FM-200® Operation, Design, & Service Manual

Sv Series, Mv Series, Lv Series

Issued February 1, 2009

JANUS FIRE SYSTEMS®

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Revision History

Revision	Description of Change	Date
---	Initial Printing	2/1/2009
A	Table 4.1.1a, 4.1.1b, 4.1.1c dimensions adjusted	3/23/2009
B	Table 4.1.1a dimensions adjusted. Table 2.1.1 capacities adjusted. Figures 2.1.3.2b, 2.2.5.2, and Section 3.8 P/N 18553 changed to 18474. Section 3.8 P/N 17513 changed to FM200. Liquid Level Charts added to Tables 6.1.1a, 6.1.1b, 6.1.1c, 6.1.1d, 6.1.1e, 6.1.1f, 6.1.1g, 6.1.1h, 6.1.1i, and 6.1.1j. Note indicating "Liquid Level Charts will be added at a later date" removed from Section 6.1.1. Appendix A Material Safety Datasheet replaced with latest Revision correcting Transportation Information. Figures 4.1.1a, 4.1.1b, 4.1.1c part numbers added for bracket assembly components. Stainless steel nozzles added to Table 2.5 and Section 2.5. Section 1.1 listings and approvals updated.	1/5/2010

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Preface

This manual is intended for use with the Janus Fire Systems® Sv Series, Mv Series, and Lv Series FM-200® Engineered Fire Extinguishing Systems. Those who install, operate, design, or service these systems should read this entire manual.

All design, implementation, and maintenance of the Janus Fire Systems® Engineered Fire Extinguishing Systems 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.

Janus Fire Systems® reserves the right to revise and improve its products as it deems necessary without prior notification. This manual describes the state of Janus Fire Systems® products at the time of its publication and may not reflect those products at all times in the future.

All references to Codes or Standards in this manual refer to the latest edition of that Code or Standard unless otherwise indicated.

Compressed gases shall be handled and used only by persons properly trained in accordance with Compressed Gas Association, Inc. (CGA) pamphlets C-1, C-6, and P-1.

CGA pamphlets are published by the Compressed Gas Association Inc. (www.cganet.com).

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1 GENERAL INFORMATION

The Janus Fire Systems® Sv, Mv, and Lv Series Fire Extinguishing Systems utilize FM-200® to protect high value assets in areas that may be normally occupied, in locations where clean-up of other agents is problematic, when storage space for a fire suppression agent is restricted, and/or when an electrically non-conductive agent is required.

FM-200® systems may be used in Class A (wood, paper, cloth, rubber, and many plastics), Class B (flammable liquids and flammable gases), and Class C (energized electrical equipment) surface fires.

NFPA 2001 mandates that clean agents such as FM-200® shall not be used on fires involving the following materials unless they have been tested to the satisfaction of the authority having jurisdiction:

- Chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, that are capable of rapid oxidation in the absence of air
- Reactive metals, such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium
- Metal hydrides
- Chemicals capable of undergoing autothermal decomposition, such as organic peroxides and hydrazine

All systems described in this manual are intended only for total flooding application. NFPA 2001 defines total flooding as the act and manner of discharging an agent for the purpose of achieving a specified minimum agent concentration throughout a hazard volume. The FM-200® must be discharged within 10 seconds and reach a minimum concentration level of 6.25% but not exceeding 9% in normally occupied spaces.

Table 1 - System Performance Specifications	
Lowest Approved Equipment Temperature	32°F (0°C)
Highest Approved Equipment Temperature	130°F (54°C)
Ambient Temperature Limits for Approved Flow Calculations	70°F ±10°F (21.1°C ±5.5°C)
Minimum Height of Protected Space	12 in (304 mm)
Maximum Height of Protected Space (single tier of nozzles)	16 ft (4877 mm)
Maximum Nozzle Drop Below Finished Ceiling	4 ft (1219 mm)
Nozzle Range (Radius)	44 ft (13411 mm)
Maximum Nozzle Height (Rise) Above Discharge Outlet	30 ft (9144 mm)

Section 1 General Information

1.1 Listings and Approvals

When designed and installed according to the information contained in this manual, the Janus Fire Systems® Sv, Mv, and Lv Series FM-200® Fire Extinguishing Systems are Underwriters Laboratories Inc. (UL) listed and Factory Mutual (FM) approved for engineered systems. System equipment has been verified through testing to function at ambient temperatures ranging from 32˚F (0˚C) to 130˚F (54˚C). Flow calculations have been verified at ambient temperatures of 70˚F ±10˚ (21.1˚C ±5.5˚). Storage outside of the range of 70˚F ±10˚ (21.1˚C ±5.5˚) may result in inaccurate flow calculations and may cause one or more nozzles to not discharge the calculated quantity of FM-200®.

1.2 Extinguishing Agent

FM-200® (HFC-227ea) is a colorless, non-toxic gas and a clean, effective, environmentally acceptable, electrically non-conductive fire suppression agent. It is formed from the elements carbon, fluorine and hydrogen (CF3CHFCF3 - heptafluoropropane). The primary extinguishing mechanism of FM-200® is heat absorption, with a secondary chemical contribution from the thermal decomposition of FM-200® in the flame.

Most metals, such as aluminum, brass, steel, and stainless steel, as well as plastics, rubber, and electronic components, are not affected by exposure to FM-200®.

In the Janus Fire Systems® FM-200® Fire Suppression Systems, FM-200® is stored as a liquid in steel cylinders and superpressurized with nitrogen to 360 psig (24.8 bar) at 70˚F (21.1˚C) to improve its flow characteristics. When discharged, FM-200® vaporizes at the discharge nozzles and becomes thoroughly mixed with the air throughout the protected area reaching a predetermined design concentration.

Table 1.3 - Time for Safe Human Exposure at Stated Concentrations for FM-200® (HFC-221ea)

FM-200® Concentration		Maximum Human Exposure Time (Minutes)
% v/v	ppm	
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
12.0	120,000	0.49

Notes:
1. Data derived from the EPA-approved and peer-reviewed PBPK model or its equivalent.
2. Based on LOAEL of 10.5% in dogs.

1.3 Safety Considerations

The United States Environmental Protection Agency (EPA) Significant New Alternatives Policy (SNAP) Program lists FM-200® (HFC-227ea) as acceptable for occupied spaces.

FM-200® must be used in accordance with the NFPA Standard 2001, specifically as follows:

> Unnecessary exposure to FM-200® — including exposure at and below the no observable adverse effects level (NOAEL)[1] concentrations of 9% or below — and FM-200® 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] NOAEL (No Observed Adverse Effect Level) - The highest concentration at which no adverse toxicological or physiological effect has been observed.

(1) FM-200® systems for spaces that are normally occupied and designed to concentrations up to the NOAEL shall be permitted. The maximum exposure in any case shall not exceed 5 minutes.

(2) FM-200® systems for spaces that are normally occupied and designed to concentrations above the NOAEL shall be permitted, given that means be provided to limit exposure to the design concentrations shown in Table 1.3 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 1.3 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 an FM-200® system designed to concentrations above the lowest observable adverse effects level (LOAEL)[2] of 10.5%, and where personnel could possibly be exposed, means shall be provided to limit exposure times using Table 1.3.

(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 FM-200® shall not be used in a concentration exceeding its LOAEL of 10.5%.

(b) Concentrations exceeding the LOAEL are permitted provided that any personnel in the area can escape within 30 seconds.

(c) A pre-discharge alarm and time delay shall be provided in accordance with the provisions noted in NFPA 2001 for Time Delays.

The discharge of FM-200® into a hazard may reduce visibility for a brief period. FM-200® may cause frostbite if liquid discharge or escaping vapor contacts the skin.

⚠WARNING

When FM-200® is exposed to temperatures greater than 1300°F (700°C), the potentially hazardous byproduct 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.

A cylinder containing FM-200® must be handled carefully. **All anti-recoil safety plugs and devices must be in place at all times when the cylinder is not connected to discharge piping.**

2 LOAEL (Lowest Observable Adverse Effect Level) - The lowest concentration at which an adverse physiological or toxicological effect has been observed.

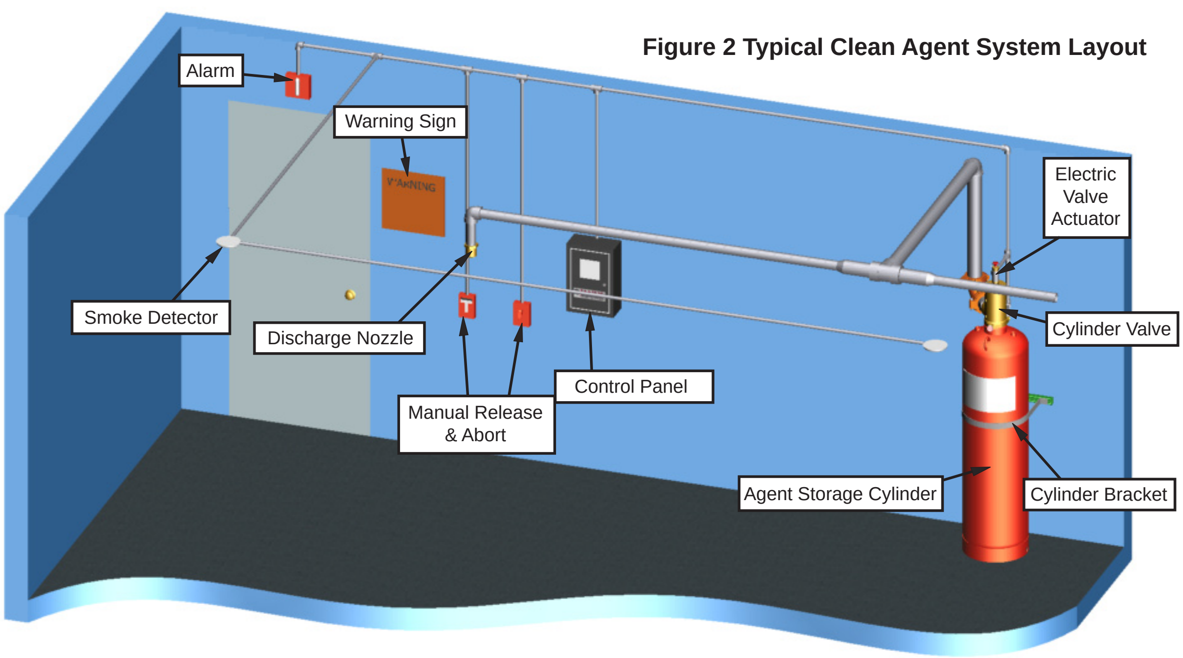
2 SYSTEM DESCRIPTION AND COMPONENTS

The Janus Fire Systems® Sv, Mv, and Lv Series Systems can be divided into the following component categories:

1. **FM-200® Storage Components** - These components consist of the cylinder assembly(s), which contains the FM-200® chemical agent, and the cylinder bracket(s), which holds the cylinder assembly securely in place.
2. **FM-200® Distribution Components** - These components consist of the discharge nozzles used to atomize the liquid FM-200® and introduce it into a protected hazard along with the associated piping system used to connect the nozzles to the cylinder assembly.
3. **Trim Components** - These components complete the installation of the FM-200® system and may include connection fittings, a pressure gauge, low-pressure supervisory switch, electric valve actuator, and manual valve actuator. The specific components used will vary slightly according to the series valve installed.
4. **Slave Arrangement Components** - These components consist of the pneumatic valve actuator(s), pilot actuation check valve, vent check, actuation hoses, and fittings required for a multiple cylinder (slave) arrangement.
5. **Supplemental Components** - These components include the discharge pressure switch and may be utilized in a variety of locations within an arrangement or for multiple purposes.
6. **Control Panel** - This device monitors the condition of the electric actuator, detectors, warning devices, cylinder pressure, and any manual release and abort stations.
7. **Early Warning and Alarm Devices** - Early warning devices coupled with manual release and abort stations maximize system efficiency while audible and visual alarm devices alert staff of alarm conditions.

The following sections describe the operation and function of all controls and indicators that are used with the Janus Fire Systems® Sv, Mv, and Lv Series FM-200® Systems.

Figure 2 Typical Clean Agent System Layout



2.1 Cylinder Assembly

The cylinder assembly consists of the cylinder, dip tube, and cylinder valve.

2.1.1 Cylinder

The FM-200® agent is stored as a liquid inside a welded steel cylinder. The cylinders are superpressurized with dry nitrogen to a pressure of 360 psig (24.8 bar) at 70°F (21°C). Every cylinder has a minimum fill density of 35 lb/ft^3 (561 kg/m^3) and a maximum fill density of 70 lb/ft^3 (1121 kg/m^3). The capacity of a cylinder varies according to the design requirements and the Series designation (See Table 2.1.1 for a list of available capacities).

Standard domestic cylinders are manufactured according to the requirements of the U.S. Department of Transportation (USDOT) and Transport Canada (TC) for compressed gas and are fitted with an identification label indicating the fill quantity of FM-200®. Each cylinder has internal neck threads to allow for connection to the cylinder valve.

Table 2.1.1 Cylinder Capacities

Valve Series	Nominal Cylinder Size	P/N	Fill Capacity				Empty Weight	
			Minimum		Maximum			
			lb	kg	lb	kg	lb	kg
Sv	40 lb	18583	22	10.0	49	19.5	36	16.3
Sv	80 lb	18584	41	18.6	81	36.7	65	29.5
Sv	130 lb	18585	66	29.9	131	59.4	77	35.0
Mv	250 lb	18525	126	57.2	252	114.3	213	96.6
Mv	420 lb	18526	211	95.7	422	191.4	279	126.6
Lv	600 lb	18527	304	137.9	609	275.3	346	157.0
Lv	900 lb	18528	455	206.4	910	412.7	471	213.6
Lv	1000 lb	18529	561	254.5	1000	453.6	766	346.5

Ordering Instructions: Specify the Cylinder Assembly P/N followed by a dash and the fill weight in pounds expressed in three digits.

2.1.1.1 Rupture Disc

A frangible rupture disc is fitted to the Lv Series cylinder body. It functions as an emergency relief device in the event of excessive internal pressure within the cylinder. Its rupture point is between 850 psi (58.6 bar) and 1000 psi (68.9 bar).

This feature is not found on the Sv Series or Mv Series cylinder. Instead, a rupture disc is located on the side of Sv Series and Mv Series cylinder valve as detailed in sections 2.1.3.1 and 2.1.3.2.

2.1.1.2 Liquid Level Indicator

The liquid level indicator consists of a sealed non-magnetic tube containing an external measurement tape fitted with a magnet. A second magnet with an opposing polarity is installed on the outside of the tube and is exposed to the FM-200® liquid. As the tape is extracted from the tube, it will engage with the second magnet creating a noticeable change in tension. The measure on the tape when this change in tension occurs indicates the current liquid level inside the cylinder and can then be compared to a chart located in Appendix B of this manual to determine the current fill weight of the cylinder.

The liquid level indicator assembly is threaded into an outlet on the head (top) of the Mv Series and Lv Series cylinders.

This feature is not found on the Sv Series cylinder.

2.1.2 Dip Tube

A rigid dip tube is threaded into the cylinder valve and extends down the entire length of the cylinder.

2.1.3 Cylinder Valve

A differential pressure operated cylinder valve controls the automatic release of FM-200® from the cylinder. It is made of forged brass and is threaded onto the cylinder neck. The features and design of each valve vary according to the Series designation.

2.1.3.1 Sv Series Valve Features *(See Figure 2.1.3.1a)*

The Sv Series valve has six key features:

1. **Valve Actuation Connection:** A threaded connection located on top of the cylinder valve serves as the attachment point for the electric (primary) or pneumatic (slave) valve actuator.

2. **Pressure Gauge:** A pressure gauge is mounted to the cylinder valve exterior to provide a visual measure of the cylinder's internal pressure. The gauge cannot be removed while the cylinder is under pressure.

3. **Rupture Disc:** A frangible rupture disc is fitted to the valve body opposite the pressure gauge. It functions as an emergency relief device in the event of excessive internal pressure within the cylinder. Its rupture point is between 850 psi (58.6 bar) and 1000 psi (68.9 bar).

4. **Low-Pressure Supervisory Switch:** A low-pressure supervisory switch is mounted to the cylinder valve and continuously monitors the internal pressure of the cylinder. It cannot be remove while the cylinder is under pressure.

5. **Discharge Outlet:** A 1 1/4 in (32 mm) FNPT connection serves as the attachment point for the discharge piping.

6. **Pilot Actuation Port:** A 3/8 in (10 mm) FNPT connection (shipped with a pipe plug) serves as the attachment point for the pilot actuation piping in multiple cylinder systems, providing the actuation pressure used to open the slave cylinder valve(s). This can also be used for attachment of the discharge pressure switch in single cylinder arrangements.

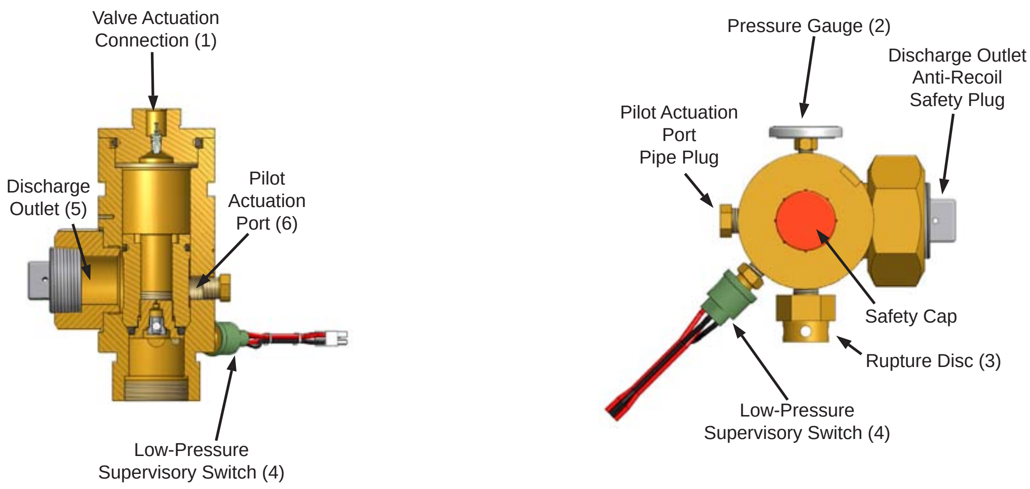


Figure 2.1.3.1a Sv Cylinder Valve Assembly

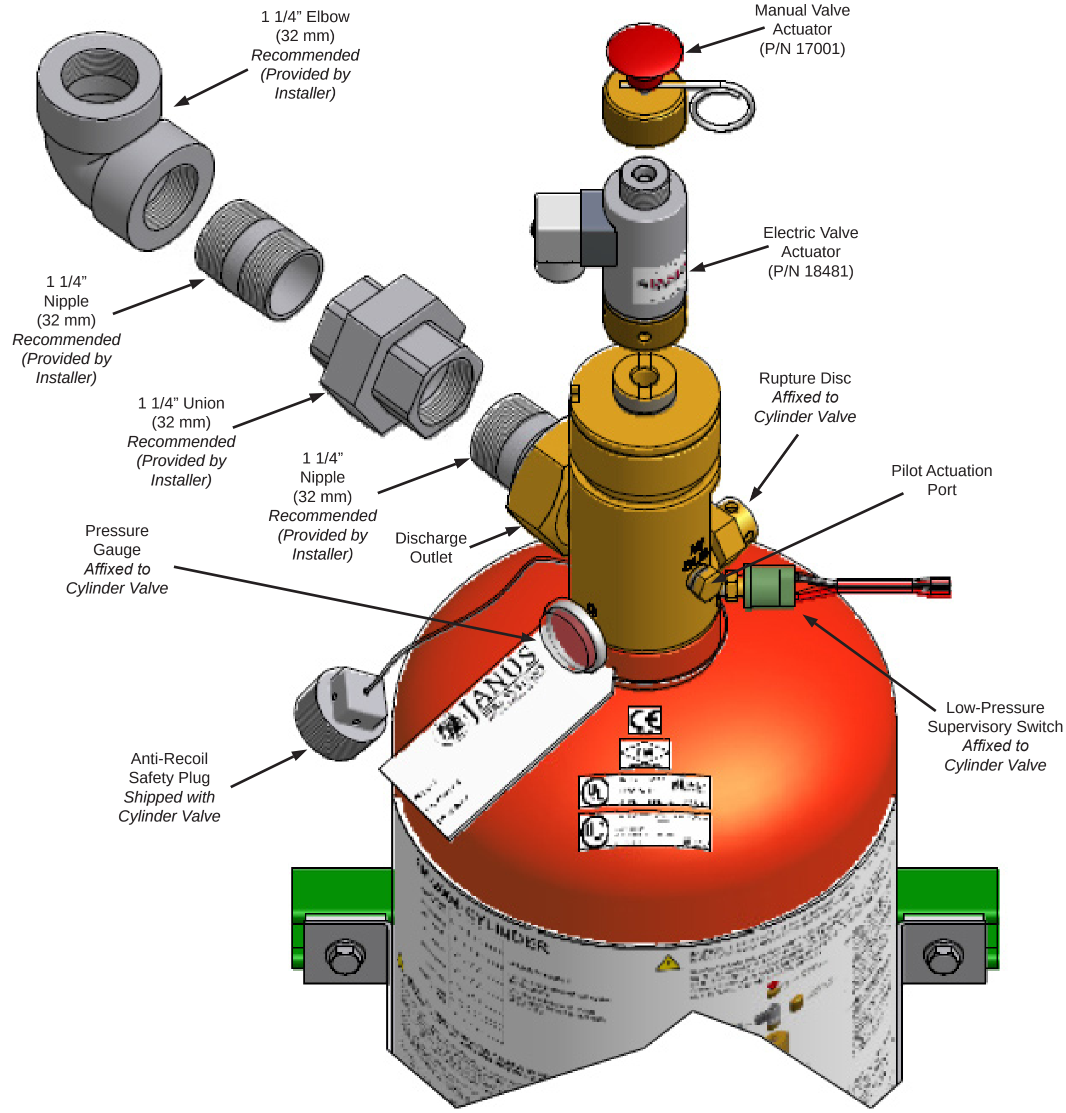


Figure 2.1.3.1b Sv Cylinder Valve w/ Trim Kit

2.1.3.2 Mv Series Valve Features *(See Figure 2.1.3.2a)*

The Mv Series cylinder valve has six key features:

1. **Valve Actuation Connection:** A threaded connection located on top of the cylinder valve serves as the attachment point for the electric (primary) or pneumatic (slave) valve actuator.

2. **Pressure Gauge Connection:** A female connection serves as the attachment point for the pressure gauge. It is fitted with a Schrader valve to allow the removal of the gauge while the cylinder is pressurized.

3. **Low-Pressure Supervisory Switch Connection:** A female connection serves as the attachment point for the low-pressure supervisory switch. A Schrader valve allows for the removal of the pressure switch while the cylinder is pressurized.

4. **Rupture Disc:** A frangible rupture disc is fitted to the valve body opposite the discharge outlet. It functions as an emergency relief device in the event of excessive internal pressure within the cylinder. Its rupture point is between 850 psi (58.6 bar) and 1000 psi (68.9 bar)

5. **Discharge Outlet:** A 2 in (50 mm) grooved connection serves as the attachment point for discharge piping.

6. **Pilot Actuation Port:** A 1/4 in (8 mm) NPT connection (shipped with a pipe plug) serves as the attachment point for the pilot actuation piping in multiple cylinder systems, providing the actuation pressure used to open the slave cylinder valve(s). This can also be used for attachment of the discharge pressure switch in single cylinder arrangements.

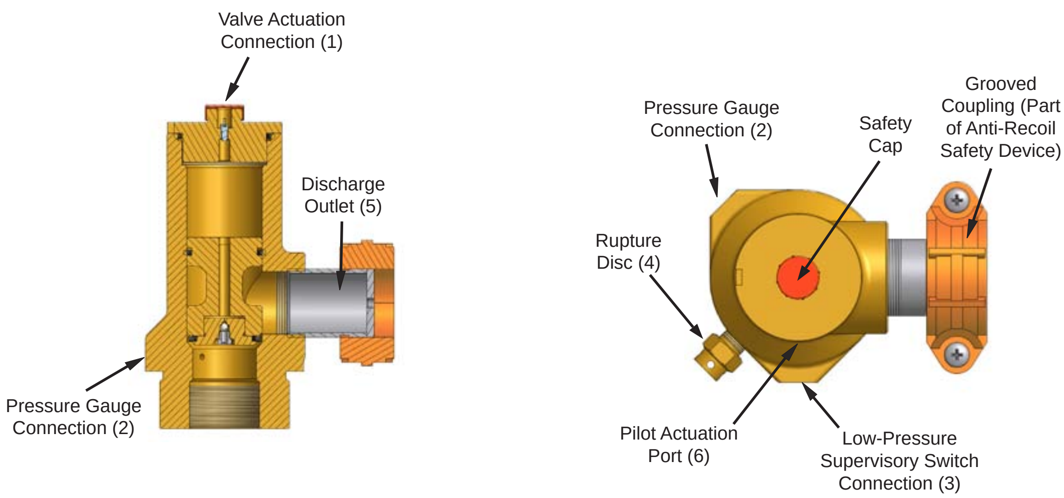


Figure 2.1.3.2a Mv Cylinder Valve Assembly

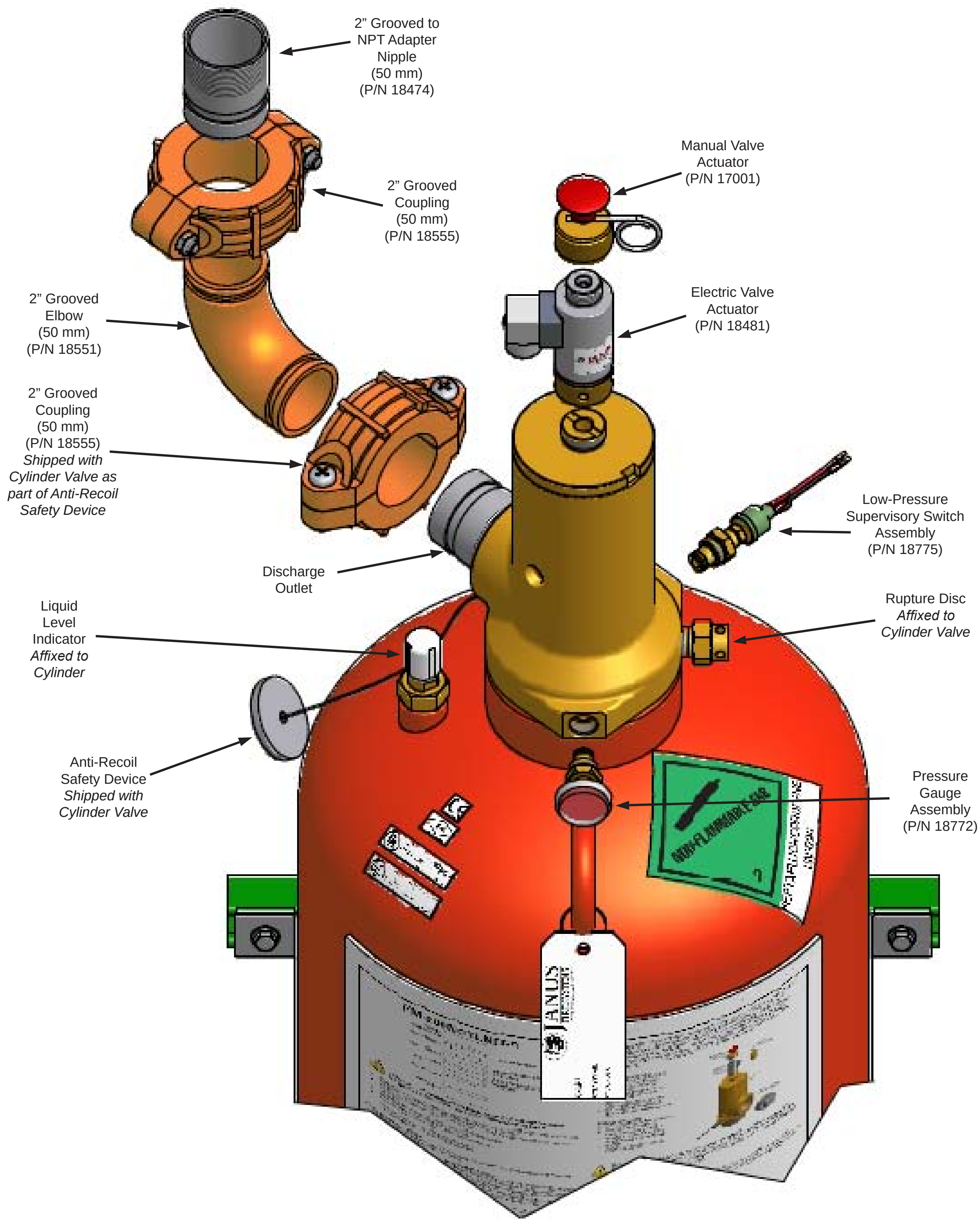


Figure 2.1.3.2b Mv Cylinder Valve w/ Trim Kit

2.1.3.3 Lv Series Valve Features *(See Figure 2.1.3.3a)*

The Lv Series cylinder valve has five key features:

1. **Valve Actuation Connection:** A threaded connection located on top of the cylinder valve serves as the attachment point for the electric (primary) or pneumatic (slave) valve actuator.
2. **Pressure Gauge Connection:** A female connection serves as the attachment point for the pressure gauge. It is fitted with a Schrader valve to allow the removal of the gauge while the cylinder is pressurized.
3. **Low-Pressure Supervisory Switch Connection:** A female connection serves as the attachment point for the low-pressure supervisory switch. A Schrader valve allows for the removal of the pressure switch while the cylinder is pressurized.
4. **Discharge Outlet:** A 3 in (80 mm) grooved connection serves as the attachment point for discharge piping.
5. **Pilot Actuation Port:** A 1/4 in (8 mm) NPT connection (shipped with a pipe plug) serves as the attachment point for the pilot actuation piping in multiple cylinder systems, providing the actuation pressure used to open the slave cylinder valve(s). This can also be used for attachment of the discharge pressure switch in single cylinder arrangements.

