



# National Fire Equipment Ltd.

## Design, Installation & Maintenance Manual For Torrent Series Automatic Extinguisher HFC-227ea Clean Agent Unit

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03	Changes in Area of Coverage & radial Distance	Feb,13, 15
02	Minor Changes	Jan, 26, 15
01	Revised as per comments received from UL by email dated Dec 31 2014	Jan, 05, 15
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Rev	Change	Date

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## Appendix A: FM-200® (HFC-227ea) Material safety Data Sheet (MSDS)

## Appendix B: Extinguishing Concentrations for Class B fuels

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## Revision History

Rev	Description of change	Date
00	First Issue for UL Consideration and UL Book	08/28/2014
01	All pages Manual P/N in Footer corrected to 51-0100 / Page 5, Introductions, U.S. Environmental Protection Agency (EPA), Significant New Alternatives Policy (SNAP) Program added, paragraph 3 added / Page 5, Safety were moved to Page 10. / Page 5, Note, UL approved revised to UL component Recognized. / Page 7, Optional Accessories – low pressure supervisory switch connection to UL/ULC listed according to NFPA 70/72 added. / Page 7-9, Hazard analysis and automatic extinguisher selection, design concentration explained for fire classes, agent calculation formula added, hazard altitude correction factor added, agent concentration calculation formula added for occupied areas. / Page 10, Safety Pre-Cautions inserted and added reference to NFPA 2001. / Page 11-12, table for safe human exposure and warnings for occupied areas added. / Page 11, Max area of coverage corrected. / Page 16, operating and storage pressure vs. temperature curves corrected/ Page 18, Manual actuator Option removed from ordering guide, Commissioning added. / Page 18-19, maintenance, reference to NFPA 2001 added. / Page 19, Annual maintenance corrected to Semi Annually, note added about not using the gauge on assembly in pressurizing procedure, and the use of a regulator if the pressure source is high pressure tank. / Page 20, Table 09 added. / Appendix A, DuPont FM-200 MSDS Added/ Appendix B, DuPont FM-200 Cup Burner extinguishing Concentration Added.	01/05/2015
02	UL File Number Added to First page / page 7, word “Supervisory” were removed from Pressure Switch,	01/26/2015
03	Page 12, Table-06 Updated to final Values/ Page 12, section 5.3 Radial Distance were corrected to 15.1 ft., general change from SF series to Torrent Series.	04/17/2015

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## 1 Introductions

The Automatic Fire Extinguisher Unit – referred to as Torrent series in this manual - is a self-contained automatic extinguisher and has been developed for protection of small and relatively confined areas. It may be used to protect hazards within marine, industrial, commercial and residential environments.

Torrent series extinguishers use HFC-227ea, an effective clean agent that's safe for use in occupied spaces. HFC-227ea is electrically nonconductive, free of residue extinguishing agent and will not harm sensitive equipment. It also exceeds all standards regulating the use of ozone depleting substances, and is approved by the U.S. Environmental Protection Agency (EPA), Significant New Alternatives Policy (SNAP) Program and Environment Canada for total flooding agents as an acceptable Halon alternative.

All design, implementation, and maintenance of the inControl Systems Inc. Automatic Fire Extinguishers must be performed in compliance with the National Fire Protection Association (NFPA) 2001 - Standard on Clean Agent Fire Extinguishing Systems, NFPA 70 - The National Electrical Code, NFPA 72 - The National Fire Alarm Code, and the guidelines outlined in this manual.

## 2 Automatic Extinguisher Description

A system comprises a storage cylinder containing HFC-227ea super-pressurized with dry nitrogen to 175 psi at 70°F, (12 bar at 21° C), and cylinder mounting bracket.

HFC-227ea is a chemical clean fire suppression gas and extinguishes a fire by removing the free radicals or heat elements from the fire triangle. (Oxygen, Heat and Fuel)

The discharge head is fitted with a pressure gauge, a filling/pressurizing valve, and a discharge nozzle with integrated heat detector. Optional Detection/discharge nozzles are available to enable varying ambient room temperatures and fire conditions to be effectively protected.

HFC-227ea extinguishes fires primarily by molecular cooling and secondly by interrupting the chemical reaction of fire. The high thermal conductivity of HFC-227ea allows low atmospheric concentrations to extinguish fires very rapidly.

**Note: The Extinguishing agent filled in the Automatic Extinguishers are UL Component recognized.**

Other optional equipment like discharge head guard for protection of the nozzle assembly against mechanical damage are available, please contact inControl Systems Inc. for more information.



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Table 01- Automatic Extinguisher Unit Dimensions

item	Model No.	Outside Diameter		Overall Height	
		in	Cm	in	Cm
1	SFS	4-1/4"	10.8	14"	35.6
2	SFM	5-1/4"	13.4	19"	48.3
7	SFL	7-1/4"	18.5	21-1/2"	54.61
8	SFX	12-3/4"	32.4	17-5/8"	44.8

