

Marinefire Srl

Global Supplier of Fire Suppression Systems
to the Marine Industry

Marine Fire Pre-Engineered Fire Suppression 760 Series

Design, Installation & Maintenance Manual



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FOREWORD

Marinefire Design and Installation & Maintenance Manual for HFC-227ea pre-engineered 760 series suppression systems incorporates the latest design requirements found in NFPA Standard 2001, as well as the most up-to-date information available for our products. This manual is a comprehensive guide of information compiled as a result of research, development and testing. It has been provided for those individuals that are responsible for the design, installation, and/or maintenance of Marinefire Srl HFC-227ea hardware and systems. It is the responsibility of the designer and installer to remain within the parameters established in this design, installation, and maintenance manual.

Sales and marketing personnel as well as marine architects, engineers, specifiers, etc. will also find the information contained in this manual useful. Marinefire fire suppression systems for the marine environment are offered only in the Pre-engineered format.

Pre-Engineered Systems – are simple systems that operate within a predetermined set of design parameters with limitations that are pre-established by testing. Marinefire marine suppression systems are tested and approved by Factory Mutual and the United States Coast Guard. These systems do not require the designer to perform any hydraulic flow calculations and they are intended to provide an easy means of designing HFC-227ea fire suppression systems.

Marinefire's pre-engineered HFC-227ea fire suppression systems must be installed and maintained in accordance with the limitations established in NFPA Standard 2001, Clean Agent Extinguishing Systems, as well as the limitations set forth by Factory Mutual Research and the United States Coast Guard. The information contained within this manual defines the established limitations in detail.

MARINE FIRE 760 series pre-engineered fire suppression systems are designed for installation in Engine Rooms and other not normally occupied areas on board Pleasure Craft (ISO 9094:2015 chapter 7.6 standard for Recreational Craft) up to 24mt waterline length. These systems are suitable to protect against A and B class fires in machinery spaces up to 100m³ gross volume.



IMPORTANT

Marinefire believes that the information incorporated into this manual is accurate. It has been compiled to allow those responsible for designing and installing Marinefire HFC-227ea systems to properly do so, and for the parties responsible for verifying the system design to determine if the design parameters have been met. The data contained within this manual is provided for informational purposes only. Marinefire disclaims all liability for any other use that may be made of the data contained within this manual by any, and all, parties. Marinefire believes this data to be accurate; however, all dimensions are approximate, and this document is presented without any guarantee or warranty whatsoever. Any questions concerning the information presented in this manual should be addressed to:

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Marinefire fire suppression systems are to be designed, installed, inspected, maintained, tested, and recharged by qualified, trained personnel in accordance with the following:

- Standard of the National Fire Protection Association No 2001, titled "Clean Agent Extinguishing Systems."
- Applicable U.S. Coast Guard Rules and Regulations
- Instructions and Limitations in this manual



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- Storage, Handling, transportation, service, maintenance, recharge, and test of agent storage containers shall be performed only by qualified trained personnel in accordance with the information in this manual.
- Compressed Gas Association* (CGA) pamphlets:
 - C-1, "Methods for Hydrostatic testing of Compressed Gas Cylinders"
 - C-6, "Standards for Visual Inspection of Compressed gas cylinders"
 - P-1, "Safe Handling of Compressed Gases in Containers"
- All information contained on the system container (s) nameplate.
- Standard for Pleasure Craft ISO 9094:2015 chapter 7.6

* CGA pamphlets are published by and available for purchase from the:

Compressed Gas Association

4221 Walney Road

Fifth Floor

Chantilly, VA 20151-2923

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1. AGENT

This section covers the fire suppressing agent utilized by Marinefire HFC-227ea. All the information contained herein is believed to be accurate and up to date. However, it should be noted that all dimensions shown are approximate and Marinefire reserves the right to adjust, as necessary.

1.1. AGENT HFC-227ea

The extinguishing agent used in Marinefire Pre-engineered 760 series Fire-Suppression Systems is Heptafluoropropane, more commonly known by its ASHRAE designation: HFC-227ea. HFC-227ea is a colorless, odorless, liquefied compressed gas. (See the Physical Properties Table below.) It is stored as a liquid, but dispensed into the hazard as a colorless, electrically nonconductive, gaseous vapor due to its relatively low boiling point. HFC-227ea has been tested and verified to be safe for use in occupied spaces when used as specified in the U.S. EPA Significant New Alternative Policy (SNAP) rules. Tests have proven that exposure to HFC-227ea is safe and effective in extinguishing fires at low concentrations; most of which are well below the EPA's maximum exposure levels. HFC-227ea is approved for use in occupied areas up to an 10.5% concentration by volume with a mandated egress time of 5 minutes or less.

1.1.1. EXTINGUISHING MECHANISM

HFC-227ea's mechanism of extinguishing fires is considered active. Its primary action is through physically cooling the fire at the molecular level. HFC-227ea is an efficient heat transfer agent. HFC-227ea removes the thermal energy from the fire to the extent that the combustion reaction cannot sustain itself. Additionally, there is a chemical action that provides a secondary means of suppressing the fire. Trace amounts of free radicals are released into the fire – thereby inhibiting the chain reaction of combustion. HFC-227ea does not significantly reduce oxygen levels and is safe for use in occupied spaces in accordance with the U.S. EPA guidelines. HFC-227ea can be removed from the protected space by simply ventilating the space after a system discharge.

1.1.2. PHYSICAL PROPERTIES OF HFC-227ea

Chemical Name	CF ₃ CHFCF ₃
Molecular Weight	170.03
Boiling Point @ 760 mm Hg	-16.4°C
Freezing Point	-131°C
Critical Temperature	101.7°C
Critical Pressure	29.1 bar
Critical Volume (cc/mole)	274
Critical Density (kg/m ³)	621
Specific Heat, Liquid (kJ/kg @ 25°C)	1.184
Specific Heat, Vapor (kJ/kg °C) @ constant pressure of 1 ATM @ 25°C	0.808
Heat of Vaporization (kJ/kg °C) at Boiling Point	132.6
Thermal Conductivity (W/m °C) of Liquid @ 25°C	0.069
Viscosity, Liquid @ 25°C	0.184 centipoise
Global Warming Potential	2900
NOAEL, VOL %	9
LOAEL, VOL %	10.5
Ozone Depletion Potential	0
US EPA SNAP Approval	Accepted
Estimated Atmospheric Lifetime	31 – 42 years
LC ₅₀ (Rats; 4 hrs – ppm)	>800,000 ppm

Table 1 – HFC227ea Physical Properties

1.2. PRE-ENGINEERED FIRE SUPPRESSION SYSTEM. USE AND LIMITATION

Marinefire Pre-engineered Fire-suppression systems must be designed and installed in accordance with the requirements outlined in this manual, the requirements of the United States Coast Guard and in accordance with the requirements of the NFPA 2001 Standard for Clean Agent Extinguishing Systems, latest edition. Marinefire HFC-227ea systems are used to protect hazards that are enclosed. An enclosed hazard area will provide a means to contain the HFC-227ea agent. By containing the agent in the enclosure, when discharged it will establish and maintain an effective extinguishing concentration. Some typical hazards that can be protected with HFC-227ea fire suppression systems include but are not limited to the following:

- Marine Applications
- Machinery Spaces
- Engine compartments
- Electrical and electronic hazards
- Storage Rooms – Flammable liquids and gases
- Paint lockers

Marinefire HFC-227ea systems shall **NOT** be used on fires involving the following materials.

- Self-oxidizing chemicals of rapid oxidizing chemicals
Examples: Cellulose Nitrate and Gunpowder.
- Reactive metal compounds
Examples: Sodium, Potassium, Barium, Magnesium, Lithium Titanium, Zirconium, Uranium, and Plutonium
- Metal hydrides
Examples: Sodium Hydride and Lithium Aluminum Hydride
- Chemicals capable of undergoing auto-thermal decomposition.
Examples: Organic Peroxides and Hydrazine.

(Reference: NFPA 2001, latest edition)

1.3. AGENT EXPOSURE

Although HFC-227ea is non-toxic, the EPA has established the guidelines for controlling the amount (concentration) of agent provided for the protected area. Based on PBPK modeling, the EPA allows HFC-227ea for use in normally occupied spaces up to a concentration of 10.5 % by volume with exposure limited to 5 minutes or less.



WARNING: The discharge of clean agent systems to extinguish a fire can result in a potential hazard to personnel from the natural form of the clean agent or from the products of combustion and decomposition that result from exposure of the agent to the fire or hot surfaces. Unnecessary exposure of personnel either to the agent in its natural form or to the products of decomposition shall be avoided.

The requirement for pre-discharge alarms and time delays in **occupied areas** are intended to prevent unnecessary exposure to humans where their presence is not critical to the operation of the area being protected. Suitable safeguards shall be provided to ensure prompt evacuation of (and prevent entry into) protected areas after discharge.

1.3.1.AGENT EXPOSURE LIMITS

1.3.1.1. SPACES NOT NORMALLY OCCUPIED

Most Marinefire suppression systems will be used to provide protection for hazards and compartments that are too small or too remote to be occupied. HFC-227ea systems can be designed for concentrations exceeding the LOAEL if the space is not normally occupied or that personnel in the hazard area can escape within 30 seconds.





Caution: *Marinefire. does not recommend HFC-227ea systems to be used in any normally occupied spaces where the design concentration required is above 10.5%.*

1.3.2. TOXICITY

HFC-227ea has been extensively tested and is approved for use in fire suppression systems around the world. The LC50 toxicity rating for HFC-227 ea is greater than 780,000 ppm. When one considers that most HFC-227ea systems are designed for concentrations providing less than 105,000 ppm, it is evident that HFC-227ea is safe to use. HFC-227ea will decompose to form halogen acids when exposed to extremely high temperatures. The formation of these acids is minimized by using fast-acting detection and control systems, and proper system design and installation for rapid discharge of the agent into the hazard area. Generation of by-products (decomposition) from the HFC-227ea discharge will be minimal when properly applied. As with all HFC agents used as fire suppressants, human exposure to concentrations above the NOAEL is limited to 5 minutes.

1.4. AGENT DISCHARGE

1.4.1. NOISE AND TURBOLENCE

The high velocity discharge from the nozzle (s) may cause enough noise to startle anyone in the vicinity of the nozzle (s). There may be enough turbulence to dislodge objects located in the path of the discharge. Enough turbulence may be created within the enclosure to move unsecured items such as paper and light objects.

1.4.2. CHILLING AND VISIBILITY

Liquid HFC-227ea discharging from the nozzle(s) will have a chilling effect on objects and can cause frostbite burns to the skin. The liquid phase vaporizes rapidly when mixed with air. Discharging the agent into an area with a humid atmosphere may cause a reduction in visibility due to condensation of water vapor normally present in the hazard area. The reduction in visibility is temporary and will clear in a short period of time.



1.4.3.PRESSURE

The normal operating pressure of a Marinefire HFC-227ea clean agent Marinefire. suppression system is 360 psig @ 70oF (24.8 bar @ 21oC). This is accomplished by super pressurizing the system with a charge of nitrogen added to the HFC-227ea agent. All Marinefire Fire-suppression cylinders are pressurized vessels, care must be observed when handling, filling, and transporting storage containers. The anti-recoil devices SHALL be in place whenever the charged container is removed from the piping network.

1.4.4.SUPER-PRESSURIZZATION

To increase the available pressure above the vapor pressure of HFC-227ea nitrogen is added to the fire suppression system container after the transfer of the HFC-227ea is complete. This process is referred to as super pressurization. Super pressurization is applied to the container for any of the following:

- To increase the total pressure available for flow from the fire suppression system container through the downstream piping network.
- To provide a “pressure pad” for the liquid to keep the liquid compressed in the liquid phase during flow through piping systems.
- To stabilize the container pressure over a wide temperature range or to maintain significant storage pressures at low temperatures.

1.5. AGENT STORAGE CONTAINERS

Agent Storage Containers are Aluminum or steel pressure vessels designed to hold the HFC-227ea under pressure until it is discharged. All Marinefire HFC-227ea Containers are suitable for use at storage temperatures of 0°F to +130°F (-17.7°C to 48.9°C). Each container is manufactured in strict accordance with DOT regulations and undergoes extensive pressure and leak testing before shipment to the field. All Marinefire HFC-227ea Containers are shipped from the factory fitted with an anti-recoil device installed in the discharge valve outlet in accordance with DOT requirements. The anti-recoil device ensures the contents of the pressurized container will be released in a slow, controlled, rate of discharge if the valve is opened during the shipping and handling process.

Marinefire HFC-227ea **aluminum** containers are filled with agent within the allowable range of 35 lbs/ ft3 to 72 lbs/ft3 (560 kg/m³ to 1120 kg/m³) of container volume.



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Marinefire HFC-227ea steel **containers** are filled with agent within the allowable range of 35 lbs/ft³ to 72lbs/ft³ (560 kg/m³ to 1120 kg/m³) of container volume in accordance with DOT requirements.

All containers are filled in 1 lb (0.5 kg) increments to the user-specified level defined for each container. Each HFC-227ea container is super pressurized with dry nitrogen to a working pressure of 360 psig at 70°F (24.8 bar at 21°C).

Marinefire 760 series HFC-227ea Containers are available in different sizes (capacities). Each container includes a pressure differential discharge valve, relief device, pressure gauge, low pressure switch (optional), radial array nozzle and provisions for the accessories available for that container size and/or style. The Discharge Valve is a pressure differential valve; it is a pressure operated device that allows the agent to be released from the container and into the protected space via the associated nozzle.

Activation of the Discharge Valve is accomplished by any one or a combination of the following:

- Manual activation via Cable Pull
- Manual activation via Push or strike actuator
- Pneumatic activation via Pneumatic actuator
- Automatic activation via Pneumatic Control Head (H.A.D.)
- Automatic activation via thermal actuator
- Automatic activation via 24 VDC solenoid (not for marine use in engine compartments, etc.)



1.5.1.CAPACITY Marinefire HFC-227ea CONTAINERS

Marinefire HFC-227ea Containers are available in the following sizes (capacities):

Model Number	Cylinder Capacity		Minimum Fill		Maximum Fill		Charge	Pressure
	In3	Lt	Lbs	Kg	Lbs	Kg	PSI	KPa
760003	105	1.7	2	0.9	4	1.8	360	2500
760005	150	2.5	3	1.4	6	2.7	360	2500
760008	250	4.1	5	2.3	10	4.5	360	2500
760010	300	4.9	6	2.7	12	5.4	360	2500
760012	350	5.7	7	3.2	14	6.3	360	2500
760016	525	8.5	10	4.5	21	9.5	360	2500
760020	650	10.7	12	5.4	27	12.2	360	2500
760028	850	13.9	15	6.8	35	15.9	360	2500
760036	1050	17.2	19	8.6	43	19.5	360	2500
760040	1400	22.9	25	11.3	58	26.3	360	2500
760050	1600	26.2	28	12.7	66	30	360	2500
760060	2000	32.8	35	15.9	83	37.6	360	2500
760080	3000	49.2	53	24	124	56.2	360	2500
760100	4000	65.6	70	31.7	166	75.3	360	2500

Table 2 – HFC227ea Containers

1.5.2.MARINEFIRE CYLINDER SPECIFICATION

Each container has been designed and fabricated in accordance with DOT requirements. The associated DOT ratings are as follows:

- Aluminum cylinders = **3AL1000**
- Steel cylinders = **4BW500**



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Each container is shipped with an anti-recoil device (pipe cap) installed on the discharge outlet of the pressure differential valve. The pipe cap supplied has a 1/8" (4 mm) hole drilled through it to allow the container pressure to vent safely to an HFC-227ea atmosphere if the discharge valve is activated prior to installation.

All containers in the Marinefire 760 series **MUST** be installed in the upright (valve up) position. Mounting Brackets are supplied with aluminum containers, mounting brackets are available for all steel containers; each must be anchored to an appropriate load-bearing structure.

