SAFETY OF LIFE AT SEA (46 CFR 199.180)
Fire Systems and Equipment Training Manual

Training Ship Golden Bear
FIREFIGHTING SYSTEMS

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1.1 INTRODUCTION: A fire aboard ship is an extremely serious and perilous event. Although the ship is made of steel and steel does not burn, the ship is full of fuel and lube oil, grease from food prep, paint and chemicals, lint from clothes dryers, plastics, and even the paint coating on the ship. All of these items are potential fuel for a fire. Coast Guard regulations require that the number of combustible items aboard ship be kept to a minimum. For example, no wooden furniture is allowed. However, potential fuels for a fire cannot be eliminated and the danger of an uncontrolled fire aboard ship is always present. With this in mind, the ship was designed with a number of features for detecting, isolating, and extinguishing any uncontrolled fires that might occur. However, none of these features will accomplish their designed function if they are not used properly. When the ship is at sea, the job of fighting a fire falls entirely on the crew. Since everyone on the training ship is a crew member, this means that YOU are responsible for knowing your firefighting job and how to use the firefighting equipment. If a fire occurs in port, we may have the assistance of shoreside firefighting professionals. While they will be experienced and know their equipment well, they will not know their way around the ship or be familiar with the ship’s firefighting systems. Therefore, YOU are responsible for knowing the ship’s equipment and how to use it 24/7 when you are aboard the ship.

In order for a fire to be produced there must be oxygen (to combine with fuel vapor), heat (to raise the temperature) and fuel (to vaporize and burn). Examples of gaseous fuels onboard a ship include acetylene, propane and hydrogen. When fuel is mix with oxygen they produce a flammable vapor. When a heat source (ignition) is added, the fire will burn until one of the three factors of a fire is eliminated. If any side of the fire triangle is missing, a fire cannot start. If any side of the fire triangle is removed, the fire will go out.

Fires can generate temperatures up to 1,000 °F. Temperatures that exceed 150 °F become hazardous to humans. However, the most serious hazard to humans is not the actual flames. The fire will produce carbon monoxide, carbon dioxide, and smoke. These gasses will dilute the oxygen content of the air from its normal 13%. Unconsciousness occurs when there is less than 10% oxygen in the air. Smoke makes it difficult to breathe and vision is blurred. If the lungs are exposed to only 1.3 % carbon monoxide, fewer than three breaths can result in unconsciousness. Carbon Dioxide attacks the respiratory system and prevents oxygen from reaching the lungs. Burning plastics and chemicals produce noxious, poisonous gasses which will result in severe illness if breathed, even for only a short time. Despite what you might have seen in the movies where fires always seem to burn without smoke, shipboard fires produce huge volumes of smoke which quickly dilutes the air inside the vessel. Thus “smoke inhalation” is the most serious hazard that you face in an uncontrolled fire aboard ship.
As humans, when encountering a problem, our first instinct is to attack the problem, get it solved, and get things back to normal. This means that our first instinct when encountering a fire is to attack the fire and try to put it out. This is exactly THE WRONG THING TO DO!! If one person could successfully fight a fire, then fire departments would be much smaller than they actually are. The fact is that many things have to be done to successfully fight a fire, and this involves many people. In addition, there may be crew members sleeping in the vicinity of the fire, and they need to be alerted to the fact that they are in danger so that they can escape. Thus, the FIRST thing that you must do when encountering a fire is to SOUND THE ALARM. Professional firefighters will tell you that fires are almost like living things. They will move, sometimes very fast, to seek out fuel and oxygen. It is critically important to isolate the fire as soon as possible and not let this happen. Thus, the SECOND thing that you must do when encountering a fire is to ISOLATE THE FIRE. By the time that you have accomplished these tasks, help should be on the way to actually fight the fire and put it out. Remember that in a dangerous, emergency situation, your brain really wants you to go with your first instinct. Only your training and knowledge will prevent you from either running away and hiding or trying to put the fire out by yourself.

REMEMBER.....FIRST, SOUND THE ALARM
SECOND, ISOLATE THE FIRE.
THIRD, WITH HELP, FIGHT THE FIRE

NATIONAL TRANSPORTATION SAFETY BOARD REPORT
ON TRAINING SHIP FIRE

About 1310, e.s.t., on December 22, 1981, a fire erupted in the engine room of the training ship BAY STATE while it was moored alongside the dock at the Massachusetts Maritime Academy. The fire caused heavy damage to the vessel's engine room and crew accommodation spaces. One person was killed and six persons were injured. Damage to the BAY STATE was estimated at $5 million. The investigation revealed that the fuel oil strainer had a history of being difficult to operate. It had become an acceptable practice to use a wrench or tool for leverage, a hammer, and even a kick by someone's foot on occasion to apply greater than normal force to shift the strainer. The chief engineer, being aided by temporary
employees and confronted with many serious problems, might overlook the fact that a duplex strainer was difficult to operate even if it had been brought to his attention. (*The fuel oil service system was on line. In an attempt to shift over strainers by kicking the handle, a small valve broke off on the fuel oil strainer. A stream of fuel oil under pressure shot up and hit an un-insulated section of steam pipe, causing the fuel oil to ignite. The person killed was a freshman cadet*)

The rapidly spreading fire probably made the upper level of the engineroom untenable about 1 minute after ignition and combined with the fact that the two fire doors in the engineroom casing were open, probably resulted in the two passageways on the second deck becoming untenable about the same time. However, all personnel could readily have escaped via the shaft alley had the peril of attempting to escape by the usual route out the doors on the second deck been recognized. Unfortunately, no one reasoned ahead of time that going up could result in a dangerous encounter with heat and smoke. When an emergency occurs, it is sometimes too late to ascertain the best course of action. In this case, some preplanning of escape routes to use, depending upon the emergency, would have been invaluable. When the ship is engaged in a training cruise with numerous cadets in the engineroom, careful preplanning and the regular conduct of realistic escape drills are considered essential to insure that optimum use is made of the limited exits from the engineroom.

Regardless of any convenience afforded by restraining the engineroom doors open, this was an unsafe practice. The fire entering the starboard passageway, which resulted in additional damage, especially to the electric cables in the second deck passageways outside the engineroom, and endangered the entire ship, quickly resulted in smoke and heat in most passageways of the extensive accommodations and jeopardized access to the CO₂ flooding controls, which were located in the second deck, starboard passageway outside of the engineroom.

