MOSAFE EQUIPMENT CO.,LTD.

HFC-227ea 'TOTAL FLOODING SYSTEM'

FIRE EXTINGUISHING SYSTEM

DESIGN AND OWNER MANUAL

(ENGINEERED SYSTEM)

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Contents

Section 1 System Introduction

About this Manual

This manual contains all the information necessary to design, install and maintain the HFC-227ea Engineered Extinguishing system supplied by Mosafe Equipment Co.,Ltd.. However the manual does not address information relating to fire detection. Please refer to the UL Code UL2166, FM Code FM5600 and BFPSA Code of Practice for Gaseous Fire Fighting Systems.

Users of this manual are assumed to be competent fire engineers with a basic knowledge of such systems. The contents are arranged in a logical order describing the various procedures in turn, alternatively specific sections can be referred to as required. Users who are not familiar with the equipment should first read the complete manual.

Definitions

System In this manual 'system' refers to the extinguishing equipment and does not include any electrical system which may initiate an agent release.

Engineered Hydraulic flow program used to predict the two phase flow of HFC-227ea through a pipe network.

Introduction

HFC-227ea is a clean, safe fire fighting agent for use in total flooding automatic extinguishing systems. It is intended as a long term replacement for Halon 1301 and, whilst maintaining the excellent fire suppression properties of Halon, has none of the environmental problems. Storage and distribution requirements are similar to Halon and the majority of system components are identical. However, HFC-227ea is not a direct replacement for existing Halon 1301 installations due to the difference in agent quantity and discharge characteristics. The minimum HFC-227ea design concentration for Class A hazard is 6.7%, for Class B hazard is 8.7%, and for Class C hazard is 7.0%, therefore requires approximately 45% additional storage capacity over that required for Halon in the same area.

The manufacturers claim that HFC-227ea is safer than Halon 1301 for use in total flooding applications and the US Environmental Protection Agency (EPA) accepts extended use exposures of up to 9%. This has been further confirmed by a published HAG report. HFC-227ea is rated as Zero Ozone Depletion (ODP), is electrically non-conductive, clean, and leaves no residue. Refer to NFPA 2001 "Clean Agent Fire Extinguishing Systems," Section 1.5 "Safety" for additional exposure requirements.

The systems described in this manual are 'engineered'. Engineered systems for example can consist of several HFC-227ea containers, manifolded together and connected via a pipe network to a number of discharge nozzles.

Systems may be activated mechanically or electrically. Mechanical manual actuation is via a strike knob attached to the container valve. Electrical actuation is via a removable side mounted solenoid. The solenoid can be energised automatically by a signal from a detection and alarm control panel.

Users of this manual should find that sufficient information is provided to plan, design, purchase components, install, operate and maintain the system. However, in the event that part of the document is not understood, or if there is any concern as to the suitability of the protection, do not hesitate to contact one of our specialist engineers for the matter to be quickly resolved.

Approvals and Standards

Mosafe's manufactured equipment and the HFC-227ea agent, have acquired comprehensive approvals and listings providing further support to the overall product.

HFC-227ea Agent

- Factory Mutual (Approved)
- Underwriters Laboratories Inc. (UL) Recognised Component
- NFPA 2001 Clean Agent Fire Extinguishing Systems (Listed Alternative)
- US EPA SNAP Rpt. (Unrestricted Listed Alternative)
- Australian Industrial Chemicals Notification (Approved)
- German Institute for Environmental Hygiene and Medicine (Approved)

Mosafe Systems Manufactured Systems

- Underwriters Laboratories Inc. (UL Listed)

Mosafe Equipment manufacture in strict accordance with the internationally recognised Quality assurance approved to ISO 9001.

Mosafe Equipment's HFC-227ea Extinguishing System Units are to be designed, installed, inspected, maintained, tested and recharged by qualified, trained personnel in accordance with The Standard on Clean Agent Fire Extinguishing Systems, NFPA2001 and to be used in accordance with Environmental Protection Agency (EPA) Significant New Alternatives Program (SNAP).

Health and Safety

A properly designed and installed extinguishing system should not present any significant health or safety problems, however, there are basic precautions to be taken to avoid accidents, and aspects of the system operation that should be understood. End-users often require reassurance regarding the safety of personnel, and this can only be given if a thorough understanding of the properties of the agent and its effects in different situations are known. Current best practice should be observed e.g. BS5306: Part 5: Section 5.1 and the BFPSA Code of Practice for Gaseous Fire Fighting Systems.

Reference should also be made to NFPA 2001 and BFPSA Volume 3 section 19 A review of the toxic and asphyxiating hazards of clean agents replacements for Halon 1301.

HFC-227ea, like halon, extinguishes by causing a chemical reaction with the combustion products, and does not remove oxygen like CO_2 and other inert agents.

Therefore, exposure to HFC-227ea at the design concentration of 6.7%, and up to 9.0%, is not hazardous to health. Exposure to higher concentrations is permissible for limited periods. Refer to NFPA 2001, 2015 Edition Section 1.5 "Safety" for exposure requirements. As with halons, the US EPA and the National Fire Protection Association (NFPA) recommend that unnecessary exposure to any agent be avoided and that personnel evacuate protected areas as quickly as possible to avoid the decomposition products of the fire.

HFC-227ea can decompose at high temperatures to form halogen acids. If so, their presence is readily detected as a sharp, pungent odour long before hazardous maximum exposure levels are reached. Fire toxicity studies conclude that generally decomposition products from the fire itself, especially carbon monoxide, smoke, heat, and oxygen depletion, create a greater hazard.

The noise created by the HFC-227ea agent discharging can be loud enough to startle people in the vicinity, but is unlikely to cause any permanent injury. Turbulence caused by the high velocity discharge can dislodge substantial objects directly in its path, and cause enough general turbulence within the protected area to move paper and light objects.

Direct contact with the vaporising liquid discharged from an HFC-227ea nozzle has a chilling effect on objects and in extreme cases can cause frostbite to the skin. The liquid phase vaporises rapidly when mixed with air and therefore limits the risk to the immediate vicinity of the nozzle. Minor reduction in visibility may occur for a brief period due to the condensation of water vapour.

First Aid

Skin Maintain at body temperature, thaw affected area with gentle heat. If frostbite occurs seek medical attention. Do not rub affected area.

Eyes Apply gentle heat, Do not allow patient to touch affected area.

HFC-227ea Agent Characteristics

HFC-227ea is a clean, gaseous agent containing no particles or oily residues. It is produced under ISO 9002 guidelines to strict manufacturing specifications ensuring product purity. HFC-227ea leaves no residue or oily deposits on delicate electronic equipment, and can be removed from the protected space by ventilation.

HFC-227ea is thermally and chemically stable, but without the extremely long atmospheric lifetimes associated with other proposed halon replacements. The atmospheric lifetime of HFC-227ea has been determined to be 36.5 years (Reference GLCC). The US EPA SNAP does not consider HFC-227ea to be a long lived substance when discharged, and as such has placed no restrictions on its use. (Environmental Protection Agency's Significant New Alternatives Program).

Typical areas that can be protected by an HFC-227ea system are detailed below; the list is by no means exhaustive:

Bank Vaults	**Libraries**
Rare Book Stores	**Electronic Data Processing**
Telephone Exchanges	**Studios**
Communication Centre	**Transformer and Switch rooms**
Control Rooms	**Test Laboratories**
Flammable Liquid Stores	

The present understanding of the functioning of HFC-227ea is that 80% of its fire fighting effectiveness is achieved through heat absorption and 20% through direct chemical means (action of the fluorine radical on the chain reaction of a flame). Complete suppression using HFC-227ea has the following advantages:

- The low concentration of HFC-227ea required means less visual obscurity and minimal risk to personnel.
- The small quantity of agent discharged minimises over-pressurisation of the protected area.
- Maximum safety for personnel due to low toxicity.

- Most effective when used with automatic detection to introduce HFC-227ea rapidly.
- The ability to prevent re-ignition as long as concentration levels are maintained.

HFC-227ea is stored as a liquified compressed gas and is discharged into the protected area as a vapour. It is stored in approved DOT(HSE)4BW500 or TPED containers and is super-pressurised with dry nitrogen to 25 Bar @ 21℃ (360 PSI @ 70℉) and 42 Bar @ 21℃ (600 PSI @ 70℉).

WARNING

HFC-227ea shall not be used on fires involving the following materials unless they have been tested to the satisfaction of the authority having jurisdiction:

- Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, those are capable of rapid oxidation in the absence of air.
- Reactive metals such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium and plutonium.
- Metal hydrides.
- Chemicals capable of undergoing autothermal decomposition, such as certain organic peroxidase and hydrazine.

Agent Physical Properties

Table 1.1

Agent Physical Properties	**HFC-227ea**
Chemical structure	CF3CHFCF3
Chemical name	Heptafluoropropane
Molecular weight	170
Boiling point	-16.4℃ (1.9℉)
Freezing point	-131.1℃ (-204℉)
Critical temperature	101.7℃ (214℉)
Critical pressure	2912 kPa (422 psi)
Critical volume	274 cc/mole (.0258cuft./lb.)
Critical density	621 Kg/m^3 (38.76lb./ft^3)
Saturated vapour density@20℃(68℉)	31.18 Kg/m^3 (1.95lb./ft^3)
(Reference: NFPA2001)	

Table 1.2

Agent Physical Properties	**N_2**
Chemical structure	N_2
Chemical name	Nitrogen
Molecular weight	28
Boiling point	-195.8℃ (-320.4℉)
Freezing point	-210.0℃ (-346℉)
Critical temperature	-146.9℃ (-232.4℉)
Critical pressure	3399 kPa (492.9 psi)
(Reference: NFPA2001)	

Table 1.3

Safety Instructions	**HFC-227ea**
Environmental	
Ozone Depletion(ODP)	0
Atmospheric Life time (yrs)	36.5
Toxicology	
Acute Exposure LC50 (%)	>80
Cardiac Sensitization	
No Observed Adverse Effect Level (NOAEL)	9.0%
Lowest Observed Adverse Effect Level (LOAEL)	10.5%
(Reference: NFPA2001)	

Section 2 System Components

This section describes the individual components that comprise a complete system. Some items are optional depending on the application, and are indicated as such.

Typical Manifold System

HFC-227ea gas fire extinguishing system includes the cylinder kit, manual release device, pilot hose, discharge hose, check valve, manifold, relief device of distributor manifold, direction valve, pressure operating switch, pipe ware and nozzle which connected to the automatic alarm system.

There are two typical manifold systems for single area system and multi-areas system.

For single area system, the solenoid actuator will act to open the master cylinder after getting the instruction from control panel, then the gas from the master cylinder will open the slave cylinders.

For multi-areas system, the solenoid actuator will act to open the pilot cylinder, then N_2 from the pilot cylinder will open the exact selective valve firstly, then open all the HFC-227ea cylinder valves.

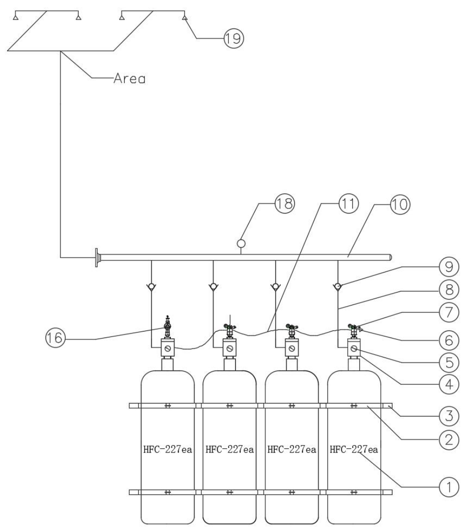


Figure 1 - Typical Manifold System for Single Area System

No.	Name	No.	Name
1	Cylinder	11	Pilot Hose
2	Mounting Bracket	12	Manifold Relief Device
3	Clamp of Cylinder	13	Pilot Cylinder
4	Cylinder Valve	14	Pilot Cylinder Pressure Gauge
5	Cylinder Pressure gauge	15	Pilot Cylinder Valve
6	Bleed Valve	16	Solenoid Actuator
7	Pneumatic and manual actuator	17	Direction valve
8	Discharge hose	18	Discharge Pressure switch
9	Discharge Check valve	19	Nozzle
10	Manifold		