1.5.2.1. CYLINDER DIMENSIONS / WEIGHT

Model Number	Cylinder Capacity		Size Nominal		Cylinder Diameters		Cylinder Height		Total Height	
	In3	Lt	Lbs	Kg	Inch.	mm	Inch.	mm	Inch.	mm
ALUMINUM CYLINDERS										
760003	105	1.7	4	1.8	3.5	88.9	13.9	355.0	17.4	445.0
760005	150	2.5	6	2.7	4.4	111.0	13.9	355.0	17.4	445.0
760008	250	4.1	10	4.5	5.25	133.3	14.9	377.3	18.4	467.3
760010	300	4.9	12	5.4	5.25	133.3	17.4	442.2	20.9	532.2
760012	350	5.7	14	6.3	5.25	133.3	20.4	517.2	23.9	607.2
760016	525	8.5	21	9.5	6.89	175.0	19.3	491.2	22.8	581.2
760020	650	10.7	27	12.2	6.89	175.0	23.4	592.8	26.9	682.8
760028	850	13.9	35	15.9	8.0	203.2	23.65	600.7	27.2	690.7
760036	1050	17.2	43	19.5	8.0	203.2	28.50	723.9	32.0	813.9
STEEL CYLINDERS										
760040	1400	22.9	58	26.3	10.0	254.0	22.25	565.2	27.75	705.2
760050	1600	26.2	66	30	10.0	254.0	24.75	628.7	30.25	768.7
760060	2000	32.8	83	37.6	10.0	254.0	30.31	769.9	35.81	909.9
760080	3000	49.2	124	56.2	12.75	323.9	29.0	736.6	34.5	876.6
760100	4000	65.6	166	75.3	12.75	323.9	37.31	947.7	42.8	1088

Table 3 – Cylinder Dimensions / Weight



1.6. ITEMS FURNISHED WITH CONTAINERS

All Marinefire HFC-227ea containers are furnished with the following items:

1.6.1. NAME PLATE

All Marinefire HFC-227ea containers are provided with a nameplate that provides the following information that is specific to each container:

- Assembly and serial numbers of the container
- Weight Information: tare, gross and agent
- Installation, operation, and safety information

All containers are filled at the factory and will be provided with a nameplate bearing the FM marking.

1.6.2. PRESSURE DIFFERENTIAL VALVE

All Marinefire HFC-227ea containers are provided with a pressure differential valve that is activated either manually or by an automatic detection system, or any combination thereof.

1.6.2.1. PRESSURE RELIEF DEVICE

A Compressed Gas Association (CGA) CGA-type 1 relief device is fitted to all Marinefire pressure differential valves. The relief pressure for Marinefire HFC-227ea cylinders is as follows:

- Aluminum cylinders is 1650 psig (11,376.35 kPa)
- Steel cylinders is 1000 psig (6894.76 kPa)

1.6.2.2. PRESSURE GAUGE

All Marinefire Pressure differential valves are provided with a Pressure Gauge (P/N 310002) to indicate the internal container pressure. The Pressure Gauge scale is calibrated to show the actual pressure in psig (kPa). The pressure gauge is color-coded to display the acceptable operating range, under-pressure range, and over-pressure range.

1.6.3. SIPHON TUBE

Siphon Tubes are provided in all Marinefire HFC-227ea containers for mounting in the upright (valve up) position. The siphon tube is installed in the container to ensure the complete dispersal of suppression agent from the container to the protected space (s).



DO NOT install Marinefire HFC-227ea Containers in the inverted (valve down) position. This will result in a system failure due to the majority of the HFC-227EA agent remaining in the container after activation.

1.6.4. LOW PRESSURE SWITCH

All Marinefire Pressure differential valves in marine service are fitted with a Low-Pressure Switch for the purpose of continuously monitoring the container pressure for a low-pressure condition. The low-pressure switch operates if the pressure inside the container drops below 238 psig (1965 kpa), sending a signal to the engine shutdown device. Low Pressure Switch (P/N 340004) is normally open (closed under pressure) and is provided with the container.

1.6.5. PRE-ENGINEERED FULL ARRAY RADIAL NOZZLE

Each container is furnished with a pre-engineered nozzle fixed to the cylinder size. Each nozzle has a predetermined discharge orifice to meet the discharge requirements of the 760 series fire suppression system. The Discharge Nozzle is the device that controls the HFC-227ea Agent flow and distributes the agent throughout the protected area. Marinefire Pre-Engineered HFC-227ea nozzles are available in Frontal / radial dispersal patterns only. Discharge Nozzles are mounted directly on the cylinder outlet. Marinefire HFC-227ea discharges nozzles are machined from brass to prevent corrosion.



Nozzles generate a reactive force in the opposite direction from the nozzle orifices. Cylinders must be mounted and bracketed correctly to counteract expected movement.

1.7. MARINE SUPPRESSION SYSTEM ORDERING FORMAT

In addition to the basic container part number that identifies the capacity and type of HFC-227ea Container, the only other options are the amount of agent required and mounting brackets for the steel cylinders, when placing an order for a Marinefire 760 series HFC-227ea Container.

760xxx xxx xxx

A B C

- A =** Basic container part number (i.e. 760008, 760020, etc.)
- B =** Agent quantity in lbs. (container must be filled in 1 lb. increments)
- Agent quantity in kg (container must be filled in 0.5 kg increments)
- C =** Low Pressure Switch

All Marinefire containers will be Factory Filled, each container is pressurized to 360 psig with dry nitrogen @ 70°F (24.8 bar @ 21°C).

1.8. CAUTION / ADVISORY SIGNS

Caution / Advisory Signs are provided to comply with NFPA 2001 requirements, and to provide the necessary information to personnel in the area.

1.8.1. NOTICE - SYSTEM ALARM SIGN (P/N 390020)

This sign is provided to alert personnel that the area or machine is protected with an HFC-227ea fire suppression system and to evacuate the area when the alarms sound. The sign measures 9" x 6" x 1/16" (229 mm x 152 mm x 1.6 mm). The sign should be placed adjacent to each audible/visual device used to notify personnel of the status of the HFC-227ea system.

1.8.2.ABORT SIGN (P/N 390026)

This sign is provided to identify each system abort station associated with the HFC-227ea system. This reduces the risk of an abort station being mistaken for a manual release or fire alarm pull station. This sign measures 4" x 2 1/4" x 1/16" (102 mm x 57 mm x 1.6 mm). The System Abort Station Sign should be placed at each abort station location for positive identification.

1.8.3.MAIN / RESERVE SIGN (P/N 390021 - 390022)

This sign is provided to identify each system main/reserve station associated with the HFC-227ea system. This sign clearly identifies the purpose of the switch. This sign measures 4" x 2 1/4" x 1/16" (102 mm x 57 mm x 1.6 mm). The System Main/Reserve Sign should be placed at each main/reserve station location for positive identification.

1.8.4.AGENT RELEASE SIGN (P/N 390023)

This sign is provided to identify each system release station associated with the HFC-227ea system. This reduces the risk of a manual discharge station being mistaken for a fire alarm pull station. This sign measures 4" x 2 1/4" x 1/16" (102mm x 57 mm x 1.6 mm). The System Release Sign should be placed at each manual release station location for positive identification.

1.8.5.NOTICE - SYSTEM DISCHARGE (P/N 390024)

This sign is provided to alert personnel that the room is protected with an HFC-227ea system and that they should not enter the area when the alarm sounds. This sign measures 9" x 6" x 1/16" (229 mm x 152 mm x 1.6 mm). The sign should be placed adjacent to each audible/visual device (typically located outside the area) used to notify personnel that the HFC-227ea system has discharged.

1.8.6.CAUTION - AREA PROTECTED BY HFC-227ea SIGN (P/N 390025)

This sign is provided to alert personnel that the room is protected with an HFC-227ea system and that they should not enter the area during or after discharge. The sign also indicates the requirement that all doors

serving the protected area must be kept always closed. This sign measures 13" x 10" x 1/16" (330 mm x 254 mm x 1.6 mm). The sign should be placed on all doors serving the protected area.

1.9. CONTROL SYSTEM & ACCESSORIES

Marinefire offers several options to allow the user to interface with the Detection & Control system as needed to suit their specific needs. The following control systems and accessories are specific to Marinefire HFC-227ea systems and will be required in various configurations. This is not intended to be a complete reference for the Detection & Control System that will be required.

1.9.1. MANUAL ACTUATOR (P/N 510001)

The Marinefire Manually Operated Push or STRIKE Actuator provides an independent means of operating a Marinefire HFC-227ea System. This device mounted directly on the pressure differential valve or on the pilot system will activate the HFC-227ea system without the need for external power. To operate the Manual Actuator, simply pull the safety pin and push the handle down. The (Push) Manual actuator can be used as a stand-alone device, or in conjunction with a detection & control system as a back-up operator.



Pic. 1 – Manual Actuator P/N 510001

1.9.2. MANUAL / PNEUMATIC ACTUATOR (P/N 510003)

The Marinefire Manually Operated Push or STRIKE Manual/ Pneumatic Actuator provide an independent means of operating a Marinefire HFC-227ea System. This device mounted directly on the pressure differential valve will activate the HFC-227ea system without the need for external power. A small amount of gas from a pilot cylinder can be used to actuate the manual pneumatic actuator mounted on the slave cylinder. To operate the Manual/Pneumatic Actuator, simply pull the safety pin and push the handle down.

The (Push) Manual Pneumatic actuator can only be used as a stand-alone device.



Pic. 2 – Manual / Pneumatic Actuator P/N 510003

1.9.3. CABLE ACTUATOR (P/N 510004)

The Marinefire cable actuator is a mechanical device that allows the HFC-227ea marine suppression system to be actuated via the operation of a manual pull cable. The HFC-227ea system can be remotely actuated when utilizing the cable actuator. This method can be used by directly connecting the cable actuator to the HFC-227ea cylinder valve or to a pilot system.



Pic. 3 – Cable Actuator P/N 540001

1.9.4. CABLE PNEUMATIC ACTUATOR (P/N 510007)

The Marinefire cable pneumatic actuator is a mechanical device that allows the HFC-227ea marine-suppression system to be actuated via the operation of a manual pull cable. The HFC-227ea system can be remotely actuated when utilizing the cable pneumatic actuator. This device mounted directly on the pressure differential valve or pilot cylinder will activate the HFC-227ea system without the need for external power. To operate the Cable / Pneumatic Actuator, simply pull the safety pin and pull the handle on the remote Manual Station.

1.9.5. PNEUMATIC ACTUATOR (P/N 510002)

The Marinefire pneumatic actuator allows the HFC-227ea marine suppression system to be activated remotely. Pressure operated actuators are devices that allow the actuation of the pressure differential valve with pressurized gas. The Marinefire HFC-227ea marine suppression system can utilize the pressure from one HFC-227ea cylinder (MASTER) to activate several other HFC-227ea marine suppression cylinders (SLAVES).



Pic. 4 – Pneumatic Actuator P/N 510002

1.9.6. THERMAL ACTUATOR / CABLE ACT. (P/N 510008, 510009, 510012)

The Marinefire thermal actuator allows the HFC-227ea marine suppression system to be activated thermally. The thermally activated device releases the agent when the thermal glass bulb actuator reaches 79,45°C (175°F). The bulb ruptures driving the spring-loaded pin down into the pressure differential valve activating the suppression system.

This actuator is available with the following OPTIONAL temperatures:

57,2°C (135°F), 68,3°C (155°F), 93,3°C (200°F), 141,1°C (286°F), 182,2°C (360°F), 260°C (500°F)



Pic. 5 – Thermal Cable Actuator P/N 510008 / 510009 / 510012

1.9.7. PNEUMATIC CONTROL HEAD (P/N 510010)

The Marinefire pneumatic control head PN 510010 is used to automatically actuate the HFC-227ea system by utilizing pneumatic heat actuated devices (HAD). Air in the HAD expands as the heat in the environment in which they are located rises. The increase in temperature causes the air in the HAD to expand, the resultant pressure increase activates the pneumatic control head releasing the HFC-227ea Marine suppression system.

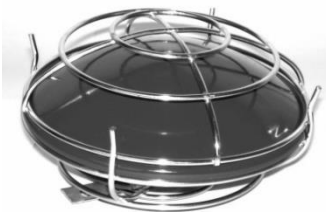
The Pneumatic operated control: head can also be activated via manual cable.



Pic. 6 – Pneumatic Control Head P/N 510010

1.9.8. HEAT ACTUATED DEVICES - HAD (P/N 510011)

Automatic actuation is accomplished with pneumatic heat activated detectors (HAD) and pneumatic control heads. The pneumatic heat detector uses the rate of rise principle, where a sudden increase in temperature will cause the system to actuate. The HAD's are located within the protected compartment and are interconnected to the pneumatic control head via stainless or copper tubing. When the air in the HAD heats up due to a fire condition in the protected compartment the air expands, builds up pressure in the HAD, the pressure is transmitted via the tubing to the pneumatic control head. When sufficient pressure is built up in the chamber of the pneumatic control head it will operate and discharge the system. Pneumatic control heads are fitted with vents so that slight changes in pressure related to normal changes in ambient temperature are vented to atmosphere.



Pic. 7 – Heat Actuated Devices P/N 510011

1.9.8.1. SPACING OF HADs

HAD spacing must not exceed 25 feet (7.62m) center to center, or 625 ft² (58,06 m²) per detector. Not more than 4 HAD s shall be used on a single system.

ACCESSORIES		
PART NUMBER		DESCRIPTION
510060		Fitting - 1/8" NPT x 3/16"
510061		Fitting - Union 3/16"
510062		Fitting - Tee 3/16"
PART NUMBER	LENGHT	DESCRIPTION
510065	6 feet	Tubing 3/16"
510066	12 feet	Tubing 3/16"
510067	24 feet	Tubing 3/16"
Table 4 – HAD Accessories		

1.10. ACTUATION ACCESSORIES

Marinefire offers several options to allow the user to discharge more than one container of HFC-227ea as needed to suit their specific needs. The following accessories are specific to Marinefire HFC-227ea systems.

1.10.1. FLEXIBLE ACTUATION HOSE

The flexible braided stainless steel actuation hose is used in multiple container systems. Pilot pressure is directed to a pneumatic actuator on each HFC-227ea container using a 1/4" actuation hose. Pneumatic accessories such as a remote pressure switch can also be connected using a flexible actuation hose.

PART NUMBER	DESCRIPTION
510031	1/4" x 12' Braided Stainless Flex Hose
510032	1/4" x 24' Braided Stainless Flex Hose
510033	1/4" x 36' Braided Stainless Flex Hose
510034	1/4" x 48' Braided Stainless Flex Hose
<i>Table 5 – Flexible Hoses</i>	



Pic. 8 – Flexible Hoses

1.10.2. ADAPTERS

Tees, elbows, and adapters are needed to interconnect the actuation hose and various pressure operated devices.

PART NUMBER	DESCRIPTION
510046	1/8" NPT x 45°
510047	1/4" NPT x 45° Adapter
510048	1/4" NPT x 45° Elbow
510048	1/4" NPT x 45° Tee
<i>Table 6 - Adapters</i>	

1.11. REMOTE MANUAL PULL STATION

Marinefire offers two options to allow the user to connect the HFC-227ea container activation devices to a remote manual release. There are times when the user will require a flexible connection, other times a rigid protected connection is required. In both cases, for protected spaces larger enough to be occupied by one person, even occasionally, an activation box supplied with a microswitch is supplied. Microswitch is activated when the protective safety glass is broken, it will release a visual and sound alarm before the discharge, as required is ISO9094:2015 chapter 7.6.3.3.

1.11.1. REMOTE MANUAL PULL STATION - SURFACE MOUNTED

The surface type remote manual pull station uses 1/16" stainless steel aircraft type cable that is routed through 3/8" pipe or rigid conduit. This method of remote operation utilizes corner pulleys to aid in the routing of the pipe and cable. The manual pull station is easy to operate, simply remove the safety pin and pull.

PART NUMBER	DESCRIPTION	
520105	Surface Mount Pull Station	
520121	Corner Pulley	
	STAINLESS CABLE	LENGHT
520110	1/16" Cable	25 ft - 7.62 mt
520111	1/16" Cable	50 ft - 15.24 mt
520112	1/16" Cable	100 ft - 30.48 mt
Table 7 – Remote Pull Station		

1.11.2. CABLE TYPE PULL STATION

The cable type pull station is a surface mounted device that utilizes a 1/16" stainless steel inner core cable routed through a flexible 1/4" conduit which can be used to run the pull cable in tight spaces. The maximum length of cable is 75 feet. In turning corners with this type of cable the maximum bend radius is 6".



