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FIRE & GAS

Deepwater Horizon

Document title:

Operator Manual

Synopsis:

This document describes the Operator Manual for the Fire & Gas System on Deepwater Horizon, RBF 8D.

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The reader

This operator manual is intended to be used by the system operator, who is assumed to be an experienced operator with a good understanding of basic fire & gas detection and logic principles. This manual should not be used as a replacement for appropriate training as required by certification authorities.

About this manual

This document describes the operating instructions for the Fire & Gas System on a Mobile Offshore Unit.

Project specific details is described in the "F&G Function & Design Specification", ref. [1.].

General operational functionality is described in "Operator Manual, Kongsberg Simrad SVC, Vessel Control System", ref. [2.].

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1. SCOPE AND PURPOSE

1.1. Objective

This document describes the operating instructions for start-up, normal operation, alarm situations, emergency stops and interruptions, for the Fire & Gas System on Deepwater Horizon, RBF 8D.

This manual is intended for operators who are already familiar with the Kongsberg Simrad AIM system.

1.2. Document Responsibility

Kongsberg Simrad AS, Process Automation, Safety, is responsible for updating this document.

2. REFERENCED DOCUMENTS

Ref. no.	Document Title
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- | | |
|-------|---|
| [1.] | Functional Design Specification F&G |
| [2.] | Operator Manual, Kongsberg Simrad SVC, Vessel Control System |
| [3.] | F&G Configuration Typical, rev B, 21.01.99 |
| [4.] | F&G Design Manual. |
| [5.] | F&G io-database. |
| [6.] | F&G Layout Drawings |
| [7.] | F&G System Philosophy. |
| [8.] | Module User Manuals for function modules in Fire & Gas (sp_fg) and shutdown (sp_sd) option libraries. |
| [8.] | AIM Operator Manual |
| [10.] | AIM Flexi Modules Manual |

3. DEFINITIONS / ABBREVIATIONS

3.1. Definitions

Display	The visual interface between the AIM system and the operator.
Display active	The PCU in a redundant pair that controls the displays.
Ethernet address	Network address that reflects the HW dipswitch settings on the network nodes.
Inhibit	Inhibition of inputs will prevent automatic action, alarms will however appear as normal.
IP address	All network nodes must have a unique IP (Internet Protocol) address that consists of a network part and a host part.
Module	<p>A "module" is an independent software routine performing an algorithm and communicates with other module's or/and the I/O system via input/output terminals. Each module consists of a graphic symbol, a software algorithm and an associated data structure that is unique for this particular module.</p> <p>Flexi modules have no predefined algorithm. They consist of logic elements (AND, OR gates etc.) and can be re-configured.</p>
Override	Override implies that automatic action will not take place on the overridden output.
Scan task	A part of the software system that administrates the execution of function modules, and also scanning of the connected I/O cards and display updating. The task controls the timing and execution sequence.
Tag Name	TAGNAME or TAG is the name given for the object module as a unique identification. The tagname will often be identical to the name of the corresponding "instrumentation tag list", but may also designate units such as motor controls, control loops or static drawing objects.

Terminal	<p>Each type of modules has a set of predefined terminals. A module's terminals are the data connection points (or ports) of communication between the modules and/or the I/O system. The module terminals are used for different purposes.</p> <p>There are three different terminal types: Input terminals, Output terminals and Process terminals. The terminals may be configured with alarms, numerical value representation, bargraphs, as part of trend pages, reports etc., depending on the terminal type.</p>
Terminal Connection	<p>Terminals of two function modules, connected together, to enable exchange of data between these modules.</p>

3.2. Abbreviations

AIM	Albatross Integrated Multifunction
AVS	Abandon Vessel Shutdown
C&E	Cause & Effect
CCR	Central Control Room
CER	Central Equipment Room
CT	Configuration Typicals
DA	Display Active
DP	Dynamic Positioning
DWS	Drilling Work Station
ECR	Engine Control Room
ESD	Emergency Shut Down
Ex	Explosion protection
F&G	Fire & Gas
FAT	Factory Acceptance Test
FDS	Function & Design Specification
FS	Function Specification
FTC	Field Termination Cabinet
H	High (alarm indicator)
HH	HighHigh (alarm indicator)
HUB	Network Centre (Fibre optic Concentrator)
HVAC	Heating Ventilation and Air Condition
HW	Hardware

I/O	Input / Output
IAS	Integrated Automation System
IAT	Internal Acceptance Test
IP	Internet Protocol
KS	Kongsberg Simrad
L	Low (alarm indicator)
LL	LowLow (alarm indicator)
LED	Light Emitting Diode
LEL	Lower Explosion Limit
LQ	Living Quarter
MFA	Manual Fire Alarm
MMI	Man Machine Interface
N/A	Not Applicable
NC	Normally Closed
NDE	Normally DeEnergised (Energised to Trip)
NE	Normally Energised (Not Energised to Trip)
NO	Normally Open
OS	Operator Station
P&ID	Piping & Instrument Diagram
PA	Public Address
PAI	Process Analogue Input
PCS	Process Control system
PCU	Process Control Unit
PDI	Process Digital Input
PDO	Process Digital Output
POWEC	Power Electronics A/S, product name on a power supply
PS	Process Station
SBC	Single Board Computer
SSS	Simrad Safety System
SW	Software

TB-xxx	Termination Board where xxxx is the board type.
UPS	UnInterruptable Power Supply
VDU	Visual Display Unit
VMS	Vessel Management System
W/H	Wheel House

4. MAIN DATA

The purpose of the Fire & Gas System is to provide early and reliable detection of F&G hazards, wherever such events are likely to occur, and alert personnel and initiate protective actions automatically or manually upon operator's activation.