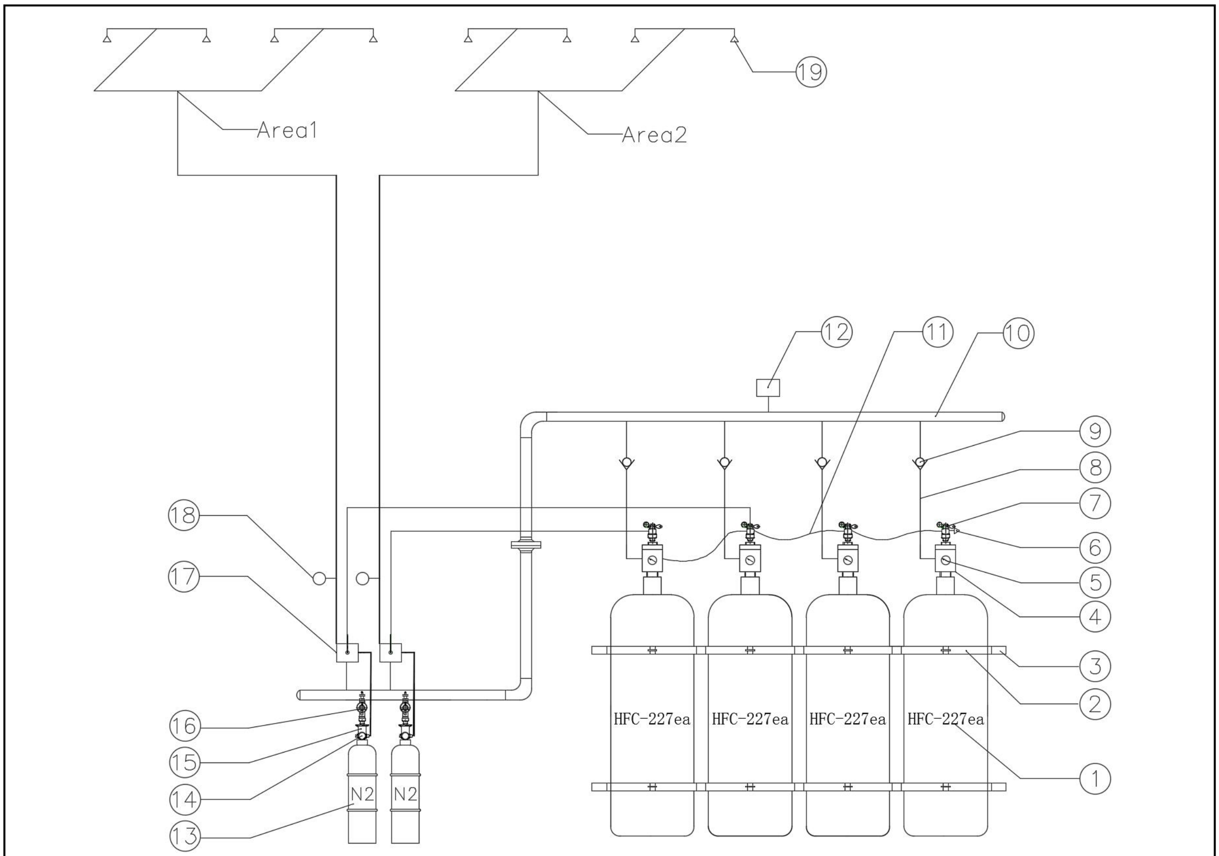


Figure 2 - Typical Manifold System for Multi-areas System

No. Name

11	Cylinder	11	Pilot Hose
12	Mounting Bracket	12	Manifold Relief Device
13	Clamp of Cylinder	13	Pilot Cylinder
14	Cylinder Valve	14	Pilot Cylinder Pressure Gauge
15	Cylinder Pressure gauge	15	Pilot Cylinder Valve
16	Bleed Valve	16	Solenoid Actuator
17	Pneumatic and manual actuator	17	Direction valve
18	Discharge hose	18	Discharge Pressure switch
19	Discharge Check valve	19	Nozzle
20	Manifold		

Technical Information

HFC-227ea Container

The 40, 50, 60, 70, 80, 90, 100, 120, 150 & 180L containers are manufactured in accordance with TPED.

Material: P355M

Carbon %	0.14 max
Manganese %	1.60 max
Silicon %	0.50 max
Phosphorus %	0.025 max
Sulphur %	0.010 max

TPED

Burst Pressure:	126 bar (1827 psi)
Hydraulic test pressure:	63 bar (914 psi)
Working Pressure:	42 bar (609 psi)

Paint Specification: Red polyester powder coated

HFC-227ea Container Assembly

The agent storage vessel consists of a container fitted with a valve and internal syphon tube, factory filled with HFC-227ea, and super-pressurized with dry nitrogen to 25 bar @ 21℃(360 psi @ 70℉) and 42 Bar @ 21℃ (600 psi @ 70℉).

Containers sharing the same manifold shall be equal in size and fill density. Containers are finished in red and are available in various sizes (Figure 3).

A nameplate is adhered to the container displaying the agent weight, tare weight, gross weight, fill density and charge date.

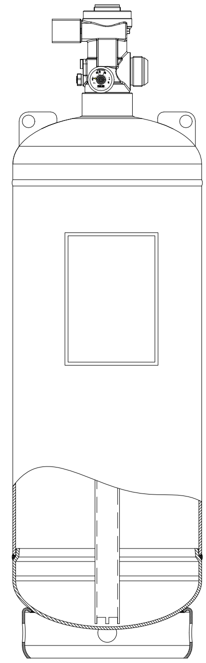


Figure 3 – HFC-227ea Container Assembly

Table 2.1 HFC-227ea Container Assembly Details.

Part No.	Nominal Working Pressure (bar)	Volume (L)	Fill Capacity (Kg)		Outlet Size (mm)	Height (mm)	Diameter (mm)	Empty Weight (Kg)
			Min.	Max.				
811.101.0153	25	40	19.2	44.8	49	830	324	42.0
811.101.0154	42							
811.101.0163	25	50	24.0	56.0	49	950	324	47.0
811.101.0164	42							
811.101.0173	25	60	28.8	67.2	49	1100	324	52.0
811.101.0174	42							
811.101.0183	25	70	33.6	78.4	49	1250	324	56.2
811.101.0184	42							

Part No.	Nominal Working Pressure (bar)	Volume (L)	Fill Capacity (Kg)		Outlet Size (mm)	Height (mm)	Diameter (mm)	Empty Weight (Kg)
			Min.	Max.				
811.101.0193	25	80	38.4	89.6	49	1400	324	62.6
811.101.0194	42							
811.101.0203	25	90	43.2	100.8	49	1200	406	68.4
811.101.0204	42							
811.101.0213	25	100	48.0	112.0	49	1310	406	72.4
811.101.0214	42							
811.101.0223	25	120	57.6	134.4	49	1245	406	96.2
811.101.0224	42							
811.101.0233	25	150	72.0	168.0	49	1495	406	113.1
811.101.0234	42							
811.101.0233	25	180	86.4	201.6	49	1745	462	130.2
811.101.0244	42							
811.101.0151	25	40	19.2	44.8	33	830	324	42.0
811.101.0152	42							
811.101.0161	25	50	24.0	56.0	33	950	324	43.6
811.101.0162	42							
811.101.0171	25	60	28.8	67.2	33	1100	324	49.9
811.101.0172	42							

Container Label

The container label details the weight of HFC-227ea contained, empty weight, fill density and charge date. Once the label is applied to the container surface, and to avoid possible tampering it cannot be removed intact.

Technical Information

Material: PET

Adhesive: A general purpose permanent, acrylic based adhesive.

Dimensions: 241.3mm x 165.1mm (9.5" x 6.5")

(Pt.No. 811.101.070 for Large Containers, 40, 50, 60, 70, 80, 90, 100, 120, 150, 180L)

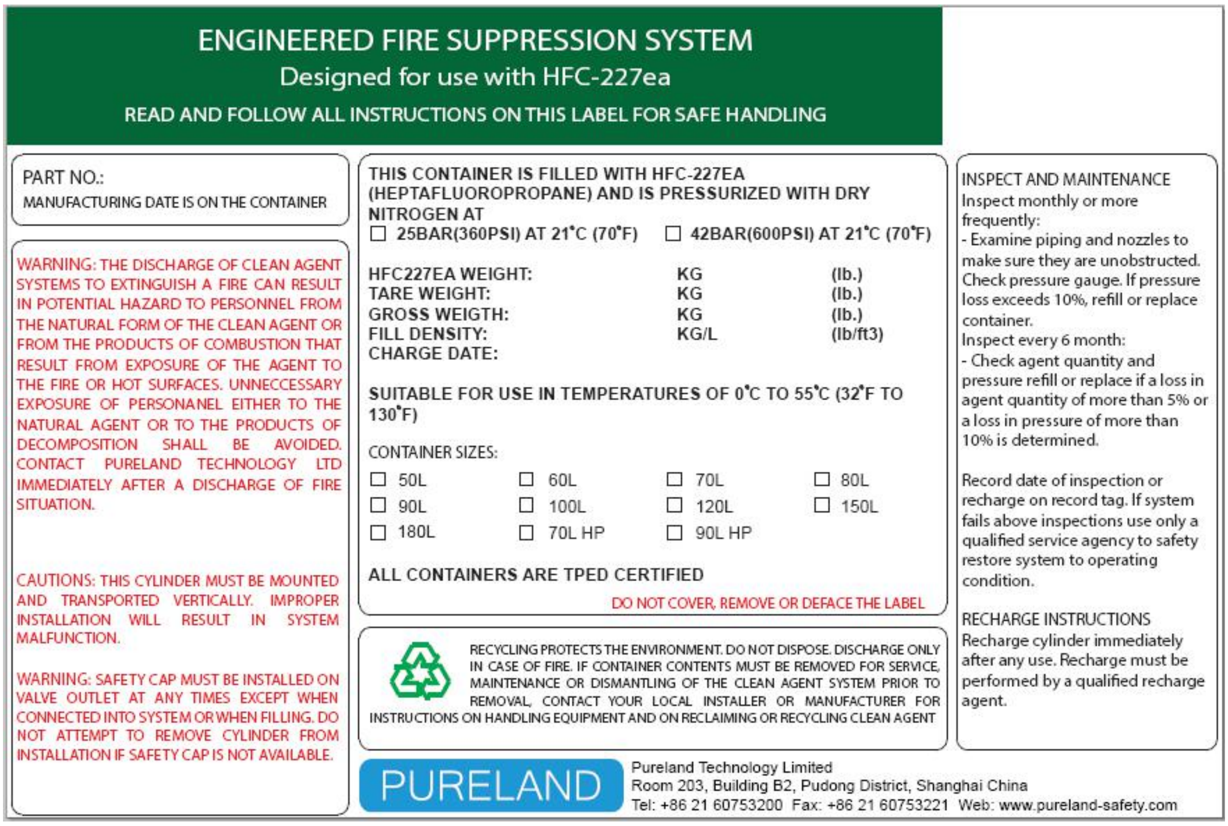


Figure 4 - Container Label

Fixing Brackets

The bracket assembly consists of a nut and bolt, two bracket straps and one back channel. To securely hold the container in position during the system discharge, two bracket assemblies are required per container. Each strap is notched for insertion into the back channel allowing the container to be properly aligned. The bracket assembly is designed to be mounted to a rigid vertical surface with the container assembly resting fully on the floor.

Table 2.2 Container Bracket

Part No.	Container Volume (L)	Container Dia. (mm)
811.106.601	3.4, 7.0	Φ140
811.106.602	40, 50, 60, 70, 80	Φ324
811.106.603	90, 100, 120, 150	Φ406
811.106.604	180	Φ462

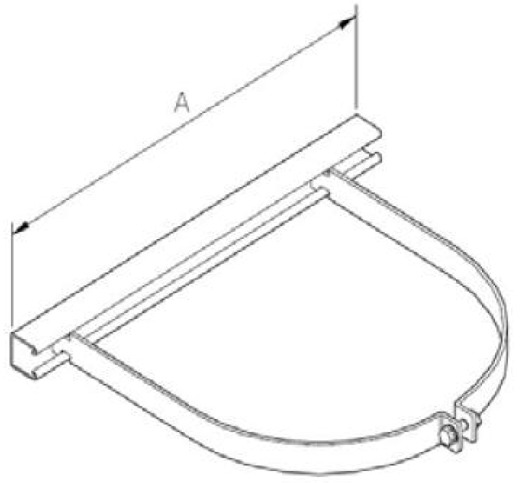


Figure 5 - Fixing Bracket

Table 2.3 Fixing Channel Dimensions

Part No.	Container Size		Dimension A (mm)									
	Volume (L)	Dia. (mm)	Container Quantity									
			1	2	3	4	5	6	7	8	9	10
811.106.701-811.106.710	40, 50, 60, 70, 80	Φ324	620	1020	1420	1820	2220	2620	3020	3420	3820	4220
811.106.711-811.106.720	90, 100 120, 150	Φ406	700	1200	1700	2200	2700	3200	3700	4200	4700	5200
811.106.721-811.106.730	180	Φ462	760	1320	1880	2440	3000	3560	4120	4680	5240	5800

Master valve

Installed in the gas cylinder, can be electric control. Build up the master extinguishing kit together with cylinders, can be used as a pilot gas in multi kits. HFC-227ea gas fire extinguishing system with master valve doesn't need to use pilot nitrogen to start the other cylinders, reduced the risk caused by nitrogen cylinder leakage to open the valve. Cylinder valve has long service life, low leakage rate, can automatically reset after use, re-filling agent needn't change any accessories (such as burst disc, etc.)

Technical Specification:

Table 2.4 Master Valve

Type	**33 mm**	**49 mm**
Body Material	Brass	Brass
Work Pressure	2.5MPa, 21℃ 4.2MPa, 21℃	2.5MPa, 21℃ 4.2MPa, 21℃
Work Temperature	-20℃~ 60℃	-20℃~ 60℃
Inlet	2.5"-12 UN	3"-12 UN
Outlet	1.875 -12 UN	2.5-12 UN
Safety Release pressure	6.0 MPa 10.0 MPa	6.0 MPa 10.0 MPa
Leakage Rate	1×10^{-4}mbarl/s	1×10^{-4}mbarl/s
Work Voltage	24V DC	24V DC
Work Current	0.25 A	0.25 A
Cable Connector	PG9	PG9
Protection Grade	IP65	IP65
Weight:	4.96Kg	9.6Kg

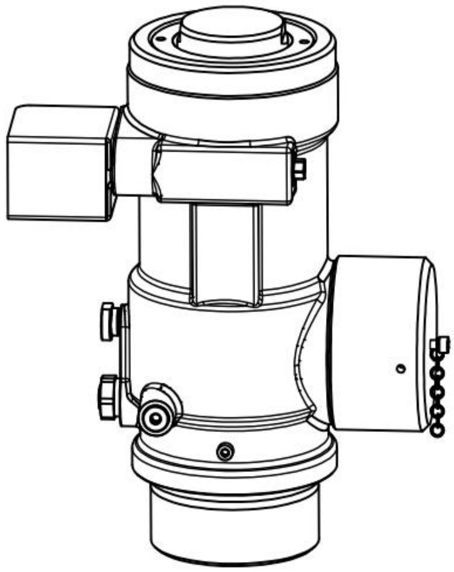


Figure 6a - Master Valve

Slave valve

Installed in the gas cylinder is used to control the release of agent. Build up the slave valve extinguishing kit together with cylinders started by master extinguishing kit. Cylinder valve has long service life, low leakage rate, can automatically reset after use, re-filling agent needn't change any accessories (such as burst disc, etc.)

