FIRETRACE®
POWER TO INNOVATE. FLEXIBILITY TO ADAPT.

DIOM Manual
Part Number: FTF000001

25 Bar
Engineered Clean Agent
Fire Suppression System

Designed for use with:

HFC-227ea Clean Agent

DESIGN, INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

UL® LISTED ULC LISTED

Clean Agent Extinguishing System Unit 4DM0 EX15893

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FOREWARD

General

This manual is written for the fire protection professional that designs, installs, and maintains Firetrace Engineered Clean Agent Fire Suppression Systems with HFC-227ea. This document outlines system components as well as and procedures required for proper design, installation, operation, and maintenance.

Firetrace assumes no responsibility for the design or function of any systems other than those addressed in this manual. The technical data contained herein is limited strictly for informational purposes only.

Firetrace Engineered Clean Agent Fire Suppression Systems with HFC-227ea are to be designed, installed, inspected, tested, maintained, and serviced by qualified trained personnel in accordance with the following:

- All instructions, limitations, etc. contained in this manual P/N FTF000001
- All information contained on the agent cylinder nameplate(s)
- NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems
- Underwriters Laboratories, Inc. Listing
- Local authority having jurisdiction

Warnings

Safety precautions are essential when any electrical or mechanical equipment is involved. These precautions should be followed when handling, servicing, and recharging Firetrace fire suppression unit cylinders and equipment. If safety precautions are overlooked or ignored, personal injury or property damage may occur.

The following notations are used throughout this manual. Always heed these precautions. They are essential to the safe use of the equipment described in this manual.

DANGER:
Identifies immediate hazards and provides specific instructions or procedures, which if not correctly followed WILL result in severe personal injury or death.

WARNING:
Identifies specific instructions or procedures, which if not correctly followed, COULD result in severe personal injury or death.

CAUTION:
Identifies specific instructions or procedures, which if not correctly followed, COULD result in minor personal injury or equipment or property damage.

Safety Precautions

The following safety precautions should always be followed:

WARNING:
Pressurized cylinders are extremely hazardous and if not handled properly can cause property damage, bodily injury, or death. Always wear safety glasses and make sure the Anti-Recoil Device is properly in place before unit installation, servicing, or other general handling.

1) Read and understand this manual and the other documents referenced herein.
2) The valve discharge Anti-Recoil Device MUST be installed on the cylinder valve always and only removed when connected into the discharge piping or when performing charging, testing, or salvaging operations in accordance with the procedures contained in this manual.
3) Wear safety glasses when working with pressurized cylinders and charging equipment. It is recommended to wear leather gloves to avoid any cryogenic burns.
4) Follow all the safety procedures included on the cylinder nameplate and in this manual.
5) Never assume that a cylinder is empty. Treat all cylinders as if they are fully charged.

Questions regarding the information contained in this manual can be addressed to:

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Section 1: General Information

1.1 Introduction

The Firetrace Engineered Clean Agent Fire Suppression Systems with HFC-227ea are UL Listed by Underwriters Laboratories and ULC Listed by Underwriters Laboratories of Canada. These units are designed for use in total flooding applications using HFC-227ea in accordance NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems.

The Firetrace Engineered Clean Agent Fire Suppression Systems with HFC-227ea have been tested to limits established by UL/ULC in compliance with the requirements specified in UL 2166 Standard for Halocarbon Clean Agent Extinguishing System Units as detailed in this manual.

The engineered concept of automatic fire suppression systems allows a range of flexibility in design parameters. The information contained in this manual will allow a systems designer to properly design a Firetrace Engineered HFC-227ea System. It will also permit an authority having jurisdiction to determine that all required design and engineering parameters have been satisfied.

1.2 HFC-227ea Clean Agent

1.2.1 Properties

HFC-227ea (heptafluoropropane, CF_3-CHF-CF_3) Clean Agent is a very stable liquefied gas, super-pressurized with nitrogen and stored in cylinder and valve assemblies as part of a Firetrace Engineered Suppression System.

HFC-227EA is a safe and effective fire extinguishing agent that can be used on type A, B, and C fires. HFC-227EA suppresses fire primarily by physical mechanisms due to its relatively high heat capacity with minimal impact on available oxygen. This allows hazard occupants to see and breathe, permitting them to safely exit the hazard area. It is a stable, liquefied gas and can be used to safely protect electronic equipment, will completely vaporize, and requires no clean up after a system discharge. Additional information on agent properties can be found in Table 1, as well as the MSDS located in Appendix C – SDS of this document.

Chemical Formula	CF_3-CHF-CF_3
Molecular Weight	170.03 g/mol
Freezing Point	-204 °F [-131 °C]
Boiling Point at 1 atm	2.6 °F [-16.36 °C]
Critical Temperature	215 °F [101.7 °C]
Critical Density	38.76 lb./ft^3 [0.621 kg/L]
Critical Pressure	422 psia [2.91 MPa]
Critical Volume	0.0258 ft^3/lbm [1.61 L/kg]
Density, Saturated Liquid	87.58 lbm/ft^3 [1.3886 kg/L]
Density, Gas at 1 atm	0.4530 lbm/ft^3 [0.00705 kg/L]
Liquid Viscosity at 77 °F [25 °C]	0.184 centipoise
Heat of Vaporization at Boiling Point	57 Btu/lbm [132.6 kJ/kg]
Vapor Pressure at 70 °F [21 °C]	58.8 psia

Table 1 – Agent Properties

1.3 Quality Requirements

Strict agent quality specifications must be maintained. These values are as outlined below:

HFC-227EA - Mole % (Minimum)	99
Acidity - PPM by Weight (Maximum)	3
Water Content - % by Weight (Maximum)	0.001

Table 2 – Agent Quality Specifications

1.4 Personnel Safety

1.4.1 Agent Concentration

As indicated in NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems, the areas into which HFC-227EA is discharged must be evacuated by personnel and the areas ventilated after discharge.

HFC-227EA has acceptable toxicity for use in occupied spaces when the guidelines in this manual, NFPA 2001, and any relevant international standards found applicable by the authority having jurisdiction are followed.

HFC-227EA has been evaluated for cardiac sensitization through test protocols approved by the United States Environmental Protection Agency (EPA). The EPA's Significant New Alternative Policy (SNAP) Program classifies HFC-227EA as acceptable for use as a total flooding agent in occupied spaces with no use limitations. Refer to SNAP Program rules for more information.

HFC-227EA has acceptable toxicity and cardiac sensitization levels for use in occupied spaces when used as specified in the United States EPA SNAP program rules.

NFPA 2001 specifies a "No Observed Adverse Effects Level" (NOAEL) for clean agent concentration. This is the highest concentration for which no adverse physiological or toxicological effect has been observed. Additionally, NFPA 2001 specifies a "Lowest Observable Adverse Effects Level" (LOAEL). This is the lowest concentration for which an adverse

physiological or toxicological effect has been observed.

NOAEL (% Vol.)	LOAEL (% Vol.)
9.0	10.5

Table 3 – NOAEL and LOAEL of HFC-227ea

Consideration shall be given to the possibility of a clean agent migrating to adjacent areas outside of the protected space. Care must be taken to ensure that the calculated concentration for normally occupied spaces does not exceed the NOAEL.

WARNING: When HFC-227EA is discharged through the nozzle, the vaporizing HFC-227EA discharge mixture will have a significant cooling effect which could cause skin irritation. Do not stand in direct line of the nozzle flow as the force of discharge could cause injury. The nozzles are designed to discharge the HFC-227EA in a horizontal plane. The flow of HFC-227EA should not be obstructed where obstructions are avoidable.

1.4.2 Thermal Decomposition Products

There is a direct correlation amount of agent, surface area of the flame front, and the quantity of thermal decomposition products (TDP) created.

The discharge of the HFC-227EA at 70 °F (21.1°C) has been established at 10 seconds maximum regardless of the weight discharged to:

1. Limit thermal decomposition products (TDP).
2. Limit of fire damage and its effects.
3. Enhance agent mixing into hazard environment.

Personnel within the area, including installers, maintenance, construction, and all those working within the area are to be instructed in the following areas:

1. Emergency lighting and directional exit signs.
2. Clear aisles and passages for exit routes.
3. Self-closing exit doors that have panic hardware provisions.
4. Continuous alarm during HFC-227EA discharge and afterward until normal atmosphere has been restored in the area.
5. Alarms within and outside of the area that will operate upon first detection of fire.
6. Warning signs located at the entrances to, and inside the areas, to inform that a HFC-227EA system is installed with instructions that are needed for the hazard.

Section 2: System Hardware

Firetrace system hardware is separated into two distinct categories:

- **Essential Hardware:** Components required to achieve a functional system
- **Secondary components:** Optional equipment which is not required for a system to normally function.

Firetrace Engineered HFC-227EA Systems are intended to be designed and installed to protect single or multiple hazards within the limitations as stated in this manual. The equipment described in this manual has been tested in accordance with UL 2166 Standard for Halocarbon Agent Extinguishing System Units. The successful result of this test program has produced a fire suppression system listed by both UL and ULC. The authority having jurisdiction should follow the information specified by this manual, NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems, and any other applicable standards.

2.1 Essential Hardware

The components shown in the following sections are essential to the functionality of the Firetrace system. Without any one of these components, the Firetrace system is incomplete and will result in the system's inability to operate.

2.1.1 Cylinder with Valve Assemblies

The engineered clean agent system cylinders are available in the following sizes: 35 lb. [15 L], 70 lb. [29 L], 150 lb. [62 L], 250 lb. [103 L], 375 lb. [153 L], 560 lb. [227 L], 900 lb. [368 L], and 1200 lb. [490 L]. Each of the system assemblies can be in filled in one pound [0.5 kg] increments between their indicated fill range as shown in table 4.

System operational temperature limits are 32 °F [0 °C] to 130 °F [54.4 °C] and system operating pressure is 360 psi [25 bar] at 70 °F [21.1 °C]. System cylinders with a capacity of 15 to 368 liters are manufactured, tested, and stamped in accordance with DOT-4BW500 and TC-4BWM34. System cylinders with a capacity of 490 liters are manufactured, tested, and stamped in accordance with DOT-SP 11953 500

System Assembly Part Number	Cylinder Size (Nominal)	Fill Range [lb.]		Fill Range [kg]		Empty Weight	Valve Size (Nominal)
		Minimum	Maximum	Minimum	Maximum		
FTF000035	35 lb. [15 L]	16	35	7.5	16.0	37.6 lb. (17.1 kg)	1 in [25 mm]
FTF000070	70 lb. [29 L]	31	71	14.0	32.0	54 lb. (24.5 kg)	1 in [25 mm]
FTF000150	150 lb. [62 L]	66	152	30.0	69.0	106.2 lb. (48.2 kg)	1 ½ in [40 mm]
FTF000250	250 lb. [103 L]	109	253	49.5	114.5	154.8 lb. (70.3 kg)	1 ½ in [40 mm]
FTF000375	375 lb. [153 L]	163	379	74.0	172.0	250 lb. (113.4 kg)	2 ½ in [65 mm]
FTF000560	560 lb. [227 L]	241	561	109.5	254.5	340 lb. (154.3 kg)	2 ½ in [65 mm]
FTF000900	900 lb. [368 L]	390	910	177.5	412.5	465.5 lb. (211.2 kg)	2 ½ in [65 mm]
FTF001200	1,200 lb. [490 L]	519	1,211	234.0	549.5	762.5 lb. (345.9 kg)	4 in [100 mm]

Table 4 – Cylinder Fill Range

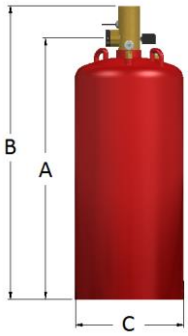


Figure 1 – Cylinder Valve and Assembly

System Assembly Part Number	Cylinder Size (Nominal)	Dimension "A"		Dimension "B"		Dimension "C"	
		in	mm	in	mm	in	mm
FTF000035	35 lb. [15 L]	17.00	432	21.50	547	10.00	254
FTF000070	70 lb. [29 L]	28.75	731	33.25	845	10.00	254
FTF000150	150 lb. [62 L]	37.75	959	43.00	1,093	12.75	324
FTF000250	250 lb. [103 L]	39.00	991	44.50	1,131	16.00	407
FTF000375	375 lb. [153 L]	55.50	1,410	64.00	1,626	16.00	407
FTF000560	560 lb. [227 L]	54.00	1,372	61.75	1,569	20.00	508
FTF000900	900 lb. [368 L]	60.50	1,537	68.25	1,734	24.00	610
FTF001200	1,200 lb. [490 L]	60.25	1,531	68.75	1,747	30.00	762

Table 5 – System Assembly Dimensions

Included in each of the cylinder assemblies are the following components:

- Cylinder Valve Assembly
- Cylinder Mounting Straps

Details of these included components can be seen in sections 2.1.1.1 through 2.1.2

2.1.1.1 Cylinder Valve Assembly

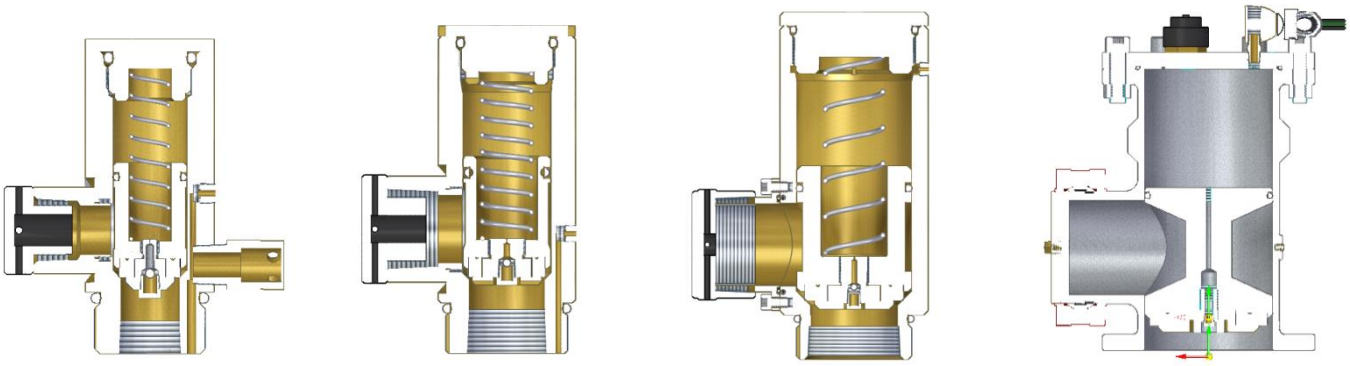
The cylinder valves are pressure differential type valves that include an actuation adapter, pressure monitoring switch, auxiliary “M” port for a discharge activation switch or other pneumatically actuated devices.

Internally within each valve is a piston equipped with elastomeric seals which separate the pressure contained within the top half of the valve from the pressure contained in the cylinder. When the pressure contained within the top half of the valve is vented via an actuation device, the piston can rise within the assembly, exposing the discharge ports. Once the discharge ports are exposed, the pressure contained within the cylinder drives the agent out the discharge port into the pipe network.

If any of the elastomeric seals should fail, a small hole in the axis of the piston allows the cylinder pressure to equalize with the pressure stored in the top half of the valve preventing any unintended actuation.

The 35 lb. [15 L] and 70 lb. [29 L] size cylinders are equipped with 1 in [25 mm] valves. The 150 lb. [62 L] and 250 lb. [103 L] size cylinders are equipped with 1 ½ in [40 mm] valves. The 375 lb. [153L], 560 lb. [227 L], and 900 lb. [368 L] cylinders are equipped with 2 ½ in [65 mm] valves. The 1,200 lb. [490 L] cylinder is equipped with a 4 in [100 mm] valve.

NOTE: All size system assemblies utilize straight siphon tubes, therefore the cylinders are to be installed only in a vertically upright (valve on top) position.



1 in [25 mm] Cylinder Valve | **1 ½ in [40 mm] Cylinder Valve** | **2 ½ in [65 mm] Cylinder Valve** | **4 in [100 mm] Cylinder Valve**

Figure 2- Valve Internals

CAUTION:
All Cylinder Valves are factory equipped with Anti-Recoil Devices. The Anti-Recoil Device SHALL ALWAYS be installed in the valve outlet unless the system is connected to the discharge piping or recharge adapters.

2.1.1.1.1 Cylinder Valve Assembly: Pressure Supervisory Switch FTF503007

The Pressure Supervisory Switch included in the valve assembly is used to monitor the pressure inside the system cylinder. It is permanently attached to the port marked "P". If the cylinder assembly were to experience a pressure drop below 300 ± 10 psig [20.7 ± 1.0 bar], the switch contacts will activate providing a signal to the control panel that the cylinder has lost pressure.

The Pressure Supervisory Switch is single pole, double throw (SPDT) and can be wired in either the normally open (NO), normally closed (NC) configurations, where the normal condition is at atmospheric pressure. When the cylinder is pressurized, the contacts close.

Refer to the control panel for correct wiring of the Pressure Supervisory Switch. When the switch is used on a standard supervisory input circuit, there will be no distinction between a wiring fault and device actuation. The switch shall be installed onto a circuit suitable for system supervision in accordance with NFPA 72: National Fire Alarm and Signaling Code. This device is only to be utilized when accepted by the authority having jurisdiction. All other uses of this switch should be approved by the authority having jurisdiction.

Switch Specification

Electrical Rating:	240 VAC – 3 A, 24 VDC – 3 A
Switch:	SPDT snap action
Contacts:	NO, NC, and Common
Pressure setting:	300 ± 14 psig [20.7 ± 1.0 bar] deactivation point

Figure 3 – Pressure Supervisory Switch

2.1.1.1.2 Cylinder Valve Assembly: Actuation Adapter

Each Valve is manufactured with an actuation adapter which allows the Linear Actuator (see section 2.2 for details) and/or a Manual Override Switch (Section 2.2.1) to be mounted to the valve assembly. The actuation adapter contains an integrated Schrader core which allows for the removal or installation of the actuator or local manual release while system is under pressure.

Should both an electronic linear actuator and a local manual actuator be required, these units are stackable as indicated in figure 4.

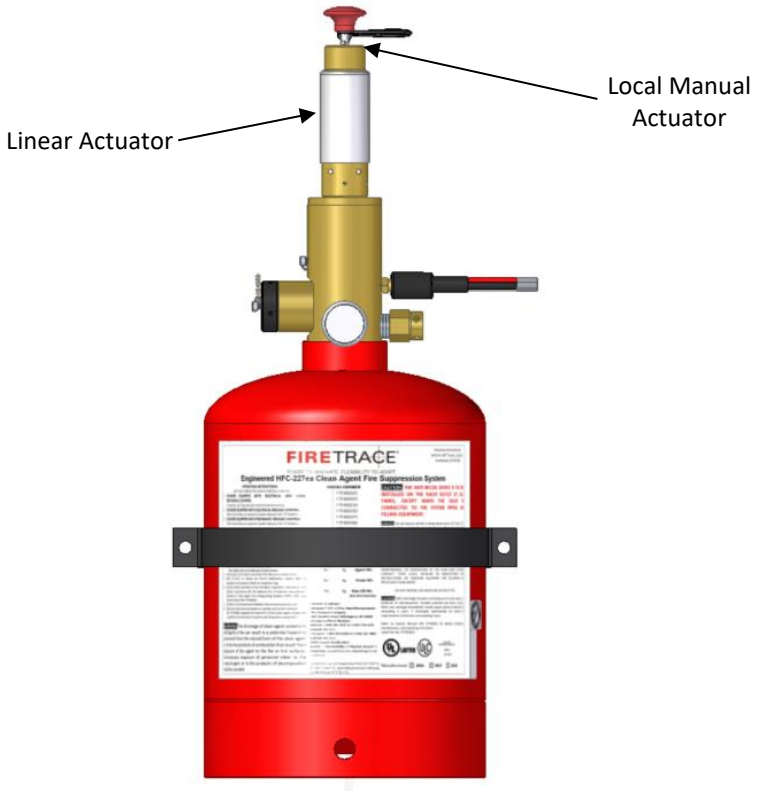


Figure 4 - Stacked Electronic Linear Actuator and Local Manual Actuator

2.1.1.1.3 Cylinder Valve Assembly: Auxiliary "M" Port

An additional 1/8-inch NPT outlet on the cylinder valve, stamped "M", is available for use as a pressure source to drive the Pneumatic Actuators as secondary control heads on a multiple cylinder system. This port can also be used to actuate a Pressure Operated Switch or additional approved accessory.

The "M" port is only pressurized during system discharge therefore components can be mounted or dismounted while the system is under pressure.

2.1.1.2 Cylinder Mounting Straps

The last component included in the Cylinder assemblies are the Cylinder Mounting Straps. The cylinder mounting straps are manufactured steel bands formed to the diameters of the cylinders with flanges for anchoring to solid surfaces or appropriately sized continuous slot metal framing channel. The channel is to be supplied by the installer. The cylinder bracket must be secured to a surface appropriate for retaining the weight of the cylinder in event of a discharge. This precaution is intended to safely support the weight of the cylinder and the reaction force of the HFC-227EA discharge.

A single cylinder bracket is required for the 35 lb. [15 L], 70 lb. [29 L], 150 lb. [62 L], and 250 lb. [103 L] cylinders. The 375 lb. [153 L], 560 lb. [227 L], 900 lb. [368 L] and 1,200 lb. [490 L] cylinders require two bracket straps per cylinder assembly. All cylinders must be mounted vertically only, with the valve up, resting firmly on the floor.

