DIOM Manual
Part Number: FTF000004

35 Bar
Engineered Clean Agent
Fire Suppression System

Designed for use with:

FK-5-1-12 Fire Protection Fluid

DESIGN, INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

Clean Agent Extinguishing System Unit 4DM0 EX15893 FM File: 3044465

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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 FK-5-1-12 Fire Protection Fluid. It is intended to communicate details 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 FK-5-1-12 Fire Protection Fluid are to be designed, installed, inspected, tested, maintained, and recharged by qualified trained personnel in accordance with the following:

- All instructions, limitations, etc. contained in this manual P/N FTF000004
- All information contained on the agent cylinder nameplate(s)
- NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems
- Underwriters Laboratories, Inc. Listing
- FM Approvals
- 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 are capable of causing 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 at all times 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 of 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 FK-5-1-12 Fire Protection Fluid are UL Listed by Underwriters Laboratories and ULC Listed by Underwriters Laboratories of Canada. These units are designed for total flooding applications using FK-5-1-12 Fire Protection Fluid in accordance NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems.

The Firetrace Engineered Clean Agent Fire Suppression Systems with FK-5-1-12 Fire Protection Fluid 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, and by FM Approvals in compliance with the requirements specified in FM 5600 Approval Standard for Clean Agent Extinguishing Systems and 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 FK-5-1-12 System. It will also permit an authority having jurisdiction to determine that all required design and engineering parameters have been satisfied.

1.2 FK-5-1-12 Clean Agents

1.2.1 Properties of 3M™ Novec™ 1230 (700010)

3M™ Novec™ 1230 Fire Protection Fluid, referenced as FK-5-1-12 in NFPA and ISO documents, is a fluorinated ketone (or fluroketone) depicted by the chemical formula $CF_3CF_2C(O)CF(CF_3)_2$. It is colorless, odorless and electrically nonconductive. It is a liquid at room temperature, pressurized with nitrogen and stored in cylinder and valve assemblies as part of a Firetrace Engineered Suppression System.

FK-5-1-12 is a clean and effective fire extinguishing agent that can be used on type A, B, and C fires. FK-5-1-12 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 – Agent Properties of Novec 1230, as well as the SDS located in Appendix C – SDS 3M ™ Novec ™ 1230 .

Table 1 – Agent Properties of 3M™ Novec™ 1230

Chemical Formula	$CF_3CF_2C(O)CF(CF_3)_2$
Molecular Weight	316.04 g/mol
Freezing Point	-162.4 °F [-108.0 °C]
Boiling Point at 1 atm.	120.6 °F [49.2 °C]
Critical Temperature	335.6 °F [168.7 °C]
Critical Density	39.91 lbm/ft3 [639.1 kg/m3]
Critical Pressure	270.44 psia [18.65 bar]
Critical Volume	0.0251 ft3/lbm [494.5 cm^3/mol]
Density, Saturated Liquid	99.9 lbm/ft3 [1.60 g/ml]
Density, Gas at 1 atm	0.851 lbm/ft3 [0.0136 g/ml]

Specific Volume, Gas at 1 atm	1.175 ft_3/lb. [0.0733 m_3/kg]
Liquid Viscosity at 32 °F [0 °C]/77 °F [25 °C]	0.56/0.39 centistokes
Heat of Vaporization at Boiling Point	37.9 Btu/lb. [88.0 kJ/kg]
Solubility of Water in Novec 1230 Liquid	<0.001% by wt.
Vapor Pressure	5.85 psig [0.404 bar]
Dielectric Strength, Relative to N_2	2.3

1.2.2 Properties of Chemori 5112™ (701010)

Chemori 5112 ™ Fire Protection Fluid, referenced as FK-5-1-12 in NFPA and ISO documents, synonym is perfluoro (2-methyle-3-pentanone); Dodecafluoro-2-methylpentan-3-one:1,1,1,2,2,4,5,5,5-nonafluroro-4-(trifluoromethyl)-3-pentanone. Typically referred to as a Fluoroketone and is depicted by the chemical formula $CF_3CF_2C(O)CF(CF_3)_2$. It is colorless, odorless and electrically nonconductive. It is a liquid at room temperature, pressurized with nitrogen and stored in cylinder and valve assemblies as part of a Firetrace Engineered Suppression System.

FK-5-1-12 is a clean and effective fire extinguishing agent that can be used on type A, B, and C fires. FK-5-1-12 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 2 – Agent Properties of Chemori 5112 ™, as well as the SDS located in Appendix D – SDS Chemori 5112 TM.

Table 2 – Agent Properties of Chemori 5112™

Chemical Formula	$CF_3CF_2C(O)CF(CF_3)_2$
Molecular Weight	316.04 g/mol
Freezing Point	-162.4 °F [-108.0 °C]
Boiling Point.	120.6 °F [49.2 °C]
Vapor Pressure @ 20 ^{0} C/ 68 ^{0} F	4.728 psi [0.326 bar]
Vapor Density	11.6

1.2.3 Properties of Dukare 1230 (702010)

Dukare 1230 Fire Protection Fluid, referenced as FK-5-1-12 in NFPA and ISO documents, synonym is Dodecafluoro -2-methyl-3-pentanone / Perfluoro (2-methyl-3-pentanone);1,1,1,2,2,4,5,5,5-Nonafluroro-4-(Trifluoromethyl)-3-Pentanone. Typically referred to as a Fluoroketone and is depicted by the chemical formula $CF_3CF_2C(O)CF(CF_3)_2$. It is colorless, faint odor and electrically nonconductive. It is a liquid at room temperature, pressurized with nitrogen and stored in cylinder and valve assemblies as part of a Firetrace Engineered Suppression System.

FK-5-1-12 is a clean and effective fire extinguishing agent that can be used on type A, B, and C fires. FK-5-1-12 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 3 – Agent Properties of Dukare 1230 , as well as the SDS located in Appendix E – SDS Dukare 1230

Table 3 – Agent Properties of Dukare 1230

Chemical Formula	$CF_3CF_2C(O)CF(CF_3)_2$
Molecular Weight	NA
Freezing Point	-162.4 °F [-108.0 °C]
Boiling Point.	120.6 °F [49.2 °C]
Vapor Pressure @ 20 ^{0} C/ 68 ^{0} F	4.728 psi [0.326 bar]
Vapor Density	11.6
Density, Saturated Liquid	99.9 lbm/ft3 [1.60 g/mL]
Vapor pressure	NA
Dielectric Strength, Relative to N2	NA

1.2.4 Properties of Waysmos FK5112 (703010)

Waysmos FK5112 Fire Protection Fluid, referenced as FK-5-1-12 in NFPA and ISO documents, synonym is Fluoroketone, Perfluoro (2-methyl-3-pentanone);1,1,1,2,2,4,5,5,5-Nonafluroro-4-(Trifluoromethyl)-3-Pentanone. Typically referred to as a Fluoroketone and is depicted by the chemical formula $CF_3CF_2C(O)CF(CF_3)_2$. It is colorless, low odor and electrically nonconductive. It is a liquid at room temperature, pressurized with nitrogen and stored in cylinder and valve assemblies as part of a Firetrace Engineered Suppression System.

FK-5-1-12 is a clean and effective fire extinguishing agent that can be used on type A, B, and C fires. FK-5-1-12 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 4 – Agent Properties of Waysmos FK5112 , as well as the SDS located in Appendix F – SDS Chemori 5112 TM.

Table 4 – Agent Properties of Waysmos FK5112

Chemical Formula	$CF_3CF_2C(O)CF(CF_3)_2$
Molecular Weight	316.04 g /mol
Freezing Point	-162.4 °F [-108.0 °C]
Boiling Point at 1 atm.	120.2 °F [49.0 °C]
Density, Saturated Liquid	99.9 lbm/ft3 [1.60 g/mL]
Critical Temperature	335.6°F [168.6°C]
Critical Density	39.91 lbm/ft^3 [639.1 kg/m^3]
Critical Pressure	270.44 psi [18.65 bar]
Critical Volume	0.0251 ft3/lbm [494.5 cc/mole]
Specific Volume, Gas at 1 atm	1.175 ft3/lb [0.0733 m3/kg]
Liquid Viscosity at 32 °F [0 °C]/77 °F [25 °C]	0.56/0.39 centistokes
Heat of Vaporization at Boiling Point	37.9 BTU/lb [88.0 kJ/kg]
Solubility of Water in Novec 1230 Liquid	NA do not mix with water
Vapor pressure	5.85 psig [0.404 bar]
Dielectric Strength, Relative to N2	2.3

1.2.5 Properties of Noah® 5112 (704010)

Noah® 5112 Fire Protection Fluid, referenced as FK-5-1-12 in NFPA and ISO documents, chemical name1,1,1,2,2,4,5,5,5-Nonafluroro-4-(Trifluoromethyl)-3-Pentanone. It is colorless, has a weak odor and electrically nonconductive. It is a liquid at room temperature, pressurized with nitrogen and stored in cylinder and valve assemblies as part of a Firetrace Engineered Suppression System.

FK-5-1-12 is a clean and effective fire extinguishing agent that can be used on type A, B, and C fires. FK-5-1-12 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 5 - Agent Properties of Noah®5112, as well as the SDS located in Appendix G – SDS NOAH® 5112.

Table 5 - Agent Properties of Noah®5112

Chemical Formula	$CF_3CF_2C(O)CF(CF_3)_2$
Molecular Weight	NA
Freezing Point	-162.4 °F [-108.0 °C]
Boiling Point.	120.2 °F [49.0 °C]
Vapor Pressure @ 20 ^{0} C/ 68 ^{0} F	4.728 psi [0.326 bar]
Vapor Density	11.6
Density, Saturated Liquid	99.9 lbm/ft3 [1.60 g/mL]
Vapor pressure	NA
Dielectric Strength, Relative to N2	NA

1.3 Quality Requirements

Strict agent quality specifications must be maintained, see Table 6 - Agent Quality Specifications

Table 6 - Agent Quality Specifications

Chemical Name	1,1,1,2,2,4,5,5,5 -Nonafluoro-4-(Trifluoromethyl)-3-Pentanone
FK-5-1-12 - Mole % (WEIGHT)	≥ 99.0
CAS No.	756-13-8

1.4 Personnel Safety

1.4.1 Agent Concentration

From NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems, the areas into which FK-5-1-12 is discharged must be evacuated by personnel and the areas ventilated after discharge.

FK-5-1-12 has acceptable toxicity for use in occupied spaces when the guidelines in this manual are followed as well as NFPA 2001 and any relevant international standards found applicable by the authority having jurisdiction.

1.4.2 Toxicological Information

Remarks: If a component is disclosed in the other sections or SDS, but doses do not appear in a table below either no data are available for that endpoint or the data are not sufficient for classification.

Table 7 – Toxicological Information of Chemori 5112™

Description	Species	Classification
Skin Irritation / Corrosion	Rabbit	Non-irritant
Serious Eye Damage / Irritation	Rabbit	Non-irritant
Skin Sensitization	Guinea pig	Weak sensitizer
Acute Toxicity	Dermal (Route) Sprague-Dawley Rat	Low acute toxicity
	Ingestion (Route) Sprague-Dawley Rat	Low acute toxicity
	Inhalation Vapor (Route) Sprague-Dawley Rat	Low acute toxicity
Information on Toxicological Effects / Routes and Symptoms of Exposure:		
Inhaled	No known health effects	
Ingestion	No known health effects	
Skin Contact	Not expected to cause significant skin irritation.	
Eye	Not expected to cause significant eye irritation.	
Chronic	No applicable information	

Table 8 – Toxicological Information of Dukare 1230

Description	Species	Value
Skin Irritation / Corrosion	Rabbit	Non-irritating to the skin
Serious Eye Damage / Irritation	Rabbit	No eye irritation
Sensitization	Guinea pig	No sensitization responses were observed.
Germ cell mutagenicity	In Vito	Not mutagenic
Acute Toxicity	Oral (Route) Rat	LD 50 > 5000 mg / kg
	Dermal (Route) Rat	LD 50 > 2000 mg / kg
	Inhalation Rat (4 hours)	LD 50 > 5000 mg / m^3

Table 9 – Toxicological Information of Waysmos FK5112

Description	Species	Value
Acute Toxicity	Oral (Route) Rat	LD 50 > 5000 mg / kg
	Dermal (Route) Rat	LD 50 > 2000 mg / kg
	Inhalation Rat (4 hours)	LD 50 > 1227 mg/l (>10 % by volume)

1.4.3 Thermal Decomposition Products

There is a direct correlation between agent discharge time and the quantity of thermal decomposition products (TDP) created. The type of fire and the amount of agent exposed to open flame are also critical factors in creation of TDP.

The discharge of the FK-5-1-12 at 70 °F (21.1°C) has been established at 10 seconds maximum regardless of the weight discharged. The rapid discharge is required 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 FK-5-1-12 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 FK-5-1-12 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 FK-5-1-12 Systems are intended to be designed and installed to protect single or multiple hazards within the limitations as stated in this manual ONLY. The equipment described in this manual is listed by Underwriters Laboratories, Inc., in accordance with UL 2166 Standard for Halocarbon Agent Extinguishing System Units. 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 one or all of these components, the Firetrace system is incomplete and will result in the system's ability to operate

2.1.1 Cylinder with Valve Assemblies

The engineered clean agent system cylinders are available in the following sizes: 38 lb. [15 L], 75 lb. [29 L], 160 lb. [62 L], 270 lb. [103 L], 400 lb. [153 L], 600 lb. [227 L], 950 lb. [368 L], and 1,300 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 500 psi [35 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

Table 10 – Cylinder Fill Range

System Assembly Part Number	Cylinder Size (Nominal)	Fill Range [lb.]		Fill Range [kg]		Empty Weight	Valve Size (Nominal)
		Minimum	Maximum	Minimum	Maximum		
FTF000015	38 lb. [15 L]	10	38	4.5	17.0	37.6 lb. (17.1 kg)	1 in [25 mm]
FTF000029	75 lb. [29 L]	16	76	7.5	34.5	54 lb. (24.5 kg)	1 in [25 mm]
FTF000062	160 lb. [62 L]	33	164	15.0	74.0	106.2 lb. (48.2 kg)	1 ½ in [40 mm]

FTF000103	270 lb. [103 L]	55	271	25.0	122.5	154.8 lb. (70.3 kg)	1 ½ in [40 mm]
FTF000153	400 lb. [153 L]	82	406	37.5	184.0	250 lb. (113.4 kg)	2 ½ in [65 mm]
FTF000227	600 lb. [227 L]	121	601	55.0	272.5	340 lb. (154.3 kg)	2 ½ in [65 mm]
FTF000368	950 lb. [368 L]	193	964	88.0	437.0	465.5 lb. (211.2 kg)	2 ½ in [65 mm]
FTF000490	1,300 lb. [490 L]	260	1297	118.0	588.0	762.5 lb. (345.9 kg)	4 in [100 mm]

Table 11 – System Assembly Dimensions

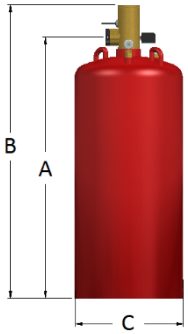


Figure 1 – Cylinder Valve and Assembly

System Assembly Part Number	Cylinder Size (Nominal)	Dimension "A"		Dimension "B"		Dimension "C"	
		in	mm	in	mm	in	mm
FTF000015	38 lb. [15 L]	17.00	432	21.50	547	10.00	254
FTF000029	75 lb. [29 L]	28.75	731	33.25	845	10.00	254
FTF000062	160 lb. [62 L]	37.75	959	43.00	1,093	12.75	324
FTF000103	270 lb. [103 L]	39.00	991	44.50	1,131	16.00	407
FTF000153	400 lb. [153 L]	55.50	1,410	64.00	1,626	16.00	407
FTF000227	600 lb. [227 L]	54.00	1,372	61.75	1,569	20.00	508
FTF000368	950 lb. [368 L]	60.50	1,537	68.25	1,734	24.00	610
FTF000490	1,300 lb. [490 L]	60.25	1,531	68.75	1,747	30.00	762

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.

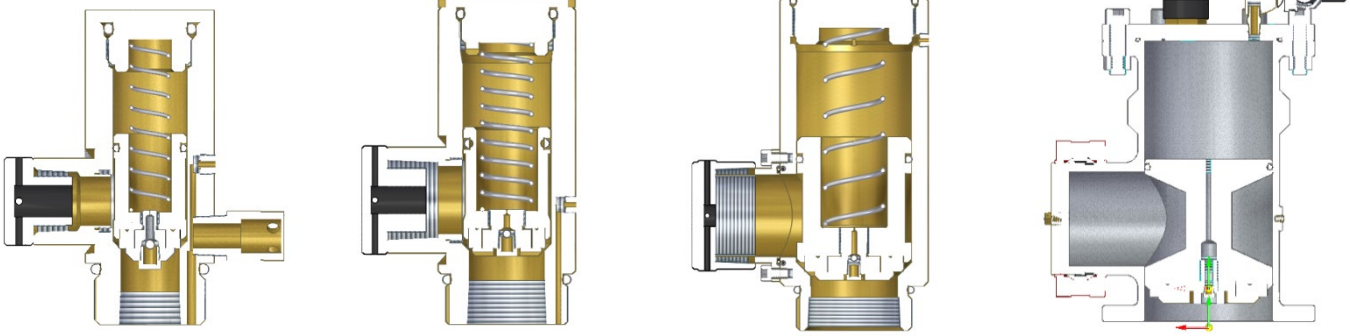
Internally within each valve is a piston equipped with elastomeric seals which separate the pressure contained within the top half of the valve from the pressure contained in the cylinder. When the pressure contained within the top half of the valve is vented via an actuation device, the piston can rise 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 38 lb. [15 L] and 75 lb. [29 L] size cylinders are equipped with 1 in [25 mm] valves. The 160 lb. [62 L] and 270 lb. [103 L] size cylinders are equipped with 1 ½ in [40 mm] valves. The 400 lb. [153L], 600 lb. [227 L], and 950 lb. [368 L] cylinders are equipped with 2 ½ in [65 mm] valves. The 1,300 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 – Cylinder Valves

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 FTF503006

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 405 ± 10 psig [26.8 ± 0.7 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:	414 ± 14 psig [28.5 ± 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.

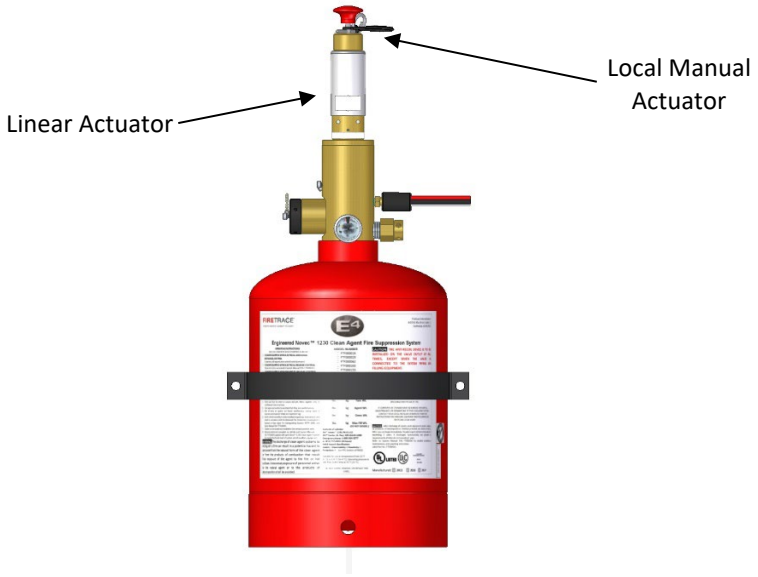


Figure 4 - Linear Actuator and Local Manual Actuator in Stacked Configuration

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 FK-5-1-12 discharge.

A single cylinder bracket is required for the 38 lb. [15 L], 75 lb. [29 L], 160 lb. [62 L], and 270 lb. [103 L] cylinders. The 400 lb. [153 L], 600 lb. [227 L], 950 lb. [368 L] and 1,300 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 cylinders mounting straps – for reference only.

Table 12 – Cylinder Dimensions

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
38 lb. [15 L]	FTF400035	1	Wall	9.8	248	12.3	311	11.3	286	1.4	35
75 lb. [29 L]	FTF400035	1	Wall	9.8	248	12.3	311	11.3	286	1.4	35
160 lb. [62 L]	FTF400150	1	Wall	12.5	318	15.0	381	14.0	356	1.4	35
270 lb. [103 L]	FTF400250	1	Wall	15.8	400	18.3	464	17.3	438	1.4	35
400 lb. [153 L]	FTF400250	2	Wall	15.8	400	18.3	464	17.3	438	1.4	35
600 lb. [227 L]	FTF400560	2	Wall	19.8	502	22.3	565	21.3	540	1.4	35
950 lb. [368 L]	FTF400950	2	Wall	23.8	603	26.3	667	25.3	643	1.4	35
1,300 lb. [490 L]	FTF401200	2	Wall	29.0	737	32.3	819	31.3	794	1.4	35
1,300 lb. [490 L]	FTF401201	2	Floor	4.5	114	10.5	267	9.5	241	1.37	35

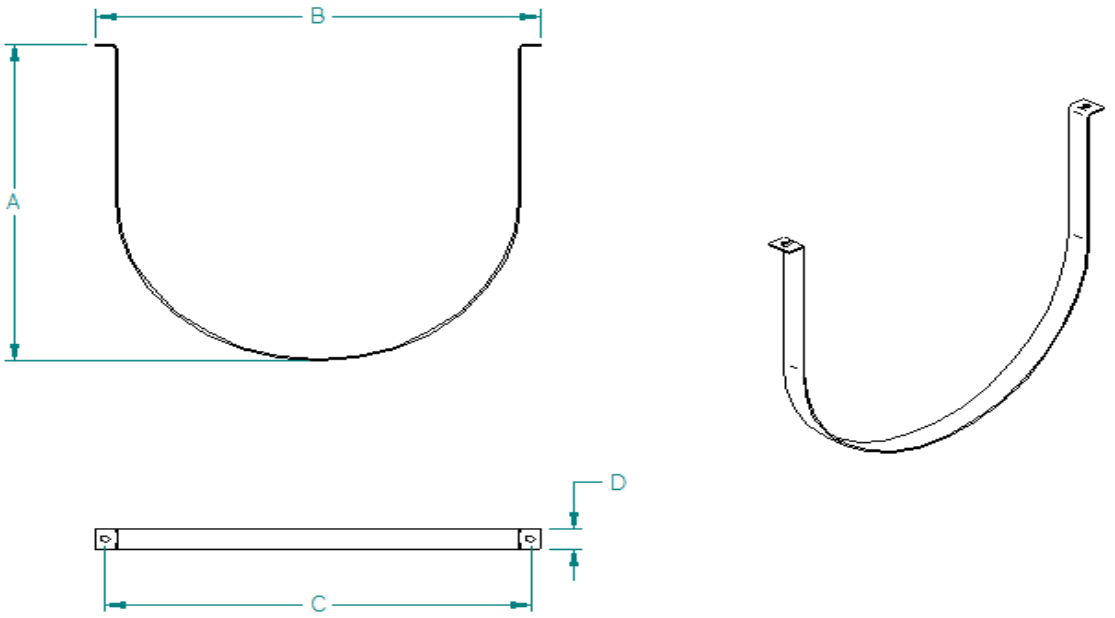


Figure 5 – Cylinder Wall Strap

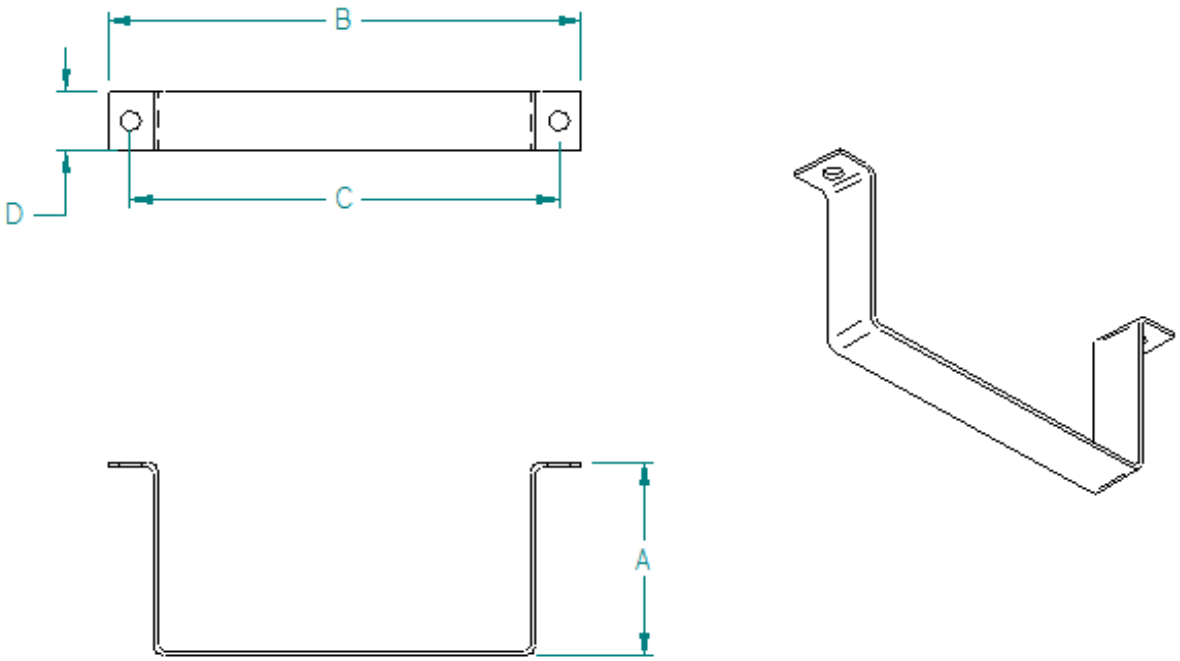


Figure 6 – Cylinder Floor Strap

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, see Figure 9 – Electric Linear Actuator.