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PART NUMBER	LENGHT		DESCRIPTION
	ft.	mt.	
521004	4	1.22	Discharge Cable
521006	6	1.83	Discharge Cable
521008	8	2.44	Discharge Cable
521010	10	3.05	Discharge Cable
521012	12	3.66	Discharge Cable
521014	14	4.27	Discharge Cable
521016	16	4.88	Discharge Cable
521018	18	5.49	Discharge Cable
521020	20	6.10	Discharge Cable
521022	22	6.71	Discharge Cable
521024	24	7.32	Discharge Cable
521026	26	7.93	Discharge Cable
521028	28	8.54	Discharge Cable
5210xx	Up to 75 feet		Discharge Cable
Table 8 – Pull Cable Size			

1.12. MOUNTING BRACKET

Each aluminum cylinder is supplied with an individual mounting bracket. Brackets are available for all steel cylinders but must be ordered separately. The brackets are bulkhead brackets to support the containers which must be deck mounted.

ALUMINUM CYLINDERS			
CYLINDER P/N	BRACKET P/N	NUMBER REQUIRED	BRACKET DESCRIPTION
760004	410002	1	Bracket 3.5"
760006	410003	1	Bracket 3.5"
760010	410005	1	Bracket 4.5 x 12
760014	410006	1	Bracket 4.5 x 16
760021	410008	1	Bracket 6 x 16
760026	410009	1	Bracket 6 x 20 x 6.9
760034	410009	1	Bracket 6 x 20 x 8
760042	410014	1	Bracket 7 x 24
STEEL CYLINDERS			
760056	410011	2	Bracket 10" - 410020
760081	410011	2	Bracket 10" - 410020
760120	410013	2	Bracket 12" - 410021
Table 9 – Mounting Plate			

10" Bulkhead bracket is available to mount 56 pound and 81 pound systems on bulkhead. PN 410012 stainless plate designed to withstand the force associated with rough seas.

1.12.1. PHISICAL MOUNTING OF 760 SERIES ON FIBERGLASS BULKHEAD



CAUTION: When mounting a fire suppression system on a fiberglass bulkhead the cylinder mounting bracket must be mounted on a structural column. If a secure location such as a structural column is not available, the cylinder mounting bracket should be mounted on a backing plate. The backing plate can be constructed of ¾" marine grade plywood, steel, aluminum or stainless plate designed to withstand the force associated with rough seas.

1.13. DISCHARGE DELAY AND PRE-DISCHARGE ALARM

Suppression systems protecting a space greater than 6,000 ft³ (169.9 m³) must be equipped with a time delay and pre-discharge alarm to warn occupants in the protected space and allow them sufficient time to exit as well as to allow ventilation systems to shut down prior to agent discharge. Systems protecting spaces less than 6,000 ft³ (169.9 m³) must be equipped with a time delay unless there is a suitable horizontal exit. Systems protecting spaces of 6,000 ft³ (169.9 m³) and under must be actuated automatically if located inside the protected space. Discharge delay is accomplished with 30 or 60 second mechanical delays. Discharge delays should be equipped with a pre-discharge alarm and by-pass valve.

1.13.1. 30 AND 60 SECOND PNEUMATIC DISCHARGE DELAYS

Pneumatic discharge delays can be accomplished by using Marinefire PN 510020 (30 second) time delay or PN 510021 (60 second) time delay.



Marinefire discharge delays operate ONLY WITH CO2 and must only be used in systems that use CO2 pilot cylinders.

This type of time delay must be installed in the actuation line piping downstream of any pressure operated equipment (including the pre-discharge alarm). A time delay bypass valve should be installed to each discharge delay to allow the discharge delay to be by passed in the event of a failure.



Pic. 9 – Pneumatic Delay

1.14. PNEUMATIC PRESSURE OPERATED TRIP

Marinefire pressure operated trips (PN 510023) are used to close off the hazard area upon system discharge. Pressure operated trips are operated by system pressure; they are designed to release self-closing units such as doors, dampers, windows. The maximum load to be attached to a pressure trip cannot exceed 100 pounds based on a minimum operating pressure of 75 psi at the pressure trip.

1.15. CARBON DIOXIDE PILOT SYSTEM

A carbon dioxide pilot cylinder can be used to activate the HFC-227ea system. The pilot systems are a combination of CO₂ cylinder and pressure differential valve. Any of the actuators listed in this section can be used to actuate the pilot system. Pilot systems are available in three sizes 5 pound, 15 pound and 35 pound. A flexible, high pressure, discharge hose P/N 510038 is available to connect the pilot system to the rigid pipe network. Mounting brackets are available for deck or bulkhead mounting, pilot systems must be installed in the vertical position or declined not more than a 30 degree angle.



Pic. 10 – CO₂ Pilot System

PART NUMBER	DESCRIPTION	DISCHARGE HOSE	HEIGHT W / VALVE	VALVE OUTLET
510016	5 Pound CO ₂ Pilot System	510038	41.25" - 1048 mm	1/2" - 15mm
510017	15 Pound CO ₂ Pilot System	510038	26.5" - 673 mm	1/2" - 15mm
510018	35 Pound CO ₂ Pilot System	510038	18.75" - 476 mm	1/2" - 15mm
Table 10 – CO ₂ Pilot Cylinders				



WARNING: The 5 pound and 15 pound systems may only be used in normally occupied spaces where a pneumatic siren is not required.

USE AND LIMITATION

The 5 pound pilot system should only be used to operate the HFC-227ea fire suppression system and pressure trips.



WARNING: The 5 pound system will not operate a time delay or pressure operated siren

The 15 pound pilot system should only be used to operate the HFC-227ea fire suppression system and pressure trips and an optional time delay in normally unoccupied spaces. 2000 cubic feet or less.



WARNING: The 15 pound system will not operate a pressure operated siren

The 35 pound pilot system can be used to operate the HFC-227ea fire suppression system, pressure trips, optional time delay and pressure operated siren.

1.16. REMOTE PRESSURE OPERATED SWITCH

The remote pressure switch Marinefire PN 440001 operates from system pressure upon discharge to energize or de-energize electrically equipment. The signal from the pressure switch may be used to enunciate system discharge or shut down ventilation and or machinery. The switch is a single pole double throw device that incorporates normally open and normally closed contacts.



Pic. 11 – Operated Pressure Switch

2. HAZARD EVALUATION

Marinefire offers Pre-Engineered HFC-227ea fire suppression systems for the marine environment. This section of the manual will detail the steps necessary to design a Marinefire HFC-227ea Marine suppression System within the limitations established by NFPA 2001, FM Approvals and the United States Coast Guard. The design of the system **MUST** be verified by following the steps outlined in this manual prior to installing any Marinefire HFC-227ea system.

Marinefire pre-engineered marine suppression systems have been tested and all limitations have been pre-established.



CAUTION: *If the specified limitations are not followed, the system may not supply the required quantity of extinguishing agent which may result in a fire not being suppressed.*

2.1. IDENTIFY HAZARD TYPE

The Hazard Type generally falls into one of or a combination of the three following categories. The designer must be aware of the Hazard Type to determine the correct design concentration, agent quantity, etc. The three Hazard Types are:

- Class “A” (wood, paper, cloth - anything that leaves an ash residue after combustion)
- Class “B” Flammable liquid or gas
- Class “C” (electrical)

2.2. DETERMINE CONCENTRATION PERCENTAGE

The following is a guideline to be used to determine the proper agent concentration percentage for the hazard (s) being protected.

2.2.1. MARINEFIRE FOR CLASS A OR C HAZARDS (MARINE)

Marinefire HFC-227ea fire suppression systems protecting Class A and C hazards in marine environment shall meet the requirements of the United States Coast Guard.

Marinefire 760 Series fire suppression systems shall be designed at a minimum of 11% concentration for all Class “C” hazards in marine environments. The United States Coast Guard does not require the protection of electrical hazards, therefore Fire Suppression Systems used for the protection of class “C” hazards are considered to be “Optional Excess Equipment”.

2.2.2. MARINEFIRE FOR CLASS B HAZARDS

Fire suppression systems utilizing HFC-227ea as the agent can be used to suppress Class B (Flammable Liquid) fires. The type of fuel will influence the design concentration. When protecting areas containing flammable liquid or gas, consult Marinefire for the design concentration required to protect the type of fuel (s) involved not listed below:

FLAMABLE LIQUID	DESIGN CONCENTRATION	FLAMABLE LIQUID	DESIGN CONCENTRATION
Acetone	9.0	Isopropanol	9.8
Benzene	9.5	JP 4	9.0
Crude Oil	8.5	JP 5	9.0
Cyclohexane	9.4	Kerosene	9.6
Diesel	8.7	Methanol	12.9
Ethanol	10.8	Methyl Ethyl Ketone	9.6
Gasoline	9.0	Toluene	6.6
N Heptane	7.5	Xylene	7.8
Hydraulic Fluid	8.5	Class C (Electrical)	7.5
Hydraulic Oils	7.7	Class A (Surfaces Fires)	7.5

Marinefire 760 series fire suppression systems used in marine environments shall be designed at a minimum of 8.7% agent concentration.

2.3. SAFETY RECOMMENDATIONS

The following are safety recommendations as outlined in NFPA 2001. The designer must be aware of the occupancy of the hazard (s) being protected to complete their evaluation of the project and adjust or recommendations, as necessary.

2.3.1. NOT NORMALLY OCCUPIED SPACES

Protected spaces that are considered to be Not Normally Occupied (e.g. flammable liquids storage room, cabinets, some machinery spaces, etc) can be designed for concentrations above the LOAEL concentration. If there is a potential for personnel to be exposed, measures shall be taken to limit exposure.



CAUTION: *Marinefire does not recommend HFC-227ea systems to be used in any normally occupied spaces where the required design concentration is above 10.5%.*

2.4. DETERMINING AGENT QUANTITY

The following steps are necessary to determine the amount of HFC-227ea agent needed to protect the hazard (s).

2.4.1. DETERMINING HAZARD VOLUME

Review the hazard dimensions and verify the volume.

First: Determine the volume of the compartment (s) being protected. Volume is calculated by multiplying the **Length x Width x Height** of the hazard area (s). The volume used to calculate the quantity of HFC-227ea agent required should be based on the empty (gross) volume.

Additional considerations include:

- The volume taken by solid, non-permeable, and non-removable objects can be deducted from the protected volume.
- Any volume that is open to the space being protected must be added (i.e. non-dampened ductwork, unclosable openings, etc.).

USCG requires that any moveable or removable object in the protected space, **CANNOT** be deducted from the gross volume; unless the factory applies a permanently applied label as stated below.



- Items in the protected space may be deducted from the gross volume if the vessel contains a boat manufacturer (factory) permanently applied label stating the volume of various installed engine compartment components that have been deducted from the gross volume of the space.

EVALUATE COMPARTMENT (HAZARD) INTEGRITY

Evaluate the integrity of the hazard area and determine if additional agent will be required to offset leakage of agent. (Refer to NFPA 2001, Annex C latest edition for details).

2.4.2. CALCULATE AGENT REQUIRED

Determine the quantity of agent required to provide the desired concentration within the hazard (s) being protected. This calculation must be based upon two important criteria:

The lowest expected ambient temperature and the design concentration required to protect this type of hazard.

2.4.2.1. CALCULATE AGENT REQUIRED BY FORMULA

To determine the agent quantity needed to produce the design concentration level, the Hazard Volume is multiplied by the factors as determined in the formula below:

$$W = \frac{V}{s} * \left(\frac{C}{100 - C} \right)$$

Where:

W	= Agent Weight in lbs. (kg)
V	= Hazard Volume / ft3 (m3)
C	= Design Concentration, % by volume
S	= Specific Vapor in ft3/lb (m3/kg)
s	= k1 + k2 (t)

Where:

k1 = 1.885, k2 = 0.00046(t), t = temperature (°F)

or

$$k1 = 0.1269, k2 = 0.0005(t), t = \text{temperature } (^{\circ}\text{C})$$

The equation to calculate “s” is an approximation.

2.4.2.2. FLOODING FACTOR TABLE - ENGLISH UNIT

As an alternative, the following tables have been compiled to make it an easier process for the system designer. The information provided is derived from the formulas shown on the previous page.

		Weight Requirements of Hazard Volume, W/V (lb/ft ³) ^b							
Temp (t) (°F) ^c	Specific Vapor Volume (s) (ft ³ /lb) ^d	Design Concentration (% by Volume) ^e							
		8.6	9	10	11	12	13	14	15
-50	3.2192	0.0292	0.0307	0.0345	0.0384	0.0424	0.0464	0.0506	0.0548
-40	3.2978	0.0285	0.0300	0.0337	0.0375	0.0414	0.0453	0.0494	0.0535
-30	3.3763	0.0279	0.0293	0.0329	0.0366	0.0404	0.0443	0.0482	0.0523
-20	3.4549	0.0272	0.0286	0.0322	0.0358	0.0395	0.0433	0.0471	0.0511
-10	3.5335	0.0261	0.0280	0.0314	0.035	0.0386	0.0423	0.0461	0.0499
0	3.6121	0.0260	0.0274	0.0308	0.0342	0.0378	0.0414	0.0451	0.0489
10	3.6906	0.0255	0.0268	0.0301	0.0335	0.0369	0.0405	0.0441	0.0478
20	3.7692	0.0250	0.0262	0.0295	0.0328	0.0362	0.0396	0.0432	0.0468
30	3.8478	0.0245	0.0257	0.0289	0.0321	0.0354	0.0388	0.0423	0.0459
40	3.9264	0.0240	0.0252	0.0283	0.0315	0.0347	0.0381	0.0415	0.0449
50	4.0049	0.0235	0.0247	0.0277	0.0309	0.0340	0.0373	0.0406	0.0441
60	4.0835	0.0230	0.0242	0.0272	0.0303	0.0334	0.0366	0.0399	0.0432
70	4.1621	0.0226	0.0238	0.0267	0.0297	0.0328	0.0359	0.0391	0.0424
80	4.2407	0.0222	0.0233	0.0262	0.0291	0.0322	0.0352	0.0384	0.0416
90	4.3192	0.0218	0.0229	0.0257	0.0286	0.0316	0.0346	0.0377	0.0409
100	4.3978	0.0214	0.0225	0.0253	0.0281	0.0310	0.0340	0.0370	0.0401
110	4.4764	0.0210	0.0221	0.0248	0.0276	0.0305	0.0334	0.0364	0.0394
120	4.5550	0.0207	0.0217	0.0244	0.0271	0.0299	0.0328	0.0357	0.0387
130	4.6336	0.0203	0.0213	0.0240	0.0267	0.0294	0.0322	0.0351	0.0381
140	4.7121	0.0200	0.0210	0.0236	0.0262	0.0289	0.0317	0.0345	0.0375
150	4.7907	0.0196	0.0206	0.0232	0.0258	0.0285	0.0312	0.0340	0.0368
160	4.8693	0.0193	0.0203	0.0228	0.0254	0.0280	0.0307	0.0334	0.0362
170	4.9479	0.0190	0.0200	0.0225	0.0250	0.0276	0.0302	0.0329	0.0357
180	5.0264	0.0187	0.0197	0.0221	0.0246	0.0271	0.0297	0.0324	0.0351
190	5.1050	0.0184	0.0194	0.0218	0.0242	0.0267	0.0293	0.0319	0.0346
200	5.1836	0.0182	0.0191	0.0214	0.0238	0.0263	0.0288	0.0314	0.0340

Table 11 – Flooding Factor English Table

- A - The manufacturer's listing specifies the temperature range for operation.
- B - W / V [agent weight requirements (lb/ft³)] = pounds of agent required per ft³ of protected volume needed to produce the indicated concentration at the temperature specified.
- C - t [temperature (°F)] = the design temperature in the hazard area.
- D - s [specific volume (ft³/lb)] = specific volume of superheated HFC-227ea vapor as approximated by the formula: $s = 1.885 + 0.0046(t)$
- E - C [concentration (%)] = volumetric concentration of HFC-227ea in air at the temperature indicated.

