Buffalo Venture FPSO
Fire Protection Systems
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Abbreviations and Definitions

BLEVE .. .. .. ..Boiling Liquid Expanding Vapour Explosion.

CCR .. .. .. .. ..Central Control Room.

CCTV .. .. .. .. ..Closed Circuit Television.

CO2 .. .. .. .. ..Carbon Dioxide.

ESD-1 .. .. .. .. ..Emergency Shut Down #1 — Total facility shutdown; total Well Head Platform shutdown including sub-surface safety valves, process modules shutdown and blowdown, engine room shutdown.

ESD-2 .. .. .. .. ..Emergency Shut Down #2 — Well Head Platform surface shutdown, process module shutdown and blowdown, engine room boilers change to MDO firing.

ESD-3 .. .. .. .. ..Emergency Shut Down #3 — Process module shutdown, not blown down. Boilers change to MDO firing.

ESD-4 .. .. .. .. ..Individual process unit shutdown.

FPSO .. .. .. .. ..Floating Production, Storage, and Offtake vessel.

HLO .. .. .. .. ..Helicopter Landing Officer.

kPa .. .. .. .. ..kilo Pascal.

LED .. .. .. .. ..Light Emitting Diode.

LEL .. .. .. .. ..Lower Explosive Limit.

MAC .. .. .. .. ..Manually Activated Call point.

MDO .. .. .. .. ..Marine Diesel Oil.

Offtake .. .. .. .. ..The pumping of crude cargo from FPSO to berthed shuttle tanker, via floating hose.

Skid A .. .. .. .. ..Aft process unit on raised platform on FPSO, supporting crude oil separation vessels and water treatment plant.

Skid B .. .. .. .. ..Forward process unit on raised platform on FPSO, supporting gas compression and gas treatment plant.

Skid C .. .. .. .. ..Forward flare unit on raised platform on FPSO, supporting liquid knock-out vessels.
Buffalo Venture FPSO Fire Protection Systems

Overview

The System

The Buffalo Venture FPSO is protected by a variety of fire fighting devices, to cover a range of applications. These consist of:

- Fire pumps, hydrants, and hose reels;
- Electric driven deluge pumps;
- Diesel driven standby deluge pump;
- Carbon dioxide release system;
- Gas, smoke, and heat detection;
- Low and high expansion foam systems;
- Automatic process module deluge system;
- Main deck and heli-deck fire monitors;
- FPSO swivel fire monitor.

Fire fighting water is provided by two distinct systems, taking suction from the sea. The existing ship’s fire pumps and fire mains, supply the facility’s hydrants for hose reel use.

The deluge pumps, both electric and diesel driven, fitted during the ship’s conversion to a FPSO, supply fire fighting water to the process module deluge, turret monitor, and foam systems.

These systems will be explained further in more detail.
Deluge System — Electric Deluge Fire Pumps

The electric driven Deluge Pumps on the Buffalo Venture are located in the Engine Room. The pumps are normally lined up to supply deluge water at all times, taking suction from the sea, via the sea chests.

The electric deluge pumps can be started in a variety of ways. The normal position for the control cabinet is in ‘remote’. The pumps can therefore be started from the CCR panel; by initiation of the process module deluge system, or by a reduction in jockey water pressure to the deluge system.

Jockey water pressure is supplied by the Process Cooling Sea Water pumps, which maintain a pressure of 500 kPa in the system. When this pressure reduces to 400 kPa, by the opening of a deck monitor for example, a cut-in switch activates and #1 and #2 deluge pumps will start automatically.

The pumps can also be started from the CCR control panel, when in the remote position locally.

The pumps can be started from the local pump control panel in the Engine Room, however any remote operation will be disabled.

After any remote activation of the pumps, and the deluge system is no longer required, the pumps can only be stopped at the local control panel. The pumps must be switched to ‘local’, and then switched off.