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.

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.

Table 13 – Electric Linear Actuator Part Numbers

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

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

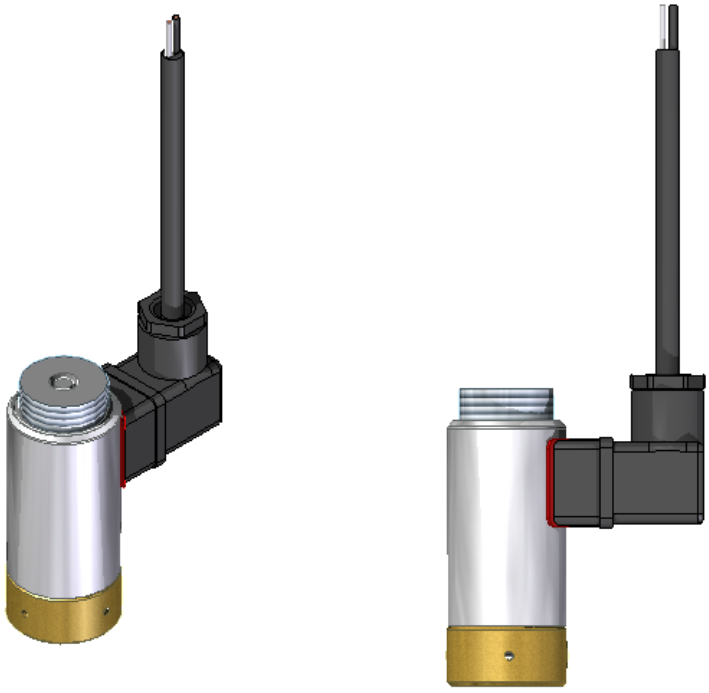


Figure 9 – Electric Linear Actuator

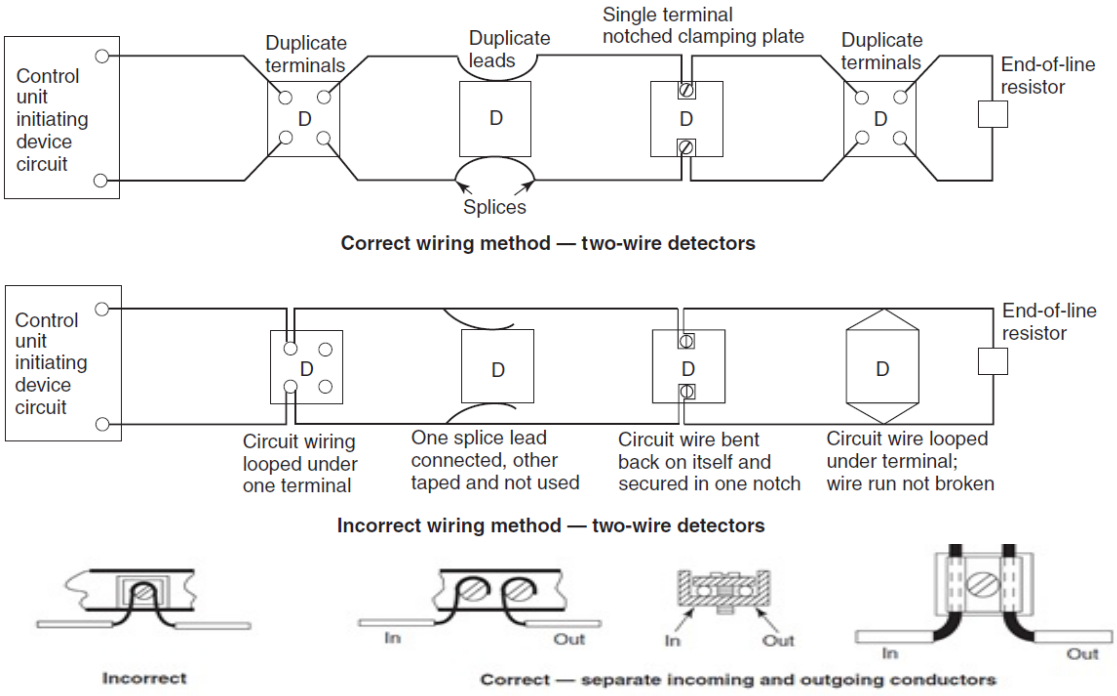


Figure 10 – Wiring Diagram per NFPA 72

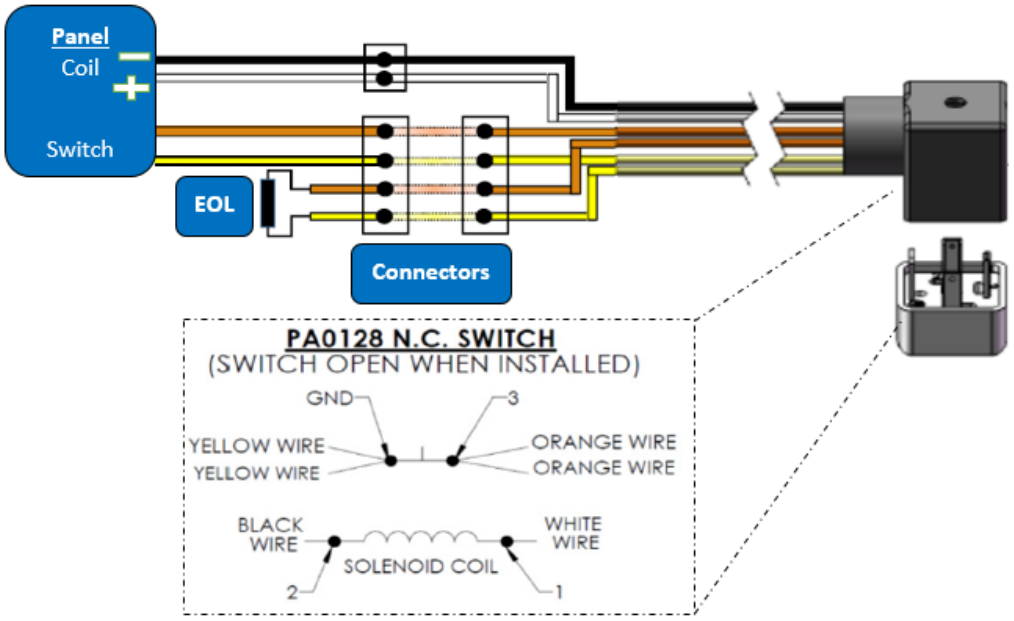


Figure 11 – Electric Linear Actuator with Monitoring Switch Wiring Diagram

2.1.3 Nozzles

Discharge nozzles are made of brass, stainless steel or aluminum (aluminum nozzles are not part of an FM Approved system) with female pipe threads. Nozzles are available in ½ in [15 mm], 1 in [15 mm], 1 ½ in [40 mm], 2 in [50 mm], and 2 ½ in [65 mm] nominal connection sizes. The nozzles are available in 180° sidewall or 360° central discharge

patterns. Orifice plates are drilled to a calculated, application specific diameter. Orifice Plates are of the same material as the nozzle containing them. 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.

Figure 12 – Nozzle Examples

2.1.3.1 Part Numbering and Nozzle Types

When specifying the nozzle part numbers – the base numbers below can be used for the initial part numbers. An additional suffix is required to denote the decimal size drill diameter of the nozzle orifice.

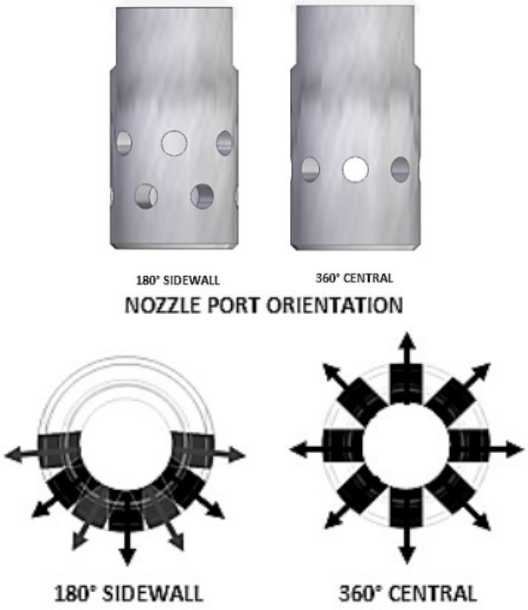


Figure 13 – Nozzle Port Orientation

Table 14 – Base Aluminum Nozzle Configurations

Nozzle Base Part Number	NPT Pipe Connection Size (Nominal)	Port Orientation
FTF661100-XXXX	½ in [15 mm]	360° Central
FTF661200-XXXX	½ in [15 mm]	180° Sidewall
FTF662100-XXXX	1 in [25 mm]	360° Central
FTF662200-XXXX	1 in [25 mm]	180° Sidewall
FTF663100-XXXX	1 ½ in [40 mm]	360° Central
FTF663200-XXXX	1 ½ in [40 mm]	180° Sidewall
FTF664100-XXXX	2 in [50 mm]	360° Central
FTF664200-XXXX	2 in [50 mm]	180° Sidewall
FTF665100-XXXX	2 ½ in [65 mm]	360° Central
FTF665200-XXXX	2 ½ in [65 mm]	180° Sidewall

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

Table 15 – Base Brass Nozzle Configurations

Nozzle Base Part Number	NPT Pipe Connection Size (Nominal)	Port Orientation
FTF661300-XXXX	½ in [15 mm]	360° Central
FTF661400-XXXX	½ in [15 mm]	180° Sidewall
FTF662300-XXXX	1 in [25 mm]	360° Central
FTF662400-XXXX	1 in [25 mm]	180° Sidewall
FTF663300-XXXX	1 ½ in [40 mm]	360° Central
FTF663400-XXXX	1 ½ in [40 mm]	180° Sidewall
FTF664300-XXXX	2 in [50 mm]	360° Central
FTF664400-XXXX	2 in [50 mm]	180° Sidewall
FTF665300-XXXX	2 ½ in [65 mm]	360° Central
FTF665400-XXXX	2 ½ in [65 mm]	180° Sidewall

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

Table 16 – Base Stainless-Steel Nozzle Configurations

Nozzle Base Part Number	NPT Pipe Connection Size (Nominal)	Port Orientation
FTF661500-XXXX	½ in [15 mm]	360° Central
FTF661600-XXXX	½ in [15 mm]	180° Sidewall
FTF662500-XXXX	1 in [25 mm]	360° Central
FTF662600-XXXX	1 in [25 mm]	180° Sidewall
FTF663500-XXXX	1 ½ in [40 mm]	360° Central
FTF663600-XXXX	1 ½ in [40 mm]	180° Sidewall
FTF664500-XXXX	2 in [50 mm]	360° Central
FTF664600-XXXX	2 in [50 mm]	180° Sidewall
FTF665500-XXXX	2 ½ in [65 mm]	360° Central
FTF665600-XXXX	2 ½ in [65 mm]	180° Sidewall

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

WARNING:
When FK-5-1-12 is discharged through the nozzle, the vaporizing FK-5-1-12 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 FK-5-1-12 in a horizontal plane. The flow of FK-5-1-12 should not be obstructed where obstructions are avoidable.

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 14 –Manual Override

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

Table 17 – Manual Override Part Numbers

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

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 16)
- 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, Figure 15 – Pneumatic Actuator .

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 Figure 16 – Secondary Control Arrangement Example and Table 18 – Pneumatic Actuator Quantities 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 15 – Pneumatic Actuator

Table 18 – Pneumatic Actuator Quantities

Maximum Quantity of Pneumatic Actuators	Maximum Overall Length of Actuation Line (Tube, Pipe or Hose)
20	60 ft. [18.29 m]

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 16 – Pneumatic Actuator Quantities.

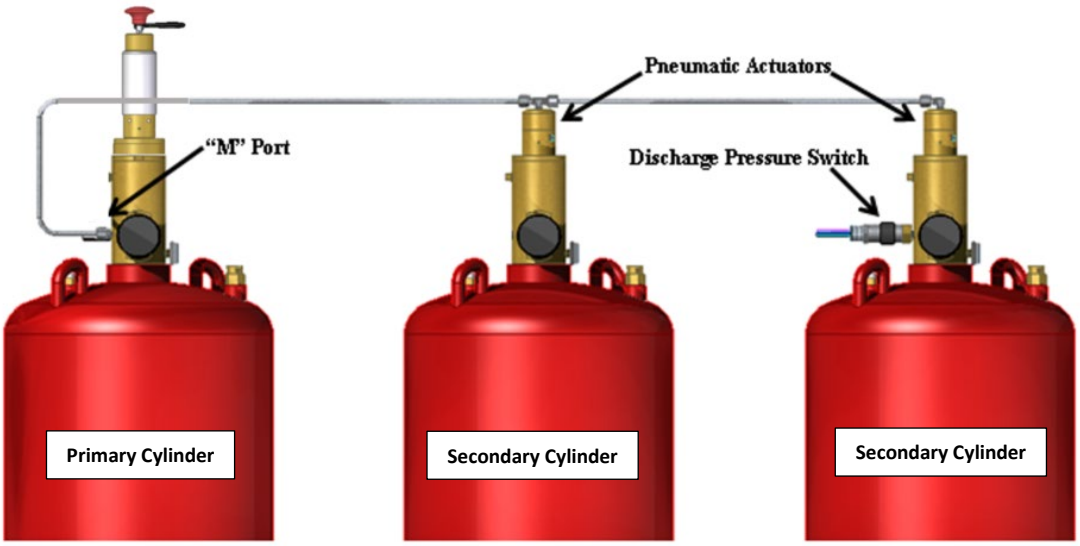


Figure 16 – Secondary Control Arrangement Example

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.

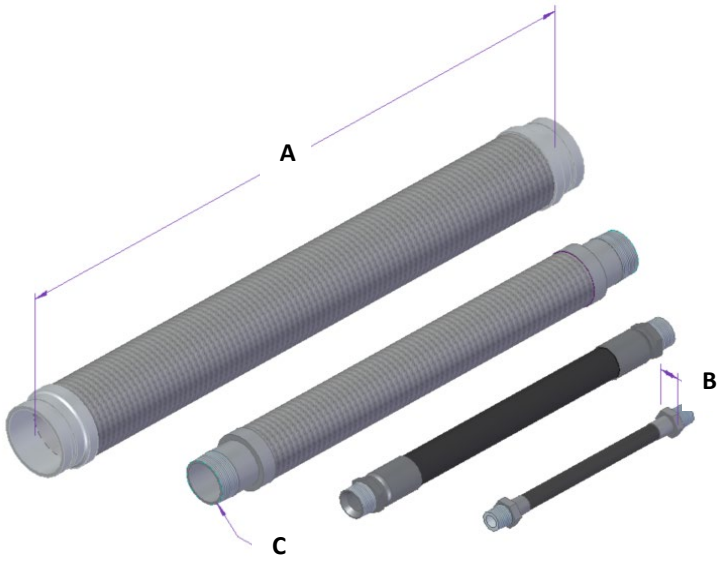


Figure 17 – Flex Hoses

Table 19 – Flex Hose Dimensions

Flex Hose Part Number	Flex Hose Size (Nominal)	Dimension "A"		Dimension "B"		Dimension "C" Fitting Style, Size	
		in	mm	in	mm	Fitting Style (male)	Size (Nominal)
FTF701005	1 in [25 mm]	24	609.6	2.25	57.2	NPT	1 in
FTF701505	1 ½ in [40 mm]	24	609.6	2.75	69.9	NPT	1 ½ in
FTF702504	2 ½ in [65 mm]	32	812.8	3.5	88.9	NPT	2 ½ in
FTF704005	4 in [100 mm]	40	1016.0	5	127.0	Groove	4 in

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 in the event that 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.

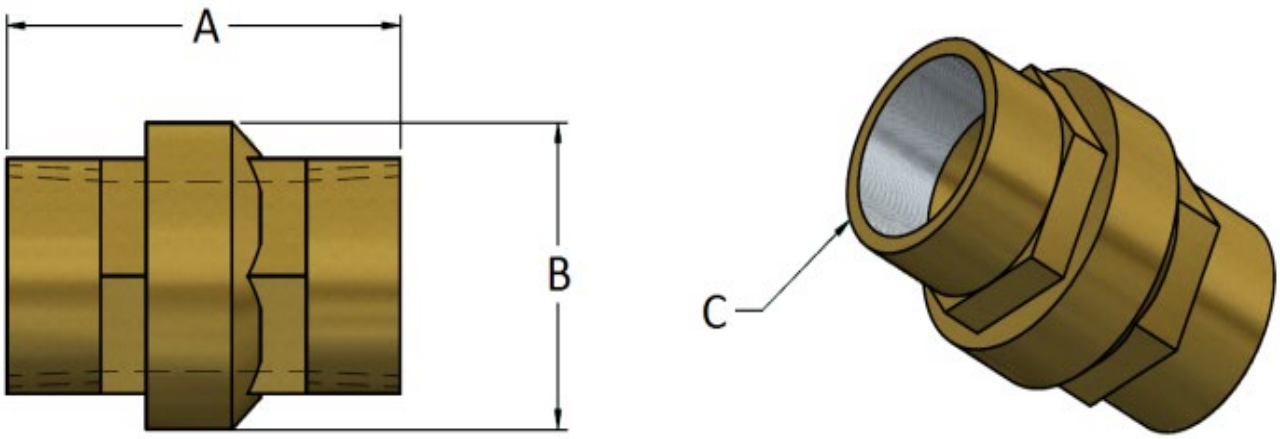


Figure 18 – Check Valve

Table 20 – Check Valve Dimensions

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

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.

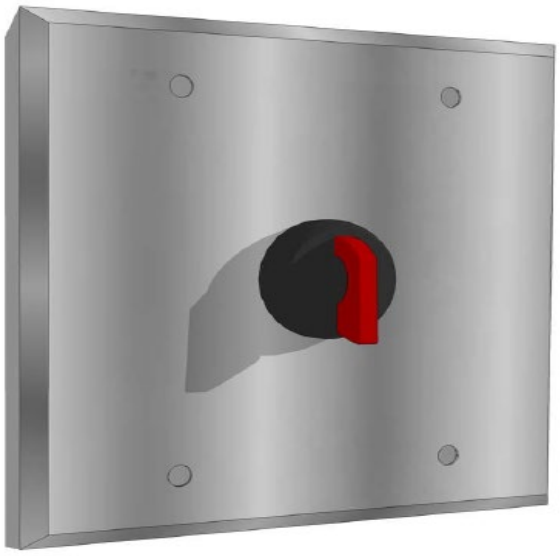


Figure 19 – Main/Reserve Selector Switch

2.2.6 Pressure Operated Switch FTF503013

The Pressure Operated Switch provides additional electrical contacts for indication of discharge, see Figure 20 – Pressure Operated Switch. The switch may be installed into the same pneumatic line for the piston actuators, provided the maximum length for tubing outlined in Table 18 – Pneumatic Actuator Quantities 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

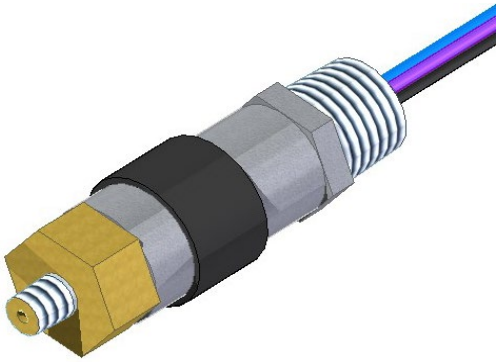


Figure 20 – Pressure Operated Switch

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].

Table 21 – Liquid Level Indicator Part Numbers

Liquid Level Indicator Part Numbers	Cylinder Sizes (Nominal)
FTF720150	160 lb. – 270 lb. [62 L – 103 L]
FTF720375	400 lb. – 950 lb. [153 L – 368 L]
FTF721200	1,300 lb. [490 L]

Figure 21 – Typical LLI Installation

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 FM standards they must meet the listed 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 FK-5-1-12 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 FK-5-1-12 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 FK-5-1-12 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, FK-5-1-12 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 22 – Minimum Design Concentrations (MDC)

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.

3.2.2 Pressure Relief Vent Area

In the event of a discharge, the protected enclosure must have sufficient structural strength and integrity to contain the agent discharge. If the pressure difference across the enclosure boundaries present a threat to the hazard enclosure, venting shall be provided to prevent excessive pressures.

Guidance to determine the pressure relief vent area can be found in the FSSA Application Guide to Estimating Enclosure Pressure & Relief Vent Area for Use with Clean Agent Extinguishing Systems and shall be in accordance with NFPA 2001 requirements.

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 respective agents. Please refer to the applicable edition of NFPA 2001 / agent manufacturer certifications for the most correct information.

For Class B hazards, refer to Annex B of NFPA 2001 for the cup burner extinguishment concentration value for 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 as per Table 22 – Minimum Design Concentrations (MDC) Contact Firetrace for guidance on hazards deviating from these requirements or for fuels not listed.

Table 22 – Minimum Design Concentrations (MDC)

Company Name	MEC Class A	MEC Class B	MDC Class A	MDC Class B	MDC Class C
3M™ Novec™ 1230	3.34	4.50	4.50	5.85	4.51
Noah® 5112	3.35	4.50	4.50	5.85	4.52
Dukare 1230	3.35	4.50	4.50	5.85	4.52
Waysmos FK5112	3.51	4.53	4.53	5.89	4.74
Chemori 5112 ™	3.75	4.50	4.50	5.85	5.06

Note:

- MEC – Minimum Extinguishing Concentration
- MDC – Minium Design Concentration

- As per NFPA 2001-2018 cup burner values and its safety factors

5.4.2.2* The flame extinguishing concentration for Class A fuels shall be determined by test as part of a listing program. As a minimum, the listing program shall conform to ANSI / UL 2127 or ANSI / UL 2166 or equivalent.

5.4.2.3 The minimum design concentration for a Class B fuel hazard shall be the extinguishing concentration, as determined in 5.4.2.1, times a safety factor of 1.3.

5.4.2.4* The minimum design concentration for a Class A surface-fire hazard shall be determined by the greater of the following:

(1) The extinguishing concentration, as determined in 5.4.2.2, times a safety factor of 1.2
(2) Equal to the minimum extinguishing concentration for heptane as determined from 5.4.2.1

5.4.2.5 The minimum design concentration for Class C hazard shall be the extinguishing concentration, as determined in 5.4.2.2, times a safety factor of 1.35.

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 FK-5-1-12 agent is required. Conversely, the lower the enclosure temperature, the more FK-5-1-12 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 23 – Atmospheric Correction Factor for applicable multipliers.

