FIRETRACE™ International

DESIGN, INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

FOR

PRE-ENGINEERED AUTOMATIC DIRECT LOW PRESSURE CLEAN AGENT EXTINGUISHER UNIT

DESIGNED FOR USE WITH:
HFC-227EA Clean Agent

CE DLP Systems:

898204 – CYLINDER ASSEMBLY, CE, DLP, FM200, 1KG
898205 – CYLINDER ASSEMBLY, CE, DLP, FM200, 2KG
898206 – CYLINDER ASSEMBLY, CE, DLP, FM200, 5KG

DOT DLP Systems:

920321 – CYLINDER ASSEMBLY, DOT, DLP, FM200, 3LB
920621 – CYLINDER ASSEMBLY, DOT, DLP, FM200, 6LB
921221 – CYLINDER ASSEMBLY, DOT, DLP, FM200, 12LB

Document: DIOM 800089 (DLP HFC-227EA)

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

Telephone: 480-607-1218
www.firetrace.com

REV	DESCRIPTION OF CHANGE	By	Appvd	ECO	DATE
A	Initial Release	JL	ZS	DCR23-004	03/02/2023

FIRETRACE™ International

DESIGN, INSTALLATION, OPERATION, AND MAINTENANCE MANUAL FOR PRE-ENGINEERED AUTOMATIC DIRECT LOW PRESSURE CLEAN AGENT EXTINGUISHER UNIT (HFC-227EA Clean Agent)

Originally Prepared By: Jacob Largo

Table of Contents

Table of Figures

List of Tables

1 FOREWORD

This manual is written for the fire protection professional that designs, installs, and maintains Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent. Those systems include:

CE DLP Systems:

- 898204 – CYLINDER ASSEMBLY, CE, DLP, FM200, 1KG
- 898205 – CYLINDER ASSEMBLY, CE, DLP, FM200, 2KG
- 898206 – CYLINDER ASSEMBLY, CE, DLP, FM200, 5KG

DOT DLP Systems:

- 920321 – CYLINDER ASSEMBLY, DOT, DLP, FM200, 3LB
- 920621 – CYLINDER ASSEMBLY, DOT, DLP, FM200, 6LB
- 921221 – CYLINDER ASSEMBLY, DOT, DLP, FM200, 12LB

Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems 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 (DIOM #: 800089)
- All information contained on the agent cylinder nameplate(s)
- Applicable parts of NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems
- Local Authority Having Jurisdiction (AHJ)

1.1 Warnings

Safety precautions are essential when any electrical or mechanical equipment is involved. These precautions should be followed when handling, servicing, and recharging Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent 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 or 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.

1.2 Safety Precautions

WARNING

Pressurized (charged) cylinders are extremely hazardous and if not handled properly can cause property damage, bodily injury, or death. Always wear safety glasses and make sure the discharge port ball valve is in the close/disarmed position and any safety/shipping plug(s) are properly in place before system installation, servicing, or other general handling.

The following safety precautions should always be followed:

1. Read and understand this manual and the other documents referenced herein.
2. The valve discharge outlet ball valve **MUST** be closed/disarmed, and any safety/shipping plug(s) **MUST** be installed on the cylinder valve at all times and only removed when connected into the discharge tubing 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.
4. Follow all the safety procedures included on the cylinder nameplate and in this manual.
5. Never assume that a cylinder is empty. Treat all cylinders as if they are fully charged.

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

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

Telephone: 480-607-1218
www.firetrace.com

2 INTRODUCTION

The Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher System with HFC-227EA Clean Agent is designed to be used in a Total Flooding manner provided that the system is designed within the limitations outlined in this manual.

The pre-engineered concept minimizes the amount of engineering involved in system design. When the enclosure meets the specifications outlined in this manual and the Firetrace Detection Tubing (FDT) is 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 (DLP) extinguisher unit, when installed, is a self-contained unit, meaning that it is equipped with all the components necessary to detect and extinguish Class A, B, and C (Class E for Europe) fires.

Each installed Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher System with HFC-227EA Clean Agent is used in tandem with its own pneumatic (FDT).

Upon direct flame impingement of the (FDT), the tubing will rupture forming a burst hole. This burst hole will act as a nozzle directly applying the agent onto the flame source, extinguishing the fire, and flooding the enclosure to prevent re-flash.

Since the units are listed as automatic units (e.g., no simultaneous manual or electric actuation means is provided), only one (1) extinguisher unit can be used to protect one (1) hazard. These extinguisher units cannot be combined to protect a larger size hazard, since they are not designed to provide for simultaneous actuation of two (2) or more units.

Local Authorities Having Jurisdiction (AHJ) should be consulted as to the acceptability for hazards and requirements covering installation.

2.1 HFC-227EA Clean Agent

HFC-227EA suppression agent used in the Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher System is heptafluoropropane, referenced as HFC-227EA.

HFC-227EA is a chlorofluorocarbon depicted by the chemical formula CF3CHFCF3 (1,1,1,2,3,3,3-heptafluoropropane). HFC-227EA is a colorless low odor gas, low in toxicity, electrically non-conductive, which leaves no residue, and is an extremely effective fire suppression agent. It is a clean and effective fire suppression agent that can be used on type A, B, and C fires.

HFC-227ea is included in NFPA 2001 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

HFC-227ea is clean and leaves no residue, thereby minimizing post discharge clean-up, keeping expensive downtime to a minimum. Additionally, HFC-227EA is non-corrosive therefore sensitive electronics and materials such as steel, aluminum, stainless steel, brass, plastics, and rubber are not affected by exposure to HFC-227EA. This agent is also environmentally friendly, having an ozone depletion potential (ODP) of 0.00.

2.1.2 Decomposition

No hazardous decomposition or by-products are known (see HFC-227EA Material Safety Data sheet located in **APPENDIX C** page 7 of 13).

2.1.3 Properties of HFC-227EA Clean Agent

For hazard information, decomposition information, and physical properties of HFC-227EA please refer to the Material Safety Data sheet located in **APPENDIX C**.

3 SYSTEM DESCRIPTION

The Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent noted in the manual include:

CE Systems:

- 898204 – CYLINDER ASSEMBLY, CE, DLP, FM200, 1KG
- 898205 – CYLINDER ASSEMBLY, CE, DLP, FM200, 2KG
- 898206 – CYLINDER ASSEMBLY, CE, DLP, FM200, 5KG

DOT Systems:

- 920321 – CYLINDER ASSEMBLY, DOT, DLP, FM200, 3LB
- 920621 – CYLINDER ASSEMBLY, DOT, DLP, FM200, 6LB
- 921221 – CYLINDER ASSEMBLY, DOT, DLP, FM200, 12LB

HFC-227EA is a gaseous fire-suppression agent that is effective for use on:

- Class A – Ordinary Combustibles surface fires
- Class B – Flammable liquid fires
- Class C – Energized equipment fires

HFC227-EA 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
- Deep Seated or burrowing fires in ordinary combustibles where the clean agent cannot reach the point of combustion

The Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent can be used, but are not limited, to protect the following:

- Electrical and Electronic Cabinets
- Telecommunication Areas
- Data Processing Areas and Cabinets
- Laboratory Fume / Exhaust Cabinets
- Pump Enclosures
- UPS Units
- Flammable Chemicals Storage Cabinets
- Generator Enclosures
- Transformer Cabinets
- Computer/Data Storage Cabinets
- CNC & VMC Machining centers

For hazards beyond the scope described above, it is recommended that the designer consult with Firetrace and the Local Authority Having Jurisdiction (AHJ) as to the suitability on the use of these agents for particular hazards, for personnel exposure effects from the design concentration, and for installation requirements.

Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent consists of the following major components:

- Cylinder/Valve assembly
- Cylinder Mounting Bracket (Heavy Duty Bracket Optional)
- Firetrace Detection Tubing (FDT) & Fittings (No Substitute)
- Pressure Supervisory Switch
- Pressure Operated Switch (Optional)
- EU Pressure Operated Switch (Optional)

Once installed, the Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher System with HFC-227EA Clean Agent becomes a self-contained, self-actuating unit that does not require an external power source.

The unit utilizes a UL recognized (per UL Standard 521) linear heat detector (see Certificate of Compliance 20140705-S35465) known as Firetrace Detection Tubing (FDT). This tubing is pressurized with dry nitrogen, is temperature sensitive, and acts as a continuous linear thermal detector that ruptures upon direct flame impingement or at temperatures above 383 °F [195 °C]. Once the (FDT) is ruptured, it forms a pseudo-discharge nozzle at the rupture point, allowing the HFC-227EA clean agent to flow through, distributing the agent through the rupture point and into the protected area.

Upon system actuation, the pressure switch can be used to indicate system discharge, sound an alarm, shutdown ventilation, shut-off electrical power, or provide additional electrical functions as may be required.

3.1 Component Descriptions

For a more comprehensive list of technical illustrations and part numbers, please see **APPENDIX A**.

3.1.1 Cylinder / Valve Assemblies

The HFC-227EA clean agent is stored in aluminum or steel cylinders and is super-pressurized with nitrogen. Each cylinder is equipped with a nickel-plated brass valve assembly.

Each valve assembly is equipped with a pressure gauge to monitor cylinder pressure, and a quarter turn ball valve that interfaces with the Firetrace Detection Tubing (FDT). The valve assembly utilizes a straight siphon tube only for the unit to only be mounted in a vertical (upright) position.

NOTE: The ball valve must be kept closed at all times when the cylinder is not in service.

3.1.2 Firetrace Detection Tubing

The Firetrace Detection Tubing (FDT) is available in a 4/6 mm (P/N: 200005) size. The (FDT) is a linear, pneumatic, fire detection device that responds to a combination of the heat and radiant energy from a fire. The tubing is a UL recognized component per UL Standard 521 (see Certificate of Compliance 20140705-S35465). The (FDT) performs three functions: heat detection, system activation, and agent discharge. One end of the tubing is installed to the top of the cylinder valve. The tubing is then installed throughout the hazard volume and finally pressurized with nitrogen.

The (FDT) is heat sensitive and in a fire situation is designed to rupture at any point along its length upon direct flame impingement or when the temperature reaches above 383 °F [195 °C]. The rupture of the tubing releases the nitrogen pressure causing the unit to actuate. The portion of the tubing nearest the fire ruptures, resulting in a formation of a pseudo-discharge nozzle that will perform a complete discharge of the HFC-227EA clean agent. For additional information on tubing properties and material compatibility, please see **Table 1** - Firetrace Detection Tubing Properties and **APPENDIX B**.

