

2 Click **CONCTR ON**.

The text in the switchboard module symbol changes from **OFF** in black colour to **ON** in green.

3 Close the module operation menu.

To turn off the consumer control, proceed as follows:

1 Display the module operation menu for the switchboard.

2 Click **CONCTR OFF**.

The text in the switchboard module symbol changes from **ON** in green colour to **OFF** in black.

3 Close the module operation menu.

5 Propulsion Control

The Propulsion Control application provides monitoring, control and safety functions for the vessel's thruster and main propulsion system.

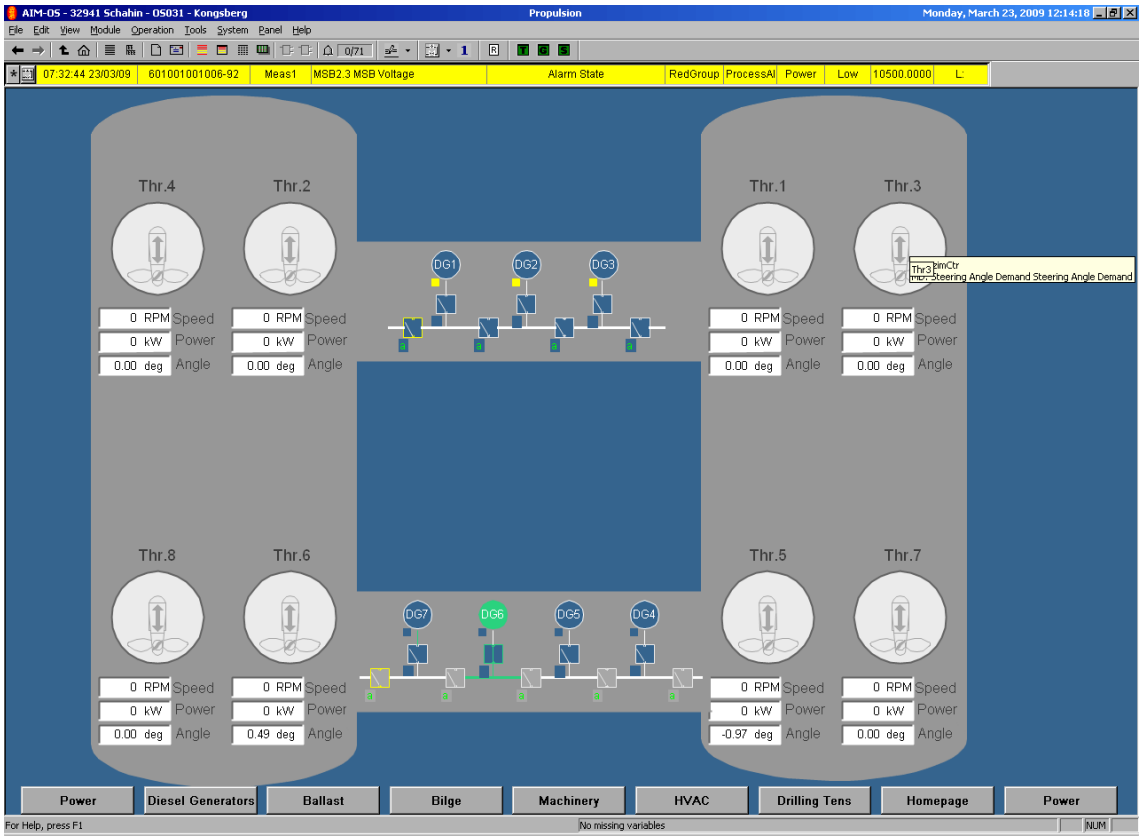
The main control locations for the vessel's thruster and main propulsion systems are the K-Thrust and/or K-Pos Operator Stations. Refer to the *K-Thrust Operator Manual* and/or *K-Pos Operator Manual*.

The K-Chief 700 Operator Stations are therefore normally used to provide details on thruster status and alarm monitoring. However, the K-Chief 700 Operator Stations are provided with a downgraded control mode, called the *Maintenance* mode. This mode, which allows individual manual control of each component within the propulsion system, is mainly for use during maintenance when performing fault-finding.

The Propulsion Process image, which is basically a "Bridge Information" image, visualises the thrusters and main propulsion system. From this image you can Refer to the command control location (K-Thrust, K-Pos or K-Chief 700), and monitor the status of the thrusters and main propulsion units. The main electrical generators and information concerning vessel loading and draught are normally also shown in the image.

The following figure shows a typical Propulsion Process image.

Figure 65 Typical propulsion process image



Open a lower level process image to see more detail on the thrusters and main propellers.

The contents of the lower level process images depend on the type of thrusters and main propulsion units in the vessel.

The propulsion control application comprises the following basic functions:

- Thruster Start/Stop sequences
- Auxiliary Equipment control
- Pitch control
- Azimuth control
- Speed (rpm) control
- Maintenance mode
- Safety
- Zero pitch
- Alarm monitoring.

Only the basic functions, together with their associated sub-functions, are described in the following paragraphs, but other functions may be implemented for special applications.

5.1 User interface

You interact with the propulsion control application through a propulsion process image that shows the thruster and propulsion system.

This top level process image has various lower level process images that are typically grouped as follows:

- A separate process image for each tunnel thruster
- A separate process image for each azimuth thruster
- A separate process image for each main propulsion unit
- Additional process images that show detailed information about the thruster and propulsion system. These are used if there is insufficient space in the upper levels to show the necessary detail.

The status, condition, measurement and alarm information for the thruster, the thruster motor and associated pumps are usually shown in the thruster process image. The image lets you:

- Manually start and stop the thruster, with or without sequence control
- Manually control the thruster-propeller pitch and/or rpm (speed)
- Manually control the auxiliary equipment of the thruster.

The azimuth thruster process image typically shows the following information in a single view:

- The status, condition, measurement and alarm information for the thruster
- The status, condition, measurement and alarm information for the thruster motor and associated pumps and valves.

The azimuth thruster process image typically allows you to:

- Start and stop the thruster with or without sequence control
- Manually start or stop the thruster
- Manually control the thruster-propeller azimuth, pitch and/or rpm (speed)
- Manually control the auxiliary equipment of the thruster.

The main propulsion process image usually gives:

- The status, condition, measurement and alarm information for the main propulsion unit
- The status, condition, measurement and alarm information for the thruster engine and associated equipment.

The main propulsion process image typically allows you to:

- Start and stop the main propulsion unit with or without sequence control
- Manually control the main propulsion-propeller rpm (speed), and/or pitch
- Manually control the auxiliary equipment of the main propulsion unit.
- Optionally, control the rudder angle.

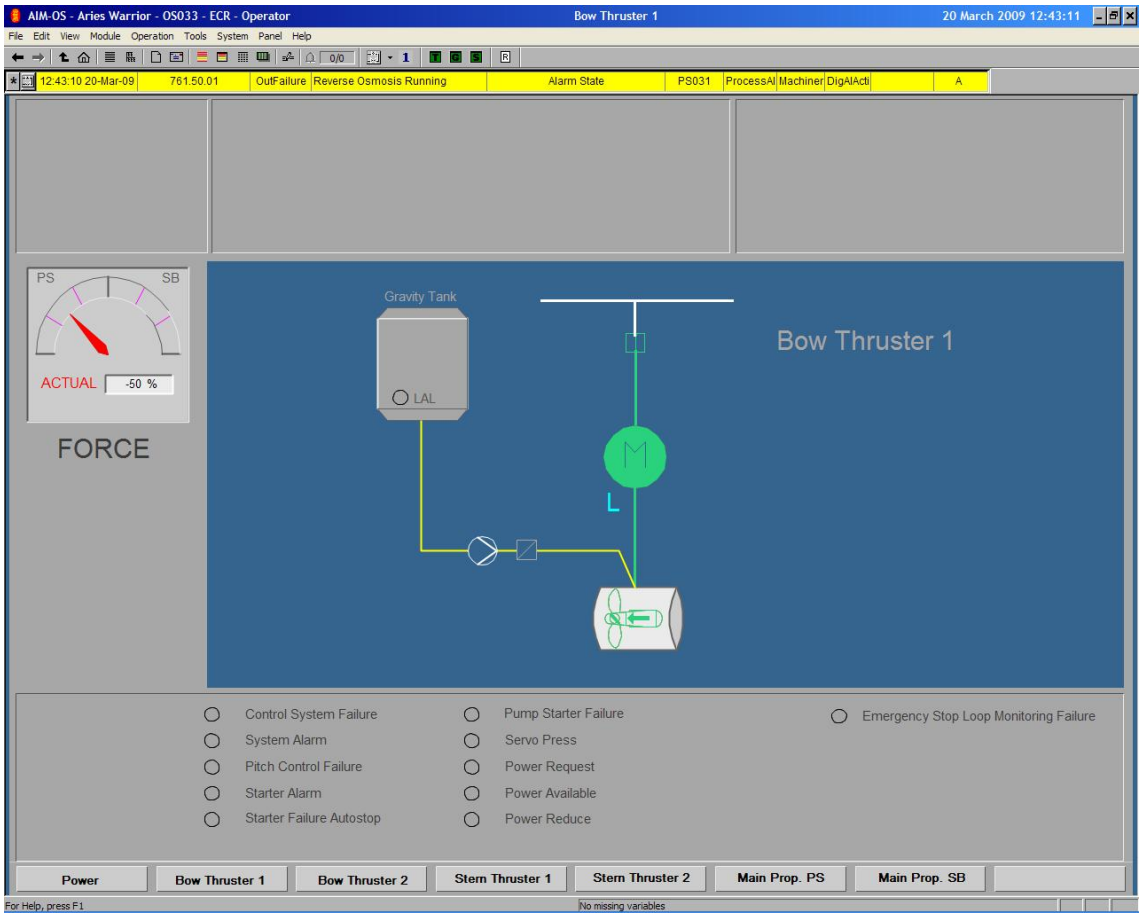
These lower level process images can be viewed by:

- Clicking a hot spot on the thruster/propulsion process image or, where applicable, one of the other lower level process images
- Using the navigator. Refer to the **Toolbars** section in the **Operator Station** topic, in the online AIM user guide.
- Clicking the **NAVIGATOR (VIEW MAP)** button in the operator panel.

5.2 Tunnel thruster process image

A typical tunnel thruster process image is shown in the following figure.

Figure 66 Typical tunnel thruster process image



This tunnel thruster process image is divided into several areas that show the subsystems of the tunnel thruster. What is shown depends on the type of thruster and which type of control (pitch and/or rpm) is available.

The thruster electrical motor, current consumption and winding temperature measurements can be shown.

The auxiliary hydraulic equipment, pump status, fluid pressure levels and temperature measurements can be shown.

Note

If a tunnel thruster is enabled and controlled by a K-Pos or K-Thrust system, the K-Chief 700 Maintenance mode is disabled. However, when the thruster motor is stopped, the K-Chief 700 system can be used to test the thruster start/stop sequences. In general, this only affects the auxiliary equipment of the thruster, the thruster is not started.

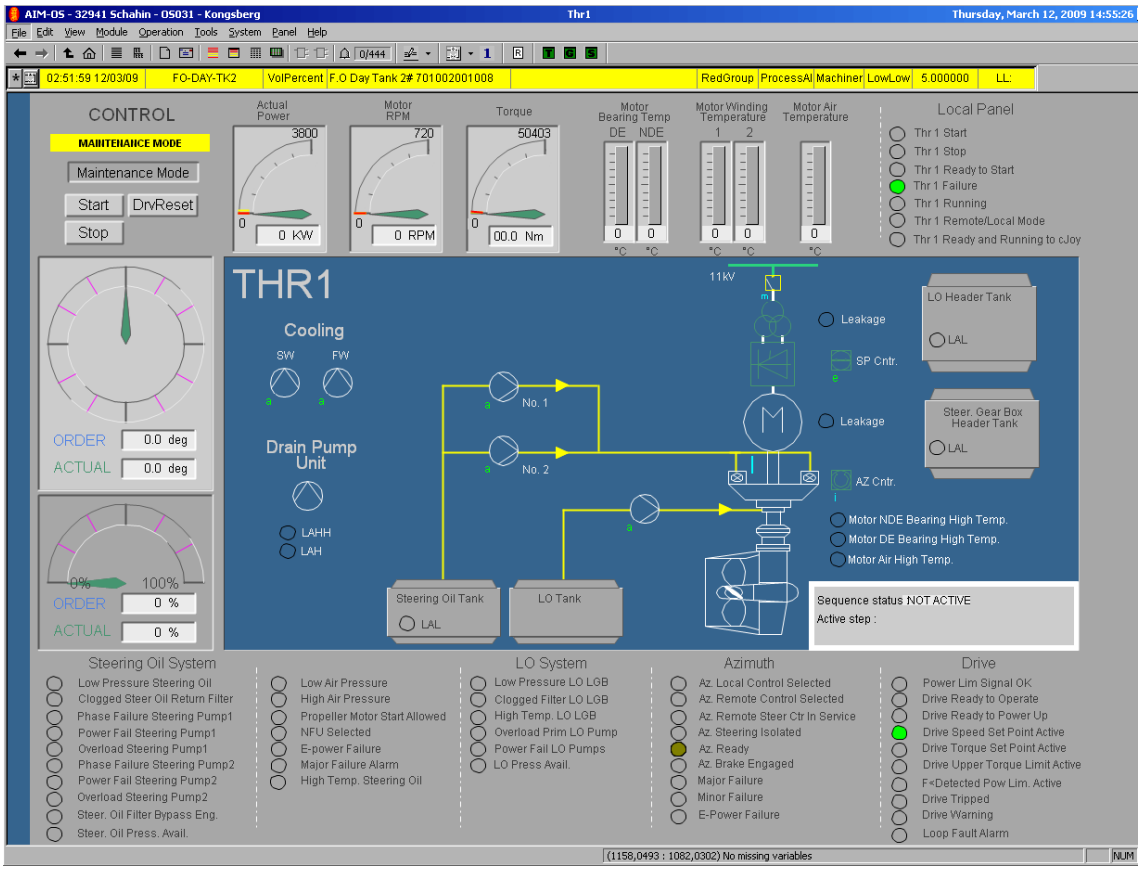
The thruster control mode, the controls for manual and sequence control, and the pitch and/or rpm measurements can be shown.

A number of status indicators may appear on the image to indicate operational and fault conditions. If there is not enough space, these will be placed on a separate Thruster Safety Process image.

5.3 Azimuth thruster process image

A typical azimuth thruster process image is shown in the following figure.

Figure 67 Typical azimuth thruster process image



This process image is divided into several areas that give you information about the subsystems of the azimuth thruster. The contents of the process image depend on the type of thruster and control (azimuth, pitch and/or rpm) available.

The thruster electric motor, current consumption and winding temperature measurements can be shown.

The auxiliary hydraulic equipment, pump status, fluid pressure and temperature measurements can be shown.

The thruster control mode plus facilities for manual and sequence control together with azimuth, pitch and/or rpm measurements may be shown.

Note

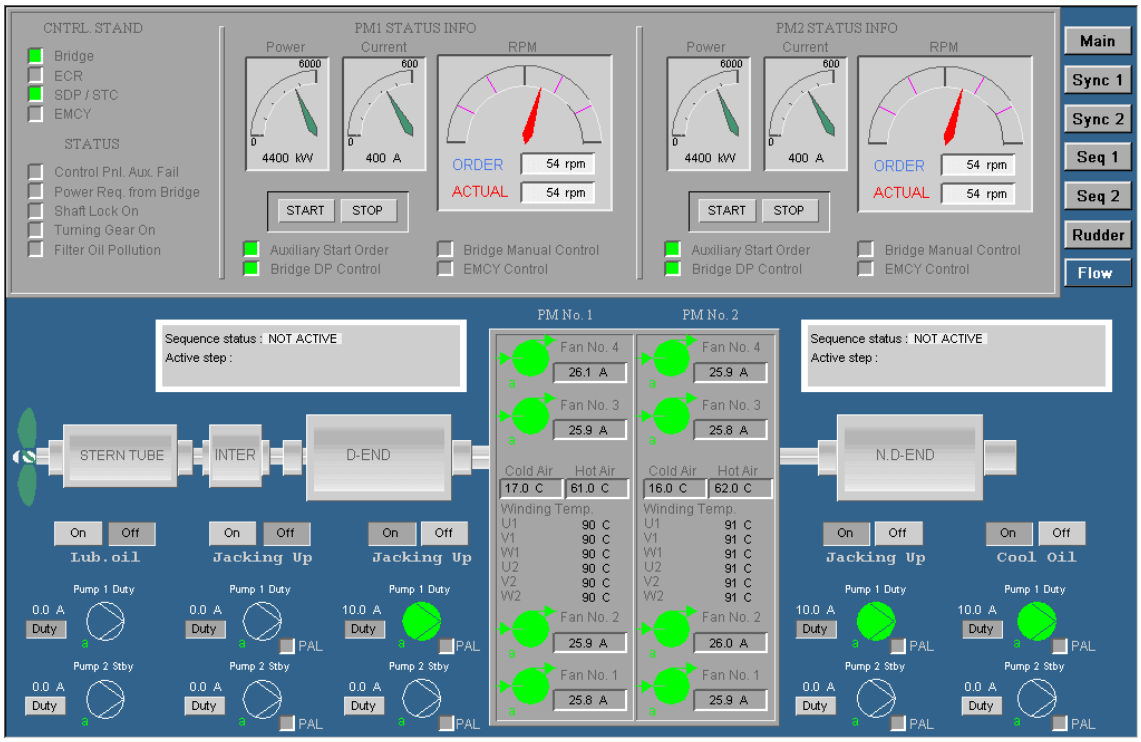
If an azimuth thruster is enabled and controlled by a K-Pos or K-Thrust system, the K-Chief 700 Maintenance mode is disabled. However, when the thruster motor is stopped, the K-Chief 700 system can be used to test the thruster start/stop sequences. In general, this only affects the auxiliary equipment of the thruster, the thruster is not started.