Table 23 – Atmospheric Correction Factor

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

3.3.4 Flooding Factors

Table 24 – Typical Application Flooding Factors – US Customary Units

Temperature, t [°F]	Specific Vapor Volume, [ft³/lb.]	Weight Requirements of Hazard Volume, W/V [lb./ft³]						
		Design Concentrations [% by Volume]						
		4.50	4.53	4.74	5.07	5.85	5.89	6.00
0	0.9856	0.0479	0.0495	0.0523	0.0574	0.0654	0.0677	0.0648
10	1.01001	0.0467	0.0483	0.051	0.0560	0.0638	0.066	0.0632
20	1.03442	0.0456	0.0472	0.0498	0.0547	0.0622	0.0644	0.0617
30	1.05883	0.0446	0.0461	0.0487	0.0534	0.0608	0.063	0.0603
40	1.08324	0.0436	0.0451	0.0476	0.0522	0.0594	0.0615	0.0589
50	1.10765	0.0426	0.044	0.0465	0.0510	0.0581	0.0601	0.0576
60	1.13206	0.0417	0.0431	0.0455	0.0500	0.0569	0.0589	0.0564
70	1.15647	0.0408	0.0422	0.0446	0.0489	0.0557	0.0576	0.0552
80	1.18088	0.0400	0.0413	0.0437	0.0479	0.0546	0.0565	0.0541
90	1.20529	0.0392	0.0405	0.0428	0.0470	0.0535	0.0553	0.053
100	1.2297	0.0384	0.0397	0.0419	0.0460	0.0524	0.0542	0.0519
110	1.25411	0.0376	0.0389	0.0411	0.0451	0.0513	0.0531	0.0509
120	1.27852	0.0369	0.0382	0.0403	0.0442	0.0503	0.0521	0.0499
130	1.30293	0.0362	0.0375	0.0396	0.0434	0.0494	0.0512	0.049

Table 25 – Typical Application Flooding Factors – SI Units

Temperature, t [°C]	Specific Vapor Volume [m³/kg]	Weight Requirements of Hazard Volume, W/V [kg/m³]						
		Design Concentrations [% by Volume]						
		4.5	4.53	4.74	5.07	5.85	5.89	6
-17.7	0.0615	0.7661	0.7928	0.8373	0.9188	1.0462	1.0826	1.0371
-15	0.0623	0.757	0.7834	0.8274	0.9079	1.0337	1.0696	1.0247
-10	0.0637	0.7407	0.7665	0.8096	0.8884	1.0115	1.0467	1.0027
-5	0.065	0.725	0.7503	0.7924	0.8696	0.9902	1.0247	0.9816
0	0.0664	0.7101	0.7348	0.7761	0.8516	0.9697	1.0035	0.9613
5	0.0678	0.6957	0.72	0.7604	0.8345	0.9502	0.9832	0.9419
10	0.0691	0.6819	0.7057	0.7453	0.8179	0.9313	0.9637	0.9232
15	0.0705	0.6687	0.692	0.7309	0.802	0.9131	0.9449	0.9052
20	0.0719	0.656	0.6788	0.717	0.7867	0.8958	0.927	0.888
21.1	0.0722	0.6532	0.6759	0.7139	0.7834	0.8921	0.9231	0.8843
25	0.0733	0.6437	0.6661	0.7035	0.772	0.879	0.9096	0.8714
30	0.0672	0.7014	0.7258	0.7666	0.8412	0.9578	0.9912	0.9495
35	0.0760	0.6205	0.6421	0.6782	0.7442	0.8473	0.8767	0.8399
40	0.0774	0.6094	0.6306	0.666	0.7309	0.8322	0.8612	0.825
45	0.0787	0.5988	0.6196	0.6545	0.7182	0.8177	0.8462	0.8106
50	0.0801	0.5886	0.6091	0.6433	0.7059	0.8037	0.8316	0.7967
54.5	0.0811	0.5856	0.606	0.6401	0.7024	0.7997	0.8275	0.7927

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 22 – Typical Application Flooding Factors - US Customary Units)
C.F. = atmospheric correction factor (see Table 21 – Atmospheric Correction Factor)
s = specific volume of superheated FK-5-1-12 fluid vapor (ft^3/lb.)
This can be approximated by the formula:

$$s = 0.9856 + 0.002441*t$$

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 23 - Typical Application Flooding Factors – SI Units)
C.F. = atmospheric correction factor (see Table 21 – Atmospheric Correction Factor)
s = specific volume of superheated FK-5-1-12 fluid vapor (m^3/kg)
This can be approximated by the formula:

$$s = 0.0664 + 0.0002741*t$$

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 FK-5-1-12 through the discharge piping is a complex two-phase flow. The Firetrace FK-5-1-12 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 FK-5-1-12 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.

Table 26 – Flow Limitations

Duration of Discharge	10 sec maximum 3.6 sec minimum
Maximum Pipe to Liquid Agent Volume	636.8%
Minimum Orifice Area to Pipe Ratio	2.85%
Maximum Orifice Area to Pipe Ratio	91.33%
Minimum Nozzle Pressure	153.3 psig [10.5 bar]
Maximum Difference in Transport Time*	5.6 sec

*** 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.

Table 27 – Minimum and Maximum Flow Rate Guidelines

NPT Pipe Size (Nominal), [in]	Flow Rate Range		Pipe Type
	[lb/sec]	[kg/sec]	
1/4	0.1 - 2.1	0.05 - 0.95	SCH 40
3/8	0.4 - 2.9	0.18 - 1.32	SCH 40
1/2	0.7 - 3.4	0.32 - 1.54	SCH 40
3/4	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
8	142.0 - 445.0	64.41 - 201.85	SCH 40

3.4.2 Tee Limitations

To obtain the most economical piping for a given hazard layout, tees are employed to branch the FK-5-1-12 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 28 – Tee Limitations.

Table 28 – Tee Limitations

Description	Limitation	Figure
Maximum Bullhead Tee Imbalance	10/90	Figure 22 – Maximum Bull Tee Imbalance
Minimum Bullhead Tee Imbalance	50/50	Figure 23 – Minimum Bull Tee Imbalance
Maximum Side Tee Imbalance	5/95	Figure 24 – Maximum Side Tee Imbalance
Minimum Side Tee Imbalance	47/53	Figure 25 – Minimum Side Tee Imbalance
Bullhead tees shall have both outlets in the same horizontal plane.		Figure 26 – Bull Tee Configurations
Side tee splits shall have the inlet and both outlets in the same horizontal plane.		Figure 27 – Side Tee Configurations

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

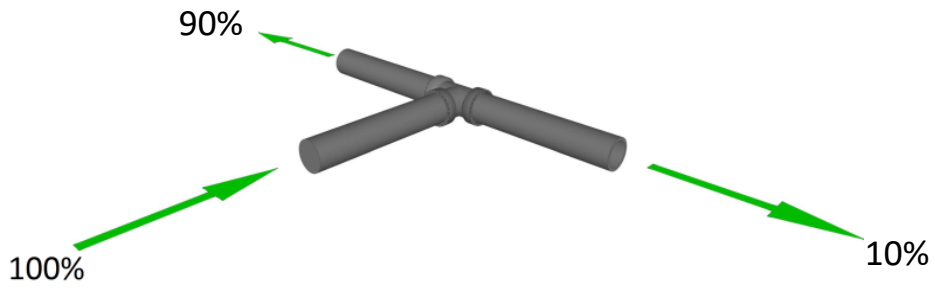


Figure 22 – Maximum Bull Tee Imbalance

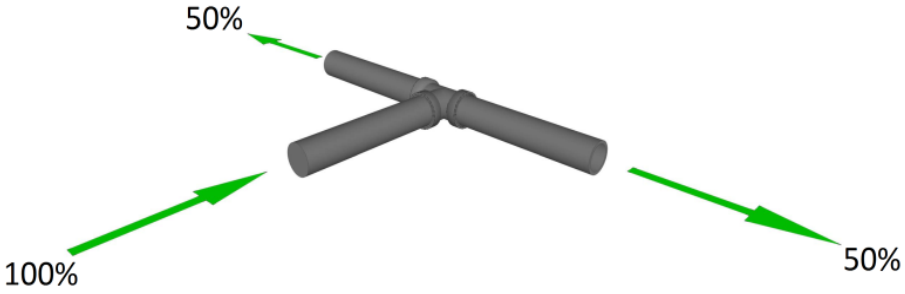


Figure 23 – Minimum Bull Tee Imbalance

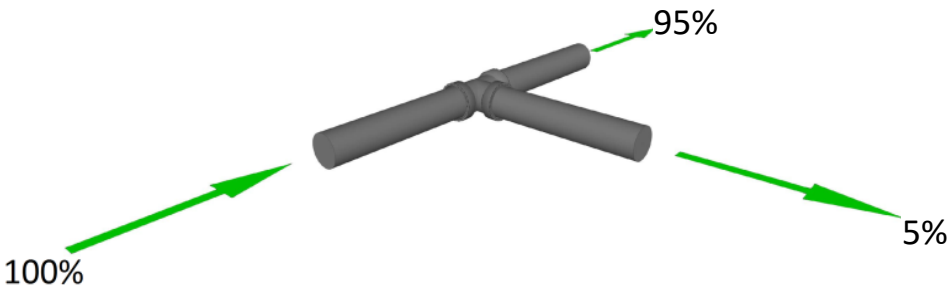


Figure 24 – Maximum Side Tee Imbalance

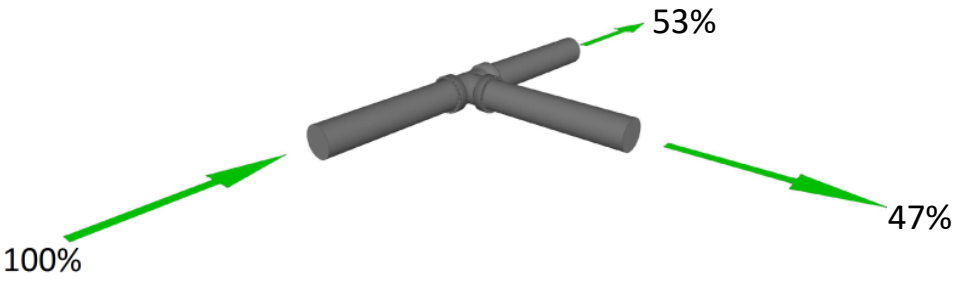


Figure 25 – Minimum Side Tee Imbalance

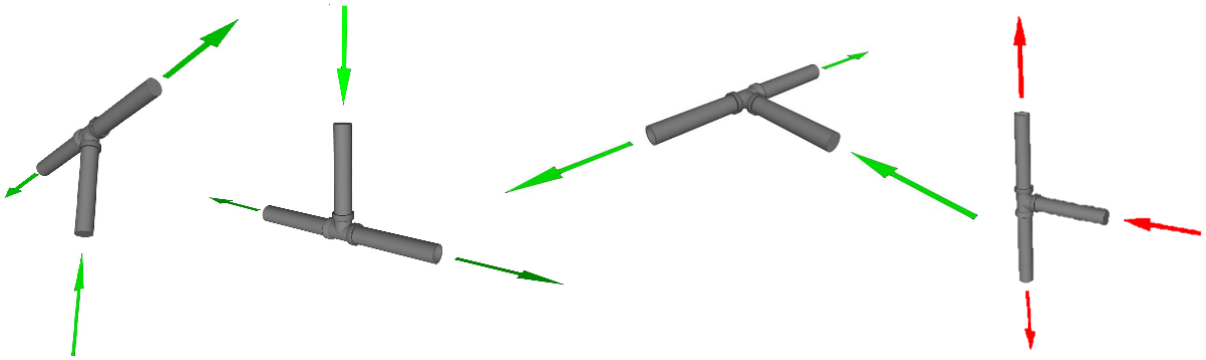


Figure 26 – Bull Tee Configurations

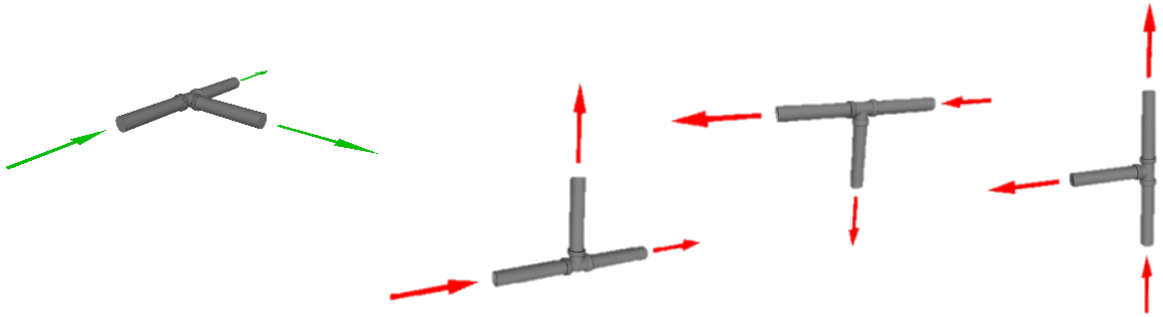


Figure 27 – Side Tee Configurations

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 Multiple Cylinder Installations

When required by hazard size, a manifold may be used to connect multiple cylinders together to feed the common piping network. Figure 28 – Typical Center Outlet Manifold and Figure 29 – Typical End Outlet Manifold show typical manifolds using threaded, grooved or welded fittings and pipe.

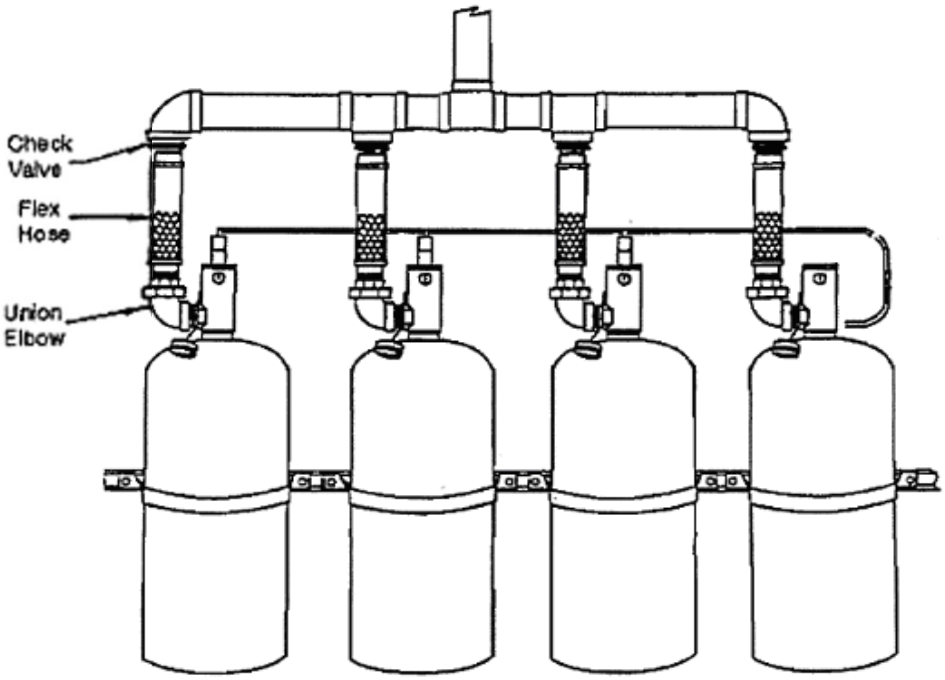


Figure 28 – Typical Center Outlet Manifold

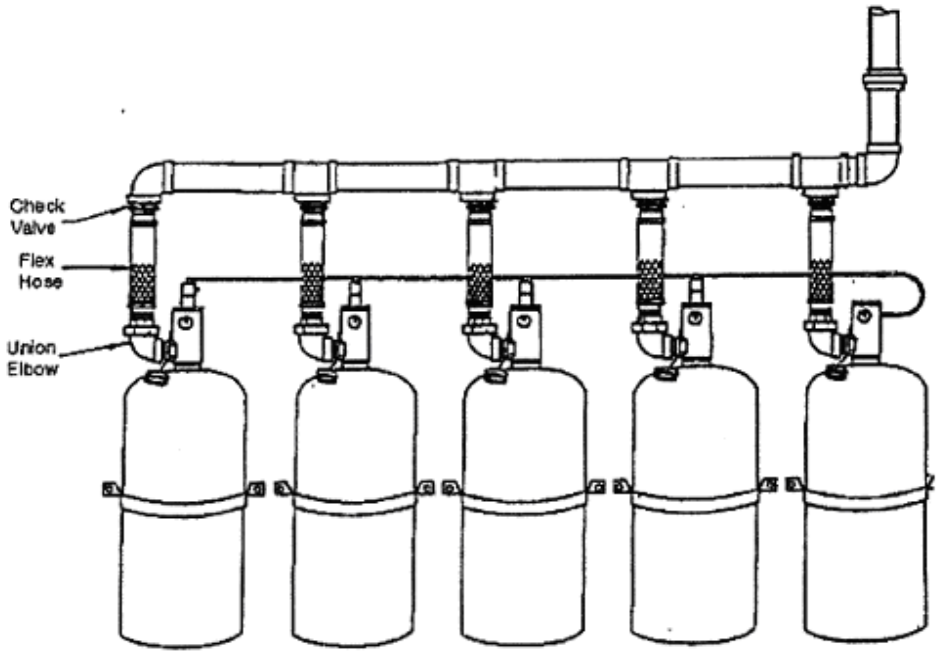


Figure 29 – Typical End Outlet Manifold

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.

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 30 – 360° Central Nozzle Coverage. 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 31 – 180° Single Sidewall Nozzle Coverage. Two 180° nozzles may be installed centrally in the hazard in a "back-to-back" orientation, providing a larger area of coverage, see Figure 32 – Back to Back Dual Sidewall Nozzle Coverage. 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

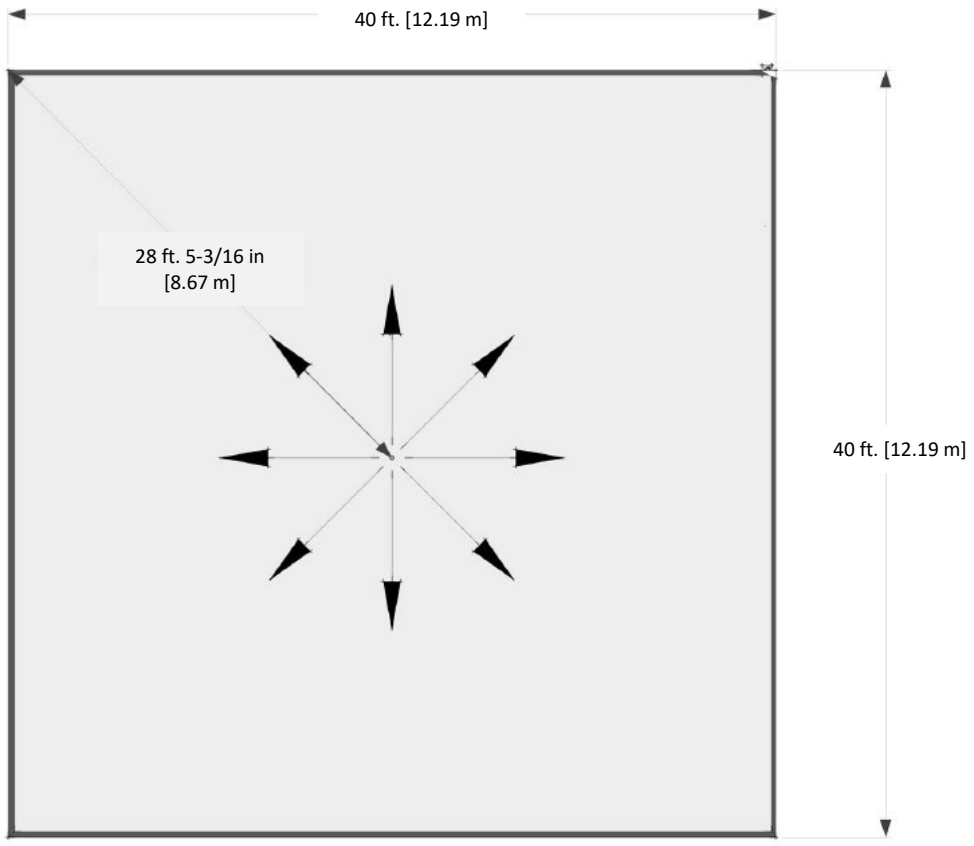


Figure 30 – 360° Central Nozzle Coverage

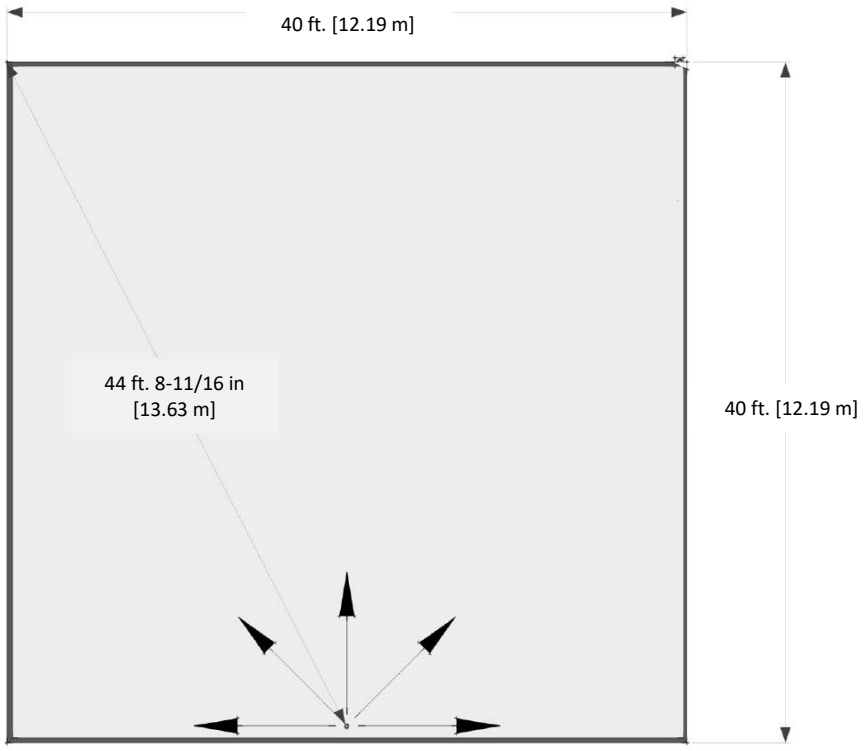


Figure 31 – 180° Single Sidewall Nozzle Coverage

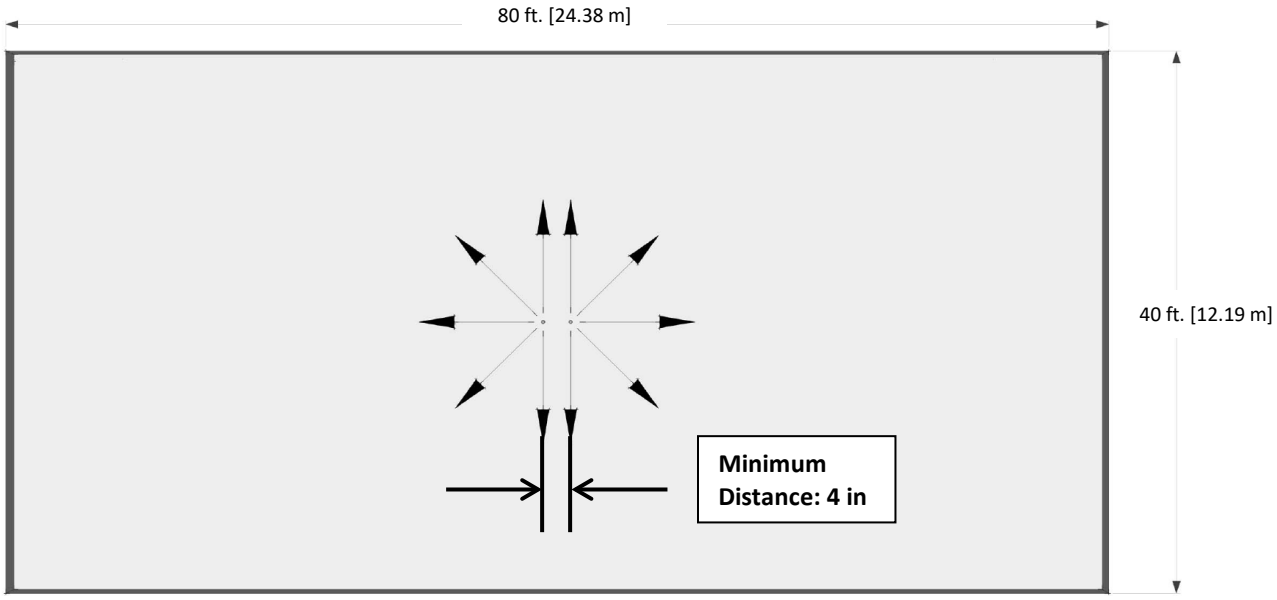


Figure 32 – Back to Back Dual Sidewall Nozzle Coverage

3.6.2 Height

Nozzles shall be installed 0 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 33 – Nozzle Installation Limitations.

All nozzles are rated for a maximum hazard height of 14 ft. [4.27 m], see Figure 34 – Single Sidewall Nozzle Height Limit and Figure 35 – Single Central Nozzle Height Limit for examples. If the hazard exceeds 14 ft. [4.27 m] in height, multiple tiers of nozzles must be used for each 14 ft. [4.27 m] increment of enclosure of height, see Figure 36 – Tiered Nozzle Example for an example.

The maximum elevation difference between the farthest horizontal pipe runs or nozzles (whichever is furthest) shall not exceed 44 ft. [13.41 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.