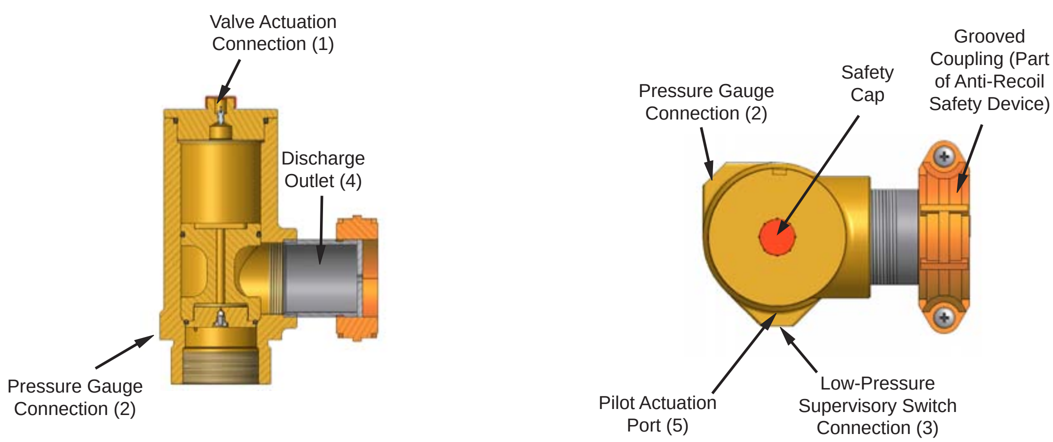


Figure 2.1.3.3a Lv Cylinder Valve Assembly

Section 2 System Description and Components

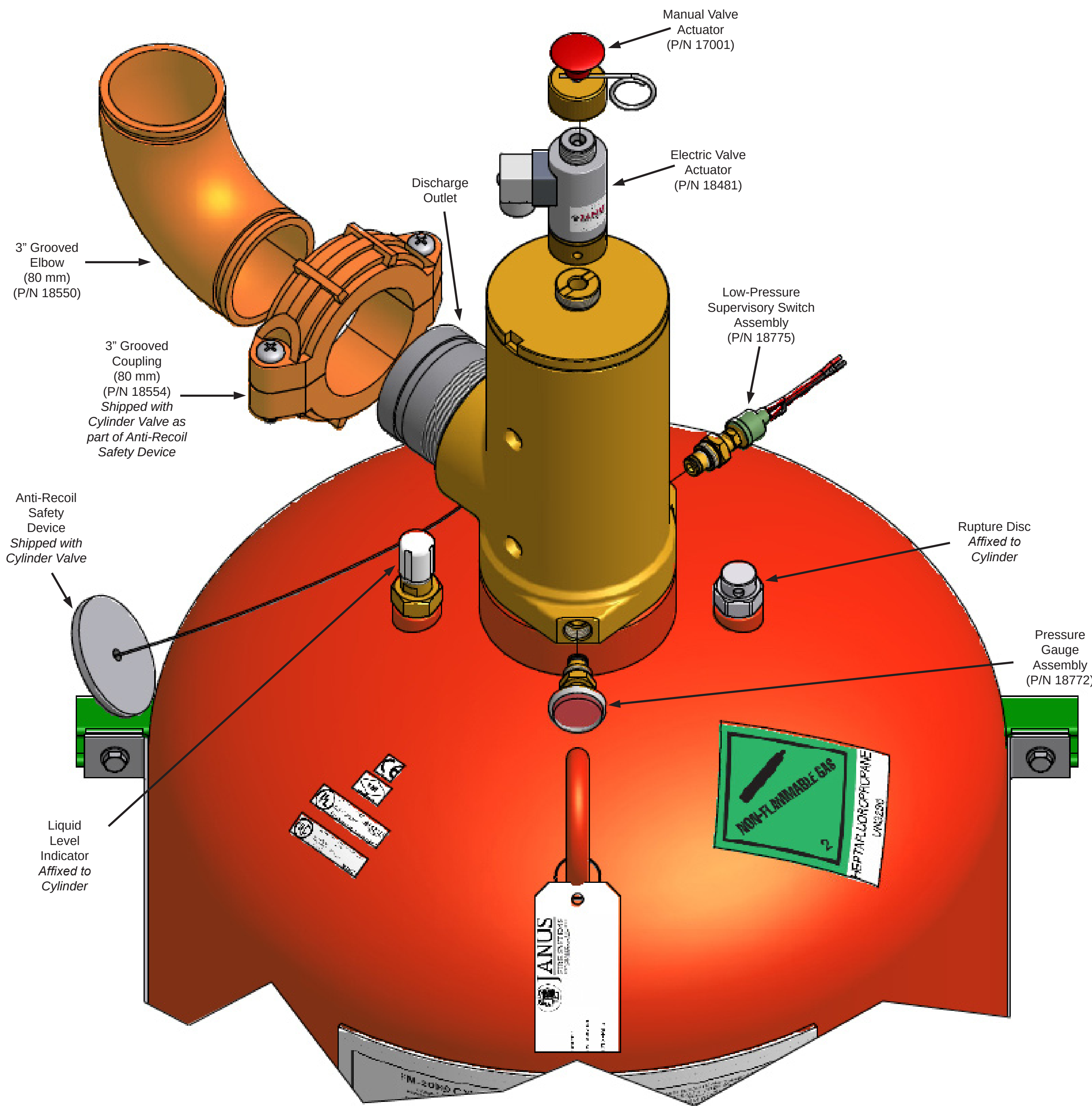


Figure 2.1.3.3b Lv Cylinder Valve w/ Trim Kit

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2.2 Trim Components

The following components complete the set up of any Sv, Mv, and Lv Series FM-200® System regardless of the specific arrangement or number of cylinders utilized.

2.2.1 Pressure Gauge

A pressure gauge for each cylinder provides a reliable means of monitoring the internal pressure condition of the cylinder as mandated by NFPA 2001. The Sv Series pressure gauge differs from the Mv and Lv Series pressure gauge in the method it is affixed to the cylinder valve.

2.2.1.1 Sv Series Pressure Gauge

P/N 17556 (See Figure 2.2.1.1)

The Sv Series pressure gauge is factory mounted to the cylinder valve opposite the rupture disc.

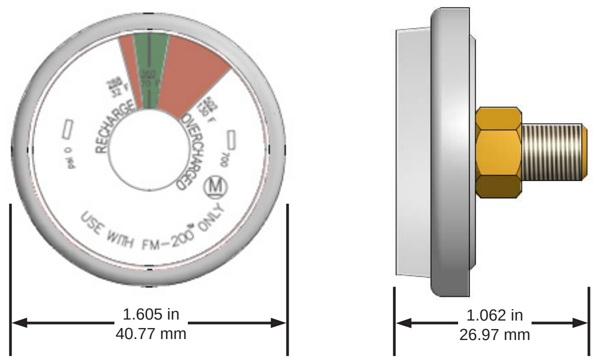


Figure 2.2.1.1 Sv Series Pressure Gauge

⚠ WARNING

The Sv Series pressure gauge is mounted to the cylinder valve and cannot be removed while the contents are under pressure.

2.2.1.2 Mv and Lv Series Pressure Gauge Assembly

P/N 18772 (See Figure 2.1.3.3)

The Mv and Lv Series pressure gauge has a swivel nut and O-ring seal allowing it to connect to the Mv and Lv Series cylinder valves at the pressure gauge connection. The pressure gauge connections of the Mv and Lv Series cylinder valves contain a Schrader valve that seals when the gauge is removed.

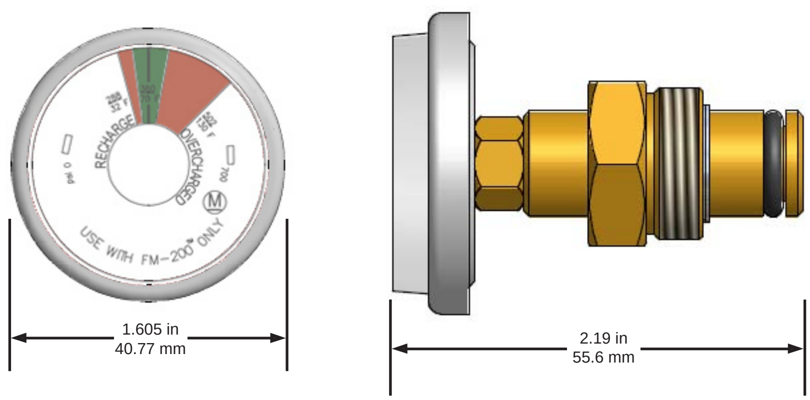


Figure 2.2.1.2 Mv and Lv Series Pressure Gauge Assembly

2.2.2 Low-Pressure Supervisory Switch

The low-pressure supervisory switch continuously monitors the pressure within the cylinder. Should the cylinder pressure drop to approximately 280 psi (19.3 bar), the switch contacts will close transmitting an abnormal signal to the system control panel. The contact configuration is single pole, single throw (SPST) with contacts rated 1.5 Amps at 24 VDC. The Sv Series low-pressure supervisory switch differs from the Mv and Lv Series low-pressure supervisory switch in the method it is affixed to the cylinder valve.

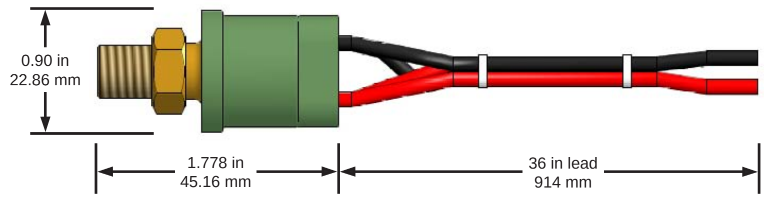


Figure 2.2.2.1 Sv Series Low-Pressure Supervisory Switch

2.2.2.1 Sv Series Low-Pressure Supervisory Switch

P/N 17032 (See Figure 2.2.2.1)

The Sv Series low-pressure supervisory switch is factory mounted to the cylinder valve between the rupture disc and pilot actuation port.

⚠ WARNING

The Sv Series low-pressure supervisory switch is mounted to the cylinder valve and cannot be removed while the contents are under pressure.

2.2.2.2 Mv and Lv Series Low-Pressure Supervisory Switch Assembly

P/N 18775 (See Figure 2.2.2.2)

The Mv and Lv Series low-pressure supervisory switch is fitted with a swivel nut and O-ring seal to allow it to attach to the Mv and Lv Series cylinder valves at the low-pressure supervisory switch connection. The low-pressure supervisory switch connections of the Mv and Lv Series cylinder valves contain a Schrader valve that seals when the switch is removed.

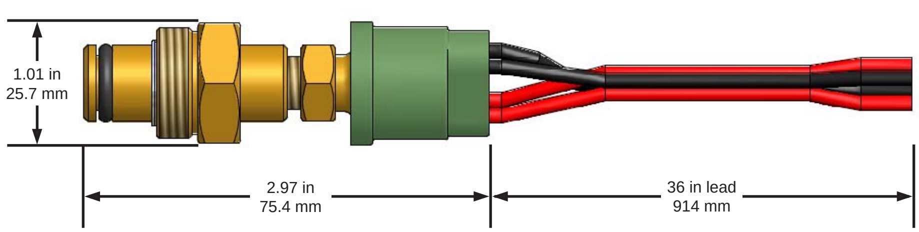


Figure 2.2.2.2 Mv and Lv Series Low-Pressure Supervisory Switch Assembly

2.2.3 Electric Valve Actuator

P/N 18481 (See Figure 2.2.3)

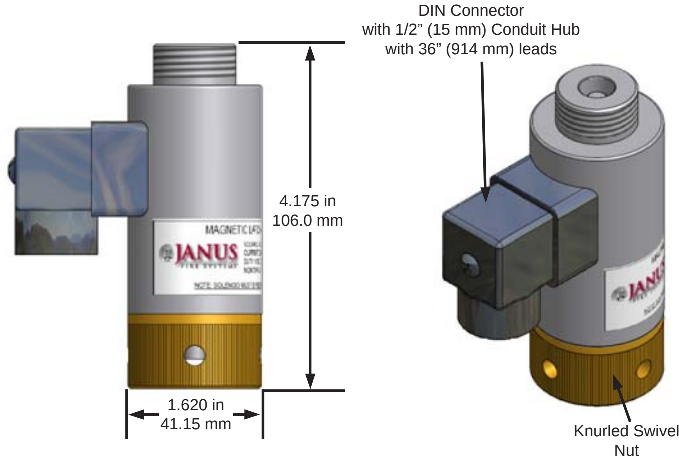


Figure 2.2.3 Electric Valve Actuator

The electric valve actuator attaches to the primary cylinder at the valve actuation connection and is utilized to automatically open the cylinder valve upon receipt of a signal from the control panel or other source. It operates between 17 and 30 VDC and consumes 500 mA (.5 Amps) at 24 VDC nominal with a maximum supervisory current of 30 mA (0.03 Amps).

The electric valve actuator body is steel construction with a brass knurled swivel nut and a stainless steel actuation pin that depresses the valve core when energized. It must be manually reset by pushing the pin up until it snaps in the "up" position.

WARNING

Attaching the electric valve actuator to the cylinder valve when the actuation pin is not fully locked into the "up" position may cause the cylinder valve to actuate, resulting in potential injury and/or property damage.

2.2.4 Manual Valve Actuator

P/N 17001 (See Figure 2.2.4)

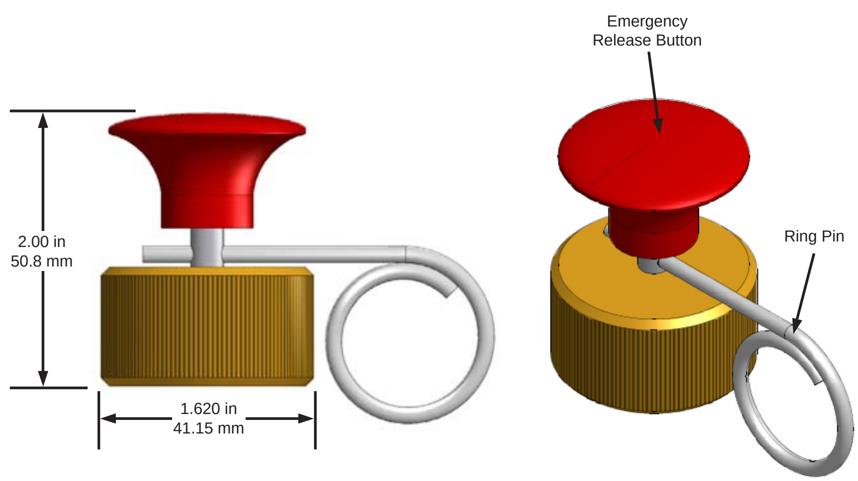


Figure 2.2.4 Manual Valve Actuator

An optional manual valve actuator may be attached to the top of the electric valve actuator and provides a means to manually open the cylinder valve. The manual valve actuator consists of a brass body, stainless steel actuation pin, and steel safety ring pin.

To discharge the primary cylinder manually, the ring pin is removed and the emergency release button is depressed forcing the actuation pin in the electric valve actuator to depress the valve core of the cylinder valve. All other connected cylinders will then open pneumatically. The manual valve actuator is reset by pulling up on the palm button and inserting the ring pin.

WARNING

Attaching the manual valve actuator to the electric valve actuator when the actuation pin is not fully locked into the "up" position may cause the cylinder valve to actuate, resulting in potential injury and/or property damage.

2.2.5 Discharge Connection Fittings

Fittings are used to connect the discharge outlet to its associated piping system in order to accommodate differences in size, outlet connection, and/or orientation between the discharge outlet and discharge piping. The fittings used vary according the Series valve.

2.2.5.1 Sv Series Fittings

(supplied by installer)

The fittings for the Sv Series discharge outlet are to be supplied by the installer. The suggested fitting arrangement is shown in Figure 2.2.5.1 and is used to extend the discharge outlet and facilitate the attachment of discharge piping.

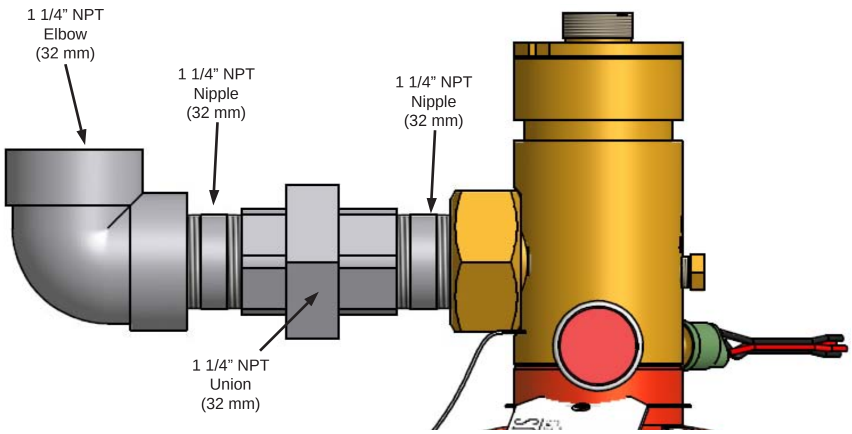


Figure 2.2.5.1 Sv Series Fittings

2.2.5.2 Mv Series Fittings

(See Figure 2.2.5.2 for P/N)

The fittings for the Mv Series discharge outlet consist of two 2 in (50 mm) grooved couplings, one 2 in (50 mm) grooved elbow, and one 2 in (50 mm) grooved to NPT adapter arranged as shown in Figure 2.2.5.2. These fittings extend the discharge outlet and allow for connection of 2 in (50 mm) NPT piping to the 2 in (50 mm) grooved outlet.

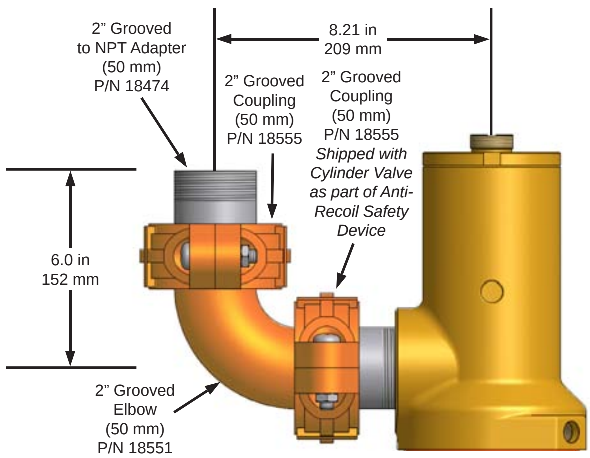


Figure 2.2.5.2 Mv Series Fittings

2.2.5.3 Lv Series Fittings

(See Figure 2.2.5.3 for P/N)

The fittings for the Lv Series discharge outlet consist of one 3 in (80 mm) grooved coupling and one 3 in (80 mm) grooved elbow arranged as shown in Figure 2.2.5.3. These fittings extend the discharge outlet and facilitate the attachment of discharge piping.

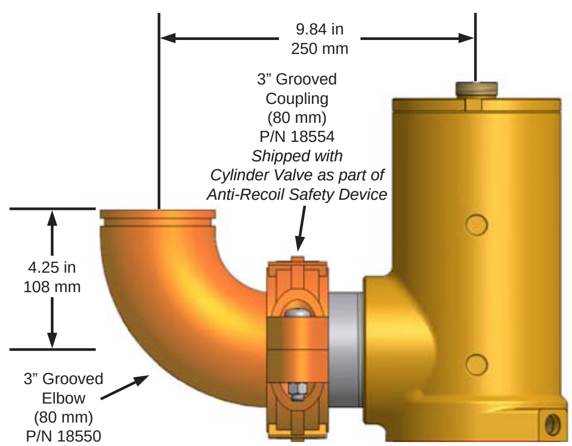


Figure 2.2.5.3 Lv Series Fittings

2.3 Slave Arrangement Components

The following components complete the set up of multiple cylinder arrangements.

2.3.1 Pneumatic Valve Actuator

P/N 17019 (See Figure 2.3.1)

In multiple cylinder systems, a pneumatic valve actuator is attached to each slave cylinder at the valve actuation connection. It receives pressure from the pilot actuation port of the primary cylinder through the pilot actuation line. When the electric valve actuator opens the primary cylinder, pressure from the primary cylinder causes each pneumatic valve actuator to open its attached cylinder pneumatically.

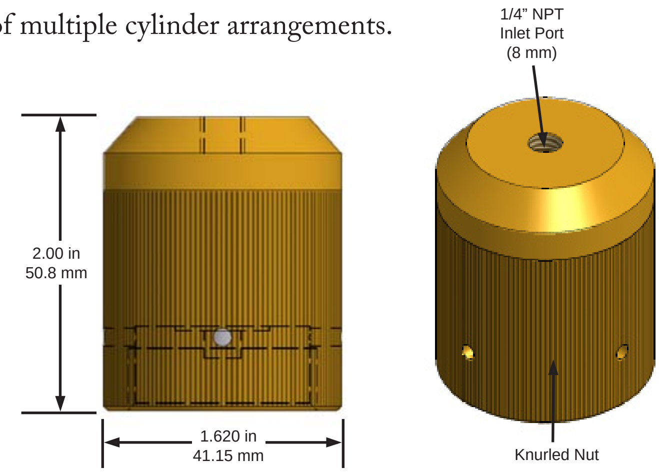


Figure 2.3.1 Pneumatic Valve Actuator

The pneumatic valve actuator is brass with a brass piston and pin. To reset the pneumatic valve actuator, pressure must first be bled down from the pilot actuation line, and then the actuation pin must be pushed up until the pin snaps into the "up" position.

⚠ WARNING

Attaching the pneumatic valve actuator to the cylinder valve when the actuation pin is not fully locked into the "up" position may cause the cylinder valve to actuate, resulting in potential injury and/or property damage.

2.3.2 Vent Check

P/N 10173 (See Figure 2.3.2)

The vent check is a safety device with 1/4 in (8 mm) male NPT threads that is to be installed in the pilot actuation line downstream of the pilot actuation check valve. It is used to bleed off pressure that may accumulate in the slave cylinder actuation piping, reducing the chance of inadvertent operation of pneumatic valve actuators. A rapid accumulation of actuation pressure will cause the nylon ball located inside the vent check to seat and seal allowing the pneumatic valve actuators to operate as intended. After actuation, pressure must be bled down from the pilot actuation line in order to unseat this nylon ball. This can be done by loosening a fitting along the pilot actuation line.

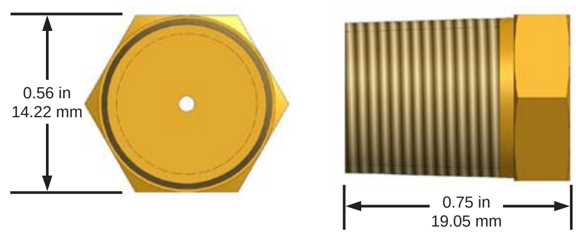


Figure 2.3.2 Vent Check

2.3.3 Pilot Actuation Check Valve

P/N 18560 (See Figure 2.3.3)

A 1/4 in (8 mm) MNPT by 37° male JIC check valve is installed in the pilot actuation port of the primary cylinder valve with direction of flow OUT of the valve. When the valve opens, pressure will be directed through the pilot actuation check valve to the pneumatic valve actuators on the slave cylinders. The purpose of the pilot actuation check valve is to ensure the pneumatic actuator(s) remain pressurized for the entire discharge period.

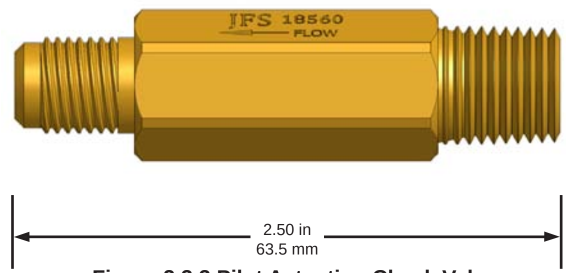


Figure 2.3.3 Pilot Actuation Check Valve

2.3.4 Pilot Actuation Adapter

P/N 18624 (See Figure 2.3.4)

A 3/8 in (10 mm) MNPT by 1/4 in (8 mm) FNPT brass pipe bushing is fitted into the pilot actuation port of the Sv Series primary cylinder to facilitate the attachment of the pilot actuation check valve. This component is not required on the Mv or Lv Series system.

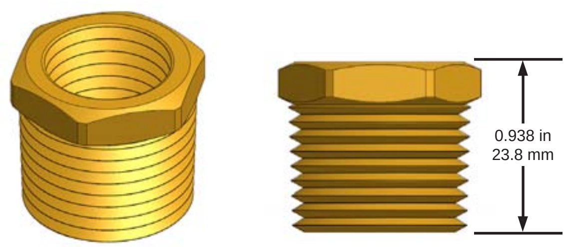


Figure 2.3.4 Pilot Actuation Adapter

2.3.5 Male NPT Adapter

P/N 18625 (See Figure 2.3.5)

A 1/4 in (8 mm) 37° male JIC by MNPT adapter fits into the pilot actuation end line tee of the final slave cylinder to facilitate the attachment of the pilot actuation line. It also may be utilized to facilitate the attachment of flex hose to the discharge pressure switch and flex hose to the pilot actuation port.

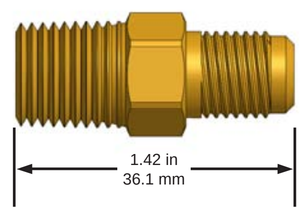


Figure 2.3.5 Male NPT Adapter

2.3.6 Pilot Actuation Mid Line Tee

P/N 18622 (See Figure 2.3.6)

A 1/4 in (8 mm) 37° male JIC by MNPT brass branch tee is utilized to attach the pilot actuation line to the pneumatic valve actuator on all but the final slave cylinder.

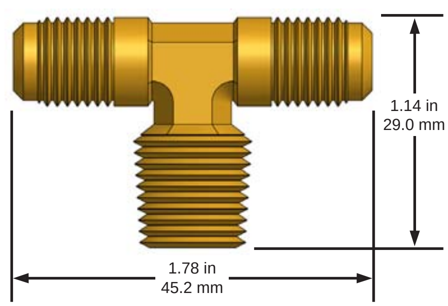


Figure 2.3.6 Pilot Actuation Mid Line Tee

2.3.7 Pilot Actuation End Line Tee

P/N 18611 (See Figure 2.3.7)

A 1/4 in (8 mm) FNPT by MNPT brass branch tee mounts to the final pneumatic valve actuator to facilitate attachment of the vent check to the pilot actuation line.

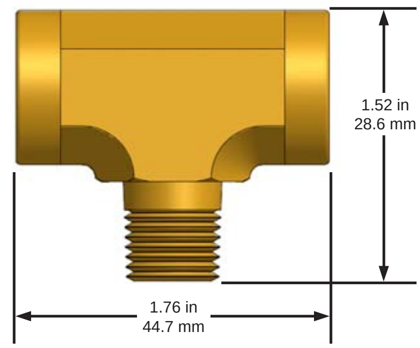


Figure 2.3.7 Pilot Actuation End Line Tee

2.3.8 Flex Hose

(See Figure 2.3.8)

Flex hoses are 3/16 in (7 mm) Teflon® lined stainless steel wire braided hoses of varying lengths with 1/4 in (8 mm) 37° female JIC flare fittings. They are utilized to interconnect cylinders when a slave arrangement is required. Flex hose can also be used to attach the discharge pressure switch to a manifold or pilot actuation port.

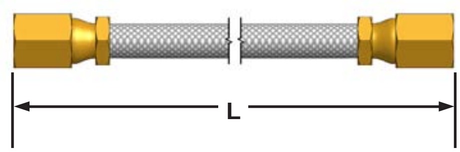


Figure 2.3.8 Flex Hose

Table 2.3.8 Flex Hose Lengths		
P/N	**Hose Length (L)**	**Series**
18648	16 in (406 mm)	Sv – 40 lb, 80 lb, 130 lb
18649	24 in (610 mm)	Mv – 250 lb, 420 lb
18650	34 in (864 mm)	Lv – 600 lb, 900 lb
18651	40 in (1016 mm)	Lv - 1000 lb

2.4 Supplemental Components

The following components are either only required for specific types of Sv, Mv, and Lv Series FM-200® System arrangements or else may be utilized in different capacities or locations depending on the specific arrangement.

2.4.1 Manifold Check Valve

P/N 18547 (Sv), 18546 (Mv), 18538 (Lv) (See Figure 2.4.1a, 2.4.1b, and 2.4.1c)

In a multiple cylinder arrangement where the slave and primary cylinders share a common manifold or in a connected main/reserve arrangement, a manifold check valve must be placed between the discharge outlet and the discharge manifold. The manifold check valve prevents back flow from the manifold should the system be inadvertently discharged when one or more cylinders are disconnected for weighing or servicing. The check valve required depends on the Series type of the system. The Sv Series check valve has 1 1/4 in (32 mm) NPT connections, the Mv Series has 2 in (50 mm) NPT connections, and the Lv Series has 3 in (80 mm) grooved connections.

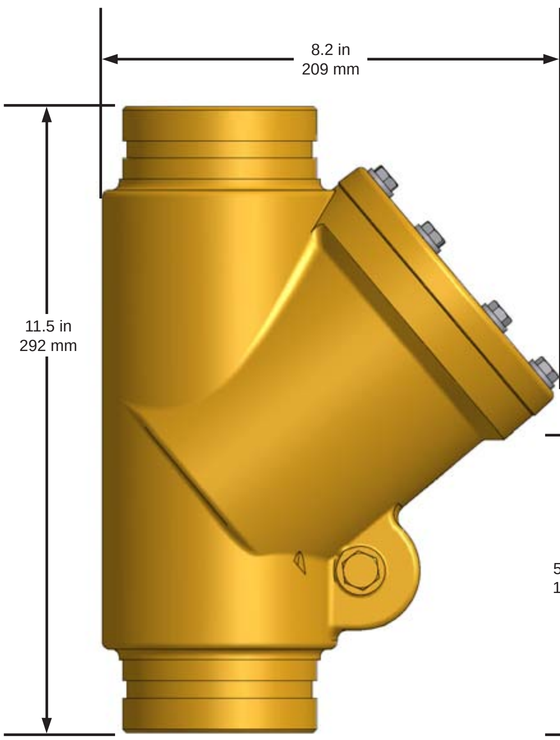


Figure 2.4.1a
Lv Manifold Check Valve

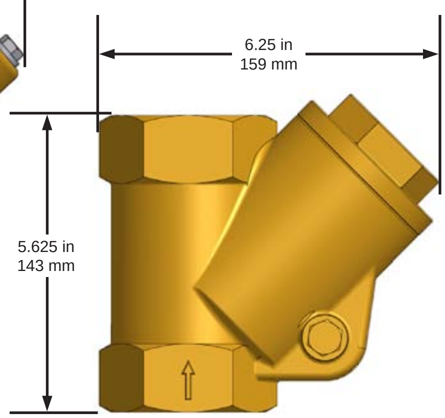


Figure 2.4.1b
Mv Manifold Check Valve

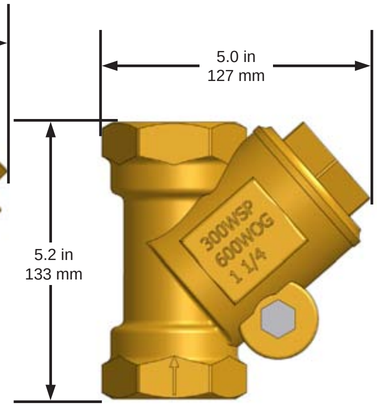


Figure 2.4.1c
Sv Manifold Check Valve

2.4.2 Discharge Pressure Switch

P/N 17013 (See Figure 2.4.3)

A discharge pressure switch is used in the system to send a signal confirming agent discharge to the control panel or to initiate the shut down of equipment that may deplete agent concentration. It is a single pole, double throw (SPDT) switch with contacts rated 10 Amps resistive at 30 VDC. The discharge pressure switch shall be required where mechanical system actuation is possible, though its placement varies according to the individual system arrangement.