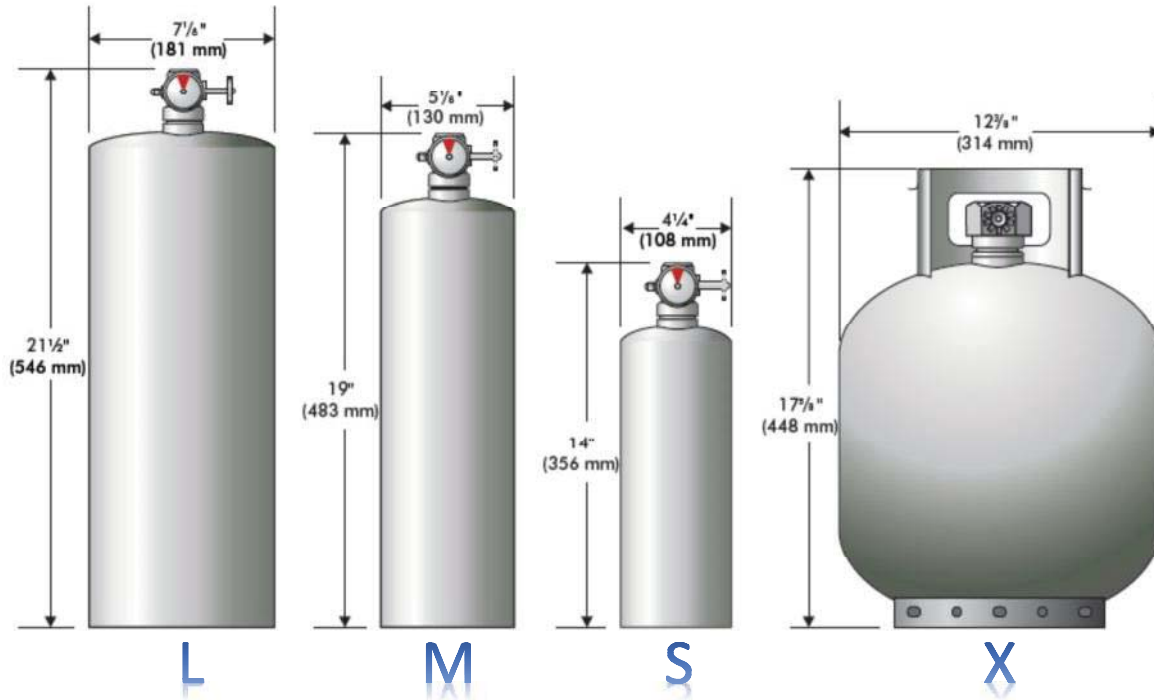


Figure 01- Automatic Extinguisher over view – front view

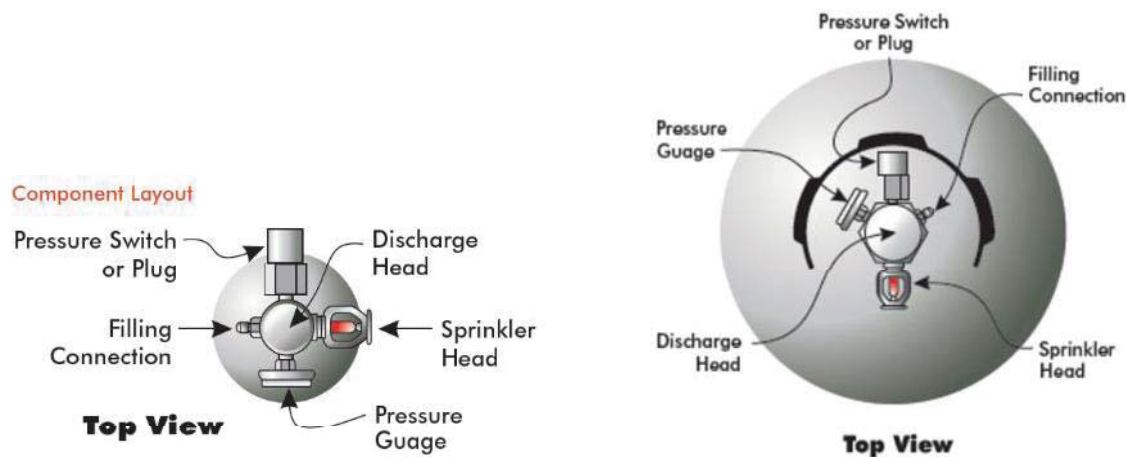


Figure 02- Automatic Extinguisher over view- top view

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### 3 Optional Accessories - Low Pressure Switch

Torrent series extinguishers are available with an optional pressure monitoring switch. This device has wire lead connections with Form C contacts (3 wires, NO & NC, SPDT) rated at 5 amps. The switch contacts change over when the cylinder pressure drops to approximately 85 psig. The switch is factory-installed and must be specifically ordered if required. It should be noted that the switch will not have any effect on the operation of the extinguisher. It cannot cause the extinguisher to discharge. The pressure switch should be connected to a UL/ULC Listed control panel or discharge indication devices according to NFPA 70 & 72.

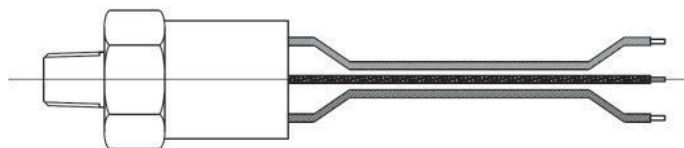


Figure 03- Pressure switch

## 4 Hazard analysis and Automatic Extinguisher Selection

### 4.1 Enclosure Volume:

Determine the volume of the space to be protected. The gross volume must be used. The gross volume is the product of the length, width and height of the compartment, plus the volume of all adjacent spaces that are open to the compartment (i.e. the bilge volume of a boat). Nothing shall be deducted for equipment occupying the compartment.

### 4.2 Design Concentration:

For the type of material used or stored in the protected space, determine the Hazard type, Class A (wood, paper, cloth, rubber, and many plastics), Class B (flammable liquids and flammable gases), Class C (energized electrical equipment), or any combination of the three.

NFPA 2001 (2012 edition) requires the minimum design concentration for a Class A surface fire to be equal to 6.7%, the minimum extinguishing concentration of heptane.

The minimum design concentration for a Class B fire depends on the extinguishing concentration for the specific fuel type found in the hazard plus a 30% safety factor. The minimum design concentrations for particular fuels based upon their cup burner extinguishing concentration are listed in Appendix B.

The minimum design concentration for a Class C fire shall be 7.0%, which is equal to the extinguishing concentration of Class A fuels times a safety factor of 1.35, in accordance with NFPA 2001 (2012 edition). concentration of HFC-227ea that will be required.

For Class A & C Fires 7% Design Concentration will suffice, however, the testing performed according to UL 2166 used 8.7 % design concentration.

The minimum quantity of agent required at sea level is determined by either multiplying the room volume by a flooding factor or by using a formula to calculate the amount of agent. Both methods are acceptable however the flooding factor is based on specific temperatures and specific design concentrations.

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The formula can be used to determine the amount of agent required for any temperature at any concentration. The formula is:

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

- W = Agent Weight in lbs. (kg)
- V = Room Volume in ft<sup>3</sup> (m<sup>3</sup>)
- C = Design Concentration, % by Volume
- s = Specific Vapor in ft<sup>3</sup>/lb (m<sup>3</sup>/kg),  $s = 1.885 + (0.0046 \times t)$ , [Metric Version:  $s = 0.1269 + (0.0005 \times t)$ ]
- t = Minimum Room Temperature in °F (°C)

### 4.3 Hazard Altitude

HFC-227ea expands to a greater specific vapor at elevations above sea level. Higher altitudes require less agent to achieve design concentration. Altitude differences can be corrected for using the correction factors listed in Table 02.

**Table 02: Altitude correction Factor**

Altitude		Atmospheric Correction Factor
ft	m	
-3,000	-920	1.11
-2,000	-610	1.07
-1,000	-300	1.04
0	0	1
1,000	300	0.96
2,000	610	0.93
3,000	910	0.89
4,000	1220	0.86
5,000	1520	0.82
6,000	1830	0.78
7,000	2130	0.75
8,000	2450	0.72
9,000	2740	0.69
10,000	3050	0.66

### 4.4 Extinguisher Selection:

Check the volume of the space to be protected against Table-03 or compare the calculated amount of agent against Table-02 and ensure the system that you choose is the correct one for your hazard area. Never install a system that has less HFC-227ea than is required.

After the automatic extinguisher size is determined, the concentration with the actual amount of agent to be discharged into the room, at the maximum anticipated temperature, will need to be calculated to determine if the concentration exceeds the 9% maximum allowed for normally occupied rooms.

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$$C = \frac{100 W \times s}{V + W \times s}$$

- C = Concentration, % by Volume
- W = Agent Weight in lbs. (kg)
- V = Room Volume in ft<sup>3</sup> (m<sup>3</sup>)
- s = Specific Vapor in ft<sup>3</sup>/lb (m<sup>3</sup>/kg),  $s = 1.885 + (0.0046 \times t)$  [ $s = 0.1269 + (0.0005 \times t)$ ]  
t = Minimum Room Temperature in °F (°C)

The assembly must have the correct sprinkler head rating for the space being protected. The sprinkler rating should be based on the maximum normal temperature in the enclosure. If in doubt as to the maximum temperature in the space, check the maximum temperature using a thermometer with any engines in the area running and/or heaters on, etc.



**CAUTION:**

**USE ONLY ONE UNIT TO PROTECT A HAZARD. THE SPRINKLER IS A HEAT DETECTOR AND DISCHARGE NOZZLE. IF MORE THAN ONE UNIT WERE INSTALLED, THE SPRINKLERS WOULD PROBABLY NOT OPERATE AT THE SAME TIME. THE AGENT DISCHARGED WOULD NOT CREATE SUFFICIENT CONCENTRATION TO EXTINGUISH A FIRE.**

**Table 03- Torrent series Maximum Protected Space**

item	Model No.	Agent Filling		Maximum Protected Space Class A & C Fires 7%		Maximum Protected Space Class B 8.7%	
		lb.	kg	Cu. Ft.	Cu. M.	Cu. Ft.	Cu. M.
1	SFS-06	6	2.7	139.00	3.94	139.00	3.94
2	SFM-07	7	3.2	205.30	5.82	162.16	4.59
3	SFM-09	9	4.1	263.95	7.48	208.49	5.90
4	SFM-12	12	5.5	277.99	7.87	277.99	7.87
5	SFL-15	15	6.8	439.92	12.47	347.49	9.84
6	SFL-20	20	9.1	555.90	15.74	463.32	13.12
7	SFL-24	24	10.9	555.90	15.74	555.99	15.74
8	SFX-31	31	13.6	909.17	25.76	718.15	20.34
9	SFX-36	36	15.9	972.97	27.55	833.98	23.62
10	SFX-42	42	19.1	972.97	27.55	972.97	27.55

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Table 04- Sprinklers available

Temperature rating		Bulb Color	Availability on SFS & SFM series	Availability on SFL series	Availability on SFX series
Deg. F	Deg. C				
135	57	ORANGE	YES	YES	YES
155	68	RED	YES	YES	YES
175	79	YELLOW	YES	YES	YES
200	93	GREEN	YES	NO	YES

## 5 Installation instructions and limitations

The installation of the Torrent series Automatic Clean Agent Fire Extinguishers should be undertaken by competent technicians familiar with NFPA 2001 and with the installation of such systems who have reviewed this manual and all hazard drawings and calculations.