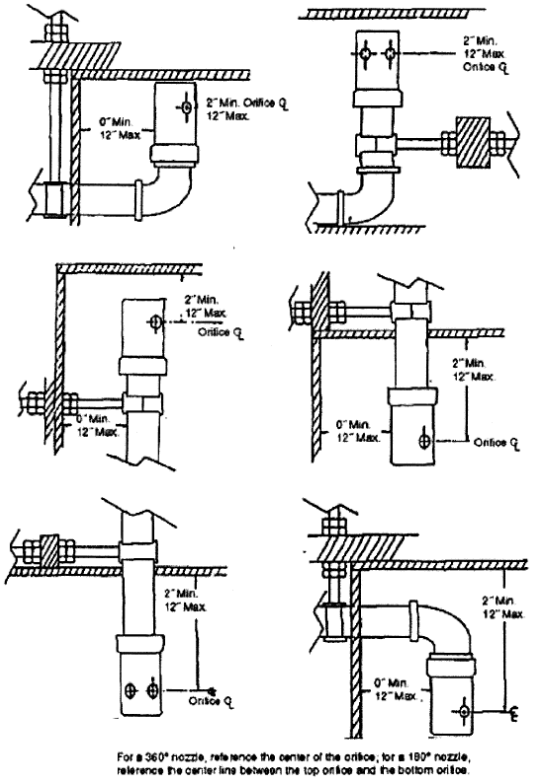


Figure 33 – Nozzle Installation Limitations

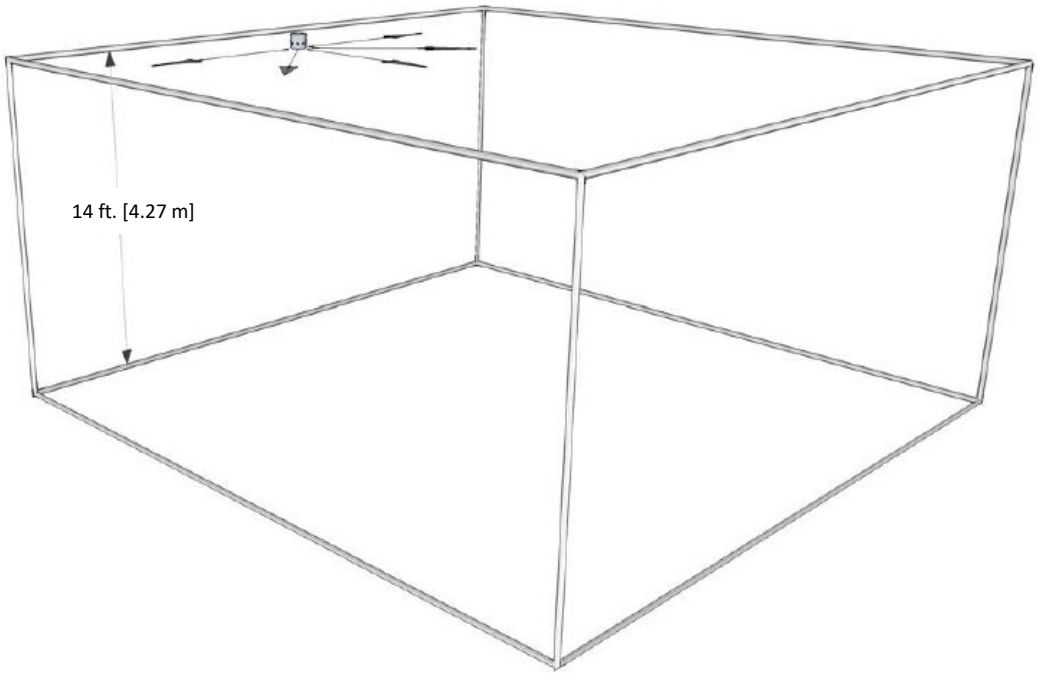


Figure 34 – Single Sidewall Nozzle Height Limit

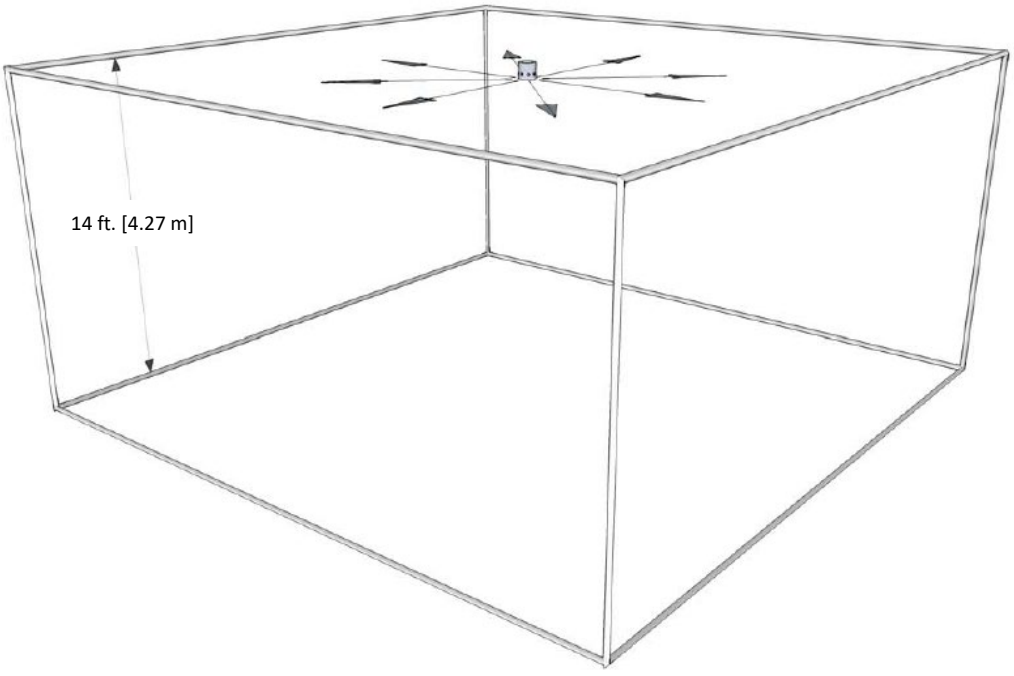


Figure 35 – Single Central Nozzle Height Limit

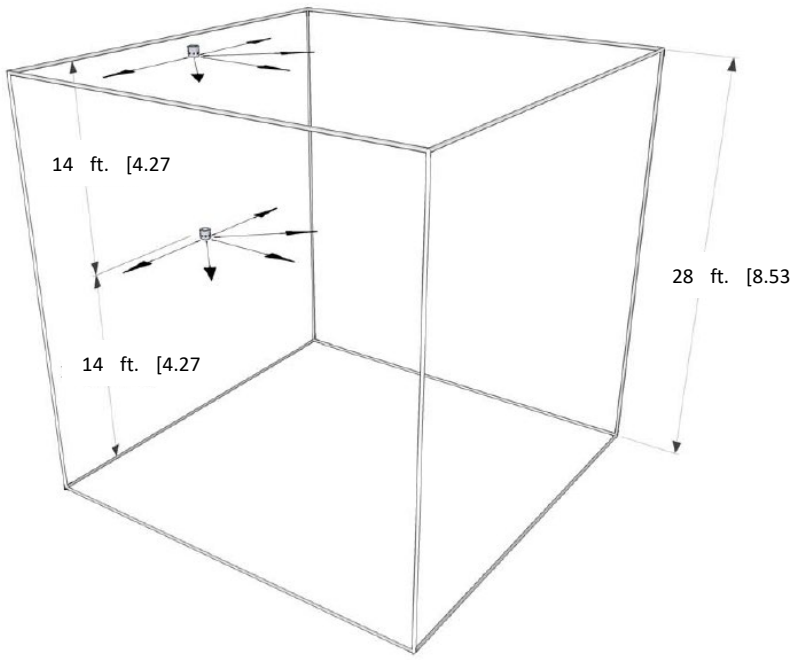


Figure 36 – Tiered Nozzle Example

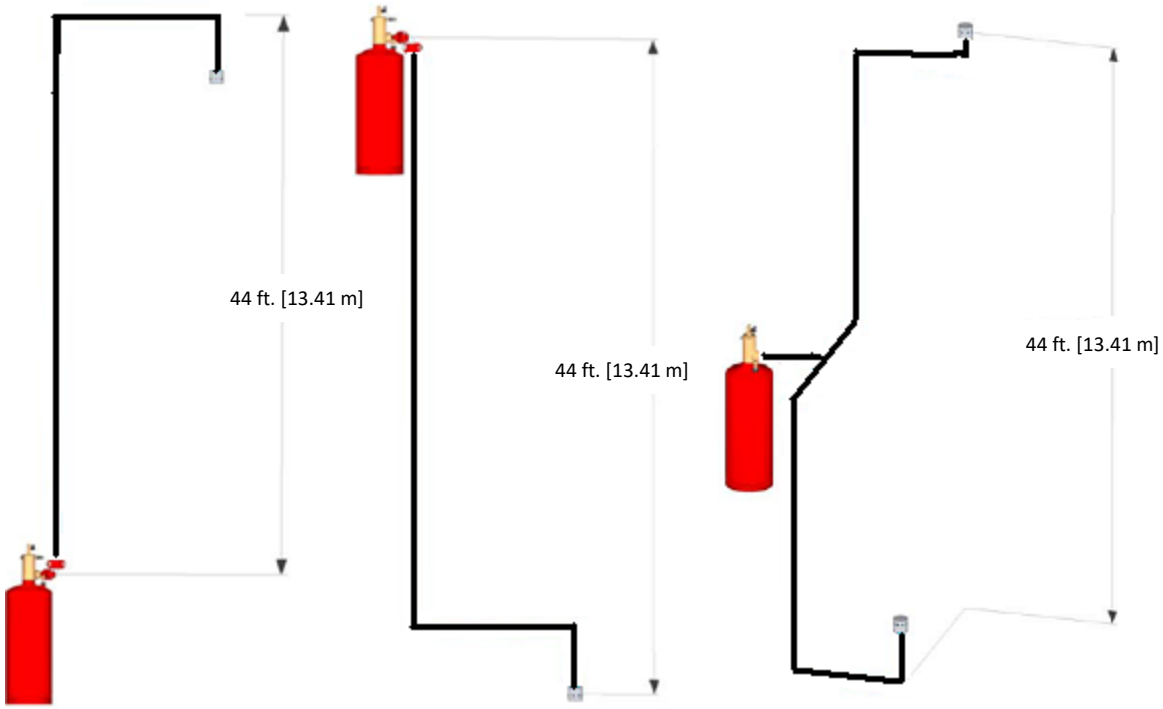


Figure 37 – Nozzle Elevation Difference

3.6.3 Equivalent Length Data

Table 29 – 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	6.9	2.1	8.1	2.5
1 in (70 lb)	17.5	5.3	7.0	2.1	6.9	2.1	8.1	2.5
1 ½ in	28.3	8.6	7.6	2.3	39.5	12.0	12.3	3.7
2 ½ in	30.8	9.4	11.6	3.5	22.0	6.7	N/A	
4 in	75.0	22.9	10.0	3.0	45.0	13.7	N/A	

3.7 Example Calculation

An example calculation is contained below.

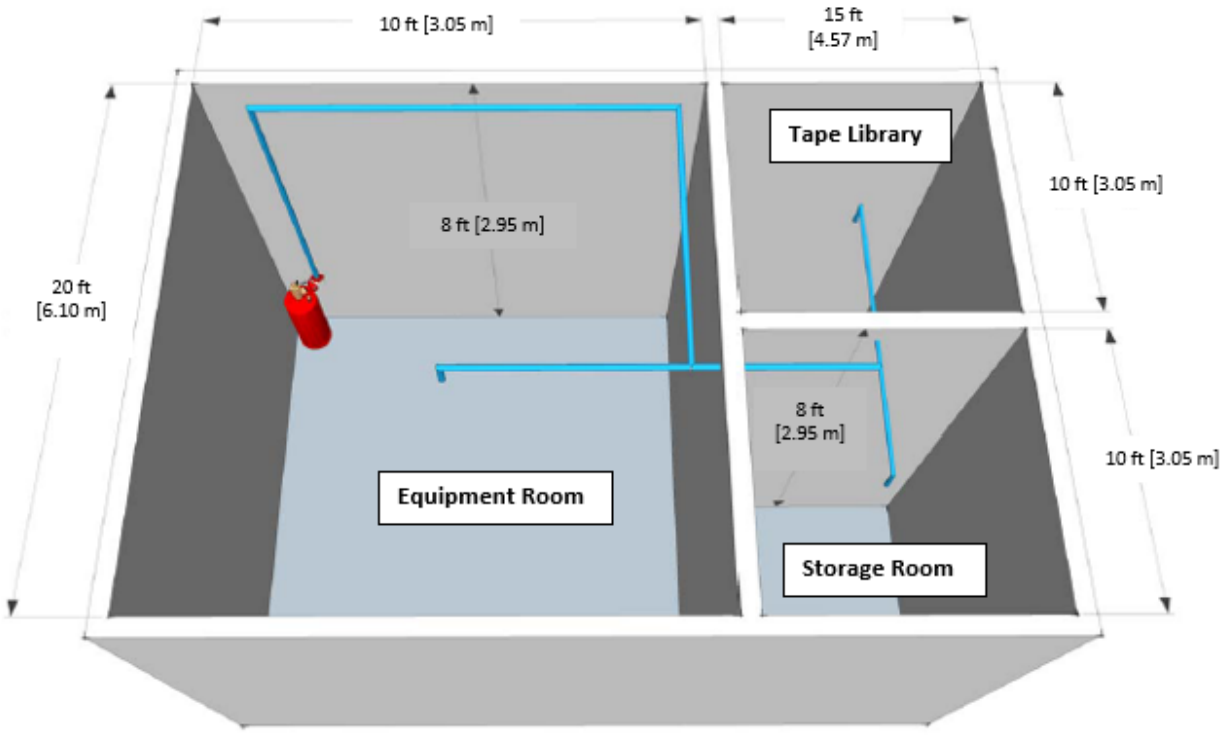


Figure 38 – Example Calculation Layout

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 4.5% for Class A Hazard (As per NFPA 2001, 2018).
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):
$V = H \times A$
$V = 8 \text{ ft.} \times 200 \text{ ft}^2 = 1{,}600 \text{ ft}^3$
$V = 2.44 \text{ m} \times 18.61 \text{m}^2 = 45.41 \text{ m}^3$

Minimum Required Agent Amount (W):
$W = V \times F.F.$
$W = 1{,}600 \text{ ft}^3 \times .0408 \text{ lb./ft}^3 = 65.28 \text{ lb.}$ or 66 lb. after rounding
$W = 45.41 \text{ m}^3 \times 0.6532 \text{ kg/m}^3 = 29.66 \text{ kg}$ or 30 kg after rounding

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

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

Minimum Required Agent Amount (W):
$W = V \times F.F.$
$W = 1{,}200 \text{ ft}^3 \times 0.0408 \text{ lb./ft}^3 = 48.96 \text{ lb.}$ or 49 lb. after rounding
$W = 34.01 \text{ m}^3 \times 0.6532 \text{ kg/m}^3 = 21.22 \text{ kg}$ or 21.5 kg after rounding

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

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

Minimum Required Agent Amount (W):
$W = V \times F.F.$
$W = 640\ ft^3 \times 0.0408\ lb./ft^3 = 26.11\ lb.$ or 27 lb. after rounding
$W = 21.96\ m^3 \times 0.6532\ kg/m^3 = 14.34\ kg.$ or 14.5 kg. after rounding

Total Agent Quantity

Table 30 – Total Amount of Agent Required

	Agent Amount [lb.]	Agent Amount [kg]
Equipment Room	66	30
Tape Library	49	21.5
Storage Room	27	14.5
Total	**142**	**66**

3.7.1 Cylinder Selection

Referring to Table 8 – Cylinder Fill Range, 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.

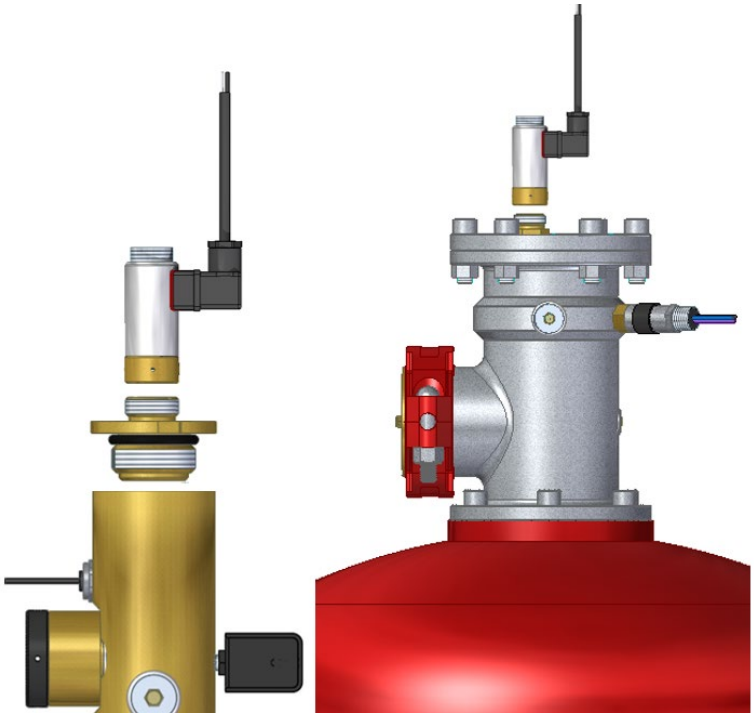


Figure 39 – Electric Linear Actuator Operated Cylinder Valve

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.

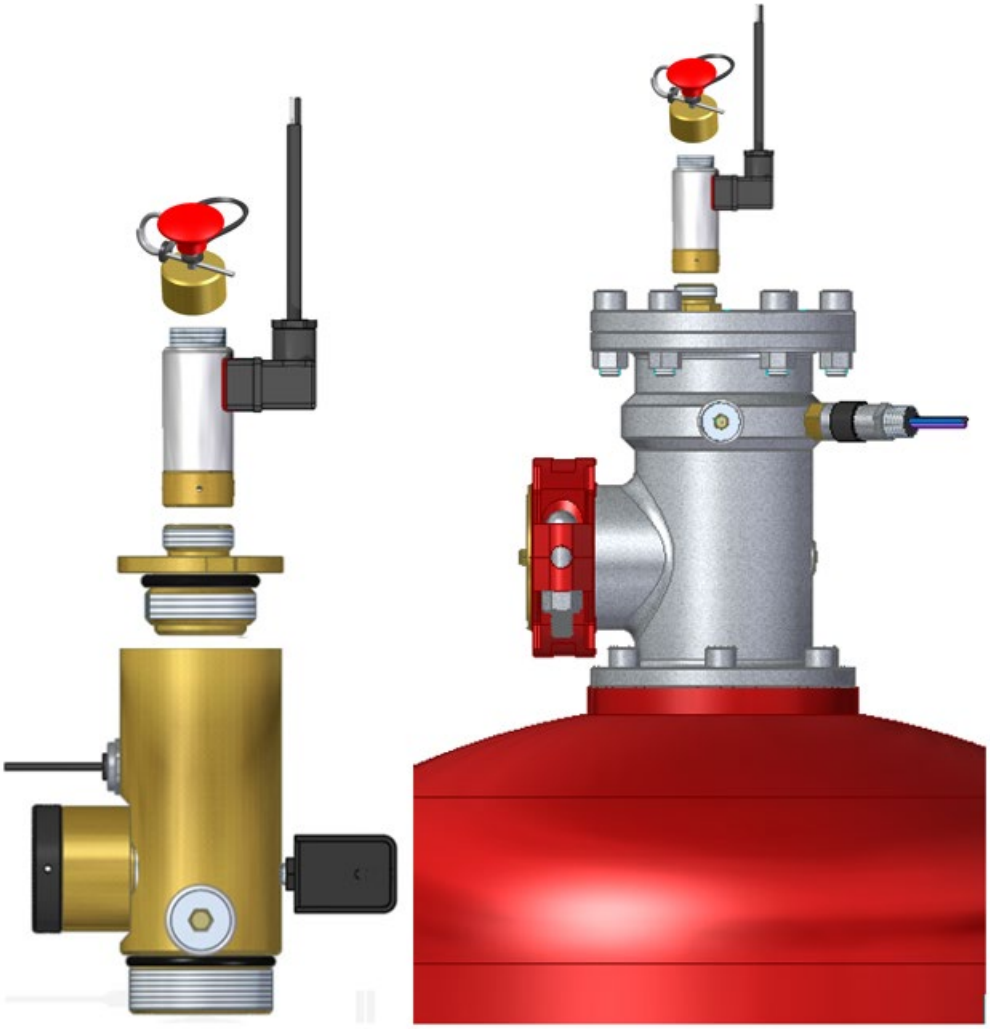


Figure 40 – Cylinder Valve Equipped with Manual Override

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

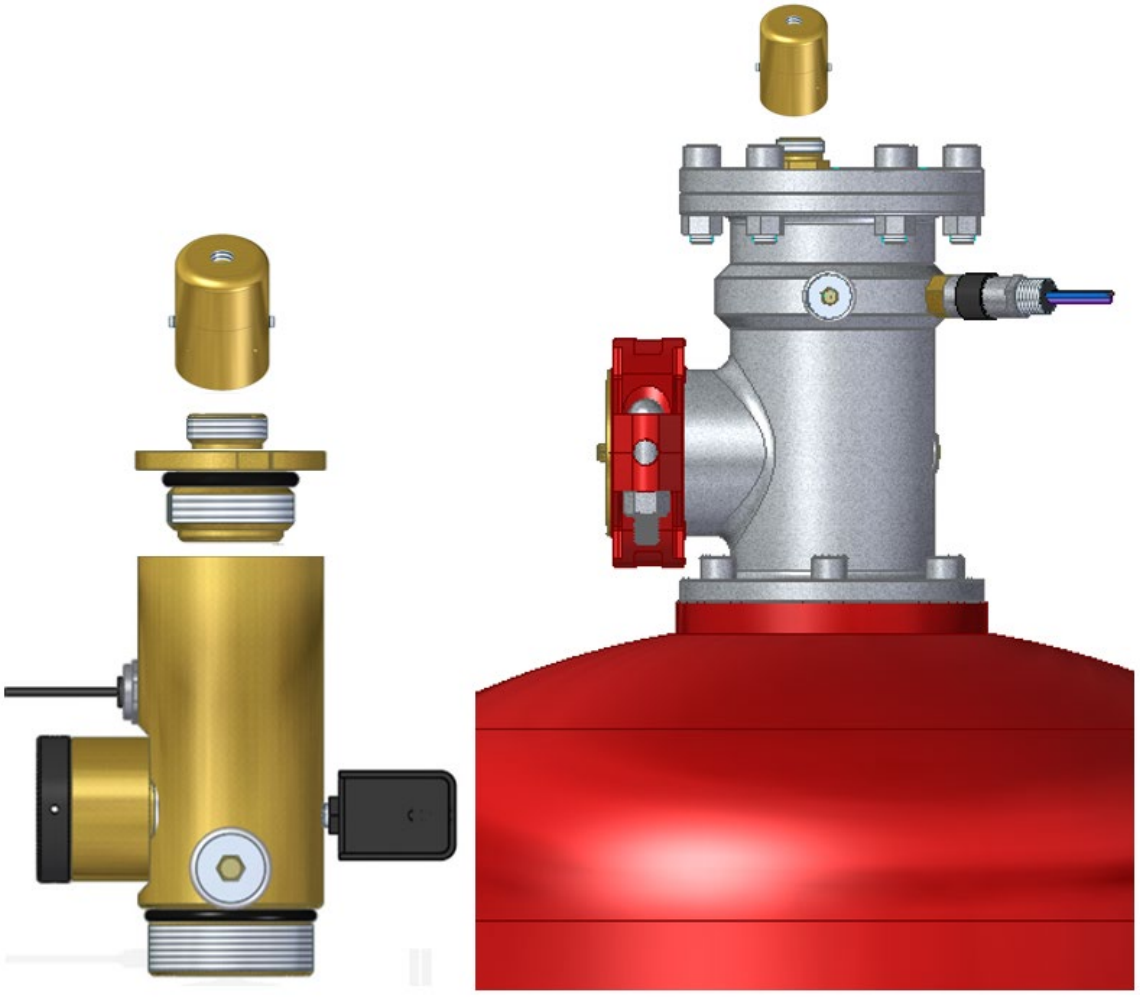


Figure 41 – Pneumatic Actuator Operated Cylinder Valve

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 FK-5-1-12 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 FK-5-1-12 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.

NOTE: Inspection of the 38 lb. [15 L] and 76 lb. [29 L] units must include being weighed. The 164 lb. [62 L], 271 lb. [103 L], 406 lb. [153 L], 601 lb. [227 L], 964 lb. [368 L] and the 1,300 lb. [490 L] units can be inspected using the Liquid Level Indicator or by being weighed.

3) Perform functional test of all component parts of the entire system. Follow instructions provided in Section4.1: Component Verification.