When the jockey water pressure of the deluge system recovers, the local control panel can then be switched over to remote, ready for stand-by operation. Otherwise, pumps will start again immediately if jockey pressure has not recovered, prior to switching to remote.
The diesel driven stand-by deluge pump on the Buffalo Venture is located in the Forward Machinery Space. The diesel deluge pump can be controlled in the field via the local control panel, or the local emergency start button.

The Diesel Deluge Pump can also be started remotely from the CCR push-button control.

This pump is a critical device in the fire protection of the vessel, as it acts as the 'last line of defence' in any fire emergency. The deluge system is configured so that if the main electric driven deluge pumps operation fails, due to power failure, and the deluge jockey water pressure remains in low state for more than 30 seconds, the diesel pump will start and supply deluge water.

Or in the case of a facility ESD-1, the diesel deluge pump will start automatically after 30 minutes of Emergency Shutdown and/or loss of power to the shutdown control panel.

As with the electric deluge pumps, operation can be switched from remote to local at the local control panel. This is normally only done to test run the pump for maintenance, and must not be left in the local position unattended.
If the pump has started automatically and is no longer required, the pump must also be switched to local position on the local control cabinet and then stopped. When the jockey pressure has recovered to above 400 kPa, the pump can be switched back to remote for normal operation and starting.

Due to the location of the diesel deluge pump being above sea level, a primary pump is positioned in the Forward Pump Room, to take suction from the sea at the forward sea chest, and supply sea water to the diesel fire pump. The operation of this system is tested regularly.
The process modules on the Buffalo Venture have an automatic deluge protection system. Fusible plugs on a pressurised air circuit, and a deluge water spray system, combine to make up this system.

The spray nozzles are situated so as to not necessarily extinguish any fire, but to provide vital cooling to the pressure vessels, and avoid the possibility of a ‘BLEVE’.

The helicopter refuelling pods are stationed at the starboard side of the process modules, and are also protected by deluge water.

The deluge spray system will activate automatically with the release of air pressure from the fusible loop via a fusible plug release. The deluge can also be activated by turning the red handle three-way valve 180° on the local panel, simulating a fusible loop air release, or from the CCR push button.

All activation methods will create an ESD-2 situation; and also sound the General Alarm, start the deluge pumps, and open deluge valve XV-1611A.

In addition to any fusible loop activation, any gas detection on the gas compression module (Skid B) will also initiate the process deluge.

The local deluge panel in the field and three-way valve arrangement is located on the main deck of the facility, aft of the main deck paint locker.
The correct placement of both fusible plugs and deluge nozzles is vital, in providing effective fire fighting and cooling capabilities.

As can be seen in these illustrations, the fusible plugs are positioned where there is a risk of loss of containment, combined with areas of hydrocarbons in their most volatile state.

For example, crude oil that is heated above its flash point in the stabilisation process, or hydrocarbons in their gaseous state, pose a potential danger if released and ignited.

Skid C Flare module however, does not have deluge water nozzles in place, only fusible plugs. Flare vessels V109 and V110 operate at atmospheric pressure, and therefore do not require the cooling deluge water.

The means to combat potential fire risks, such as the process deluge system, are engineered into the design of hydrocarbon processing units, as on the Buffalo Venture FPSO.
Fire Pumps & Fire Main

The fire pumps and fire main system on the Buffalo Venture, is as it was prior to conversion to a FPSO. The deluge pumps and deluge system were added to the vessel as part of the conversion.

The fire pumps system consists of the Fire & General Service Pump, and the Fire & Bilge Pump. These pumps are situated in the Engine Room, taking suction from the sea.

The pumps supply what was the original ship’s fire main, which in service on the FPSO, supply sea water to all fire hydrants in all parts of the facility. Most hydrants have a numbered fire box in close proximity to the hydrant outlet, containing a fire hose and nozzle.