Status indicators can be shown in the process image to indicate operational and fault conditions. If there is not enough space, these indicators are placed on a separate thruster safety process image.

5.4 Main propulsion process image

A typical main propulsion process image for an electrically driven system is shown in the following figure.

Figure 68 Typical electrical main propulsion process image



This process image is divided into several areas that give you information about the subsystems of the main propulsion unit. The contents of the process image depend on the type of main propulsion unit and type of control (rpm and/or pitch or rudder) available.

For an electrical driven main propulsion unit, the motor together with bearing, temperature and winding temperature measurements, and pump and cooling fan status may be shown.

For a mechanically driven main propulsion unit, the following information is given:

- The thruster engine exhaust gas temperature and deviation
- Liner and bearing temperatures
- Crankcase pressure.

In addition, the following information can be given:

- Temperature and pressure of fuel oil
- Temperature and pressure of lubrication oil
- Temperature and pressure of cooling water
- Temperature and pressure of the charge air
- Temperature and pressure of the starting air.
-

For controllable pitch propellers (CPP), the following information is shown:

- The auxiliary hydraulic equipment

- Hydraulic pump status
- Pressure and temperature of the hydraulic fluid

Optionally, the following information can be shown:

- The main propulsion unit control mode
- Controls for manual and sequenced control
- Pitch and/or rpm measurements
- Rudder position measurements.

Status indicators can be shown on the process image to indicate operational and fault conditions. If there is not enough space, these are shown on a separate main propulsion safety process image.

5.5 Thruster/propulsion control

The local thruster/propulsion controllers are installed close to the thruster/propulsion drive units. They control and monitor the drive units and auxiliary equipment.

5.5.1 Thruster start/stop sequences

When the **K-Thrust** console gives a thruster start and stop request, a sequence of checks is done before the thruster is started or stopped.

Before starting the thruster, start interlock conditions such as brakes or critical process alarms are checked. If no such conditions are present, the **Ready to start** lamp is lit. If there is not enough electrical power capacity available, the K-Chief 700 system automatically requests the PMS application to start another generator. Any auxiliary equipment is started and the thrust is set to zero. If all of the process conditions are correct, the drive motor starts, if the thruster is not set in the **Maintenance** mode. If the thruster fails to start before the start timeout expires, a **Start failure** alarm is given.

The stop sequence:

- Reduces the thrust to zero
- Stops the thruster drive motor
- Stops the auxiliary pumps.

If the thruster does not stop before the thruster stop timeout expires, a **Stop failure** alarm is given.

5.5.2 Auxiliary equipment control

The auxiliary equipment supported by the K-Chief 700 system depends on the configuration of the thruster/propulsion system installed on your vessel.

The most common types of auxiliary equipment are:

- Hydraulic valves

- Hydraulic pitch pumps
- Hydraulic azimuth/steering pumps
- Lubrication pumps
- Cooling water pumps
- Cooling fans.

Starting and stopping the pumps and fans and opening and closing the valves is normally part of the automatic thruster/propulsion start and stop sequences. These sequences are initiated from the **K-Thrust** console. In the **Maintenance** mode, you can control the auxiliary equipment using the applicable module operation menu. Refer to section on page .

Pumps that are critical to the process can have a redundant standby pump. The standby pump logic is incorporated into the K-Chief 700 thruster/propulsion application.

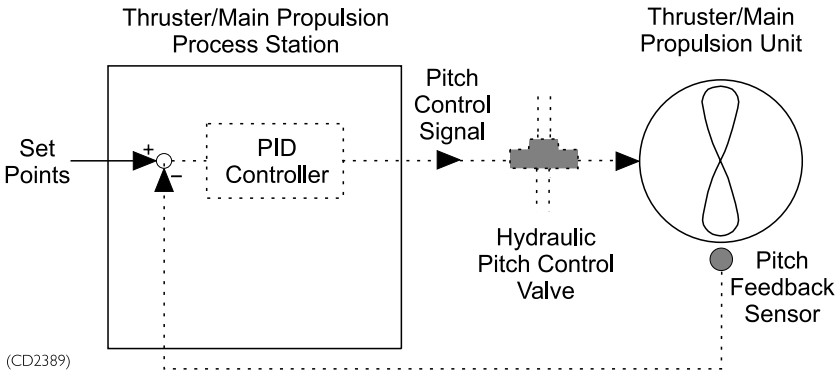
5.5.3 Pitch control

Servo control of the pitch can be done internally through the control logic in the applicable process station, or externally by a Local Control Unit.

If the process station for the thruster/main propulsion contains the pitch servo loop, the setpoints are received from the K-Thrust/K-Pos or K-Chief 700 system through the network. A PID controller compares the pitch feedback from the thruster/main propulsion unit against setpoint value from the K-Thrust/K-Pos or K-Chief 700 system and controls the hydraulic pitch valve accordingly. Refer to the section *PID controller modules* on page 74.

The principle of pitch follow-up (servo) control via a thruster/main propulsion Process Station is illustrated in the following figure:

Figure 69 Servo control of the pitch by a process station



Manual pitch control, which is implemented by means of the commands on the PID controller module operation menu, is only possible in the Maintenance mode. Refer to the *Maintenance mode* on page 119 and *Typical procedures* on page 120.

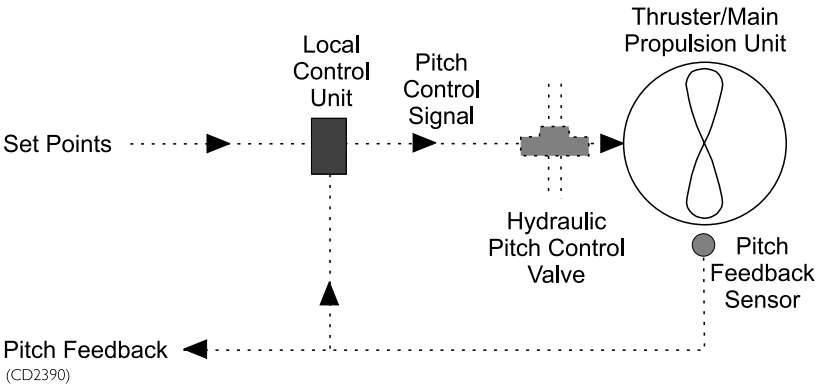
If, after a predefined timeout period, no more setpoints are received by the thruster/propulsion Process Station, the pitch is automatically reduced to zero. The pitch setpoint is also reduced to zero when a thruster/propulsion start or stop is requested.

For electrically driven thrusters the motor current is monitored so that, if it exceeds a specified limit, the pitch is temporarily reduced before it is gradually stepped back to the commanded setpoint.

If the Local Control Unit contains the pitch servo loop, setpoints are received cyclically from the K-Thrust/K-Pos or K-Chief 700 system via the dual communication network. The Local Control Unit compares the pitch feedback from the thruster/main propulsion unit against setpoint value from the K-Thrust/K-Pos or K-Chief 700 system and controls the hydraulic pitch valve accordingly. The pitch feedback from the thruster/main propulsion unit is also sent to the K-Thrust/K-Pos or K-Chief 700 system for monitoring purposes.

The principle of pitch follow-up (servo) control by a Local Control Unit is illustrated in the following figure:

Figure 70 Pitch servo control by a Local Control Unit



Local (non follow-up) control is normally achieved by means of control handles on the local hydraulic-pitch valve control unit or tailor-made control panels interfaced to the hydraulic-pitch valve control unit.

5.5.4 Azimuth control

Azimuth follow-up (servo) control may be performed internally via the control logic in a thruster/main propulsion Process Station or externally by means of a Local Control Unit.

The follow-up (servo) control for the azimuth angle is similar to that described for pitch control. The feedback angle is normally monitored by a sine/cosine potentiometer.

Manual azimuth control, which is implemented by means of the commands on the PID controller module operation menu, is only possible in the **Maintenance** mode.

5.5.5 Speed (rpm) control

Speed (rpm) control is usually always done through a local control unit similar to that used for pitch control.

5.5.6 Maintenance mode

The *Maintenance* mode is used during system installation, maintenance and fault finding, and can be selected for each thruster individually from the Operator Stations.

In the *Maintenance* mode the individual units in the thruster/propulsion system, such as pumps, valves, motors and so on can be checked and manually controlled from the Operator Station. Refer to section on page .

Tuning and adjustments of pitch, rpm and azimuth controllers for each thruster or main propulsion unit can be carried out while in the Maintenance mode. Dedicated Trend images will normally be available so that they can be used as an aid when tuning and adjusting pitch, rpm and azimuth controlled thrusters and main propulsion units.

Caution

All pitch and azimuth servo loop controllers are tuned during thruster/propulsion commissioning prior to vessel delivery. Under NO circumstances should any attempt be made to readjust these controllers without first consulting Kongsberg Maritime.

5.5.7 Safety

Emergency Stop buttons that are connected directly to the starter control circuits by hard wiring may be provided for each thruster. If installed, these will normally be located on a panel near the K-Thrust Operator Station.

Control and feedback signals for pitch and azimuth are monitored, and any failure in these signals will normally stop the thruster. The control actions taken depend on the application and the type of thruster system. Deviations outside a specified limit between setpoint and feedback values over a certain time will cause an alarm to be generated. For sine/cosine measurements, an alarm will be generated if the two signals do not match. Equipment protection systems can shutdown the thruster unit. refer to the KFDD or equipment FDS.

5.5.8 Zero pitch

The Zero pitch control function is only available for pitch controlled tunnel thrusters. This function, which is usually enabled by a **ZERO PITCH FUNCTION** button in the Thruster Process image, automatically sets the pitch of a stopped thruster to zero.

Normally, when a thruster is stopped, its pitch setting is maintained. However, when the Zero pitch control function is enabled, it checks the pitch and if it is other than zero, the function automatically starts the hydraulic pumps, reduces the pitch to zero and then stops the hydraulic pumps.

5.5.9 Alarm monitoring

Alarms in the Propulsion Control application images are monitored and displayed in the same way as for all other images (Refer to the *Alarms and messages* topic in the online AIM user guide).

5.6 Typical procedures

The following procedures are examples and only intended to illustrate the interaction between the operator and the Propulsion Control application for typical tasks.

Note

The operation menus may differ depending on the software version of the function module in question.

5.6.1 Changing pitch

The following procedure tells you how to change the pitch setpoint for a thruster or main propulsion unit propeller.

It is assumed that no alarms or other conditions blocking the operation of the thruster or main propulsion unit, are active.

If the thruster/main propulsion pitch can be operated using a **SET PITCH** button, proceed as follows:

1 Display the appropriate Thruster or Main Propulsion Process image.

2 Observe the displayed information for the thruster or main propulsion unit.

3 If applicable, ensure that the Operator Station has command control of the thruster command group (Refer to the *Command Control* topic in the online AIM user guide).

4 If the thruster is under K-Thrust/K-Pos control, click the **DP CONTROL/MAINTENANCE MODE** toggle button on the Thruster Process image.

The *Maintenance* mode is selected for the thruster or main propulsion unit.

5 Start the necessary auxiliary machinery.

6 Make sure that the thruster motor is not running.

7 Click the **PITCH CONTROLLER** button/symbol.

The numeric input dialog box appears.

8 Change the displayed value to the required pitch value (in positive or negative %) and click the **OK** button.

The Numeric input dialog box is closed and the ordered pitch symbol changes to indicate the entered value.

As the pitch of the propeller changes to the given pitch value, the pitch symbol shows the new pitch value.

5.6.2 Changing azimuth

The following procedures tell you how to change the azimuth setpoint for an azimuth thruster.

It is assumed that no alarms or other conditions blocking the operation of the thruster or main propulsion unit, are active.

If the thruster/main propulsion pitch can be operated using a **SET AZIMUTH** button, proceed as follows:

1 Display the appropriate Azimuth Thruster Process image.

2 Observe the displayed information for the thruster.

3 If applicable, ensure that the Operator Station has command control of the thruster command group (Refer to the *Command Control* topic in the online AIM user guide).

4 If the thruster is under K-Thrust/K-Pos control, click the **DP CONTROL/MAINTENANCE MODE** toggle button on the Thruster Process image.

The *Maintenance* mode is selected for the thruster or main propulsion unit.

5 Start the necessary auxiliary machinery.

6 Make sure that the thruster is not running.

7 Click the **SET AZIMUTH** button/symbol.

A **Numeric input** dialog box is displayed.

8 Change the displayed value to the required azimuth value (0 to 360) and then click the **OK** button.

The **Numeric input** dialog box closes and the azimuth symbol shows the new value.

As the azimuth angle of the thruster changes to the given value, the azimuth symbol shows the new value.

6 Redundancy and Criticality Assessment System

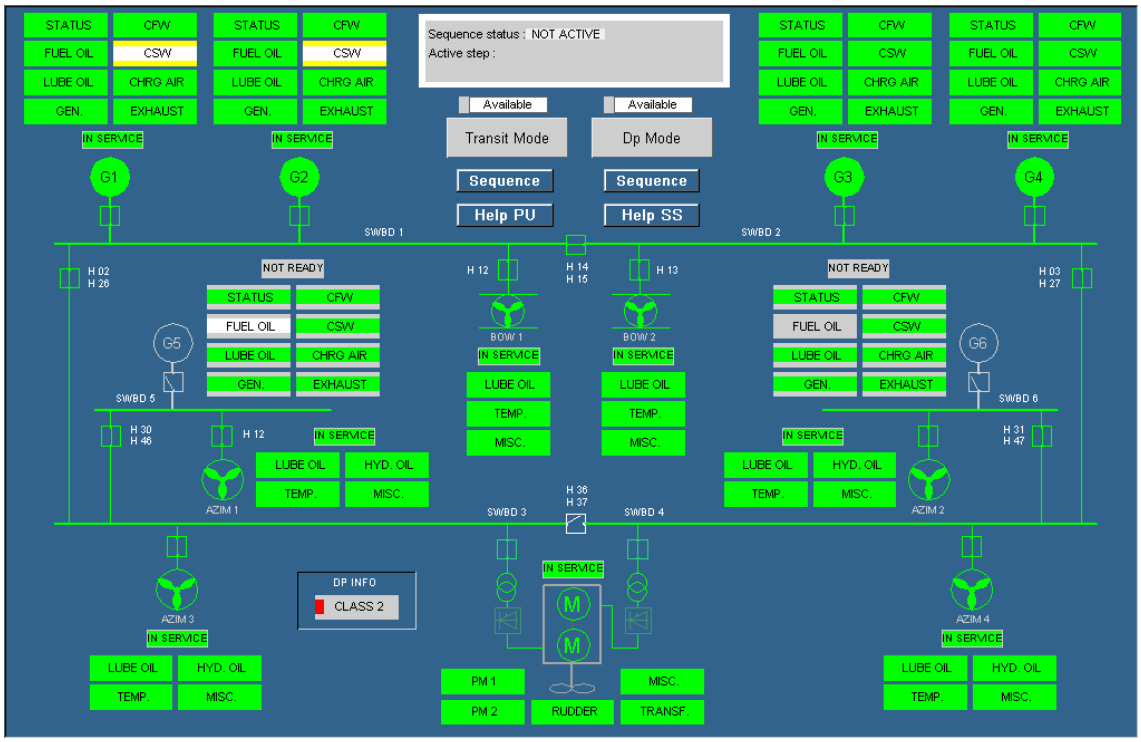
The Redundancy and Criticality Assessment (RCA) System is an integrated on-line fault monitoring and criticality assessment tool that monitors and confirms that the resources required for a specific operational control mode are available.