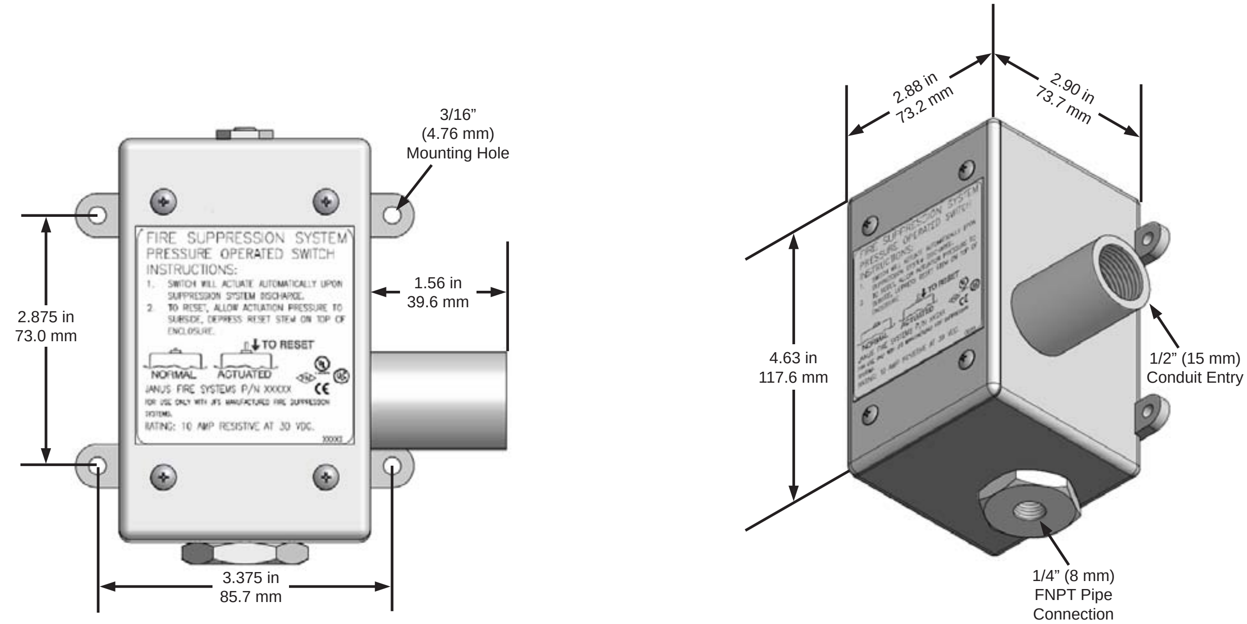
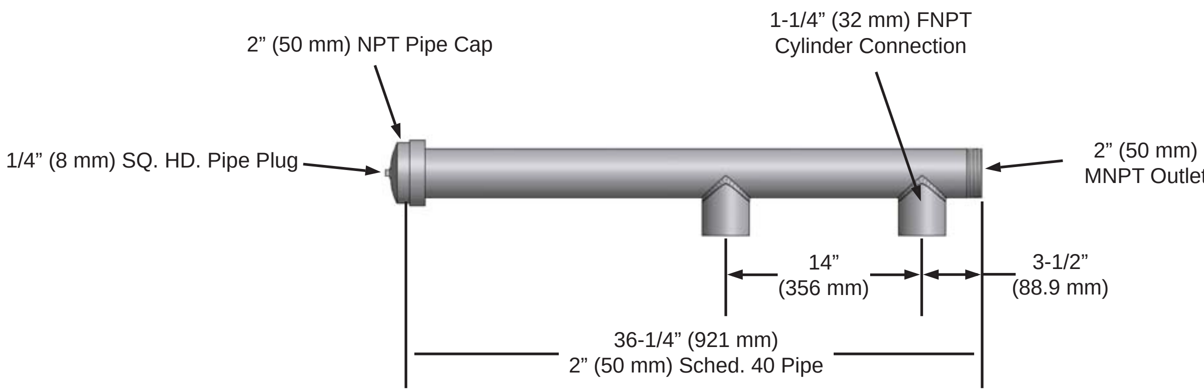


Figure 2.4.2 Discharge Pressure Switch

2.4.3 Discharge Manifold

(supplied by installer)

A discharge manifold may be used in a multiple cylinder system to direct the flow of agent from two or more cylinders into a common pipe. Manifolds are to be supplied by the installer and may be constructed out of threaded or welded pipe and fittings. When two or more cylinders are grouped together with a common manifold, they must be of the same size and fill. A manifolded cylinder arrangement must be fitted with a manifold check valve. Suggested manifold dimensions and arrangements are shown in Figure 2.4.3a, 2.4.3b, 2.4.3c, 2.4.3d, and 2.4.3e.



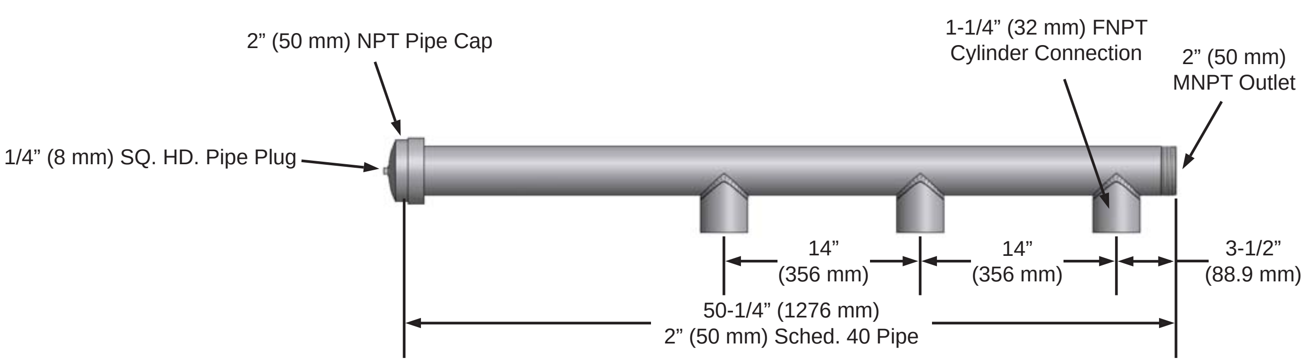


Figure 2.4.3a Suggested Manifold Configurations for 40, 80, and 130 lb Cylinders

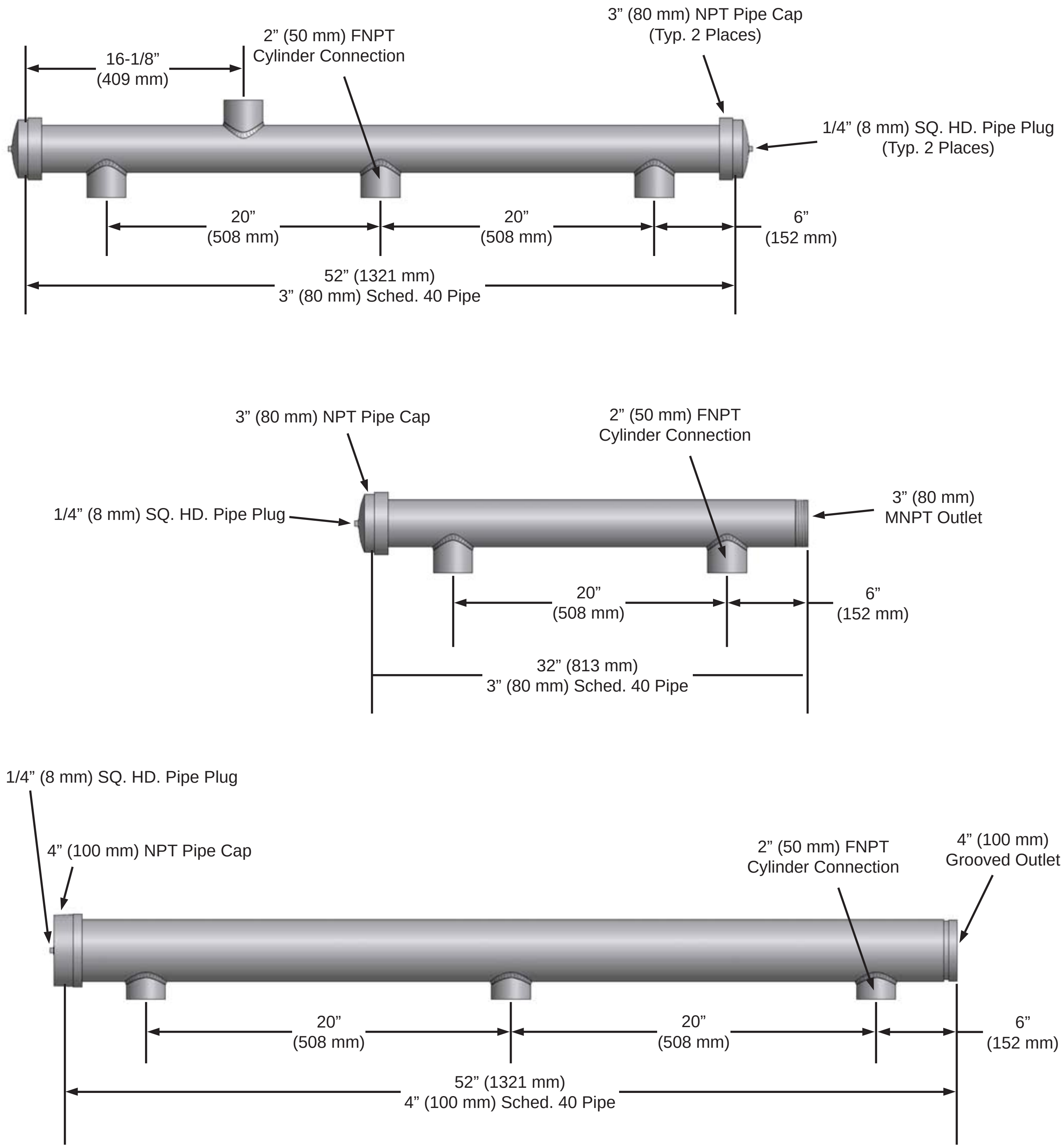


Figure 2.4.3b Suggested Manifold Configurations for 250 and 420 lb Cylinders

Section 2 System Description and Components

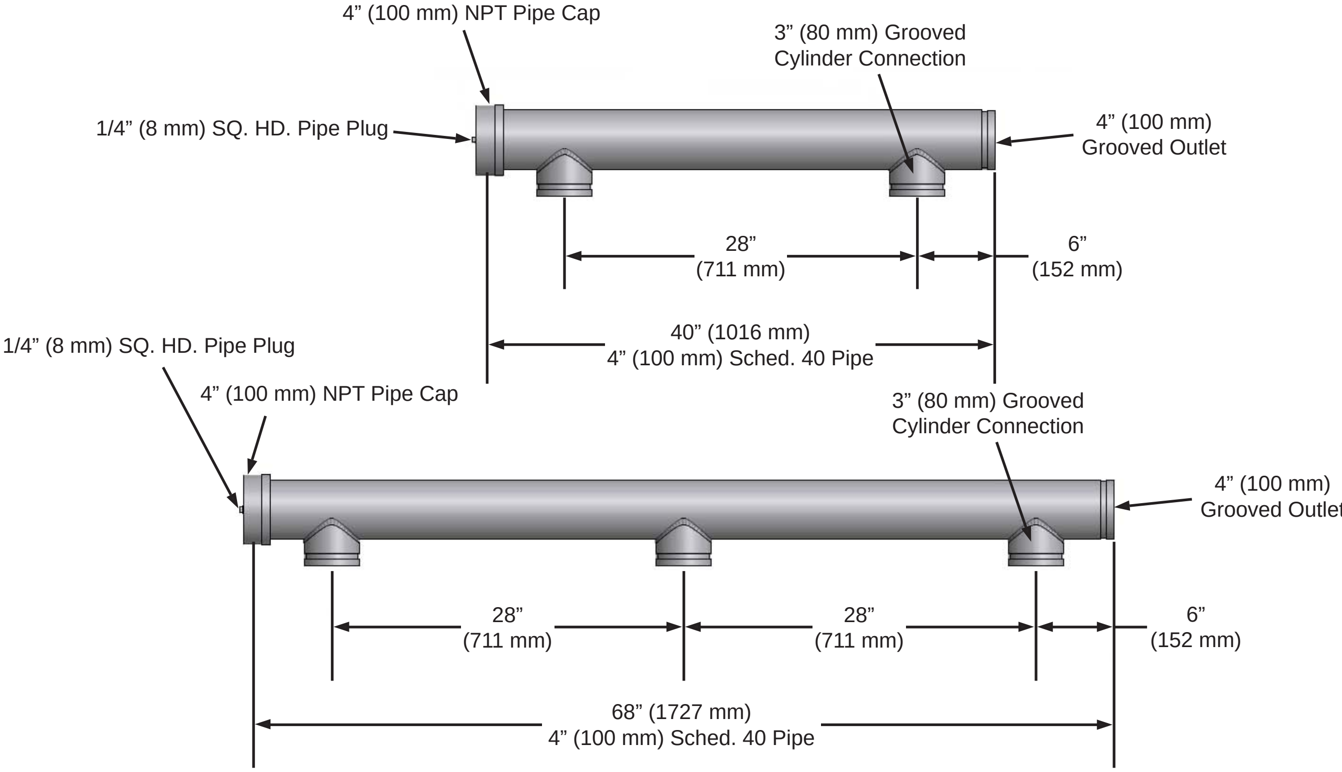


Figure 2.4.3c Suggested Manifold Configurations for 600 and 900 lb Cylinders

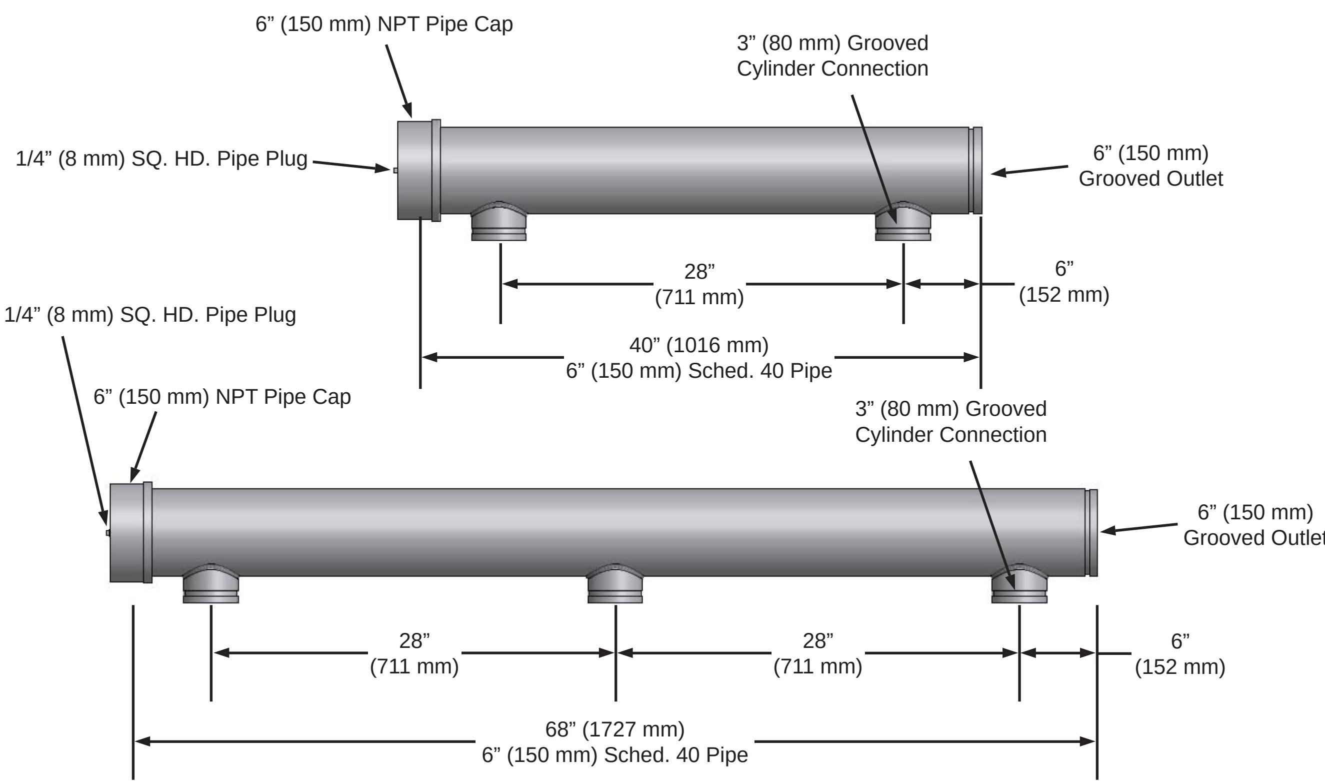
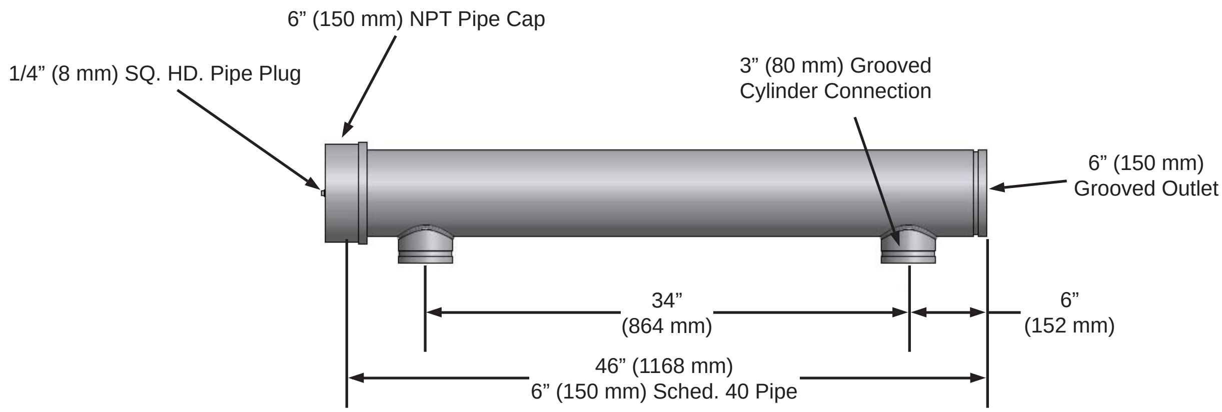


Figure 2.4.3d Suggested Manifold Configurations for 900 lb Cylinders



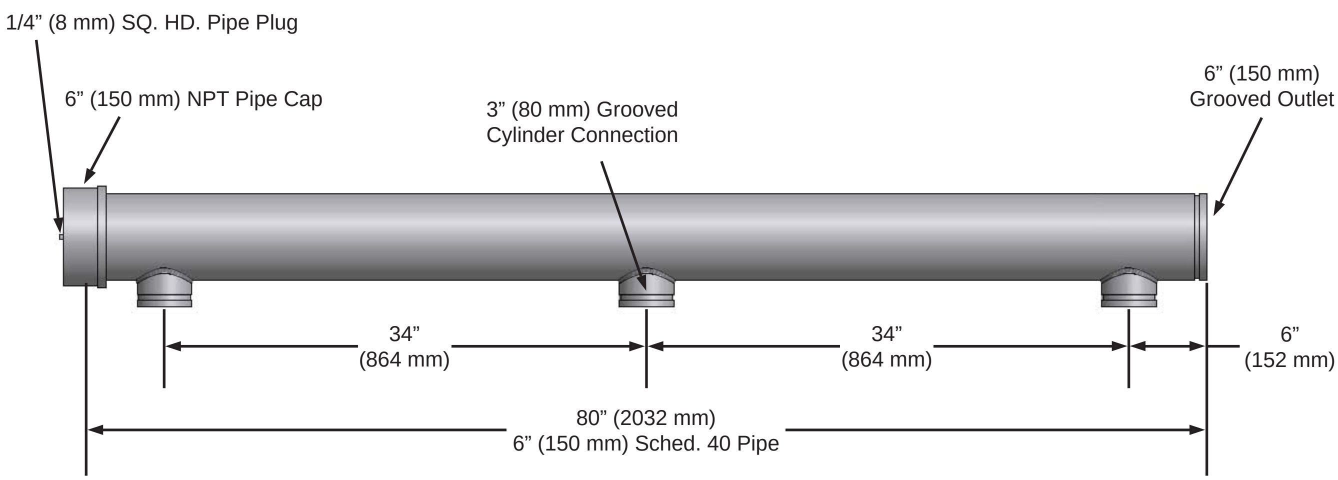


Figure 2.4.3e Suggested Manifold Configurations for 1000 lb Cylinders

2.5 Discharge Nozzles

(See Figure 2.5)

Discharge nozzles are used to disperse the FM-200® agent. Available in brass or stainless steel, the nozzles are performance tested to ensure that the agent is properly distributed throughout the protected area (Brass nozzles are UL Listed and FM Approved. Stainless steel nozzles are UL Listed; FM Approval pending). Discharge nozzles are available with three separate port arrangements to accommodate placement in varying locations around a room or enclosure: 90˚ (1 port) corner nozzles, 180˚ (2 port) sidewall nozzles, and 360˚ (4 port) radial nozzles. Each nozzle is stamped with the nozzle part number and orifice diameter.

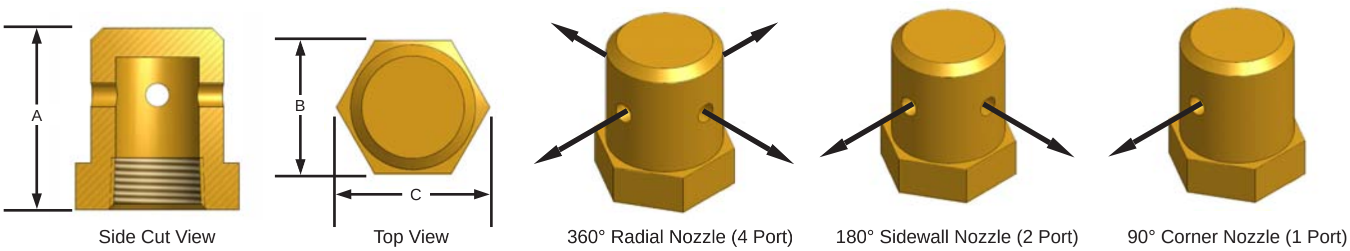


Figure 2.5 Discharge Nozzle Configurations

Table 2.5 - Discharge Nozzle Sizes												
Nozzle Orientation Part Number						Nominal Pipe Size	Nozzle Dimensions					
Brass			Stainless Steel				A		B		C	
360°	180°	90°	360°	180°	90°		in	mm	in	mm	in	mm
18507	18500	18493	18796	18789	18782	3/8 in (10mm)	1.436	36.5	1.125	28.57	1.30	33.02
18508	18501	18494	18797	18790	18783	1/2 in (15 mm)	1.722	43.7	1.250	37.75	1.44	36.58
18509	18502	18495	18798	18791	18784	3/4 in (20 mm)	1.926	48.9	1.500	38.10	1.73	43.94
18510	18503	18496	18799	18792	18785	1 in (25 mm)	2.176	55.3	1.750	44.45	2.02	51.31
18511	18504	18497	18800	18793	18786	1 1/4 in (32 mm)	2.500	63.5	2.250	57.15	2.60	66.04
18512	18505	18498	18801	18794	18787	1 1/2 in (40 mm)	2.689	68.3	2.250	57.15	2.60	66.04
18513	18506	18499	18802	18795	18788	2 in (50 mm)	3.100	78.7	3.000	76.20	3.46	87.88

Ordering Instructions: Specify the Nozzle P/N followed by a dash and the three digits representative of the drill code as provided by the Janus Design Suite software.

Example: 18507-XXX = Nozzle: 360°, 3/8” (10 mm), Brass (with drill code as specified)

3 SYSTEM DESIGN

This section lists the methods and guidelines necessary to properly design an engineered Janus Fire Systems® FM-200® Fire Extinguishing System.

3.1 Hazard Analysis

The first step in designing an engineered FM-200® total flooding system is to identify the unique requirements of the area to be protected.

3.1.1 Fuel Source

The design specifications for the FM-200® system are dependent on the hazard type, so it is first necessary to identify the type of hazard to be protected.

Hazard type is classified according to the combustible materials found in an area and may be considered 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 requires the minimum design concentration for a Class A surface fire to be the extinguishing concentration plus a 20% safety factor resulting in a minimum design concentration of 6.25% (7% for FM approval).

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 Tables 3.1.1a and 3.1.1b in Appendix B.

The minimum design concentration for a Class C fire shall be at least that for a Class A surface fire.

For a manual-only system that does not include automatic detection and actuation, the design concentration for a Class A surface fire or Class C fire is the extinguishing concentration plus a 30% safety factor resulting in a minimum design concentration of 6.8% (7.6% for FM approval).

The design concentration for a manual-only Class B fire system is the same as an automatic system.

FM-200® design concentrations should be calculated according to the lowest expected ambient temperature within the protected area. When calculating the concentration levels for normally occupied spaces, the design concentration for FM-200® must not exceed the NOAEL (No Observed Adverse Effect Level) of 9% at the highest expected ambient temperature as stated in NFPA 2001.

3.1.2 Hazard Dimensions

Once the minimum design concentration is determined, the volume for the protected area must be calculated. Volume is determined by multiplying the area's length by its width by its height (Volume = l x w x h).

The space below a raised floor (underfloor) must be included in the system design unless it is sealed from the room above. Separate nozzles are required for the underfloor and discharge should occur from both the room and underfloor nozzles simultaneously. All rooms located above a common unsealed underfloor must be protected by simultaneously operated systems to ensure minimum design concentration is reached.

If not shut down or closed automatically, the volume of the self-contained recirculating dampered ventilation systems ducts and components mounted below the ceiling height of the protected space must be considered as part of the total hazard volume when determining the quantity of agent.

3.1.3 Hazard Integrity

If a protected hazard is not sufficiently sealed, agent leakage may occur. Leakage of FM-200® may prevent the required concentration levels from being reached or maintained for the entire holding period, making it difficult for the FM-200® to extinguish the source of ignition. When a room opening does exist, adding more agent within a room to counter leakage may actually increase the rate of loss due to an increase in pressure created by the additional agent.

Doors should be checked for tightness. Weather stripping, seals, and door sweeps should be installed to minimize leakage. Any door required to remain open must be closed automatically prior to the discharge of the FM-200® agent.

Walls should be inspected for openings that could result in agent leakage. Openings or penetrations for cables or ducts should be permanently sealed. Joints where walls contact floors, other walls, and ceilings should be caulked or otherwise sealed. Caulking materials should be chosen based upon their elasticity and fire rating.

Ductwork leading into or out of the hazard area must contain dampers with airtight seals.

Shut down is recommended for any recirculating air handling units prior to discharge. Mechanical air handlers can contribute to agent loss.

Floor drains in the protected space or underfloor must have traps with automatic primers or environmentally acceptable seals to preclude the loss of agent through an open trap.

A room integrity test must be performed to confirm any potential sources of leakage. NFPA 2001 contains an outline for such testing.

3.1.4 Hazard Altitude

FM-200® 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 3.1.4.

Table 3.1.4 - Altitude Correction Chart

Altitude		Enclosure Pressure		Correction Factor
ft	m	psia	mm Hg	
-3,000	-914	16.25	840	1.11
-2,000	-610	15.71	812	1.07
-1,000	-305	15.23	787	1.04
0	0	14.71	760	1.00
1,000	305	14.18	733	0.96
2,000	610	13.64	705	0.93
3,000	914	13.12	678	0.89
4,000	1219	12.58	650	0.86
5,000	1524	12.04	622	0.82
6,000	1829	11.53	596	0.78
7,000	2134	11.03	570	0.75
8,000	2438	10.64	550	0.72
9,000	2743	10.22	528	0.69
10,000	3048	9.77	505	0.66

Note: Multiply the design quantity at sea level by the correction factor to obtain the adjusted quantity for a given altitude.

3.2 Agent Requirement

Once the requirements and dimensions of the hazard are determined, they can be used to calculate the required amount of FM-200® agent. FM-200® quantities are classified according to storage weight. There are two methods to calculate the required weight. Either the volume of the protected area can be multiplied by an agent factor listed in Tables 3.2a or 3.2b (See Appendix B for factors and design worksheet) or the following formula can be used:

US Standard

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

W = Agent weight in pounds

V = Hazard volume in cubic feet

C = FM-200® design concentration, percent by volume

s = FM-200® specific vapor in cubic feet/pounds
s = 1.885 + (0.0046 x t)
t = minimum room temperature in °F

Example A: Our room has a volume of 24,500 ft^3, our ambient temperature is 70°F, and our design concentration is 6.25% (UL). Using the first method, we consult Table 3.2a and find our agent factor is 0.0302. Now we multiply our volume by this factor to determine the agent weight.

$$24{,}500\ ft^3 \times 0.0302\ lbs/ft^3 = 739.9\ lbs$$

Example B: Using the second method for the same situation, we would use the formula as follows:

$$s = 1.885 + (0.0046 \times 70) = 2.207$$

$$W = \frac{24500}{2.207}\left(\frac{6.25}{100 - 6.25}\right) = 740.1\ lbs$$

Agent weights are always rounded up to the nearest whole pound for filling. For Example A this would be 740 lbs, and for Example B this would be 741 lbs.