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. FK-5-1-12 does not leave a residue, thus, there are no clean-up operations resulting from an FK-5-1-12 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 FK-5-1-12 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 cylinders 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 FK-5-1-12 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 FK-5-1-12 Cylinder and Valve Assemblies

Table 31 – Base System Assemblies

Part Number	Description
FTF000015	38 lb. [15 L] Cylinder / 1 in [25 mm] Valve Assembly
FTF000029	75 lb. [29 L] Cylinder /1 in [25 mm] Valve Assembly
FTF000062	160 lb. [62 L] Cylinder / 1 ½ in [40 mm] Valve Assembly
FTF000103	270 lb. [103 L] Cylinder /1 ½ in [40 mm] Valve Assembly
FTF000153	400 lb. [153 L] Cylinder / 2 ½ in [65 mm] Valve Assembly
FTF000227	600 lb. [227 L] Cylinder / 2 ½ in [65 mm] Valve Assembly
FTF000368	950 lb. [368 L] Cylinder / 2 ½ in [65 mm] Valve Assembly
FTF000490	1,300 lb. [490 L] Cylinder / 4 in [100 mm] Valve Assembly

6.2 Cylinder Valve Controls and Monitoring Devices

Table 32 – System Releasing 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
FTF503006	Pressure Supervisory Switch, 414 psig Falling, SPDT
FTF503013	Pressure Operated Switch
FTF700041	Pneumatic Actuator, Next Gen

6.3 Engineered Nozzles

Table 33 – Aluminum Nozzles

Part Number	Description
FTF661100-XXXX	½ in [15 mm] NPT, 360° Central, Aluminum
FTF661200-XXXX	½ in [15 mm] NPT, 180° Sidewall, Aluminum
FTF662100-XXXX	1 in [25 mm] NPT, 360° Central, Aluminum
FTF662200-XXXX	1 in [25 mm] NPT, 180° Sidewall, Aluminum
FTF663100-XXXX	1 ½ in [40 mm] NPT, 360° Central, Aluminum
FTF663200-XXXX	1 ½ in [40 mm] NPT, 180° Sidewall, Aluminum
FTF664100-XXXX	2 in [50 mm] NPT, 360° Central, Aluminum
FTF664200-XXXX	2 in [50 mm] NPT, 180° Sidewall, Aluminum
FTF665100-XXXX	2 ½ in [65 mm] NPT, 360° Central, Aluminum
FTF665200-XXXX	2 ½ in [65 mm] NPT, 180° Sidewall, Aluminum

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

Table 34 – Brass Nozzles

Part Number	Description
FTF661300-XXXX	½ in [15 mm] NPT, 360° Central, Brass
FTF661400-XXXX	½ in [15 mm] NPT, 180° Sidewall, Brass
FTF662300-XXXX	1 in [25 mm] NPT, 360° Central, Brass
FTF662400-XXXX	1 in [25 mm] NPT, 180° Sidewall, Brass
FTF663300-XXXX	1 ½ in [40 mm] NPT, 360° Central, Brass
FTF663400-XXXX	1 ½ in [40 mm] NPT, 180° Sidewall, Brass
FTF664300-XXXX	2 in [50 mm] NPT, 360° Central, Brass
FTF664400-XXXX	2 in [50 mm] NPT, 180° Sidewall, Brass
FTF665300-XXXX	2 ½ in [65 mm] NPT, 360° Central, Brass
FTF665400-XXXX	2 ½ in [65 mm] NPT, 180° Sidewall, Brass

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

Table 35 – Stainless Steel Nozzles

Part Number	Description
FTF661500-XXXX	½ in [15 mm] NPT, 360° Central, Stainless Steel
FTF661600-XXXX	½ in [15 mm] NPT, 180° Sidewall, Stainless Steel
FTF662500-XXXX	1 in [25 mm] NPT, 360° Central, Stainless Steel
FTF662600-XXXX	1 in [25 mm] NPT, 180° Sidewall, Stainless Steel
FTF663500-XXXX	1 ½ in [40 mm] NPT, 360° Central, Stainless Steel
FTF663600-XXXX	1 ½ in [40 mm] NPT, 180° Sidewall, Stainless Steel
FTF664500-XXXX	2 in [50 mm] NPT, 360° Central, Stainless Steel
FTF664600-XXXX	2 in [50 mm] NPT, 180° Sidewall, Stainless Steel
FTF665500-XXXX	2 ½ in [65 mm] NPT, 360° Central, Stainless Steel
FTF665600-XXXX	2 ½ in [65 mm] NPT, 180° Sidewall, Stainless Steel

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

6.4 System Accessories

Table 36 – System Accessories

Part Number	Description
FTF701001	1 in [25 mm] Check Valve
FTF700004	Flex Hose (Metal) ¼ in x 48 in - Actuation
FTF700024	Flex Hose (Metal) ¼ in x 24 in - Actuation
FTF700025	Flex Hose (Metal) ¼ in x 36 in - Actuation
FTF701005	Flex Hose, Discharge, 1 in
FTF701501	1 ½ in [40 mm] Check Valve
FTF701505	Flex Hose, Discharge, 1 ½ in
FTF702501	2 ½ in [65 mm] Check Valve
FTF702504	Flex Hose, Discharge, 2 ½
FTF704003	4 in [100 mm] Check Valve
FTF704005	Flex Hose, Discharge, 4 in SS Braid
FTF720150	Liquid Level Indicator – 160 lb. [62 L] and 270 lb. [103 L]
FTF720375	Liquid Level Indicator – 400 lb. [153 L], 600 lb. [227 L], and 950 lb. [368 L]
FTF721200	Liquid Level Indicator –1,300 lb. [490 L]

6.5 Legacy Parts List

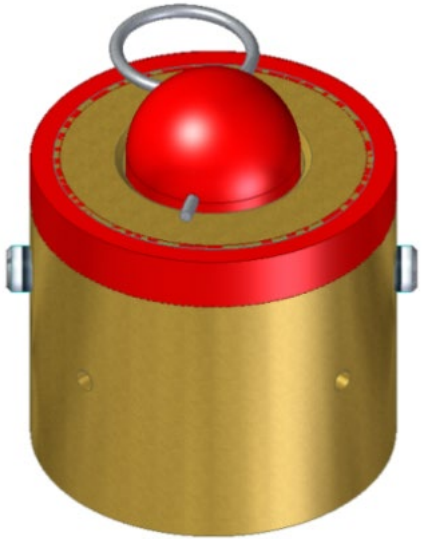
Table 37 – Legacy Parts

Part Number	Description
FTF200015	38 lb. [15 L] Cylinder / 1 in [25 mm] Valve No Top Cap Assembly
FTF200029	75 lb. [29 L] Cylinder /1 in [25 mm] Valve No Top Cap Assembly
FTF200062	160 lb. [62 L] Cylinder / 1 ½ in [40 mm] Valve No Top Cap Assembly
FTF200103	270 lb. [103 L] Cylinder /1 ½ in [40 mm] Valve No Top Cap Assembly
FTF200153	400 lb. [153 L] Cylinder / 2 ½ in [65 mm] Valve No Top Cap Assembly
FTF200227	600 lb. [227 L] Cylinder / 2 ½ in [65 mm] Valve No Top Cap Assembly
FTF200368	950 lb. [368 L] Cylinder / 2 ½ in [65 mm] Valve No Top Cap Assembly
FTF200490	1,300 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]
FTF700040	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)
FTF503011	Pressure Supervisory Switch Explosion Proof

6.5.1 Legacy Manual Actuator FTF700040

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 42 – Legacy Manual Actuator FTF700040

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 44 & 45) 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.

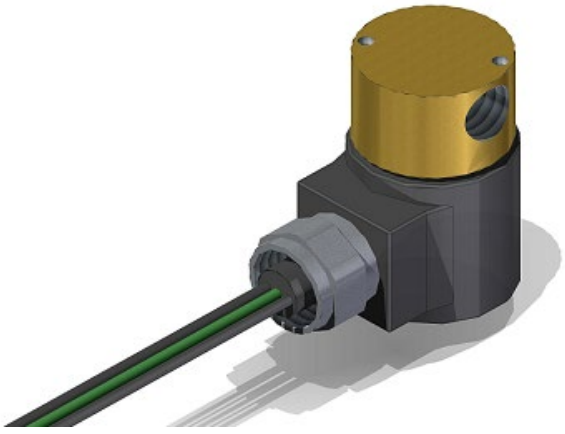


Figure 43 – Legacy Electric Solenoid

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.

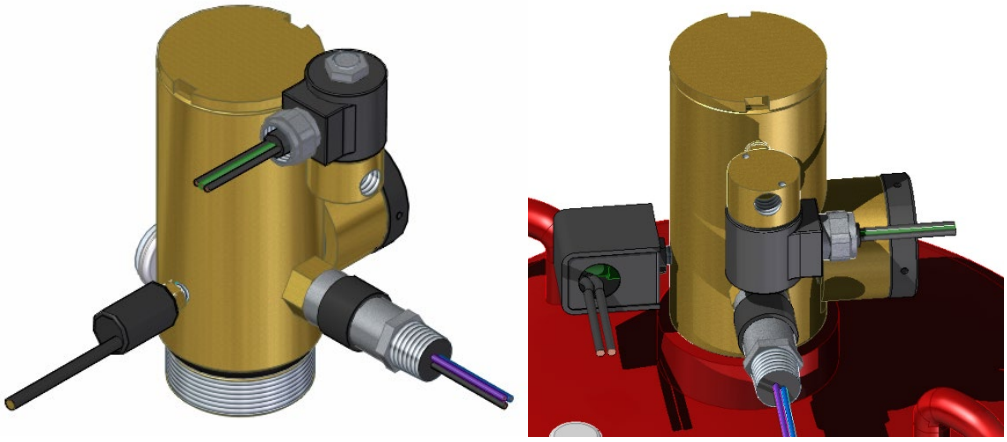


Figure 44 – Legacy Electric Solenoid on Side Port

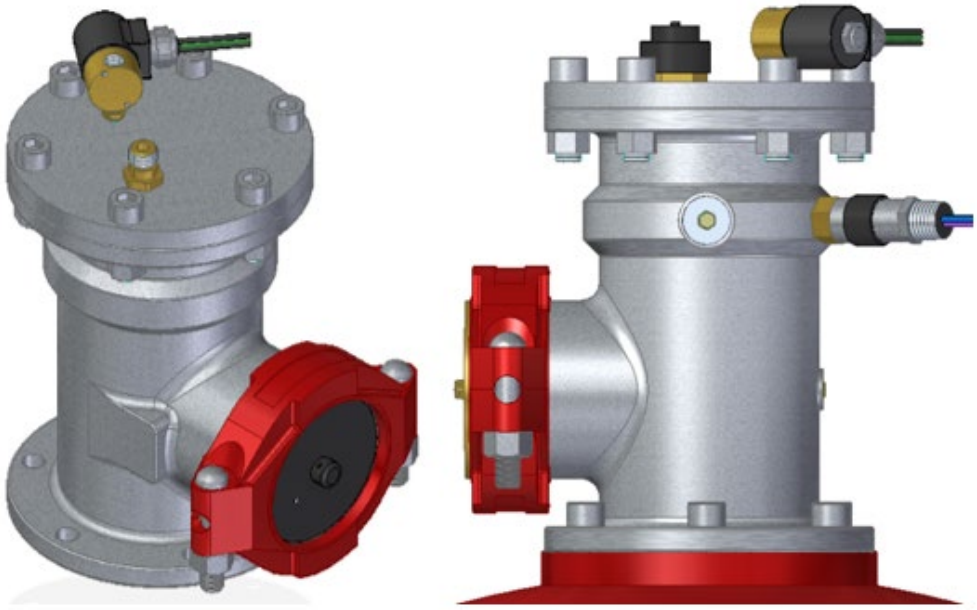


Figure 45 – Legacy Electric Solenoid on Top Port

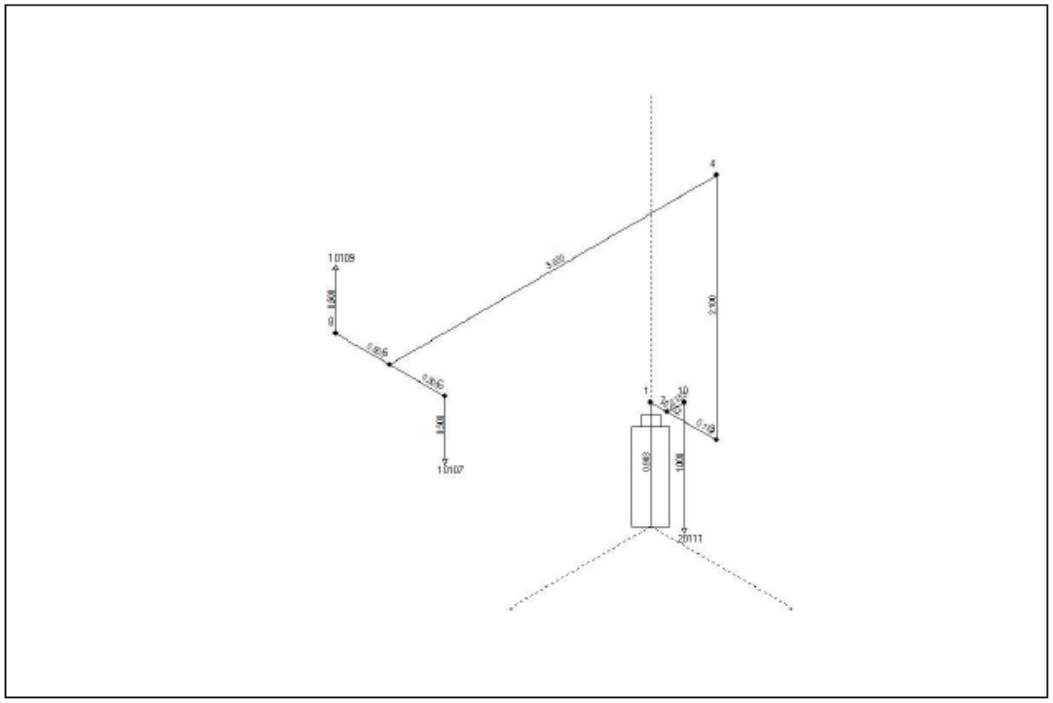
Appendix A – Flow Calculation Example

FIRETRACE

VdS SCHADENVERHÜTUNG FK-5-1-12 -Calculationprogram Version 7.5
Licenced to: Firetrace
File: - Customer

Page: 1
Serial no: [dongle]
1/10/2013

Project:	Example 1
Project-No:	x1
Building:	
Object:	
Contractor:	
Owner:	
Project engineer:	d.odonnell
Date:	1/10/2013
Altitude above sealevel:	0 m
Regulation rule for calculation of FK-5-1-12 quantities:	NFPA 2001 (edition 2000)
Pipe catalogue:	Schedule40 v2_1.1.rkl
Component catalogue:	FT Components 1.0.0.arm
Nozzle catalogue:	FT Nozzles - 1.0.1.noz



Pipesystem data:

Section-No:	Starting-node	Endnode	Length [m]	Height [m]	Pipetype	Diameter [mm]	Fitting *	Component code	Component coefficient	Nb of containers FK-5-1-12 quantity
1	0	1	0.983	0.983	10	40.9	C	120	0.980	1
2	1	2	0.152	0.000	13	40.9	E	-	-	
3	2	3	0.152	0.000	13	40.9	T-0°	-	-	
4	3	4	2.100	2.100	13	40.9	E	-	-	
5	4	5	3.000	0.000	13	40.9	E	-	-	
6	5	6	0.500	0.000	13	26.6	T-90°	-	-	
7	6	10107	0.500	-0.500	13	26.6	E	-	-	34.5
8	5	8	0.500	0.000	13	26.6	T-90°	-	-	
9	8	10109	0.500	0.500	13	26.6	E	-	-	34.5
10	2	10	0.152	0.000	13	15.8	T-90°	-	-	
11	10	20111	1.000	-1.000	13	15.8	E	-	-	13.8

* C=Component, B=Bend, T=T-Piece, E=Elbow

Legend of pipetypes

Type	Pipeclass	Pipe roughness
10	Schedule 40 - 1/4" to 6" Diameter smooth	
13	Schedule 40 - 1/4" to 6" Diameter black pipe	

Legend of components

Code	Type	Resistance coefficient
120	160LB [62L] Cylinder / 1.5" [40mm] Valve - PN: FTF000029	0.980

Calculation zone data:

Zone	Total volume [m3]	Volume of building parts [m3]	Calculated volume [m3]	Total surface [m2]	Max. Over-pressure [mbar]	Design temp. [°C]	Extinguish-conc. [% Vol]	Design factor	Design conc. [% Vol]	Design quantity [kg]
1 Main Room Void	100.0	0.0	100.0	0.0	1.000	20.0	3.5	1.35	4.7	69.01
2 Subfloor	20.0	0.0	20.0	0.0	1.000	20.0	3.5	1.35	4.7	13.80

Regulation rule for calculation of FK-5-1-12 quantities: NFPA 2001 (edition 2000)
Altitude above sealevel: 0.0 m

Calculation results:

FK-5-1-12 storage data:

Design quantity:	82.8 kg
Supplement factor:	1.00
Minimum storage quantitiy:	82.8 kg
Container volume:	103.0 l
Filling ratio:	0.80 kg/l
Filling pressure:	34.5 bar abs
FK-5-1-12 -mass per container:	82.8 kg
Number of containers:	1
Actual storage quantity:	82.8 kg
Storage temperature:	20.0 °C
Starting container pressure:	34.5 bar abs

Discharge time:

Discharge time air:	0.2 s
Total gas discharge time:	1.9 s
Two-phase discharge time:	10.0 s
Total discharge time:	11.9 s

System information:

Container working pressure:	20.5 bar abs
Container working temperature:	20.0 °C
Total network volume:	9.9 l
Medium pipe content:	15.4 kg FK-5-1-12
Filling portion in pipe system:	0.19 kg FK-5-1-12 /kg FK-5-1-12 -storage

Pipe system:

Section-No:	Starting-node	Endnode	Pressure [bar abs]	Flowrate [kg/s]	Pipedimension Di [mm]	DN
1	0	1	20.17	7.84	40.9 *	1 1/2"
2	1	2	19.95	7.84	40.9 *	1 1/2"
3	2	3	19.88	6.54	40.9 *	1 1/2"
4	3	4	19.33	6.54	40.9 *	1 1/2"
5	4	5	19.07	6.54	40.9 *	1 1/2"
6	5	6	18.88	3.27	26.6 *	1"
7	6	10107	18.66	3.27	26.6 *	1"
8	5	8	18.88	3.27	26.6 *	1"
9	8	10109	18.51	3.27	26.6 *	1"
10	2	10	19.71	1.31	15.8 *	1/2"
11	10	20111	19.29	1.31	15.8 *	1/2"

* Attention! This pipe dimension is not in the pipe catalogue!

Nozzle data:

Calculation-zone no:	Nozzle no.	Nozzle type	Number of orifices	Pipeconnection Di [mm]	DN	Orifice [mm]	FK-5-1-12 out-put [kg]
1	10109	1	1	26.6	1"	12.0	34.5
1	10107	1	1	26.6	1"	11.9	34.5
2	20111	2	1	15.8	1/2"	7.5	13.8

MAXIMUM TRANSPORT TIME DIFF. BETWEEN NOZZLES: 20111./ 10107. IS 1.67 S

Concentrations:

Calculation-zone no:	Gascomposition after discharge [%] O2	FK-5-1-12	N2
1	19.9	4.7	74.5
2	19.9	4.7	74.5

Pressure relief opening:

Calculation-zone no:	Recommended area against overpressure Area [m²]	Overpressure [mbar]	Max. flow [kg/s]
1	0.063	1.0	6.5
2	0.013	1.0	1.3

Component list:

Component	Number	Code	Coefficient
160LB [62L] Cylinder	1	120	1.000

Nozzle-type	Number
360° Central	2
180° Sidewall	1

Pipe-type	Di [mm]	DN	Length [m]
10	40.90	1 1/2"	1.000
13	40.90	1 1/2"	5.500
13	26.60	1"	2.000
13	15.80	1/2"	1.200

Number of bends (+) and elbows (-)

Bend-type	Di [mm]	DN	Number
-90	40.90	1 1/2"	3
-90	26.60	1"	2
-90	15.80	1/2"	1

Number of T-distributors (in- and outdiameter)