2.4.2.3. FLOODING FACTOR TABLE - METRIC UNIT

Temp (t) (°C) ^c	Specific Vapor Volume (s) (m ³ /kg) ^d	Weight Requirements of Hazard Volume, W/V (kg/m ³) ^b							
		Design Concentration (% by Volume) ^e							
		8.6	9	10	11	12	13	14	15
-50	0.1971	0.4774	0.5018	0.5638	0.6271	0.6919	0.7582	0.8260	0.8954
-45	0.2015	0.4669	0.4908	0.5514	0.6134	0.6767	0.7415	0.8079	0.8758
-40	0.2059	0.4569	0.4803	0.5396	0.6002	0.6622	0.7256	0.7906	0.8570
-35	0.2103	0.4473	0.4702	0.5283	0.5876	0.6483	0.7104	0.7740	0.8390
-30	0.2148	0.4381	0.4605	0.5174	0.5755	0.6350	0.6958	0.7580	0.8217
-25	0.2192	0.4293	0.4513	0.507	0.5639	0.6222	0.6818	0.7428	0.8052
-20	0.2236	0.4208	0.4423	0.497	0.5528	0.6099	0.6683	0.7281	0.7893
-15	0.2280	0.4127	0.4338	0.4873	0.5421	0.5981	0.6554	0.7140	0.7740
-10	0.2324	0.4048	0.4255	0.4781	0.5318	0.5867	0.6429	0.7004	0.7593
-5	0.2368	0.3973	0.4176	0.4692	0.5219	0.5758	0.6309	0.6874	0.7451
0	0.2412	0.3900	0.4100	0.4606	0.5123	0.5652	0.6194	0.6748	0.7315
5	0.2457	0.3830	0.4026	0.4523	0.5031	0.5551	0.6083	0.6627	0.7183
10	0.2501	0.3762	0.3955	0.4443	0.4942	0.5453	0.5975	0.6510	0.7057
15	0.2545	0.3697	0.3886	0.4366	0.4856	0.5358	0.5871	0.6397	0.6934
20	0.2589	0.3634	0.3820	0.4291	0.4774	0.5267	0.5771	0.6288	0.6816
25	0.2633	0.3573	0.3756	0.422	0.4694	0.5178	0.5675	0.6182	0.6702
30	0.2677	0.3514	0.3694	0.415	0.4616	0.5093	0.5581	0.6080	0.6591
35	0.2722	0.3457	0.3634	0.4083	0.4541	0.5010	0.5490	0.5981	0.6484
40	0.2766	0.3402	0.3576	0.4017	0.4469	0.4930	0.5403	0.5886	0.6381
45	0.2810	0.3349	0.3520	0.3954	0.4399	0.4853	0.5318	0.5793	0.6280
50	0.2854	0.3297	0.3465	0.3893	0.4331	0.4778	0.5236	0.5704	0.6183
55	0.2898	0.3247	0.3412	0.3834	0.4265	0.4705	0.5156	0.5617	0.6089
60	0.2942	0.3198	0.3361	0.3776	0.4201	0.4634	0.5078	0.5533	0.5998
65	0.2987	0.3151	0.3312	0.372	0.4138	0.4566	0.5003	0.5451	0.5909
70	0.3031	0.3105	0.3263	0.3666	0.4078	0.4499	0.4930	0.5371	0.5823
75	0.3075	0.3060	0.3216	0.3614	0.4020	0.4435	0.4860	0.5294	0.5739
80	0.3119	0.3017	0.3171	0.3562	0.3963	0.4372	0.4791	0.5219	0.5658
85	0.3163	0.2975	0.3127	0.3513	0.3907	0.4311	0.4724	0.5146	0.5579
90	0.3207	0.2934	0.3084	0.3464	0.3854	0.4252	0.4659	0.5076	0.5502
95	0.3251	0.2894	0.3042	0.3417	0.3801	0.4194	0.4596	0.5007	0.5427

Table 12 - Flooding Factor Metric Table

- A- The manufacturer's listing specifies the temperature range for operation.
- B - W/V [agent weight requirements (kg/m³)] = pounds of agent required per m³ of protected volume needed to produce the indicated concentration at the temperature specified.
- C - t [temperature (°C)] = the design temperature in the hazard area.
- D - s [specific volume (m³/Kg)] = specific volume of superheated HFC-227ea vapor as approximated by the formula: $s = 0.1269 + 0.0005(t)$
- E - C [concentration (%)] = volumetric concentration of HFC-227ea in air at the temperature indicated.

2.4.3.ADDITIONAL CONSIDERATION

Additional quantities of agent are required using design factors to compensate for special conditions that may affect the ability of the system to extinguish the fire. Therefore, additional agent may be necessary for either



of the following situations: altitude adjustments or leakage. The system designer MUST be aware of these criteria and adjust, as necessary.

2.4.3.1. ALTITUDE CORRECTION FACTORS

The design quantity of HFC-227ea shall be adjusted to compensate for ambient pressures that vary more than eleven percent [equivalent to approximately 3000 ft. (915 m) of elevation change] from standard sea level pressures [29.92 in. Hg at 70°F].

ALTITUDE		ENCLOSURE PRESSURE		CORRECTION FACTOR
Feet	Kilometers	PSIA	Mm Hg	
- 3.000	- 0.92	16.25	840	1.11
- 2.000	- 0.61	15.71	812	1.07
- 1.000	- 0.30	15.23	787	1.04
0	0.00	14.71	760	1.00
1.000	0.30	14.18	733	0.96
2.000	0.61	13.64	705	0.93
3.000	0.91	13.12	679	0.89
4.000	1.22	12.58	650	0.86
5.000	1.52	12.04	622	0.82
6.000	1.83	11.53	596	0.78
7.000	2.13	11.03	570	0.75
8.000	2.45	10.64	550	0.72
9.000	2.74	10.22	528	0.69
10.000	3.05	9.77	505	0.66
Table 13 – Altitude Correction Factor				



2.4.3.2. *CALCULATE ACTUAL CONCENTR. AT MAX TEMP.*

The next step is to determine the expected concentration level at the maximum temperature for the hazard (s). This is a necessary step when designing systems for occupied spaces to properly evaluate the exposure and egress time limitations discussed in Section “2 - HAZARD EVALUATION”.

The expected concentration can be determined by applying the following formula.

$$C = \frac{100 * W * S}{V + (W * S)}$$

Where:

W = Agent Weight in lbs. (kg)

V = Hazard Volume / ft³ (m³)

C = Design Concentration, % by volume

S = Specific Vapor in ft³/lb (m³/kg)

Refer to Section 2.4.2 of this Manual for determining the S value.

2.4.3.3. *LEAKAGE*

The physical characteristics of the protected compartment (s) must be taken into consideration when designing an HFC-227ea system. Un closeable openings must be kept to a minimum to prevent loss of agent into adjacent areas; all openings must be sealed or equipped with automatic closures. Forced-air ventilating systems shall be shut down or closed automatically where their continued operation would adversely affect the ability of the system to extinguish a fire. Completely self-contained re circulating ventilation systems are not required to be shut down but recommended.

Dampers should be of the “low smoke” or 100% closing type to ensure an adequate seal and prevent leakage. Where the ventilation system is not shutdown or dampered, the volume of the associated ductwork and ventilation unit(s) shall be considered as part of the total hazard volume when determining the amount of agent needed. All enclosures must be sealed to achieve and maintain the desired concentration for a period that is sufficient for emergency personnel to respond. Under normal circumstances, the agent will extinguish the fire rapidly, thereby limiting the potential for fire damage and the creation of dangerous products of decomposition. Therefore, it is critical that the protected space be constructed to prevent any leakage from the protected space (s).



General guidelines for controlling leakage from the compartment are as follows:

Hatches and Doors

All hatches entering and/or exiting from the perimeter of the protected space (s) should have drop seals on the bottom, weather-stripping around the jams, latching mechanisms and door closure hardware. In addition, double doors should have a weather-stripped astragal to prevent leakage between the doors, and a coordinator to assure the proper sequence of closure. Doors that cannot be kept normally closed shall be equipped with door closure hardware and door holders that will release the door (s) upon a system alarm.

Ductwork

All ductwork leading into, or out of, the protected space (s) should be isolated with sealed, “low smoke” dampers. Dampers should be spring-loaded or motor-operated to provide 100% air shutoff upon activation.

Air Handling / Ventilation

It is recommended that all air handling/ventilation units be shut down upon alarm to prevent leakage into other areas. If the air handling unit (s) cannot be shutdown, the volume of the associated ductwork must be added to the total volume of the protected space, and agent must be added to compensate for the additional volume.

Penetrations

All holes, cracks, gaps, or penetrations of the perimeter bulkheads defining the compartment (s) must be sealed. Less obvious areas of leakage include wire trays, pipe chases, and deck drains. Make certain that deck drains have traps filled with a non-evaporating product to prevent leakage.

Bulkheads

All perimeter bulkheads that define the hazard area (s) should extend deck to deck, and each should be sealed top and bottom on the interior side. Where bulkheads do not extend deck to deck, bulkheads will have to be installed or extended to achieve the desired sealing characteristics.

Porous Walls

Porous walls must be sealed, or the HFC-227ea agent will leak through. A room integrity fan pressurization test is an accepted means of determining how long the protected space will hold the agent (concentration) after a discharge. In conjunction with testing the integrity of the room, the test has a program that predicts the performance of the HFC-227ea system so that the Authority Having Jurisdiction can determine if the system has been designed and installed properly. The room integrity fan pressurization test must be performed in accordance with the manufacturer’s requirements, and NFPA 2001, Annex C.



2.5. SYSTEM DESIGN CONCEPT

2.5.1. PRE-ENGINEERED SYSTEM DESIGN CONCEPT

Pre-Engineered Systems utilize configurations that are simple to design and easy to install. The Pre-Engineered concept minimizes the engineering effort required to design an effective system by utilizing a fixed series of equipment and a tightly defined set of design criteria. Marinefire 760 series Pre-Engineered Systems must be designed with the containers arranged in a modular configuration as described.

2.5.1.1. MODULAR SYSTEMS

Modular Systems can be defined as a design concept where the containers are located throughout or around the protected compartment (s). This keeps the discharge requirements down to a minimum. With Marinefire 760 series suppression systems a modular approach is necessary.

2.5.2. CONTAINER SELECTION

Generally, the selection of container (s) is determined by the amount of HFC-227ea required vs. the approved fill ranges for the various container sizes. However, additional factors such as the System Design Concept, container storage location may have an impact on this decision.

2.5.2.1. CONTAINER LIMITATIONS

Although the selection of containers is determined by the amount of agent required the number of containers required is influenced by the geometry of the compartment. It is imperative that the containers be installed so the agent can flow freely throughout the compartment.

Note: United States Coast Guard requires that 760 series fire suppression systems protecting any space greater than 2,000 cubic feet be equipped with a minimum of two cylinders.

2.5.3. CONTAINER SIZE AND FILL RANGE

All containers must be filled within the allowable fill range mandated by DOT and UL Standard 2166. The acceptable fill ranges are as follows:



760 Series

Design, Installation & Maintenance Manual

- **Aluminum** containers is based upon a minimum fill density of 35 lbs./ft³ (760 kg/m³) of container volume, to a maximum of 70 lbs./ft³ (928 kg/m³), in 1 lb. (0.5 kg) increments.
- **Steel** containers is based upon a minimum fill density of 35 lbs./ft³ (760 kg/m³) of container volume, to a maximum of 70 lbs./ft³ (864kg/m³), in 1 lb. (0.5 kg) increments.

2.5.3.1. CYLINDER DATA – ENGLISH

MARINEFIRE P/N	CYL. CAP. (In3)	MIN. AGENT (lbs.)	MAX AGENT (lbs.)	CHARGE PRESSURE (PSI)
ALUMINUM CYLINDERS - 1/2" Valve (P/N 420001)				
760-50	105	2	4	360
760-100 to 760-125	150	3	6	360
760-150 to 760-225	250	5	6	360
760-250 to 760-275	300	6	12	360
760-300 to 760-325	350	7	14	360
ALUMINUM CYLINDERS - 3/4" Valve (P/N 420002)				
760-350 to 760-500	525	10	21	360
760-525 to 760-600	650	12	27	360
760-625 to 760-800	850	15	35	360
760-825 to 760-1000	1050	19	43	360
760-1050 to 760-1500	1600	28	66	360
ALUMINUM CYLINDERS - 1" Valve (P/N 420003)				
760-1600 to 760-1900	2000	35	83	360
760-1600 to 760-2850	3000	53	124	360
760-2900 to 760-3500	4000	70	166	360
760-3550 to 760-4800	5000	87	209	360
760-4850 to 760-6750	7000	122	291	360
<i>Table 14 – Cylinder Data / English</i>				

2.5.3.2. CYLINDER DATA – METRIC

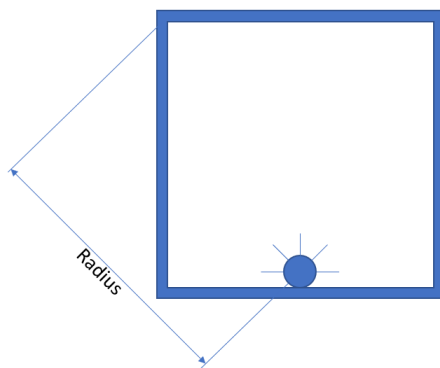
Marinefire P/N	CYL. CAP. (Lt)	MIN. AGENT (Kg)	MAX AGENT (Kg)	CHARGE PRESSURE (KPa)
ALUMINUM CYLINDERS - 1/2" Valve (P/N 420001)				
760-50	1.7	0.9	1.8	2500
760-100 to 760-125	2.5	1.4	2.7	2500
760-150 to 760-225	4.1	2.3	4.5	2500
760-250 to 760-275	4.9	2.7	5.4	2500
760-300 to 760-325	5.7	3.2	6.3	2500
ALUMINUM CYLINDERS - 3/4" Valve (P/N 420002)				
760-350 to 760-500	8.5	4.5	9.5	2500
760-525 to 760-600	10.7	5.4	12.2	2500
760-625 to 760-800	13.9	6.8	15.9	2500
760-825 to 760-1000	17.2	8.6	19.5	2500
760-1050 to 760-1500	26.2	12.7	30.0	2500
STEEL CYLINDERS - 1" Valve (P/N 420003)				
760-1600 to 760-1900	32.8	15.9	37.6	2500
760-1600 to 760-2850	49.2	24	56.2	2500
760-2900 to 760-3500	65.6	31.7	75.3	2500
760-3550 to 760-4800	81.9	39.4	94.5	2500
760-4850 to 760-6750	114.7	55.1	132.3	2500
Table 15 - Cylinder Data / Metric				

2.6. PRE-ENGINEERED SYSTEM, NOZZLE LIMITATION

The system designer must consider the type of system to be used and the mounting location of cylinder. For pre-engineered 760 series Marinefire suppression system individual cylinders are applied to protect a specific (maximum) volume.

2.6.1. NOZZLE AREA COVERAGE

Nozzle Area Coverage must also be considered when designing a Marinefire HFC-227ea pre-engineered 760 series System. Each system size has been FM approved for the maximum area coverage limitations listed below. The maximum area coverage is expressed as a radius ("R") of coverage along the discharge axis for all radial full array nozzles. Nozzle area coverage values are established by testing. For Pre-Engineered Nozzles the full array radial nozzle type can be located a minimum of one (1) ft. (0.3 m) below the ceiling (or highest point of protection).



Pic. 12 – Nozzle Area Coverage

2.6.1.1. **NOZZLE AREA COVERAGE**

FULL ARRAY RADIAL NOZZLE - AREA COVERAGE					
Nozzle Size		Radius (R) Dimension		Ceiling Height Range	
Inches	mm	Feet	mt.	Feet	mt.
1/2	15	28.5	8.7	1'0" - 8'0"	0.3 - 2.5
3/4	20	28.5	8.7	1'0" - 10'0"	0.3 - 3.0
1	25	28.5	8.7	1'0" - 12'0"	0.3 - 3.7
Table 16 – Nozzle Coverage Area					

2.6.2. **NOZZLE DISCHARGE OBSTRUCTIONS**

Bulkheads, partitions, equipment racks, engines, and tall equipment can provide area coverage obstructions for nozzle discharges. For this reason, the discharge “path” of the nozzles must also be considered when determining the position of the pre-engineered suppression system. Anytime solid obstructions extend to where they could interfere with the “line-of-sight” (within 1'-0" of ceiling) discharge path from a nozzle, they should be treated as separate areas. Nozzles should be aimed in a manner that will provide a clear discharge path that reaches all outer extremes of the protected compartment.

