

CHAPTER 6

FIRE-FIGHTING SYSTEMS

Learning Objectives: Recall the location, design, and operation of shipboard fire-fighting systems to include firemain, aqueous film-forming foam (AFFF), magazine sprinkler, installed carbon dioxide (CO₂), and Halon systems.

To fight fires onboard ship effectively, damage control personnel must not only be very familiar with the primary damage control equipment but must also be knowledgeable of fire-fighting systems onboard Navy ships. This chapter provides general information about fire-fighting systems. Detailed information is contained in the manufacturer's technical manual for each system.

FIREMAIN SYSTEMS

Learning Objective: Recall the function of a shipboard firemain and the components of the three basic types of firemain systems onboard Navy ships along with the design and use of magazine sprinkler systems.

The firemain system receives water pumped from the sea. It distributes this water to fireplugs, sprinkling systems, flushing systems, machinery cooling-water systems, washdown systems, and other systems as required. The firemain system is used primarily to supply the fireplug and the sprinkling systems; the other uses of the system are secondary.

TYPES OF FIREMAIN SYSTEMS

Navy ships have three basic types of firemain systems. They are as follows:

1. The single-main system
2. The horizontal loop system
3. The vertical offset loop system

The type of firemain system in any particular ship depends upon the characteristics and functions of the ship. Small ships generally have a straight-line, single-main system. Large ships usually have one of the loop systems or a composite system, which is some combination or variation of the three basic types.

The design of the three basic types of firemain systems is as follows:

1. The single-main firemain system shown in figure 6-1 consists of a single piping run that extends fore and aft. This type of firemain is generally installed near the centerline of the ship, extending forward and aft as far as necessary.
2. The horizontal loop firemain system shown in figure 6-2 consists of two single fore-and-aft, cross-connected piping runs. The two individual lengths of piping are installed in the same horizontal plane (on the same deck) but are separated athwartships as far as practical.

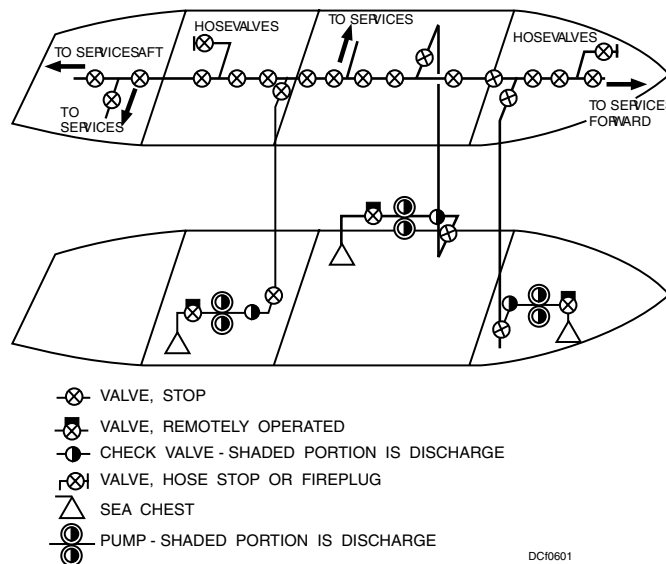


Figure 6-1. Single-main firemain system.

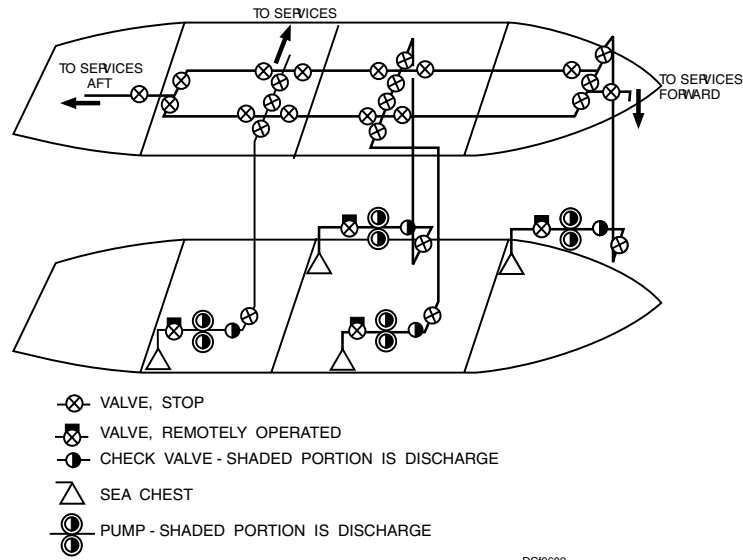


Figure 6-2. Horizontal loop firemain system.

3. The vertical offset loop firemain system shown in figure 6-3 consists of two single piping runs, installed fore-and-aft in an oblique (that is, angled) plane, separated both vertically and athwartship, connected at the ends to form a loop. The lower section of the firemain is located as low in the ship as practical on one side, and the upper section is located on the damage control deck on the opposite side of the ship. Athwartship cross-connections are usually provided at each pump riser.

A commonly used variation is a composite firemain system that consists of two piping runs installed on the damage control deck and separated athwartships. A bypass section of piping is installed at

the lower level near the centerline. Cross-connections are installed alternately between one service piping run and the bypass piping.

MAGAZINE SPRINKLER SYSTEMS

Sprinkler systems are used for emergency cooling of, and fire fighting in, magazines, ready-service rooms, ammunition, and missile handling areas. A magazine sprinkler system consists of a network of pipes. These pipes are secured to the overhead and connected by a sprinkler system control valve to the ship's firemain system. The pipes are fitted with spray

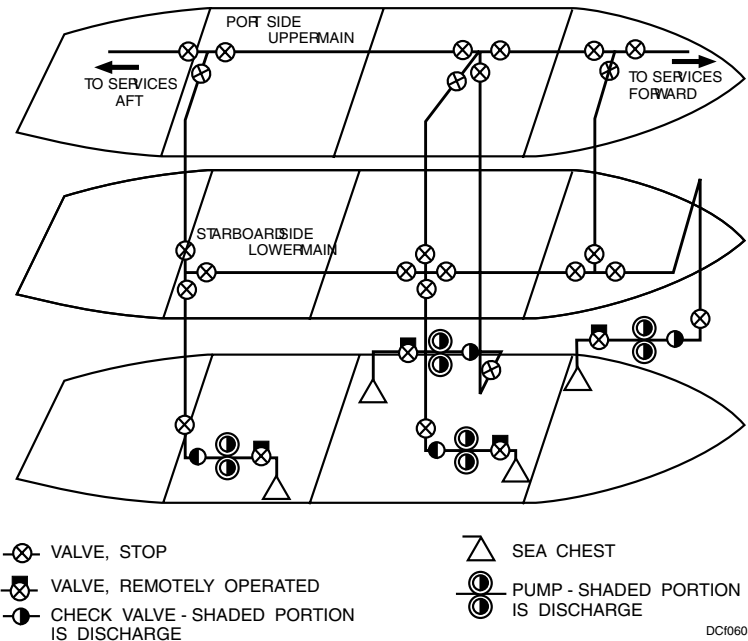


Figure 6-3. Vertical offset loop firemain system.

heads or sprinkler-head valves. They are arranged so the water forced through them showers all parts of the magazine or ammunition and missile-handling areas. A modern sprinkler system can wet down all exposed bulkheads at the rate of 2 gallons per minute per square foot. It can sprinkle the deck area at the rate of 4 gallons per minute per square foot.

Magazine sprinkler systems can completely flood their designated spaces within an hour. To prevent unnecessary flooding of adjacent areas, all compartments equipped with sprinkler systems are watertight. Upper deck handling and ready-service rooms are equipped with drains that limit the water level to a few inches.

The valves that control the operation of the magazine sprinkler system are as follows:

1. The manual control valve. This valve permits hydraulic operation of the sprinkler valve.

2. The hydraulically operated remote control valve. This diaphragm operated globe type valve is opened by operating pressure acting against the underside of the disk and closed by operating pressure acting on top of the diaphragm. This valve permits the sprinkler valve to be secured from other stations, whether or not it was manually or automatically actuated.

3. The spring-loaded lift check valve. This spring-loaded, diaphragm operated, lift check valve closes tightly against the reverse flow and opens wide to permit flow in the normal direction. Spring-loaded lift check valves permit the control system to be operated from more than one control station by preventing backflow through the other stations.

4. The hydraulically operated check valve. This valve permits the operating pressure to be vented from the diaphragm chamber of the magazine-sprinkling valve, thereby permitting that valve to close rapidly and completely.

5. Power operated check valve. This piston operated poppet type valve is opened by pressure from the "close" loop of the actuating pressure acting against the piston.

The Gunner's Mates assigned to a ship's company maintain the magazine sprinkler systems. However, personnel in the Damage Controlman rating must consider what effect their maintenance or repair on the firemain system will have on the magazine sprinkler systems.