Metric

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

W = Agent weight in kilograms

V = Hazard volume in cubic meters

C = FM-200® design concentration, percent by volume

s = FM-200® specific vapor in cubic meters/kilograms
s = 0.1269 + (0.0005 x t)
t = minimum room temperature in °C

Example A: Our room has a volume of 7460 m^3, our ambient temperature is 20°C, and our design concentration is 6.25% (UL). Using the first method, we consult Table 3.2b and find our agent factor is 0.4856. Now we multiply our volume by this factor to determine the agent weight.

$$7460\ m^3 \times 0.4870\ kg/m^3 = 3633.0\ kg$$

Example B: Using the second method for the same situation, we would use the formula as follows:

$$s = 0.1269 + (0.0005 \times 20) = 0.1369$$

$$W = \frac{7460}{0.1369}\left(\frac{6.25}{100 - 6.25}\right) = 3632.8 \text{ kg}$$

An agent weight calculated using metric measurements must be converted to pounds and rounded up to the nearest pound for ordering purposes using the conversion factors found in Table B.2a of Appendix B.

A check should be made using either method to ensure that the maximum NOAEL level of 9% of FM-200® is not exceeded based upon the highest expected ambient temperature of the protected area.

3.3 Number of Cylinders

Once the necessary quantity of agent has been calculated, the size and number of cylinders required can be determined. Refer to table 2.1 for a list of available cylinder sizes and capacities. If the required weight exceeds the fill capacity of one cylinder, multiple cylinders must be used. When two or more cylinders are grouped together with a common manifold, they must be of the same size and fill. A manifolded cylinder arrangement must be fitted with a manifold check valve.

3.4 Cylinder Location

The cylinder(s) should be located in a climate controlled area that is relatively clean, dry, accessible, and vibration-free. Avoid high traffic areas or other areas where physical damage or tampering is more likely. The cylinder(s) should not be located where they could be exposed to splashing or submersion in any liquid.

⚠ CAUTION

Flow calculations have been verified at an ambient temperature of 70°F (21.1°C). Storage outside of the range of 70°F ±10° (21.1°C ±5.5°) may result in inaccurate flow calculations and cause one or more nozzles to not discharge the designed quantity of FM-200®.

The cylinder(s) should optimally be placed outside the protected area in a location that permits convenient access for inspection, maintenance, and removal. Placement inside the protected area is acceptable if the cylinder(s) are not exposed to fire or excessive heat that could impair system operation.

The primary cylinder is fitted with a manual valve actuator for emergency manual release of the FM-200® agent. The cylinder must be placed so that the emergency release button is readily accessible to ensure operation in emergency situations.

⚠ CAUTION

The cylinder assembly must be mounted in a vertical position so its valve assembly is located at the top of the cylinder. All cylinders for a single hazard must be stored at the same temperature.

The cylinder(s) should be mounted to wall frames or columns capable of rigidly supporting the cylinder bracket by bolting or welding and oriented so that the pressure gauge faces out. The cylinder must rest on a surface capable of supporting the combined weight of the cylinder and agent.

3.5 Nozzle Determination

The placement, arrangement, and selection of discharge nozzles should be considered according to the hazard configuration and the coverage of each nozzle. Nozzles are designed for 90° (corner), 180° (sidewall), and 360° (radial) orientation. The maximum coverage of a single nozzle is 64 ft x 64 ft (19.5 m x 19.5 m).

The 90° corner nozzle can cover an area that is up to 32 ft x 32 ft (9.75 m x 9.75 m). The centerline of a 90° corner nozzle must be located within 12 in (305 mm) of each adjacent wall and not more than 44 ft (13.4 m) from the farthest point it is intended to protect. The nozzle must be oriented so that the orifice is aimed 45° from adjacent walls.

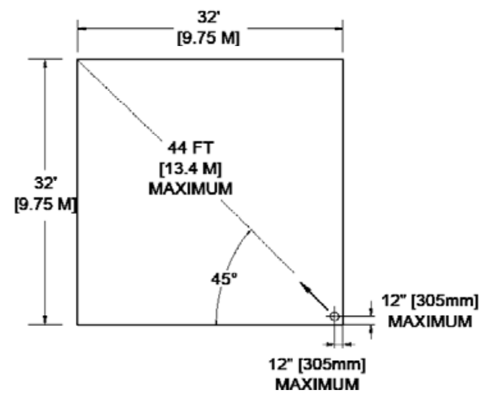


Figure 3.5a 90° Corner Nozzle Coverage

The 180° sidewall nozzle can cover an area that is up to 64 ft x 32 ft (19.5 m x 9.75 m). The centerline of a 180° nozzle must be located within 12 in (305 mm) of each adjacent wall and not more than 44 ft (13.4 m) from the farthest point it is intended to protect. The nozzle must be oriented so that each orifice is aimed 45° from adjacent walls.

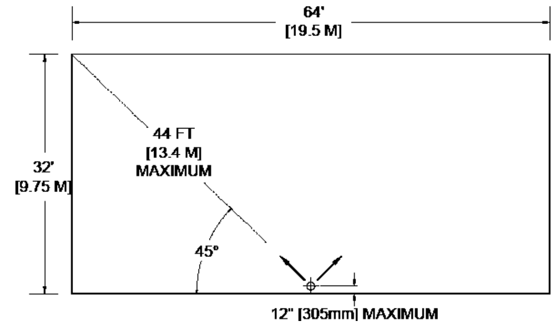


Figure 3.5b 180° Sidewall Nozzle Coverage

The 360° radial nozzle can cover an area that is up to 64 ft x 64 ft (19.5 m x 19.5 m). The centerline of a 360° nozzle cannot be more than 44 ft (13.4 m) from the farthest point it is intended to protect. The nozzle must be oriented so that each orifice is at an angle of 45° from an imaginary line drawn through its center and running perpendicular to each wall as shown in Figure 3.5c.

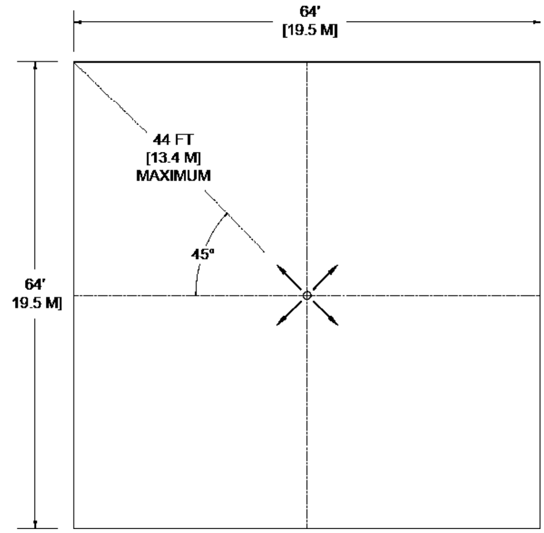


Figure 3.5c 360° Radial Nozzle Coverage

All nozzles: Discharge nozzles must be located at or near the ceiling with the centerline of the orifices no more than 4 ft (1.2 m) below the ceiling. The maximum height for a single tier of nozzles is 16 ft (4.88 m) from floor to ceiling. For ceiling heights greater than 16 ft (4.88 m), additional tiers may be installed so that the maximum distance between the floor and lowest row does not exceed 16 ft (4.88 m) and the maximum distance between rows does not exceed 16 ft (4.88 m). Each nozzle must be positioned vertically, installed either on the bottom or top of a vertical pipe section and should be placed as close to the cylinders as possible to minimize system piping. The ceiling tiles around each nozzle must be clipped to hold them in place during a discharge and to prevent damage.

⚠ 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.

Underfloors: The coverage and limitations for a nozzle protecting an underfloor are identical to those stated above. In addition, the minimum height of an underfloor that may be protected is 12 in (305 mm). The density of equipment present in a protected underfloor effects the coverage capability of a nozzle. In most circumstances, when horizontal line of sight in the underfloor is more than 70% obstructed, reduce the maximum coverage distance for each nozzle by 50%. Otherwise, use the maximum coverage calculations.

3.6 Pipe Determination

Pipe sizes must be determined using the Janus Fire Systems® Design Suite flow calculation software. Table 3.6 may be referenced for the purposes of estimation. The actual diameters may vary due to distance or software optimization.

Table 3.6 - Pipe Size vs. Flow Rate

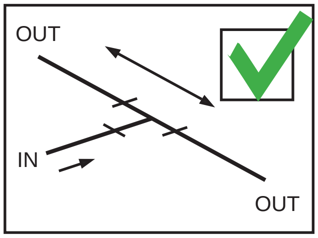
Schedule 40 Pipe Size Nominal Inches (mm)	Minimum Flow Rate For All Sections Leading to a Tee		60% of Flow Rate For All Sections Ending with a Nozzle	
	Lbs/Sec	Kg/Sec	Lbs/Sec	Kg/Sec
3/8 (10)	.775	.352	.465	.211
1/2 (15)	1.29	.585	.774	.351
3/4 (20)	2.27	1.03	1.36	.617
1 (25)	3.65	1.65	2.19	.993
1 1/4 (32)	6.34	2.88	3.80	1.72
1 1/2 (40)	8.73	3.96	5.07	2.30
2 (50)	14.91	6.76	8.95	4.06
2 1/2 (65)	22.03	9.99	13.22	6.00
3 (80)	35.67	16.18	21.40	9.71
4 (100)	64.64	29.32	38.78	14.63
5 (125)	102.86	46.66	61.72	28.00
6 (150)	143.27	64.99	85.96	39.00

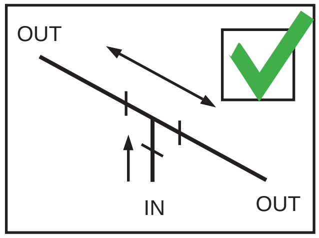
⚠ CAUTION

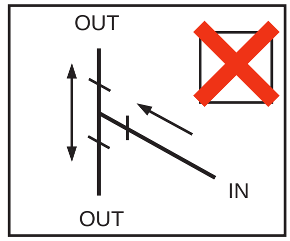
Flow calculations have been verified at an ambient temperature of 70°F (21.1°C). Storage outside of the range of 70°F ±10° (21.1°C ±5.5°) may result in inaccurate flow calculations and cause one or more nozzles to not discharge the designed quantity of FM-200®.

CAUTION

The outlets of a tee branch must be on the same horizontal plane or an imbalance will result from the gravitational effects of the liquid and vapor separation and may cause one or more nozzles to not discharge the designed concentration of FM-200®.







3.6.1 Elevation Changes

Any elevation differences between outlet tees exceeding 30 ft (9.1 m) are beyond the limitations set forth by the Underwriters Laboratories. Although sound engineering theory is used to predict pressure changes due to elevation, actual testing has not been performed outside of this range. Should this distance be exceeded, consideration should be given to rerouting piping to reduce elevation differences.

1. If nozzles are located above the discharge outlet, then the maximum elevation difference between the discharge outlet and the highest horizontal pipe run or discharge nozzle (whichever is highest) shall not exceed 30 feet (9.1 m).

2. If nozzles are only located below the discharge outlet, then the maximum elevation difference between the discharge outlet and the lowest horizontal pipe run or discharge nozzle (whichever is lowest) shall not exceed 30 feet (9.1 m).

3. If nozzles are located both above and below the discharge outlet, then the maximum elevation difference between the highest horizontal pipe run or discharge nozzle (whichever is highest) and the lowest horizontal pipe run or discharge nozzle (whichever is lowest) shall not exceed 30 feet (9.1 m).

3.7 Peripheral Equipment and Accessories

The final step is the selection and placement of any and all control panels, detection devices, and accessories. This section provides a brief overview of these components. A more detailed description is available in other publications.

3.7.1 Control Panel

The control panel must be compatible with the electric valve and actuator and should be UL listed and/or FM approved for releasing device service. The control panel should be located in an accessible area and installed in compliance with NFPA 72 (National Fire Alarm Code).

3.7.2 Early Warning Detection

Detector selection is dependent upon hazard occupancy and environmental conditions. FM-200® Systems are designed to extinguish a fire rapidly in its incipient stage. The use of smoke detectors of appropriate type must be considered to provide the earliest possible indication of a fire detection with a low susceptibility to false alarms. Typically a combination of ionization and photoelectric detectors affords a relatively stable early warning detection system.

Air sampling detection systems can also be utilized.

In most applications, the detection devices are installed in a cross-zone (double knock) or voting configuration. Cross-zoning of early warning detectors affords stability yet provides early detection.

3.7.3 Accessories

Audible and visual devices may be utilized to indicate alarm conditions, system status, or trouble conditions within the system. Audible alarm devices must be of a sufficient decibel level to be heard over the maximum noise level in the protected hazard.

3.8 Sample Equipment Order List

Sample Sv Series Single Cylinder Equipment Order List		
Quantity	P/N	Description
1	18584-065	Cylinder Assembly, FM-200, 80 lb
65 lbs	FM200	FM-200® Agent
1	18595	Bracket Assembly, Cylinder, 10”
1	18481	Electric Valve Actuator
1	17001	Manual Valve Actuator
As Required	Various	Discharge Nozzles
1	18773	Switch, Discharge Pressure, w/ 1/2” (15 mm) Conduit Connection
1	18489	Sign, Warning, Exit, Clean Agent
1	18770	Sign, Warning, Entrance, Clean Agent

Sample Sv Series Three Cylinder Equipment Order List		
Quantity	P/N	Description
3	18584-050	Cylinder Assembly, FM-200, 80 lb
150 lbs	FM200	FM-200® Agent (50 lbs per Cylinder)
3	18595	Bracket Assembly, Cylinder, 10”
1	18481	Electric Valve Actuator
1	17001	Manual Valve Actuator
2	17019	Pneumatic Valve Actuator
1	18624	Bushing, 3/8” MNPT x 1/4” FNPT (10 mm x 8 mm), Brass *Pilot Actuation Adapter*
1	18560	Valve, Check, 1/4” MNPT x 1/4” JIC Male (8 mm x 8 mm), Brass *Pilot Actuation Check Valve*
2	18648	Hose, Flex, 3/16”, 1/4” (8 mm) JIC Female - 16” (406 mm)
1	18622	Tee, 1/4” JIC Male x 1/4” MNPT (8 mm x 8 mm), Brass *Pilot Actuation Mid Line Tee*
1	18625	Adapter, 1/4” MNPT x 1/4” JIC Male (8 mm x 8 mm), Brass *Male NPT Adapter*
1	18611	Tee, 1/4” FNPT x 1/4” MNPT (8 mm x 8 mm), Brass *Pilot Actuation End Line Tee*
1	10173	Vent Check
As Required	Various	Discharge Nozzles
1	18773	Switch, Discharge Pressure, w/ 1/2” (15 mm) Conduit Connection
3	18547	Valve, Check, 1-1/4” FNPT (32 mm)
1	18489	Sign, Warning, Exit, Clean Agent
1	18770	Sign, Warning, Entrance, Clean Agent

Sample Mv Series Single Cylinder Equipment Order List		
Quantity	P/N	Description
1	18526-350	Cylinder Assembly, FM-200, 420 lb
350 lbs	FM200	FM-200® Agent
1	18535	Bracket Assembly, Cylinder, 16”
1	18481	Electric Valve Actuator
1	17001	Manual Valve Actuator
1	18772	Gauge Assembly, Pressure, FM-200
1	18775	Switch Assembly, Low-Pressure Supervisory
1	18555	Coupling, Grooved, 2” (50 mm)
1	18551	Elbow, Grooved, 2” (50 mm)
1	18474	Nipple, Grooved x MNPT, 2” (50 mm)
As Required	Various	Discharge Nozzles
1	18773	Switch, Discharge Pressure, w/ 1/2” (15 mm) Conduit Connection
1	18489	Sign, Warning, Exit, Clean Agent
1	18770	Sign, Warning, Entrance, Clean Agent

Sample Mv Series Two Cylinder Equipment Order List (Manifolded)		
Quantity	P/N	Description
2	18525-200	Cylinder Assembly, FM-200, 250 lb
400 lbs	FM200	FM-200® Agent (200 lbs per Cylinder)
2	18535	Bracket Assembly, Cylinder, 16”
1	18481	Electric Valve Actuator
1	17001	Manual Valve Actuator
2	18772	Gauge Assembly, Pressure, FM-200
2	18775	Switch Assembly, Low-Pressure Supervisory
2	18555	Coupling, Grooved, 2” (50 mm)
2	18551	Elbow, Grooved, 2” (50 mm)
2	18474	Nipple, Grooved x MNPT, 2” (50 mm)
1	17019	Pneumatic Valve Actuator
1	18560	Valve, Check, 1/4” MNPT x 1/4” JIC Male (8 mm x 8 mm), Brass *Pilot Actuation Check Valve*
1	18649	Hose, Flex, 3/16”, 1/4” (8 mm) JIC Female - 24” (610 mm)
1	18625	Adapter, 1/4” MNPT x 1/4” JIC Male (8 mm x 8 mm), Brass *Male NPT Adapter*
1	18611	Tee, 1/4” FNPT x 1/4” MNPT (8 mm x 8 mm), Brass *Pilot Actuation End Line Tee*
1	10173	Vent Check
As Required	Various	Discharge Nozzles
1	18773	Switch, Discharge Pressure, w/ 1/2” (15 mm) Conduit Connection
2	18546	Valve, Check, 2” FNPT (50 mm)
1	18489	Sign, Warning, Exit, Clean Agent
1	18770	Sign, Warning, Entrance, Clean Agent

Sample Lv Series Single Cylinder Equipment Order List		
Quantity	**P/N**	**Description**
1	18529-945	Cylinder Assembly, FM-200, 1000 lb
945 lbs	FM200	FM-200® Agent
1	18537	Bracket Assembly, Cylinder, 30”
1	18481	Electric Valve Actuator
1	17001	Manual Valve Actuator
1	18772	Gauge Assembly, Pressure, FM-200
1	18775	Switch Assembly, Low-Pressure Supervisory
1	18554	Coupling, Grooved, 3” (80 mm)
1	18550	Elbow, Grooved, 3” (80 mm)
As Required	Various	Discharge Nozzles
1	18773	Switch, Discharge Pressure, w/ 1/2” (15 mm) Conduit Connection
1	18489	Sign, Warning, Exit, Clean Agent
1	18770	Sign, Warning, Entrance, Clean Agent

Sample Lv Series Three Cylinder Equipment Order List (Manifolded)		
Quantity	**P/N**	**Description**
3	18527-450	Cylinder Assembly, FM-200, 600 lb
1350 lbs	FM200	FM-200® Agent (450 lbs per Cylinder)
3	18536	Bracket Assembly, Cylinder, 24”
1	18481	Electric Valve Actuator
1	17001	Manual Valve Actuator
3	18772	Gauge Assembly, Pressure, FM-200
3	18775	Switch Assembly, Low-Pressure Supervisory
3	18554	Coupling, Grooved, 3” (80 mm)
3	18550	Elbow, Grooved, 3” (80 mm)
2	17019	Pneumatic Valve Actuator
1	18560	Valve, Check, 1/4” MNPT x 1/4” JIC Male (8 mm x 8 mm), Brass *Pilot Actuation Check Valve*
2	18650	Hose, Flex, 3/16”, 1/4” (8 mm) JIC Female - 34” (864 mm)
1	18622	Tee, 1/4” JIC Male x 1/4” MNPT (8 mm x 8 mm), Brass *Pilot Actuation Mid Line Tee*
1	18625	Adapter, 1/4” MNPT x 1/4” JIC Male (8 mm x 8 mm), Brass *Male NPT Adapter*
1	18611	Tee, 1/4” FNPT x 1/4” MNPT (8 mm x 8 mm), Brass *Pilot Actuation End Line Tee*
1	10173	Vent Check
As Required	Various	Discharge Nozzles
1	18773	Switch, Discharge Pressure, w/ 1/2” (15 mm) Conduit Connection
3	18538	Valve, Check, 3” Grooved (80 mm)
1	18489	Sign, Warning, Exit, Clean Agent
1	18770	Sign, Warning, Entrance, Clean Agent

4 SYSTEM INSTALLATION

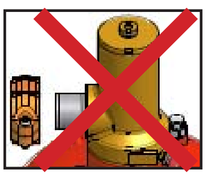
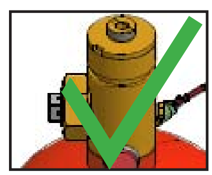
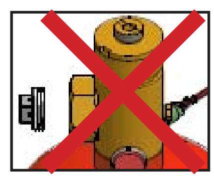
The installation of the Janus Fire Systems® FM-200® Clean Agent Fire Extinguishing System should be undertaken by competent mechanical and electrical technicians familiar with NFPA 2001 and with the installation of clean agent systems who have reviewed this manual and all hazard drawings and calculations. No special tools are required to assemble the equipment.

A complete hazard analysis and system design, including a drawing of the system layout, must be completed before the installation of any system and submitted to the authority having jurisdiction (AHJ). The design, drawings, and material list should be compared with conditions found on site. Cylinder size and agent fill must match design calculations. Temperature and humidity of the area must be within system limitations and room integrity must be consistent with the initial design. All components should be inspected for shipping damage.

Materials such as piping, pipe hangers, fittings, tubing, conduit, and mounting hardware are not typically supplied by Janus Fire Systems. These items are to be supplied by the installer and must meet the minimum required material specifications found in this manual, NFPA 2001 - Standard on Clean Agent Fire Extinguishing Systems, NFPA 72 - The National Electrical Code, as well as local building and fire codes or local norms.

System equipment has been verified through testing to function in ambient temperatures ranging from 32˚F (0˚C) to 130˚F (54˚C). Flow calculations have been verified at ambient temperatures of 70˚F ±10˚ (21.1˚C ±5.5˚). Storage outside of the range of 70˚F ±10˚ (21.1˚C ±5.5˚) may result in inaccurate flow calculations and cause one or more nozzles to not discharge the designed quantity of FM-200®.

⚠ WARNING

Discharge of an unsecured cylinder may result in injury, death, or damage to property from violent cylinder movement or over-exposure to high concentrations of agent. The cylinder is fitted with an anti-recoil safety plug or device to protect against accidental discharge. Do not remove the anti-recoil safety device from the discharge outlet until the cylinder is securely mounted in the bracket and the cylinder is ready to be connected to the discharge piping system. Do not transport the cylinder unless the anti-recoil safety device is in place. Handle the cylinder assembly with care even when the safety device is in place.

Do not install the electric, manual, or pneumatic valve actuators until all cylinder straps, pipe, and nozzles are securely installed. Failure to comply could result in accidental discharge of the cylinder. Remove the electric, manual, and pneumatic valve actuators before transporting cylinder.

Do not apply excessive force to the low-pressure supervisory switch or pressure gauge or attempt to carry the cylinder assembly or cylinder valve by the low-pressure switch or pressure gauge. If the low-pressure supervisory switch or pressure gauge breaks at the fitting, agent will discharge through the port potentially causing personal injury or property damage.

4.1 Mechanical Installation

Mechanical installation may be performed in conjunction with electrical installation or performed separately, but both installations must be completed before the system is commissioned (Section 5).

WARNING

Do not install the electric, pneumatic, or manual valve actuators until the system has been fully commissioned as detailed in Section 5. Failure to comply could result in personal injury or death from violent cylinder movement or over-exposure to high concentrations of agent.

4.1.1 Installing Cylinder Bracket Channels

To avoid accidental damage or wear to the cylinder assembly during the installation of discharge piping and nozzles, the cylinder assembly should only be placed into position after those installations are completed. Installation of the cylinder bracket back channels will suffice as a reference point for properly locating discharge piping. The cylinder must be oriented so that the pressure gauge faces out.

CAUTION

The cylinder assembly must be mounted in a vertical position so its valve assembly is located at the top of the cylinder. All cylinders for a single hazard must be stored at the same temperature.

Fasten the back channels securely to a rigid load-bearing vertical surface at the appropriate height. The cylinder must rest on a surface capable of supporting the combined weight of the cylinder and agent.

Figure 4.1.1a Sv Cylinder Bracket & Dimensions

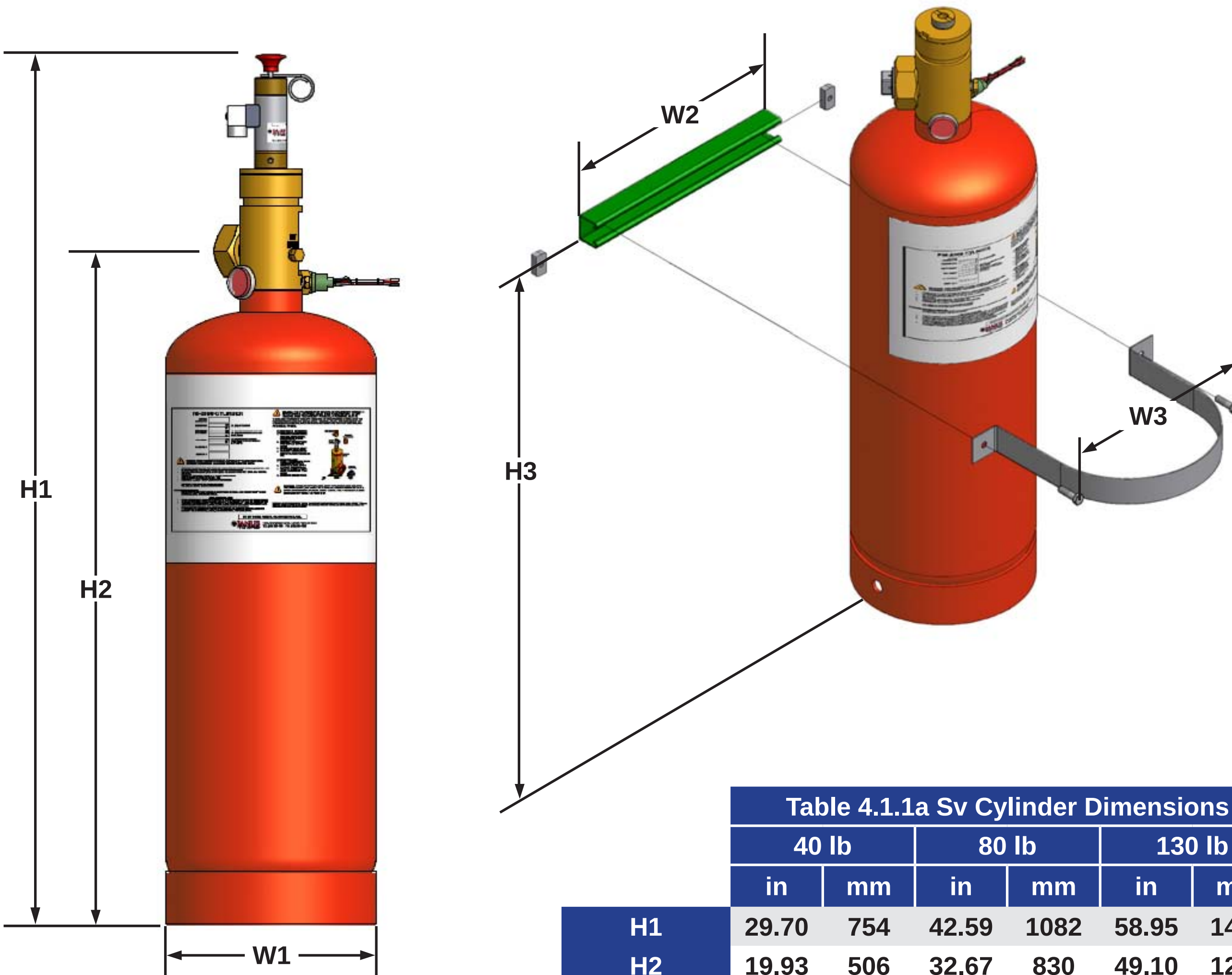


Table 4.1.1a Sv Cylinder Dimensions	40 lb		80 lb		130 lb	
	in	mm	in	mm	in	mm
H1	29.70	754	42.59	1082	58.95	1497
H2	19.93	506	32.67	830	49.10	1247
H3	13.63	346	15.75	400	30.75	781
W1	10.0	254	10.0	254	10.0	254
W2	14.0	356	14.0	356	14.0	356
W3	11.9	302	11.9	302	11.9	302
Bracket P/N	17222		17222		17222	

Bracket Assembly includes:
(2) 3/8" twirl nuts (P/N 18811)
(2) 3/8"-16 1-1/14" cap screws (P/N 18606)
(1) strap (P/N 18596)
(1) back channel (18604/Ft)