No special tools are required to assemble the equipment.

- Use only one cylinder assembly for a single protected area. For large spaces, enquire about a Pre-engineered or engineered system.
- Select your installation Point according to installation limitations and Select an accessible, unobstructed mounting location on the upper section of a vertical wall or bulkhead in the room or compartment to be protected.
- Note the size and location of any openings in the walls. To prevent loss of agent, all openings, such as doors and windows, must be closed or have automatic closures installed. Also note any air conditioning or ventilating fans. These must be shut down on the discharge of HFC-227ea.

### 5.1 Safety Pre-Cautions

Users should read and understand this manual and the Material Safety Datasheet (MSDS) Supplied by the product and/or available at [www.incontorlsystems.net](http://www.incontorlsystems.net).

- Protect the assembly from mechanical impacts at all times.
- Do not discharge any Torrent series Extinguishers, unless securely installed according to User manual.
- Never remove parts from the assembly while under pressure.

The United States Environmental Protection Agency (EPA) Significant New Alternatives Policy (SNAP) Program lists HFC-227ea as acceptable for occupied spaces.

NFPA 2001 presents information on the toxicological effects of HFC-227ea. The no observable adverse effect level (NOAEL) is the highest concentration at which no adverse physiological or toxicological effect has been observed, which is 9%. The lowest observable adverse effect level (LOAEL) is the lowest concentration at which an adverse physiological or toxicological effect has been observed, which is 10.5 %.

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**Table 05: Time for Safe Human Exposure at Stated Concentrations for HFC-227ea**

HFC-227ea Concentration		Maximum permitted human exposure
% vol	ppm	minutes
9.0	90,000	5.00
9.5	95,000	5.00
10.0	100,000	5.00
10.5	105,000	5.00
11.0	110,000	1.13
11.5	115,000	0.60
12	150,000	0.49
Notes:		
1- Data derived From EPA-approved and peer-reviewed PBPK model or its equivalent.		
2- Based on LOAEL of 10.5 percent in dogs.		

HFC-227ea must be used in accordance with the NFPA Standard 2001, specifically as follows:

Unnecessary exposure to halocarbon clean agents—including exposure at and below the no observable adverse effects level (NOAEL)—and halocarbon decomposition products shall be avoided. Means shall be provided to limit exposure to no longer than 5 minutes. Unprotected personnel shall not enter a protected space during or after agent discharge. The following additional provisions shall apply:

- 1- Halocarbon systems for spaces that are normally occupied and designed to concentrations up to the NOAEL (9%) shall be permitted. The maximum exposure in any case shall not exceed 5 minutes.
- 2- Halocarbon systems for spaces that are normally occupied and designed to concentrations above the NOAEL (9%) shall be permitted if means are provided to limit exposure to the design concentrations shown in Table 05 that correspond to an allowable human exposure time of 5 minutes. Higher design concentrations associated with human exposure times less than 5 minutes as shown in Table 05 shall not be permitted in normally occupied spaces. An exposure and egress analysis shall be performed and approved.
- 3- In spaces that are not normally occupied and protected by a halocarbon system designed to concentrations above the lowest observable adverse effects level (LOAEL) of 10.5 % and where personnel could possibly be exposed, means shall be provided to limit exposure times using Table 05.
- 4- In spaces that are not normally occupied and in the absence of the information needed to fulfill the conditions listed above, the following provisions shall apply:
  - A. Where egress takes longer than 30 seconds but less than 1 minute, the halocarbon agent shall not be used in a concentration exceeding its LOAEL.
  - B. Concentrations exceeding the LOAEL shall be permitted provided that any personnel in the area can escape within 30 seconds.

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**Warning:**

When FM-200® is exposed to temperatures greater than 1300°F (700°C), the potentially hazardous by-product hydrogen fluoride (HF) will be formed. The system is designed to discharge within 10 seconds or less to minimize the amount of HF formed during extinguishment. The effects of agent decomposition on equipment must be considered when using FM-200® in hazards with high ambient temperatures (e.g., furnaces and ovens).

The Material Safety Data Sheet (MSDS) on FM-200® can be found in Appendix A of this manual and should be read and understood before working with the agent. Training of personnel, fire drills, and evacuation plans should be considered.

Failure to follow the safety instructions and this manual guide lines may cause an accident or personal injury, for which inControl Systems Inc. declines any responsibility.

## 5.2 Maximum Area of coverage:

The maximum area that can be protected by Torrent series Extinguishers has been achieved through fire testing according to UL 2166, the Maximum area for each assembly can be found in below table.

**Table 06-Maximum Area of Coverage**

item	Model	Agent Filling		Max area of coverage	
	No.	lb.	kg	Sq. ft.	Sq. m.
1	SFS-06	6	2.7	94.7	8.80
2	SFM-07	7	3.2	94.7	8.80
3	SFM-09	9	4.1	94.7	8.80
4	SFM-12	12	5.5	94.7	8.80
5	SFL-15	15	6.8	93.1	8.65
6	SFL-20	20	9.1	93.1	8.65
7	SFL-24	24	10.9	93.1	8.65
8	SFX-31	31	13.6	97.51	9.06
9	SFX-36	36	15.9	97.51	9.06
10	SFX-42	42	19.1	97.51	9.06

## 5.3 Radial Distance from the extinguisher:

Max radial Distance is defined as the furthest point of the enclosure (top plane view) from the center line of the extinguisher or the center line of the Brass discharge head (if installed horizontally). The radial distance plays an important role in finding the right place to install the extinguisher, the radial distance should not exceed 15.1 ft (4.60 m).

## 5.4 Enclosure Height Limitations:

The maximum enclosure height for Extinguisher installation is 10 ft (3m). The minimum enclosure height for Extinguisher installation for SFX series is 3.75 ft and 1.5 feet for all other types.

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## 5.5 Sprinkler Orientation

- Locate the unit high on a wall, with sprinkler 4 to 6 inches (102 to 153 mm) from the ceiling. Ensure there is nothing in front of the sprinkler that would impede agent discharge.
- The nozzle installation should be in accordance to **NFPA 2001- 5.4 NOZZLE CHOICE AND LOCATION**.
- The sprinkler must discharge horizontally, and towards the main hazard in the space or towards the centre of the space being protected, see Figure 04.



### CAUTION:

NFPA 2001 mandates that agent shall not directly impinge on areas where personnel could be found in the normal work area and that agent shall not directly impinge on loose objects or shelves, cabinet tops, or similar surfaces where loose objects could be present and become airborne during discharge.