2.6.3.NOZZLE FLOW RATE

Marinefire Part Number	System Size Pounds HFC227	Nozzle	Flow Rate (Pounds / Sec)
760003	4	1/2"	0.4
760005	6	1/2"	0.625
760008	10	1/2"	1.00
760010	12	1/2"	1.50
760012	14	1/2"	1.50
760016	21	3/4"	2.20
760020	27	3/4"	2.70
760028	35	3/4"	3.40
760036	45	3/4"	4.50
760040	58	1"	6.00
760050	66	1"	6.00
760060	83	1"	8.50
760080	124	1"	12.00
760100	166	1"	12.00
Table 17 – Nozzle Flow rate			

This chart is for informational purposes only.

3. SYSTEM INSTALLATION

3.1. CONTAINER LOCATION(S)

The type and location (s) of the storage container (s) is based on several considerations.

A) Agent Quantity

The agent storage container (s) selected must have the capacity to store the total quantity of agent required for the hazard area to be protected.

B) System Type

An area might be protected by several smaller containers or it might be protected by a large capacity container.

C) Serviceability

In general, the larger the container, the more difficult it will be to remove it from the system for maintenance and service.

D) Proximity

HFC-227ea - 760 series containers should be located within the hazard (s) that they protect.

E) Environmental Effects

Do not locate containers where they would be subject to excessive moisture, physical damage, exposure to corrosive chemicals, or harsh weather conditions.

3.1.1. STORAGE TEMPERATURE LIMITATION

Marinefire HFC-227ea Marine suppression systems have been tested and are approved for a service temperature range of 0°F to +130°F (-18°C to 54.4°C).



CAUTION: HFC-227ea container and valve assemblies must be handled, installed, and serviced in accordance with the instructions contained in this manual and The Compressed Gas Association (CGA) pamphlets C-1, C-6, and P-1. CGA pamphlets are available from the CGA, 4221 Walney Road, Chantilly, VA 20151-2923.

Failure to follow these instructions can cause HFC-227ea containers to violently discharge, resulting in injury, death, and or property destruction.

3.2. INSTALLATION OF 4, 6, AND 10 POUNDS SYSTEMS

Position the HFC-227ea container in its designated location; container may only be mounted in the vertical position.

3.2.1.MOUNTING BRACKET 4 AND 6 POUNDS SYSTEMS

Fix the bracket base to the bulkhead, structural column or deck using four (4) 1/4" bolts.

3.2.2.MOUNTING BRACKET 10 AND 14 POUNDS SYSTEMS

Fix the bracket base to the bulkhead, structural column or deck using four (4) 3/8" bolts.

3.2.3.PHISICAL MOUNTING OF 760 SERIES ON FIBREGLASS BULKHEAD



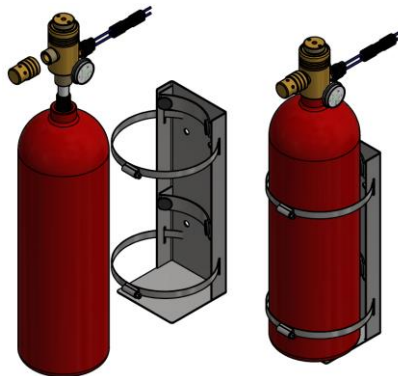
CAUTION: When mounting a fire suppression system on a fibreglass bulkhead the cylinder mounting bracket must be mounted on a structural column. If a secure location such as a structural column is not available, the cylinder mounting bracket should be mounted on a backing plate. The backing plate can be constructed of 3/4" marine grade plywood, aluminium or stainless plate designed to withstand the force associated with rough seas.

3.2.4.SETTING THE CONTAINER

Upon completing the mounting of the bracket, place the HFC-227ea container in the bracket and secure it in place with the stainless-steel straps provided.

3.2.5. ORIENT (AIM) THE NOZZLE TO MAXIMUM COVERAGE

Remove the discharge port safety cap from the HFC-227ea Marine suppression system container and connect the nozzle to the container outlet.



Pic. 13 – Installation of 4-14 Pound Systems

3.3. INSTALLATION OF 21, 27, 35 AND 45 POUNDS SYSTEM

Position the HFC-227ea container in its designated location; container may only be mounted in the vertical position.

3.3.1. MOUNTING BRACKET

Fix the bracket base to the bulkhead, structural column or deck using four (4) 3/8" stainless steel bolts.

3.3.2. PHYSICAL MOUNTING OF 760 SERIES ON FIBREGLASS BULKHEAD



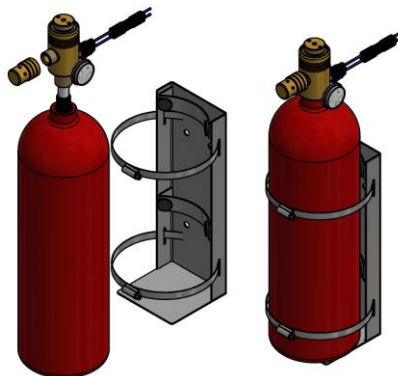
CAUTION: When mounting a fire suppression system on a fiberglass bulkhead the cylinder mounting bracket must be mounted on a structural column. If a secure location such as a structural column is not available, the cylinder mounting bracket should be mounted on a backing plate. The backing plate can be constructed of $\frac{3}{4}$ " marine grade plywood, aluminium or stainless plate designed to withstand the force associated with rough seas.

3.3.3. SETTING THE CONTAINER

Upon completing the mounting of the bracket, place the HFC-227ea container in the bracket and secure it in place with the stainless-steel straps provided.

3.3.4. ORIENT (AIM) THE NOZZLE TO MAXIMUM COVERAGE

Remove the discharge port safety cap from the HFC-227ea Marine suppression system container and connect the nozzle to the container outlet.



Pic. 14 - Installation of 21-45 Pound Systems

3.4. INSTALLATION OF 58, 83 AND 125 POUNDS SYSTEM

Position the HFC-227ea container in its designated location; container may only be mounted in the vertical position.

3.4.1. MOUNTING BRACKET

Fix both channels (furnished by installer) to the bulkhead or structural column using two (2) 3/8" steel bolts per channel.

The container must be deck supported.

Channel may be welded to the bulkhead or support using good welding practices. (Weld in accordance with AWS D1.1 Structural Welding Code.)

3.4.2. PHYSICAL MOUNTING OF 760 SERIES ON FIBREGLASS BULKHEAD



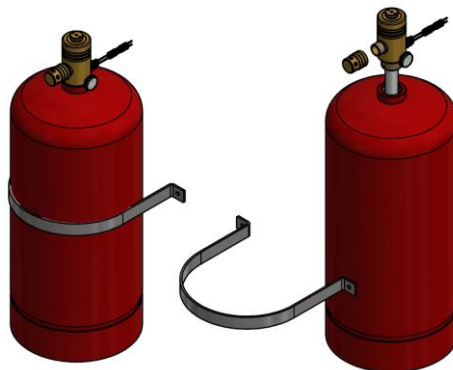
CAUTION: When mounting a fire suppression system on a fiberglass bulkhead the cylinder mounting bracket must be mounted on a structural column. If a secure location such as a structural column is not available, the cylinder mounting bracket should be mounted on a backing plate. The backing plate can be constructed of 3/4" marine grade plywood, aluminium or stainless plate designed to withstand the force associated with rough seas.

3.4.3. SETTING THE CONTAINER

Upon completing the mounting of the channels, place the HFC-227ea container against the channels, set the brackets, and secure them in place at the top and bottom of the container using the hardware provided.

3.4.4. ORIENT (AIM) THE NOZZLE TO MAXIMUM COVERAGE

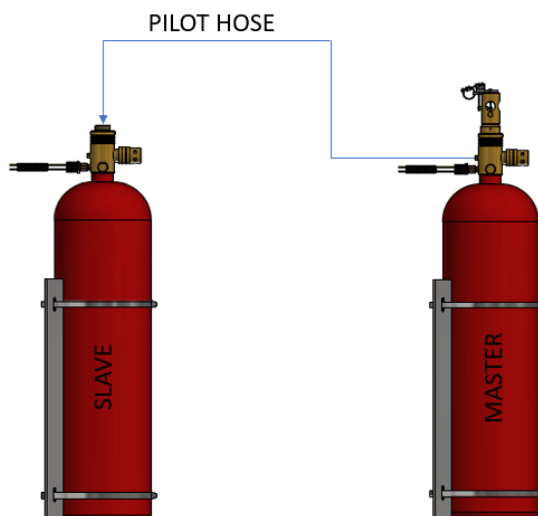
Remove the discharge port safety cap from the HFC-227ea Marine suppression system container and connect the nozzle to the container outlet.



Pic. 15 - Installation of 58-125 Pound Systems

3.5. INSTALLATION OF MULTIPLE CONTAINERS

There are times when it may be necessary to install more than one container in a hazard area. Marinefire pre-engineered systems may be configured in a master slave arrangement; where the master container is actuated manually, or pneumatically by a pneumatic operated control head, the slave containers are then actuated pneumatically. Pneumatic actuators can be used to actuate up to ten (10) HFC-227ea containers using a Master/Slave configuration where the Master container is actuated automatically, and the remaining containers are actuated through the pilot pressure ports on the side of the container valve. The HFC-227ea containers are interconnected using ¼" braided hose; schedule 40 or schedule 80 pipe, or tubing. Not more than 100' of pipe can be run from the first to the last container. Multiple cylinders in a hazard area must each contain the same amount of agent.



Pic. 16 – Installation of Multiple Containers

3.6. INSTALLATION OF ACTUATORS

3.6.1. PNEUMATIC ACTUATOR (P/N 510002)



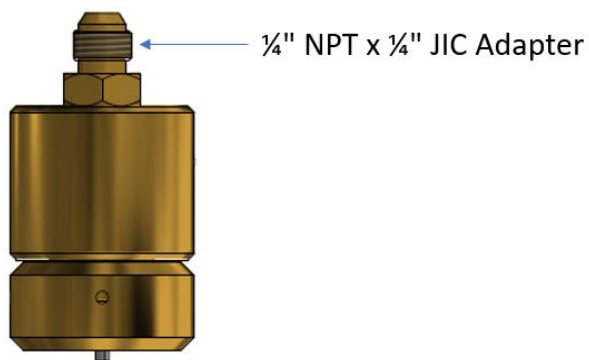
WARNING: Before installing the actuator check to ensure that the actuating plunger is in the set position. Installation of the actuator with the plunger in the discharged position will cause an accidental discharge.

- Install the proper fitting (elbow, straight, tee) into the actuator. Use only PTFE tape, exclude the first two threads.
- Remove the actuator port safety cap from the HFC-227ea container valve; and carefully screw the pneumatic actuator onto the HFC-227ea valve. **HAND TIGHTEN ONLY.**



WARNING: Ensure the pilot line is not pressurized

- Connect the pilot line to the actuator.



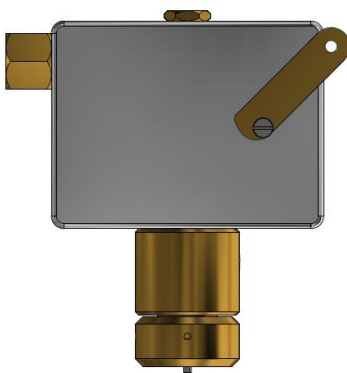
Pic. 17 – Installation Pneumatic Actuator

3.7. CABLE ACTUATOR (P/N 510004)



WARNING: Before installing the actuator check to ensure that the actuating plunger is in the set position. Installation of the actuator with the plunger in the discharged position will cause an accidental discharge.

- Remove the cover from the box of the cable actuator and then connect the cable assembly. Tighten the cable set screw with a 3/32" Allen wrench.
- Upon completion of fitting the cable, reinstall the actuator cover.
- Remove the actuator port safety cap from the HFC-227ea container valve; and carefully screw the cable actuator onto the HFC-227ea valve. HAND TIGHTEN ONLY. Ensure that the pull station is completely installed, and the safety pins fitted. Failure to follow these instructions may result in accidental discharge.



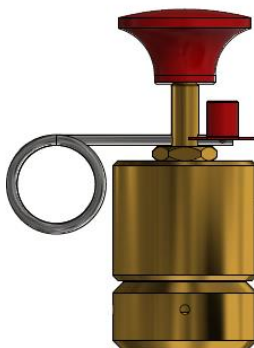
Pic. 18 – Cable Actuator

3.8. MANUAL ACTUATOR (P/N 510001)



WARNING: Before installing the actuator check to ensure that the actuating plunger is in the set position. Installation of the actuator with the plunger in the discharged position will cause an accidental discharge. Do not remove the safety pin.

- Remove the actuator port safety cap from the HFC-227ea container valve; and carefully screw the manual actuator onto the HFC-227ea valve. **HAND TIGHTEN ONLY.**
- Ensure that the safety pin is installed; failure to follow these directions may result in an accidental discharge.
- Do not remove safety pin.



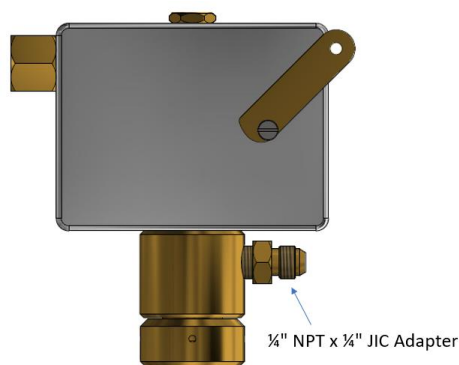
Pic. 19 – Installation Manual Actuator

3.9. CABLE-PNEUMATIC ACTUATOR (P/N 510005)



WARNING: Before installing the actuator check to ensure that the actuating plunger is in the set position. Installation of the actuator with the plunger in the discharged position will cause an accidental discharge.

- Install the proper fitting elbow, straight, tee, into the actuator. Use only PTFE tape, exclude the first two threads.
- Remove the cover from the box of the cable actuator and then connect the cable assembly. Tighten the cable set screw with a 3/32" Allen wrench.
- Install the actuator cover and safety pin.
- Remove the actuator port safety cap from the HFC-227ea container valve; and carefully screw the cable-pneumatic actuator onto the HFC-227ea valve. **HAND TIGHTEN ONLY.** Install the actuator cover. Ensure that the pull station is completely installed, and the safety pins fitted. Failure to follow these instructions may result in accidental discharge.
- Connect the pilot line to the actuator. Ensure the pilot line is not pressurized. Failure to follow these instructions may result in accidental discharge.
- Ensure that the pull station is completely installed, and the safety pins fitted. Failure to follow these instructions may result in accidental discharge. Install the cover.



Pic. 20 – Cable / Pneumatic Actuator

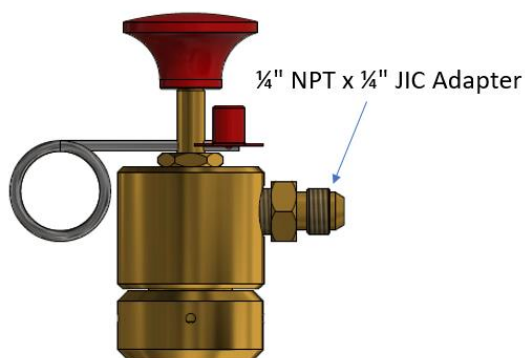
3.10. MANUAL-PNEUMATIC ACTUATOR (P/N 510003)



WARNING: Before installing the actuator check to ensure that the actuating plunger is in the set position. Installation of the actuator with the plunger in the discharged position will cause an accidental discharge.

- Install the proper fitting (elbow, straight, tee) into the actuator. Use only PTFE tape, exclude the first two threads.

- Remove the actuator port safety cap from the HFC-227ea container valve; and carefully screw the manual-pneumatic actuator onto the HFC-227ea valve. **HAND TIGHTEN ONLY**. Install the actuator cover.
- Connect the pilot line to the actuator. Ensure the pilot line is not pressurized. Failure to follow these instructions may result in accidental discharge.
- Do not remove the safety pin.



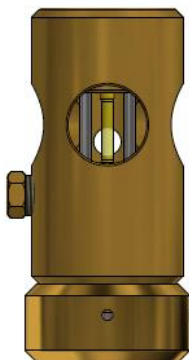
Pic. 21 – Manual / Pneumatic Actuator

3.11. THERMAL ACTUATOR INSTALLATION (P/N 510008)



WARNING: Before installing the actuator check to ensure that the actuating plunger is in the set position. Installation of the actuator with the plunger in the discharged position will cause an accidental discharge.

- When applicable, install flexible cable by connecting S-hook and tightening outer nut. Do not remove the safety pin currently.
- Remove safety pin after all work has been completed.
- Before installing the actuator check to ensure that the actuating plunger is in the set position Remove the actuator port safety cap from the HFC-227ea container valve; and carefully screw the actuator onto the HFC-227ea container valve. **HAND TIGHTEN ONLY**.