*Mistakes made: Fire doors tied open  
Failure to use proper escape routes  
Failure to sound the general alarm  
Failure to isolate the fire  
Failure to use fixed CO₂ engine room flooding  
Failure to use fuel oil pump and valve remote shutdowns*

2 FIRE ALARMS, DETECTION, and ESCAPES

2.1 Fire Alarms: On board the training ship Golden Bear there are many fire pull alarms located throughout the ship. These pull alarms are red in color and located chest level on the bulkheads. When activated by pushing in and pulling down on the handle, a signal will be sent to the fire detection panel on the Bridge and Quarterdeck, indicating which pull has been activated, and the general alarm will also sound immediately. If a fire is seen by any person, there should be no hesitation to pull the alarm. A fire should never be fought alone! Pulling an alarm should be the first thing done. However, these alarms must *not* be pulled if there is not a fire. A fire onboard ship is very serious and fooling around by pulling an alarm falsely is a serious offence.
The Fire Alarm pull boxes are located outside of every stair tower door, on the inside to every hatch leading outside the ship’s houses, and on the outside of every exit door from the engine spaces. These emergency fire pulls are all small, red boxes (as pictured above) and are mounted about four feet above the deck. Once the handle is pulled, a signal is sent to the bridge which immediately activates the general alarm. This is represented by a continuous ringing of the general alarm. The location of the activated pull will also be indicated on the Bridge and Quarterdeck Fire detection panels.

**Note:** No pull alarms are located out on deck. They must be activated from within the house. Also, in the Engine Room, there are two alarms located on the port and starboard side of the EOS. No other pull alarms are located elsewhere in the Engine Room.
2.2 Heat/Fire Detection: A fire detector is a device that gives warning when fire, excessive heat, or smoke occurs in the area protected by the device. The fire detection system relays the alarm to an indicator panel, located on the Bridge and Quarterdeck watch office, which gives both an audible and visual alarm and indicates where the activated detector is located. Thus, the watch, both at sea and in port, is the first to receive a fire detection alarm and is responsible for initiating the proper action.

The fire detection system is an automatic system. Sensors measure either temperature (heat detector) or ultra violet light level (flame scanner), send this measurement to a system module which compares the measurement to a setpoint, computes whether it is above or below setpoint, and initiates an alarm if it is above setpoint.

In the engine spaces, should a heat or flame detector sense a fire, or a pull station be activated, all sirens will sound, all strobe lights will flash, alarm bells with visual signals will be activated in the E.O.S., and the activated detector will be indicated on the control panel on the bridge and quarterdeck watch office. If a fire is detected in a non-engine space, only the fire detection panel in the pilot house and in the quarterdeck watch stations will alarm. If this alarm is not acknowledged (silenced or reset) within two minutes, the system will automatically activate the ship’s general alarm system.

See appendices at the end of this manual for operating instructions for the fire detection system.
2.3 Fire Escapes: As can be seen from the report on the Massachusetts Maritime Academy training ship fire, failing to have a plan for escaping a space in the event of a fire usually ends in tragedy. When you are in a space that is on fire which is giving off huge amounts of smoke, your natural preservation response kicks in….GET THE HELL OUT OF HERE FAST!! There is nothing wrong with this self preservation response to a very dangerous situation, initial fear and panic are the natural, universal human response. However, what you do next is critically important. When the brain is controlled by fear and panic, then you jump at the first thing that comes to mind, which is leave by the normal way that you enter and exit the space. For engine spaces located low in the ship, this almost always means going up ladders and out a door near the top of the engine room. However, this is also the way that the heat and smoke are going. So discipline and knowledge must kick in and override the fear response. You must go down to the engine space entrance to the escape trunks. You must know exactly where these escape trunks are and be able to find them, even in limited visibility.

SHAFT ALLEY        AUX MACHINERY ROOM        E.O.S.
ENGINE SPACE EMERGENCY ESCAPE TRUNKS

The shaft alley and E.O.S. escape trunks exit at deck hatches and the auxiliary machinery room escape trunks ends at doors. It is critical that none of these exit hatches or doors be blocked at any time and this should be checked once each watch when making rounds.

3 FIRE ISOLATION

3.1 Fire/Watertight Doors: The ship is divided into five fire zones. The zone boundary bulkheads and doors are all rated A-60, meaning that they will hold up against fire and smoke for 60 minutes. The zone boundaries below the main deck are watertight, meaning that all penetrations (pipes, electrical cables, etc.) are watertight. The only doors are watertight doors in the engine spaces between zones 3 & 4 and zones 4 & 5. Interior bulkheads and doors above the main deck are fire and smoke proof for 60
minutes (A-60) and the exterior bulkheads and doors are weatherproof in addition to their A-60 rating.

Watertight Doors: The watertight doors between the engine room and AMR and between AMR and shaft alley are hydraulically operated. They can be operated locally, from E.O.S., from the fire control room, from the bridge, or from an exterior station on the 02 deck, starboard side, near lifeboat #3.

Local controls at the door include a motor switch for opening and closing the W.T. door using the electric hydraulic pump. The switch is spring loaded, so you must hold the switch in the direction that you want the door to move until the door reaches the desired position, then let go of the switch. Also at the local control is a hydraulic hand pump which can be used to open or close the door, depending on the direction of rotation that you move the crank handle. An electric pump motor control switch and a hydraulic hand pump are located on each side of the door so that the door can be opened or closed from either side.

Note that the doors can only be closed, not opened, from the fire control room and the bridge. When the doors are closed from these stations, the switch must be returned to the RESET position so that they can be opened locally or from E.O.S.
The W.T. doors can also be controlled remotely from either E.O.S., the Fire Control Room, or the Bridge. FR 154 and FR 144 are abbreviations for the location of the doors. Remember that FRAME 144 is forward and labels the door between the engine room and A.M.R. while FRAME 154 is aft and labels the door between the A.M.R. and the shaft alley.