Each cylinder assembly is supplied with the relevant number of cylinder mounting straps – for reference only

Cylinder Size (Nominal)	Required Strap Part Number	Qty Required Per Cylinder	Anchor Point	Dimension "A"		Dimension "B"		Dimension "C"		Dimension "D"	
				in	mm	in	mm	in	mm	in	mm
35 lb. [15 L]	FTF400035	1	Wall	9.8	248	12.3	311	11.3	286	1.4	35
70 lb. [29 L]	FTF400035	1	Wall	9.8	248	12.3	311	11.3	286	1.4	35
150 lb. [62 L]	FTF400150	1	Wall	12.5	318	15.0	381	14.0	356	1.4	35
250 lb. [103 L]	FTF400250	1	Wall	15.8	400	18.3	464	17.3	438	1.4	35
375 lb. [153 L]	FTF400250	2	Wall	15.8	400	18.3	464	17.3	438	1.4	35
560 lb. [227 L]	FTF400560	2	Wall	19.8	502	22.3	565	21.3	540	1.4	35
900 lb. [368 L]	FTF400950	2	Wall	23.8	603	26.3	667	25.3	643	1.4	35
1,200 lb. [490 L]	FTF401200	2	Wall	29.0	737	32.3	819	31.3	794	1.4	35
1,200 lb. [490 L]	FTF401201	2	Floor	4.5	114	10.5	267	9.5	241	1.37	35

Table 6- Mounting Strap Dimensions

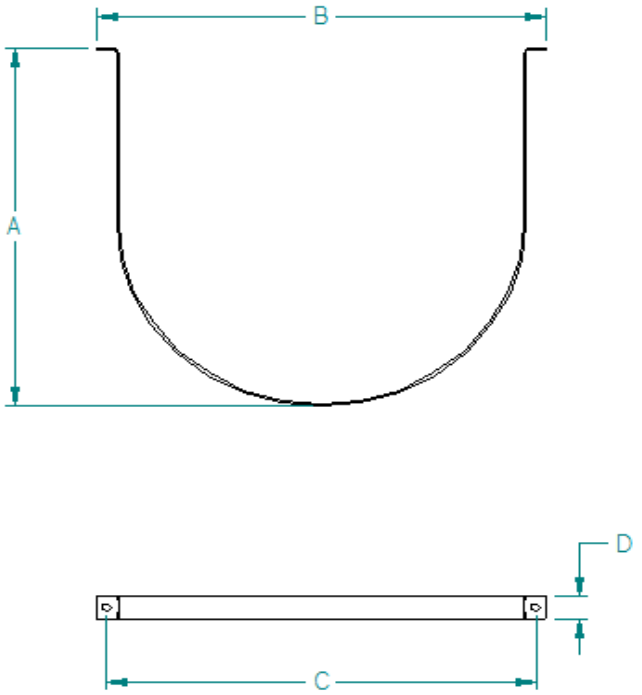


Figure 5 – Cylinder Wall Strap

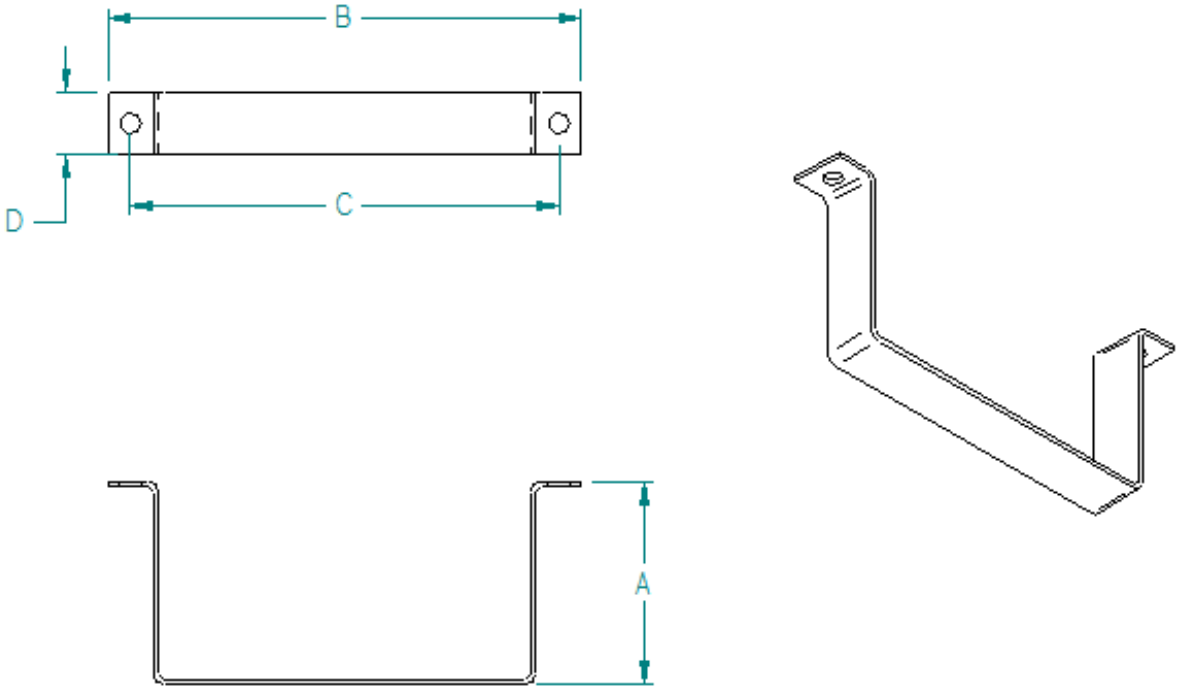


Figure 6 – Cylinder Floor Strap

Figure 7 – Cylinder Securing Options

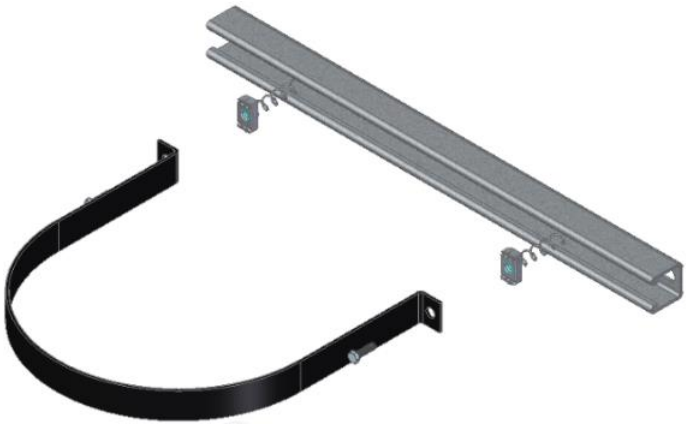


Figure 8 – Strap Installation Example

2.1.2 Electric Linear Actuator FTF500125

The Electronic Linear Actuator operates the cylinder/valve assembly by venting the pressure above the piston in the cylinder valve allowing the piston to slide upward and commence system discharge.

The Electric Linear Actuator mounts to the Actuation Adapter threads located on top of the cylinder valve assembly. The threaded attachment allows for ease of removal for inspection and maintenance purposes.

The Electric Linear Actuator houses a pin, magnetically held in place while the system remains in an idle state. Once powered, the pin moves downward, thereby depressing the Actuation Adapter valve core, releasing pressure from the cylinder valve, and actuating the system.

The Electric Linear Actuator must be actuated from a UL Listed control panel for releasing device service that is

compatible with Firetrace equipment. Prior to the installation of the Electric Linear Actuator to the actuation circuit, confirm the electrical rating is compatible with the electrical ratings of the actuation circuit. The Electric Linear Actuator is available in 24 VDC only.

NOTE: The actuation circuit is rated at 24 VDC, 0.5 Amps. The maximum supervisory current should not exceed 30mA.

Wiring of the Electric Linear Actuator to the actuation circuit shall comply with NFPA requirements. For more information review the wiring methods found in NFPA 72, Chapter 17. The method outlined in NFPA is also seen in Figure 10.

Wiring of the dual leads provided for the Electric Linear Actuator with monitoring switch shall comply with wiring methods in accordance with the installation instructions provided with the UL Listed control panel for releasing device service, or as shown in Figure 10.

The removal of the Electric Linear Actuator will result in the internal monitoring switch to close, resulting in the annunciation of a supervisory signal at a required operator interface for the releasing service fire alarm control panel.

The Electric Linear Actuator shall be installed with UL Listed conduit connectors. By utilizing flexible metal conduit connectors or liquid-tight conduit connectors, the solenoid coil wires and dual leads for the internal monitoring switch are mechanically protected from damage.

CAUTION:
Do not electrically activate the Electric Linear Actuator at any time unless the discharge valve outlet has the Anti-Recoil Device installed or the discharge piping is installed.

Electric Actuator Part Number	Voltage (Nominal)	Description	Compatible with Cylinder Valve Size(s)
FTF500125	24 VDC	Electric Linear Actuator with Monitoring Switch	All Sizes

Table 7 – Electric Linear Actuator Part Numbers

NOTE: Use of the Electric Linear Actuator is not optional. This part is required to be ordered with the system should anything other than a local manual actuator be required for actuation

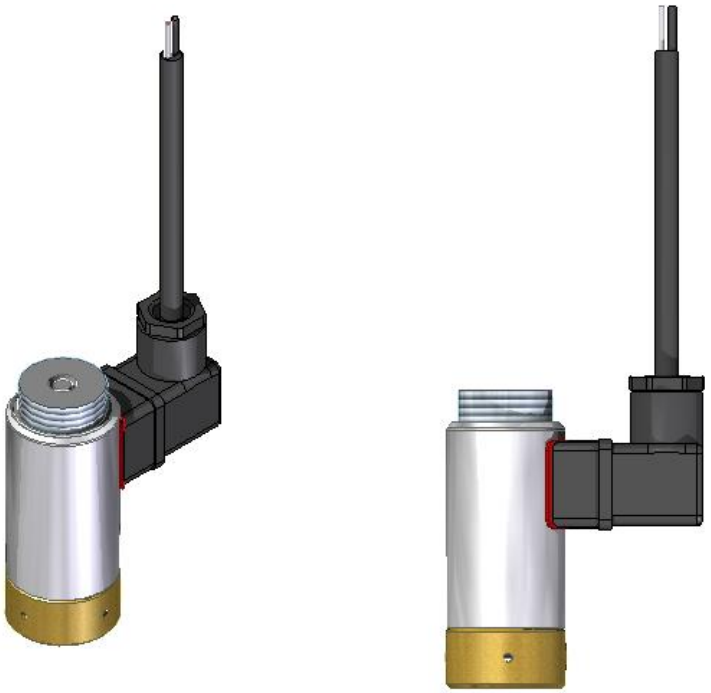


Figure 9 – Electric Linear Actuator

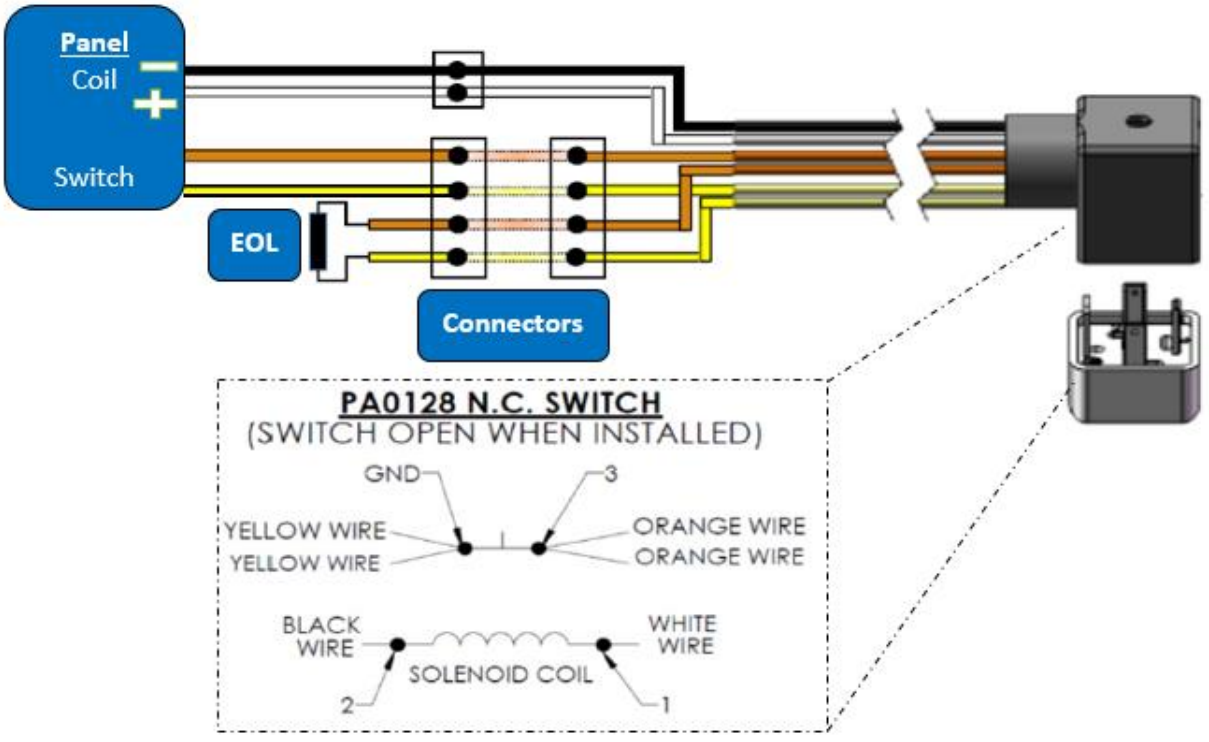


Figure 10- Electronic Linear Actuator Wiring Schematic

2.1.3 Nozzles

Discharge nozzles are made of aluminum, brass, or stainless steel with female pipe threads. Nozzles are available in ½ in [13 mm], ¾ in [19 mm], 1 in [25 mm], 1 ¼ in [32 mm], 1 ½ in [40 mm], and 2 in [50 mm] nominal connection sizes. The nozzles are available in 180° sidewall or 360° central discharge patterns. Any combination of types of nozzles may be used in a single area. When multiple nozzles are employed, the coverage for each nozzle must not exceed its maximum length and area of coverage. Refer to Section 0for nozzle coverage information.

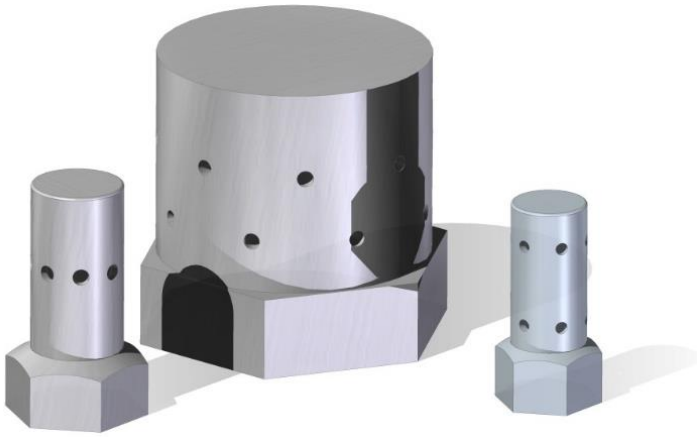


Figure 11 – Nozzle Examples

2.1.3.1 Part Numbering and Nozzle Types

Refer to Tables 8,9, and 10 for the initial Nozzle part numbers. An additional suffix is required to denote the decimal size drill diameter of the nozzle orifice.

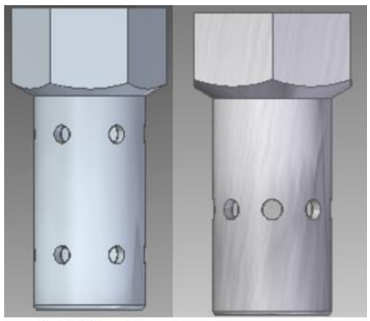
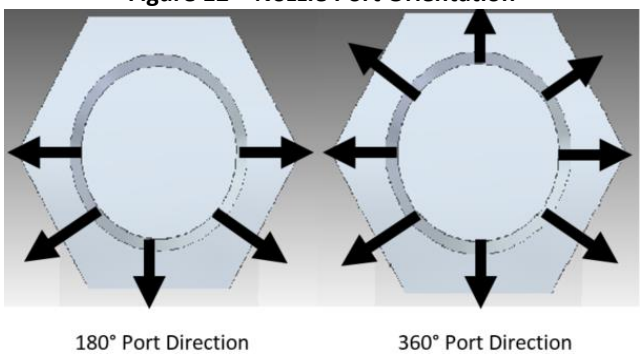


Figure 12 – Nozzle Port Orientation



Nozzle Part Number	NPT Pipe Connection Size (Nominal)	Port Orientation	Drill Diameter Range, [in]
FTF610000-XXXX	½ in [13 mm]	360° Central	0.078 - 0.196
FTF610001-XXXX	½ in [13 mm]	180° Sidewall	
FTF620000-XXXX	¾ in [19 mm]	360° Central	0.136 - 0.261
FTF620001-XXXX	¾ in [19 mm]	180° Sidewall	
FTF630000-XXXX	1 in [25 mm]	360° Central	0.166 – 0.332
FTF630001-XXXX	1 in [25 mm]	180° Sidewall	
FTF640000-XXXX	1 ¼ in [32 mm]	360° Central	0.218 – 0.438
FTF640001-XXXX	1 ¼ in [32 mm]	180° Sidewall	
FTF650000-XXXX	1 ½ in [40 mm]	360° Central	0.257 – 0.500
FTF650001-XXXX	1 ½ in [40 mm]	180° Sidewall	
FTF660000-XXXX	2 in [50 mm]	360° Central	0.328 – 0.657
FTF660001-XXXX	2 in [50 mm]	180° Sidewall	

Table 8- Aluminum Nozzle Configurations

The –XXXX of the nozzle part number designates the orifice drill size. Drill diameter size shall be determined using Firetrace flow calculation software.

Nozzle Part Number	NPT Pipe Connection Size (Nominal)	Port Orientation	Drill Diameter Range, [in]
FTF610002-XXXX	½ in [13 mm]	360° Central	0.078 - 0.196
FTF610003-XXXX	½ in [13 mm]	180° Sidewall	
FTF620002-XXXX	¾ in [19 mm]	360° Central	0.136 - 0.261
FTF620003-XXXX	¾ in [19 mm]	180° Sidewall	
FTF630002-XXXX	1 in [25 mm]	360° Central	0.166 – 0.332
FTF630003-XXXX	1 in [25 mm]	180° Sidewall	
FTF640002-XXXX	1 ¼ in [32 mm]	360° Central	0.219 – 0.438
FTF640003-XXXX	1 ¼ in [32 mm]	180° Sidewall	
FTF650002-XXXX	1 ½ in [40 mm]	360° Central	0.257 – 0.500
FTF650003-XXXX	1 ½ in [40 mm]	180° Sidewall	
FTF660002-XXXX	2 in [50 mm]	360° Central	0.328 – 0.657
FTF660003-XXXX	2 in [50 mm]	180° Sidewall	

Table 9- Brass Nozzle Configurations

The –XXXX of the nozzle part number designates the orifice drill size. Drill diameter size shall be determined using Firetrace flow calculation software.

Nozzle Part Number	NPT Pipe Connection Size (Nominal)	Port Orientation	Drill Diameter Range, [in]
FTF610004-XXXX	½ in [13 mm]	360° Central	0.078 - 0.196
FTF610005-XXXX	½ in [13 mm]	180° Sidewall	
FTF620004-XXXX	¾ in [19 mm]	360° Central	0.136 - 0.261
FTF620005-XXXX	¾ in [19 mm]	180° Sidewall	
FTF630004-XXXX	1 in [25 mm]	360° Central	0.166 – 0.332
FTF630005-XXXX	1 in [25 mm]	180° Sidewall	
FTF640004-XXXX	1 ¼ in [32 mm]	360° Central	0.217 – 0.438
FTF640005-XXXX	1 ¼ in [32 mm]	180° Sidewall	
FTF650004-XXXX	1 ½ in [40 mm]	360° Central	0.257 – 0.500
FTF650005-XXXX	1 ½ in [40 mm]	180° Sidewall	
FTF660004-XXXX	2 in [50 mm]	360° Central	0.328 – 0.657
FTF660005-XXXX	2 in [50 mm]	180° Sidewall	

Table 10- Stainless Steel Nozzle Configurations

The –XXXX of the nozzle part number designates the orifice drill size. Drill diameter size shall be determined using Firetrace flow calculation software.

2.2 Optional Components

The components in the following sections are optional meaning they are not required for essential operation of the Firetrace Engineered Fire Suppression System. Customer requirements, local specifications/standards, and final system configuration will dictate if they are necessary or required.

2.2.1 Manual Override FTF500126

A Manual Override can be added to cylinder valves in the event a Local Manual Actuator is required. If a Local Manual Actuator is required, per NFPA 2001, you must also include a Pressure Operated Switch (P/N FTF503013)

The Manual Override mounts to the actuation adapter threads located on top of the Electric Linear Actuator. The threaded attachment allows for ease of removal for inspection and maintenance purposes.

The Manual Override features a push-button that moves the internal pin downward and manually actuates the Electric Linear Actuator.

Figure 13 –Manual Override

CAUTION:
Do not remove the safety pin until ready to actuate system discharge.

Manual Override Part Number	Parts Required
FTF500126	FTF500125 – Electric Linear Actuator

Table 11- Manual Override Part Numbers

2.2.2 Pneumatic Actuator FTF700041

The Pneumatic Actuator is required if more than one cylinder must be actuated simultaneously. Situations in which this could arise are:

- Primary/Secondary Cylinder Banks (Figure 13)
- When two systems must operate simultaneously from one electronic signal

The Pneumatic Actuator mounts to the threads on the Actuation Adapter, located on top of the valve assembly. The Pneumatic Actuator features a pneumatically driven piston that slides downward, thereby depressing the Schrader Core contained within the actuation adapter, releasing pressure from the cylinder valve and actuating the system.

The pressure required to operate the Pneumatic Actuator is obtained from the "M" port of the primary cylinder. Multiple cylinders equipped with a Pneumatic Actuator can be activated from one master cylinder using ¼ inch metal flex hose, see Table 12 and Figure 15 for additional information.

NOTE: Pneumatic Actuators must be mounted directly to the actuation adapter threads on top of the valve. These are not to be used in a stacked configuration.

Figure 14 – Pneumatic Actuator

Cylinder Size (Nominal)	Cylinder Valve Size	Maximum Quantity of Pneumatic Actuators	Maximum Overall Length of Actuation Line (Tube, Pipe or Hose)
35 lb. [15 L]	1 in [25 mm]	7	50 ft. [15.24 m]
70 lb. [29 L]	1 in [25 mm]	7	50 ft. [15.24 m]
150 lb. [62 L]	1 ½ in [40 mm]	7	50 ft. [15.24 m]
250 lb. [103 L]	1 ½ in [40 mm]	7	50 ft. [15.24 m]
375 lb. [153 L]	2 ½ in [65 mm]	6	30 ft. [9.14 m]
560 lb. [227 L]	2 ½ in [65 mm]	6	30 ft. [9.14 m]
900 lb. [368 L]	2 ½ in [65 mm]	6	30 ft. [9.14 m]
1,200 lb. [490 L]	4 in [100 mm]	6	30 ft. [9.14 m]

Table 12 – Pneumatic Actuator Limitations

NOTE: When using the ¼ inch metal flex hose (24 inch or 36 inch), the length of the flex hose is to be subtracted from the maximum length of tubing to determine the maximum amount of tubing that can be used. At no time may the total length of tubing and the flex hose exceed the stated lengths under Table 12.

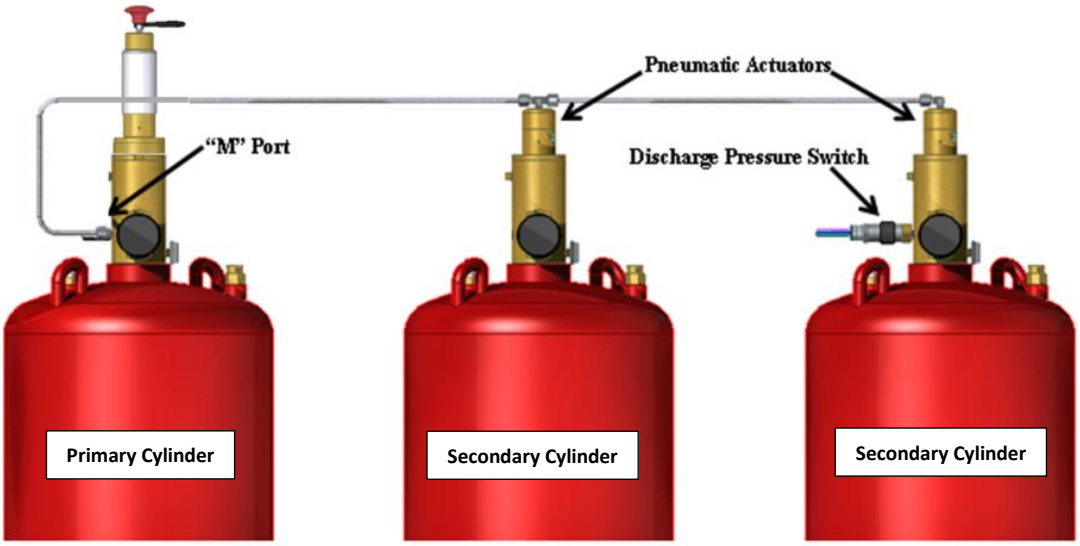


Figure 15 – Secondary Control Arrangement Example

2.2.3 Discharge Flex Hoses

Discharge flex hoses are used to connect the agent storage containers to the manifold in single or multiple (manifolded or main/reserve) cylinder arrangements. The 1 in [25mm] and 1 ½ in [40mm] discharge flex hoses are constructed of high pressure hydraulic rubber. The 2 ½ in [65 mm] and 4 in [100 mm] discharge flex hoses are constructed of stainless steel braided hose. The 1 in [25 mm], 1 ½ in [40 mm] and 2 ½ in [65 mm] sizes are fitted with male NPT threads on both ends. The 4 in [100 mm] sizes are fitted with grooved ends.