REVIEW QUESTIONS

- Q1. The firemain system is used primarily to supply seawater to what other systems?
1. Bilge and heating
 2. Air-conditioning and main power
 3. Boiler and auxiliary power
 4. Fireplug and sprinkling
- Q2. There is a total of how many basic types of firemain systems designed for use on large Navy ships?
1. 1
 2. 2
 3. 3
 4. 4
- Q3. What type of firemain system is separated both vertically and athwartship?
1. Single-main
 2. Horizontal
 3. Auxiliary
 4. Vertical offset loop
- Q4. Sprinkler systems are used for emergency cooling of, and fire fighting in, magazines, ready-service rooms, ammunition, and missile handling areas.
1. True
 2. False
- Q5. What are the two basic types of hydraulically controlled sprinkler systems used on naval ships?
1. The reciprocal and jet types
 2. The pump-operated vacuum and the full bore types
 3. The firemain-operated dry type and the firemain-operated wet type
 4. The main power and auxiliary power types

Q6. What Navy rating maintains the magazine sprinkler systems?

1. Gunner's Mate
2. Engineman
3. Damage Controlman
4. Machinist's Mate

Damage control personnel must have a basic understanding of the operation of AFFF systems and the function of each of the components of the system. Different ships use different AFFF setups. However, once you understand the basic operation of system components, you should be ready to use the AFFF systems aboard any Navy ship.

COMPONENTS

The primary components and associated equipment of a shipboard AFFF system include the following:

- AFFF Generating Equipment
- AFFF Single-Speed Injection Pump
- AFFF Two-Speed Injection Pump
- AFFF Transfer Pumps
- AFFF Tanks
- AFFF Valves
- Balanced Pressure Proportioner (Type II)
- Balanced Pressure Proportioner (Type III)

INSTALLED AQUEOUS FILM-FORMING FOAM (AFFF) SYSTEM

Learning Objective: Recall the operation and function of the components of an installed AFFF system.

Aqueous film-forming foam (AFFF) is one of the most widely used fire-fighting agents. AFFF is primarily used aboard ship to fight class BRAVO fires, often in conjunction with Purple-K-Powder (PKP). AFFF is delivered through both portable and installed equipment. Two types of installed AFFF systems are shown in figures 6-4 and 6-5.

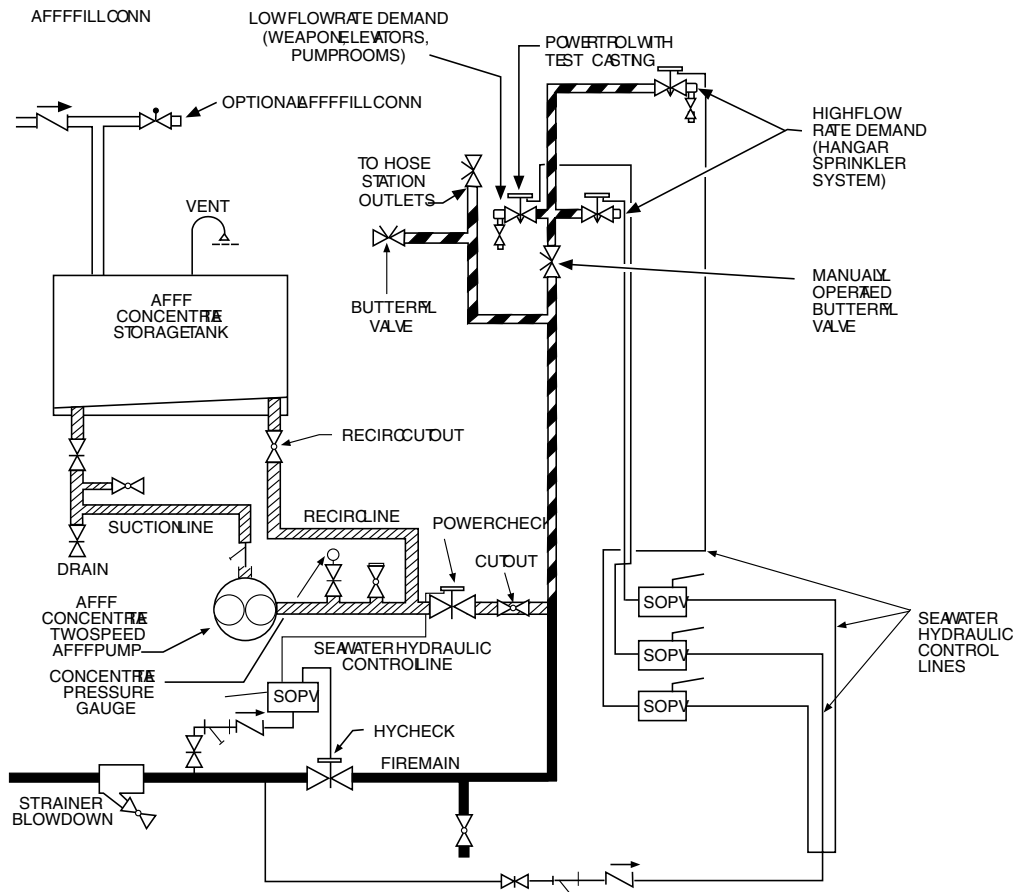


Figure 6-4. Typical two-speed AFFF system.

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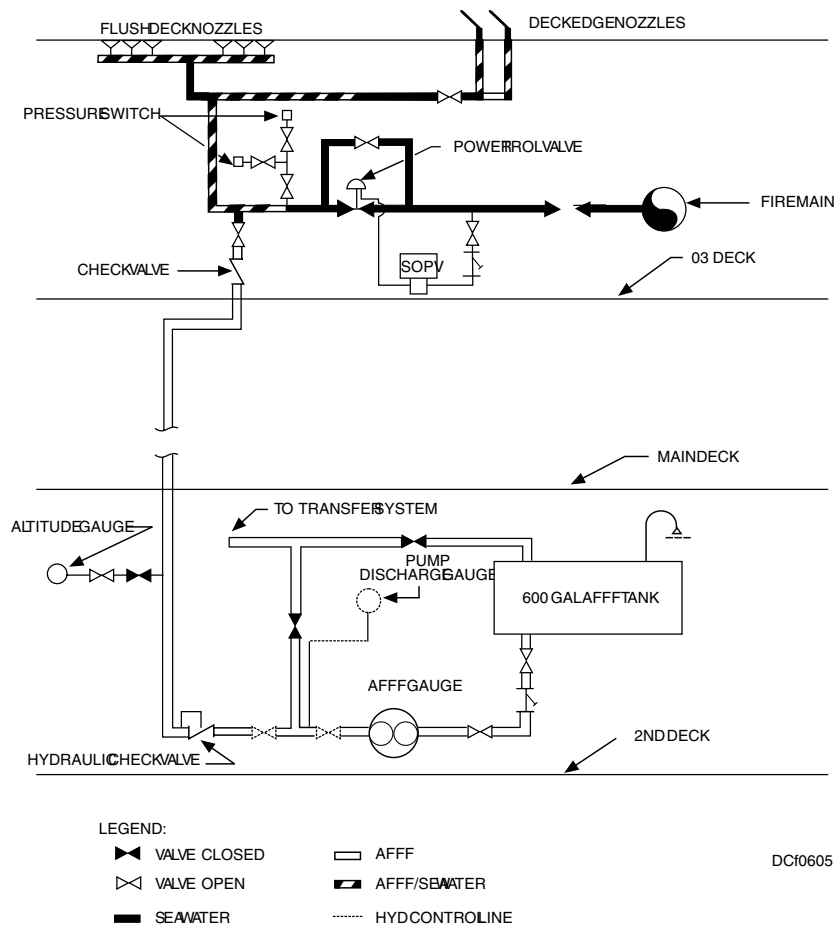


Figure 6-5. Typical high capacity single-speed pump system.

- AFFF Sprinkler System
- AFFF Transfer System
- AFFF Testing Equipment

AFFF Generating Equipment

Installed AFFF generating equipment is usually located in main machinery spaces, JP-5 pump rooms, on flight decks, and in hangars and helo bays. The reason for this is that research has revealed that these are the places where class Bravo fires most often occur.

There are two types of pumps used with the installed AFFF system. They are the AFFF single-speed injection pump and the AFFF two-speed injection pump.

AFFF Single-Speed Injection Pump

The AFFF single-speed injection pump (fig. 6-6) is a permanently mounted, positive displacement, electrically driven, sliding-vane type of pump. These pumps are provided in capacities of 12, 27, and 60 gallons per minute (gpm). The pump unit consists of

a pump, a motor, and a reduction gear (except 12 gpm that is direct drive), coupled together with flexible couplings and mounted on a steel base. The pump is fitted with an internal relief valve, which opens to prevent damage to the pump. The injection pump and the injection station piping are sized to produce a 6 percent nominal concentration at peak demand by injecting AFFF concentrate into the seawater distribution system. AFFF concentrate is supplied from an AFFF tank. In some installations there is a 1-1/2-inch hose connection between the pump and the pump cutout valve. This hose connection is used to transfer AFFF concentrate to other tanks by connecting hoses between the pump and fill lines of the other tank. AFFF is transferred by manually starting the injection pump that is used to supply the washdown countermeasure system with AFFF. This action allows the system to be used as a fire-extinguishing system for flight decks, fantail, and helicopter landing flight decks and platforms. Besides washdown countermeasure systems, injection pumps also supply AFFF to reentry hose reels, well decks, and fueled vehicle stowage decks.

