FIRETRACE®

POWER TO INNOVATE. FLEXIBILITY TO ADAPT.

DESIGN, INSTALLATION, OPERATION AND MAINTENANCE MANUAL

FOR

PRE-ENGINEERED AUTOMATIC INDIRECT
NOVEC™ 1230
EXTINGUISHER UNITS

Models: 951506, 952006, 952506, 953006, 953506 and 955006

P/N 800026

Firetrace USA LLC.
8435 N. 90th St, Suite 2
Scottsdale, AZ 85258 USA

Telephone: 480-607-1218
Fax: 480-315-1316

Website: www.firetrace.com
Email: firetrace@firetrace.com

REV	DESCRIPTION OF CHANGE	By	Appvd	ECO	DATE
A	Initial Release	ACH	RCG	ECO16-0114	06-06-2016
B	Additional models 951506, 952506, 953006 and 955006	TB	TB	ECO18-071	08/13/2018
C	Update values in Table 3.3: Cylinder Pressure-Temperature Relationship.	RC	TB	ECO19-043	03/14/2019

FIRETRACE®

AUTOMATIC FIRE SUPPRESSION SYSTEMS

DIOM 800026 – Novec 1230™ IHP Systems DIOM

Originally Prepared By: Alex Hildebrand

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1.0 FORWARD

1.1 General

This manual is written for the fire protection professional that designs, installs, and maintains Firetrace Pre-engineered Automatic High Pressure Novec™ 1230 (FK-5-1-12) Extinguisher Units.

Firetrace Novec™ 1230 automatic high-pressure extinguisher units 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 800026
- All information contained on the agent cylinder nameplate(s).
- NFPA-2001, Standard on Clean Agent Extinguishing Systems, Latest Edition.
- Local Authority having jurisdiction.

1.2 Safety Precautions

Safety precautions are essential when any electrical or mechanical equipment is involved. These precautions should be followed when handling, servicing, and recharging Firetrace Novec™ 1230 automatic high-pressure extinguisher unit cylinders and equipment. If safety precautions are overlooked or ignored, personal injury or property damage may occur.

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

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

⚠ WARNING:
This warning symbol identifies specific instructions or procedures, which, if not correctly followed, COULD result in severe personal injury of death.

⚠ CAUTION:
This caution symbol identifies specific instructions or procedures, which, if not correctly followed, COULD result in minor personal injury or equipment or property damage.

The following safety precautions should always be followed:

⚠ WARNING
Pressurized (charged) cylinders are extremely hazardous and if not handled properly are capable of causing bodily injury, death or property damage.

1. Read and understand this manual and the other documents referenced herein.
2. The valve discharge outlet safety cap and filling port cap **MUST** be installed on the cylinder valve at all times and only removed when connected into the discharge tubing, or when performing testing, or salvaging operations in accordance with the procedures contained in this manual.
3. Make sure that the ball valve (attached to the cylinder valve) is closed (lever is in "OFF" position), the detection tubing has been removed from the cylinder valve; and the safety caps installed, before removing the cylinder from the installation, and before performing any charging, leak tests or salvage operations.
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.

Any questions concerning the information contained in this manual should be addressed to:

Firetrace USA LLC.
8435 N 90th St, Suite 2
Scottsdale, AZ 85258 USA
Telephone: 480-607-1218
Fax: 480-315-1316
Email: firetrace@firetrace.com

The following web site should be visited for frequent technical announcements

www.firetrace.com

2.0 INTRODUCTION

These units are designed for total flooding using Novec™ 1230, in accordance with NFPA-2001, *Standard on Clean Agent Extinguishing Systems. Latest Edition*

Each installed pre-engineered unit is equipped with its own detection tubing and its own discharge hose and nozzles. The pre-engineered concept minimizes the amount of engineering involved in the units design. When the discharge hoses and nozzles are installed within the limitations stated in this manual, no hydraulic calculations are required to determine pressure drop, agent flow or discharge time.

The hazard being protected can be any size, shape or volume, provided that the hazard being protected is within the limitations described in this Manual. Each extinguisher unit, when installed, is a self-contained unit, meaning that it is equipped with its own automatic (non-electric) detection system, which when actuated, automatically releases the suppression agent into the hazard area.

Local authorities having jurisdiction should be consulted to verify that the Firetrace Indirect High Pressure system meets all standards relevant to a particular application.

2.1 3M™ Novec™ 1230 Extinguishing Agent

The extinguishing agent used in Firetrace self-contained automatic direct and indirect fire suppression units is Dodecafluoro-2-methylpentan-3-one, more commonly known as FK-5-1-12 or the trade name 3M™ Novec 1230™.

Novec 1230™ (1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE) is a colorless low odor fluid, low in toxicity, electrically non-conductive, leaves no residue, and is an extremely effective fire suppression agent when used at concentrations specified by both NFPA 2001 (Latest Edition) and/or the Manufacturer.

Novec 1230™ is included in NFPA-2001, under the generic name FK-5-1-12, and has been evaluated and approved for use in occupied areas as a Total Flooding agent; when used as specified under the U.S. Environmental Protection Agency (EPA) SNAP Program rules. Refer to the SNAP Program rules for more information.

2.1.1 Cleanliness

Novec™ 1230 is a UL listed clean and leaves no residue, thereby minimizing any after fire clean up, along with keeping expensive downtime to a minimum. Most materials such as steel, aluminum, stainless steel, brass, as well as plastics, rubber and electronic components are not affected by exposure to Novec™ 1230. This agent is also environmentally friendly, having an ozone depletion potential (ODP) of 0.00 and an atmospheric lifetime of 5 days (the closest halocarbon alternative is 33 years).

2.1.2 Thermal Decomposition

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 design factors laid out in this manual should be followed to limit the quantity of TDP created.

Possible Hazardous Decomposition or By-Products include:

Substance	Condition
Carbon Monoxide	During Combustion
Carbon Dioxide	During Combustion
Hydrogen Fluoride	During Combustion

See Appendix of NFPA 2001, Batterymarch Park, Quincy, Massachusetts 02169, for further discussion of FK-5-1-12 Fire Fighting mechanism.

2.1.3 Physical Properties of Novec™ 1230

For hazard information, decomposition information, and physical properties of Novec™ 1230 please refer to the Material Safety Data Sheet located in Appendix A.

3.0 SYSTEM DESCRIPTION

3.1 General

The Firetrace Novec™ 1230 Automatic High-Pressure units are available in the following sizes:

951506	Charged with 15.0 Lbs. of Novec™ 1230
952006	Charged with 20.0 Lbs. of Novec™ 1230
952506	Charged with 25.0 Lbs. of Novec™ 1230
953006	Charged with 30.0 Lbs. of Novec™ 1230
953506	Charged with 35.0 Lbs. of Novec™ 1230
955006	Charged with 50.0 Lbs. of Novec™ 1230

These units are designed for use in Total Flooding applications. A lock-out valve shall be provided on all systems except where dimensional constraints prevent personnel from entering the protected space.

The Firetrace Novec™ 1230 units can be used, but are not limited, to protect the following:

- Electrical and electronic cabinets.
- Telecommunication areas.
- Data Processing areas and cabinets.
- Other high value assets.
- Laboratory fume /exhaust cabinets
- Pump enclosures
- UPS units
- Flammable Chemicals storage cabinets

- Generator Enclosures
- Transformer Cabinets
- Computer/Data Storage Cabinets
- CNC & VMC Machining centers
- Many other applications

Novec™ 1230 is a gaseous fire-extinguishing agent that is effective for use on (please refer to Appendix A for the FM Approval system specifications and limitations):

- Class A –
  - ⇒ Surface type fires
  - ⇒ Deep seated fires
- Class B – Flammable liquid fires
- Class C – Electrical equipment fires

Novec™ 1230 should not be used where the following materials may be present.

- Pyrotechnic chemicals containing their own oxygen supply.
- Reactive metals such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium and plutonium.
- Metal hydrides.
- Chemicals capable of undergoing auto thermal decomposition, such as certain organic peroxides and hydrazine.

For hazards beyond the scope described above, it is recommended that the designer consult with Firetrace, NFPA-2001, and the local authority having jurisdiction, as to the suitability on the use of Novec™ 1230 for a particular hazard, for personnel exposure effects from the design concentration, and for installation requirements.
Firetrace Novec™ 1230 Automatic High Pressure Extinguisher Units consist of the following major components:

- Novec™ 1230 High Pressure Cylinder/Valve assembly.
- Cylinder Mounting Bracket.
- Firetrace detector/actuation tubing and fittings (no substitute).
- Discharge nozzles.
- Discharge Port Adapter
- Pressure switch
- Discharge tubing and fittings (furnished by others).

Once installed, the Firetrace Automatic High Pressure Unit becomes a self-contained, self-actuating unit that does not require an external source of power or electricity.

The unit utilizes unique Firetrace flexible tubing that is attached to the cylinder valve. This tubing is pressurized with dry nitrogen to maintain the cylinder valve in the closed position. The tubing is temperature sensitive, and acts as a continuous linear thermal detector that ruptures upon direct flame impingement. Once the detector tubing is ruptured, the cylinder valve automatically opens, allowing the Novec™ 1230 agent to flow through the discharge tubing, distributing the extinguishing agent through the nozzle(s) onto the protected area. Upon actuation, the pressure switch can be used to indicate discharge, shutdown ventilation, close all openings, shut-off electrical power, etc. as may be required.

3.1.1 Operating Pressure

The Novec™ 1230 agent is stored in the cylinder as a liquid, pressurized with dry nitrogen at 50 bar (725 psig) @ 70°F.