Table 1: Firetrace Detection Tubing Properties

Hydrostatic Burst Pressure	Minimum Burst Pressure	1100 psi [75 bar]
	Typical Burst Pressure	1300 psi [88 bar]
Electrical Properties	Volume Resistivity	1014 (per DIN 53481)
	Dielectric Strength	40k V/mm (per DIN 53481)

3.1.3 Firetrace Tubing Cutter

The Firetrace Tubing Cutter (P/N: 600210) is used to ensure that the Firetrace Detection Tubing (FDT) is cut with a square, clean finish, free of debris.

3.1.4 Filling Adapter

The filling adapter (P/N: 900007) is used for the pressurization of the Firetrace Detection Tubing (FDT). One end of the filling adapter is equipped with M10 x 1 threads, allowing for easy installation to the End of Line (EOL) Adapter. The opposite end of the filling adapter is equipped with G1/8 threads.

3.1.5 Pressure Supervisory Switch

The pressure supervisory switch (P/N: 400052) is used to monitor the pressure inside the unit cylinder. The pressure supervisory switch is factory installed into the pressure switch port located on the valve assembly. If the unit loses pressure and reaches a pressure of 99 psig ± 9 psi [6.8 ± 0.6 bar] or below, the switch contacts will activate, providing a signal to indicate that the unit has lost pressure.

The pressure supervisory switch is single pole, double throw (SPDT) and can be wired in either the normally open (NO) or normally closed (NC) configurations, where the normal condition is at atmospheric pressure. When the unit is pressurized, the contacts switch over. The pressure supervisory switch shall be installed in accordance with NFPA 70 and NFPA 72.

3.1.6 Pressure Operated Switch

The pressure operated switch (P/N: 400004) is available as an optional part for the DOT system detection line. The pressure operated switch is installed into an End of Line (EOL) Adapter. The pressure operated switch is used to monitor unit actuation. Additionally, the pressure operated switch can be wired to energize electrically operated equipment, shut down electrically operated equipment, sound an alarm, or provide additional electrical functions as may be required. If the detection line reaches a pressure of 70 ± 10 psig [4.8 ± 0.7 bar] or below, the switch contacts will activate, providing a signal to indicate that the unit has been activated.

The pressure operated switch is single pole, double throw (SPDT) and can be wired in either the normally open (NO) or normally closed (NC) configurations, where the normal condition is at atmospheric pressure. The pressure switch shall be installed in accordance with NFPA 70 and NFPA 72.

3.1.7 EU Pressure Operated Switch

The EU pressure operated switch (P/N: 400034) is available as an optional part for the CE system detection line. It is also available as an alternate for DOT system detection line. The EU pressure operated switch set point is factory set during production. The EU pressure operated switch is installed into an End of Line (EOL) Adapter. The EU pressure operated switch is used to monitor unit actuation. Additionally, the EU pressure operated switch can be wired to energize electrically operated equipment, shut down electrically operated equipment, sound an alarm, or provide additional electrical functions as may be required. If the detection line reaches a pressure below the set point of the EU pressure operated switch, the switch contacts will activate, providing a signal to indicate that the unit has been activated.

The EU pressure operated switch is single pole, double throw (SPDT) and can be wired in either the normally open (NO) or normally closed (NC) configurations, where the normal condition is at atmospheric pressure. The pressure switch shall be installed in accordance with NFPA 70 and NFPA 72.

Firetrace recommends that all units use a pressure switch coupled with a device to alert personnel in the event of discharge.

NOTE: Extended discharge is to be expected due to the nature of the Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher System. Pressure within the system can slowly drop, which could provide a delay in the actuation of the pressure switch due to this extended discharge. The pressure switch shall be installed as part of the detection line, at the end of the detection network.

Table 2: Pressure Switch Properties

Operating Parameters	Pressure Supervisory Switch P/N: 400052	Pressure Operated Switch P/N: 400004		EU Pressure Operated Switch P/N: 400034
Electrical Rating	36 VDC – 6 AMP 240 VAC – 3 AMP	28 VDC – 15 AMP		250 V – 5 AMP – 50 Hz
		NO: 120 VAC – 10 AMP 240 VAC – 5 AMP	NC: 120 VAC – 25 AMP 240 VAC – 25 AMP	
Temperature Range	-5 °F to 175 °F [-20.6 °C to 79.4 °C]	-20 °F to 150 °F [-28.9 °C to 65.6 °C]		14 °F to 176 °F [-10 °C to 80 °C]

NOTE: Do not use the pressure supervisory switch as a handle when handling the extinguishing unit. Doing so can result in pressure leakage, damage to the pressure switch, and/or system discharge.

4 SYSTEM DESIGN AND LIMITATIONS

The pre-engineered system concept minimizes the amount of engineering required when evaluating a design for a specific application. Provided that the volume of the hazard, surface area coverage, agent quantity, and Firetrace Detection Tubing (FDT) is installed within the limitations outlined in this manual, no calculations are required for pressure drop, flow rates, or discharge time.

NOTE: The basis for determining the agent quantity and concentration levels is derived from NFPA 2001 and is deemed to be compliant with the standard in this aspect.

4.1 Specifications

4.1.1 Storage and Operating Temperature Range

The Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent and equipment are designed to be stored and operated at the ambient temperature range of -4°F to +140°F (-20°C to +60°C)

4.1.2 System Operating Pressure

The normal operating pressure of the control cabinet and converter cabinet systems is 150 psig at 70°F. **Table 3** shows the cylinder gauge pressure-temperature relationship for systems pressurized to 150 psig at 70°F.

Table 3: Pressure vs Temperature Chart for Systems Pressurized to 150 psig at 70°F

Gauge Pressure vs Temperature Chart			
Temperature		**Pressure**	
°F	**°C**	**psig**	**bar**
-4	-20.0	88	6.1
0	-17.8	91	6.3
5	-15.0	94	6.5
10	-12.2	97	6.7
15	-9.4	101	7.0
20	-6.7	104	7.2
25	-3.9	108	7.4
30	-1.1	111	7.7
35	1.7	115	7.9
40	4.4	119	8.2
45	7.2	124	8.5
50	10.0	128	8.8
55	12.8	134	9.2
60	15.6	139	9.6
65	18.3	143	9.9
70	***21.1***	***150***	***10.3***
75	23.9	156	10.8
80	26.7	163	11.2
85	29.4	170	11.7
90	32.2	177	12.2
95	35.0	184	12.7
100	37.8	192	13.2
105	40.6	201	13.9
110	43.3	209	14.4
115	46.1	218	15.0
120	48.9	228	15.7
125	51.7	239	16.5
130	54.4	249	17.2
135	57.2	258	17.8
140	60.0	267	18.4

4.2 Design Procedure

The following procedures should be used to design a Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher System with HFC-227EA Clean Agent:

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.)
c. Determine the anticipated minimum and maximum ambient temperatures expected within the enclosure to be protected. (These must be within the recommended minimum and maximum service temperatures of the system.)
d. Determine the integrity of the enclosure and if any openings must be closed at the time of agent discharge.
e. Determine the cylinder size required based on the hazard volume limitations.
f. Based on the total quantity of agent being used at the maximum ambient temperature expected within the enclosure, evaluate personnel safety exposure limits.
g. Determine the location of the system cylinder.
h. Determine the arrangement and placement of the Firetrace Detection Tubing (FDT).
i. Determine any auxiliary equipment requirements such as a pressure switch(es) to sound alarms, shut down ventilation, shut off electrical power, etc.

4.3 Minimum Design Concentrations

The minimum design concentration to be used with Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent include a minimum safety factor (SF), as specified in NFPA 2001.

A minimum design concentration of 12.1% was established using the minimum design concentration of commercial grade heptane. Minimum design concentrations will vary for different Class B fuels.

It is recommended that the designer consult with Firetrace, NFPA 2001, and the Local Authority Having Jurisdiction (AHJ), as to the suitability on the use of HFC-227EA for a particular hazard, for personnel exposure effects from the design concentrations, and for installation requirements.

4.4 System Limitations

- A single container heat detection tube installation run protecting a maximum volume of **6 m³ ***.
- A maximum of **four** heat detection tube runs connected to a single container where no single protected volume exceeds **6 m³ *** volume.
- A maximum individual heat detection tube length of **50ft [15.24m]** from the container outlet to the end of any single detection tube run.

The 6 m³ volume limitation applies only to 12 lb. [5 kg] system. For the 3 lb. [1 kg] and 6 lb. [2 kg] system, the volumes are limited to those values show in Table 4.

4.4.1 Enclosure Volume Limitations

The Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent are designed to enable a single cylinder heat detection tube installation run to protect an enclosure of any size or shape, provided that the volume does not exceed the maximum volume limitations. Additionally, the overall height of the enclosure shall not exceed 12 ft [3.65 m]. **Table 4** below lists the maximum enclosure volume for each unit size.

Table 4: Maximum Enclosure Volume Limitations

Model Number	Agent Amount	Maximum Enclosure Volume
920321 / 898204	3 lb. [1 kg]	35.31 ft³ [1 m³]
920621 / 898205	6 lb. [2 kg]	70.63 ft³ [2 m³]
921221 / 898206	12 lb. [5 kg]	211.89 ft³ [6 m³]

4.4.2 Ventilation and Unclosable Openings

Provisions must be made to provide means to close all openings in the hazard enclosure and shut off ventilation at the time of discharge, if feasible. If openings are determined to be unclosable or ventilation is unable to be shut down, the volume of airflow for a reasonable amount of time due to these impediments must be included in the overall volume calculations/survey.

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

4.4.3 Fire Detection Tubing Limitations

The Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent are designed to detect and extinguish fires within small enclosures using Firetrace Detection Tubing (FDT). The tubing is used to perform three functions, heat detection, system activation, and agent discharge.

To ensure that the entire height of an enclosure is protected, the tubing must be installed in layers. The maximum height between layers shall not exceed 1.64 ft [0.5 m].

To ensure that the entire area of each layer is protected, the tubing must be installed in passes. The maximum distance between each pass shall not exceed 10.22 in [25.96 cm].

The maximum distance from any wall to the tubing shall not exceed 5.11 in [12.98 cm]. The maximum bend radius shall not exceed 6 in [15.24 cm].

The tubing may be installed in runs to protect segmented areas within an enclosure. The maximum tube length from the container outlet to the end of any single tube run shall not exceed 50ft [15.24 m]. Up to 4 tube runs may be connected to a single cylinder, provided that the volume of each segmented area does not exceed the maximum volume limitations.

The MAH is the maximum activation height of the tubing above the protected risk. The MAH for 4/6 mm tubing is 3.94 in [100 mm]. For better response time in the event of a fire, the tubing should be placed at a height less than the MAH above the hazard.