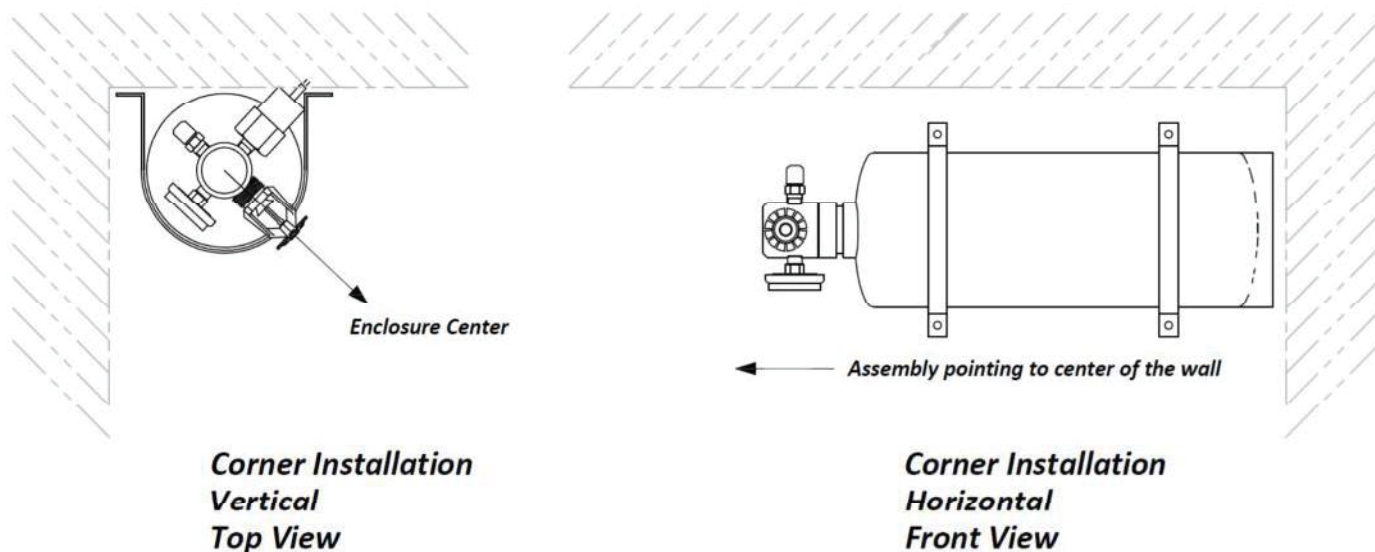


Figure 04- Corner installation

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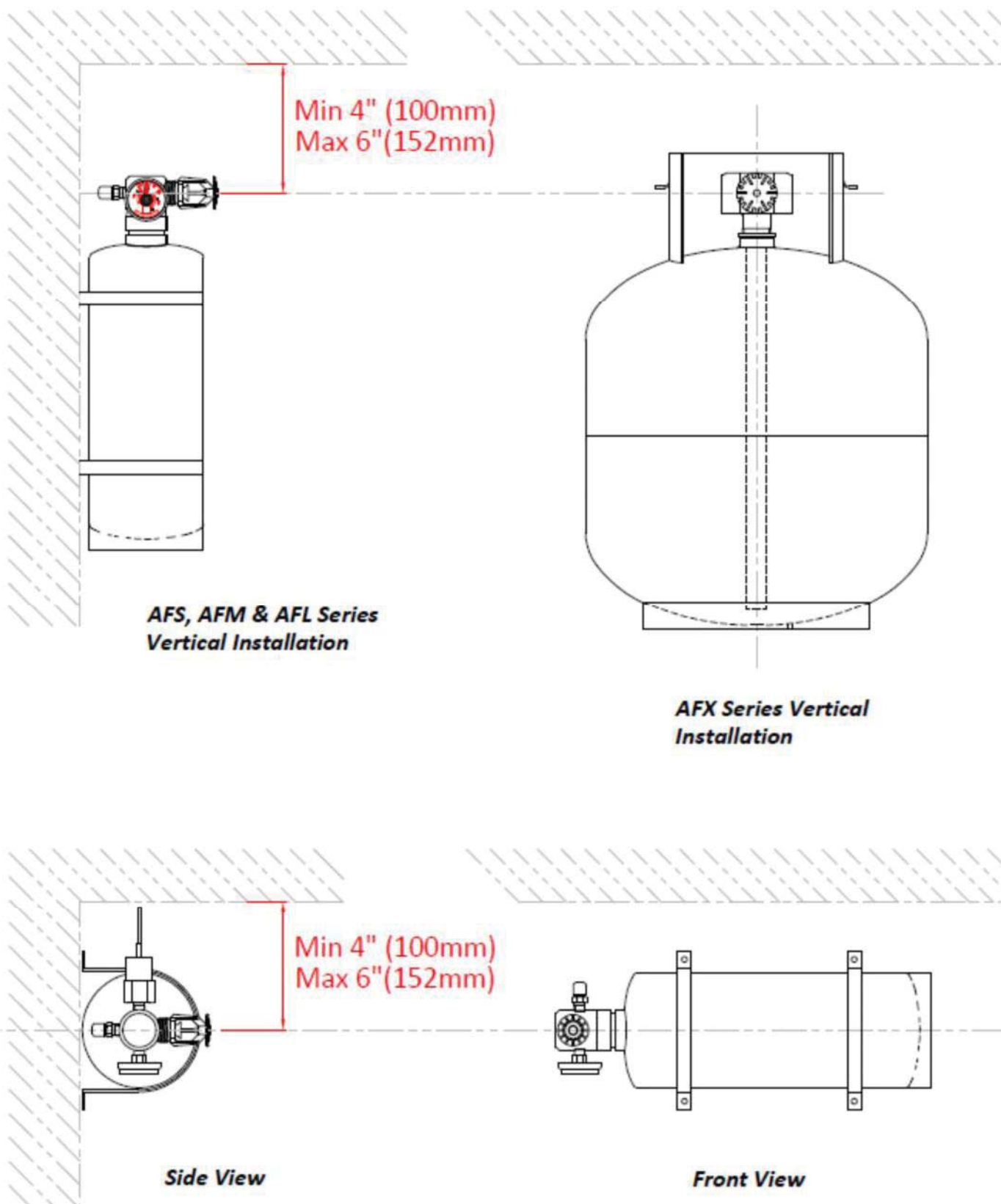


Figure 05- horizontal installation of the Assembly

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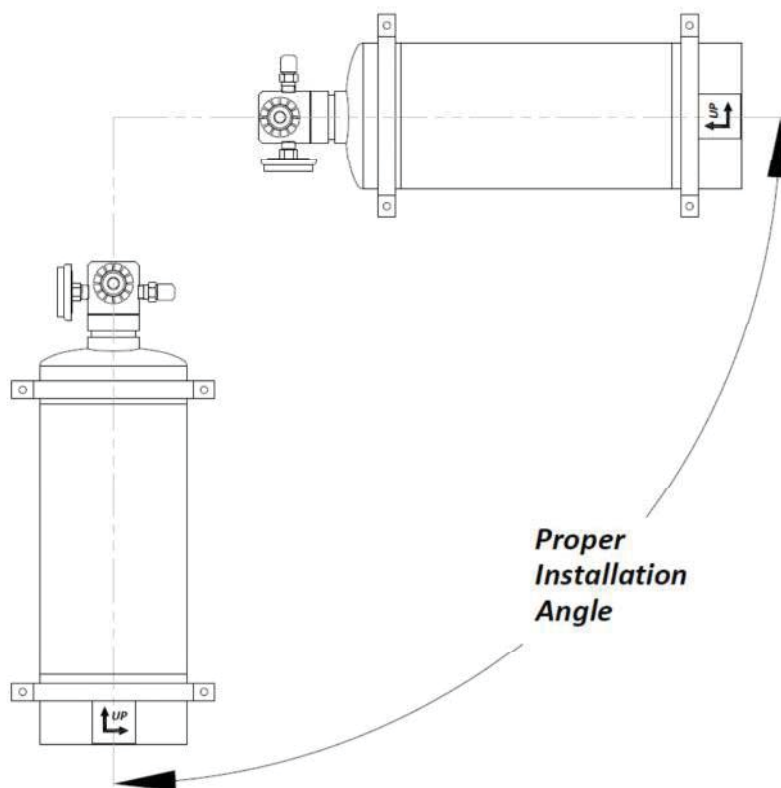
**CAUTION:**

**DO NOT INSTALL CYLINDER CLOSE TO ANY HIGH-HEAT SOURCE OR VENTILATION UNITS SUCH AS SPACE HEATERS.**

### 5.6 Installation Orientation

Torrent series Models SFS, SFM and SFL may be mounted in a vertical, horizontal or angular position. Model SFX must always be mounted in the vertical position. When vertical, the unit must be upright with the sprinkler head at the top. For small units. An arrow on the cylinder indicates possible vertical and horizontal orientations.

When horizontal, the sprinkler head must discharge horizontally with the pressure gauge facing downward. If angular, the sprinkler head must not be lower than the centre line of the cylinder. Install the extinguisher so that the pressure gauge is facing outwards and is easily seen for maintenance.



**Figure 06- SFS, SFM & SFL correct installation angle.**

**Note: for marine applications:** when installing extinguishers on boats, it is preferable to mount the cylinders vertically on forward or aft bulkheads. Horizontal cylinders should be mounted parallel to the keel with assembly's head pointing to front of the vessel.