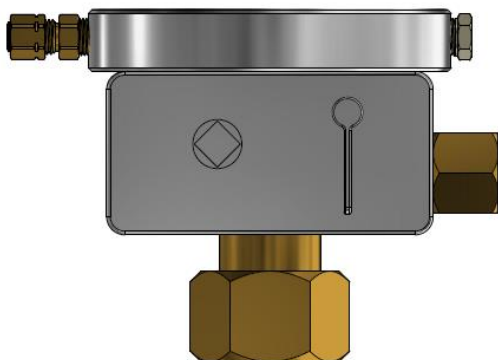
Pic. 22 – Therma Actuator

3.12. PNEUMATIC OPERATED CONTROL HEAD INSTALLATION (P/N 510010)



WARNING: Before installing the control head check to ensure that the actuating plunger is in the set position, with the safety pin installed and sealed in position. Installation of the control head with the plunger in the discharged position will cause an accidental discharge.

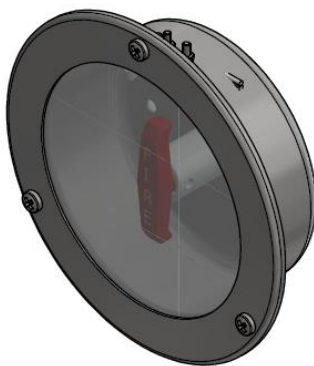
- Remove the side cover from the control head.
- Loosen the set screws on the operating lever mechanism.
- Install the stainless-steel cable through the 3/8" NPT port, feed the cable through the port in the actuating lever. Tighten the 3/8" NPT cable nut.
- Verify that the control head mechanism is in the **SET** position; then tighten both set screws on the operating lever.
- Install the detection tubing and tighten with a 3/8" tubing wrench.
- Check to ensure that the actuating plunger is in the set position, remove the actuator port safety cap from the HFC-227ea container valve; and carefully mount the control head onto the HFC-227ea container valve and screw the control head down and snug with a 1-1/2" wrench.
- Install the pneumatic control head side cover.



Pic. 23 – Pneumatic Control Head

3.13. MANUAL PULL STATION, INSTALLATION (NOT FOR FM SYSTEMS)

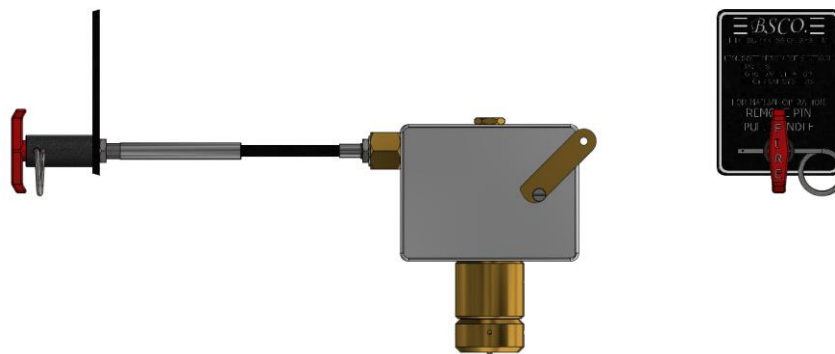
- Locate the manual pull station Marinefire PN (MF-1001016) as shown on the system design drawings.
- Connect the pull box to the cable actuator using 3/8" galvanized schedule 40 pipe.
- Only one cable per pipe run. Install a corner pulley Marinefire PN 520121 at each change in pipe direction.
- Beginning at the pull boxes, remove all covers from the corner pulleys. Feed the cable through the corner pulley into the 3/8" pipe. Connect one end of the cable-to-cable fastener in the pull box, allowing short end to project at least 1/2". Seat the cable in the groove by pulling on the long end. Screw the fastener and cable into the handle. Route the other end of the cable to the actuator; take up as much slack as possible. Attach the end of the cable to the fastener in the control head. Install the corner pulley covers. Install cable actuator.



Pic. 24 – Manual Pull Station

3.14. MANUAL PULL STATION, FLEXIBLE CABLE INSTALLATION

- Locate the manual pull station Marinefire PN MF-1001016 as shown on the system design drawings. Run the flexible cable to the desired location, not to exceed fifty (75) feet.
- Ensure the cable is run in an area where it will be free of physical damage. The cumulative number of bends in flexible cable must not exceed 3600. All bends in flexible cable must have a minimum radius of 6".
- Using the face plate as a template, mark and drill a 13/32" diameter hole. Install the locking nut, washer, "O" ring, retaining nut, and handle.
- Install the safety pin and seal.
- Attach cable end to cable actuator and fit lid.



Pic. 25 – Manual Pull Station, Flexible Cable

3.15. MECHANICAL 30 & 60 SEC. DISCHARGE DELAY INSTALLATION

Installation of the Marinefire 30 second time delay (PN 510020) and 60 second time delay (PN 510021) by positioning the time delay in its designated location. The time delay may be mounted in the vertical (valve up) or horizontal position. Mount the bracket to the bulkhead or deck using 4 – 3/8" bolts.

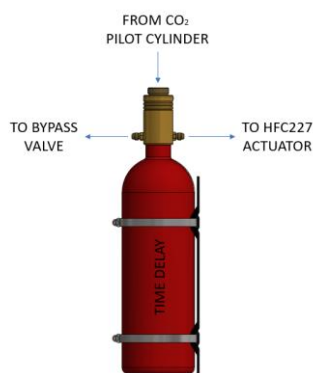


PHYSICAL MOUNTING OF DISCHARGE DELAY ON FIBERGLASS BULKHEAD

CAUTION: When mounting the time delay on a fibreglass bulkhead the cylinder mounting bracket must be mounted on a structural column. If a secure location such as a structural column is not available, the cylinder mounting bracket should be mounted on a backing plate. The backing plate can be constructed of $\frac{3}{4}$ " marine grade plywood, aluminium or stainless plate designed to withstand the force associated with rough seas.

Place the time delay assembly in the bracket and secure it in place with the stainless-steel clamps provided.

Connect the pilot hoses as shown on below picture:



Pic. 26 – Mechanical Discharge Delay

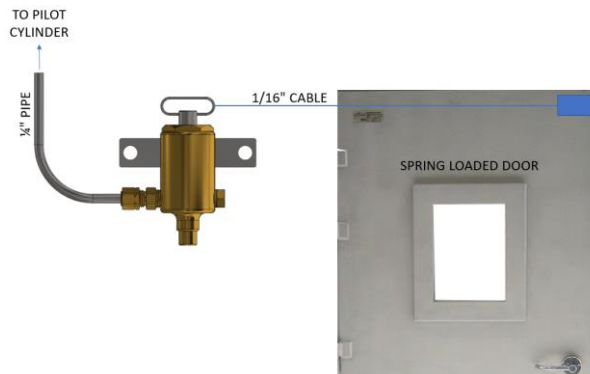
3.16. PNEUMATIC PRESSURE OPERATED TRIP INSTALLATION

- Installation of the Marinefire pneumatic pressure operated trip (PN 510023). Position the pressure trip in its designated location. The pressure trip may be mounted in the vertical or horizontal position.
- Mount the pressure trip using 2 – $\frac{1}{4}$ " bolts.
- Connect the pilot hose to the inlet port.



CAUTION: If the second port is not used, ensure the $\frac{1}{4}$ NPT plug is installed

- Connect the pilot hoses.
- Connect wire form to spring loaded device using a minimum $\frac{1}{16}$ " diameter wire rope.



Pic. 27 – Pneumatic Operated Trip

4. FINAL SYSTEM CHECKOUT

The checkout procedures outlined in this section are intended to represent the minimum requirement for the extinguishing portion of the system. Additional procedures may be required by the authority having jurisdiction (AHJ) USCG, ABS, RINA, DNV/GL, Lloyds etc.. The control portion of the system should be thoroughly checked out according to the manufacturer's recommendations and the requirements of the authority having jurisdiction (AHJ).

4.1. COMPARTMENT (HAZARD) AREA CHECK

A good review of the hazard area is just as important as the proper operation of system components. Certain aspects about the hazard may have changed, or been overlooked, which could affect overall system performance. The following should be thoroughly checked.

4.1.1.AREA CONFIGURATION

The area dimensions should be checked against those shown on the system plan(s). If the area volume has changed, the agent weight should be recalculated and compared with the agent weight supplied. The area should also be checked for bulkheads or movable partitions, which have been added or changed. If bulkheads or partitions have been added, check to see that all areas within the compartment still receive adequate nozzle coverage and agent distribution.

4.1.2. AREA LEAKAGE

The hazard area should be checked for openings which could allow agent leakage after system discharge. Openings, such as cable, pipe and duct penetrations into the area, should be permanently sealed. Other sources of leakage should be checked for and sealed, especially in sub-deck areas, where potential leak points are easily overlooked. Hatches entering the hazard area(s) should be checked for tightness. Seals and door sweeps should be installed to minimize leakage. Joints where bulkheads contact decks, or other bulkheads, should be sealed as these are potential leak points most often overlooked. Bulkhead switch and receptacle boxes should be sealed. Sub-deck drains must have “P”- traps and be sealed with a non-evaporating liquid, such as anti-freeze or mineral oil. All penetrations between decks must be sealed.

4.2. CONTAINERS

Check to make sure all containers and brackets are securely fastened.

Check all container pressure gauges. They should be reading 360 PSIG at 70°F (24.8 bar at 21°C). For temperatures other than 70°F (21°C), reference Section 6, Table 18. Activate the control system automatically. This procedure should be repeated for manual actuation of the control system. Verify that containers of correct weight and pressure are installed in accordance with the design drawings.

4.3. NOZZLES

Check to see that the nozzle is installed and secured and the container is located according to system plans. Make sure the nozzle is tight and that discharge orifices are properly oriented. Check nozzle orifices for obstructions and make sure no large objects have been placed in front of the nozzle that would block the discharge. Nozzles and mounting brackets must be installed such as to not cause injury to personnel. Agent should not be discharged at head height or below, where personnel in the normal work area could be injured by an agent discharge. Agent must not directly impinge on any loose objects, cabinet tops or shelves or similar surfaces where loose objects could be propelled by an agent discharge.

All manual pull stations must be properly installed readily accessible, and accurately identified as to their purpose.

4.4. AUXILIARY FUNCTIONS

Operation of auxiliary functions such as door closures, damper closures, air handling shutdown, etc. should be verified when the control system is activated, both manually and automatically.



WARNING: *If the air handling system is **NOT** being shut down during system discharge, it must be of the recirculation type, and enough agent should have been added to compensate for the duct and plenum volumes. After all checkout functions have been performed, and the control system checked out according to the manufacturer's recommendations, proceed with arming of the system, as outlined in Section 3 - SYSTEM INSTALLATION.*

4.5. ENCLOSURE INTEGRITY - DOOR FAN TESTING

Door fan testing provides a method to estimate worst-case room leakage. The door fan calculation method makes it possible to predict the timeline for a descending interface to fall to a given height and estimate how long an extinguishing concentration will be maintained within the protected space. This procedure is limited to door fan technology. This is not intended to preclude alternative technology such as acoustic sensors. Enclosure integrity testing is not intended to verify other aspects of Clean Agent system reliability; i.e., hardware operability, agent mixing, hydraulic calculations, and piping integrity.

Refer to NFPA Standard 2001, Section 4-3.2 for additional test requirements. The door fan testing procedure should not be an exact model of a discharge test. The complexity of this procedure should not obscure the fact that most failures to hold concentration are due to the leaks in the lower surfaces of the enclosure, but the door fan does not differentiate between upper and lower leaks. The door fan provides a worst-case leakage estimate that is very useful for enclosures with complex hidden leaks but will generally require more sealing than is necessary to pass a discharge test. Refer to NFPA Standard 2001, Section 4-7.2.3 and Appendix "C" for additional information and door fan test procedures.

5. SYSTEM OPERATION

5.1. GENERAL

Compressed HFC-227ea liquid is held in the container by a pressure differential discharge valve. When the discharge valve is actuated by an actuator the valve position is displaced and the compressed liquid escapes through the discharge port of the valve and which is directed through the valve to the nozzle. The nozzle provides the proper flow rate and distribution of HFC-227ea.

5.2. OPERATING PROCEDURES

Operating instructions are a critical part of the Marinefire HFC-227ea Marine suppression system installation. The instructions for each mode of activation should be posted near the mode of operation described. Instructions posted remotely from the cylinder storage area should indicate the location of the HFC-227ea cylinders.

5.2.1. REMOTE MANUAL OPERATION

- Activating the HFC-227ea Marine suppression System, operate as follows:
- Evacuate the hazard area immediately.
- Close all doors and windows.
- Proceed to the manual pull station for the hazard area.
- Remove the safety pin from the pull station.
- Pull to operate the manual pull station and activate the HFC-227ea fire suppression system.
- **ALLOW NO ONE TO ENTER THE HAZARD AREA.**
- In the event the system does not discharge, go to the container storage area and follow the LOCAL OPERATING INSTRUCTIONS.
- Follow post operation instructions "5.2.4 POST FIRE OPERATION".

5.2.2.LOCAL MANUAL OPERATION

Activating the HFC-227ea Marine suppression System, operate as follows:

- Evacuate the hazard area immediately.
- Close all doors and windows.
- Proceed to the appropriate HFC-227ea system cylinder for the hazard area.
- Remove the safety pin from the strike actuator.
- Push the knob down located on top of the system cylinder to activate the HFC-227ea fire suppression system.
- **ALLOW NO ONE TO ENTER THE HAZARD AREA.**
- Follow post operation instructions "5.2.4 POST FIRE OPERATION".

5.2.3.AUTOMATIC OPERATION

When a system is designed to activate automatically, personnel must evacuate the protected area promptly upon hearing the alarm indicating the system is discharging. Automatically Activating the HFC-227ea Marine suppression System, operate as follows:

- All doors and windows and other closeable openings should be equipped with automatic closure devices.
- Evacuate the hazard area immediately.
- **ALLOW NO ONE TO ENTER THE HAZARD AREA.**
- Follow post operation instructions "5.2.4 POST FIRE OPERATION".

5.2.4.POST FIRE OPERATION

After an HFC-227ea Marine suppression system discharge, one must observe all posted warnings, (see below), before entering the hazard area. Integrity of the hazard area must be maintained to prevent the migration of products of decomposition to adjacent areas outside of the protected space. After extinguishment, a minimum agent hold time of 15 minutes must be maintained, in Accordance with NFPA 2001. No one should enter the area until it is cooled down and the person in charge deems it safe to enter the protected space.

When ventilating the protected space of products of combustion, care should be taken to allow smoke, decomposition products, etc., to clear the area away from personnel or critical equipment.



WARNING:

- Do not enter the compartment with an open flame or lit cigarette.
- Flammable vapours, if present, may cause re-ignition or explosion.
- Do not enter the compartment until the fire is completely extinguished.
- Do not enter the compartment until it has been ventilated thoroughly.
- If someone must enter the compartment after the fire has been extinguished, use self-contained breathing apparatus.

5.2.5. CYLINDERS RECHARGE

After an HFC-227ea Marine suppression system discharges, all containers must be recharged and the fire suppression system returned to a full service condition in a reasonable amount of time. Return all discharged cylinders to a factory trained Marinefire, Marine suppression system distributor to be recharged.



WARNING: ACTUATORS DO NOT RESET AUTOMATICALLY

5.3. SPECIAL SYSTEM PRECAUTIONS (Actuators)

After an HFC-227ea Marine suppression system discharge **ALL ACTUATORS**; cable operated, pneumatically and manually operated must be manually reset prior to reinstallation on the HFC-227ea cylinder valve.

5.3.1.PRESSURE OPERATED PNEUMATIC ACTUATORS

All Marinefire Marine suppression system pressure operated actuators **will not reset automatically**. As a precaution before attaching any actuator to a control head; check to ensure the actuating pin is in the retracted position.

5.3.2.MANUALLY OPERATED ACTUATORS

All Marinefire Marine suppression system manually operated actuators (cable or strike) **will not reset automatically**. As a precaution before attaching any actuator to a control head; check to ensure the actuating pin is in the retracted position.

5.3.3.PNEUMATICALLY OPERATED CONTROL HEAD

All Marinefire Marine suppression system pneumatically operated control heads **do not reset automatically**. As a precaution before attaching any pneumatic control head to the suppression system valve; check to ensure the actuating pin is in the retracted position.