The detection system processes input signals from the field-mounted detectors and manual fire alarm stations.

The protection system is designed to initiate shutdown actions, via the ESD System. Examples of shutdown actions are close fire dampers, stop/start ventilation fans or close fire doors. Alerting personnel is done through the PA control system, gas detection beacons and light signal columns.

MMI for the Fire & Gas system is from the operator stations. The F&G main display (VDU) will give an overall view of the F&G status, and the fire area display will give more details.

5. OPERATIONAL FUNCTIONALITY

5.1. General Operation

General operational functionality is described in "Operator Manual, Kongsberg Simrad SVC, Vessel Control System", ref [2.].

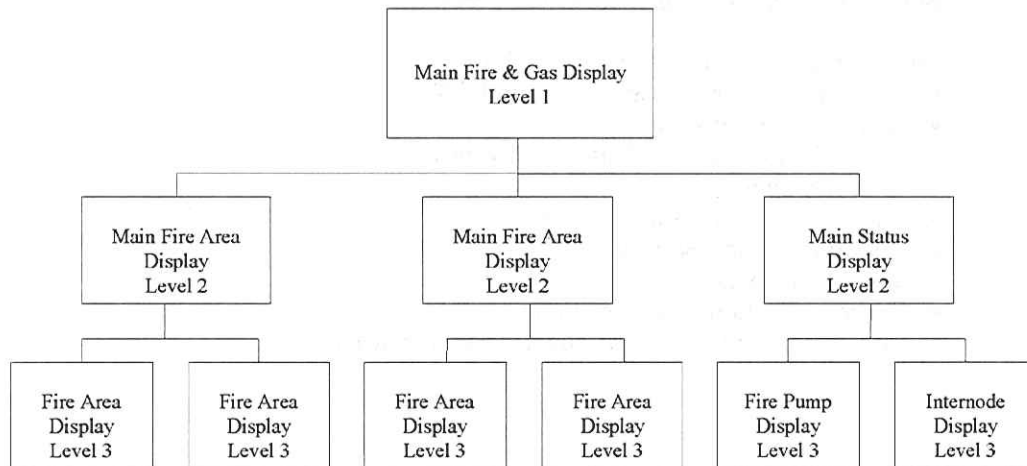
This manual contains information like:

- Command Control / Logging On and Off
- Alarm / Event System
- Basic Monitoring and Control / Navigation
- Trend System
- Equipment View / Status Alarms
- Operator Station Settings
- Module Settings
- Operator Station Configurations
- System Start-up and Shut-down (Process Station)

5.2. Navigate through the Fire & Gas System

Communication between the operator and the F&G-system is through the operator station. The F&G main display (VDU) will give a quick overview of the situation, and the fire area display will give more detailed information.

The VDU display topology has a tree structure. Level one contains **the main display**. Level two shows the **main fire areas**, ex one deck. Level three shows the



detailed **fire areas**.

Figure 5-1, F&G Display Topology

The main display will give a view of the different areas on the ship, see figure below.

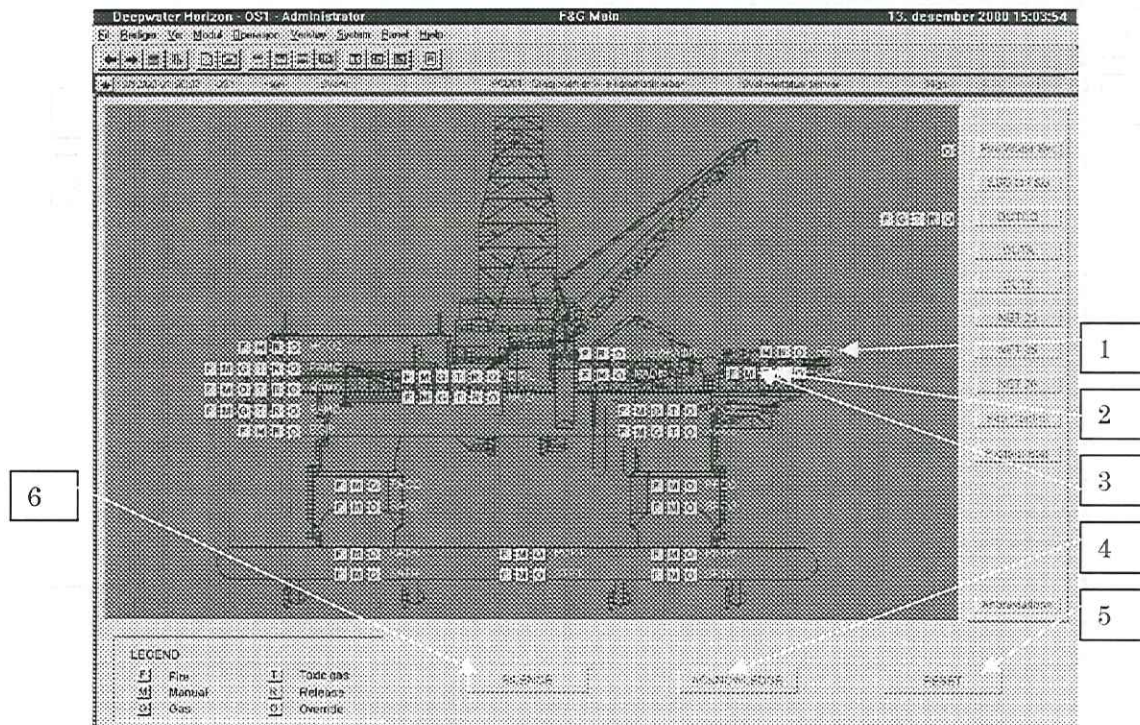


Figure 5-2, Main F&G Display

The main fire & gas display includes:

- 1: The main fire area name.
- 2: Alarm and status lamps for the main fire area.
- 3: A jump-module/hot-spot to the main fire area.
- 4: A acknowledge-button, that will acknowledge all non-acknowledged alarms within the entire F&G system and reset the fire central.
- 5: A reset-button, which will initiate a reset sequence on all the Fire & Gas output loops.
- 6: A silence-button, which will turn off the audible alarm from the BS100 fire central and from the matrix in the CCR, ECR and DWS.

To get a more detailed view of an area, move the cursor to the wanted area and operate on the jump-module/hot-spot.

The fire area display is showing all details, like detectors and layout, see figure below.

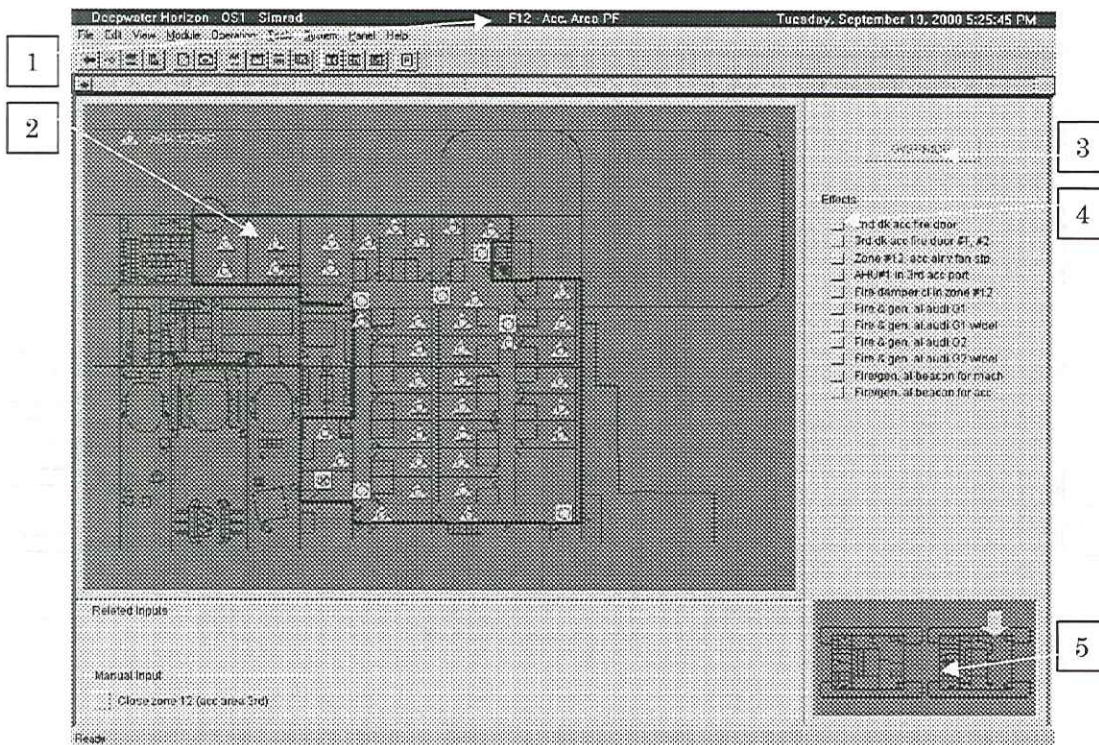


Figure 5-3, Fire Area Display

The fire area display is divided into different parts:

- 1: A short description of the fire area
- 2: Detectors belonging to this fire area.
- 3: Override button. This button override all outputs in this fire area.
- 4: Outputs/actions, listed in the C&E.
- 5: A geographical overview, where the fire area is shown. If you place the cursor in this picture and click the left mouse button, it will act as an hot spot. This will bring you back to the level 2 display.




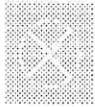
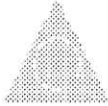
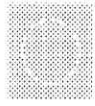
Upon alarm the detector module symbol will change to flashing alarm colour. The activated outputs modules will change to activation colour. When the alarm is acknowledged, the alarm colour will stop to flash and turn to steady alarm colour.

5.3. Fire & Gas Detectors

See the "F&G Function & Design Specification", ref. [1.] for more details about the detectors.

5.3.1. Detector symbols

The Fire & Gas detectors / outputs has different symbols.

Symbol	detector
	Gas point detector, ex HC-gas
	Gas point detector, ex H2S-gas
	Flame detector
	Heat detector
	Smoke detector
	Manual fire alarm

5.4. Fire & Gas Alarms

The operator will, during an alarm situation, be alerted from the VDU (Operator station) and the matrix in CCR, ECR and DWS.

Any alarm, in the F&G system, will activate keyboard alarm horn, and the alarm will be displayed through the AIM alarm system.

A Fire & Gas alarm of emergency priority, will activate the status lamps on the main Fire & Gas display (VDU), both type and location.

The main F&G display will give a view of the different areas on the ship. In non-alarm situation the lamps will be grey/white, upon an alarm the lamps will change to alarm colour. Each area has a selection of alarm lamps, the different lamps show what kind of alarm that are activated.

The main fire area contains a selection of alarm lamps for each fire area.