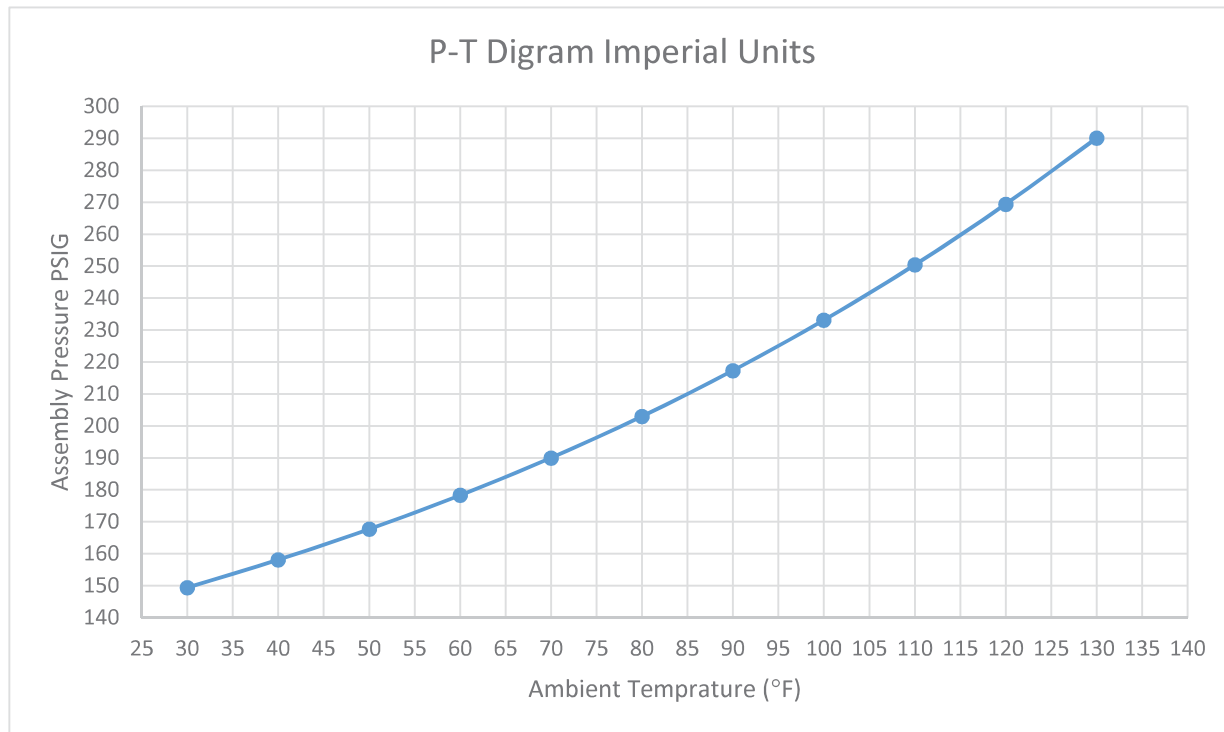
Do not install the extinguisher on the underside of the access hatch of an engine compartment, or any removable cover or door. If a specific hazard is to be protected, such as an engine or other piece of machinery, the cylinder should be located as close as possible to the hazard.

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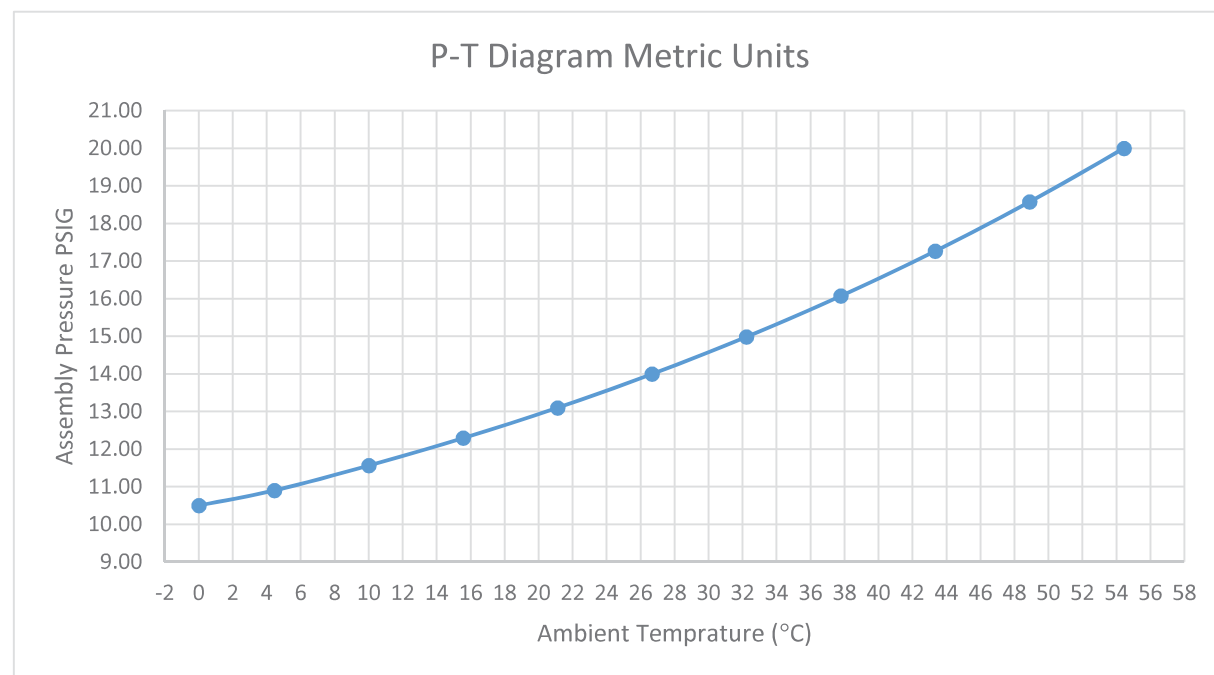
## 5.7 Operating and storage Temperature

Storage and operating temperature of the all assemblies are 32°F to +130°F (0°C to +54.4°C).

- Assembly Pressure when conditioned at minimum operating temperature is 150 Psi
- Assembly Pressure when conditioned at maximum operating temperature is 290 Psi



**Figure 07- Pressure vs. Temperature (Imperial Units)**



**Figure 08- Pressure vs. Temperature (Metric Units)**

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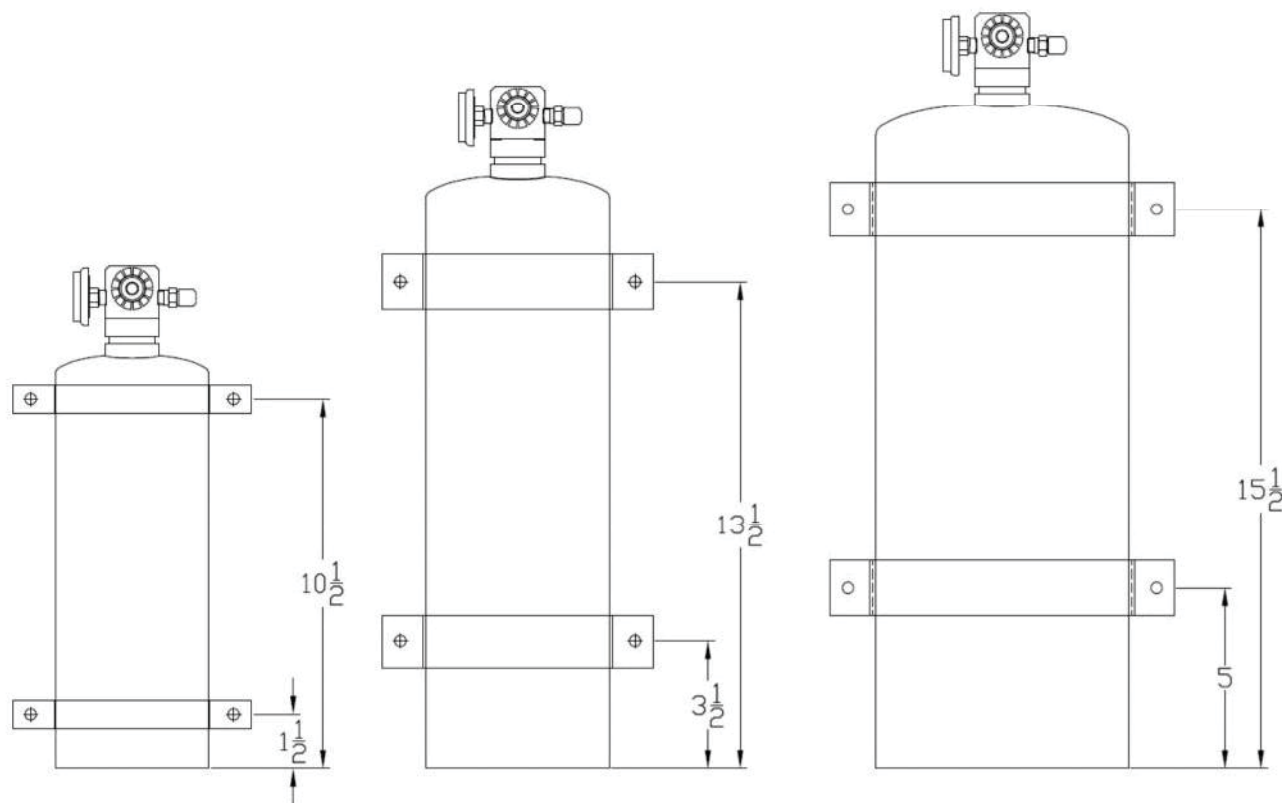
## 5.8 Mounting brackets