The recommended assembly configuration is to install an elbow to the cylinder valve discharge outlet, then install the flex hose between the elbow and a check valve, with the check valve connected to the appropriate fitting in the manifold.

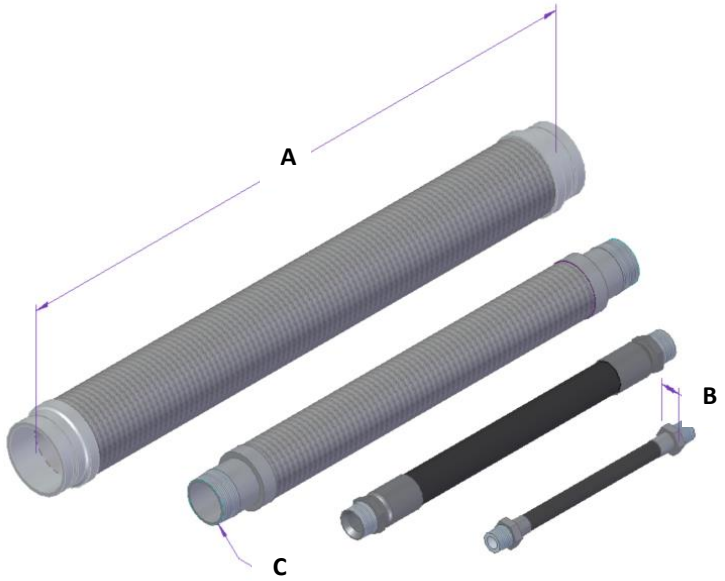


Figure 16 – Flex Hoses

Flex Hose Part Number	Flex Hose Size (Nominal)	Dimension "A"		Dimension "B"		Dimension "C" Fitting Style, Size	
		in	mm	in	mm	Fitting Style	Size (Nominal)
FTF701004	1 in [25 mm]	18	457.2	2.25	57.2	NPT	1 in
FTF701504	1 ½ in [40 mm]	18	457.2	2.75	69.9	NPT	1 ½ in
FTF702502	2 ½ in [65 mm]	18	457.2	3.5	88.9	NPT	2 ½ in
FTF704001	4 in [100 mm]	30.5	762.0	5	127.0	Grooved	4 in

Table 13 – Flex Hose Dimensions

2.2.4 Check Valves

Check Valves must be used anytime more than one cylinder is discharging into a common pipe network. This occurs when:

- Cylinders set up in a Primary/Secondary arrangement
- Main/Reserve arrangements

Their purpose is to prevent loss of agent if any of the agent storage cylinders are not connected to the manifold at time of system discharge.

All component valve bodies are constructed of brass for durability and protection against corrosion, except for the 4 inch, which is constructed of steel. All check valves have a wrench flat on the outer surface for installation. Check valves may be installed in the vertical or horizontal position.

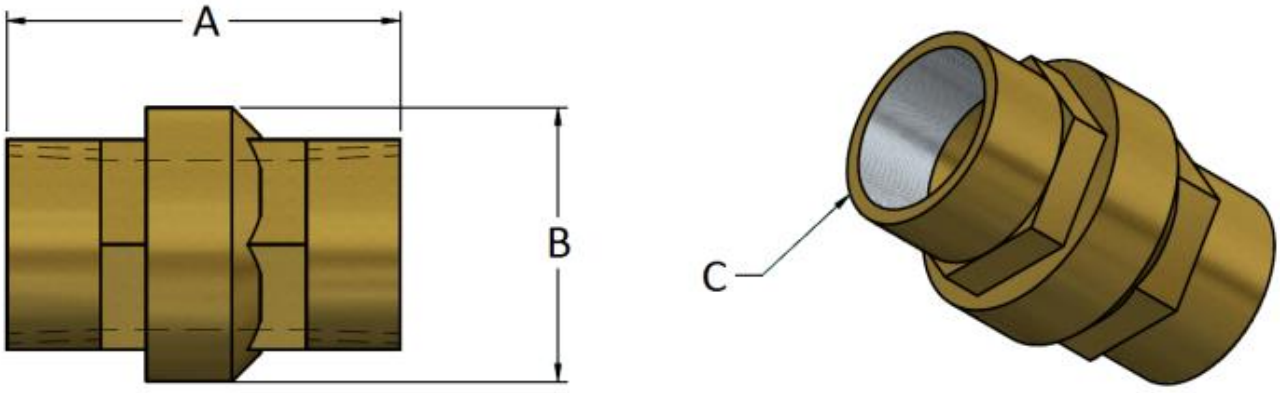


Figure 17 – Check Valve

Check Valve Part Number	Check Valve Size (Nominal)	Dimension "A"		Dimension "B"		Dimension "C" Fitting Style, Size	
		in	mm	in	mm	Fitting Style (female)	Size (Nominal)
FTF701001	1 in [25 mm]	2.76	70.1	1.93	49.0	NPT	1 in
FTF701501	1 ½ in [40 mm]	3.17	80.5	2.87	72.9	NPT	1 ½ in
FTF702501	2 ½ in [65 mm]	4.37	111.0	4.39	111.5	NPT	2 ½ in
FTF704003	4 in [100 mm]	5.38	137.0	6.00	152.0	Grooved	4 in

Table 14 – Check Valve Dimensions

2.2.5 Main/Reserve Selector Switch FTF502001

The Main/Reserve Selector Switch is a means of transferring the electrical supply from the main cylinder releasing solenoid to the reserve cylinder releasing solenoid.

Figure 18 – Main/Reserve Selector Switch

2.2.6 Pressure Operated Switch FTF503013

The Pressure Operated Switch provides additional electrical contacts for indication of discharge, see Figure 19. The switch may be installed into the same pneumatic line for the piston actuators, provided the maximum length for tubing outlined in Table 12 is not exceeded. The switch may also be connected to any point of the discharge piping between the cylinder and nozzle. The Pressure Operated Switch must be included in the system if a Local Manual Actuator is used to be compliant with NFPA 2001

Switch Specification

Electrical Rating : 240 VAC – 3 A, 24 VDC – 3 A
Switch : Single pole, double throw (SPDT) snap action
Contacts : NO, NC, and Common
Pressure setting : 20 ± 10 psig [1.4 ± 0.7 bar] actuation upon pressure rise

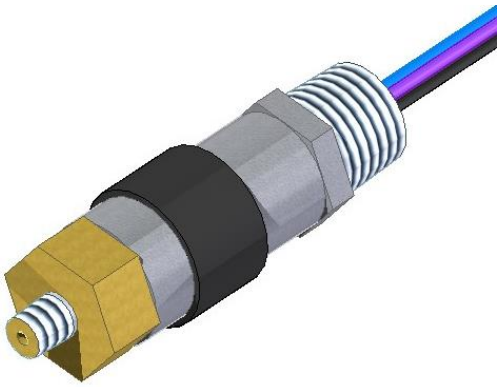


Figure 19- Pressure Operated Switch

2.2.7 Liquid Level Indicator

The Firetrace Liquid Level Indicator is a simple, manually operated device which provides a means to determine the clean agent liquid level in vertically mounted agent storage containers. Once the liquid level is determined, it can then be converted into pounds (kilograms) of clean agent present in the agent storage container.

A float equipped with a magnet moves with the liquid level along the unit stem. Level readout is obtained by simply removing the protective cap and pulling out a calibrated tape until magnetic interlock with the float is felt. With the tape in this position, the readout is obtained at the point where the tape emerges from the unit housing. Using the graph (per cylinder size) located in Appendix B – Liquid Level Indicator Charts, to determine the corresponding amount of clean agent in the cylinder. Graph data is for conditions at 32 °F [0 °C], 70 °F [21 °C], and 130 °F [54.4 °C].

Liquid Level Indicator Part Numbers	Cylinder Sizes (Nominal)
FTF720150	150 lb. – 250 lb. [62 L – 103 L]
FTF720375	375 lb. – 900 lb. [153 L – 368 L]
FTF721200	1,200 lb. [490 L]

Table 15- LLI Part Numbers

Figure 20- LLI Illustration

2.3 Non-Firetrace Supplied Items

The items listed in the section below are to be sourced through local suppliers. These items are essential to the installation of the Firetrace system, however they are not supplied by Firetrace. To ensure the items meet proper industry as well as UL and NFPA 2001 standards they must meet the following criteria. If they do not conform to the noted standards the system is not in compliance with the established limitations.

2.3.1 Pipe, Fittings, and Pipe Supports

All piping must be installed in accordance with good commercial practices and applicable national standards.

2.3.1.1 Pipe Requirements

Piping must be Schedule 40 steel pipe, either galvanized or black. Specifications ASTM A-53 or A-106, ANSI B36.10 must be used for steel pipe. Where Schedule 40 steel pipe is not used, piping shall be in accordance with the requirements of NFPA 2001.

NOTE: Cast iron pipe and steel pipe to specification ASTM A-120 or non-metallic pipe shall NOT be used.

NOTE: All piping must be thoroughly cleaned to remove burrs and swabbed with a degreasing solvent to remove all traces of cutting oils and chips.

2.3.2 Pipe Fittings and Piping Joining

Piping, fittings, and pipe supports shall be in accordance with the latest edition of NFPA 2001 available from National Fire Protection Association. Also, consult ANSI B31.1., The Power Piping Code. Temperature ratings of the fittings must not be exceeded. All threaded joints must be in accordance with ANSI B20.1. Ductile iron 300-pound class or higher ASTM A-395, or steel ASTM A-234 is acceptable. The method of joining all pipe must be in accordance with the latest requirements listed in NFPA 2001. Acceptable fittings include screwed, flanged, welded, or grooved.

NOTE: Grooved fittings are to be machined groove or rolled grooved only.

2.3.3 Piping Reductions

Reductions in pipe size can be made by using concentric "bell" reducers or reducing bushing fittings after the tee.

2.3.4 Pipe Supports

The piping system shall be securely supported by listed and/or approved hangers. Pipe supports must be installed with allowance for expansion and contraction and must be rated to support the dead weight of the piping and the thrust forces of the HFC-227EA discharge. Refer to ANSI B31.1 for bracing requirements.

NOTE: Discharge piping, no matter what length, must be rigidly supported with pipe hangers and supports to structural members to prevent potential cylinder valve rotation. Consult ANSI B31.1.

Section 3: Design

3.1 Introduction

The design section provides an understanding of the characteristics of HFC-227EA in relation to its flow from its storage container, through the piping network and discharging from the distribution nozzles. Information is also given for the authority having jurisdiction for approving the system installation. Systems shall be installed and maintained in accordance with NFPA 2001, all applicable codes and regulations, and this manual**.**

The Firetrace Engineered HFC-227EA System is primarily designed for total flooding applications to extinguish Class A, B, and C type fires. For systems requiring extended discharge or "local application" design please contact Firetrace for additional guidance.

In general, HFC-227EA systems are not suitable in fire suppression applications involving hazards other than Class A, B, or C fuels. The concentration by volume for flame extinguishment for various liquids and gases included in NFPA 2001 are shown in Table 16.

CAUTION:
Clean agent shall NOT be used on fires involving the following materials:

1. **Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, which are capable of rapid oxidation in the absence of air.**
2. **Reactive metals such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium.**
3. **Metal hydrides.**
4. **Chemicals capable of undergoing auto-thermal decomposition, such as certain organic peroxides and hydrazine.**

It is important that every system be designed to provide maximum extinguishing characteristics and that the limitations stated in this manual are followed.

3.2 Defining the Scope of Protection

Before performing any calculations, the following hazard information must be established to determine the proper design parameters required to sufficiently protect the hazard:

1. The hazard class: A, B, or C. Based on the class of fire, the design concentration by volume will be assigned.
2. Pressure Adjustment: The design quantity of agent shall be adjusted to compensate for ambient pressures that vary with elevations greater than 3,000 ft. [915 m] above standard sea level.
3. The minimum and maximum temperature of the agent storage cylinder(s) must be established.
4. The minimum and maximum ambient temperature in the volume being protected must be established.
5. The exact internal dimensions of the hazard; in terms of length, width and height.
6. Will materials, stock, etc. that accrue on a daily basis affect the volume in any appreciable amounts?
7. If any air handling equipment is assigned to the hazard, review equipment capacity as to air changes per hour. A hold time of the agent after discharge must be taken into consideration.

3.2.1 Ventilation and Unclosable Openings

Openings in the hazard volume must be sealed. When the system is discharged into an enclosure, normal gaps and openings under doorways must not impact system performance. Doors and normal vents that are required in the enclosure must be closed prior to, or at the time of system discharge. Doors or closures that normally swing to a closed position and are not held open do not require a system-generated mechanism to operate. Doors and closures, including ventilation, which are held open while operating must have devices installed to close at the start or prior to system discharge. All doors should be closed and ventilation fans shut down prior to discharge.

3.3 Amount of Agent Required

3.3.1 Minimum Design Concentration

Minimum design concentrations required for Class A, B, and C fire extinguishment can be found in the table below. The minimum design concentrations are referenced from NFPA 2001, 2018 edition. Please refer to the applicable edition of NFPA 2001 for the most correct information.

For Class B hazards, refer to Annex B of NFPA 2001 for the cup burner extinguishment concentration value of the particular Class B fuel(s) to be protected. Choose the fuel with the highest cup burner extinguishment value in the hazard and apply a 30% safety factor (multiply this extinguishment concentration value by 1.3) for the design concentration. The minimum design concentration for the protection of all Class B hazards shall be 5.9%. Contact Firetrace for guidance on hazards deviating from these requirements or for fuels not listed.

Fuel	Concentration % by Volume (Per NFPA 2001)
Class A	The minimum design concentration for a Class A hazard shall be the minimum extinguishing concentration for Heptane as determined by UL2166, 2127 or equivalent test standard. **6.7%**
Class B	The design concentration of a Class B fire shall be the greater value of the two following scenarios: A) The Highest cup burner extinguishing value of Class B fuel found within protected hazard, times a safety factor of 1.30. B) The cup burner value of Heptane (6.7%) times a factor of safety of 1.30 This value is typically: **8.7%**
Class C	The minimum design concentration for a Class C hazard shall be the extinguishing concentration for a Class A hazard as determined by UL 2166 (5.2%) times a safety factor of 1.35. **7.0%**

Table 16 – Minimum Design Concentrations (MDC)

3.3.2 Agent Storage Temperature

CAUTION:

The highest and lowest foreseeable container operating/storage temperatures must be input into the software calculation to accurately predict flow characteristics.

Hazard enclosure temperature will impact the agent quantity required. The higher the enclosure temperature, the less HFC-227EA agent is required. Conversely, the lower the enclosure temperature, the more HFC-227EA agent is required. When calculating the minimum required amount of agent, always use the lowest foreseeable temperature.

3.3.3 Pressure Adjustment

The design quantity of agent shall be adjusted to compensate for ambient pressures that vary with elevations greater than 3,000 ft. [915 m] above standard sea level, see Table 17 for the list of multipliers.

Altitude		Enclosure Pressure		Correction Factor (CF)
ft.	km	psia	mm Hg	
-3,000	-0.92	16.25	840	1.11
-2,000	-0.61	15.71	812	1.07
-1,000	-0.30	15.23	787	1.04
0	0.00	14.70	760	1.00
1,000	0.30	14.18	733	0.96
2,000	0.61	13.64	705	0.93
3,000	0.91	13.12	678	0.89
4,000	1.22	12.58	650	0.86
5,000	1.52	12.04	622	0.82
6,000	1.83	11.53	596	0.78
7,000	2.13	11.03	570	0.75
8,000	2.45	10.64	550	0.72
9,000	2.74	10.22	528	0.69
10,000	3.05	9.77	505	0.66

Table 17– Atmospheric Correction Factor

3.3.4 Flooding Factors

Temp (*t*) (°F)[c]	Specific Vapor Volume (*s*) (ft^3/lb)[d]	Weight Requirements of Hazard Volume, W/V (lb/ft^3)[b] Design Concentration (% by Volume)[a]									
		6	7	8	9	10	11	12	13	14	15
10	1.9264	0.0331	0.0391	0.0451	0.0513	0.0570	0.0642	0.0708	0.0776	0.0845	0.0916
20	1.9736	0.0323	0.0381	0.0441	0.0501	0.0563	0.0626	0.0691	0.0757	0.0825	0.0894
30	2.0210	0.0316	0.0372	0.0430	0.0489	0.0550	0.0612	0.0675	0.0739	0.0805	0.0873
40	2.0678	0.0309	0.0364	0.0421	0.0478	0.0537	0.0598	0.0659	0.0723	0.0787	0.0853
50	2.1146	0.0302	0.0356	0.0411	0.0468	0.0525	0.0584	0.0645	0.0707	0.0770	0.0835
60	2.1612	0.0295	0.0348	0.0402	0.0458	0.0514	0.0572	0.0631	0.0691	0.0753	0.0817
70	2.2075	0.0289	0.0341	0.0394	0.0448	0.0503	0.0560	0.0618	0.0677	0.0737	0.0799
80	2.2538	0.0283	0.0334	0.0386	0.0439	0.0493	0.0548	0.0605	0.0663	0.0722	0.0783
90	2.2994	0.0278	0.0327	0.0378	0.0430	0.0483	0.0538	0.0593	0.0650	0.0708	0.0767
100	2.3452	0.0272	0.0321	0.0371	0.0422	0.0474	0.0527	0.0581	0.0637	0.0694	0.0752
110	2.3912	0.0267	0.0315	0.0364	0.0414	0.0465	0.0517	0.0570	0.0625	0.0681	0.0738
120	2.4366	0.0262	0.0309	0.0357	0.0406	0.0456	0.0507	0.0560	0.0613	0.0668	0.0724
130	2.4820	0.0257	0.0303	0.0350	0.0398	0.0448	0.0498	0.0549	0.0602	0.0656	0.0711
140	2.5272	0.0253	0.0298	0.0344	0.0391	0.0440	0.0489	0.0540	0.0591	0.0644	0.0698
150	2.5727	0.0248	0.0293	0.0338	0.0384	0.0432	0.0480	0.0530	0.0581	0.0633	0.0686
160	2.6171	0.0244	0.0288	0.0332	0.0378	0.0425	0.0472	0.0521	0.0571	0.0622	0.0674
170	2.6624	0.0240	0.0283	0.0327	0.0371	0.0417	0.0464	0.0512	0.0561	0.0611	0.0663
180	2.7071	0.0236	0.0278	0.0321	0.0365	0.0410	0.0457	0.0504	0.0552	0.0601	0.0652
190	2.7518	0.0232	0.0274	0.0316	0.0359	0.0404	0.0449	0.0496	0.0543	0.0592	0.0641
200	2.7954	0.0228	0.0269	0.0311	0.0354	0.0397	0.0442	0.0488	0.0535	0.0582	0.0631

Table 18 – Typical Application Flooding Factors – US Customary Units

Temp (t) (°C)[c]	Specific Vapor Volume (s) (m³/kg)[d]	Weight Requirements of Hazard Volume, W/V (kg/m³)[b] Design Concentration (% per Volume)[a]									
		6	7	8	9	10	11	12	13	14	15
–10	0.1215	0.5254	0.6196	0.7158	0.8142	0.9147	1.0174	1.1225	1.2301	1.3401	1.4527
–5	0.1241	0.5142	0.6064	0.7005	0.7987	0.8951	0.9957	1.0985	1.2038	1.3114	1.4216
0	0.1268	0.5034	0.5936	0.6858	0.7800	0.8763	0.9748	1.0755	1.1785	1.2839	1.3918
5	0.1294	0.4932	0.5816	0.6719	0.7642	0.8586	0.9550	1.0537	1.1546	1.2579	1.3636
10	0.1320	0.4834	0.5700	0.6585	0.7490	0.8414	0.9360	1.0327	1.1316	1.2328	1.3264
15	0.1347	0.4740	0.5589	0.6457	0.7344	0.8251	0.9178	1.0126	1.1096	1.2089	1.3105
20	0.1373	0.4650	0.5483	0.6335	0.7205	0.8094	0.9004	0.9934	1.0886	1.1859	1.2856
25	0.1399	0.4564	0.5382	0.6217	0.7071	0.7944	0.8837	0.9750	1.0684	1.1640	1.2618
30	0.1425	0.4481	0.5284	0.6104	0.6943	0.7800	0.8676	0.9573	1.0490	1.1428	1.2388
35	0.1450	0.4401	0.5190	0.5996	0.6819	0.7661	0.8522	0.9402	1.0303	1.1224	1.2168
40	0.1476	0.4324	0.5099	0.5891	0.6701	0.7528	0.8374	0.9230	1.0124	1.1029	1.1956
45	0.1502	0.4250	0.5012	0.5790	0.6586	0.7399	0.8230	0.9080	0.9950	1.0840	1.1751
50	0.1527	0.4180	0.4929	0.5694	0.6476	0.7276	0.8093	0.8929	0.9784	1.0660	1.1555
55	0.1553	0.4111	0.4847	0.5600	0.6369	0.7156	0.7960	0.8782	0.9623	1.0484	1.1365
60	0.1578	0.4045	0.4770	0.5510	0.6267	0.7041	0.7832	0.8641	0.9469	1.0316	1.1183
65	0.1604	0.3980	0.4694	0.5423	0.6167	0.6929	0.7707	0.8504	0.9318	1.0152	1.1005
70	0.1629	0.3919	0.4621	0.5338	0.6072	0.6821	0.7588	0.8371	0.9173	0.9994	1.0834
75	0.1654	0.3859	0.4550	0.5257	0.5979	0.6717	0.7471	0.8243	0.9033	0.9841	1.0668
80	0.1679	0.3801	0.4482	0.5178	0.5890	0.6617	0.7360	0.8120	0.8898	0.9694	1.0509
85	0.1704	0.3745	0.4416	0.5102	0.5803	0.6519	0.7251	0.8000	0.8767	0.9551	1.0354
90	0.1730	0.3690	0.4351	0.5027	0.5717	0.6423	0.7145	0.7883	0.8638	0.9411	1.0202

Table 19 – Typical Application Flooding Factors – SI Units

3.3.5 Agent Calculation

The minimum required amount of agent can be calculated from either of the following formulas:

$$W = V * C.F. * F.F.$$

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

For US Customary Units:
W = weight of agent (lb.)
V = volume of enclosure to be protected (ft^3)
F.F. = flooding factor (see Table 18 or 19)
C.F. = atmospheric correction factor (see Table 17)
s = specific volume of superheated HFC-227ea vapor (ft^3/lb.)
This can be approximated by the formula:

$$s = 1.885 + 0.0046*t$$

t = design temperature in the hazard area (°F)
C = concentration of agent required (%)

NOTE: The agent required is always rounded up to the nearest whole pound when determining agent fill in US Customary Units.