3.1.2 Operating Temperature Range Limitations:

The ambient operating temperature range for all unit components is:
-20°F to +140°F (-29°C to +60°C).

3.2 Component Descriptions

3.2.1 Novec™ 1230 Cylinder Valve Assemblies

Novec™ 1230 is stored in DOT/TC aluminum cylinders as a compressed liquid at 50 bar (725psig) @ 70°F.

Each cylinder is equipped with a brass valve and a quarter turn ball valve that interfaces with the Firetrace detector tubing. The ball valve must be kept closed at all times when the cylinder is not in service.

In addition, the Novec™ 1230 Cylinder valves are equipped with a pressure relief (rupture disc) device in compliance with DOT/TC requirements.

Each valve is also equipped with (1) discharge outlet port and (1) filling port. Each port is provided with a safety cap that must be installed whenever a cylinder is not in service. These caps are safety devices designed to prevent uncontrolled discharge of the cylinder in the event that the valve is accidentally actuated.

⚠ WARNING

The safety caps must be installed on the valve discharge port and filling port at all times, except when connected into the units discharge tubing or when filling. Failure to follow these instructions could result in personal injury, death or property damage.

Table 3.1 describes the 20 and 30 pound cylinder assemblies. Each cylinder is equipped with a straight siphon tube and can only be mounted in a vertical (upright) position.

Table 3.1: Novec™ 1230 Cylinder / Valve Assemblies

Nom Size	**Assy Part**	**Outside Dia.**		**Overall Height**		**Internal Volume**		**Novec™ 1230 Agent**		**Fill Ratio**
	No.	in.	cm	in.	Cm	in^3	cm^3	lb.	kg	Kg/L
15	951506	6.89	17.5	16.6	42.2	408	6686	15.0	6.80	1.017
20	952006	8.00	20.3	29.0	73.7	816	13372	20.0	9.07	0.678
25	952506	8.00	20.3	29.0	73.7	816	13372	25.0	11.34	0.848
30	953006	8.00	20.3	29.0	73.7	816	13372	30.0	13.61	1.018
35	953506	8.00	20.3	29.0	73.7	816	13372	35.0	15.88	1.188
50	955006	8.00	20.3	38.0	96.5	1429	23417	50.0	22.68	0.969

Table 3.2 describes the DOT/TC Specifications used for the manufacture of the Clean Agent cylinders.

Table 3.2: DOT/TC Cylinder Specifications

Nominal Size	**DOT Spec**	**TC Spec**	**Cylinder Service Pressure Psig (Bar)**	**Test Pressure**	
				DOT Psig (Bar)	**TC Psig (Bar)**
15	3AL1800	3ALM124	1800 (124)	3000 (207)	2700 (186)
20	3AL1800	3ALM124	1800 (124)	3000 (207)	2700 (186)
25	3AL1800	3ALM124	1800 (124)	3000 (207)	2700 (186)
30	3AL1800	3ALM124	1800 (124)	3000 (207)	2700 (186)
35	3AL1800	3ALM124	1800 (124)	3000 (207	2700 (186)
50	3AL1800	3ALM124	1800 (124)	3000 (207)	2700 (186)

The Firetrace Novec™ 1230 Units are designed for an operating temperature range of -20°F to +140°F (-29°F to 60°C). Table 3.3 shows the cylinder at a charged pressure of 725 psig (50 Bar) at 70°F (21.1°C).

Table 3.3: Cylinder Pressure-Temperature Relationship

Cylinder Pressure			
Temperature		Pressure	
°F	°C	psig	kPa
-20	-28.9	551	3801.7
-10	-23.3	571	3935.1
0	-17.8	590	4068.6
10	-12.2	609	4202.0
20	-6.7	629	4335.4
32	0.0	652	4495.6
40	4.4	668	4602.3

50	10.0	687	4735.8
60	15.6	706	4869.2
70	21.0	725	5000.0
80	26.7	745	5136.1
90	32.2	764	5269.6
100	37.8	784	5403.0
110	43.3	803	5536.4
120	48.9	822	5669.9
130	54.4	842	5802.3
140	60.0	861	5936.8

3.2.2 Cylinder Mounting Bracket

A wall mounted painted steel bracket is used to mount the 20 and 35lb cylinder/valve assemblies in a vertical (upright) position. Each bracket is equipped with an interlocking steel strap that is secured with a metallic pin.

3.2.3 Firetrace Flexible Detector/Actuation Tubing

The Firetrace tubing is used as a combination linear heat detector and unit activation device to cause actuation of the Novec™ 1230 agent cylinder. The tubing is installed throughout the hazard volume, with one end connected to the Novec™ 1230 cylinder valve. The tubing is pressurized with nitrogen to 195 psig while maintaining the ball valve in the "OFF" position. An optional pressure gauge or pressure switch can be connected to the other end of the detector tube to monitor tubing pressure and/or signal unit actuation etc. The detector tubing is heat sensitive and in a fire situation is designed to rupture at any point along the tube. The rupture of the tube releases the nitrogen pressure causing the Novec™ 1230 cylinder valve to actuate, resulting in complete discharge of the extinguishing agent through the nozzles.

3.2.4 Discharge Nozzle

Discharge nozzles are used to distribute Novec™ 1230 agent uniformly throughout the hazard area. One size nozzle is available for use with all IHP models, and must be used within the limitations described in this Manual

3.2.5 Pressure Switch

A pressure switch (P/N 400005) is available as an optional item. This switch can be connected at the end of the line of the Firetrace detector tubing to monitor unit actuation and to energize or de-energize electrically operated equipment. Firetrace recommends that all units use a pressure switch coupled with some device to alert personnel in the event of discharge. The pressure switch activates at 135 psig, and releases at 70 psig.

3.2.6 Recharge Adapters, Novec™ 1230 Cylinder

The recharge adapter (P/N 310400) is connected to the filling port located on the cylinder valve during the cylinder recharging procedure. The adapter is used for refilling the cylinder with dry nitrogen.

3.2.7 Cylinder N_2 Recharge Adapter

The recharge adapter (P/N 600213) is connected to the Firetrace tubing, and the other end of the tubing is attached to the ball valve, located on the cylinder valve, during the

charging procedure. The adapter is used to apply nitrogen pressure to the detection tubing, and to keep the valve piston seated.

3.2.8 Novec™ 1230 Warning Nameplate

The Warning Plate is required to warn personnel not to enter the hazard area during or after discharge. Warning signs shall be provided in a conspicuous location, at the entrance to the protected areas, or in the case of cabinet protection on the front face of the cabinet. Signs must be in accordance with NFPA 2001, Section 4.3.

4.0 SYSTEM DESIGN AND LIMITATIONS FOR TOTAL FLOODING

4.1 General

The Firetrace series of Novec™ 1230 Pre-Engineered Automatic Indirect High Pressure Extinguisher units were tested and limits established by Firetrace. These units were subjected to numerous performance tests, in order to verify their suitability and to establish design limitations for:

- Hazard volume
- Nozzle placement
- Design concentrations & design factors
- Detector tubing placement

The pre-engineered automatic unit concept minimizes the amount of engineering required when evaluating a design for a specific application. So long as the discharge piping, tubing, and nozzles are installed within the limits prescribed in this manual, no calculations are required for pressure drop, flow rates or discharge time. When the additional limitations of hazard volume, design concentration, agent quantity, detector arrangement, etc., are also met, the unit installation can be understood to comply with the design requirements, NFPA-2001.

4.2 Design Procedure

The following procedures should be used to design a Firetrace Novec™ 1230 pre-engineered IHP automatic extinguisher unit. In addition, the applicable requirements specified in NFPA-2001 should be followed.

a. Conduct a survey and analysis of the hazard to be protected.

b. Determine the height, length, and width of the enclosure. Calculate the volume. All of these parameters must be within the dimensional limits specified in this manual. (See Section 4.3, Table 4.1).

c. Determine the anticipated minimum and maximum ambient temperatures expected within the enclosure to be protected.

d. Determine the minimum design concentration required for the hazard. (See Section 4.5 and Table 4.3).

e. Determine the integrity of the enclosure. Are there any openings that must be closed at the time of agent discharge? (See Section 4.6).

f. Calculate the quantity of Novec™ 1230 agent required, with the proper design concentration, to protect the enclosed space. (Refer to Section 4.7 and Example 4.8.1).

g. Determine the cylinder size required, based on the hazard volume limitations, enclosure size, and quantity of Novec™ 1230 agent required.

h. Determine the location of the Novec™ 1230 cylinder.

i. Determine the location and quantity of nozzles required, based on the size and configuration of the enclosure. (See Section 4.9 and Table 4.6).

j. Determine the routing and quantity of discharge pipe (tubing) required. The discharge pipe (tubing) and fitting limitations must not be exceeded. (See Section 4.9 and Table 4.6).

k. Determine the arrangement and placement of the Firetrace detector tubing. (See Section 4.10).

l. Determine any auxiliary equipment requirements, such as pressure switch(s) to sound alarms, shut-down ventilation, shut-off electrical power, etc.

m. Prepare system drawings, bill of materials list, etc; following Section 4.4 of NFPA-2001 2015 Edition.

4.3 Hazard Enclosure Volume Limitations

The maximum volume for each size unit is shown in Table 4.1. The protected enclosure can be any size or shape provided that the volume does not exceed the limitations shown in Table 4.1.

