Lichfield Fire&Safety Equipment Co. Ltd.

LF-227ea TOTAL FLOODING
FIRE EXTINGUISHING SYSTEM
(HFC-227ea)

DESIGN AND INSTALLATION MANUAL

(ENGINEERED SYSTEM)

Part No. LF-227IOM
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Contents

Section 1 SYSTEM INTRODUCTION

1.0 About this Manual

This manual contains all the information necessary to design, install and maintain the LIFECO HFC-227ea Engineered Extinguishing system supplied by LIFECO Equipment Co., Ltd.. However the manual does not address information relating to fire detection. Please refer to the UL Code UL2166 and NFPA2001 Clean Agent Fire Extinguishing 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.

1.1 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.

1.2 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. THE DETECTORS AND CONTROL PANELS USED IN CONJUNCTION WITH THE LIFECO HFC-227EA EXTINGUISHING SYSTEM MUST USE UL LISTED PRODUCTS.

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.

1.3 Approvals and Standards

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

HFC-227ea Agent

- Underwriters Laboratories Inc. (UL) Recognised Component
- NFPA 2001 Clean Agent Fire Extinguishing Systems (Listed Alternative)

LIFECO Systems Manufactured Systems

- Underwriters Laboratories Inc. (UL Listed)

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

LIFECO 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).

1.4 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. NFPA2001.

Reference should also be made to NFPA 2001 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 Section "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.

1.5 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. 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	Auxiliary Power Room

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 TPED/GB/DOT 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 HFC-227ea Agent Physical Properties

Chemical structure	CF_3CHFCF_3
Chemical name	Heptafluoropropane
Molecular weight	170
Boiling point	-16.4°C (1.9°F)

Freezing point	-131.1°C (-204°F)
Critical temperature	101.7°C (214°F)
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 Nitrogen Physical Properties

Chemical structure	N_2
Chemical name	Nitrogen
Molecular weight	28
Boiling point	-195.8°C (-320.4°F)
Freezing point	-210.0°C (-346°F)
Critical temperature	-146.9°C (-232.4°F)
Critical pressure	3399 kPa (492.9 psi)
(Reference: NFPA2001)	

Table 1.3 HFC-227ea Safety Instructions

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)	

WARNING

THE LIFECO HFC-227EA SYSTEM PERIODICALLY BE INSPECTED BY TRAINED PERSONNEL.

THE LIFECO HFC-227EA SYSTEM IS THE SYSTEMS TESTED WITHIN LIMITATIONS CONTAINED IN THE DETAILED INSTALLATION MANUAL. THE SYSTEM DESIGNER MUST BE CONSULTED WHENEVER CHANGES ARE PLANNED FOR THE SYSTEM OR AREA OF PROTECTION. AN AUTHORIZED INSTALLER OR SYSTEM DESIGNER MUST BE CONSULTED AFTER THE SYSTEM HAS DISCHARGED.

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.

2.1 Typical Manifold System

HFC-227ea gas fire extinguishing system includes the cylinder kit, manual release device, discharge hose, check valve, manifold, and relief device of distributor manifold, pressure operating switch, pipe ware and nozzle. HFC-227ea gas fire extinguishing system is linked with automatic alarm system for automatic control. LIFECO typical manifold systems are only for single area protection.
For single area system, the solenoid actuator will act to open the master cylinder after getting the instruction from control panel, and then the gas from the master cylinder will open the slave cylinders.

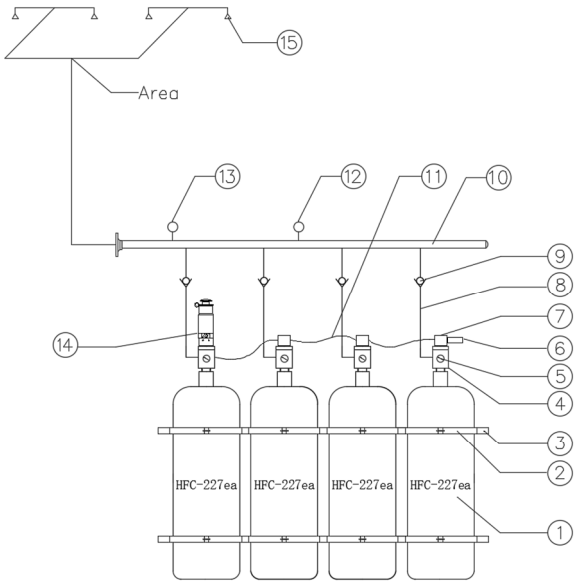


Figure 2.1 – LIFECO Manifold System for Single Area System

No.	Part Name	No.	Part Name
1	Cylinder	9	Manifold Check Valve
2	Mounting Bracket	10	Manifold
3	Fix Steel Channel	11	Pilot Hose
4	Container Valve	12	Manifold Safety Valve
5	Agent Pressure Gauge	13	Discharge Pressure Switch
6	Bleed Valve	14	Solenoid Actuator
7	Pneumatic Actuator	15	Nozzle
8	Discharge Hose		

2.2 HFC-227ea Container

Multiple series of containers are available, including:
The 16.6, 28.3, 40, 50, 60, 70, 80, 90, 100, 120, 150,160 & 170 L containers are manufactured in accordance with TPED.
The 40, 50, 60, 70, 80, 90, 100, 120, 150 & 170 L containers are manufactured in accordance with GB.
The 16.7, 28.3, 49, 52, 62, 80, 103, 106, 147 & 153 L containers are manufactured in accordance with DOT.

Technical Information

Table 2.2.1 HFC-227ea TPED Container

Material	P355M Carbon: ≤0.14% Manganese: ≤1.60% Silicon: ≤0.50% Phosphorus: ≤0.025% Sulphur: ≤0.010%
Nominal Working Pressure	42 bar (609 psi)
Pneumatic Test Pressure	63 bar (914 psi)
Burst Test Pressure	≥ 126 bar (1827 psi)
Work Temperature	-20 °C ~ 65 °C
Paint Specification	Red Polyester Powder Coated
Certification	TPED

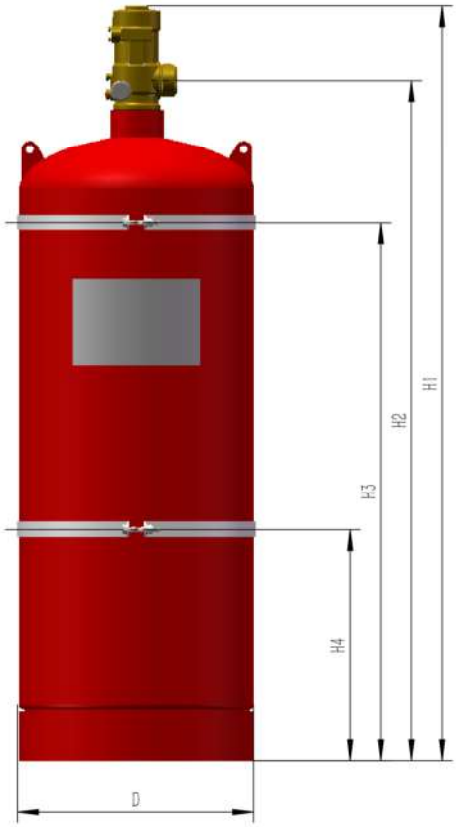


Figure 2.3 - Container Assembly

Table 2.2.2 HFC-227ea GB Container

Material	HP345 Carbon: ≤0.20% Manganese: ≤1.50% Silicon: ≤0.35% Phosphorus: ≤0.025% Sulphur: ≤0.015% Aluminium acid-soluble: ≥0.015
Nominal Working Pressure	53 bar
Hydrostatic Test Pressure	80 bar
Work Temperature	0 °C ~ 50 °C
Paint Specification	Red Polyester Powder Coated
Certification	GB

Table 2.2.3 HFC-227ea DOT Container

Material	HP345 (G3) Carbon: ≤0.20% Manganese: ≤1.25% Phosphorus: ≤0.025%

	Sulphur: ≤0.015%
Nominal Working Pressure	500 psi
Hydrostatic Test Pressure	1000 psi
Burst Test Pressure	＞ 2000 psi
Paint Specification	Red Polyester Powder Coated
Certification	DOT

2.3 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 2.3).

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

Table 2.3.1 HFC-227ea Container Assembly Details (TPED Container)

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	Fill Capacity (kg)		Outlet Size (mm)	Empty Weight (kg)
				Min.	Max.		
811.101.0156	LF227SP-25-40D	25	40	19.2	44.8	49	42
811.101.0166	LF227SP-25-50D	25	50	24.0	56.0	49	48
811.101.0176	LF227SP-25-60D	25	60	28.8	67.2	49	53
811.101.0186	LF227SP-25-70D	25	70	33.6	78.4	49	59
811.101.0196	LF227SP-25-80D	25	80	38.4	89.6	49	64
811.101.0206	LF227SP-25-90D	25	90	43.2	100.8	49	73
811.101.0216	LF227SP-25-100D	25	100	48.0	112.0	49	78
811.101.0226	LF227SP-25-120D	25	120	57.6	134.4	49	89
811.101.0236	LF227SP-25-150D	25	150	72.0	168.0	49	105
811.101.0246	LF227SP-25-160D	25	160	76.8	179.2	49	104
811.101.0135	LF227SP-25-16.6C	25	16.6	8.0	18.6	33	21
811.101.0145	LF227SP-25-28.3C	25	28.3	13.6	31.7	33	29
811.101.0155	LF227SP-25-40C	25	40	19.2	44.8	33	37
811.101.0165	LF227SP-25-50C	25	50	24.0	56.0	33	42
811.101.0175	LF227SP-25-60C	25	60	28.8	67.2	33	47
811.101.0158	LF227SP-42-40D	42	40	19.2	44.8	49	42
811.101.0168	LF227SP-42-50D	42	50	24.0	56.0	49	48
811.101.0178	LF227SP-42-60D	42	60	28.8	67.2	49	53
811.101.0188	LF227SP-42-70D	42	70	33.6	78.4	49	59

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	Fill Capacity (kg)		Outlet Size (mm)	Empty Weight (kg)
				Min.	Max.		
811.101.0198	LF227SP-42-80D	42	80	38.4	89.6	49	64
811.101.0208	LF227SP-42-90D	42	90	43.2	100.8	49	73
811.101.0218	LF227SP-42-100D	42	100	48.0	112.0	49	78
811.101.0228	LF227SP-42-120D	42	120	57.6	134.4	49	89
811.101.0238	LF227SP-42-150D	42	150	72.0	168.0	49	105
811.101.0248	LF227SP-42-160D	42	160	76.8	179.2	49	104
811.101.0258	LF227SP-42-170D	42	170	81.6	190.4	49	108
811.101.0137	LF227SP-42-16.6C	42	16.6	8.0	18.6	33	21
811.101.0147	LF227SP-42-28.3C	42	28.3	13.6	31.7	33	29
811.101.0157	LF227SP-42-40C	42	40	19.2	44.8	33	37
811.101.0167	LF227SP-42-50C	42	50	24.0	56.0	33	42
811.101.0177	LF227SP-42-60C	42	60	28.8	67.2	33	47

Table 2.3.2 HFC-227ea Container Assembly Details (GB Container)

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	Fill Capacity (kg)		Outlet Size (mm)	Empty Weight (kg)
				Min.	Max.		
811.101.0456	LF227SP-25-40M	25	40	19.2	44.8	49	47
811.101.0466	LF227SP-25-50M	25	50	24.0	56.0	49	58
811.101.0476	LF227SP-25-60M	25	60	28.8	67.2	49	65
811.101.0486	LF227SP-25-70M	25	70	33.6	78.4	49	72
811.101.0496	LF227SP-25-80M	25	80	38.4	89.6	49	80
811.101.0506	LF227SP-25-90M	25	90	43.2	100.8	49	94
811.101.0516	LF227SP-25-100M	25	100	48.0	112.0	49	100
811.101.0526	LF227SP-25-120M	25	120	57.6	134.4	49	113
811.101.0546	LF227SP-25-150M	25	150	72.0	168.0	49	134
811.101.0455	LF227SP-25-40K	25	40	19.2	44.8	33	41
811.101.0465	LF227SP-25-50K	25	50	24.0	56.0	33	52
811.101.0475	LF227SP-25-60K	25	60	28.8	67.2	33	59
811.101.0458	LF227SP-42-40M	42	40	19.2	44.8	49	47
811.101.0468	LF227SP-42-50M	42	50	24.0	56.0	49	58
811.101.0478	LF227SP-42-60M	42	60	28.8	67.2	49	65
811.101.0488	LF227SP-42-70M	42	70	33.6	78.4	49	72
811.101.0498	LF227SP-42-80M	42	80	38.4	89.6	49	80
811.101.0508	LF227SP-42-90M	42	90	43.2	100.8	49	94
811.101.0518	LF227SP-42-100M	42	100	48.0	112.0	49	100
811.101.0528	LF227SP-42-120M	42	120	57.6	134.4	49	113
811.101.0548	LF227SP-42-150M	42	150	72.0	168.0	49	134

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	Fill Capacity (kg)		Outlet Size (mm)	Empty Weight (kg)
				Min.	Max.		
811.101.0568	LF227SP-42-170M	42	170	81.6	190.4	49	149
811.101.0457	LF227SP-42-40K	42	40	19.2	44.8	33	41
811.101.0467	LF227SP-42-50K	42	50	24.0	56.0	33	52
811.101.0477	LF227SP-42-60K	42	60	28.8	67.2	33	59

Table 2.3.3 HFC-227ea Container Assembly Details (DOT Container)

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	Fill Capacity (kg)		Outlet Size (mm)	Empty Weight (kg)
				Min.	Max.		
811.101.0766	LF227SP-25-49S	25	49	23.5	54.9	49	48
811.101.0776	LF227SP-25-52S	25	52	25.0	58.2	49	56
811.101.0786	LF227SP-25-62S	25	62	29.8	69.4	49	53
811.101.0806	LF227SP-25-80S	25	80	38.4	89.6	49	65
811.101.0826	LF227SP-25-103S	25	103	49.4	115.4	49	82
811.101.0836	LF227SP-25-106S	25	106	50.9	118.7	49	84
811.101.0856	LF227SP-25-147S	25	147	70.6	164.6	49	105
811.101.0866	LF227SP-25-153S	25	153	73.4	171.4	49	108
811.101.0735	LF227SP-25-16.7R	25	16.7	8.0	18.7	33	21
811.101.0745	LF227SP-25-28.3R	25	28.3	13.6	31.7	33	29
811.101.0765	LF227SP-25-49R	25	49	23.5	54.9	33	42
811.101.0775	LF227SP-25-52R	25	52	25.0	58.2	33	50
811.101.0785	LF227SP-25-62R	25	62	29.8	69.4	33	47

Table 2.3.4 HFC-227ea Container Assembly Dimension (TPED Container)

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	H1 (mm)	H2 (mm)	H3 (mm)	H4 (mm)	D (mm)
811.101.0156	LF227SP-25-40D	25	40	841	695	470	220	Ø324
811.101.0166	LF227SP-25-50D	25	50	969	823	600	330	Ø324
811.101.0176	LF227SP-25-60D	25	60	1102	956	600	330	Ø324
811.101.0186	LF227SP-25-70D	25	70	1231	1085	800	450	Ø324
811.101.0196	LF227SP-25-80D	25	80	1362	1216	950	450	Ø324
811.101.0206	LF227SP-25-90D	25	90	1084	938	600	330	Ø406
811.101.0216	LF227SP-25-100D	25	100	1166	1020	750	450	Ø406
811.101.0226	LF227SP-25-120D	25	120	1329	1183	900	450	Ø406
811.101.0236	LF227SP-25-150D	25	150	1575	1429	1050	450	Ø406
811.101.0246	LF227SP-25-160D	25	160	1346	1200	900	450	Ø462
811.101.0135	LF227SP-25-16.6C	25	16.6	668	566	400	200	Ø228.6

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	H1 (mm)	H2 (mm)	H3 (mm)	H4 (mm)	D (mm)
811.101.0145	LF227SP-25-28.3C	25	28.3	975	873	600	330	Ø228.6
811.101.0155	LF227SP-25-40C	25	40	775	673	470	220	Ø324
811.101.0165	LF227SP-25-50C	25	50	903	801	600	330	Ø324
811.101.0175	LF227SP-25-60C	25	60	1036	934	600	330	Ø324
811.101.0158	LF227SP-42-40D	42	40	841	695	470	220	Ø324
811.101.0168	LF227SP-42-50D	42	50	969	823	600	330	Ø324
811.101.0178	LF227SP-42-60D	42	60	1102	956	600	330	Ø324
811.101.0188	LF227SP-42-70D	42	70	1231	1085	800	450	Ø324
811.101.0198	LF227SP-42-80D	42	80	1362	1216	950	450	Ø324
811.101.0208	LF227SP-42-90D	42	90	1084	938	600	330	Ø406
811.101.0218	LF227SP-42-100D	42	100	1166	1020	750	450	Ø406
811.101.0228	LF227SP-42-120D	42	120	1329	1183	900	450	Ø406
811.101.0238	LF227SP-42-150D	42	150	1575	1429	1050	450	Ø406
811.101.0248	LF227SP-42-160D	42	160	1346	1200	900	450	Ø462
811.101.0258	LF227SP-42-170D	42	170	1407	1261	900	450	Ø462
811.101.0137	LF227SP-42-16.6C	42	16.6	668	566	400	200	Ø228.6
811.101.0147	LF227SP-42-28.3C	42	28.3	975	873	600	330	Ø228.6
811.101.0157	LF227SP-42-40C	42	40	775	673	470	220	Ø324
811.101.0167	LF227SP-42-50C	42	50	903	801	600	330	Ø324
811.101.0177	LF227SP-42-60C	42	60	1036	934	600	330	Ø324

Table 2.3.5 HFC-227ea Container Assembly Dimension (GB Container)

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	H1 (mm)	H2 (mm)	H3 (mm)	H4 (mm)	D (mm)
811.101.0456	LF227SP-25-40M	25	40	1134	988	750	300	Ø260
811.101.0466	LF227SP-25-50M	25	50	1119	973	750	300	Ø312
811.101.0476	LF227SP-25-60M	25	60	1261	1115	750	300	Ø312
811.101.0486	LF227SP-25-70M	25	70	1403	1257	1050	300	Ø312
811.101.0496	LF227SP-25-80M	25	80	1545	1399	1050	300	Ø312
811.101.0506	LF227SP-25-90M	25	90	1126	980	750	300	Ø416
811.101.0516	LF227SP-25-100M	25	100	1200	1055	750	300	Ø416
811.101.0526	LF227SP-25-120M	25	120	1360	1214	900	300	Ø416
811.101.0546	LF227SP-25-150M	25	150	1599	1453	1050	300	Ø416
811.101.0455	LF227SP-25-40K	25	40	1068	966	750	300	Ø260
811.101.0465	LF227SP-25-50K	25	50	1055	953	750	300	Ø312
811.101.0475	LF227SP-25-60K	25	60	1197	1095	750	300	Ø312
811.101.0458	LF227SP-42-40M	42	40	1134	988	750	300	Ø260

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	H1 (mm)	H2 (mm)	H3 (mm)	H4 (mm)	D (mm)
811.101.0468	LF227SP-42-50M	42	50	1119	973	750	300	Ø312
811.101.0478	LF227SP-42-60M	42	60	1261	1115	750	300	Ø312
811.101.0488	LF227SP-42-70M	42	70	1403	1257	1050	300	Ø312
811.101.0498	LF227SP-42-80M	42	80	1545	1399	1050	300	Ø312
811.101.0508	LF227SP-42-90M	42	90	1126	980	750	300	Ø416
811.101.0518	LF227SP-42-100M	42	100	1200	1055	750	300	Ø416
811.101.0528	LF227SP-42-120M	42	120	1360	1214	900	300	Ø416
811.101.0548	LF227SP-42-150M	42	150	1599	1453	1050	300	Ø416
811.101.0568	LF227SP-42-170M	42	170	1758	1612	1200	300	Ø416
811.101.0457	LF227SP-42-40K	42	40	1068	966	750	300	Ø260
811.101.0467	LF227SP-42-50K	42	50	1055	953	750	300	Ø312
811.101.0477	LF227SP-42-60K	42	60	1197	1095	750	300	Ø312

Table 2.3.6 HFC-227ea Container Assembly Dimension (DOT Container)

Cylinder with Valve Assembly Part No.	Container Assembly Type	Nominal Working Pressure (bar)	Nominal Cylinder Volume (L)	H1 (mm)	H2 (mm)	H3 (mm)	H4 (mm)	D (mm)
811.101.0766	LF227SP-25-49S	25	49	964	820	600	300	Ø324
811.101.0776	LF227SP-25-52S	25	52	764	618	400	200	Ø406
811.101.0786	LF227SP-25-62S	25	62	1134	988	750	300	Ø324
811.101.0806	LF227SP-25-80S	25	80	1367	1221	900	300	Ø324
811.101.0826	LF227SP-25-103S	25	103	1179	1033	750	300	Ø406
811.101.0836	LF227SP-25-106S	25	106	1204	1058	750	300	Ø406
811.101.0856	LF227SP-25-147S	25	147	1539	1393	1050	300	Ø406
811.101.0866	LF227SP-25-153S	25	153	1589	1443	1050	300	Ø406
811.101.0735	LF227SP-25-16.7R	25	16.7	674	572	400	200	Ø228.6
811.101.0745	LF227SP-25-28.3R	25	28.3	979	877	600	300	Ø228.6
811.101.0765	LF227SP-25-49R	25	49	900	798	600	300	Ø324
811.101.0775	LF227SP-25-52R	25	52	700	596	400	200	Ø406
811.101.0785	LF227SP-25-62R	25	62	1068	966	750	300	Ø324

2.4 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: 279.8mm x 168.0 mm (11" x 6.5")

(**Pt. No. 811.108.101** for Containers 16.6, 16.7, 28.3, 40, 49, 50, 52, 60, 62, 70, 80, 90, 100, 103, 106, 120, 147, 150, 153, 160 & 170 L)