4.4.3.1 Tubing Limitations Example

An example of a system configuration is shown below:

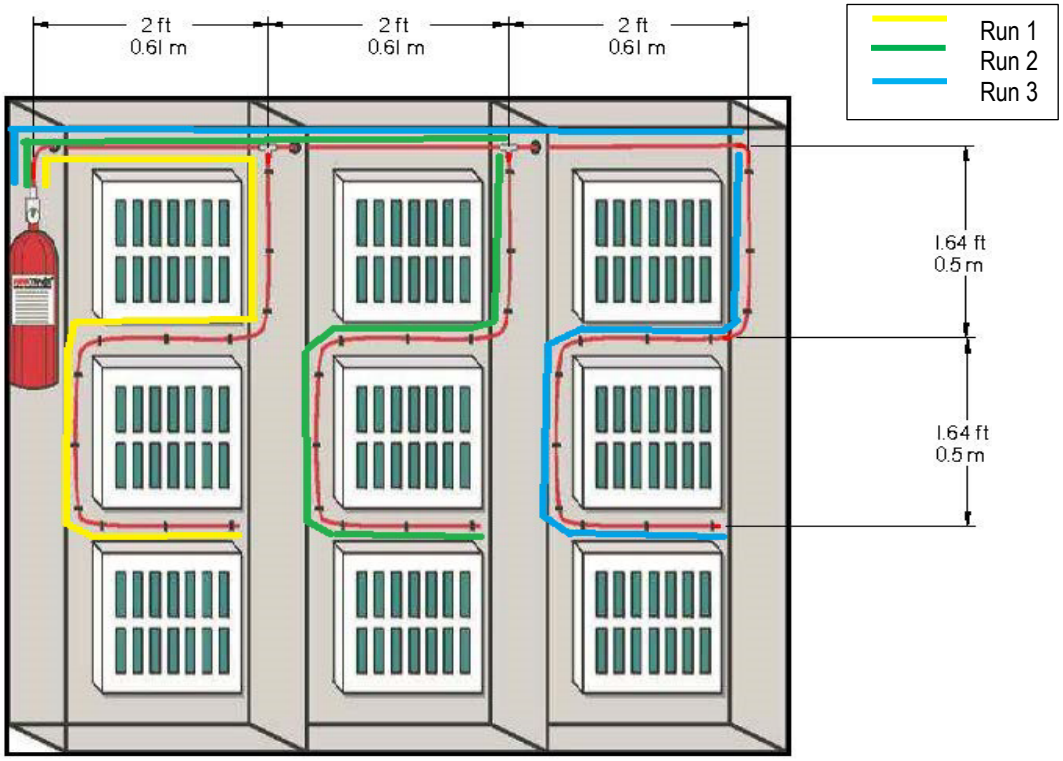


Figure 1 – Example System Configuration

The tubing is installed in three different runs to protect the segmented sections within the enclosure. The total length of Run 1 is 9.28 ft [2.83 m]. The total length of Run 2 is 11.28 ft [3.44 m]. The total length of Run 3 is 13.28 ft [4.05 m]. Each tubing run is less than the maximum tube run length of 50ft [15.24m].

The tubing is also installed in layers to protect the overall height of the enclosure. Each layer does not exceed the maximum height between layers of 1.64 ft [0.5 m].

The tubing is fastened on the sides of the walls, ensuring the distance between the tubing to any wall does not exceed 5.11 in [12.98 cm].

5 INSTALLATION INSTRUCTIONS

WARNING

HFC-227EA cylinder/valve assemblies must be handled, installed, and serviced only by qualified and trained personnel in accordance with the instruction contained in this manual, on the cylinder nameplate, and any other regulations and codes that may apply. Failure to follow these instructions could result in property damage, severe injury, or death.

WARNING

During transportation, ensure the ball valve, located on the top of the cylinder valve, is maintained in the "OFF" position. Failure to follow these instructions will result in actuation and discharge of the cylinder contents.

WARNING

Pressurized (charged) cylinders are extremely hazardous and if not handled properly can cause property damage, bodily injury, or death. Never handle the systems by the pressure switches, electric solenoids, or pressure gauges. Always wear safety glasses and make sure the discharge port ball valve is in the close/disarmed position and any safety/shipping plug(s) are properly in place before system installation, servicing, or other general handling.

CAUTION

This unit is designed as an Automatic unit. No manual or electric means is provided for simultaneous actuation of multiple units. Only one (1) unit can be used to protect one hazard. These extinguisher units cannot be combined to protect a larger size hazard since they are not designed to provide for simultaneous actuation of two (2) or more units.

5.1 Extinguisher Unit Installation

The extinguisher unit should be installed as close as possible to the protected enclosure. In some cases, the extinguisher unit can be mounted inside the protected enclosure. The unit shall be installed in a readily accessible location to allow for ease of inspection, service, and maintenance. The unit shall be located in an environment protected from the weather and where the temperature range is -4 °F to 140 °F [-20 °C to 60 °C]. Additionally, a label shall be affixed to the enclosure, stating that the enclosure is fitted with a pre-engineered extinguisher unit.

The extinguisher unit and bracket must be mounted in the vertical plane and oriented so that the pressure gauge is facing out and away from the mounting wall to facilitate visual inspection.

Mount the extinguisher unit where it will not be subjected to accidental damage or movement. Suitable protection must be installed where necessary to prevent damage or movement.

1. Securely mount the cylinder bracket to structural support using 2 or more mounting holes.
2. Position the cylinder in the bracket with the pressure gauge facing out. Secure the cylinder in place using the bracket straps or band clamps.

5.2 Component Installation

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 should be installed in accordance with the instructions in this Manual.

5.2.1 Firetrace Detection Tubing

Location and spacing of the tubing are critical to the response time in the event of a fire. The tubing should be placed above the hazard areas being protected. It is recommended that the tubing be placed in a manner such that it is situated horizontally above potential fire sources. It is not recommended that the (FDT) is oriented vertically adjacent to a potential fire source. Tubing installation should always be inspected to ensure the tubing is not kinked, crushed, or vulnerable to damage. Tubing shall not be installed on any galvanic surfaces.

1. Secure the detection tubing using Mounting Tabs at no more than 12-18 in [30.48-45.72 cm] intervals.
2. All (FDT) fittings at joints must be secured.
3. (FDT) must be secured within 6 in [15.24 cm] of all joints or fittings to prevent leakage due to bends near joints.
4. Use the appropriate rubber/plastic grommets when the detection tubing is routed through sharp holes, to prevent damage to the tubing.
5. When mounting to metal surfaces, rubber P-clips or a small piece of copper/rubber hosing is required to mount to the metal surface.
6. All (FDT) fittings and joints are to be inspected for leaks with a solution of liquid soap and water.

⚠ CAUTION

Do not kink, bend, or crush Firetrace tubing to prevent leakage which could result in accidental unit discharge. Do not install tubing in a hazardous environment where the maximum ambient temperature exceeds 300 °F [148.9 °C].

5.2.2 Slip-On Fittings

All high-pressure slip-on fittings must be secured in the following manner:

1. Cut the tube end (using a Firetrace Detection Tube (FDT) cutter P/N: 600210), ensuring the cut is square, clean, and free from burrs. Verify that no debris is left in the tube.
2. Thoroughly clean the tubing with a clean cloth (no cleaning agent) to a distance of at least 2 in [5.08 cm] from the cut end (removing all dirt, grease, or grime). This will ensure a good seal inside the fitting.
3. Slide the tubing into the opening, until it butts up against the inner wall. Pull lightly on the tubing and the brass outer ring should move outward slightly.

For a comprehensive list of Slip-On Fittings, refer to **APPENDIX A**.

5.2.3 End of Line Accessories

All the following accessories will connect to an End of Line (EOL) Adapter. The (EOL) Adapter can be installed by following the appropriate procedures in **Section 5.2.2**.

(EOL) Adapters are not designed to provide a lasting seal without the use of one of the following items:

Pressure Gauge:
The Pressure Gauge must be installed with its included O-ring. Thread the pressure gauge into the (EOL) Adapter so that the gauge indicates the tubing pressure.

Pressure Operated Switch:
The Pressure Operated Switch must be installed in the (EOL) Adapter with its included O-ring and washer. Insert the washer into the (EOL) Adapter, and then thread the Pressure Operated Switch until an audible “click” can be heard. The Pressure Operated Switch is now active.

NOTE: Without installation of the included washer, the Operational Pressure Switch will not be active. For rapid activation, Pressure Operated Switch shall be installed as part of the detection line, at the end of the detection network.

EU Pressure Operated Switch:
The EU pressure operated switch must be installed in the (EOL) Adapter with its included O-ring. Thread the EU pressure operated switch until an audible “click” can be heard. The EU pressure operated switch is now active.

End of Line Adapter Plug:
The (EOL) Adapter Plug must be installed with its included O-ring. Thread the plug into the (EOL) Adapter.

5.3 System Activation

1. Ensure the detection tubing, fittings, and accessories are installed according to the procedures specified in **Section 5.2** of this manual.
2. Attach the filling adapter to the End of Line (EOL) Adapter
3. Using a regulated dry nitrogen supply, pressurize the detection tubing through the filling adapter. It is recommended to have a portable dry nitrogen cylinder or Firetrace Nitrogen Fill Kit for on-site use.
4. Remove the filling adapter and thread the pressure gauge into the (EOL) Adapter. Verify that the tubing is pressurized to the correct pressure reading.
5. With the gauge still installed to the (EOL) Adapter, test for leakage:
   - Apply soapy water solution to the cylinder valve connection, (EOL) Adapter connection, and the pressure gauge connection. Observe for bubble leaks.
   - After 30 minutes, check the pressure gauge reading. Any decrease in pressure is an indication of a leak.
   - In the event of a leak go back to **Section 5.2** and verify the installation of all fittings and accessories.
6. If the pressure operated switch is to be installed, remove the pressure gauge, and install the pressure switch according to the procedures in **Section 5.2.3**.
   a. Check pressure switch connection for bubble leaks using soapy water solution.
   b. Ensure proper electrical connections are made to annunciate unit discharge, shut down ventilation, etc., as may be required by the end user or the Local Authority Having Jurisdiction (AHJ). (All electrical connections are to be in accordance with NFPA 70 National Electric Code and NFPA 72 National Fire Alarm and Signaling Code.)

NOTE: It shall not be possible for the user to isolate any power supply or alarm connections to the unit without also isolating the power supply to the enclosure or placing the system into an alarm status.