Table 4.1: Enclosure Size Limitations

Model	Novec™ 1230 (Lbs [kg])	Minimum Volume (Ft^3 [m^3])	Maximum Volume (Ft^3[m^3])
951506	15.0 [6.8]	205 [5.8]	291 [8.3]
952006	20.0 [9.1]	274 [7.8]	388 [11.0]
952506	25.0 [11.3]	342 [9.7]	485 [13.7]
953006	30.0 [13.6]	411 [11.6]	582 [16.5]
953506	35.0 [15.9]	479 [13.6]	679 [19.2]
955006	50.0 [22.7]	685 [19.4]	970 [27.5]
Volumes are based on 6.4% Design Concentration			

Model	FK-5-1-12	Number of Nozzles	Max Area Coverage Per Nozzle	Total Area Coverage per Unit	Maximum Height	Total Volume Coverage per Unit
951506	15.0 lb [6.8kg]	1	6.1' x 6.1' = 37.3 Ft^2	37.3 Ft^2	7.8 Ft	(a)
		2	4.3' x 4.3' = 18.7 Ft^2	37.3 Ft^2	7.8 Ft	(a)
		4	3.1' x 3.1' = 9.3 Ft^2	37.3 Ft^2	7.8 Ft	(a)
952006	20.0 lb [9.1kg]	1	7.1' x 7.1' = 49.7 Ft^2	49.7 Ft^2	7.8 Ft	(a)
		2	5.0' x 5.0' = 24.9 Ft^2	49.7 Ft^2	7.8 Ft	(a)
		4	3.5' x 3.5' = 12.4 Ft^2	49.7 Ft^2	7.8 Ft	(a)
952506	25.0 lb [11.3kg]	2	5.6' x 5.6' = 31.1 Ft^2	62.2 Ft^2	7.8 Ft	(a)
		4	3.9' x 3.9' = 15.5 Ft^2	62.2 Ft^2	7.8 Ft	(a)
953006	30.0 lb [13.6kg]	2	6.1' x 6.1' = 37.3 Ft^2	74.6 Ft^2	7.8 Ft	(a)
		4	4.3' x 4.3' = 18.7 Ft^2	74.6 Ft^2	7.8 Ft	(a)

953506	35.0 lb [15.9kg]	2 4	6.6' x 6.6' = 43.5 Ft^2 4.7' x 4.7' = 21.8 Ft^2	87.1 Ft^2 87.1 Ft^2	7.8 Ft 7.8 Ft	(a) (a)
955006	50.0 lb [22.7kg]	4	5.6' x 5.6' = 31.1 Ft^2	124.4 Ft^2	7.8 Ft	(a)

Table 4.2: Enclosure Size and Nozzle Limitations

4.4 General Specifications

4.4.1 Storage and Operating Temperature Range:

The Firetrace Novec™ 1230 units and equipment are designed to be stored and operated at an ambient temperature range of -20°F to +140°F. (-29°C to +60°C).

4.4.2 System Operating Pressure:

The normal operating pressure for the unit is 725 psig at 70°F (50 Bar at 21.1°C).

4.5 Minimum Design Concentrations

The minimum design concentrations to be used with Firetrace Novec™ 1230 units shall not be less than 5.9 %. For class B hazards, proper consideration must be given to the material involved in the hazard, the design concentration should then be given a safety factor (SF) of 30%, as specified in NFPA-2001, Year 2015 edition.

Table 4.2: Minimum Safety Factor

Hazard Type	Minimum Safety Factor
Class B Flammable Liquids	30%

Table 4.3 lists Novec™ 1230 minimum design concentrations that must be used with Firetrace Novec™ 1230 units for Class A hazards and the various Class B fuels shown.

Consult Firetrace website, or contact Firetrace if the hazard you desire to protect is not listed.

Table 4.3: Minimum Novec™ 1230 Concentrations for Extinguishment

Material	Theoretical Minimum Novec™ 1230 Concentration %	Minimum Design Novec™ 1230 Concentration %
Class A (surface fires) [(a)]	3.75	4.5

Including plastic materials typically found in electrical/electronic equip.		
Class B fuels [(b)]		
1-Butanol	5.33	6.4
1-Propanol	5.83	7
2,2,4-Trimethylpentane	5.08	6.1
2-butoxyethanol	5.67	6.8
2-(2-Methoxyethoxy)-Ethanol	6.08	7.3
Acetic Acid	4.08	4.9
Acetone	4.67	5.6
Acetonitrile	3.17	3.8
AvGas	4.33	5.2
AvTur	4.67	5.6
Benzene	3.17	3.8
Benxyl Alcohol	4.42	5.3
Butoxyethylacetate	5.00	6.0
Heptane	4.75	5.7
Commercial Hexanes	4.67	5.6
Cyclohexane	4.92	5.9
Cyclohexylamine	4.58	5.5
Cyclopentane	4.42	5.3
Cyclopentanone	5.00	6.0
Denatured Alcohol	5.75	6.9
Diesel Fuel	3.67	4.4
Diethyl Ether	5.33	6.4
Dimetholxymethane	6.17	7.4
DMSo	5.33	6.4
Ethane	5.25	6.3
Ethanol	6.00	7.2
Ethyl Acetate	5.08	6.1
Gasoline-87	4.92	5.9
Glycerine	6.92	8.3
Glycol Ether DB	6.00	7.2
Hexanes	4.67	5.6
Hexene	5.00	6.0
Hydrogen	11.08	13.3
Hydrogen Sulfide	4.50	5.4
Iso-Butane	5.25	6.3
Isobutyl Alcohol	5.50	6.6
Isobutyl Isobutyrate	4.75	5.7
Isooctane	5.08	6.1
Isopropyl Alcohol	5.33	6.4
Jet A	4.50	5.4
Kerosene	4.92	5.9
Methane	6.08	7.3

Methanol	7.08	8.5
Methyl Amyl Ketone	5.00	6.0
Methyl Ethyl Ketone	4.92	5.9
Methyl Formate	5.83	7.0
Methyl Isobutyl Ketone	4.75	5.7
Methyl Siloxane	6.58	7.9
Methyl Tert Butyl Ether	4.92	5.9
Methylpyrrolidone	4.92	5.9
Mineral Oil, Heavy	5.83	7.0
Mineral Oil, Light	5.75	6.9
Morpholine	5.67	6.8
M-Xylene	3.67	4.4
N-Butane	4.92	5.9
N-Heptane	4.92	5.9
N-Hexane	4.67	5.6
Nitromethane	7.42	8.9
N-Pentane	5.08	6.1
Octane	4.75	5.7
Propane	6.25	7.5
Propylene Glycol	6.08	7.3
Propylene Glycol Mono Ethyl Ether	6.08	7.3
Pyrrolidine	5.08	6.1
Technical Heptane	4.67	5.6
Tetrahydrofuran	5.42	6.5
Toluene	3.83	4.6
Transformer Oil	4.92	5.9
Note: The theoretical minimum extinguishing concentrations in air for the materials in the table were obtained from a compilation of Bureau of Mines, *Limits of Flammability of Gases and Vapors* (Bulletins 503 and 627)		

For all materials not given in Table 4.3, the minimum theoretical Novec™ 1230 concentration shall be obtained from some recognized source or determined by test.

4.6 Openings and Ventilation Shutdown

Provisions must be made to provide means to close all openings in the hazard enclosure and shut-off ventilation at the time of discharge.

4.7 Novec™ 1230 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 4.4 – Typical Application Flooding Factors – US Customary Units)
C.F. = Atmospheric Correction Factor
s = Specific Volume of superheated Novec™ 1230 fluid (FK-5-1-12) vapor [ft^3/lb].
This can be approximated by the formula:
s = 0.9856 + 0.002441*T
T = The 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 number 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 4.5 – Typical Application Flooding Factors – SI Units)
C.F. = Atmospheric Correction Factor
s = Specific Volume of superheated Novec™ 1230 fluid (FK-5-1-12) vapor [m^3/kg].
This can be approximated by the formula:
s = 0.0664 + 0.0002741*T
T = The design temperature in the hazard area (°C)
C = Concentration of Agent Required (%)

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.

Table 4.4 – Typical Applications Flooding Factors – US Customary Units

Temp (t) (°F)	Specific Vapor Volume (s) (ft^3/lb)	Weight Requirements of Hazard Volume, W/V (lb/ft^3)					
		Design Concentrations (% by Volume)					
		6	6.2	6.4	7	7.5	8
0	0.98560	0.0648	0.0671	0.0694	0.0764	0.0823	0.0882
10	1.01001	0.0632	0.0654	0.0677	0.0745	0.0803	0.0861
20	1.03442	0.0617	0.0639	0.0661	0.0728	0.0784	0.0841
30	1.05883	0.0603	0.0624	0.0646	0.0711	0.0766	0.0821
40	1.08324	0.0589	0.0610	0.0631	0.0695	0.0749	0.0803
50	1.10765	0.0576	0.0597	0.0617	0.0679	0.0732	0.0785
60	1.13206	0.0564	0.0584	0.0604	0.0665	0.0716	0.0768
70	1.15647	0.0552	0.0572	0.0591	0.0651	0.0701	0.0752
80	1.18088	0.0541	0.0559	0.0579	0.0637	0.0687	0.0736
90	1.20529	0.0530	0.0548	0.0567	0.0624	0.0673	0.0722
100	1.22970	0.0519	0.0537	0.0556	0.0612	0.0659	0.0707
110	1.25411	0.0509	0.0527	0.0545	0.0600	0.0646	0.0693
120	1.27852	0.0499	0.0517	0.0535	0.0589	0.0634	0.0680
130	1.30293	0.0490	0.0507	0.0525	0.0578	0.0622	0.0667