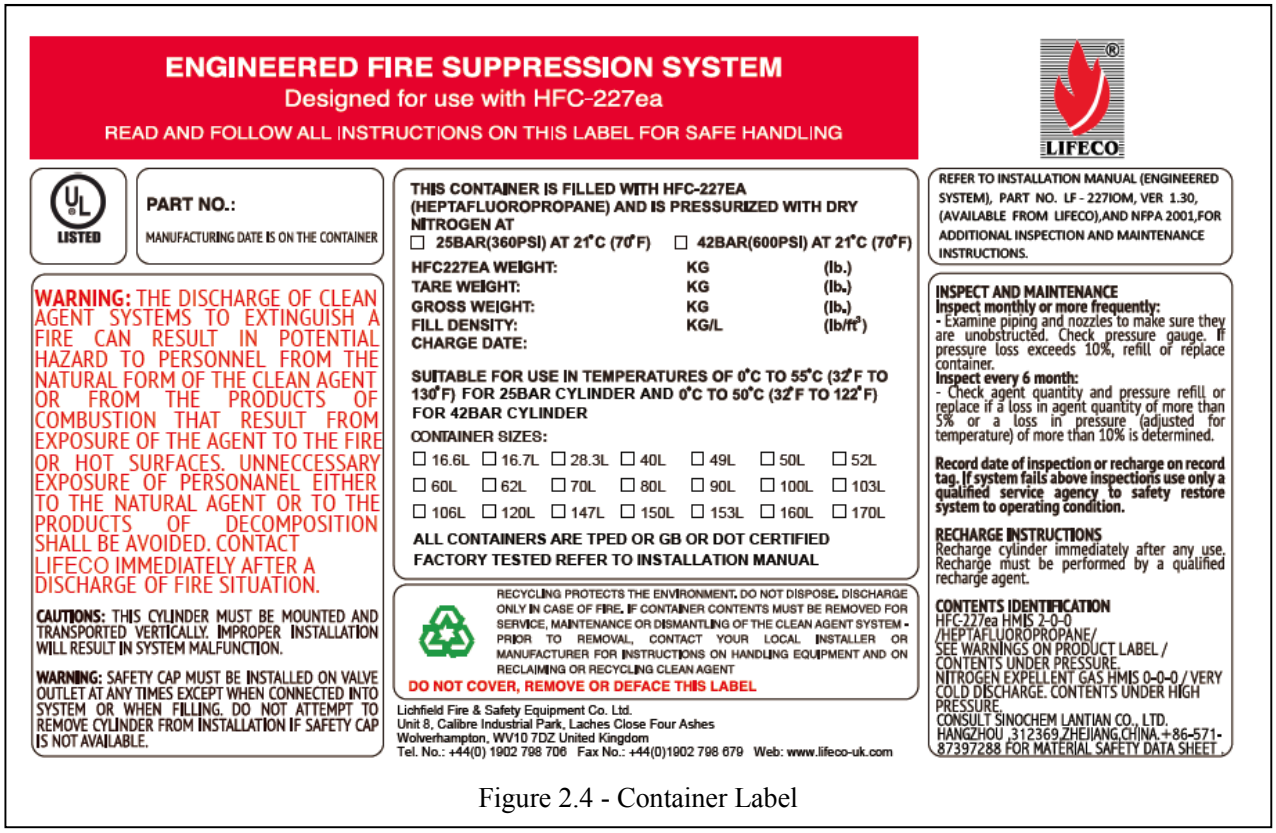


Figure 2.4 - Container Label

2.5 Cylinder 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.

Figure 2.5 - Fixing Bracket

Table 2.5.1 Container Mounting Strap

Part No.	Container Volume (L)	Container Dia. (mm)
811.106.601	16.6, 16.7, 28.3	Φ228.6
811.106.602	40	Φ260
811.106.603	50, 60, 70, 80	Φ312
811.106.604	40, 49, 50, 60, 62, 70, 80	Φ324
811.106.605	90, 100, 103, 106, 120, 147, 150, 153, 170	Φ406, Φ416
811.106.606	160, 170	Φ462
Fastening Bolt	M10X60	

Table 2.5.2 Fixing Back Channel Dimensions

Part No.	Container Diameter (mm)	Dimension A (mm)									
		Container Quantity									
		1	2	3	4	5	6	7	8	9	10
811.106.731-811.106.740	Φ228.6 Φ260	500	800	1100	1400	1700	2000	2300	2600	2900	3200
811.106.701-811.106.710	Φ312 Φ324	600	1000	1400	1800	2200	2600	3000	3400	3800	4200
811.106.711-811.106.720	Φ406 Φ416	700	1200	1700	2200	2700	3200	3700	4200	4700	5200
811.106.721-811.106.730	Φ462	700	1200	1700	2200	2700	3200	3700	4200	4700	5200

2.6 Container Valve

Installed in the gas cylinder is used to control the release of agent. Build up the container valve extinguishing kit together with cylinders started by Solenoid Actuator, Manual Actuator or Pneumatic Actuator. Container 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.). The pressure gauge port of the container valve are available with connection thread of M10X1 or NPT1/8.

Figure 2.6 - Container Valve

Technical Specification:

Table 2.6 Container Valve

Type	33 mm 25 bar		33 mm 42 bar		49 mm 25 bar		49 mm 42 bar	
Part No.	811.101.0013	811.101.0017	811.101.0014	811.101.0018	811.101.0023	811.101.0027	811.101.0024	811.101.0028
Body Material	Brass		Brass		Brass		Brass	
Nominal Working Pressure	25 bar @21°C		42 bar @21°C		25 bar @21°C		42 bar @21°C	
Safety Relief pressure (Burst Disc Rating)	60±6 bar		100±10 bar		60±6 bar		100±10 bar	
Work Temperature	-20 °C ~60 °C							
Inlet	2.5"-12UN				3”-12UN			
Outlet	1.875"-12UN				2.5"-12UN			
Actuator Port	M42X1.5							
Pilot Pipe Connection	G1/8							
Pressure Gauge Port	M10X1	NPT1/8	M10X1	NPT1/8	M10X1	NPT1/8	M10X1	NPT1/8
Overall Size (mm)	124 (L) ×102 (W) ×184 (H)	124 (L) ×121 (W) ×184 (H)	124 (L) ×102 (W) ×184 (H)	124 (L) ×121 (W) ×184 (H)	149 (L) ×110 (W) ×238 (H)	149 (L) ×129 (W) ×238 (H)	149 (L) ×110 (W) ×238 (H)	149 (L) ×129 (W) ×238 (H)
Weight	4.9 kg				9.5 kg			

2.7 Safety Relief Device

A burst disc is factory fitted to every container valve assembly. It is designed to rupture when the container becomes over pressurized when subjected to temperatures above the designed storage temperature of the container.

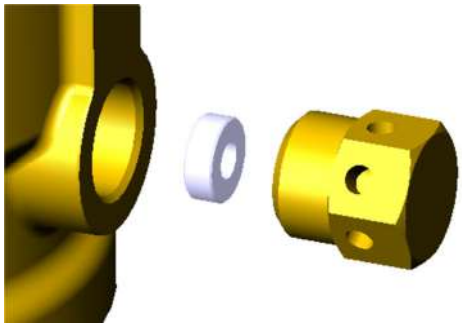


Figure 2.7 - Safety Relief Device

Technical Specification:

Table 2.7 Safety Relief Device

Part No.	811.101.090	811.101.091
Applicable System	25 bar system	42 bar system
Body Material	Brass	
Burst Disc Material	Nickel	
Burst Pressure	60 ± 6 bar	100 ± 10 bar
Work Temperature	-20 °C ~ 55 °C	
Installation Torque	35 Nm	

2.8 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 container assembly.

Figure 2.8 - Pressure Gauge

Technical Specification:

Table 2.8 Pressure Gauge

Part No.	811.101.080	811.101.082	811.101.081	811.101.083
Applicable System	25 bar system		42 bar system	
Gauge Diameter	ϕ41 mm			
Body Material	Stainless steel			
Range	0-25-48 bar		0-42-70 bar	
Precision Grade	1.6 Grade			
Work Temperature	-20 °C ~ 60 °C			
Connection Thread	Axial M10X1	Axial NPT1/8	Axial M10X1	Axial NPT1/8
Weight	0.05 kg			
Certification	UL			

2.9 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.

Wiring: Remove the two screws retaining the cover and cover gasket. A 1/2" NPT conduit connection is provided on the left hand side of the enclosure. Two cast-in knockouts for the 1/2" conduit are located on the side and back of the enclosure. These can easily be knocked out by placing the blade of a screwdriver in the groove and tapping sharply with a hammer. The three switch terminals are clearly labeled "common", "normally open" and "normally closed". For switches supplied with leadwires, the following color coding applies: Common-Yellow, Normally Closed-Orange, Normally Open-Brown.

Technical Specification:

Table 2.9 Discharge Pressure Switch

Part No.	811.108.008
Model	SYK101
Material	Die cast aluminum, epoxy powder coated internally and externally
Work Temperature	-40°C ~ 70°C
Over Range Pressure	103.4 bar/ 1500 psi
Proof Pressure	172.4 bar/ 2500 psi
Bursting Pressure	⩾200 bar
Action Pressure	3.5 bar
Switch Output	One SPDT snap action switch; switch may be wired "normally open"
Electrical Rating	15A 125/250/480 VAC, 2A 24VDC
Protection Grade	IP65
Connection Thread	NPT1/4 Female
Electrical Entry	NPT1/2 Female
Overall Size	102mm W × 178mm H × 60mm T
Weight	1.0 kg
Life	6,000 Times
Certification	UL

Figure 2.9.1 - Discharge Pressure Switch

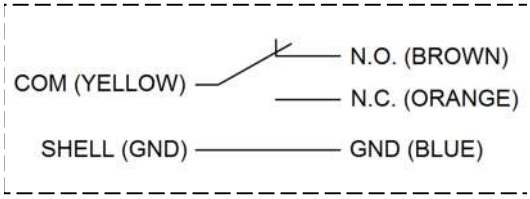


Figure 2.9.2 – Discharge Pressure Switch Wire Diagram

2.10 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.

Figure 2.10 – Safety Valve

Technical Specification:

Table 2.10 Safety Valve

Part No.	811.108.004	811.108.005
Applicable System	25 bar system	42 bar system
Body Material	Brass	
Burst Disc Material	Stainless Steel	
Burst Disc Color Code	Blue (Atmospheric Side)	Red (Atmospheric Side)
Burst Pressure	46 ± 4.6 bar	72 ± 7.2 bar
Work Temperature	-20°C ~ 55°C	
Installation Torque	35 Nm	
Connection Thread	NPT3/4 or R3/4	
Overall Size	72 mm (L)× ϕ47mm (D)	
Weight	0.15 kg	

2.11 Electrical Actuator（Removable）

The removable Electrical Actuator locates to the top of the container valve. 24 VDC is required for electrical 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:

Table 2.11 Electrical Actuator

Part No.	811.101.060
Manufacturer	TLX Technologies
Model	PA0421
Material	Body: Mild Steel Swivel Nut: Brass Manual Button: ABS Limit Pin: Stainless Steel
Electrical/ Electronic Configurations	Voltage Supply: 24 VDC Current Supply: 0.50 A Monitoring Current: ＜30 mA Reverse Polarity Compatible Via Bridge Rectifier Circuit. Supervisory Switch (N.C.) internal to Actuator.
Mechanical Configurations	Nominal Pin Movement: 6.35 mm Connection: M42x1.5 Female Overall Size: 175 mm x Ø 53 mm Min Force Provided: 240 N Max Manual Actuation Force: 150 N
Actuation Type	Latching
Reset Method	Manually Via Reset Tool Supplied
Working Temperature	-20 °C to 55 °C
Weight	0.9 kg
Factory Test	100% Check on Start/ Finish Position
Approvals	UL

Figure 2.11.1 - Electrical Actuator

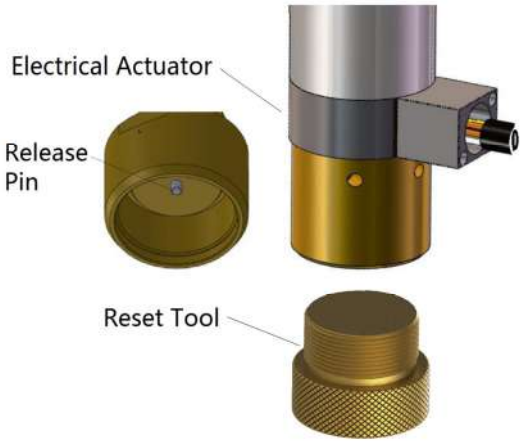


Figure 2.11.2 - Actuator Reset Tool

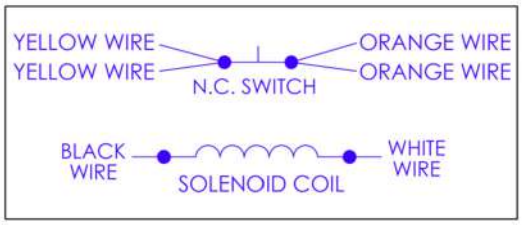


Figure 2.11.3 - Electrical Actuator Wire Diagram

The Electrical Actuator will operate after receiving a 24 VDC nominal voltage signal from the panel. The actuator will latch in the fire position after the signal terminates. It will require to be manually reset by removing the unit from the valve and inserting (screwing in) the Reset Tool (Part No.811.101.066, see Figure 2.11.2)

A Manual Button is installed on the top of the actuator. In addition to the electrically actuate, the actuator can be activated directly by pressing the Manual Button. Before pressing the Button manually, the limit pin at the bottom of the button should be pulled out.

2.12 Pneumatic/Manual Actuator

The actuator is installed on the container valve, is used to manually or pneumatically operate container valve.
The Pneumatic and Manual Actuator is used to manual mechanically or pneumatically 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:

Table 2.12 Pneumatic/Manual Actuator

Part No.	811.101.065
Material	Body / Piston Rod: Brass Handle / Safety Pin: SS304
Max. Working Pressure	60 bar
Min Actuation Pressure	4 bar
Manual Operating Force	30 N
Install Thread	M42×1.5 Female
Pneumatic Port	G1/8 Female
Work Temperature	-20 °C ~ 60 °C
Overall Size	150 mm (H) × ϕ50mm (D)
Weight	0.6 kg
Install Torque	~15 Nm

Figure 2.12 - Pneumatic & Manual Actuator

2.13 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:

Table 2.13 Pneumatic Actuator

Part No.	811.101.064
Material	Body: Brass Piston Rod: Brass
Max. Working Pressure	60 bar
Min Actuation Pressure	4 bar
Install Thread	M42×1.5 Female
Pneumatic Port	G1/8 Female
Work Temperature	-20 °C ~ 60 °C
Overall Size	50 mm (H) × ϕ50mm (D)
Weight	0.5 kg
Install Torque	~15 Nm

Figure 2.13 - Pneumatic Actuator

2.14 Manual Actuator

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.

Figure 2.14 - Manual Release Device

Technical Specification:

Table 2.14 Manual Actuator

Part No.	811.101.063
Material	Body / Piston Rod: Brass Handle / Safety Pin: SS304
Manual Operating Force	30 N
Install Thread	M42×1.5 Female
Work Temperature	-20 °C ~ 60 °C
Overall Size	110mm (L) × 50mm (W)_x 60mm (H)
Weight	0.5 kg
Install Torque	~15 Nm

2.15 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.

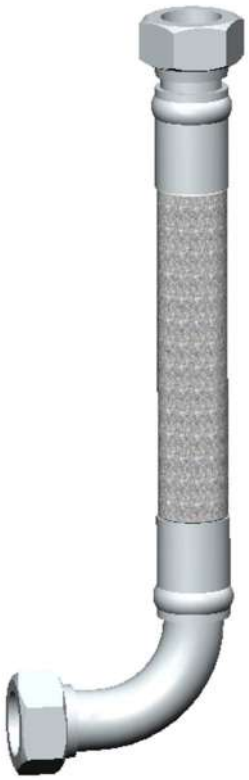


Figure 2.15 - Discharge Hose

Technical Specification

Table 2.15 Discharge Hose

Part No.	811.102.001	811.102.002
Hose Material	Teflon hose with stainless steel braid overlay	
Type	1¼" (33 mm)	2" (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°C ~60°C	-20°C ~60°C
Working Pressure	42 bar	42 bar
Burst Pressure	>200 bar	>200 bar
Weight	2.8 kg	4.6 kg

2.16 Valve Outlet Adaptor

When a single container is being used without a manifold, three type adaptors are available for connection to the container valve outlet, either grooved, threaded or welded.

Grooved Type

Threaded Type

Welded Type

Figure 2.16 – Valve Outlet Adaptor

Technical Specification

Table 2.16.1 Valve Outlet Adaptor- Grooved Type

Part No.	811.102.010	811.102.011
Material	Stainless Steel	
Type	VOA-33G	VOA-49G
Nominal Diameter	1¼" (33 mm)	2" (49 mm)
Length	150 mm	184 mm
Inlet Thread	1.875"-12UN	2.5"-12 UN
Working Temperature	-20°C ~60°C	-20°C ~60°C
Working Pressure	42 bar	42 bar
Weight	0.9 kg	1.7 kg

Table 2.16.2 Valve Outlet Adaptor- Threaded Type

Part No.	811.102.014	811.102.015
Material	Stainless Steel	
Type	VOA-33T	VOA-49T
Nominal Diameter	1¼" (33 mm)	2" (49 mm)
Length	150 mm	184 mm
Inlet Thread	1.875"-12UN	2.5"-12 UN
Outlet Thread	NPT or R 1¼	NPT or R 2
Working Temperature	-20°C ~60°C	-20°C ~60°C
Working Pressure	42 bar	42 bar
Weight	1.0 kg	2.0 kg

Table 2.16.3 Valve Outlet Adaptor- Welded Type

Part No.	811.102.012	811.102.013
Material	Stainless Steel	
Type	VOA-33W	VOA-49W
Nominal Diameter	1¼" (33 mm)	2" (49 mm)
Length	150 mm	184 mm
Inlet Thread	1.875"-12UN	2.5"-12 UN
Working Temperature	-20°C ~60°C	-20°C ~60°C
Working Pressure	42 bar	42 bar
Weight	0.9 kg	1.7 kg

2.17 Pilot Hose

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

Technical Specification:

Table 2.17 Pilot Hose

Part No.	811.102.003	811.102.004	811.102.005
Hose Material	Steel wire braided rubber hose		
Nominal Diameter	Φ6 mm		
Length	400 mm	500 mm	700 mm
Connection Thread	M12×1.5		
Install Torque	22.5±2.5 N·m		
Min. Bending Radius	60 mm		
Working Temperature	-20℃~60℃		
Working Pressure	42 bar		
Burst Pressure	>200 bar		

Figure 2.17 - Pilot Hose

2.18 Bleed Valve

On manifold 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 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 container valve or check valve. It also provides a means by which pressure trapped in the actuation line may be manually relieved. 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:

Table 2.18 Bleed Valve

Part No.	811.101.006
Material	Brass
Max. Woring Pressure	64 bar
Flow Rate	≥ 6 L/min @ 0.6 bar
Closed Pressure	0.7 ~ 1.5 bar
Install Thread	G1/8
Work Temperature	-20 °C ~ 60 °C
Overall Size	50 mm H × ϕ24 mm Dia
Weight	0.1 kg
Install Torque	8 Nm

Figure 2.18 - Bleed Valve

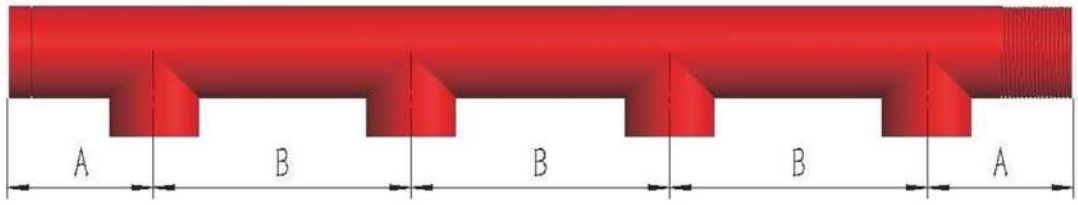
2.19 Manifold

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.

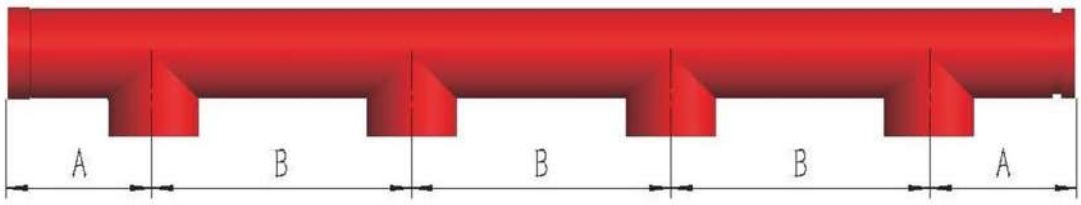
Technical Information

Table 2.19 Manifold

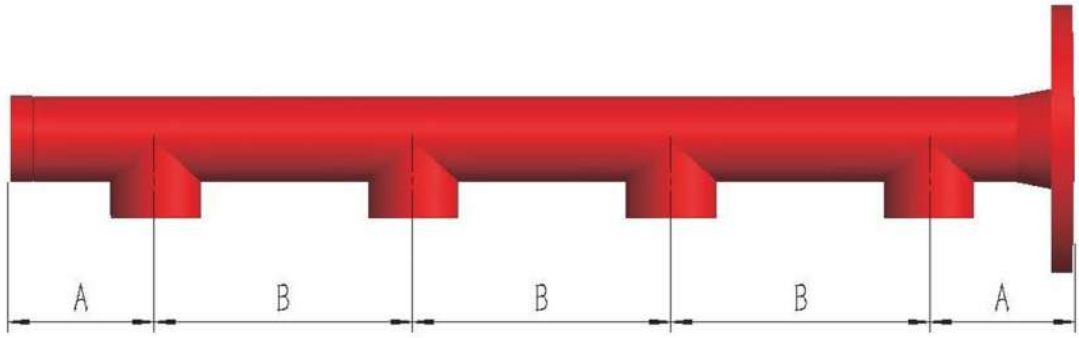
Part No.	811.101.006
Material	ASTM A106 Gr B / BS 3601 Schedule 80
Inter	Check valve threaded connections
Outlet	BSP/NPT Taper, Flange and Grooved Coupling
Test Pressure	90 bar (1305 psi)



T Type – BSP/NPT Thread End



G Type - Grooved Coupling End



F Type - Flange End

Figure 2.19 - Manifold Type

Table 2.19 Manifolds Size

Part No.	Size (mm)	A (mm)	B (mm)	Check Valve Size
811.105.432T/F/G	2 port 50	150	400	33
811.105.433T/F/G	3 port 50	150	400	33
811.105.434T/F/G	4 port 50	150	400	33
811.105.532T/F/G	2 port 65	150	400	33
811.105.533T/F/G	3 port 65	150	400	33
811.105.534T/F/G	4 port 65	150	400	33
811.105.535T/F/G	5 port 65	150	400	33
811.105.632T/F/G	2 port 80	150	400	33
811.105.633T/F/G	3 port 80	150	400	33
811.105.634T/F/G	4 port 80	150	400	33
811.105.635T/F/G	5 port 80	150	400	33
811.105.636T/F/G	6 port 80	150	400	33
811.105.642T/F/G	2 port 80	150	400	49
811.105.643T/F/G	3 port 80	150	400	49
811.105.644T/F/G	4 port 80	150	400	49
811.105.645T/F/G	5 port 80	150	400	49
811.105.646T/F/G	6 port 80	150	400	49
811.105.652T/F/G	2 port 80	150	450	49
811.105.653T/F/G	3 port 80	150	450	49
811.105.654T/F/G	4 port 80	150	450	49
811.105.655T/F/G	5 port 80	150	450	49
811.105.662T/F/G	2 port 80	150	500	49
811.105.663T/F/G	3 port 80	150	500	49
811.105.664T/F/G	4 port 80	150	500	49
811.105.732T/F/G	2 port 100	150	400	33
811.105.733T/F/G	3 port 100	150	400	33
811.105.734T/F/G	4 port 100	150	400	33
811.105.735T/F/G	5 port 100	150	400	33
811.105.736T/F/G	6 port 100	150	400	33
811.105.737T/F/G	7 port 100	150	400	33
811.105.742T/F/G	2 port 100	150	400	49
811.105.743T/F/G	3 port 100	150	400	49
811.105.744T/F/G	4 port 100	150	400	49
811.105.745T/F/G	5 port 100	150	400	49
811.105.746T/F/G	6 port 100	150	400	49
811.105.747T/F/G	7 port 100	150	400	49
811.105.752T/F/G	2 port 100	150	450	49
811.105.753T/F/G	3 port 100	150	450	49
811.105.754T/F/G	4 port 100	150	450	49

Part No.	Size (mm)	A (mm)	B (mm)	Check Valve Size
811.105.755T/F/G	5 port 100	150	450	49
811.105.756T/F/G	6 port 100	150	450	49
811.105.757T/F/G	7 port 100	150	450	49
811.105.762T/F/G	2 port 100	150	500	49
811.105.763T/F/G	3 port 100	150	500	49
811.105.764T/F/G	4 port 100	150	500	49
811.105.765T/F/G	5 port 100	150	500	49
811.105.766T/F/G	6 port 100	150	500	49
811.105.767T/F/G	7 port 100	150	500	49
811.105.842T/F/G	2 port 125	150	400	49
811.105.843T/F/G	3 port 125	150	400	49
811.105.844T/F/G	4 port 125	150	400	49
811.105.845T/F/G	5 port 125	150	400	49
811.105.846T/F/G	6 port 125	150	400	49
811.105.847T/F/G	7 port 125	150	400	49
811.105.852T/F/G	2 port 125	150	450	49
811.105.853T/F/G	3 port 125	150	450	49
811.105.854T/F/G	4 port 125	150	450	49
811.105.855T/F/G	5 port 125	150	450	49
811.105.856T/F/G	6 port 125	150	450	49
811.105.857T/F/G	7 port 125	150	450	49
811.105.862T/F/G	2 port 125	150	500	49
811.105.863T/F/G	3 port 125	150	500	49
811.105.864T/F/G	4 port 125	150	500	49
811.105.865T/F/G	5 port 125	150	500	49
811.105.866T/F/G	6 port 125	150	500	49
811.105.867T/F/G	7 port 125	150	500	49
811.105.952T/F/G	2 port 150	150	450	49
811.105.953T/F/G	3 port 150	150	450	49
811.105.954T/F/G	4 port 150	150	450	49
811.105.955T/F/G	5 port 150	150	450	49
811.105.956T/F/G	6 port 150	150	450	49
811.105.957T/F/G	7 port 150	150	450	49
811.105.962T/F/G	2 port 150	150	500	49
811.105.963T/F/G	3 port 150	150	500	49
811.105.964T/F/G	4 port 150	150	500	49
811.105.965T/F/G	5 port 150	150	500	49
811.105.966T/F/G	6 port 150	150	500	49
811.105.967T/F/G	7 port 150	150	500	49

Finish: Primed, Ready to paint on site.