For SI Units:
W = weight of agent (kg)
V = volume of enclosure to be protected (m^3)
F.F. = flooding factor (see Table 18 or 19)
C.F. = atmospheric correction factor (see Table 17)
s = specific volume of superheated HFC-227ea vapor (m^3/kg)
This can be approximated by the formula:

$$s = 0.1269 + 0.0005*t$$

t = design temperature in the hazard area (°C)
C = concentration of agent required (%)

NOTE: The agent required is always rounded up to the nearest half kilogram when determining agent fill in SI Units.

NOTE: Care must be taken that the calculated concentration for normally occupied spaces at the highest expected ambient temperature in the space does not exceed 10% V/V, per NFPA 2001.

NOTE: This calculation includes an allowance for the normal leakage from a "tight" enclosure due to agent expansion.

3.4 Design Parameters

The flow of HFC-227EA through the discharge piping is a complex two-phase flow. The Firetrace HFC-227EA Engineered Systems have been investigated and comply with UL test standards for clean agents. NFPA 2001 compliance, or other international codes where applicable, shall be followed by the system designer. The flow calculation software and design parameters are intended to insure proper application for "balanced" and "unbalanced" systems.

For unbalanced systems, one or more of the following conditions apply:

1. Unequal flow rates at one or more nozzles.
2. Unequal orifice areas in multiple nozzle systems.
3. Unequal pipe sizes and/or lengths of branch legs.
4. Odd number of nozzles.
5. Both bullhead tees and side/thru tee applications are used.

The hydraulic flow calculation program will select the pipe sizes for each section in the piping network based on the HFC-227EA flow rate for each section. However, if so desired, pipe sizes can be manually input into the program.

The verification of flow testing was conducted at 500 psi and 70 °F ± 10 °F, using the specified piping and fittings available within the manual. If storage temperature is outside the ± 10 °F temperature range and the piping and fittings are varied from the specified piping, there is a risk that the system may not supply the designed quantity of extinguishing agent.

Duration of Discharge	10 sec maximum 6 sec minimum
Agent to Pipe Volume	82.1%
Limit of Agent Before First Tee	9.3%
Minimum Orifice Area to Pipe Ratio	10% [½ in nozzles] or 20% [all others]
Maximum Orifice Area to Pipe Ratio	81.3%
Minimum Nozzle Pressure	68 psig [4.7 bar]
Maximum Arrival Time Imbalance	1.02 sec
Maximum Run-out Time Imbalance	2.16 sec

Table 20 – Design Limitations

*** NOTE: The maximum difference in transport time limitation has been found as an acceptable means of evaluating maximum allowable nozzle arrival and runout imbalances.**

3.4.1 Pipe Limitations

The table below provides an indication of flow rate through a range of pipe sizes. A flow calculation shall be performed to confirm both pipe sizing and feasibility of the piping network.

NPT Pipe Size (Nominal), [in]	Flow Rate Range		Pipe Type
	[lbm/sec]	[kg/sec]	
½	0.7 - 3.4	0.32 - 1.54	SCH 40
¾	2.0 - 5.8	0.90 - 2.63	SCH 40
1	3.4 - 8.4	1.54 - 3.81	SCH 40
1 ¼	5.8 - 13.0	2.63 - 5.90	SCH 40
1 ½	8.4 - 19.5	3.81 - 8.85	SCH 40
2	13.0 - 33.0	5.89 - 14.97	SCH 40
2 ½	19.5 - 58.0	8.85 - 26.31	SCH 40
3	33.0 - 95.0	14.96 - 43.09	SCH 40
4	58.0 - 127.0	26.30 - 57.61	SCH 40
5	95.0 - 222.0	43.09 - 100.70	SCH 40
6	127.0 - 317.8	57.60 - 144.15	SCH 40

Table 21 – Minimum and Maximum Flow Rate Guidelines

3.4.2 Tee Limitations

To obtain the most economical piping for a given hazard layout, tees are employed to branch the HFC-227EA flow to the various locations within the hazard or multiple hazards. The exit branches of the tees must be in the horizontal plane. The maximum and minimum percent imbalances permitted are shown below in Table 22.

Description	Limitation, [%]	Figure
Maximum Bullhead Tee Imbalance	30/70	Figure 21
Minimum Bullhead Tee Imbalance	50/50	Figure 22
Maximum Side Tee Imbalance	35/65	Figure 23
Minimum Side Tee Imbalance	10/90	Figure 24
Bullhead tees shall have both outlets in the same horizontal plane		Figure 25
Side tee splits shall have the inlet and both outlets in the same horizontal plane		Figure 26
Minimum distance of elbow before tee splits	10 nom pipe diameter	Not Shown
Minimum distance between tee splits	10 nom pipe diameter	Not Shown

Table 22 – Tee Limitations

***When using a Side T, the strait through path is always the path always has the highest flow.**

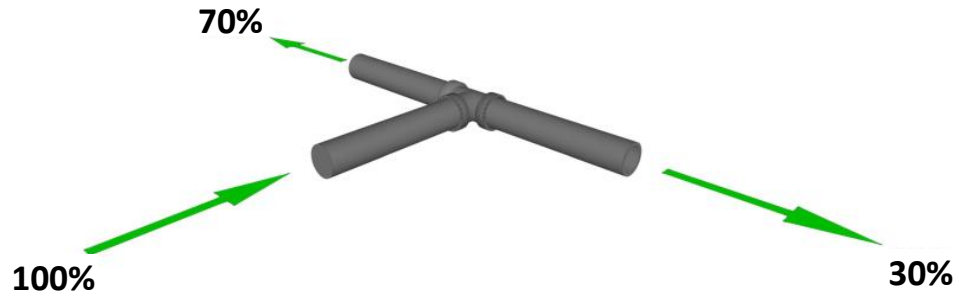


Figure 21 – Maximum Bull Tee Imbalance

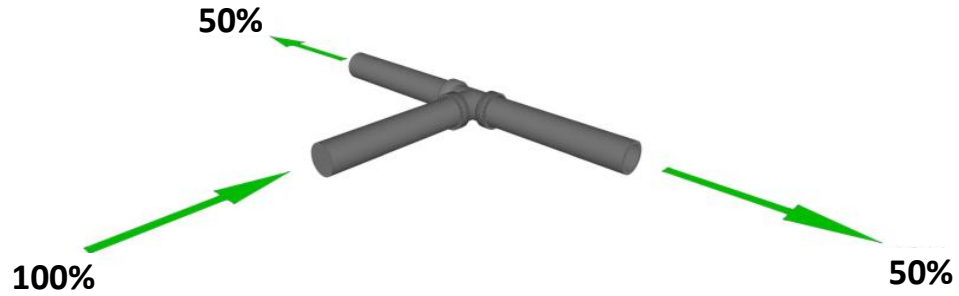


Figure 22 – Minimum Bull Tee Imbalance

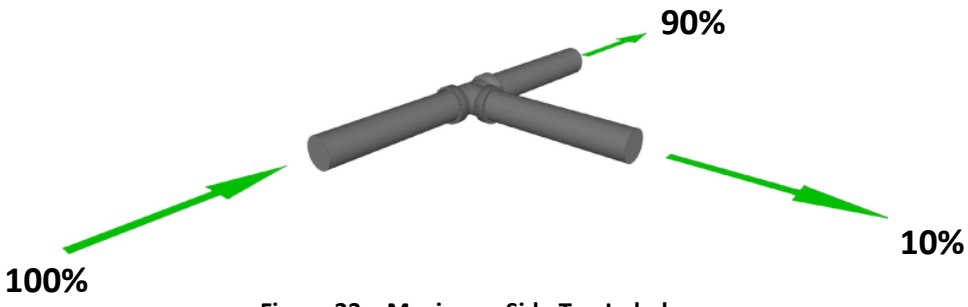


Figure 23 – Maximum Side Tee Imbalance

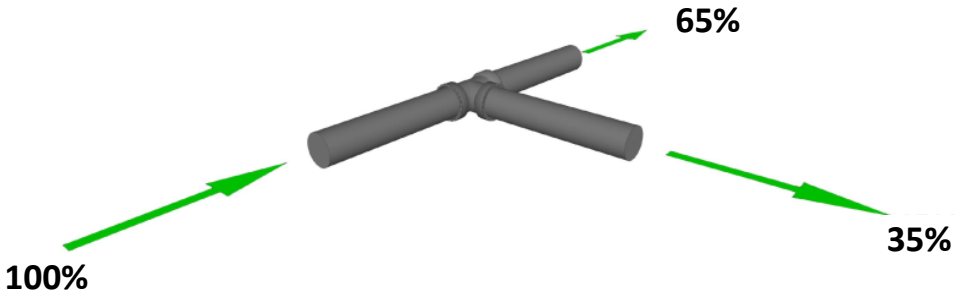


Figure 24 – Minimum Side Tee Imbalance

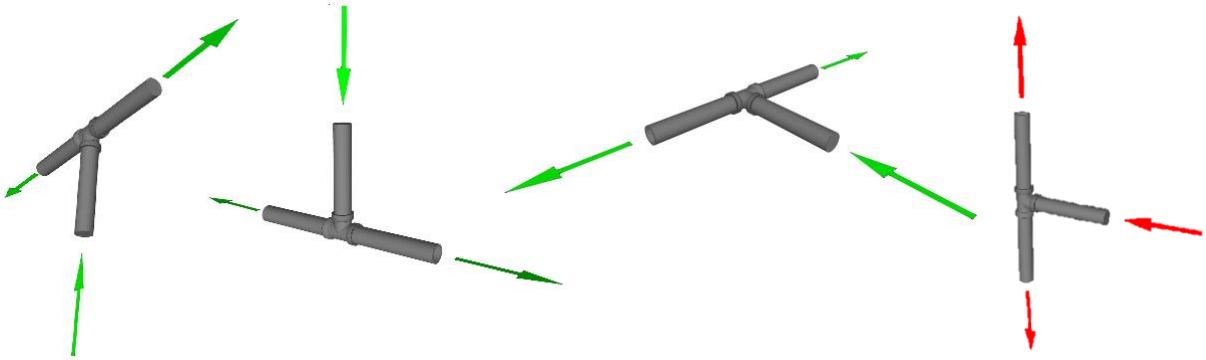


Figure 25 – Bull Tee Configurations

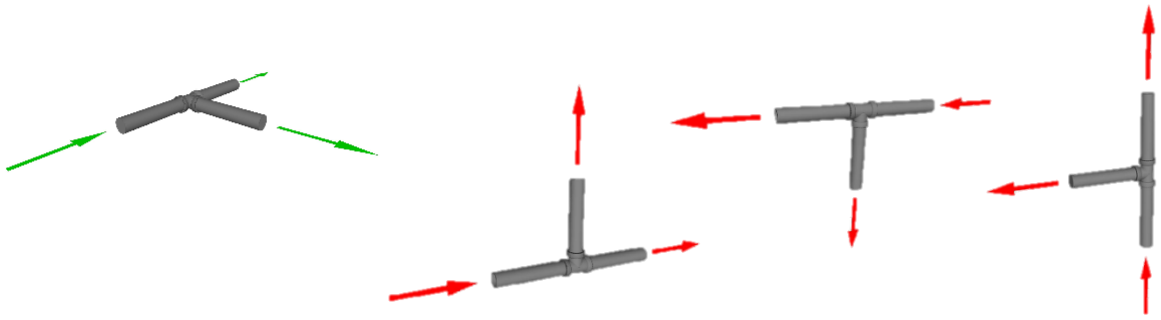


Figure 26 – Side Tee Configurations

3.5 Storage Cylinders

The following are configurations for cylinder use in the engineered design method:

1) Single hazard with one cylinder and its piping and nozzle system.
2) Single hazard with multiple cylinders, each with their own piping and nozzle system.
3) Single hazard with multiple cylinders discharging through a common piping and nozzle system.
4) Multiple hazards with one cylinder discharging through its piping and nozzle system.
5) Multiple hazards with multiple cylinders discharging through a common piping and nozzle system.

3.5.1 Manifolding

When required by hazard size, a manifold may be used to connect multiple cylinders together to feed the common piping network. Details of these configurations are as follows.

NOTE: When designing systems connected to a common pipe network, all connected cylinders must be of the same size and fill density.

NOTE: If the hazard requires an even number of cylinders, a center outlet manifold can be used. If the hazard requires an odd number of cylinders, an end outlet type of manifold is required.

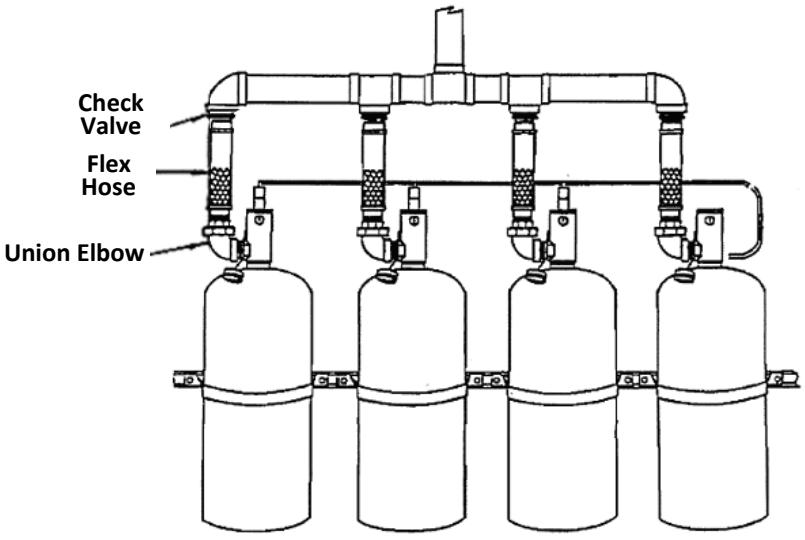


Figure 27- Typical Center Outlet Manifold

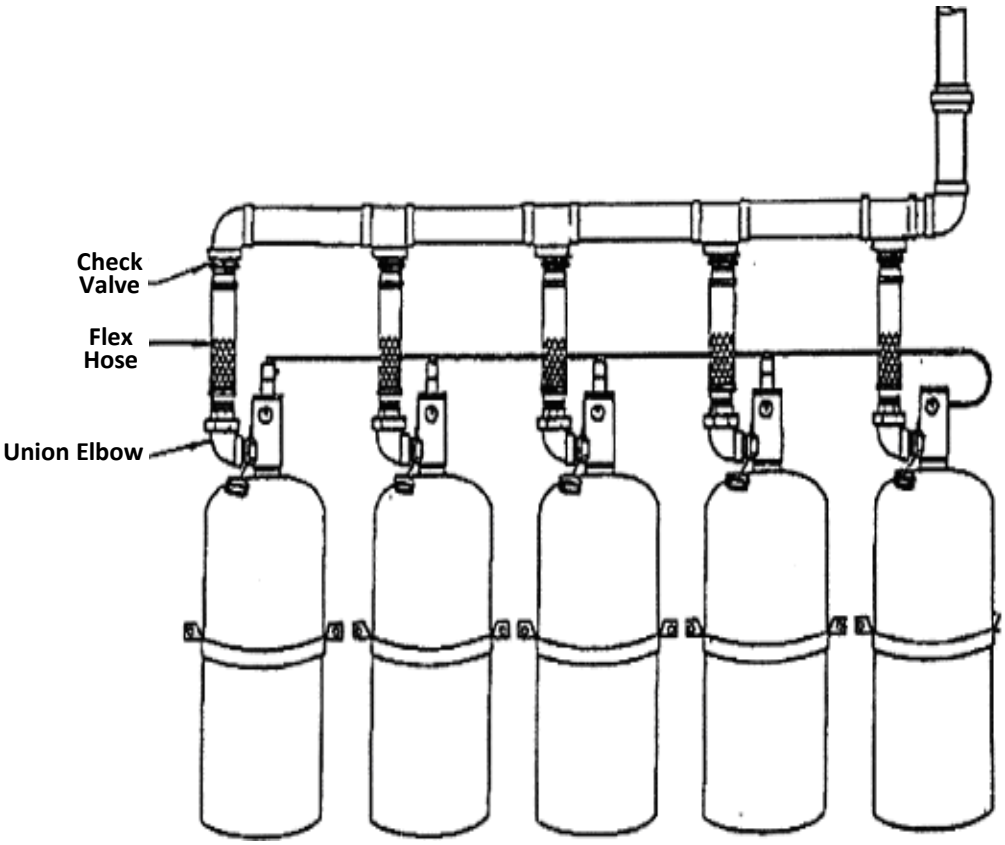


Figure 28- Typical End Outlet Manifold

3.6 Nozzle Coverage

3.6.1 Area

Nozzles shall be installed vertically upright or vertically down (pendant) with the outlet path of the nozzles projected perpendicular to the walls of the enclosure.

The 360° central nozzle shall be installed centrally in the hazard where possible, see Figure 29. The maximum linear coverage shall not exceed 28 ft. 3-5/16 in [8.62 m].

When installing the 180° type nozzle, the outlet ports are to be oriented directly opposite the wall on which the nozzle is being installed. A single 180° sidewall nozzle shall be installed adjacent to a wall, see Figure 29

Two 180° nozzles may be installed centrally in the hazard in a "back-to-back" orientation, providing a larger area of coverage, see Figure 30. The Linear throw from the nozzle to any one point in the hazard shall not exceed 44 ft. 8-11/16 in [13.63 m] for a single nozzle.

NOTE: Maximum coverage area may not exceed 1600 sq. ft. per nozzle

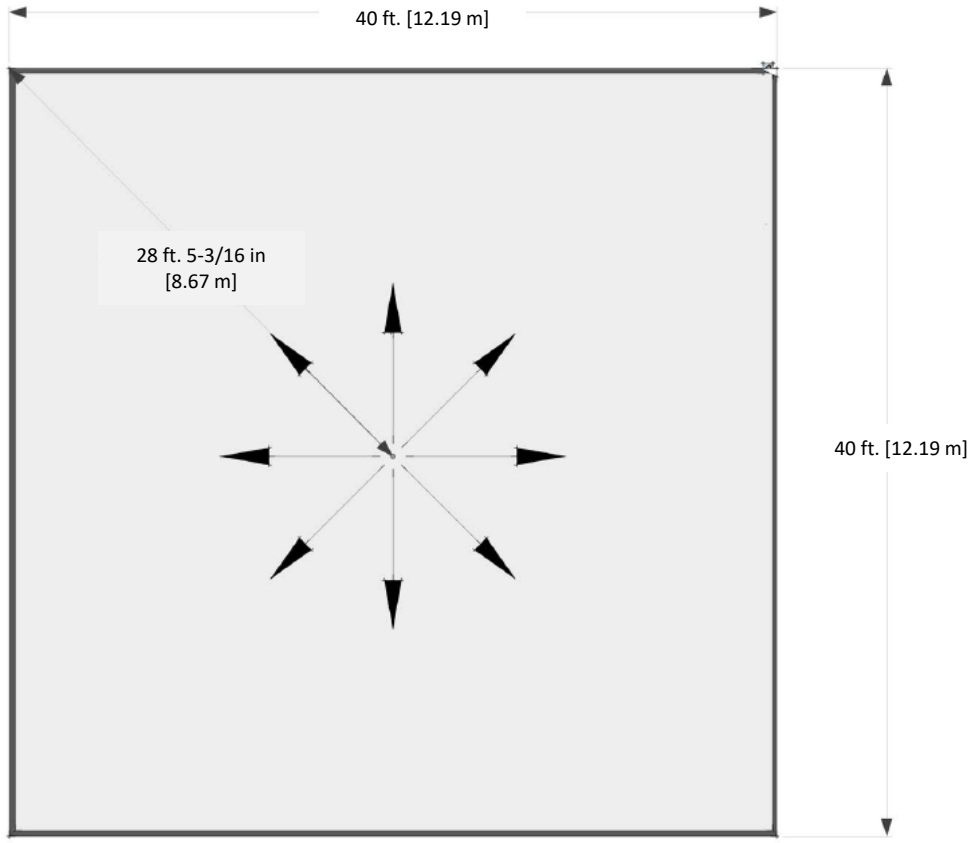


Figure 29- 360° Central Nozzle Coverage

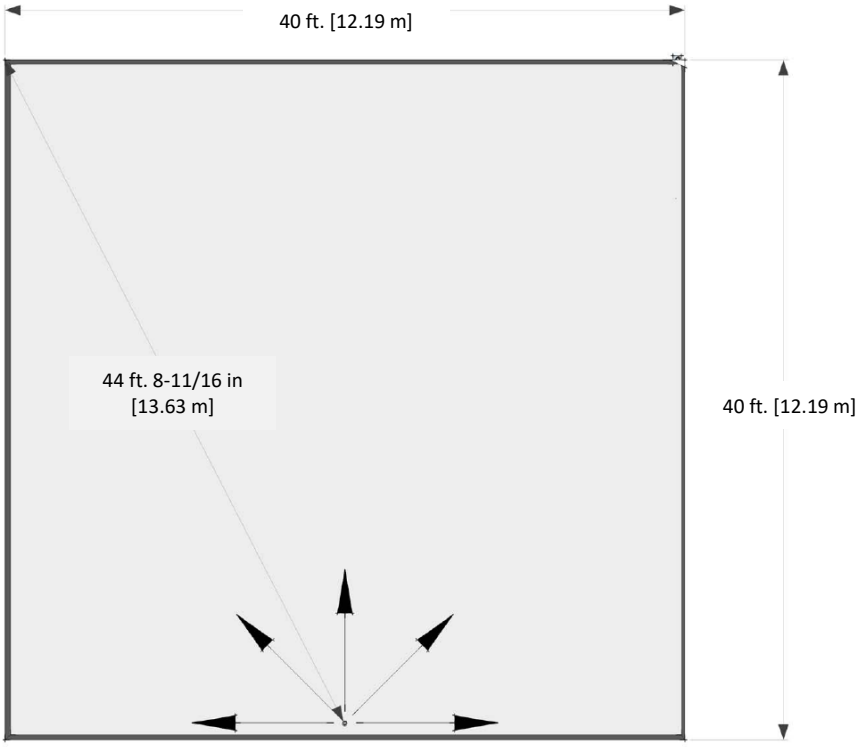


Figure 29 – 180° Single Sidewall Nozzle Coverage

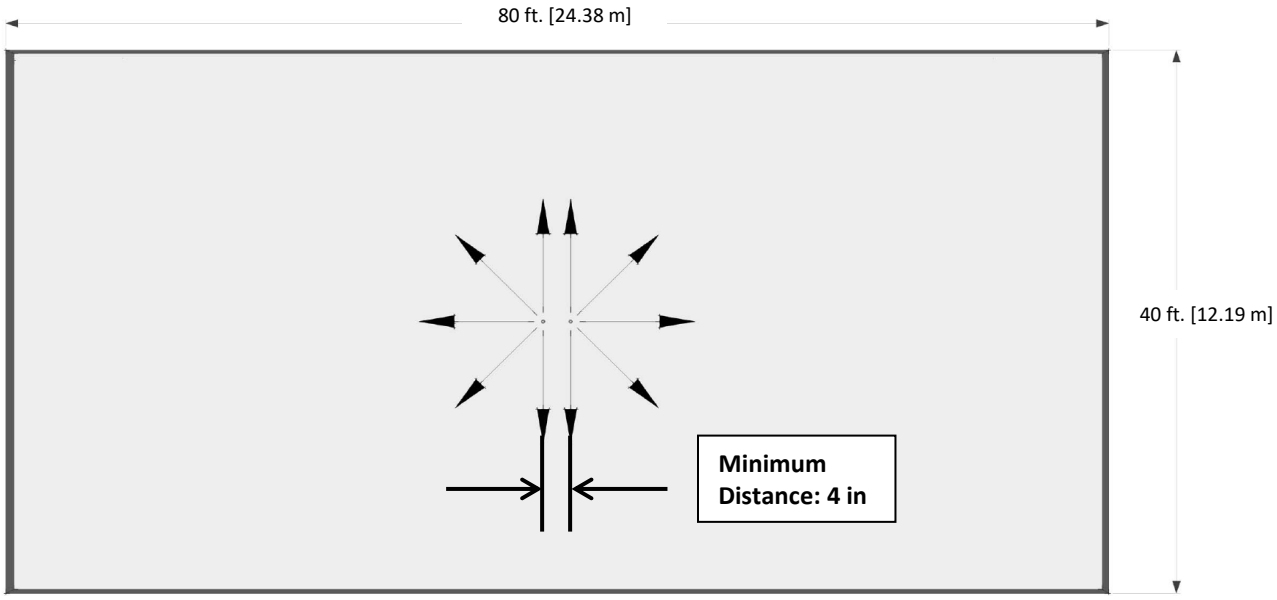


Figure 30 – Back to Back Dual Sidewall Nozzle Coverage

3.6.2 Height

Nozzles shall be installed 2 to 12 inches down from the top of the hazard when referenced from the ceiling. When referencing the wall to the nozzle, the range of installation is from 0 to 12 inches from the wall to the center of the nozzle, see Figure 30 for illustration.