5.4.1. Alarm priorities

The Fire & Gas detectors / output loops has different alarm priorities:

detector	alarms
Gas point detector	<ul style="list-style-type: none">• emergency priority alarm for high gas concentrations• High priority alarm for low gas concentrations• low priority alarm for open, short circuit, internal failure and clean optics.
Flame detector	<ul style="list-style-type: none">• emergency priority alarm for flame detection• low priority alarm for detector failure
Heat detector	<ul style="list-style-type: none">• emergency priority alarm for heat detection• low priority alarm for detector failure
Smoke detector	<ul style="list-style-type: none">• emergency priority for smoke detection• high priority alarm for prewarning• low priority alarm for detector failure
Manual fire alarm	<ul style="list-style-type: none">• emergency priority on alarm• low priority alarm for detector failure
Output loops	<ul style="list-style-type: none">• low priority alarm on feedback error• low priority alarm for detector failure• emergency priority alarm for Co2 release

5.4.2. Alarm colours

Upon alarm the detector module symbol changes to alarm colour and the tag will change to flashing alarm colour. Which output modules to activate are defined in the input C&E module.

Colour:	Alarm Priority or State:
White	<ul style="list-style-type: none">• Normal, no alarms or action.
Yellow	<ul style="list-style-type: none">• Low priority alarm, an alarm that does not require immediate actions.• System alarms, like open/short circuit, line fault, clean optic, earth fault, feedback-error.
Red	<ul style="list-style-type: none">• High priority alarm - alarms that requires action.• Alarms like prewarning, AlarmH, AlarmL and GasHigh.• Manually activated shutdown.
Magenta	<ul style="list-style-type: none">• Emergency priority alarm - alarms that requires immediately action.• All emergency alarms like AlarmHH, and GasHighHigh.• All shutdown actions like close fire damper.
Cyan	<ul style="list-style-type: none">• Module mode is inhibit, override, blocked input/output.
Brownish	<ul style="list-style-type: none">• Module mode is passive.

5.4.3. Alarm/status lamps on the VDU

The alarm/status lamps on the VDU has different colours:



Fire, magenta coloured element with the letter F inside. Magenta flashing state indicates that a fire detector (smoke, heat or flame) is in alarm state. The element will go steady when acknowledged.



Gas, magenta coloured element with the letter G (HC) or T(H₂S) inside. Magenta flashing state indicates that at a gas detector has reached minimum low level alarm. The element will go steady when acknowledged.



Manual fire alarm, magenta coloured. Magenta flashing state indicates that a manual fire alarm has been activated. The element will go steady when acknowledged.



Released, magenta coloured element with the letter R inside. Magenta flashing state indicates that a co₂ release is in alarm state. The element will go steady when acknowledged.



Inhibit/Override, cyan coloured element with the letter O inside. Indicates that at least one input is inhibited or that an output is overridden.

5.4.4. Voting

Outputs due to fire detection are activated from the fire & gas or the ESD System. The C&E will show which outputs that will be activated in the different situations.

- Confirmed fire: Manual fire alarm, flame detection, 2 out of any smoke/heat detectors within a fire area, or an unacknowledged alarm after 2 minutes.
- Gas detection: CGD, TGD and beacons will be activated according to these combinations:

H2S High Alarm	10ppm
H2S HighHigh Alarm	20ppm
HC High Alarm	20%LEL
HC HighHigh Alarm	60%LEL

5.5. System Alarms

The operator will in case of a system alarm be alerted from the operator station. The alarm will activate keyboard alarm horn and be displayed through the AIM alarm system.

AIM System alarms are described in "Operator Manual, Kongsberg Simrad SVC, Vessel Control System", ref. [2].

5.5.1. Power failure

The onb_io-module will give an alarm in case of a power failure in one of the POWEC-modules. POWEC is the 24 volt power source for the whole Fire & Gas cabinet and field equipment. The POWEC is placed in the top rack of the F&G-cabinet.