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

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

2.20 Manifold Bracket Assembly

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

Table 2.20 Manifold Mounting Strap & Support

Part No.	Manifold Nominal Diameter	Manifold Outer Diameter (mm)
811.107.007	DN50 (2”)	60
811.107.008	DN65 (2.5”)	76
811.107.009	DN80 (3”)	89
811.107.010	DN100 (4”)	114
811.107.011	DN125 (5”)	141
811.107.012	DN150 (6”)	165
Fastennig Bolt	M8X35	
Adapter Bracket	Manifold Cantilever Support Part No. 811.107.101	
Adapter Bracket Length	400 mm	

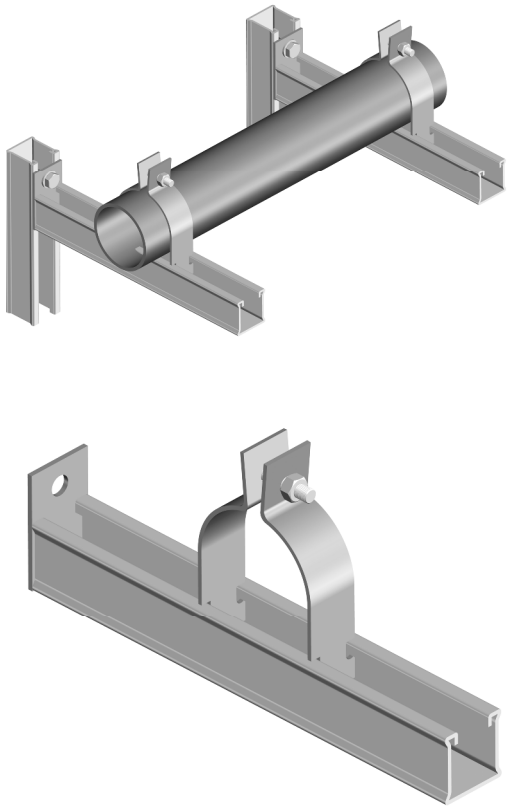


Figure 2.20 - Manifold Bracket Assembly

2.21 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.

Figure 2.21 - Manifold Check Valve

Technical Specification:

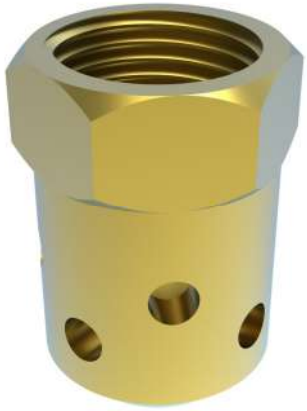
Table 2.21 Manifold Check Valve

Part No.	811.103.001	811.103.002
Size	33mm	49mm
Body Material	Brass	Brass
Stem Material	Stainless steel	Stainless steel
Work Pressure	80 bar	80 bar
Leakage Test Pressure	80 bar	80 bar
Hydraulic Strength Test Pressure	100 bar	100 bar
Inlet Thread	1.875"-12UN	2.5"-12UN
Outlet Thread	NPT2 or R2	NPT2½ or R2½
Weight:	0.9 Kg	1.82 Kg

2.22 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.

180° Nozzle



360° Nozzle

Figure 2.22 - Discharge Nozzle

Technical Specification:

Table 2.22.1 Discharge Nozzle

Part No.	811.104.XXX	811.114.XXX
Nozzle Type	180° 8 Port	360° 8 Port
Material	Brass	
Distance From Ceiling	Max. 370 mm	
Connection Thread	NPT or Rc 3/8 to 2 Female	
Installation Mode	Side Wall	Center
Installation Orientation	Pendent or Upright	

Table 2.22.2 Discharg30e Nozzle List

180° Nozzle				360° Nozzle			
Part No.	Nozzle Type	Hole Dia. (mm)	Thread	Part No.	Nozzle Type	Hole Dia. (mm)	Thread
811.104.001	A180-10-1.4	1.4	3/8"	811.114.001	A360-10-1.4	1.4	3/8"
811.104.002	A180-10-1.6	1.6	3/8"	811.114.002	A360-10-1.6	1.6	3/8"
811.104.003	A180-10-1.8	1.8	3/8"	811.114.003	A360-10-1.8	1.8	3/8"
811.104.004	A180-10-2.0	2.0	3/8"	811.114.004	A360-10-2.0	2.0	3/8"
811.104.005	A180-10-2.2	2.2	3/8"	811.114.005	A360-10-2.2	2.2	3/8"
811.104.006	A180-10-2.4	2.4	3/8"	811.114.006	A360-10-2.4	2.4	3/8"
811.104.007	A180-10-2.6	2.6	3/8"	811.114.007	A360-10-2.6	2.6	3/8"
811.104.008	A180-10-2.8	2.8	3/8"	811.114.008	A360-10-2.8	2.8	3/8"
811.104.009	A180-10-3.0	3.0	3/8"	811.114.009	A360-10-3.0	3.0	3/8"
811.104.010	A180-10-3.2	3.2	3/8"	811.114.010	A360-10-3.2	3.2	3/8"
811.104.011	A180-10-3.4	3.4	3/8"	811.114.011	A360-10-3.4	3.4	3/8"
811.104.012	A180-10-3.6	3.6	3/8"	811.114.012	A360-10-3.6	3.6	3/8"
811.104.013	A180-10-3.8	3.8	3/8"	811.114.013	A360-10-3.8	3.8	3/8"

180° Nozzle				360° Nozzle			
Part No.	Nozzle Type	Hole Dia. (mm)	Thread	Part No.	Nozzle Type	Hole Dia. (mm)	Thread
811.104.101	A180-15-2.2	2.2	1/2"	811.114.101	A360-15-2.2	2.2	1/2"
811.104.102	A180-15-2.5	2.5	1/2"	811.114.102	A360-15-2.5	2.5	1/2"
811.104.103	A180-15-2.8	2.8	1/2"	811.114.103	A360-15-2.8	2.8	1/2"
811.104.104	A180-15-3.1	3.1	1/2"	811.114.104	A360-15-3.1	3.1	1/2"
811.104.105	A180-15-3.4	3.4	1/2"	811.114.105	A360-15-3.4	3.4	1/2"
811.104.106	A180-15-3.7	3.7	1/2"	811.114.106	A360-15-3.7	3.7	1/2"
811.104.107	A180-15-4.0	4.0	1/2"	811.114.107	A360-15-4.0	4.0	1/2"
811.104.108	A180-15-4.3	4.3	1/2"	811.114.108	A360-15-4.3	4.3	1/2"
811.104.109	A180-15-4.6	4.6	1/2"	811.114.109	A360-15-4.6	4.6	1/2"
811.104.110	A180-15-5.0	5.0	1/2"	811.114.110	A360-15-5.0	5.0	1/2"
811.104.201	A180-20-3.1	3.1	3/4"	811.114.201	A360-20-3.1	3.1	3/4"
811.104.202	A180-20-3.4	3.4	3/4"	811.114.202	A360-20-3.4	3.4	3/4"
811.104.203	A180-20-3.7	3.7	3/4"	811.114.203	A360-20-3.7	3.7	3/4"
811.104.204	A180-20-4.0	4.0	3/4"	811.114.204	A360-20-4.0	4.0	3/4"
811.104.205	A180-20-4.3	4.3	3/4"	811.114.205	A360-20-4.3	4.3	3/4"
811.104.206	A180-20-4.6	4.6	3/4"	811.114.206	A360-20-4.6	4.6	3/4"
811.104.207	A180-20-5.0	5.0	3/4"	811.114.207	A360-20-5.0	5.0	3/4"
811.104.208	A180-20-5.3	5.3	3/4"	811.114.208	A360-20-5.3	5.3	3/4"
811.104.209	A180-20-5.6	5.6	3/4"	811.114.209	A360-20-5.6	5.6	3/4"
811.104.210	A180-20-5.9	5.9	3/4"	811.114.210	A360-20-5.9	5.9	3/4"
811.104.211	A180-20-6.2	6.2	3/4"	811.114.211	A360-20-6.2	6.2	3/4"
811.104.212	A180-20-6.6	6.6	3/4"	811.114.212	A360-20-6.6	6.6	3/4"
811.104.301	A180-25-3.9	3.9	1"	811.114.301	A360-25-3.9	3.9	1"
811.104.302	A180-25-4.3	4.3	1"	811.114.302	A360-25-4.3	4.3	1"
811.104.303	A180-25-4.7	4.7	1"	811.114.303	A360-25-4.7	4.7	1"
811.104.304	A180-25-5.1	5.1	1"	811.114.304	A360-25-5.1	5.1	1"
811.104.305	A180-25-5.5	5.5	1"	811.114.305	A360-25-5.5	5.5	1"
811.104.306	A180-25-5.9	5.9	1"	811.114.306	A360-25-5.9	5.9	1"
811.104.307	A180-25-6.3	6.3	1"	811.114.307	A360-25-6.3	6.3	1"
811.104.308	A180-25-6.7	6.7	1"	811.114.308	A360-25-6.7	6.7	1"
811.104.309	A180-25-7.1	7.1	1"	811.114.309	A360-25-7.1	7.1	1"
811.104.310	A180-25-7.5	7.5	1"	811.114.310	A360-25-7.5	7.5	1"
811.104.311	A180-25-7.9	7.9	1"	811.114.311	A360-25-7.9	7.9	1"
811.104.312	A180-25-8.4	8.4	1"	811.114.312	A360-25-8.4	8.4	1"
811.104.401	A180-32-5.1	5.1	1¼"	811.114.401	A360-32-5.1	5.1	1¼"
811.104.402	A180-32-5.5	5.5	1¼"	811.114.402	A360-32-5.5	5.5	1¼"
811.104.403	A180-32-5.9	5.9	1¼"	811.114.403	A360-32-5.9	5.9	1¼"
811.104.404	A180-32-6.3	6.3	1¼"	811.114.404	A360-32-6.3	6.3	1¼"
811.104.405	A180-32-6.7	6.7	1¼"	811.114.405	A360-32-6.7	6.7	1¼"

180° Nozzle				360° Nozzle			
Part No.	Nozzle Type	Hole Dia. (mm)	Thread	Part No.	Nozzle Type	Hole Dia. (mm)	Thread
811.104.406	A180-32-7.1	7.1	1¼"	811.114.406	A360-32-7.1	7.1	1¼"
811.104.407	A180-32-7.5	7.5	1¼"	811.114.407	A360-32-7.5	7.5	1¼"
811.104.408	A180-32-7.9	7.9	1¼"	811.114.408	A360-32-7.9	7.9	1¼"
811.104.409	A180-32-8.4	8.4	1¼"	811.114.409	A360-32-8.4	8.4	1¼"
811.104.410	A180-32-8.8	8.8	1¼"	811.114.410	A360-32-8.8	8.8	1¼"
811.104.411	A180-32-9.2	9.2	1¼"	811.114.411	A360-32-9.2	9.2	1¼"
811.104.412	A180-32-9.6	9.6	1¼"	811.114.412	A360-32-9.6	9.6	1¼"
811.104.413	A180-32-10.0	10.0	1¼"	811.114.413	A360-32-10.0	10.0	1¼"
811.104.414	A180-32-10.4	10.4	1¼"	811.114.414	A360-32-10.4	10.4	1¼"
811.104.415	A180-32-10.8	10.8	1¼"	811.114.415	A360-32-10.8	10.8	1¼"
811.104.416	A180-32-11.0	11.0	1¼"	811.114.416	A360-32-11.0	11.0	1¼"
811.104.501	A180-40-6.5	6.5	1½"	811.114.501	A360-40-6.5	6.5	1½"
811.104.502	A180-40-7.0	7.0	1½"	811.114.502	A360-40-7.0	7.0	1½"
811.104.503	A180-40-7.5	7.5	1½"	811.114.503	A360-40-7.5	7.5	1½"
811.104.504	A180-40-8.0	8.0	1½"	811.114.504	A360-40-8.0	8.0	1½"
811.104.505	A180-40-8.5	8.5	1½"	811.114.505	A360-40-8.5	8.5	1½"
811.104.506	A180-40-9.0	9.0	1½"	811.114.506	A360-40-9.0	9.0	1½"
811.104.507	A180-40-9.5	9.5	1½"	811.114.507	A360-40-9.5	9.5	1½"
811.104.508	A180-40-10.0	10.0	1½"	811.114.508	A360-40-10.0	10.0	1½"
811.104.509	A180-40-10.5	10.5	1½"	811.114.509	A360-40-10.5	10.5	1½"
811.104.510	A180-40-11.0	11.0	1½"	811.114.510	A360-40-11.0	11.0	1½"
811.104.511	A180-40-11.5	11.5	1½"	811.114.511	A360-40-11.5	11.5	1½"
811.104.512	A180-40-12.0	12.0	1½"	811.114.512	A360-40-12.0	12.0	1½"
811.104.513	A180-40-12.5	12.5	1½"	811.114.513	A360-40-12.5	12.5	1½"
811.104.514	A180-40-12.9	12.9	1½"	811.114.514	A360-40-12.9	12.9	1½"
811.104.601	A180-50-8.5	8.5	2"	811.114.601	A360-50-8.5	8.5	2"
811.104.602	A180-50-9.0	9.0	2"	811.114.602	A360-50-9.0	9.0	2"
811.104.603	A180-50-9.5	9.5	2"	811.114.603	A360-50-9.5	9.5	2"
811.104.604	A180-50-10.0	10.0	2"	811.114.604	A360-50-10.0	10.0	2"
811.104.605	A180-50-10.5	10.5	2"	811.114.605	A360-50-10.5	10.5	2"
811.104.606	A180-50-11.0	11.0	2"	811.114.606	A360-50-11.0	11.0	2"
811.104.607	A180-50-11.5	11.5	2"	811.114.607	A360-50-11.5	11.5	2"
811.104.608	A180-50-12.0	12.0	2"	811.114.608	A360-50-12.0	12.0	2"
811.104.609	A180-50-12.5	12.5	2"	811.114.609	A360-50-12.5	12.5	2"
811.104.610	A180-50-13.0	13.0	2"	811.114.610	A360-50-13.0	13.0	2"
811.104.611	A180-50-13.5	13.5	2"	811.114.611	A360-50-13.5	13.5	2"
811.104.612	A180-50-14.0	14.0	2"	811.114.612	A360-50-14.0	14.0	2"
811.104.613	A180-50-14.5	14.5	2"	811.114.613	A360-50-14.5	14.5	2"
811.104.614	A180-50-15.0	15.0	2"	811.114.614	A360-50-15.0	15.0	2"

180° Nozzle				360° Nozzle			
Part No.	Nozzle Type	Hole Dia. (mm)	Thread	Part No.	Nozzle Type	Hole Dia. (mm)	Thread
811.104.615	A180-50-15.5	15.5	2"	811.114.615	A360-50-15.5	15.5	2"
811.104.616	A180-50-16.0	16.0	2"	811.114.616	A360-50-16.0	16.0	2"
811.104.617	A180-50-16.5	16.5	2"	811.114.617	A360-50-16.5	16.5	2"

Note:

The orifice diameter is defined with flow calculation software.

LIFECO Nozzle connection is female thread, and is available in NPT and BSPT. NPT thread nozzle, marked with N after the nozzle code; BSPT thread nozzle, marked with R after the nozzle code.

2.23 Pilot Pipe Connector G1/8

Pilot pipe connector G1/8 is used to connect the pilot hose and actuator, to introduce a pilot gas from the pilot hose for pneumatically actuating other valves.

Figure 2.23 - Pilot Pipe Connector G1/8

Technical Specification:

Table 2.23 Pilot Pipe Connector G1/8

Part No.	811.111.001
Size	Ø4 mm
Material	Stainless Steel
Connection	M12*1.5× G1/8
Max. Working Pressure	150 bar
Overall Size	S14 mm* 25 mm
Weight:	0.025 kg

2.24 Pilot Hose Connector

Pilot Hose Connector is used to connect two pilot hoses together.

Figure 2.24 - Pilot Hose Connector

Technical Specification:

Table 2.24 Pilot Hose Connector

Part No.	811.111.002
Size	Ø4 mm
Material	Brass
Connection	M12*1.5× M12*1.5
Max. Working Pressure	150 bar
Overall Size	S14 mm* 26 mm
Weight:	0.028 kg

2.25 Pilot Pipe Connector NPT¼

Pilot pipe connector NPT¼ connects the pilot hose to the discharge pressure switch.

Figure 2.25 - Pilot Pipe Connector NPT¼

Technical Specification:

Table 2.25 Pilot Pipe Connector NPT¼

Part No.	811.111.003
Size	Ø4 mm
Material	Brass
Connection	M12*1.5× NPT¼
Max. Working Pressure	150 bar
Overall Size	S17 mm* 29 mm
Weight:	0.032 kg

2.26 Pressure Switch Connector

Pressure switch connector is used to connect the pressure switch and the manifold joint.

Figure 2.26 - Pressure Switch Connector

Technical Specification:

Table 2.26 Pressure Switch Connector NPT¼

Part No.	811.111.004
Size	Ø6 mm
Material	Brass
Connection	NPT¼× NPT¼
Max. Working Pressure	150 bar
Overall Size	S17 mm* 36 mm
Weight:	0.035 kg

2.27 Inside Warning Sign

This Inside Warning Sign provides instructions to personnel who may work in an area protected with HFC-227ea fire system. The sign reminds the relevant personnel to leave the protected area immediately when the fire extinguishing system is activated. One sign is to be fixed to all export doors out of an HFC-227ea fire system protected area.

Figure 2.27 - Inside Warning Sign

Technical Specification:

Table 2.27 Inside Warning Sign

Part No.	811.108.104
Size	210 mm ×210 mm
Material	Aluminum

2.28 Outside Warning Sign

The Outside Warning Sign provides instructions to personnel who may enter an area protected with HFC-227ea fire system. This warning sign reminds the relevant personnel not to enter the protected area when the HFC-227ea firefighting system is activated. One plate is to be fixed to all entrance doors into an HFC-227ea fire system protected area.

Figure 2.28 - Outside Warning Sign

Technical Specification:

Table 2.28 Outside Warning Sign

Part No.	811.108.105
Size	210 mm ×210 mm
Material	Aluminum

Section 3 SYSTEM DESIGN

3.1 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. All systems are designed in accordance with the NFPA 2001.

3.1.1 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 Minimum Design Concentration for Class A fire is 6.7%, for Class B fire is 8.7% and for Class C fire is 7.0%. All design concentration calculations are based on extinguishing concentrations plus an additional 20% safety factor for Class A and 30% safety factor for Class B. The minimum design concentration for Class C shall be the flame extinguishing concentration of Class A plus an additional 35% safety factor.
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.

Table 3.1 HFC-227ea Cardiac Sensitization

Cardiac Sensitization (From NFPA2001)	HFC-227ea Concentration
No Observed Adverse Effect Level (NOAEL)	9.0%
Lowest Observed Adverse Effect Level (LOAEL)	10.5%

The flame extinguishing concentration for Class B fuels shall be determined by the cup burner method described in NFPA 2001. The HFC-227ea cup burner valve is 6.7% for commercial grade Heptane.
The minimum design concentration for a Class B fuel hazard shall be the flame extinguishing concentration for Class B, times a safety factor of 1.3.

The flame extinguishing concentration for Class A fuels shall be determined by test as part of a listing program. As a minimum, the listing program shall conform to ANSI/UL2127 or ANSI/UL 2166 or equivalent.
The minimum design concentration for a Class A surface-fire hazard shall be determined by the greater of the following:
(1) The flame extinguishing concentration for Class A fuels times a safety factor of 1.2.
(2) Equal to the minimum extinguishing concentration for heptane cup burner valve.

The minimum design concentration for a Class C hazard shall be the flame extinguishing concentration for Class A fuels times a safety factor of 1.35.
The minimum design concentration for spaces containing energized electrical hazards supplied at greater than 480 volts that remain powered during and after discharge shall be determined by testing, as necessary, and a hazard analysis.