Section 4 System Installation

Figure 4.1.1b Mv Cylinder Bracket & Dimensions

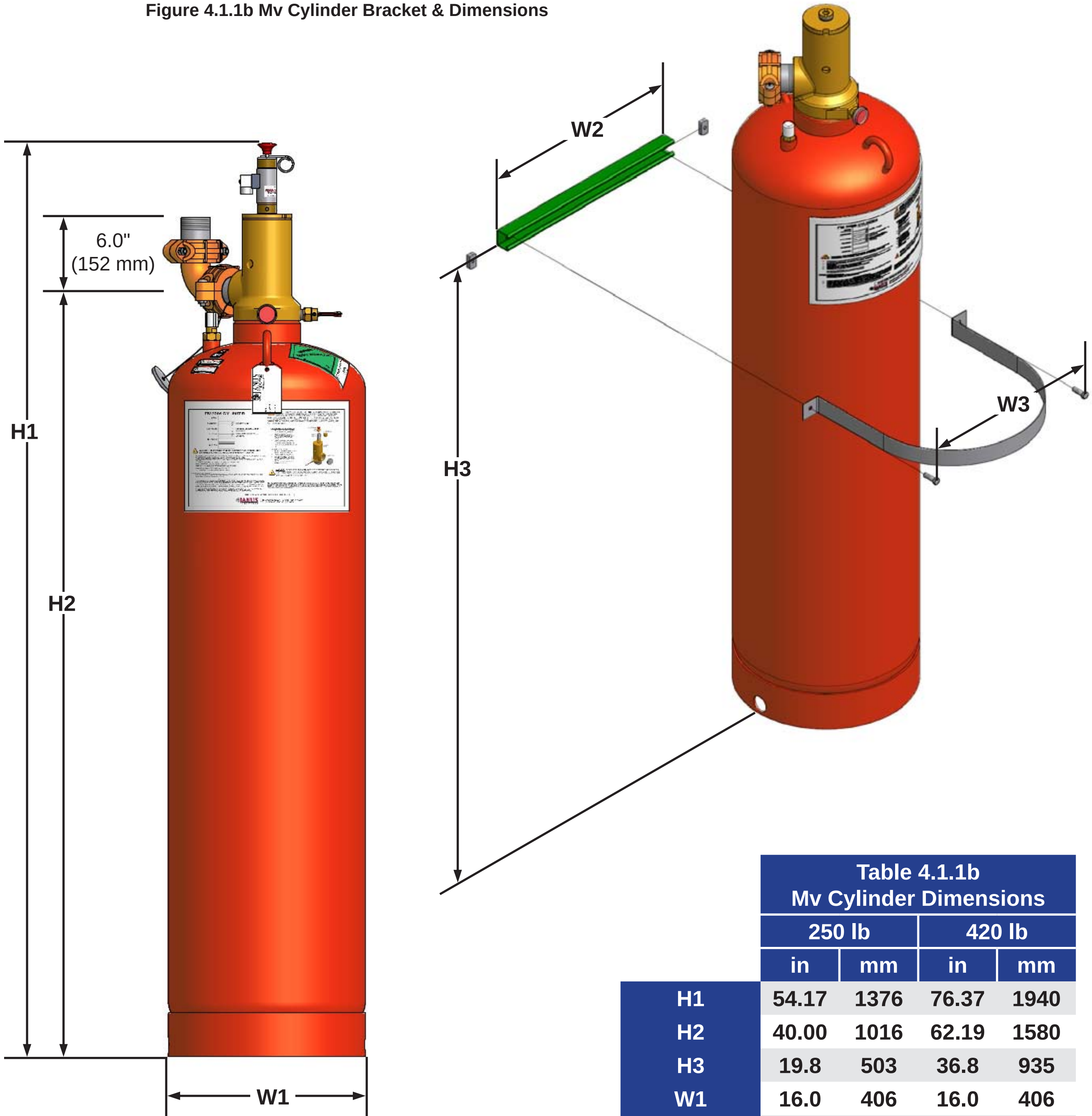
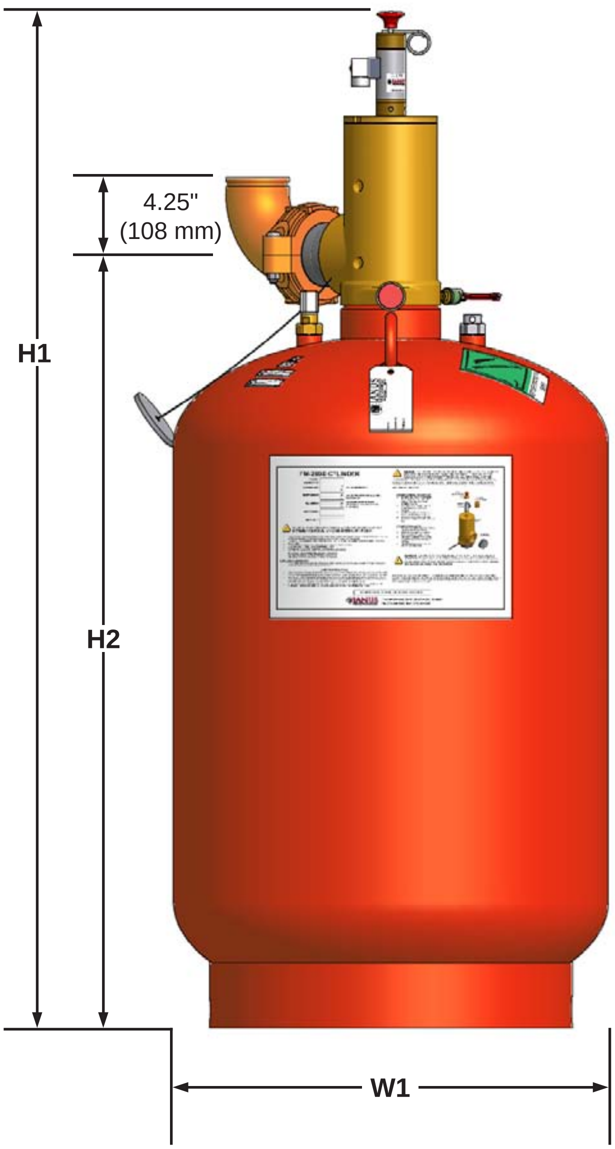


	Table 4.1.1b Mv Cylinder Dimensions			
	250 lb		420 lb	
	in	mm	in	mm
H1	54.17	1376	76.37	1940
H2	40.00	1016	62.19	1580
H3	19.8	503	36.8	935
W1	16.0	406	16.0	406
W2	20.0	508	20.0	508
W3	17.9	455	17.9	455
Bracket P/N	18535		18535	

Bracket Assembly includes:
(2) 3/8" twirl nuts (P/N 18811)
(2) 3/8"-16 1-1/14" cap screws (P/N 18606)
(1) strap (P/N 18597)
(1) back channel (18604/Ft)

Figure 4.1.1c Lv Cylinder Bracket & Dimensions



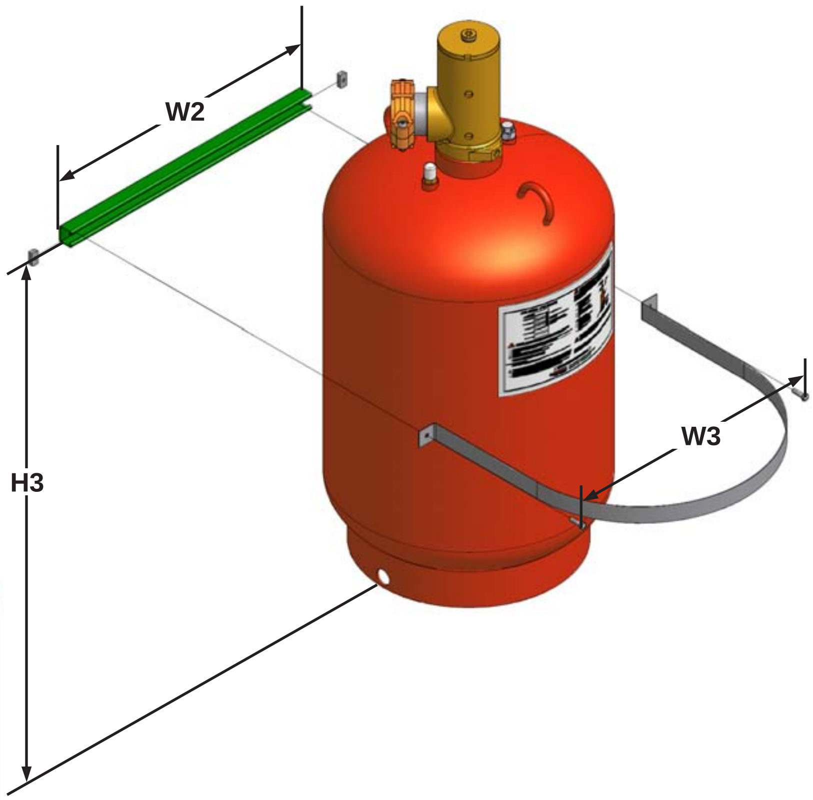


Table 4.1.1c Lv Cylinder Dimensions	600 lb		900 lb		1000 lb	
	in	mm	in	mm	in	mm
H1	58.67	1490	75.99	1930	67.48	1714
H2	44.92	1141	62.17	1579	53.73	1365
H3	21.5	546	38.0	965	30.0	762
W1	24.0	610	24.0	610	30.0	762
W2	28.0	711	28.0	711	34.0	864
W3	25.9	658	25.9	658	31.9	810
Bracket P/N	18536		18536		18537	

Bracket Assembly includes:
(2) 3/8" twirl nuts (P/N 18811)
(2) 3/8"-16 1-1/14" cap screws (P/N 18606)
(1) strap (600/900 lb - P/N 18598; 1000 lb - P/N 18599)
(1) back channel (18604/Ft)

4.1.2 Installing Discharge Piping

Discharge pipe, fittings, brackets, hangers, and are not normally included in the scope of Janus Fire Systems®. Materials should be new and free from rust and corrosion. Pipe size, schedule, routing, reductions, changes in elevations, etc must be in accordance with the drawings and calculations created using the Janus Design Suite software. Any deviations in routing or fitting quantities must be coordinated and verified by the system designer prior to implementing changes.

Pipe must comply with NFPA 2001 and be either Schedule 40 or 80. Pipe can be of any of the following fabrication classifications.

Seamless - Round pipe without a longitudinal seam.

Electric Resistance Welded (ERW) - Pipe with a longitudinal joint where fusion of the joint is produced by the heat obtained from the resistance to the flow of electric current.

Furnace Butt Welded Pipe (Welded Pipe) - Pipe fabricated by mechanical pressure developed by drawing the furnace heated metal through a conical die that serves to form and weld the tubular shape.

Refer to Table 4.1.2 for acceptable pipe grades.

Table 4.1.2 Acceptable Pipe Grades	
Seamless	Grade A-106 C, Grade A-53 A or B, Grade A-106 A or B
Electric Resistance Welded (ERW)	Grade A-53 A or B
Furnace Welded	Grade A-53 F

WARNING

Cast iron pipe, steel pipe conforming to ASTM A-120, aluminum pipe, or non-metallic pipe shall not be used.

4.1.2.1 Threaded Pipe

At a minimum threaded pipe joints must be reamed free of burrs and obstructions. Any lubricants used in the threading process must be cleaned from the ends of the pipe to reduce the chance of cutting lubricant or shavings entering the nozzle orifices or being deposited in ceilings or equipment. Threaded joints must conform to ANSI B1-20.1. Pipe sections should be swabbed with appropriate nonflammable degreasing solvent to remove any traces of preservatives or lubricant.

Prior to fit up dry compressed air or nitrogen can be used to “blow out” any debris left in the pipe bore during the cleaning process.

The exposed threaded joints must be wrapped with polytetrafluoroethylene (PTFE or Teflon tape) or anaerobic PTFE-based paste. Both are used as a lubricant that allows threads to mate more readily and fills any variances in the thread surfaces.

4.1.2.2 Threaded Fittings

Threaded fittings must comply with NFPA 2001 and be at a minimum class 300 malleable iron, class 300 ductile iron, or have a **minimum rated working pressure** of 416 psi (28.7 bar) at 70°F (21.1°C).

⚠ WARNING

Class 150 lb fittings shall not be used.

4.1.2.3 Grooved Fittings and Couplings

Grooved fittings and couplings must comply with NFPA 2001 and have a **minimum rated working pressure** of 416 psi (28.7 bar) at 70°F (21.1°C) based upon carbon steel pipe roll or cut grooved in accordance with the fitting or coupling manufacturer's guidelines.

Gaskets must be compatible with FM-200® agent (typically EPDM having a temperature range of -30°F to 230°F [-34°C to 110°C]). Gasket lubricant must be in accordance with manufacturer's specifications.

4.1.2.4 Pipe Reductions

Reductions in pipe sizes may be accomplished using threaded or grooved concentric reducing fittings, steel or stainless steel concentric swage fittings, or steel or stainless steel reducing bushings. All such fittings must comply with NFPA 2001 and have a **minimum rated working pressure** of 416 psi (28.7 bar) at 70°F (21.1°C).

⚠ WARNING

Pipe reductions can be made using machined or forged steel hex bushings. Malleable and/or cast iron bushings are NOT to be used.

4.1.2.5 Pipe Supports and Hangers

FM-200® system piping must be adequately supported with appropriate pipe supports and hangers to withstand the thrust exerted during system discharge. The number of supports and hangers required depends on the specific system piping configuration.

All supports and hangers shall comply with NFPA 2001 and be used in accordance to their manufacturer's limits and specifications and state and local building codes.

Hangers and supports must be steel. They must adequately allow for movement or contraction occurring from changing thermal conditions.

Hangers and supports must be designed and installed to minimize vertical and lateral sway or thrust.

Hangers and supports must be placed at every change in direction of the piping network and at every nozzle. Additional supports shall be placed at intermediate location in between.

When intermediate hangers are of the rod type, they must be steel clad or steel clevis, of proper size, and with a solid bar-type hanger rod to support the weight of the pipe and agent.

When grooved pipe, fittings, and couplings are used, brackets and supports must be anchored per the fitting manufacturer's specifications. No grooved pipe length shall be left unsupported.

WARNING

Cast iron supports, conduit clamps, or "C" clamps are not to be used to support pipe.

4.1.3 Installing Nozzles

Nozzle type, style, and orifice diameter are determined based upon flow calculations made by the Janus Design Suite software during the system design. Discharge nozzles are female NPT thread and must be installed as designed according to the guidelines covered under section 3.5.

Due to the thrust generated from a 90° corner or 180° sidewall nozzle, a rigid hanger or support must be located within 12 in (305 mm) of the nozzle to prevent pipe movement and/or nozzle rotation during discharge.

4.1.4 Installing Cylinder Assembly

Position the cylinder assembly against the back channel so that the pressure gauge faces out.

Secure the mounting strap into the back channel with the bracket held horizontally. Fasten the strap with the supplied 3/8"-16 1-1/4" cap screw and 3/8" twirl nut.

4.1.4.1 Installing Pressure Gauge Assembly (Mv and Lv Series only)

Install the pressure gauge assembly into the pressure gauge connection and tighten the swivel nut to 10 lb*ft. When the swivel nut is almost tight, the pressure gauge assembly will upset the Schrader valve. The O-ring on the pressure gauge assembly immediately seals to prevent loss of FM-200®.

Once the pressure gauge assembly is connected, it should be used to check the pressure inside the cylinder. A pressure drop of more than 10% indicates the cylinder assembly must be recharged or replaced. Pressure should be 360 psig (24.8 bar) at 70°F (21°C). Refer to Table 6.2.1.1 in Appendix B for normal pressures at other temperatures.

4.1.4.2 Installing Low-Pressure Supervisory Switch Assembly (Mv and Lv Series only)

Install the low-pressure supervisory switch assembly into the low-pressure supervisory connection and tighten the swivel nut to 10 lb*ft. When the swivel nut is almost tight, the low-pressure supervisory switch assembly will upset the Schrader valve. The O-ring on the low-pressure supervisory switch assembly immediately seals to prevent loss of FM-200®.

4.1.5 Installing Discharge Pressure Switch

Pressure to operate the discharge pressure switch is supplied by the primary cylinder. In a single cylinder system, it can be connected to the pilot actuation port or a tee in the discharge piping. In a multiple cylinder systems, it can be connected to the discharge manifold or the pilot actuation port of the final slave cylinder.

The discharge pressure switch has a SPDT contact for connection to the control panel. The switch will send a signal to the control panel confirming system actuation. If a control panel is not included, the discharge pressure switch can provide necessary control functions for closing any doors or dampers in the room or enclosure or to initiate the shut down of equipment that may deplete agent concentration.

1. Mount the switch box securely onto a wall or structural member using the mounting holes provided. Preferred mounting is upright with pipe and conduit connections to the bottom.
2. Connect 1/2 inch conduit and appropriate wiring to the electrical connection on the switch box.
3. To switch loads heavier than the switch rating, or requiring more than two contacts, the switch should be used to operate a relay or contactor to control the load.
4. Connect the 1/4 inch NPT connection at the bottom of the front plate to the carbon dioxide piping using 1/4 inch steel pipe or 1/4 inch or 3/16 inch O.D. copper tube. Install a union fitting at base of cover to allow removal of front plate for testing.

4.1.6 Installing Pilot Actuation Line

On a multiple cylinder system, the primary and slave cylinders must be interconnected with pilot actuation hose and fittings.

Up to 16 cylinders can be actuated simultaneously on a single system. The primary cylinder valve will be opened electrically and then up to 15 slave cylinders will be opened pneumatically using actuation pressure received from the primary cylinder through the pilot actuation line.

The pilot actuation line begins at the pilot actuation port of the primary cylinder. The total length of the pilot actuation line from the primary cylinder to the last cannot be greater than 70 ft (21.3 m).

A pilot actuation check valve **must** be installed into the pilot actuation port with the direction of flow ***out*** of the valve. This pilot actuation check valve is used to maintain pressure in the pilot actuation line and pneumatic valve actuators to ensure the valve remains open during discharge and a complete dispersal of slave cylinder contents is achieved.

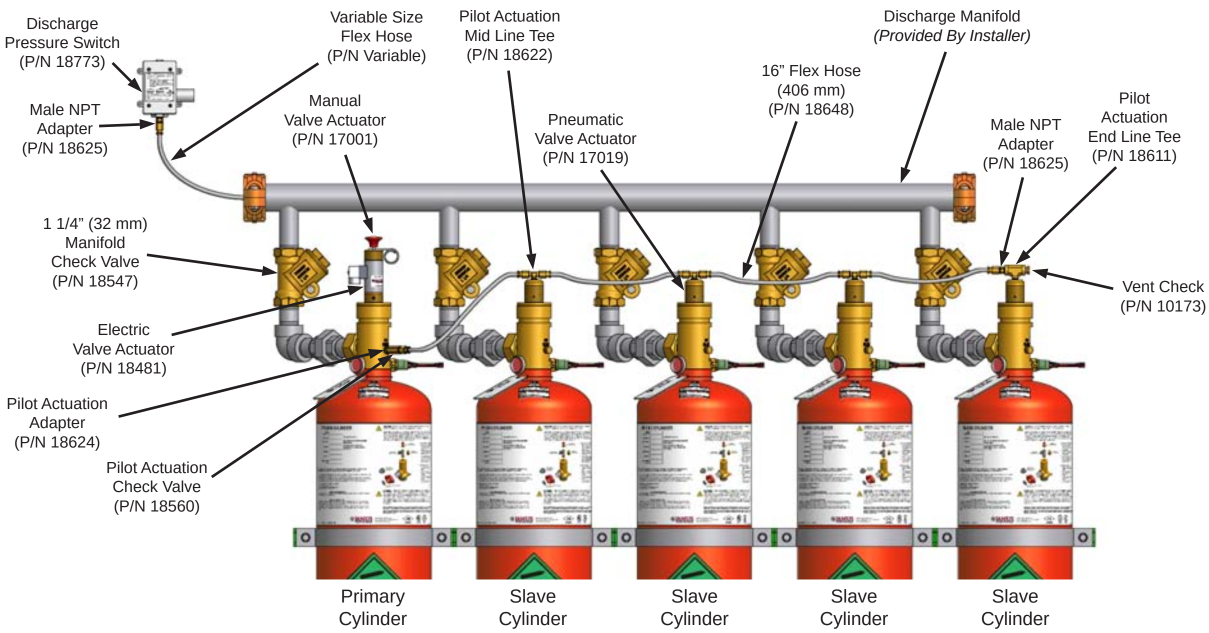
The pilot actuation line connects to each slave cylinder at a 1/4 in (8 mm) female NPT inlet port in the pneumatic valve actuator. One pneumatic valve actuator is required for each additional slave cylinder.

A vent check must be installed in the pilot actuation line downstream of the pilot actuation check valve typically at the last cylinder. It is used to bleed off pressure that may accumulate in the pilot actuation line, reducing the chance of inadvertent operation of the pneumatic valve actuators.

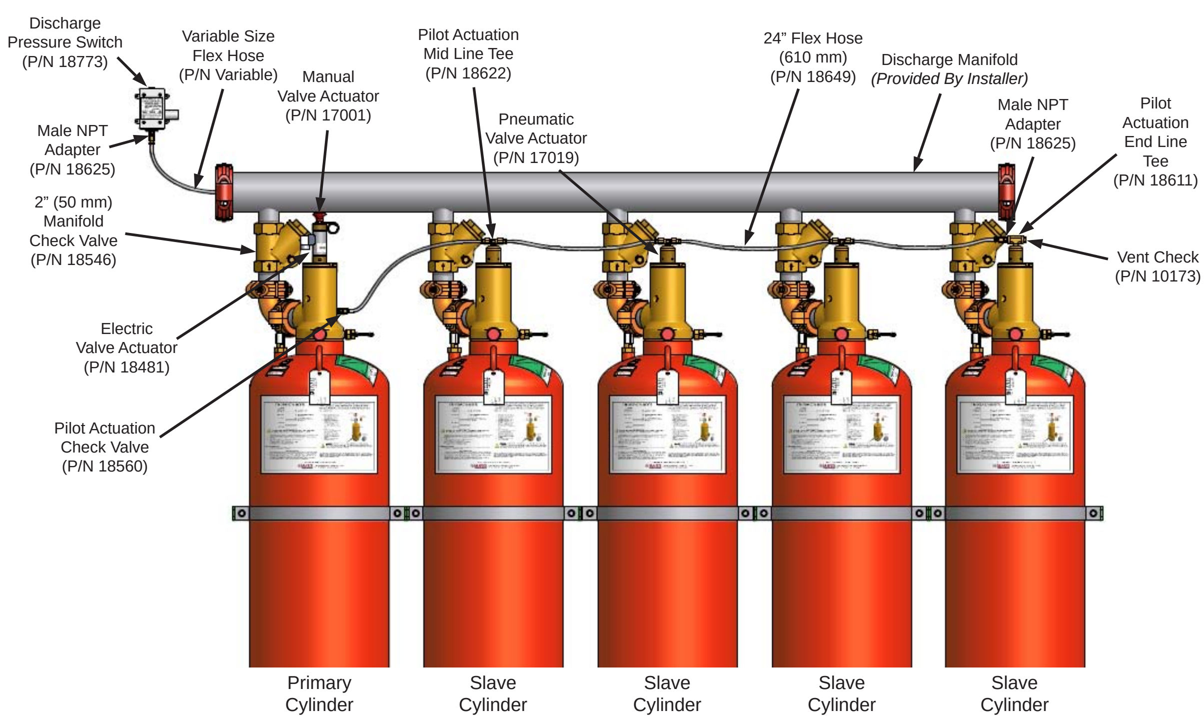
Before assembling the pilot actuation line, the hose and fittings should be carefully cleaned internally to remove all oil, dirt, or foreign material.

Teflon tape or joint compound must be used on all threaded connections. Use care when applying pipe tape or joint compound so they don't enter the pipe. Do not use pipe tape or compound on flared fittings.

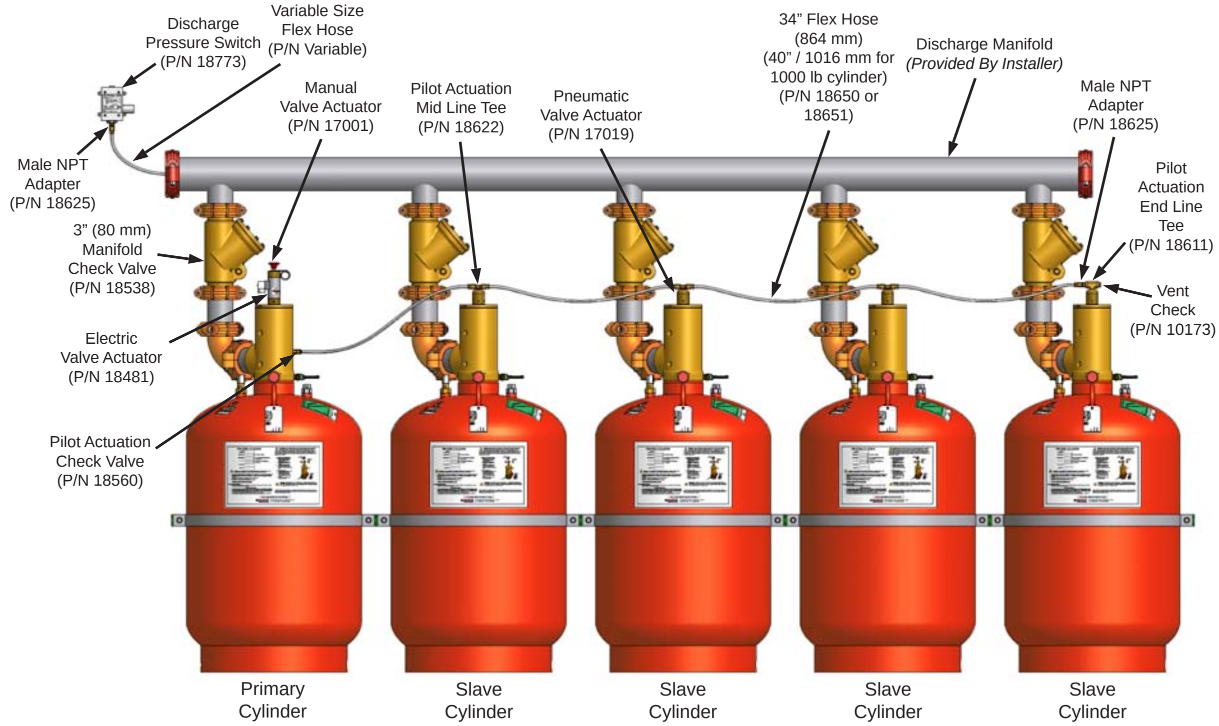
On multiple cylinder systems, the discharge pressure switch must not be connected to the pilot actuation line. It may be connected to the discharge manifold or the pilot actuation port of the final slave cylinder.



4.1.6a Pilot Actuation Line Configuration for Sv Series Cylinders



4.1.6b Pilot Actuation Line Configuration for Mv Series Cylinders



4.1.6c Pilot Actuation Line Configuration for Lv Series Cylinders

4.2 Electrical Installation

Electrical installation may be done in conjunction with mechanical installation or separately, but both installations must be completed before the system is commissioned (Section 5). Wiring must be installed in accordance with the guidelines of NFPA 70 - National Electrical Code, NEMA, and local electrical codes. Early warning detection, audible and visible alarm device, and control panels must be installed and tested in accordance with NFPA 70 - National Electrical Code and NFPA 72 - National Fire Alarm Code as well as local electrical codes.

5 COMMISSIONING SYSTEM

WARNING

Do not install the electric, pneumatic, or manual valve actuators until the system has been fully commissioned. Failure to comply could result in personal injury or death from violent cylinder movement or over-exposure to high concentrations of agent.

The system checkout procedures outlined in this chapter are intended to represent the minimum requirements for the extinguishing system portion of the system. NFPA 2001 should also be consulted. Additional procedures may be required by the local authority having jurisdiction (AHJ).

The control system portion of the system providing automatic detection and release should be thoroughly checked out according to the appropriate technical manual and the requirements of the local authority having jurisdiction (AHJ) before completing this section.

5.1 System Review

Conduct a room integrity (door fan) test in accordance with NFPA 2001. The results of this test will provide equivalent leakage area and, when conducted in accordance with the manufacturer's instructions, will predict the timeline for a descending interface to fall to a given height and estimate how long the extinguishing concentration will be maintained in the protected room.

Check security and tightness of cylinder mounting brackets to a solid structure and cylinder bracket straps.

Check and record cylinder pressure gauges and room temperature. Pressure should be 360 psig at 70°F (24.8 bar at 21°C). For temperatures other than 70°F (21°C) refer to the pressure temperature chart in the appendix.

Check the stamped fill weight on the cylinder nameplate to verify it is the correct amount for the room as determined and documented in the design.

Piping should be checked for correct size, length, and grade and compared to the installation drawings, Janus Design Suite flow calculation results, and manual limitations.

Check pipe supports for proper type, mounting, and spacing.

Check that nozzle location, size, and drill diameters of orifices match both installation/design drawings and calculations.

5.2 Discharge Piping Pressure Test

⚠WARNING

Do not apply pressure to the discharge piping while the pipe is connected to the discharge outlet. Applying pressure to the discharge outlet may cause the valve to open and pressurize the distribution pipe with the FM-200® agent, causing personal injury or property damage.

NFPA 2001 mandates that all fittings be checked for tightness and pressure tested. Remove the nozzles and install pipe caps. Remove the discharge piping from the cylinder valve and install the anti-recoil safety device onto the cylinder discharge outlet. Connect a source of dry compressed air or nitrogen to the distribution piping. Slowly increase the pressure in the piping to 40 psi (2.76 bar) and then close the valve supplying pressure. Check the pressure after 10 minutes. If the pressure is above 32 psig (2.20 bar) (80% of test pressure) the system is considered sealed. If it drops below 32 psig (2.20 bar) check and tighten all fittings then re-run the test. After completing the test remove pipe caps, reinstall nozzles, and reconnect discharge piping to cylinder.

⚠WARNING

Pressure testing may potentially cause a rupture of the piping system and introduce dangerous projectiles into the protected area. Personnel should be evacuated prior to pressure testing.

NFPA 2001 allows this pressure test to be omitted if the total piping contains no more than one change in direction between the cylinder outlet and the nozzle and all piping is physically checked for tightness.

Dry compressed air or nitrogen must be discharged through the piping network and nozzles to verify the flow is continuous and that the piping and nozzles are unobstructed. Make certain air/nitrogen is discharging from all nozzles.

Check all nozzles to be sure the correct nozzles are installed as shown on the installation drawing, installed securely to the pipe, properly anchored, and properly oriented.

Check all nozzles for any obstructions or objects placed in the direct pattern of discharge.

Perform a full functional test of the control system in accordance with the appropriate technical manual and system design drawings including verification that all control functions such as damper and door closure, HVAC shut down, and power shut down occur as intended.

If the HVAC is NOT being shutdown prior to system discharge it must be of the re-circulating close loop type and enough agent must be provided to compensate for the volume of the duct and plenum.

5.3 Installing Pneumatic Valve Actuator

WARNING

Attaching the pneumatic valve actuator to the cylinder valve when the actuation pin is not fully locked into the "up" position may cause the cylinder valve to actuate, resulting in potential injury and/or property damage.

Reset the pneumatic valve actuator by pushing up on the actuation pin until it bottoms out on the inside of the actuator body. If the pin is not reset, it will depress the valve core stem when the pneumatic valve actuator is threaded onto valve actuation connection causing the valve to open.

The pneumatic valve actuator should be installed hand tight until contact is made between the actuator and the top of the cylinder valve. A small gap will be present between the bottom of the pneumatic valve actuator and the valve body.