The Fire & G.S. pump, and the Fire & Bilge pump, can be started either locally in the engine room, at the local stop/start stations, or remotely from the CCR, via the Utilities Mimic Panel.
The Fire & G.S. pump can be lined-up to provide cooling water to the engine room plant if required.

Before starting either pump from the CCR, confirmation is required from the Utilities Technician as to which fire pump is lined-up for fire pump service.

It is also good practice to open a fire hydrant, prior to starting a fire pump. This will reduce the risk of water hammer and damaging the pump or fire main piping.
Fire Water Cross-Over

Located in Foam Room A, a cross-over arrangement exists, to provide redundancy for the Fire Main and Deluge systems.

Cross-over valve FMV-1 provides this, by acting as the main isolation point between both fire water systems. Opening this valve can provide back up if one system’s operation should fail.

For example, if the deluge pump’s operation failed, and foam required in an emergency, the crossover valve FMV-1 could be opened to supply water from the Fire & G.S. pump or Fire & Bilge pump, and supply water to the deluge system.

The cross-over valve FMV-1 can be found in the port aft corner of Foam Room A. The fire water systems manifold together in Foam Room A, to allow for a variety of flow-paths. The cross-over valve remains in the ‘Normally Closed’ position, until commoning of the fire water systems is required.
The Low Expansion Foam System on the Buffalo Venture supplies fire fighting foam to the main deck and heli-deck areas, delivered via fixed monitors. The foam tank and manifold are located in Foam Room A, on the upper deck level of the accommodation.

The facility exists to common the deluge system water supply, to the existing fire main system, to provide redundancy if required. The cross-over valve to perform this, is located in Foam Room A, and is normally closed.

The deluge and foam system manifold in Foam Room A is normally lined up for automatic activation, to supply foam to the main deck and heli-deck monitors, as per the plan on display in Foam Room A.

If foam is required on deck, the deluge pumps are activated via the opening of a monitor, or from the CCR push buttons. Once deluge water flow is established, foam is initiated from the CCR foam control panel.

This automatically opens the sea water inlet valve to the foam eductor, and the foam outlet valve to the deluge system.

If these valves fail to operate automatically, they can both be opened manually with a spanner, on location at the foam valves as back-up.

If foam is no longer required, the system is stopped by pushing the stop button on the CCR foam control panel. The deluge pumps can then be stopped as previously described.
The High Expansion Foam System on the Buffalo Venture provides fire protection for the Engine Room, and Cargo Pump Room.

Positioned in both areas are a series of foam diffusers, which are injected with high expansion foam via three nozzles to each diffuser. This arrangement spreads foam over the entire area to smother and extinguish any fire. All ventilation fans are stopped in these areas to assist with this.

The high expansion foam tank and distribution system is located in Foam Room B, in the port aft area of the accommodation, upper deck level.

As with the use of Carbon Dioxide to extinguish fire, high expansion foam also poses a risk to life when activated, due to the dense nature of the foam.

If personnel remain in the engine room or cargo pump room upon activation, breathing could be impaired, as with identification of escape routes. A warning horn is sounded prior to foam release, to alert personnel to evacuate these areas.

The engine room and cargo pump room are extremely hazardous areas for personnel to remain in, if an emergency situation occurs.

It must be confirmed prior to high expansion foam release that no personnel are present in the area.

The release of the high expansion foam is only at the discretion of the OIM, due to the hazard the foam itself poses to life, and the damaging properties of the foam to plant. Combined with the presence of fire and smoke, an extremely hazardous situation will escalate, and personnel must be evacuated if a fire emergency develops.

The high expansion foam system is activated via the control panel located in the CCR. Displayed on the control panel are instructions in its use.
Initially, the manual block valve MV1, located in Foam Room B, must be opened prior to automatic activation of the foam. This is kept shut to ensure no release of the foam occurs, for the hazardous reasons discussed.

If the foam system will not activate automatically, it can be manually carried out in Foam Room B.