6. MAINTENANCE

The following maintenance procedures and intervals indicated are meant to represent the minimum requirements for Marinefire HFC-227ea systems. These procedures do not preclude those required by NFPA 2001 and or the authority having jurisdiction. More frequent service intervals may be necessary if systems are installed in more severe service applications. This section does not cover maintenance and service procedures for electrical or control portions of the system. Consult the appropriate product manuals for those items.



WARNING:

HFC-227ea and Nitrogen cylinders must be handled, installed, inspected and serviced by qualified technicians who have attended a factory sponsored training program. Handling of HFC-227ea and nitrogen cylinders shall



be by those trained personnel and accomplished in accordance with the instructions contained in this manual and compressed Gas Association (CGA) pamphlets C-1, C-6 and P-1. CGA pamphlets may be obtained from the Compressed Gas Association, 4221 Walney Road, Fifth Floor, Chantilly, VA 20151-2923.

6.1. MAINTENANCE PROGRAM

A regular maintenance program must be established for the continuous operation of all HFC-227ea fire suppression systems. A periodic maintenance program shall be established and followed. A maintenance log must be maintained for ready reference. The log must include the following accumulated data:

- Inspection Interval.
- Inspection procedure performed.
- Maintenance performed because of the inspection.
- Name of inspector performing the task.

If the inspection reveals any rust or corrosion on the cylinders, immediately clean and repaint the area. Perform hydrostatic test on the cylinder in accordance with authorities having jurisdiction requirements.

6.1.1.DISCHARGE NOZZLE

Every Six Months:

Check to see that nozzle orifices are clear and unobstructed and verify that the orifices are not showing signs of corrosion. Check to see that nozzle orifices are not clogged or that the nozzles are not physically damaged. Replace damaged nozzles. If the nozzles are dirty or clogged remove and clean clogged orifices replace the nozzle in its original location and position. Make sure the nozzle is aimed or positioned correctly. Verify that the correct nozzle part number is installed.

Radial Nozzles must never be painted. If nozzles have been painted, they must be replaced by nozzles with the same part number. Random interchanging of nozzles could have an adverse effect on the distribution of agent in the hazard area.

6.1.2.AGENT STORAGE CONTAINERS

6.1.2.1. MONTHLY INSPECTION

Check all container control heads for physical damage, deterioration or corrosion. If any deterioration or corrosion is evident replace the control head. Check all support brackets. Tighten loose fittings; replace all damaged or corroded parts.

6.1.2.2. THREE MOUNTS INSPECTION

Check the pressure gauge on each container. The nominal pressure should be 360 PSIG at 70°F (24.8 bar @ 21°C); however, the pressure will vary with temperature. In the range of 50°F to 80°F (10°C to 27°C) the difference is approximately 2 psig (15 kPa) per degree. If the pressure loss indicated exceeds ten percent of the nominal pressure, check the container for leaks and repair as necessary.

APPROXIMATE CONTAINER PRESSURE Vs. TEMPERATURE			
US STANDARD		METRIC	
TEMPERATURE °F	PRESSURE - PSIG	TEMPERATURE °C	PRESSURE - bar
0	210	-18	14
32	261	0	18
40	276	4	19
50	334	10	21
60	340	16	23
70	360	21	25
80	377	27	26
90	406	32	28
100	464	38	32
110	493	43	34
120	551	49	38

Table 18 – Pressure VS Temperature

6.1.2.3. SIX MOUNTS INSPECTION

Verify the weight of the agent in each container matches the agent weight stamped on the label. If the weight indicates a shortage exceeding five percent of required weight, the container must be removed from service for repair and/or recharge.



WARNING: The control panel must be disabled *BEFORE* removing any container to be weighed. Disconnect all cylinder control heads, discharge hoses, and flexible pilot hoses to prevent accidental discharges. Install protection cap on the HFC-227ea cylinder valve actuation port and safety cap on cylinder actuation port.

6.2. AFTER SYSTEM DISCHARGE

The containers should be removed and sent to the factory or an “authorized” Marinefire fire Suppression system distributor for valve rebuilding (if required) and container recharge.

6.2.1. CONTROL HARDWARE

Inspect all actuation hoses for loose fittings, damaged threads, dirt or frayed wire braid. Tighten all loose fittings, replace damaged or distorted parts, and tighten all loose fittings. Clean all components that are corroded or dirty. The valve will need to be rebuilt using the appropriate rebuild kit after the container has been discharged. If the container has not discharged and a leaking valve needs to be rebuilt, the contents of the container must be transferred to another container before rebuilding the valve.



WARNING: Container contents are under high pressure. *NEVER* attempt to rebuild the valve until the contents have been transferred and the pressure gauge *READS 0 PSIG (0 bar)*. Care should be taken when handling valve components to avoid damage of any kind.

6.2.2. PNEUMATIC DETECTION SYSTEM TESTS

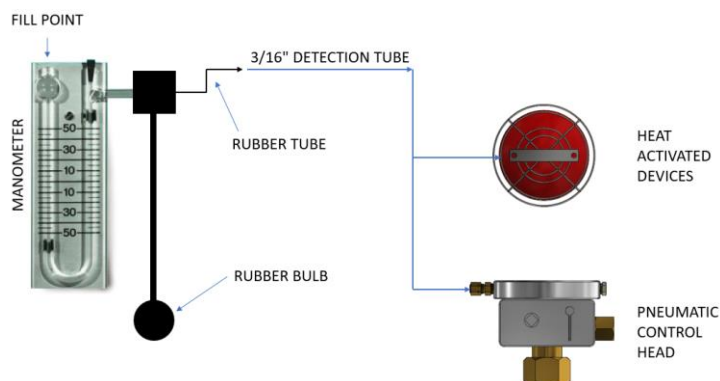
Remove the pneumatic control head from the container. Use extreme caution when disconnecting the control head and ancillary components, accidental discharge may occur.

6.2.2.1. PNEUMATIC CONTROL HEAD TEST

Connect the test fitting of the manometer to the diaphragm chamber of the control head; make sure adequate clearance is provided at the mounting unit so the control head will not be damaged during operation. If the control head has been operated, reset by placing a large screwdriver in the reset stem, turn clockwise (slight resistance will be met) until the stem locks in position. (Arrow on reset stem will line up with "SET" arrow on the control head nameplate).

6.2.2.2. MANOMETER TEST (Control Head)

Use a monometer test set (not part of the fire Suppression system) fill the open tube with water until the water level in both tubes reaches the "ZERO" mark. Close off the rubber "A" by squeezing tightly or clamping; apply pressure by gently squeezing the rubber bulb "C". The control head must operate at the factory pressure setting plus or minus 10%(tolerance allowed). The pressure required to operate the control head is the difference in inches, between the water levels in the two tubes, and is equal to twice the reading of either tube, i.e., 2 inches in two tubes or one inch in one tube. After the control head had operated be sure not to allow water to enter the control head. (Always release rubber tube "A" before allowing the Bulb "C: to expand to normal).



Pic. 28 – Manometer Test Set



6.2.2.3. PNEUMATIC CONTROL HEAD VENT TEST

To test the vent for correct calibration before disconnecting the manometer from the control head; the following steps must be taken. Squeeze the rubber bulb “C” approximately halfway or enough to achieve sufficient vacuum for the test, close tube” A” by pinching or using a crimp clamp. Allow the bulb to expand gradually to its normal shape. This will create a partial vacuum, causing the water level to change, indicating inches of vacuum applied to the control head (the vacuum must be more than 3 inches to observe drop form 3 inches to 1 inch).

The water column will recede to “)” level as air passes through the vent. The time elapsed (number of seconds) for the water column to recede 2 inches, reading from 3 inches to 1 inch on both legs and 1 1/2 inch to ½ inch on either leg is the number of the vent (calibrated rate of flow). If the time required to pass the above amount of water is 5 seconds the control head vent is “Number 5”. The time will vary when vents are tested due to the added volume in the control head diaphragm chamber. A Number 5 vent may test from 5 to 7 seconds, which is acceptable. If the vent reading is much higher it will increase the systems sensitivity and may not be within the acceptable limits. Table 19 shows acceptable times allowed for vent testing sensitivity using the manometer method with a vent installed in a control head. When the test is complete, disconnect the manometer from the control head. Reset the control head by turning the reset stem to the “SET” position.

CONTROL HEAD VENT SETTING	ALLOWABLE TIME (Seconds)
40 sec.	40 - 60
20 sec.	20 - 27
10 sec.	20 - 25
5 sec.	5 - 7

Table 19 – Pneumatic Control Head Calibration Chart

6.2.2.4. LEAKEAGE TEST FOR PNEUMATIC TUBING & DETECTORS

Connect the manometer test fitting to the pneumatic tubing at the control head connection nut. Squeeze the rubber bulb “C” fully, then close off the rubber tube “A”. Gradually release the rubber bulb to its normal shape. The water level in the two tubes of the manometer will change creating a vacuum. Hold a minimum 8 inches of vacuum (difference between the two sides of the “U” tube or 4 inches on each side. If all the connections are tight, the water level will not change if the rubber tube “A” remains closed. If the water level falls at all, it is

indicative of a leak in the detection circuit. When the test is completed; disconnect the test set from the tubing, reset the control head.

6.2.2.5. FUNCTIONAL TEST OF PNEUMATIC DETECTION SYSTEM

Hold a container of hot water under the heat detector, immersing the chamber of the detector in the hot water. At least 50% of the detector must be immersed and the hot water must be at least 100°F (37.8°C) above the ambient temperature. Note the time between application of the hot water to the detector and the operation of the control head. The control head must operate in approximately 1 second. Do not apply heat for more than 15 seconds; the detector is not functioning if the control head has not operated in that time.

The heat test must be performed on each heat detector. Between each test wait at least 5 minutes for the system to return to normal, reset the control head and continue testing until each detector has been tested.

If the application of heat does not cause the control head to function within 15 seconds, remove the container of hot water and investigate the cause of failure.

- Inadequate heat differential
- Tubing is leaking (hole in tubing)
- Connections not tight
- Obstruction in tubing

6.2.2.6. TROUBLESHOOTING PNEUMATIC DETECTION SYSTEM

If any of the four deficiencies listed cause a failure of the system to operate the manometer can be used to assist in the troubleshooting. Connect the manometer test fitting to the pneumatic tubing at the control head connection nut. Replace union connection with a control head heat "T". Close the open tube "A" on the manometer with a crimp clamp. The manometer is now a part of the detection system and will provide a visual record of the events that transpire when the detector is subjected to heat or cold. The manometer will provide a visual indication of the pressure build up within the detection circuit and will assist the technician in identifying the problem. This procedure will determine whether there is sufficient or insufficient pressure build-up during the system test.

6.3. RECHARGING CONTAINERS

All Marinefire HFC-227ea Containers shall be filled by an authorized Marinefire system distributor in accordance with fill procedures outlined in section 7 of this manual, paragraph 7.5.

6.3.1. CONTAINER TEST AND INSPECTION

Marinefire HFC-227ea containers shall not be recharged without a retest if more than five years have elapsed since the last test. The retest consists of a complete external and internal visual inspection in accordance with the Code of Federal Regulations, Title 49, Section 173.34(e)(10). The CFR requirements also refer to the Compressed Gas Association (CGA) Pamphlet C-6, Section 3. Cylinders continuously in service without discharging shall receive a complete external [visual] inspection every five years. The cylinder does not need to be emptied for this inspection.

All visual inspections must be performed according to the regulations of CFR Title 49 and CGA Pamphlet C-6, Section 3. All inspections are to be done by CGA / DOT approved inspectors only.

(Reference: NFPA No. 2001, Section 4-2). Note that transporting charged containers that have not been tested within 5 years could be illegal. Federal and local regulations should be consulted before transporting. Refer to National Fire Protection pamphlet 2001, Section 4-2.1.

6.4. CHANGING / PRESSURE GAUGE

All Marinefire HFC-227ea Containers DO NOT allow the user to add or replace the pressure gauge and/or low-pressure switch while the container is pressurized. To change the pressure gauge or switch; if the container has not discharged, transfer the contents of the container to another container before beginning any repairs. Once the gas has been transferred and the pressure relieved from the container:

- Remove the device to be replaced.
- Apply sealant (LocTite 262 or equal) to the male thread connection of the gauge. DO NOT overlap the end of the connection – the first thread should be uncovered.
- Install the replacement device. Tighten with a wrench; the gauge should be facing you and positioned where it can be read,
- Check the assembly for leaks using a suitable leak test device. (Refer to the Recharge Manual for recommendations and leak test procedures.)

6.5. CHANGING and/or ADDING LOW PRESSURE SWITCH

Marinefire HFC-227ea containers may be factory equipped with a low-pressure switch. If there is a malfunction or a leaking low-pressure switch, follow these procedures to replace the low pressure switch. If the container has not discharged, transfer the contents of the container to another container before beginning any repairs. Once the gas has been transferred and the pressure relieved from the container:

- Remove the pressure switch from the control head.
- Apply sealant (LocTite 569) to the male thread connections of the pressure switch. DO NOT overlap the end of the connections – the first thread should be uncovered.
- Install the new low-pressure switch into the control head and tighten with a wrench.
- Charge the cylinder to the specified weight. Refer to section 7.5 of this manual for cylinder recharge instructions.
- Check the assembly for leaks using a suitable leak test device. (Refer to the Recharge Manual for recommendations and leak test procedures.)

7. SYSTEM SERVICE

Marinefire HFC-227ea containers must be recharged when the container pressure gauge indicates that the pressure is below normal (360 PSIG @ 70°F (24.8 Bar@ 21°C)) or immediately after the system has discharged or a loss of weight more than 5% of the original agent weight, or loss of pressure (adjusted for temperature) of more than 10%.

7.1. REMOVING HFC-227ea CONTAINER(S)

- Disconnect the supervisory pressure switch by disconnecting the electrical connection from the system.
- Remove the actuator from the control valve. Immediately install the actuation port safety cap.
- Disconnect the HFC-227ea container from the discharge piping network, immediately install the outlet safety cap (anti recoil device).
- Remove the HFC-227ea Container from the brackets.

7.2. VALVE INSPECTION & DISASSEMBLY

Because HFC-227ea will dissolve lubricants it is necessary to disassemble the control valve to inspect, lubricate and service components prior to recharging the system. Prior to the removal of the valve from the container make certain that all pressure has been relieved.

- Remove the control valve assembly and siphon tube from the cylinder.
- Remove the “O” ring between the valve and cylinder.
- Remove siphon tube (if applicable)
- Remove the top cap and piston assembly from the valve.
- Remove the following.
 - Top cap “O” ring
 - Piston “O” ring
 - Piston Seal
- Clean “O” ring grooves and remove all foreign matter.
- Examine the Schrader valve core for any evidence of damage.
 - Depress the pin to make sure it snaps back freely.
 - If necessary, replace the valve core.
 - When you install a new valve core; torque to 1 ½ to 3-inch pounds.
- Upon completion of the valve core installation, measure the distance from the top of the valve core to the actuator seating surface. The measurement must be 0.345 – 0.355 inches (8.5mm – 9mm).

7.3. VALVE ASSEMBLY

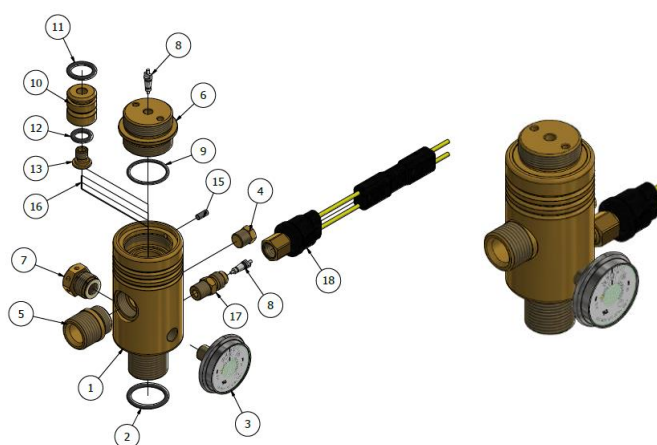
To reassemble the control valve:

- Clean the interior of the valve.
- Lubricate and install the lower “O” ring on to the piston.
- Lubricate and install the upper “O” ring on to the piston.
- Press piston body into the valve body.
- Lubricate and install the valve top cap “O” ring into the valve body.
- Install valve top and torque to 30 foot pounds.
- If the siphon tube was removed, wire brush the top of the tube to remove any residue. Apply a thin film of Loctite 680 to the top end of the tube, install the tube into the valve and tighten the retaining screws.