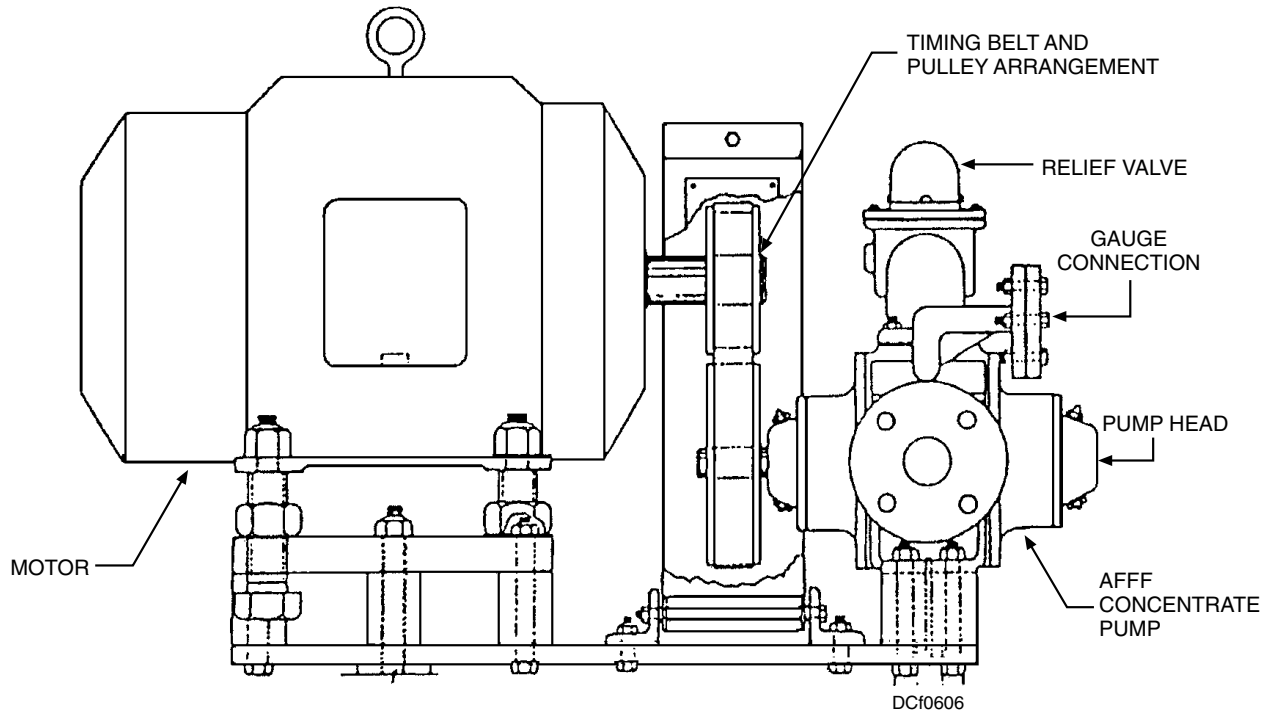


Figure 6-6. AFFF single-speed injection pump.

AFFF Two-Speed Injection Pump

The AFFF two-speed injection pump (fig. 6-7) is designed to meet the demand for either a low or a high fire-fighting capability. The two-speed AFFF pump consists of a positive displacement pump rated at 175 psi, a motor, and a reducer, coupled together with flexible couplings and mounted on a steel base. The pump is designed to inject AFFF concentrate into the seawater supply at a constant flow rate, depending on the pressure and demand of fire-fighting requirements. AFFF concentrations will exceed 6 percent in most cases. The low-speed mode is used for individual AFFF demand hose reel stations. The high-speed mode

is used when fire-fighting flow rates exceed 250 gpm for hangar bay and deck-edge sprinklers and 450 gpm for bilge sprinklers. The motor on the two-speed pump receives power from a motor controller supplied by a power panel that receives main ship's power from both the ship's service switchboard and the emergency service switchboard. The power panel is equipped with an automatic bus transfer (ABT) to ensure a constant supply of electrical power to the two-speed pump. The motor controller has provisions for both local and remote control. From the local control station, the pump can be started at either high or low speed. Remote control stations are segregated into high and low demand stations. High demand stations, such as

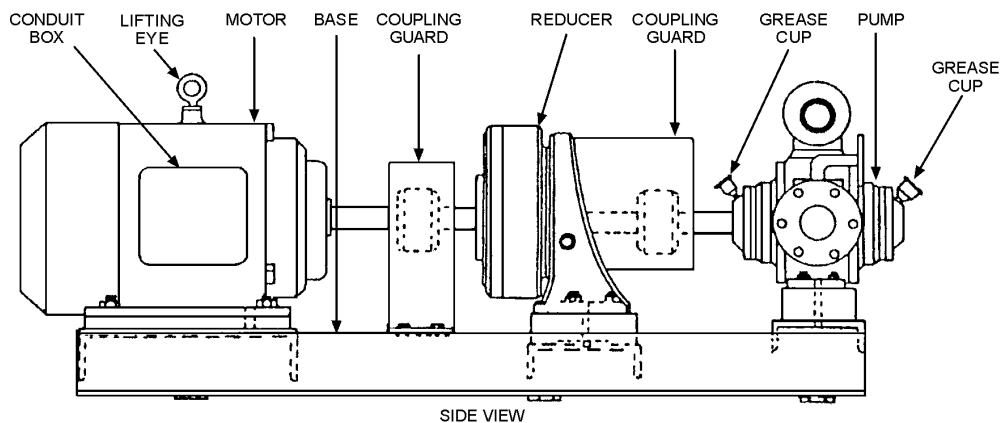


Figure 6-7. AFFF two-speed injection pump.

that for a hangar bay sprinkler system, start the pump at high speed. Low demand stations, such as that for a hose reel, start the pump at low speed. When the system is being secured, you can only stop the pump at the local control station.

AFFF Transfer Pumps

The AFFF transfer pump is a permanently mounted, single-speed, centrifugal type, electrically driven pump. These pumps are provided in 360-gpm capacity. The transfer pump moves AFFF concentrate through the AFFF fill-and-transfer subsystem to all AFFF station service tanks on a selective basis.

AFFF Tanks

AFFF is stored in service tanks of 50- to 2,000-gallon capacity and storage/transfer tanks of up to 3,500-gallon capacity. The tanks are rectangular or cylindrical in shape and are fabricated out of 90/10 copper-nickel or corrosion-resistant steel. Each service tank is located inside the AFFF station and is fitted with a gooseneck vent, drain connection, fill connection, liquid level indicator, recirculating line, and an access manhole for tank maintenance. The gooseneck vent prevents excess buildup of pressure within the tank during storage and prevents a vacuum when the system is in operation.

AFFF Valves

The AFFF system requires a variety of valves with different functions. These valves include the following:

- Powertrol valve
- Powercheck valve
- Powertrol valve with test connection
- Hytrol valve
- Hycheck valve
- Solenoid-operated pilot valve
- Balancing valve
- Balanced pressure proportioner (Type II)
- Balanced pressure proportioner (Type III)

POWERCTRL VALVE.—The powertrol valve shown in figure 6-8 is a diaphragm type, normally closed, seawater pressure-operated control valve. This valve allows the flow of AFFF/seawater solution

through the distribution system or controls seawater flow on flight deck injection systems. The powertrol is held closed by spring pressure. The valve is actuated when the control line is pressurized to firemain pressure by the service solenoid-operated pilot valve (SOPV). This control line pressure is exerted on the bottom of the diaphragm of the valve and the valve is forced open against the spring.

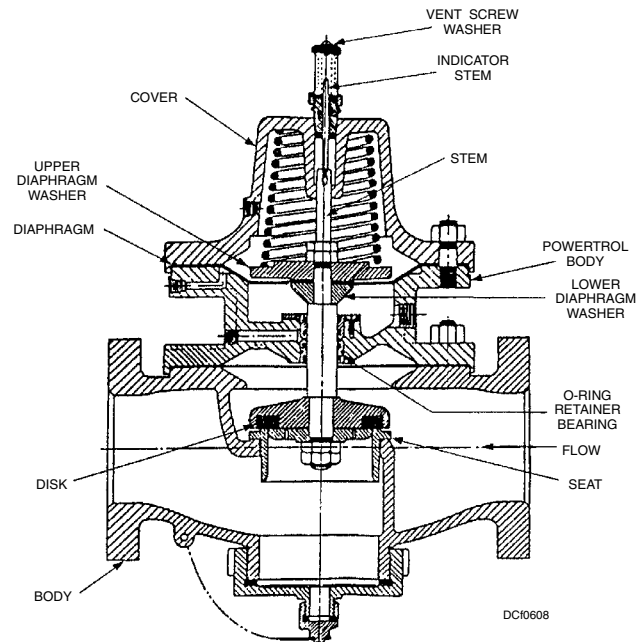


Figure 6-8. Powertrol valve.

POWERCHECK VALVE.—The powercheck valve (fig. 6-9) is a diaphragm type, normally closed, seawater pressure-operated control valve. This valve allows flow of AFFF from the pump to be mixed with seawater, and protects the AFFF tank from seawater contamination or dilution. The powercheck is essentially a powertrol valve that has a lift-check feature built into it. When there is no pressure on the control line, the upper valve spring forces the valve closed and the lift check feature is inoperative. When there is firemain pressure on the control line, this pressure acts on the bottom of the diaphragm and opens the valve against the upper valve spring. AFFF flow pushes the disk and lower stem up and allows AFFF to flow. If the back pressure downstream of the valve exceeds the pressure on the upstream side of the valve, the valve disc holder and stem will slide to the CLOSED position, preventing any backflow through the valve. On balanced pressure proportioning systems, the powercheck does not have a lower spring.