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 no conductivity 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 ° C) (752 ° F)

3.1.2 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 1200 Pa (0.402 ft H_2O) developed during discharge.

3.1.3 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 300 mm (12") below the slab need not be considered. Obstructions greater than 300 mm (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.

3.1.4 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.

3.1.5 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 pressurized the HFC-227ea extinguishing system should not be exposed to temperatures other than the storage / operating temperature range of 0 to 54 ℃. (32 °F to 130 °F). This also includes while being in storage or transported.

3.1.6 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 presents in the hazard.

3.1.7 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.

3.1.8 Agent Quantities

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

3.1.9 Agent Storage

HFC-227ea is stored as a liquefied compressed gas in appropriate containers to meet TPED requirements. Nitrogen in the container maintains a super-pressurization of 25 bar at 21°C (360 psi at 70°F) (for 25 bar system) and 42 bar at 21°C (600 psi at 70°F) (for 42 bar system). 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°C (32°F to 130°F), the optimum temperature being 21℃(70℉).

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 °C (32 °F to 130 °F). This also includes while being in storage or transported.

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

In the system design, the limitations for filling and storage of HFC-227ea agent:

- **Cylinder fill density: Minimum 0.480 kg/L, Maximum 1.121 kg/L.**

3.1.10 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.

In the system design, the limitations for Manifolds:

- **Manifold dead volume ratio: Maximum 5.0%.**

3.1.11 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.

3.2 Agent Flow Characteristics

3.2.1 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 vapor space above the liquid providing the increased propulsion necessary to discharge the HFC-227ea from the container.

3.2.2 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 vapor. 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 vapor (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.

3.2.3 Initial Vapor Discharge

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

3.2.4 Trailing Vapor Pressure

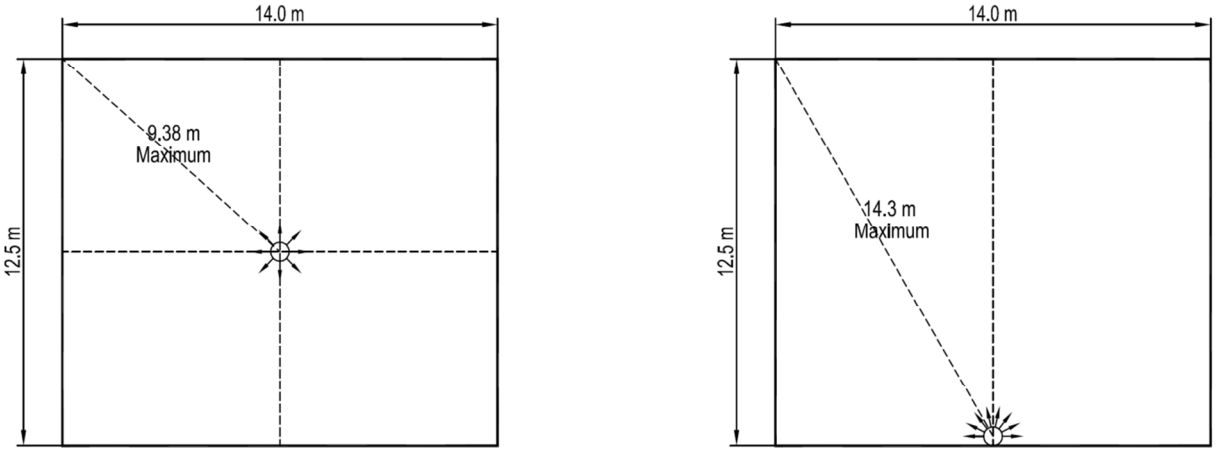
Discharge time is defined as the time required to discharge from the nozzle 95 percent of the agent mass at 21°C (70°F). For some halocarbon agents, it is the time interval between the first appearance of liquid at the nozzle and the time at which the discharge becomes predominantly gaseous. This is 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.

3.3 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 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 9.38 m (30.8 ft) for a 360° nozzle and 14.3 m (47.0 ft) for a 180° nozzle.**

- **The maximum coverage area for either nozzle is 174.0 m^2 (1873 ft^2) .**
- Nozzle orifices must not be placed where they may discharge into nearby objects.
- Nozzles must be installed a maximum of 370 mm (14.5") below the ceiling.
- **5.5 m (18.04 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.
- **300 mm (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 50 mm (2"). Measured from center of the nozzle to the wall.
- **Nozzle orifice area to pipe area ratio: minimum 0.15, maximum 0.80.**
- **Average pressure at nozzles: minimum 5.35 bar.**
- **Pressure variation between nozzles of the same system: maximum allowed 6.0 bar.**
- **Arrival time imbalance between nozzles: maximum allowable 1.00 s.**
- **Runout time imbalance between nozzles: maximum allowable 2.00 s.**
- **Discharge time: minimum allowed 6.0 s, maximum allowed 10.0 s.**



360° Radial Nozzle Arrangement　　180°Radial Nozzle Arrangement

Figure 3.3 Nozzle Discharge Radius

- **The ratio between the nozzle area and the pipe cross sectional area immediately preceding the nozzle is limited to a minimum of 0.15 (15%) and a maximum of 0.80 (80%).** Pipe and nozzle sizes need to be confirmed by the LIFECO Flow Calculation Software (HFC-227ea).

Table 3.3 Max. & Min. Flow Rates

Pipe Size mm (in)	Minimum flow rate kg/s (lb/s)	Maximum flow rate kg/s (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 (1¼)	2.722 (6.00)	5.670 (12.50)
40 (1½)	4.082 (9.00)	9.072 (20.00)
50 (2)	6.350 (14.00)	13.61 (30.00)
65 (2½)	9.072 (20.00)	24.95 (55.00)
80 (3)	13.61 (30.00)	44.92 (99.00)
100 (4)	24.95 (55.00)	56.70 (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.		

3.4 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 10-35%, bull tee splits will be between 25-75%. All Tee outlets must be in the same horizontal plane.

See examples Figure 3.4.

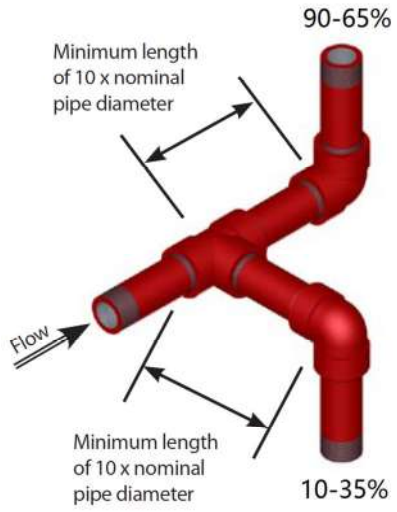


Figure 3.4a - Side Tee Split Limit

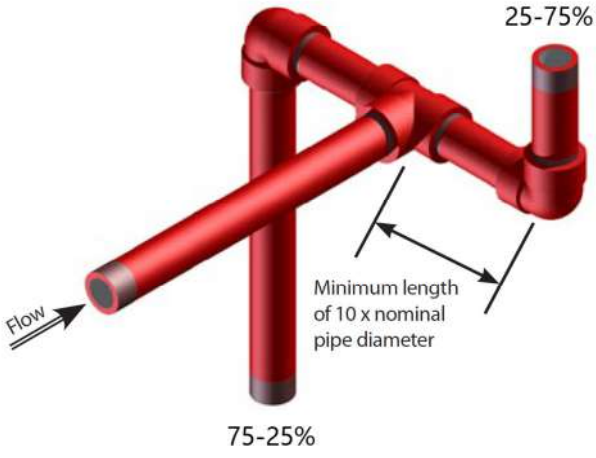


Figure 3.4b – Bull Tee Split Limit

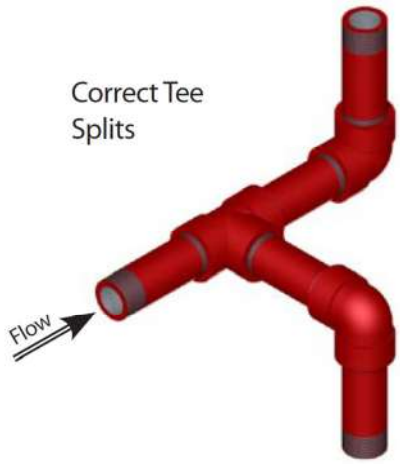


Figure 3.4c – Side tee orientation "Correct"

Figure 3.4d – Side tee orientation "Incorrect"

Figure 3.4e – Bull tee orientation "Correct"

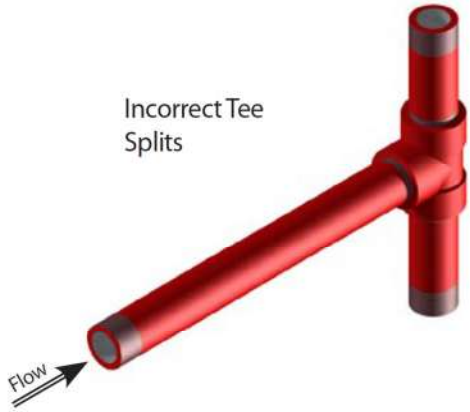


Figure 3.4f – Bull tee orientation "Incorrect"

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

3.5 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 3.4.

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.

In the system design, the limitations for piping:

- **Percent of agent in pipe: maximum allowed 107.0%.**
- **Percent agent before the first tee: minimum allowed 36.2%.**
- **Elevation change in network: maximum allowed 12.19m (40 ft).**

Section 4 FLOW CALCULATION

4.1 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 dependent 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 4.1 and Talbe 4.2) or by using the formula (HFC-227ea Equation Calculations) and then multiplying by the altitude correction factor (Table 4.3).

Example:
Hazard Volume: 200 m^3
Room Temperature: 20 ° C
Agent Concentration: 7.3%
Flooding Factor: 0.5736 (look up Table 4.2)
Quantity of HFC-227ea required: 0.5736 * 200 =114.72 kg.
Note: Refer to NFPA2001 Table of "HFC-227ea Total Flooding Quantity" .

Table 4.1 HFC-227ea Weight Calculations (Imperial).

Temp. T (°F)	Specific Vapor Volume S (ft^3/lb)	Weight Requirements of Hazard Volume, W/V(lb/ft^3) Design Concentration(% by Volume)										
		6.4	**7.0**	**7.3**	**8.0**	**9.0**	**10.0**	**11.0**	**12.0**	**13.0**	**14.0**	**15.0**
10	1.9264	0.0354	0.0391	0.0409	0.0451	0.0513	0.057	0.0642	0.0708	0.0776	0.0845	0.0916
20	1.9736	0.0346	0.0381	0.0399	0.0441	0.0501	0.0563	0.0626	0.0691	0.0757	0.0825	0.0894
30	2.0210	0.0338	0.0372	0.0390	0.0430	0.0489	0.0550	0.0612	0.0675	0.0739	0.0805	0.0873
40	2.0678	0.0330	0.0364	0.0381	0.0421	0.0478	0.0537	0.0598	0.0659	0.0723	0.0787	0.0853
50	2.1146	0.0323	0.0356	0.0372	0.0411	0.0468	0.0525	0.0584	0.0645	0.0707	0.0770	0.0835
60	2.1612	0.0316	0.0348	0.0364	0.0402	0.0458	0.0514	0.0572	0.0631	0.0691	0.0753	0.0817
70	2.2075	0.0310	0.0341	0.0357	0.0394	0.0448	0.0503	0.056	0.0618	0.0677	0.0737	0.0799
80	2.2538	0.0303	0.0334	0.0349	0.0386	0.0439	0.0493	0.0548	0.0605	0.0663	0.0722	0.0783
90	2.2994	0.0297	0.0327	0.0342	0.0378	0.0430	0.0483	0.0538	0.0593	0.0650	0.0708	0.0767
100	2.3452	0.0292	0.0321	0.0336	0.0371	0.0422	0.0474	0.0527	0.0581	0.0637	0.0694	0.0752
110	2.3912	0.0286	0.0315	0.0329	0.0364	0.0414	0.0465	0.0517	0.0570	0.0625	0.0681	0.0738

Temp. T (°F)	Specific Vapor Volume S (ft^3/lb)	Weight Requirements of Hazard Volume, W/V(lb/ft^3) Design Concentration(% by Volume)										
		6.4	**7.0**	**7.3**	**8.0**	**9.0**	**10.0**	**11.0**	**12.0**	**13.0**	**14.0**	**15.0**
120	2.4366	0.0281	0.0309	0.0323	0.0357	0.0406	0.0456	0.0507	0.0560	0.0613	0.0668	0.0724
130	2.4820	0.0275	0.0303	0.0317	0.0350	0.0398	0.0448	0.0498	0.0549	0.0602	0.0656	0.0711
140	2.5272	0.0270	0.0298	0.0312	0.0344	0.0391	0.0440	0.0489	0.0540	0.0591	0.0644	0.0698

Table 4.2 HFC-227ea Weight Calculations (Metric).

Temp. T (°C)	Specific Vapor Volume S (m^3/Kg)	Weight Requirements of Hazard Volume, W/V (kg/m^3) Design Concentration (% by Volume)										
		6.4	**7.0**	**7.3**	**8.0**	**9.0**	**10.0**	**11.0**	**12.0**	**13.0**	**14.0**	**15.0**
-10	0.1215	0.5615	0.6196	0.6481	0.7158	0.8142	0.9147	1.0174	1.1225	1.2301	1.3401	1.4527
-5	0.1241	0.5499	0.6064	0.6346	0.7005	0.7987	0.8951	0.9957	1.0985	1.2038	1.3114	1.4216
0	0.1268	0.5388	0.5936	0.6210	0.6858	0.7800	0.8763	0.9748	1.0755	1.1785	1.2839	1.3918
5	0.1294	0.5281	0.5816	0.6086	0.6719	0.7642	0.8586	0.9550	1.0537	1.1546	1.2579	1.3636
10	0.1320	0.5179	0.5700	0.5966	0.6585	0.7490	0.8414	0.9360	1.0327	1.1316	1.2328	1.2264
15	0.1347	0.5080	0.5589	0.5846	0.6457	0.7344	0.8251	0.9178	1.0126	1.1096	1.2089	1.3105
20	0.1373	0.4985	0.5483	0.5736	0.6335	0.7205	0.8094	0.9004	0.9934	1.0886	1.1859	1.2856
25	0.1399	0.4894	0.5382	0.5629	0.6217	0.7071	0.7944	0.8837	0.9750	1.0684	1.1640	1.2618
30	0.1425	0.4805	0.5284	0.5526	0.6104	0.6943	0.7800	0.8676	0.9573	1.0490	1.1428	1.2388
35	0.1450	0.4720	0.519	0.5431	0.5996	0.6819	0.7661	0.8522	0.9402	1.0303	1.1224	1.2168
40	0.1476	0.4638	0.5099	0.5335	0.5891	0.6701	0.7528	0.8374	0.9230	1.0124	1.1029	1.1956
45	0.1502	0.4559	0.5012	0.5243	0.579	0.6586	0.7399	0.823	0.0908	0.9950	1.0840	1.1751
50	0.1570	0.4482	0.4929	0.5016	0.5694	0.6476	0.7276	0.8093	0.8929	0.9784	1.0660	1.1555
55	0.1553	0.4408	0.4847	0.5071	0.5600	0.6369	0.7156	0.7960	0.8782	0.9623	1.0484	1.1365

Table 4.3 Altitude Correction Factor

Altitude above sea level ft (m)	Correction Factor
-3000 (-920)	1.11
-2000 (-610)	1.07
-1000 (300)	1.04
0 (0)	1.00
1000 (300)	0.96
2000 (610)	0.93
3000 (910)	0.89
4000 (1220)	0.86
5000 (1520)	0.82
6000 (1830)	0.78
7000 (2130)	0.75
8000 (2450)	0.72
9000 (2740)	0.69
10000 (3050)	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 pressure 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℉).

4.2 HFC-227ea Equation Calculations

The weight of agent required for a hazard area can also be calculated from the formula shown below:

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

W = Weight of agent required, kg (lbs.)

V = Net volume of hazard, calculated as the gross volume minus the volume of fixed structures impervious to clean agent vapor, m^3 (ft^3)

S = Specific agent vapor volume at 1 atm and the minimum anticipated temperature of hazard volume, m^3/kg (ft^3/lbs.)

C = Required HFC-227ea Design Concentration, (vol %)

Where:

$$S = 0.1269 + 0.0005131 \cdot t \quad \text{(Metric Units)}$$

$$S = 1.885 + 0.0046 \cdot t \quad \text{(Imperial Units)}$$

t = Design temperature in hazard area ℃ (℉)

4.3 Engineered Systems

LIFECO 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 LIFECO or LIFECO trained personnel are permitted to perform system calculations. If in the future, companies other than LIFECO wish to use the program, representatives will be required to attend a formal training session. All system calculations are conducted either 'in house' by LIFECO or authorized 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.

- 5.35 bar (77.7 psi) minimum nozzle pressure.
- 107% maximum pipe volume against the agent volume.
- Between 6 - 10 seconds discharge time.
- 10 - 35 % side tee split.
- 25 -75 % bull tee split.
- 0.48 kg/L (29.9 lbs. /ft^3) - 1.12 kg/L (69.8 lbs. /ft^3) fill density.
- Maximum liquid arrival time imbalance of 1.0 seconds.
- Maximum liquid run out time imbalance of 2.0 seconds.
- Maximum nozzle height is 5.5 m (18.04 ft.).
- Minimum of 36.2% agent in pipe before first tee.
- The ratio between the nozzle area and the pipe cross sectional area immediately preceding the nozzle is limited to a minimum of 0.15 (15%) and a maximum of 0.80 (80%). Pipe and nozzle sizes need to be confirmed by the LIFECO Flow Calculation Software (HFC-227ea).

Table 4.4 Max. & Min. Flow Rates

Pipe Size mm (in)	Minimum flow rate kg/s (lb/s)	Maximum flow rate kg/s (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 (1¼)	2.722 (6.00)	5.670 (12.50)
40 (1½)	4.082 (9.00)	9.072 (20.00)
50 (2)	6.350 (14.00)	13.61 (30.00)
65 (2½)	9.072 (20.00)	24.95 (55.00)
80 (3)	13.61 (30.00)	44.92 (99.00)
100 (4)	24.95 (55.00)	56.70 (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 4.5 Equivalent Length for Threaded Fittings (ASTM Sch.40 Threaded)

Diameter		90° Elbow		45° Elbow		Thru Tee		Side Tee		Union	
mm	(in)	m	(ft)	m	(ft)	m	(ft)	m	(ft)	m	(ft)
10	(3/8)	0.40	(1.3)	0.18	(0.6)	0.24	(0.8)	0.82	(2.7)	0.09	(0.3)
15	(1/2)	0.52	(1.7)	0.24	(0.8)	0.30	(1.0)	1.04	(3.4)	0.12	(0.4)
20	(3/4)	0.67	(2.2)	0.30	(1.0)	0.42	(1.4)	1.37	(4.5)	0.15	(0.5)
25	(1)	0.85	(2.8)	0.40	(1.3)	0.55	(1.8)	1.74	(5.7)	0.18	(0.6)
32	(1¼)	1.13	(3.7)	0.52	(1.7)	0.70	(2.3)	2.29	(7.5)	0.24	(0.8)
40	(1½)	1.31	(4.3)	0.61	(2.0)	0.82	(2.7)	2.65	(8.7)	0.27	(0.9)
50	(2)	1.68	(5.5)	0.79	(2.6)	1.06	(3.5)	3.41	(11.2)	0.37	(1.2)

Diameter		90° Elbow		45° Elbow		Thru Tee		Side Tee		Union	
mm	(in)	m	(ft)	m	(ft)	m	(ft)	m	(ft)	m	(ft)
65	(2½)	2.01	(6.6)	0.94	(3.1)	1.25	(4.1)	4.08	(13.4)	0.43	(1.4)
80	(3)	2.50	(8.2)	1.16	(3.8)	1.55	(4.7)	5.06	(16.6)	0.55	(1.8)
100	(4)	3.26	(10.7)	1.52	(5.0)	2.04	(5.1)	6.64	(21.8)	0.73	(2.4)
125	(5)	4.08	(13.4)	1.92	(6.3)	2.56	(6.7)	8.35	(27.4)	0.91	(3.0)
150	(6)	4.94	(16.2)	2.32	(7.6)	3.08	(8.4)	10.0	(32.8)	1.07	(3.5)

Table 4.6 Equivalent Length for Welded Fitting (ASTM Sch.40 Welded)

Diameter		90° Elbow		45° Elbow		Thru Tee		Side Tee		Union	
mm	(in)	m	(ft)	m	(ft)	m	(ft)	m	(ft)	m	(ft)
10	(3/8)	0.21	(0.7)	0.06	(0.2)	0.15	(0.5)	0.49	(1.6)	0.09	(0.3)
15	(1/2)	0.24	(0.8)	0.09	(0.3)	0.21	(0.7)	0.64	(2.1)	0.12	(0.4)
20	(3/4)	0.34	(1.1)	0.12	(0.4)	0.27	(0.9)	0.85	(2.8)	0.15	(0.5)
25	(1)	0.43	(1.4)	0.15	(0.5)	0.34	(1.1)	1.07	(3.5)	0.18	(0.6)
32	(1¼)	0.55	(1.8)	0.21	(0.7)	0.46	(1.5)	1.40	(4.6)	0.24	(0.8)
40	(1½)	0.64	(2.1)	0.24	(0.8)	0.52	(1.7)	1.65	(5.4)	0.27	(0.9)
50	(2)	0.85	(2.8)	0.30	(1.0)	0.67	(2.2)	2.10	(6.9)	0.37	(1.2)
65	(2½)	1.01	(3.3)	0.37	(1.2)	0.82	(2.7)	2.50	(8.2)	0.43	(1.4)
80	(3)	1.25	(4.1)	0.46	(1.5)	1.01	(3.3)	3.11	(10.2)	0.55	(1.8)
100	(4)	1.65	(5.4)	0.61	(2.0)	1.34	(4.4)	4.08	(13.4)	0.73	(2.4)
125	(5)	2.04	(6.7)	0.76	(2.5)	1.68	(5.5)	5.12	(16.8)	0.91	(3.0)
150	(6)	2.47	(8.1)	0.91	(3.0)	2.01	(6.6)	6.16	(20.2)	1.07	(3.5)

Table 4.7 Equivalent Length for Grooved Fitting (ASTM Sch.40 Grooved)