All nozzles are rated for a maximum hazard height of 16 ft. [4.88 m], see Figure 31 and 32 for examples. If the hazard exceeds 16 ft. [4.88 m] in height, multiple tiers of nozzles must be used for each 16 ft. [4.88 m] increment of enclosure of height, see Figure 33 for an example.

Listed below are the elevation difference limitations for the system design, these are also illustrated in Figure 34

1) If nozzles are only located above the container outlet, the maximum elevation difference between the container outlet and the farthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 30 ft. [9.14 m].
2) If nozzles are only located below the container outlet, the maximum elevation difference between the container outlet and the farthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 30 ft. [9.14 m].
3) If nozzles are located above and below the container outlet, the maximum elevation difference between the farthest horizontal pipe runs or nozzles (whichever is furthest) shall not exceed 30 ft. [9.14 m].

The minimum hazard height at maximum nozzle spacing is 1 ft. [0.30 m]. For hazard heights less than 1 ft. [0.30 m], nozzle quantity and spacing density must be increased. Contact Firetrace for additional guidance.

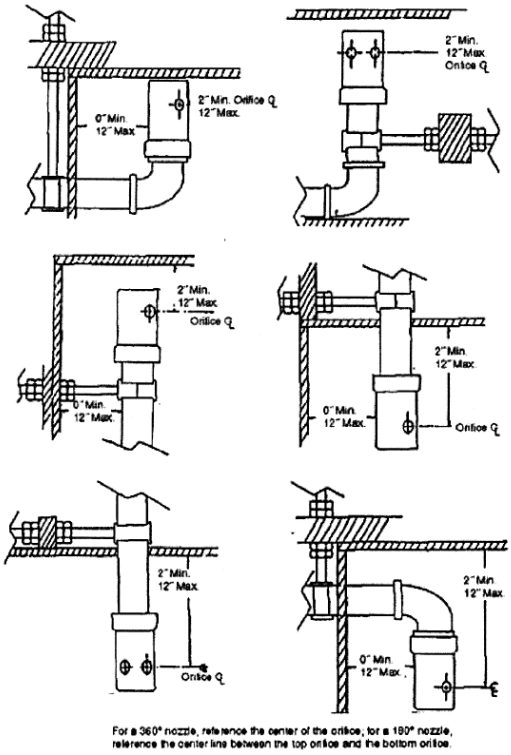


Figure 30 – Nozzle Installation Limitations

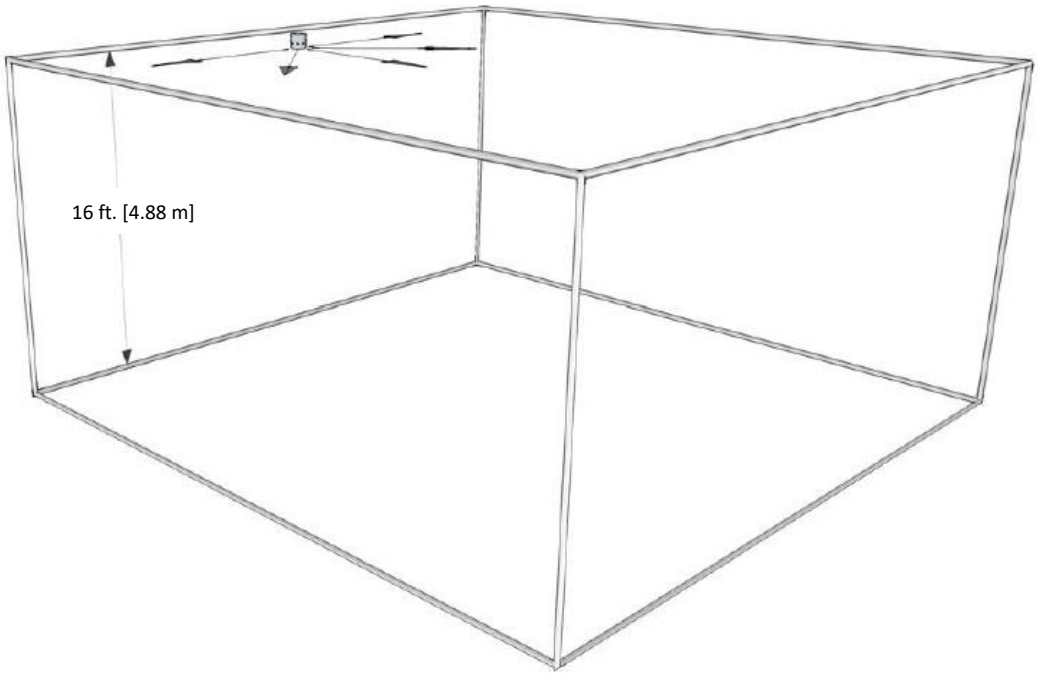


Figure 31 – Single Sidewall Nozzle Height Limit

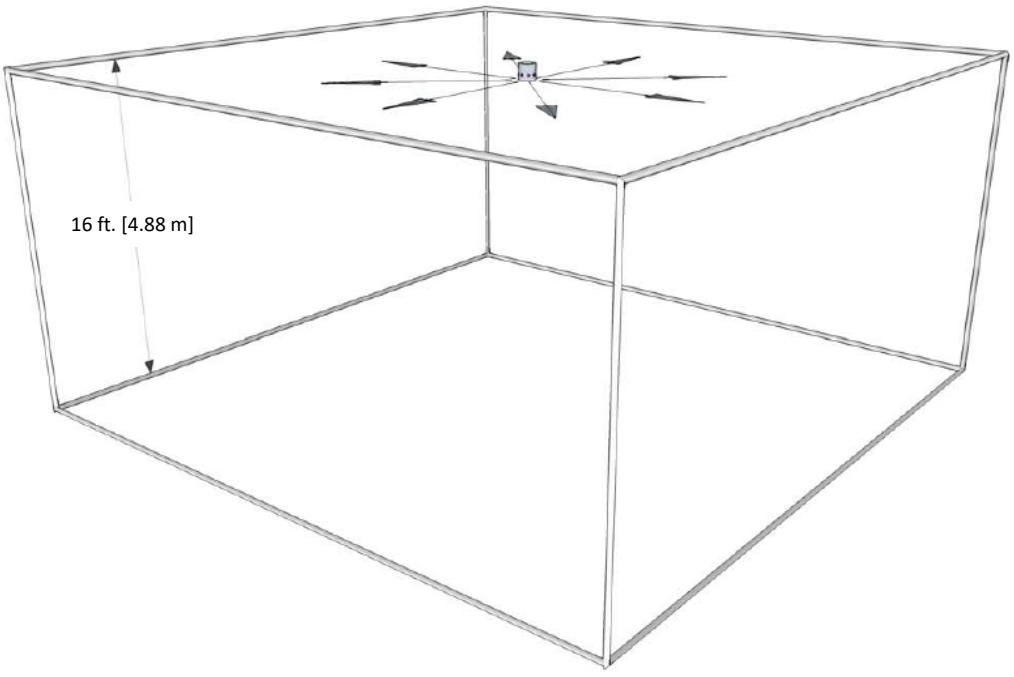


Figure 32 – Single Central Nozzle Height Limit

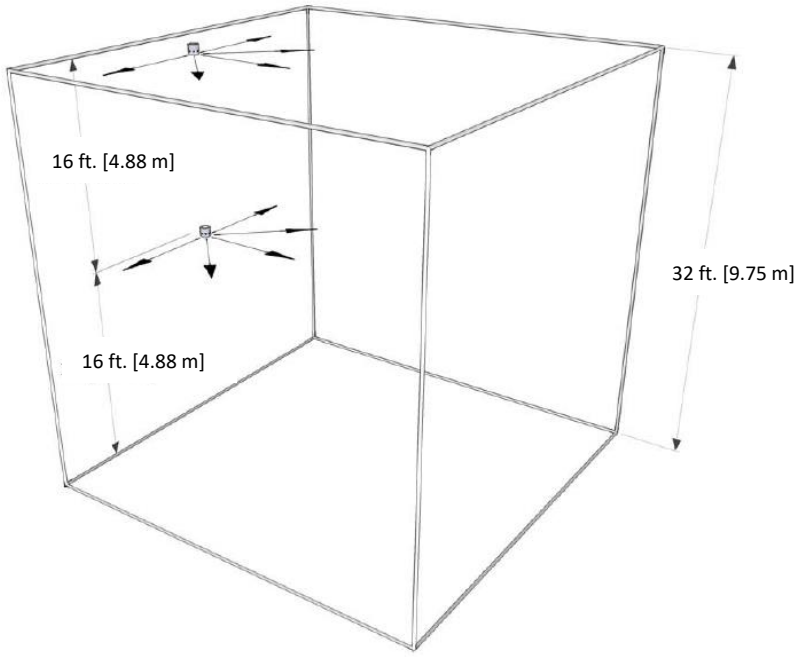


Figure 33 – Tiered Nozzle Example

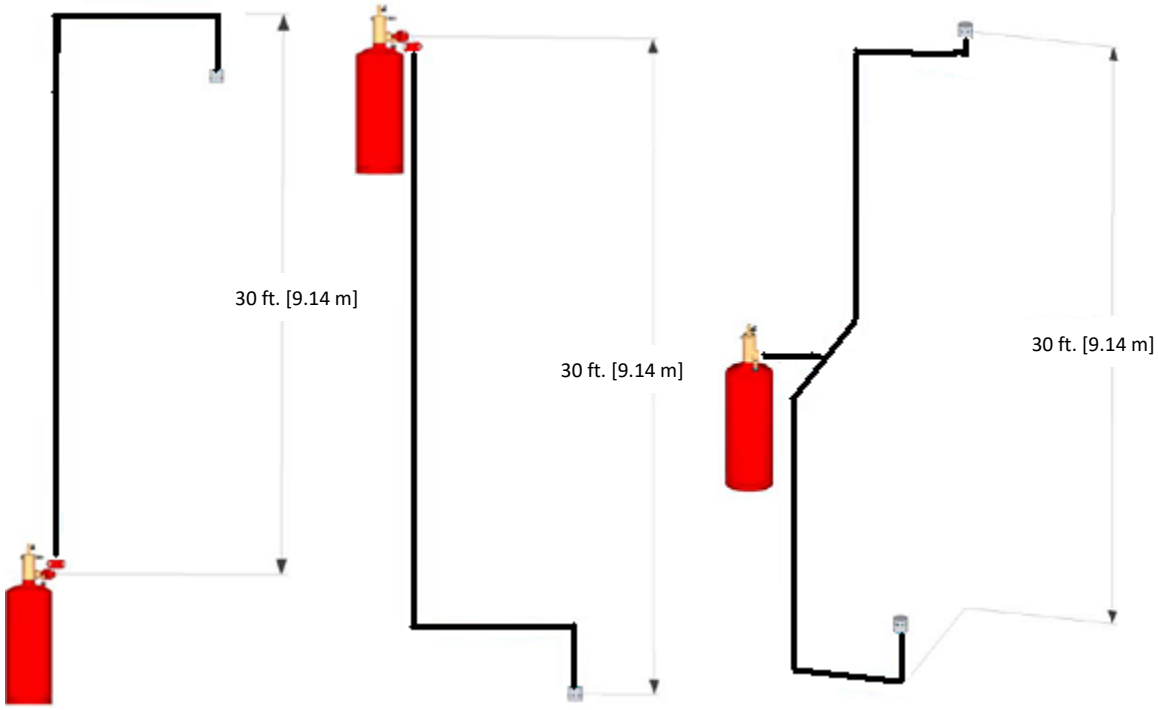


Figure 34- Nozzle Elevation Difference

3.6.3 Equivalent Length Data

Table 23 – Equivalent Length Assemblies

Nominal Size	Valve and Siphon Tube		Discharge Flex Hose		Check Valve		Shuttle Valve	
	ft	m	ft	m	ft	m	ft	m
1 in (35 lb)	16.5	5.0	7.0	2.1	5.2	1.6	8.1	2.5
1 in (70 lb)	17.5	5.3	7.0	2.1	5.2	1.6	8.1	2.5
1 ½ in	28.3	8.6	7.6	2.3	37.7	11.5	12.3	3.7
2 ½ in	30.8	9.4	11.6	3.5	20.4	6.2	N/A	
4 in	75.0	22.9	10.0	3.0	40.5	12.3	N/A	

3.7 Example Calculation

An example calculation is contained below.

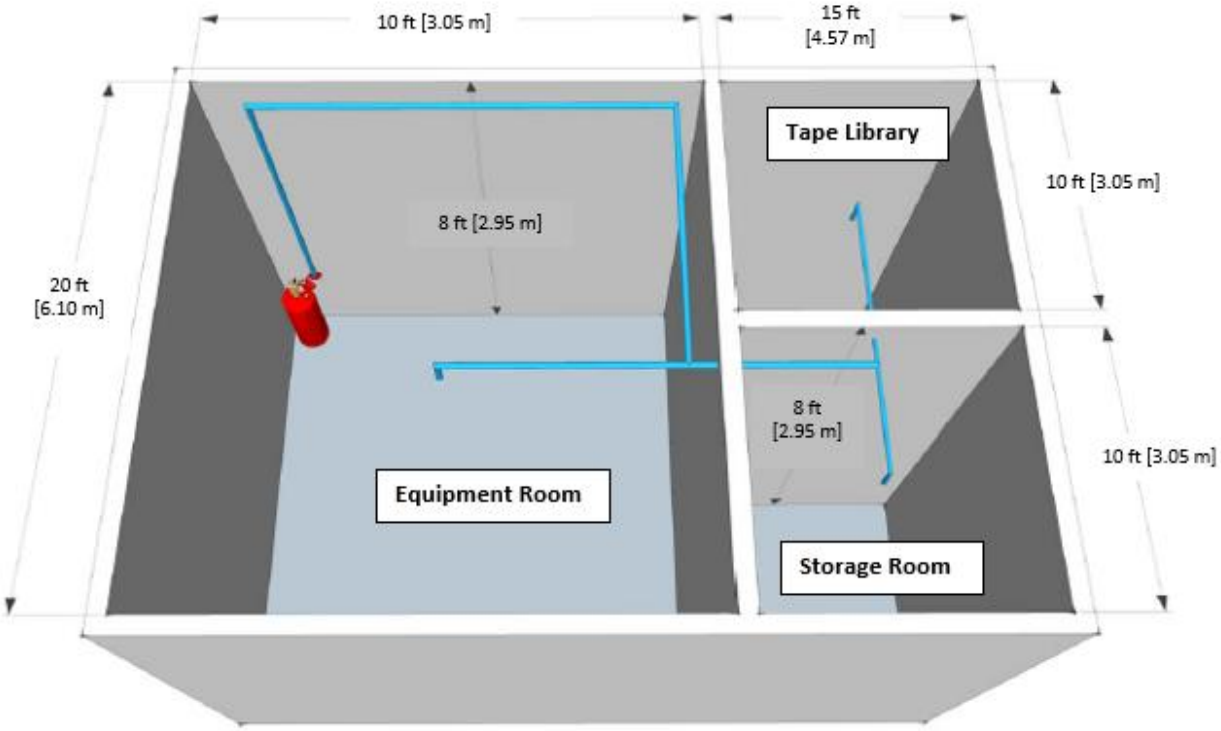


Figure 35- Sample Calculation Layout

Scope of Protection

Three volumes require protection:

1. Equipment Room: 10 ft. x 20 ft. x 8 ft. (L x W X H)
2. Tape Library: 15 ft. x 10 ft. x 8 ft. (L x W x H)
3. Storage Room: 15 ft. x 10 ft. x 8 ft. (L x W x H)

Concentration specified, by the requirements of the end user are 6.7% for Class A Hazard.
Minimum ambient temperature: 70 °F [21 °C]
Application Elevation: <1,000 ft. [<0.30 km]

Agent Calculation

Equipment Room:
Area (A):
$A = L \times W$
$A = 10 \text{ ft.} \times 20 \text{ ft.} = 200 \text{ ft}^2$
$A = 3.05 \text{ m} \times 6.10 \text{ m} = 18.61 \text{ m}^2$

Volume (V):

$V = H \times A$
$V = 8$ ft. $\times$ 200 ft^2 = 1,600 ft^3
$V = 2.44$ m $\times$ 18.61m^2 = 45.41 m^3

Minimum Required Agent Amount (W):
$W = V \times F.F.$
$W = 1{,}600$ ft^3 $\times$ .03254 lb./ft^3 = 52.064 lb. or 53 lb. after rounding
$W = 45.41$ m^3 x 0.5233 kg/m^3 = 23.763 kg or 24 kg after rounding

Tape Library:
Area (A):
$A = L \times W$
$A = 15$ ft. $\times$ 10 ft. = 150 ft^2
$A = 4.57$ m x 3.05 m = 13.94 m^2

Volume (V):
$V = H \times A$
$V = 8$ ft. $\times$ 150 ft^2 = 1,200 ft^3
V= 2.44 m x 13.94 m^2 = 34.01 m^3

Minimum Required Agent Amount (W):
$W = V \times F.F.$
$W = 1{,}200$ ft^3 $\times$ 0.03254 lb./ft^3 = 39.04 lb. or 40 lb. after rounding
$W = 34.01$ m^3 x 0.5233 kg/m^3 = 17.79 kg or 18 kg after rounding

Storage Room:
Area (A):
$A = L \times W$
$A = 8$ ft. $\times$ 10 ft. = 80 ft^2
$A = 2.95$ m x 3.05 m = 9 m^2

Volume (V):
$V = H \times A$
$V = 8$ ft. $\times$ 150 ft^2 = 640 ft^3
V= 2.44 m x 13.94 m^2 = 21.96 m^3

Minimum Required Agent Amount (W):
$W = V \times F.F.$
$W = 640$ ft^3 $\times$ .03254 lb./ft^3 = 20.82 lb. or 21 lb. after rounding
$W = 21.96$ m^3 x 0.5233 kg/m^3 = 11.49 kg. or 11.5 kg. after rounding

Total Agent Quantity

	Agent Amount [lb.]	Agent Amount [kg]
Equipment Room	53	24
Tape Library	40	18
Storage Room	21	11.5
Total	**114**	**53.5**

Table 24 – Total Amount of Agent Required

3.7.1 Cylinder Selection

Referring to Table 4, the following system assembly should be selected:

Assembly Number : FTF000062
Nominal Size : 160 lb. [62 L]
Minimum Fill Weight : 33 lb. [15.0 kg]
Maximum Fill Weight : 164 lb. [74.0 kg]

3.7.2 Software Output Example

Please refer to Appendix A – Flow Calculation Example.

Section 4: Operation and Maintenance

4.1 Component Verification

WARNING:
Electrically operated control devices that are not supervised, are not to be removed during the installation and/or servicing of the system.

4.1.1 Electric Linear Actuator FTF500125

WARNING:
Prior to any functional tests, supervised electrically operated releasing devices must be electrically disabled to prevent cylinder discharge during inspection and/or maintenance.

The Electric Linear Actuator can be tested with the following procedure:

1) Disconnect the supervisory leads from the control panel.
2) Remove the Electric Linear Actuator from the Top Plug Actuation Adapter.
3) Reconnect the supervisory leads to the control panel.
4) Energize the Electric Linear Actuator by cycling the control panel. The Electric Linear Actuator pin will move downward.
5) De-energize the Electric Linear Actuator and disconnect the supervisory leads from the control panel.
6) Manually push the pin to the top of the Electric Linear Actuator assembly.
7) Once the pin is reset, return the Electric Linear Actuator to the Top Plug Actuation Adapter.
8) Reconnect the supervisory leads to the control panel.

CAUTION:
Do not return the Electric Linear Actuator to the Top Plug Actuation Adapter without resetting the pin.
If you do not reset the pin, the valve will discharge.

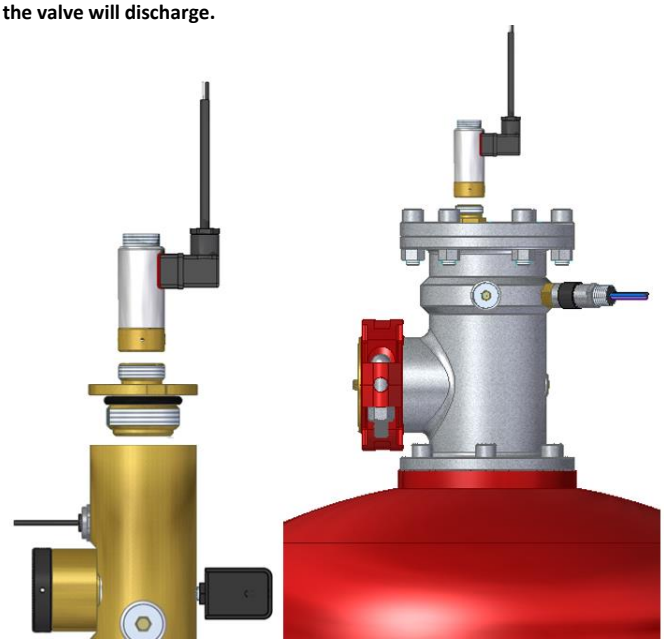


Figure 36- Electronic Linear Actuator Layout

4.1.2 Manual Override FTF500126

The Manual Override can be tested with the following procedure:

1) Remove the Manual Override from the top of the Electric Linear Actuator.
2) Remove the safety pull pin.
3) Operate the push-button and observe that the internal pin fully travels downward.

4) Reset the Manual Override push-button. Push the internal pin firmly to the top of the assembly.
5) Return the safety pull pin to the assembly.
6) Return the Manual Override to the top of the Electric Linear Actuator.

CAUTION:
Do not return the Manual Override to the top of the Electric Linear Actuator without resetting the internal pin.
If you do not reset the pin, the valve will discharge.

CAUTION:
Ensure the safety pull pin is correctly installed and secured in the Manual Override assembly until the system is to be activated by use of the device.