The exterior station consists of a hand pump for each of the two W.T. doors. These pumps can only be used to close the doors, not to open them. There are indicator lights to show when the door has reached the end of its travel in the open or closed position.
NOTE: Caution must be exercised when stringing hoses or power cords through the W.T. doors because if the door is closed, it will cut the hose or cord in half. Stringing cords and hoses through W.T. doors should be avoided, but if absolutely necessary, signs should be placed at each operating station warning of this hazard.

Other doors between fire zones below the main deck are watertight, but use mechanical “dogs” to achieve this and can only be opened and closed locally.

When a door has individual dogs as shown above, it is important to always unlatch them in the proper sequence. The hinge side dogs are released first, then the handle side is done. This is because if there were any pressure on the door, say due to flooding in the compartment, and the handle side dogs were released with the hinge side dogs still secured, the moment arm would be tremendous and the door might be bent, making it worthless as a watertight door (this is a common Coast Guard exam question).
The other type of watertight door has a single handle which is mechanically linked to and actuates all of the dogs at the same time. These are used for the escape trunks and for exterior weatherproof doors above the main deck. The weatherproof doors are also fire proof for 60 minutes. The interior doors at fire boundaries are usually in passageways or stairwells that get a high volume of foot traffic. The doors would either wear out from all of the opening or closing, or they would get tied open. In order to avoid these problems, these doors are held open by electromagnets and can be released and closed from the bridge or locally in the event of a fire.

In areas with less foot traffic, normally closed doors can be used.
21.3.2 Ventilation Fans: Ventilation fans and their associated ducting and climate control are essential for making the interior of the ship livable. However, in a fire, they are a source of fresh air (oxygen) to support the combustion and the ducts provide a route for the fire to spread. Thus during a fire, it is essential to isolate the air supply by securing vent fans and closing dampers in the ducting. Only the ventilation and ducting in the area of the fire should be secured and isolated. Maintaining ventilation in adjacent spaces will help keep out smoke and heat.

The ship is designed so that each fire zone has its own ventilation system and, in general, the ducts do not transverse fire boundaries. Remote shutdowns located on the bridge, in E.O.S., and in the fire control room are arranged so that only the area affected by the fire is shut down.

Even with the supply vent fans secured, the fire can still draw air through the vents and use them to spread. Thus, dampers are interspersed throughout the ducting system so that sections can be isolated to cut off air and isolate the fire. The dampers for the engine room, auxiliary machinery room, boiler room, and emergency diesel room will close automatically when the fire suppression system is actuated.
The emergency diesel generator air damper can be shut down from outside the space, preventing air from entering the space to support combustion.

21.3.3 Emergency Oil Shutoff Devices: Fuel oil and lube oil do not catch fire or burn when they are contained in a oil tank or piping because there is not enough oxygen to support combustion. However, oil that has leaked from its containment now has sufficient air to support combustion and will burn if provided with an ignition source. Thus, an effective way to suppress an oil fire is to shut off the flow out of a leak and cut off the supply of fuel to the fire. It is critical that you know how to do this and that you know the location of all remote oil pump and valve shutoffs.

Since all of the fuel oil service and transfer pumps are electrically driven, the shut-offs simply cut the electrical supply to the pump motor. The fuel oil isolation valves may be either solenoid valves or pneumatic actuated valves. The solenoid valves close when electrical supply is cut off. The pneumatic actuated valves will close when air pressure is applied.
The fuel oil and lube oil pump and valve controls shown above are all located on the E.O.S. console. In addition, fuel oil to the boilers can be shut down from a control box on the forward bulkhead of the E.O.S. and from a box located just outside the port main deck door to the engine room.

Note that the remote boiler shutdowns will not secure the boiler fuel oil booster pumps located in the engine room. They can be secured locally, in E.O.S., and in the boiler room.
Fire Control Station: Fuel oil pump and F.O. and L.O. tank suction valves can be closed from the console.

Bridge: The bridge console also contains emergency remote controls for shutting down fuel and lube oil valves and for shutting down fuel oil pumps.
Boiler Room: The boiler fuel oil booster pumps located in the engine room can be shut down from the boiler room.

Emergency Diesel Generator: The fuel oil suction valve from the fuel oil tank located in the emergency diesel room can be shut off from outside the space.

21.4 FIXED FIREFIGHTING SYSTEMS

21.4.1 Firemain, Fire Pumps, and Fire Stations: The firemain system is the ship’s first line of defense against fire. It is required no matter what other fire extinguishing systems are installed. Every crew member can expect to be assigned to a station requiring knowledge of the use and operation of the ship’s fire main.

The firemain system supplies water to all areas of the vessel. Fortunately, the supply of water at sea is limitless. The movement of water to the fire location is restricted only the capacity of the system itself, the effect of the water on the stability of the ship, and the capacity of the fire pumps.

The firemain system is composed of the fire pumps, piping (main and branch lines), control valves, hose and nozzles. The fire pumps provide the power to move water through the piping to fire stations located throughout the ship. The valves, hose, and nozzles are used to control the firefighting water and direct it onto the fire.
Fire Stations and Piping:

The piping carries the firefighting water from the pumps to the fire stations. The piping must be large enough in diameter to distribute the maximum required discharge from two fire pumps operating simultaneously. The water pressure in the system must be a minimum of 50 psi at the two hydrants that are highest on the ship (75 psi for tankers). The piping system consists of a large main pipe and smaller branch lines leading off to the fire stations. The horizontal loop system used on the TSGB consists of two parallel main pipes connected together at their furthest point fore and aft to form a complete loop. Branch lines extend the system to the fire stations. In the event of a rupture in the main line, the ruptured section of pipe can be isolated while maintaining flow to all other parts of the system.

At least two (one on each side of the ship) shore connections to the firemain are required. Each shore connection is fitted with a cutoff and check valve.
Each shore connection must have one portable international shore connection (flange). On the TSGB, one is stored in Damage Control Locker #1 and the other in Damage Control Locker #2. The threaded part of the flange connects to the ship’s fire hose or station. The slotted four bolt flange can be attached to any other four bolt flange, no matter what its diameter is, thus allowing it to match fittings that are available at most ports and terminals throughout the world. They enable the crew to take advantage of the pumping capability of the shore installation or fire department at any port.