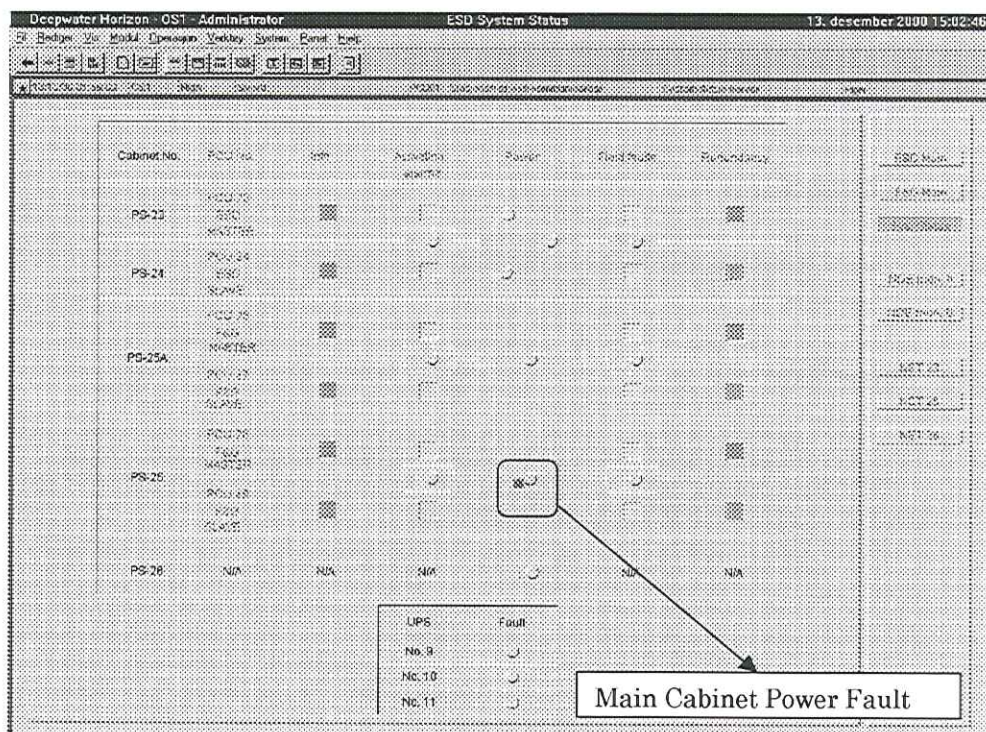


Figure 5-4 Main Cabinet Power Fault

5.5.2. IO-power failure

A power failure in one of the io-power-modules will be alarmed as a system alarm, i.e. only indicated on the alarmpage and not on the System Status display. The alarm will differentiate between Left/Right power. The io-powers are placed in the io-rack, and they are powered from the POWEC-modules. The io-power is the power source for the PCU and the io-cards.

5.5.3. Communication error

The rs_comms-module gives an alarm in case of a communication error between the Fire central (BS100) and the PCU. The communication status is found on the dedicated BS100 Fire central display.

5.5.4. Net-fault

The netdi-module gives an alarm in case of a communication error on the net between two PCU's.

In case of a net-fault on both net, the net-signals will change to the fail-safe-setting.

5.5.5. SBC fan alarm

An alarm is given on the alarmpage if the SBC fan stops.

5.5.6. Signal fault

Input modules will give signal fault if the input current is over the short circuit limit or under the open circuit limit. The module will give an line fault alarm if the current is varying too much from the normal value.

5.6. Operating from the Operator stations (VDU)

5.6.1. Acknowledge alarms

Upon alarm the detector module symbol changes to flashing alarm colour, and the status lamp will be activated on the main display.

The alarm can be acknowledged in different ways:

1. By pressing the acknowledge button on the Fire & Gas main display, then all non-acknowledged alarms within the entire F&G system will be acknowledged. The button will be deactivated automatically after a short time delay.
2. By selecting the alarm page, and then acknowledge the specific alarm-line.
3. By operating on the detector by use of the left mouse button and select Acknowledge.

5.6.2. Reset outputs

The outputs may be reset when the alarm source disappears. It is not possible to reset in an alarm situation.

The outputs can be reset by activation of the reset button on the main display. The button will be deactivated automatically after a short time delay.

The reset procedure:

1. Operate the acknowledge button.
2. Operate the reset button.

It is also possible to reset by operating on the output by use of the left mouse button and then select reset.

Note: give the previous button time to be deactivated before activating the next button.

Outputs from the F&G system to the ESD system are latched at the input side of the ESD system and not at the F&G output. Hence, reset of the F&G output is not necessary.

5.6.3. Manual activation of outputs

Outputs may be activated manually by operating on the outputs and then pressing the "activate" menu field button.

After deactivating the outputs, it is necessary to follow this procedure:

1. Operate the acknowledge button.
2. Operate the reset button.

Note: give the acknowledge button time to be deactivated before activating the reset button.

5.6.4. Inhibit / Override

It is important to inspect the inhibit/override list available through standard AIM module status menu at regular intervals. Inhibited or overridden functions in a safety system should not be allowed for longer periods.

5.6.4.1. Inhibit

Inputs can be inhibited by the operator individually (per module) from the operator station. This will inhibit the F&G action, but not the alarms on the VDU.

Inhibit will be indicated on the VDU with a cyan element O on the main display and on the lower level two displays, where an "i" in front of the input symbol on the display will appear.

Note that the fire detectors have no effects in the KS F&G system. Outputs are set from the Fire central itself or from the ESD system. Hence, inhibiting a fire detector in the KS F&G system will have no effect and will not prevent any output activation. Use the fire central "Disable detector" function.

5.6.4.2. Override

The operator can perform overrides from the level three pictures per fire area or individually. This will override automatic action on this particular output or alternatively for the whole fire area.

Override will be indicated on the VDU with a cyan element O on the main display and on the lower level two displays, where a cyan "o" in front of the output symbol on the display will appear.

The override button in the fire area display may be used as an area reset.

5.6.5. Fire Pumps

The fire pumps are placed in a dedicated firewater display. This display gives an overview of the duty standby selection and gives information about the fire pump status, like started, running, available and failure. It is not possible to start the fire pumps from this display. To start the fire pumps, press the dedicated button on the matrix.

The Foam pump is placed in this display as well, and gives information about the fire pump status, like started, running, available and failure.

5.6.6. BS100 fire central

The BS100 fire central is placed on a dedicated display. Navigate to the display by operating the jump-module/hot-spot in the main display.

The BS100 fire central display contains possibilities for resetting the fire central, and gives status on the communication and status for the fire central and the status on the different detector loops, see Figure 5-5 below.