Each automatic extinguisher is supplied with mounting brackets manufactured and tested according to UL 2166, when installing the brackets use screws specified in table 5 and suitable for application mounting surface.

**Table 07-Mounting Brackets**

Model	Bracket P/N	Min. Screw Size	Min. Screw Length
<b>SFS</b>	04-0073	# 8 (M4)	1-1/4" (30 mm)
<b>SFM</b>	04-0048	#12 (M6)	1-1/4" (30 mm)
<b>SFL</b>	04-0049	#12 (M6)	1-1/4" (30 mm)
<b>SFX</b>	06-0200	#12 (M6)	1-1/4" (30 mm)

When mounting the brackets for SFS, SFM and SFL follow the dimensions from Figure-08.



**Figure 09- Recommended brackets spacing dimensions**

## 6 When Fire Occurs

When a fire occurs, the heat developed causes the bulb of the sprinkler head to burst (at a predetermined temperature), the sprinkler opens and the agent is discharged.

When actuation occurs, a bang may be heard followed by the rushing sound of the discharging HFC-227ea.

Occupied spaces should be evacuated immediately upon discharge of the system.

On pleasure boats, when discharge occurs, immediately shut down all engines, forced ventilation (blowers) and electrical systems (generators). This is necessary to ensure that (a) the fire cannot be fuelled by the continued

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operation of this equipment, and (b) the extinguishing agent concentration is allowed to remain in the protected space to prevent re-ignition, and is not exhausted by the ventilation blowers.

Do not open doors or hatches to the protected space. This would feed air to the fire and a re-flash could occur. Allow the extinguishing agent to remain in the compartment (to soak) for at least ten (10) minutes.

## 7 Ordering Guide

SF	S	YY		TTT	P
Type & Extinguishing Agent	Cylinder Size	Agent Filling		Sprinkler Head Temp Rating	Pressure Switch
		lb.	kg		
SF: Automatic Extinguisher Sprinkler type Using HFC-227ea	S	06	2.7	135°F (57°C) 155°F (68°C) 175°F (79°C) 200°F (93°C)*	P: Pressure Switch  S: Standard (No pressure Switch)
	M	07	3.2		
		09	4.1		
		12	5.5		
	L	15	6.8		
		20	9.1		
		24	10.9		
	X	31	14.1		
		36	15.9		
		42	19.1		

\* check Sprinkler temperature availability from Table 3

## 8 Commissioning

Check the following to ensure the system is ready to operate and work efficiently.

1. Check the sprinkler orientation to point to the center of the room. (for more info refer to 5.6 of this manual)
2. Ensure the installation orientation to according to 5.7 of this manual.
3. Check the radial distance from the furthest hazard in the room to the extinguisher, check if it exceed the limitations mentioned in 5.4 of this manual.
4. Check the distance of the sprinkler head to the ceiling to be compliant to 5.6 of this manual.
5. Check the mounting brackets and ensure the extinguisher does not turn or move in the brackets.
6. Check for the label of the extinguisher and the gauge to be visible for service.
7. Inspect the enclosure for unclosed openings, refer to Annex C of NFPA 2001 for more information on Enclosure integrity procedure.

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## 9 Maintenance

The installation, maintenance and testing of the Torrent series Automatic Clean Agent Fire Extinguishers should be undertaken by competent technicians according to NFPA 2001.

The installer should be familiar with such systems who have reviewed this manual and all hazard drawings and calculations.

### 9.1 Monthly

- A. Check the pressure gauge against figure 07 or 08, If the pressure loss is more than 10% the unit requires servicing.
- B. Ensure that nothing has been placed in front of the sprinkler that would interfere with the agent discharge.
- C. Ensure that the size and shape of the protected space has not changed. Any penetrations made through the enclosure should be sealed to restore the original fire resistance rating of the enclosure.

### 9.2 Semi Annually

- A. Remove and weigh the cylinder assembly. Compare its weight with weight indicated on the nameplate. If the weight loss is more than 5% of agent weight. The unit requires servicing, Record weight on a record tag permanently attached to the cylinder, as well as in an inspection report.
- B. Check unit for damage and corrosion.
- C. Ensure the brackets are secure on the wall.

### 9.3 Testing

- A. Cylinders continuously in service without discharging should be given an external visual inspection every five years.
- B. Cylinders should not be recharged without hydro static testing if more than five years have elapsed since date of the last test. Complete visual inspection is permitted as a means of retest (per NFPA 2001, 7.2).
- C. Where external visual inspections indicate that the cylinder has been damaged, strength tests (hydrostatic testing) should be conducted.
- D. Extinguishers that have discharged due to an actual fire should not be recharged because exposure to heat and flame may weaken the cylinder.

## 10 Recharging

Recharging these units should be carried out by an authorized distributor of inControl Systems Inc.

- 1) Wash the cylinder assembly to remove dirt, grease and foreign materials. Visually inspect the unit for damaged and missing parts.
- 2) The cylinder shall not be recharged without a test for cylinder strength, if:
  - a. Inspection shows any damage or corrosion.
  - b. The cylinder has been subjected to any unacceptable shock or vibration.
  - c. Five (5) or more years have elapsed since the cylinder was last tested.
- 3) The cylinders should be condemned and discarded, if:
  - a. It has been exposed to the direct action of a fire, or to high heat.
  - b. Dents or evidence of welding are encountered.
- 4) Replace the broken Sprinkler head and damaged parts with parts supplied from inControl Systems Inc. refer Table 09 for replacement parts P/N.
- 5) Connect the recharging adapter to the Schrader valve on the discharge head and fill the unit to 100 Psi with dry nitrogen. Using gas/air detecting fluid, or soap and water solution, check unit for leaks.
- 6) Empty the unit of nitrogen, place the unit on an appropriate scale and fill the unit with the weight of HFC-227ea indicated on the cylinder nameplate.
- 7) Super pressurize the unit with dry nitrogen to 175 Psi at 70°F (12 bar at 21°C)

Note: The pressure gauge attached to the extinguisher unit is not to be used to determine when the intended charging pressure has reached.

Note: A pressure regulator should be used when the pressure source is a tank of high pressure gas.

- 8) Shake the unit and re-pressurize until the pressure remains steady at 175 Psi at 70°F (12 bar at 21°C), and then remove the charging adapter. The unit should stand for min of 12 hours to ensure complete absorption of nitrogen into the HFC-227ea. Nitrogen should be added to ensure pressure is at 175 Psi at 70°F (12 bar at 21°C).
- 9) Check the unit for leaks, and replace the cap on the Schrader valve.
- 10) If pressure switch is included, check the switch contacts before and after to ensure contacts change over.
- 11) Return unit to client for reinstallation in the cylinder bracket.