Technical Specification:

Table 2.5 Slave Valve

Type	33mm	49mm
Body Material	Brass	Brass
Work Pressure	2.5MPa, 21℃ 4.2MPa, 21℃	2.5MPa, 21℃ 4.2MPa, 21℃
Work Temperature	-20℃~60℃	-20 ℃ ~60 ℃
Inlet	2.5-12"UN	3-12"UN
Outlet	1.875"-12UN	2.5"-12UN
Safety Release Pressure	6.0 MPa 10.0 MPa	6.0 MPa 10.0 MPa
Leakage Rate	1×10^{-4}mbarl/s	1×10^{-4}mbarl/s
Weight	4.9 Kg	9.5 Kg

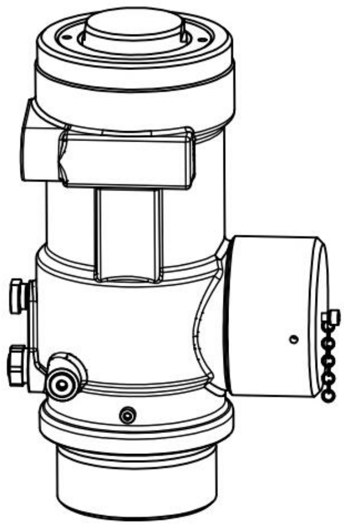


Figure 6b - Slave Valve

Safety Relief Device

A burst disc is factory fitted to every valve assembly, include Master Valve, Slave Valve and Pilot Cylinder Valve. It is designed to rupture when the container becomes over pressurized when subjected to temperatures above the designed storage temperature of the container.

Technical Specification:

Bust pressure: 6.0 MPa for 25 bar system
10.0 MPa for 42 bar system

Body Material: Brass

Burst Disc Material: Nickel

Release Pressure: 6.0 MPa for 25 bar system
10.0 MPa for 42 bar system

Installation Torque: 35 N·m

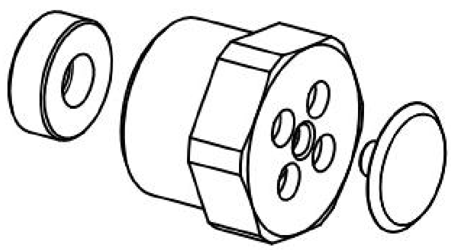


Figure 7 - Safety Relief Device

Pressure Gauge

Agent Pressure Gauge is installed on each extinguishing agent container valve, as a method of visually monitoring the internal pressure condition of the cylinder assembly.

Technical Specification:

Gauge Diameter: Φ41mm

Range: 0 ~ 35 bar for 25bar system
0 ~ 54 bar for 42bar system

Body Material: Stainless steel

Install Thread: Axial M10×1.0

Precision Grade: 1.6 Grade

Work Temperature: -20 ℃ ~ 60 ℃

Weight: 0.05 Kg

Manufacturing standard and Certification: UL

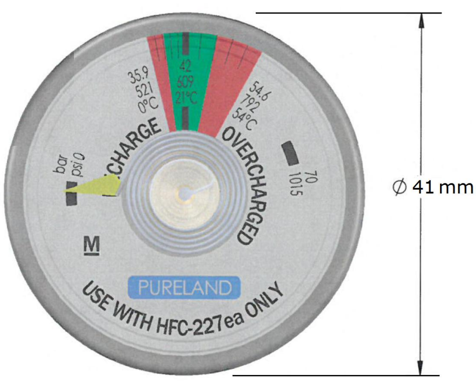


Figure 8 - Pressure Gauge

Safety Valve

The Safety Valve is installed in the Manifold; a burst disc is fitted to this valve. When the internal pressure of the manifold exceeds the expected pressure, the safety disc will be broken quickly, then release the inside pressure. The burst disc is designed to rupture when the manifold becomes over pressurized.

Technical Specification:

Body Material: Brass

Burst Disc Material: Stainless Steel

Bust pressure: 4.6 MPa for 25 bar system

7.2 MPa for 42 bar system

Torque: 35 Nm

Overall Size: 84 mm L× Φ 47mm Dia.

Figure 9 – Safety Valve

Solenoid Actuator（Removable）

The removable Solenoid Actuator locates to the top of the container valve. 24 VDC is required for solenoid operation. Provision is made for the connection of a manual actuator to the top of the actuator assembly. Due to the design of the bridge rectifier it will operate regardless of how it is wired up; the positive supply from control panel can be connected to either terminal 1 or 2 with the reverse for the negative supply.

Technical Specification:

1. Material:
   a. Body: Mild Steel
   b. Swivel nut: Brass
   c. Actuation pin: Stainless Steel
2. Electrical/Electronic requirements/configurations:
   a. Voltage supply range:18-30 VDC (24 VDC nominal)
   b. Current supply range: 0.30 ~ 1.0 A
   c. Max monitoring current: 10 mA
   d. Back EMF Protection: Bridge rectifier
   e. Supervisory switch (N.C.) Internal to actuator
   f. Electrical Connection: Hirschman Type din plug
3. Mechanical configuration:
   a. Nominal pin movement: 6.35 mm
   b. Temperature range: -20℃ ~ +55℃
   c. Connection: M42×1.5
   d. Overall Size: 168mm L× Φ 53mm Dia.
4. Certification: UL

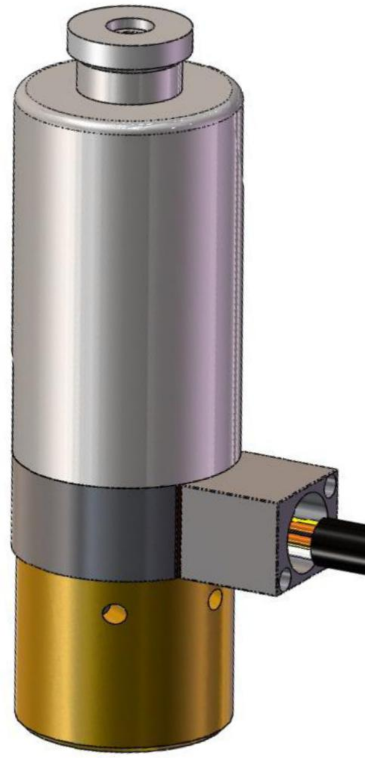


Figure 10 - Solenoid Actuator

Pneumatic and Manual Actuator

Installed on the container valve, used to pneumatically or manually open container valve.

The Pneumatic and Manual Actuator is used to pneumatically or manual mechanically operate the system at the container position and is fitted to the top of the valve assembly. Pressure from a 'Master' container or manual force is used to actuate the valve.

Technical Specification:

Body Material: Brass

Piston Rod: Brass

Install Thread: M42×1.5 Female

Install Torque: ~15N·m

Pneumatic Connection Thread: G1/8 Female

Min Actuation Pressure: 0.4 MPa

Working Temperature: -20℃~60℃

Manual Operating Force: < 150 N

Overall Size: 70 mm H×φ50mm Dia.

Weight: 0.6 Kg

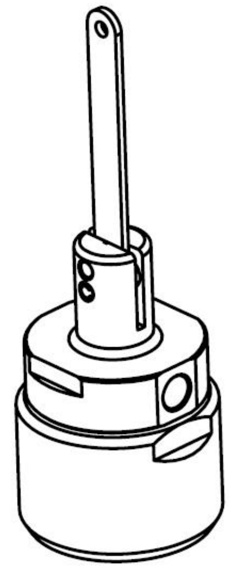


Figure 11 - Pneumatic and Manual Actuator

Pneumatic Actuator

The Pneumatic Actuator is used to pneumatically operate the system at the container position and is fitted to the top of the valve assembly. Pressure from a 'Master' Container is used to actuate the valve, via small bore piping or a flexible hose.

Technical Specification:

Body Material: Brass

Piston Rod: Brass

Install Thread: M42×1.5 Female

Install Torque: ~15N·m

Pneumatic Connection Thread: G1/8 Female

Min Actuation Pressure: 0.4 MPa

Working Temperature: -20℃~60℃

Overall Size: 50 mm H× Φ 50mm Dia.

Weight: 0.5 Kg

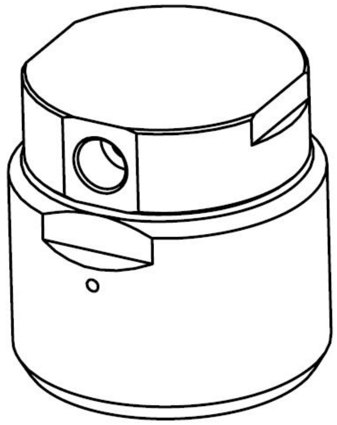


Figure 12 - Pneumatic Actuator

Manual Release Device

The Manual Actuator is used to mechanically operate the system at the container position and is fitted to the top of the valve assembly. Inadvertent operation is prevented by a safety pin which has to be removed before releasing.

Technical Specification:

Body Material: Brass

Piston Rod: Brass

Install Thread: M42×1.5 Female

Install Torque: ~15N·m

Working Temperature: -20℃~60℃

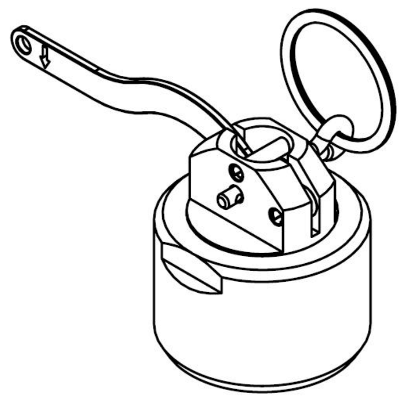


Figure 13 - Manual Release Device

Manual Operating Force: < 150 N
Overall Size: 50 mm H× Φ 50mm Dia.
Weight: 0.5 Kg

Pilot Cylinder

The 3.4 & 7.0 L cylinders are manufactured in accordance with TPED.

Material	
Carbon %	0.34 ~0 .38
Manganese %	1.40 ~1.70
Silicon %	0.10 ~ 0.30
Phosphorus %	0.020 max
Sulphur %	0.010 max

TPED	
Hydraulic test pressure:	250 bar (3625 psi)
Working Pressure:	166.7 bar (2417 psi)

Paint Specification:	Red polyester powder coated

Pilot Cylinder Valve

Installed in the gas cylinder, can be electric control. Build up the pilot kit together with N_2 cylinder, can be used as a pilot gas in multi kits. The Pilot Cylinder valve has long service life, low leakage rate, can automatically reset after use, re-filling agent needn't change any accessories (such as burst disc, etc.)

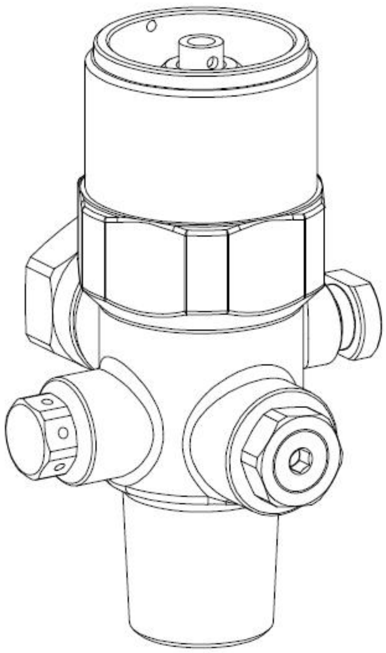


Figure 14 - Pilot Cylinder Valve

Technical Specification:

Table 2.6 Pilot Cylinder Valve

Body Material	Brass
Working Pressure	1.0 MPa @ 21℃
Working Temperature	-20℃~ 65℃
Inlet Thread	PZ27.8×1/14"
Outlet Thread	M14×1.5
Safety Release pressure	3.6 MPa
Leakage Rate	1×10^{-4} mbarl/s
Weight	1.8 Kg

Pilot Cylinder Valve Pressure Gauge

This pressure gauge is installed on the pilot cylinder valve used for real-time display of cylinder pressure.

Technical Specification:

Gauge Diameter: Φ 41 mm

Range: 0 ~ 11.4bar

Body Material: Stainless steel Install

Thread: Axial M10×1.0 Male

Precision Grade: 1.6 Grade

Work Temperature: -40 ℃ ~ 60 ℃

Weight: 0.05 Kg

Manufacturing and Certification standard: UL

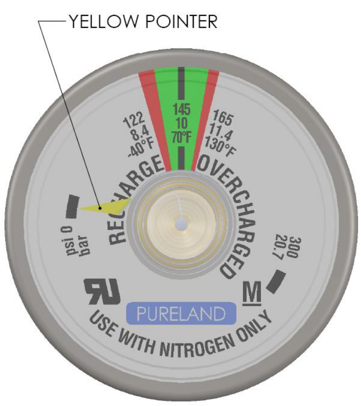


Figure 15 - Pilot Cylinder Valve Pressure Gauge

Discharge Hose

Container installations may be connected to the system by means of a flexible discharge hose.This enables containers to be disconnected for maintenance or recharge without dismantling other container mountings, manifold connections and pipework, etc.The flexible discharge hose is provided with a swivel fitting at the inlet. Discharge hose is installed between container valve and check valve used to connect agent cylinder in a system, convenient installation and maintenance of them.