5.4 Installing Electric Valve Actuator

WARNING

Do not install the electric valve actuators until all pipe and nozzles are securely installed and system has been fully commissioned. Failure to comply could result in personal injury or death from violent cylinder movement or over-exposure to high concentrations of agent.

Attaching the electric valve actuator to the cylinder valve when the actuation pin is not fully locked into the "up" position may cause the cylinder valve to actuate, resulting in potential injury and/or property damage.

Reset the electric valve actuator by pushing the pin up until it latches. If the pin is not reset, the valve core stem could be depressed when the electric valve actuator is threaded onto the valve top causing the cylinder valve to actuate.

Do not install the electric valve actuator if the control panel is in alarm or trouble. Clear all alarm conditions and trouble conditions on the panel before installing the electric valve actuator.

The electric valve actuator assembly has a swivel base that is threaded onto the valve top.

The actuator is to be installed **hand tight until** contact is made between the actuator and valve top. A small gap will be present between the bottom of the actuator and the valve body.

5.5 Installing Manual Valve Actuator

⚠ WARNING

Attaching the manual valve actuator to the electric valve actuator when the actuation pin is not fully locked into the "up" position may cause the cylinder valve to actuate, resulting in potential injury and/or property damage.

Reset the manual valve actuator by pulling up on the palm button and inserting the ring pin. The actuation pin should be in the full up position before installing on the electric valve actuator. If the pin is not reset the valve could open when the manual valve actuator is threaded onto the electric valve actuator.

The manual valve actuator assembly has a swivel base that is threaded onto the top of the electric valve actuator.

The actuator is to be installed **hand tight until** contact is made between the manual valve actuator and the top of the electric valve actuator. A small gap may be present between the bottom of the manual valve actuator and the top of the electric valve actuator.

⚠ CAUTION

The system is now fully armed and commissioned. Actuation of the manual or electric valve actuators will result in the discharge of the system.

5.6 Warning Signs

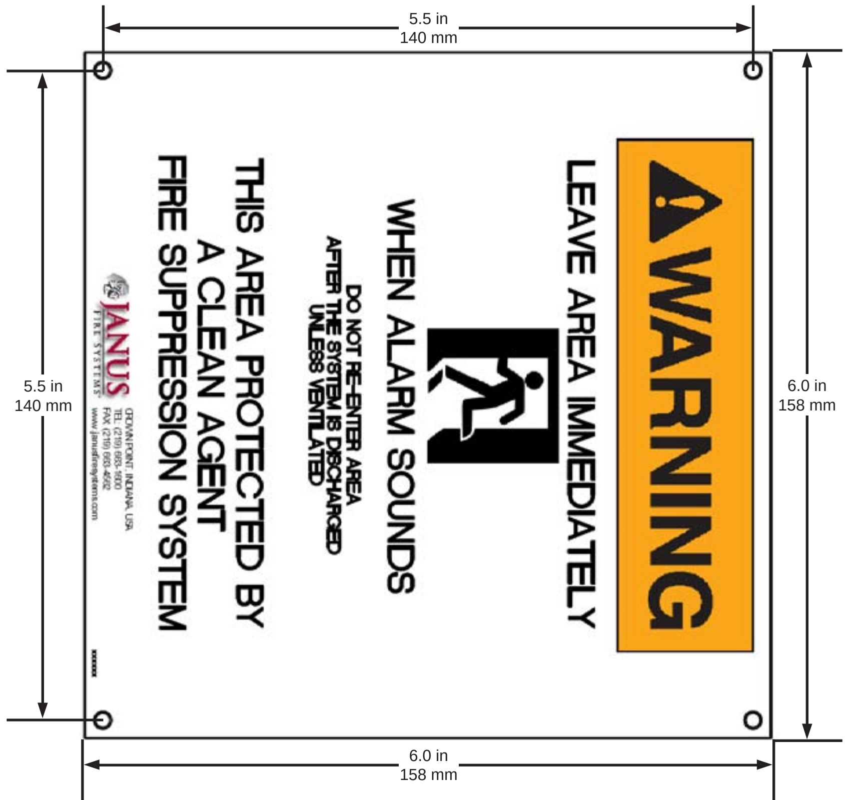
Warning signs must be placed at entrances to and inside protected areas.

5.7 Additional Considerations

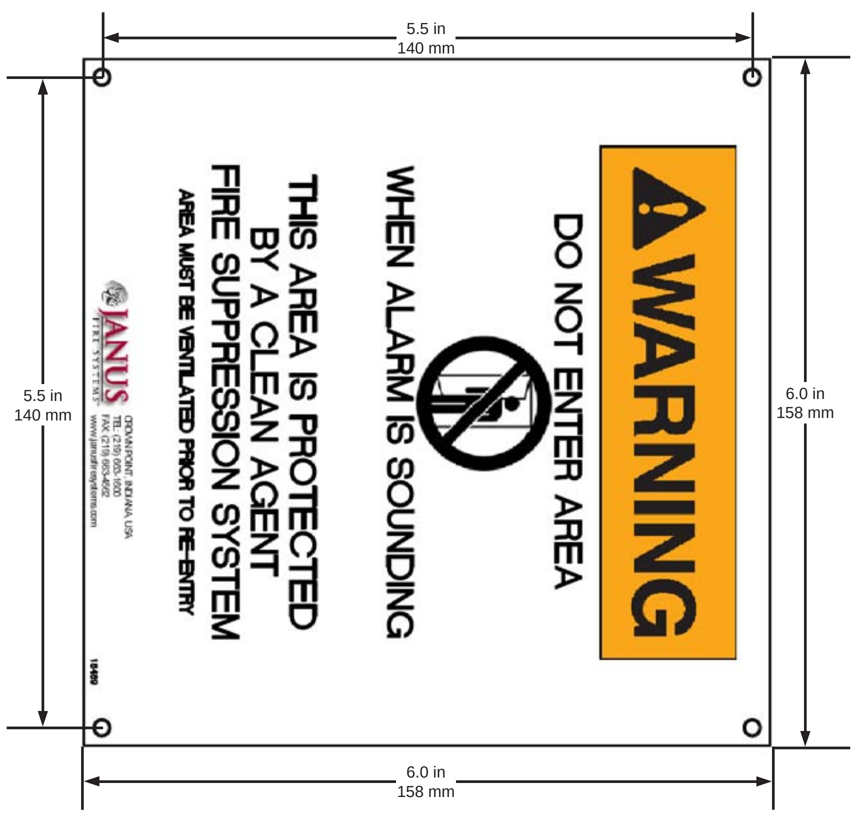
Janus Fire Systems® equipment as shipped does not require painting.

5.8 Enclosure Venting Considerations

The effectiveness of a total flooding fire extinguishing system depends, in part, on retention of the agent mixture within the protected volume for a period of time. Retention of the agent within the enclosure requires that leakage be minimized, however, addition of a gaseous fire extinguishing agent to an enclosure having limited vent area will naturally result in a change of pressure therein. If the enclosure is sealed too tightly during the agent discharge, i.e., too little vent area, the pressure change could exceed the structural strength of the enclosure. Conversely, if the enclosure has too much vent area then FM-200® leakage will occur rapidly, leading to short retention time of the agent within the protected volume. Thus, the use of gaseous fire extinguishing systems must address both pressure relief within the protected volume during the period of agent discharge, and retention of the agent-air mixture within the enclosure for a specified period of time after the completion of the discharge.



5.6a Clean Agent Warning Sign - Exit (P/N 18489)



5.6b Clean Agent Warning Sign - Entrance (P/N 18770)

A door fan integrity test should be performed to determine both the estimated leakage rate of FM-200 and provide the existing vent area in the protected volume. The Janus Design Suite can provide an estimate of the vent area required for the amount of FM-200 being discharged. With the combined information, adjustments can be made to determine additional venting needs for the enclosure.

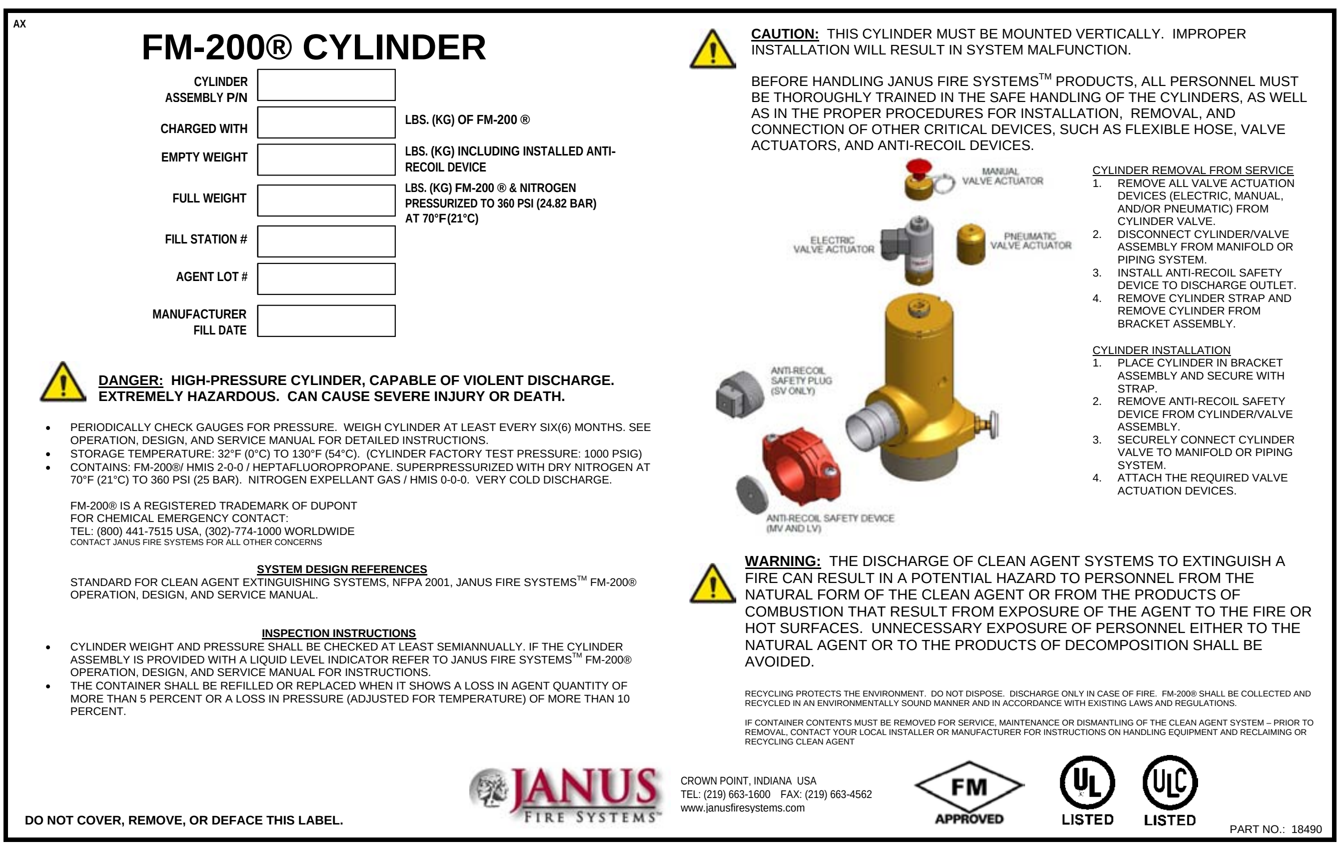
For more complete information regarding enclosure integrity and venting consideration please consult *Fire Suppression Systems Association Guide to Estimating Enclosure Pressure and Pressure Relief Vent Area for Applications Using Clean Agent Fire Extinguishing Systems*, **PRG-01, First Edition, August 2008**, NFPA 2001 and Janus Design Suite FM-200 Calculation Manual.

5.9 Manual

An "as built" instruction and maintenance manual that includes a full sequence of operations and a full set of drawings and calculations shall be maintained on site.

5.10 Label

Each cylinder is fitted with an identification label indicating the fill quantity of FM-200®.



AX

FM-200® CYLINDER

CYLINDER ASSEMBLY P/N		
CHARGED WITH		LBS. (KG) OF FM-200 ®
EMPTY WEIGHT		LBS. (KG) INCLUDING INSTALLED ANTI-RECOIL DEVICE
FULL WEIGHT		LBS. (KG) FM-200 ® & NITROGEN PRESSURIZED TO 360 PSI (24.82 BAR) AT 70°F(21°C)
FILL STATION #		
AGENT LOT #		
MANUFACTURER FILL DATE		

DANGER: HIGH-PRESSURE CYLINDER, CAPABLE OF VIOLENT DISCHARGE. EXTREMELY HAZARDOUS. CAN CAUSE SEVERE INJURY OR DEATH.

- PERIODICALLY CHECK GAUGES FOR PRESSURE. WEIGH CYLINDER AT LEAST EVERY SIX(6) MONTHS. SEE OPERATION, DESIGN, AND SERVICE MANUAL FOR DETAILED INSTRUCTIONS.
- STORAGE TEMPERATURE: 32°F (0°C) TO 130°F (54°C). (CYLINDER FACTORY TEST PRESSURE: 1000 PSIG)
- CONTAINS: FM-200®/ HMIS 2-0-0 / HEPTAFLUOROPROPANE. SUPERPRESSURIZED WITH DRY NITROGEN AT 70°F (21°C) TO 360 PSI (25 BAR). NITROGEN EXPELLANT GAS / HMIS 0-0-0. VERY COLD DISCHARGE.

FM-200® IS A REGISTERED TRADEMARK OF DUPONT
FOR CHEMICAL EMERGENCY CONTACT:
TEL: (800) 441-7515 USA, (302)-774-1000 WORLDWIDE
CONTACT JANUS FIRE SYSTEMS FOR ALL OTHER CONCERNS

SYSTEM DESIGN REFERENCES

STANDARD FOR CLEAN AGENT EXTINGUISHING SYSTEMS, NFPA 2001, JANUS FIRE SYSTEMS™ FM-200® OPERATION, DESIGN, AND SERVICE MANUAL.

INSPECTION INSTRUCTIONS

- CYLINDER WEIGHT AND PRESSURE SHALL BE CHECKED AT LEAST SEMIANNUALLY. IF THE CYLINDER ASSEMBLY IS PROVIDED WITH A LIQUID LEVEL INDICATOR REFER TO JANUS FIRE SYSTEMS™ FM-200® OPERATION, DESIGN, AND SERVICE MANUAL FOR INSTRUCTIONS.
- THE CONTAINER SHALL BE REFILLED OR REPLACED WHEN IT SHOWS A LOSS IN AGENT QUANTITY OF MORE THAN 5 PERCENT OR A LOSS IN PRESSURE (ADJUSTED FOR TEMPERATURE) OF MORE THAN 10 PERCENT.

CAUTION: THIS CYLINDER MUST BE MOUNTED VERTICALLY. IMPROPER INSTALLATION WILL RESULT IN SYSTEM MALFUNCTION.

BEFORE HANDLING JANUS FIRE SYSTEMS™ PRODUCTS, ALL PERSONNEL MUST BE THOROUGHLY TRAINED IN THE SAFE HANDLING OF THE CYLINDERS, AS WELL AS IN THE PROPER PROCEDURES FOR INSTALLATION, REMOVAL, AND CONNECTION OF OTHER CRITICAL DEVICES, SUCH AS FLEXIBLE HOSE, VALVE ACTUATORS, AND ANTI-RECOIL DEVICES.

CYLINDER REMOVAL FROM SERVICE

1. REMOVE ALL VALVE ACTUATION DEVICES (ELECTRIC, MANUAL, AND/OR PNEUMATIC) FROM CYLINDER VALVE.
2. DISCONNECT CYLINDER/VALVE ASSEMBLY FROM MANIFOLD OR PIPING SYSTEM.
3. INSTALL ANTI-RECOIL SAFETY DEVICE TO DISCHARGE OUTLET.
4. REMOVE CYLINDER STRAP AND REMOVE CYLINDER FROM BRACKET ASSEMBLY.

CYLINDER INSTALLATION

1. PLACE CYLINDER IN BRACKET ASSEMBLY AND SECURE WITH STRAP.
2. REMOVE ANTI-RECOIL SAFETY DEVICE FROM CYLINDER/VALVE ASSEMBLY.
3. SECURELY CONNECT CYLINDER VALVE TO MANIFOLD OR PIPING SYSTEM.
4. ATTACH THE REQUIRED VALVE ACTUATION DEVICES.

WARNING: THE DISCHARGE OF CLEAN AGENT SYSTEMS TO EXTINGUISH A FIRE CAN RESULT IN A POTENTIAL HAZARD TO PERSONNEL FROM THE NATURAL FORM OF THE CLEAN AGENT OR FROM THE PRODUCTS OF COMBUSTION THAT RESULT FROM EXPOSURE OF THE AGENT TO THE FIRE OR HOT SURFACES. UNNECESSARY EXPOSURE OF PERSONNEL EITHER TO THE NATURAL AGENT OR TO THE PRODUCTS OF DECOMPOSITION SHALL BE AVOIDED.

RECYCLING PROTECTS THE ENVIRONMENT. DO NOT DISPOSE. DISCHARGE ONLY IN CASE OF FIRE. FM-200® SHALL BE COLLECTED AND RECYCLED IN AN ENVIRONMENTALLY SOUND MANNER AND IN ACCORDANCE WITH EXISTING LAWS AND REGULATIONS.

IF CONTAINER CONTENTS MUST BE REMOVED FOR SERVICE, MAINTENANCE OR DISMANTLING OF THE CLEAN AGENT SYSTEM – PRIOR TO REMOVAL, CONTACT YOUR LOCAL INSTALLER OR MANUFACTURER FOR INSTRUCTIONS ON HANDLING EQUIPMENT AND RECLAIMING OR RECYCLING CLEAN AGENT

DO NOT COVER, REMOVE, OR DEFACE THIS LABEL.

CROWN POINT, INDIANA USA
TEL: (219) 663-1600 FAX: (219) 663-4562
www.janusfiresystems.com

FM APPROVED — UL LISTED — ULC LISTED

PART NO.: 18490

5.10 FM-200® Cylinder Label

6 SYSTEM INSPECTION AND MAINTENANCE

Each Janus Fire Systems® FM-200® Clean Agent Fire Extinguishing System must be properly inspected and maintained at regular intervals by competent individuals qualified in the installation and testing of clean agent extinguishing systems and thoroughly trained in the functions they are expected to perform.

It is the owner's responsibility to coordinate and schedule inspection and maintenance and verify that individuals performing the functions are properly trained as required by NFPA 2001.

6.1 Monthly Inspection

Inspection is a quick check of the system and is intended to give reasonable assurance that the system is fully charged and operational. This is done by reviewing the system to check that it has not been tampered with, all components are in place, no physical damage exists or no condition exists that could prevent operation.

This section does not cover inspection requirements of the detection, control, and releasing system. Consult the appropriate technical manual for those products and instructions on performing inspection.

The individual conducting the inspection should be familiar and knowledgeable with the system components and the intended operation of the system.

The system should be inspected on monthly intervals or more frequently if conditions dictate, with records maintained identifying as a minimum the person performing the inspection, date of inspection, observations, and results of the inspection noting any action to be taken.

A minimum of the following items should be checked during inspection:

- Visually verify that the control panel is free of trouble or alarm conditions.
- Check each cylinder bracket to make certain the cylinder is securely mounted.
- Check the pressure gauge on each cylinder to determine that cylinder pressure is in the correct range for the temperature.
- Check to make certain the discharge piping is properly connected to the discharge outlet.
- Check that all actuators are properly installed on the cylinder valves: electric valve actuator on primary cylinder and pneumatic valve actuators on any slave cylinders.
- Check the manual valve actuator to be certain the ring pin is properly installed and sealed in place.
- Check that all pilot actuation piping is properly connected.
- Visually inspect all components for any signs of damage, denting, corrosion, etc.
- Check the nozzles to make sure they are properly aimed, securely connected to the pipe, free of debris, not painted, and that no objects are blocking their discharge pattern.
- Visually check detectors to make certain they are in place, not damaged, not coated with dust, dirt or debris, not painted, and not obstructed.

- Check all electric manual release stations and abort switches to make certain they have not been tampered with, are in their normal and operational condition, are accessible, and are visible.
- Check all alarm devices to make certain they have not been tampered with, are not damaged or dirty, corroded, etc.
- Check all warning signs to make certain they are in place, not covered or obstructed, not painted over, and easily visible.
- Check all doors to confirm they are not blocked or held open and that automatic door closures will allow doors to close.
- Visually inspect the hazard for any changes that may have occurred such as additional partitions, moved partitions, new equipment, different fuels, openings or penetrations for cable or ductwork, HVAC modifications, etc.

Any discrepancy or problem found during inspection must be brought to the attention of the proper personnel and corrected.

6.1.1 Liquid Level Indicator

The liquid level indicator may be used in the Mv and Lv Series Systems to approximate the fill weight of a cylinder without having to disconnect the cylinder.

The ambient temperature of the cylinder must first be measured before obtaining a measure with the liquid level indicator. Make certain the cylinder is stored at this temperature for at least 24 hours to ensure an accurate reading.

Remove the protective cap on the liquid level indicator and slowly pull the tape until the magnet engages. Record the measurement on the tape to the nearest eighth of an inch. Consult the graphs located in Appendix B of this manual and use this measurement along with the ambient temperature to determine the approximate weight of the cylinder contents. If the weight determined from this graph shows a 5% or greater loss from the fill weight stamped on the cylinder label, the cylinder must be weighed to confirm these readings. See Section 6.2.1.2 for instructions on weighing.

Once measurement is recorded, replace the tape in the liquid level indicator. First pull the tape until the magnet disengages and then slide it back into the cylinder. Make certain the cap is replaced.

6.2 Maintenance

Maintenance is a thorough check of the system and is intended to give maximum assurance that the system will operate effectively and safely. It includes a thorough examination and any necessary repair, recharge, part replacement, or hydrostatic testing that may be required.

This section does not cover maintenance and service requirements of the detection, control, and releasing system. Consult the appropriate technical manual for those products and instructions on performing service and maintenance.

Notify all appropriate personnel that the fire extinguishing system will be disconnected and not functional during the duration of the service. When service is completed notify all appropriate personnel to make them aware that the system is back in service. Appropriate personnel may include the facility Owner or Manager, Safety Director or Manager, Security Director or Manager, Emergency Response Team, Maintenance, Department Manager, or local Fire Department.

Those individuals responsible for maintenance of a Janus Fire Systems® FM-200® clean agent fire extinguishing system must be trained.

Minimally, the date of service, name of technician performing the service, results of the service, gross weight, agent weight, cylinder pressure, cylinder temperature, and any other observations should be recorded noting any action taken to address or rectify a discrepancy.

6.2.1 Semi-Annual Maintenance

In addition to the monthly inspection steps, at least semiannually the agent quantity and pressure shall be checked.

6.2.1.1 Pressure Check

Check the pressure indicated by the gauge and the temperature of the cylinder and compare with the Table 6.2.1.1 in Appendix B. If the gauge pressure is below the pressure shown in the "90% Pressure" column for the temperature of the cylinder, the cylinder must be removed from service, agent recovered, all leaks identified and repaired, and the cylinder refilled.

6.2.1.2 Cylinder Weighing

The cylinder shall be weighed on a calibrated scale and the weight compared to the weight stamped on the cylinder label. When weighing the cylinder the anti-recoil safety plug or device must be installed in the discharge outlet and the electric or pneumatic valve actuator must be removed from the cylinder valve and the shipping cap installed on the top of the valve.

The maximum weight loss allowed is 5% of the fill weight (agent weight).

Example: A 130 lb (59.0 kg) cylinder filled with 76 lb (34.5 kg) of agent with a total weight stamped on the cylinder label of 163 lb (73.94 kg) can have a maximum loss of 3.8 lb (1.73 kg) or 5% of 76 (5% of 34.5). If the agent weight is below 72.2 lb (32.77 kg) or the total cylinder weight is below 159.2 lb (72.21 kg) (163 – 3.8) (73.94 – 1.73) the cylinder must be removed from service, agent recovered, all leaks identified & repaired, and the cylinder refilled.

6.2.2 Annual Maintenance

In addition to the monthly inspection steps and semiannual maintenance the system shall be thoroughly examined at least once each year.

A minimum of the following steps should be performed during the annual maintenance:

- Survey the hazard to determine if it has changed from what the system was designed to protect. While surveying the hazard look for different fuels, loss of hazard integrity, new hazards, etc. If discrepancies are found the changes must be noted and the system re-calculated to determine if the system is appropriate for the existing hazard.
- Thoroughly inspect the perimeter of the enclosure for penetrations or openings that could adversely affect agent leakage. Any openings found should be noted on the service report and sealed.
- Remove all actuators from cylinder valves and test for proper operation. Leave all actuators off until service is completed.

⚠ WARNING

Do not install the electric, pneumatic, or manual valve actuators until the system has been fully inspected. Failure to comply could result in personal injury or death from violent cylinder movement or over-exposure to high concentrations of agent.

- Examine the cylinder and valve assembly for any signs of damage, denting, corrosion, etc. as described in NFPA 2001. If any deficiency is identified the cylinder shall be hydrostatically tested.
- Check the cylinder bracket for corrosion or damage and make certain it is securely fastened to a rigid vertical structure.
- Check to be certain the cylinder is securely installed in the bracket with the appropriate fasteners and that the bracket is at the correct height
- Check all nozzles to make certain they are securely installed on the pipe, aimed properly, not corroded, not plugged, correct orifice size, correct style, and the discharge pattern is not obstructed.
- Check the condition of the piping to make certain it is properly secured in the hangers and all fittings are tight.
- Visually inspect the discharge hose for signs of damage, corrosion, abrasions, weather checking, or aging. If any deficiency is identified the hose shall be replaced or hydrostatically tested.

- Check all warning signs to make certain they are in place, mounted securely, readable, not damaged, and not obstructed.
- Perform a full functional test of the detection, control, and release system to be certain the sequence of operation is correct, all detectors function as intended, electric manual release stations operate, abort switches operate, all electric valve actuators function properly, all alarm devices operate, all doors and dampers close, HVAC shuts down, and power shuts off to the hazard area. For detailed instructions follow procedures in the appropriate control system technical manual and consult NFPA 72.
- Reset all electric manual release stations, abort switches, the control panel, and all actuators. After the control panel has returned to normal with no trouble signals, no supervisory signals, and no alarm signals and all valve actuators have been reset, reconnect the discharge pipe/hose and reinstall all pneumatic, electric, and manual valve actuators following the procedures outlined in sections 5.3 through 5.5.

6.2.3 Five Year Maintenance

In addition to the monthly inspection, semiannual maintenance, and annual maintenance, the agent cylinders shall be thoroughly examined and the system discharge hoses shall be hydrostatically tested every five years.

All cylinders shall be visually examined in accordance with NFPA 2001 and the Compressed Gas Association Pamphlet C-6. Section 3; except that the cylinders need not be emptied or stamped while under pressure.

7 SYSTEM RECHARGE AND RESET

Those individuals responsible for maintenance of a Janus Fire Systems® FM-200® clean agent fire extinguishing system must be trained.

To maintain FM Approval cylinder recharge must be done at a Janus Fire Systems® recognized facility.

This chapter does not include instructions on resetting the automatic control system. Refer to the appropriate technical manual for this information.

7.1 Piping and Nozzles

High heat from a fire could damage piping and nozzles, and possibly pipe support members. Check all pipe supports and fittings for any signs of damage or corrosion. Remove nozzles from pipe and inspect for damage, corrosion, or obstructions. Clean nozzles and reinstall making certain to tighten and aim properly.

7.2 Recharging

Recharge consists of removing the cylinder, reconditioning and cleaning the valve assembly, and refilling and pressurizing the cylinder.

⚠ WARNING

Do not transport the cylinder unless the anti-recoil safety device is in place. Handle the cylinder assembly with care even when the safety device is in place.

Do not apply excessive force to the low-pressure supervisory switch or attempt to carry the cylinder assembly or valve assembly by the low-pressure switch. The low-pressure supervisory switch is not designed or intended to be used to carry the cylinder or valve. If the low-pressure supervisory switch breaks at the fitting agent will discharge through the port causing possible personal injury or property damage.

- Remove the electric and pneumatic valve actuators and install the shipping cap onto the valve actuation connection.
- Remove the empty cylinders by removing the discharge pipe/hose and installing the anti-recoil safety plug or device.
- Disconnect the low-pressure supervisory switch electrical connector.
- Disconnect the low-pressure supervisory switch and pressure gauge.
- Remove the cylinder from the bracket.

Section 7 System Recharge and Reset

⚠WARNING

Check the pressure gauge and cylinder weight to verify the cylinder is empty and at atmospheric pressure before attempting to remove the valve. Failure to comply could result in personal injury or death from violent cylinder movement or over-exposure to high concentrations of agent.

- Remove the valve assembly from the cylinder.
- Remove the dip tube from the valve assembly.
- Remove and discard the collar O-ring.
- Remove the top cap.
- Push the piston assembly up and out of the top of the valve body and discard.
- Clean all internal valve surfaces using caution not to scratch or nick the seating surfaces.
- Lightly lubricate the upper O-ring on the new piston and the internal valve bore with Dow Corning No. 4 or equivalent and insert into the valve body.
- Remove and discard the valve core from the valve cap assembly.
- Install a new valve core into the valve cap with a torque of 5 in.-lb. (0.56 N•m).
- To prevent damage to the valve cap O-ring during installation cover the threads of the valve cap with masking tape.
- Lightly lubricate the valve cap O-ring with Dow Corning No. 4 or equivalent and install on the valve cap.
- Remove masking tape from valve cap threads and clean the threads on the valve cap. Carefully thread the top cap onto the valve assembly. Tighten securely, do not apply excessive force.
- To prevent damage to the collar O-ring during installation cover the threads of the valve body with masking tape.
- Lightly lubricate the new collar O-ring with Dow Corning No. 4 or equivalent and install on the valve body.
- Clean the threads on the dip tube and thread into the valve body assembly. Tighten securely.
- Remove masking tape and clean the collar threads on the valve body. Clean the seating surface of the cylinder collar. Install valve assembly into cylinder, tighten securely.
- Follow the procedures outlined in the technical manual supplied with the recharge station to fill the cylinder to the correct amount by weight. See nameplate for fill weight and fill to a minimum of the stamped fill weight and no more than ¼ pound (4 oz) (113 g) above the stamped fill weight.
- Pressurize cylinder with dry nitrogen to required pressure based on the ambient temperature. Forcefully agitate the cylinder while pressurizing so the agent can absorb nitrogen. Add nitrogen as necessary until the required pressure is reached.