Diameter		90° Elbow		45° Elbow		Thru Tee		Side Tee		Union	
mm	(in)	m	(ft)	m	(ft)	m	(ft)	m	(ft)	m	(ft)
20	(3/4)	0.40	(1.3)	0.18	(0.6)	0.40	(1.3)	0.98	(3.2)	0.15	(0.5)
25	(1)	0.91	(3.0)	0.46	(1.5)	0.91	(3.0)	1.83	(6.0)	0.18	(0.6)
32	(1¼)	1.22	(4.0)	0.61	(2.0)	1.22	(4.0)	2.13	(7.0)	0.24	(0.8)
40	(1½)	1.52	(5.0)	0.76	(2.5)	1.52	(5.0)	3.05	(10.0)	0.27	(0.9)
50	(2)	1.83	(6.0)	0.91	(3.0)	1.83	(6.0)	3.66	(12.0)	0.37	(1.2)
65	(2½)	2.44	(8.0)	1.22	(4.0)	2.44	(8.0)	5.18	(17.0)	0.43	(1.4)
80	(3)	2.74	(9.0)	1.37	(4.5)	2.74	(9.0)	6.10	(20.0)	0.55	(1.8)
100	(4)	3.96	(13.0)	1.98	(6.5)	3.96	(13.0)	7.92	(26.0)	0.73	(2.4)
125	(5)	4.57	(15.0)	2.29	(7.5)	4.57	(15.0)	9.75	(32.0)	0.91	(3.0)
150	(6)	5.49	(18.0)	2.74	(9.0)	5.49	(18.0)	11.58	(38.0)	1.07	(3.5)

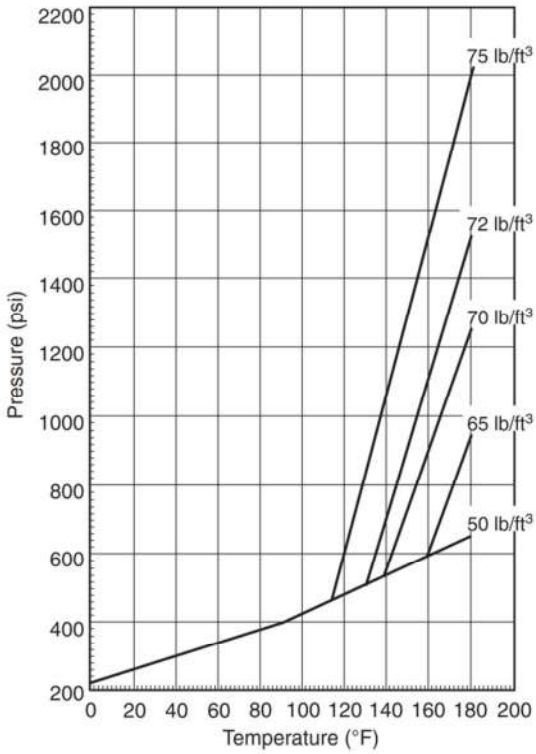
Table 4.8 Equivalent Length for other system components

Component	Nominal pipe size	Equivalent length (m)
33mm Container Valve (1¼ in)	33 mm (1¼ in)	12.0
49mm Container Valve (2 in)	49 mm (2 in)	12.4
33mm Flex Hose (Discharge Hose) (1¼ in)	33mm (1¼ in)	4.0
49mm Flex Hose (Discharge Hose) (2 in)	49 mm (2 in)	3.7

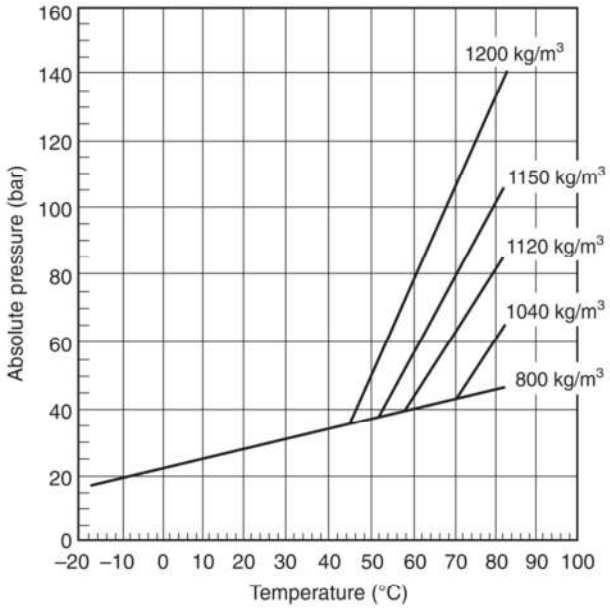
Component	Nominal pipe size	Equivalent length (m)
33mm Valve Outlet Adaptor (1¼ in)	33 mm (1¼ in)	1.5
49mm Valve Outlet Adaptor (2 in)	49 mm (2 in)	2.0
33mm Check Valve (1¼ in)	33mm (1¼ in)	9.0
49mm Check Valve (2 in)	49 mm (2 in)	10.0
33mm Check & Flex (1¼ in)	33 mm (1¼ in)	13.0
49mm Check & Flex (2 in)	49 mm (2 in)	13.7

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

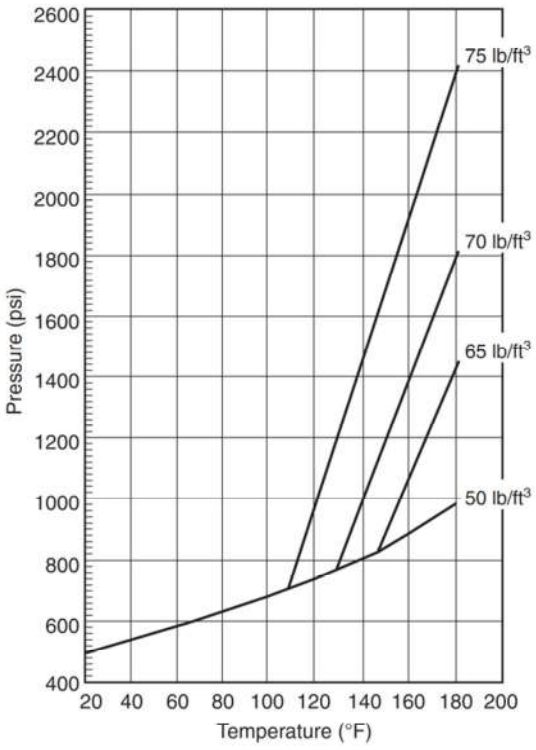
Isometric Diagram of HFC-227ea Pressurized with Nitrogen



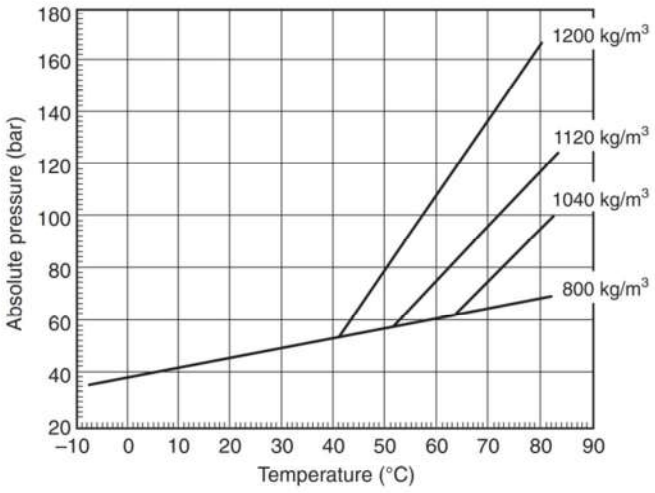
(1) Pressurized to 360 psi at 70°F



(2) Pressurized to 25 bar at 21°C



(3) Pressurized to 600 psi at 70°F



(4) Pressurized to 40 bar at 21°C

Section 5 SYSTEM INSTALLATION

5.0 General Information

All installation shall be carried out by an approved contractor with the correct equipment and previous experience of gaseous extinguishing systems.
Only listed equipment and devices shall be used in the systems installation.
The system installation mainly includes the following:

- Container Installation
- Piping and Nozzles
- Actuation Controls
- Ancillary Equipment
- Completion Procedures

Specific installation drawings must be prepared for the hazard area in accordance with system design as calculated by the LIFECO Flow Calculation Software (HFC-227ea). These drawings should be followed closely in order to ensure the system meets its design criteria. The pipe network is sized in order to obtain correct discharge time, nozzle pressures, agent quantity and various other design considerations. If for any reason, the pipe network requires modifications the system must be recalculated before proceeding with installation. Installation drawings contain the following information;

- Enclosure Volumes.
- Agent Quantities.
- Pipe Network layout Plan.
- Pipe Network Isometric.
- Pipe Diameters, Pipe Length Drops and Rises.
- Nozzle Data.
- Container Data.
- Solenoid Actuator Technical Data.
- Low Pressure Switch Wiring Chart
- Fittings Data.

Installation drawings shall be submitted for approval to the appropriate authority prior to system installation. After the equipment arrives at the installation site, please confirm that the system components comply with the parking list and installation drawings.

The container weight is checked at the factory prior to dispatch and recorded on the label attached to the container. If there is any doubt regarding the weight, or leakage is suspected, the container should be weighed to confirm there is no weight loss. Determine the container storage temperature and refer to the Temperature Correction Chart to check the pressure within the container (see Table 8.1.2).

5.1 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 fixed on a stable bracket, in a vertical orientation only.

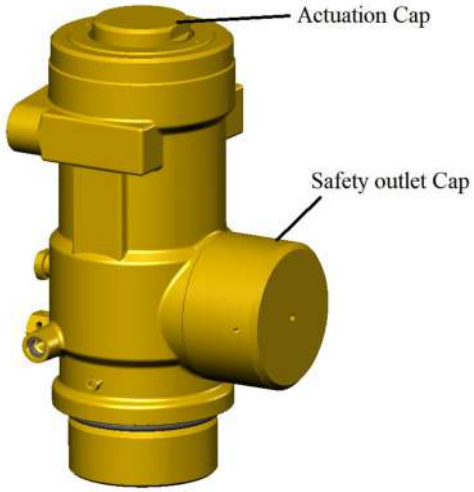


Figure 5.1.1 - Safety outlet & Actuation Caps

Container Valve Safety Cap Installation

During the shipping of the container assembly and before the container assembly is fixed in place, the safety caps should be firmly installed at the ports of the container valve.

Table 5.1.1 Safety Outlet Cap & Actuation Cap

Type	33 mm Valve Outlet Cap	49 mm Valve Outlet Cap	Actuation Port Cap
Part No.	811.101.090	811.101.091	811.101.092
Material	Brass	Brass	Plastic
Port Connection	1.875 -12 UN	2.5-12 UN	M42×1.5

Single Container Installation

1. Fix the back channels of the mounting brackets to the wall at the appropriate heights, using suitable anchor type bolts (not supplied).
2. Position the container against the back channel with the pressure gauge facing forward.
3. Insert the container straps at middle and secure with the bolts provided (see Figure 5.1.2).
4. Remove the safety outlet cap from the valve outlet port and install a Container Valve Outlet Adaptor (see Figure 5.1.3).
5. Install the initial pipe and then disconnect the container and refit the safety outlet cap to the valve outlet
6. Re-connect the pipe to the container with container valve adaptor after the pipework system is complete and the discharge nozzles have been installed.

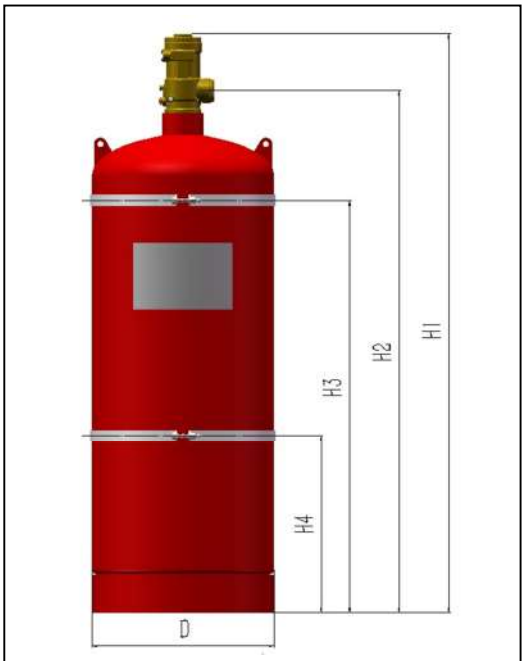


Figure 5.1.2 - Container Strap Location

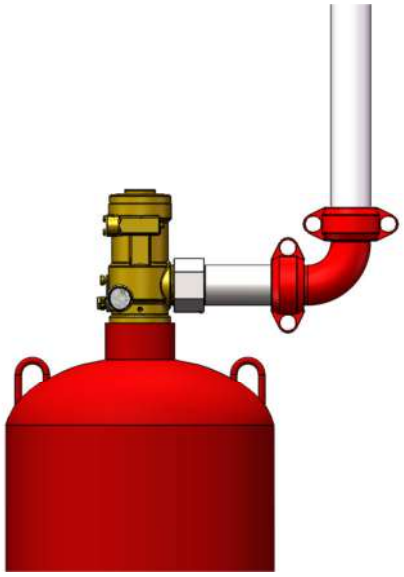
CAUTION: DO NOT OVER TIGHTEN THE CONTAINER CONNECTION. EXCESSIVE TIGHTENING MAY CAUSE THE VALVE OUTLET THREAD TO BE DAMAGED AND ADVERSELY AFFECT THE SYSTEM OPERATION.

Table 5.1.2 Bracket Fixing Heights – TPED Container

Cylinder Size (L)	H1 (mm)	H2 (mm)	H3 (mm)	H4 (mm)	D (mm)
Cylinder with 49mm Container Valve					
40	841	695	470	220	Ø324
50	969	823	600	330	Ø324
60	1102	956	600	330	Ø324
70	1231	1085	800	450	Ø324
80	1362	1216	950	450	Ø324
90	1084	938	680	330	Ø406
100	1166	1020	750	450	Ø406
120	1329	1183	900	450	Ø406
150	1575	1429	1050	450	Ø406
160	1346	1200	900	450	Ø462
170	1407	1261	900	450	Ø462
Cylinder with 33mm Container Valve					
16.6	668	566	400	200	Ø228.6
28.3	975	873	600	330	Ø228.6
40	775	673	470	220	Ø324
50	903	801	600	330	Ø324
60	1036	934	600	330	Ø324

Table 5.1.3 Bracket Fixing Heights – GB Container

Cylinder Size (L)	H1 (mm)	H2 (mm)	H3 (mm)	H4 (mm)	D (mm)
Cylinder with 49mm Container Valve					
40	1134	988	750	300	Ø260
50	1119	973	750	300	Ø312
60	1261	1115	750	300	Ø312
70	1403	1257	1050	300	Ø312
80	1545	1399	1050	300	Ø312
90	1126	980	750	300	Ø416
100	1200	1055	750	300	Ø416
120	1360	1214	900	300	Ø416
150	1599	1453	1050	300	Ø416
170	1758	1612	1200	300	Ø416
Cylinder with 33mm Container Valve					
40	1068	965	750	300	Ø260
50	1055	952	750	300	Ø312
60	1197	1094	750	300	Ø312



Grooved Type VOA

Threaded Type VOA

Figure 5.1.3 - Container Valve Outlet Adaptor Installation

Table 5.1.4 Bracket Fixing Heights – DOT Container

Cylinder Size (L)	H1 (mm)	H2 (mm)	H3 (mm)	H4 (mm)	D (mm)
Cylinder with 49mm Container Valve					
49	964	820	600	300	Ø324
52	764	618	400	200	Ø406
62	1134	988	750	300	Ø324
80	1367	1221	900	300	Ø324
103	1179	1033	750	300	Ø406
106	1204	1058	750	300	Ø406
147	1539	1393	1050	300	Ø406
153	1589	1443	1050	300	Ø406
Cylinder with 33mm Container Valve					
16.7	674	571	400	200	Ø228.6
28.3	979	876	600	300	Ø228.6
49	900	797	600	300	Ø324
52	700	595	400	200	Ø406
62	1068	965	750	300	Ø324

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 manifold assembly consists of the manifold, 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, using suitable anchor type bolts (not supplied).
2. Position the containers against the back channels with pressure gauge facing forward (the valve outlets pointing left or right) at the required spacing for the manifold ports.
3. Insert the container straps at middle and secure with the bolts provided.

Manifold Bracket Installation

1. Fix the two uni-strut (back vertical channels) to the wall at the appropriate height using suitable anchor type bolts. 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.
2. Locate and secure the cantilever brackets to each channel using M10×40mm 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. Install check valve into the manifold port, and then install discharge hose between the valve discharge outlet and the check valve, as the following steps.

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. Thread the hose swivel nut onto the check valve until the swivel nut covers the entire check valve threads.

CAUTION: MAKE CERTAIN THE SWIVEL NUT COVERS THE ENTIRE 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.

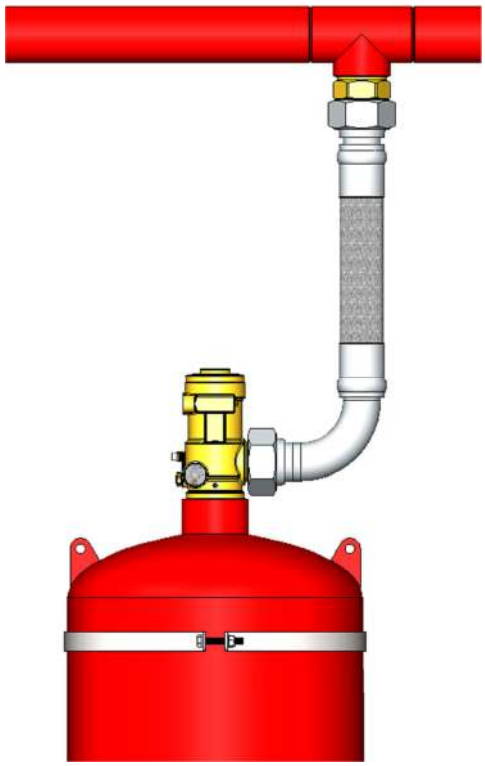


Figure 5.1.4 – Discharge Hose / Check Valve Installation

Table 5.1.5 Manifold Bracket Fixing Heights

Container Assembly Code	Valve Size (mm)	Height From Floor to top of cantilever (mm)
TPED Container Assembly		
16.6C	33	1210
28.3C	33	1520
40C	33	1320
50C	33	1450
60C	33	1580
40D	49	1490
50D	49	1620
60D	49	1750
70D	49	1880
80D	49	2010
90D	49	1730
100D	49	1820
120D	49	1980
150D	49	2220
160D	49	1990
170D	49	2050

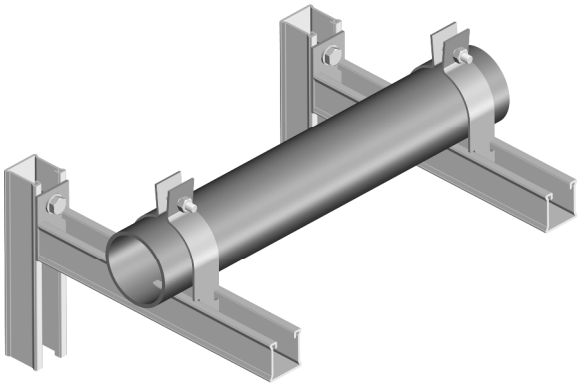


Figure 5.1.5 - Manifold Fixing

Container Assembly Code	Valve Size (mm)	Height From Floor to top of cantilever (mm)
GB Container Assemby		
40K	33	1610
50K	33	1600
60K	33	1740
40M	49	1780
50M	49	1770
60M	49	1910
70M	49	2050
80M	49	2195
90M	49	1775
100M	49	1850
120M	49	2010
150M	49	2250
170M	49	2410
DOT Container Assemby		
16.7R	33	1220
28.3R	33	1525
49R	33	1445
52R	33	1245
62R	33	1610
49S	49	1615
52S	49	1415
62S	49	1785
80S	49	2015
103S	49	1830
106S	49	1855
147S	49	2190
153S	49	2240

5.2 Pipe Installation

In general, the installation should commence at the union elbow / manifold assembly and progress along to the discharge nozzles. Install the Pipework to the installation drawings provided, ensuring that the following is adhered to:

- The piping material must conform to the requirements of NFPA 2001 4.2.1.
- The pipe must be reamed, blown clear and swabbed with an appropriate solvent to remove mill varnish and cutting oil before assembly as required by NFPA 2001 4.2.1.
- PTFE (Teflon) tape is the only acceptable pipe sealant and must be applied to the male threads.

Requirements Of Applicable Pipe & Fitting

Table 5.2.1 Steel Pipework Requirements of UK

Standard	Type of Pipe	Grade of Steel	Min. Wall Thickness*	Nominal Pipe Size
BS 1387 (BS EN 10255)	Butt Welded	--	Heavy	3/8”-2”
BS 3601 (BS EN 10216-1)	Seamless	430	Schedule 40 (Schedule 80 for screwed joints)	3/8”-4”
			Schedule 80	5”-6”
BS 3602-1 (BS EN 10216-1)	Hot/ Cold Finished Seamless	360 / 430	Schedule 40 (Schedule 80 for screwed joints)	3/8”-6”
* Where schedule numbers are given, these determine the min. wall thickness in accordance with BS1600. Where the specified pipe is not obtainable in these dimensions, the next larger thickness should be used.				

Table 5.2.2 Steel Pipework Requirements of US

Standard	Type of Pipe	Connection	Min. Wall Thickness	Nominal Pipe Size
ASTM A-106	Seamless Grade C	Threaded / Welded	Schedule 40	3/8”-6”
	Seamless Grade B			
	Seamless Grade A			
ASTM A-53	Seamless Grade B			
	Seamless Grade A			
	ERW Grade B			
	ERW Grade A			
	Furnace Weld Class F			

Table 5.2.3 Fitting of UK

Standard	Type of Pipe	Nominal Pipe Size
BS 1740	Screwed	3/8”-6”
BS 3799	Forged Steel, Screwed complying with grade WPA or WPB	
	Forged Steel, Socket Weld, complying with grade WPA or WPB	
BS 1640: Part 3	Forged Steel, Butt Weld, complying with grade WPA or WPB	
ANSI B16.3	Screwed, Class 150	3/8”-3”
ANSI B16.9	Forged Steel, Butt Weld, Class 300	
Note: Do not use 90° sharp elbows/tees for system installation		

Table 5.2.4 Fitting of US

Fitting Description	Nominal Pipe Size
Class 300 Malleable or Ductile Iron	3/8”-3”
Class 1000 Rated Ductile Iron or Forged Steel Class 300 Flanged Joints	3/8”-6”

CAUTION: PIPING MUST BE OF NONCOMBUSTIBLE MATERIAL HAVING PHYSICAL AND CHEMICAL CHARACTERISTICS, SUCH THAT ITS INTEGRITY UNDER STRESS CAN BE PREDICTED WITH RELIABILITY. LIFECO FLOW CALCULATION SOFTWARE (HFC-227EA) HAS ONLY BEEN VERIFIED FOR THE SPECIFIC TYPES AND SCHEDULE OF PIPE AND FITTINGS COVERED IN THIS MANUAL. THERE IS A RISK THAT THE SYSTEM MAY NOT SUPPLY THE REQUIRED QUANTITY OF AGENT IN UNBALANCED SYSTEMS WHEN OTHER PIPE TYPES AND FITTINGS ARE USED.

Pipe Hangers

Pipe hangers must be spaced according to the size of pipe.