Technical Specification

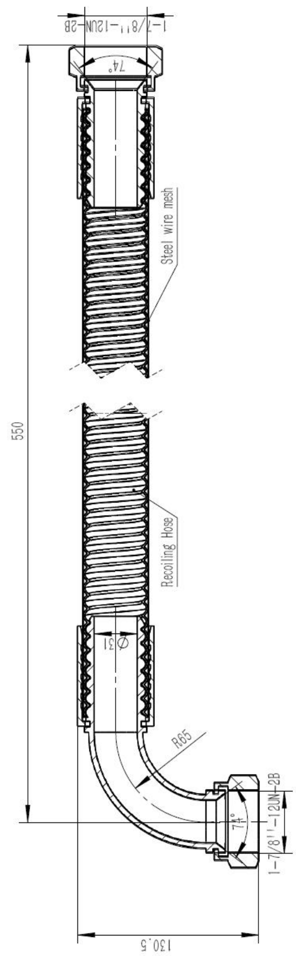


Figure 16 - Discharge hose

Table 2.7 Discharge Hose

Hose Material	Teflon hose with stainless steel braid overlay	Teflon hose with stainless steel braid overlay
Type	33 mm	49 mm
Length	550 mm	700 mm
Inlet Thread	1.875"-12UN	2.5"-12 UN
Outlet Thread	1.875"-12UN	2.5"-12 UN
Minimum Bending Radius	400 mm	500 mm
Working Temperature	-20℃~60℃	-20℃~60℃
Working Pressure	4.2 MPa	4.2 MPa
Burst Pressure	>20.0MPa	>20.0MPa
Weight	2.8 Kg	4.6 Kg

Pilot Hose

The pilot hose is used to connect pressure activated devices to the system, e.g. the pilot cylinder to the slave container to the pressure switch.

Technical Specification:

Hose Material: Steel wire braided rubber hose
Nominal Diameter: Φ6 mm
Install Thread: G1/8
Install Torque: 22.5±2.5N·m
Bending Radius: 75mm min.
Length: 400mm, 500mm, 700mm
Working Temperature: -20℃~60℃
Working Pressure: 4.2 MPa
Burst Pressure: >20.0 MPa

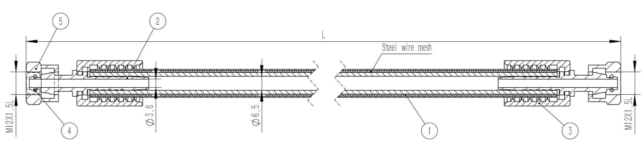


Figure 17 - Pilot Hose

Bleed Valve

On manifolded systems with connected reserves it is necessary to fit bleed valves at the location of the pneumatic actuator of the last slave container of both duty and reserve actuation lines. Also on systems utilising a pilot cylinder for operation, a bleed valve is required to be fitted into the pilot line.

The bleed valve acts to relieve a gradual pressure build-up occurring perhaps as a result of a leaking pilot cylinder or check valve. It also provides a means by which pressure trapped in the actuation line may be manually relieved.

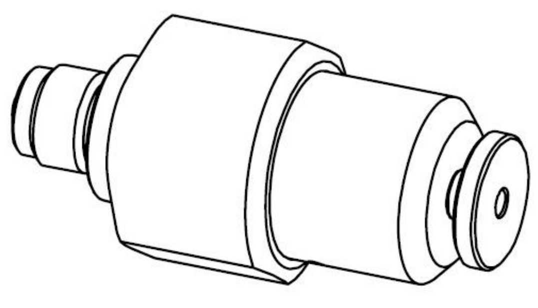


Figure 18 - Bleed Valve

The bleed valve relieves automatically up to a pressure of approximately 1.5 bar and seals at pressures above this.

Bleed valve is installed in the end of a closed pipeline, normal opened. It is used to eliminate leakage gas due to accumulate in the pipeline, to prevent the system false starts, it will be closed, while inlet pressure up to setting point. After activation press the valve button, release the gas in the pipeline, then valve is reset.

Technical Specification:

Body Material: Brass

Install Thread: G1/8

Flow Rate: ≥6 L/min @ 0.06 MPa

Closed Pressure: 0.07~0.15 MPa

Install Torque: 8 N·m

Maximum Working Pressure: 6.4 MPa

Working Temperature: -20℃~60℃

Weight: 0.1 Kg

Manifold

Manifolds are fabricated sections of steel pipe-work. They enable multiple containers to be connected to a common pipe network. They can be used in conjunction with check valves in situations where main / reserve containers arrangements are required.

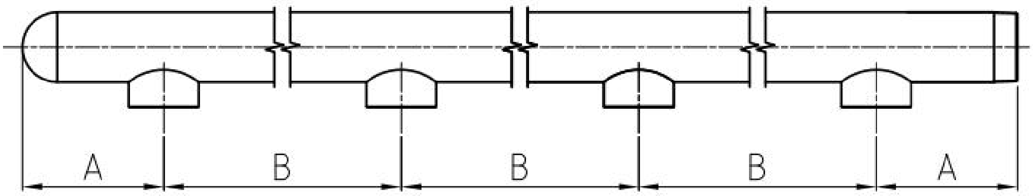
Technical Information

Material: ASTM A106 Gr B / BS 3601 Schedule 80

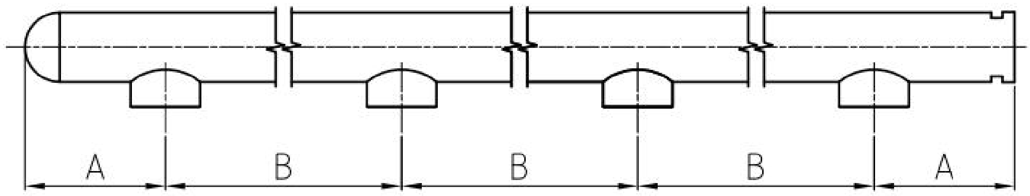
Inlet: Check valve threaded connections

Outlet: BSP Taper, Flange and Grooved Coupling

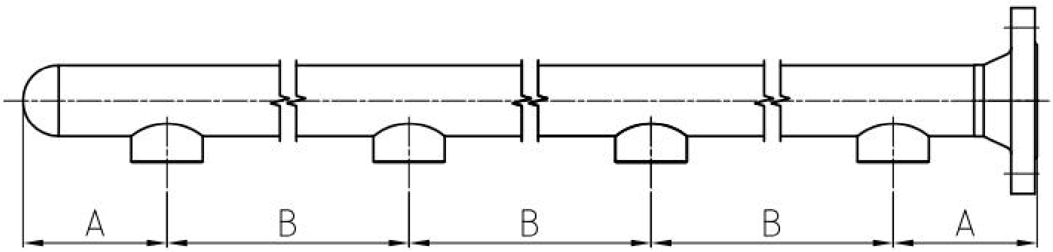
Test Pressure: 90 bar (1305 psi)



T type - BSP Thread end



G type - Grooved Coupling end



F type - Flange end

Figure 19 - Manifold Type

Table 2.8 Manifolds Size

Part No.	Size (mm)	Dim.A (mm)	Dim.B (mm)	Part No.	Size (mm)	Dim.A (mm)	Dim.B (mm)
811.105.101.T/F/G	2 port 65	150	400	811.105.310.T/F/G	5 port 100	150	560
811.105.102.T/F/G	3 port 65	150	400	811.105.311.T/F/G	6 port 100	150	560
811.105.103.T/F/G	4 port 65	150	400	811.105.312.T/F/G	7 port 100	150	560
811.105.104.T/F/G	5 port 65	150	400	811.105.401.T/F/G	2 port 150	150	500
811.105.201.T/F/G	2 port 80	150	500	811.105.402.T/F/G	3 port 150	150	500
811.105.202.T/F/G	3 port 80	150	500	811.105.403.T/F/G	4 port 150	150	500
811.105.203.T/F/G	4 port 80	150	500	811.105.404.T/F/G	5 port 150	150	500
811.105.204.T/F/G	5 port 80	150	500	811.105.405.T/F/G	6 port 150	150	500
811.105.205.T/F/G	6 port 80	150	500	811.105.406.T/F/G	7 port 150	150	500
811.105.301.T/F/G	2 port 100	150	500	811.105.407.T/F/G	2 port 150	150	560

Part No.	Size (mm)	Dim.A (mm)	Dim.B (mm)	Part No.	Size (mm)	Dim.A (mm)	Dim.B (mm)
811.105.302.T/F/G	3 port 100	150	500	811.105.408.T/F/G	3 port 150	150	560
811.105.303.T/F/G	4 port 100	150	500	811.105.409.T/F/G	4 port 150	150	560
811.105.304.T/F/G	5 port 100	150	500	811.105.410.T/F/G	5 port 150	150	560
811.105.305.T/F/G	6 port 100	150	500	811.105.411.T/F/G	6 port 150	150	560
811.105.306.T/F/G	7 port 100	150	500	811.105.412.T/F/G	7 port 150	150	560
811.105.307.T/F/G	2 port 100	150	560	811.105.413.T/F/G	8 port 150	150	560
811.105.308.T/F/G	3 port 100	150	560	811.105.414.T/F/G	9 port 150	150	560
811.105.309.T/F/G	4 port 100	150	560	811.105.415.T/F/G	10 port 150	150	560

Finish: Primed, Ready to paint on site.

Note: 1. Assembly includes 33 / 49mm check valves and end cap.

2. T- Thread Connection, F- Flange Connection, G- Grooved Connection.

Manifold Bracket Assembly

A manifold bracket assembly consists of two lengths of unirax, mounted vertically on a wall or bulk head to enable height adjustment of the manifold assembly. Cantilever brackets are located over the unirax and each are held in position using a uninut long spring, washer and hex head screw. Manifold brackets slot into the cantilever and are clamped using a hex head screw and plain nut.

65mm (2.5") Manifold Bracket Part No. 811.107.007
80mm (3")   Manifold Bracket Part No. 811.107.008
100mm (4") Manifold Bracket Part No. 811.107.009
150mm (6") Manifold Bracket Part No. 811.107.010
Manifold Cantilever Support Part No. 811.107.101

Figure 20 - Manifold Bracket Assembly

Manifold Check Valve

Manifold check valves are of mushroom pattern type and lift into the manifold as discharge occurs. The function of the check valve is to prevent loss of extinguishing agent during discharge from an outlet, should a container have been removed. All check valves are ordered separately to the manifold assembly.

Manifold check valve is installed on the manifold behind the discharge hose to control the extinguishing agent.

Technical Specification:

Table 2.9 Manifold Check Valve

Type	33mm	49mm
Body Material	Brass	Brass
Stem Material	Stainless steel	Stainless steel
Work Pressure	8.0 MPa	8.0 MPa
Leakage Test Pressure	8.0 MPa	8.0 MPa
Hydraulic Strength Test Pressure	10.0 MPa	10.0 MPa
Inlet Thread	1.875"-12UN	2.5"-12UN
Outlet Thread	R2	R2.5
Weight:	0.9Kg	1.82Kg

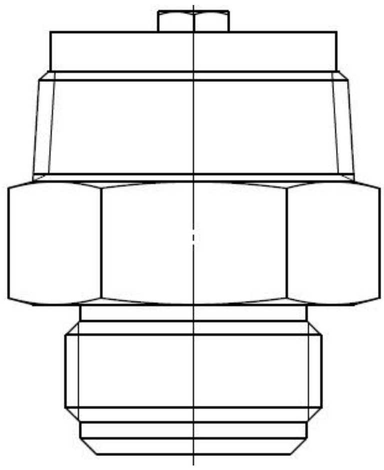


Figure 21 - Manifold Check Valve

Discharge Nozzle

HFC-227ea is distributed within the protected area by the discharge nozzle which is sized to ensure the correct flow of agent for the risk. Nozzles are available with 8 ports to allow for 180° or 360° horizontal discharge patterns. Ports are drilled in special increments to the specified system design. Discharge nozzles are installed in the end of pipeline hole size is calculated, discharge the gas uniformly, and satisfies the requirement of discharge time.

Technical Specification:

Body Material: Brass

Assembly Thread: Taper Female Thread

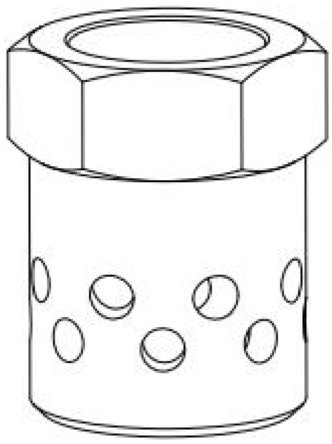


Figure 22a - 180° Nozzle

Figure 22b - 360° Nozzle

Table 2.10 Discharge Nozzle

180° Nozzle				360° Nozzle			
Part No.	Nozzle Type	Hole Dia. (mm)	Thread	Part No.	Nozzle Type	Hole Dia. (mm)	Thread
811.104.101	180-15-2.2	2.2	BSP1/2"	811.114.101	360-15-2.2	2.2	BSP1/2"
811.104.102	180-15-2.5	2.5	BSP1/2"	811.114.102	360-15-2.5	2.5	BSP1/2"
811.104.103	180-15-2.8	2.8	BSP1/2"	811.114.103	360-15-2.8	2.8	BSP1/2"
811.104.104	180-15-3.1	3.1	BSP1/2"	811.114.104	360-15-3.1	3.1	BSP1/2"
811.104.105	180-15-3.4	3.4	BSP1/2"	811.114.105	360-15-3.4	3.4	BSP1/2"
811.104.106	180-15-3.7	3.7	BSP1/2"	811.114.106	360-15-3.7	3.7	BSP1/2"
811.104.107	180-15-4.0	4.0	BSP1/2"	811.114.107	360-15-4.0	4.0	BSP1/2"
811.104.108	180-15-4.3	4.3	BSP1/2"	811.114.108	360-15-4.3	4.3	BSP1/2"
811.104.109	180-15-4.6	4.6	BSP1/2"	811.114.109	360-15-4.6	4.6	BSP1/2"
811.104.110	180-15-5.0	5.0	BSP1/2"	811.114.110	360-15-5.0	5.0	BSP1/2"
811.104.201	180-20-3.1	3.1	BSP3/4"	811.114.201	360-20-3.1	3.1	BSP3/4"
811.104.202	180-20-3.4	3.4	BSP3/4"	811.114.202	360-20-3.4	3.4	BSP3/4"
811.104.203	180-20-3.7	3.7	BSP3/4"	811.114.203	360-20-3.7	3.7	BSP3/4"
811.104.204	180-20-4.0	4.0	BSP3/4"	811.114.204	360-20-4.0	4.0	BSP3/4"
811.104.205	180-20-4.3	4.3	BSP3/4"	811.114.205	360-20-4.3	4.3	BSP3/4"
811.104.206	180-20-4.6	4.6	BSP3/4"	811.114.206	360-20-4.6	4.6	BSP3/4"
811.104.207	180-20-5.0	5.0	BSP3/4"	811.114.207	360-20-5.0	5.0	BSP3/4"
811.104.208	180-20-5.3	5.3	BSP3/4"	811.114.208	360-20-5.3	5.3	BSP3/4"
811.104.209	180-20-5.6	5.6	BSP3/4"	811.114.209	360-20-5.6	5.6	BSP3/4"
811.104.210	180-20-5.9	5.9	BSP3/4"	811.114.210	360-20-5.9	5.9	BSP3/4"
811.104.211	180-20-6.2	6.2	BSP3/4"	811.114.211	360-20-6.2	6.2	BSP3/4"
811.104.212	180-20-6.6	6.6	BSP3/4"	811.114.212	360-20-6.6	6.6	BSP3/4"
811.104.301	180-25-3.9	3.9	BSP1"	811.114.301	360-25-3.9	3.9	BSP1"
811.104.302	180-25-4.3	4.3	BSP1"	811.114.302	360-25-4.3	4.3	BSP1"
811.104.303	180-25-4.7	4.7	BSP1"	811.114.303	360-25-4.7	4.7	BSP1"
811.104.304	180-25-5.1	5.1	BSP1"	811.114.304	360-25-5.1	5.1	BSP1"
811.104.305	180-25-5.5	5.5	BSP1"	811.114.305	360-25-5.5	5.5	BSP1"
811.104.306	180-25-5.9	5.9	BSP1"	811.114.306	360-25-5.9	5.9	BSP1"
811.104.307	180-25-6.3	6.3	BSP1"	811.114.307	360-25-6.3	6.3	BSP1"
811.104.308	180-25-6.7	6.7	BSP1"	811.114.308	360-25-6.7	6.7	BSP1"
811.104.309	180-25-7.1	7.1	BSP1"	811.114.309	360-25-7.1	7.1	BSP1"
811.104.310	180-25-7.5	7.5	BSP1"	811.114.310	360-25-7.5	7.5	BSP1"
811.104.311	180-25-7.9	7.9	BSP1"	811.114.311	360-25-7.9	7.9	BSP1"
811.104.312	180-25-8.4	8.4	BSP1"	811.114.312	360-25-8.4	8.4	BSP1"
811.104.401	180-32-5.1	5.1	BSP1¼"	811.114.401	360-32-5.1	5.1	BSP1¼"
811.104.402	180-32-5.5	5.5	BSP1¼"	811.114.402	360-32-5.5	5.5	BSP1¼"
811.104.403	180-32-5.9	5.9	BSP1¼"	811.114.403	360-32-5.9	5.9	BSP1¼"
811.104.404	180-32-6.3	6.3	BSP1¼"	811.114.404	360-32-6.3	6.3	BSP1¼"

180° Nozzle				360° Nozzle			
Part No.	Nozzle Type	Hole Dia. (mm)	Thread	Part No.	Nozzle Type	Hole Dia. (mm)	Thread
811.104.405	180-32-6.7	6.7	BSP1¼"	811.114.405	360-32-6.7	6.7	BSP1¼"
811.104.406	180-32-7.1	7.1	BSP1¼"	811.114.406	360-32-7.1	7.1	BSP1¼"
811.104.407	180-32-7.5	7.5	BSP1¼"	811.114.407	360-32-7.5	7.5	BSP1¼"
811.104.408	180-32-7.9	7.9	BSP1¼"	811.114.408	360-32-7.9	7.9	BSP1¼"
811.104.409	180-32-8.4	8.4	BSP1¼"	811.114.409	360-32-8.4	8.4	BSP1¼"
811.104.410	180-32-8.8	8.8	BSP1¼"	811.114.410	360-32-8.8	8.8	BSP1¼"
811.104.411	180-32-9.2	9.2	BSP1¼"	811.114.411	360-32-9.2	9.2	BSP1¼"
811.104.412	180-32-9.6	9.6	BSP1¼"	811.114.412	360-32-9.6	9.6	BSP1¼"
811.104.413	180-32-10.0	10.0	BSP1¼"	811.114.413	360-32-10.0	10.0	BSP1¼"
811.104.414	180-32-10.4	10.4	BSP1¼"	811.114.414	360-32-10.4	10.4	BSP1¼"
811.104.415	180-32-10.8	10.8	BSP1¼"	811.114.415	360-32-10.8	10.8	BSP1¼"
811.104.416	180-32-11.0	11.0	BSP1¼"	811.114.416	360-32-11.0	11.0	BSP1¼"
811.104.501	180-40-6.5	6.5	BSP1½"	811.114.501	360-40-6.5	6.5	BSP1½"
811.104.502	180-40-7.0	7.0	BSP1½"	811.114.502	360-40-7.0	7.0	BSP1½"
811.104.503	180-40-7.5	7.5	BSP1½"	811.114.503	360-40-7.5	7.5	BSP1½"
811.104.504	180-40-8.0	8.0	BSP1½"	811.114.504	360-40-8.0	8.0	BSP1½"
811.104.505	180-40-8.5	8.5	BSP1½"	811.114.505	360-40-8.5	8.5	BSP1½"
811.104.506	180-40-9.0	9.0	BSP1½"	811.114.506	360-40-9.0	9.0	BSP1½"
811.104.507	180-40-9.5	9.5	BSP1½"	811.114.507	360-40-9.5	9.5	BSP1½"
811.104.508	180-40-10.0	10.0	BSP1½"	811.114.508	360-40-10.0	10.0	BSP1½"
811.104.509	180-40-10.5	10.5	BSP1½"	811.114.509	360-40-10.5	10.5	BSP1½"
811.104.510	180-40-11.0	11.0	BSP1½"	811.114.510	360-40-11.0	11.0	BSP1½"
811.104.511	180-40-11.5	11.5	BSP1½"	811.114.511	360-40-11.5	11.5	BSP1½"
811.104.512	180-40-12.0	12.0	BSP1½"	811.114.512	360-40-12.0	12.0	BSP1½"
811.104.513	180-40-12.5	12.5	BSP1½"	811.114.513	360-40-12.5	12.5	BSP1½"
811.104.514	180-40-13.0	13.0	BSP1½"	811.114.514	360-40-13.0	13.0	BSP1½"
811.104.601	180-50-8.5	8.5	BSP2"	811.114.601	360-50-8.5	8.5	BSP2"
811.104.602	180-50-9.0	9.0	BSP2"	811.114.602	360-50-9.0	9.0	BSP2"
811.104.603	180-50-9.5	9.5	BSP2"	811.114.603	360-50-9.5	9.5	BSP2"
811.104.604	180-50-10.0	10.0	BSP2"	811.114.604	360-50-10.0	10.0	BSP2"
811.104.605	180-50-10.5	10.5	BSP2"	811.114.605	360-50-10.5	10.5	BSP2"
811.104.606	180-50-11.0	11.0	BSP2"	811.114.606	360-50-11.0	11.0	BSP2"
811.104.607	180-50-11.5	11.5	BSP2"	811.114.607	360-50-11.5	11.5	BSP2"
811.104.608	180-50-12.0	12.0	BSP2"	811.114.608	360-50-12.0	12.0	BSP2"
811.104.609	180-50-12.5	12.5	BSP2"	811.114.609	360-50-12.5	12.5	BSP2"
811.104.610	180-50-13.0	13.0	BSP2"	811.114.610	360-50-13.0	13.0	BSP2"
811.104.611	180-50-13.5	13.5	BSP2"	811.114.611	360-50-13.5	13.5	BSP2"
811.104.612	180-50-14.0	14.0	BSP2"	811.114.612	360-50-14.0	14.0	BSP2"
811.104.613	180-50-14.5	14.5	BSP2"	811.114.613	360-50-14.5	14.5	BSP2"
811.104.614	180-50-15.0	15.0	BSP2"	811.114.614	360-50-15.0	15.0	BSP2"
811.104.615	180-50-15.5	15.5	BSP2"	811.114.615	360-50-15.5	15.5	BSP2"

180° Nozzle				360° Nozzle			
Part No.	Nozzle Type	Hole Dia. (mm)	Thread	Part No.	Nozzle Type	Hole Dia. (mm)	Thread
811.104.616	180-50-16.0	16.0	BSP2"	811.114.616	360-50-16.0	16.0	BSP2"
811.104.617	180-50-16.5	16.5	BSP2"	811.114.617	360-50-16.5	16.5	BSP2"

Note: The orifice diameter is defined with flow calculation Software.

Table 2.11 Discharge Nozzle Equivalent Orifice Area

Nozzle Code	180° & 360° 8 Holes Nozzle		Nozzle Code	180° & 360° 8 Holes Nozzle	
	Equivalent Orifice Area (mm^2)	Drill Diameter for Every Hole （mm）		Equivalent Orifice Area (mm^2)	Drill Diameter for Every Hole （mm）
6	30.40	2.2	30	443.21	8.4
7	39.26	2.5	31	453.82	8.5
8	49.25	2.8	32	486.42	8.8
9	60.36	3.1	33	508.78	9.0
10	72.61	3.4	34	531.65	9.2
11	85.99	3.7	35	566.89	9.5
12	95.54	3.9	36	578.88	9.6
13	100.50	4.0	37	628.13	10.0
14	116.14	4.3	38	679.38	10.4
15	132.91	4.6	39	692.51	10.5
16	138.75	4.7	40	732.65	10.8
17	157.03	5.0	41	760.04	11.0
18	163.38	5.1	42	830.70	11.5
19	176.44	5.3	43	904.51	12.0
20	190.01	5.5	44	981.45	12.5
21	196.98	5.6	45	1061.54	13.0
22	218.65	5.9	46	1144.76	13.5
23	241.45	6.2	47	1231.13	14.0
24	249.30	6.3	48	1320.64	14.5
25	273.61	6.6	49	1413.29	15.0
26	281.97	6.7	50	1509.08	15.5
27	316.64	7.1	51	1608.01	16.0
28	353.32	7.5	52	1710.08	16.5
29	392.02	7.9			

Discharge Pressure Switch

Feedback the information generated by the agent release pressure to tell the extinguishing control panel that system is opened, to indicate extinguishing agent released.

Manufacturer: United Electric Controls
Model: H100-704
Material: Gravity die-cast enclosure in aluminium-silicon alloy, epoxy painted internally and externally.
Working Temperature: -40℃~ 71℃
Design Pressure: 10 MPa
Action Pressure: 0.5 MPa
Protection Grade: NEMA 4X, IP66
Process Connection Thread: NPTF1/4
Electrical Entry: NPTF1/2
Weight: 1.7Kg
Certification: UL

Figure 23 - Relief Device of Manifold

Section 3 Installation

Container Installation

The container location is identified on the system drawings and should be protected from extremes of temperature, and be accessible for service and maintenance. The containers must be firmly secured to a wall or bulkhead.

33mm(1¼") Safety Outlet Cap Part No.811.101.032
49mm(2") Safety Outlet Cap Part No.811.101.033
Actuation Cap Part No.811.101.034

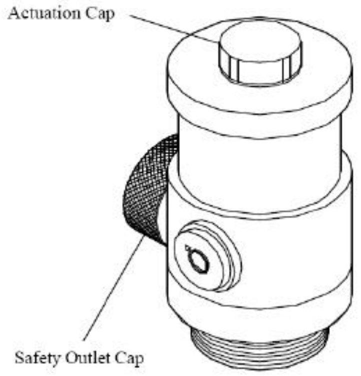


Figure 24 - Safety outlet and Actuation Caps

Single Container Installation

1. Fix the back channels of the mounting brackets to the wall at the appropriate heights (see table 11), using suitable anchor type bolts (not supplied).
2. Position the container against the back channel with the valve outlet pointing left.
3. Insert the container straps at top and bottom and secure with the bolts provided (see Figure 30).
4. Remove the Safety Outlet cap from the valve outlet adaptor (see Figure 29).
5. With the outlet cap removed from the valve outlet adaptor, install a union coupling.
6. Remove the union and replace the Safety Outlet Cap after the initial pipe run has been installed.

Table 3.1 Bracket Fixing Heights

Container Size (L)	No.of Unistrut Channels	Height From Floor to Bracket (mm)
50	2	300, 650
60	2	350, 750
70	2	400, 800
80	2	400, 900
90	2	400, 800
100	2	400, 850
120	2	400, 800
150	2	400, 1100
180	2	400, 1300

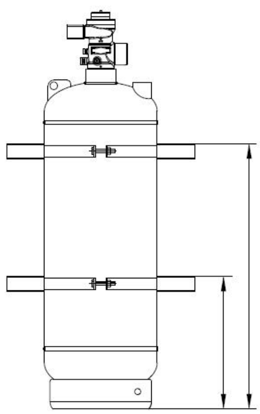


Figure 25 - Container Strap Location

Multiple Container Installation

Containers are manifolded together for three main reasons:

- To reduce the amount of piping required by connection to one feeder pipe.
- For systems that require main and reserve.
- Combining the correct containers to obtain the required quantity of agent within a specific

hazard Area.

A typical 80mm (3"), three port manifold assembly consists of the manifold, three check valves and an end cap. Each check valve is bolted to a screw inlet on the manifold.

1. Fix the back channels of the mounting brackets to the wall at the appropriate heights (see table 7), using suitable anchor type bolts (not supplied).
2. Position the containers against the back channels with the valve outlets pointing left at the required spacing for the manifold ports (see Figure 14, dimension B).
3. Insert the container straps at top and bottom and secure with the bolts provided (see Figure 14).

Manifold Bracket Installation

1. Fix the two back vertical channels to the wall at the appropriate height using suitable anchor type bolts(see table 8).