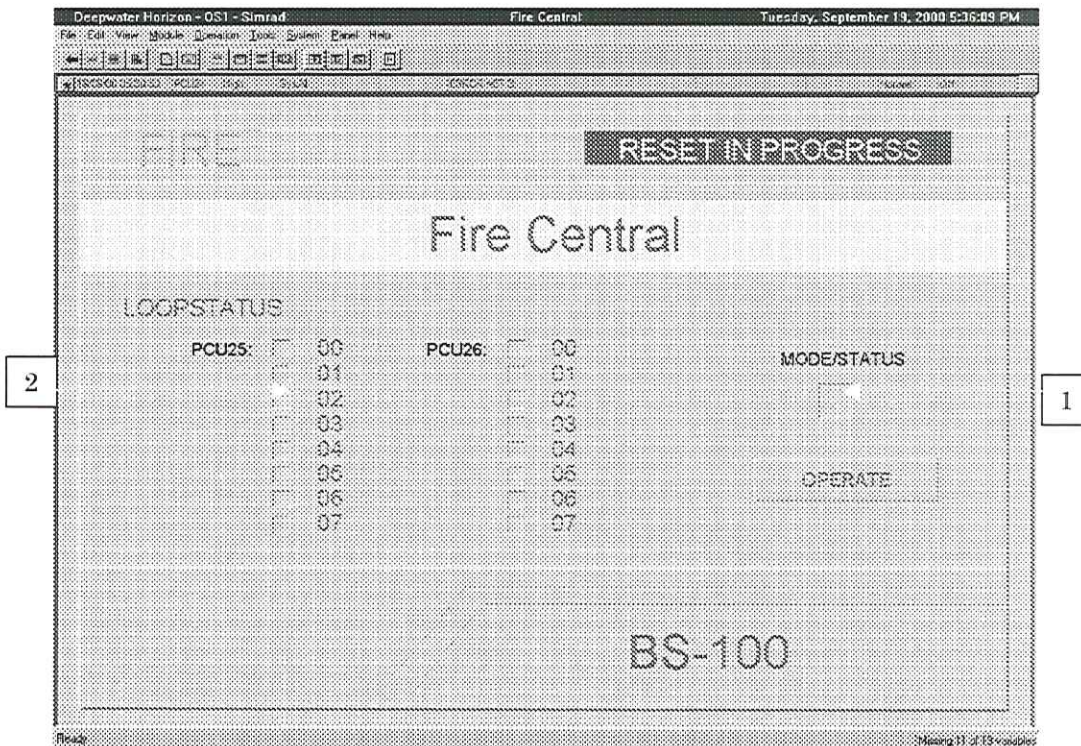


Figure 5-5, BS100 fire central

- 1: The BS100-module, communicate with the BS100 fire central through a serial line.
- 2: The different loops connected to the fire central.

6. OPERATION INSTRUCTIONS

6.1. Operation Upon Fire & Gas Situation

Upon alarm the detector module symbol changes to flashing alarm and the status lamp will be activated on the main display. The Fire or Gas indication lamp on the matrix in CCR, ECR and DWS will also start to flash.

To get a more detailed view of a fire area, move the cursor to the wanted fire area and operate the jump-module/hot-spot.

The detailed fire area will show the detector in alarm and the activated outputs. The activated outputs are defined in the C&E.

Operating procedure:

Action:	
1.	Silence the audible alarms by using the silence-button, either on the main Fire & Gas display or from the matrix in CCR, or ECR or from DWS.
2.	Acknowledge the alarm, in the fire area display.
3.	Send someone to investigate the alarm.
4.	When the alarm situation is cleared, start the reset procedure:
4.1	Operate the acknowledge-button, either on the main Fire & Gas display or from the matrix in CCR, or ECR or from DWS.
4.2	Operate the reset-button, either on the main Fire & Gas display or from the matrix in CCR, or ECR or from DWS.

6.2. Start-up of the Fire & Gas system

6.2.1. Start-up of both PCU's in a redundant PCU-pair

Stop of both PCU's in a redundant PCU-pair:

- During major system changes.
- An uncontrolled stop of a PCU must be reported to Kongsberg Simrad.

Start-up procedure:

Action:	
1.	Work permission.
2.	Check power system and fuses in the cabinet.
3.	Check network.
4.	Start both PCU's, at the same time.
5.	Check the PCU status page on the operator stations.
6.	Check the PCU redundancy status page, see that both master and slave are OK, and that master is active.
7.	Both PCU's are OK.
7.1.	Check alarm inputs.
7.1.1.	Check alarm page, and acknowledge all system alarms.
7.1.2.	Operate the acknowledge-button.
7.2.	Check outputs:
7.2.1.	All NE-output will be activated, because of the stop.
7.2.2.	Operate the reset-button.

6.2.2. Start-up of one PCU in a redundant PCU-pair

Stop of one PCU in a redundant PCU-pair:

- During configuration, only permitted personnel.
- An uncontrolled stop of a PCU must be reported.

Start-up procedure:

Action:	
1.	Work permission.
2.	Check alarm input and activated outputs.
3.	Check network.
4.	Start the PCU.
5.	Check the PCU status page on the operator stations.
6.	Check the PCU redundancy page, see that both master and slave are OK, and that master is active.
7.	PCU are OK.
7.1.	Check alarm page, and acknowledge all system alarms.
7.2.	Check alarm inputs.
7.3.	Check outputs (no outputs will be activated because of a single PCU stop / start).
8.	PCU not OK.
8.1.	Report the failure.
8.2.	Take the necessary precaution, because of a single Fire & Gas system.