The RCA application software first verifies that all involved equipment is correctly set up for the intended Vessel Control mode. Then, when it is running, it continuously checks that it is healthy and functioning correctly. The software also monitors and reports the status of all standby equipment to provide an overall redundancy status. If a malfunction is detected, the software reports the situation according to the criticality of the event.

The RCA System Process image provides facilities for operational mode control and visualises the status of the involved equipment. This visualisation is achieved by means of Process Unit (PU) symbols that represent machinery (such as thrusters, generators with power buses and main engines) together with subsystem (SS) symbols that represent the various auxiliary systems associated with each PU. From this image you can select vessel control modes and monitor the status of the involved equipment via the PU and SS status indicators.

The following figure shows a typical RCA System Process image:

Figure 71 Typical RCA System Process image



6.1 User interface

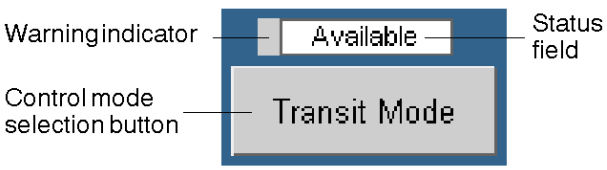
The user interface for the RCA application is divided into the following main parts:

- Mode control
- Equipment state
- Mode transfer
- Event presentation (optional).

6.1.1 Mode control

The Mode control part of the user interface comprises various control mode selection buttons each with an adjacent status field as shown in the following figure:

Figure 72 Control mode selection button and status text field



These buttons allow you to:

- Select the initial Vessel Control mode provided that the required equipment is running
- Deselect the selected Vessel Control mode and enter the "no Vessel Control mode"
- Change the selected Vessel Control mode and start an equipment start/stop sequence program

Provided that all the required equipment is running and the applicable equipment state requirements have been met, you can select the initial Vessel Control mode by means of the appropriate control mode selection (toggle) button.

When a vessel control mode selection button is clicked, a control mode confirmation dialog box, with the name of the clicked button following the word Operate, is displayed.

In the example shown in the following figure, the Transit control mode selection button has been clicked.

Figure 73 Confirm operation dialog box for control mode

Clicking the **Yes** button activates the control mode selection, whereas clicking the **No** button terminates the selection (without any action). Both of these actions also close the dialog box.

The selected control mode may be deselected or another control mode selected in the same manner.

6.1.1.1 Vessel Control mode state

The state of each Vessel Control mode is indicated by the text and the background colour in the status field adjacent to each control mode selection button.

The Vessel Control mode states indicated by the text and background colour of the control mode selection button status field are listed in the following table:

Table 5 Vessel Control mode state indications

Status Field Text	Status FieldColour	Vessel Control Mode State
Not Ready	Grey	One or more of the PUs required for the mode are not in a legal state. This means the *Vessel Control* mode cannot be selected.
Ready	White	The equipment state requirements, that must be fulfilled to allow the Vessel Control mode to be selected, have been met. When the *Vessel Control* mode is selected, a predefined sequence of equipment start/stop will be performed provided that an automatic mode control program is applied.

Table 5 Vessel Control mode state indications (cont'd.)

Status Field Text	Status FieldColour	Vessel Control Mode State
Blocked	Grey	The control mode is blocked, i.e. the *Vessel Control* mode cannot be selected due to the current system set up, or because another mode is in the selected state. The required system set up is defined during the configuration of the *Vessel Control* mode modules.
In Service	Green	The equipment state requirements have been fulfilled and the selected *Vessel Control* mode is running.
Invalid	Red	The *Vessel Control* mode has changed to **Invalid** because one or more of the equipment state requirements was not fulfilled when **In Service** was activated or because the equipment start/stop sequence program has aborted. If an "invalid" state occurs after a mode has been established, the mode requirements are kept. This means the power system requirements will be maintained if, for example, one of the thrusters fails. The "invalid" state will change to "ready" or "not ready" when another mode is selected.
Selected	Yellow	The *Vessel Control* mode has been selected but not fully established, i.e. the equipment start/stop sequence program is still being performed.
Terminating	Yellow	An exit is being made from the *Vessel Control* mode (an equipment start/stop sequence for entering another control mode is in progress).
Available	White	All conditions and equipment state requirements for *Vessel Control* mode selection are fulfilled (required equipment is already "in service"). The equipment start/stop sequence program must be started to enter the mode. Any equipment that is not required for the mode is automatically stopped.

The states indicated by the colour of the warning indicator at the left-hand end of the status field are listed in the following table:

Table 6 Mode Control state indications

Indicator Colour	Warning State
Magenta	PU or one or more SSs tripped, or conditions exist that will quickly implement a trip.
Red	Major fault in the PU or one or more SSs. For example, a High High (HH) or Low Low (LL) alarm condition, as defined in the appropriate RCA-PU or RCA-SS State Diagram. Refer to the section *State diagrams* on page 130.
Yellow	Minor fault in the PU or one or more SSs. For example, a High (H) or Low (L) alarm condition, as defined in the appropriate RCA-PU or RCA-SS State Diagram (Refer to the *State diagrams* on page 130) is active. SS requirements warning . Refer to the on page and on page .
Cyan	The required SS standby equipment is "not ready".

Details of the equipment state requirements for each *Vessel Control* mode can be viewed by displaying the **Module Parameters** dialog box (Refer to the *Process images* topic in the online AIM user guide) for the module symbol of the corresponding *Vessel Control* mode status text field.

6.1.2 Equipment State

The Equipment State part of the user interface allows you to monitor the overall status of all the PUs and associated SSs that are involved with the various *Vessel Control* modes.

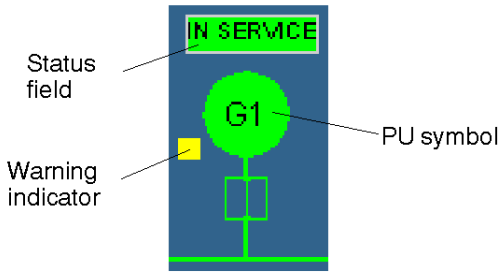
Each PU and each of the associated SSs are controlled by special RCA modules whose tag names are prefixed with "pu_" for PUs and "ss_" for SSs.

6.1.2.1 Process Unit status

The current state of the equipment monitored by a PU (pu_) module is indicated by means of the colour of the PU module symbol, a status field and a warning indicator.

The arrangement of these status indications for a generator is shown in the following figure:

Figure 74 PU status indications



The state of each PU is indicated by the colour of the PU symbol, the text and the background colour in the status field adjacent to the PU symbol, and the warning indicator.

The states indicated by the PU symbol colour together with the texts displayed in the status field are listed in the following table:

Table 7 Process Unit state indications

PU Symbol Colour	Status Field Text	Process Unit State
Green	**IN SERVICE**	The PU is "in service", i.e. it is running correctly with all SS requirements fulfilled.
White	**READY**	The PU is "ready to start", i.e. all SS conditions for "ready to start" are fulfilled.

Table 7 Process Unit state indications (cont'd.)

PU Symbol Colour	Status Field Text	Process Unit State
White	**STANDBY**	The PU is "in standby" (only indicated if the PU has a standby state).
Grey	**NOT READY**	The PU is "not ready" for operation, i.e. the PU or one of its SSs are "not ready".

Note

The background colour of the status field is always the same as the colour of the PU symbol.

The states indicated by the colour of the warning indicator are listed in the following table:

Table 8 Process Unit warning indications

Indicator Colour	Warning State
Magenta	PU tripped or conditions exist that will quickly implement a trip.
Red	Major fault in the PU. For example, a High High (HH) or Low Low (LL) alarm condition, as defined in the appropriate RCA-PU State Diagram (Refer to the*State diagrams* on page 130) is active.
Yellow	Minor fault in the PU. For example, a High (H) or Low (L) alarm condition, as defined in the appropriate RCA-PU State Diagram (Refer to the *State diagrams* on page 130) is active. SS requirements warning (Refer to the on page and on page).

6.1.2.2 Subsystem status

The current state of the equipment monitored by a subsystem (ss_) module is indicated by means of the background colour of the four fields that make up the SS module symbol as shown in the following figure:

Figure 75 Subsystem state indications

Field A indicates the subsystem state (Refer to the *Sub-system states indicated by Field A* on page 128).

Field B indicates (in order of priority):

— Not required (highest priority)

— Tripped warnings

— Major warnings

— Minor warnings.

Field C indicates (in order of priority):

— Standby equipment not ready warnings (highest priority)

— Tripped warnings

— Major warnings

— Minor warnings.

Note

Field C is only used when Field B indicates "Not required".

Field D indicates (in order of priority):

— Standby equipment not ready warnings (highest priority)

— Not required

— Tripped warnings

— Major warnings

— Minor warnings.

If more than one warning is active, the warning with the highest priority is always indicated.

The subsystem states indicated by the colour of Field A are listed in the following table:

Table 9 Sub-system states indicated by Field A

Colour	Subsystem State
Green	The SS is "in service", i.e. the critical criteria for "SS running" are fulfilled.
White	The SS is "ready to start", i.e. the critical criteria for "SS ready" are fulfilled.
Grey	The SS is "not ready" for operation, i.e. one or more of the critical criteria for "SS running" or "SS ready" are not correct.

The sub-system warnings indicated by the colour of Fields B, C and D are listed in the following table:

Table 10 Subsystem states indicated by Fields B, C and D

Colour	Warning State
Magenta	SS tripped, or conditions exist that will quickly implement a trip.
Red	Major fault in the SS. For example, a High High (HH) or Low Low (LL) alarm condition, as defined in the appropriate RCA-SS State Diagram (Refer to the*State diagrams* on page 130) is active.
Yellow	Minor fault in the SS. For example, a High (H) or Low (L) alarm condition, as defined in the appropriate RCA-SS State Diagram (Refer to the *State diagrams* on page 130) is active.
Cyan	The required SS standby equipment is "not ready".

Table 10 Subsystem states indicated by Fields B, C and D (cont'd.)

Colour	Warning State
Grey	There are no active requirements for the SS.
Same colour as Field A	There are no warnings.

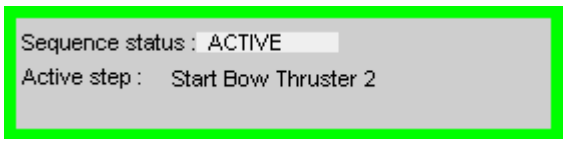
The current state of the PU and SS equipment can also be viewed by selecting the appropriate level of Process image for the particular items of equipment. For example, the Generator Set Process image for a diesel generator.

Details of the equipment state requirements for each PU and SS can be viewed by displaying the **Module Parameters** dialog box (Refer to the *Module Editor* topic in the online AIM user guide) for the module symbol of the corresponding PU or SS.

6.1.3 Mode transfer

The Mode transfer part of the user interface is managed by a multiple (top-level) control sequence that has a separate control sequence and Sequence Process image for each *Vessel Control* mode. All of these *Vessel Control* mode control sequences are controlled by a common Sequence Administrator module (Refer to the *Sequence administrator module* on page 80) which is represented as shown in the following figure:

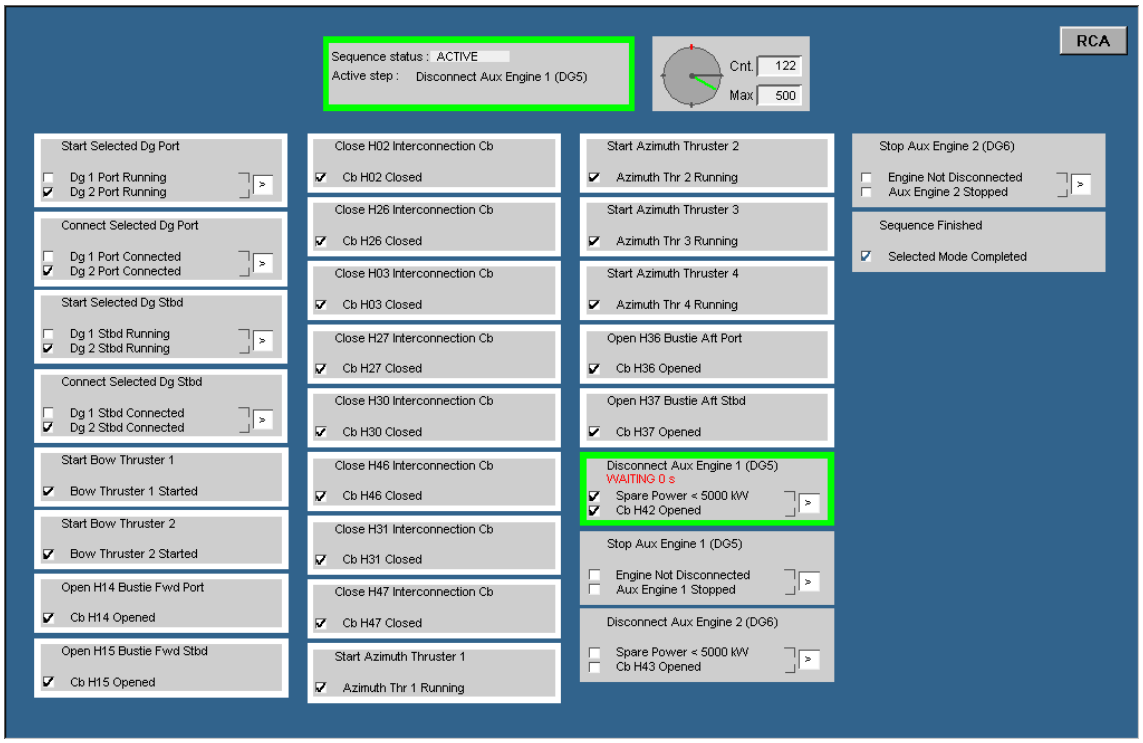
Figure 76 Sequence Administrator



The Sequence Process image for each *Vessel Control* mode can be displayed by means of a **Sequence** hot spot, located next to the corresponding control mode selection button.

An example of a typical Sequence Process image for a *Vessel Control* mode transfer is shown in the following figure:

Figure 77 Typical Vessel Control mode transfer Sequence Process image



6.1.4 Event presentation

RCA historic events may be presented by displaying the Event List image and selecting the **Historic Event Page** (Refer to the *Event system* topic in the online AIM user guide). If provided, the **Historic Event Page** can be displayed by clicking the **RCA EVENTS** button on the RCA System Process image.

In order to only display the alarms and events related to the RCA system, you must change the active event filter to the "RCA mode" group filter by selecting **Group: Mode_RCA** in the drop-down text box of the Filter selector on the Event List image toolbar.

6.2 State diagrams

The state diagrams constitute the basis for the state composition of the PU and SS modules. Each PU and SS module has its own state diagram whose layout has a fixed format and whose content is used as input for the configuration of the RCA system. It should be noted that the layout of a RCA-PU state diagram is slightly different to that of a RCA-SS state diagram.

The state diagrams are prepared as part of the engineering work and are automatically integrated into the K-Chief 700 system software.