- Hangers must be placed within 300 mm (12”) of the discharge nozzle.
- Hangers must be placed between elbows that are more than 600 mm (24”) apart.
- Hangers must be fixed to a structure capable of supporting the Pipework.

Table 5.2.5 Hanger Spacing

Pipe Size (mm)	Maximum Spacing (m)
10 (3/8”)	1.0 (3 ft)
15 (1/2”)	1.5 (5 ft)
20 (3/4”)	1.8 (6 ft)
25 (1”)	2.1 (7 ft)
32 (1¼”)	2.4 (8 ft)
40 (1½”)	2.7 (9 ft)
50 (2”)	3.4 (11 ft)
65 (2½”)	3.5 (11.5 ft)
80 (3”)	3.7 (12 ft)
100 (4”)	4.3 (14 ft)
125 (5”)	4.7 (15.5 ft)
150 (6”)	5.2 (17 ft)

Earthing and Electrical Clearance

All system components shall be located to maintain no less than minimum clearances from energized electrical parts. Systems within electrical substations or switchrooms shall be efficiently earthed to prevent the metalwork becoming electrically charged. Adequate earthing of systems will minimize the risk of electrostatic discharge. Where exposed electrical conductors are present and, where practicable, clearances no smaller than those given in table 5.2.6 shall be provided, between the electrical conductors and all parts of the system that may be approached during maintenance.

Table 5.2.6 Safety Clearances

Max. Rated Voltage (KV)	Min. Section Clearance (m)	Min. Ground Clearance (m)
15	2.59 (8.5 ft)	--
33	2.74 (9.0 ft)	--
44	2.89 (9.5 ft)	--
66	3.05 (10 ft)	--
88	3.20 (10.5 ft)	2.44 (8.0 ft)
110	3.35 (11 ft)	2.44 (8.0 ft)
132	3.50 (11.5 ft)	2.44 (8.0 ft)
165	3.81 (12.5 ft)	2.44 (8.0 ft)
220	4.27 (14.0 ft)	2.44 (8.0 ft)
275	4.57 (15.0 ft)	2.44 (8.0 ft)

Section Clearance: Minimum clearance from any point on or about the permanent equipment where a person may be required to stand (measure from position of the feet) to the nearest unscreened live conductor in air. Ground clearance: Minimum clearance from any point on or about the permanent equipment where a person may be required to stand (measure from position of the feet) to the nearest part not at earth potential of an insulator supporting a live conductor.
Reference NFPA 2001, section 1.5.2.

5.3 Nozzle Installation

There are two basic LIFECO Engineered System nozzle configurations:
1. The 360° nozzle, which provides a full 360° discharge pattern designed for placement in the center of the hazard.
2. The 180° nozzle, which provides a 180° discharge pattern designed for placement adjacent to a side wall of the hazard.
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.

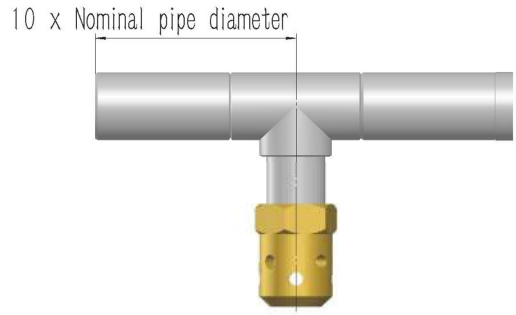


Figure 5.3 - Dirt Trap

A false ceiling comprising loose tiles must have the tiles retained within a 2.0 m (6.5ft) radius of the nozzle, to prevent movement during system discharge. Nozzles should be installed a maximum of 370 mm (14.5") below the ceiling.
After the system piping has been blown free of debris, install the discharge nozzles in strict accordance with the system drawings. Orient the nozzles as shown on drawings. Make certain that the correct nozzle type, part number and orifice size are installed in the proper location.

Nozzle Placement

• Orientation - Nozzles must be mounted perpendicular to the ceiling or subfloor surface and oriented with the orifices radiating symmetrically outward from the pipe network.
• Ceiling Clearance - Nozzles must be installed so that the orifices are located 0 to 14.5 in. below the ceiling.
• Maximum Height - The maximum protected height for a single row of nozzles is 18 feet (5.5 m). Nozzles may be tiered to accommodate enclosures with ceiling heights greater than 18 ft. (5.5 m), but no greater than 36 ft. (11 m).
• Minimum Ceiling Height- The minimum ceiling height for UL Listed systems is 1 ft. (0.3 m) or 12 in.
• 180° Nozzles - 180° nozzles must be located 12 in. (0.3 m) from a wall, with the orifices directed away from the wall. The nozzle shall be located as close to the center of the wall as possible, but at least 1/3 of the way along the wall from the center. 180° nozzles may be used in a back-to-back configuration. The nozzles should be place 1 to 2 ft. (0.3 m to 0.6 m) apart.
• 360° Nozzles - 360° nozzles must be located as close to the center of the enclosure as possible.

• Multiple Nozzles - Nozzles whose discharge patterns will intersect must be placed at least 4 ft. (1.2 m) apart to assure adequate agent distribution.

The other limits on nozzle conditions can see Sec.3.3 Nozzle Selection and Location of this manual.

5.4 Actuation Installation

The activation method depends on the system configuration and any specific contract requirements, which can be divided into the following:

• Single Container Actuation

• Multiple Container Actuation

Single Container Removable Electrical Actuator

The removable electrical actuator is fitted to the top of the valve assembly as follows:

1. Check the actuator mechanism to ensure that it is in the latched position by fully screwing in the reset tool, i.e. pin retracted (see Figure 2.11.2 and Figure 5.4.1).
2. Remove the actuator cap from the top of the valve assembly.
3. Carefully screw the actuator to the valve assembly (see Figure 5.4.2).

If no other actuators are to be installed ensure that the protective cap on the actuator is retained in position.

The electrical signal from the detection and/or control equipment is connected in accordance with the wiring diagram detailed in Figure 5.4.3 when all other installations have been completed.

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.

Before this system is put into operation, the removable solenoid can be checked by firing the system. To do this, REMOVE THE ELECTRICAL ACTUATOR from the valve. With power to the actuator, the pin should be firmly in the down position. Ensure that the electrical actuator is reset prior to fitting on to the container valve. FAILURE TO RESET THE ACTUATOR WILL RESULT IN THE POTENTIALLY

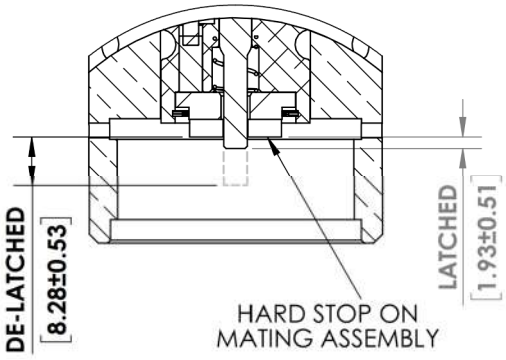


Figure 5.4.1 – Actuator Latched Position

Figure 5.4.2 – Electrical Actuator Location

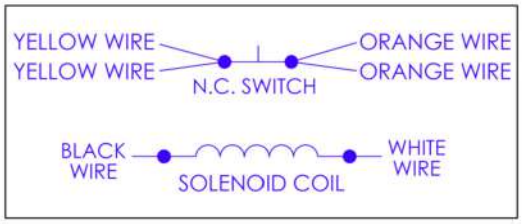


Figure 5.4.3 - Electrical Actuator Wire Diagram

HAZARDOUS DISCHARGE OF THE CONTAINER.

Single Container Manual Button

A Manual Button is installed on the top of the Electrical Actuator. In addition to the electrically actuate, the actuator can be activated directly by pressing the Manual Button. Before pressing the Button manually, the limit pin at the bottom of the button should be pulled out.

Figure 5.4.4 - Actuator Manual Button

Multiple Container Pneumatic Actuator

Where several containers comprise one system and are discharged simultaneously, one container is designated as the 'master' container, and the others are 'slave' containers. The master container can be actuated electrically or manually. The slave containers are actuated pneumatically by the action of the master container discharging.

Check that the actuating plungers are in the raised position (see Figure 5.4.5). Remove the actuation cap from the top of the valve assembly and carefully screw the pneumatic actuator to the valve on each slave container.

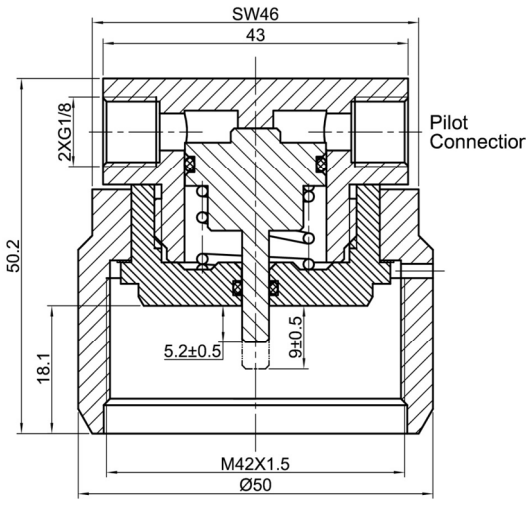


Figure 5.4.5 – Pneumatic Actuator Location

Multiple Container Slave Actuation Pilot Line

For slave containers the pneumatic connection is made using flexible pilot hoses. To fit the pilot hoses, remove the 1/8" pilot pressure port plug from the master container valve assembly and install the 1/8" pilot pipe connector for the 33 mm and 49mm valves.

Install the 1/8" pilot pipe connector on to all pneumatic actuators (wrench tight). Connect one end of the pilot hose to the connector on the master container and one end to the other one on the pneumatic actuator. The maximum number of slave actuated containers is 6 (7 containers system in total).

After every 7 containers another master container must be created, using an electrical actuator. All the electrical actuators must operate simultaneously to ensure the correct discharge time.

The pneumatic actuator of the last slave container in a multi-cylinder group should be installed with a bleed valve, in addition to connecting the pilot hose from the previous container.

Bleed valve is used to release the low pressure in the pilot pipeline to prevent the misoperation of slave valve caused by the accumulation of air pressure in pilot pipe (such as micro-leakage of the master valve). When the master valve is opened, a higher pressure is quickly established and the bleed valve is immediately closed, the pilot pipeline is closed.

Pilot Hose Connecting Between Slave Valves

Pilot Hose Connecting Between Master & Slave Valve

Bleed Valve Connecting of Last Slave Container

Figure 5.4.6 - Multiple Container Actuation

5.5 Ancillary Equipment Installation

Discharge Pressure Switch Installation On 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 1/8" pilot pressure port on the valve to the connector on the pressure switch (see Figure 5.5.1).

Figure 5.5.1 - Discharge Pressure Switch Installation for Single Container Systems

Discharge Pressure Switch Installation On Multiple Container Systems

On multi-container installations the pressure switch should be located close to the last slave container and connected by pilot hose from the last slave container valve's 1/8" pilot pressure port to the connector on the pressure switch (see Figure 5.5.2).

Figure 5.5.2 - Discharge Pressure Switch Installation for Multiple Container Systems

Discharge Pressure Switch Installation

Always locate the pressure switch where shock, vibration and temperature fluctuations are minimal. Do not mount it in ambient temperatures exceeding working temperature limits.
Discharge pressure switch may be mounted in any position provide the electrical conduit is not facing up. The recommended mounting position is vertical (pressure connection facing down), specifically where heavy condensation is expected.
Discharge pressure switch may be mounted and operated in any position. They may be surface mounted via the two mounting ears on either side of the enclosure, or directly to a rigid pipe by using the pressure connection.
Should the control be installed where condensation is expected, vertical mounting is recommended as a means of keeping water away from switch terminals.

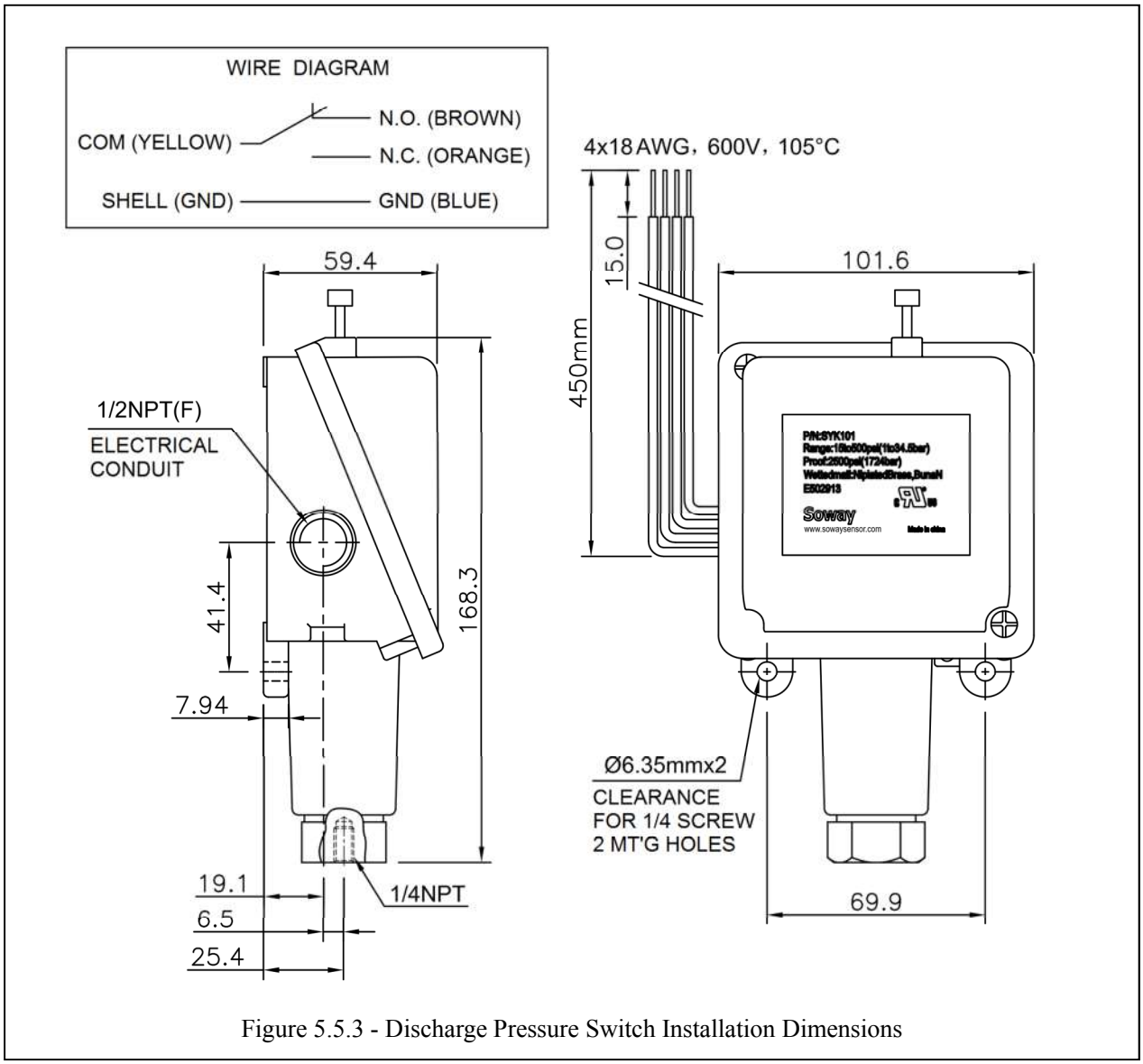


Figure 5.5.3 - Discharge Pressure Switch Installation Dimensions

CAUTION: ALWAYS HOLD A WRENCH ON THE PRESSURE HOUSING HEX WHEN MOUNTING UNIT. DO NOT TIGHTEN BY TURNING ENCLOSURE. THIS WILL DAMAGE SENSOR AND WEAKEN SOLDER OR WELDED JOINT.

Discharge pressure switch supplied with a external manual reset button, be sure to leave sufficient finger space

over the reset button for the operator to reset the pressure switch.

CAUTION: DISCONNECT ALL SUPPLY CIRCUITS BEFORE WIRING UNIT. WIRE UNITS ACCORDING TO NATIONAL AND LOCAL ELECTRICAL CODES. MAXIMUM RECOMMENDED WIRE SIZE IS 14 AWG. THE RECOMMENDED TIGHTENING TORQUE FOR FIELD WIRING TERMINALS IS 1 TO 2 N-M (7 TO 17 IN-LBS).

CAUTION: ELECTRICAL RATINGS STATED IN LITERATURE AND ON NAMEPLATE SHOULD NEVER BE EXCEEDED. OVERLOAD ON A SWITCH CAN CAUSE FAILURE ON THE FIRST CYCLE.

Remove the two screws retaining the cover and cover gasket. A 1/2" NPT conduit connection is provided on the left hand side of the enclosure. Two cast-in knockouts for the 1/2" conduit are located on the side and back of the enclosure. These can easily be knocked out by placing the blade of a screwdriver in the groove and tapping sharply with a hammer. The three switch terminals are clearly labeled "common", "normally open" and "normally closed".
For optional switches supplied with leadwires, the following color coding applies:

Common (C)	YELLOW
Normally Closed (N.C.)	ORANGE
Normally Open (N.O.)	BROWN

Door Warning Sign

Door warning signs are required at all exits and entrances to protected area, ideally mounted on the door. Plates may be drilled and screw fixed or attached using suitable adhesive.

Section 6 SYSTEM OPERATION

6.0 General Comments

Personnel required to work in the protected area should be conversant with the detection and extinguishing equipment installed and trained in fire procedures. All life-saving equipment must be properly maintained.
The method of system operation is chosen at the design stage to suit the protection required for the hazard area and the environmental factors appropriate to that area. This section of the document provides information relevant to all the standard operational systems to cover the eventuality of changes to, or expansion of the original design.

6.1 System Detection and Actuation

Each system is designed to suit the hazard area, whether the area is normally manned or unmanned, and whether the detection/actuation devices are to be manual or automatic. From an operational point of view, the system can be divided into the following three types:

- Manual
- Fully Automatic
- Automatic with Manual Intervention

Manual System

Manual systems depend on human detection of a fire in the hazard area and prompt action to actuate the manual actuator for the HFC-227ea system to discharge and flood the protected area and extinguish the fire.
All other instructions associated with manual operation in this manual regarding safety precautions and fire drills form part of this procedure.

Fully Automatic System

Where a sensitive fire detection system is included for the automatic release of extinguishing agent, the system shall only be capable of automatic release once two or more sensors detect the fire.
The number of detectors and their spacing is designed to ensure a satisfactory response time. To ensure personnel may safely evacuate the risk area an adjustable time delay should be fitted such that sufficient time may elapse prior to system discharge. Ideally, the delay period shall not exceed 30 seconds.
Prior to system discharge (and at the commencement of any time delay period) a clearly audible alarm different from any other used shall sound and continue until the
complete system is reset. In areas of high ambient noise level, a visual indication may also be required, in addition to the audible warning.
The design of a system for automatic detection, signal distribution, alarms, etc. is not always of LIFECO Equipment supply. Therefore, details appertaining to fire detection and alarm operation and maintenance are not included in this document.

CAUTION: DETECTION & CONTROL EQUIPMENT SHALL BE UL LISTED
DETECTORS SHALL BE UL LISTED FOR THE INTENDED APPLICATION. CONTROL PANELS SHALL BE UL LISTED FOR RELEASING DEVICE SERVICE AND COMPATIBLE WITH DETECTION AND HFC-227EA ENGINEERED TOTAL FLOODING FIRE EXTINGUISHING SYSTEM.

Fully Automatic System with Manual Intervention

Manual intervention of an automatic system may be included for the following condition;

Where personnel are required to work within the protected area. In protected areas where personnel are present and the concentration is greater than NOAEL, it is recommended that the automatic feature of the system is isolated during occupation. This may be achieved either by an electrically contacted lock assembly or by a clearly marked key switch at a suitable location outside the risk area.

6.2 Conditions During a Fire

The user's fire and safety instructions to personnel should include advice on the conditions prevailing during the discharge of an hfc-227ea system. This advice is intended to prepare the personnel for the situations likely to arise and therefore minimise the risks of panic. Three major conditions prevail during HFC-227ea extinguishing agent discharge of which personnel should be made aware:

HFC-227ea Concentration

HFC-227ea total flooding systems greater than 9% design concentration should only be used with manual actuation in normally occupied areas. A normally occupied area is defined as an area intended for occupancy.
Any area protected by HFC-227ea should be evacuated prior to start of system discharge. Where egress of normally occupied areas cannot be accomplished within one minute, HFC-227ea total flooding systems shall be designed not to exceed 9.0% concentration.
Refer to NFPA 2001, Paragraph 1.5.1.2.1 for additional information.

HFC-227ea Decomposition

HFC-227ea decomposes when exposed to temperatures exceeding 482 °C (900 °F); such as flames, hot metal surfaces, etc. The rate of this decomposition is dependent upon the size of the area where extreme temperatures are found, and also upon the length of HFC-227ea exposure time.
To reduce decomposition, HFC-227ea systems are designed to discharge and extinguish the fire quickly. The maximum duration of discharge for these systems at 21 °C (70 °F) is 10 seconds, so the minimum amount of decomposition occurs. Hydrogen Fluoride is the most toxic decomposition product. This material generates a sharp acrid odour, which is easily detected and acts as a warning and a good safeguard to personnel.

HFC-227ea Discharge Conditions

HFC-227ea has low boiling point, consequently the discharge is very cold at the point where it leaves the nozzle. Care should be taken to avoid working within 1.0 m (3.28 ft) of discharge nozzles.
The velocity of discharge of HFC-227ea from a discharge nozzle is very high, care should be taken to ensure that objects which may become dangerous projectiles are secured or removed from the hazard area.

6.3 Actions Following a Fire

These notes are only applicable to the hazard area(s) protected by a HFC-227ea fire extinguishing system. Where such a system may form part of or combine with other forms of fire protection systems then composite instructions for all systems are necessary to ensure the safety of personnel and property following a fire. If the organisation has appointed, or nominated, a responsible person to act as a 'Fire Officer'. Actions following a fire should be coordinated and/or directed by the Fire Officer.

Actions Immediately Following a Fire

These actions should, at a minimum, include the following:

- Advise the emergency services, Fire, Accident, Police if appropriate.
- Organize a 'roll-call' of employees and any visitors.
- Prevent unauthorised personnel from entering the hazard area.
- In the case of deep seated fires, the hazard space should be kept tightly closed for at least 60 minutes after discharge of the HFC-227ea extinguishing agent. It is essential that the fire be completely extinguished before ventilating the space. Before permitting any one to enter the space, ventilate thoroughly or ensure self-contained breathing equipment is used.
- Do not enter the hazard area in which fire has been extinguished with an open flame or lighted cigarette as the possible presence of flammable vapours may cause re-ignition or explosion.

Should it be necessary to enter a space containing HFC-227ea or decomposition products the following precautions should be taken :

- Use a fresh air mask or self contained breathing equipment.
- Do Not use a filter mask or canister type mask.
- Do Not enter space unless you are under observation from outside the space or tethered by a lifeline.
- Ensure that all pressurised equipment is isolated or safe from release.