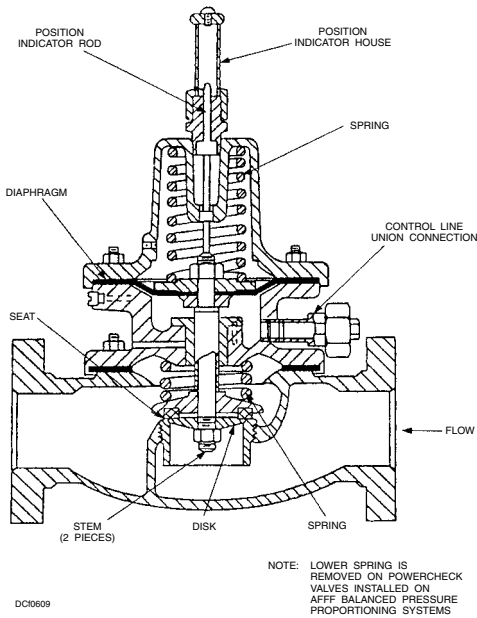


Figure 6-9. Powercheck valve.

POWERTROL VALVE WITH TEST CONNECTION.—The powertrol valve with test connection is a diaphragm-type, hydraulically operated, globe control valve. It is essentially a powertrol valve with test capabilities. This valve is normally used as a sprinkler group control valve. It would be impractical to test a sprinkler group unless the fluid flow could be diverted before it is discharged through the sprinkler heads. To perform a test, remove the test connection cap from the bottom of the valve and insert the test fitting. The test fitting has an O ring to provide a seal between the fitting and the valve seat. Connect a drain hose to the fitting and place the outlet end of the hose in a suitable location. When the operating chamber is pressurized, the valve opens. Fluid is routed over the top of the seat, diverted through the test fitting and out the drain hose. The valve is successfully tested and the sprinkler groups are dry. When the test is complete, vent the operating chamber, remove the test fitting, and reinstall the test connection cap.

HYTROL VALVE.—The hytrol valve (fig. 6-10) is a diaphragm type, fail open, seawater pressure-operated control valve which controls the flow of AFFF solution to systems. When in ready status, the top of the diaphragm is subject to spring pressure and control line pressure. When the control line pressure is removed, the firemain pressure overcomes the spring pressure and opens the valve. When an SOPV directs firemain pressure to the control line, the pressure on top of the diaphragm

balances the firemain pressure on the bottom of the diaphragm and allows the spring to close the valve.

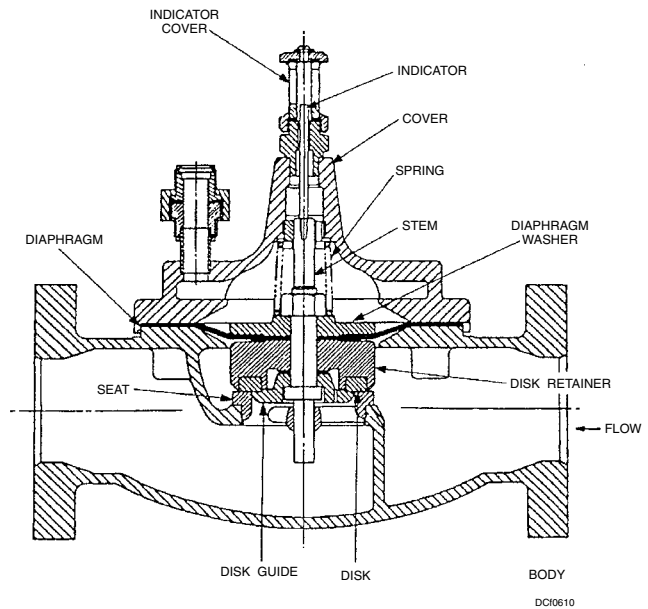


Figure 6-10. Hytrol valve.

HYCHECK VALVE.—The hycheck valve (fig. 6-11) is a diaphragm type, fail open, seawater pressure-operated control valve, which allows the flow of seawater from the firemain system to be mixed with AFFF concentrate. The hycheck is equipped with a sliding lift check feature like the powercheck valve. When the AFFF system is in standby, the hycheck is held closed by firemain pressure from the master SOPV on top of the diaphragm. When firemain pressure on the diaphragm is relieved by the master SOPV, the hycheck is forced open by firemain pressure. If foam demand stops and the AFFF/seawater solution pressure equals or exceeds the firemain pressure, the lower spring closes the valve disk. This prevents the AFFF pump from pumping concentrate back into the firemain.

SOLENOID-OPERATED PILOT VALVE (SOPV).—Solenoid-operated pilot valves (fig. 6-12) are electrically operated pilot valves that control the activation of many AFFF fire-extinguishing systems. All SOPVs (master and service) have four control line ports; one port is always connected to supply pressure (firemain), and a second port is the valve drain (which should be piped to discharge within the coaming of the AFFF station). The other two control ports are connected by control lines to diaphragm-operated control valves on master SOPVs. Service SOPVs

have one control port plugged. See technical manual NAVSEA S6435-B1-MMO-010, *Solenoid Operated Pilot Valve, Model CSM5M-3A*, for more information on SOPVs.

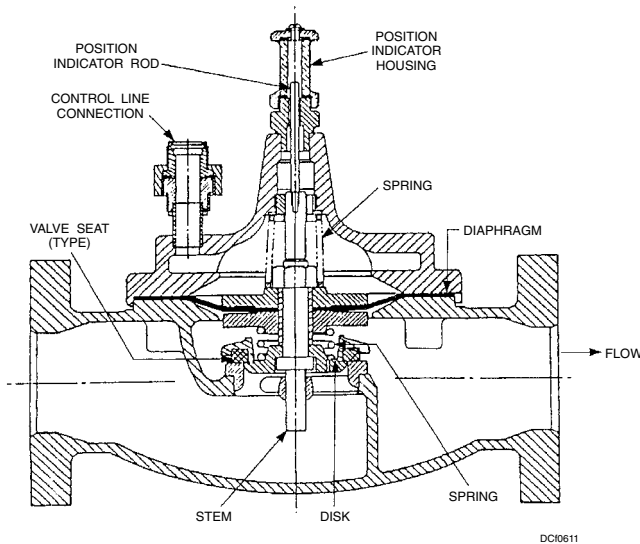


Figure 6-11. Hycheck valve.

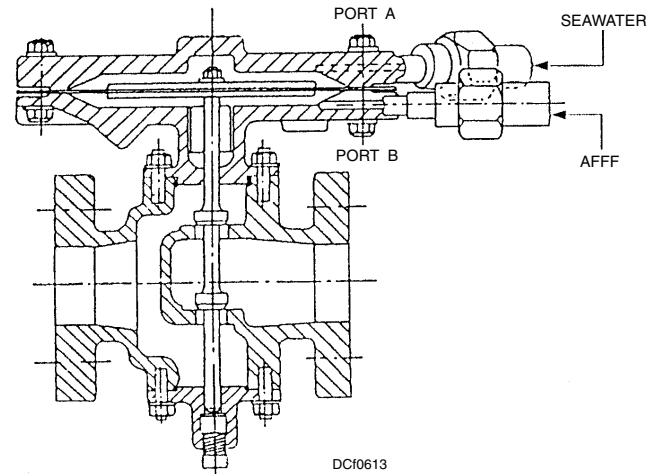


Figure 6-13. Balancing valve.

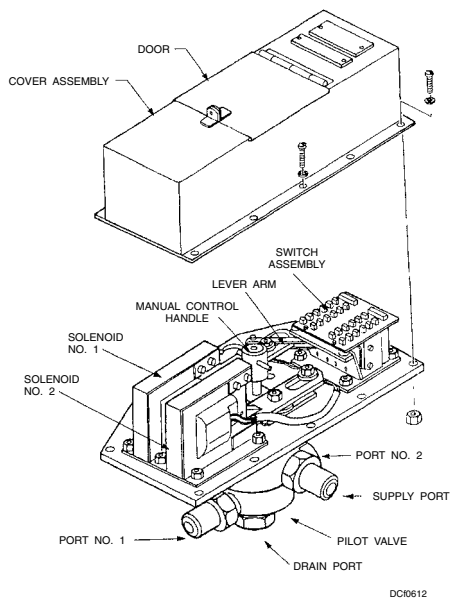


Figure 6-12. Solenoid-operated pilot valve (SOPV).

BALANCING VALVE.—The balancing valve (fig. 6-13) automatically proportions the correct amount of AFFF concentrate with seawater. The balancing valve is a diaphragm-actuated control valve that responds to pressure changes between the AFFF concentrate supply line and the firemain. Two sensing lines are attached to the balancing valve, one to

monitor the pressure in the AFFF concentrate piping, and one to monitor the firemain pressure. The pressure differential between these lines moves the diaphragm in the control valve. As the AFFF/seawater flow increases, the firemain sensing line pressure drops, and the control valve adjusts by forcing more AFFF concentrate into the proportioner.