Foam Room B consists of a foam tank, a foam pump, local pump operation panel, control valves, and deluge water/foam distribution manifold.

The control valves and foam pump can be manually operated if required.

For an engine room fire, the Diesel Deluge Pump is started manually from the CCR, as the integrity of the Electric Deluge Pumps will be compromised by the release of the high expansion foam in that area.

Either electric or diesel deluge pumps can be used for a Cargo Pump Room fire.
Instructions to manually operate the high expansion foam system, is displayed on the port side bulkhead of Foam Room B. Two of the control valves, AV1 and AV2, require the cap to be removed from the bonnet of the valve, and the valve screwed open with a spanner. The correct sized tools for this task are in position on site.

The distribution valves AV3 and AV4 are manually operated by turning the red handle on the valve body.

Pressure gauges exist on the flow path of deluge water supply and foam supply, to ensure adequate pressure is reached prior to release of the foam.

As when operating the system automatically, valve MV1 must be opened prior to activation.

The system can be stopped at either local or CCR control panels.
Deck Monitors

The main deck of the Buffalo Venture has a number of fire fighting monitors installed, supplied with sea water from the deluge system.

The monitors are operated by opening both isolation valves, and directing the nozzle to the required area. Opening the isolation valves, creates a reduction in the jockey water pressure of the deluge system, and automatically starts the deluge pumps.

Low expansion foam can be supplied to the deck monitors, for any deck fires where a foam blanket is the best means of extinguishment. Otherwise, deluge water can be utilised to provide additional cooling to process vessels in the proximity of the monitor, if required.
Deck Hydrants

All areas of the Buffalo Venture are fitted with hydrants and fire boxes, including the main deck, engine room, accommodation, and machinery spaces.

The hydrants are supplied with sea water, via the Fire & General Service pump, or the Fire & Bilge pump.

If required to use a fire hydrant for fire fighting, the fire box fitted near all hydrants contains a fire hose and nozzle. When the hose and nozzle are assembled and fitted to the hydrant, open the hydrant valve and hose nozzle, and contact the CCR by radio or via the Incident Controller for a fire pump to be started.

Ensure the hydrant and hose nozzle are open, to expel air from the fire main and hose. Otherwise water hammer will occur, and controlling the fire hose will become difficult.

Also ensure if in the vicinity of a fire emergency, that the situation is communicated correctly to the CCR, as the use of a fire hose alone may be inadequate, and the user may be in more danger, if the situation escalates.
The fire protection system for the turret structure and swivel of the Buffalo Venture, consists of one fire water monitor and a fusible loop. Gas detectors are also fitted, however their action is to shutdown and blowdown the process modules.

Any fusible loop heat detection will activate an ESD-2; indicate on the ESD Panel in the CCR the 'Turret Water Monitor Activation' light, also light up Zone 23 on the Fire & Gas Panel, and sound the General Alarm.

The turret fire monitor is a similar system to the process module deluge, however separate. Any release of air pressure from the fusible loop, via a fusible plug, will automatically start the deluge pumps and open the control valve FW-616V, to send water to the turret monitor.

The turret monitor can also be activated from the local control panel, located at the base of the turret rigid arm, starboard outboard side. This is the only means of manually operating the turret deluge monitor.
Local activation is done by turning the red handle three-way valve 180°, to exhaust the air pressure from the fusible loop, to simulate a fusible plug air release.

Unlike the process modules, the turret monitor deluge cannot be activated from the CCR. A light exists on the CCR ESD Panel, to warn of any activation, along with an ESD-2 and sounding of the General Alarm.
Heli-Deck Fire System

The Heli-deck of the Buffalo Venture has fixed fire fighting equipment, to contend with any helicopter emergency on deck. This equipment consists of two fixed monitors, fire hydrants and hose reels, two large dry powder extinguishers, and fire fighting suits and breathing apparatus ready for use.

For the duration of a helicopter operation, a member of the helicopter crew is dedicated to man the fire monitor.