Table 4.5 – Typical Applications Flooding Factors – SI Units

Temp (t) (°C)	Specific Vapor Volume (s) (m^3/kg)	Weight Requirements of Hazard Volume, W/V (kg/m^3)					
		Design Concentrations (% by Volume)					
		6	6.2	6.4	7	7.5	8
-20	0.0609	1.0478	1.0850	1.1224	1.2355	1.3309	1.4274
-17.7	0.0615	1.0371	1.0739	1.1109	1.2229	1.3173	1.4128
-15	0.0623	1.0247	1.0611	1.0977	1.2083	1.3017	1.3960
-10	0.0637	1.0027	1.0383	1.0740	1.1823	1.2736	1.3659
-5	0.0650	0.9816	1.0164	1.0514	1.1574	1.2468	1.3371
0	0.0664	0.9613	0.9954	1.0297	1.1335	1.2211	1.3095
5	0.0678	0.9419	0.9753	1.0089	1.1106	1.1964	1.2831
10	0.0691	0.9232	0.9559	0.9889	1.0886	1.1726	1.2576
15	0.0705	0.9052	0.9374	0.9697	1.0674	1.1498	1.2332
20	0.0719	0.8880	0.9195	0.9512	1.0471	1.1279	1.2097
21.1	0.0722	0.8843	0.9156	0.9472	1.0427	1.1232	1.2046
25	0.0733	0.8714	0.9023	0.9334	1.0275	1.1068	1.1870
30	0.0672	0.9495	0.8857	0.9162	1.0086	1.0865	1.1652
35	0.0760	0.8399	0.8697	0.8997	0.9904	1.0669	1.1442
40	0.0774	0.8251	0.8543	0.8838	0.9729	1.0480	1.1239
45	0.0787	0.8107	0.8395	0.8684	0.9559	1.0298	1.1044
50	0.0801	0.7968	0.8251	0.8535	0.9396	1.0121	1.0855
54.4	0.0813	0.7850	0.8129	0.8409	0.9256	0.9971	1.0694
55	0.0815	0.7834	0.8112	0.8392	0.9238	0.9951	1.0672

4.8 Maximum Protected Volume

The maximum volume that can be protected by the Firetrace Novec™ 1230 units is dependent on the minimum design concentration. The maximum volumes calculated from Table 4.4 for concentrations of 6.4% for Firetrace Novec 1230 systems are listed below.

Table 4.6: Maximum Protected Volume for IHP Systems

Model	Volume (ft^3[m^3])
951506	Up to 291 [8.3]
952006	Up to 388 [11.0]
952506	Up to 485 [13.7]
953006	Up to 582 [16.5]
953506	Up to 679 [19.2]
955006	Up to 970 [27.5]

4.8.1 Example Calculations

The requirements given in Sections 4.1 through 4.8 describe the procedures to be used to design and size a Firetrace IHP Novec™ 1230 unit.

The following example provides guidelines, following procedures 4.2.a, through 4.2.e., in order to determine the quantity of Novec™ 1230 agent required and cylinder size for a total flooding application.

Example:

Given:

- Hazard – Small cabinet storing Ethyl Alcohol (Ethanol).
- Class B hazard
- Enclosure size: 4′ wide x 10′ long x 6′ high. One (1) access door equipped with self-closing apparatus
- Minimum anticipated ambient temperature: 50°F
- Maximum anticipated ambient temperature: 90°F

Procedure:

a. Determine min. design concentration required (Refer to Table 4.2)

Use 7.2% min. design concentration for Ethyl Alcohol.

b. Calculate hazard volume (V).

V = 4′ x 10′ x 6′ =240 Ft^3

$$W = \left(\frac{240}{s}\left(\frac{7.2}{100-7.2}\right)\right)$$

Where,

$$s = 0.9856 + 0.002441 * 90 = 1.20529$$

Therefore,

$$W = 15.449lbs$$

4.9 Nozzle and Discharge Tubing Requirements

4.9.1 Discharge Nozzle Limitations

One size nozzle P/N 510024 is to be used with all Firetrace IHP Novec™ 1230 extinguisher units in total flooding applications.

Placement of nozzles shall be such that discharge of Novec™ 1230 will not splash flammable liquids or create dust clouds that could extend the fire.

It is encouraged that multiple nozzles be used to protect each hazard to reduce discharge times. "Equivalent Length of Pipe" for Firetrace IHP Novec™ 1230 systems is not exceeded. Refer to section 4.9.3 for information regarding the "Equivalent Length of Pipe".

4.9.2 Discharge Piping & Fitting Specifications

All Firetrace Novec™ 1230 IHP Units shall use flexible hose distribution networks.

Hose Specifications:

Material: Braided Steel Hose

Size: Up to 20lb Unit – ½" Internal diameter
25lb and over Unit – 5/8" Internal diameter

Hose Fitting Specifications

Material: Stainless Steel Fittings
Type: Class 300

4.9.3 Maximum Piping and Fitting Limitations

The maximum "Equivalent Length of Piping" shall not exceed 40ft. The "Equivalent Length of Piping" includes individual lengths of pipe and all pipe fittings. Table 4.6 includes the equivalent lengths of 5/8 inch threaded pipe fittings that need to be considered when determining the total "Equivalent Length of Piping".

Table 4.6: Equivalent length in feet of threaded pipe fittings.

Pipe Size	Elbow Std. 45°	Elbow Std. 90°	Elbow 90° Long Radius & Tee Thru Flow	Tee Side	Union Coupling
1/2	0.8	1.7	1.0	3.4	0.4

4.9.4 Nozzle Area Coverage

Please refer to Table 4-2 for the maximum area coverage (regardless of the number of nozzles used) and maximum nozzle arrangement limitations, respectively, for each system size. Figure 4.1 displays some acceptable examples of configurations that meet these limitations.

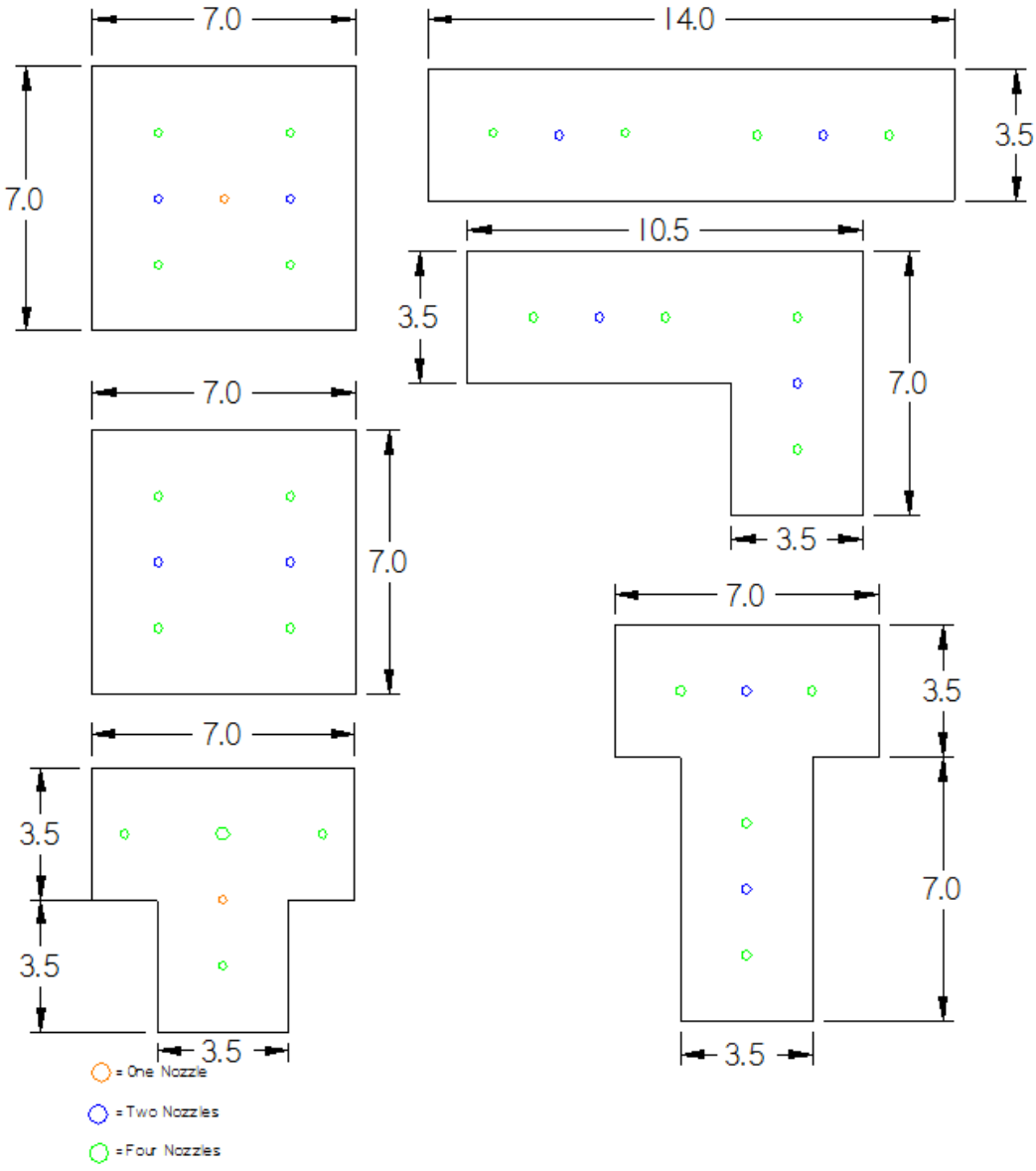


Figure 4.1 – Nozzle Layout Examples (Dimensions in Feet)

4.10 Firetrace Detector Tubing

For the Indirect Novec™ 1230 units, the Firetrace tube is used as a combination heat detector and unit activation device to cause actuation of the Novec™ 1230 agent cylinder.