An example of a completed RCA-PU state diagram is shown in the following figure:

Figure 78 RCA-PU state diagram

Vessel		Vessel Name	PCU #	5	vsn 1.0
Tag name		pu_G1P	Red PCU #		RCA-PU STATE DIAGRAM
Level		RCA_PU			
Revision		06/01/98			IN SERVICE / UNIT IN STANDBY / UNIT READY TO START / TRIPPED / MAJOR FAULT / MINOR FAULT
Comments		This is PU for Generator 1 Port, with several subsystems.			
				OP1	1v2 / 1&2 / 1&2 / 1&2 / 1&2 / 1&2
Unit name		GENERATOR 2		OP2	& & & & & & & & & & & & v v v v v v

Tag	PCU	Description	TermName	Test	Cause & Effect matrix
DG1P	5	DG1P LOCAL/REMOTE	ReadySt		X X
DG1P	5	DG1P RUNNING	Running		X X
DG1P_CB	5	DG1P CIRCUIT BREAKER	OutClosed		X C
DG1P_CB	5	DG1P CIRCUIT BREAKER	CBTripped		C X
DG1P.072	5	DG1P SHORT CIRCUIT	Meas1		X
dg1_stblk	5	Start Block (PLC)	OutStBlk		C
THR3.077	5	THR3 CB CLOSED	OutClosed		X C
DG1P	5	DG in standby selected	Standby		X
DG1P_CB	5	DG1P CIRCUIT BREAKER	ReadyClose		X
############		END line must always be inserted			

An example of a completed RCA-SS state diagram is shown in the following figure:

Figure 79 RCA-SS state diagram

Vessel		Vessel Name	PCU #	5	vsn 1.0
Tag name		ss_G1P_CW	Red PCU #		RCA-SS STATE DIAGRAM
Level		RCA_SS			
Revision:		06/01/98			OPERATION OK / READY TO START / STBY SYST AVAILABLE / TRIPPED / MAJOR FAULT / MINOR FAULT / SPARE
Comments:		This is Main Gen. 1 Sub System Cool Water.			
				OP1	1v2 / 1v2 / 1v2 / 1v2 / 1v2 / 1v2
Unit name		CoolW		OP2	& & & & & & & & v v v

Tag	PCU	Description	TermName	Test	Cause & Effect matrix
DG1P.023	5	DG1P HT CW OUTLET TEMP SHD	ShutDwn		X
DG1P.024an	5	DG1P HT CW OUTLET TEMP	H		X
DG1P.025an	5	DG1P HT CW INLET PRESS	L		X
DG1P.026an	5	DG1P LT CW INLET PRESS	L		X
DG1P.064	5	DG1P WATER LEKEAGE IN GENERATC	Meas1		X
PUMP43.01	3	LT FW PUMP PORT NO1	OutRunning		X C
PUMP43.01	3	LT FW PUMP PORT NO1	NotRemInt		X X
PUMP43.01	3	LT FW PUMP PORT NO1	OutCtrMode		X
PUMP44.01	3	LT FW PUMP PORT NO2	OutRunning		X C
PUMP44.01	3	LT FW PUMP PORT NO2	NotRemInt		X X
PUMP44.01	3	LT FW PUMP PORT NO2	OutCtrMode		X
############		END line must always be inserted			

Notation used:

R - required
W - warning
I - Don't care/Ignore
Empty - don't care

Subsystem requirements according to PU state

	Pu in service	PU Ready to start	PU in standby
Subsystem in Service	R	I	R
Subsystem Ready to start	I	R	R
Subsyst. Stby equipment Ready	W	W	W

The information contained in the fields of the two state diagrams is expanded in the following three tables:

- describes the information contained in the “Header" part of the RCA-PU and RCA-SS State Diagrams.
- describes the information contained in the “Matrix" part of the RCA-PU and RCA-SS State Diagrams.
- describes the information contained in the “Subsystem requirements” part of the RCA-SS State Diagram.

Table 11 Header part of RCA-PU and RCA-SS State Diagrams

Information field	**Used in K-Chief 700 System**	**Data Type**	**Description**
Vessel	no	text string	Identification of system/vessel.
Tag name	yes	text string	Used as tag name for the module.
Level	yes	fixed text string “RCA-PU" or “RCA-SS"	Used to define module type, “RCA-PU” - Process Unit “RCA-SS” - Subsystem
Revision	yes	date string (e.g. yy/mm/dd)	Included in the module.
Comments	no	text lines	For diagram construction use only.
PCU#	yes	integer > 0 (PCU no.)	PCU for which a configuration file has been made. The corresponding SS module is located in this PCU.
Red PCU#	yes	integer > 0 (PCU no.)	The number of the slave PCU for this PCU.
OP1	yes	text string (logical expression)	Logical expression comprising column numbers and operators AND (&) or OR (v). For example, 1v2 which means state OK if column 1 OR column 2 is true. (1&2)v(3&4) which means: state OK if either column 1 AND column 2 or column 3 AND column 4 is true.

Table 11 Header part of RCA-PU and RCA-SS State Diagrams (cont'd.)

Information field	Used in K-Chief 700 System	Data Type	Description
OP2	yes	text string (logical operator “&" or “v")	Logical operator used for the computation of a Boolean value by applying the operators AND (&) or OR (v) between all used digital input values marked as included in this column of the “Cause & Effect matrix". Note that fields marked with “C" are inverted (complemented) before they are used.
State labels (IN SERVICE etc.)	no	—	Defined states used by this RCA module.
Unit name	yes	text string	Denotes the actual PU or SS. For PUs the syntax is <equipmentname> <equipmentnumber>

Table 12 Matrix part of RCA-PU and RCA-SS State Diagrams

Information Field	Used in K-Chief 700 System	Data Type	Description
Tag	yes	text string	“Tag" (name), “PCU" and “TermName" together define an incoming signal that is to be used in the “Cause & Effect matrix". It must correspond to a tag name and an output terminal for a module configured in the K-Chief 700 system.
PCU	no (not required)	integer > 0 (PCU no.)	PCU number for the signal with the tag “TagName" and the signal name “TermName". (For information only).

Table 12 Matrix part of RCA-PU and RCA-SS State Diagrams (cont'd.)

Information Field	Used in K-Chief 700 System	Data Type	Description
Description	yes	text string	Copy of the description from the K-Chief 700 signal database. (Used for the creation of a Help file).
TermName	yes	text string	Corresponds to the terminal name of a module with the tag "TagName" that is configured in the K-Chief 700 system.
Test	no	character (“ " (blank), “0" or “1")	Values used for internal validation in the diagram (if requested by the user). Not yet implemented.
Cause & Effect fields	yes	character (“X", “C" or “ (blank))	Input signals corresponding to fields marked with “X" are taken into account for the Boolean value for the column. For fields marked with “C", the input signal is inverted first. (Typically used for alarms.)
End Line	yes	##########	This line terminates the module terminal connection lines and is used by the generation process.

Table 13 Subsystem requirements part of RCA-SS State Diagram

Information Field	Used in K-Chief 700 System	Data Type	Description
Subsystem in service	yes	character (“R" - required, “W"- warning “I" - Ignore or ” “(blank) - don't care)	These three fields define how the SS is required to operate for the various states of the PU.
Subsystem ready to start	yes	character (“R" - required, “W"- warning “I" - Ignore or “ “(blank) - don't care)	These three fields define the required “ready to start" conditions for the various states of the PU.
Subsystem standby equipment Ready	yes	character (“R" - required, “W"- warning “I" - Ignore or ” “(blank) - don't care)	These three fields define the SS standby equipment that must be ready to operate for the various states of the PU.

6.2.1 Failure analysis

The first step of a failure analysis is to check the RCA System Process image for “Mode” failures and “Equipment State" failures. After this, the specific events generated by the RCA system should be checked.

In the situation where a selected Vessel Control mode fails, the first reason for the failure will be reported in the event database and shown in the Historic Event Page of the Event list image (Refer to the *Event list images* on page 27). The PU that fails and the SS that causes the failure will also report an event. In addition, the reason for failure can also be viewed by displaying the Module Parameters dialog box (Refer to the Module Editor topic in the online AIM user guide) of the PU and SS modules concerned.

An example of the RCA events that result when a Vessel Control mode is running and then fails, is shown in the following figure:

Figure 80 RCA Events for a Vessel Control mode failure

Time	Tag	Description	State	Value	Terminal	Cmd Group	Station	Priority	Type	Red
05:22:51 23/05/01	Dpmode	# GEN. on SWBD 1 not ok	Void	On		RCA	PCU11	UnPri	ProcMsg	
05:22:51 23/05/01	Dpmode	Dpmode ABORTED	Void	On		RCA	PCU11	UnPri	ProcMsg	
05:22:51 23/05/01	pu_G1P	Fail: OPER. OK	Void	On		RCA	PCU05	UnPri	ProcMsg	
05:22:51 23/05/01	ss_G1P_CW	OPER. OK -> READY	Void	On		RCA	PCU05	UnPri	ProcMsg	
05:22:51 23/05/01	ss_G1P_CW	Fail: OPER. OK	Void	On		RCA	PCU05	UnPri	ProcMsg	
05:22:50 23/05/01	ss_G1P_CW	Fail: In6 PUMP43.01/OutRunning	Void	On		RCA	PCU05	UnPri	ProcMsg	
05:22:50 23/05/01	Dpmode	Dpmode now IN SERVICE	Void	On		RCA	PCU11	UnPri	ProcMsg	
05:22:50 23/05/01	Dpmode	Transfer to Dpmode OK.	Void	On		RCA	PCU11	UnPri	ProcMsg	

Note

The events have been filtered to show only RCA events. This is achieved by creating an alarm filter (e.g. Group: Mode_RCA) that allows only events from the RCA Command group to be displayed (Refer to the Event system topic in the online AIM user guide).

The above example shows the RCA events that are generated when the DP *Vessel Control* mode is selected and running, and then suddenly the generator cooling water pump (PUMP43.01) stops.

This causes the “Generator 1 Port" PU module to report that the pump is "not running" and the corresponding Cooling Water SS to report both an error and a state change. This, in turn, causes the DP *Vessel Control* mode module to report a mode failure. The mode control module also causes the DP *Vessel Control* mode status text field to indicate **Invalid**.

7 Cargo and Ballast Control

The Cargo and Ballast Control application is a monitoring and control facility covering onboard liquids such as ballast and liquid cargo fluids.

It comprises the following stand-alone functions:

- **Cargo Control** provides monitoring of cargo liquids and control of cargo handling equipment
- **Ballast Control** monitors the tank levels of all vessel fluids used as ballast and controls the pumps and valves of the vessel's ballast system
- **Load and Stability Calculator** is an application running either on a separate dedicated Load and Stability Calculator PC, which may communicate with the K-Chief 700 system by serial line or other interface methods, or on a K-Chief 700 OS as a 3rd party application program. Stability results from the load calculator are presented both at the Load and Stability Calculator and at the Operator Stations.

All monitoring and control functions are available to the operator at each Operator Station. However, operational control will normally be restricted to one specific Operator Station by means of the Command transfer function (Refer to the *Command Control* topic in the online AIM user guide).

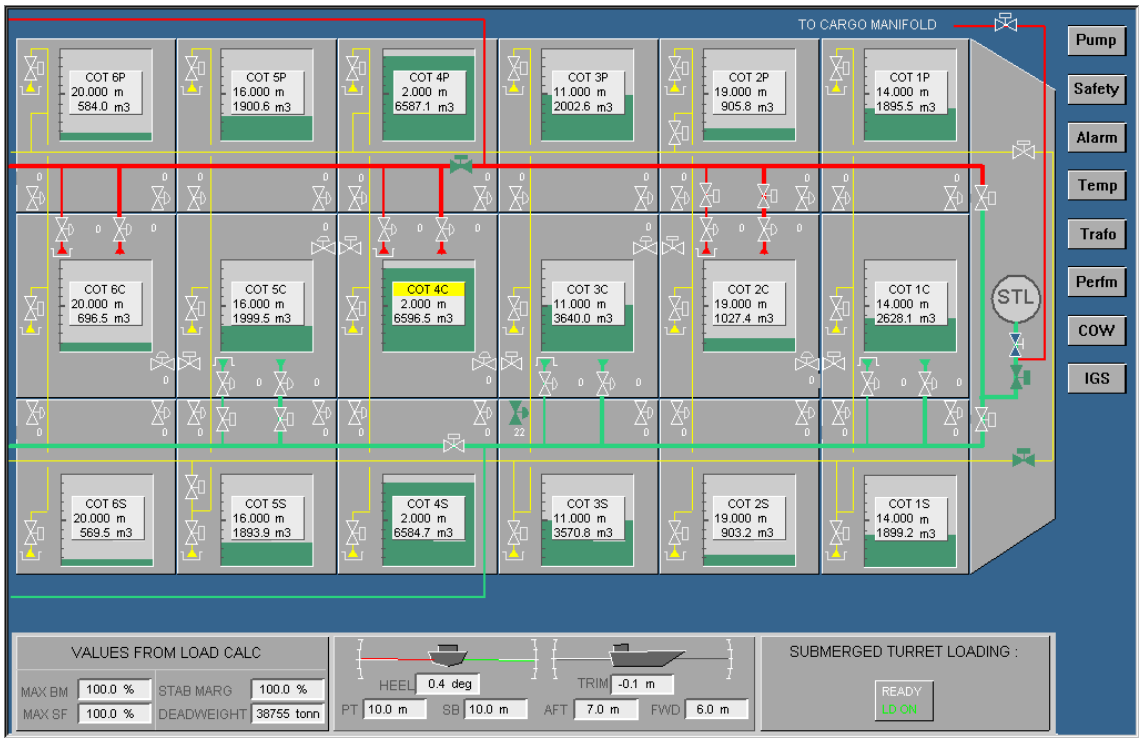
7.1 Cargo Control

Cargo Control usually has two main Process images, one for the tanks and the other for the pumps.

From the Cargo Tank Process image you will be able to monitor the cargo fluid levels, temperatures and pressures within each tank, and control the valves for filling, emptying and stripping the tanks.

A typical Cargo Tank Process image is shown in the following figure:

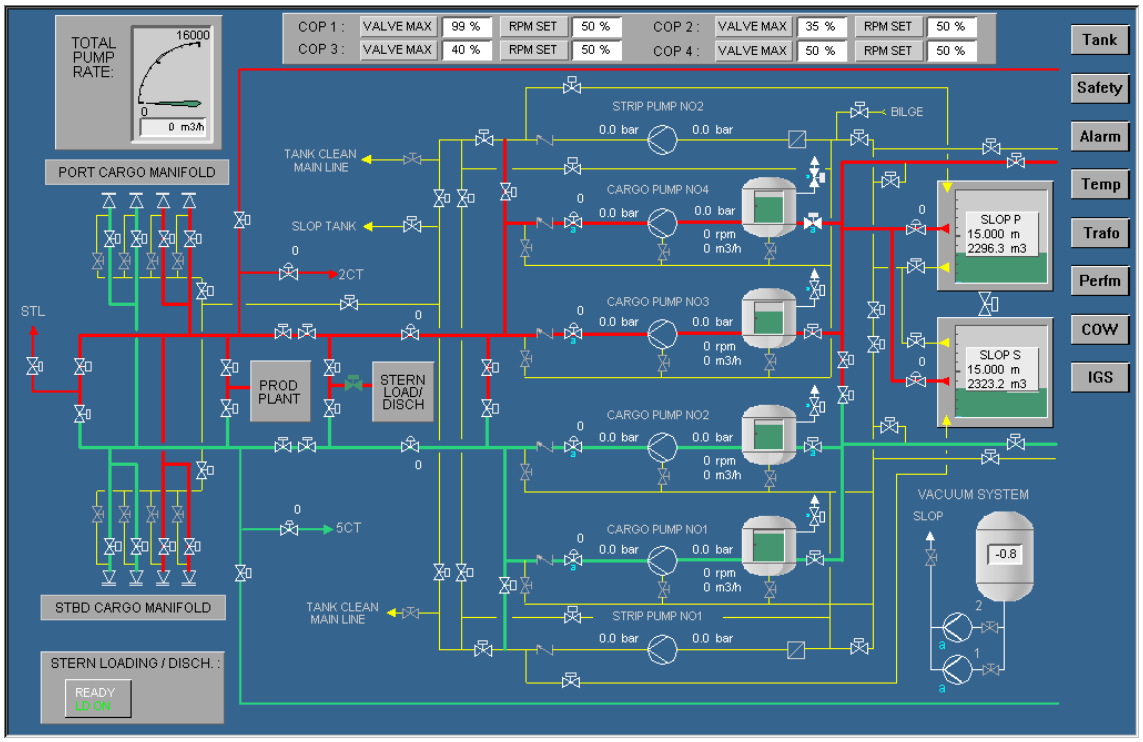
Figure 81 Typical Cargo Tank Process image



From the Cargo Pump Process image you will be able to monitor and control the cargo and stripping pumps together with the valves for routing of fluids to and from the cargo tanks. This image may also allow you to monitor and control some of the auxiliary equipment associated with the cargo pumps.

A typical Cargo Pump Process image is shown in the following figure:

Figure 82 Typical Cargo Pump Process image



Other auxiliary equipment and systems associated with Cargo Control can be viewed in more detail by selecting a second (lower) level Process image. The contents of these lower (second) level Process images will depend on the equipment installed onboard the vessel. For device-specific information, refer to the user documentation for the device.

The Cargo Control function comprises the following:

- Manual control
- Automatic routing.