Fire Pumps: The ship has three fire pumps located in separate spaces. Each pump is an electric motor driven centrifugal pump. Each pump takes suction from a sea chest through a suction valve and strainer. Each discharge is fitted with a relief valves set at 125 psi and a discharge pressure gauge. The fire pumps can be started from several remote locations in addition to the local start location.
The Fire & Ballast Pump and the Fire & General Service Pump can be started from the E.O.S. console. The emergency fire pump cannot be started from E.O.S. The POWER ON indicator light shows that the circuit breaker at the switchboard for the pump is closed and electrical power is available to the pump motor controller. The CONTROL AVAILABLE light indicates that the electrical power switch at the motor controller is closed, providing electrical power up to the START/STOP switch.

In addition, the Fire & Ballast Pump has a selector switch which controls the remote control discharge valves. Selecting FM (shown) opens the FIRE MAIN discharge valve, selecting AFFF opens the line to the AFFF room, and BALLAST opens the valve to the ballast main. When starting a fire pump remotely, it is critically important to remember “Action-Reaction”. If, after starting the pump, the fire main pressure does not come up, the suction valve could be closed. If the pump is run in this condition, the pump will be damaged in short order. If fire main pressure does not come up after starting a pump, the pump should be stopped and the problem investigated immediately.

METERS SHOWING FIRE MAIN PRESSURE ARE LOCATED IN E.O.S., FIRE CONTROL, AND THE BRIDGE
All three fire pumps can also be remotely started from the panel in the Fire Control Room. The CONTROL LOCATION indicator lights show the location from which the pump was started. For the EMERGENCY FIRE PUMP, the SEA SUCTION valve and the FIRE MAIN DISCHARGE valve will open automatically when the selector switch is placed in the FIRE MAIN position and the pump is started. Also, there is an additional valve remote control located just inside the door on the main deck level of the trunk going down to the pump.

For the FIRE AND GENERAL SERVICE PUMP, the FIRE MAIN DISCHARGE valve will open automatically when the pump is started. For the FIRE AND BALLAST PUMP, when the selector is turned to FIRE MAIN, the SEA SUCTION valve and the FIRE MAIN DISCHARGE VALVE will open automatically when the pump is started.
Finally, all three fire pumps can be started from the bridge. However, no matter where the pumps are started from, it is still the responsibility of the engineers on watch to check the pumps for proper operation.

BRIDGE CONSOLE FIRE PUMP CONTROLS and INDICATORS

Fire Stations: The purpose of the fire main system is to deliver water to the fire stations that are located throughout the ship. A fire station consists basically of a fire hydrant (water outlet) with valve and associated hose and nozzles. Fire stations and hoses must be highly visible and easily put into service. Fire stations are located to ensure that the water streams from at least two hydrants will overlap. Exterior fire stations are located in steel cabinets and have 2 ½ inch fire hoses and fittings. The larger fire hoses can be used on exterior fires because the water coming out of the hose just runs over the side of the ship. Interior fire stations are located in recesses in the bulkheads and are easily visible. They have the smaller 1 ½ inch fire hoses because the water coming out of the hose stays in the interior of the ship. One way to think about this is that the water used to fight a fire in the interior of the ship is also sinking the ship!

NORMANDIE FIRE STARTED BY A WELDERS TORCH IN New York HARBOR WATER USED TO FIGHT THE INTERIOR FIRE CAUSED SHIP TO CAPSIZE & SINK
Hoses: Each fire station must have a single 50 foot length of fire hose. The hose couplings must be made of brass and have National Standard fire hose coupling threads. These threads are different than pipe threads and you cannot attach a fire hose directly to a threaded pipe. The hose is lined with synthetic rubber to stand up under high pressure and to minimize friction losses. Its inner surface is very smooth so water will flow through it with a minimum of friction. The outer covering of the hose is a jacket of heavy cloth or synthetic material. The hose has a male coupling at the nozzle end and a female thread at the hydrant end. The hose must remain hooked up to the hydrant at all times. Care must be taken not to damage the hose during fire drills or actual use. Take
precautions not to allow the outer covering to be cut or the coupling threads made of relatively soft brass to be bent or deformed.

A spanner wrench is a special tool designed specifically for tightening or breaking apart fire hose connections. They are located with the fire hose at each fire station. However, hand tight connections are usually adequate and the wrench should only be used when absolutely necessary.

Nozzles: The purpose of the nozzle is to allow the fire fighter to direct the water onto the fire and to have options as to the stream or spray pattern the water will have. The two types of nozzles used on the training ship are the combination nozzle and the adjustable fog nozzle.

The combination nozzle can be used to deliver a straight stream, high velocity fog, or low velocity fog through an applicator attachment. The pattern selection is made by
moving the handle to one of three positions. With the handle toward the nozzle outlet, the nozzle is shut. One way to remember this is to recall that when dragging a charged fire hose, the best way is to grab the handle and pull the hose. While doing this, you would want the nozzle shut, not spraying water on you! With the handle in the mid position, the nozzle pattern is high velocity fog. Finally, with the handle back toward the hose, the nozzle pattern is a solid stream.

In order to use the combination nozzle with the low velocity fog applicator attachment, the handle must be in the OFF position. The Spring Latch is then pushed in which allows the High Velocity Fog Tip to be rotated 90° and pulled out of the nozzle. The end of the low velocity fog applicator can then be inserted with the two pins aligned, turned 90°, and locked into position. The mid position of the combination nozzle now becomes the low velocity fog position. Only 4 foot applicators can be used in the engine room.

![Diagram of low velocity fog applicator attachments]

LOW VELOCITY FOG APPLICATOR ATTACHMENTS

Adjustable fog nozzles can deliver an adjustable fog pattern or a solid stream. The low velocity fog applicator cannot be used with this type of nozzle. The handle has two positions, forward is shut off and back (shown) is on. The spray pattern is then adjusted by rotating the nozzle barrel. It can be adjusted from a 90° low velocity fog to narrower, higher velocity fog patterns to a solid stream.