The detector tubing is heat sensitive and in a fire situation is designed to rupture at any point along the tube upon direct flame impingement.

Location and spacing of the tubing is critical to the response time in the event of a fire. The tubing should be placed above the hazard areas being protected. The drawing in Appendix A provides general guidelines for placement of the detector tubing along with the maximum spacing and height limitations. Depending on the configuration of specific hazards, the guidelines may, or may not, be applicable. The maximum length of tubing that can be used for any IHP unit is 120 feet. The maximum height that is allowed between layers is 3.28 feet. The maximum distance between passes is 21.12 inches. **NOTE:** It is recommended that the tubing **not** be placed horizontally adjacent to potential fire sources as this may significantly delay response time.

5.0 INSTALLATION INSTRUCTIONS

This section provides installation instructions covering components and limitations described in Sections 3 and 4 of this manual.

All components should be installed to facilitate proper inspection, testing, recharging, and any other required service or maintenance as may be necessary. Equipment must not be subjected to severe weather conditions or mechanical, chemical, or other damage, which could render the equipment inoperative. The equipment must be installed in accordance with instructions in this manual and NFPA 2001

⚠ WARNING

Novec™ 1230 cylinder/valve assemblies must be handled, installed, and serviced in accordance with the instruction contained in this manual and on the cylinder nameplate. Failure to follow these instructions could result in severe injury, property damage or death.

5.1 Novec™ 1230 Cylinder/Valve and Bracket Assemblies

The Novec™ 1230 cylinders should be located as close as possible to the protected enclosure. In some cases the cylinder can be mounted inside the protected enclosure. The assemblies shall be located in a readily accessible location to allow for ease of inspection service and maintenance. The cylinders shall be located in an environment protected from the weather and where the temperature range is between -20°F and + 140°F (-29°C and +60°C).

Cylinder and bracket must be mounted in the vertical plane with the cylinder valve facing up.

Mount the cylinder where it will not be subject to accidental damage or movement. Suitable protection must be installed where necessary to prevent damage or movement.

> **⚠ CAUTION**
> Make sure that the ball valve, located on the cylinder valve, is maintained in the "OFF" position, and the discharge port safety caps are in place. Failure to follow these instructions will result in actuation and discharge of the cylinder contents.

1. Securely mount the cylinder bracket to structural support using 2 or more mounting holes.

2. Secure cylinder in place using the bracket strap.

5.2 Discharge Piping and Nozzles

1. Locate the nozzle(s) following the guidelines and limitations described in Section 4.9.

2. Determine the routing of the discharge piping following the guidelines and limitations described in Section 4.9

3. Remove the safety cap from the valve discharge port as required. Attach female connection fittings (Firetrace P/N 200201) onto discharge port.

4. Install the necessary piping and fittings between the cylinder and nozzle(s). Secure piping with appropriate size piping clamps as required.

5.3 Firetrace Detection Tubing

> **⚠ CAUTION**
> 1. Do not kink, bend, or crush Firetrace tubing in order to prevent leakage, which could result in accidental unit discharge.
> 2. Do not install tubing in a hazardous environment where the maximum ambient temperature exceeds 176°F (80°C)
> 3. Do not place the tubing on a surface where the temperature of the surface exceeds 140°F (60°C)
> 4. Maximum length of detector tubing shall not exceed 120 Feet.

1. Follow guidelines as outlined in section 4.10 and the drawing in Appendix A for the tubing placement.

2. Secure detection tubing using Mounting Tabs at 1.5 ft. intervals.

3. Use appropriate rubber/plastic grommets when detection tubing is routed through sharp holes in order to prevent damage to the tubing.

4. Connect the end of line adapter and spring top unit to the detection tubing as shown in Appendix A.

5. When installing tubing to the cylinder valve make sure that the detection tubing is pushed through the top of the slip on fitting. There are two o-ring seals within the fitting, and both need to be secure around the tubing

6. Ensure the detection tubing is pushed through the end of line adapter all the way through to the shoulder

7. The detector tubing is now ready to be pressurized with nitrogen. (See section 5.4 for pressurization procedure)

5.4 Pressurization of Firetrace Detection Tubing

1. Attach the filling adapter (P/N 600023) to the detector-tubing end of line adapter.

2. Using a regulated dry nitrogen supply, pressurize the detection tubing with dry nitrogen through the filling adapter to 195 psig. It is recommended to have a portable dry nitrogen cylinder for on-site use.

3. Remove the filling adapter and attach calibrated test pressure gauge & 0-ring to verify that the tubing is pressurized to at least 195 psig at 70°F.

4. With gauge still attached to the end of line adapter, test for leakage.
   - Apply soapy water solution to the cylinder valve connection, end of line adapter connection, and the pressure gauge connection. Observe for bubble leaks.
   - Wait 30 minutes, then observe pressure gauge. Any decrease in pressure is an indication of a leak.
   - In the event of a leak go back to Section 5.3 and repeat steps 4, 5, & 6.
   - If no leaks are observed proceed to step 5 of Section 5.4

5. If an optional pressure switch is to be installed in the EOL adapter, remove pressure gauge and install the washer and pressure switch using wiring instructions located on the device. Check pressure switch connection for bubble leaks using soapy water solution.

6. After confirming that there is no leakage within the detector tubing, **SLOWLY** rotate the ball valve lever counter clockwise to the "ON" position.

⚠ CAUTION
If the ball valve lever is opened abruptly this may result in activation of the cylinder valve and unit discharge.

7. Tamper proof the unit by choosing one of the options below
   a. Option #1 Remove the ball valve lever completely. Follow directions for removal of lever listed in Appendix A.

b. Option #2 Attach tamper seal around the ball valve lever to secure it in the "ON" position, which the set/ready position is also shown in Appendix A.

8. Ensure appropriate electrical connections to the optional EOL pressure switch, which can be used to annunciate unit discharge, shut down ventilation, etc., as may be required by the end user or the AHJ. (All electrical connections are to be in accordance to NFPA 70 National Electric Code)

9. Attach the warning nameplate(s) (Firetrace P/N 800031) to the appropriate locations.

10. Unit is now fully armed and ready for use.

6.0 SERVICE, MAINTENANCE, & FILLING INSTRUCTIONS

⚠ WARNING

1. Novec™ 1230 cylinder/valve assemblies must be handled, installed, inspected and serviced only by qualified and trained personnel in accordance with the instructions contained in this manual, the cylinder nameplate, NFPA-2001, and any other regulations and codes that may apply.
2. Before performing maintenance or refilling procedures refer to the material safety data sheets in the appendix at the back of this manual.

6.1 General

A regular program of systematic maintenance must be established for continuous, proper operation of all Novec™ 1230 units, and to avoid violating the warranty. A periodic maintenance schedule must be followed and an inspection log maintained for ready reference. As a minimum, the log must record: (1) inspection interval, (2) inspection procedure performed, (3) maintenance performed, if any, as a result of inspection, and (4) name of inspector performing task.

6.2 Periodic Service and Maintenance

Perform service and maintenance of the Novec™ 1230 unit in accordance with the schedule shown in Table 6.2

Table 6.2: Periodic service and maintenance schedule.

Schedule	Requirement	Reference Paragraph
Weekly	Visually inspect unit components	6.3.1
Monthly	Visually inspect unit components.	6.3.1

Semi-Annually	Check Novec™ 1230 cylinder weight. Check nozzles for obstruction.	6.3.2
Every 5 Years	Perform external visual inspection of Novec™ 1230 Cylinders.	6.3.3

6.3 Periodic Service and Maintenance Procedures

6.3.1 Weekly/Monthly: Performed by Owner or End User

1. Make a general visual inspection of the Novec™ 1230 cylinder and equipment for damaged or missing parts.
2. Ensure access to hazard areas, discharge nozzles, and cylinders are unobstructed and that there are not obstructions to the operation of the equipment or distribution of Novec™ 1230 agent.
3. Inspect detection tubing in hazard area for abrasion, distortion, cuts, or dirt accumulation, and that there are no obstructions preventing tubing from sensing a fire should one occur.
4. Verify that there have been no changes in the size of the enclosure and that no new ventilation has been added.

6.3.2 Semi-Annual Inspection

1. Check Novec™ 1230 cylinder for weight.
2. Remove cylinder from the installation as follows:
    - Close ball valve, by turning ball valve lever clockwise to the "OFF" position.
    - Disconnect detector tubing at the ball valve. Note: There will be a loss of nitrogen pressure out of the tubing.
    - Disconnect piping and fittings from the cylinder valve discharge port.
    - Immediately install safety cap onto the valve discharge port.
    - Remove cylinder from bracket
3. Weigh cylinder. Compare measured weight with weight found on the cylinder nameplate. If the container shows a loss in agent quantity of more than 10 percent, the cylinder shall be refilled or replaced.
4. Remove nozzle(s) and inspect for obstructions. Reinstall nozzles.
5. Reinstall cylinder and re-pressurize detector tubing with nitrogen following the applicable procedures outlined in Section 5.0.

6.3.3 Five Year Inspection

Novec™ 1230 cylinders continuously in service without discharging shall be given a complete external visual inspection in place, every 5 years or more frequently if required.

6.4 Post Fire Maintenance

In the event of a unit discharge the following procedures shall be performed.

6.4.1 Novec™ 1230 Cylinder Valve

Remove the cylinder assembly from the installation following procedures detailed in Section 6.3.2, Step 2. Inspect and service the Novec™ 1230 cylinder valve as follows:

> **⚠ WARNING**
>
> Prior to removal of the valve from the cylinder, verify that all pressure has been released. To relieve any remaining pressure loosen but do not remove the valve safety caps. Then open the ball valve to the "ON" position and allow any residual pressure to leak out past the plugs.