Balanced-Pressure Proportioner (Type II)

The Type II balanced-pressure proportioner (fig. 6-14), proportions the correct amount of AFFF concentrate necessary to produce effective AFFF/seawater solution over a wide range of flows and pressures. The system is actuated by activating an SOPV, electrically or manually. The SOPV will vent the operating chamber of the hycheck valve and pressurize the operating chamber of the powertrol valve. The switch assembly of an SOPV will cause electrical activation of the pump assembly (positive displacement, sliding vane, or rotary gear) via the motor controller. The pump assembly will pressurize the AFFF concentrate piping to the demand proportioned and balancing valve. Water flow through the proportioner will move the water float towards the large opening of the water sleeve, depending on the number of gallons required for fire fighting. The AFFF concentrate float is directly controlled by the movement of the water float, thus influencing the amount of AFFF concentrate that enters the water stream.

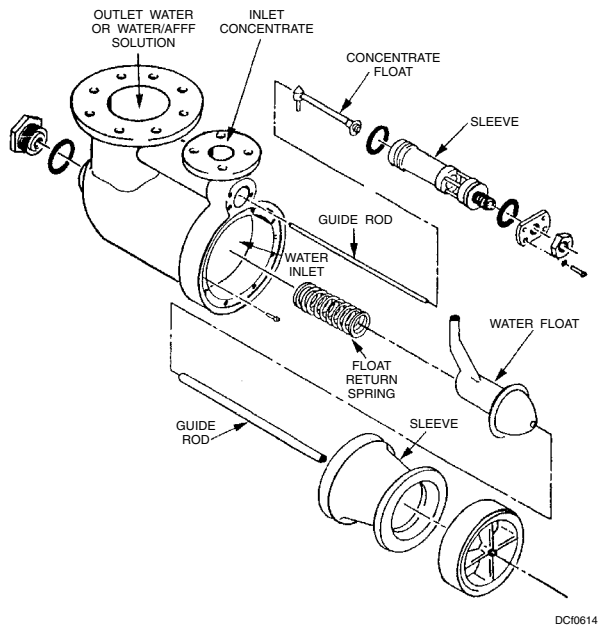


Figure 6-14. Balanced-pressure proportioner (Type II).

Water and AFFF concentrate enter the proportioner at the same pressure; hence, the name balanced pressure-proportioning system. The balanced pressure theory is a direct result of the balancing valve. One sensing line is located downstream of the hycheck valve, and another is located upstream of the AFFF concentrate discharge check valve. They route the water pressure and AFFF concentrate pressure to the operating chambers of the balancing valve. The water-sensing line is piped to the top operating chamber and the AFFF concentrate-sensing line is piped to the lower operating chamber. As the gallonage is increased or decreased through the proportioner due to demand, the water pressure will decrease or increase, respectively, in the water-operating chamber. When this happens, the balancing valve will automatically regulate the AFFF concentrate pump discharge pressure to equal the water pressure. The balancing valve will constantly recirculate the AFFF concentrate to the service tank. The amount of AFFF concentrate returned to the service tank through the recirculating piping varies. It depends on the position of the balancing valve, which is directly controlled by pressure in the water-operating chamber. Water and AFFF concentrate will be correctly proportioned in the proportioner due to the venturi principle and then discharged into the distribution piping.

Balanced-Pressure Proportioner (Type III)

The purpose, actuation of system, and balancing valve theory for the Type III balanced-pressure proportioner (fig. 6-15), are identical to those of the

Type II proportioner. The Type III proportioner houses no internal moving parts and uses the venturi principle to allow for complete mixing of AFFF/seawater solution. An orifice plate controls the volume of gallons of AFFF concentrate entering the proportioner. The size of the orifice is determined by the maximum demand for fire-fighting agent placed on the system. The water-sensing line connection for the Type III proportioner is piped directly from the proportioner body to the balancing valve. Type III proportioner systems use a positive displacement, sliding vane pump.

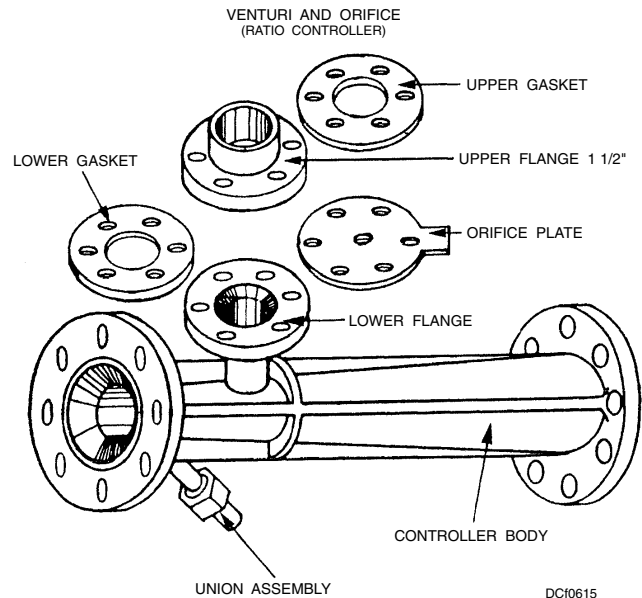


Figure 6-15. Balanced-pressure proportioner (Type III).

AFFF SPRINKLER SYSTEM

Sprinkler systems are a convenient and quick method for the fire party to apply AFFF/water solution or water to large areas of burning fuel. The system consists of a large header pipe with smaller branch connections and attached sprinkler heads. A sprinkler group control valve (powerrol or hytrol with test connection) will control the discharge flow to the sprinkler heads. An SOPV or a manual control valve may actuate the group control valve. Some sprinkler systems are activated by a manually operated cutout valve. Actuation controls for the group control valves may be located in primary flight control, the navigational bridge, the helo control, a conflagration station, locally at the AFFF generating station, and at various locations throughout the ship, depending on the sprinkler system installation and type of ship. An AFFF sprinkler system is a subsystem of AFFF generating systems. Some of the different types of sprinkler systems aboard naval ships are listed below.

- The bilge sprinkling system is located in the main and auxiliary machinery spaces with the sprinkler heads installed below the lower level deck plates. Overhead sprinkling is installed in the overhead of helo and hangar bays, well decks, vehicle cargo holds, and fuel pump rooms. Some diesel-powered ships have the overhead sprinkler system installed in the main machinery space.

- The flush-deck system uses the countermeasure washdown flush-deck nozzles to discharge AFFF/water solution during flight deck and helo deck fires. This capability is currently available to all aircraft carriers, helicopter carriers, and some auxiliary and combatant ships.

- The deck-edge sprinkler sprays AFFF/water solution over the flight deck of aircraft carriers and helicopter carriers. The system consists of spray nozzles that are positioned at the deck-edge combing of the port and starboard sides on helicopter and flight decks. The nozzles project the AFFF/water solution across the deck in an arc pattern to spray over the top of the burning fuel and aircraft.

AFFF TRANSFER SYSTEM

AFFF generating stations use large volumes of AFFF concentrate during fire fighting. The service tank alone may not contain enough concentrate to combat a conflagration-type fire. Transfer capabilities are available to replenish the AFFF concentrate service tanks. The installed system consists of a reserve transfer pump (positive displacement, sliding vane, or centrifugal), reserve storage tanks, and associated piping and valves. The transfer system can deliver AFFF concentrate to on-station service tanks via a transfer main. The transfer main consists of a large pipe with smaller branch connections interconnecting the AFFF service and storage tanks. This feature gives the on-station concentrate pump the capability of delivering AFFF concentrate into the transfer main. Once the transfer main is pressurized, either by the reserve pump or by the on-station pump, all AFFF generating station service tanks can be replenished. On-station pumps used in conjunction with jumper hoses and hose connection valves may be used to transfer AFFF concentrate. Some ships can replenish the service tanks with 55-gallon containers located near the generating station. They do this with an installed hand-operated pump or air-regulated transfer system. The air-regulated transfer system may be used to replenish reserve storage tanks. Ships may replenish service tanks or storage

tanks by manually dumping AFFF concentrate from 5-gallon containers via a fill connection.

AFFF TESTING EQUIPMENT

AFFF concentrate and AFFF/seawater solution must be tested periodically to ensure that the fire party has an effective agent to combat class BRAVO fires. To accomplish the test, you must have a basic understanding of the equipment used to conduct the test. The testing equipment includes the hand refractometer and the quantab chloride titrator strip.

Refractometer

The hand refractometer gives accurate readings of total dissolved solids in aqueous solutions. If an AFFF generating system is tested according to procedures, the refractometer reading indicates the percent of solids present. For the readings to be meaningful, you must draw samples from the same water source and AFFF concentrate service tank that were used to generate the AFFF/water solution. For example, if a ship has 20 AFFF generating systems, then you must take 20 AFFF concentrate samples and 20 AFFF/water solution samples.