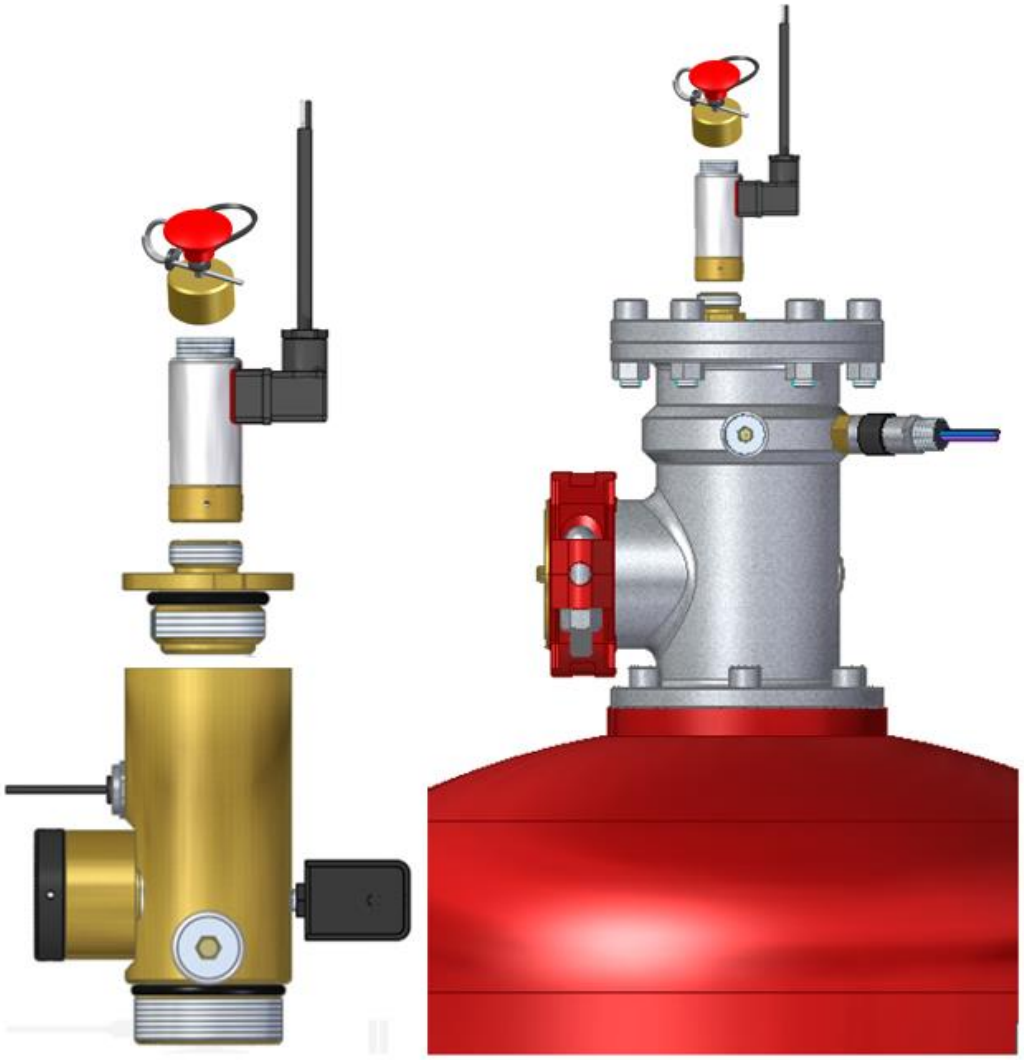


Figure 39- Stacked Electronic Linear Actuator and Manual Override

4.1.3 Pneumatic Actuator FTF700041

The Pneumatic Actuator can be tested with the following procedure:

1) Detach ¼ inch flex hose or actuation tubing from the top of the Pneumatic Actuator.
2) Remove the Pneumatic Actuator from the Top Plug Actuation Adapter.
3) Attach a regulated nitrogen source to the top of the Pneumatic Actuator.

4) Apply 20 – 25 psig pressure to the top of the Pneumatic Actuator. The piston rod must travel a full stroke, becoming locked into place.
5) Relieve pressure from the top of the Pneumatic Actuator.
6) Reset the internal piston of the Pneumatic Actuator. Push the internal piston firmly to the top of the assembly.
7) Return the Pneumatic Actuator to the Top Plug Actuation Adapter.
8) Attach the ¼ inch flex hose or actuation tubing to the top of the Pneumatic Actuator.

CAUTION:
Do not return the Pneumatic Actuator to the Top Plug Actuation Adapter without resetting the internal piston

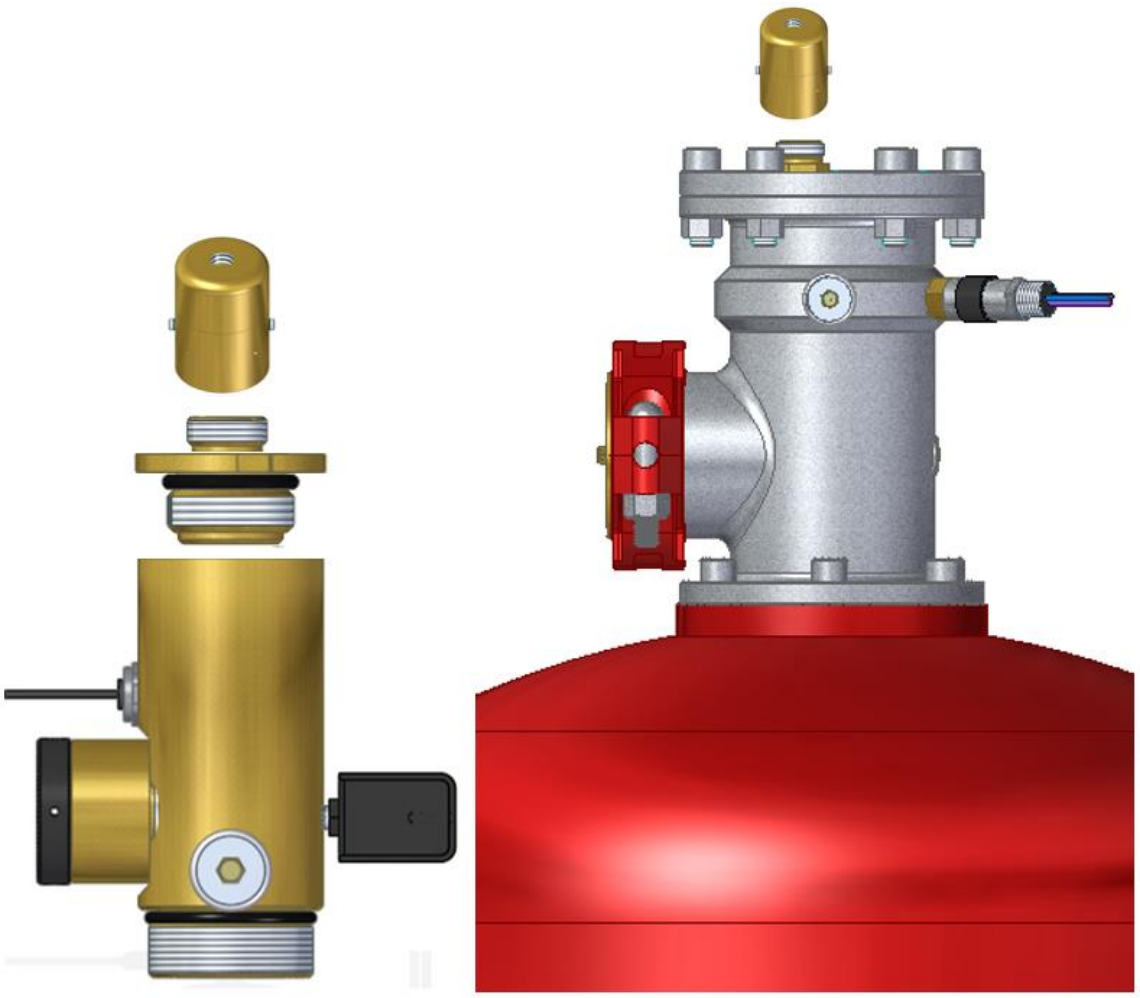


Figure 37- Pneumatically Operated Cylinder Assembly

4.1.4 Liquid Level Indicator operation

Level readout is obtained by simply removing the protective cap and pulling out the calibrated tape until magnetic interlock with the float is felt. With the tape in this position, the reading is obtained at the point where the tape emerges from the unit housing. With the graph (one per cylinder size) the tape reading is converted to pounds of clean agent in the cylinder. Graph data is for conditions at 0 °F [-17.7 °C], 70 °F [21 °C], and 130 °F [54.4 °C]. Tolerance is ± 2% of cylinder fill weight. From the reading in inches Y axis, trace to the intercept line and drop down to the X axis for the read indication of agent fill in the cylinder.

4.2 Inspection Schedule

Only Firetrace qualified HFC-227EA recharge personnel shall inspect cylinder, valve, and controls for operability or damage.

4.2.1 Weekly

The following are to be performed on a weekly basis by the owner or designated personnel:

1) Check pressure gauge on cylinder valve(s). If the pressure is 10% below the pressure required for the temperature of the cylinder at time of inspection, the cylinder must be serviced by an authorized Firetrace distributor.
2) Check for physical damage or missing parts of the HFC-227EA system hardware.
3) Check that the discharge nozzles are properly oriented and secured.
4) Check for obstructions that would interfere with nozzle discharge pattern or mechanical operation of the system.
5) Check that all tamper seals are intact and properly secured.

4.2.2 Semi-Annual

The semi-annual maintenance is to be performed by an authorized Firetrace distributor:

1) Repeat weekly inspection.
2) Check agent quantity and pressure of refillable containers. If a container shows a loss in net weight of more than 5% or a loss in pressure (adjusted for temperature) of more than 10%, it shall be refilled or replaced.
3) Perform functional test of all component parts of the entire system. Follow instructions provided in Section4.1: Component Verification.

NOTE: Inspection of the 38 lb. [15 L] and 75 lb. [29 L] units must include being weighed. The 160 lb. [62 L], 270 lb. [103 L], 400 lb. [153 L], 600 lb. [227 L], 950 lb. [368 L] and the 1,300 lb. [490 L] units can be inspected using the Liquid Level Indicator or by being weighed.

NOTE: This system consists of components tested within limitations contained in this manual. The designer of this system must be consulted prior to any planned changes to either the system or the area being protected. An authorized Firetrace distributor must be consulted after the system has discharged.

Section 5: Post Discharge

5.1 Enter the Protected Enclosure

In the event of a discharge or fire, trained first responders must provide clearance of the enclosure to ensure it has been be properly vented to remove any residual suppressant and Thermal Decomposition Products. HFC-227EA does not leave a residue, thus, there are no clean-up operations resulting from an HFC-227EA discharge. An authorized Firetrace distributor must be consulted after the system has discharged to service the system. The cylinder must be removed from the bracket to be recharged with HFC-227EA and re-pressurized with dry nitrogen.

5.2 Remove from Service

The subsequent steps should be followed when removing a system from service:

1) Disconnect power source from all actuation and monitoring devices
2) Remove cylinder piping from cylinder valves.
3) Attach Anti-Recoil Device on all cylinder valve outlets.
4) Disconnect all cylinder assembly electronic devices
5) Loosen cylinder bracketing and remove cylinders.
6) Secure until a qualified Firetrace technician can remove the system for service.
7) Have cylinders recharged by a qualified Firetrace HFC-227EA recharge facility.
8) Replace all parts as necessary. Check nozzles for any damage, misalignment, or foreign matter. After system discharges through a check valve, functionally test the check valve for free movement.

5.3 Return to Service

The subsequent steps should be followed when returning a system to service:

1) Replace cylinder(s) in bracket(s) and secure brackets.
2) Remove Anti-Recoil Device from all cylinder valve outlets.
3) Reconnect discharge piping.
4) Reset control panel.
5) Re-install all cylinder valve controls, follow instructions given in Section 4: Operation and Maintenance.

Section 6: Parts Lists

6.1 Base HFC-227EA Cylinder and Valve Assemblies

Part Number	Description
FTF000035	35 lb. [15 L] Cylinder / 1 in [25 mm] Valve Assembly
FTF000070	70 lb. [29 L] Cylinder / 1 in [25 mm] Valve Assembly
FTF000150	150 lb. [62 L] Cylinder / 1 ½ in [40 mm] Valve Assembly
FTF000250	250 lb. [103 L] Cylinder / 1 ½ in [40 mm] Valve Assembly
FTF000375	375 lb. [153 L] Cylinder / 2 ½ in [65 mm] Valve Assembly
FTF000560	560 lb. [227 L] Cylinder / 2 ½ in [65 mm] Valve Assembly
FTF000900	900 lb. [368L] Cylinder / 2 ½ in [65 mm] Valve Assembly
FTF001200	1,200 lb. [490 L] Cylinder / 4 in [100 mm] Valve Assembly

Table 25 – Base System Assemblies

6.2 Cylinder Valve Controls and Monitoring Devices

Part Number	Description
FTF500125	Electric Linear Actuator with Monitoring Switch (24 VDC)
FTF500126	Manual Override for Electric Linear Actuator
FTF502001	Main/Reserve Switch
FTF503007	Pressure Supervisory Switch, 300 psig
FTF503013	Pressure Operated Switch
FTF700041	Pneumatic Actuator, Next Gen

Table 26 – System Releasing and Monitoring Devices

6.3 Engineered Nozzles

See Section 2.1.3 for Nozzle Part Numbers and Drill Sizing

6.4 System Accessories

Part Number	Description
FTF700024	Flex Hose, Actuation, 24 in
FTF700025	Flex Hose, Actuation, 36 in
FTF700004	Flex Hose, Actuation, 48 in
FTF701004	Flex Hose, Discharge, 1 in
FTF701504	Flex Hose, Discharge, 1 ½ in
FTF702502	Flex Hose, Discharge, 2 ½
FTF704001	Flex Hose, Discharge, 4 in
FTF701001	1 in [25 mm] Check Valve
FTF701501	1 ½ in [40 mm] Check Valve
FTF702501	2 ½ in [65 mm] Check Valve
FTF704003	4 in [100 mm] Check Valve
FTF720150	Liquid Level Indicator – 150 lb. [62 L] and 250 lb. [103 L]
FTF720375	Liquid Level Indicator – 375 lb. [153 L], 560 lb. [227 L], and 900 lb. [368 L]
FTF721200	Liquid Level Indicator – 1,200 lb. [490 L]

Table 27- System Accessories

6.5 Legacy Parts

Part Number	Description
FTF200035	35 lb. [15 L] Cylinder / 1 in [25 mm] Valve No Top Cap Assembly
FTF200070	70 lb. [29 L] Cylinder / 1 in [25 mm] Valve No Top Cap Assembly
FTF200150	150 lb. [62 L] Cylinder / 1 ½ in [40 mm] Valve No Top Cap Assembly
FTF200250	250 lb. [103 L] Cylinder / 1 ½ in [40 mm] Valve No Top Cap Assembly
FTF200375	375 lb. [153 L] Cylinder / 2 ½ in [65 mm] Valve No Top Cap Assembly
FTF200560	560 lb. [227 L] Cylinder / 2 ½ in [65 mm] Valve No Top Cap Assembly
FTF200900	900 lb. [368L] Cylinder / 2 ½ in [65 mm] Valve No Top Cap Assembly
FTF201200	1,200 lb. [490 L] Cylinder / 4 in [100 mm] Valve No Top Cap Assembly
FTF500011	Electric Solenoid (12 VDC) for valves: 1 in [25 mm], 1 ½ in [40 mm], 2 ½ in [65 mm]
FTF500023	Electric Solenoid (24 VDC) for valves: 1 in [25 mm], 1 ½ in [40 mm], 2 ½ in [65 mm]
FTF501223	Electric Solenoid (24 VDC) for valve: 4 in [100 mm]
FTF700010	Manual Actuator (not compatible with linear actuator – direct valve fitment only)
FTF400035	Single wall strap for 38 lb [15 L] (one required)
FTF400035	Single wall strap for 75 lb [29 L] (one required)
FTF400150	Single wall strap for 160 lb [62 L] (one required)
FTF400250	Single wall strap for 270 lb [103 L] (one required)
FTF400250	Single wall strap for 400 lb [153 L] (one required)
FTF400560	Single wall strap for 600 lb [227 L] (two required)
FTF400950	Single wall strap for 950 lb [368 L] (two required)
FTF401200	Single wall strap for 1,300 lb [490 L] (two required)
FTF401201	Single floor strap for 1,300 lb [490 L] (two required)

Table 28 – Legacy Parts

6.5.1 Legacy Manual Actuator FTF700010

Manual actuation of the system can be accomplished using this component. The Manual Actuator features a push-button that moves the internal pin downward, thereby depressing the Actuation Adapter valve core and releasing pressure from the cylinder valve. This allows the piston to slide upward and commence system discharge.

The Manual Actuator mounts to the threads on the Actuation Adapter, located on the Top Plug of the cylinder valve.

CAUTION:
Do not remove the safety pin until ready to actuate system discharge.

NOTE: Use of the Manual Actuator requires a cylinder valve equipped with a Top Plug Actuation Adapter and is not intended to be mounted on to the linear actuator. Using this device would not allow for an electrical releasing mechanism on the system. Installation is performed at the factory before filling and pressurizing the system.

Figure 38 – Legacy Manual Actuator FTF700010

6.5.2 Legacy Electric Solenoids FTF500011, FTF500023 & FTF501223

The Electric Solenoid is permanently fixed to the cylinder valve body. It is factory installed in the side port of the cylinder valve or the top port of the 4 in [100mm] cylinder valve. (See Figures 40 & 41) The Electric Solenoid valve is normally closed, and the valve requires electrical energy to remain open. The Electric Solenoid valves are available in 12 VDC and 24 VDC configurations.

Cylinder valves equipped with the Electric Solenoid must be actuated from a UL Listed control panel for releasing device service that is compatible with Firetrace equipment. Prior to the installation of the Electric Solenoid to the actuation circuit, confirm the electrical ratings of the solenoid are compatible with the electrical ratings of the actuation circuit.

Wiring of the Electric Solenoid to the actuation circuit shall comply with NFPA requirements. The solenoid valve circuit must be supervised for a break in the wiring, and/or a ground in accordance with the control unit provided for the extinguishing system.

The threaded nut provided for the securement of the enclosure for the coil to the valve body for the Electric Solenoid shall be mechanically secured against removal. They shall not be disassembled or removed during servicing and/or maintenance of the system.

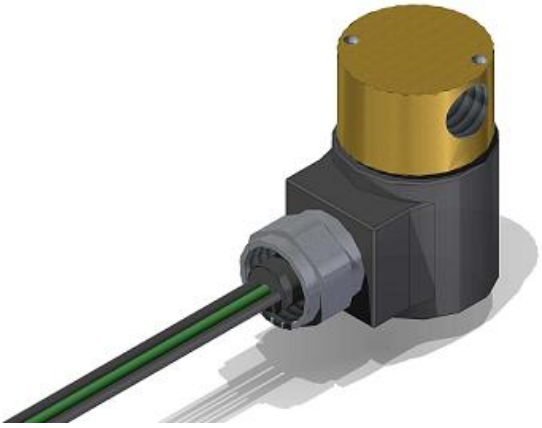


Figure 39 – Legacy Electric Solenoid

WARNING:
The solenoid valve shall not be removed from the cylinder valve. In case of malfunction, please contact an authorized Firetrace distributor.

CAUTION:
Do not electrically activate the Electric Solenoid at any time unless the discharge valve outlet has the Anti-Recoil Device installed or the discharge piping is installed.

WARNING:
Electrically operated releasing devices that are not supervised, are not to be removed during the installation and servicing of the system.

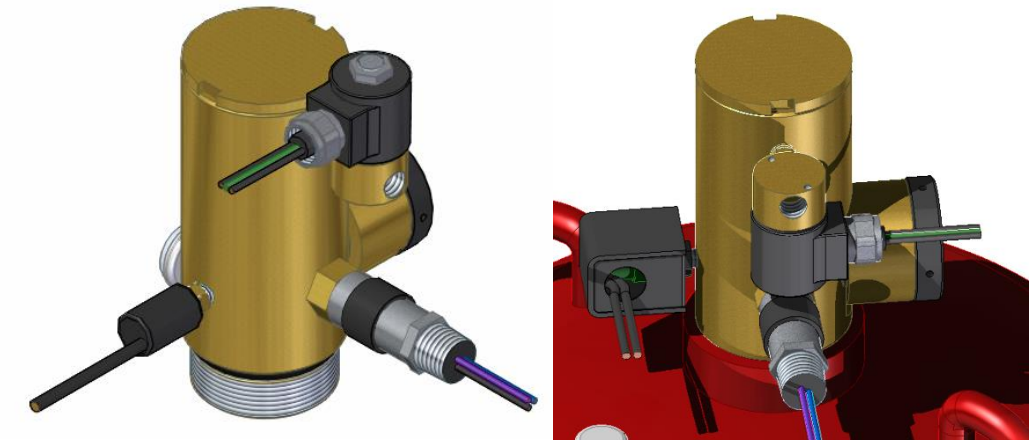


Figure 40 – Legacy Electric Solenoid on Side Port

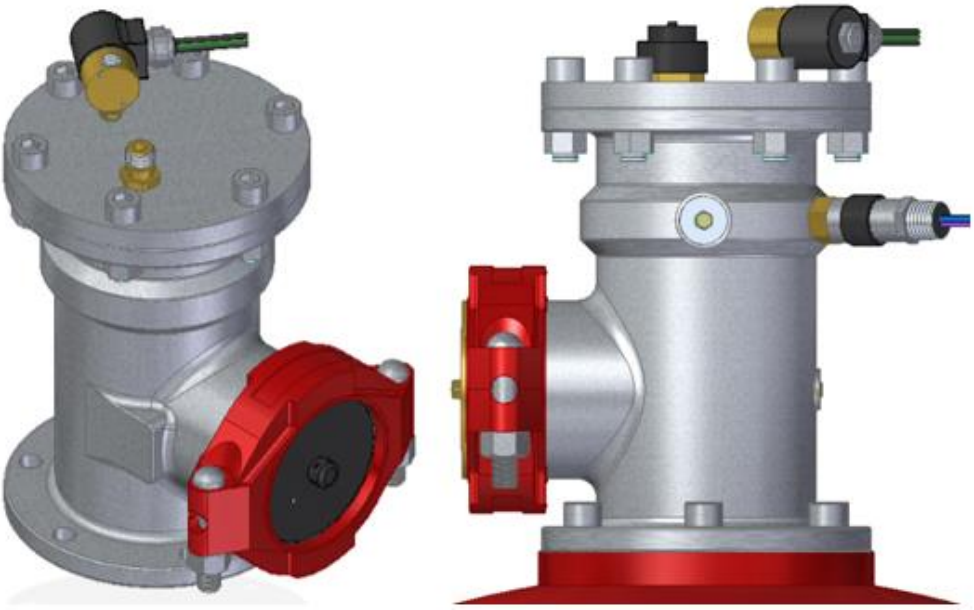


Figure 41 – Legacy Electric Solenoid on Top Port

Appendix A – Flow Calculation Example

FIRETRACE®

POWER TO INNOVATE. FLEXIBILITY TO ADAPT.

Firetrace International

8435 N. 90th Street, Suite 2
Scottsdale, AZ 85258
Phone: (480) 607-1215
Firetrace HFC-227ea FlowCalc FTF3.10
UL: EX15893
Project: IT Server Room
File Name: ABC Fire Protection.FLC

Consolidated Report
Customer Information

Company Name: ABC Fire Protection
Address: 505 Main Street
Anytown, USA 12345

Phone: 555-555-0020
Contact: John Doe
Title: Special Hazards Manager

Project Data

Project Name: IT Server Room
Designer:
Number: TF - 1
Account:
Location:
Description:

Page: 1 of 7
Calculation Date/Time: Thursday, February 07, 2013, 3:03:49 PM

FIRETRACE
POWER TO INNOVATE. FLEXIBILITY TO ADAPT.