Number	Input	90-out	90-out	0-out
1	40.9	15.8	0.0	40.9
1	40.9	26.6	26.6	0.0

Appendix B – Liquid Level Indicator Charts

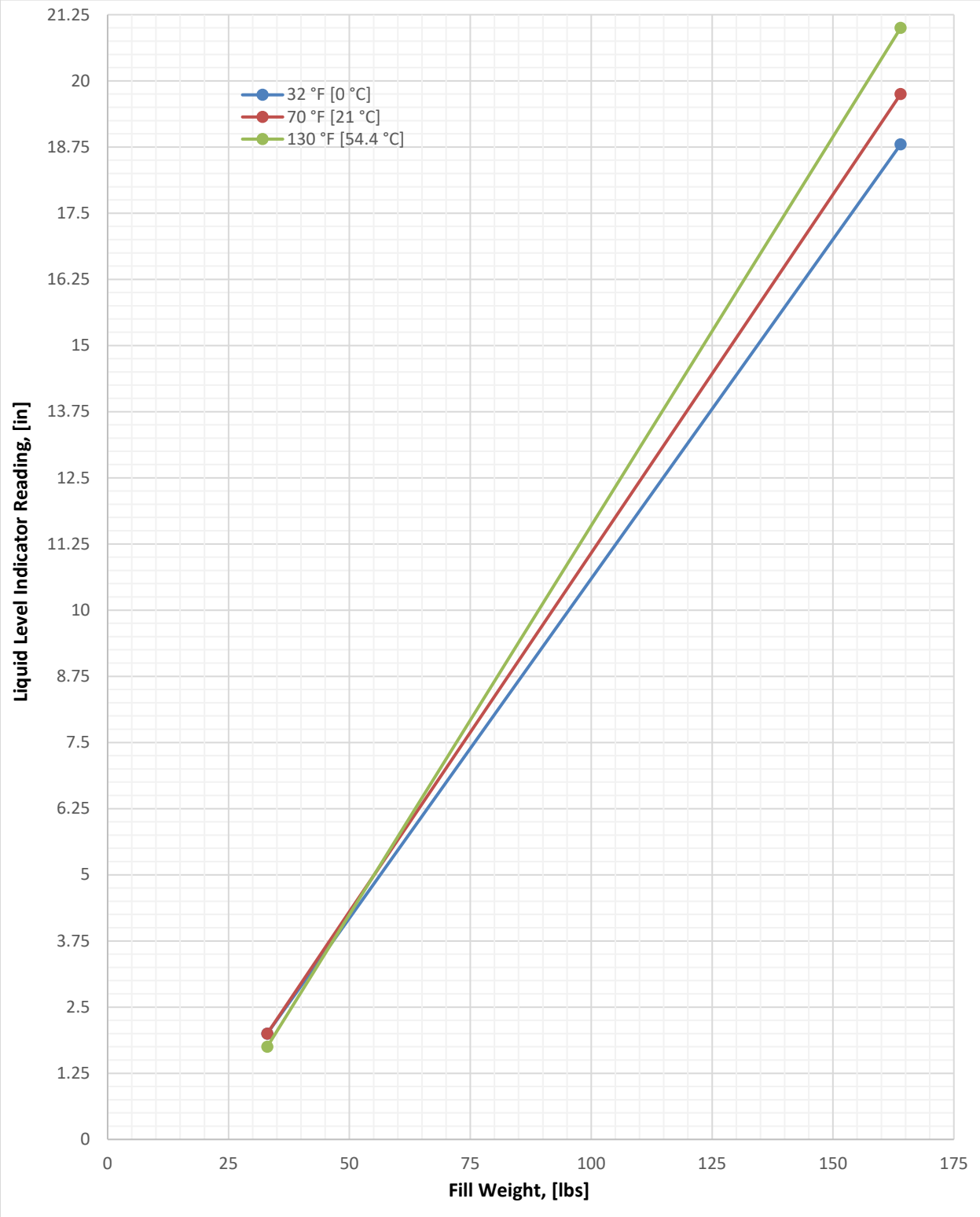


Figure 46 – 160 lb. [62 L] LLI Chart

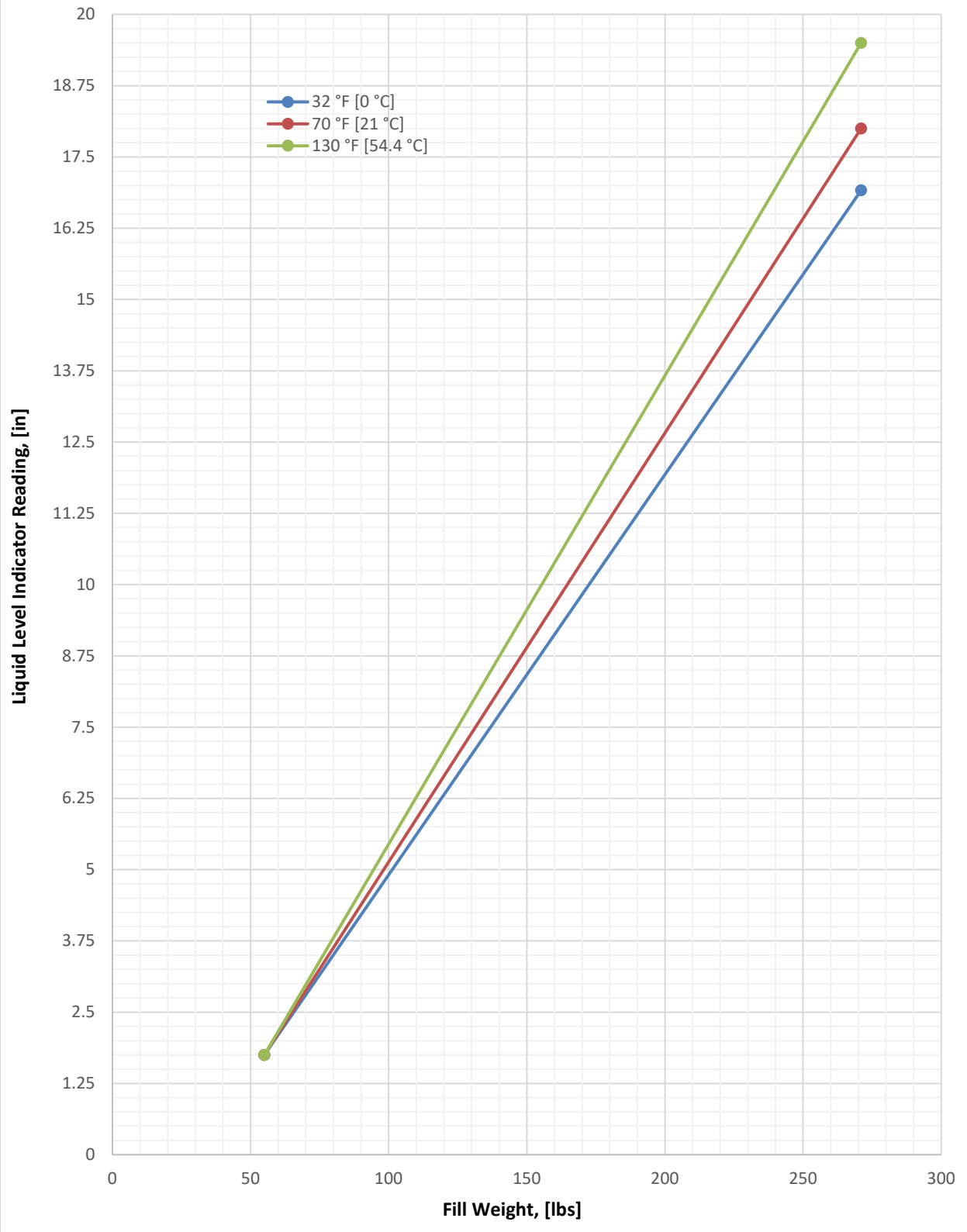


Figure 47 – 270 lb. [103 L] LLI Chart

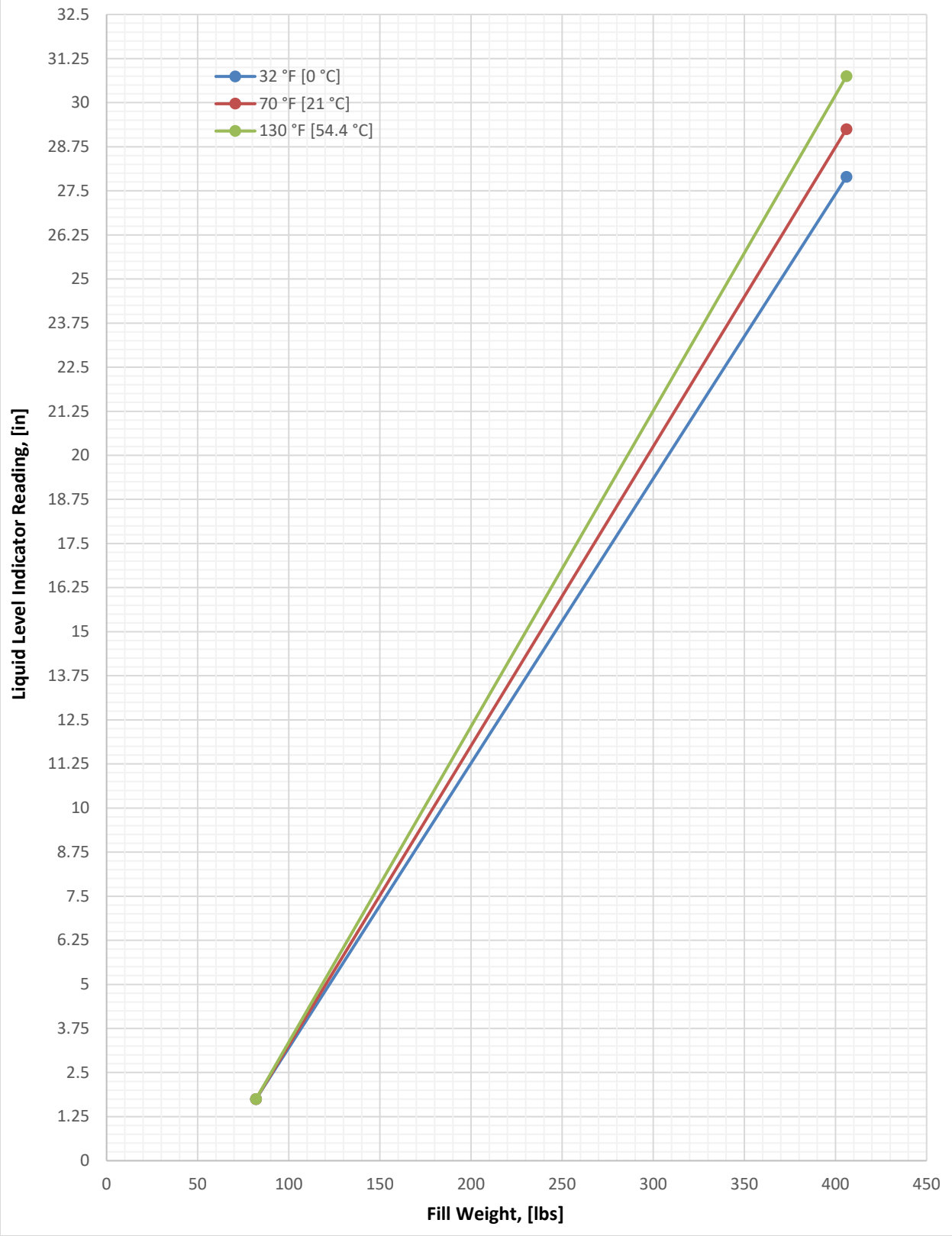


Figure 48 – 400 lb. [153 L] LLI Chart

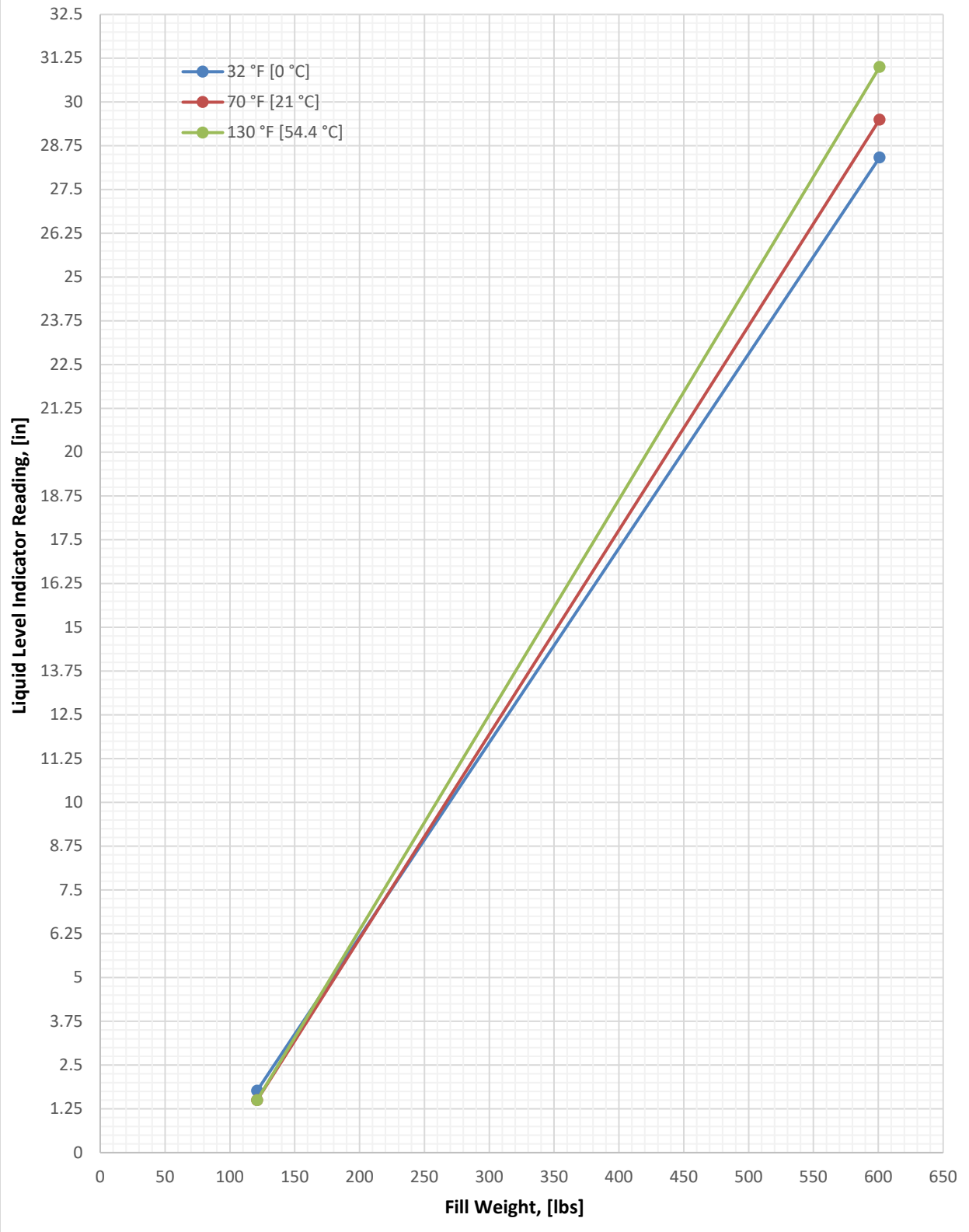


Figure 49 – 600 lb. [227 L] LLI Chart

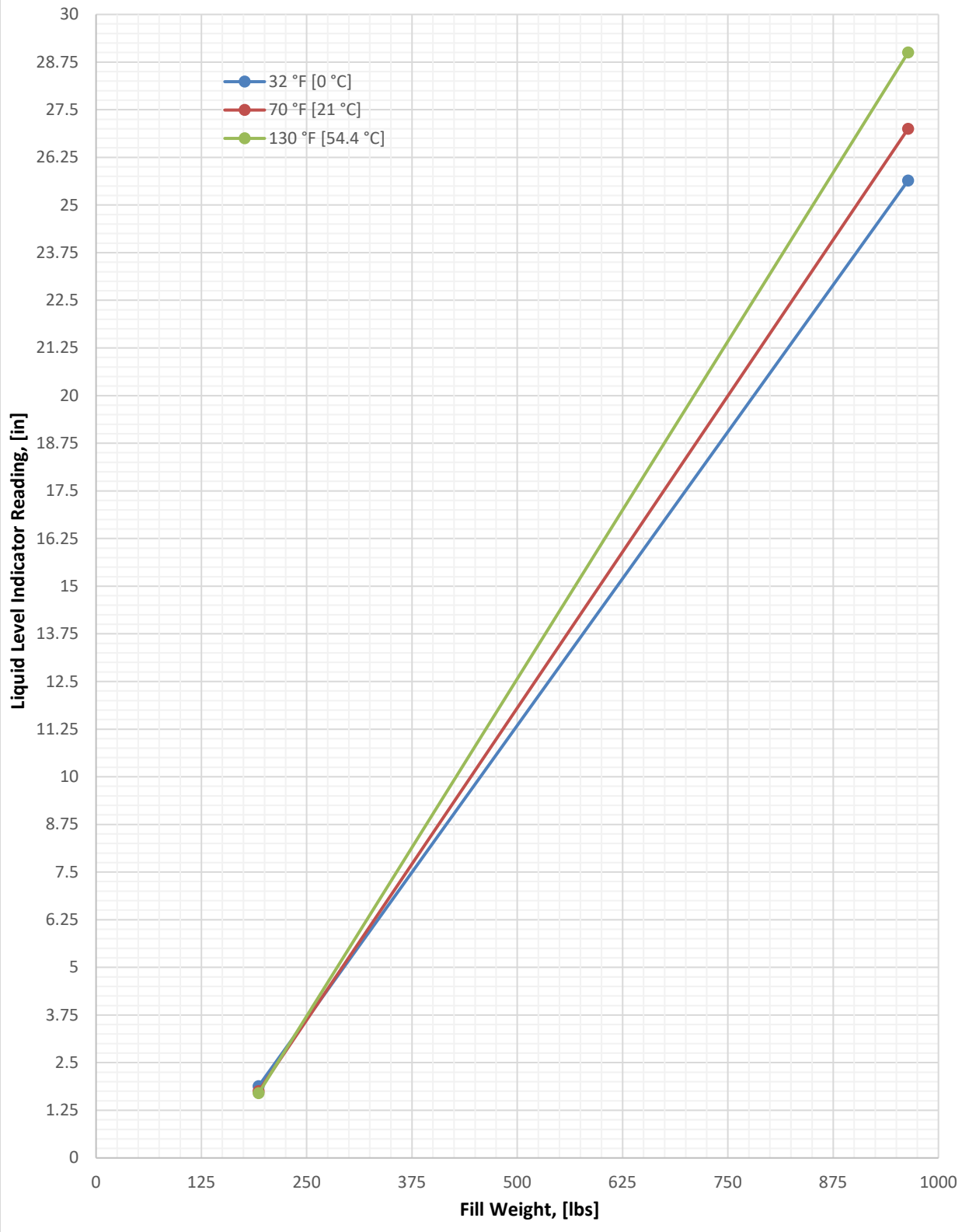


Figure 50 – 950 lb. [368 L] LLI Chart

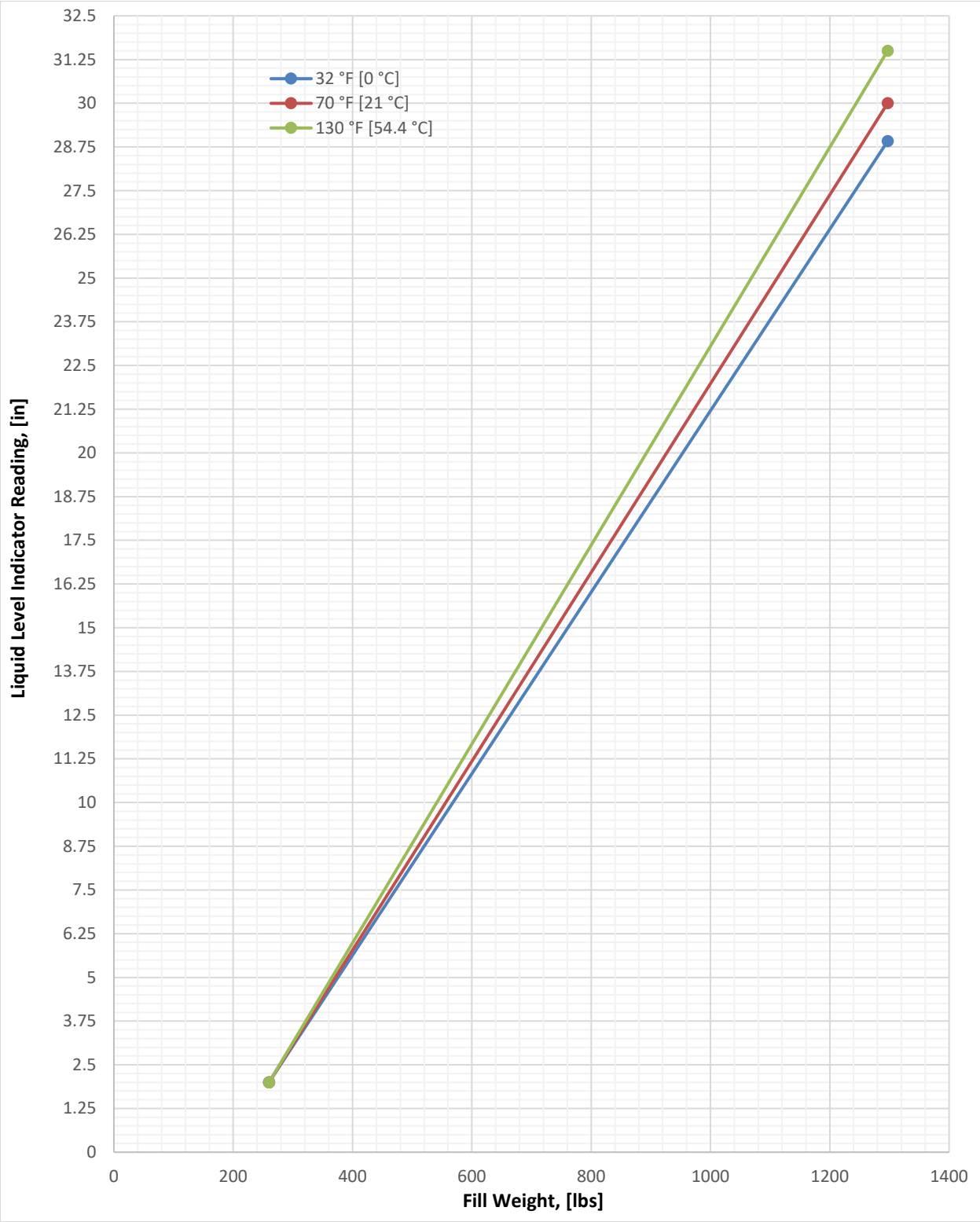


Figure 51 – 1,300 lb. [490 L] LLI Chart

Appendix C – SDS 3M ™ Novec ™ 1230

Safety Data Sheet

Document Group:	16-3425-2	**Version Number:**	33.00
Issue Date:	02/27/23	**Supercedes Date:**	02/27/23

SECTION 1: Identification

1.1. Product identifier
3M™ Novec ™ 1230 Fire Protection Fluid

Product Identification Numbers
98-0212-3203-2, 98-0212-3217-2, 98-0212-3414-5
7100010142, 7100024956, 7010321413

1.2. Recommended use and restrictions on use

Recommended use
Streaming and Flooding Fire Protection

1.3. Supplier's details

MANUFACTURER:	3M
DIVISION:	Electronics Materials Solutions Division
ADDRESS:	3M Center, St. Paul, MN 55144-1000, USA
Telephone:	1-888-3M HELPS (1-888-364-3577)

1.4. Emergency telephone number
1-800-364-3577 or (651) 737-6501 (24 hours)

SECTION 2: Hazard identification

2.1. Hazard classification
Not classified as hazardous according to OSHA Hazard Communication Standard, 29 CFR 1910.1200.

2.2. Label elements
Signal word
Not applicable.

Symbols
Not applicable.

Pictograms
Not applicable.

SECTION 3: Composition/information on ingredients

Ingredient	C.A.S. No.	% by Wt
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	756-13-8	>= 99.5

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation:
No need for first aid is anticipated. If symptoms develop, remove the affected person to fresh air. Get medical attention.

Skin Contact:
If exposed, wash with soap and water. If signs/symptoms develop, get medical attention.

Eye Contact:
If exposed, flush eyes with large amounts of water. Remove contact lenses if easy to do. Continue rinsing. If signs/symptoms develop, get medical attention.

If Swallowed:
Do not induce vomiting. Rinse mouth. If you feel unwell, get medical attention.

4.2. Most important symptoms and effects, both acute and delayed
No critical symptoms or effects. See Section 11.1, information on toxicological effects.

4.3. Indication of any immediate medical attention and special treatment required
Not applicable

SECTION 5: Fire-fighting measures

5.1. Suitable extinguishing media
Use a fire fighting agent suitable for the surrounding fire.

5.2. Special hazards arising from the substance or mixture
Exposure to extreme heat can give rise to thermal decomposition.

Hazardous Decomposition or By-Products

Substance	Condition
Carbon monoxide	During Combustion
Carbon dioxide	During Combustion
Toxic Vapor/Gas	During Combustion

5.3. Special protective actions for fire-fighters
Wear full protective clothing, including helmet, self-contained, positive pressure or pressure demand breathing apparatus, bunker coat and pants, bands around arms, waist and legs, face mask, and protective covering for exposed areas of the head.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Ventilate the area with fresh air. Refer to other sections of this SDS for information regarding physical and health hazards, respiratory protection, ventilation, and personal protective equipment.

6.2. Environmental precautions
Avoid release to the environment. For larger spills, cover drains and build dikes to prevent entry into sewer systems or bodies of water.

6.3. Methods and material for containment and cleaning up

Contain spill. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Remember, adding an absorbent material does not remove a physical, health, or environmental hazard. Collect as much of the spilled material as possible. Place in a closed container approved for transportation by appropriate authorities. Clean up residue with an appropriate solvent selected by a qualified and authorized person. Ventilate the area with fresh air. Read and follow safety precautions on the solvent label and SDS. Seal the container. Dispose of collected material as soon as possible in accordance with applicable local/regional/national/international regulations.

SECTION 7: Handling and storage

7.1. Precautions for safe handling
Contents may be under pressure, open carefully. Do not breathe thermal decomposition products. For industrial/occupational use only. Not for consumer sale or use. Do not use in a confined area with minimal air exchange. Avoid release to the environment.

7.2. Conditions for safe storage including any incompatibilities
Protect from sunlight. Store in a well-ventilated place. Store at temperatures not exceeding 38C/100F Store away from strong bases. Store away from amines.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Occupational exposure limits
If a component is disclosed in section 3 but does not appear in the table below, an occupational exposure limit is not available for the component.

Ingredient	C.A.S. No.	Agency	Limit type	Additional Comments
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	756-13-8	Manufacturer determined	TWA:150 ppm(1940 mg/m3)	

ACGIH : American Conference of Governmental Industrial Hygienists
AIHA : American Industrial Hygiene Association
CMRG : Chemical Manufacturer's Recommended Guidelines
OSHA : United States Department of Labor - Occupational Safety and Health Administration
TWA: Time-Weighted-Average
STEL: Short Term Exposure Limit
CEIL: Ceiling

8.2. Exposure controls

8.2.1. Engineering controls
For those situations where the material might be exposed to extreme overheating due to misuse or equipment failure, use with appropriate local exhaust ventilation sufficient to maintain levels of thermal decomposition products below their exposure guidelines.

8.2.2. Personal protective equipment (PPE)

Eye/face protection

Eye protection not required.

Skin/hand protection
Select and use gloves and/or protective clothing approved to relevant local standards to prevent skin contact based on the results of an exposure assessment. Selection should be based on use factors such as exposure levels, concentration of the substance or mixture, frequency and duration, physical challenges such as temperature extremes, and other use conditions.

Consult with your glove and/or protective clothing manufacturer for selection of appropriate compatible gloves/protective clothing.
Gloves made from the following material(s) are recommended: Neoprene
Nitrile Rubber

If this product is used in a manner that presents a higher potential for exposure (eg. spraying, high splash potential etc.), then use of protective coveralls may be necessary. Select and use body protection to prevent contact based on the results of an exposure assessment. The following protective clothing material(s) are recommended: Apron - Neoprene
Apron – Nitrile

Respiratory protection

For those situations where the material might be exposed to extreme overheating due to misuse or equipment failure, use a positive pressure supplied-air respirator.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Appearance	
Physical state	Liquid
Color	Colorless
Specific Physical Form:	Liquid
Odor	Low Odor
Odor threshold	*No Data Available*
pH	*Not Applicable*
Melting point	-108 °C
Boiling Point	49 °C [@ 760 mmHg]
Flash Point	No flash point
Evaporation rate	> 1 Units not avail. or not appl. [*Ref Std:*BUOAC=1]
Flammability (solid, gas)	Not Applicable
Flammable Limits(LEL)	None detected
Flammable Limits(UEL)	None detected
Vapor Pressure	40.4 kPa [@ 25 °C]
Vapor Density	11.6 [*Ref Std:*AIR=1]
Density	1.6 g/ml
Specific Gravity	1.6 [@ 68 °F] [*Ref Std:*WATER=1]
Solubility in Water	Nil
Solubility- non-water	*No Data Available*
Partition coefficient: n-octanol/ water	*No Data Available*
Autoignition temperature	*Not Applicable*
Decomposition temperature	*No Data Available*
Viscosity	0.6 centipoise [@ 25 °C]
Molecular weight	*No Data Available*
Volatile Organic Compounds	1600 g/l [*Test Method:*calculated SCAQMD rule 443.1]
Percent volatile	100 %
VOC Less H2O & Exempt Solvents	1600 g/l [*Test Method:*calculated SCAQMD rule 443.1]

SECTION 10: Stability and reactivity

10.1. Reactivity
This material may be reactive with certain agents under certain conditions - see the remaining headings in this section.

10.2. Chemical stability
Stable.

10.3. Possibility of hazardous reactions
Hazardous polymerization will not occur.

10.4. Conditions to avoid
Light

10.5. Incompatible materials
Strong bases
Amines
Alcohols

10.6. Hazardous decomposition products

Substance	Condition
Hydrogen Fluoride	At Elevated Temperatures - extreme conditions of heat

Refer to section 5.2 for hazardous decomposition products during combustion.

If the product is exposed to extreme condition of heat from misuse or equipment failure, toxic decomposition products that include hydrogen fluoride and perfluoroisobutylene can occur. Extreme heat arising from situations such as misuse or equipment failure can generate hydrogen fluoride as a decomposition product.