Use the refractometer to determine the percent of solids present in the aqueous solution samples. Once you have the readings, you can determine the percent of AFFF concentrate that is being proportioned with water by using the following formula:

$$RS - RW = A$$

$$RT - RW = B$$

$$\frac{A}{B} \times 100 = \text{Percent of AFFF concentrate}$$

RS = the hose sample (AFFF/water solution)

RT = the service tank sample (AFFF concentrate)

RW = the water sample

Quantab Chloride Titrator

Quantab chloride titrator strips are used to measure salt (chloride) in aqueous solutions. Seawater contains approximately 20,000 ppm (parts per million) of chloride. The allowable limit for chloride contamination of AFFF concentrate is 2,000 ppm, which equates to a 10 percent contamination.

CAUTION

All approved AFFF concentrates have been subjected to 10 percent seawater contamination tests and have passed corrosion tests for metals approved in AFFF generating systems. Contamination above the 10 percent limit causes two problems: (1) AFFF generating system components will corrode and (2) Improper AFFF/water solutions result in an ineffective fire-fighting agent.

If contamination exceeds 2,000 parts per million (ppm), the source of contamination must be identified and corrected before dumping the contents of the AFFF concentrate tank. Clean all AFFF concentrate components before replenishing the service tank. Carry out all AFFF testing procedures according to the planned maintenance requirements.

REVIEW QUESTIONS

- Q7. What type of pump for the installed AFFF system is provided in capacities of 12, 27, and 60 gpm?
1. High-speed reciprocal
 2. Single-speed injection
 3. Centrifugal
 4. Two-speed injection
- Q8. AFFF is stored in storage/transfer tanks having a capacity of up to 3,500 gallons and in service tanks that vary in capacity from 50 gallons to what maximum size?
1. 1,000 gallons
 2. 2,000 gallons
 3. 3,000 gallons
 4. 4,000 gallons
- Q9. What type of seawater pressure-operated control valve allows the flow of AFFF/seawater solution through the distribution system or controls seawater flow on flight deck AFFF injection systems?
1. Hytrol
 2. Balancing valve
 3. Powertrol
 4. Hycheck

Q10. What type of seawater pressure-operated control valve allows the flow of seawater from the firemain system to be mixed with AFFF concentrate?

1. Hycheck
2. Globe
3. Balancing valve
4. Hytrol

Q11. What type of valve automatically proportions the correct amount of AFFF concentrate with seawater?

1. Hytrol
2. Hycheck
3. Powertrol
4. Balancing valve

INSTALLED CARBON DIOXIDE (CO₂) SYSTEMS

Learning Objective: Recall the location, design, and operation of installed CO₂ systems.

Carbon dioxide (CO₂) is a colorless, odorless gas that is naturally present in the atmosphere at an average concentration of 0.03 percent. It is used for extinguishing fires because it reduces the concentration of oxygen in the air to the point where combustion stops. Typically, CO₂ concentrations of 30 to 70 percent are required to extinguish fires. Carbon dioxide extinguishers are installed in naval ships to provide a dependable and readily available means to flood (or partially flood) certain areas that present unusual fire hazards. An installed CO₂ extinguishing system has one or more 50-pound cylinders. The cylinders may be installed singly or in batteries of two or more. Except for their size and releasing mechanisms, the 50-pound portable cylinders are essentially the same as the 15-pound portable cylinders.

The two types of installed CO₂ systems are the CO₂ hose-and-reel installation and the CO₂ flooding system. The CO₂ flooding system is used for spaces that are not normally occupied by personnel.

CO₂ HOSE-AND-REEL SYSTEM

The CO₂ hose-and-reel installation (fig. 6-16) consists of two cylinders, a length of special CO₂ hose coiled on a reel, and a horn-shaped nonconducting nozzle equipped with a second control valve. When the hose and reel are both installed near the normal access, each of the two cylinders may be actuated individually. Due to space limitations, cylinders may not be located near the hose reel. When the cylinders are more than 10 feet from the hose reel, manual pull boxes are provided at the hose reel for discharging each cylinder individually.

WARNING

Grooved nut discharge heads are to be installed only for CO₂ hose reel installations. They must not be installed with CO₂ total flooding systems.

To operate a CO₂ hose-and-reel system, you should adhere to the procedure that include the steps as follows:

1. Ensure the horn valve is in the CLOSED position.
2. Open the control valve on the cylinder intended for use.
3. Unreel the hose and run the horn to the point of attack on the fire.
4. Open the horn valve by turning the lever or by depressing the squeeze grip.
5. Direct the CO₂ discharge toward the base of the fire.

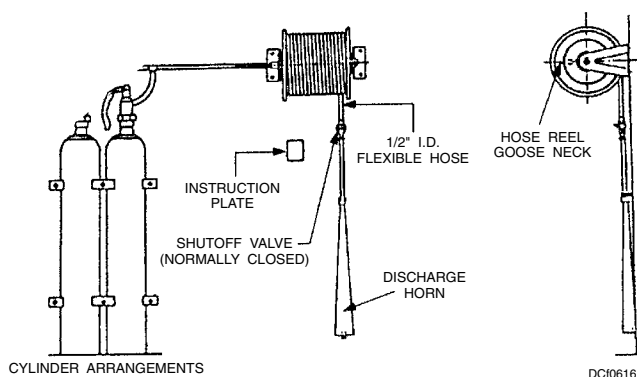


Figure 6-16. CO₂ hose-and-reel system.

CO₂ FLOODING SYSTEM

The CO₂ flooding system (fig. 6-17) consists of one or more cylinders connected by piping from the valve outlets to a manifold. Fixed piping leads from the manifold to various areas of the compartment to be flooded. Cables run from the valve control mechanisms to pull boxes that are located outside the compartment containing the cylinders. (Sometimes, the cylinders are also located outside of the compartment to be protected.) To release CO₂, just break the glass in the front of the pull box and pull the handle of the cable leading to the CO₂ cylinders.

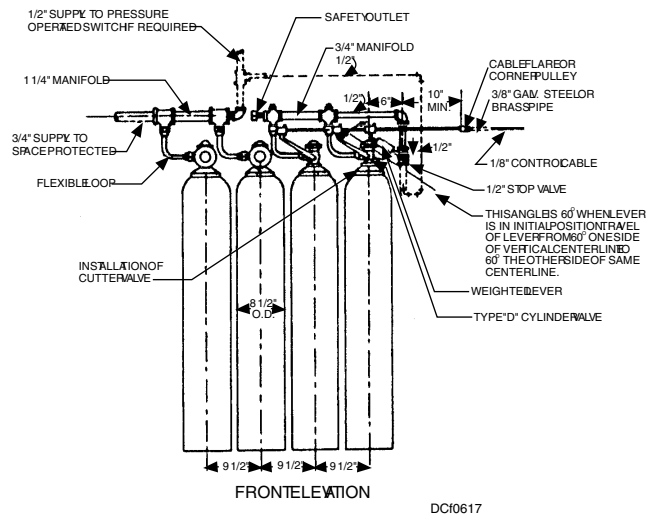


Figure 6-17. CO₂ flooding system.

There are usually one or two valve control devices in a CO₂ flooding system. The number of valve control devices provided will depend on the number of cylinders in the bank. The remaining cylinders in the bank (if any) are provided with pressure-actuated discharge heads. These heads open automatically when pressure from the controlled cylinders enters the discharge head outlet.

Several manufacturers make various components of the CO₂ systems installed on naval ships. These components differ in some minor details. Therefore, for detailed information on a specific installation, always consult the appropriate manufacturer's technical manual.

CAUTION

Before operating an installed CO₂ system, ensure all openings in the compartment are closed and the ventilation system for the space is secured. These precautions are necessary to prevent the loss of CO₂.

REVIEW QUESTIONS

- Q12. The CO₂ flooding system is used for spaces that are normally occupied by personnel.
1. True
 2. False
- Q13. When using the CO₂ hose-and-reel system, you should always direct the CO₂ discharge toward the base of the fire.
1. True
 2. False
- Q14. Before operating an installed CO₂ system, you should ensure all openings in the compartment are closed and the ventilation system for the space is secured.
1. True
 2. False

HALON SYSTEMS

Learning Objective: Recall the location, design components, and capabilities of shipboard Halon systems.

Halon is a halogenated hydrocarbon, which means that one or more of the hydrogen atoms in each hydrocarbon molecule have been replaced by one or more atoms from the halogen series (fluorine, chlorine, bromine, or iodine). A Halon numbering system has been developed to provide a description of the various halogenated hydrocarbons. The first digit in the number represents the number of carbon atoms in the molecule; the second digit, the number of fluorine atoms; the third digit, the number of chlorine atoms; the fourth digit, the number of bromine atoms; and the fifth digit, the number of iodine atoms, if any. In this system, terminal zero digits, if any, are not expressed.

The two types of Halon used aboard Naval ships are Halon 1301 and 1211. Halon 1301 is the most commonly used type because it is installed and used in fixed flooding systems for extinguishing flammable liquid fires.

Halon 1211 is a colorless gas that has a sweet smell and is known chemically as bromochlorodifluoromethane. It is used for twin agent aqueous film-forming foam (AFFF)/Halon 1211

applications on some flight and hangar deck mobile fire-fighting apparatus. Portable 20-pound Halon 1211 fire extinguishers are installed in MHC-51 class coastal minesweeping ships and air-cushion landing craft (LCAC). Halon 1211 is stored and shipped as a liquid and pressurized with nitrogen gas. Pressurization is necessary since the vapor pressure is too low to convey it properly to the fire area.