- Once required pressure is reached, use the valve closing adapter (P/N 17292) to close the valve. The procedure to close the valve is:
  1) Close the ball valve controlling flow of agent and nitrogen through the valve outlet.
  2) Set the regulator on the nitrogen supply used to close the valve to 550 psi (38 bar).
  3) Momentarily open the ball valve controlling nitrogen flow to the recharge adapter. The ball valve should not remain open for more than 2 seconds to avoid over pressurizing the cylinder. Close ball valve after step 4 is completed.
  4) Vent the pressure from the recharge fitting attached to the valve outlet by opening and closing the vent ball valve. Immediately close the ball valve opened in step 3.
  5) Once the pressure is removed from the outlet adapter the system cylinder valve should be closed.
  6) Open the vent ball valve at the outlet adapter. Absence of pressure verifies that the valve is closed. If pressure is present, close the vent valve immediately and repeat the valve closing procedure starting at step 2.
- Let cylinder assembly stand for 3 hours and check for leaks using a soap solution.
- Check cylinder gauge pressure based on pressure temperature chart.
- Weigh cylinder assembly to be certain the filled weight is correct and equal to the total weight shown on the cylinder label.
- Replace the charged cylinder in the bracket and follow procedures outlined in Section 4 and Section 5 to reinstall the system.
- Inform appropriate personnel that the system is back in service.

Appendix A

Material Safety Datasheet

The MSDS format adheres to the standards and regulatory requirements of the United States and may not meet regulatory requirements in other countries.

Janus Fire Systems Page 1
Material Safety Data Sheet

FM-200
MSDS101 Revised 29-JUN-2009

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

FM-200 is a registered trademark of DuPont.

CAS Number	:	431-89-0
Formula	:	CF3 CHF CF3
Molecular Weight	:	170.03
CAS Name	:	Propane, 1,1,1,2,3,3,3-Heptafluoro-

Tradenames and Synonyms

FM200
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

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont Fluoroproducts
1007 Market Street
Wilmington, DE 19898

PHONE NUMBERS

Product Information	:	1-800-441-7515 (outside the U.S. 302-774-1000)
Transport Emergency	:	CHEMTREC 1-800-424-9300(outside U.S. 703-527-3887)
Medical Emergency	:	1-800-441-3637 (outside the U.S. 302-774-1000)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
1,1,1,2,3,3,3-Heptafluoropropane	431-89-0	99.95

HAZARDS IDENTIFICATION

Potential Health Effects

Based on animal data, overexposure to FM-200 by inhalation may cause suffocation, if air is displaced by vapors, and irregular heart beat with a strange sensation in the chest, "heart thumping," apprehension, lightheadedness, feeling of fainting, dizziness, weakness, sometimes progressing to loss of consciousness and death.

FM-200 may cause frostbite if liquid or escaping vapor contacts the skin.

FM-200 may cause "frostbite-like" effects if the liquid or escaping vapors contact the eyes.

In one study, human volunteers were selected to inhale FM-200 at a concentration of 6000 ppm but the study was terminated due to a rise in pulse rate that was believed to be unrelated to the chemical. In a subsequent study with human volunteers inhaling concentrations up to 8000 ppm no clinically significant effects were observed for any of the measured laboratory parameters.

Individuals with preexisting diseases of the cardiovascular system or nervous system may have increased susceptibility from excessive exposures.

Carcinogenicity Information

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

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, immediately remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

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. Call a physician.

(FIRST AID MEASURES - Continued)

INGESTION

Ingestion is not considered a potential route of exposure.

FIRE FIGHTING MEASURES

Flammable Properties

1,1,1,2,3,3,3-Heptafluoropropane is not flammable, however in the presence of a flame or ignition source it may decompose to form toxic hydrogen fluoride or carbonyl fluoride.

Non-flammable.

Extinguishing Media

Use media appropriate for surrounding material.

Fire Fighting Instructions

Self-contained breathing apparatus (SCBA) may be required if cylinders rupture or release under fire conditions.

Keep cylinders cool with water spray applied from a safe distance.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

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

Evacuate personnel, thoroughly ventilate area, use self-contained breathing apparatus. Keep upwind of leak - evacuate until gas has dispersed.

Initial Containment

Use forced ventilation to disperse vapors.

HANDLING AND STORAGE

Handling (Personnel)

Do not breathe gas. Avoid contact with eyes, skin, or clothing. Wash thoroughly after handling. Wash clothing after use.

Storage

Store in a clean, dry place. Store below 52 C (126 F).

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use only with adequate ventilation. Keep container tightly closed.

Personal Protective Equipment

EYE/FACE PROTECTION

Wear safety glasses or coverall chemical splash goggles.

RESPIRATORS

Wear NIOSH approved respiratory protection, as appropriate.

PROTECTIVE CLOTHING

Where there is potential for skin contact have available and wear as appropriate impervious gloves, apron, pants, and jacket.

Exposure Guidelines

Exposure Limits
FM-200
AEL * (DuPont) : 1000 ppm, 8 & 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.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Boiling Point	: -16.4 C (2.5 F)
Melting Point	: -131 C (-204 F)
Vapor Pressure	: 65.7 psia @ 25 C (77 F) (453.3 kPa)
Liquid Density	: 1.386 g/cm3 @ 25 C (77 F) (86.53 lb/ft3)
Critical temperature	: 101.6 C (214.9 F)
Critical pressure	: 424.7 psia (2930 kPa)
Odor	: None.

(PHYSICAL AND CHEMICAL PROPERTIES - Continued)

Form : Liquified Gas

STABILITY AND REACTIVITY

Chemical Stability

Stable at normal temperatures and storage conditions.

Avoid sources of heat or open flame.

Incompatibility with Other Materials

Incompatible with strong reducing agents such as alkali metals (e.g., sodium, potassium), alkali-earth metals (e.g., magnesium, calcium), and powdered aluminum or zinc.

Decomposition

Decomposes by reaction with high temperature (open flames, glowing metal surfaces, etc.) forming hydrofluoric acid, carbonyl fluorides, carbon monoxide and carbon dioxide.

Polymerization

Polymerization will not occur.

TOXICOLOGICAL INFORMATION

Animal Data

FM-200:

Inhalation 4 hour LC50: > 788,698 ppm in rats

Repeated exposure of rats by inhalation for 4 weeks at concentrations up to 50,000 ppm revealed no toxicologically significants effects. The NOEL for this study was 50,000 ppm. A 90-day inhalation study in rats did not find any exposure related effects at 105,000 ppm. The NOEL for this study was 105,000 ppm.

Cardiac sensitization, a potentially fatal disturbance of heart rhythm associated with a heightened sensitivity to the action of epinephrine, occurred in dogs at 105,000 ppm. The NOAEL for cardiac sensitization was 90,000 ppm. In a different study to evaluate cardiac sensitization in dogs, concentrations of 90,000, 105,000, and 140,000 ppm caused a dose-related increase in incidence and severity; at 90,000 ppm efffects were minimal or mild in nature.

Inhalation studies in rabbits and rats do not suggest developmental toxicity at concentrations up to

MSDS101 Janus Fire Systems Page 6
Material Safety Data Sheet

(TOXICOLOGICAL INFORMATION - Continued)

105,000 ppm. Tests have shown that FM-200 does not cause genetic damage in bacterial or mammalian cell cultures. Tests in animals for carcinogenicity or reproductive toxicity have not been conducted.

DISPOSAL CONSIDERATIONS

Waste Disposal

Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations. Incinerate material in accordance with Federal, State/Provincial and Local requirements.

TRANSPORTATION INFORMATION

Shipping Information

DOT		DOT	
Proper Shipping Name	: Heptafluoropropane	Proper Shipping Name	: Fire Extinguishers
Hazard Class	: 2.2	Hazard Class	: 2.2
I.D. No. (UN/NA)	: UN 3296	I.D. No. (UN/NA)	: UN 1044
DOT Label(s)	: Nonflammable Gas	DOT Label(s)	: Nonflammable Gas

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Listed.

TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

Acute : Yes
Chronic : No
Fire : No
Reactivity : No
Pressure : No

OTHER INFORMATION

NFPA, NPCA-HMIS

NFPA Rating
Health : 1
Flammability : 0
Reactivity : 1

NPCA-HMIS Rating
Health : 1
Flammability : 0

Material Safety Data Sheet

(Continued)

Reactivity : 0

Personal Protection rating to be supplied by user depending on use conditions.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

```
Responsibility for MSDS : MSDS Coordinator
>                       : Janus Fire Systems
Address                 : Crown Point, IN 46307
Telephone               : (219) 663-1600
```

This information is based upon technical information believed to be reliable. It is subject to revision as additional knowledge and experience is gained.

End of MSDS

Appendix B

Assorted Charts & Worksheets

Appendix B

B.1 Design Worksheet

U.S. Standard

FM-200® Surface Fire Requirements

Class A / Class C

Project:		**Date:**	
Hazard:		**Engineer:**	

Required FM-200® – UL (6.25% Concentration)

Volume		Design Concentration Factor @ 70°F		FM-200® Weight Sea Level		Altitude Correction Factor[1]		Required Weight FM-200®	
	ft^3 x	.0302	=		lbs x		=		lbs

Required FM-200® – FM (7% Concentration)

Volume		Design Concentration Factor @ 70°F		FM-200® Weight Sea Level		Altitude Correction Factor[1]		Required Weight FM-200®	
	ft^3 x	.0341	=		lbs x		=		lbs

Note: For other design concentrations or ambient temperatures use the formula located in section 3.2.

Storage Requirements

Required Weight FM-200®		Number of Cylinders		Weight per Cylinder	
	lbs /		=		lbs / cylinder[2]

	Cylinders Main		Cylinders Reserve

Qty	Series Valve	Nominal Cylinder Size	Fill Capacity		Qty	Series Valve	Nominal Cylinder Size	Fill Capacity	
			Minimum	Maximum				Minimum	Maximum
	Sv	40 lb	22 lbs	49 lbs		Mv	420 lb	211 lbs	422 lbs
	Sv	80 lb	41 lbs	81 lbs		Lv	600 lb	304 lbs	607 lbs
	Sv	130 lb	66 lbs	131 lbs		Lv	900 lb	455 lbs	910 lbs
	Mv	250 lb	138 lbs	274 lbs		Lv	1000 lb	619 lbs	1000 lbs

1 See Table 3.1.4 for altitude correction factor.
2 Agent weights must be rounded UP to the nearest whole pound when ordering for filling purposes.

B.2 Design Worksheet

Metric

FM-200® Surface Fire Requirements

Class A / Class C

Project:		**Date:**	
Hazard:		**Engineer:**	

Required FM-200® – UL (6.25% Concentration)

Volume		Design Concentration Factor @ 21.1°C		FM-200® Weight Sea Level		Altitude Correction Factor[1]		Required Weight FM-200®	
	m^3 x	.4850	=		kg x		=		kg

Required FM-200® – FM (7% Concentration)

Volume		Design Concentration Factor @ 21.1°C		FM-200® Weight Sea Level		Altitude Correction Factor[1]		Required Weight FM-200®	
	m^3 x	.5476	=		kg x		=		kg

Note: For other design concentrations or ambient temperatures use the formula located in section 3.2.

Storage Requirements

Required Weight FM-200®		Number of Cylinders		Weight per Cylinder	
	kg /		=		kg / cylinder[2]

	Cylinders Main		Cylinders Reserve

Qty	Series Valve	Nominal Cylinder Size	Fill Capacity		Qty	Series Valve	Nominal Cylinder Size	Fill Capacity	
			Minimum	Maximum				Minimum	Maximum
	Sv	40 lb	22 lbs (10.0 kg)	49 lbs (19.5 kg)		Mv	420 lb	211 lbs (95.7 kg)	422 lbs (191.4 kg)
	Sv	80 lb	41 lbs (18.6 kg)	81 lbs (36.7 kg)		Lv	600 lb	304 lbs (137.9 kg)	607 lbs (275.3 kg)
	Sv	130 lb	66 lbs (29.9 kg)	131 lbs (59.4 kg)		Lv	900 lb	455 lbs (206.4 kg)	910 lbs (412.8 kg)
	Mv	250 lb	138 lbs (62.6 kg)	274 lbs (124.3 kg)		Lv	1000 lb	619 lbs (280.8 kg)	1000 lbs (453.6 kg)

1 See Table 3.1.4 for altitude correction factor.
2 Agent weights calculated using metric measurements must be converted to pounds and rounded UP to the nearest whole pound when ordering for filling purposes. See Table B.2a for conversion factors.

Appendix B

TABLE 3.2a FM-200® (HFC-227ea) TOTAL FLOODING QUANTITY (U.S. STANDARD)										
Temp (*t*) [°F][b]	FM-200® Specific Vapor Volume (*s*) [ft^3/lb][c]	FM-200® Weight Requirements of Hazard Volume, W/V (lb/ft^3)[a]								
		FM-200® Design Concentration (*C*) [% by Volume][d]								
		6.25%	6.8%	7%	7.6%	8%	9%	10%	10.5%	11%
10	1.9264	0.0345	0.0378	0.0391	0.0426	0.0451	0.0513	0.0570	0.0608	0.0642
20	1.9736	0.0337	0.0369	0.0381	0.0416	0.0441	0.0501	0.0563	0.0593	0.0626
30	2.0210	0.0330	0.0361	0.0372	0.0407	0.0430	0.0489	0.0550	0.0580	0.0612
40	2.0678	0.0322	0.0353	0.0364	0.0398	0.0421	0.0478	0.0537	0.0567	0.0598
50	2.1146	0.0315	0.0345	0.0356	0.0389	0.0411	0.0468	0.0525	0.0555	0.0584
60	2.1612	0.0308	0.0338	0.0348	0.0381	0.0402	0.0458	0.0514	0.0543	0.0572
70	2.2075	0.0302	0.0331	0.0341	0.0373	0.0394	0.0448	0.0503	0.0532	0.0560
80	2.2538	0.0296	0.0324	0.0334	0.0365	0.0386	0.0439	0.0493	0.0521	0.0548
90	2.2994	0.0290	0.0317	0.0327	0.0358	0.0378	0.0430	0.0483	0.0510	0.0538
100	2.3452	0.0284	0.0311	0.0321	0.0351	0.0371	0.0422	0.0474	0.0500	0.0527
110	2.3912	0.0279	0.0305	0.0315	0.0344	0.0364	0.0414	0.0465	0.0491	0.0517
120	2.4366	0.0274	0.0299	0.0309	0.0338	0.0357	0.0406	0.0456	0.0481	0.0507
130	2.4820	0.0268	0.0294	0.0303	0.0331	0.0350	0.0398	0.0448	0.0472	0.0498
140	2.5272	0.0264	0.0288	0.0298	0.0325	0.0344	0.0391	0.0440	0.0464	0.0489
150	2.5727	0.0259	0.0283	0.0293	0.0319	0.0338	0.0384	0.0432	0.0456	0.0480

[a] *W / V* [agent weight requirements (lb/ft^3)] - pounds of agent required per cubic foot of protected volume to produce indicated concentration at temperature specified.

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

[b] *t* [temperature (°F)] - the design temperature in the hazard area.

[c] *s* [specific volume (ft^3/lb)] - specific volume of superheated FM-200® vapor may be approximated by the formula:
$s = 1.885 + 0.0046t$
where t = temperature (°F)

[d] *C* [concentration (%)] - volumetric concentration of FM-200® in air at the temperature indicated.

TABLE 3.2b FM-200® (HFC-227ea) TOTAL FLOODING QUANTITY (METRIC)										
Temp (*t*) [°C][b]	FM-200® Specific Vapor Volume (*s*) [m^3/kg][c]	FM-200® Weight Requirements of Hazard Volume, *W/V* (kg/m^3)[a] — FM-200® Design Concentration (*C*) [% by Volume][d]								
		6.25%	6.8%	7%	7.6%	8%	9%	10%	10.5%	11%
-10	0.1215	0.5469	0.5985	0.6196	0.6747	0.7158	0.8142	0.9147	0.9624	1.0174
-5	0.1241	0.5359	0.5865	0.6064	0.6612	0.7005	0.7987	0.8951	0.9431	0.9957
0	0.1268	0.5253	0.5750	0.5936	0.6482	0.6858	0.7800	0.8763	0.9245	0.9748
5	0.1294	0.5152	0.5638	0.5816	0.6356	0.6719	0.7642	0.8586	0.9066	0.9550
10	0.1320	0.5054	0.5532	0.5700	0.6236	0.6585	0.7490	0.8414	0.8894	0.9360
15	0.1347	0.4960	0.5429	0.5589	0.6120	0.6457	0.7344	0.8251	0.8729	0.9178
20	0.1373	0.4870	0.5330	0.5483	0.6008	0.6335	0.7205	0.8094	0.8570	0.9004
25	0.1399	0.4782	0.5234	0.5382	0.5900	0.6217	0.7071	0.7944	0.8416	0.8837
30	0.1425	0.4698	0.5142	0.5284	0.5796	0.6104	0.6943	0.7800	0.8268	0.8676
35	0.1450	0.4617	0.5053	0.5190	0.5696	0.5996	0.6819	0.7661	0.8125	0.8522
40	0.1476	0.4538	0.4967	0.5099	0.5599	0.5891	0.6701	0.7528	0.7986	0.8374
45	0.1502	0.4462	0.4884	0.5012	0.5505	0.5790	0.6586	0.7399	0.7853	0.8230
50	0.1527	0.4389	0.4803	0.4929	0.5415	0.5694	0.6476	0.7276	0.7723	0.8093
55	0.1553	0.4318	0.4725	0.4847	0.5327	0.5600	0.6369	0.7156	0.7598	0.7960
60	0.1578	0.4249	0.4650	0.4770	0.5242	0.5510	0.6267	0.7041	0.7477	0.7832

[a] *W / V* [agent weight requirements (kg/m^3)] - pounds of agent required per cubic foot of protected volume to produce indicated concentration at temperature specified.

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

[b] *t* [temperature (°C)] - the design temperature in the hazard area.

[c] *s* [specific volume (m^3/kg)] - specific volume of superheated FM-200® vapor may be approximated by the formula:
$s = 0.1269 + 0.0005t$
where t = temperature (°C)

[d] *C* [concentration (%)] - volumetric concentration of FM-200® in air at the temperature indicated.

Appendix B

Table 3.1.1a 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
I-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

Table 3.1.1a 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* 77.00% octane gaso-line 8.00% isobutynol 14.90% methanol 0.10% H2O	9.49

* Value determined in ISO cup burner testing (ISO 14520-1:2000, Annex B.)

Appendix B

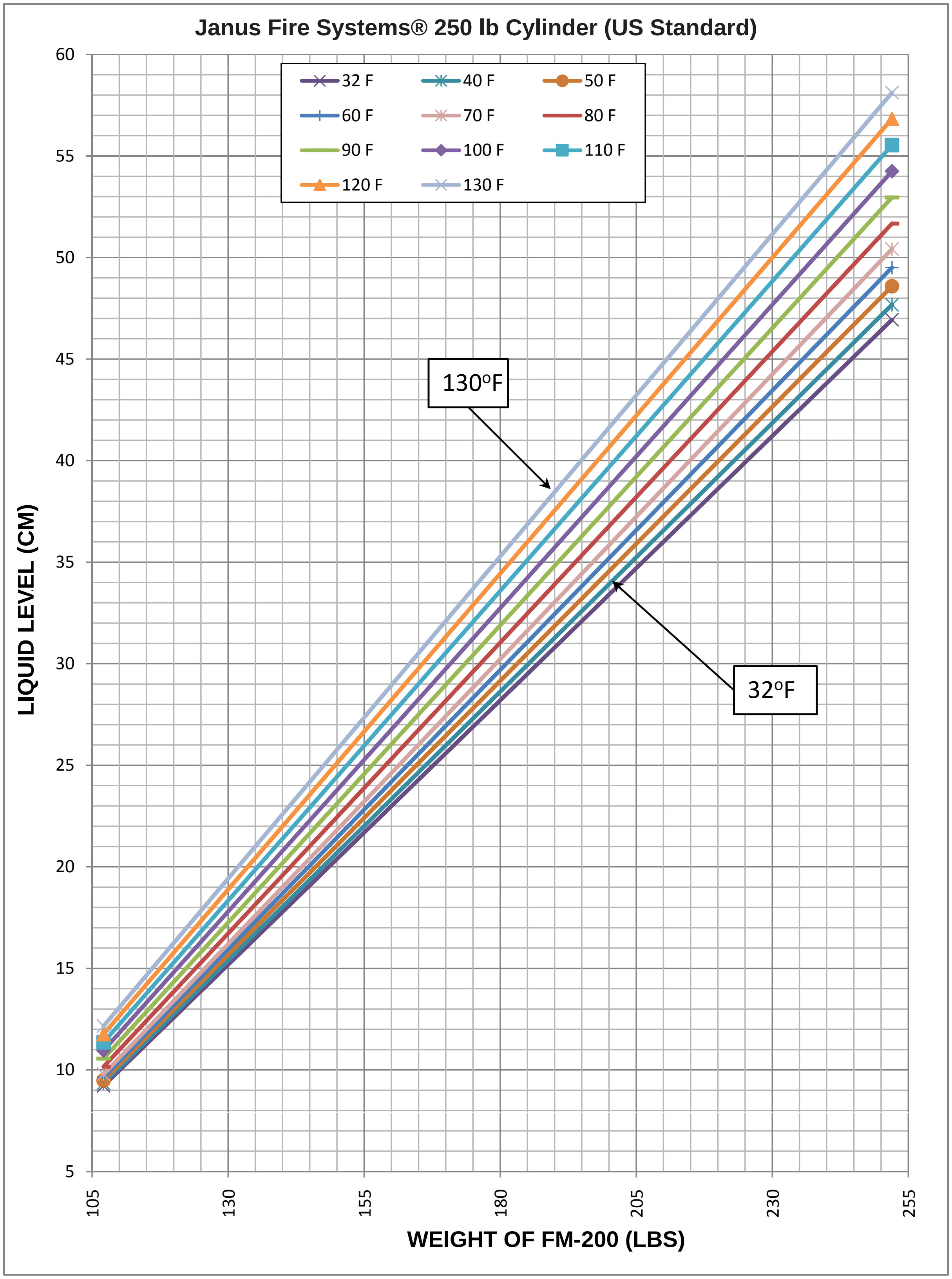
Table 3.1.1b FM-200® Inerting Concentrations	
Fuel Source	**Design Concentration % v/v**
i-Butane	12.43
1-Chloro-1,1-difluoroethane (HCFC-142b)	8.71
1,1-Difluoroethane (HFC-152a)	9.46
Difluoromethane (HFC-32)	8.71
Ethylene oxide	14.96
Hydrogen	26.40
Methane	8.80
Pentane	12.76
Propane	12.76

Table 6.2.1.1 - Approximate Container Pressure vs. Temperature					
Temperature		**Pressure**		**90% Pressure**	
°F	**°C**	**psig**	**bar**	**psig**	**bar**
32	0.0	288 (284)	19.86 (19.56)	259 (256)	17.87 (17.62)
40	4.4	303	20.89	273	18.80
50	10	321	22.13	289	19.92
60	15.6	340	23.44	306	21.10
70	21.1	360	24.82	324	22.34
80	26.7	381	26.27	343	23.64
90	32.2	402	27.72	362	24.95
100	37.8	425	29.30	383	26.37
110	43.3	449	30.96	404	27.86
120	48.9	475	32.75	428	29.48

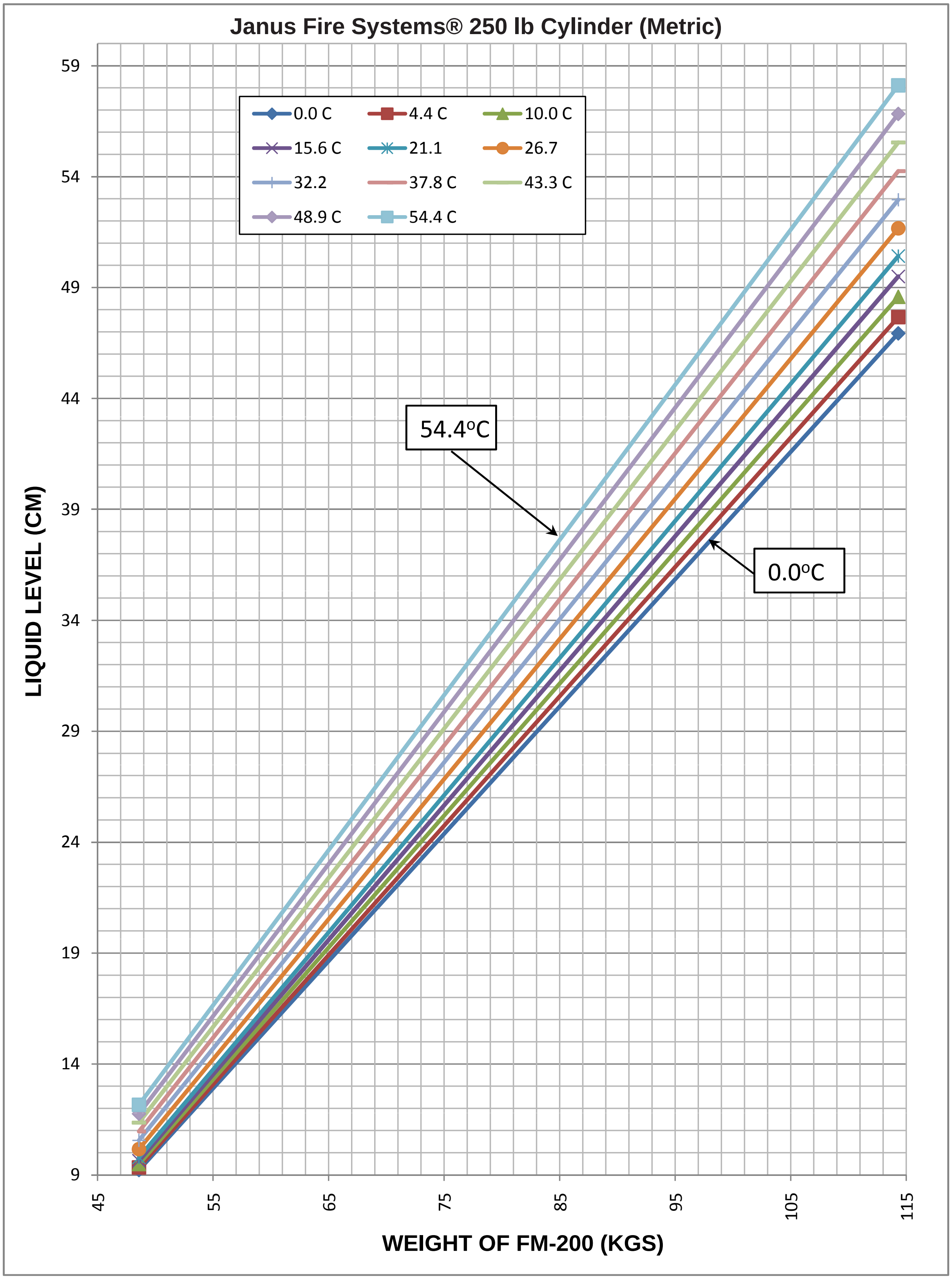
Table B.1a U.S. Standard to Metric Conversion Factors (Approximate)			
Measure	U.S. Standard	Multiply By	Metric
Length	inches (in)	25.4	millimeters (mm)
	feet (ft)	304.8	millimeters (mm)
	feet (ft)	0.3048	meters (m)
Area	square inches (in^2)	645.16	square millimeters (mm^2)
	square feet (ft^2)	0.0929	square meters (m^2)
Weight (mass)	ounces (oz)	28.349	grams (g)
	pounds (lb)	0.4536	kilograms (kg)
Volume	cubic inches (in^3)	16387.06	cubic millimeters (mm^3)
	fluid ounces (fl oz)	29.57	milliliters (mL)
	cubic feet (ft^3)	0.0283	cubic meters (m^3)
Pressure	inches of mercury (inHG)	3.453	kilopascals (kPa)
	pounds per square inch (psi)	6.895	kilopascals (kPa)
	pounds per square inch (psi)	0.0689	bar (bar)
Temperature	degrees Fahrenheit (°F)	5/9 (after subtracting 32)	degrees Celsius (°C)

Table B.2a Metric to U.S. Standard Conversion Factors (Approximate)			
Measure	Metric	Multiply By	U.S. Standard
Length	millimeters (mm)	0.0394	inches (in)
	millimeters (mm)	0.00328	feet (ft)
	meters (m)	3.2808	feet (ft)
Area	square millimeters (mm^2)	0.00155	square inches (in^2)
	square meters (m^2)	10.764	square feet (ft^2)
Weight (mass)	grams (g)	0.03527	ounces (oz)
	kilograms (kg)	2.205	pounds (lb)
Volume	cubic millimeters (mm^3)	0.00006102	cubic inches (in^3)
	milliliters (mL)	0.0338	fluid ounces (fl oz)
	cubic meters (m^3)	35.336	cubic feet (ft^3)
Pressure	kilopascals (kPa)	0.2896	inches of mercury (inHG)
	kilopascals (kPa)	0.1450	pounds per square inch (psi)
	bar (bar)	14.5138	pounds per square inch (psi)
Temperature	degrees Celsius (°C)	9/5 (after adding 32)	degrees Fahrenheit (°F)