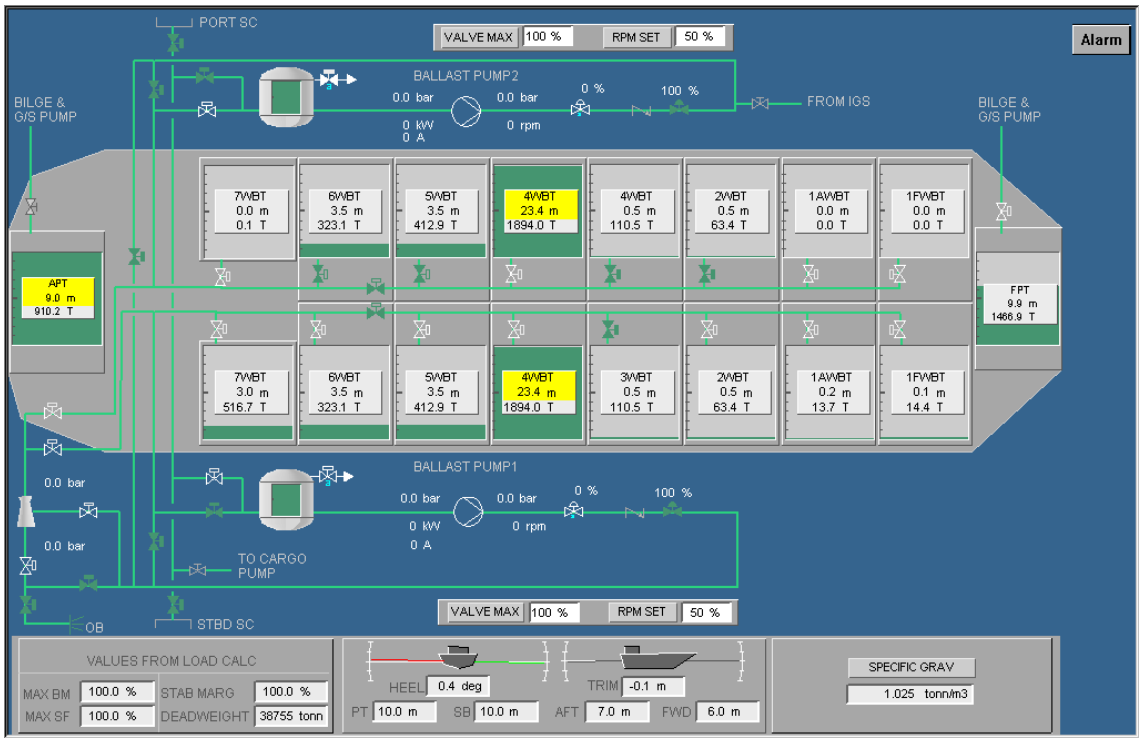
Only the basic functions together with their associated subfunctions are described in the following paragraphs, but other functions may be implemented for special applications.

7.2 Ballast Control and Ballast Exchange

The Ballast Control function usually has one main Process image that visualises the entire ballast system. From this image you can monitor the tank levels of all vessel fluids used as ballast, and control the ballast system pumps and valves. It will also show vessel heel and trim data and, if installed on the vessel, include facilities for communicating with and showing values from an online Load and Stability Calculator.

A typical Ballast Process image is shown in the following figure:

Figure 83 Typical Ballast Process image



System and alarm status can be viewed in more detail by selecting a second (lower) level Process image. The contents of this lower (second) level Process image will depend on the equipment installed on board the vessel.

The Cargo Control function comprises the following:

- Manual control
- Route guidance
- Automatic routing
- Heeling control.

Only the basic functions together with their associated subfunctions are described in the following paragraphs, but other functions may be implemented for special applications.

7.3 User interface

The Cargo and Ballast Process images show the fluid control systems. They comprise tank, valve and pump symbols all of which are interconnected by means of piping and manifolds. You can monitor the status of each device by displaying the images and operate them as required by means of the module operation menus.

The starting and stopping of pumps and the opening and closing of the valves is normally a part of the automatic cargo and ballast tank filling and emptying sequences initiated from the Operator Station.

In the *Manual* operation mode, the pumps and valves can be controlled from the module operation menu for each individual item of equipment (Refer to the on page).

In addition to tank, valve and pump symbols, the images may contain a Global Control module which makes it possible to control the operation of several tanks, pumps and valves simultaneously.

The Cargo and Ballast second (lower) level Process images are displayed using one of the following methods:

- A hot spot on the Ballast Process image or, where applicable, one of the other second (lower) level Process images.
- The Navigator (Refer to the *Toolbars* section in the Operator Station topic in the AIM user guide).
- The **NAVIGATOR (VIEW MAP)** button on the Operator panel (Refer to the *Automation panel layout* on page 36).

7.4 Global Control module

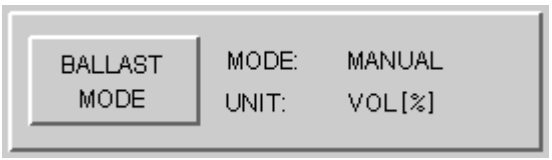
The Global Control module is used to control and monitor the mode, measurement units and status of several tanks, pumps and valves simultaneously.

7.4.1 Symbol

The Global Control module symbol comprises a box with text components that show the current operational state of the function module.

An example of a Global Control module symbol is shown in the following figure:

Figure 84 Global Control module symbol



7.4.2 Status indications

The displayed status text varies depending on the selections made via the commands on the Global Control module operation menu which are described in *Operation menu* on page 142.

The text box at the left of the symbol shows the selected control mode for the function module, i.e. **BALLAST MODE** or **STRIPPING MODE**.

The **MODE**: field shows the selected operating mode, i.e. **MANUAL** or **AUTO**.

The **UNIT**: field shows the units that are being used for the Measured and Requested Level Values in the tank symbols (Refer to the *Symbols* on page 143).

Depending on the selection made, via the Global Control module operation menu, the text displayed in the **UNIT**: field will be one of the following:

VOL%	Percentage of the tank's capacity, occupied by the fluid in the tank.
LEVEL	Height of the fluid in the tank (in m)
VOLUME	Content of the fluid in the tank (in m^3)
WEIGHT	Weight of the fluid in the tank (in tonnes)
ULLAGE	Height of the free space above the fluid in the tank (in metres)
DENSITY	Density of the fluid in the tank (in tonnes/m^3)

7.4.3 Operation menu

Note

The operation menu may differ depending on the software version of the function module in question.

The commands on the operation menu of a Global Control module may be as shown on *Global Control module operation menu* on page 143.

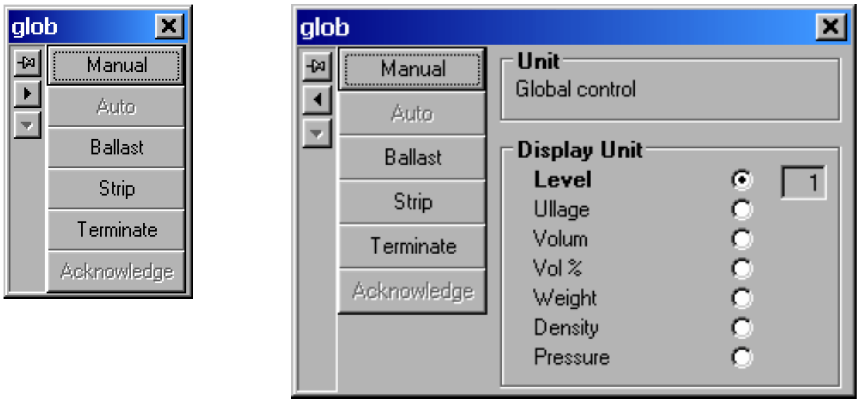
The command buttons allow you to:

- select the ***Manual*** or ***Automatic*** operation modes for the Global Control module. In order to obtain the same result in the *Manual* operation mode as the entry of a single command in the *Automatic* operation mode, you will have to enter several commands (one for each step in the sequence), in the correct order, on different module symbols in the route.
- select the **ballast** command, which reassigns the normal emptying route to the Tank Empty function and cancels any previously selected STRIP command. This command is available both in the *Manual* and *Automatic* operation modes.
- select the **strip** command, which is an operational control mode selector that is used when the ballast tanks need to be completely emptied. This command is available both in the *Manual* and *Automatic* operation modes.
- **terminate** an operation, which stops and cancels all operations that are controlled from the Global Control module. Terminate operations cannot be recovered. This command is only available in the *Automatic*operation mode.
- set the display unit for tank measurements:
  - The `Vol%` command sets the units of the displayed numeric measured values for all tanks to % (percentage) volume of the tank capacity.
  - The `Level` command sets the units of the displayed numeric measured values for all tanks to m (metres).
  - The `Volume` command sets the units of the displayed numeric measured values for all tanks to m^3 (cubic metres).
  - The `Weight` command sets the units of the displayed numeric measured values for all tanks to t (tonnes).

– The `Ullage` command sets the units for the displayed numeric measured values for all tanks to the free space above the fluid which is expressed in m (metres).
– The `Density` command sets the displayed numeric measured values for all tanks to the density of the ballast fluid which is expressed in ton/m^3 (tonnes/cubic metre).

These commands are available both in the *Manual* and *Automatic* operation modes.

Figure 85 Global Control module operation menu



7.5 Tank modules

Within the Cargo and Ballast Process images there are various tank modules that are used to control and monitor the contents of the various Cargo and Ballast tanks. Two main types of tank modules are used - Tank 1 and Tank 3. Tank 1 is a monitoring module, whereas Tank 3 is a control and monitoring module. Tank 3 is normally used together with a Global Control module.

7.5.1 Symbols

The graphic representation of both tank modules comprises text components and a symbol with a graphic level indicator. The piping and manifolds between tanks are not part of the tank module symbol. However, they are related to the symbols in order to show emptying and filling routes.

Figure 86 Tank 1 module symbol

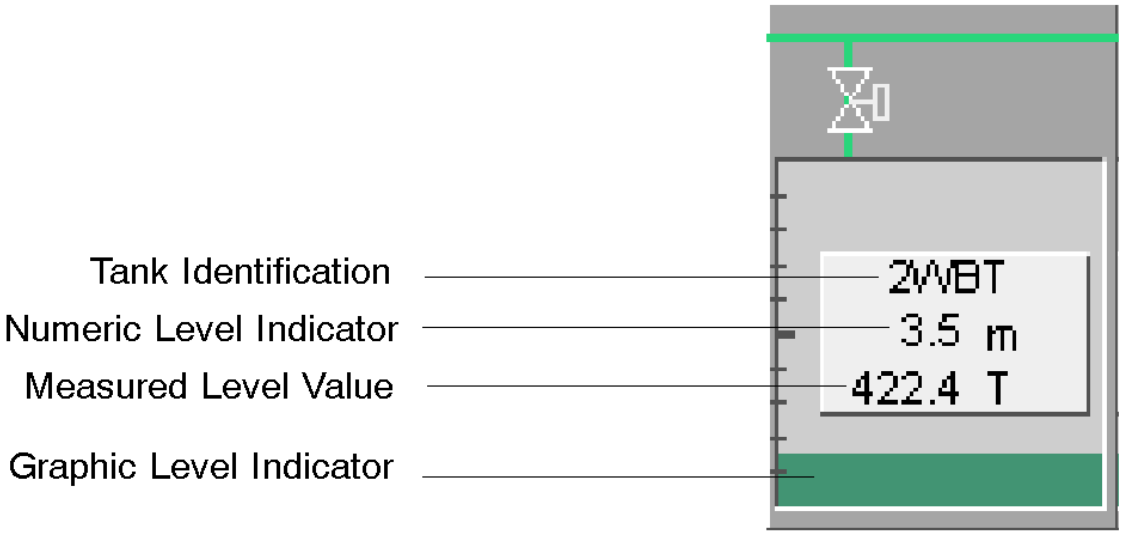
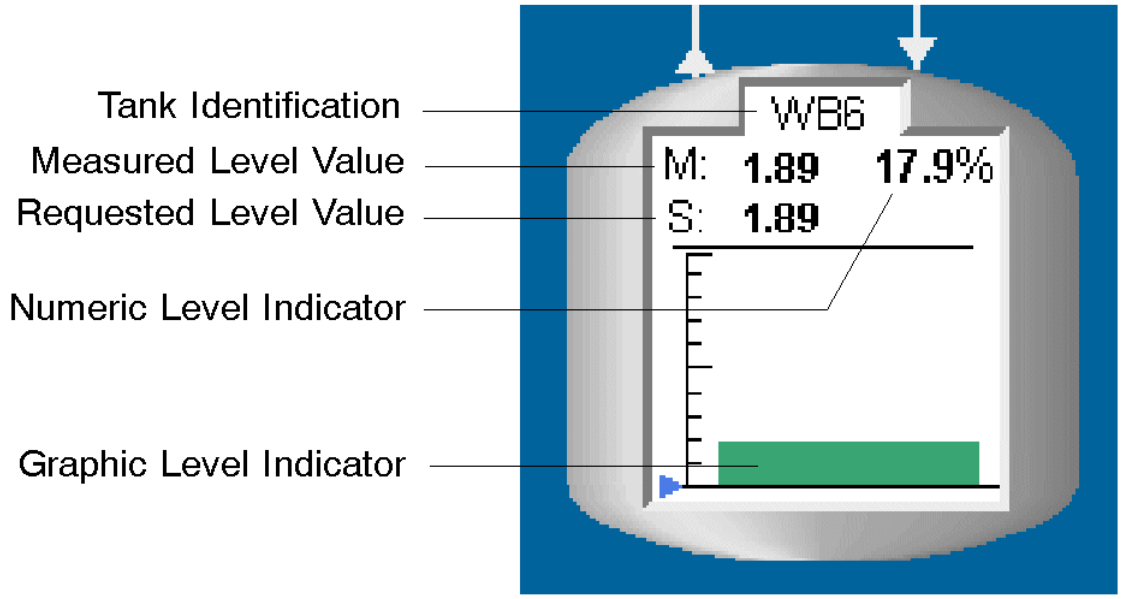


Figure 87 Tank 3 module symbol



The Tank Identification is the unique name of the tank.

The Measured Level Value number represents the measurement performed by the active sensor. The applied measurement depends on the selection made in the Global Control module (for example, VOLUME).

If only one sensor is active, the Measured Level Value expresses the measured level exactly. If two sensors are active, it expresses the mean value of the two measurements.

The colour of the Measured Level Value is normally *Yellow*. However, if no sensors in the tank are active, it intermediately changes colour to *Brown*.

The Requested Level Value number expresses the operator-defined limit for filling or emptying the tank. The applied unit to express this limit depends on the selection made in the Global Control module.

The Numeric Level Indicator shows (numerically) the volume of fluid in the tank.

The Graphic Level Indicator inside the tank symbol shows (graphically) the volume of fluid in the tank relative to its capacity.

7.5.2 Status indications

The colour of the Requested Level Value is *White*.

The colour of the tank symbol outline indicates the operational state for the tank. When no operations are active, the outline is Brown. When an operation has started, the outline is *Green*.

During a Tank Tank operation, the symbol turns *Yellow* when the tank is selected and remains yellow until the operation is started.

7.5.2.1 Tank 3 module operation menu

Note

The operation menu may differ depending on the software version of the function module in question.

The commands on the operation menu of a Tank 3 module may be as shown in *Tank 3 module operation menu* on page 147.