![Adjustable fog nozzle]

Figure 12.8C. The adjustable fog nozzle will deliver a 30° or 90° fog pattern as well as a solid stream.
4.2 Halon System: The fixed Halon 1301 fire suppression system on the TSGB is designed to fight fires in the engine room, the auxiliary machinery room, the Deck flammable liquids storeroom (2-166-2), and the emergency generator room; spaces where the possibility of an oil fire are the greatest. Halon 1301 enters the space as a colorless, odorless, electrically nonconductive gas and acts to chemically break the combustion chain reaction. The Halon 1301 fire extinguishing system is a very effective way to extinguish an “out of control fire” by flooding the compartment into which it is released. This means that all personnel must be evacuated, the compartment sealed off (all doors and hatches closed), and the ventilation secured. There is only one charge of Halon 1301 for each space, so it must be used correctly the first time. Failure to completely seal off the space before releasing the Halon gas means that this fire suppression system will be ineffective with disastrous results. Halon should only be released into a space when ordered by the ship’s most senior officers, the Captain or the Chief Engineer.

Note: Because Halon 1301 is a halogenated chemical which has been proven to have a negative effect on the environment, it is no longer used as a fire fighting agent. However, it can be maintained in installed systems until used. After being used, the system must be converted to some other fixed fire suppression system.

The Halon is stored in liquid form under pressure in cylinders located outside the space being protected. The cylinders are connected to a manifold that, in turn, is connected to piping leading to the protected space. All cylinders on a common manifold are of the same size. The Halon gas then is distributed through nozzles located throughout the protected space. Enough Halon is available to provide a concentration of 7% of the protected space. A remote release (pull box) station is required for each protected space. It is located close to one of the exits from the space. Posted instructions at the release station describe how to activate the system from the station. They also describe the alternative means of manually activating the system in case the remote release fails. A warning siren, actuated by pressure from the Halon system, sounds the alarm when the agent is about to be discharged into the protected space. The discharge is delayed to give personnel sufficient time to evacuate the space before the Halon is released. At each siren location, a sign is posted explaining the purpose of the alarm. In addition, signs are posted at the entrance to each protected space warning the crew not to enter the space without breathing apparatus after the system has been activated. The ventilation system for the protected space will be automatically shut down when the system is activated. In addition, for the engine room and emergency diesel generator room, all engines will be automatically shut down upon activation of the Halon system. However, the closing of doors and hatches to the space is not automatic and must be carried out before the Halon is released into the space.

Engine Room and Auxiliary Machinery Room: The release of Halon for these two spaces can be initiated from remote pull stations in E.O.S., the fire control room, and locally in the Halon room (2-104-2). In addition, the Auxiliary Machinery Room has remote pull boxes located in the engine room next to the watertight door (FR 144). Release is initiated only after receiving orders to do so from the proper authority (Captain or Chief Engineer). Release is accomplished by breaking the glass and pulling the handle, first in the Valve Control Box and second in the Cylinder Control Box.
**Engine Room Halon System:** The engine room Halon 1301 system consists of twelve 550 lb. Halon cylinders, two 50 lb. pilot CO\(_2\) cylinders, a control stop valve with a cable operated control head, pressure switches, alarm sirens, discharge delay, pull boxes, and discharge nozzles. System actuation is accomplished by the operation of both remote manual pull boxes. Operating the cylinder valve pull box actuates the CO\(_2\) pilot cylinders and operation of the control valve pull box opens the control valve to permit the CO\(_2\) gas to discharge into the actuation piping. Pressurized CO\(_2\) gas provides the force required to operate the pressure switches, sound the alarm sirens, and open the pressure-operated valves on the Halon cylinders. The pressure switches send the signals to shut down the ventilation, fuel oil pumps, fuel oil purifiers, and the main engines and SSDG engines. Halon 1301 gas is routed into the system piping and discharged through nozzles installed in the engine room. In addition, the control head mounted on the pilot CO\(_2\) cylinders is provided with a manual lever to permit local manual actuation at the CO\(_2\) cylinders.

A preset time delay assembly in the CO\(_2\) piping provides a 60 second interval between the time that the CO\(_2\) pressure sounds the alarm sirens in the engine room and operates the pressure switches and the time that the Halon 1301 is actually released into the engine room. This time delay is also provided with a manual control head to permit a manual bypass of this delay period.

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<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>HALON CYLINDER</td>
</tr>
<tr>
<td>2</td>
<td>FLEXIBLE HOSE, HALON CYL.</td>
</tr>
<tr>
<td>3</td>
<td>CO(_2) CYLINDER, MANUALLY ACTUATED</td>
</tr>
<tr>
<td>4</td>
<td>FLEXIBLE HOSE, CO(_2) CYLINDER</td>
</tr>
<tr>
<td>5</td>
<td>TIME DELAY</td>
</tr>
<tr>
<td>6</td>
<td>STOP VALVE</td>
</tr>
<tr>
<td>7</td>
<td>PRESSURE SWITCH</td>
</tr>
<tr>
<td>8</td>
<td>SAFETY OUTLET</td>
</tr>
<tr>
<td>9</td>
<td>PRESSURE OPERATED SIREN</td>
</tr>
</tbody>
</table>

**ENGINE ROOM HALON SYSTEM**

**LEGEND:**

- ——— = CO\(_2\) FLOW LINE
- ——— = HALON FLOW LINE
CO2 PILOT CYLINDERS WITH CYLINDER CONTROL PULL CABLE (3,4)

HALON CYLINDERS WITH CO2 PRESSURE ACTUATED RELEASE HEADS (1,2)

CO2 PRESSURE ACTUATED PRESSURE SWITCHES FOR SHUTING DOWN VENTILATION AND ENGINES (7)

CONTROL VALVE WITH VALVE CONTROL PULL CABLE (6)

60 SEC. TIME DELAY WITH MANUAL OVERRIDE (5)

SIREN (9)