SECTION 11: Toxicological information

The information below may not be consistent with the material classification in Section 2 if specific ingredient classifications are mandated by a competent authority. In addition, toxicological data on ingredients may not be reflected in the material classification and/or the signs and symptoms of exposure, because an ingredient may be present below the threshold for labeling, an ingredient may not be available for exposure, or the data may not be relevant to the material as a whole.

11.1. Information on Toxicological effects

Signs and Symptoms of Exposure

Based on test data and/or information on the components, this material may produce the following health effects:

Inhalation:
No health effects are expected.

Skin Contact:
Contact with the skin during product use is not expected to result in significant irritation.

Eye Contact:
Contact with the eyes during product use is not expected to result in significant irritation.

Ingestion:
No known health effects.

Toxicological Data
If a component is disclosed in section 3 but does not appear in a table below, either no data are available for that endpoint or the data are not sufficient for classification.

Acute Toxicity

Name	Route	Species	Value
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-	Dermal	Professio	LD50 estimated to be > 5,000 mg/kg

PENTANONE		nal judgeme nt	
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Ingestion	Professio nal judgeme nt	LD50 estimated to be > 5,000 mg/kg
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Inhalation-Vapor (4 hours)	Rat	LC50 > 1,227 mg/l

ATE = acute toxicity estimate

Skin Corrosion/Irritation

Name	Species	Value
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Rabbit	No significant irritation

Serious Eye Damage/Irritation

Name	Species	Value
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Rabbit	No significant irritation

Skin Sensitization

Name	Species	Value
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Guinea pig	Not classified

Respiratory Sensitization

For the component/components, either no data are currently available or the data are not sufficient for classification.

Germ Cell Mutagenicity

Name	Route	Value
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	In Vitro	Not mutagenic
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	In vivo	Not mutagenic

Carcinogenicity

For the component/components, either no data are currently available or the data are not sufficient for classification.

Reproductive Toxicity

Reproductive and/or Developmental Effects

Name	Route	Value	Species	Test Result	Exposure Duration
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Inhalation	Not classified for female reproduction	Rat	NOAEL 38.7 mg/l	premating & during gestation
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Inhalation	Not classified for male reproduction	Rat	NOAEL 38.7 mg/l	premating & during gestation
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Inhalation	Not classified for development	Rat	NOAEL 39.5 mg/l	during gestation

Target Organ(s)

Specific Target Organ Toxicity - single exposure

Name	Route	Target Organ(s)	Value	Species	Test Result	Exposure Duration
1,1,1,2,2,4,5,5,5-	Inhalation	nervous system	Not classified	Rat	NOAEL	2 hours

NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE					100,000 ppm	
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Inhalation	cardiac sensitization	Not classified	Dog	Sensitization Negative	17 minutes

Specific Target Organ Toxicity - repeated exposure

Name	Route	Target Organ(s)	Value	Species	Test Result	Exposure Duration
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	Inhalation	liver | kidney and/or bladder | heart | endocrine system | hematopoietic system | muscles | nervous system | respiratory system | vascular system	Not classified	Rat	NOAEL 38.6 mg/l	90 days

Aspiration Hazard
For the component/components, either no data are currently available or the data are not sufficient for classification.

Please contact the address or phone number listed on the first page of the SDS for additional toxicological information on this material and/or its components.

SECTION 12: Ecological information

Ecotoxicological information

Please contact the address or phone number listed on the first page of the SDS for additional ecotoxicological information on this material and/or its components.

Chemical fate information

Please contact the address or phone number listed on the first page of the SDS for additional chemical fate information on this material and/or its components.

SECTION 13: Disposal considerations

13.1. Disposal methods
Dispose of contents/ container in accordance with the local/regional/national/international regulations.

Dispose of waste product in a permitted industrial waste facility. As a disposal alternative, incinerate in a permitted waste incineration facility. Proper destruction may require the use of additional fuel during incineration processes. Combustion products will include HF. Facility must be capable of handling halogenated materials. Empty drums/barrels/containers used for transporting and handling hazardous chemicals (chemical substances/mixtures/preparations classified as Hazardous as per applicable regulations) shall be considered, stored, treated & disposed of as hazardous wastes unless otherwise defined by applicable waste regulations. Consult with the respective regulating authorities to determine the available treatment and disposal facilities.

EPA Hazardous Waste Number (RCRA): Not regulated

SECTION 14: Transport Information

For Transport Information, please visit http://3M.com/Transportinfo or call 1-800-364-3577 or 651-737-6501.

SECTION 15: Regulatory information

15.1. US Federal Regulations
Contact 3M for more information.

EPCRA 311/312 Hazard Classifications:

Physical Hazards
Not applicable

Health Hazards
Not applicable

15.2. State Regulations
Contact 3M for more information.

15.3. Chemical Inventories
The components of this product are in compliance with the new substance notification requirements of CEPA.

The components of this material are in compliance with the China "Measures on Environmental Management of New Chemical Substance". Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of the Korean Toxic Chemical Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of Japan Chemical Substance Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this product are in compliance with the chemical notification requirements of TSCA. All required components of this product are listed on the active portion of the TSCA Inventory.

Contact 3M for more information.

15.4. International Regulations
Contact 3M for more information.

This SDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

SECTION 16: Other information

NFPA Hazard Classification
Health: 3 **Flammability:** 1 **Instability:** 0 **Special Hazards:** None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

The NFPA Health code of 3 is due to emergency situations where the material may thermally decompose and release Hydrogen Fluoride. During normal use conditions, please reference Section 2 and Section 11 of the SDS for additional health hazard information.

HMIS Hazard Classification
Health: 0 **Flammability:** 1 **Physical Hazard:** 0 **Personal Protection:** X - See PPE section.

Hazardous Material Identification System (HMIS® IV) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the inherent properties of the material under expected conditions of normal use

and are not intended for use in emergency situations. HMIS® IV ratings are to be used with a fully implemented HMIS® IV program. HMIS® is a registered mark of the American Coatings Association (ACA).

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Issue Date:	02/27/23	**Supercedes Date:**	02/27/23

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Appendix D – SDS Chemori 5112 ™

MSDS NUMBER : CR-05112
ISSUED DATE : OCTOBER 17, 2018

SAFETY DATA SHEET

1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE

This SDS adheres to the standards and regulatory requirements of the United States and may note meet regulatory requirements in other countries.

SECTION 1 – IDENTIFICATION OF SUBSTANCE

PRODUCT IDENTIFIER

Trade Name	: CHEMORI 5112™
Chemical Name	: 1,1,1,2,2,4,5,5,5-nonafluoro-4-(trifluoromethyl)-3-pentanone
Synonyms	: CF3CF2C(O)CF(CF3)2, FK-5-1-12, perfluoro(2-methyl-3-pentanone)
Chemical formula	: C6F12O
CAS number	: 756-13-8

RELEVANT IDENTIFIED USES OF THE SUBSTANCE

Relevant identified uses	: Streaming and flooding fire protection

DETAILS OF THE SUPPLIER OF THE SAFETY DATA SHEET

Registered company name	: CHEMORI LLC
Address	: 16180 SW 72nd Avenue, Portland, Oregon 97224
Email	: corporate@chemori.com
Phone Number	: 1-800-893-9619 (within USA and Canada) 1-503-747-7775 (Outside USA and Canada)
Emergency Phone Number	: 1-800-424-9300 (within USA and Canada) 1-703-527-3887 (outside USA and Canada)

SECTION 2 – HAZARD IDENTIFICATION

CLASSIFICATION OF THE SUBSTANCE

Non-hazardous chemical. According to NFPA 704 and HMIS hazard rating schemes.

NFPA 704 HAZARD CLASSIFICATION

HEALTH = 1
FLAMMABILITY = 0
REACTIVITY = 0
SPECIAL HAZARDS = None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency

Page 1 of 10

response personnel to address the hazards that are presented by short-term, acute exposure to materials under conditions of fire, spill or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

HMIS HAZARD CLASSIFICATION

HEALTH	=	**1**
FLAMMABILITY	=	**0**
REACTIVITY	=	**1**
PROTECTION	=	**X (*Section 8*)**

Hazardous Material Identification System (HMIS) hazard ratings are designed to inform employees of chemical hazard in the workplace. The provided ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS ratings are to be used with a fully implemented HMIS program.

NFPA/ HMIS HAZARD INDEX

0 = MINIMAL HAZARD, 1 = SLIGHT HAZARD, 2 = MODERATE HAZARD, 3 = SERIOUS HAZARD, 4 = SEVERE HAZARD, X = DEPENDING ON THE USE CONDITIONS

Label elements

Hazard pictogram(s)	: Not Applicable
Signal word	: Not Applicable

Hazard statement(s)

H412	: Harmful to aquatic life with long lasting effects.

Precautionary statement(s) Prevention

P273	: Avoid release to the environment.

Precautionary statement(s) Response: Not Applicable

Precautionary statement(s) Storage: Not Applicable

Precautionary statement(s) Disposal

P501	: Dispose of contents/ container in accordance with local regulations.

SECTION 3 – COMPOSITION / INFORMATION ON INGREDIENTS

Substances

INGREDIENT NAME	CAS NUMBER	% [WEIGHT]
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	756-13-8	>99.9

SECTION 4 – FIRST AID MEASURES

Description of first aid measures

Eye Contact	: Flush eyes with plenty of water immediately. If sign or symptom persists, get medical attention without delay.
Skin Contact	: Wash affected area with water (and soap if available). If sign or symptom persists, get medical attention in event of irritation.
Inhalation	: Move the person to get fresh air. If sign or symptom persists, get medical attention.
Ingestion	: Immediately give the person a glass of water. First aid is not generally required, if in doubIt, get medical attention. Never give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed

See Section 11. Toxicological information.

Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5 – FIRE AND EXPLOSION HAZARD

Extinguishing media

- There is no restriction on the type of extinguisher which may be used.
- Use extinguishing media suitable for surrounding area.

Special hazards arising from the substance or mixture

Fire Incompatibility	: Avoid contamination with oxidizing agents, such as nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may occur.

Special protective equipment and precautions for fire-fighters

Fire Fighting

- Alert fire Brigade and tell them location and nature of hazard.
- Wear breathing apparatus plus protective gloves in the event of a fire.
- Prevent, by any means available, spillage from entering drains or water courses.
- Use firefighting procedures suitable for surrounding area.
- Do not approach containers suspected to be hot.
- Cool fire exposed containers with water spray from a protected location.
- If safe to do so, remove containers from path of fire.
- Equipment should be thoroughly decontaminated after use.

Fire/ Explosion Hazard	• Non-combustible. • Not considered to be a significant fire risk. • Heating may cause expansion or decomposition leading to violent rupture of containers. • May emit corrosive, poisonous fumes. • Decomposes on heating and produces acrid and toxic fumes of: carbon dioxide (CO_2), hydrogen fluoride and other pyrolysis products typical of burning organic material.

SECTION 6 — ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

See section 8

Environmental precautions

See section 12

Methods and material for containment and cleaning up

Minor Spills	• Clean up all spills immediately. • Avoid breathing vapors and contact with skin and eyes. • Using personal protective equipment to control personal contact with the substance. • Contain and absorb spill with sand, earth or inert material. • Wipe up. • Place in an appropriate labelled container for waste disposal.
Major Spills	Moderate hazard. • Clear area of personnel. • Alert Fire Brigade and provide location and nature of hazard. • Wear breathing apparatus and gloves. • Avoid spillage from entering drains or water course by any means available. • Stop leak if safe to do so. • Contain and absorb spill with sand, earth or inert material. • Collect recoverable product into an appropriate labelled container for recycling. • Wash area and avoid runoff from entering drains. • After cleaning up, decontaminate all protective clothing and equipment prior to storing and re-using. • If contamination of drains occurs, advise emergency services.

SECTION 7 — HANDLING AND STORAGE

Precautions for safe handling

Safe handling	• Storage in sealed containers may result in pressure buildup, open carefully. • Always release caps or seals slowly to ensure low dissipation of vapors. • Prevent all personal contacts, including inhalation. • Wear personal protective clothing and equipment when risk of exposure occurs. • Use in a well-ventilated area. • Avoid contact with moisture and incompatible materials. • Do not eat, drink or smoke when handling. • Keep container securely sealed when not in use. • Prevent physical damage to containers. • Always wash hands with soap and water after handling.
Other Information	• Store in original containers. • Keep containers securely sealed. • Store in a cool, dry, well-ventilated area. • Store away from incompatible materials and foodstuff containers. • Protect containers again physical damage and check regularly for leaks.

Conditions for safe storage, including any incompatibilities

Suitable container	• Store in bulging containers. • Packing as recommended by manufacturer. • All containers should be clearly labelled and free from leaks.
Storage incompatibility	• Separate from alcohol and water. • Avoid strong bases. • Avoid direct sunlight and UV light.

SECTION 8 — EXPOSURE CONTROLS / PERSONAL PROTECTION

Control parameters

EXPOSURE LIMIT:

Chemical name	Limit type
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	TWA: 150 ppm

TWA: Time-Weighted-Average

Exposure Controls	
Appropriate engineering controls	• Local exhaust ventilation is required to control exposures to below exposure limits. • Provide adequate ventilation in warehouse or closed storage area.

Personal Protection	
Eye and face protection	• Safety glasses with side shields. • Chemical goggles if wearing contact lenses.
Skin protection	• See hand section below.
Hands/ feet protection	• Gloves must be worn on clean hands. After using gloves, hands should be washed and dried thoroughly.
Body protection	• See other section below.
Other protection	• Skin cleansing cream. • Eye wash unit.
Respiratory protection	• Type AX filter of sufficient capacity. The wearer must be warned to leave the contaminated area immediately on detecting any odours through the respirator. The odour may indicate that the mask is not functioning properly or not properly fitted.

SECTION 9 — PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties:

APPEARANCE	:	Colorless, low odor liquid
MOLECULAR WEIGHT (G/MOL)	:	316.04
BOILING POINT	:	49.2 °C / 120.6 °F
FREEZING POINT	:	–108 °C / –162.4 °F
VAPOR PRESSURE @ 20 °C/68 °F	:	0.326 bar
VAPOR DENSITY (AIR=1)	:	11.6
SPECIFIC GRAVITY (H_20=1)	:	1.6
VOC	:	1600 g/l
EVAPORATION RATE (Butyl acetate = 1)	:	>1
SOLUBILITY IN WATER	:	Nil
VISCOSITY	:	0.6 cP at 77 °F (25 °C)
pH	:	Not Applicable
AUTO-IGNITION TEMPERATURE	:	Not Applicable
FLASH POINT	:	Not Applicable

SECTION 10 – STABILITY AND REACTIVITY

Reactivity	• See section 7
Chemical stability	• Product is considered stable. • Unstable in the presence of incompatible materials. • Hazardous polymerization will not occur.
Possibility of hazardous reactions	• See section 7
Conditions to avoid	• See section 7
Incompatible materials	• See section 7
Hazardous decomposition products	• See section 5

SECTION 11 – TOXICOLOGICAL INFORMATION

Information on Toxicological Effects/ Routes and Symptoms of Exposure

Inhaled	• No known health effects
Ingestion	• No known health effects
Skin contact	• Not expected to cause significant skin irritation.
Eye	• Not expected to cause significant eye irritation.
Chronic	• No applicable information

Toxicological Data

Remark: If a component is disclosed in the other sections but does not appear in a table below, either no data are available for that endpoint or the data are not sufficient for classification.

(1) Skin Irritation/ Corrosion:

Chemical name	Species	Classification
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Rabbit	Non-irritant

(2) Serious Eye Damage/ Irritation:

Chemical name	Species	Classification
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Rabbit	Non-irritant

(3) Skin Sensitisation:

Chemical name	Species	Classification
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Guinea pig	Weak sensitiser

(3) Acute Toxicity:

Chemical name	Route	Species	Classification
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Dermal	Sprague-Dawley rat	Low acute toxicity
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Ingestion	Sprague-Dawley rat	Low acute toxicity
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	Inhalation-Vapor	Sprague-Dawley rat	Low acute toxicity

Please contact the address listed on the first page of the SDS for additional toxicological Information on this material and/or its components.

SECTION 12 – ECOLOGICAL INFORMATION

Ecotoxicity	• No applicable information
Persistence and degradation	• Photolytic half-life is 3 to 5 days. Degradation product from photolytic is trifluoroacetic acid (TFA).
Bio-accumulative potential	• No applicable information
Others	• Ozone Depletion Potential: 0 • Global Warming Potential: 1 for 100-year time horizon

NOTE: Hydrolysis is not expected to be a significant degradation pathway. Product is highly insoluble in water and volatile, and use as a clean extinguishing agent would not typically result in releases to aquatic environments.

SECTION 13 – DISPOSAL CONSIDERATIONS

Waste treatment methods

Product/ Packaging disposal	• Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. • Disposal of waste product in a permitted industrial waste facility. Combustion products could include HF. Facility must be capable of handling halogenated materials. • Do not allow wash water from cleaning or process equipment to enter drains. • It may be necessary to collect all wash water for treatment before disposal. • In all cases disposal to sewer may be subject to local laws and regulations. • Where in doubt, contact the responsible authority. • Recycle where possible. • Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified. • Dispose of by: burial in a land-fill specifically licensed to accept chemical and/or pharmaceutical wastes or incineration in a licensed

apparatus.
- Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.

SECTION 14 – TRANSPORT INFORMATION

As the unpressurized agent, CHEMORI 5112, is not a compressed or liquefied gas, non-flammable and low in toxicity. Thus, it is an unregulated material and has no UN designation.

When shipping pressurized as a Fire Extinguishing Unit, the UN number as follows:

U.S. DOT

PROPER SHIPPING NAME	:	Fire Extinguisher with compressed or liquefied gas
HAZARD CLASS	:	2.2 Non-flammable gas
UN NUMBER	:	UN1044

AIR TRANSPORT - ICAO OR IATA

PROPER SHIPPING NAME	:	Fire Extinguisher with compressed or liquefied gas
HAZARD CLASS	:	2.2 Non-flammable gas
UN NUMBER	:	UN1044

WATER – IMDG

PROPER SHIPPING NAME	:	Fire Extinguisher with compressed or liquefied gas
HAZARD CLASS	:	2.2 Non-flammable gas
UN NUMBER	:	UN1044

SECTION 15 – REGULATORY INFORMATION

Safety, health and environmental regulations/ legislation specific for the substance or mixture

1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone (CAS 756-13-8) is found on the following regulatory lists:

National Inventory	Status
Australia - AICS	All ingredients are on the inventory
Canada - DSL	All ingredients are on the inventory
Canada - NDSL	Not determined or not on the inventory and are not exempt from listing
China - IECSC	All ingredients are on the inventory
Europe – EINEC/ ELINCS/ NLP	All ingredients are on the inventory
Japan - ENCS	All ingredients are on the inventory

Korea - KECI	All ingredients are on the inventory
New Zealand - NZIoC	All ingredients are on the inventory
Philippines - PICCS	Not determined or not on the inventory and are not exempt from listing
USA - TSCA	All ingredients are on the inventory

SECTION 16 – OTHER INFORMATION

Other Information

Chemori urges each customer or recipient of this SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this SDS, and any hazards associated with the product. The above information is provided in good faith and believed to be accurate, but does not claim to be all inclusive. Since conditions for use of the product are not under the control of the company, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product. Users should consider these data only as a guide to the appropriate precautionary and emergency handling of the product. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that his activities comply with all federal, state, provincial or local laws. The information presented here is based on data available at the time of shipping, is subject to change without notice as new information is obtained, and may not be valid for such material used in combination with any other material or in any process. However, no warranty of any kind, express or implied, is given.

Revision Date: 17/10/2018

Definitions and Abbreviations:

- TWA: Time-Weighted-Average;
- AICS: Australia Inventory of Chemical Substances;
- DSL: Domestic Substances List in Canada;
- NDSL: Non-Domestic Substance List in Canada;
- IECSC: Inventory of Existing Chemical Substances Produced or Imported in China;
- EINEC/ ELINCS/ NLP: European Inventory of Existing Commercial Chemical Substances/ European List of Notified Chemical Substances/ No-longer Polymers List;
- ENCS: Existing and New Chemical Substances in Japan;
- KECI: Korea Existing Chemicals Inventory;
- NZIoC: New Zealand's Inventory of Chemicals;
- PICCS: Philippine Inventory of Chemicals and Chemical Substances;
- TSCA: Toxic Substances Control Act Chemical Substance Inventory in USA.

Appendix E – SDS Dukare 1230

SAFETY DATA SHEET

According to UN GHS, Annex 4 - Guidance on the Preparation of SDS

Version 4 **Issue date** 16-Nov-2016
Product name Fire suppression clean agent Dukare 1230 (FK-5-1-12) **Revision date** 3-Dec-2021

1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

Product identifier

Product name	Fire suppression clean agent Dukare 1230 (FK-5-1-12)
Chemical name	1,1,1,2,2,4,5,5,5- Nonafluoro-4-(Trifluoromethyl)-3-Pentanone
CAS No	756-13-8
REACH registration number	01-2120426966-44-XXXX

Other means of identification

Synonym	Dodecafluoro-2-methyl-3-pentanone / Perfluoro(2-methyl-3-pentanone)

Recommended use of the chemical and restrictions on use

Recommended use	Extinguishing agents, cleaning agents, solvents, hear transfer/cooling liquid
Uses advised against	No information available

Details of the supplier of the safety data sheet

Supplier	Sinochem Lantian Trading Co., Ltd. / Sinochem Lantian Fluoro Materials Co., Ltd.
Address	Hangzhou / Shangyu, Zhejiang
Postal code	310051 / 312369
Phone	+86-571-87397288
FAX	+86-571-88904247
E-mail	wengyuanda@sinochem.com
EU OR	REACH24H Consulting Group
Address	Paramount Court, Corrig Road, Sandyford, Dublin 18, Ireland
Postal code	/
Phone	+353 1 8899 951
FAX	+353 1 6865 683
E-mail	reach@reach24h.com

Emergency telephone number
+86-571-88844390

2. HAZARDS IDENTIFICATION

Classification of the substance or mixture
Hazardous to the aquatic environment, long-term (chronic) Category 3

Label elements

Symbols/Pictograms	None
Signal word	None
Hazard statements	H412 - Harmful to aquatic life with long lasting effects
Precautionary statements	P273 - Avoid release to the environment
	P501 - Dispose of contents/ container to an approved waste disposal plant

Other hazards
No information available

3. COMPOSITION/INFORMATION ON INGREDIENTS

Description Substance

Chemical name	CAS No	Weight-%
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	756-13-8	>= 99.90

4. FIRST AID MEASURES

Description of first aid measures

General advice	Do not get in eyes, on skin, or on clothing. Do not breathe dust/fume/gas/mist/vapors/spray. In case of accident or unwellness, seek medical advice immediately (show directions for use or safety data sheet if possible).
Inhalation	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Vapors are heavier than air and can cause suffocation by reducing oxygen available for breathing. Administer oxygen if breathing is difficult. Get medical advice/attention if you feel unwell.
Skin contact	Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Wash contaminated clothing before reuse. If skin irritation persists, call a physician.
Eye contact	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.
Ingestion	Not an expected route of exposure. If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label. Never give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed
No information available.

Indication of any immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Extinguishing media

Suitable extinguishing media	The substance can be used as extinguishing agent. Wear suitable respiratory equipment to protect from harmful gases caused by thermal decomposition.
Unsuitable extinguishing media	No information available.

Specific hazards arising from the chemical
Thermal decomposition can lead to release of irritating and toxic gases and vapors, such as carbon monoxide, carbon dioxide, hydrogen fluoride.

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

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures
Evacuate personnel to safe areas. Remove all sources of ignition. Ensure adequate ventilation, especially in confined areas. Avoid contact with eyes and skin. Do not breathe dust/fume/gas/mist/vapors/spray. Do not eat, drink or smoke when using this product. Wash thoroughly after handling.

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

Methods and material for containment and cleaning up
Avoid breathing dust/fume/gas/mist/vapors/spray. Avoid release to the environment.

7. HANDLING AND STORAGE

Precautions for safe handling
Handle in accordance with good industrial hygiene and safety practice. Do not handle until all safety precautions have been read and understood. Keep away from heat, sparks, flame and other sources of ignition. Ensure adequate ventilation, especially in confined areas. Avoid contact with skin and eyes. Do not breathe dust/fume/gas/mist/vapors/spray. Do not eat, drink or smoke when using this product. Wash thoroughly after handling.

Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Keep away from heat, sparks, flame and other sources of ignition. Keep locked up and out of reach of children. Keep away from food, drink and animal feeding stuffs. Store in accordance with local regulations.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters
Exposure limits
No data applicable

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

Individual protection measures, such as personal protective equipment

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

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Liquid
Color	Colorless
Odor	Faint odor
Odor threshold	Not determined
pH	Not determined
Melting point/freezing point	-108.0 °C
Boiling point / boiling range	49.2 °C
Flammability (solid, gas)	Not flammable
Flammability limit in air	Not determined
Flash point	Not determined
Autoignition temperature	Not determined
Decomposition temperature	Not determined
Kinematic viscosity	Not determined
Dynamic viscosity	Not determined
Solubility(ies)	Practically insoluble in water
Partition coefficient (LogPow)	Not determined
Vapor pressure	0.3260 bar (20 °C)
Density	1.60 g/mL
Relative density	Not determined
Vapor density	11.6

Evaporation rate	Not determined
Explosive properties	Not an explosive
Oxidizing properties	Not determined

Other information
No information available

10. STABILITY AND REACTIVITY

Reactivity
No information available.