Back channels are used to ensure that the appropriate height adjustment is available when connecting the discharge hose from the valve outlet to the manifold check valve (see figure 23).

2. Locate and secure the cantilever brackets to each channel using M10 x 40mm Hex Head screw and uninut long spring 10mm.
3. Locate manifold brackets in cantilever channel and unirax end caps.
4. Remove outlet safety cap and attach discharge hose between valve and manifold. Adjust cantilever height as required and secure in position.
5. For safety remove discharge hose and replace safety caps, while pipework is installed.
6. **For 3 in. valve:** To install hose/check valve assembly between the valve discharge outlet and the pipe manifold, complete the following steps.(see Figure 25).

Caution. Make certain the swivel nut covers the paint on the check valve threads or malfunction of the hose/check valve combination may result. Do not overtighten, as the nut will bend the hose, resulting in flow restriction.

a. Install the check valve into the manifold inlet.

b. Align the valve outlet with the inlet of the discharge hose. Install the swivel nut on the discharge valve. Wrench tighten.

c. Thread the hose swivel nut onto the check valve until the swivel nut covers the paint on the check valve threads. Secure the nut with the locking set screw (provided) to prevent the nut from loosening with vibration.

Table 3.2 Manifold Bracket Fixing Heights

Container Size (L)	Valve Size (mm)	Height From Floor to top of cantilever (mm)
40		
50	33	1500
60	33	1650
70	33	1800
80	33	1950
90	33	1750
100	33	1860

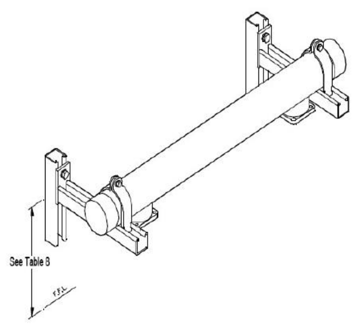


Figure 26 - Manifold Assembly

120	49	1795
150	49	2045
180	49	2295

Nozzle Installation

All nozzles require the installation of a dirt trap comprising 1 side tee, 2 nipples, and 1 pipe cap. Fit the nozzle to the nipple on the dirt trap and check the nozzle orifice to ensure proper orientation. Dirt trap lengths should be no more than 10 times nominal pipe diameter.

A false ceiling comprising loose tiles must have the tiles retained within a 2m (6.5ft) radius of the nozzle, to prevent movement during system discharge. Nozzles should be installed a maximum of 300mm (12") below the ceiling.

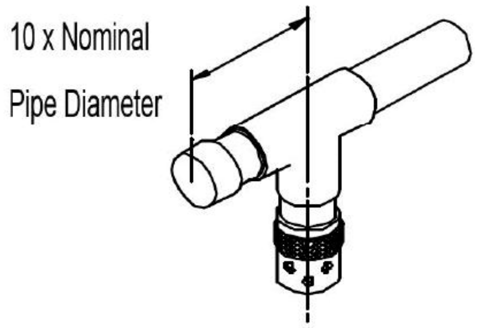


Figure 27 - Dirt Trap

Slave Actuation Pilot Line

For slave containers the pneumatic connection is made using flexible pilot hoses. To fit the pilot hoses, remove the 1/4" pilot pressure port plug from the master container valve assembly and install the 1/4" male adaptor (Part No. 811.102.006) for the 33 mm and 49mm valves.

Install the 1/4" male adaptor on to all pneumatic actuators (wrench tight). Connect one end of the pilot hose Part No. 811.102.003-5 to the adaptor on the master container and one end to the other one on the pneumatic actuator. The maximum number of slave actuated containers is 9 (10 containers system in total).

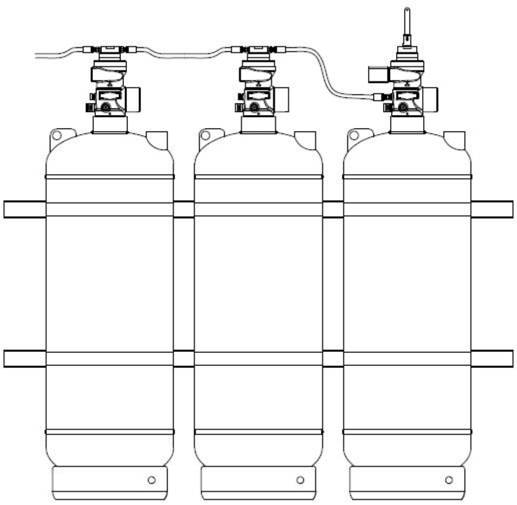


Figure 28 - Multiple Container Actuation

Discharge Pressure Switch Installation

Single Container Systems

On single container installations the pressure switch should be located close to the valve assembly and connected with a pilot hose from the pressure port outlet on the valve to the connector on the pressure switch (see Figure 29a).

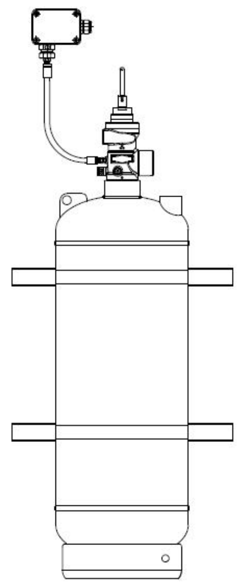


Figure 29a - Discharge Pressure Switch Installation for single container systems

Multiple Container Systems

On multi-container installations the pressure switch should be located close to the last slave container and connected by pilot hose to the tee connector on the pneumatic actuator (see Figure 29b).

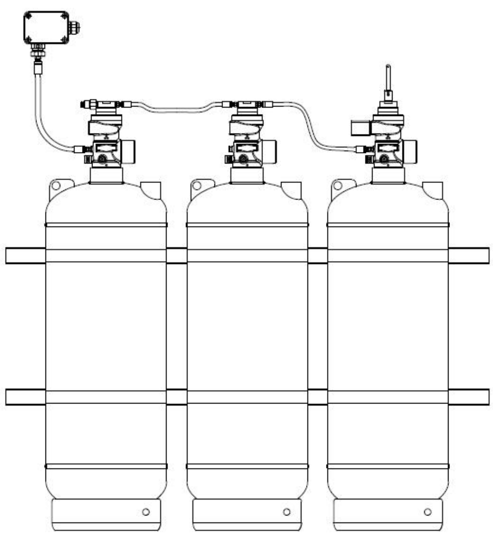


Figure 29b - Discharge Pressure Switch Installation for multiple container systems

Section 4 System Design

System Design

There are two main elements of system design. The first is the risk assessment; determining the type of protection required, considerations such as ventilation, openings and restrictions; equipment location. etc. The second is calculating the quantity of HFC-227ea required, including floor and/or ceiling voids, positioning of nozzles, electrical requirements, etc.

A Site Survey / Request form is a useful tool to aidememory for addressing the relevant factors, and can be used subsequently to substantiate the design criteria. This can be found in Appendix A. All systems are designed in accordance with the BFPSA Code of Practise for Gaseous Fire Fighting Systems, the appropriate British Standards, currently BS5306 section 5.1. and NFPA 2001.

Hazard Analysis

The first, and one of the most important, exercises in planning an HFC-227ea extinguishing system is the hazard survey. The information derived from the survey should include risk assessment, environmental conditions, personnel considerations, system operation both in normal conditions and after a discharge, access and construction limitations, dimensions, volumes, and any special requirements.

HFC-227ea systems are suitable for use in normal commercial and industrial environments. The design concentration for Class A & C fires is 7.17% but differs for Class B fires. To determine other recommended design concentrations for Class B flammable liquids, consult Macron Safety Systems Limited as well as referring to NFPA 2001, 2000 edition, paragraph 3-4.2 and UL -2166, first edition, paragraph 61.2(b). However the minimum design concentration for flammable liquids is 9%. All design concentration calculations are based on extinguishing concentrations plus an additional 20% safety factor for Class A & C and 30% safety factor for Class B, and manually actuated only systems, plus an additional 3% safety factor for nozzle performance (commercial grade Heptane excluded).
All system design calculations are calculated at minimum design concentration to determine agent quantity. Maximum design concentration should be at the maximum anticipated enclosure temperature, for comparison see NOAEL / LOAEL values.
(See table 3 or Refer to NFPA 2001, 2000 edition.)

The HFC-227ea cup burner valve is 6.7% for commercial grade Heptane.
Nozzle distribution test concentration = 6.9%
Calculations:
Cup burner or fire test concentration X nozzle efficiency factor X safety factor.
Nozzle efficiency factor = 6.9 / 6.7= 1.03
Safety factor:
Class A = 1.2
Class B = 1.3
Class C = Class A
For Class A (Determined by fire test) - 5.8% x 1.03 x 1.2 =7.17%
For UL 5.2% x 1.03 x 1.2 = 6.4%
For Class B (Commercial grade Heptane)- 6.7% x 1.03 x 1.3 =9.0%
For Class B (Other class B fuels)- cup burner x 1.03 x 1.3 = Design concentration, but not less than9.0%
For Class C - Use at least design concentration
for Class A surfaces fires (7.17)

For systems with only manual actuation - cup burner x 1.03 x 1.3 = design concentration but not less than 9.0%.

Rugged environments, and those requiring intrinsically safe or flameproof equipment, require special consideration and should be discussed fully with our company before finalising a system design. HFC-227ea is suitable for use with the following materials:

Class A Fires involving solid materials usually of an organic nature, in which combustion normally takes place with the formation of glowing embers.
Class B Fires involving flammable liquids or liquefiable solids and flammable gases.
Class C Fires involving energized electrical equipment where the electrical nonconductivity of the extinguishing media is of importance.

Caution. HFC-227ea is not effective on the following:

- Class A Deep seated fires.
- Class D Combustible metals.
- Chemicals capable of auto-thermal recomposition.
- Chemicals capable of rapid oxidation.
- Enclosures with hot surfaces (>400℃) (752℉)

Hazard Structure

The protected enclosure shall be bounded by rigid elements of building construction. The ceiling should be not less than 0.3m (1.ft) above the hazard. The rigid elements should have a fire resistance of not less than 30 min when tested in accordance with BS476: Part 20, Part 21, Part 22 or Part 23 as appropriate.

During agent discharge, the hazard enclosure will experience a pressure change. The hazard structure must be capable of withstanding a pressure of 600 pa (0.201 ftH_20) developed during discharge.

Hazard Volume

In total flooding applications the risk area must comprise an enclosed space with no significant openings so that the design concentration can be achieved and maintained. Generally, the calculation is based on an empty area; the subsequent furniture and fittings having little effect on the actual concentration. Similarly, large equipment cabinets and control panels should not be considered in the calculation as it is assumed that the internal area is required to be filled with agent.

Each enclosed space is considered as a risk area and requires at least one nozzle. A floor void, ceiling void, cable duct, etc., is treated as a separate adjacent area and requires simultaneous discharge to occur.

Ceiling obstructions such as beams that are less than 300mm (12") below the slab need not be considered. Obstructions greater than 300mm (12") can affect the distribution of agent and may require additional nozzles. Consult our company if in doubt. Please note that floor voids cannot be protected separately from the associated room.

To determine the volume refer to the site drawings, ensuring that the scale is accurate and that heights are denoted, or make a sketch of the area adding dimensions and any relevant details. Calculate the volume of each area.

Ventilation

If the hazard enclosure has no means of adequate venting after discharge, consideration should be given to installing a normally closed means of ventilation with extraction arrangements which will discharge directly to open air.

Air conditioning and/or forced ventilation can affect the system performance and the quantity of agent required.

(i) Self-contained air conditioning unit

A self-contained unit conditions the air within the enclosure and does not rely on a fresh air supply, or draw air from other parts of the building.

If the hazard has a self-contained unit and it is located within the area without an outside air supply, no additional agent is required. It is not necessary to shut down the unit prior to a discharge as the mixing effect is beneficial.

(ii) Central air conditioning unit

A central air conditioning unit relies on air from outside and is often linked by ducts to other parts of the building, therefore, prior to a discharge, the unit should be shut down and/or dampers operated to close the ducts. Sufficient time must be allowed for the plant to stop, or dampers to close, before discharge occurs.

Dampers should be installed in both supply and return air ducts, as close as possible to the area. The duct volume between the hazard and the damper must be added to the overall volume.

Hazard Temperature

Determine as accurately as possible the anticipated minimum and maximum temperatures likely to be experienced within the protected area. Minimum agent quantity requirements are based on minimum hazard. At maximum temperature, hazard concentration must not exceed the NOAEL/LOAEL values for normally occupied spaces, reference NFPA 2001, Section 1-6 "Safety."

Once assembled , filled and pressurised the HFC-227ea extinguishing system should not be exposed to temperatures other than the storage / operating temperature range of 0 to 54℃. (32℉ to 130℉). This also includes while being in storage or transported.

Hazard Fuels

All fuels in the hazard must be identified and the corresponding agent concentration requirements. The design concentration (percent by volume) required for the hazard will be the highest concentration required by any one of the fuels present in the hazard.

Personnel Safety

Natural Agent: To avoid possible injury, avoid any exposure to HFC-227ea in volume concentrations greater than 9% unless using self contained breathing apparatus. Limit exposure times as in NFPA 2001, Section 1-6 "Safety."

Symptoms of overexposure to concentrations greater than 10.5% may include dizziness, impaired coordination, reduced mental acuity, cardiac effects or unconsciousness. In the event of overexposure, remove to fresh air immediately and summon medical assistance.

Frostbite: Direct skin contact with HFC-227ea in the immediate area of discharge may cause frostbite.

Agent Quantities

Normally the agent quantity is the weight required to produce the desired concentration at the lowest temperature within the hazard enclosure.

Agent Storage

HFC-227ea is stored as a liquified compressed gas in appropriate containers to meet DOT 4BW500 and TPED requirements. Nitrogen in the container maintains a super-pressurisation of 25 bar at 21℃ (360 psi at 70℉) and 42 bar at 21℃ (600 psi at 70℉). The chosen location should provide protection from severe weather, mechanical, chemical, or other types of damage. The ambient temperature of the storage area must be between 0℃ to 54℃ (32℉ to 130 ℉), the optimum temperature being 21℃(70℉).