7. Ensure the pressure supervisory switch electrical connections are properly installed to annunciate low pressure within the extinguisher unit. (All electrical connections are to be in accordance with NFPA 70 National Electric Code and NFPA 72 National Fire Alarm and Signaling Code.)
8. With the system fully installed and all components properly affixed within the hazard area, **SLOWLY** rotate the lever on the ball valve counterclockwise to the “ON” position.
9. Remover the ball valve lever with a small Phillips head screwdriver.
10. Install the Anti-Tamper device (P/N: 201132) in accordance with **APPENDIX B**.

6 SERVICE AND MAINTENANCE INSTRUCTIONS

WARNING

HFC-227EA cylinder/valve assemblies must be handled, installed, inspected, and serviced only by qualified personnel in accordance with the instructions contained in this Manual, the cylinder nameplate, NFPA 2001, and any other regulations and codes that may apply.

Before performing maintenance or refilling procedures refer to the material safety data sheets in ***APPENDIX C****.*

WARNING

Pressurized (charged) cylinders are extremely hazardous and if not handled properly can cause bodily injury, death, or property damage. Always wear safety glasses and make sure the discharge port ball valve is in the close/disarmed position and any safety/shipping plug(s) are properly in place before system installation, servicing, or other general handling.

6.1 General

A regular program of systematic maintenance must be established for continuous, proper operation of all HFC-227EA systems 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.

For any deficiencies that are found, appropriate corrective actions shall be taken immediately.

The following includes the Firetrace recommendations for service and inspection of fire suppression systems. Local Authorities Having Jurisdiction (AHJ) may have additional service and maintenance requirements based on local codes and/or regulations. The requirements of the local AHJ must be followed.

NOTE: Operational shutdown during equipment maintenance is not required. It shall not be possible for the user to isolate any electrical power supply or alarm connections to the system without also isolating power supply to the enclosure or placing the system into an alarm status.

6.2 Periodic Service and Maintenance Procedures

6.2.1 Monthly Inspection

Inspection by the owner or end user should verify the following:

1. The Extinguisher Unit is in its proper location.
2. The Tamper Indicator is intact.
3. The Maintenance Tag or Certificate is in place and legible.
4. The Extinguisher Unit shows no physical damage or degradation that might prevent operation such as:
    i. Cuts or abrasions to the Firetrace Detection Tubing (FDT)
    ii. Color distortion of the (FDT) or extinguisher unit
    iii. Dirt accumulation along the (FDT)
    iv. Dirt accumulation along any of the fittings
5. The Pressure Gauge is in the operable range.
6. Verify the Protected Equipment nor the Hazard has been replaced, modified, or relocated.
7. If the pressure operated switch is installed:
    i. Check pressure switch connection for bubble leaks using soapy water solution.
    ii. Ensure the proper electrical connections are made. (All electrical connections are to be in accordance with NFPA 70 National Electric Code and NFPA 72 National Fire Alarm and Signaling Code.)
8. Ensure the pressure supervisory switch electrical connections are properly installed to annunciate low pressure within the extinguisher unit. (All electrical connections are to be in accordance with NFPA 70 National Electric Code and NFPA 72 National Fire Alarm and Signaling Code.)

6.2.2 Semiannual Visual Inspection

Semiannual Inspection is to be performed only by a Certified Firetrace Distributor. Inspection should include a repetition of the monthly inspection as well as verification of extinguisher unit weight. Extinguisher unit weight should be verified using the following steps:

1. Close the ball valve by turning the ball valve lever clockwise to the “OFF” position.
2. Depressurize the Firetrace Detection Tubing (FDT) by removing any components installed into the End of Line (EOL) Adapter and threading the fill kit adapter into the (EOL) Adapter.
3. Disconnect the Firetrace Detection Tubing (FDT) from the ball valve.
4. Remove the cylinder from the cylinder bracket.
5. Weigh the extinguisher unit. Compare the measured weight with the weight found on the nameplate. If the extinguisher unit shows a loss in agent quantity of more than 5 percent or a loss in pressure (adjusted for temperature) of more than 10 percent, the unit shall be refilled or replaced.
6. Reinstall the extinguisher unit and pressurize the detection tubing with nitrogen, see **Section 5** for instructions.

6.2.3 Five Year Inspection

HFC-227EA cylinders continuously in service without discharging shall be given a complete external visual inspection in place, every 5 years or more frequently if required.

Follow external visual inspection guidelines detailed in **Section 6.2.2**.

6.3 Hydrostatic Testing

6.3.1 DOT Systems

Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with 3M™ Novec™ 1230 Clean Agent DOT cylinders are built to DOT-4B specifications and therefore fall under DOT CFR Title 49 & NFPA 2001 regulations for retest and reinspection.

All DOT-4B, 4BA and 4BW cylinders used exclusively in 3M™ Novec™ 1230 service are to be retested and reinspected per DOT CFR Title 49, Section 180.205 & 180.209 as well as NFPA 2001, Container Test Section at the prescribed intervals for the cylinder/agent type used. All retest/reinspection 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 follow the test procedures as described in the applicable CGA pamphlet.

A complete visual inspection can be used in lieu of hydrostatic testing if cylinders are undamaged following the guidelines in DOT CFR Title 49, Section 180.205 & 180.209 as well as NFPA 2001, Container Test Section. Subsequent inspections as described in DOT CFR Title 49, Section 180.205 & 180.209, NFPA 2001, Container Test Section, as well as the local regulating authority will be required. The visual inspection shall be conducted only by competent persons and in conformance with the applicable CGA pamphlet. Inspections must be made only by persons holding a current RIN and the results recorded and maintained in conformance with DOT CFR Title 49, Section 180.215 & NFPA 2001, Container Test Section. Where external visual inspection indicates that the container has been damaged, additional strength tests shall be required in accordance with applicable transportation regulations.

6.3.2 CE Systems

Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent CE cylinders built to either BS EN 1928 or BS EN 1802 specifications fall under CE regulations for retest prior to refill.

BS EN 1928 or BS EN 1803 cylinders used exclusively in HFC-227EA service are required to be retested and restamped prior to recharge and shipment if the last retest date has expired.

Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent (BS EN 1928/BS EN 1803) containers requiring retest must be hydrostatically tested in accordance per BS EN 1928/BS EN 1803 as applicable. This periodic retest must be performed by an authorized retester who is certified to the Transportable Pressure Equipment Directive (TPED) requirements and any additional applicable requirements per Annex A.

Intervals Between Periodic Inspection and Test

In order to ensure continued safe operation, cylinders shall be periodically submitted to inspection and test in accordance with annex B. A cylinder shall fall due for a periodic inspection and test on its first receipt by a filler after the expiry of the interval in annex B.

NOTE Table B.1 gives a list of the intervals between periodic inspections for some gases which complies with the current RID/ADR regulations and also gives recommendations which could be subsequently adopted by the RID/ADR regulations.

Provided the cylinder has been subjected to normal conditions of use and has not been subjected to abusive and abnormal conditions rendering the cylinder unsafe, there is no general requirement for the user to return a gas cylinder before the contents have been used even though the test interval may have lapsed. However it is suggested that cylinders are retested within a period not exceeding twice the time interval.

In the case of cylinders used for emergency purposes (e.g. fire extinguishers, breathing apparatus), it is the responsibility of the person in possession (owner or user) to submit it for a periodic inspection within the interval specified in annex B or as specified in the relevant cylinder design standard/regulation, if this is shorter.

List of Procedures for Periodic Inspection and Test

The inspection and test shall be carried out only by competent persons who shall ensure that the cylinders are fit for continued safe use.

NOTE A competent person is a person who has the necessary technical knowledge, experience and authority to assess and approve materials for use with gases and to define any special conditions of use that are necessary. Such a person will also normally be formally qualified in an appropriate technical discipline.

Each cylinder shall be submitted to periodic inspection and test. The following procedures form the requirements for such inspection and test, and are explained more fully in later clauses:

- Identification of cylinder and preparation for inspection and test (clause 5);
- External visual inspection (clause 6);
- Inspection of welds (6.2);
- Internal visual inspection (clause 7);
- Supplementary tests (clause 8);
- Inspection of cylinder neck (clause 9);
- Pressure test, proof test only (clause 10);
- Repair of cylinders (clause 11);
- Inspection of valve (clause 12);
- Final operations (clause 13);
- Rejection and rendering cylinders unserviceable (clause 14).

Where cylinders are manufactured according to National Regulations and are intended to be qualified under the Transportable Pressure Equipment Directive (TPED) for free movement and use between member states of the European Union, additional requirements are specified in annex A.

It is recommended that the above listed tests are performed in the suggested sequence. In particular the internal visual examination (clause 7) should be carried out before the pressure test (clause 10).

Cylinders which fail the inspection or tests shall be rejected (see clause 13). When, after the above tests, doubts still exist as to the extent of a defect or the condition of a cylinder, then additional tests may be performed in accordance with clause 8, until such doubts are positively resolved or the cylinder shall be rendered unserviceable.

Some cylinders rejected during periodic inspection and test may be recovered in accordance with annex C.

Annex B
(normative)

Inspection periods

Table B.1 — Intervals between periodic inspections and test [a]

Description	Gas type (examples) [b]	Normative intervals [c] Period years	Informative recommendations for next revision of ADR Period years
Compressed gases	Ar, N_2, He etc.	10	10
	H_2 [d]	10	10
	Air, O_2	10	10
	Self-contained breathing Air, O_2, etc	[e]	5
	Gases for underwater breathing apparatus	[e]	2,5 (internal visual) and 5 (full) [f]
	CO [g]	5	5
Liquefied gases	CO_2, N_2O etc.	10	10 [h]
Corrosive gases	[i]	3	3 (internal visual) and 5 (full) [k]
Toxic gases	CH_3Br	5	10
Very toxic gases	AsH_3, PH_3 etc.	5	5
Gas mixtures	a) all mixtures except b) below b) mixtures completely in the gaseous state containing toxic and/or very toxic components.	3, 5 or 10 years according to classification 3 years for groups TC, TFC, TOC 5 years for groups T, TF, TO 10 years for groups A, O, F	a) Lowest test period of any component b) For such mixtures, if the toxicity of the final mixture is such that $LC_{50} \geq$ a volume fraction of 200×10^{-6}, a 10 year period applies, and if the toxicity of the final mixture is such that $LC_{50} \leq$ a volume fraction of 200×10^{-6} a 5 year period applies

[a] At all times certain requirements may necessitate a shorter time interval e.g. the dew point of the gas, polymerization reactions and decomposition reactions, cylinder design specification, change of gas service.

[b] This list of gases is not exhaustive. A full list of gases can be found in RID/ADR.

[c] These intervals conform to the 1999 edition of RID/ADR.

[d] Pay particular attention to the requirements of clause 5 and possible additional testing in accordance with EN 1795 for change of service.