1. Only after verifying that the cylinder has been depressurized, remove valve from cylinder.
2. Perform a visual inspection of the valve to verify that no damage occurred due to the fire. If integrity of the valve looks compromised, contact Firetrace. The valve should not be serviced by anyone other than a Firetrace Technician.
3. Change the cylinder/valve o-ring. Discharge of Novec™ 1230 causes the o-ring to undergo vacuum decompression; failure to change the o-ring will result in leaks around the cylinder/valve connection.
4. Re-seat the piston in the valve by following the procedure in Section 6.6, Step 2.

6.5 Novec™ 1230 Cylinder Retest

Firetrace Novec™ 1230 cylinders are built to DOT-3AL specifications and therefore fall under DOT regulations for retest prior to refill.

DOT-3AL cylinders used exclusively in Novec™ 1230 service are required to be retested and re-stamped prior to recharge and shipment if the last retest date has expired.

Firetrace Novec™ 1230 (DOT-3AL) containers requiring retest must be hydrostatically tested in accordance with DOT CFR Title 49, Section 173.34(e). This periodic retest must be performed by an authorized retester having a current identification number issued by the Associated Administrator for Hazardous Material Safety of DOT, and must include an internal and external examination in accordance with CGA pamphlet C-6, C-6.1, C-6.2, or C-6.3, as applicable. The test procedures are described in CGA pamphlet C-1. Because volumetric expansion of the container must be measured, only the water jacket volumetric expansion method or the direct expansion methods are acceptable.

As an alternate option, Novec™ 1230 agent containers may be given a complete external visual inspection, as detailed in Section 173.34(e)(13), in lieu of hydrostatic test. The visual inspection shall only be made by competent persons. A person who performs the visual examination specified in 173.34(e)(13) is not required to have a re-tester's identification number.

Retest can be performed by either of the following methods:

Retest Method	First Retest Due (Yrs)	Subsequent Retest Due (Yrs)	Special Marking
Full hydrostatic test including determination of cylinder expansion.	5	5	Retest Date Month/Year
External visual inspection per paragraph 173.34(e)(13) and CGA pamphlet C-6, Section 3.	5	5	Retest Date followed by "E"

6.6 Filling Procedures

1. Weigh and record cylinder empty weight with valve and the 2 safety caps installed.
2. Remove the safety cap from the discharge port and visually check that the piston is seated inside of the valve. Replace safety cap. (If piston is not seated, apply 195 psi of Nitrogen pressure through the ball valve. You will be able to hear the piston change positions. Return ball valve to "OFF" position and remove hose connection).
3. Remove safety cap from filling port and attach Firetrace Novec™ 1230 filling adapter (P/N 600024) to filling port
4. Attach Novec™ 1230 supply line to filling adapter. (Novec™ 1230 is to be pumped)
5. Place the cylinder, with supply line hooked up, on scale and zero the scale. Open the supply of Novec™ 1230 from bulk tank to fill the cylinder to the required weight.
6. Close supply of Novec™ 1230 while maintaining all connections.
7. Disconnect Novec™ 1230 supply line from the recharge adapter and immediately attach the nitrogen fill line.
8. Check the temperature and consult Table 3.3. Charge the cylinder to the pressure indicated in the table based on the local temperature.
9. Disconnect the Nitrogen charging line and filling adapter. Immediately install the safety cap onto the fill port.

⚠ CAUTION

Any hissing or discharge coming from vent valve indicates that the piston is not seating properly or has opened. If this occurs, repeat Step 10 and verify that the cylinder valve piston remains closed.

10. Verify weight by checking it against what is printed on the label.
11. Leak test the cylinder.
12. Cylinder is now ready to be transported to the installation site.

Note: All reasonable efforts must be made to prevent emitting any Novec™ 1230 to the environment during filling or servicing of Firetrace units.