The command buttons allow you to:

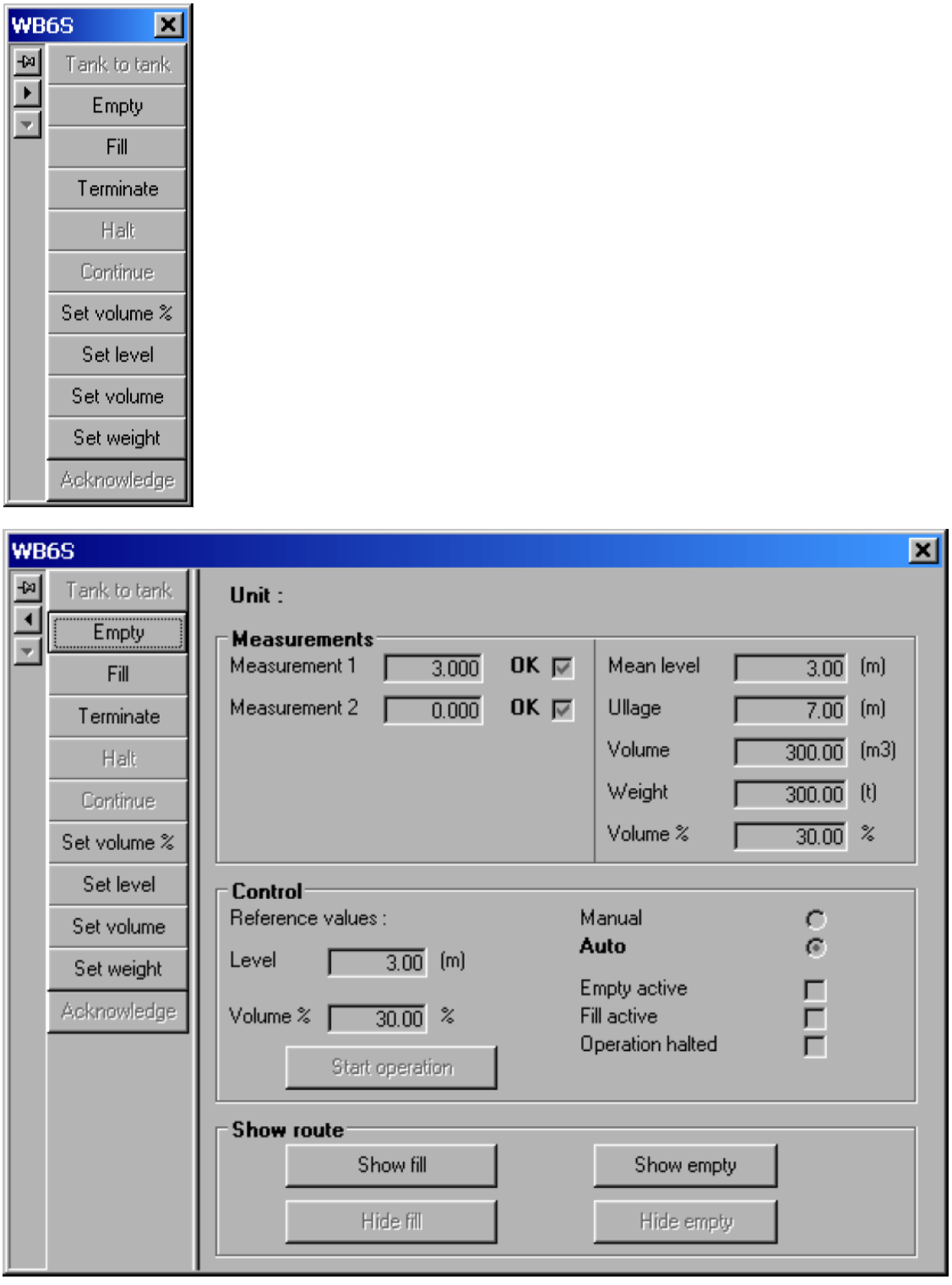
- select the **TankTank** command, which is used to enable the transport of fluid between two tanks (Refer to the *Filling a tank from another tank* on page 152). Alternatively, you can either use the automatic functions Empty and Fill or, in the Global Control *Manual* operation mode, operate each valve and pump in the route in the required order. When the Tank 3 module is used together with a Global Control module, this command is available both in the *Manual* and *Automatic* operation modes of the Global Control module.
- select the **Show/Hide Empty** command, which is a toggle command that allows you to switch between highlighting (show) and turning off (hide) the route that the cargo/ballast fluid is intended to follow when emptying a tank. Clicking `HIDE EMPTY` cancels the effect of a previously selected `SHOW EMPTY` command. When the Tank 3 module is used together with a Global Control module, this command is available both in the *Manual* and *Automatic* operation modes of the Global Control module.
- select the **Show/Hide Fill** command, which is a toggle command that allows you to switch between highlighting (show) and turning off (hide) the route that the cargo/ballast fluid is intended to follow when filling a tank. Clicking `HIDE FILL`

cancels the effect of a previously selected SHOW FILL command. When the Tank 3 module is used together with a Global Control module, this command is available both in the *Manual* and *Automatic* operation modes of the Global Control module.

- select the **Empty** command, which initiates the sequence of operations required to empty the tank. You can interrupt the emptying operation by means of the HALT and TERMINATE commands. When the Tank 3 module is used together with a Global Control module, this command is only available when the *Automatic* operation mode of the Global Control module is selected.
- select the **Fill** command, which initiates the sequence of operations required to fill the tank. You can interrupt the filling operation by means of the HALT and TERMINATE commands. When the Tank 3 module is used together with a Global Control module, this command is only available when the *Automatic* operation mode of the Global Control module is selected.
- select the **Terminate** command, which acts as an emergency stop. It stops and cancels all operations which are controlled from the Tank 3 module. Terminated operations cannot be recovered. When the Tank 3 module is used together with a Global Control module, this command is only available when the *Automatic* operation mode of the Global Control module is selected.
- select the **Halt** command, which suspends the sequence of operations initiated by a complex command. When the Tank 3 module is used together with a Global Control module, this command is only available when the *Automatic* operation mode of the Global Control module is selected.
- select the **Continue** command, which resumes a sequence of operations that have been suspended by the HALT command. When the Tank 3 module is used together with a Global Control module, this command is only available when the *Automatic* operation mode of the Global Control module is selected.
- select the following commands:
  - **Vol%**, which allows you to enter a relative volume setpoint for the fluid in the tank in percentage (%) of the tank capacity. The value acts as a setpoint for automatic tank operations.
  - **Level**, which allows you to enter a level setpoint in m (metres). The value acts as a setpoint for automatic tank operations.
  - **Vol**, which allows you to enter a volume setpoint for the fluid in the selected tank in m^3 (cubic metres). The value acts as a setpoint for automatic tank operations.
  - **Weight**, which allows you to enter a weight setpoint for the fluid in the selected tank in t (tonnes). The value acts as a setpoint for automatic tank operations.

The commands are set via the Numeric input dialog box. When the Tank 3 module is used together with a Global Control module, these commands are only available when the *Automatic* operation mode of the Global Control module is selected.

Figure 88 Tank 3 module operation menu



7.5.3 Routes

The graphic representation of the connections between tank symbols and their inlets and outlets varies according to the route indication requests from a specific tank module. Normally, flow is indicated as opposed to line (pipe) pressure.

The interconnections, including valve and pump symbols which are not part of the requested route, are *Grey*. There is no flow in *Grey* pipes.

When a request to show the route for a specific tank is made, the colour of the relevant pipes, valves and pumps changes to *White*. There is, however, still no flow.

As the emptying or filling operation proceeds, the pipes and manifolds change colour to *Green* to indicate that there is pressure or flow. Note that valves and pumps have their specific colour conventions to indicate the closed/stopped, transient and open/running states.

7.6 Typical procedures

The following procedures are examples and only intended to illustrate the interaction between the operator and the Ballast Control function for typical tasks.

All the procedures assume that you have the Ballast Process image displayed.

Note

The operation menu may differ depending on the software version of the function module in question.

7.6.1 Filling a tank manually

1 Move the cursor over the Global Control module symbol and press the left trackball button.

2 Click **MANUAL**.

The Global Control module operation menu is displayed. The operational mode indicator changes from **AUTO** to **MANUAL**, and the valve and pump module symbols which are controlled from the Global Control module, change from solid to outline.

3 Move the cursor over the module symbol for Tank A and press the left trackball button.

The Tank A module operation menu is displayed.

4 Click **SHOW FILL**.

The filling route is highlighted in white.

5 Move the cursor over the module symbol for the valve in the route which is closest to the tank and press the left trackball button.

The Valve module operation menu is displayed.

6 Click **OPEN**.

The valve operates and changes colour. The part of the route which is filled with ballast fluid changes colour to *Green*.

7 Repeat steps 5 and 6 until all valves included in the route are opened.

It is important to open the valves in the correct order.

8 Move the cursor over the module symbol for the pump and press the left trackball button.

9 Click **START**.

When the pump is running, the entire route changes colour to *Green* to indicate that the fluid is flowing towards the tank.

Dependent on the type of pump, it may be required to execute steps 13 and 14 prior to step 10.

10 When the tank is filled up to the required level, move the cursor over the module symbol for the valve and press the left trackball button.

11 Click **CLOSE**.

12 Repeat steps 10 and 11 until all valves in the route are closed.

13 Move the cursor over the module symbol for the pump and press the left trackball button.

14 Click **STOP**.

The entire route is now white.

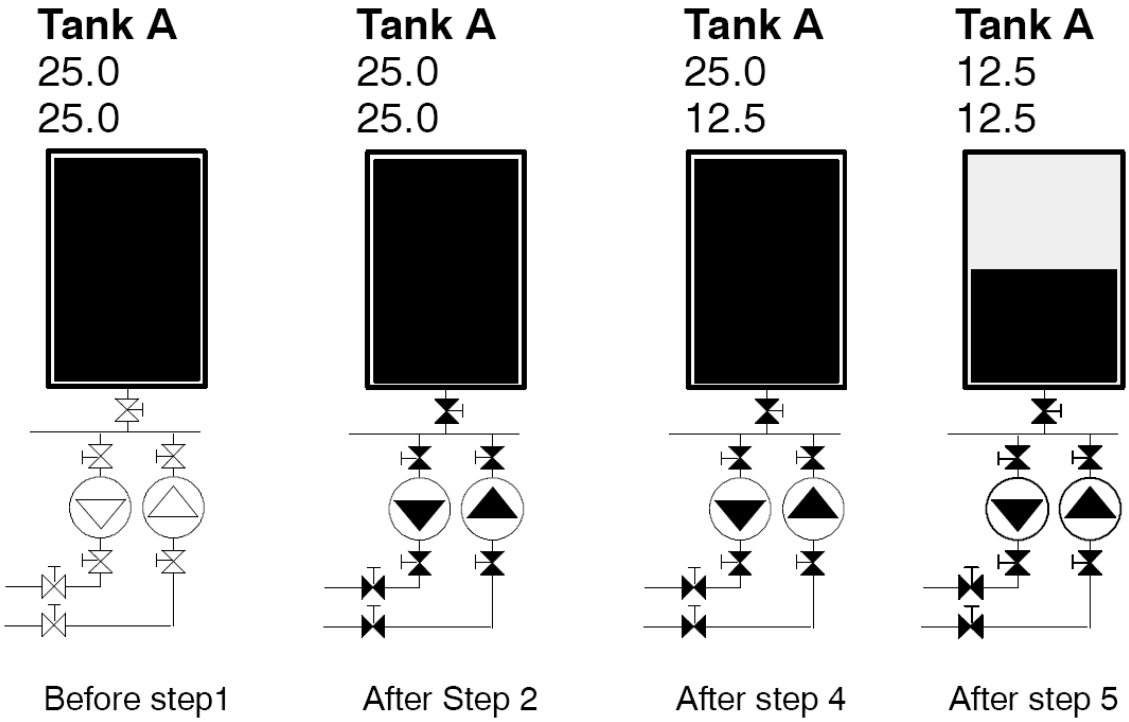
15 Move the cursor over the module symbol for the tank and press the left trackball button.

16 Click **HIDE FILL**.

7.6.2 Automatic emptying to a set limit

This procedure assumes that the Global Control module is in *Manual* operation mode, the selected measurement is **LEVEL** and Tank A is filled up. It describes the interaction required to empty the tank until the fluid occupies only half the capacity of the tank.

Figure 89 Different phases of an emptying operation



1 Move the cursor over the module symbol for the Global Control module and press the left trackball button.

The Global Control module operation menu is displayed.

2 Click **AUTO**.

The operational mode indicator changes from **MANUAL** to **AUTO**, and the valve and pump symbols which are controlled from the Global Control module, change from outline to solid.

3 Move the cursor over the Tank module symbol and press the left trackball button.

The Tank module operation menu is displayed.

4 Click **VOL%** and then enter **50** in the displayed **Numeric input** dialog box, using the numeric buttons on the Operator panel. Confirm by clicking the **OK** button on the dialog box.

The displayed Requested Level Value for Tank A changes to the value which represents 50% of the total tank capacity.

5 Click **EMPTY**.

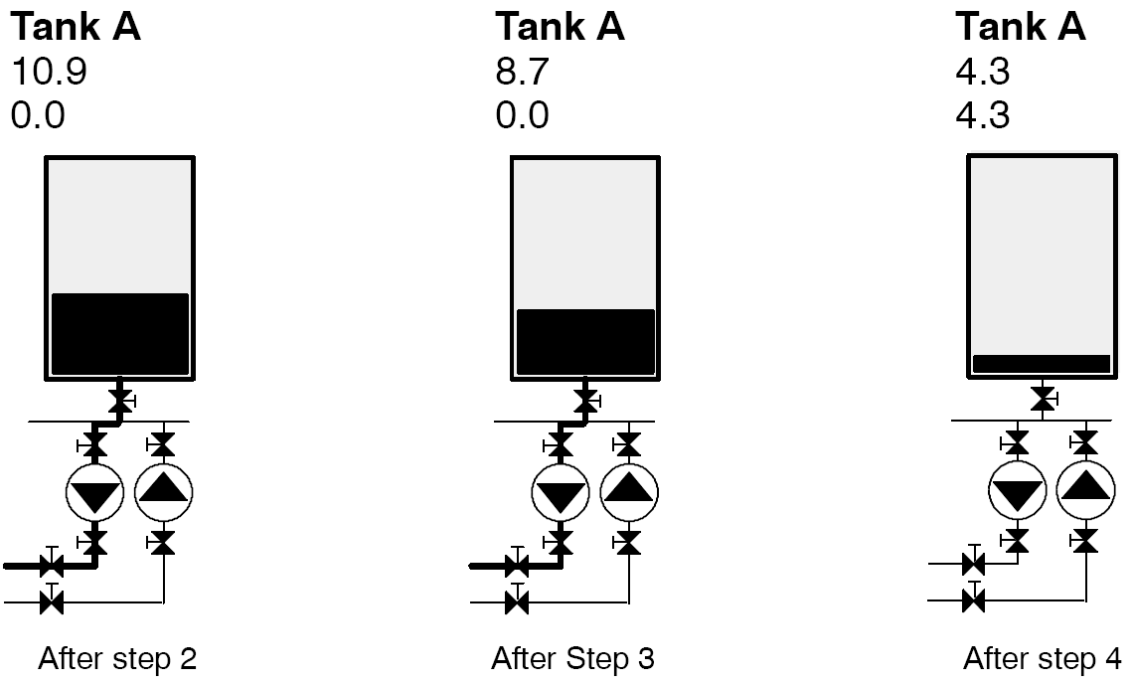
The emptying route is highlighted. Even if the entire system is under pressure, only the route for the selected tank(s) turns Green to give a clear presentation of the flow.

Valve and pump symbols in this route change colour according to their operational status. The route becomes *Green* when there is flow in the pipes. As the requested volume is reached, the valves and pumps operate and the route indication changes colour from *Green* to *Grey* (not highlighted). Note that the Measured Level Value now equals the Requested Level Value.

7.6.3 Interrupting an automatic operation

The start conditions for this procedure are identical with the end status of the automatic emptying procedure. This procedure describes how further emptying is initiated, suspended, resumed and stopped using the commands on the Global Control module operation menu.

Figure 90 Halt, Continue and Terminate commands



1 Click **EMPTY**.

The Requested Level Value changes to **0.0**, the route is highlighted and, as the ballast fluid flows through the pipes, the colour of the route changes to *Green*.

The Measured Level Value decreases gradually.

2 Click **HALT**.

The valve and pump symbols in the emptying route operate, the flow stops and the colour of the route changes from *Green* to *White*.

The route remains highlighted and the Requested Level Value remains unchanged.

3 Click **CONTINUE**.

The valve and pump symbols in the emptying route operate, flow is indicated in the pipes, and the colour of the route changes from *White* to *Green*.

The emptying process is re-established as if step 2 had not occurred.

4 Click **TERMINATE**.

The valve and pump symbols in the emptying route operate, flow in the pipes stops and the colour of the route changes from *Green* to *Grey*.

The route is no longer highlighted and the Requested Level Value is set to the same value as the Measured Level Value.

7.6.4 Filling a tank from another tank

In this procedure, Tank A is filled from Tank B and no Requested Level Value is set in either tank.

1. Move the cursor over the module symbol for Tank B and press the left trackball button.
2. Click **TANK TANK**.

   The tank symbol outline changes colour to Yellow.
3. Move the cursor over the module symbol for Tank B and press the left trackball button.
4. Click **TANK TANK**.

   The tank symbol outline changes colour to Yellow, and the emptying and filling routes between tanks A and B are highlighted.
5. Click **FILL**.

   The Requested Level Value for Tank A changes to its maximum value while the Requested Level Value for Tank B remains unchanged. The filling route for Tank A is highlighted, and valve and pump symbols change colour according to the progression of the filling process. The colour of tank symbols and routes change to *Green* while there is flow in the pipes.

   The operation is automatically terminated whenever the Requested Level Value for Tank A is reached or the Measured Level Value for Tank B becomes **0.00**. At this point the colour route changes to *Grey* and the tank symbols change to *Brown*.

7.6.5 Converting a level value to weight

This procedure assumes that the **UNIT**: field of the Global Control module shows **LEVEL** and the **MODE**: field shows **AUTO**.

1. Move the cursor over the Global Control module symbol and press the left trackball button.
2. Click **WEIGHT**.

   The Requested Level Value and Measured Level Value for all tanks controlled by the Global Control module are recalculated. The new Measured Level Value expresses the weight of the ballast fluid in the tank while the old value expressed the corresponding level of the fluid in the tank.

   Similarly, the Requested Level Value expresses the requested weight which corresponds with the previously requested level.

8 Extended Alarm Systems

8.1 Watch call system

8.1.1 Watch call system overview

Watch call is an alarm extension system to allow critical locations on the vessels to be operated unmanned (during night shift or during loading/offloading etc). Some definitions of the main concepts in the WCS are explained in the table below.