Hydraulic calculations are made at 21℃ (70℉). When the storage temperature varies by + 5.5 ℃ (+ 10 ℉) from 21℃ (70℉), there is a risk that the system will not supply the designed quantity of extinguishing agent.

Manifolds

It may be necessary to manifold agent containers to provide the required amount of agent for a hazard, or to make available the proper increments of agent weight for the protection of multiple hazards.

Whenever containers are manifolded, the following rules must be observed.

1. All containers connected to the same manifold or pipe must be the same size and filled with the same agent weight, pressure and fill density.
2. Agent containers must be located in a single row and spaced according to section.
3. A connected reserve may be employed in some circumstances providing a secondary supply of agent.
4. Flexible discharge hoses and check valves must be used at each inlet.

Agent Distribution

Distribution piping will be installed only with approved piping as indicated in Section 5.
Pipe size reductions may be made by using reducing tees or reducing bushings or reducing couplings.

Agent Flow Characteristics

Nitrogen Superpressurisation

Nitrogen is added to the HFC-227ea containers. This addition of nitrogen, known as superpressurisation, will cause a portion of the nitrogen to mix with the HFC-227ea, the remaining portion of the nitrogen will remain in the vapour space above the liquid providing the increased propulsion necessary to discharge the HFC-227ea from the container.

Flow in Pipe

In a properly designed distribution piping network the flow of HFC-227ea will consist of a two phase mixture of liquid and vapour. The properties of this mixture will vary with its composition; therefore, when the mixture contacts the pipeline walls, the friction decreases the density of the mixture resulting in a non-linear pressure drop and an increase in flow velocity.

Another consequence of two-phase flow is the potential for separation of liquid and vapour. In a properly designed pipe network, the velocity of the mixture will be high enough to maintain highly turbulent flow. However, if the pipeline diameter is too large for the design flow rate, the two phases may separate, leading to alternate discharges of liquid and vapour (slugging) or layering of the two phases. Therefore, the pipeline must be properly sized to keep the HFC-227ea flow turbulent enough to prevent phase separation. Hydraulic calculations are made at 21℃(70℉). Temperatures other than 21℃(70℉) may result in variations in system discharge characteristics. When the storage temperature varies by + 5.5℃(+ 10℉) there is a risk that the system will not supply the designed quantity of extinguishing agent.

Initial Vapour Discharge

At the instant the discharge valve is opened, rapid expansion of the agent will cool the piping network.

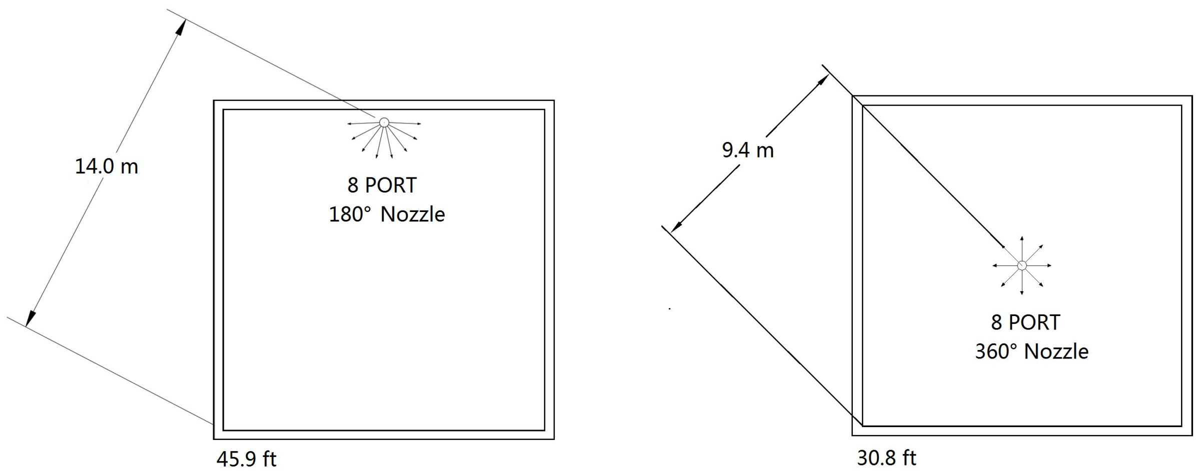
Trailing Vapour Pressure

Discharge time is defined as the average liquid discharge time through all nozzles in the system. After the liquid portion of the discharge has been completed, there will be a short transition period followed by the delivery of the remaining HFC-227ea nitrogen mixture as a vapour. This is due to flashing of the trailing edge of the fluid as it moves from the tank to the nozzles. In some systems the transition period is relatively long; this can lead to confusion as to when the discharge is complete, possibly resulting in an inaccurate measurement of the discharge time.

Nozzle selection and location

The number of nozzles required is based on the hazard size and configuration and the coverage provided by the nozzle. Nozzles are available in 7-port or 8-port versions to provide 180 or 360 degree discharge patterns respectively. When considering the optimum nozzle location, the following factors should be taken into account.

- Nozzle location is affected by the shape of the hazard area.
- The maximum discharge radius is 9.4m (30.8ft) for a 360° nozzle and 14m (45.9ft) for a 180° nozzle.
- The maximum coverage area for either nozzle is 174.0m^2 (1872 ft^2) .
- Nozzle orifices must not be placed where they may discharge into nearby objects.
- Nozzles must be installed a maximum of 300 mm (12") below the ceiling.
- 5.5m(16.5 ft) maximum protection height for 360° and 180° nozzle.
- 180° nozzles must be mounted adjacent to a wall and must be located to cover the entire area.
- 300mm(12") minimum void height (i.e. Sub-floors & false ceilings).
- Maximum distance 180° nozzles should be placed from a wall 300 mm (12"), the minimum 50mm (2"). Measured from centre of the nozzle to the wall.



Nozzle Discharge Radius

System Design Procedure

The following procedure must be followed when designing HFC-227ea systems.

- Determine hazard material and required design concentration.
- Identify individual enclosure volumes and deduct any impermeable volumes where appropriate.
- Determine hazard altitude and correction factor.
- Calculate quantity of HFC-227ea per enclosure, at minimum design temperature.
- Determine container size and fill density.
- Select nozzle type and location.
- Design pipe network.
- Calculate quantity of HFC-227ea per nozzle.
- Check percentage agent split at tee's.
- Identify all pipe lengths, rises, falls and nozzle reference numbers.

Note: The side tee splits shall be between 10-30%, bull tee splits will be between 30-70%. All Tee outlets must be in the same horizontal plane.

See examples Figure 27 a-f.

Figure 27a - Side Tee Split limits.

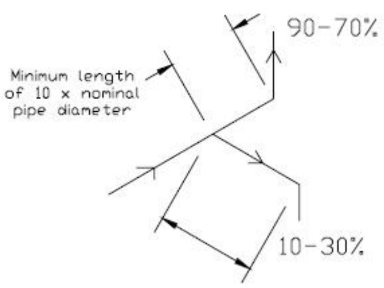


Figure 27b - Bull Tee Split limits.

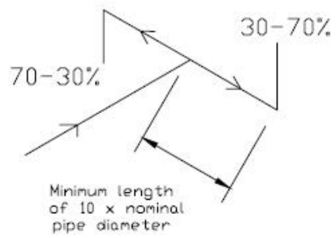


Figure 27c - Side tee orientation "correct"

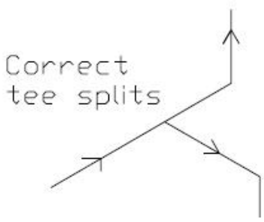


Figure 27d - Side tee orientation "incorrect"

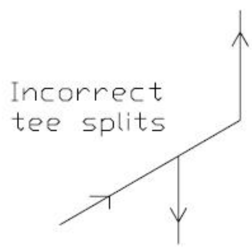


Figure 27e - Bull tee orientation "correct"

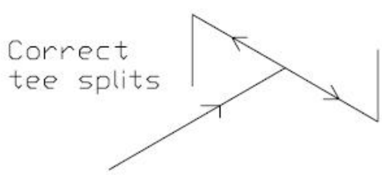
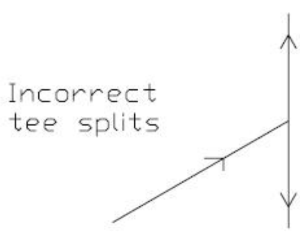


Figure 27f - Bull tee orientation "incorrect"



NOTE: Incorrect orientation of side and bull tee could result in separation of the FM200 from the Nitrogen (due to HFC-227ea greater density). The design would also be outside the parameters permitted by the calculation software. See figures 27d and 27f.

Piping Practices

Due to the two phase flow of HFC-227ea®, certain piping practices must be adhered to. Mainly that the flow split must be on the horizontal plane. There are two types of tee used in HFC-227ea systems, a through /side tee and a bull tee. Both have limitations on the minimum and maximum allowable flow splits which are detailed in section 4, page 36.

It should also be noted that system designers shall allow a minimum of 10 times the nominal pipe diameter around tee splits before any change of direction.

System designers should aim to design as far as possible balanced pipe networks, use minimum lengths of pipe, use minimum numbers of elbows, maximize pipe volume before the 1st tee and incorporate similar pipe run lengths to nozzles.

Section 5 Flow Calculation

Introduction

In determining the quantity of HFC-227ea required for a particular application, it is important to assess the hazard area correctly. The following information will need to be determined as discussed in Section 3.

1. Hazard Volume.
2. Minimum Room Temperature.
3. Hazard Type.
4. Height above sea-level.

The Hazard volume can be determined by calculating the room volume and deducting any impermeable volumes that may be contained within the area. The anticipated temperature of the Hazard area will normally be advised by the client. The agent concentration is dependant upon the type of hazard being protected, the type of nozzle used and hazard altitude. The quantity of HFC-227ea can be calculated by using the flooding factors (Table 6. imperial / 6a. metric) or by using the formula (HFC-227ea Equation Calculations) and then multiplying by the altitude correction factor (table 7).

Example:
Hazard Volume: 9800ft^3
Room Temperature: 70℉
Agent Concentration: 7.17%
Flooding Factor: 0.0351
Quantity of HFC-227ea required: 0.0351 x 9800 =343.98lbs

Note: Specific Vapour Volume data shown in Table 7 are experimentally derived values and the specific vapour volume equation (S) has a correlation coefficient of 0.99. However the equation can be used to give a close approximation of required agent quantities.

Table 5.1 HFC-227ea Weight Calculations(Imperial).

Temp. T (°F)c	Specific Vapor Volume S (ft^3/lb)d	**Weight Requirements of Hazard Volume, W/V(lb/ft3) Design Concentration(% by Volume)**										
		6.4	**7.0**	**7.17**	**8.0**	**9.0**	**10.0**	**11.0**	**12.0**	**13.0**	**14.0**	**15.0**
10	1.9264	0.0354	0.0391	0.0401	0.0451	0.0513	0.057	0.0642	0.0708	0.0776	0.0845	0.0916
20	1.9736	0.0346	0.0381	0.0391	0.0441	0.0501	0.0563	0.0626	0.0691	0.0757	0.0825	0.0894
30	2.0210	0.0338	0.0372	0.0382	0.0430	0.0489	0.0550	0.0612	0.0675	0.0739	0.0805	0.0873
40	2.0678	0.0330	0.0364	0.0373	0.0421	0.0478	0.0537	0.0598	0.0659	0.0723	0.0787	0.0853
50	2.1146	0.0323	0.0356	0.0365	0.0411	0.0468	0.0525	0.0584	0.0645	0.0707	0.0770	0.0835
60	2.1612	0.0316	0.0348	0.0357	0.0402	0.0458	0.0514	0.0572	0.0631	0.0691	0.0753	0.0817
70	2.2075	0.0310	0.0341	0.0349	0.0394	0.0448	0.0503	0.056	0.0618	0.0677	0.0737	0.0799
80	2.2538	0.0303	0.0334	0.0342	0.0386	0.0439	0.0493	0.0548	0.0605	0.0663	0.0722	0.0783
90	2.2994	0.0297	0.0327	0.0335	0.0378	0.0430	0.0483	0.0538	0.0593	0.0650	0.0708	0.0767
100	2.3452	0.0292	0.0321	0.0329	0.0371	0.0422	0.0474	0.0527	0.0581	0.0637	0.0694	0.0752
110	2.3912	0.0286	0.0315	0.0323	0.0364	0.0414	0.0465	0.0517	0.0570	0.0625	0.0681	0.0738
120	2.4366	0.0281	0.0309	0.0316	0.0357	0.0406	0.0456	0.0507	0.0560	0.0613	0.0668	0.0724

130	2.4820	0.0275	0.0303	0.0311	0.0350	0.0398	0.0448	0.0498	0.0549	0.0602	0.0656	0.0711
140	2.572	0.0270	0.0298	0.0306	0.0344	0.0391	0.0440	0.0489	0.0540	0.0591	0.0644	0.0698

Table 5.2 HFC-227ea Weight Calculations (Metric).