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
Hazardous polymerization does not occur.

Conditions to avoid
No information available.

Incompatible materials
None known based on information supplied.

Hazardous decomposition products
Carbon monoxide, carbon dioxide, hydrogen fluoride.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Chemical name	Route	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Oral	Rat	LD50 > 5000 mg/kg
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Dermal	Rat	LD50 > 2000 mg/kg
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Inhalation	Rat (4 hours)	LC50 > 5000 mg/m^3

Skin corrosion/irritation

Chemical name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Rabbit	Non-irritating to the skin.

Serious eye damage/eye irritation

Chemical name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Rabbit	No eye irritation

Sensitization

Chemical name	Species	Value
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Guinea pig	No sensitization responses were observed.

Germ cell mutagenicity (Mammalian Chromosome Aberration Test & Mammalian Cell Gene Mutation Test)

Chemical name	Route	Value (to somatic cell)
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	In Vitro	Not mutagenic

Carcinogenicity
No information available.

Reproductive toxicity
No information available.

STOT - single exposure
No information available.

STOT - repeated exposure (28-Day (Subacute) Inhalation Toxicity Study)

Chemical name	Route	Target organ	Species	Test result	Exposure duration
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone	Inhalation	liver | kidney and/or bladder | heart | endocrine system | hematopoietic system | muscles | nervous system | respiratory system | vascular system	Rat	NOAEL 3000000 mg/m³ (6h/d, 5d/w)	28 days

Aspiration hazard
No information available.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Chemical name	Algae/aquatic plants EC50	Fish LC50	Crustacea EC50
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone (CAS: 756-13-8)	10.6 mg/L 96h Pseudokirchneriella subcapitata	> 1070 mg/L 96h Pimephales promelas	> 1080 mg/L 48h Daphnia magna

Persistence and degradability
Not readily biodegradable.

Bioaccumulation
BCF = 1.2 - 4.8

Mobility
No information available.

Other adverse effects
No information available.

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products	Disposal should be in accordance with applicable regional, national and local laws and regulations.
Contaminated packaging	Disposal should be in accordance with applicable regional, national and local laws and regulations.
EU waste code (product as sold)	07 01 03* Organic halogenated solvents, washing liquids and other mother liquors 14 06 02* Other halogenated solvents and solvent mixtures

14. TRANSPORT INFORMATION

UN number	Not regulated
UN proper shipping name	Not regulated
Hazard class	Not regulated
Packing group	Not regulated
Environmental hazards	Non-marine pollutant
Special precautions	No information available
Transport in bulk according to Annex II of MARPOL and the IBC Code	Not applicable

15. REGULATORY INFORMATION

International inventories

Component	AICS	DSL/NDSL	EINECS/ELINCS	ENCS	IECSC	KECL	PICCS	TSCA
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(Trifluoromethyl)-3-Pentanone (>= 99)	X	X	X	X	X	X	-	X

"-" Not Listed
"X" Listed

16. OTHER INFORMATION

Revision note

Issue date	16-Nov-2016
Revision date	19-Oct-2019
Revision note	Add REACH information
Revision date	07-May-2021
Revision note	Add EU waste code (product as sold)
Revision date	24-Sept-2021
Revision note	Revise “Product name”, add “Chemical name”
Revision date	3-Dec-2021
Revision note	Add toxicological information(Germ cell mutagenicity & STOT-repeated exposure)

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

TWA - TWA (Time Weighted Average)
STEL - STEL (Short Term Exposure Limit)
Ceiling - Maximum limit value
TSCA - Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
IECSC - Chinese Inventory of Existing Chemical Substances
EINECS/ELINCS - European INventory of Existing Commercial chemical Substances/European LIst of Notified Chemical Substances
ENCS - Japanese Existing and New Chemical Substances
KECL - Korea Existing Chemicals List
NZIoC - New Zealand Inventory of Chemicals
PICCS - The Philippine Inventory of Chemicals and Chemical Substances
AICS - The Australian Inventory of Chemical Substances

Disclaimer

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 given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

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

Appendix F – SDS Waysmos FK5112

Safety Data Sheet

Section 1 – Chemical Product and Company Identification

Product Name	FK-5-1-12
Chemical Name	1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone
Synonym	FLUOROKETONE, Perfluoro(2-Methyl-3-Pentanone), NOVEC1230™
Product Use	Fire extinguishing agent
Manufacturer	Shanghai Waysmos Fine Chemical Co., Ltd.
Address	388 Liangle Road, Laogang, Pudong New Area, Shanghai, China
Email	sales@waysmos.com
Telephone	+86-571-85069383
Fax	+86-571-85069385

Section 2 –Hazard Identification

Hazard classification	This material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200)
Hazard pictograms	
Signal word	Warning
Hazard statements	H412: Harmful to aquatic life with long lasting effects.
Precautionary statements	P261: Avoid breathing vapours. P273: Avoid release to the environment. P280: Wear protective gloves/protective clothing.
Other Hazard	Overheating and over pressurizing may cause gas release or violent container bursting.

Section 3 – Composition/Information on Ingredients

Ingredient name	CAS No.	%(weight)
1,1,1,2,2,4,5,5,5,-Nonafluoro-4-(trifluoromethyl)-3-pentanone	756-13-8	≥99. 0

Section 4 – First Aid Measures

Inhalation	Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. If unconscious, place in recovery position and get medical attention immediately
Skin	Remove and isolate contaminated clothing and shoes. Wash immediately with plenty of soap and water. Get medical attention if frostbitten by liquid or if irritation persists
Eyes	Immediately flush with large amounts of water for at least 15 minutes Get medical attention if irritation occurs
Ingestion	DO NOT induce vomiting unless instructed to do so by a physician. Get medical attention immediately if symptoms develop.
Note to physician	Immediate medical attention is not required When symptoms persist or in all cases of doubt seek medical advice

Section 5 – Fire Fighting Measures

Extinguishing media	Product is a fire extinguishing media. Use media appropriate for surrounding material
Special hazards arising from the substance or mixture	Thermal decomposition may cause toxic products Containers may explode in heat of fire.
Special protective equipment for firefighters	Wear self-contained breathing apparatus with a full face-piece operated in positive pressure mode and chemical-protective clothing. Prevent fire extinguishing water from contaminating surface water or the ground water system

Section 6 – Accidental Release Measures

Personal precautions, protective equipment and emergency procedures	Refer to section 8 of SDS for personal protection details. Wear mask and appropriate protective clothing for daily operation. Prevent skin and eye contact. Keep unprotected persons away. If outside do not approach from downwind.
Environmental precautions	Do not discharge into drains/surface waters/groundwater
Methods and material for containment and cleaning up	Evacuate area. Keep upwind. Stop leak if without risk. Ventilate area especially low places remove open flames and heating elements. Disperse it with floor level forced air
Reference to other SECTIONs	See SECTION 7 for information on safe handling See SECTION 8 for information on personal protection equipment See SECTION 13 for information on disposal

Section 7 – Handling and Storage

Handling	Avoid direct contact with the substance. Wash thoroughly after handling. Ensure there is sufficient ventilation of the area. Do not handle in a confined space. Avoid the formation or spread of mists in the air. Contents may be under pressure, open carefully. Do not breathe thermal decomposition products. For industrial or professional use only. Do not eat, drink or smoke when using this product. Do not drag, slide or roll containers. Do not drop containers or permit them to strike against each other. Never apply flame or localized heat directly to any part of the container.
Storage	Store in dry, cool, well ventilated area. Keep container tightly closed. Keep out of direct sunlight and ultraviolet, keep away from incompatible materials, water, keep away from sources of heat or ignition. Containers should be properly stored and secured to prevent falling or being knocked over.

Section 8 –Exposure Controls/Personal Production

8.1 Control parameters

Occupational exposure limit values	150 ppm, 8 hr TWA

8.2 Exposure controls

Appropriate engineering controls	Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits
Personal protective equipment	
Respiratory Protection	Self-contained breathing apparatus or full facepiece supplied-air respirator must be available in case of emergency.
Skin Protection	Wear protective gloves/clothing to prevent contact
Eye Protection	Safety glasses/chemical splash goggles
Environmental exposure controls	Do not empty into drains

Section 9 – Physical and Chemical Properties

9.1 Information on basic physical and chemical properties

Appearance	Liquid
Color	colorless
Odour	Low odor
pH	Not available
Melting point	-108°C
Boiling point	49 °C
Flash point	Not available
Evaporation rate	> 1(BUOAC = 1.0)
Flammability (solid, gas)	Not flammable
Upper/lower flammability or explosive limits	Not available
Vapour pressure	40.4 Kpa (25°C)
Specific gravity (H_2O=1	1.6 g/cm^3
Solubility(ies)	Not available
Partition coefficient: n-octanol/water	log Kow = 2.11

Auto-ignition temperature	Not available
Viscosity	0.6 mPa.s (25°C)

Section 10 – Stability and Reactivity

Reactivity	Stable under recommended storage and handling conditions (see SECTION 7, handling and storage)
Chemical stability	Stable under normal conditions of use
Possibility of hazardous reactions	No known hazardous reactions
Conditions to avoid	Keep away from heat and ignition sources. Protect from sunlight
Incompatible materials	Strong oxidizing materials, Strong acids and bases
Hazardous decomposition products	Thermal decomposition can lead to release of irritating or toxic gases/vapors: carbon oxides, hydrogen fluoride

Section 11 – Toxicological Information

11.1 Information on toxicological effects

Acute Toxicity

Ingredient name	LD50 Oral(rat)	LD50 Dermal (rat)	LC50 Inhalation (rat)
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	> 2,000 mg/kg	> 2,000 mg/kg	>1,227 mg/l/4h (>10% by volume)

Skin corrosion/irritation	No information available
Serious eye damage/irritation	No information available
Respiratory or skin sensitization	No information available
Germ cell mutagenicity	No information available
Reproductive toxicity	No information available
STOT-single exposure	No information available
STOT-repeated exposure	No information available
Aspiration hazard	No information available
Carcinogenicity	Not listed as a carcinogen by NTP, IARC, or OSHA

Section 12 – Ecological Information

Toxicity (Ecotoxicity Fish, LC_{50})	>1200 mg/l (Zebra Fish, 96h)
Degradability	Atmospheric lifetime is approximately 0.014 years(5 days)
Bioaccumulation/ Accumulation	No data available
Mobility in Environmental Media	Not available
Other adverse effects	Ozone Depletion Potential (CFC 11 = 1.0): 0.00 Global Warming Potential (CO_2 = 1.0): 1.00

Section 13 –Disposal Considerations

Waste Disposal Method

Disposal must be made according to local and national regulations. Empty containers should be taken for local recycling, recovery or waste disposal.

Section 14—Transport Information

ITEM	LAND ☐ EU: ADR/RID ☐ US: DOT	SEA IMDG	AIR ICAO / IATA
UN-Number	General cargo	General cargo	General cargo
Packaging Group			

Special precautions for user None determined

Section 15—Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
Listed in international inventories:

Ingredient name	TSCA	DSL	NDSL	ELINCS	ENCS	CHINA	KECL	PICCS	AICS
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	YES	YES	NDA	YES	YES	YES	YES	YES	YES

Section 16 – Other Information

In accordance with good practices of personal cleanliness and hygiene handle with the care and avoid unnecessary contact with this product.
This information is being supplied to you under OSHA Hazard Communication Standard 29 CFR 1910.1200 and is offered in good faith as typical values and not as a product specification. The information contained herein is based on the data available to us and is believed to be true and accurate.
No warranty expressed or implied regarding the accuracy of this data. The hazards connected with the use of the material or the results to be obtained from the use thereof are made. Shanghai Waysmos Fine Chemical Co., Ltd. assumes no responsibility for damage or injury from the use of the product described herein

Appendix G – SDS NOAH® 5112

ZHEJIANG NOAH FLUOROCHEMICAL CO., LTD

SAFETY DATA SHEET

Product Name: Noah 5112 Prepared according to GB/T 16483 and GB/T 17519
Issue Date: 05/09/2023 **Document group:** 01230905 **Edition:** 5.0

Section 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name:	Noah 5112/Perfluoro (2-methyl-3-pentanone); 1,1,1,2,2,4,5,5,5-nonafluoro-4-(trifluoromethyl)pentan-3-one.
Chemical Formula :	$C_6F_{12}O$.
Company Name:	Zhejiang Noah Fluorochemical Co., Ltd.
Company Address:	No.6 Weft Nine Road, Shangyu Economic Development Zone, Hangzhou Bay, Shaoxing City, Zhejiang Province, China.
Post Code:	312300
Web:	www.zjnoah.cn
Tel:	0575-82827265/82923692/829579766
Email:	noah@zjnoah.cn
Emergency Tel:	0532-83889090 (24 h)

Recommended and Restricted use of the Chemical:

Fully submerged fluid extinguishing agent.

Section 2: HAZARD IDENTIFICATION

Emergency Overview:

Get medical attention if you feel unwell.

Label Elements:	Not applicable.
Pictograms:	Not applicable.
Warnings:	Not applicable.
Hazard Statement:	H412 Harmful to aquatic life and has long lasting effects.
Precaution:	P202 Do not operate until you have read and understood all safety precautions.
Incident Response:	P391 Collection of spills.
Safe Storage:	P233 + P403 Keep container tightly closed. Store in a well-ventilated place.

Disposal:

P501 Disposal of contents and/or container should be in accordance with local, regional, national, and international regulations.

Physical and Chemical Hazards:

Not classified based on available information, please see section 9 and 10 for more information.

Health Hazards:

Not classified based on available information, please see section 11 for more information.

Environmental Hazards:

Harmful to aquatic life and has long lasting effects.

Other Hazards: No data.

Section 3: INGREDIENTS

Chemical Name: Noah 5112/ Perfluoro (2-methyl-3-pentanone)

Component	% by weight	CAS NO.
Perfluoro (2-methyl-3-pentanone)	< =100	756-13-8

Section 4: FIRST AID MEASURES

Inhalation:

Remove person to fresh air. If you feel unwell, get medical attention.

Ingestion:

If you feel unwell, gargle with warm water and seek medical advice.

Skin Contact:

Wash thoroughly with soap and water. If you feel unwell, seek medical attention.

Eye Contact:

Lift the eyelid and rinse with running water for at least 15 minutes, if wearing contact lenses, please take off and then rinse. Seek medical attention if you feel unwell.

The Most Important Symptoms and Health Effect: No data.

Advice for Protecting Rescuers:

Personal protective equipment should be used when entering the scene of the accident.

Special Note to Doctors: Treat symptomatically.

Section 5: FIRE-FIGHTING MEASURES

Extinguishing Agent: The product is an extinguishing agent.

Special Hazards: Thermal decomposition in contact with acute heat: carbon monoxide, carbon dioxide, hydrogen fluoride, toxic vapors and gases.

Fire-fighting Precautions and Protective Measures: Wear protective equipment and self-contained breathing apparatus (SCBA). Avoid inhaling products and thermal decomposition products or other substances in the fire area. When the container is exposed, spray the container with water to keep it cool to avoid breakage. Pay attention to the stability and reactivity of harmful thermal decomposition products.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal Protective Measures, Protective Equipment and Emergency Procedures:

Use personal protective equipment. Ensure adequate ventilation. Avoid inhaling large amount of vapor. Cut off the source of leakage as much as possible. Ensure that people stay away from the leakage area or stay in the upwind direction of the leakage area. Unrelated persons are prohibited from entering. It is recommended that emergency responders wear air-carrying breathing apparatus and rubber oil-resistant gloves. Delimit the warning area according to the affected area of liquid flow and steam diffusion.

Environmental Protection Measures:

If it can be operated safely, prevent further leakage. Avoid the product entering the drain, surface water, and underground water.

The Containment and Cleaning Methods of Leaked Chemicals and Disposal Materials Used:

For larger leaks, the drainage ditch should be filled and build dikes to prevent the product from entering drainage system. Collect the residue containing the product as soon as possible and transport to the place permitted by the relevant authorities for disposal. From the edge of the leakage area to the inward treatment. Cover with bentonite, vermiculite or commercially available inorganic absorbent material. Mix well with these absorbers until dry. Collect as much of the spill as you can. Wash the residue with detergent and water. Seal the container well. When discharging this material, the user needs to verify that it is reported in accordance with local, state, and federal regulations.

Preventive Measures for Secondary Disasters:

Prevent leaks from entering sewers, surface water and groundwater.

Section 7: HANDLING AND STORAGE

Operational Disposal:

Operators should be trained and strictly abide by the operating procedures. It is recommended that operators wear general work protective clothing and suitable chemical protective gloves. Avoid inhaling steam. The contents may be under pressure, be careful not to inhale thermal decomposition products when opening. The workplace should have ventilation systems and equipment. Wash hands and face thoroughly after operation. Be light when handing to prevent the package from breaking and causing losses. Equipped with corresponding types and quantities of leakage emergency treatment equipment.

Storage:

Storage and transportation requirements shall be handled as non-dangerous goods, and follow the industry's conventional storage and transportation requirements. And the container should be stored in a clean, ventilated, and dry warehouse. Avoid direct sunlight, strong bases, amines and alcohols. And use appropriate labels. Use appropriate labels, spill emergency treatment equipment and appropriate containment materials.

Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational exposure limits: TWA: 150ppm (1935 $mg \cdot m^{-3}$).

Engineering Control:

Local exhaust ventilation shall be provided over open containers. In cases where material is exposed to extreme heat due to misoperation or equipment failure, the use of a container with a local exhaust port is sufficient to ensure that the thermal decomposition product is below explosive levels. Use ordinary dilution ventilation and local exhaust ventilation to keep airborne hazardous substances (dust/smoke/gas/smoke/steam/spray) below the relevant exposure limits. If ventilation is insufficient, wear respiratory protective equipment.

Personal Protective Equipment:

Respiratory Protection: As a good industrial hygiene rule: avoid inhaling steam, mist or spray. Not required under normal service conditions. If thermal decomposition occurs, do not inhale the vapor and wear a respirator. According to the concentration of pollutants in the air, choose a half mask or full mask type respirator. Based on the exposure assessment results, respiratory protection was selected to prevent respiratory exposure. Consult the respirator manufacturer to select the appropriate respirator.

Hand Protection:	It is recommended to wear suitable protective gloves.
Eye Protection:	Goggles.
Skin and Body Protection:	Wear protective clothing in case of emergency.

Other Measures:

Local regulations on normal protection of chemical handling and industrial hygiene must be followed and thermal decomposition products must not be inhaled.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance and Properties:	Colorless transparent liquid.
Odor:	Odorless.
pH:	Not applicable.
Freezing Point:	-108 °C.
Boiling Point:	49.2 °C.
Saturated Vapor Pressure:	44.4 kPa (25 °C).
Vapor Density:	No data.
Density:	1.601 $g \cdot mL^{-1}$ (25 °C).
Insulation performance (110 kV):	3.8 mA
Octanol/Water Partition Coefficient:	No data.
Autoignition Temperature:	Not applicable.
Flash Point (Closed Cup):	No flash point.
Upper and Lower Flammability Limit or Explosion Limit:	No data.
Kinematic Viscosity:	0.4014 $mm^2 \cdot s^{-1}$ (25 °C).
GWP:	< 1.
ODP:	0.
Atmospheric Lifetimes (day):	5.

Section 10: STABILITY AND REACTIVITY

Stability:	Stable.

Incompatible Materials:	Strong bases, amines and alcohols.
Conditions to Avoid:	Sunlight, moist.
Aggregating harm:	No.
Hazardous Decomposition Products:	CO, CO_2, HF, toxic vapors, gases, particulates.

Section 11: TOXICOLOGICAL INFORMATION

Acute Toxicity:
Acute dermal toxicity, lethal dose of 50% LD_{50}>2000 mg·kg^{-1} (big mouse);
Acute inhalation toxicity, lethal concentration of 50% LC_{50} (4 h) > 20528.0 mg·m^{-3};
Acute imported toxicity, lethal dose of 50% LD_{50} > 5000 mg·kg^{-1}.

Skin Corrosion/Irritation: No irritation to rabbit skin.

Serious Eye Damage/Eye Irritation: No irritation to rabbit eyes.

Respiratory Tract Sensitization: For the component(s), either no data are currently available or the data are not sufficient for classification

Skin Sensitization: For the component(s), either no data are currently available or the data are not sufficient for classification

Germ Cell Mutagenicity: For the component(s), either no data are currently available or the data are not sufficient for classification

Carcinogenicity: For the component(s), either no data are currently available or the data are not sufficient for classification

Reproduction toxicity: For the component(s), either no data are currently available or the data are not sufficient for classification

Bacterial Reverse Mutation Test:
For the component(s), either no data are currently available or the data are not sufficient for classification

In Vitro Mammalian Cell Chromosome Aberration Test:
For the component(s), either no data are currently available or the data are not sufficient for classification

Mammalian Erythrocyte Micronucleus Test:
For the component(s), either no data are currently available or the data are not sufficient for classification

In Vitro Mammalian Cell Gene Mutation Test:
For the component(s), either no data are currently available or the data are not sufficient for classification

Rodent 28-day Repeated Dose Oral Toxicity: For the component(s), either no data are currently available or the data are not sufficient for classification

Sub-chronic (90 days) Inhalation Toxicity Test: For the component(s), either no data are currently available or the data are not sufficient for classification

Inhalation Hazard: For the component(s), either no data are currently available or the data are not sufficient for classification

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity: For the component(s), either no data are currently available or the data are not sufficient for classification

Persistence and Degradability: For the component(s), either no data are currently available or the data are not sufficient for classification

Potential Bioaccumulation: For the component(s), either no data are currently available or the data are not sufficient for classification

Mobility in Soil: For the component(s), either no data are currently available or the data are not sufficient for classification

Life cycle of environmental impacts: For the component(s), either no data are currently available or the data are not sufficient for classification

Section 13: DISPOSAL CONSIDERATIONS

Waste Chemicals:

Dispose of waste in licensed industrial waste disposal facilities. Incineration in a licensed waste incineration facility as one of the options for waste disposal. Proper destruction may use additional fuel in the incineration process. Thermal decomposition products include HF and equipment must be capable of handling halogenated materials.

Contaminated Packaging:

Consult the competent authorities to determine available treatment and disposal facilities.

Section 14: TRANSPORT INFORMATION

IMDG/IMO: not regulated.

UN number: ADR/RID, IMDG, IATA-DGR: not applicable.

UN proper shipping name: ADR/RID, IMDG, IATA-DGR: Not restricted.

Transport hazard class(es): ADR/RID, IMDG, IATA-DGR: not applicable.

Packing group: ADR/RID, IMDG, IATA-DGR: not applicable.

Environmental hazards: Marine pollutant: no.

Special precautions for user: No dangerous good in sense of these transport regulations.

Transport in bulk according to Annex II of Marpol and the IBC Code: No data available.

Transportation precautions:

During transportation, it is necessary to ensure that the container does not leak, collapse, fall, damage, invert, or shock violently. Direct sunlight and liquid water such as rain should be avoid during transportation.

Section 15: REGULATORY INFORMATION

The following laws, regulations, rules and standards have made corresponding provisions on the management of this product:

"Environmental Management Measures for New Chemical Substances" (Ministry of Environmental Protection Decree No. 7 of 2010): Not listed.

"Regulations on the Safety Management of Hazardous Chemicals":

"Dangerous Chemicals Catalogue" (2015 Edition): Not listed.

"GB18218-2009 Identification of Major Hazard Sources of Hazardous Chemicals": Not listed.

"Regulations on Labor Protection in Workplaces where Toxic Substances are used" (Order 352 of The State Council in 2002): Not listed.

Section 16: OTHER INFORMATION

NFPA Ratings:
NFPA Code for Health-3;
NFPA Code for Flammability-0;
NFPA Code for Reactivity-0;
NFPA Code for Special Hazards-None.
HMIS Ratings:
HMIS Code for Health-0;
HMIS Code for Flammability-0;
HMIS Code for Physical Hazard-1;
HMIS Code for Personal Protection-See Section 8.
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Revision Date: September 05, 2023.
Revision Department:
Zhejiang Noah Fluorochemical Co., Ltd. Tel: 0575-82827265/82923692/82957976.
Revision Information: 5th revision.
Standards: This SDS is compiled in accordance with GB/T 16483-2008 "Chemical Safety Technical Specification Content and Item Sequence" (Compiling Guide: GB/T 17519-2013 "Chemical Safety Technical Specification Compilation Guide").
Abbreviations and Acronyms: CAS: CAS Registry Number, LD_{50}: lethal does of 50%, LC_{50}: lethal concentration of 50%, RID: International Rail Transport Dangerous Goods Regulations, TWA: Time-weighted Average.
Other Information: This SDS is compiled based on the ingredient content and other information provided by the applicant and our company's existing knowledge, and is only used as a guide. Users of this SDS must make independent judgments on the correctness and completeness of the content, determine its applicability based on the actual situation, and bear relevant legal responsibilities for the consequences of use.