**Table 09: list of replacement Parts**

P/N	Description
01-0015	Extinguishing Agent, HFC-227ea (UL Listed)
03-0033	Seal, O-ring, NBR, 0.859 ID x 0.139 W
04-0024	Cylinder, SFS
04-0025	Cylinder, SFM
04-0026	Cylinder, SFL
04-0200	Cylinder, SFX
04-0041	Tube, Siphon Bent, 3/8" NPT threaded, Steel, SFS
04-0042	Tube, Siphon Bent, 3/8" NPT threaded, Steel, SFM
04-0043	Tube, Siphon Bent, 3/8" NPT threaded, Steel, SFL
04-0199	Tube, Siphon Bent, 1/2", Steel, SFX
04-0047	Cap, Vent Valve, Plastic
04-0055	Valve Stem, Schrader
04-0075	Valve, Vent Core, Schrader
04-0073	Strap, Cylinder, 4" Dia, SFS
04-0048	Strap, Cylinder, 5" Dia, SFM
04-0049	Strap, Cylinder, 7" Dia, SFL
06-0200	Bracket, Mounting, SFX (04-0211 + 04-0212)
04-0464	Pressure Gauge, HFC-227ea, 175 Psi, 1/8" NPT
04-0541-XXX	Head, Sprinkler, SFS & SFM, followed by - XXX indicates Temperature
04-0542-XXX	Head, Sprinkler, SFL, followed by - XXX indicates Temperature
04-0543-XXX	Head, Sprinkler, SFX, followed by - XXX indicates Temperature
08-0025	Nut, Sealing, TRU Seal, 3/4" NPT
08-0037	Plug, Steel, Hex Soc. Hd., 1/8" NPT
11-0051	Switch, Pressure, SPDT, 1/8" NPT

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## Appendix A

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## Safety Data Sheet

**FM-200®**

Version 2.1

Revision Date 08/28/2014

Ref. 130000036866

This SDS adheres to the standards and regulatory requirements of the United States and may not meet the regulatory requirements in other countries.

**SECTION 1. PRODUCT AND COMPANY IDENTIFICATION**

Product name	:	FM-200®
Tradename/Synonym	:	FE-227 2-Hydroperfluoropropane Propane, 1,1,1,2,3,3,3-Heptafluoro- HFC-227eaHP 2-Hydroheptafluoropropane Heptafluoropropane 2-H-heptafluoropropane 1,1,1,2,3,3,3-Heptafluoropropane R-227 R227 HFC-227ea
Product Use	:	Fire extinguishing agent
Restrictions on use	:	For industrial use only.
Manufacturer/Supplier	:	DuPont 1007 Market Street Wilmington, DE 19898
Product Information	:	+1-800-441-7515 (outside the U.S. +1-302-774-1000)
Medical Emergency	:	1-800-441-3637 (outside the U.S. 1-302-774-1139)
Transport Emergency	:	CHEMTREC: +1-800-424-9300 (outside the U.S. +1-703-527-3887)

**SECTION 2. HAZARDS IDENTIFICATION**

<b>Product hazard category</b>	
Gases under pressure	Liquefied gas

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**Label content**

Pictogram

:



Signal word

: Warning

Hazardous warnings

: Contains gas under pressure; may explode if heated.

Hazardous prevention  
measures

: Protect from sunlight. Store in a well-ventilated place.

**Other hazards**

Misuse or intentional inhalation abuse may lead to death without warning.

Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.

Rapid evaporation of the liquid may cause frostbite.

**SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS**

Component	CAS-No.	Concentration
1,1,1,2,3,3,3-Heptafluoropropane	431-89-0	100 %

**SECTION 4. FIRST AID MEASURES**

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General advice	: Never give anything by mouth to an unconscious person. When symptoms persist or in all cases of doubt seek medical advice.
Inhalation	: Remove from exposure, lie down. Move to fresh air. Keep patient warm and at rest. Artificial respiration and/or oxygen may be necessary. Consult a physician.
Skin contact	: In case of contact, immediately flush skin with plenty of water for at least 15 minutes. Take off all contaminated clothing immediately. Consult a physician. Wash contaminated clothing before re-use. Treat for frostbite if necessary by gently warming affected area.
Eye contact	: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Consult a physician if necessary.
Ingestion	: Is not considered a potential route of exposure.
Most important symptoms/effects, acute and delayed	: No applicable data available.
Protection of first-aiders	: No applicable data available.
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. FIREFIGHTING MEASURES**

Suitable extinguishing media	: This material is a fire extinguishing agent.
Unsuitable extinguishing media	: No applicable data available.
Specific hazards	: The product is not flammable.
Special protective equipment for firefighters	: No applicable data available.
Further information	: No applicable data available.

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**SECTION 6. ACCIDENTAL RELEASE MEASURES**

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

- |                             |  |
|-----------------------------|--|
| Safeguards (Personnel)      | : Evacuate personnel, thoroughly ventilate area, use self-contained breathing apparatus. Keep upwind of leak - evacuate until gas has dispersed. |
| Environmental precautions   | : No applicable data available.  |
| Spill Cleanup               | : Ventilate area using forced ventilation, especially low or enclosed places where heavy vapors might collect.                                   |
| Accidental Release Measures | : No applicable data available.  |

**SECTION 7. HANDLING AND STORAGE**

- |                             |  |
|-----------------------------|--|
| Handling (Personnel)        | : Do not breathe gas. Avoid contact with skin, eyes and clothing. Provide sufficient air exchange and/or exhaust in work rooms. For personal protection see section 8. Wash hands thoroughly after handling. Wash clothing after use. Decomposition will occur when product comes in contact with open flame or electrical heating elements.<br>Handle in accordance with good industrial hygiene and safety practice.   |
| Handling (Physical Aspects) | : No applicable data available.  |
| Dust explosion class        | : No applicable data available.  |
| Storage                     | : Valve protection caps and valve outlet threaded plugs must remain in place unless container is secured with valve outlet piped to use point.<br>Do not drag, slide or roll cylinders.<br>Never attempt to lift cylinder by its cap.<br>Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.<br>Cylinders should be stored upright and firmly secured to prevent falling or being knocked over.<br><br>Separate full containers from empty containers.<br>Keep at temperature not exceeding 52°C.<br>Do not store near combustible materials.<br>Keep container tightly closed in a dry and well-ventilated place.<br>Store in original container.<br>Protect from contamination.<br>Avoid area where salt or other corrosive materials are present. |

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Storage period : No applicable data available.

Storage temperature : &lt; 52 °C (&lt; 126 °F)

**SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION**

Engineering controls : Use only with adequate ventilation. Keep container tightly closed.

Personal protective equipment

Respiratory protection : Wear NIOSH approved respiratory protection as appropriate.

Hand protection : Additional protection: Impervious gloves

Eye protection : Safety glasses with side-shields Additionally wear a face shield where the possibility exists for face contact due to splashing, spraying or airborne contact with this material.

Skin and body protection : Where there is potential for skin contact, have available and wear as appropriate, impervious gloves, apron, pants, jacket, hood and boots.

Protective measures : Self-contained breathing apparatus (SCBA) is required if a large release occurs.

Exposure Guidelines

Exposure Limit Values

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

AEL \*

(DUPONT)

1,000 ppm

8 &amp; 12 hr. TWA

\* AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

**SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES**

Appearance (Physical state, form, colour, etc.)