Appendix B

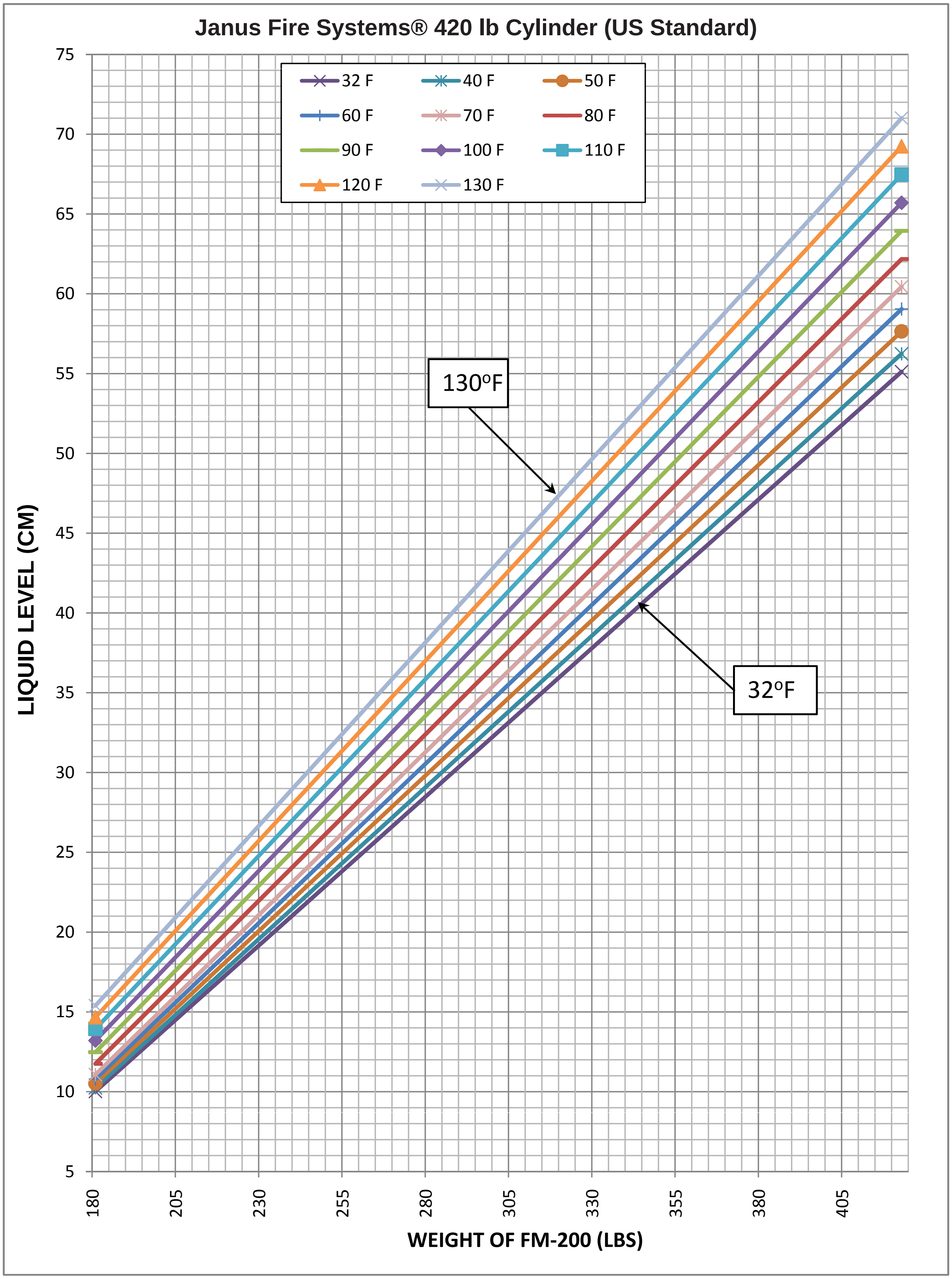


6.1.1a Liquid Level Chart – 250 lb Cylinder (U.S. Standard)

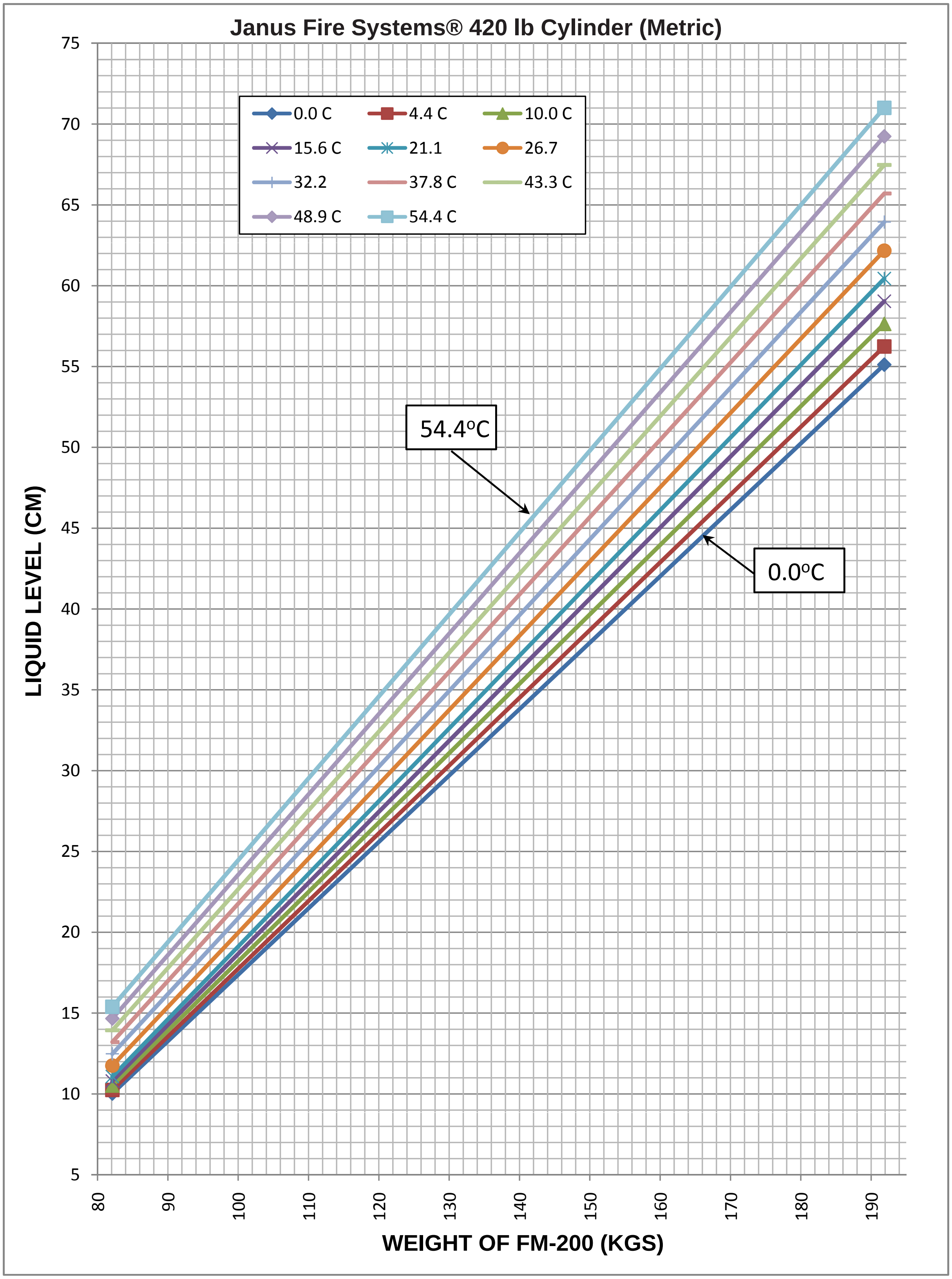


6.1.1b Liquid Level Chart – 250 lb Cylinder (Metric)

Appendix B

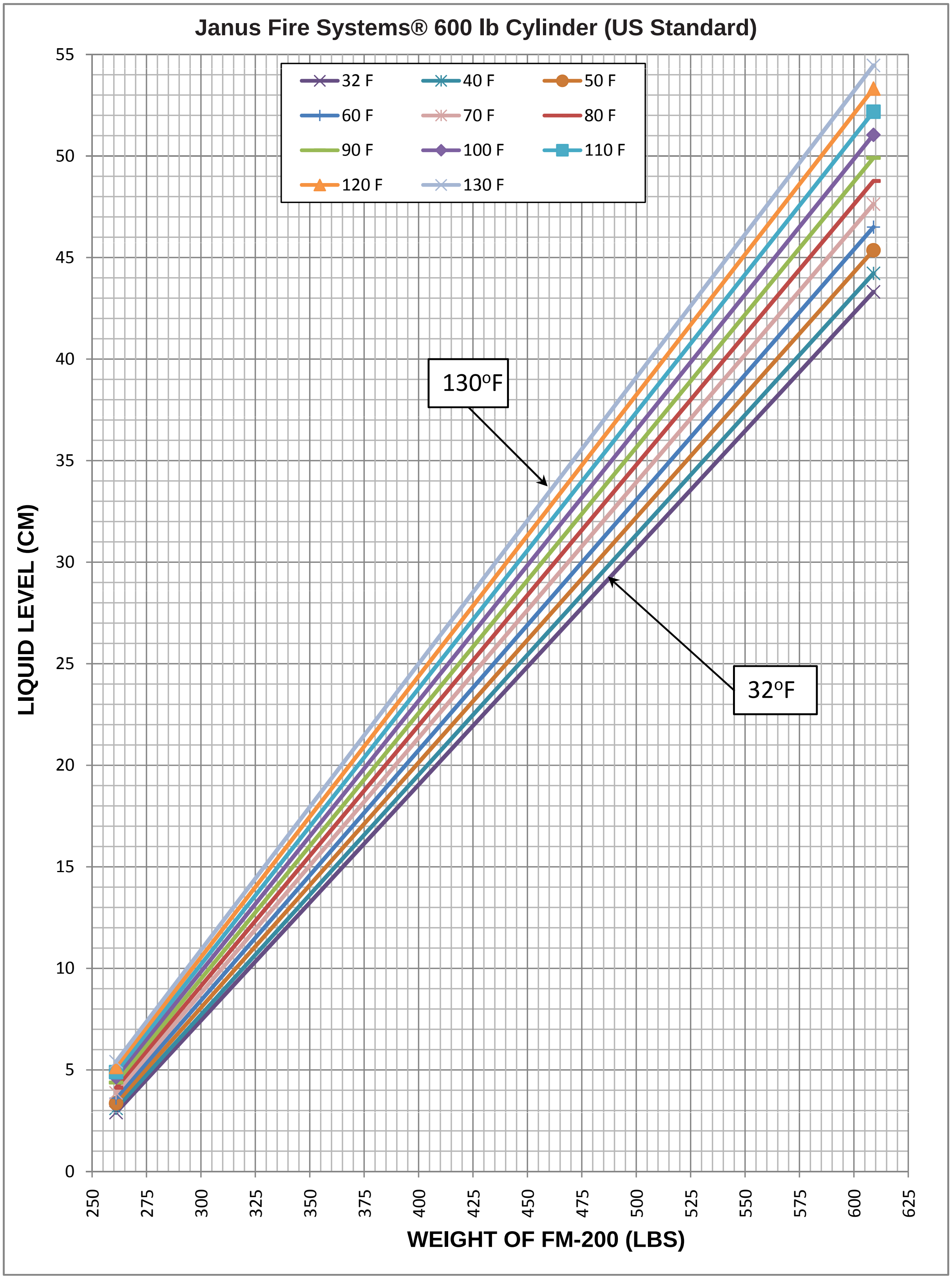


6.1.1c Liquid Level Chart – 420 lb Cylinder (U.S. Standard)

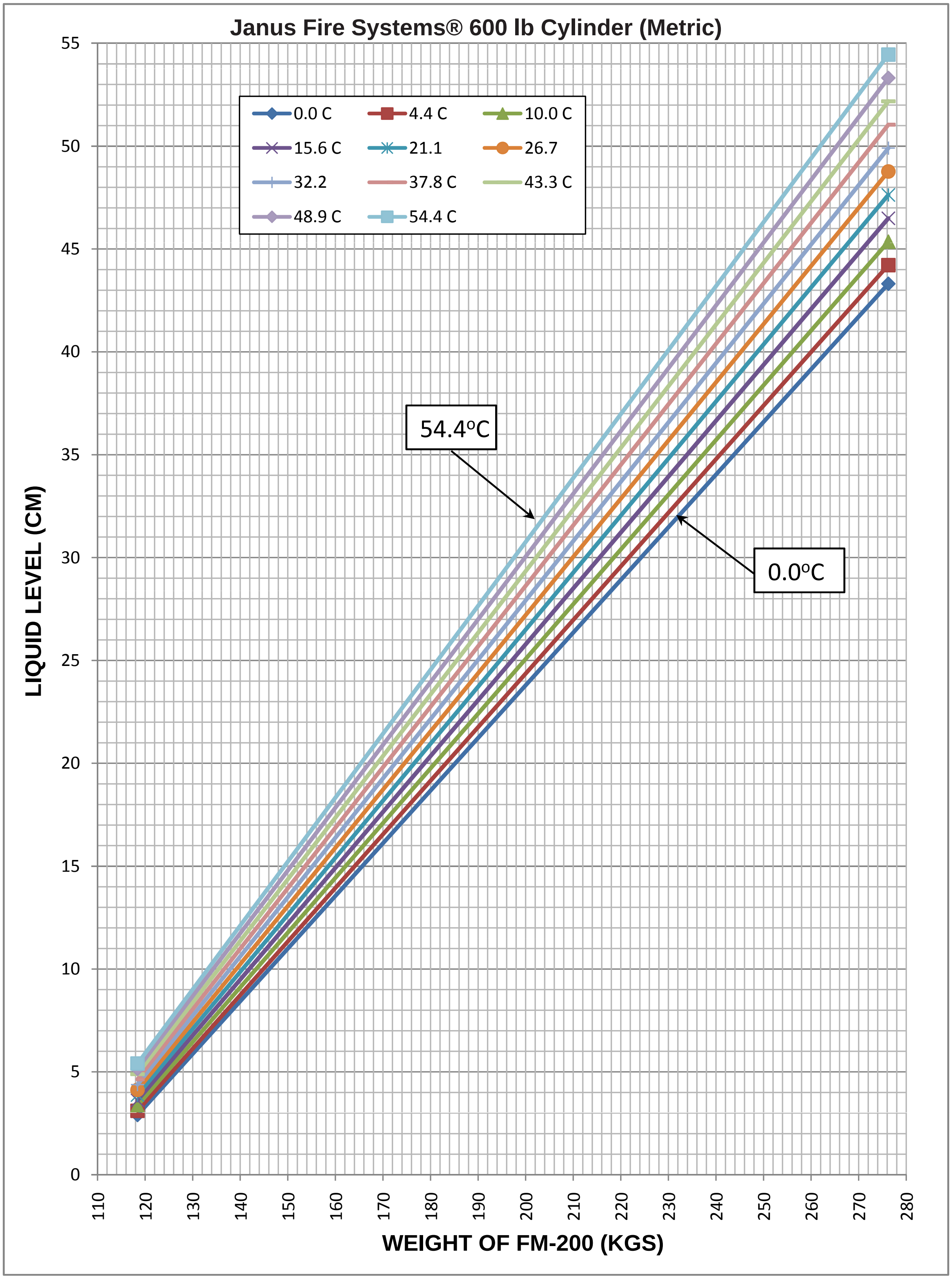


6.1.1d Liquid Level Chart – 420 lb Cylinder (Metric)

Appendix B

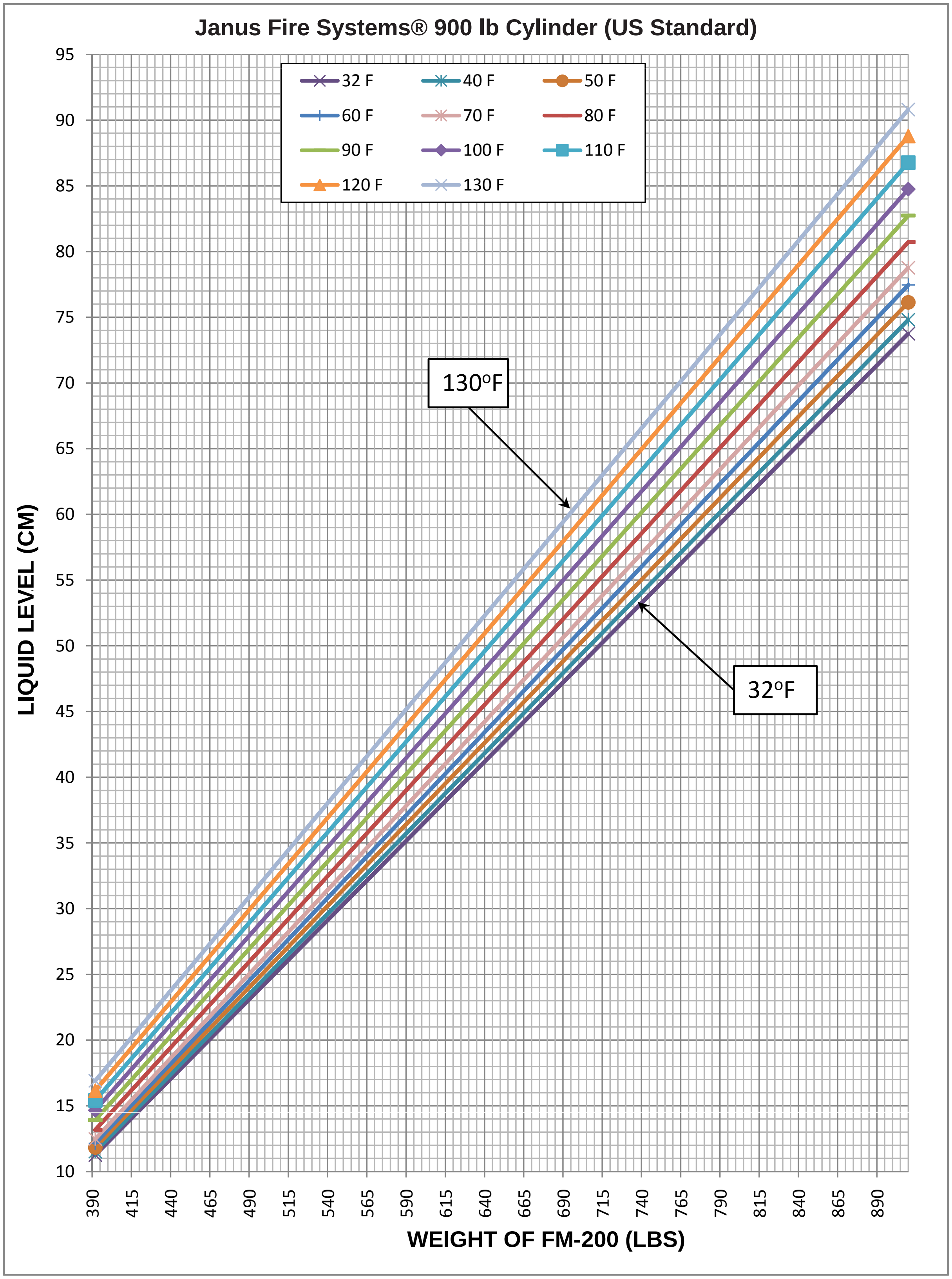


6.1.1e Liquid Level Chart – 600 lb Cylinder (U.S. Standard)

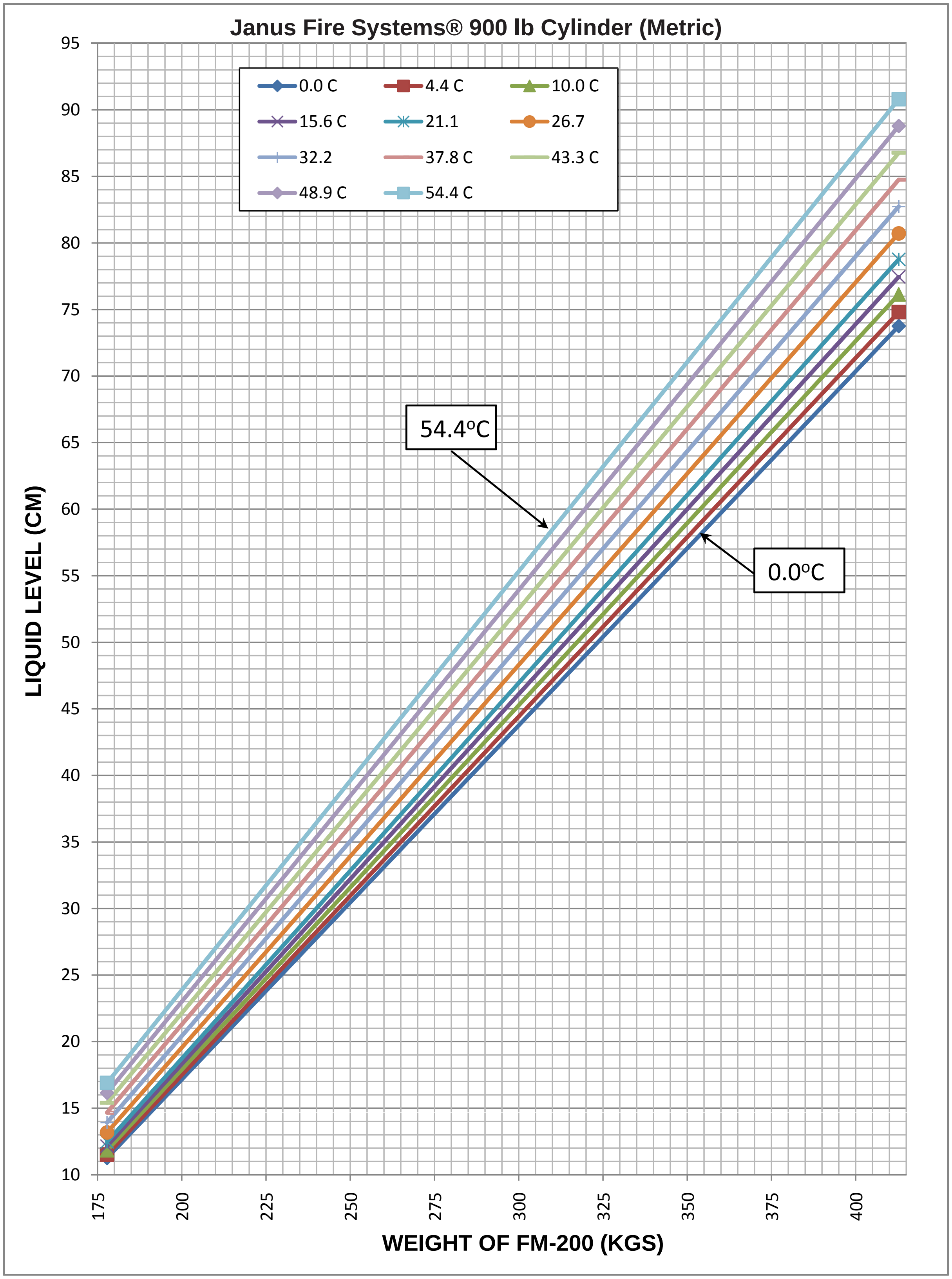


6.1.1f Liquid Level Chart – 600 lb Cylinder (Metric)

Appendix B

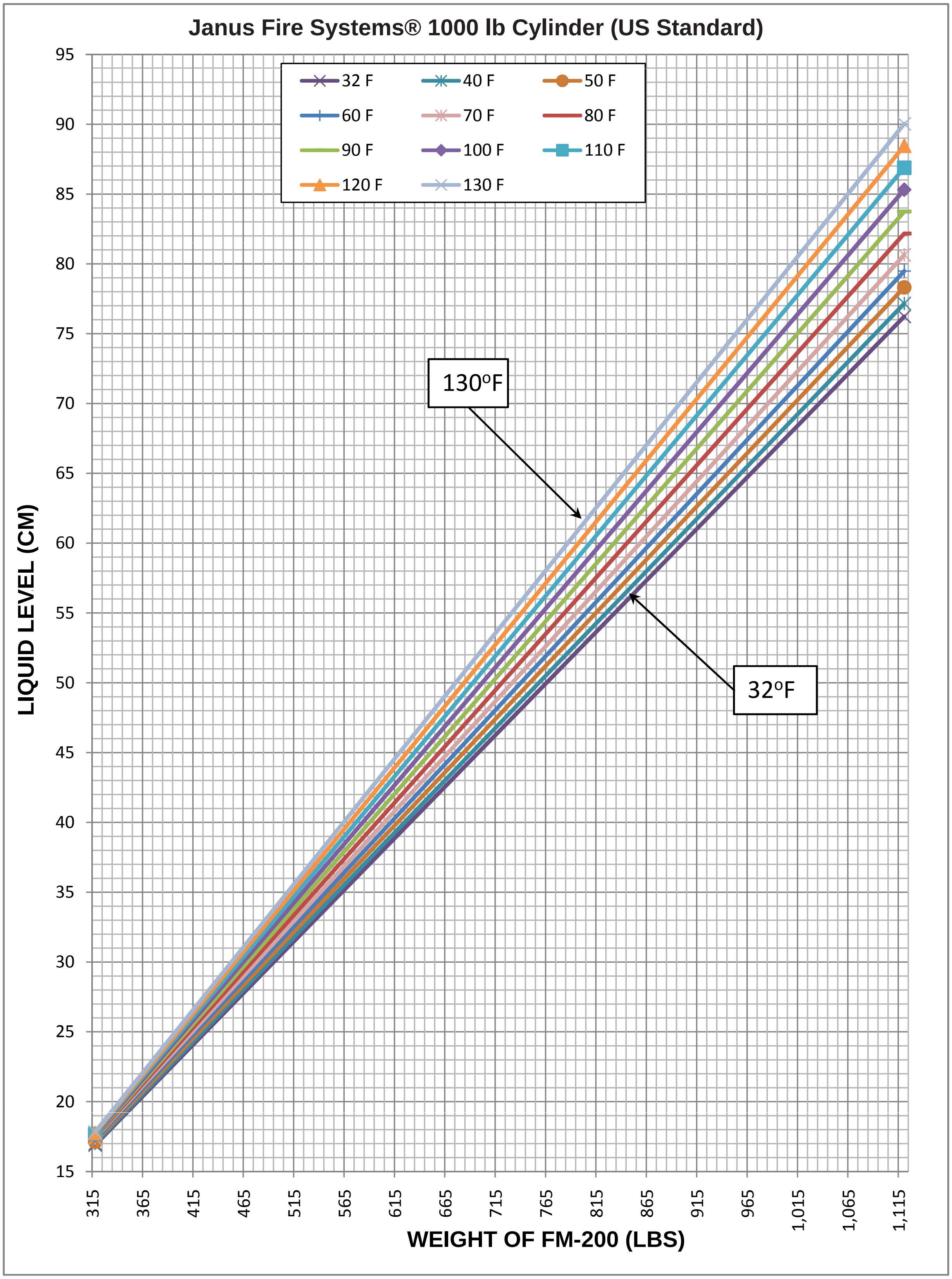


6.1.1g Liquid Level Chart – 900 lb Cylinder (U.S. Standard)

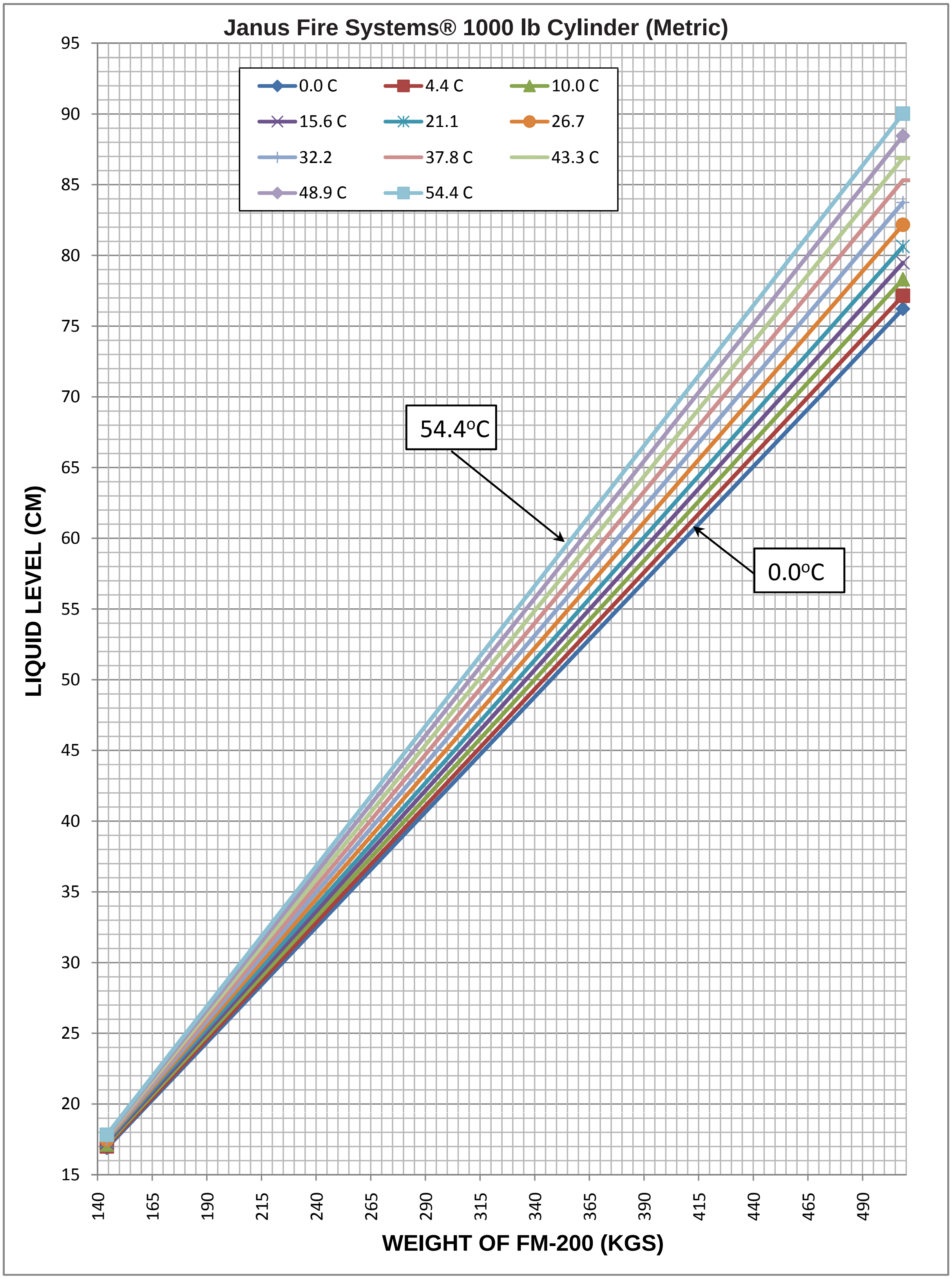


6.1.1h Liquid Level Chart – 900 lb Cylinder (Metric)

Appendix B



6.1.1i Liquid Level Chart – 1000 lb Cylinder (U.S. Standard)



6.1.1j Liquid Level Chart – 1000 lb Cylinder (Metric)