[e] Not currently listed in RID/ADR.

[f] For cylinders used for self-contained underwater breathing apparatus in addition to the full retest period of 5 years, an internal visual inspection need to be performed every 2,5 years.

[g] This product requires very dry gas (see EN ISO 11114-1).

[h] This test period may be used provided the dryness of the product and that of the filled cylinder are such that there is no free water, and that this condition is proven and documented within a quality system of the filler. If these conditions cannot be fulfilled alternative or more frequent testing may be appropriate.

[i] For RID/ADR purposes, corrosivity is with reference to human tissue and NOT cylinder material, as per annex I.

[k] For gas mixtures shown to be corrosive for the cylinder material, the time period for single corrosive gases applies.

Figure 2 – ANNEX B (EN 1928/1803)

7 SYSTEM DEPRESSURIZATION AND CHARGING

WARNING

HFC-227EA cylinder/valve assemblies must be handled, installed, and serviced only by qualified and trained personnel in accordance with the instruction contained in this manual, on the cylinder nameplate, and any other regulations and codes that may apply. Failure to follow these instructions could result in property damage, severe injury, or death.

WARNING

Pressurized (charged) cylinders are extremely hazardous and if not handled properly can cause property damage, bodily injury, or death. Never handle the systems by the pressure switches, electric solenoids, or pressure gauges. Always wear safety glasses and make sure the discharge port ball valve is in the close/disarmed position and any safety/shipping plug(s) are properly in place before system installation, servicing, or other general handling.

Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher Systems with HFC-227EA Clean Agent must be handled, installed, inspected, and serviced only by qualified and trained personnel in accordance with the instructions contained in the appropriate manual, unit nameplate, and any other regulations and codes that may apply.

7.1 Depressurizing the Unit

CAUTION

Do not kink, bend, or crush Firetrace tubing to prevent leakage which could result in accidental unit discharge. Do not install tubing in a hazardous environment where the maximum ambient temperature exceeds 300 °F [148.9 °C].

1. Turn the ball valve lever to the “OFF” position (perpendicular to the valve.)
2. Depressurize the Firetrace Detection Tubing (FDT) by removing any components installed into the End of Line (EOL) Adapter and threading the fill kit adapter (P/N: 200173) into the (EOL) Adapter.
3. Remove the Firetrace Detection Tubing (FDT) from the top of the ball valve.
4. SLOWLY, open the ball valve SLIGHTLY so only a small amount of nitrogen can be heard being released from the unit.
5. Ensure the unit is depressurized by verifying the pressure gauge reads 0 psig.
6. SLOWLY open the ball valve completely.

7.2 System Recharge

Use the following steps to recharge an empty Firetrace Pre-Engineered Automatic Direct Low Pressure (DLP) Clean Agent Extinguisher System with HFC-227EA Clean Agent:

1. Weigh and record the empty weight of the cylinder and valve assembly.
2. Install the Firetrace Detection Tubing (FDT) to the top of the valve assembly.
3. Connect the filling adapter to the End of Line (EOL) Adapter.
4. Connect the HFC-227EA fill line to the fill adapter and record the weight shown on the scale.
5. Zero the scale.
6. Ensure the ball valve is open and open the HFC-227EA fill line.
7. Once the required weight is reached, close the HFC-227EA fill line.
8. Close the ball valve.
9. Open the valve vent to bleed the excess HFC-227EA from the fill line and disconnect the HFC-227EA fill line from the fill adapter.
10. Connect the dry nitrogen fill line to the fill adapter. Ensure it is regulated to 150 psig at 70 °F [10.3 bar at 21 °C] (pressure may have to be adjusted for temperatures higher or lower than 70°F).
11. Open the ball valve and pressurize the cylinder with dry nitrogen.
12. Close the ball valve and shake the cylinder to allow the nitrogen to be absorbed by the HFC-227EA. (Some pressure loss will be observed.)
13. Open the ball valve and pressurize back up to 150 psig at 70 °F, as will be indicated on the system pressure gauge.
14. Repeat steps 11 thru 13 until shaking of the system does not result in any pressure loss (i.e., no further nitrogen absorption) and a pressure of 150 psig is reached.
15. Disconnect the dry nitrogen fill line.
16. Verify the system gross weight by checking it against what is printed on the label.
17. Leak test the unit by using a calibrated leak detector.
18. The unit is now ready to be transported to the installation site.

WARRANTY

Firetrace USA, LLC.
Limited Warranty & Purchaser's Exclusive Remedy

****

LIMITED WARRANTY & PURCHASER'S EXCLUSIVE REMEDY

Purchaser's Limited Warranty

Firetrace USA, LLC (hereafter referred to as Firetrace) provides the following **Limited Warranty** only to the original purchaser, who purchases the Firetrace unit from an Authorized Firetrace Distributor. The **Limited Warranty** includes all Firetrace units, and its component parts supplied by Firetrace. Hereafter these products will be referred to as "Firetrace Products". When the Firetrace Products are properly installed by an authorized Firetrace distributor, ***in complete*** accordance with the written instructions contained in the instruction Manuals, or other data supplied with Firetrace products, and when the Firetrace products have not subsequently been modified or altered, unless by express written instructions from Firetrace, then the Firetrace products are warranted to be free of defects in materials and workmanship for a period of three (3) years from the date of shipment from Firetrace, Scottsdale Arizona, as long as the following conditions are met:

(1) The ***original*** purchaser must maintain a semi-annual maintenance service agreement with an authorized Firetrace distributor, commencing with the date the Firetrace product was accepted by the purchaser and placed into service. The service agreement **shall** remain in effect for the duration of the warranty.
(2) The Firetrace Warranty Registration Card (P/N: 800100) must be completed and returned to Firetrace within thirty (30) days of the installation of the Firetrace unit.

Firetrace products that are not certified, as specified in the paragraphs 1 and 2 above, will carry a maximum limited warranty of one (1) year from the date of shipment from Firetrace.

Purchaser's Exclusive Remedy

The original purchaser's sole and exclusive remedy, unless varied by express written agreement with Firetrace, is as follows: Repair or replacement, at Firetrace's option, of any defective part which is returned to Firetrace within ninety (90) days of discovery of the defect.

Because of the deleterious effects of corrosion, heat, rust, dirt, debris and other factors of use and installation over which Firetrace has no control, **FIRETRACE MAKES NO OTHER WARRANTIES OF ANY KIND, WHETHER EXPRESSED OR IMPLIED, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, BEYOND THOSE EXPRESSLY PROVIDED FOR IN THIS *LIMITED* WARRANTY**. These warranties shall be void where defects occur due to improper maintenance, installation, service, alterations and/or modifications subsequent to installation, not expressly authorized in writing by Firetrace or due to intentional or negligent acts of the original purchaser or third parties.

Non-Assignability of Warranty

The limited warranty set forth herein may not be assigned, transferred, or sold in any way and extends only to the *original* purchaser.

Disclaimer of Consequential Damages

In no event shall Firetrace be liable for any consequential or incidental damages arising from the purchase and/or use of Firetrace products, including but not limited to: damages resulting from loss of use of Firetrace products, the costs of replacing discharged suppression agent, damages for lost profits or income, or damages for resulting harm to property other than the Firetrace products.

Use of Non-Firetrace Components

All Firetrace units must exclusively use Firetrace components, especially for connections made to the Firetrace tubing. Failure to exclusively use Firetrace components will void this limited warranty and release Firetrace of any and all liability on the performance of the Firetrace components and unit.

SOME FACTORS INFLUENCING ENGINEERING DESIGN AND PRODUCT APPLICATION OF FIRETRACE UNITS

The following are some of the factors that influence engineering design and application of Firetrace units. In many cases, these factors are difficult to accurately estimate, and it is for these reasons that Firetrace makes ***no*** warranties other than those specifically stated in this **Limited Warranty**.

1. The Firetrace unit has been designed to provide protection against fire, both existing and imminent, for a limited duration of time when: the unit is fully operational; used in its normal, expected environment; the unit and its component parts are properly installed, maintained, and operated in ***complete*** accordance with written instructions supplied with the unit.

2. The duration of the protection against fires dependent upon a sufficient concentration of agent being maintained in the protected hazard area for a pre-determined period of time. This duration will be shortened by conditions or circumstances which may ventilate, cause the agent concentration dilution within the protected hazard area thereby causing an insufficient concentration of agent as is needed to extinguish or prevent the existence or re-ignition of combustion or fire. All hazard areas have different rate of ventilation, leakage, or agent dilution that, in many cases, may be impossible to predict or determine. Air vents, air conditioning units, gaps and cracks in the enclosure, windows, cable, and pipe penetrations, etc., all may affect the agent concentration and the duration of the protection against fire. Also, unforeseen changes in the configuration of a hazard area such as removal of a wall, an explosion or fire external to the protected space, changes in the enclosures configuration, etc. can influence the duration of the fire protection. It is because of these many, and varied, circumstances and conditions that Firetrace makes ***no*** warranty as to the duration of the protection against fire.

3. The effectiveness of an agent, such as HFC-227EA and/or CO_2, as a fire extinguishant is directly related to the concentration of the agent required to extinguish various substances. Not all substances require the same agent concentration to be extinguished. Therefore, Firetrace can only assume that the customer has properly defined the hazard area(s) being protected.

4. The effectiveness of the Firetrace unit is dependent upon the timely discharge of the agent fire extinguishant into the protected area. If unforeseen circumstances such as an explosion, failure of the detection system to activate the Firetrace unit, failure to Manually activate the unit, etc. occur, they can prevent the unit discharge from being accomplished in a timely manner, and the fire may become deep seated or out of control and completely destroy the hazard area. Since Firetrace has no control over these circumstances, there are ***no*** warranties as to the effectiveness of extinguishment of the fire other than those specifically stated in this **Limited Warranty**.

5. Even if the Firetrace unit is completely effective in suppressing a fire, failure to remove the ignition source of the fire could result in a re-ignition of the fire. If possible, the source of the fire should immediately be eliminated to prevent re-ignition. Protection against re-ignition only exists when a sufficient concentration of agent remains in the hazard area, as stated above.

Since the effectiveness of the Firetrace unit depends on when, under what circumstances, it is used, the judgment of operating personnel as to when to activate a Firetrace unit, in an emergency, affects the protection provided by the unit. Because of the widely carrying conditions and circumstances under which the Firetrace unit can be used, some conditions can cause its effectiveness to be unpredictable. Therefore, evacuation of personnel from the protected areas ***must*** be accomplished without delay.