Temp. T (°C)c	Specific Vapor Volume s (m^3/Kg)d	**Weight Requirements of Hazard Volume, W/V(Kg/m^3) Design Concentration (% by Volume)**										
		6.4	**7.0**	**7.17**	**8.0**	**9.0**	**10.0**	**11.0**	**12.0**	**13.0**	**14.0**	**15.0**
-10	0.1215	0.5615	0.6196	0.6357	0.7158	0.8142	0.9147	1.0174	1.1225	1.2301	1.3401	1.4527
-5	0.1241	0.5499	0.6064	0.6223	0.7005	0.7987	0.8951	0.9957	1.0985	1.2038	1.3114	1.4216
0	0.1268	0.5388	0.5936	0.6091	0.6858	0.7800	0.8763	0.9748	1.0755	1.1785	1.2839	1.3918
5	0.1294	0.5281	0.5816	0.5968	0.6719	0.7642	0.8586	0.9550	1.0537	1.1546	1.2579	1.3636
10	0.1320	0.5179	0.5700	0.5851	0.6585	0.7490	0.8414	0.9360	1.0327	1.1316	1.2328	1.2264
15	0.1347	0.5080	0.5589	0.5734	0.6457	0.7344	0.8251	0.9178	1.0126	1.1096	1.2089	1.3105
20	0.1373	0.4985	0.5483	0.5625	0.6335	0.7205	0.8094	0.9004	0.9934	1.0886	1.1859	1.2856
25	0.1399	0.4894	0.5382	0.5520	0.6217	0.7071	0.7944	0.8837	0.9750	1.0684	1.1640	1.2618
30	0.1425	0.4805	0.5284	0.5420	0.6104	0.6943	0.7800	0.8676	0.9573	1.0490	1.1428	1.2388
35	0.1450	0.4720	0.519	0.5326	0.5996	0.6819	0.7661	0.8522	0.9402	1.0303	1.1224	1.2168
40	0.1476	0.4638	0.5099	0.5232	0.5891	0.6701	0.7528	0.8374	0.9230	1.0124	1.1029	1.1956
45	0.1502	0.4559	0.5012	0.5142	0.579	0.6586	0.7399	0.823	0.0908	0.9950	1.0840	1.1751
50	0.1570	0.4482	0.4929	0.4919	0.5694	0.6476	0.7276	0.8093	0.8929	0.9784	1.0660	1.1555
55	0.1553	0.4408	0.4847	0.4973	0.5600	0.6369	0.7156	0.7960	0.8782	0.9623	1.0484	1.1365

Table 5.3 Altitude Correction Factor

Altitude above sea level ft(Km)	**Correction Factor**
-3000 (-0.92)	1.11
-2000 (-0.61)	1.07
-1000(0.30)	1.04
0 (0.00)	1.00
1000 (0.30)	0.96
2000 (0.61)	0.93
3000 (0.91)	0.89
4000 (1.22)	0.86
5000 (1.52)	0.82
6000 (1.83)	0.78
7000 (2.13)	0.75
8000 (2.45)	0.72
9000 (2.74)	0.69
10000(3.05)	0.66

At elevations above sea-level, HFC-227ea has a greater specific volume because of the reduced atmospheric pressure. A system designed for sea-level conditions will therefore develop an actual higher concentration at levels above sea-level and an actual lower concentration at levels below sea-level. The adjusted agent quantity is calculated by multiplying W (from the equation on the left) by the altitude correction factor. The design quantity of the clean agent shall be adjusted to compensate for ambient pres-sure that vary more than 11 percent (equivalent to approximately 915m (3000 ft) of elevation change) from standard sea level pressure 760 mm Hg at 0℃ (29.92 in Hg at 70℉).

HFC-227ea Equation Calculations

The weight of agent required for a hazard area can also be calculated from the formula shown below; W = (V/S) × (C/100-C)

W = Weight of Agent required Kg (lbs)

V = Hazard Volume m^3 (ft^3)

S = Specific Vapour Volume cu.m/Kg (ft3/lbs) where S = 0.1269 + 0.0005131 t(℃)

Or (S= 1.885 + 0.0046 t ℉)

t = Design Temperature in Hazard Area℃(℉)

C = Required HFC-227ea Design Conc. (% by volume) at Design Temperature (t).

Engineered Systems

Mosafe Equipment Co.,Ltd. Engineered systems are based on NFPA2001. The program predicts the two phase flow of HFC-227ea and nitrogen through a pipe network. Information detailing the enclosure is entered and the program calculates the required pipe sizes, nozzle drill sizes, average nozzle pressures and discharge time.

As system design calculations are critical to the success of the extinguishing system, only Mosafe Equipment Co.,Ltd. or Mosafe Equipment Co.,Ltd. trained personnel are permitted to perform system calculations. If in the future, companies other than Mosafe Equipment Co.,Ltd. wish to use the program, representatives will be required to attend a formal training session. All system calculations are conducted either 'in house' by Mosafe Equipment Co.,Ltd. or authorised suppliers.

NOTE: The calculation method has been designed for specific types of fittings, pipes, and pipe inside diameter. When these limitations are not maintained, there is a risk that the system will not supply the required quantity of extinguishing agent.

Program Parameters

When designing pipe network systems, the following design parameters should be considered to avoid system reject when running the calculation.

- 4.8 bar (69.6 psi) minimum nozzle pressure.
- 107% maximum pipe volume against the agent volume.
- Between 9 - 11 seconds discharge time.
- 10 - 30 % side tee split.
- 30 -70 % bull tee split.
- 0.56Kg/L(34.9lbs/ft^3) - 1.12 Kg/L(69.8lbs/ft^3) fill density.
- Max. liquid arrival time imbalance of 1.0 seconds.
- Maximum liquid run out time of 2.0 seconds.
- Maximum nozzle height is 5.5m (18.04ft) .

- Minimum of 10% agent in pipe before first tee.
- Maximum of 32 nozzles per system.
- Maximum of 12 enclosures per system.
- The ratio between the nozzle area and the pipe cross sectional area immediately preceding the nozzle is limited to a minimum of 0.20 (20%) and a maximum of 0.80 (80%).

Table 5.4 Max.&Min.Flow Rates.

Pipe Size mm (in)	**Minimum flow rate Kg/s(lb/s)**	**Maximum flow rate Kg/sec.(lb/s)**
10(3/8)	0.272(0.60)	0.907(2.00)
15(1/2)	0.454(1.00)	1.361(3.00)
20(3/4)	0.907(2.00)	2.495(5.50)
25 (1)	1.588 (3.50)	3.855(8.50)
32(11/4)	2.722 (6.00)	5.67 (12.50)
40(11/2)	4.082 (9.00)	9.072(20.00)
50 (2)	6.35(14.00)	13.61(30.00)
65(21/2)	9.072(20.00)	24.95(55.00)
80 (3)	13.61(30.00)	44.92(99.00)
100 (4)	24.95(55.00)	56.7(125.00)
125 (5)	40.82(90.00)	90.72(200.00)
150 (6)	54.43(120.00)	136.1(300.00)
Note:This information is for Schedule 40 pipe, and serves as an estimate only.		
Pipe and nozzle sizes need to be confirmed by the computer program.		

Table 5.5 Equivalent Length for Threaded Fittings 300lb

Diameter mm(in)	**90° Elbow (m)**	**45° Elbow (m)**	**Thru Tee (m)**	**Side Tee (m)**	**Union (m)**	**Union Elbow (m)**
15(1/2)	1.7	0.8	1.0	3.4	0.4	2.1
20(3/4)	2.2	1.0	1.4	4.5	0.5	2.7
25 (1)	2.8	1.3	1.8	5.7	0.6	3.4
32(11/4)	3.7	1.7	2.3	7.5	0.9	5.2
40(11/2)	4.3	2.0	2.7	8.7	1.0	5.6
50 (2)	5.5	2.6	3.5	11.2	1.2	6.7
65(21/2)	6.5	3.1	4.1	13.4	1.4	8.0
80 (3)	8.2	3.8	5.1	16.8	1.8	10.0
100 (4)	10.7	5.0	6.7	21.8	2.4	13.0
125 (5)	13.4	6.3	8.4	27.4	3.0	16.4
150 (6)	16.2	7.6	10.1	32.8	3.5	19.7

Table 5.6 Equivalent Length for Victaulic Fitting.

Diameter mm(in)	90° Elbow (m)	45° Elbow (m)	Thru Tee (m)	Side Tee (m)
20(3/4)	1.3	0.6	1.3	3.2
25 (1)	1.7	0.8	1.7	4.2
32(11/4)	2.1	1.0	2.1	5.3
40(11/2)	2.6	1.2	2.6	6.3
50 (2)	3.5	1.8	3.5	8.5
65(21/2)	4.3	2.2	4.3	10.8
80 (3)	5.0	2.6	5.0	13.0
100 (4)	6.8	3.4	6.8	16.0
125 (5)	8.5	4.2	8.5	21.0
150 (6)	10.0	5.0	10.0	25.0

Table 5.7 Equivalent Length for Welded Fitting.

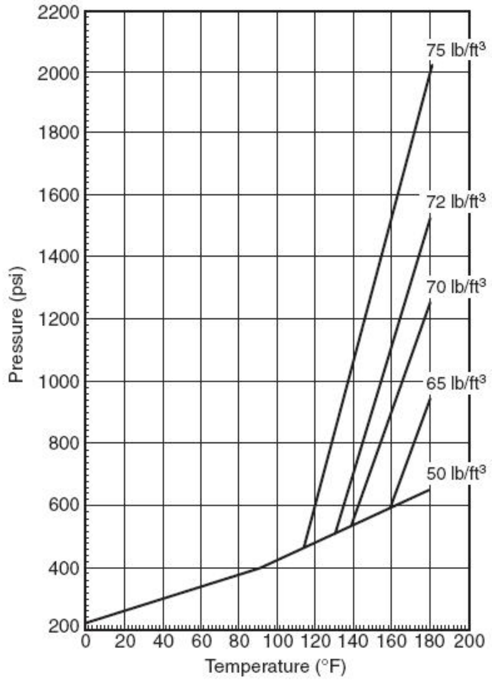
Diameter mm(in)	90° Elbow (m)	45° Elbow (m)	Thru Tee (m)	Side Tee (m)
15(1/2)	0.8	0.3	0.7	2.1
20(3/4)	1.1	0.4	0.9	2.8
25 (1)	1.4	0.5	1.1	3.5
32(11/4)	1.8	0.7	1.5	4.6
40(11/2)	2.1	0.8	1.7	5.4
50 (2)	2.8	1.0	2.2	6.9
65(21/2)	3.3	1.2	2.7	8.2
80 (3)	4.1	1.5	3.3	10.2
100 (4)	5.4	2.0	4.4	13.4
125 (5)	6.7	2.5	5.5	16.8
150 (6)	8.1	3.0	6.6	20.2

Table 5.8 Equivalent Length for other system components.

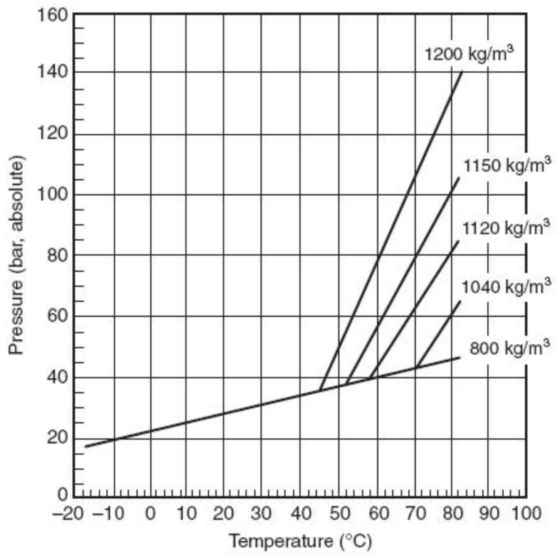
Component	Nominal pipe size	Equivalent length (m)
33mm valve(1-1/4 in.valve)	33 mm (1-1/4 in.)	8.10
49mm valve(2 in.valve)	49 mm (2 in.)	10.82
33mm flex hose(1-1/4 in.flex hose)	33mm(1-1/4in.)	10.46
49mm flex hose(2 in.flex hose)	49 mm (2 in.)	5.65
33mm Check & Flex(1-1/4 in.Check & Flex)	33 mm (1-1/4 in.)	14.76
49mm Check & Flex(2 in.Check & Flex)	49 mm (2 in.)	13.12

Figures based upon schedule 40 ASTM A106-77 pipe (nominal pipe size given in table).

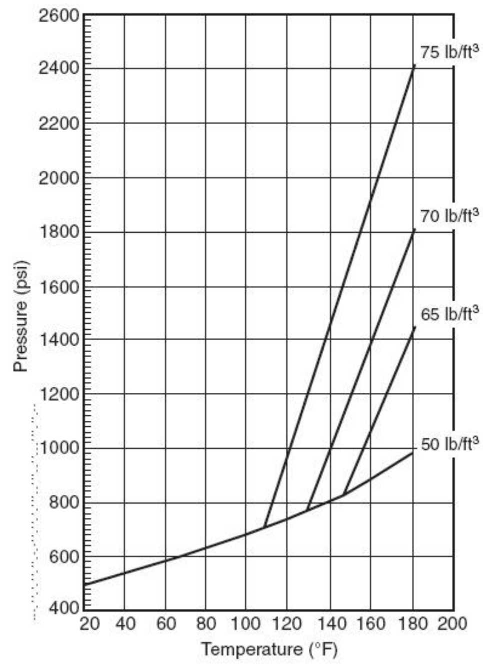
Isometric Diagram of HFC-227ea Pressurized with Nitrogen.



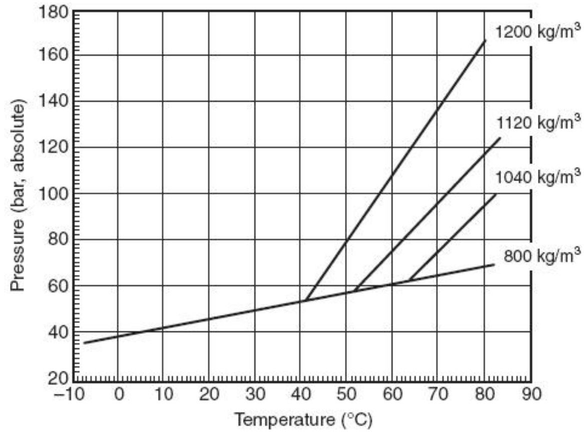
(1) Pressurized to 360 psi at 70°F



(2) Pressurized to 2.5 MPa at 21°C



(3) Pressurized to 600 psi at 70°F



(4) Pressurized to 4.1 MPa at 21°C