Halon 1211 is not used in total flooding systems. It has a low volatility combined with a high liquid density, which permits the agent to be sprayed as a liquid. As a liquid spray Halon 1211 may be propelled into the fire zone more effectively than is possible with other gaseous agents. Halon 1211 is used in twin agent systems installed on mobile firefighting apparatus on carrier type ships. For flight and hangar deck fire-fighting procedures, refer to NAVAIR 00-80-R-14, *NATOPS U.S. Navy Aircraft Firefighting and Rescue Manual*.

Both Halon 1211 and 1301 chemically inhibit the flame front of a fire. Halon decomposes upon contact with flames or hot surfaces above 900°F (482°C). Decomposition products are principally hydrogen fluoride and hydrogen bromide, which have a sharp irritating odor even at low concentrations.

The short discharge time of Halon 1301 (10 seconds maximum) keeps the thermal decomposition products well below lethal concentrations. However, a real hazard lies in the products of combustion from the fire such as carbon monoxide. These products combined with oxygen depletion, heat, and smoke pose a great hazard to personnel.

WARNING

Personnel should not remain in a space where Halon 1301 has been released to extinguish a fire unless some type of breathing apparatus is worn.

Most people can be exposed to a 5 to 7 percent concentration of Halon 1301 for a period up to 10 minutes without danger to their health. However, safety precautions dictate that spaces should be evacuated anytime a Halon system discharge occurs.

Human exposures to both Halon 1301 and to Halon 1211 have shown that Halon 1301 concentrations up to about 7 percent by volume, and Halon 1211 concentrations of 2 to 3 percent by volume, have little noticeable effect on personnel. At Halon 1301

concentrations between 7 and 10 percent and Halon 1211 concentrations between 3 and 4 percent, personnel experienced dizziness and tingling of the extremities, indicative of mild anesthesia. At Halon 1301 concentrations above 10 percent and Halon 1211 concentrations above 4 percent the dizziness becomes pronounced, the subjects feel as if they will lose consciousness (although none have), and physical and mental dexterity is reduced.

The discharge of Halon 1211 to extinguish a fire may create a hazard to personnel from the natural Halon 1211 itself and from the products of decomposition that result from the exposure of the agent to the fire or other hot surfaces. Prolonged exposure to concentrations greater than 4 percent carries with it the possible risk of unconsciousness and even death. Although Halon 1211 vapor has a low toxicity, its decomposition products can be hazardous. When using Halon 1211 in unventilated or confined spaces, operators and others should avoid breathing the gases, and should only use the agent needed to accomplish extinguishment. Although they are potentially hazardous, no significant adverse health effects have been reported from the use of Halon 1301 or 1211 as a fire-extinguishing agent since their introduction into the marketplace 30 years ago.

WARNING

In flammable gas cylinder storerooms, 20 percent Halon 1301 is required to extinguish a fire. Therefore, if the system is activated, personnel must leave the space immediately.

Direct contact with vaporizing Halon 1301 and Halon 1211 liquid has a strong chilling effect on objects and can cause frostbite and burns to the skin. The liquid phase vaporizes rapidly during discharge and therefore limits this hazard to the immediate vicinity of the nozzle.

High velocity discharge from nozzles is sufficient to move unsecured paper and light objects, which could cause personnel injury. Discharge of a total flooding system can cause noise loud enough to be startling.

In humid atmospheres, reduction in visibility may occur due to condensation of water vapor in the air.

Halon 1211 and Halon 1301 are severe ozone depleting substances. These agents should be used only against actual fires. Any Halon cylinder containing only a partial charge, or is being turned in to supply, shall not be vented to the atmosphere for any reason.

Halon 1301 (known chemically as bromotrifluoromethane) consists of one atom of carbon, three atoms of fluorine, no chlorine atoms, one bromine atom, and no iodine atoms. For shipboard installation, Halon 1301 is super pressurized, with nitrogen, and stored in gas cylinders as a liquid. When released, it vaporizes to a colorless, odorless gas with a density of approximately five times that of air. Halon 1301 systems (fig. 6-18). It may be installed in main machinery rooms, fire rooms, engine rooms, auxiliary machinery rooms, fuel pump rooms, ship service or emergency generator rooms, auxiliary boiler rooms, main propulsion or generator engine modules, helicopter recovery assist, securing and traversing (RAST) areas, machinery rooms, tactical towed array sonar (TACTAS) handling rooms, and in spaces where flammable liquids are stored or issued. Aboard aircraft carriers, gas-powered bomb hoist storerooms may be protected by Halon 1301.

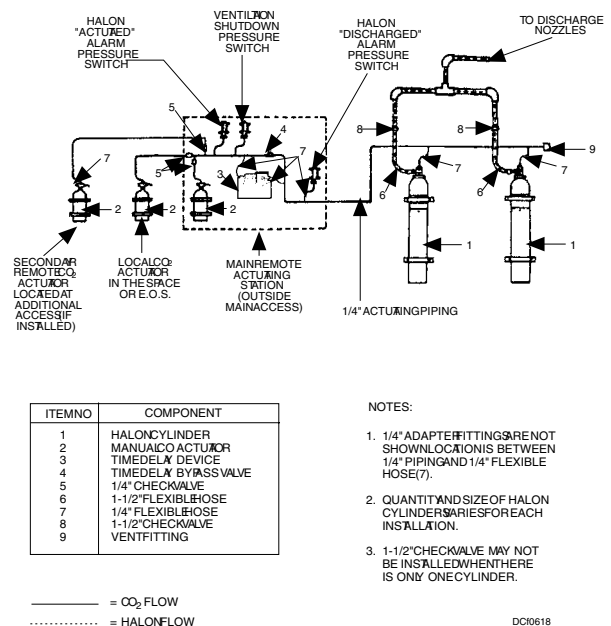


Figure 6-18. Halon 1301 system.

Halon systems use one or more cylinders containing Halon 1301 in a liquid form. The function of the system is to extinguish fires that are beyond the capacity of portable fire extinguishing equipment, and where abandonment of the space is necessary.

COMPONENTS

The components of the Halon system include the following:

- Halon 1301 cylinders
- 5-pound CO₂ actuators
- Vent fittings
- 1/4-inch copper nitrogen tubing connections with a 4-inch loop that are called actuation lines
- Flexible discharge hoses
- Check valve
- Time-delay device
- Time-delay device bypass valve
- CO₂ actuation system piping
- Pressure switches
- Halon discharge piping
- Discharge nozzles
- In-line filter
- Electrically operated alarms and indicators

LOCATION

The usual location for Halon cylinders is inside a protected compartment within a space; however, they may be located outside or in a Halon cylinder room. Halon systems placed in machinery spaces (Main Machinery Rooms, Firerooms, Engine Rooms, Auxiliary Machinery Rooms) will have 60-second time delays. In compartments other than Machinery Spaces, Halon systems usually have a 30-second time delay, and only a primary Halon system. Engine enclosures or modules have a 30-second time delay for both primary and reserve Halon systems.

CAPABILITIES

Each system is designed so a single discharge of Halon 1301 provides a concentration of 5 to 7 percent Halon 1301 by volume of air throughout the protected space. Sufficient Halon is required so the concentration will remain at a minimum of 5 percent for 15 minutes. Some Halon protected spaces have a duplicate reserve Halon system to supplement the primary one. Each Halon fixed-flooding system is designed to discharge completely the Halon 1301 gas

into the protected space within 10 seconds following the start of the discharge.

SYSTEM ACTUATION AND FEATURES

Each system is usually provided with more than one CO₂ actuator station. The actuators can be installed either inside or outside the space. Features of the system include automatic ventilation shutdown, actuation of local and remote alarms, manual time delay bypass, and halon discharge indicator light.

SYSTEM OPERATION

Normal operation of the halon system may be accomplished by performing the following actions:

1. Break the glass or open the enclosure at a remote actuating stations. Remove the safety pin, which is secured by a lead and wire seal.
2. Fully operate the discharge lever and secure it in the OPERATE position. The released carbon dioxide will immediately actuate two pressure switches. One pressure switch operates lights and horns (or bells) within the space, and a bell and amber system actuated light outside the space at actuating stations and space accesses. The other pressure switch will initiate shut down of ventilation fans and operate any installed vent closures.
3. If alarms do not operate, or ventilation does not shut off, pull out the reset/actuation knob on the associated pressure switch. If operation still does not occur, manually shut off ventilation systems, and pass the word to evacuate the space.
4. After the time delay operates, the carbon dioxide pressure will operate the Halon cylinder valves to discharge Halon to its associated nozzles. A third pressure switch downstream of the time delay device will then actuate a red light indicating Halon discharge.

5. In the event the timing of the time delay device exceeds 70 seconds (for a 60-second device), or 35 seconds (for a 30-second device), the time delay should be bypassed by opening the time delay bypass valve.

WARNING

The time delay bypass valve should not be operated until after the full delay time of 30 or 60 seconds has passed.

Additional features include automatic ventilation shutdown, actuation of local and remote predischARGE alarms, manual time delay bypass, automatic ventilation closures (if installed), and Halon discharged indicator light.

An AFFF bilge sprinkling system normally supplements Halon 1301 systems in machinery spaces and pump rooms. The AFFF bilge sprinkling system, where installed, should be actuated at the same time as the Halon system. AFFF bilge sprinkling systems are not installed if the bilge is too shallow.