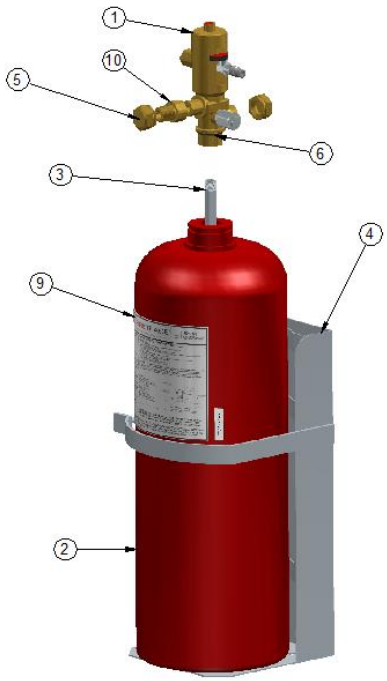
APPENDIX A

COMPONENT DESCRIPTION DRAWINGS

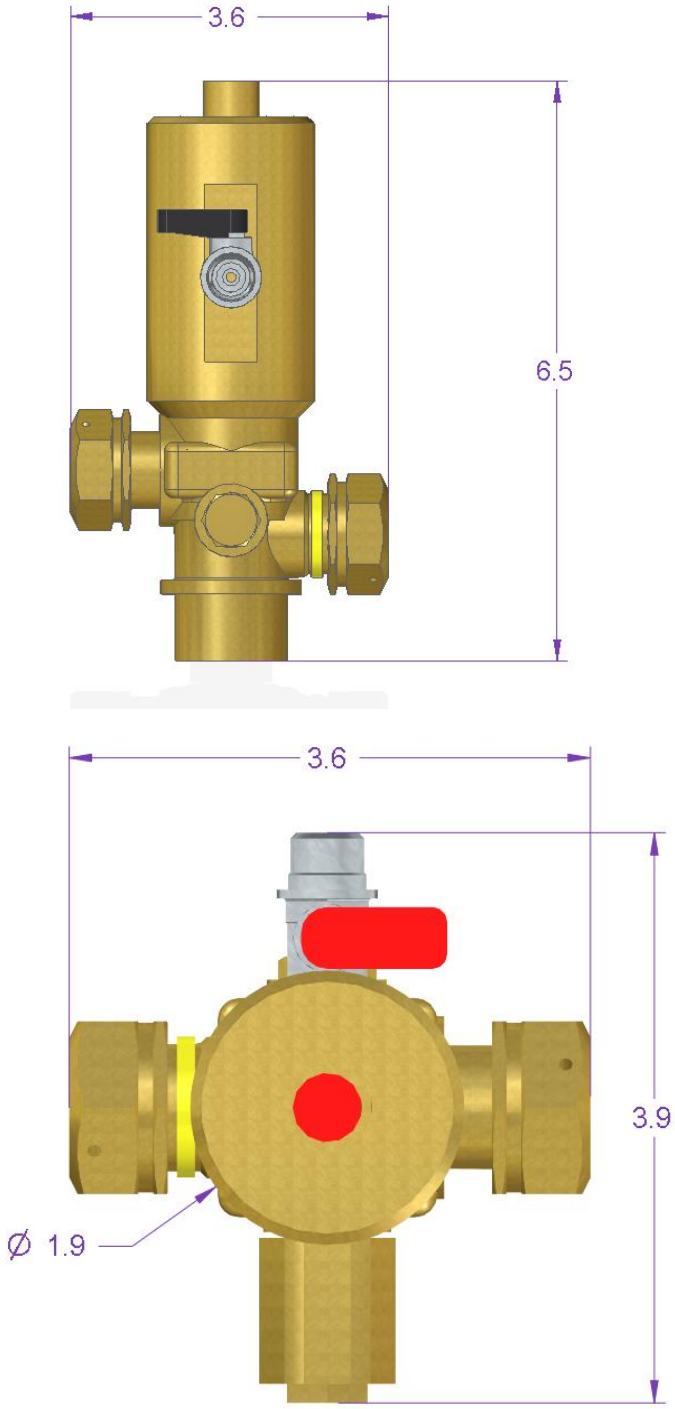
INSTALLATION DRAWINGS

Parts List – IHP Novec™ 1230 Fire Supression Systems

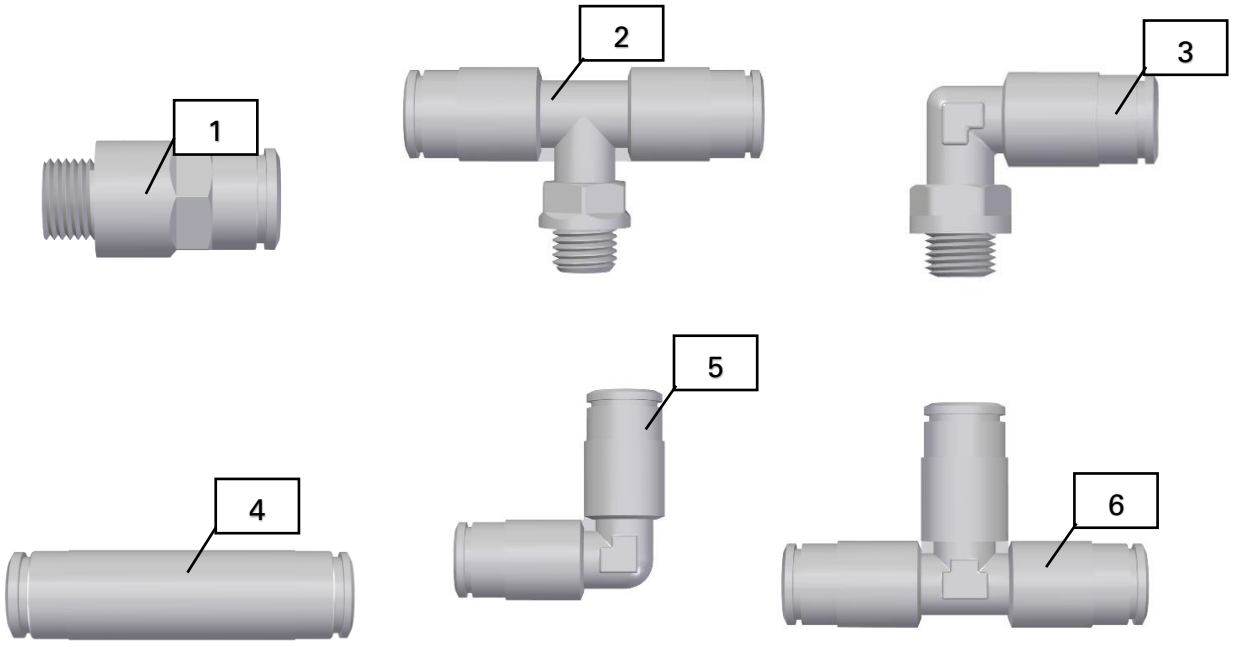
ITEM	PART NO.	DESCRIPTION	SYSTEM
1	310201	IHP Valve	All Systems
2	110200	20 Lb. Cylinder	20 LB
3	600006	Siphon Tube $^{5}/_{8}$"x 21$^{1}/_{2}$"	20 LB
4	111020	20 Lb. Heavy Duty Bracket	20 LB
5	310310	Discharge Port Safety Cap	All Systems
6	310305	Collar O-Ring	All Systems
*	200160	Spring Top Support Unit	All Systems
*	600053	Pull Pin	All Systems
9	600007	Nameplate: Novec 1230 IHP	All Systems
*	600131	Label: IHP Novec 1230 Generic	All Systems
*	800100	Warranty/Registration Card	All Systems
10	200201	Discharge Port Adapter	All Systems
* PART NOT PICTURED			



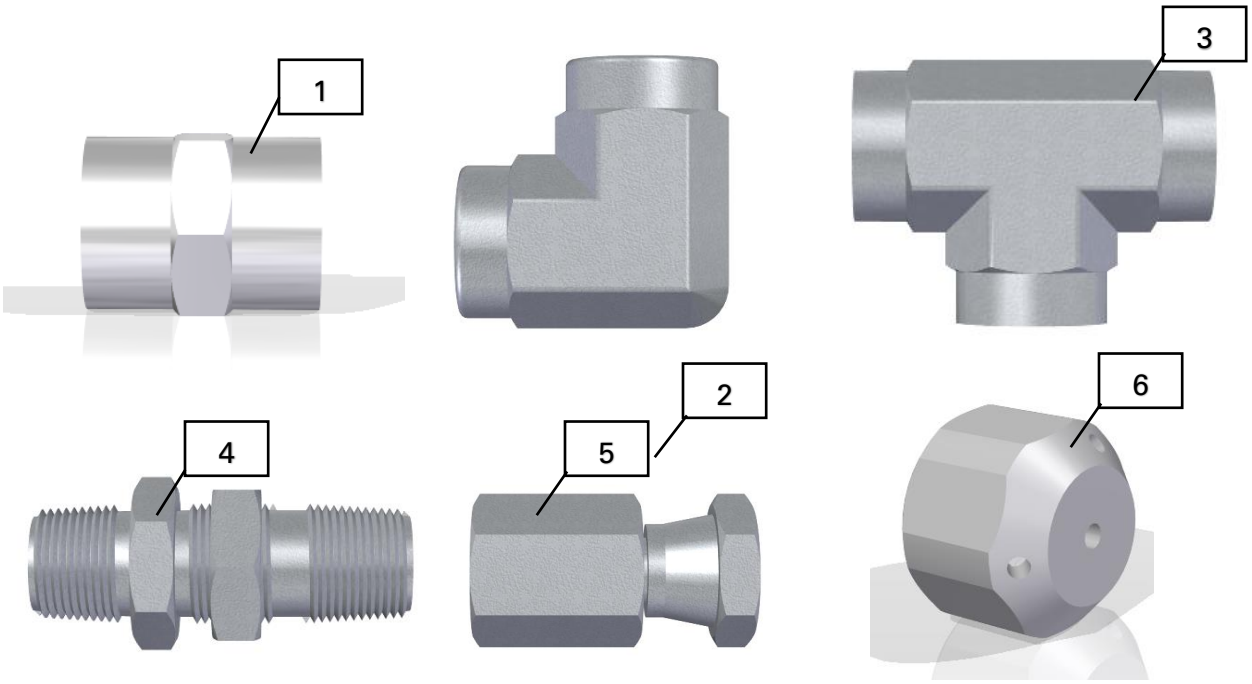
Firetrace Indirect High Pressure (IHP) Valve
P/N 310201



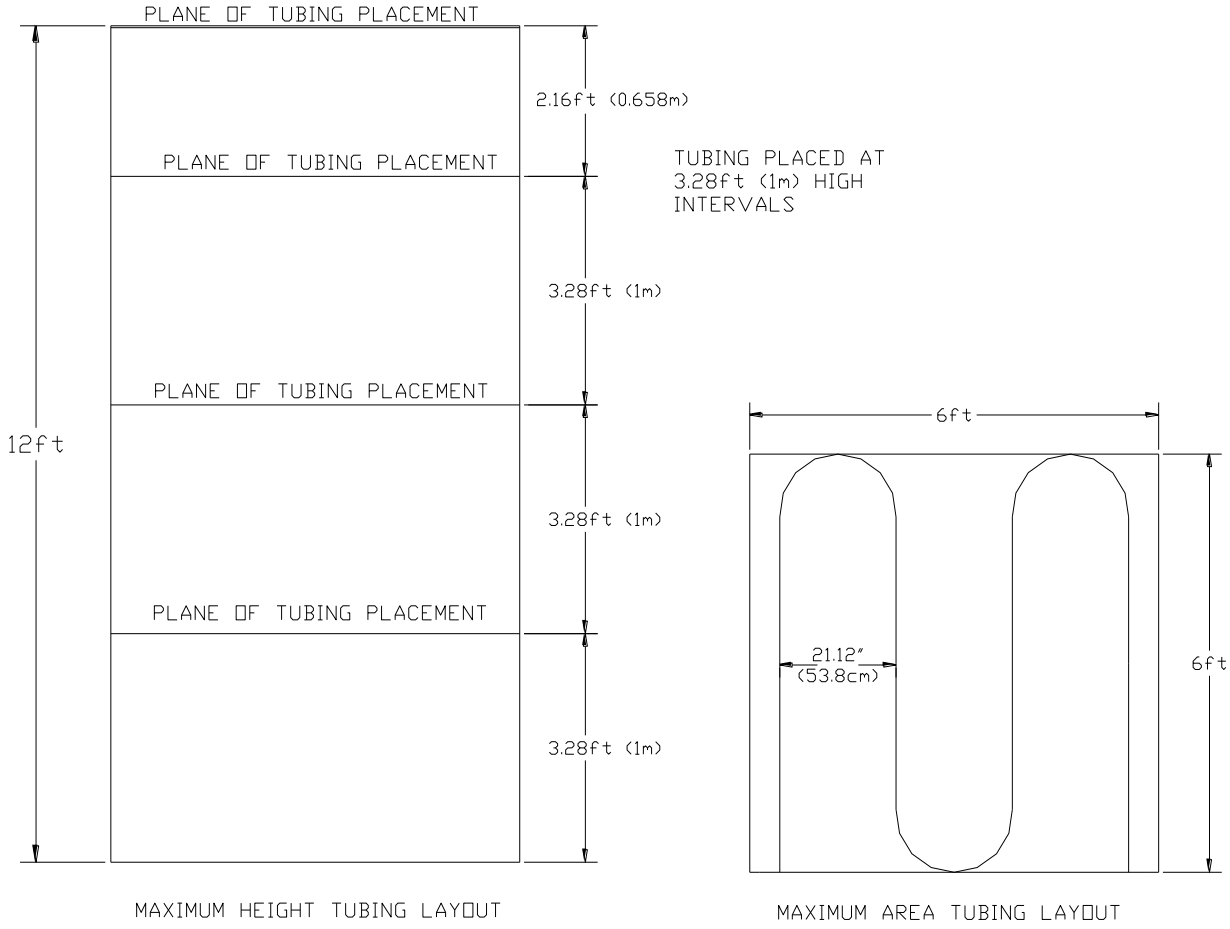
ITEM	PART NO.	DESCRIPTION	SYSTEM
1	200179	Threaded Slip-on Fitting	All Systems
2	200177	Threaded Slip-on Tee	All Systems
3	200159	Threaded Slip-on Elbow	All Systems
4	200158	Slip-on Tubing Coupling	All Systems
5	200178	Slip-on Tubing Elbow	All Systems
6	200157	Slip-on Tubing Tee	All Systems



ITEM	PART NO.	DESCRIPTION	SYSTEM
1	850028	Fitting- High Pressure Hose to Hose	All Systems
2	850029	Fitting – Hose to Hose Elbow	All Systems
3	850030	Fitting – Hose to Hose Tee	All Systems
4	850031	Fitting Hose to ½" Nozzle Bulkhead	All Systems
5	850037	Fitting, Swivel Adapter	All Systems
6	500024	High Pressure Total Flooding Nozzle	All Systems



Firetrace Tubing Placement Diagram



Side View

Overhead View

Maximum Length: 120ft
Maximum Height Between Layers: 3.28ft
Maximum Distance Between Passes: 21.12in

APPENDIX B

Material Safety Data Sheet

3M MATERIAL SAFETY DATA SHEET 3M(TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12] 04/09/2007

Material Safety Data Sheet

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: 3M(TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]
MANUFACTURER: 3M
DIVISION: Electronics Markets Materials Division
ADDRESS: 3M Center
St. Paul, MN 55144-1000

EMERGENCY PHONE: 1-800-364-3577 or (651) 737-6501 (24 hours)

Issue Date: 04/09/2007
Supersedes Date: 09/11/2006
Document Group: 16-3425-2

Product Use:
Intended Use: STREAMING AND FLOODING FIRE PROTECTION

SECTION 2: 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 > 99.9

SECTION 3: HAZARDS IDENTIFICATION

3.1 EMERGENCY OVERVIEW
Specific Physical Form: Liquid
Odor, Color, Grade: clear colorless, low odor.
General Physical Form: Liquid
Immediate health, physical, and environmental hazards:

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

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

Inhalation:
If thermal decomposition occurs:
May be harmful if inhaled.
Ingestion:
No health effects are expected.