APPENDIX A

SYSTEM PARTS LIST

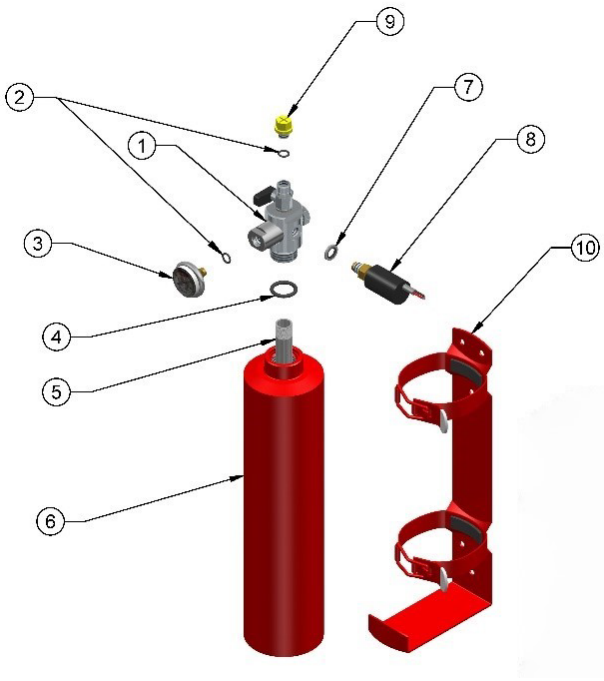
&

DISCHARGE LINE PARTS LIST

System Parts List: DOT System

MODELS:
920321 3 lb HFC-227ea DLP
920621 6 lb HFC-227ea DLP
921221 12 lb HFC-227ea DLP

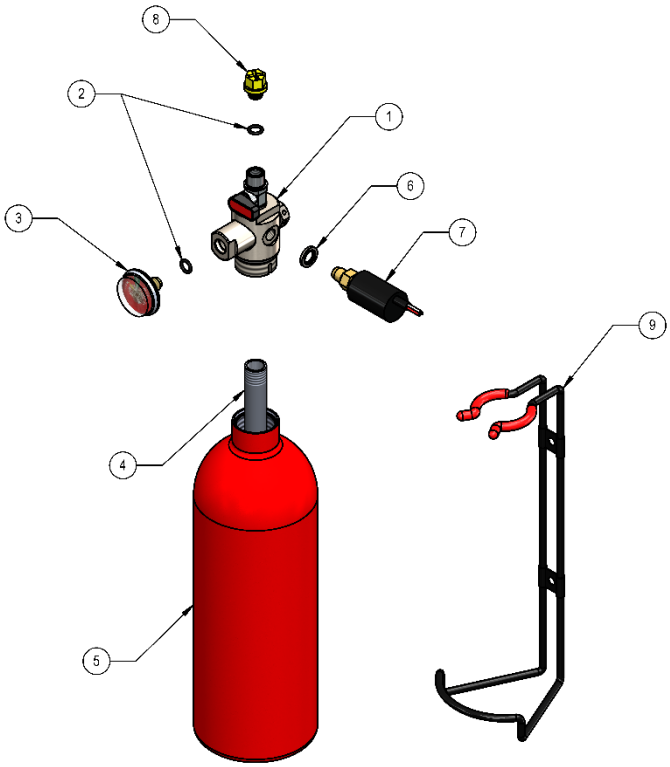
ITEM	P/N	DESCRIPTION	SYSTEM
1	300109	DOT DLP Valve	All Systems
2	400002	O-Ring, Gauge/Transport Cap	All Systems
3	400020	Gauge, Generic	All Systems
4	300200	O-Ring, Cylinder Connection	All Systems
5	600029	Siphon Tube	All Systems
6	100301	Small DLP Cylinder	3 LB
6	100601	Medium DLP Cylinder	6 LB
6	101201	Large DLP Cylinder	12 LB
7	600033	Bonded Seal	All Systems
8	400052	Pressure Supervisory Switch, HFC-227ea (Optional)	All Systems
9	200103	Transport Cap	All Systems
NP	200179	Slip-on Union	All Systems
10	100003	Small Bracket	3 LB
10	100006	Medium Bracket	6 LB
10	111206	Large Bracket	12 LB
NP – PARTS NOT PICTURES			



System Parts List: CE System

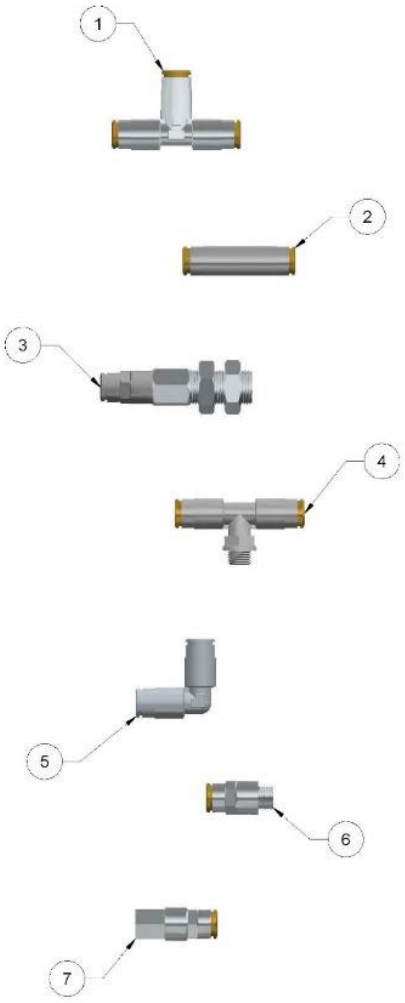
MODELS:
898204 1 kg HFC-227ea DLP
898205 2 kg HFC-227ea DLP
898206 5 kg HFC-227ea DLP

ITEM	P/N	DESCRIPTION	SYSTEM
1	831211	CE DLP Valve	All Systems
2	400002	O-Ring, Gauge/Transport Cap	All Systems
3	400020	Gauge, Generic CE	All Systems
4	860010	1 kg Siphon Tube	1 kg
4	600029	2 kg Siphon Tube	2 kg
4	860012	5 kg Siphon Tube	5 kg
5	810100	1 kg Cylinder	1 kg
5	810200	2 kg Cylinder	2 kg
5	810500	5 kg Cylinder	5 kg
NP	200179	Slip-On Union	All Systems
6	600033	Bonded Seal	All Systems
7	400052	Pressure Supervisory Switch, HFC-227ea (Optional)	All Systems
8	200103	Transport Cap	All Systems
9	810101	1 kg bracket	1 kg
9	810202	2 kg Bracket	2 kg
9	810505	5 kg Bracket	5 kg
NP – PARTS NOT PICTURED			



Detection Line Parts List

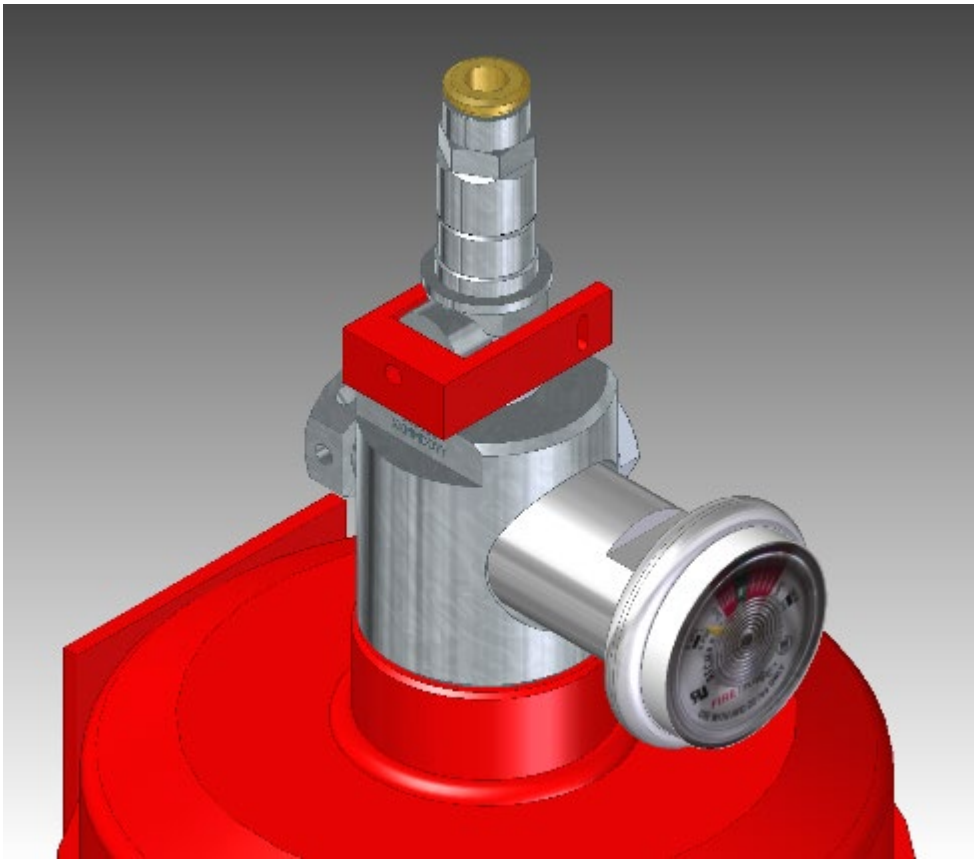
ITEM	P/N	DESCRIPTION
NP	200005	Firetrace Detection Tubing (4/6)
NP	200150	Rubber Grommets (Qty. 2)
NP	200151	Plastic Grommets (Qty. 2)
NP	200171	Mounting Tabs (4/6) (Qty. 12)
NP	201006	Magnetic Mounting Clips (4/6) (Qty. 6)
1	200157	Tube Tee (4/6)
2	200158	Tube Union (4/6)
NP	200159	Tube to Threads Elbow (4/6)
3	200168	Tube to End of Line Adapter (4/6)
NP	200169	Tube Tee to In Line Adapter (4/6)
4	200177	Tube Tee to Threads (4/6)
5	200178	Tube Elbow (4/6)
6	200179	Tube to Threads Union (4/6)
7	200203	Tube Plug (4/6)
NP	310303	End of Line Adapter Plug with O-Ring
NP	400004	Pressure Operated Switch
NP	400028	Pressure Gauge with O-Ring
NP	400034	EU Pressure Operated Switch
NP	900007	Filling Adapter
NP – PARTS NOT PICTURED		



APPENDIX B

TAMPER PROOF INSTRUCTIONS

Tamper Proof Instruction



1. Verify that the ball lever is in the “ON” position
2. Remove the lever
3. Install the sleeve (as pictured above)
4. Apply the plastic tie wrap and record the serial number stamped on the wrap.