Section 7 SYSTEM MAINTENANCE

7.0 General Introduction

This section provides user inspection and maintenance guidance for HFC-227ea Engineered Systems. The user should prepare a log to record all inspections, maintenance, measurements and actions taken. The continued capability for effective performance of an HFC-227ea Total Flooding Fire Suppression System depends on fully adequate maintenance procedures, with periodic testing. Reference NFPA 2001 section 7-1 to 7-6 and ISO 14520-1.

7.1 User's Programme of Inspection

The installer should provide the user with an inspection programme for the system and components. The programme shall include instructions on the action to be taken in respect of faults. The user's inspection programme is intended to detect faults at an early stage to allow rectification before the system may have to operate. A suitable programme is as follows :

Weekly Check of Hazard Area

Inspect the hazard area against the original layout to ensure that there have been no changes that might affect the proper performance of the fire protection system. Changes might include:

- Contents of area
- Use of area
- Air Handling equipment in area
- Openings in area
- Floor / ceiling voids
- Partitioning

Weekly Check of Containers

Check storage container pressure gauges and ambient temperature, compare these pressures to the Temperature Correction Chart (see Table 8.1.2) to determine temperature corrected pressure. If the container corrected pressure shows a loss of more than 10%, the containers should be removed for weighing. All measurements and actions shall be recorded in the log book.

Weekly Check of System Components

Make a visual inspection of the system components, distribution piping and nozzles. Check the immediate vicinity of all equipment to ensure that no accidental damage or tampering has occurred.

Weekly General Check

Inspect the hazard area, access routes, container storage area, floor voids and areas above suspended ceilings to ensure housekeeping is good and that no refuse has accumulated. Ensure that access to the system container assemblies and local remote controls is unobstructed.

Monthly Check of Notices

Inspect system and protected spaces to ensure that warning signs, safety precautions and operating instructions are posted and clearly visible.

Monthly Personnel Training Check

Check that all personnel who may have to operate the equipment or system are properly trained and are authorized to do so, and in particular that new employees have been instructed in its use.

7.2 Contract Service and Maintenance

Systems shall be thoroughly inspected and tested for proper operation by qualified contract personnel in accordance with the requirements of NFPA as well as any other standard accepted to the authority having jurisdiction. Before any checks are carried out, ensure the extinguishing system is isolated electrically and mechanically and remove all electrical and pneumatic actuators. No maintenance work should be carried out without obtaining approval from the Fire Officer and advising any personnel within the hazard area. The following Programme should be carried out in addition to the User's Programme of Inspection. The user shall be provided with a signed and dated report of the inspection advising any rectification carried out or needed.

3 Monthly Actuator Check .

Test and service all actuating mechanisms.

3 Monthly Electrical Systems Check

Test and service all electrical detection and alarm systems as recommended in NFPA as well as any other standard accepted to the authority having jurisdiction.

6 Monthly Container Check

Externally inspect containers for signs of damage or unauthorised modifications. Check container labels are securely fixed and legible. Check container brackets and fittings.

6 Monthly Contents Check

Examine the container pressure gauge reading and refer to the temperature correction chart. If the container pressure corrected to temperature is below 10% of the stated pressure it must be replaced or recharged.
Verification of the content of HFC-227ea in the containers may be achieved through container weighing. If containers show a extinguishant loss of more than 5% or a pressure loss (adjusted for temperature) of more than 10%, the container should be refilled or replaced.

Container Weighing

Where the container is weighed to determine the content of HFC-227ea, the weighing procedure is as follows:

- Remove all manual actuators, electrical actuators and pressure actuation pipe or tubing and flexible electrical connectors.
- Disconnect and remove discharge piping / discharge hoses from container valves.
- Fit safety caps onto container valves.
- Remove containers from bracketing and weigh containers. Any container showing more than the maximum allowable weight loss must be recharged by a qualified recharge agent.
- Record weight of container on record tag.

- Replace containers in bracketing and remove anti-recoil caps.
- Reconnect discharge piping / discharge hoses and all acutato, pressure actuation pipe or tubing and flexible electric connectors.

If the weight loss exceeds 5% of the weight of charge, the container must be recharged.

6 Monthly Control Valve & Actuator Check

Check all manual and pneumatic actuators for free movement of the piston. Replace whole unit where appropriate. Check all control valves for correct manual function and automatic valves additionally, for correct automatic function.

6 Monthly Pipe Network Check

Externally check pipework to determine its conditions. Replace or pressure test and repair as necessary Pipework showing corrosion or mechanical damage.

6 Monthly Nozzle Check

Inspect nozzles for dust and debris, clean out where necessary.

6 Monthly Enclosure Check

Carry out a full visual check of the enclosure for integrity and confirm the dimensions and the configuration of the hazard are as the original drawings or previous visit. If drawings are not available and this is the first visit then dimensions should be taken and passed to the engineering department together with the quantity of agent to enable a calculation to be carried out to ensure the correct quantity of gas has been used.

12 Monthly Hose Check

All system hoses should be examined for damage. If visual examination shows any deficiency, the hose shall be replaced.

12 Monthly Integrity Test

Integrity test the enclosure to determine if the leakage area has changed sufficiently from that measured during installation.

Electrical Actuator Ten Year Lifespan

The removable electrical actuator has a life span of 10 years from manufacture, and so should be replaced before this date is reached.

Personnel Training

All persons who may be expected to inspect, test, maintain or operate the fire extinguishing system shall be kept adequately trained in the functions they are expected to perform. Personnel working in an enclosure protected by a gaseous extinguishant shall receive training in the operation, use of the system and safety issues.

7.3 Mechanical Servicing Procedure

1. Remove valve actuator(s) from the container valve(s)
2. For master/slave system complete the following steps to check the slave actuation system:
    1) Disconnect pneumatic actuators from the slave container valves
    2) Disconnect the pilot loop from the master container valve and install the appropriate plug
    3) Introduce 4 bar (58 psi) pressure into the pilot actuation line to the pneumatic actuators
    4) Check that the pistons in the pneumatic valve actuators have fully operated
    5) Check for leaks. There must be less than 10% loss in pressure within 1 minute
    6) Vent pressure in the pilot actuation line and re-set all of the actuators
    7) Introduce 34 bar (493 psi) pressure into the pilot actuation line to the pneumatic actuators
    8) Check that the pistons in the pneumatic valve actuators have fully operated
    9) Check for leaks. There must be less than 10% loss in pressure within 1 minute
    10) Vent pressure in the pilot actuation line and reset all of the actuators
3. To check the electrical actuation system (for single container systems only electrical actuators are fitted):
    1) Remove electrical actuators from valve assembles
    2) Activate the detection system in accordance with procedures provided with the system. When this test is performed, the release circuit of the detection system must operate the electric actuators causing the plungers to be firmly extended.
    3) Examine the auxiliary electrical device/alarm, door closers etc., have all operated correctly
    4) Ensure actuator is reset before refitting, using the reset tool provided
4. For master/slave system, remove the appropriate port plug and reconnect the pilot actuation line to the slave port on the back of the master valve.
5. Reset pressure switches after the test has been completed

An approved distributor is carrying out the maintenance on the detection system. If the servicing of the detection system is being carried out at the same time as the mechanical service by another nominated body.

7.4 Specialised Maintenance Duties

Container Hydrostatic Pressure Testing

In countries where NFPA 2001 applies the following criteria are used for hydrostatic pressure testing :
Containers only need hydrostatic pressure testing after discharge. Systems under local jurisdiction may have other rules of hydrostatic pressure testing, please follow these rules.

7.5 Finally

Carry out a final visual inspection of the system and the protected area to ensure that all equipment has been reinstalled and reconnected properly. Ensure that any associated control/indication panel is displaying normal operation. Complete the site log book, recording work carried out and parts used. Inform the responsible person that the work is complete and that the system is back on-line.

Section 8 RECHARGING PROCEDURE

CAUTION: RECHARGING PROCEDURE CAN ONLY BE CARRIED OUT BY THE ORIGINAL EQUIPMENT MANUFACTURER OR LIFECO SYSTEM TRAINED FILLING STATIONS. THE SECTION OF THIS MANUAL IS FOR INFORMATION ONLY.

8.1 Valve Refurbishment (O.E.M Only)

CAUTION: REFURBISHMENT OF CONTAINER VALVES CAN ONLY BE CARRIED OUT BY THE ORIGINAL EQUIPMENT MANUFACTURER. THE SECTION OF THIS MANUAL IS FOR INFORMATION ONLY.

On receiving a container that requires to be recharged the following operations are carried out. See Figure 8.1 for component description. Ensure all parts are cleaned fully before any part is replaced.

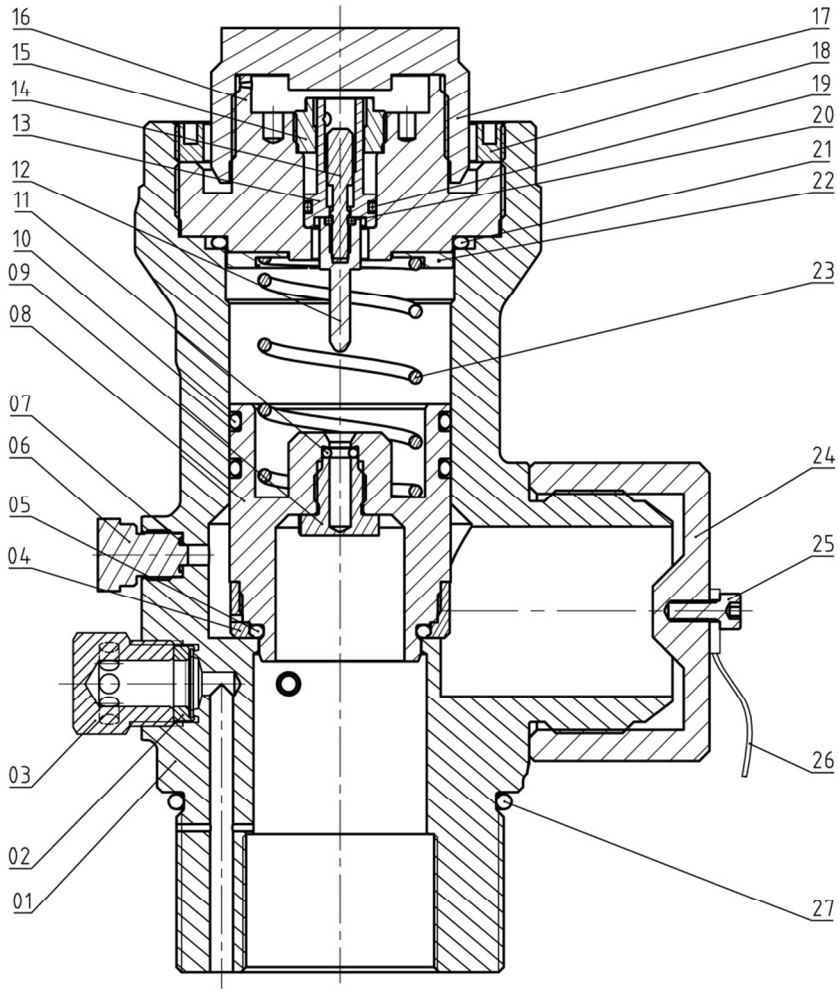


Figure 8.1 Container Valve Assembly (for Reference Only)

1. Check that the container is empty.
2. Remove valve, siphon tube from container.
3. Unscrew the Actuator Plug (#17).
4. Use special tool to unscrew the Fixing Screw (#18), and then remove the Spring Support (#16).
5. O-ring (#21) for the Spring Support (#16) has to be removed.

6. Remove Spring Washer (#22) and Spring (#23).
7. Remove Piston (#8) from valve body and dispose. Remove and replace the main piston O-ring (#10). Apply PTEE silicone grease to new O-ring. Locate replacement Piston (#8) assembly.
8. Replace Piston (#8) into valve, spray a small quantity of PTFE silicone grease into the bore of the valve body.
9. Reinstall the Spring Washer (#22) and the Spring (#23).
10. Replace O-ring (#21) for the Spring Support with new.
11. Reinstall the Spring Support (#16). If necessary, remove the Actuator Screw (#15), remove Actuator Piston (#13), and replace the O-ring (#19) of the actuator-piston. Then reinsert Actuator Piston (#13) into the Spring Support (#16), then reinstall Actuator Screw (#15).
12. If valve has been removed from neck ring, replace the O-ring for cylinder neck (#27).
13. The outlet adapter may require to be replaced, if this is so the outlet will need to be removed and threads cleaned.
14. Remove the Safety Plug (#3) and Burst Disc Assembly (#2) if damaged from burst disc port and replace with a new assembly, Then reinstall the Safety Plug (#3).
All O-ring seals must be lubricated using PTFE silicone grease. See Table 8.1 for details about replacement parts.
On completion of a valve refurb the valve assy is subjected to two tests - Valve Assy Pre-dome and Leak Test. The test can only be carried out by the original equipment manufacturer. The valve can only be put into use agein after passing the test.

Table 8.1 Replacement Parts List

No.	Part Name	Part No. for 33mm Valve	Part No.for 49mm Valve
1	Body	811.101.0.101	811.101.0.201
2	Burst Disc Assembly	811.101.090	811.101.090
3	Safety Plug	811.101.0.213	811.101.0.213
4	Locking Nut of Seat Disc	811.101.0.103	811.101.0.203
5	O-ring for Piston Gasket	811.115.112	811.115.101
6	Plug of G1/8	811.101.0.212	811.101.0.212
7	O-ring for G1/8 Plug	811.115.102	811.115.102
8	Piston	811.101.0.102	811.101.0.202
9	Locking Nut	811.101.0.204	811.101.0.204
10	O-ring for Main Piston	811.115.113	811.115.103
11	O-ring for Piston Locking Nut	811.115.104	811.115.104
12	Actuator Lower Pin	811.101.0.205	811.101.0.205
13	Actuator Piston	811.101.0.206	811.101.0.206
14	Actuator Upper Pin	811.101.0.207	811.101.0.207
15	Actuator Screw	811.101.0.208	811.101.0.208
16	Spring Support	811.101.0.105	811.101.0.209
17	Actuator Plug	811.101.0.216	811.101.0.216
18	Fixing Screw	811.101.0.107	811.101.0.215
19	O-ring for Actuator Piston	811.115.105	811.115.105
20	O-ring for Actuator Seat	811.115.106	811.115.106
21	O-ring for Spring Support	811.115.114	811.115.107

No.	Part Name	Part No. for 33mm Valve	Part No.for 49mm Valve
22	Spring Washer	811.101.0.104	811.101.0.211
23	Spring	811.101.0.108	811.101.0.219
24	Plug of Outlet	811.101.0.106	811.101.0.217
25	Cap Screw	M4X10 A2-70	M4X10 A2-70
26	Steel Wire Rope	15NAT1X19	15NAT1X19
27	O-ring for Cylinder Neck	811.115.115	811.115.108

8.2 Filling with LIFECO Filling Machine

1. With the Container ready for filling a check is made to the filling instruction sheet and the container fill weight, time, date and fill details record.

2. The container is placed on a scale and the appropriate filling adapter attached to the container valve discharge port.

3. Reset the scale to zero to compensate for weight of container and filling adapter.

4. Attach the filling (/venting) hose from the filling rig outlet to filling adapter.

5. Switch on the pump marked 'Liquid' on filling cabinet and fill container to required weight, refer to Table 8.2.1 Fill Tolerance. When the fill is reached switch off pump. Quickly release the remaining agent in the fill hose, and the container valve will closed itself.

Table 8.2.1 Fill Tolerance Table

Container Size	Fill Tolerance (kg)	Tolerance (bar)
16.6 L	+0.09, -0	+0.75, -0
16.7 L	+0.09, -0	+0.75, -0
28.3 L	+0.15, -0	+0.75, -0
40 L	+0.20, -0	+0.75, -0
49 L	+0.25, -0	+0.75, -0
50 L	+0.25, -0	+0.75, -0
52 L	+0.26, -0	+0.75, -0
60 L	+0.30, -0	+0.75, -0
62 L	+0.31, -0	+0.75, -0
70 L	+0.35, -0	+0.75, -0
80 L	+0.40, -0	+0.75, -0
90 L	+0.45, -0	+0.75, -0
100 L	+0.50, -0	+0.75, -0
103 L	+0.51, -0	+0.75, -0
106 L	+0.53, -0	+0.75, -0
120 L	+0.60, -0	+0.75, -0
147 L	+0.73, -0	+0.75, -0
150 L	+0.75, -0	+0.75, -0
153 L	+0.76, -0	+0.75, -0
160 L	+0.80, -0	+0.80, -0
170 L	+0.85, -0	+0.80, -0

6. Remove filling hose from the filling adapter, and weigh to verify fill is within tolerance, adjust if required.

7. Connect the nitrogen filling port and the filling adapter with the filling hose.

8. Open the nitrogen filling valve, slowly increase the nitrogen pressure on the pressure regulator to the stated pressure on the filling instruction sheet, making the relevant allowances in pressure to compensate for the current room temperature (see the temperature correction chart Table 8.2.2). Read off the calibrated external fill pressure gauge to determine when the intended charging pressure has been reached. (Check that the container pressure gauge reads within ± 1 bar (± 14.5 psi) of the fill gauge, replace container gauge if outside this tolerance).

Table 8.2.2 Temperature Correction Chart

Temperature		25 Bar System Developed Pressure		42 Bar System Developed Pressure	
°C	°F	Bar	psi	Bar	psi
0.0	32	20.2	292.8	35.9	520.7
0.6	33	20.3	294.8	36.0	522.1
1.1	34	20.5	296.7	36.2	525.3
1.7	35	20.6	298.6	36.4	527.6
2.2	36	20.7	300.6	36.5	529.9
2.8	37	20.9	302.5	36.7	532.3
3.3	38	21.0	304.5	36.9	534.6
3.9	39	21.1	306.4	37.0	536.9
4.4	40	21.3	308.3	37.2	539.2
5.0	41	21.4	310.3	37.3	541.6
5.6	42	21.5	312.2	37.5	543.9
6.1	43	21.7	314.1	37.7	546.2
6.7	44	21.8	316.1	37.8	548.5
7.2	45	21.9	318.0	38.0	550.8
7.8	46	22.1	319.9	38.1	553.2
8.3	47	22.2	321.9	38.3	555.5
8.9	48	22.3	323.8	38.5	557.8
9.4	49	22.5	325.8	38.6	560.1
10.0	50	22.6	327.7	38.8	562.4
10.6	51	22.7	329.6	38.9	564.8
11.1	52	22.9	331.6	39.1	567.1
11.7	53	23.0	333.5	39.3	569.4
12.2	54	23.1	335.4	39.4	571.7
12.8	55	23.3	337.4	39.6	574.0
13.3	56	23.4	339.3	39.7	576.4
13.9	57	23.5	341.2	39.9	578.7
14.4	58	23.7	343.2	40.1	581.0
15.0	59	23.8	345.1	40.2	583.3
15.6	60	23.9	347.1	40.4	585.6
16.1	61	24.1	349.0	40.5	588.0
16.7	62	24.2	350.9	40.7	590.3
17.2	63	24.3	352.9	40.9	592.6
17.8	64	24.5	354.8	41.0	594.9
18.3	65	24.6	356.7	41.2	597.2
18.9	66	24.7	358.7	41.3	599.6
19.4	67	24.9	360.6	41.5	601.9
20.0	68	25.0	362.5	41.7	604.2
20.6	69	25.1	364.5	41.8	606.5
21.1	70	25.3	366.4	42.0	609.1
21.7	71	25.4	368.4	42.2	612.2
22.2	72	25.5	370.3	42.4	615.2
22.8	73	25.7	372.2	42.6	618.3
23.3	74	25.8	374.2	42.8	621.3
23.9	75	25.9	376.1	43.1	624.4
24.4	76	26.1	378.0	43.3	627.4
25.0	77	26.2	380.0	43.5	630.5
25.6	78	26.3	381.9	43.7	633.5
26.1	79	26.5	383.8	43.9	636.5
26.7	80	26.6	385.8	44.1	639.6
27.2	81	26.7	387.7	44.3	642.6
27.8	82	26.9	389.6	44.5	645.7
28.3	83	27.0	391.6	44.7	648.7
28.9	84	27.1	393.5	44.9	651.8
29.4	85	27.3	395.5	45.2	654.8
30.0	86	27.4	397.4	45.4	657.9
30.6	87	27.5	399.3	45.6	660.9
31.1	88	27.7	401.3	45.8	664.0
31.7	89	27.8	403.2	46.0	667.0
32.2	90	27.9	405.1	46.2	670.1
32.8	91	28.1	407.1	46.4	673.1
33.3	92	28.2	409.0	46.6	676.1
33.9	93	28.3	410.9	46.8	679.2
34.4	94	28.5	412.9	47.0	682.2
35.0	95	28.6	414.8	47.3	685.3
35.6	96	28.7	416.8	47.5	688.3
36.1	97	28.9	418.7	47.7	691.4
36.7	98	29.0	420.6	47.9	694.4
37.2	99	29.1	422.2	48.1	697.5
37.8	100	29.3	424.5	48.3	700.5
38.3	101	29.4	426.4	48.5	703.6
38.9	102	29.5	428.4	48.7	706.6
39.4	103	29.7	430.3	48.9	709.6
40.0	104	29.8	432.2	49.1	712.7
40.6	105	29.9	434.2	49.4	715.7
41.1	106	30.1	436.1	49.6	718.8
41.7	107	30.2	438.1	49.8	721.8
42.2	108	30.3	440.0	50.0	724.9
42.8	109	30.5	441.9	50.2	727.9
43.3	110	30.6	443.9	50.4	731.0
43.9	111	30.7	445.8	50.6	734.0
44.4	112	30.9	447.7	50.8	737.1
45.0	113	31.0	449.7	51.0	740.1
45.6	114	31.1	451.6	51.2	743.1
46.1	115	31.3	453.5	51.5	746.2
46.7	116	31.4	455.5	51.7	749.2
47.2	117	31.5	457.4	51.9	752.3
47.8	118	31.7	459.4	52.1	755.3
48.3	119	31.8	461.3	52.3	758.4
48.9	120	31.9	463.2	52.5	761.4
49.4	121	32.1	465.2	52.7	764.5
50.0	122	32.2	467.1	52.9	767.5
50.6	123	32.3	469.0	53.1	770.6

Temperature		25 Bar System Developed Pressure		42 Bar System Developed Pressure	
°C	°F	Bar	psi	Bar	psi
51.1	124	32.5	471.0	53.3	773.6
51.7	125	32.6	472.9	53.6	776.6
522	126	32.7	474.8	53.8	779.7
52.8	127	32.9	476.8	54.0	782.7
53.3	128	33.0	478.7	54.2	785.8
53.9	129	33.1	480.7	54.4	788.8
54.4	130	33.3	482.6	54.6	791.9

CAUTION: THE PRESSURE GAUGE ATTACHED TO THE EXTINGUISHING SYSTEM CAN **NOT** TO BE USED TO DETERMINE WHEN THE INTENDED CHARGING PRESSURE HAS BEEN REACHED.