3.3 POTENTIAL ENVIRONMENTAL EFFECTS
This substance has a high Henry's Law constant and therefore will be primarily found in the atmosphere where photolysis will be the dominant reaction pathway. The ultimate degradation products of the photolysis reaction are HF, CO2 and trifluoroacetic acid (TFA).
This substance does not contribute to ozone depletion; it has an atmospheric lifetime of approximately 5 days and a Global Warming Potential (GWP) of 1 (IPCC 2001 Method).

SECTION 4: FIRST AID MEASURES

4.1 FIRST AID PROCEDURES
The following first aid recommendations are based on an assumption that appropriate personal and industrial hygiene practices are followed.

Eye Contact: No need for first aid is anticipated.
Skin Contact: No need for first aid is anticipated.
Inhalation: If signs/symptoms develop, remove person to fresh air. If signs/symptoms persist, get medical attention.
If Swallowed: No need for first aid is anticipated.

SECTION 5: FIRE FIGHTING MEASURES

5.1 FLAMMABLE PROPERTIES
Autoignition temperature *Not Applicable*
Flash Point *Not Applicable*
Flammable Limits - LEL [*Details:* Nonflammable]
Flammable Limits - UEL [*Details:* Nonflammable]
5.2 EXTINGUISHING MEDIA
Product is a fire-extinguishing agent.
5.3 PROTECTION OF FIRE FIGHTERS

Special Fire Fighting Procedures: Wear full protective equipment (Bunker Gear) and a self-contained breathing apparatus (SCBA).
Unusual Fire and Explosion Hazards: Not applicable.
Note: See STABILITY AND REACTIVITY (SECTION 10) for hazardous combustion and thermal decomposition information.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Accidental Release Measures: Observe precautions from other sections. Call 3M- HELPS line (1-800-364-3577) for more information on handling and managing the spill. Ventilate the area with fresh air.

Contain spill. For larger spills, cover drains and build dikes to prevent entry into sewer systems or bodies of water. 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. Collect as much of the spilled material as possible. Clean up residue. Place in a metal container approved for transportation by appropriate authorities. Seal the container. Dispose of collected material as soon as possible.

In the event of a release of this material, the user should determine if the release qualifies as reportable according to local, state, and federal regulations.

SECTION 7: HANDLING AND STORAGE

7.1 HANDLING

For industrial or professional use only. Contents may be under pressure, open carefully. Avoid breathing of vapors, mists or spray. Do not breathe thermal decomposition products.

7.2 STORAGE

Keep container in well-ventilated area. Store out of direct sunlight. Store away from heat. Store away from strong bases, amines, and alcohols.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 ENGINEERING CONTROLS

Provide appropriate local exhaust ventilation on open containers. Provide appropriate local exhaust when product is heated.

8.2 PERSONAL PROTECTIVE EQUIPMENT (PPE)

8.2.1 Eye/Face Protection

As a good industrial hygiene practice:
Avoid eye contact with vapors, mists, or spray.

8.2.2 Skin Protection

Gloves are not required.

8.2.3 Respiratory Protection

Under normal use conditions, airborne exposures are not expected to be significant enough to require respiratory protection.
As a good industrial hygiene practice: Avoid breathing of vapors, mists or spray.
If thermal decomposition occurs, wear supplied air respiratory protection.

8.2.4 Prevention of Swallowing

Not applicable.

8.3 EXPOSURE GUIDELINES

Ingredient	Authority	Type	Limit	Additional Information
1,1,1,2,2,4,5,5,5-NONAFLUORO-4- (TRIFLUOROMETHYL)-3-PENTANONE	3M	TWA	150 ppm	

SOURCE OF EXPOSURE LIMIT DATA:
ACGIH: American Conference of Governmental Industrial Hygienists
CMRG: Chemical Manufacturer Recommended Guideline
OSHA: Occupational Safety and Health Administration
AIHA: American Industrial Hygiene Association Workplace Environmental Exposure Level (WEEL)

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Specific Physical Form: Liquid
Odor, Color, Grade: clear colorless, low odor.
General Physical Form: Liquid
Autoignition temperature *Not Applicable*
Flash Point *Not Applicable*
Flammable Limits - LEL [*Details:* Nonflammable]
Flammable Limits - UEL [*Details:* Nonflammable]
Boiling point 49 ºC
Vapor Density 11.6 [*Ref Std:* AIR=1]
Vapor Pressure 244 mmHg [@ 20 ºC]
Specific Gravity 1.6 [*Ref Std:* WATER=1]
pH *Not Applicable*
Melting point -108 ºC
Solubility in Water Nil
Evaporation rate > 1 [*Ref Std:* BUOAC=1]
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]
Viscosity 0.6 centipoise [@ 25 ºC]

SECTION 10: STABILITY AND REACTIVITY

Stability: Stable.
Materials and Conditions to Avoid: Strong bases; Amines; Alcohols Additional Information: Listed materials to avoid should not be mixed with liquid Novec 1230 fluid. Avoid direct sunlight and ultraviolet light.
Hazardous Polymerization: Hazardous polymerization will not occur.

Hazardous Decomposition or By-Products

Substance Condition
Carbon monoxide During Combustion
Carbon dioxide During Combustion
Hydrogen Fluoride During Combustion
Hazardous Decomposition: Hydrogen fluoride has an ACGIH Threshold Limit Value of 3 parts per million (as fluoride) as a Ceiling
Limit and an OSHA PEL of 3 ppm of fluoride as an eight hour Time-Weighted Average and 6 ppm of fluoride as a Short Term
Exposure Limit. The odor threshold for HF is 0.04 ppm, providing good warning properties for exposure.

SECTION 11: TOXICOLOGICAL INFORMATION

Please contact the address listed on the first page of the MSDS for Toxicological Information on this material and/or its components.

SECTION 12: ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION
Please refer to existing literature on TFA

CHEMICAL FATE INFORMATION
Photolytic half-life: 3-5 days.
Photolytic degradation products may include Trifluoroacetic acid (TFA)
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 Disposal Method: Incinerate in an industrial or commercial facility in the presence of a combustible material. Combustion
products will include HF. Facility must be capable of handling halogenated materials.
As a disposal alternative, dispose of waste product in a facility permitted to accept chemical waste. Reclaim if feasible. For
information on product return, contact your distributor.
EPA Hazardous Waste Number (RCRA): Not regulated
Since regulations vary, consult applicable regulations or authorities before disposal.

SECTION 14:TRANSPORT INFORMATION

ID Number(s):
98-0212-3031-7, 98-0212-3201-6, 98-0212-3203-2, 98-0212-3217-2, 98-0212-3371-7, 98-0212-3414-5
Please contact the emergency numbers listed on the first page of the MSDS for Transportation Information for this material.

SECTION 15: REGULATORY INFORMATION

US FEDERAL REGULATIONS
Contact 3M for more information.
311/312 Hazard Categories:
Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No Immediate Hazard - No Delayed Hazard - No

STATE REGULATIONS
Contact 3M for more information.

CHEMICAL INVENTORIES
The components of this product are in compliance with the chemical notification requirements of TSCA.
One or more of the components of this product have been notified to ELINCS (European List of Notified or New Chemical Substances). Certain restrictions apply. Contact the selling division for additional information.
All the components of this product are listed on China's Inventory of Chemical Substances.
The components of this material are in compliance with the new chemical notification requirements for the Korean Existing Chemicals Inventory.
Contact 3M for more information.
Additional Information: The components of this product are in compliance with the chemical notification requirements of the

National Industrial Chemical Notification and Assessment Scheme (NICNAS) of Australia, the Canadian Environmental Protection
Act (CEPA) and the Ministry of Economy, Trade and Industry of Japan.

INTERNATIONAL REGULATIONS
Contact 3M for more information.

ADDITIONAL INFORMATION
U.S. EPA. Significant New Alternatives Policy Program (SNAP) approved for uses is streaming and flooding fire protection application.
This MSDS 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:** 0 **Reactivity:** 1 **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.

HMIS Hazard Classification
Health: 0 **Flammability:** 0 **Reactivity:** 1 **Protection:** X - See PPE section.
Hazardous Material Identification System (HMIS(r)) 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(r) ratings are to be used with a fully implemented HMIS(r) program. HMIS(r) is a registered mark of the National Paint and Coatings Association (NPCA).
Revision Changes:
Section 1: Product use information was modified. Copyright was modified.
Section 14: ID Number(s) was modified.

DISCLAIMER: The information in this Material Safety Data Sheet (MSDS) is believed to be correct as of the date issued. 3M

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