APPENDIX C

SAFETY DATA SHEETS

HFC-227EA CLEAN AGENT

&

COMPRESSED NITROGEN

SAFETY DATA SHEET

FM-200™

Version	Revision Date:	SDS Number:	Date of last issue: 07/02/2019
9.3	10/10/2019	1334268-00044	Date of first issue: 02/27/2017

SECTION 1. IDENTIFICATION

Product name : FM-200™

SDS-Identcode : 130000036866

Manufacturer or supplier's details

Company name of supplier : The Chemours Company FC, LLC

Address : 1007 Market Street
Wilmington, DE 19801 United States of America (USA)

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

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

Recommended use of the chemical and restrictions on use

Recommended use : Firefighting agent

Restrictions on use : For professional users only.

SECTION 2. HAZARDS IDENTIFICATION

GHS classification in accordance with 29 CFR 1910.1200

Gases under pressure : Liquefied gas

Simple Asphyxiant

GHS label elements

Hazard pictograms :

Signal Word : Warning

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

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

Other hazards

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

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

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

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

CAS-No. : 431-89-0

Components

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

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

SECTION 4. FIRST AID MEASURES

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

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

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

In case of eye contact : Get medical attention immediately.

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

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

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

Notes to physician : Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, that may be used in

situations of emergency life support should be used with special caution.

SECTION 5. FIRE-FIGHTING MEASURES

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

SECTION 6. ACCIDENTAL RELEASE MEASURES

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

SECTION 7. HANDLING AND STORAGE

Technical measures	:	Use equipment rated for cylinder pressure. Use a backflow preventative device in piping. Close valve after each use and when empty.

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

Storage period	:	> 10 y
Further information on storage stability	:	The product has an indefinite shelf life when stored properly.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

Contains no substances with occupational exposure limit values.

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

Personal protective equipment

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

Wash contaminated clothing before re-use.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

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

Decomposition temperature	:	No data available
Viscosity		
Viscosity, kinematic	:	Not applicable
Explosive properties	:	Not explosive
Oxidizing properties	:	The substance or mixture is not classified as oxidizing.
Particle size	:	Not applicable

SECTION 10. STABILITY AND REACTIVITY

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

SECTION 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation
Skin contact
Eye contact

Acute toxicity

Not classified based on available information.

Components:

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

Acute inhalation toxicity	:	LC50 (Rat): > 788696 ppm Exposure time: 4 h Test atmosphere: gas Method: OECD Test Guideline 403 No observed adverse effect concentration (Dog): 90000 ppm Test atmosphere: gas Symptoms: Cardiac sensitization Lowest observed adverse effect concentration (Dog): 105000 ppm

Test atmosphere: gas
Symptoms: Cardiac sensitization

Cardiac sensitisation threshold limit (Dog): 730,190 mg/m³
Test atmosphere: gas
Symptoms: Cardiac sensitization

Skin corrosion/irritation

Not classified based on available information.

Serious eye damage/eye irritation

Not classified based on available information.

Respiratory or skin sensitization

Skin sensitization

Not classified based on available information.

Respiratory sensitization

Not classified based on available information.

Components:

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

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

Germ cell mutagenicity

Not classified based on available information.

Components:

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

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

Carcinogenicity

Not classified based on available information.

Components:

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

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

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

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

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

Reproductive toxicity

Not classified based on available information.

Components:

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

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

STOT-single exposure

Not classified based on available information.

STOT-repeated exposure

Not classified based on available information.

Components:

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

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

Repeated dose toxicity

Components:

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

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

Aspiration toxicity

Not classified based on available information.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Components:

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

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

Toxicity to algae/aquatic plants	:	ErC50 (Pseudokirchneriella subcapitata (green algae)): > 114 mg/l Exposure time: 72 h Method: OECD Test Guideline 201 Remarks: Based on data from similar materials NOEC (Pseudokirchneriella subcapitata (green algae)): 13.2 mg/l Exposure time: 72 h Method: OECD Test Guideline 201 Remarks: Based on data from similar materials

Persistence and degradability

Components:

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

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

Bioaccumulative potential

No data available

Mobility in soil

No data available

Other adverse effects

Product:

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

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

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

SECTION 14. TRANSPORT INFORMATION

International Regulations

UNRTDG

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

Labels	:	2.2

IATA-DGR

UN/ID No.	:	UN 3296
Proper shipping name	:	Heptafluoropropane
Class	:	2.2
Packing group	:	Not assigned by regulation
Labels	:	Non-flammable, non-toxic Gas
Packing instruction (cargo aircraft)	:	200
Packing instruction (passenger aircraft)	:	200

IMDG-Code

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

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

Not applicable for product as supplied.

Domestic regulation

49 CFR

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

Special precautions for user

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

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know

CERCLA Reportable Quantity

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

SARA 304 Extremely Hazardous Substances Reportable Quantity

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

SARA 302 Extremely Hazardous Substances Threshold Planning Quantity

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

SARA 311/312 Hazards : Gases under pressure
Simple Asphyxiant

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

US State Regulations

Pennsylvania Right To Know

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

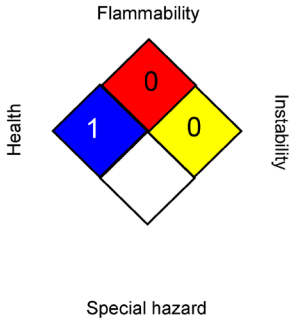
International Regulations

Montreal Protocol (Ozone Depleting Substances) : 1,1,1,2,3,3,3-Heptafluoropropane

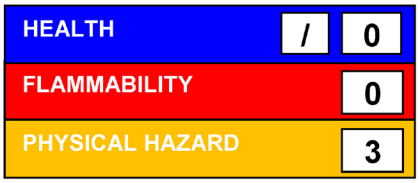
SECTION 16. OTHER INFORMATION

Further information

NFPA 704:



HMIS® IV:



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

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

Full text of other abbreviations

AICS - Australian Inventory of Chemical Substances; ASTM - American Society for the Testing of Materials; bw - Body weight; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DOT - Department of Transportation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; EHS - Extremely Haz-

ardous Substance; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; HMIS - Hazardous Materials Identification System; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; MSHA - Mine Safety and Health Administration; n.o.s. - Not Otherwise Specified; NFPA - National Fire Protection Association; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; RCRA - Resource Conservation and Recovery Act; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; RQ - Reportable Quantity; SADT - Self-Accelerating Decomposition Temperature; SARA - Superfund Amendments and Reauthorization Act; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative

Sources of key data used to compile the Material Safety Data Sheet	:	Internal technical data, data from raw material SDSs, OECD eChem Portal search results and European Chemicals Agency, http://echa.europa.eu/
Revision Date	:	10/10/2019

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

US / Z8

SECTION: 1. Product and company identification

1.1. Product identifier

Product form	Substance
Name	Nitrogen, compressed
CAS No	7727-37-9
Formula	N2
Other means of identification	Dinitrogen, Refrigerant R728, Nitrogen, Medipure Nitrogen, Extendapak Nitrogen, Nitrogen - Diving Grade

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

Use of the substance/mixture	Industrial use Medical applications Food applications Diving Gas (Underwater Breathing)

1.3. Details of the supplier of the safety data sheet

Praxair, Inc.
39 Old Ridgebury Road
Danbury, CT 06810-5113 - USA
T 1-800-772-9247 (1-800-PRAXAIR) - F 1-716-879-2146
www.praxair.com

1.4. Emergency telephone number

Emergency number	Onsite Emergency: 1-800-645-4633 CHEMTREC, 24hr/day 7days/week — Within USA: 1-800-424-9300, Outside USA: 001-703-527-3887 (collect calls accepted, Contract 17729)

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification (GHS-US)

Compressed gas H280

2.2. Label elements

GHS-US labeling

Hazard pictograms (GHS-US)

GHS04

Signal word (GHS-US)	WARNING
Hazard statements (GHS-US)	H280 - CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED OSHA-H01 - MAY DISPLACE OXYGEN AND CAUSE RAPID SUFFOCATION.
Precautionary statements (GHS-US)	P202 - Do not handle until all safety precautions have been read and understood P271+P403 - Use and store only outdoors or in a well-ventilated place. CGA-PG05 - Use a back flow preventive device in the piping. CGA-PG10 - Use only with equipment rated for cylinder pressure. CGA-PG06 - Close valve after each use and when empty. CGA-PG02 - Protect from sunlight when ambient temperature exceeds 52°C (125°F).

2.3. Other hazards

No additional information available

2.4. Unknown acute toxicity (GHS-US)

No data available

SECTION 3: Composition/information on ingredients

3.1. Substance

Name : Nitrogen, compressed

CAS No : 7727-37-9

Name	Product identifier	%
Nitrogen	(CAS No) 7727-37-9	99.5 - 100

3.2. Mixture

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures after inhalation : Immediately remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, qualified personnel may give oxygen. Call a physician.

First-aid measures after skin contact : Adverse effects not expected from this product.

First-aid measures after eye contact : Adverse effects not expected from this product. In case of eye irritation: Rinse immediately with plenty of water. Consult an ophthalmologist if irritation persists.

First-aid measures after ingestion : Ingestion is not considered a potential route of exposure.

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

No additional information available

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

None.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Use extinguishing media appropriate for surrounding fire.

5.2. Special hazards arising from the substance or mixture

Reactivity : Under certain conditions, nitrogen can react violently with lithium, neodymium, titanium (above 1472°F/800°C), and magnesium to form nitrides. At high temperature, it can also combine with oxygen and hydrogen.

5.3. Advice for firefighters

Firefighting instructions : Evacuate all personnel from the danger area. Use self-contained breathing apparatus (SCBA) and protective clothing. Immediately cool containers with water from maximum distance. Stop flow of gas if safe to do so, while continuing cooling water spray. Remove ignition sources if safe to do so. Remove containers from area of fire if safe to do so. On-site fire brigades must comply with OSHA 29 CFR 1910.156 and applicable standards under 29 CFR 1910 Subpart L—Fire Protection.

Protection during firefighting : Compressed gas. asphyxiant. Suffocation hazard by lack of oxygen.

Special protective equipment for fire fighters : Standard protective clothing and equipment (Self Contained Breathing Apparatus) for fire fighters.

Specific methods : Use fire control measures appropriate for the surrounding fire. Exposure to fire and heat radiation may cause gas containers to rupture. Cool endangered containers with water spray jet from a protected position. Prevent water used in emergency cases from entering sewers and drainage systems.

Stop flow of product if safe to do so.

Use water spray or fog to knock down fire fumes if possible.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Evacuate area. Ensure adequate air ventilation. Wear self-contained breathing apparatus when entering area unless atmosphere is proven to be safe. Stop leak if safe to do so.