MANUAL CYLINDER RELEASE (PULL PIN, THEN PULL HANDLE)
Auxiliary Machinery Room, Emergency Generator Room, and Deck Flammable Liquids Storeroom (2-166-2): These Halon systems are the same. Also, they are essentially the same as the engine room system with the exception of the CO₂ pilot cylinders. These systems use Halon 1301 as the gas that pressurizes the pilot line and initiates the release of the main Halon cylinder/s. The cylinder control pull cable is attached to the head of the main Halon cylinder. When pulled, Halon flows into the piping system, but is blocked from going to the space by the STOP VALVE (3). When the valve control cable is pulled, Halon pressurizes an attached pilot line, actuating a pressure switch and a siren. It also passes through the time delay (25 seconds) before being allowed to flow to the STOP VALVE. When it does reach the STOP VALVE, the pressure causes this valve to open, allowing the main Halon bottle to discharge into the space.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>HALON CYLINDER</td>
</tr>
<tr>
<td>2</td>
<td>FLEXIBLE HOSE, HALON CYL.</td>
</tr>
<tr>
<td>3</td>
<td>STOP VALVE 1-1/2' NPT</td>
</tr>
<tr>
<td>4</td>
<td>TIME DELAY</td>
</tr>
<tr>
<td>5</td>
<td>STOP VALVE 1/2' NPT</td>
</tr>
<tr>
<td>6</td>
<td>PRESSURE SWITCH</td>
</tr>
<tr>
<td>7</td>
<td>SAFETY OUTLET</td>
</tr>
<tr>
<td>8</td>
<td>CHECK VALVE</td>
</tr>
<tr>
<td>9</td>
<td>PRESSURE OPERATED SIREN</td>
</tr>
</tbody>
</table>

**LEGEND**

--- = N₂ FLOW LINE  
——— = HALON FLOW LINE
4.3 Carbon Dioxide System: A method of extinguishing fires by smothering is the use of the inert gas, carbon dioxide (CO\textsubscript{2}). CO\textsubscript{2} is about 1.5 times heavier than air. This makes CO\textsubscript{2} a suitable extinguishing agent because it tends to settle and blanket the fire.

CO\textsubscript{2} is a dry, non-corrosive gas, which is inert when in contact with most substances and will not leave a residue and damage machinery or electrical equipment. In both, the gaseous state and the finely divided solid (snow) state, it is a nonconductor of electricity regardless of voltage, and can be safely used in fighting fires that would present the hazards of electrical shock. CO\textsubscript{2} extinguishes the fire by diluting and displacing its oxygen supply. If gaseous CO\textsubscript{2} is directed into a fire so that sufficient oxygen to support
combustion is no longer available, the flames will die out. Depending on the fuel, this action will take place when the 23 percent oxygen content, normally present in air, is diluted with CO₂ below 15 percent oxygen. Some ordinary combustible class A fires require that the oxygen content be reduced to less than 6 percent in order to extinguish glowing combustion (smoldering fire).

**CAUTION:** CO₂ can produce unconsciousness and death when present in fire extinguishing concentrates. The reaction in such cases is more closely related to suffocation. A concentration of 9 percent is about all most people can withstand without losing consciousness within a few minutes. Therefore, caution must be exercised when discharging CO₂ in confined spaces. A typical discharge of liquid CO₂ has a white cloudy appearance due to finely divided dry ice particles carried along with the flash vapor. Some water will condense from the atmosphere creating additional fog, which will persist for a time.

On board the TSGB, the fixed CO₂ firefighting system is used to protect the boiler room, the Engineering flammable liquid storeroom (2-169-2), and the paint locker. The boiler room was converted from another use after Halon was no longer permitted, thus CO₂ was selected. The boiler room system consists of three CO₂ cylinders located in the adjacent fan room, an exterior pull box, an alarm, and an automatic air damper shutdown. To operate the pull box, rotate the locking lever up and open the metal cover. Then break the glass cover inside and pull the handle completely out.
Be sure that the engine room and exterior doors to the boiler room are closed before releasing the CO$_2$ into the space.

The CO$_2$ systems for the Engineering flammable storeroom and the paint locker are basically the same as for the boiler room. The pull box release is located just outside the door of each of these spaces.
4.4 AFFF System: The aqueous film-forming foam produces a water film that is only 0.001 inches thick, but is able to float on an oil surface and both block the generation of vapor and cool the surface.

The foam is made from surfactants, through a fairly complex chemical process. One end of a surfactant molecule is polar (water soluble), whereas the other end is nonpolar (oil soluble, but not water soluble). In use, the surfactant is mixed with water before it reaches the nozzle. As the surfactant mixes with the water, the polar end dissolves and the nonpolar end remains intact. When the surfactant reaches the surface of the flammable liquid, the nonpolar end dissolves in the fuel. The polar end drags water along with it. Thus, a thin film of water floats on top of the water-insoluble flammable liquid. It remains on the surface even thought it is heavier than the burning fuel; the surface tension holding the nonpolar end is greater than the force of gravity.

Because AFFF works through surface tension, it spreads the water thinly, but over a larger surface area than untreated water could cover. The thin water film spreads across the flammable liquid and keeps the flammable vapors beneath its surface. When vapor cannot reach the flames, flame production ceases.

The water film can be broken if it is agitated. It may also be broken by the roll and pitch of a ship that is underway, especially in heavy weather.

The AFFF foam chemical concentrate is stored in 5 gallon plastic containers. It is produced in two strengths, 3% and 6%. These are the percentages of concentrate to be used in making the foam solution. Thus, if 3% concentrate is used, 3 parts of concentrate must be mixed with 97 parts of water to make 100 parts of foam solution. If 6% concentrate is used, 6 parts of concentrate must be mixed with 94 parts of water. The 3% foam solution is just as effective as the 6% solution. The difference is in shipping and storing the products. Five containers of 3% concentrate make as much foam as 10 containers of 6% concentrate.
The fixed AFFF system on the TSGB is designed to mix the proper proportion of foam concentrate and water and then pump the foam solution to one of three locations through the AFFF piping system. For the engine room and auxiliary machinery room locations, the foam solution flows out of pipes located near the tank tops (bilges). For the helo deck, the foam solution is delivered to the two AFFF fire stations located forward and on either side of this deck.

The proportioning system for mixing the AFFF foam concentrate with water is located in the AFFF room, main deck, port side. The major components of the system are as follows:

(13) The foam concentrate tank has a capacity of 75 gallons of foam concentrate. The tank is equipped with suction, return, and drain lines. The tank provides foam concentrate to the foam generator pump.