If a fire emergency develops during refueling, the person on fire duty will open a monitor, at the HLO’s call, and place the foam spear into an open foam drum on deck.

#1 and #2 deluge pumps will start, and supply deluge water and foam to the deck fire. The foam drum contains approximately one and a half minutes of foam for immediate coverage, as the main low expansion foam supply in Foam Room A will take approximately one and a half minutes to reach the heli-deck.

The main supply of foam is activated at the Foam Panel by the CCR Technician, who is constantly monitoring the helicopter operation via CCTV.
The heli-deck of the Buffalo Venture has a main thoroughfare and stairs down to the helicopter muster room, one level below. This is located at the forward end of the heli-deck, indicated by the yellow pathway.

An emergency exit is at the aft end of the heli-deck, with stairs leading down to the next level. A fire hydrant is also positioned at the aft emergency exit. If escaping via the aft exit, the person must keep in mind the likelihood of the aircraft’s tail rotor being in the vicinity.

A ‘crash box’ is in place on the heli-deck, to recover passengers if a crash on deck occurs. The crash box contains a variety of tools, a fire blanket, and life-lines for this purpose. The crash box is located forward of the refueling station.

If a helicopter engine fire occurs whilst on deck, the initial response is at the pilots discretion, in communication with the Helicopter Landing Officer (HLO).

The Supa-Puma helicopter has its own engine fire extinguishing system, activated in the cockpit by the pilots. Two large dry chemical extinguishers with snorkels to reach the engine in-takes, are positioned on the heli-deck as back-up, if required.
Gas Detection System

The gas detection system is an automated system, where detectors are strategically placed around process, compressor, and flare modules. The cargo pump room, engine room, and accommodation ventilation system are also protected from any influx of hydrocarbon gas. These send an indication to the Central Control Room (CCR) if any gas is present, and perform various functions depending on the amount of gas and location detected.

Example of a gas detector head on process module. This high pressure gas cooler will have any gas released from a leaking flange or pipe rupture detected.

The gas detector panel in the CCR. Any recorded gas reading is relayed in LEL format, from any of the 48 gas detector heads on the facility. A light will indicate which head is reading LEL, with the percentage amount shown on the LED screen.

Functions

- A 10% LEL gas reading will give an alarm in the CCR, indicating to the Technician that gas has been detected, and from which head.
- A >40% LEL gas reading will shutdown the facility and ventilation fans if on the process module, and initiate the process deluge if on the compressor module.
- A >40% gas reading from the cargo pump room will stop the pumps if an offtake is underway, and if in the engine room area, shutdown necessary equipment such as ventilation fans, to maintain a safe facility.
Smoke and Heat Detection

The Buffalo Venture FPSO has thermal and smoke detection devices, located at various locations around the facility.

The Accommodation and Engine Room are protected by smoke and heat detectors; the Cargo Pump Room, Forward Machinery Space and Forward Pump Room by smoke detectors; the Flare, Gas Compressor and Process modules by fusible plugs.

Any detection is relayed to the Fire Alarm Panel located in the CCR, indicated by the affected zone light, and the fire and general alarm activation.

Action is then taken to extinguish fire by appropriate means, if not already activated automatically.
Certain spaces on the Buffalo Venture FPSO are protected by CO₂ release systems. These areas are #1 and #2 Boiler hoods, boiler crude fuel ducting, galley, main deck paint locker, and the Forward Machinery Space. These are designated high fire risk areas, where the most effective way to control any likelihood of fire, is to enclose the area and release CO₂ to extinguish.

Using CO₂ to extinguish any fire, although highly effective, is a hazard to life itself.

Therefore the use of CO₂ is strictly controlled, whereby any entry to a CO₂ protected space under normal operations is logged in the CCR. Under emergency situations, it is imperative to ensure no person remains in the void space prior to release of CO₂, as it is an asphyxiant.