6.1.1. For non-emergency personnel

No additional information available

6.1.2. For emergency responders

No additional information available

6.2. Environmental precautions

No additional information available

6.3. Methods and material for containment and cleaning up

No additional information available

6.4. Reference to other sections

See also sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Wear leather safety gloves and safety shoes when handling cylinders. Protect cylinders from physical damage; do not drag, roll, slide or drop. While moving cylinder, always keep in place removable valve cover. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Never insert an object (e.g., wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Slowly open the valve. If the valve is hard to open, discontinue use and contact your supplier. Close the container valve after each use; keep closed even when empty. Never apply flame or localized heat directly to any part of the container. High temperatures may damage the container and could cause the pressure relief device to fail prematurely, venting the container contents. For other precautions in using this product, see section 16.

Safe use of the product : **The suitability of this product as a component in underwater breathing gas mixtures** is to be determined by or under the supervision of personnel experienced in the use of underwater breathing gas mixtures and familiar with the physiological effects, methods employed, frequency and duration of use, hazards, side effects, and precautions to be taken.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions : Store in a cool, well-ventilated place. Store and use with adequate ventilation. Store only where temperature will not exceed 125°F (52°C). Firmly secure containers upright to keep them from falling or being knocked over. Install valve protection cap, if provided, firmly in place by hand. Store full and empty containers separately. Use a first-in, first-out inventory system to prevent storing full containers for long periods.

OTHER PRECAUTIONS FOR HANDLING, STORAGE, AND USE: When handling product under pressure, use piping and equipment adequately designed to withstand the pressures to be encountered. Never work on a pressurized system. Use a back flow preventive device in the piping. Gases can cause rapid suffocation because of oxygen deficiency; store and use with adequate ventilation. If a leak occurs, close the container valve and blow down the system in a safe and environmentally correct manner in compliance with all international, federal/national, state/provincial, and local laws, then repair the leak. Never place a container where it may become part of an electrical circuit.

7.3. Specific end use(s)

None.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Nitrogen, compressed (7727-37-9)	
ACGIH	Not established
USA OSHA	Not established

Nitrogen (7727-37-9)	
ACGIH	Not established
USA OSHA	Not established

8.2. Exposure controls

Appropriate engineering controls	: Use a local exhaust system with sufficient flow velocity to maintain an adequate supply of air in the worker's breathing zone. Mechanical (general). General exhaust ventilation may be acceptable if it can maintain an adequate supply of air.
Eye protection	: Wear safety glasses with side shields.
Skin and body protection	: Wear metatarsal shoes and work gloves for cylinder handling, and protective clothing where needed. Wear appropriate chemical gloves during cylinder changeout or wherever contact with product is possible. Select per OSHA 29 CFR 1910.132, 1910.136, and 1910.138.
Respiratory protection	: When workplace conditions warrant respirator use, follow a respiratory protection program that meets OSHA 29 CFR 1910.134, ANSI Z88.2, or MSHA 30 CFR 72.710 (where applicable). Use an air-supplied or air-purifying cartridge if the action level is exceeded. Ensure that the respirator has the appropriate protection factor for the exposure level. If cartridge type respirators are used, the cartridge must be appropriate for the chemical exposure (e.g., an organic vapor cartridge). For emergencies or instances with unknown exposure levels, use a self-contained breathing apparatus (SCBA).

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Gas
Appearance	: Colorless gas.
Molecular mass	: 28 g/mol
Color	: Colorless.
Odor	: No odor warning properties.
Odor threshold	: No data available
pH	: Not applicable.
Relative evaporation rate (butyl acetate=1)	: No data available
Relative evaporation rate (ether=1)	: Not applicable.
Melting point	: -210 °C
Freezing point	: No data available
Boiling point	: -195.8 °C
Flash point	: No data available
Critical temperature	: -149.9 °C
Auto-ignition temperature	: Not applicable
Decomposition temperature	: No data available
Flammability (solid, gas)	: No data available
Vapor pressure	: Not applicable
Critical pressure	: 3390 kPa
Relative vapor density at 20 °C	: No data available
Relative density	: No data available
Density	: 1.16 kg/m³
Relative gas density	: 0.97
Solubility	: Water: 20 mg/l
Log Pow	: Not applicable
Log Kow	: Not applicable
Viscosity, kinematic	: Not applicable
Viscosity, dynamic	: Not applicable
Explosive properties	: Not applicable
Oxidizing properties	: None.
Explosion limits	: No data available

9.2. Other information

Gas group	: Compressed gas
Additional information	: None.

SECTION 10: Stability and reactivity

10.1. Reactivity

Under certain conditions, nitrogen can react violently with lithium, neodymium, titanium (above 1472°F/800°C), and magnesium to form nitrides. At high temperature, it can also combine with oxygen and hydrogen.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

May occur.

10.4. Conditions to avoid

None under recommended storage and handling conditions (see section 7).

10.5. Incompatible materials

None.

10.6. Hazardous decomposition products

None.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Not classified

Skin corrosion/irritation : Not classified

pH: Not applicable.

Serious eye damage/irritation : Not classified

pH: Not applicable.

Respiratory or skin sensitization : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Reproductive toxicity : Not classified

Specific target organ toxicity (single exposure) : Not classified

Specific target organ toxicity (repeated exposure) : Not classified

Aspiration hazard : Not classified

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : No ecological damage caused by this product.

12.2. Persistence and degradability

Nitrogen, compressed (7727-37-9)	
Persistence and degradability	No ecological damage caused by this product.

Nitrogen (7727-37-9)	
Persistence and degradability	No ecological damage caused by this product.

12.3. Bioaccumulative potential

Nitrogen, compressed (7727-37-9)	
Log Pow	Not applicable
Log Kow	Not applicable
Bioaccumulative potential	No ecological damage caused by this product.

Nitrogen (7727-37-9)	
Log Pow	Not applicable for inorganic gases.
Log Kow	Not applicable.
Bioaccumulative potential	No ecological damage caused by this product.

12.4. Mobility in soil

Nitrogen, compressed (7727-37-9)	
Mobility in soil	No data available.
Ecology - soil	No ecological damage caused by this product.

Nitrogen (7727-37-9)	
Mobility in soil	No data available.
Ecology - soil	No ecological damage caused by this product.

12.5. Other adverse effects

Effect on ozone layer: None.

Effect on the global warming: None.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations: Dispose of contents/container in accordance with local/regional/national/international regulations. Contact supplier for any special requirements.

SECTION 14: Transport information

In accordance with DOT

Transport document description: UN1066 Nitrogen, compressed, 2.2

UN-No.(DOT): UN1066

Proper Shipping Name (DOT): Nitrogen, compressed

Transport hazard class(es) (DOT): 2.2 - Class 2.2 - Non-flammable compressed gas 49 CFR 173.115

Hazard labels (DOT): 2.2 - Non-flammable gas

Additional information

Emergency Response Guide (ERG) Number: 121 (UN1066) 120 (UN1977)

Other information: No supplementary information available.

Special transport precautions: Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. Before transporting product containers: - Ensure there is adequate ventilation. - Ensure that containers are firmly secured. - Ensure cylinder valve is closed and not leaking. - Ensure valve outlet cap nut or plug (where provided) is correctly fitted. - Ensure valve protection device (where provided) is correctly fitted.

Transport by sea

UN-No. (IMDG): 1066

Proper Shipping Name (IMDG): NITROGEN, COMPRESSED

Class (IMDG): 2 - Gases

MFAG-No: 121

Air transport

UN-No.(IATA): 1066

Proper Shipping Name (IATA): Nitrogen, compressed

Class (IATA)	: 2
Civil Aeronautics Law	: Gases under pressure/Gases nonflammable nontoxic under pressure

SECTION 15: Regulatory information

15.1. US Federal regulations

Nitrogen, compressed (7727-37-9)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory	
SARA Section 311/312 Hazard Classes	Sudden release of pressure hazard

15.2. International regulations

CANADA

Nitrogen, compressed (7727-37-9)
Listed on the Canadian DSL (Domestic Substances List)

Nitrogen (7727-37-9)
Listed on the Canadian DSL (Domestic Substances List)

EU-Regulations

Nitrogen, compressed (7727-37-9)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

15.2.2. National regulations

Nitrogen, compressed (7727-37-9)
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on IECSC (Inventory of Existing Chemical Substances Produced or Imported in China) Listed on the Korean ECL (Existing Chemicals List) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances)

15.3. US State regulations

Nitrogen, compressed(7727-37-9)	
U.S. - California - Proposition 65 - Carcinogens List	No
U.S. - California - Proposition 65 - Developmental Toxicity	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Female	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No
State or local regulations	U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Nitrogen (7727-37-9)				
U.S. - California - Proposition 65 - Carcinogens List	U.S. - California - Proposition 65 - Developmental Toxicity	U.S. - California - Proposition 65 - Reproductive Toxicity - Female	U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No significance risk level (NSRL)
No	No	No	No	

Nitrogen (7727-37-9)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

SECTION 16: Other information

Revision date : 6/24/2015 12:00:00 AM

Other information : When you mix two or more chemicals, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist or other trained person when you evaluate the end product. Before using any plastics, confirm their compatibility with this product.

Praxair asks users of this product to study this SDS and become aware of the product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this SDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information.

The opinions expressed herein are those of qualified experts within Praxair, Inc. We believe that the information contained herein is current as of the date of this Safety Data Sheet. Since the use of this information and the conditions of use are not within the control of Praxair, Inc., it is the user's obligation to determine the conditions of safe use of the product.

Praxair SDSs are furnished on sale or delivery by Praxair or the independent distributors and suppliers who package and sell our products. To obtain current SDSs for these products, contact your Praxair sales representative, local distributor, or supplier, or download from www.praxair.com. If you have questions regarding Praxair SDSs, would like the document number and date of the latest SDS, or would like the names of the Praxair suppliers in your area, phone or write the Praxair Call Center (Phone: 1-800-PRAXAIR/1-800-772-9247; Address: Praxair Call Center, Praxair, Inc., P.O. Box 44, Tonawanda, NY 14151-0044).

NFPA health hazard : 0 - Exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.

NFPA fire hazard : 0 - Materials that will not burn.

NFPA reactivity : 0 - Normally stable, even under fire exposure conditions, and are not reactive with water.

NFPA specific hazard : SA - This denotes gases which are simple asphyxiants.

HMIS III Rating

Health : 0 Minimal Hazard - No significant risk to health

Flammability : 0 Minimal Hazard

Physical : 3 Serious Hazard

SDS US (GHS HazCom 2012) - Praxair

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.