(7) The diaphragm (back pressure) control valve regulates the amount of foam concentrate flowing through the return line. This action regulates the foam concentrate available to the ratio controller.
(9) The ratio controller measures the volume of water flowing through it and mixes the foam concentrate accordingly. The ratio controller is equipped with a sensing line which is connected to the diaphragm control valve for regulating foam concentrate.

Eight foam maker nozzles are provided in the engine room bilge. The function of a nozzle is to introduce air into the mixture of foam concentrate and seawater flowing in the line. This introduction of air is what produces the quick-dispersing foam. Foam-makers are installed in a fixed installation the engine room bilge.

Each helo deck AFFF station is equipped with a 1 ½ inch gate valve with hose connections and 100 feet of 1 ½ inch hose with nozzle.

In order to operate the system, proceed as follows:

a) Open the water supply valve in the AFFF room. The posted directions say to start one of the fire pumps first, however, this is a butterfly valve and if pressure is applied to one side by the fire pump, the valve will be jammed shut. Experience has proven that opening the valve first with no pressure on either side will allow successful opening and avoid delays in getting the system on line.
b) Start a fire pump and line it up to the AFFF piping. The emergency fire pump is considered the primary fire pump for AFFF service, but any of the fire pumps can be used.

c) Start the foam concentration pump (component #2) which automatically opens motorized valve #5

d) Open the discharge valve to one of the desired areas; engine room, auxiliary machinery room, or helo deck. These valves can be opened locally in the AFFF room or remotely in the fire control room.
AFFF VALVE REMOTE CONTROLS IN FIRE CONTROL ROOM

DISCHARGE VALVE TO HELO DECK

AFFF STATION HELO DECK

DISCH. VALVES TO E.R. & A.M.R.

AFFF OUTLET A.M.R. BILGE
4.5 Aqueous Potassium Carbonate System: Aqueous Potassium Carbonate (APC) is used on the Golden Bear as the extinguishing agent in the fixed firefighting system over the galley cooking range and associated exhaust ductwork. When the APC is sprayed over the burning surface, a soap like froth is generated that excludes air from the surface of the burning material.

The system is composed of a chemical cylinder, piping, nozzles, and a detector. There are two sets of piping, one in front of the filters over the cooking surface, and one behind the plenum and in the ducting. The nozzles are covered with blowout seals so that they cannot become clogged with cooking grease. Automatic operation is achieved by joining lengths of control cable together with fusible links. The cable and links are placed under tension by a spring in the pressure release box. Excessive heat on a fusible link (360°F) melts the fusible link and releases the cable tension. The spring pulls the lever toward it. This action activates the pressure release cartridge, releasing nitrogen gas under pressure, which activates the lever control head, causing the APC cylinder to discharge.
The system can also be activated manually from two different locations

*SHUTDOWN LEFT OF GRIDDLE*  
*SHUTDOWN AT DOOR OF SCULLERY*

5 SEMI-FIXED FIREFIGHTING EQUIPMENT:

5.1 Engine Room CO₂ System: A semi portable fire extinguisher is one from which a hose can be run out to the fire. The other components of the system are fixed in place, usually because they are too heavy to move. The semi-fixed (semi portable) system provides a way of getting a sizeable amount of extinguishing agent to a fire rapidly. This allows the fire fighter to make a sustained attack on the fire. The disadvantage is the protected area is limited by the length of the hose connected into the system. Where possible, a fire is first attacked with the semi-fixed system. If this attack controls or extinguishes the fire, then the large fixed system need not be activated.
The engine room carbon dioxide hose-reel system is shown above. The system consists of two CO$_2$ cylinders, a hose stored on a reel, and a CO$_2$ discharge horn with an ON-OFF control valve. The system is activated manually, by use of a control lever mounted on top of the CO$_2$ cylinder. Only one lever need be operated, pressure from the first cylinder opens the valve of the second, so both will be used.

The steps in activating the semi-fixed CO$_2$ system are as follows:

1) Activate the cylinder by removing the locking pin and operating the lever of the control cylinder.
2) Run out the CO$_2$ hoseline to the fire area.
3) Open the horn valve by pushing the handle forward.
4) Direct the CO$_2$ at the near edge of the fire. For a bulkhead fire, direct the CO$_2$ at the bottom and work up. As the flames recede, follow them slowly with the CO$_2$.
5) Continue the discharge until any smoldering materials are covered with snow.
6) To temporarily stop the flow of CO$_2$, close the horn valve by pulling the handle back.
6 PORTABLE FIREFIGHTING EQUIPMENT:

6.1 CO₂ Extinguisher: Carbon dioxide extinguishers are used primarily on class B (petroleum) and class C (electrical) fires. The most common sizes contain from 5 to 20 pounds of CO₂, not including the weight of the relatively heavy cylinder. The CO₂ is mostly in the liquid state at a pressure of 850 psi. The range varies between 3 to 8 feet and the duration between 8 to 30 seconds, depending on the size.

The extinguisher is carried to the fire in an up-right position. The short range of the extinguisher means the operator must get fairly close to the fire. The extinguisher is placed on the deck and the locking pin is removed. The discharge is controlled by squeezing the two handles together. The operator must grasp the hose handle, and not the discharge horn. The CO₂ expands and cools very quickly as it leaves the extinguisher. The horn gets cold enough to frost over and this can cause severe frostbite.

6.2 Dry Chemical Extinguisher:
The portable stored pressure dry chemical fire extinguishers range in size from 2 to 30 pounds. They have a range of from 10 to 30 feet. Extinguishers under 10 pounds have a duration of 8 to 10 seconds while larger extinguishers provide up to 30 seconds of discharge time. The extinguisher has a small pressure gauge near the handle so that the operator can tell if there is sufficient pressure in the extinguisher. The extinguisher is carried and used upright. The ring pin is removed and the flow of dry chemical is controlled with the squeeze grip handle on the top of the cylinder. The discharge is directed at the seat of the fire, starting at the near edge. The stream should be moved from side to side with rapid motions, to sweep the fire off the fuel. On the weather deck, the fire should be approached from the windward if possible. Dry chemical extinguishers extinguish fires by breaking the chemical chain reaction with little or no cooling. Thus a reflash is possible of the surrounding surfaces are hot. Additional dry chemical or another appropriate extinguishing agent must be available as backup until all sources of ignition are eliminated.