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1
Enclosure Number:	1
Name:	Analyzer Building
Enclosure Temperature...	
Minimum:	70 F
Maximum:	70 F
Maximum Concentration:	7.022 %
Design Concentration...	
Adjusted:	7.022 %
Minimum:	7.000 %
Minimum Agent Required:	153.5 lbs
Width:	50.0 ft
Length:	10.0 ft
Height:	9.0 ft
Volume:	4500.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	4500.0 cubic ft
Adjusted Agent Required:	154.0 lbs
Number of Nozzles:	2

Calculation Date/Time: Thursday, February 07, 2013, 3:03:49 PM

FIRETRACE
POWER TO INNOVATE. FLEXIBILITY TO ADAPT.

Consolidated Report
Agent Information

Agent: HFC-227ea / Propellant N2

Adjusted Agent Required:	154.0 lbs
Cylinder Name:	250 lb. Cylinder
Cylinder Part Number:	FTF000250
Number of Main Cylinders:	1
Number of Reserve Cylinders:	0
Manifold:	No Manifold
Pipe Take Off Direction:	Horizontal
Agent Per Cylinder:	154.0 lbs
Fill Density:	42.5 lbs / cubic ft
Cylinder Empty Weight:	154.8 lbs
Weight, All Cylinders + Agent:	308.8 lbs
Floor Area Per Cylinder:	1.40 square ft
Floor Loading Per Cylinder:	221 lbs / square ft

Pipe Network

Part 1 - Pipe

			Pipe			
Description	Start	End	Type	Diameter	Length	Elevation
Main Cyl. X 1	0	1		1-1/2 in	3.19 ft	3.19 ft
Pipe	1	2	40T	1-1/2 in	1.00 ft	0.00 ft
Pipe	2	3	40T	1-1/2 in	6.75 ft	6.75 ft
Pipe	3	4	40T	1-1/2 in	20.00 ft	0.00 ft
Pipe	4	5	40T	1-1/2 in	5.00 ft	0.00 ft
Pipe	5	6	40T	1 in	1.00 ft	0.00 ft
Pipe/E1-N1	6	7	40T	1 in	1.00 ft	-1.00 ft
Pipe	5	8	40T	1 in	1.00 ft	0.00 ft
Pipe/E1-N2	8	9	40T	1 in	1.00 ft	-1.00 ft

Calculation Date/Time: Thursday, February 07, 2013, 3:03:49 PM

FIRETRACE
POWER TO INNOVATE. FLEXIBILITY TO ADAPT.

Consolidated Report

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
0	1	0	0	0	0	0		0.00 ft	28.3 ft
1	2	0	0	0	0	0		0.00 ft	1.0 ft
2	3	1	0	0	0	0		0.00 ft	11.1 ft
3	4	1	0	0	0	0		0.00 ft	24.3 ft
4	5	1	0	0	0	0		0.00 ft	9.3 ft
5	6	0	0	0	1	0		0.00 ft	6.7 ft
6	7	1	0	0	0	0		0.00 ft	3.8 ft
5	8	0	0	0	1	0		0.00 ft	6.7 ft
8	9	1	0	0	0	0		0.00 ft	3.8 ft

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	154.0 lbs				
1	2	154.0 lbs				
2	3	154.0 lbs				
3	4	154.0 lbs				
4	5	154.0 lbs				
5	6	77.1 lbs				
6	7	77.1 lbs	E1-N1	1 in	Sidewall	0.3069 square in
5	8	76.9 lbs				
8	9	76.9 lbs	E1-N2	1 in	Sidewall	0.3069 square in

Parts Information

Total Agent Required: 154.0 lbs
Cylinder Name: 250 lb. Cylinder (Part: FTF000250)
Number Of Cylinders: 1
Field1

Nozzle	Type	Diameter	Nozzle Area	Part Number
E1-N1	Sidewall	1 in	0.3069 square in	FTF6322108
E1-N2	Sidewall	1 in	0.3069 square in	FTF6322108

Calculation Date/Time: Thursday, February 07, 2013, 3:03:49 PM

FIRETRACE
POWER TO INNOVATE. FLEXIBILITY TO ADAPT.

Consolidated Report

Nozzle	Drill Diameter	Drill Size
E1-N1	0.2210 inches	0.221
E1-N2	0.2210 inches	0.221

Pipe:	Type	Diameter	Length
	40T	1 in	4.00 ft
	40T	1-1/2 in	32.75 ft

List of 90 degree elbows:
2 - 1 in
3 - 1-1/2 in

List of Tees:
1 - 1-1/2 in

System Acceptance

*** WARNING - The data in this project may have been changed after the calculations were performed.**

System Discharge Time: 9.9 seconds
Percent Agent in Pipe: 30.3%
Percent Agent Before First Tee: 28.9%

Enclosure Number: 1
Enclosure Name: Analyzer Building

Minimum Design Concentration: 7.000%
Adjusted Design Concentration: 7.022%
Predicted Concentration: 7.022%
Maximum Expected Agent Concentration: 7.022% (At 70 F)

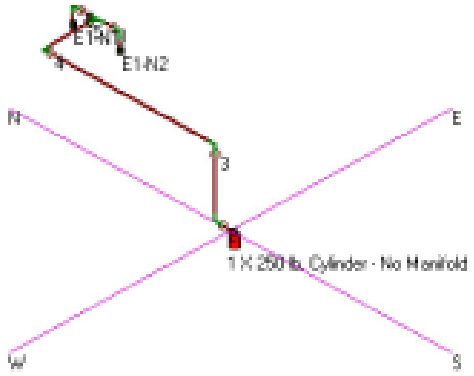
Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	76.8 lbs	77.1 lbs	77.0 lbs	160 psig
E1-N2	76.7 lbs	76.9 lbs	77.0 lbs	160 psig

Calculation Date/Time: Thursday, February 07, 2013, 3:03:49 PM

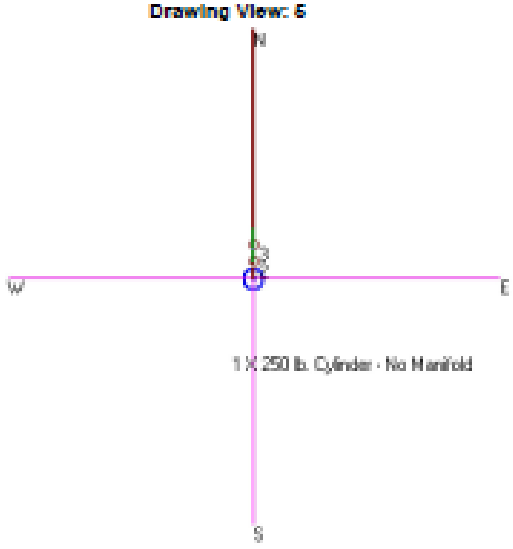
FIRETRACE
POWER TO INNOVATE. FLEXIBILITY TO ADAPT.

Consolidated Report

Drawing View: 1



Drawing View: 6



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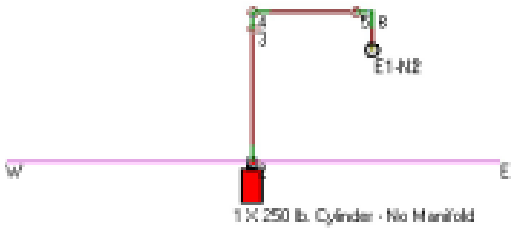
Calculation Date/Time: Thursday, February 07, 2013, 3:03:49 PM

FIRETRACE
POWER TO INNOVATE. FLEXIBILITY TO ADAPT.

Consolidated Report

Drawing View: 9



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Appendix B – Liquid Level Indicator Charts