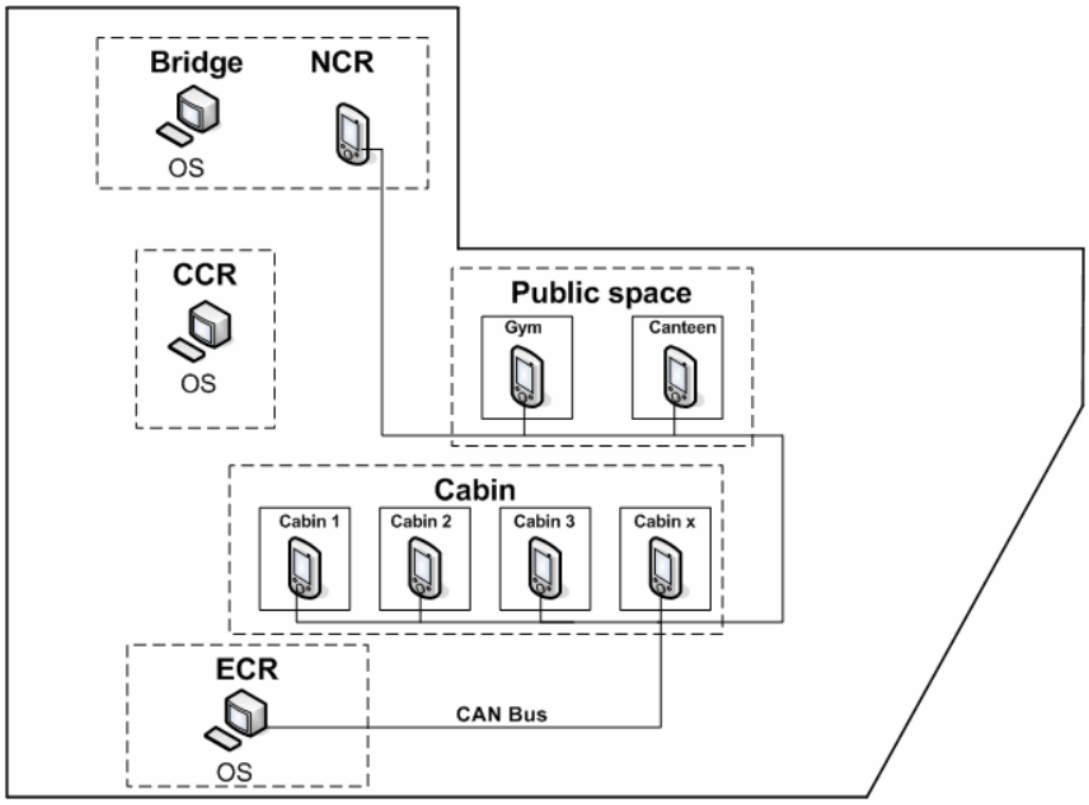
WCU	Watch Cabin Unit: A panel for cabin and public area placement. Where the WBU has controls for watch transfer, the WCU has LEDs to determine the location from which a call is made using the watch call officer calling system.
WBU	Watch Bridge Unit: A panel to be used on the bridge. There is normally only one of these panels in the system. Apart from the normal controls, the WBU also has facilities to reject/accept a watch transfer initiated/requested by bridge. The WBU has call functionality to invoke call duty for engine and cargo.
Duty	Each officer defined in the system is either on or off duty. If he is on duty, he will be so for all his current qualifications
Qualifications	All configured alarm groups are members of one of three possible qualifications: Machinery, Cargo and Navigation.
Dead Man	Also called officer fitness. An alarm group can be defined with special properties that force the alarm to be handled with instant propagation. This can optionally depend on the activation of the watch call tag **DeadManIn**.

UMS	Unmanned Machinery Space, or “ECR, unmanned”. This mode defines that the vessel can operate without operator presence in the ECR. Also called bridge watch, as the bridge maintains supervision with the duty officer responding to process alarms.
Officer Call	The system allows a simple call system (notification and acknowledgement only) that allows bridge and GUI to request the attention of either all officer within a qualification or the sub set that represent those on watch within a qualification.
GUI	Graphical User Interface. The AIM OS has an embedded view that resembles a watch call panel. This panel is for duty assignment and watch transfer. There is normally no physical panel in CCR or ECR.
CAN/CAL	The CAN bus (control area network) is the low level transport protocol used in the WC system. The CAL

	protocol (CAN Application Layer) is an application layer protocol that offers bus master and traffic rules.

8.1.2 Watch call system topology

Figure 91 Watch call system topology



The vessel is fitted with two types of panels. watch bridge unit(s) (WBU) and watch cabin units (WCU). The WBU is installed on the bridge and the WCU are installed in public areas and private spaces (cabins) configured as public and private panels, respectively. Public panels are a collective group of equal panels whereas private panels are associated with either the specific cabin or the role of the person occupying the cabin. All panels are connected using a serial bus called CANBus, which connects all the panels to the two operator stations in the ECR for operational redundancy. The physical bus is not redundant. The two operating stations in the ECR, as well as the operating stations in the NCR and CCR are provided with a graphical user interface for operating and maintaining the watch call system. Restrictions based on the logged in user and location (CCR/NCR/ECR) apply. The GUI is serviced using the normal AIM Process net, so no CANBus is available to the NCR or CCR operator stations.

8.1.3 Watch call operation

The system is not active until an officer is set **On duty**. When this is done, all public panels, bridge panel and duty officer panels are active. All GUIs and active panels reflect the duty assignment by lighting the duty indicator associated with the applicable officer. Alarms within the qualification(s) of that officer are notified to this person using the public panels and the private panel. With an officer on duty, the ECR can request to transfer engine watch to bridge. When the bridge accepts, the bridge assumes a monitoring responsibility. Engine officers cannot be set on/off duty without the bridge first accepting a new request for non-UMS state. It is common practice that, in UMS state, an alarm also triggers the dead man system . This is also known as the patrol man system. While the watch is on bridge, it observes alarm notification and duty officer responding. The bridge panel will reflect when officer acknowledges notifications and alarms. The aim of any such notification is to make the officer acknowledge the alarm on his AIM operator station. Until the alarm is acknowledged, the system propagates the alarm and alerts more officers according to the configuration and timers.

8.1.4 Watch call terminology

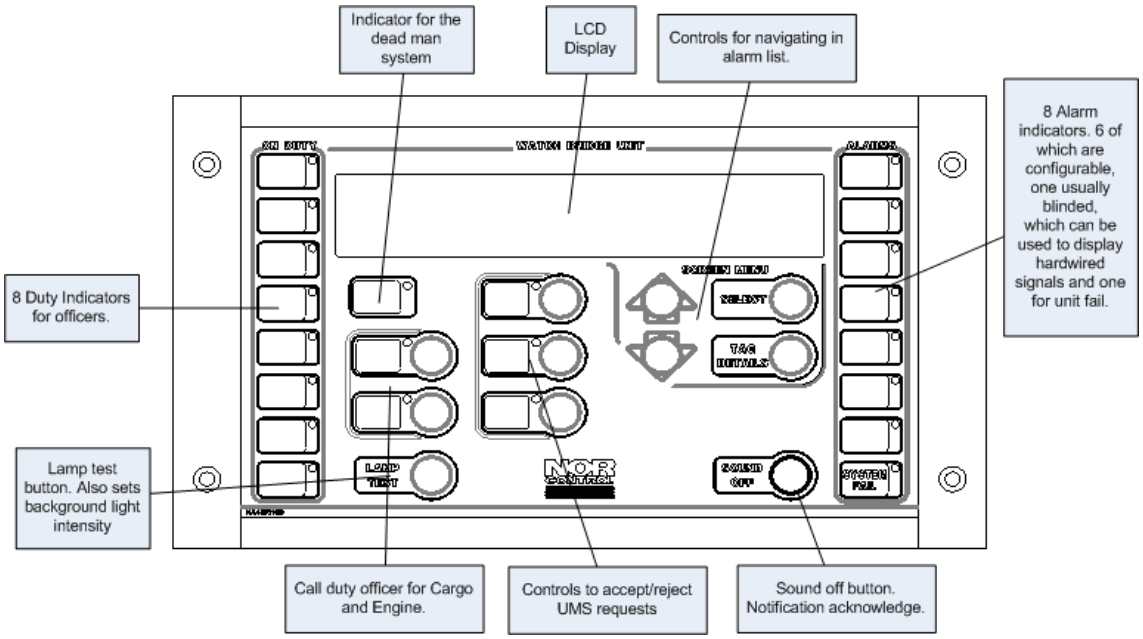
Selected alarms from the process system are associated with alarm groups. Every alarm group is associated with a qualification that may be engine, cargo or navigation. A select number of officers/cabins are defined in the system and associated with one or more qualifications for which they (or the occupant of the cabin) may be responsible. Panels are distributed in private cabins, in offices associated to a particular officer, on the bridge and in designated public areas. The system is normally inactive, and is activated by officers being set on duty from the normal OS GUI at the location responsible for the qualification.

8.1.5 Panels

The panels remain passive until the system is activated (by an officer being set on duty). In active mode, the panels in the public and private spaces for the specific officer are activated and display the alarm state of the systems under the officer's responsibility. In active state, a buzzer sounds when a notification is issued to either the officer on duty or to a group of officers.

The figure below shows the cabin watch panel.

Figure 92 Cabin watch panel



8.1.6 Watch call repeat alarm feature

The repeat alarm feature of the Watch Call System monitors all responses to an alarm condition to ensure that the alarm is acknowledged. The repeat alarm feature distributes the alarms using three sequences to make sure that the alarm does not go unacknowledged:

First alarm

The first alarm is relayed to:

- The area designated as **Watch Responsible**
- The **On Duty** engineers **Watch Cabin Units**
- The **Watch Cabin Units** in all public areas

Second repeat alarm

If the first alarm remains unacknowledged after a set period of time, it is repeated and relayed to:

- The area designated as **Watch Responsible**
- The On Duty engineers **Watch Cabin Units**
- The **Watch Cabin Units** in all public areas

Third repeat alarm

If the alarm is still not acknowledged, after a set period of time, it is repeated and relayed to:

- The area designated as **Watch Responsible**

- The **Watch Cabin Units** for **ALL QUALIFIED** engineers
- The **Watch Cabin Units** in all public areas

8.1.7 Watch bridge unit

8.1.7.1 Explanation of controls and indicators

Two different types of watch bridge units are available:

- The LCD (Liquid Crystal Display) type, with a 4 row by 40 character display and seven alarm groups.
- The LED (Light Emitting Diode) type, with nineteen alarm groups.

The following illustrations describes the main functionality of the two types.

The main difference between the two types is that the LCD type can display individual alarm messages. The LED type has a larger number of alarm groups.

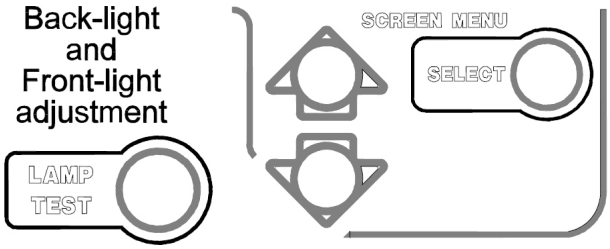
- The LCD type displays the date and time when no one is **ON DUTY**.
- For the LED type all the indicators are dark when no one is **ON DUTY**.
- The repeat alarm function is activated if an alarm is not acknowledged within a set period of time.

8.1.7.2 How to adjust illumination for LCD type panels

1 **Background lighting:** Push **LAMP TEST**, then **SELECT** and use the arrow buttons.

2 **Front lighting:** Push **LAMP TEST** and use the arrow buttons.

Figure 93 Illumination adjustment



8.1.7.3 How to adjust illumination for LED type panels

1 **Background lighting:** Use the arrow buttons.

2 **Front lighting:** Push **LAMP TEST** and then use the arrow buttons.

8.1.7.4 How to test the panel

1 Push **LAMP TEST** to check that the LEDs illuminate and the buzzer sounds.

- If the LEDs remain dark or the buzzer is silent, replace the panel. There are no field serviceable parts inside.

8.1.8 Watch cabin unit

8.1.8.1 How to respond to alarms

When an alarm condition occur the buzzer will sound and the alarm is indicated on the Watch Cabin Unit. Do the following:

1 Push **SOUND OFF**.

2 Read the alarm information on the display or the text next to the indicator.

3 Take appropriate action.

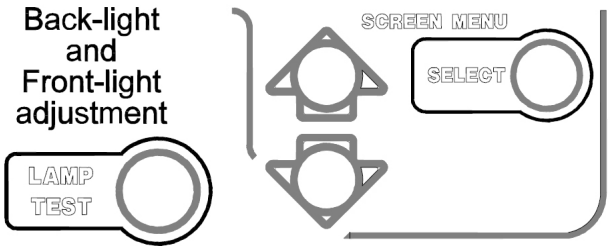
4 Check that the alarm is no longer displayed when the alarm situation no longer exist.

8.1.8.2 How to adjust illumination for LCD type panels

1 **Background lighting:** Push **LAMP TEST**, then **SELECT** and use the arrow buttons.

2 **Front lighting:** Push **LAMP TEST** and use the arrow buttons.

Figure 94 Illumination adjustment



8.1.8.3 How to adjust illumination for LED type panels

1 **Background lighting:** Use the arrow buttons.

2 **Front lighting:** Push **LAMP TEST** and then use the arrow buttons.

8.1.8.4 How to test the panel

1 Push **LAMP TEST** to check that the LEDs illuminate and the buzzer sounds.

- If the LEDs remains dark or the buzzer is silent, replace the panel. There are no field serviceable parts inside.

8.1.9 HMI Panel

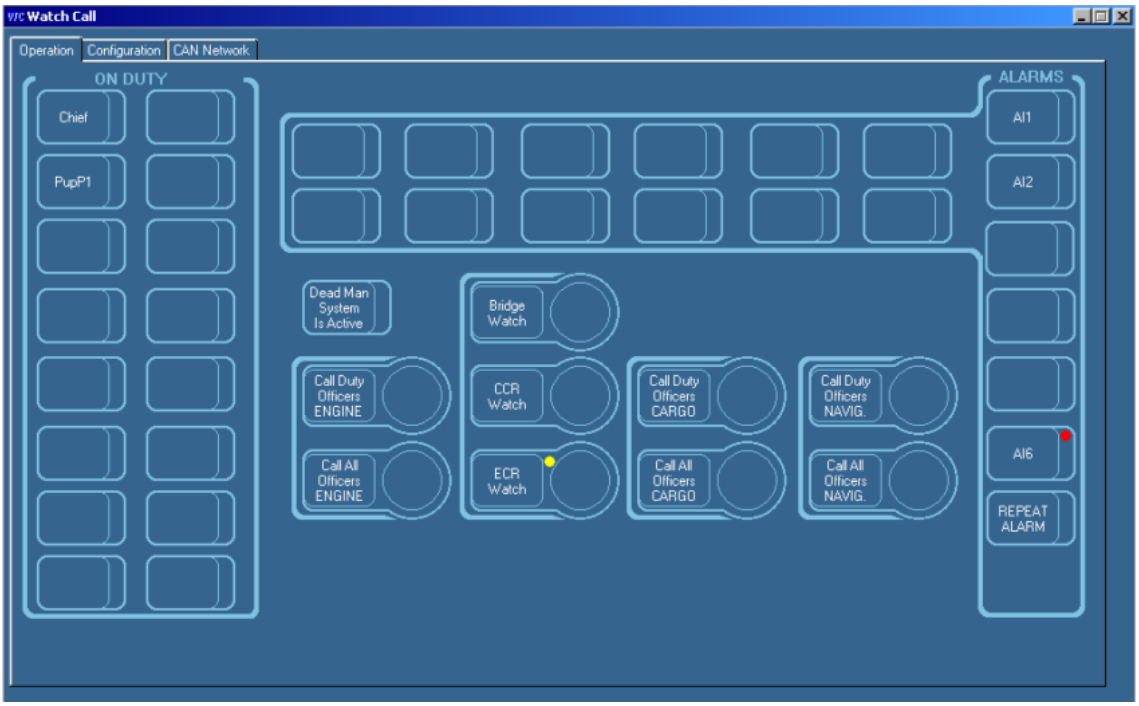
Human machine interface on page 160is a screenshot of the HMI used in the K-Chief 700 system to access Watch Call. The image mimics an actual WC panel and allows an officer to:

- Set the officer on duty
- Call the duty officer
- Call all the officers of a similar qualification.

Note

The figure below shown the HMI for the ECR qualification. The HMI for other qualifications will be different.