8 PERSONNEL FIREFIGHTING GEAR:

8.1 Personal Dress: In an actual fire situation, only a relatively small number of crew are going to be involved in directly fighting the fire. Most of the crew is going to be involved in setting fire boundaries, carrying gear to the fire scene, refilling oxygen bottles for the SCBA’s, etc. However, even when carrying out these jobs, you may well be exposed to very hot decks and bulkheads and smoke and steam generated by the fire and water applied to it. In order to protect yourself from injury and carry out your part of the firefighting effort effectively, you must be wearing clothes that provide at least some protection from the hazards of firefighting. At a minimum, this dress consists of long pants and shirt, or coveralls, work boots, and a hat. Gloves and safety glasses are also highly recommended. As engineers, we are usually dressed in these items while on duty. However, we usually dress in a more relaxed, casual manner when we are off-duty.

Our first instinct when the fire alarm sounds is to get to our fire station location as fast as possible and start doing our part to extinguish the fire. However, once again, our training must take control. The first thing that you should do, whether in a fire drill or an actual event, is make sure that you are dressed in the minimum protective clothing. So if you are hanging out on deck in shorts and a tee-shirt, this means trying to get to your room, if possible, and quickly get into your coveralls and boots, grab you gloves, safety glasses, and a hard hat, and then go to your assigned station. It helps if this gear is stored in the same place in your room every time so that you know exactly where it is and can lay your hands on it in a hurry.
8.2 Turnout Gear: For those crew members who will have to come into close proximity to the actual fire, either as part of a search and rescue team or as part of a firefighting team, the clothing described in the previous section is not enough. These personnel will have to put on the “turnouts” provided. This is the same protective clothing used by professional firefighters. It is heavy, cumbersome, and not easy to put on, so if you are assigned to a job where you have to wear this gear, you must practice, practice, and practice.

TURNOUT GEAR STOWED IN E.O.S.

The turnout gear consists of heavy pants and jacket, rubber boots, heavy gloves, a flash hood, and helmet with face shield. People come in different sizes, but the turnout gear on ships is usually all one size. The pants, jacket, and helmet can be adjusted somewhat to fit individuals, so this should be done before the gear is stowed so that it is ready to go when needed. On board the training ship, turnout gear is stowed in E.O.S., the two damage control lockers, and in the deck training locker. Although you’re normal fire station probably will not require you to put on the turnout gear, there is always the possibility of a fire in port. Under these circumstances, the normally assigned person may be ashore and if you are in the duty section, then you might have to “pinch hit”. Thus, every crew member should be familiar with this gear and know how to use it if necessary.

8.3 Self Contained Breathing Apparatus (SCBA) The SCBA has been the standard self-contained breathing apparatus for professional firefighters for years and has finally become the standard aboard merchant ships also. Here, we will cover the basic parts and how the SCBA works. You should become familiar with the proper use of the SCBA and how to wear it. Again, while your normal firefighting assignment might not include the use of the SCBA, you may be called upon to use one if you are in the duty section in port and a fire emergency occurs. A series of videos explaining the SCBA are at the following website:
8.4 Emergency Escape Breathing Device (EEBD): Studies of fire casualties have proven that most casualties are the result of smoke and toxic fumes and not from the fire itself. For this reason, the EEBD was developed for emergency escape. It provides the wearer with 15 to 30 minutes of breathable air. It is to be worn until you can get topside during evacuation from below deck spaces. The EEBD is designed to provide respiratory and eye protection in an atmosphere that will not support life.

EEBD STORAGE LOCKER…EEBD’s ARE LOCATED IN VARIOUS WATCH AND WORK STATIONS THROUGHOUT THE ENGINE SPACES.
The Ocenco M-20.2 EEBD - THE WORLD’S SMALLEST AND MOST DURABLE EEBD.

Think of it as a Life Preserver You Wear on Your Belt

The Ocenco M-20.2 compressed oxygen EEBD (Emergency Escape Breathing Device) provides up to 32 minutes of protection.

The Ocenco M-20.2 EEBD can be donned in seconds: simply un latch the case, pull out the unit, and insert the mouthpiece and nose clip.

The attached hood can be donned at anytime during the escape.

The compressed oxygen and mouthpiece combination allows the Ocenco M-20.2 EEBD to be donned in a smoke filled environment.

The compact Ocenco M-20.2 EEBD can be belt worn in all confined spaces.

The M-20.2 Meets the New SOLAS Requirement for EEBD’s

The Ocenco M-20.2 EEBD has been selected for exclusive use by the US Navy, US Coast Guard and the Hellenic Navy.

THE OCENCO M-20.2 EEBD:

Quick, easy use — pulling the unit from the case automatically starts oxygen flow.

Low life cycle cost — 15 year service life – annual shipboard visual inspection.

Belt wearable — so light and compact it can be worn comfortably on a belt.

Full visibility — the clear Teflon hood protects the user from hazardous environments while allowing a full field of view.

Maximum Protection — Teflon hood and breathing bag provide excellent heat and chemical resistance.
**M-20.2 EEBD**

**EMERGENCY ESCAPE BREATHING DEVICE**

![Diagram of M-20.2 EEBD]

### M-20.2 PHYSICAL CHARACTERISTICS AND PERFORMANCE DATA

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical performance duration</td>
<td>15-32 minutes</td>
</tr>
<tr>
<td>Donning time</td>
<td>less than 10 seconds</td>
</tr>
<tr>
<td>Weight</td>
<td>3.1 lbs (1.4 kg)</td>
</tr>
</tbody>
</table>
| Dimensions                     | M-20.2 EEBD - 6.8 x 6.8 x 3 in (17 x 17 x 7.6 cm)  
                                   | Secondary Container - 9.2 x 9.2 x 4.3 in (23 x 23 x 10.9 cm) |
| Storage temperature range      | 41°F to 14°F (-20°C to 65°C)                 |
| Service life                   | 15 years                                     |
| Oxygen delivery system         | Automatic on, compressed oxygen, demand regulated |
| Inspection                     | Annual visual for stored units               |
| M20.2 NSN No.                  | NSN 1HM 4240-01-439-5537                    |
| M-20.21 Trainer NSN No.        | NSN 1HM 4240-01-459-0076                    |