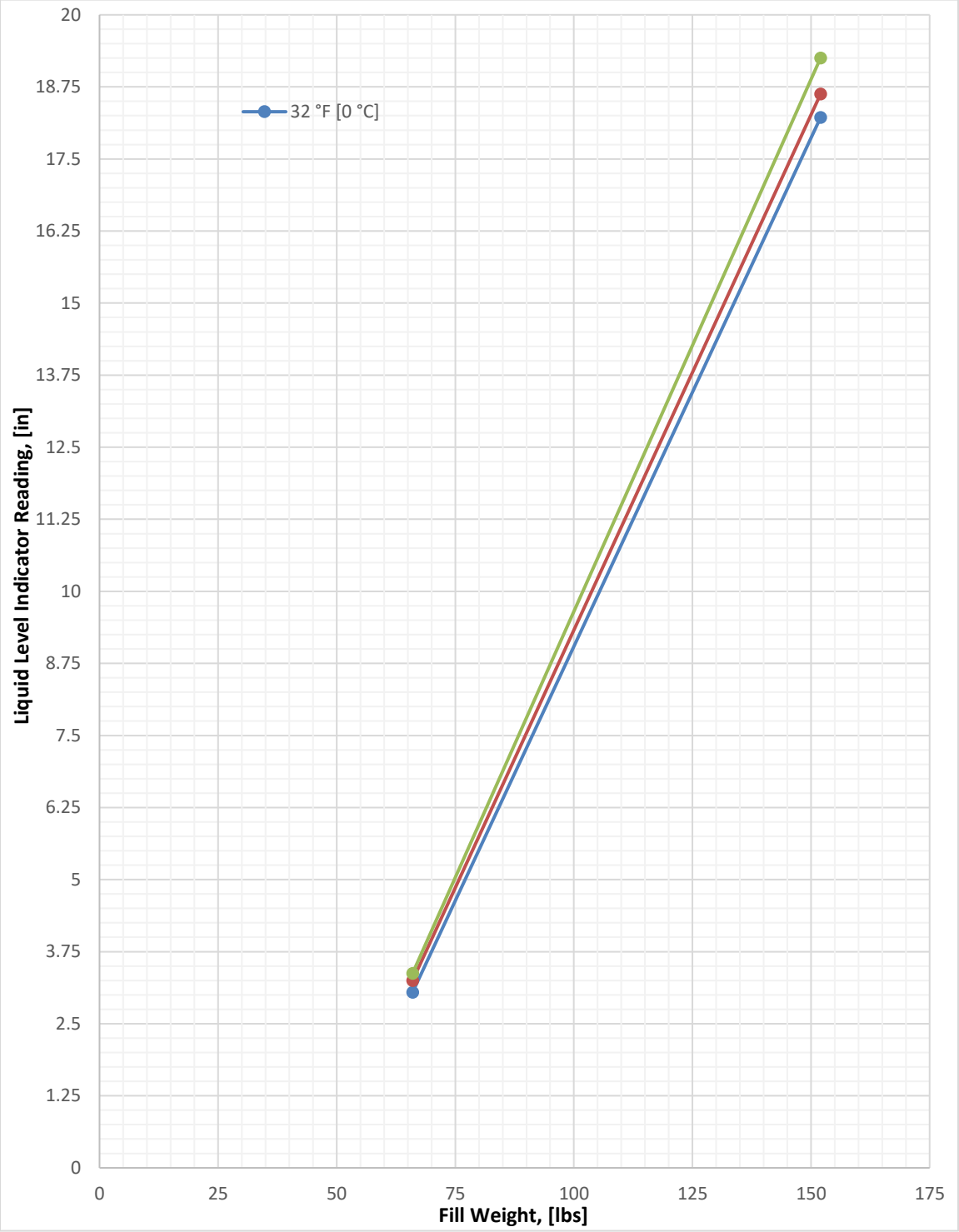


Figure 42- 150 lb. [62 L] LLI Chart

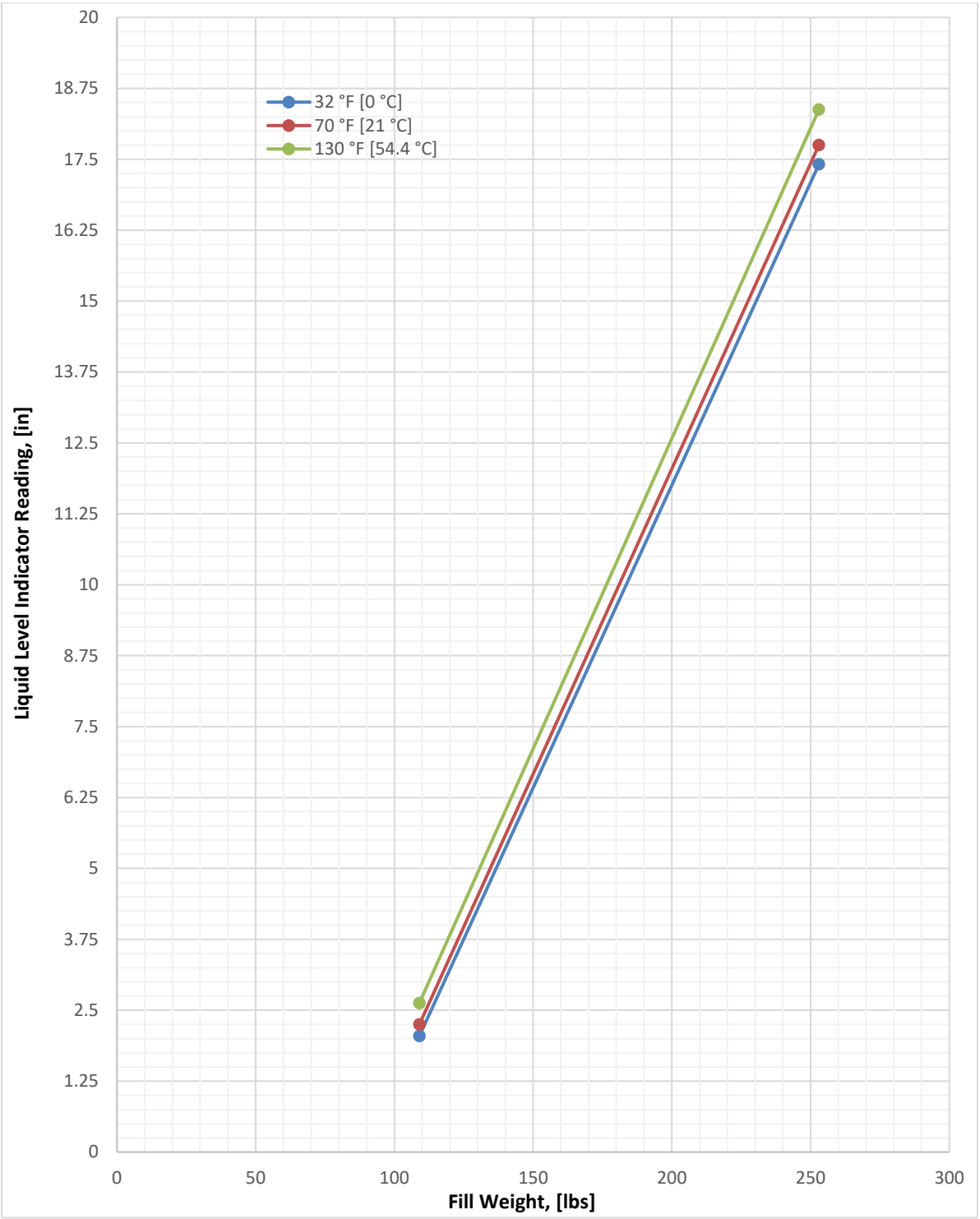


Figure 43- 250 (103L) LLI Chart

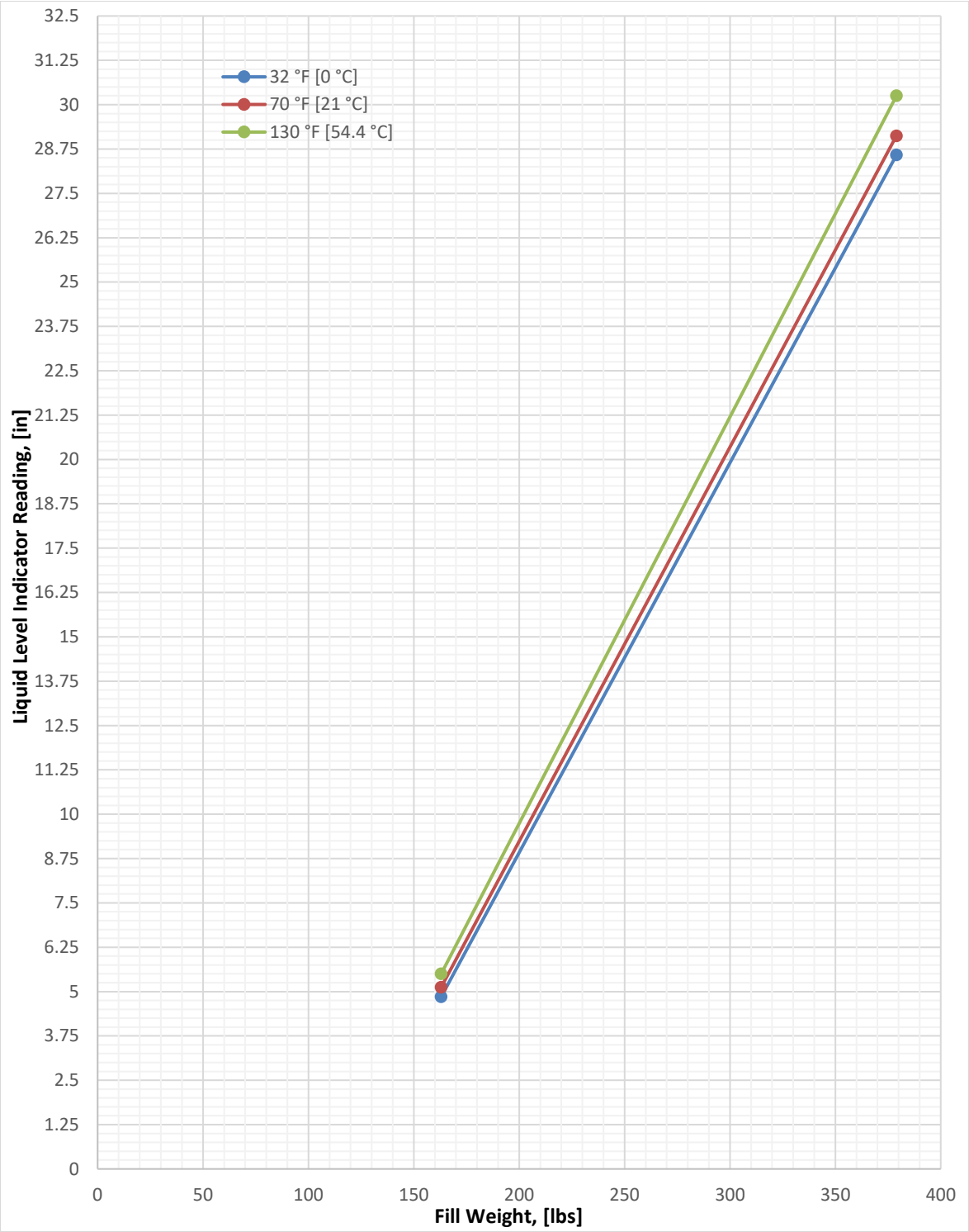


Figure 44- 375 (153L) LLI Chart

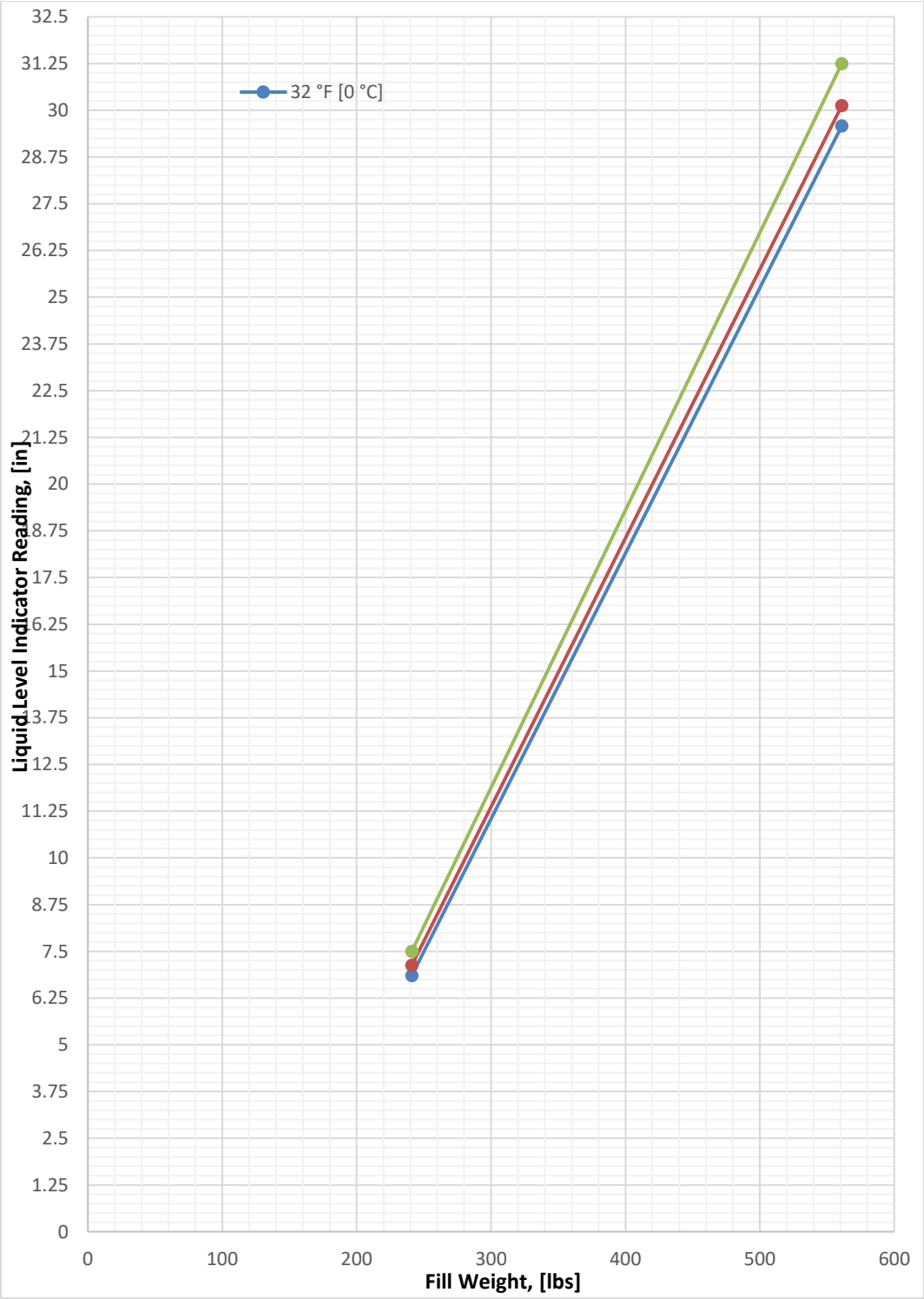


Figure 45- 560 lb. (227) LLI Chart

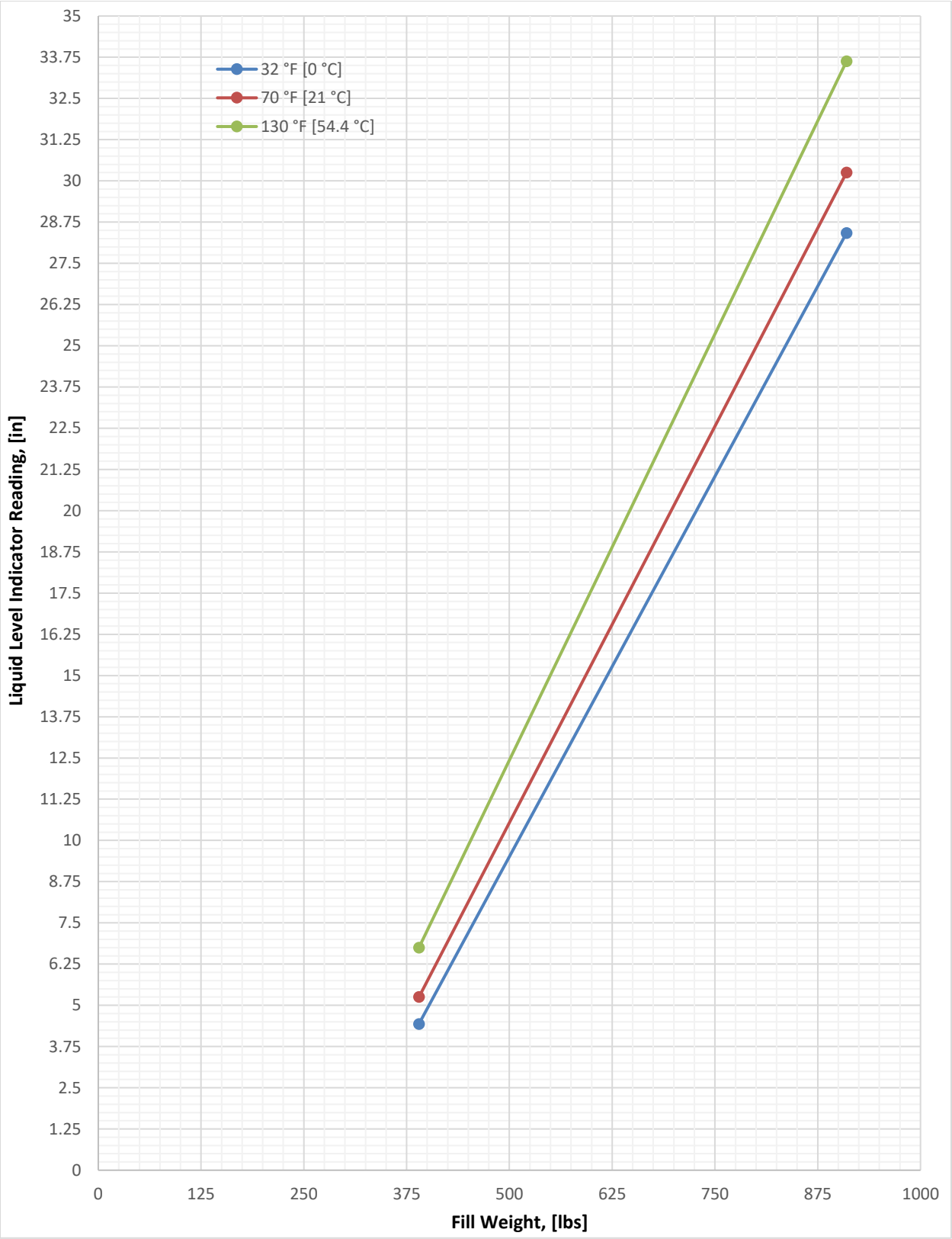


Figure 46- 900 lb. (369) LLI Chart

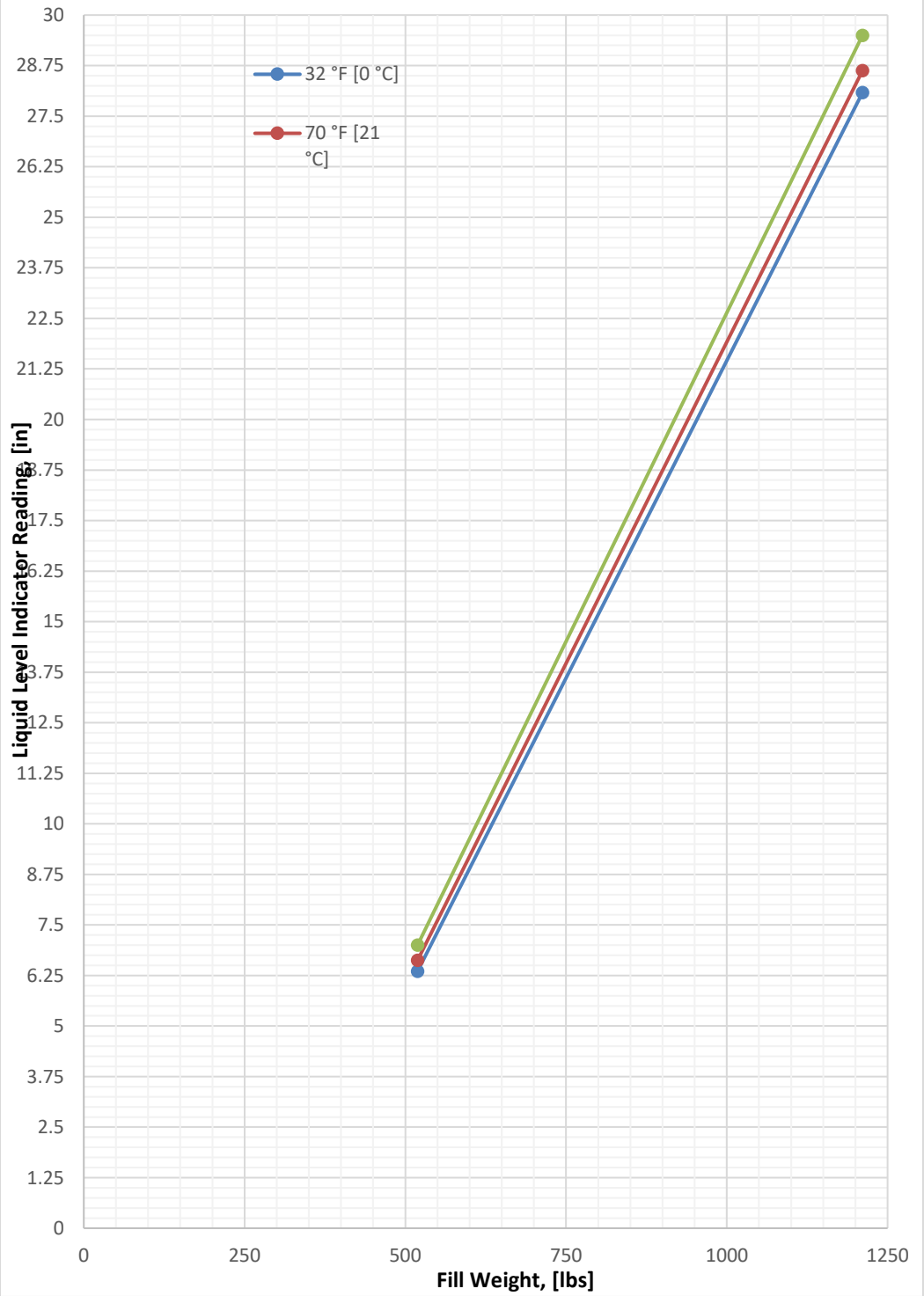


Figure 47 – 1,200 lb. [490 L] LLI Chart

Appendix C – SDS

SAFETY DATA SHEET

FM-200™

Version	Revision Date:	SDS Number:	Date of last issue: 08/08/2018
9.0	10/05/2018	1334268-00041	Date of first issue: 02/27/2017

SECTION 1. IDENTIFICATION

Product name : FM-200™

SDS-Identcode : 130000036866

Manufacturer or supplier's details

Company name of supplier : The Chemours Company FC, LLC

Address : 1007 Market Street
Wilmington, DE 19899 United States of America (USA)

Telephone : 1-844-773-CHEM (outside the U.S. 1-302-773-1000)

Emergency telephone : Medical emergency: 1-866-595-1473 (outside the U.S. 1-302-773-2000) ; Transport emergency: +1-800-424-9300 (outside the U.S. +1-703-527-3887)

Recommended use of the chemical and restrictions on use

Recommended use : Firefighting agent

Restrictions on use : For professional users only.

SECTION 2. HAZARDS IDENTIFICATION

GHS classification in accordance with 29 CFR 1910.1200

Gases under pressure : Liquefied gas

Simple Asphyxiant

GHS label elements

Hazard pictograms :

Signal Word : Warning

Hazard Statements : H280 Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.

Precautionary Statements : **Storage:**
P410 + P403 Protect from sunlight. Store in a well-ventilated place.

Other hazards

Vapors are heavier than air and can cause suffocation by reducing oxygen available for breathing.
Misuse or intentional inhalation abuse may cause death without warning symptoms, due to

cardiac effects.
Rapid evaporation of the product may cause frostbite.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

Substance name : 1,1,1,2,3,3,3-Heptafluoropropane

CAS-No. : 431-89-0

Components

Chemical name	CAS-No.	Concentration (% w/w)
1,1,1,2,3,3,3-Heptafluoropropane*	431-89-0	>= 90 - <= 100

* Voluntarily-disclosed non-hazardous substance
Actual concentration is withheld as a trade secret

SECTION 4. FIRST AID MEASURES

General advice : In the case of accident or if you feel unwell, seek medical advice immediately.
When symptoms persist or in all cases of doubt seek medical advice.

If inhaled : If inhaled, remove to fresh air.
Get medical attention if symptoms occur.

In case of skin contact : Thaw frosted parts with lukewarm water. Do not rub affected area.
Get medical attention immediately.

In case of eye contact : Get medical attention immediately.

If swallowed : Ingestion is not considered a potential route of exposure.

Most important symptoms and effects, both acute and delayed : May cause cardiac arrhythmia.
Other symptoms potentially related to misuse or inhalation abuse are
Cardiac sensitization
Anaesthetic effects
Light-headedness
Dizziness
confusion
Lack of coordination
Drowsiness
Unconsciousness
Contact with liquid or refrigerated gas can cause cold burns and frostbite.

Protection of first-aiders : No special precautions are necessary for first aid responders.

Notes to physician : Treat symptomatically and supportively.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	Not applicable Will not burn
Unsuitable extinguishing media	:	Not applicable Will not burn
Specific hazards during fire fighting	:	Exposure to combustion products may be a hazard to health. If the temperature rises there is danger of the vessels bursting due to the high vapor pressure.
Hazardous combustion products	:	No hazardous combustion products are known
Specific extinguishing methods	:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Fight fire remotely due to the risk of explosion. Use water spray to cool unopened containers. Remove undamaged containers from fire area if it is safe to do so. Evacuate area.
Special protective equipment for fire-fighters	:	Wear self-contained breathing apparatus for firefighting if necessary. Use personal protective equipment.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Evacuate personnel to safe areas. Avoid skin contact with leaking liquid (danger of frostbite). Ventilate the area. Follow safe handling advice and personal protective equipment recommendations.
Environmental precautions	:	Prevent further leakage or spillage if safe to do so. Retain and dispose of contaminated wash water.
Methods and materials for containment and cleaning up	:	Ventilate the area. Local or national regulations may apply to releases and disposal of this material, as well as those materials and items employed in the cleanup of releases. You will need to determine which regulations are applicable. Sections 13 and 15 of this SDS provide information regarding certain local or national requirements.

SECTION 7. HANDLING AND STORAGE

Technical measures	:	Use equipment rated for cylinder pressure. Use a backflow preventative device in piping. Close valve after each use and when empty.
Local/Total ventilation	:	Use only with adequate ventilation.

Advice on safe handling	:	Avoid breathing gas. Handle in accordance with good industrial hygiene and safety practice, based on the results of the workplace exposure assessment Wear cold insulating gloves/ face shield/ eye protection. Valve protection caps and valve outlet threaded plugs must remain in place unless container is secured with valve outlet piped to use point. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder. Prevent backflow into the gas tank. Use a pressure reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems. Close valve after each use and when empty. Do NOT change or force fit connections. Prevent the intrusion of water into the gas tank. Never attempt to lift cylinder by its cap. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Keep away from heat and sources of ignition. Take precautionary measures against static discharges. Take care to prevent spills, waste and minimize release to the environment.
Conditions for safe storage	:	Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Separate full containers from empty containers. Do not store near combustible materials. Avoid area where salt or other corrosive materials are present. Keep in properly labeled containers. Keep in a cool, well-ventilated place. Keep away from direct sunlight. Store in accordance with the particular national regulations.
Materials to avoid	:	Do not store with the following product types: Self-reactive substances and mixtures Organic peroxides Oxidizing agents Flammable liquids Flammable solids Pyrophoric liquids Pyrophoric solids Self-heating substances and mixtures Substances and mixtures which in contact with water emit flammable gases Explosives Acutely toxic substances and mixtures Substances and mixtures with chronic toxicity
Recommended storage temperature	:	< 126 °F / < 52 °C
Storage period	:	> 10 y

Further information on storage stability	:	The product has an indefinite shelf life when stored properly.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

Contains no substances with occupational exposure limit values.

Engineering measures	:	Ensure adequate ventilation, especially in confined areas. Minimize workplace exposure concentrations.

Personal protective equipment

Respiratory protection	:	General and local exhaust ventilation is recommended to maintain vapor exposures below recommended limits. Where concentrations are above recommended limits or are unknown, appropriate respiratory protection should be worn. Follow OSHA respirator regulations (29 CFR 1910.134) and use NIOSH/MSHA approved respirators. Protection provided by air purifying respirators against exposure to any hazardous chemical is limited. Use a positive pressure air supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstance where air purifying respirators may not provide adequate protection.
Hand protection Material	:	Low temperature resistant gloves
Remarks	:	Choose gloves to protect hands against chemicals depending on the concentration specific to place of work. For special applications, we recommend clarifying the resistance to chemicals of the aforementioned protective gloves with the glove manufacturer. Wash hands before breaks and at the end of workday. Breakthrough time is not determined for the product. Change gloves often!
Eye protection	:	Wear the following personal protective equipment: Chemical resistant goggles must be worn. Face-shield
Skin and body protection	:	Skin should be washed after contact.
Protective measures	:	Wear cold insulating gloves/ face shield/ eye protection.
Hygiene measures	:	Ensure that eye flushing systems and safety showers are located close to the working place. When using do not eat, drink or smoke. Wash contaminated clothing before re-use.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Liquefied gas
Color	:	colorless
Odor	:	slight, ether-like
Odor Threshold	:	No data available
pH	:	No data available
Melting point/freezing point	:	-201.1 °F / -129.5 °C
Initial boiling point and boiling range	:	1 °F / -17 °C (1,013 hPa)
Flash point	:	Not applicable
Evaporation rate	:	Not applicable
Flammability (solid, gas)	:	Will not burn
Upper explosion limit / Upper flammability limit	:	Upper flammability limit Method: ASTM E681 None.
Lower explosion limit / Lower flammability limit	:	Lower flammability limit Method: ASTM E681 None.
Vapor pressure	:	4.547 hPa (77 °F / 25 °C) 540 hPa (-22 °F / -30 °C) 29,360 hPa (253 °F / 123 °C)
Relative vapor density	:	5.87
Density	:	1.388 g/cm³ (77 °F / 25 °C) (as liquid)
Solubility(ies) Water solubility	:	0.23 g/l (77 °F / 25 °C)
Partition coefficient: n-octanol/water	:	log Pow: 0.36
Autoignition temperature	:	No data available
Decomposition temperature	:	No data available
Viscosity Viscosity, kinematic	:	Not applicable

Explosive properties	:	Not explosive
Oxidizing properties	:	The substance or mixture is not classified as oxidizing.
Particle size	:	Not applicable

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	Not classified as a reactivity hazard.
Chemical stability	:	Stable if used as directed. Follow precautionary advice and avoid incompatible materials and conditions.
Possibility of hazardous reactions	:	Can react with strong oxidizing agents.
Conditions to avoid	:	Heat, flames and sparks.
Incompatible materials	:	Oxidizing agents
Hazardous decomposition products	:	No hazardous decomposition products are known.

SECTION 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation
Skin contact
Eye contact

Acute toxicity

Not classified based on available information.

Components:

1,1,1,2,3,3,3-Heptafluoropropane:

Acute inhalation toxicity	:	LC50 (Rat): > 788696 ppm Exposure time: 4 h Test atmosphere: gas Method: OECD Test Guideline 403 No observed adverse effect concentration (Dog): 90000 ppm Test atmosphere: gas Symptoms: Cardiac sensitization Lowest observed adverse effect concentration (Dog): 105000 ppm Test atmosphere: gas Symptoms: Cardiac sensitization Cardiac sensitisation threshold limit (Dog): 730,190 mg/m³ Test atmosphere: gas Symptoms: Cardiac sensitization

Skin corrosion/irritation

Not classified based on available information.

Serious eye damage/eye irritation

Not classified based on available information.

Respiratory or skin sensitization

Skin sensitization

Not classified based on available information.

Respiratory sensitization

Not classified based on available information.

Components:

1,1,1,2,3,3,3-Heptafluoropropane:

Routes of exposure	:	Skin contact
Species	:	Humans
Result	:	negative

Germ cell mutagenicity

Not classified based on available information.

Components:

1,1,1,2,3,3,3-Heptafluoropropane:

Germ cell mutagenicity - Assessment	:	Weight of evidence does not support classification as a germ cell mutagen.

Carcinogenicity

Not classified based on available information.

Components:

1,1,1,2,3,3,3-Heptafluoropropane:

Carcinogenicity - Assessment	:	Weight of evidence does not support classification as a carcinogen

IARC No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

OSHA No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

NTP No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity

Not classified based on available information.

Components:

1,1,1,2,3,3,3-Heptafluoropropane:

Reproductive toxicity - As-	:	Weight of evidence does not support classification for

sessment reproductive toxicity

STOT-single exposure

Not classified based on available information.

STOT-repeated exposure

Not classified based on available information.

Components:

1,1,1,2,3,3,3-Heptafluoropropane:

Assessment	:	No significant health effects observed in animals at concentrations of 250 ppmV/6h/d or less.

Repeated dose toxicity

Components:

1,1,1,2,3,3,3-Heptafluoropropane:

Species	:	Rat
NOAEL	:	105000 ppm
LOAEL	:	>105000 ppm
Application Route	:	inhalation (gas)
Exposure time	:	13 Weeks
Method	:	OECD Test Guideline 413
Remarks	:	No significant adverse effects were reported

Aspiration toxicity

Not classified based on available information.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Components:

1,1,1,2,3,3,3-Heptafluoropropane:

Toxicity to fish	:	LC50 (Danio rerio (zebra fish)): > 200 mg/l Exposure time: 96 h Method: OECD Test Guideline 203 Remarks: Based on data from similar materials
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia magna (Water flea)): > 200 mg/l Exposure time: 48 h Method: OECD Test Guideline 202 Remarks: Based on data from similar materials
Toxicity to algae	:	ErC50 (Pseudokirchneriella subcapitata (green algae)): > 114 mg/l Exposure time: 72 h Method: OECD Test Guideline 201 Remarks: Based on data from similar materials NOEC (Pseudokirchneriella subcapitata (green algae)): 13.2

mg/l
Exposure time: 72 h
Method: OECD Test Guideline 201
Remarks: Based on data from similar materials

Persistence and degradability

Components:

1,1,1,2,3,3,3-Heptafluoropropane:

Biodegradability : Result: Not readily biodegradable.
Method: OECD Test Guideline 301D

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

Product:

Results of PBT and vPvB assessment : This substance is not considered to be persistent, bioaccumulating and toxic (PBT). This substance is not considered to be very persistent and very bioaccumulating (vPvB).

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : Dispose of in accordance with local regulations.

Contaminated packaging : Empty containers should be taken to an approved waste handling site for recycling or disposal.
Empty pressure vessels should be returned to the supplier.
If not otherwise specified: Dispose of as unused product.

SECTION 14. TRANSPORT INFORMATION

International Regulations

UNRTDG

UN number	:	UN 3296
Proper shipping name	:	HEPTAFLUOROPROPANE
Class	:	2.2
Packing group	:	Not assigned by regulation
Labels	:	2.2

IATA-DGR

UN/ID No.	:	UN 3296
Proper shipping name	:	Heptafluoropropane
Class	:	2.2
Packing group	:	Not assigned by regulation

Labels	:	Non-flammable, non-toxic Gas
Packing instruction (cargo aircraft)	:	200
Packing instruction (passenger aircraft)	:	200

IMDG-Code

UN number	:	UN 3296
Proper shipping name	:	HEPTAFLUOROPROPANE
Class	:	2.2
Packing group	:	Not assigned by regulation
Labels	:	2.2
EmS Code	:	F-C, S-V
Marine pollutant	:	no

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied.

Domestic regulation

49 CFR

UN/ID/NA number	:	UN 3296
Proper shipping name	:	Heptafluoropropane
Class	:	2.2
Packing group	:	Not assigned by regulation
Labels	:	NON-FLAMMABLE GAS
ERG Code	:	126
Marine pollutant	:	no

Special precautions for user

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know

CERCLA Reportable Quantity

This material does not contain any components with a CERCLA RQ.

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 302 Extremely Hazardous Substances Threshold Planning Quantity

This material does not contain any components with a section 302 EHS TPQ.

SARA 311/312 Hazards	:	Gases under pressure Simple Asphyxiant
SARA 313	:	This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

US State Regulations

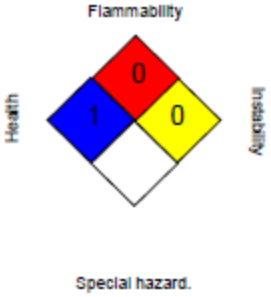
Pennsylvania Right To Know

1,1,1,2,3,3,3-Heptafluoropropane 431-89-0

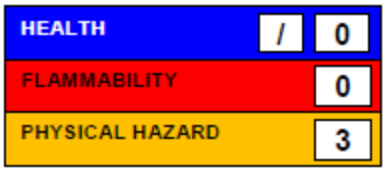
SECTION 16. OTHER INFORMATION

Further information

NFPA 704:



HMIS® IV:



HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. The "*" represents a chronic hazard, while the "/" represents the absence of a chronic hazard.

Before use read Chemours safety information.
For further information contact the local Chemours office or nominated distributors.
All chemical substances in this material are included on or exempted from listing on the TSCA Inventory of Chemical Substances.

Full text of other abbreviations

AICS - Australian Inventory of Chemical Substances; ASTM - American Society for the Testing of Materials; bw - Body weight; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DOT - Department of Transportation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; EHS - Extremely Hazardous Substance; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; HMIS - Hazardous Materials Identification System; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Pre-

vention of Pollution from Ships; MSHA - Mine Safety and Health Administration; n.o.s. - Not Otherwise Specified; NFPA - National Fire Protection Association; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; RCRA - Resource Conservation and Recovery Act; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; RQ - Reportable Quantity; SADT - Self-Accelerating Decomposition Temperature; SARA - Superfund Amendments and Reauthorization Act; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative

Sources of key data used to compile the Material Safety Data Sheet	:	Internal technical data, data from raw material SDSs, OECD eChem Portal search results and European Chemicals Agency, http://echa.europa.eu/
Revision Date	:	10/05/2018

Items where changes have been made to the previous version are highlighted in the body of this document by two vertical lines.

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and shall not be considered a warranty or quality specification of any type. The information provided relates only to the specific material identified at the top of this SDS and may not be valid when the SDS material is used in combination with any other materials or in any process, unless specified in the text. Material users should review the information and recommendations in the specific context of their intended manner of handling, use, processing and storage, including an assessment of the appropriateness of the SDS material in the user's end product, if applicable.

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