Figure 95 Human machine interface



8.1.9.1 Areas of operation

In the table below the operations allowed for each location has been summarized.

Operations\Locations	ECR	NCR	CCR	Bridge Panel
Set Duty Engine	*			
Set Duty Cargo			*	
Set Duty Navigation		*		
Call Duty Engine	*	*	*	*
Call Duty Cargo	*	*	*	*
Call Duty Navigation	*	*	*	
Call All Engine	*	*	*	
Call All Cargo	*	*	*	
Call All Navigation	*	*	*	
Request UMS\Non-UMS	*			
Approve\Decline UMS		*		*

8.1.10 Alarm handling scenario

The system is in UMS state and there is an engine related alarm.

8.1.10.1 System response

On all public panels, bridge panel(s) and cabin panel(s) :

- Buzzer sounding (indicating notification).
- Alarm group indicator flashing (indicating unacknowledged alarm).
- Duty indicator for officer flashing (indicating ongoing notification).
- A control signal is issued to the control system (dead man system).

Note

If, at any time, the process alarm is acknowledged from the AIM operator station, the buzzers switch off and the alarm indicator enters the steady state. When the alarm enters the normal state, the alarm indicator is switched off. No further notification is given for that alarm.

You can silence alarms in all the panels locally by pushing the **Sound off** button. If you press the **Sound off** on the cabin panel, the duty indicator stops flashing. When you silence an alarm, the alarm sounds again after a predetermined duration. The default is three minutes. The same notification is given again with the exception of the following:

- The repeat alarm indicator is mirroring the relevant alarm indicator on the bridge panel.
- Additional officers that are subscribed to the repeat Alarm 1 of the qualification (engine, cargo or navigation) are notified.

After the expiration of a predetermined “Repeat Alarm 2” duration (also three minutes by default) after Repeat Alarm 1, the same notification as per repeat alarm 1 is issued with the following additions:

- All officers of the qualification of the alarm are notified.
- Additional officers subscribed to the repeat alarm 2 of the qualification are notified.
- The repeat alarm 2 reissues all notifications every three minutes until the alarm in acknowledged.

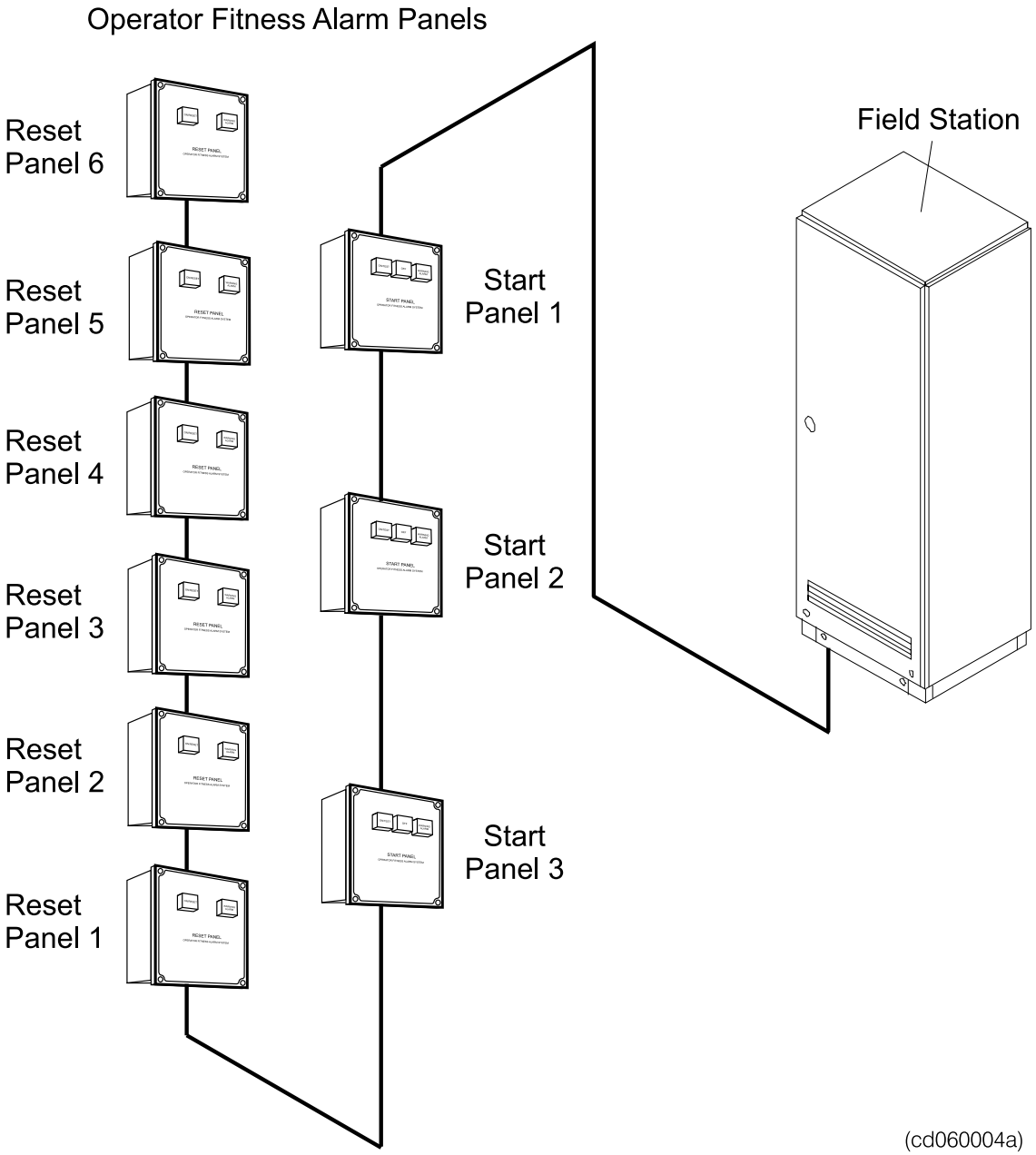
8.2 Operator fitness alarm system

8.2.1 System Overview

The Operator Fitness Alarm System (OFAS) is part of the alarm and monitoring function of the K-Chief 700 system. The Operator fitness alarm system panels are located in strategic areas or rooms onboard the vessel.

The illustration below shows a typical OFAS configuration.

Figure 96 Typical OFAS configuration

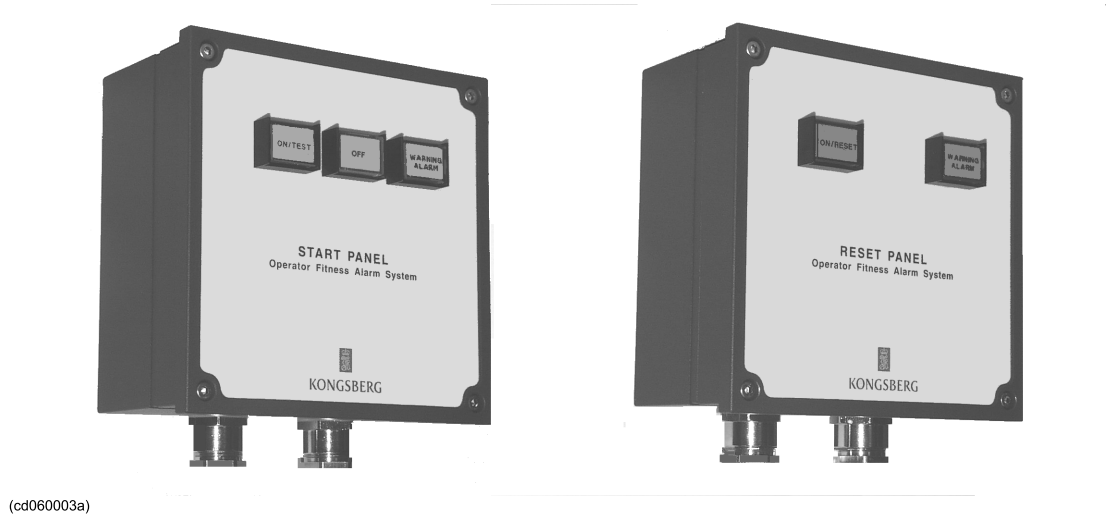


The Start Panel, located in the entrance to the engine room, is connected by a single cable to one of the field stations. This process station is connected by the local area network (LAN) to the K-Chief 700 operator stations. The system can be activated manually from one of the Start Panels located in the entrance to the engine room or from the OFAS process image. It is also activated automatically by the watch calling system when an **Engine zero** (E0) alarm is given.

The OFAS reset period is set to 30 minutes and a pre-warning alarm is given 5 minutes before the operator fitness/dead man alarm is given. If an active OFAS is not manually turned off or reset within the specified reset period, the OFAS/dead man alarm is given.

The main physical difference between the two types of operator fitness panels is the number of switches available on the front. Refer to the illustration below with the start panel to the left.

Figure 97 OFAS panels



(cd060003a)

8.2.2 Start panel

The Start panels have a green **ON/TEST** button, a yellow **OFF** button and a red **WARNING ALARM** indicator lamp. Lamp test can be performed by pressing the **ON/TEST** button for more than 10 seconds.

Press the **ON/TEST** button to set the OFAS **On**. A down count of the allowed work window is then started. The work window is typically set to 30 min, and a pre-warning is given after 25 min.

Press the **OFF** button to turn the OFAS **Off**.

8.2.3 Reset panel

The reset panels have a green **ON/RESET** button and a red **WARNING ALARM** indicator lamp. You can test the lamp by pressing the **ON/RESET** button for more than 10 seconds.

To switch the OFAS **On**, press the **ON/RESET** button. Press the **ON/RESET** button when the OFAS is active, to reset the counter to the start of the thirty minute count down.

The **WARNING ALARM** indicator on both panel types flashes when the pre-warning time expires, typically after 25 minutes. You can stop the indication by either pressing the **RESET** button in the OFAS reset panel or by pressing the **OFF** button in the OFAS start panel or on the OFAS process image. However, if you do not push the **RESET** or **OFF** button within the alarm limit time of thirty minutes, the dead man alarm is activated, and the flashing indicator lamp is steadily lit.

9 System Startup and Shutdown

The K-Chief 700 Operator Stations and Field Stations (controller cabinets) are usually left with power switched on and the system fully operational.

9.1 System startup

If the complete system has been shut down for some reason, for example after maintenance, use the following procedures to restart the system.

However, if only a part of the system has been shut down (such as one of the Operator or Field Stations), then only the relevant station startup procedure needs to be performed.

9.1.1 Uninterruptible Power Supply

At each of the K-Chief 700-related Uninterruptible Power Supply (UPS) cabinets, switch on power and start up the equipment as described in the manufacture's manual.

9.1.2 Power Distribution Units

The following procedure should be performed at each K-Chief 700-related Power Distribution Unit (PDU).

To switch on power at a PDU, proceed as follows:

1 Unlock and open the front door of the PDU.

2 Switch on the 230 (120) VAC circuit breaker.

3 Switch on the 24 VDC circuit breakers.

4 Close and lock the front door of the PDU.

9.1.3 Network Distribution Units

The following procedure should be performed at each K-Chief 700- related Network Distribution Unit (NDU).

To switch on power at a NDU, proceed as follows:

1 Unlock and open the front door of the NDU.

2 Switch on the 230 (120) VAC circuit breaker.

3 Switch on the 24 VDC circuit breakers.

4 Close and lock the front door of the NDU.

9.1.4 Operator Stations

The following procedure should be performed at each K-Chief 700 Operator Station.

To start up an Operator Station, proceed as follows:

1 Remove the front panel from the computer compartment below the Operator panel table.

2 Switch on the 230 (120) VAC circuit breakers.

3 Switch on the 24 VDC circuit breakers.

4 Check that the Windows based operating system loads and performs an automatic log on.

5 After the automatic log on has been completed, check that the K-Chief 700 Operator Station application software starts and displays the K-Chief 700 wallpaper picture on the colour monitor screen.

6 After approximately one and a half minutes, check that the K-Chief 700 wallpaper picture is replaced by the AIM-2000 splash-screen with a status window at the bottom left corner showing the starting progress of the configured OS components.

7 After approximately one more minute, check that the AIM-2000 splash-screen is replaced by the K-Chief 700 Root Process image.

8 Refit the front panel to the computer compartment below the Operator panel table.

9.1.5 Field Stations

The Field Stations automatically request and download their application software from their dedicated server Operator Station. This means that at least one of the Operator Stations should be running before you start any of the Field Stations.

The following procedure should be performed at each K-Chief 700 Field Station.

To start up a Field Station, proceed as follows:

1 Open the door of the Field Station.

2 Switch on the 230 (120) VAC circuit breakers.

3 Switch on the 24 VDC circuit breakers.

4 After approximately one minute, check that the RUN LED on the front panel of each of the RCU or RIO modules shows green.

5 Close the door of the Field Station.

9.2 User log on

9.2.1 Logging on

There are four log-on levels: guest, operator, power user and system user. Often the system is configured with Operator as default user. After an operator station power on/re-boot it may be necessary to log on with an appropriate user level if a default user is not configured.

For operator interactions with the process, e.g. operating a ballast valve, it requires that you are logged in at the correct operator level and that Command Control Area "Ballast" is controlled from the operator station group this operator station is a member of. It may be necessary to transfer/take command over the Command Control Area "Ballast" before operating can take place. Refer to the AIM user guide for details about Command Control.

Rights for the various log-on levels

Logged on as Guest you will not be able to operate on any Command Group. Logged-on as Operator you will be allowed to operate the system within the limits of the Command Control System. Power users will have basically the same rights as operator, but can in addition set/change alarm limits and parameter values. As System user you have all power user rights and in addition all advanced system configuration rights.

9.2.2 Logging on to a different user level

To change user on an OS, proceed as follows:

1. On the **File** menu, point to →**User...** and select →**Change User/ Log Off....** The **Change User** dialog box is displayed.
2. Select the wanted user name from the drop-down list and type in the applicable password.
3. Click the **Change user** button. The new user is now logged on.

9.2.3 Automatic switch to default user on time-out

The system is often configured with a function that automatically switch to a default user after a time-out based on operator inactivity for e.g. 30 min. However, if log-on level is Guest, this function is not activated.

9.3 System shutdown

If the system has to be stopped for some reason, for example for maintenance, use the following procedures to shut down the system.

However, if only a part of the system requires to be shut down (such as one of the Operator or Field Stations), then only the relevant station shutdown procedure needs to be performed.

Note

Shutting down the entire system or any part of it should normally only be performed after authorisation has been given by the system administrator.

9.3.1 Field Stations

Caution

Do not turn off units that are shared with other systems before the consequences are understood and permission is given from proper authority.

The following procedure should be performed at each K-Chief 700 Field Station.

To shut down a Field Station, proceed as follows:

1 Open the door of the Field Station.

2 Switch off the 24 VDC circuit breakers.

3 Switch off the 230 (120) VAC circuit breakers.

4 Close the door of the Field Station.

9.3.2 Operator Stations

The following procedure should be performed at each K-Chief 700 Operator Station.

To shut down an Operator Station, proceed as follows:

1 If applicable, log on as a member of the *Power User* group. Refer to the *Access system* topic in the online AIM user guide.

2 On the **File** menu, click **Exit...**. The **Shut Down?** dialog box is displayed.

3 Click the **Yes** button. The K-Chief 700 Operator Station application software closes down and you are returned to a blank Windows Desktop.

4 Click the **Shut Down** button.

5 The Operator Station shuts down

6 Remove the front panel from the computer compartment below the Operator panel table.

7 Switch off the 24 VDC circuit breakers.

8 Switch off the 230 VAC circuit breakers.

9 Refit the front panel to the computer compartment below the Operator panel table.

9.3.3 Network Distribution Units

Caution

Do not turn off units that are shared with other systems before the consequences are understood and permission is given from proper authority.

The following procedure should be performed at each NDU associated with K-Chief 700.

To switch off power at a NDU, proceed as follows:

1 Unlock and open the front door of the NDU.

2 Switch off the 24 VDC circuit breakers.

3 Switch off the 230 VAC circuit breaker.

4 Close and lock the front door of the NDU.

9.3.4 Power Distribution Units

Caution

Do not turn off units that are shared with other systems before the consequences are understood and permission is given from proper authority.

The following procedure should be performed at each K-Chief 700-related PDU.

To switch off power at a PDU, proceed as follows:

1 Unlock and open the front door of the PDU.

2 Switch off the 24 VDC circuit breakers.

3 Switch off the 230 VAC circuit breaker.

4 Close and lock the front door of the PDU.

9.3.5 Uninterruptible Power Supply

Caution

Do not turn off units that are shared with other systems before the consequences are understood and permission is given from proper authority.

At each K-Chief 700-related UPS cabinet, shut down the equipment and switch off power as described in the manufacture's manual.