If fire is detected in the void space, the severity of the situation is determined by the Incident Controller. Only under the instruction of the Offshore Installation Manager will CO₂ be released.

All CO₂ systems, at all locations on the facility, have instructions clearly posted in the event of a fire, to activate effectively if instructed to do so by the OIM.
Engine Room Fire Protection

The engine room on the Buffalo Venture is an enclosed, ventilated space. Fire protection systems include the High Expansion Foam system as previously discussed; gas detection on ventilation ducting, an enclosed extraction and gas detection system on the boiler hoods, smoke and heat detectors, hydrant and hose reels for water and foam application, and a variety of fire extinguishers.

The boiler’s firing fronts have hoods fitted and an air extraction system, to contain any gas that may be released. If gas is detected within the boiler hood, the boiler fuel supply will change immediately over to Marine Diesel Oil.

The MDO system is supplied from tanks in the engine room, and will therefore prevent any propagation of potential fire to the fuel ducting and the crude and fuel gas supply. Once gas is detected and investigated, CO$_2$ may be activated at the OIM’s discretion.
Gas detection is also in place at the feed filter tank vent. The feed filter tank receives steam condensate returns from the process unit and other utilities, to be re-used as boiler feed water.

If hydrocarbons have communicated with the heating steam within a heat exchanger on the process module, and returns to the engine room with the steam condensate, any gas released will be detected and initiate an ESD-2.

Any smoke or heat detection within the engine room is relayed back to the Fire Alarm Panel in the CCR, and will sound the General Alarm. The source of the detection will then be investigated and acted upon accordingly.

The engine room workshop has a 30 minute timer override, to allow for hotwork, without inadvertently setting off the Fire Panel alarm and General Alarm.
The engine room area ventilation inlet ducts have gas detectors installed. Any detection will have the same executive action as the process module gas detection, by activating an ESD-2. However, engine room equipment and power supplies will also be shutdown, and stop all ventilation fans automatically.

Six fire hydrants and hose reels are in place at various deck levels in the engine room.

Foam drums and nozzles are also at hand, for fire fighting using a branch line. The foam drums are in place due to the hydrant system being supplied from the Fire & G.S or Fire & Bilge pump, and no direct low expansion foam supply from the deluge system.

Fire extinguishers are in various locations also, including foam on large capacity trolleys, dry chemical and CO₂, dependant on the area.
Accommodation Fire Protection

The accommodation area of the Buffalo Venture has a wide range of fire systems, to protect this area of the facility where personnel on board are located.

The accommodation ventilation and air conditioning system provide positive pressure within the accommodation space, to resist any ingress of harmful gases.

Any smoke or heat detection within the accommodation is relayed back to the Fire Alarm Panel in the CCR, and will sound the General Alarm.

The source of the detection will then be investigated and acted upon.

Located around the accommodation passageways are a number of fire boxes, containing a hose reel and nozzle for connection to a hydrant fitted inside the box.

On all levels of the accommodation, fire extinguishers of varying types are located, depending on the application required. Foam, CO₂, and Dry Chemical types are used, and are typically found in passageways and near stairwells on all deck levels.
The accommodation area ventilation and air-conditioning inlet ducts have gas detectors and dampers installed.

Any gas detection will have the same executive actions as a process module gas detection, by activating an ESD-2 shutdown. In addition, some engine room equipment and power supplies will also be shutdown.

All exhaust ventilation and air conditioning dampers will also close automatically, and all vent and air conditioning fans will stop.

Doors within the accommodation will automatically close, and if fire and smoke is present in the air-conditioning ducting, dampers can be shut manually around the passageways to prevent propagation.
On any fire emergency within the accommodation, it is imperative to proceed to the muster point as the general alarm is sounded, and wait for instructions from the Incident Controller. If witnessing the incident and in the vicinity, clear concise instructions must be relayed to the Central Control Room, so the situation can be evaluated. This applies to all areas of the facility.