7.4. SAFETY DEVICE REPLACEMENT (Burst Disc)

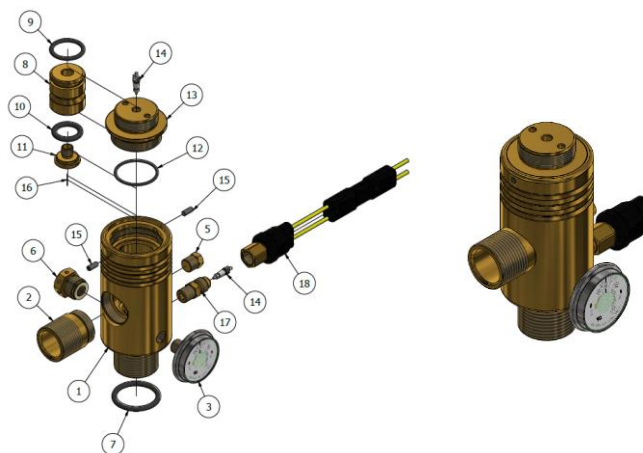
Identify the burst disc assembly to ensure that it is identical to the one being replaced.

- Remove the safety device assembly from the valve body by unscrewing the safety device nut, disc, and washer from the valve body.
- Install a new washer, the replacement disc and nut to the control valve body.
- Torque to 25 foot pounds.



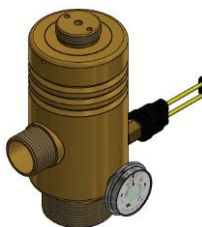
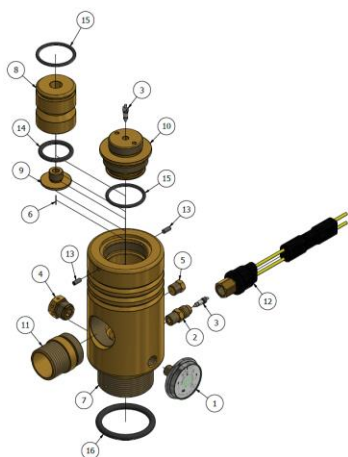
ELENCO PARTI			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	320001	Valve Body 1/2"
2	1	381118	O-Ring 2.62 x ID21.89
3	1	310001	Pressure Gauge 360 PSI HFC-227
4	1	310075	1/8" NPT Plug
5	1	320030	Outlet 1/2" NPT
6	1	320023	Valve Cap 1 1/4"
7	1	310025	Relief Assembly
8	2	310011	Schrader Core 805-8
9	1	380021	O-ring 1.78 x ID23.52
10	1	320010	Piston 1/2"
11	1	381113	O-Ring 2.62 x ID13.95
12	1	381110	O-Ring 2.62 x ID9.19
13	1	320020	Piston Cap 1/2"
15	1	360002	Hexagonal Socket 6-32" UNC
16	1	312000	Stainless Steel Wire Dia. 0.61
17	1	310008	Schrader Body
18	1	340004	1/4" female flare fittings

Pic. 29 – 1/2" Valve Assembly P/N 420001



ELENCO PARTI			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	320002	Valve Body 3/4"
2	1	320031	Outlet 3/4" NPT
3	1	310001	Pressure Gauge 360 PSI HFC-227
5	1	310075	1/8" NPT Plug
6	1	310025	Relief Assembly
7	1	381216	O-Ring 3.53 x ID28.17
8	1	320011	Piston 3/4"
9	1	381117	O-ring 2.62 x ID20.29
10	1	381208	O-Ring 3.53 x ID15.47
11	1	320021	Piston Cap 3/4"
12	1	380024	O-ring 1.78 x ID28.3
13	1	320024	Valve Cap 1 1/2"
14	2	310011	Schrader Core 805-8
15	2	360002	Hexagonal Socket 6-32" UNC
16	1	312000	Stainless Steel Wire Dia. 0.61
17	1	310008	Schrader Body
18	1	340004	1/4" female flare fittings

Pic. 30– 3/4" Valve Assembly P/N 420002



ELENCO PARTI			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	310001	Pressure Gauge 360 PSI HFC-227
2	1	310008	Schrader Body
3	2	310011	Schrader Core 805-8
4	1	310027	Relief Assembly
5	1	310075	1/8" NPT Plug
6	1	312000	Stainless Steel Wire Dia. 0.61
7	1	320003	Valve Body - 1"
8	1	320012	Piston 1"
9	1	320022	Piston Cap 1"
10	1	320025	Valve Cap 1 5/8"
11	1	320032	Outlet 1" NPT
12	1	340004	1/4" female flare fittings
13	2	360002	Hexagonal Socket 6-32" UNC
14	1	381120	O-ring 3.53 x ID24.99
15	2	381124	O-Ring 2.62 x ID31.42
16	1	381327	O-Ring 5.33 x ID43.82

Pic. 31- 1" Valve Assembly P/N 420003

7.5. RECHARGING OR REFILLING OF HFC-227ea CONTAINER(S)



CAUTION:

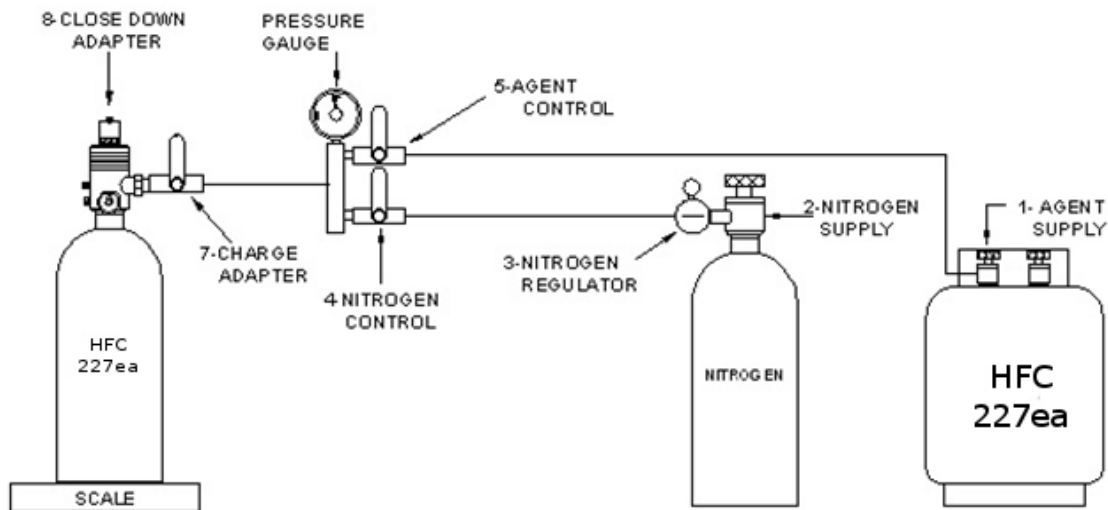
Recharging a container can be dangerous. Never attempt to work on a container unless it is chained in a safe manner and/or the charging adapter or a safety cap is attached to the outlet of the control valve. Before recharging, look for the date of manufacture or latest test date on the cylinder. The container may require retesting.

- Check the cylinder for the last hydrostatic test date. Hydro test if required.
- Perform visual inspection in accordance with CGA pamphlet C-6. Record results.
- Weigh the container to be recharged with the valve assembly in place.
- Close all the valves in the charging system.
- Connect the HFC-227ea agent source.
- Position the container to be filled on the calibrated scale.
- Remove the safety caps.
- Attach the charge and close adapters. (Refer to Pic. 32)

- Open the HFC-227ea supply valve. Item 1
- Open the HFC-227ea control valve. Item 5
- Open the charge adapter valve. Item 7
- When the container reaches the desired charge, weight close the HFC-227 control valve (Item 5)
- To super-pressurize with Nitrogen. Open the Nitrogen supply valve item 2 and adjust the Nitrogen regulator Item 3 until the calibrated gauge shows a reading of 360 PSIG + 25 PSIG, - 0 PSIG (24.4Bar + 1.7 Bar, - 0 Bar)
- Open the nitrogen control valve Item 4. Agitate the container to assist in the absorption of the Nitrogen. Observe the container pressure gauge as the absorption of the Nitrogen will cause a reduction of pressure in the container being recharge.
- When pressurized properly at 360 PSIG @ 70° F (24.4Bar at 21.1° C), close the charge adapter Item 7 and nitrogen control valve item 4.
- Remove the fill hose from the charge adapter item 7 and fit to close adapter 8.
- Adjust the regulator to 600 PSIG + or – 50 PSIG (34.5 Bar + or – 3.5 Bar).
- Open the nitrogen control valve item 4 for approximately 5 seconds.
- Open charge adapter 7 to vent the outlet port.
- If the charge adapter item 7 is leaking, repeat step 19 until the piston seats and the leaking ceases.
- Close the Nitrogen supply valve item 2.
- Remove the close adapter item 8, and fit the actuation port safety cap.
- Remove the charge adapter and fit the outlet port safety cap.
- Weigh the fully charged container to make sure it was filled with the correct amount of HFC-227ea Agent.
- Check the gauge on the control valve to make sure the container was super-pressurized to the correct amount of pressure.
- Leak test the container, (refer to paragraph 7.6)

Item Number	Description
1	HFC-227ea Supply Valve
2	Nitrogen Supply Valve
3	Nitrogen Regulator
4	Nitrogen Control Valve
5	HFC-227ea Control Valve
6	Calibrated Gauge

7	Charge Adapter
8	Close Down Adapter
9	Calibrated Gauge
10	Container Being Recharged



Pic. 32 – Container Recharging

7.6. LEAK DETECTION

After the container has been filled with the required amount of HFC-227ea it must be carefully checked for leaks. All leak points on the container control valve must be checked with a Yokogawa H-10 Series Halogen leak detector, D-TEK refrigeration leak detector, or equal. The leak detector must be calibrated prior to each use and, once each hour during use, using a model LS-20 leak standard set to the minimum leakage rate for the container being filled. Refer to paragraph 7.7 for details on calibrating and using the leak detector.

7.7. LEAK TESTING PROCEDURE

This leak test procedure is based on the use of a Yokogawa H-10 Series Halogen leak detector, D-TEK refrigeration leak detector device, or equal and the LS-20 leak standard for HFC-227ea. Consult the



760 Series

Design, Installation & Maintenance Manual

manufacturers' manual for operational details. To perform a leak test on a container with Marinefire HFC-227ea proceed as follows:

- Turn on the leak detector at least 5 minutes prior to its use. Allow it to stabilize.
- Allow the LS-20 leak standard to condition at a temperature of 70°F + or – 10°F (21°C + or – 12°C), while set at the maximum leak rate, for approximately 5 minutes, prior to calibrating the leak detector.
- Once the initial warm up is complete, set the LS-20 leak standard to the maximum allowable leak rate for the size container being checked. Table 20 details the maximum leakage rate allowed for each Marinefire HFC-227ea container. If the maximum leak rate for the container exceeds the maximum leak rate for the leak standard, use the maximum leak rate of the leak standard.
- Use the LS-20 leak standard to calibrate the leak detector to the required leak rate for the container being tested. This is done by slowly passing the detector probe past the LS-20 leak capillary and adjusting the leak detector balance knob, until the leak detector responds to the appropriate setting. Refer to the manufacturer's instructions for detector calibration.
- The leak detector shall be calibrated with the LS-20 Leak Standard before any leak testing begins and at least once every hour thereafter, while leak testing continues.
- Slowly check all seams, welds, and container components, gauge, outlet, pressure switch. The inspection area should be well ventilated and separate from the fill area.
- If a leak is detected it is recommended that the container be blown off with air or dry nitrogen to remove any pockets of HFC-227ea agent that may have accumulated during the fill process.
- If no leaks are present the container may be placed back in service.
- Record all data in the fill station logbook.
- Containers identified as having unacceptable leak rates shall be emptied, inspected, and repaired or rebuilt as required in accordance with the Marinefire Design, Installation or Maintenance and Service manuals. See Table 20 for container data leak rate.

Container Data / Leak Rate					
Part No.	DOT Specification	Size Nominal	Size Nominal	Max. Leak Rate	Max. Leak Rate
760003	3AL1000	4	1.7	0.125	3.54
760005	3AL1000	6	2.5	0.140	3.97
760008	3AL1000	10	4.1	0.165	4.68
760010	3AL1000	12	4.9	0.18	5.10

760012	3AL1000	14	5.7	0.20	5.67
760016	3AL1000	21	8.5	0.23	6.52
760020	3AL1000	27	10.7	0.26	7.37
760028	3AL1000	35	13.9	0.37	10.49
760036	3AL1000	43	17.2	0.48	13.60
760040	4BW500	58	22.9	0.52	14.74
760050	4BW500	66	26.2	0.62	17.58
760060	4BW500	83	32.8	0.87	24.66
760080	4BW500	124	49.2	1.04	29.48
760100	4BW500	166	65.6	1.31	37.14

Table 20 – Container Leak Rates

7.8. SERVICE TOOLS

7.8.1.CHARGE ADAPTERS

Adapter	Part Number
½	470004
¾	470005
1	470006
Close Down	470007

7.8.2.CYLINDER HYDRO-TEST ADAPTERS

Adapter	Part Number
1" Hydro-test	470001
1 1/4" Hydro-test	470002
2" Hydro-test	470003

7.8.3. VALVE TEST ADAPTERS

Adapter	Part Number
1" Valve Test	470008
1 1/4" Valve Test	470009
2" Valve Test	470010

7.8.4. VALVE INSTALLATION TOOLS

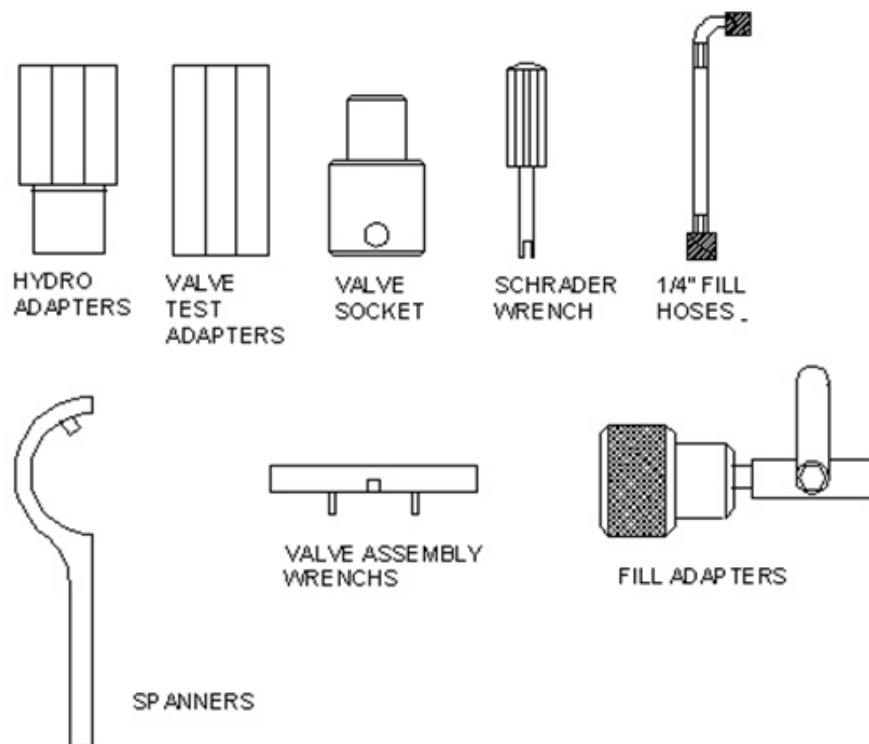
Adapter	Part Number
1 3/4"	470023
2"	470024
2 1/2"	470025

7.8.5. PRESSURE RELIEF DEVICE

Adapter	Part Number
Schrader Core	470021
1/2" Piston	470040
3/4" Piston	470041
1 1/8" Piston	470042
Top Cap Wrench	470031

7.8.6. FILL HOSES

Adapter	Part Number
1/4" x 36"	470060
1/4" x 60"	470061
3/8" x 60"	470062
1/4" x 60HP	470066



Pic. 33 – Service Tool