7. FIRE & GAS SYSTEM DESCRIPTION

7.1. Fire & Gas System Topology

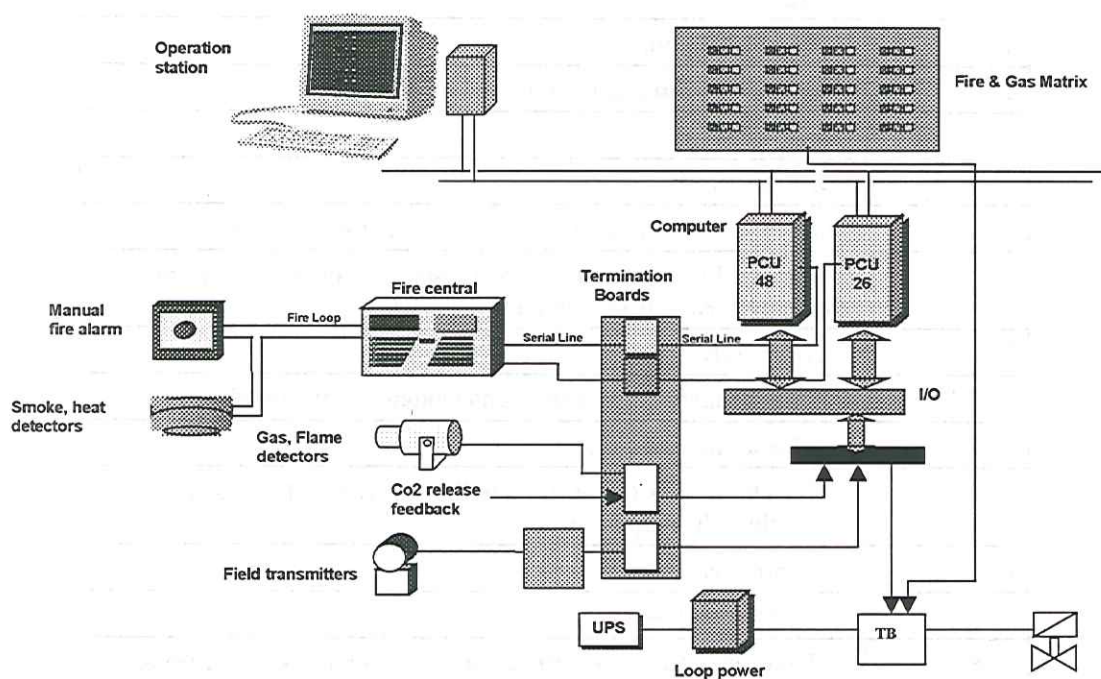


Figure 6-7-1, System Topology

The figure above shows the arrangement of the equipment in the F&G system. The figure shows the connection between the operator station, the F&G cabinet and the field equipment.

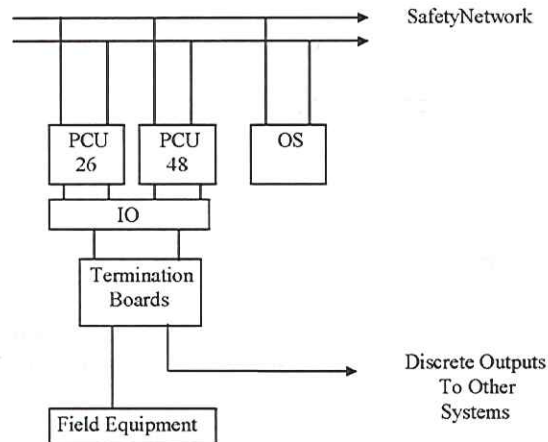


Figure 6-7-2, SBC redundant F&G System

The figure above shows the arrangement of the equipment in the F&G cabinet. The figure shows a SBC redundant F&G System. SBC redundancy is redundant PCU with single IO-cards.

Both computers read all inputs and are able to set outputs, but only one of the computer write to the operator station and the matrix.

Field equipment, field cables barriers, addressable fire central and termination cards are however single.

Heat, smoke, and manual fire alarms are controlled by Autronica BS-100 unit and transmitted on serial lines to the computers. All other types of inputs are hardwired to digital or analogue input cards.

Operator stations are connected to the PCU's through a redundant net. The F&G system is dependent of the safety net for proper functioning.

The net is also used upon start-up of the system, loading the PCU's, activation of printers and to get more detailed information of the system from the operator station.

7.1.1. F&G system, main components

7.1.2. Process Stations

The F&G nodes are located in a Local Equipment Room, adjacent to the CCR. The cabinets are dedicated for the control and monitoring of the Fire & Gas System.

7.1.3. Safety operator station

The safety operator station, OS 7, has been dedicated to operation and monitoring of the ESD and the F&G system. The F&G and ESD systems can also be accessed from the other operator stations. An alarm printer with F&G/ESD alarm filter is connected to the operator station. This printer prints all alarms automatically.

7.1.4. Hardware arrangement

The figure below shows the F&G Cabinet swingframe :

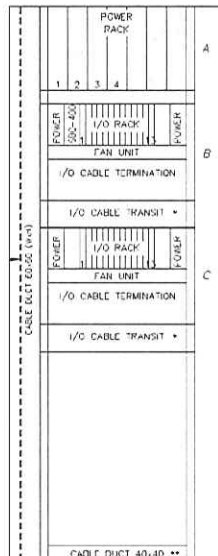


Figure 6-7-3, F&G Cabinet swingframe

More detailed hardware arrangement drawing will be included in a separate document.

7.1.5. Interface to Autronica BS100 fire central

A fire central is connected to both PCU's in a redundant pair, see figure below. Thus, if one PCU stops the other still have full communication with the fire central and contact with the fire areas. The PCU's and the fire central communicate on a redundant serial line. TBSL is the termination board for serial line.