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Form	: Liquefied gas
Color	: No applicable data available.
Odor	: none
Odor threshold	: No applicable data available.
pH	: No applicable data available.
Melting point/freezing point	: Melting point/range -131 °C (-204 °F)
Boiling point/boiling range	: Boiling point -16.3 °C (2.7 °F)
Flash point	: No applicable data available.
Evaporation rate	: No applicable data available.
Flammability (solid, gas)	: The product is not flammable.
Upper explosion limit	: Method: None per ASTM E681-98
Lower explosion limit	: Method: None per ASTM E681-98
Vapor pressure	: 4.547 hPa at 25 °C (77 °F)
Vapour density	: No applicable data available.
Density	: 1.388 g/cm3 at 25 °C (77 °F) (as liquid)
Specific gravity (Relative density)	: No applicable data available.
Bulk density	: No applicable data available.
Water solubility	: No applicable data available.
Solubility(ies)	: No applicable data available.
Partition coefficient: n-octanol/water	: No applicable data available.
Auto-ignition temperature	: No applicable data available.
Decomposition temperature	: No applicable data available.
Viscosity	: No applicable data available.

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**SECTION 10. STABILITY AND REACTIVITY**

Reactivity	: Decomposes on heating.
Chemical stability	: Stable at normal temperatures and storage conditions.
Possibility of hazardous reactions	: Polymerization will not occur.
Conditions to avoid	: The product is not flammable in air under ambient conditions of temperature and pressure. When pressurised with air or oxygen, the mixture may become flammable. Certain mixtures of HCFCs or HFCs with chlorine may become flammable or reactive under certain conditions. To avoid thermal decomposition, do not overheat.
Incompatible materials	: Alkali metals Alkaline earth metals, Powdered metals, Powdered metal salts
Hazardous decomposition products	: Hazardous decomposition products , Hydrofluoric acid...% , Carbonyl difluoride, Carbon monoxide, Carbon dioxide

**SECTION 11. TOXICOLOGICAL INFORMATION**

FM-200®

Inhalation 4 h LC50	: > 788698 ppm , Rat
Inhalation	: Dog Cardiac sensitization
Dermal	: Not applicable
Oral	: Not applicable
Skin irritation	: No skin irritation, Not tested on animals Not expected to cause skin irritation based on expert review of the properties of the substance.
Eye irritation	: No eye irritation, Not tested on animals Not expected to cause eye irritation based on expert review of the properties of the substance.

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**Sensitisation** : Does not cause skin sensitisation., Not tested on animals  
Not expected to cause sensitization based on expert review of the properties of the substance.

Did not cause sensitisation on laboratory animals. There are no reports of human respiratory sensitization.

**Repeated dose toxicity** : Inhalation  
Rat  
-  
No toxicologically significant effects were found.

**Further information** : Cardiac sensitisation threshold limit : 730190 mg/m3

1,1,1,2,3,3,3-Heptafluoropropane  
**Carcinogenicity**

: Not classifiable as a human carcinogen.  
Animal testing did not show any carcinogenic effects.

**Mutagenicity** : Animal testing did not show any mutagenic effects.  
Tests on bacterial or mammalian cell cultures did not show mutagenic effects.

**Reproductive toxicity** : No toxicity to reproduction  
Animal testing showed no reproductive toxicity.

**Teratogenicity** : Animal testing showed no developmental toxicity.

**Carcinogenicity**

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, or OSHA, as a carcinogen.

**SECTION 12. ECOLOGICAL INFORMATION****Aquatic Toxicity**

1,1,1,2,3,3,3-Heptafluoropropane  
96 h LC50

: Danio rerio (zebra fish) > 200 mg/l OECD Test Guideline 203  
Information given is based on data obtained from similar substances.

72 h ErC50

: Pseudokirchneriella subcapitata (green algae) > 114 mg/l OECD Test

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## Guideline 201

Information given is based on data obtained from similar substances.

72 h NOEC

: Pseudokirchneriella subcapitata (green algae) 13.2 mg/l OECD Test Guideline 201

Information given is based on data obtained from similar substances.

48 h EC50

: Daphnia magna (Water flea) > 200 mg/l OECD Test Guideline 202  
Information given is based on data obtained from similar substances.**SECTION 13. DISPOSAL CONSIDERATIONS**Waste disposal methods -  
Product

: Can be used after re-conditioning. Recover by distillation or remove to a permitted waste disposal facility. Comply with applicable Federal, State/Provincial and Local Regulations.

Contaminated packaging

: Empty pressure vessels should be returned to the supplier.

**SECTION 14. TRANSPORT INFORMATION**

DOT

UN number

: 3296

Proper shipping name

: Heptafluoropropane

Class

: 2.2

Labelling No.

: 2.2

IATA\_C

UN number

: 3296

Proper shipping name

: Heptafluoropropane

Class

: 2.2

Labelling No.

: 2.2

IMDG

UN number

: 3296

Proper shipping name

: HEPTAFLUOROPROPANE

Class

: 2.2

Labelling No.

: 2.2

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**SECTION 15. REGULATORY INFORMATION**

- |                                |   |
|--------------------------------|---|
| TSCA                           | : On the inventory, or in compliance with the inventory   |
| SARA 313 Regulated Chemical(s) | : 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. |
| California Prop. 65            | : Chemicals known to the State of California to cause cancer, birth defects or any other harm: none known   |

**SECTION 16. OTHER INFORMATION**

® Registered trademark of E.I. du Pont de Nemours and Company  
 Before use read DuPont's safety information. For further information contact the local DuPont office or DuPont's nominated distributors. ® DuPont's registered trademark

Revision Date : 08/28/2014

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

Significant change from previous version is denoted with a double bar.

## Appendix B:

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## FM-200® (HFC-227ea) Cup Burner Extinguishing Concentrations

Fuel Source	Design Concentration % v/v
Acetone	8.97
Acetonitrile	8.71
t-Amyl Alcohol	9.49
AV Gas	8.45
Benzene	8.71
n-Butane	8.71
n-Butanol	9.88
2-Butoxyethanol	9.62
2-Butoxyethyl Acetate	8.97
n-Butyl Acetate	9.10
Carbon disulfide	15.34
Chloroethane	8.71
Crude Oil	8.71
Cyclohexane	9.36
Cyclohexylamine	8.71
Cyclopentanone	9.62
1,2-Dichloroethane	8.71
Diesel	8.71
N,N-Diethylethanolamine	10.14
Diethyl Ether	9.75
Ethane	8.71
Ethanol	10.79
Ethyl Acetate	8.84
Ethyl Benzene	8.71
Ethylene	10.92
Ethylene Glycol	9.88
Gasoline	8.97
n-Hexane	8.97
1-Hexene	8.97
Hydraulic Fluid	8.71
Hydraulic Oil	8.71
Hydrogen	17.16
Isobutyl Alcohol	9.88
Isopropanol	9.75

Figures based on testing by Great Lakes Chemical Company May 1996.  
102 mm Chimney; 30 mm cup, 5 cm/s air linear velocity

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## FM-200® (HFC-227ea) Cup Burner Extinguishing Concentrations (Cont'd)

Fuel Source	Design Concentration % v/v
JP4	8.97
JP5	8.97
Kerosene	9.62
Methane	8.71
Methanol	13.52
2-Methoxyethanol	12.22
Methyl Ethyl Ketone	9.62
Methyl Isobutyl Ketone	9.10
Mineral Sprits	8.71
Morpholine	10.27
Nitromethane	12.87
n-Pentane	8.84
Propane	8.71
I-Propanol	10.01
Propylene	8.71
Propylene Glycol	11.18
Pyrrolidine	9.49
Tetrahydrofuran	9.62
Tetrahydrothiophene	8.71
Toluene	8.71
Tolylene-2,4-diisocyanate	8.71
Transformer Oil	9.49
Xylene	8.71
n-Heptane *	8.71
Tetraethyl Orthosilicate*	10.53
Tetrahydrothiophene (CS Captan)*	8.71
Ukraine Petrol Mixture*	9.49
77.00% octane gaso- line	
8.00% isobutynol	
14.90% methanol	
0.10% H2O	
* Value determined in ISO cup burner testing (ISO 14520-1:2000, Annex B.)	

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## FM-200® Inerting Concentrations

Fuel Source	Design Concentration % v/v
i-Butane	12.43
1-Chloro-1,1-difluoroethane (HCFC-142b)	8.71
1,1-Difluoroethane (HFC-152a)	9.46
Difluoromethane (HFC-32)	8.71
Ethylene oxide	14.96
Hydrogen	26.40
Methane	8.80
Pentane	12.76
Propane	12.76

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