CAUTION: WHEN SUPERPRESSURISING, A PRESSURE REGULATOR MUST BE USED WHEN THE PRESSURE SOURCE IS A TANK OF HIGH PRESSURE GAS.

9. Vibrate and agitate the container to accelerate nitrogen absorption into the agent and top up the pressure accordingly. Switch off nitrogen supply once absorption has stopped.

10. Quickly release the remaining nitrogen in the fill hose to atmosphere, and the container valve will close itself (Top up if necessary).

11. Remove the closing down line adapter.

12. If valve does not close after releasing nitrogen in filling hose, the container must be refilled nitrogen to the specified pressure. Ensure vent valve is closed when not required to prevent contamination on fill line.

13. Test all ports of container assembly with water/soap solution.
If leaks are observed, minor leaks may be cured by tightening the offending components.

14. Remove filling adapter, leak test the outlet and attach safety (anti-recoil) cap. Note: When leak testing outlet with spray, do not look directly into port, examine quickly from an angle.)

15. Reset scales and note down gross weight.

16. Make certain all safety caps are in place.

17. Attach label to container stating the following information. Job number, Customer, Project, Container size, Fill weight, Gross weight, Date filled, Type of agent.

18. Place container in bonded area for leak monitoring for at least 24 hours prior to dispatch.

19. After 24 hours a Leak Test on the container is conducted.

20. Insert filling information on to container label.

21. Adhere label to container.

8.3 Filling without LIFECO Filling Machine

1. With the Container ready for filling a check is made to the filling instruction sheet and the container fill weight, time, date and fill details record.

CAUTION: CHECK THE PRESSURE GAUGE OF THE CYLINDER TO BE FILLED. THE PRESSURE SHOULD BE ZERO TO ENSURE THAT THERE IS NO PRESSURE INSIDE THE CYLINDER. WHEN THERE IS PRESSURE IN THE CYLINDER, THE PRESSURE SHOULD BE RELEASED UNLESS IT IS REFILLED TO SUPPLEMENT THE EXTINGUISHING AGENT OR DRIVE NITROGEN.

2. Place the cylinder on a scale, remove the actuator (including Solenoid Actuator, Pneumatic & Manual Actuator, Pneumatic Actuator and Manual Actuator, etc.) from the top of the cylinder valve (if any).

NOTE: THE ACTUATOR MUST BE REMOVED BEFORE FILLING, OTHERWISE IT MAY CAUSE ABNORMAL CONDITIONS SUCH AS THE VALVE CANNOT BE CLOSED AFTER FILLING.

Connect the Filling Cap to the discharge port of the cylinde valve. The Filling Cap is composed of a steel plug cover and a filling valve, as shown in the figure 8.3.1.

Figure 8.3.1 Filling Cap

Connection dimensions of the Filling Cap to the cylinder valve are shown in Table 8.3.1

Table 8.3.1 Filling Cap Connection

Cylinder Valve Type	33mm	49mm
Connection	1.875"-12UN	2.5"-12UN

The other end of the filling cap is connected to the filling hose and the connecting thread should be adapted to the filling hose. At this point, ensure that Filling Valve on Filling Cap is closed

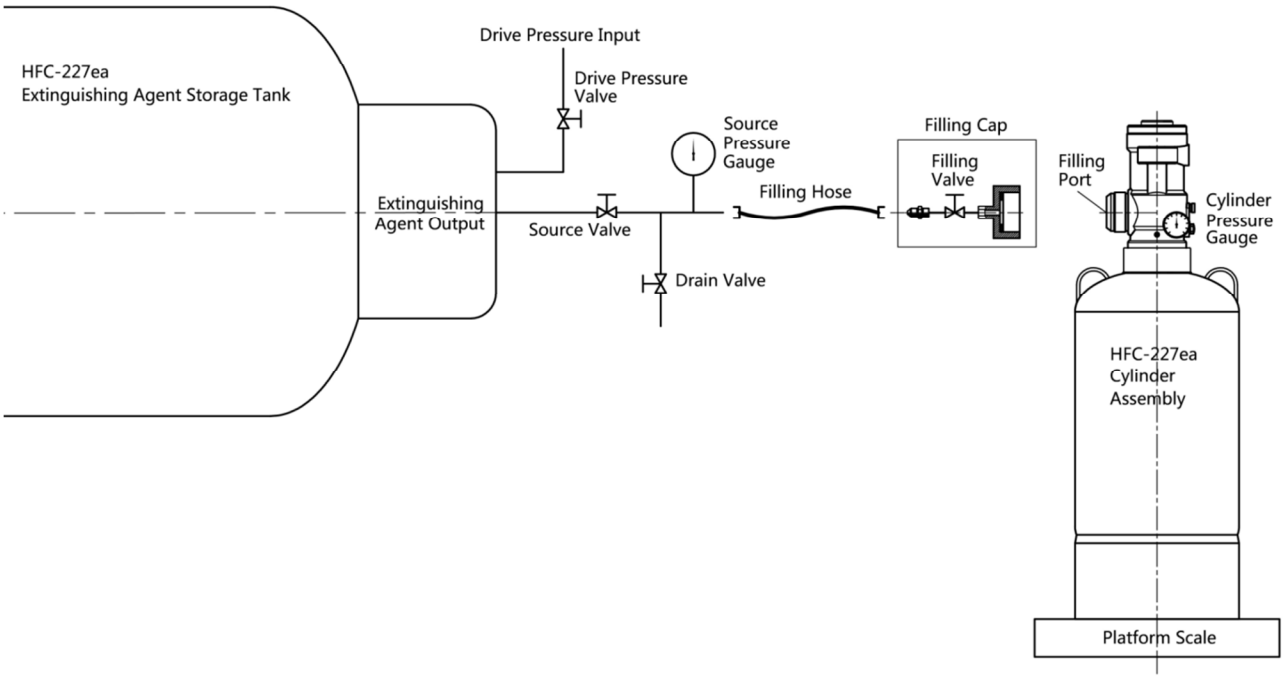


Figure 8.3.2 Typical HFC-227ea Extinguishing Agent Filling Connection Diagram

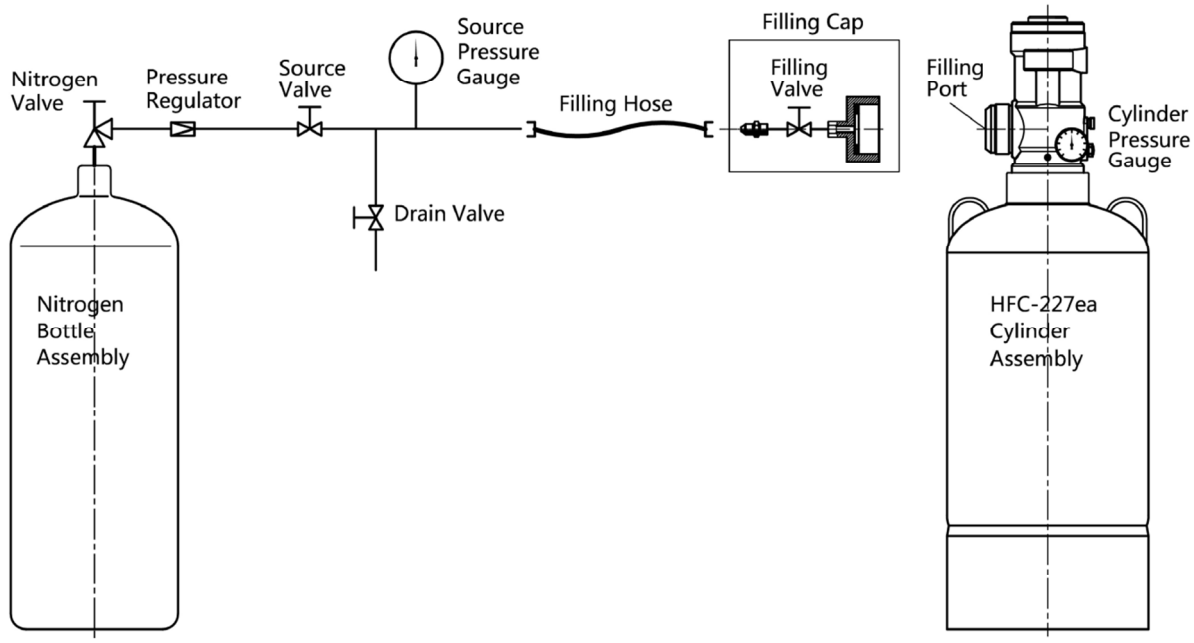


Figure 8.3.3 Typical Pressurized Nitrogen Filling Connection Diagram

3. Connect the HFC-227ea agent storage tank and the filling cap with a filling hose. A typical HFC-227ea extinguishing agent filling connection diagram is shown in Figure 8.3.2.

4. After the filling line is connected, open the Source Valve and the extinguishing agent will enter the Filling Hose along the line. At this point, reset the scale to zero to compensate for weight of cylinder, filling hose (with agent inside) and filling cap.

5. Open the Drive Pressure Valve to pressurize the fire extinguisher tank. Open the filling valve on the filling cap, and the fire extinguishing agent with a certain pressure will open the valve core othe cylinder valve and enter the cylinder. At the same time, the cylinder valve Actuating Piston will be pushed out under pressure. This

is normal and do not press the piston rod back.

Figure 8.3.4 Actuating Piston

Under the pressure of the agent tank, the extinguishing agent continuously enters the cylinder. Gradually fill the cylinder to the required weight, see Filling Tolerance Table (Table 8.2.1). When the required filling amount is reached, close the filling valve on the filling cap and the source valve. Open the drain valve, release the pressure in the filling hose, and remove the filling hose. Quickly open the filling valve on the filling cap to drain the remaining agent in the filling cap, and the valve will close itself.

6. Remove filling hose from the filling adapter, and weigh to verify fill is within tolerance, adjust if required.

7. Connect the nitrogen filling port and the filling cap with the filling hose, as shown in Figure 8.3.3.

8. Open the nitrogen valve, slowly increase the nitrogen pressure on the pressure regulator to the stated pressure on the filling instruction sheet, making the relevant allowances in pressure to compensate for the current room temperature (see Table 8.2.2 Temperature Correction Chart). Read the value of the Source Pressure Gauge (calibrated) to determine when the intended charging pressure has been reached. (Check that the cylinder pressure gauge reads within ± 1 bar (± 14.5 psi) of the source gauge, replace cylinder gauge if outside this tolerance).

CAUTION: THE PRESSURE GAUGE ATTACHED TO THE EXTINGUISHING SYSTEM CAN **NOT** TO BE USED TO DETERMINE WHEN THE INTENDED CHARGING PRESSURE HAS BEEN REACHED.

CAUTION: WHEN SUPERPRESSURISING, A PRESSURE REGULATOR MUST BE USED WHEN THE PRESSURE SOURCE IS A TANK OF HIGH PRESSURE GAS.

9. Vibrate and agitate the cylinder to accelerate nitrogen absorption into the agent and top up the pressure accordingly. Switch off nitrogen supply once absorption has stopped.

10. Close the nitrogen source valve and close the filling valve on the filling cap. Open the drain valve, release

the pressure in the filling hose, and remove the filling hose. Quickly open the filling valve to remove the remaining nitrogen inside filling cap and the cylinder valve will close itself.

11. If cylinder valve does not close after releasing nitrogen in filling cap, the cylinder must be refilled nitrogen to the specified pressure. Ensure vent valve is closed when not required to prevent contamination on fill line.

12. Remove the filling hose.

13. Test all ports of cylinder assembly with water/soap solution. If leaks are observed, minor leaks may be cured by tightening the offending components.

14. Remove filling cap, leak test the outlet and attach anti-recoil cap. Note: When leak testing outlet with spray, do not look directly into port, examine quickly from an angle.)

15. Reset scales and note down gross weight.

16. Make certain all safety caps are in place.

17. Attach label to cylinder stating the following information. Job number, Customer, Project, Cylinder size, Fill weight, Gross weight, Date filled, Type of agent.

18. Place cylinder in bonded area for leak monitoring for at least 24 hours prior to dispatch.

19. After 24 hours a Leak Test on the cylinder is conducted.

20. Insert filling information on to cylinder label.

21. Adhere label to cylinder.

Section 9 WARRANTY, DISCLAMIMERS & LIMITATIONS

9.1 WARRANTY

Following the commissioning of the system, all equipment will be covered by the company's twelve-month parts warranty (excluding parts accidentally or maliciously damaged by others). For further information, refer to LIFECO Systems 'Terms and conditions' document.

9.2 DISCLAIMERS & LIMITATIONS

Whilst every care has been taken in the publication of this user's guide to describe our products accurately, it is not considered binding. LIFECO Systems reserves the right to make any alterations without notice. All issues are uncontrolled copies.

Section 10 APPENDIX A - HFC-227EA MSDS

SAFETY DATA SHEET

Regulation (EC) No 1907/2006 (REACH), Annex II
(COMMISSION REGULATION (EU) No 453/2010)

Version 2
Product Name HFC-227ea

Issue Date 08-Oct-2015
Revision date 03-May-2018

SECTION 1: Identification of the substance /mixture and of the company/undertaking

1.1. Product identifier

Product Name	HFC-227ea
Chemical Name	1,1,1,2,3,3,3-heptafluoropropane
CAS NO	431-89-0
EC NO	207-079-2
REACH registration number	01-2119485489-18-XXXX

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Used as refrigerants, medical propellant; extinguishing agent, explosion-proof, flame retardants.
Uses advised against	No information available

1.3. Details of the supplier of the safety data sheet

Supplier	Sinochem Lantian Co., Ltd./ Sinochem Lantian Trading Co., Ltd. / Sinochem Lantian Fluoro Materials Co. Ltd.
Address	Zhejang Hangzhou (Shangyu)
Postal Code	312369
Phone	+86-571-87397288
FAX	+86-571-88904247
E-mail	
Importer	
Address	
Postal Code	
Phone	
FAX	
E-mail	

1.4. Emergency telephone number
+86-532-83889090

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture
Classification according to Regulation (EC) No. 1272/2008 [CLP]
Gases under pressure Liquefied gas - (H280)

2.2. Label elements
Symbols/Pictograms

Signal word	Warning
Hazard Statements	H280 - Contains gas under pressure; may explode if heated
Precautionary Statements	P410 + P403 - Protect from sunlight. Store in a well-ventilated place

2.3. Other hazards

No information available.

SECTION 3: Composition/information on ingredients

3.1 Substance

Chemical Name	EC No	CAS No	Weight-%	Classification according to Regulation (EC) No. 1272/2008 [CLP]
Propane, 1,1,1,2,3,3,3-heptafluoro-	207-079-2	431-89-0	>=99.0	Liquefied gas H280

SECTION 4: First aid measures

4.1. Description of first aid measures

General advice

Do not get in eyes, on skin, or on clothing. Do not breathe dust/fume/gas/mist/vapors/spray. In case of accident or unwellness, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Vapors are heavier than air and can cause suffocation by reducing oxygen available for breathing. Administer oxygen if breathing is difficult. Get medical advice/attention if you feel unwell.

Skin Contact

Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Wash contaminated clothing before reuse. If skin irritation persists, call a physician.

Eye contact

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

Ingestion

Not an expected route of exposure. If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label. Never give anything by mouth to an unconscious person.

4.2. Most important symptoms and effects, both acute and delayed

No information available.

4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media No information available.

5.2. Special hazards arising from the substance or mixture

Thermal decomposition can lead to release of irritating and toxic gases and vapors, such as gaseous hydrogen fluoride and fluorophosgene.

5.3. Advice for firefighters

Evacuate personnel to safe areas. Move containers from fire area if you can do it without risk. Cool drums with water spray. Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Stay upwind. Ensure adequate ventilation, especially in confined areas.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Evacuate personnel to safe areas. Ensure adequate ventilation, especially in confined areas. Remove all sources of ignition. Do not touch or walk through spilled material. Avoid contact with skin, eyes or clothing. Avoid breathing dust/fume/gas/mist/vapors/spray. Use personal protection recommended in Section 8.

6.2. Environmental precautions

Local authorities should be advised if significant spillages cannot be contained. Prevent entry into waterways, sewers, basements or confined areas.

6.3. Methods and material for containment and cleaning up

Allow substance to evaporate. Avoid breathing dust/fume/gas/mist/vapors/spray. Avoid release to the environment.

6.4. Reference to other sections

See Section 7 for more information
See section 8 for more information
See section 13 for more information

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Handle in accordance with good industrial hygiene and safety practice. Ensure adequate ventilation, especially in confined areas. Avoid contact with skin, eyes or clothing. Wash contaminated clothing before reuse. Do not breathe dust/fume/gas/mist/vapors/spray. Do not eat, drink or smoke when using this product. Wash thoroughly after handling. Use personal protection recommended in Section 8.

7.2. Conditions for safe storage, including any incompatibilities

Keep container tightly closed in a dry and well-ventilated place. Keep away from heat, sparks, flame and other sources of ignition. Storage temperature: <52 °C. Keep locked up and out of reach of children. Keep only in original container. Keep away from food, drink and animal feeding stuffs. Store in accordance with local regulations.

7.3. Specific end use(s)

Apart from the uses mentioned in SECTION 1.2 no other specific uses are stipulated.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Chemical Name	Latvia	France	Finland	Germany	Italy
Propane, 1,1,1,2,3,3,3-heptafluoro- (CAS #: 431-89-0)	TWA: 2 ppm TWA: 20 mg/m^3	-	-	-	-

Derived No Effect Level (DNEL)

	Route	Type of effect	DNEL
For the worker	Inhalation	Systemic effects - Long-term	61279 mg/m^3
For the general population	Inhalation	Systemic effects - Long-term	6355 mg/m^3

Predicted No Effect Concentration (PNEC)

Compartment	PNEC
Water	Freshwater: 0.1 mg/L
	Intermittent releases: 1 mg/L
Sediment	Freshwater: 1.3 mg/kg sediment dw
STP	1.73 mg/L

8.2. Exposure controls

Engineering Controls

Ensure adequate ventilation, especially in confined areas. Showers. Eyewash stations. Remove all sources of ignition.

Personal protective equipment

Eye/face protection	Wear safety glasses with side shields (or goggles).
Hand Protection	Wear protective gloves.
Skin and body protection	Suitable protective clothing.
Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment.

Environmental exposure controls

Do not allow into any sewer, on the ground or into any body of water

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Appearance	Gas
Color	Colorless
Odor	Odorless
Odor Threshold	Not determined
pH	Neutral
Melting point/freezing point	-131.0 °C
Boiling point / boiling range	-17 °C
Flash point	Not determined
Evaporation rate	Not determined
Flammability (gas)	Not flammable
Flammability Limit in Air	Not determined
Vapor Pressure	457.7 kPa (25 °C)
Vapor density (as air=1)	6.04
Density	1.46 g/cm^3
Relative density	1.46
Bulk density	Not determined
Specific gravity	Not determined
Water solubility	260 mg/L (25 °C)
Partition coefficient (LogPow)	2.11
Autoignition temperature	532 °C
Decomposition temperature	Not determined
Kinematic viscosity	Not determined
Dynamic viscosity	Not determined
Explosive properties	Not an explosive
Oxidizing properties	Not determined

9.2. Other information

No information available

SECTION 10: Stability and reactivity

10.1. Reactivity

Contact with strong oxidizers, alkali metals and alkaline earth metals may cause fires or explosions.

10.2. Chemical stability

Stable under recommended storage conditions.

10.3. Possibility of hazardous reactions

Hazardous polymerization does not occur.

10.4. Conditions to avoid
Heat, flames and sparks. Strong heating. Incompatible materials. Compressed air, oxygen, chlorine.

10.5. Incompatible materials
Light and/or alkaline metals, alkaline earth metals, powdered metals, oxidizing agents.

10.6. Hazardous decomposition products
Gaseous hydrogen fluoride (HF). Fluorophosgene.

SECTION 11: Toxicological information

11.1. Information on toxicological effects
Acute toxicity

Chemical Name	Oral LD50	Dermal LD50	Inhalation LC50
Propane, 1,1,1,2,3,3,3-heptafluoro- (CAS #: 431-89-0)	-	-	> 788696 ppm 4h (Rat)

Skin corrosion/irritation
Non-irritating to the skin.

Serious eye damage/eye irritation
No eye irritation.

Sensitization
No sensitization responses were observed.

Germ cell mutagenicity
Genotoxicity: negative.

Carcinogenicity
No information available.

Reproductive toxicity
No information available.

STOT - single exposure
No information available

STOT - repeated exposure
No information available

Aspiration hazard
No information available.

SECTION 12: Ecological information

12.1. Toxicity

Chemical Name	Algae/aquatic plants EC50	Fish LC50	Crustacea EC50
Propane, 1,1,1,2,3,3,3-heptafluoro- (CAS #: 431-89-0)	> 114 mg/L 72h Pseudokirchnerella subcapitata	-	> 200 mg/L 48h Daphnia magna

12.2. Persistence and degradability
The test substance was not biodegradable by micro-organisms under the present test conditions.

12.3. Bioaccumulative potential
LogPow = 2.11

12.4. Mobility in soil
No information available

12.5. Results of PBT and vPvB assessment
PBT/vPvB assessment information is not available as chemical safety assessment not conducted.

12.6. Other adverse effects
No information available.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste from residues/unused products	Disposal should be in accordance with applicable regional, national and local laws and regulations.
Contaminated packaging	Disposal should be in accordance with applicable regional, national and local laws and regulations.

SECTION 14: Transport information

14.1 UN Number	3296
14.2 Proper shipping name	HEPTAFLUOROPROPANE (REFRIGERANT GAS R 227)
14.3 Hazard Class	2.2
14.4 Packing Group	Not regulated
14.5 Environmental hazards	Non-marine pollutant
14.6 Special precautions	No information available
14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture
European Union

Component	EINECS/ELINCS	SVHC candidates	RESTRICTIONS - REACH TITLE VII
Propane, 1,1,1,2,3,3,3-heptafluoro- 431-89-0 (>=99.0%)	X	-	-

Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work
Take note of Directive 94/33/EC on the protection of young people at work
Take note of Directive 92/85/EC on the protection of pregnant and breastfeeding women at work

International Inventories

Component	TSCA	DSL/NDSL	ENCS	IECSC	KECL	PICCS	AICS
Propane, 1,1,1,2,3,3,3-heptafluoro- 431-89-0	X	X	X	X	X	-	X

(>=99.0%)							

"-" Not Listed
"X" Listed

15.2. Chemical safety assessment

No information available

SECTION 16: Other information

This material safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006

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Key or legend to abbreviations and acronyms used in the safety data sheet

TWA - TWA (time-weighted average)
STEL - STEL (Short Term Exposure Limit)
Ceiling - Maximum limit value
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances

Full text of H-Statements referred to under section 3

H280 - Contains gas under pressure; may explode if heated

Disclaimer

The information provided in this Material Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

-------- End of Safety Data Sheet --------