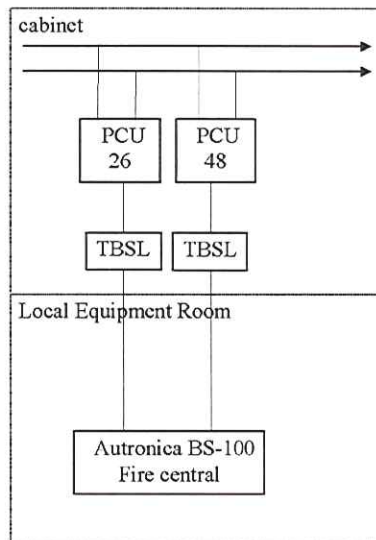


Figure 6-7-4, F&G-PCU and BS100 Interface.

7.1.6. IO-cards

Analogue input

Field signals from analogue detectors are monitored on the termination board. Upon detected loop fault a system alarm is given but the module will not initiate a F&G activation alarm.

Field signals from digital detectors are normally read as an analogue signal, to make it possible to monitor the signal for short/open circuit and earthfault.

Digital input

Field signals from digital detectors are monitored on the I/O card. Upon detected card fault a system alarm is given but the module will not initiate a F&G activation alarm.

Output loop

The output loop power is redundant and powered from different sources A/B.

To identify the signal loop type, a HardWare Loop Typical (HWLT) is needed. The HWLT that are used in the F&G system for this project is referred in the IO-allocation.

NE output loop

Normally energised (NE) loops, under normal condition the current is floating to the field device. Upon activation of field equipment the current will be shut off.

When removing a PDO card, the operator must check which equipment that will be affected.

NDE output loop

Normally energised (NE) loops, under normal condition the current is not floating to the field device. Upon activation of field equipment the current will be turned on.

Removing a PDO card with only NDE outputs will not activate the outputs.

7.2. Software configuration

The F&G system will be built using standard AIM software modules generally parameterised and connected according to the standard for safety systems. See the "F&G Function & Design Specification", ref. [1.] for more details.

7.3. Detection and protection

The F&G system is the interface between the Detection system and the Protection system. In addition the F&G will interface the PA system and the ESD system.

7.3.1. Detection

To read and control the inputs from the detection system different input loops (hardware) and input modules (software) are used. See the "F&G Function & Design Specification", ref. [1.] for more details.

The main types of detection used in the F&G system are:

- Gas detection.
- Flame detection.
- Heat detection.
- Smoke detection.
- Manual fire alarm.

7.3.2. Protection

To control the outputs to the visual and audible alarm devices and the ESD system, different output loops (hardware) and output modules (software) are used. See the "F&G Function & Design Specification", ref. [1.] for more details.

The main types of visual and audible alarm devices used in the F&G system are:

- PA
- Light signal columns
- Beacons

7.4. Common outputs (Digital Outputs Display)

Outputs may be activated from several fire areas. These outputs are connected via a type of logic OR gate to one or several IO's. The status of the outputs to IO can be found on a dedicated display.

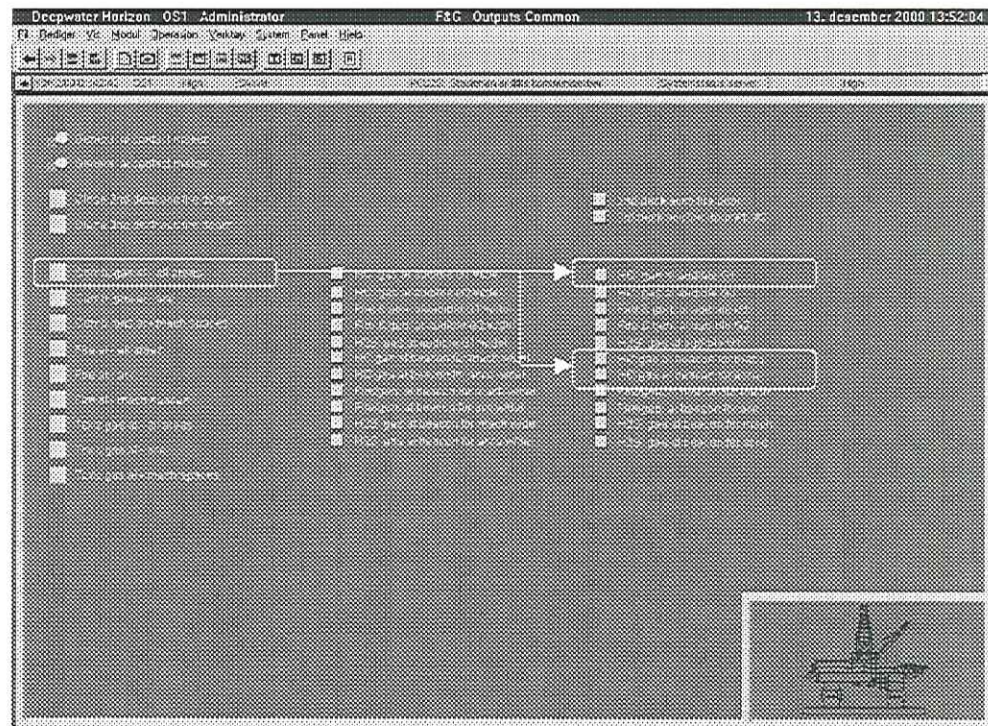


Figure 7-5 Common outputs connections

1. ESD interface : Overall status for outputs that are activated from more than one fire area.
2. Hitec HVAC interface : Overall status for outputs
3. PA & Lamp & LSC interface : One common signal is represented on each fire area. The one-to-many relationship is show here.