REVIEW QUESTIONS

- Q15. Halon systems are used to extinguish fires that are beyond the capacity of portable fire extinguishing equipment, and where abandonment of the space is necessary.
1. True
 2. False
- Q16. The full discharge of the gas from a Halon 1301 system into a protected space is completed in how many seconds?
1. 10
 2. 20
 3. 30
 4. 40
- Q17. What type of system normally supplements Halon 1301 systems in machinery spaces and pump rooms?
1. APC
 2. PKP
 3. AFFF
 4. Magazine sprinkler

AQUEOUS POTASSIUM CARBONATE (APC)

Learning Objective: Recall the location, design components, and operation of a typical installed aqueous potassium carbonate (APC) fire-extinguishing system.

Aqueous potassium carbonate (APC) fire-extinguishing systems (fig. 6-19) are installed in

Navy ships to provide protection for galley deep-fat and doughnut fryers and their exhaust systems. Aqueous potassium carbonate is specifically formulated to extinguish fire in the reservoirs by combining with the hot cooking-oil surface to form a combustion-resistant soap layer, thereby cutting off the grease from its source of oxygen. There is little or no cooling with APC. A typical APC fire-extinguishing system is shown in figure 6-19. For more information about the APC fire extinguishing system, refer to the technical manual NAVSEA S9555-AR-MMO-010, *Fire Extinguishing System, Deep-Fat and Doughnut Fryer*.

COMPONENTS

Each APC system includes one or two cylinders filled with a solution of potassium carbonate in water pressurized with compressed nitrogen (N₂). Discharge piping from the cylinder(s) leads to one or more nozzles which spray the solution into the cooking oil reservoirs, along the galley hood plenum, or up into the galley hood exhaust duct. A spring-tensioned cable keeps the system inactive. When this tension is released, the system is activated and N₂ is released from a pressurized cartridge. This action opens the lever control heads, releasing the aqueous potassium carbonate.

OPERATION

Operation of the APC fire-extinguishing system is normally fully automatic. Manual backup modes of operation are provided at the cylinder assembly, pressure release control box, and the remote manual control box.

Automatic Operation

Excessive heat on one of the fusible links melts the link and releases the cable tension. The extension spring in the pressure-control box pulls the lever, which activates the pressure release cartridge. N₂ gas from the pressure-release cartridge activates the lever control head(s), causing the cylinder(s) to discharge.

Manual Operation

The aqueous potassium carbonate (APC) system has three manual modes of operation:

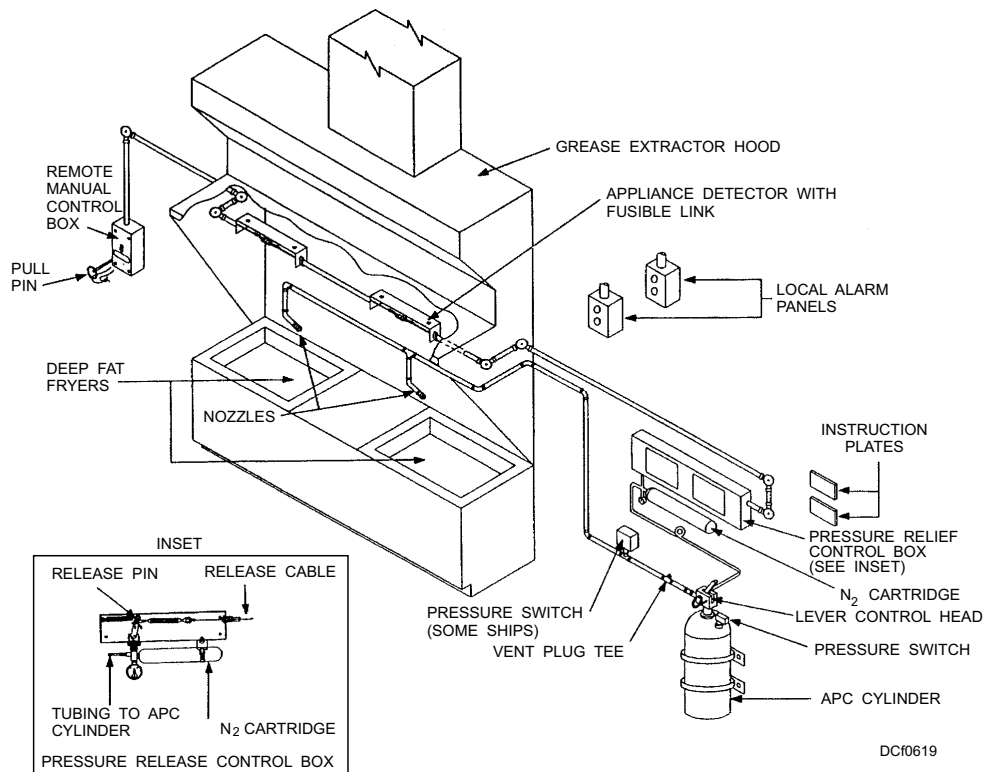


Figure 6-19. Aqueous potassium carbonate (APC) fire extinguishing system.

1. At the cylinder assembly, remove the release pin in the lever-control head completely, and operate the lever. This discharges the cylinder directly.

2. At the pressure release control box, open the box and remove the release pin completely. This disconnects the release cable and allows the extension spring to activate the system as described under automatic operation.

3. At the remote manual-control box, remove the release pin completely. This disconnects the anchored end of the release cable, releases the tension, and allows the extension spring to activate the system as described under automatic operation.

Q19. Each APC system includes one or two cylinders filled with a solution of potassium carbonate in water pressurized with what type of compressed gas?

1. Oxygen
2. Bromine
3. Helium
4. Nitrogen

Q20. The APC system has a total of how many manual modes of operation?

1. One
2. Two
3. Three
4. Four

REVIEW QUESTIONS

Q18. Aqueous potassium carbonate (APC) fire-extinguishing systems are installed in naval ships to provide protection for deep fat and doughnut fryers and their exhaust systems.

1. True
2. False

SUMMARY

In this chapter, you have been introduced to the design and function of the major installed shipboard fire-fighting systems. The systems include the firemain systems, magazine sprinkler systems, aqueous film-forming foam (AFFF) systems, carbon dioxide (CO₂) systems, Halon systems, and the aqueous potassium carbonate (APC) system.

REVIEW ANSWERS

- A1. The firemain system is used primarily to supply seawater to what other systems? **(4) Fireplug and sprinkling systems**
- A2. There is a total of how many basic types of firemain systems designed for use on large Navy ships? **(3) 3**
- A3. What type of firemain system is separated both vertically and athwartship? **(4) Vertical offset loop**
- A4. Sprinkler systems are used for emergency cooling of, and fire fighting in, magazines, ready-service rooms, ammunition, and missile handling areas. **(1) True**
- A5. What are the two basic types of hydraulically controlled sprinkler systems used on naval ships? **(3) The firemain-operated dry type and the firemain-operated wet type.**
- A6. What Navy rating maintains the magazine sprinkler systems? **(1) Gunner's Mate**
- A7. What type of pump for the installed AFFF system is provided in capacities of 12, 27, and 60 gpm? **(2) Single-speed injection pump**
- A8. AFFF is stored in storage/transfer tanks having a capacity of up to 3,500 gallons and in service tanks that vary in capacity from 50 gallons to what maximum size? **(2) 2,000 gallons**
- A9. What type of seawater pressure-operated control valve allows the flow of AFFF/seawater solution through the distribution system or controls seawater flow on flight deck AFFF injection systems? **(3) Powertrol**
- A10. What type of seawater pressure-operated control valve allows the flow of seawater from the firemain system to be mixed with AFFF concentrate? **(1) Hycheck**
- A11. What type of valve automatically proportions the correct amount of AFFF concentrate with seawater? **(4) Balancing valve**
- A12. The CO₂ flooding system is always used in spaces that are normally occupied by personnel. **(2) False. The CO₂ flooding system should only be used in spaces that are normally NOT occupied by personnel.**
- A13. When using the CO₂ hose-and-reel system, you should always direct the CO₂ discharged from the hose toward the base of the fire. **(1) True**
- A14. Before operating an installed CO₂ system, you should ensure all openings in the compartment are closed and the ventilation system for the space is secured. **(1) True**
- A15. Halon systems are used to extinguish fires that are beyond the capacity of fire extinguishing equipment, and where abandonment of the space is necessary. **(1) True**
- A16. The full discharge of the gas from a Halon 1301 system into a protected space is completed in how many seconds? **(1) 10 seconds**
- A17. What type of system normally supplements Halon 1301 systems in machinery spaces and pump rooms? **(1) AFFF. An AFFF sprinkling system normally supplements Halon 1301 systems in machinery spaces and pump rooms.**
- A18. Aqueous potassium carbonate (APC) fire-extinguishing systems are installed in naval ships to provide protection for deep-fat and doughnut fryers and their exhaust systems. **(1) True**
- A19. Each APC system includes one or two cylinders filled with a solution of potassium carbonate in water pressurized with what type of compressed gas? **(4) Nitrogen**
- A20. The APC system has a total of how many manual modes of operation? **(3) Three manual backup modes of operation are provided at the cylinder assembly, the pressure release control box, and the remote manual control box.**

