CHEMETRON™

Fire Systems

FM-200™

SIGMA SERIES

ENGINEERED SYSTEMS

DESIGN, INSTALLATION, OPERATION & MAINTENANCE MANUAL

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Foreword

Chemetron Fire Systems reserves the right to revise and improve its products as it deems necessary without notification. This publication is intended to describe the state of this product at the time of its publication, and may not reflect the product at all times in the future.

This technical manual provides the necessary information for the design, installation, operation and maintenance of a Chemetron FM-200 Sigma Series Engineered System. This is a single volume technical manual arranged in 6 sections, followed by an Appendix.

IMPORTANT

CHEMETRON FM-200 SYSTEMS, MANUFACTURED BY CHEMETRON FIRE SYSTEMS, ARE TO BE DESIGNED, INSTALLED, MAINTAINED AND TESTED BY QUALIFIED, TRAINED PERSONNEL IN ACCORDANCE WITH THE FOLLOWING STANDARDS OR REGULATIONS.

- INSTRUCTIONS AND LIMITATIONS OF THIS MANUAL.
- NFPA 2001, STANDARD ON CLEAN AGENT FIRE EXTINGUISHING SYSTEMS
- NFPA 70, NATIONAL ELECTRICAL CODE
- NFPA 72, NATIONAL FIRE ALARM CODE
- STORAGE, HANDLING, TRANSPORTATION, SERVICE AND MAINTENANCE OF CYLINDER ASSEMBLIES SHALL ONLY BE BY PERSONNEL TRAINED IN THE PROPER PROCEDURES IN ACCORDANCE WITH COMPRESSED GAS ASSOCIATION (CGA) PAMPHLETS C-1, C-6, G-6 AND P-1.

  CGA PAMPHLETS ARE PUBLISHED BY THE COMPRESSED GAS ASSOCIATION, 1235 JEFFERSON DAVIS HIGHWAY, ARLINGTON, VA 22202.

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General Comments

- Factory Mutual Research Corporation (FMRC) does not accept metric unit calculations. They will not be approved for Factory Mutual installations.
- FM-200 Systems using concentrations below 6.25% are not UL & ULC Listed nor Factory Mutual Approved.
- UL, ULC & FMRC require multiple tiers of nozzles for heights above 16' 0" (4.88 M).
- After an FM-200 system discharge, the FM-200 cylinder(s) should be returned to an authorized Chemetron filling location for recharge.
- Any undated reference to a Code or Standard appearing in this manual shall be interpreted as referring to the latest edition of that code or standard.

1 GENERAL INFORMATION AND SAFETY PRECAUTIONS

1.1 GENERAL

The Chemetron Sigma series systems are automatic fire suppression systems. These systems use the FM-200 (HFC-227ea) chemical agent and consist of three basic components. The basic components used for these systems are (refer to Figure 1.1):

- ➤ Storage/Distribution Components
- ➤ Control Panels
- ➤ Detection and Alarm Devices

1. The storage components consist of the agent containers, container supports (racks), piping and discharge nozzles for the distribution of the extinguishing agent.

2. The control panel is the brain of the system and is used to monitor the detection and accessories.

3. The detection, alarm devices, and accessories are the external devices that act as the eyes and voice of the system as they give audible or visual signals.

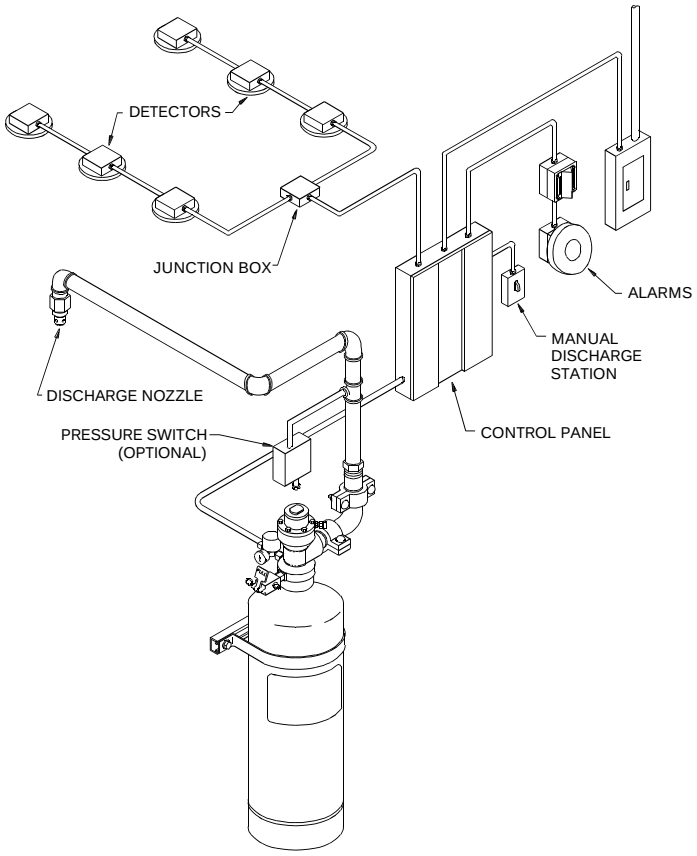


Figure 1.1 - FM-200 Typical Sigma System Components

The systems offer fire suppression in accordance with the National Fire Protection Association (NFPA) NFPA 2001 - Standard on Clean Agent Fire Extinguishing Systems, NFPA 70 - National Electrical Code, NFPA 72 - National Fire Alarm Code, and the guidelines contained in this manual. The system and its components should only be used for total flooding applications, **not local application protection.** A total flooding application can be defined as injecting FM-200 into a room, area, or compartment that has the structural integrity to retain the agent that has been discharged. The design of such a system requires that the FM-200 chemical agent be discharged from its container within 10 seconds and be thoroughly mixed throughout the room or area, reaching a minimum concentration level of 6.25% but not exceeding 9% in normally occupied spaces.

When designed and installed using the information contained in this manual, the system meets the approval of Factory Mutual Research Corporation (FMRC) and Underwriters Laboratories (UL & ULC). The flow calculation method has been verified based on an ambient temperature of 60°F (15.7°C) to 80°F (26.9°C). Installation of cylinder/valve assemblies outside this range for the ambient temperature limits of 32°F (0°C) to 130°F (54.4°C) may result in the calculation not being accurate and consequently, insufficient quantities of agent may be discharged from one or more nozzles.

FM-200 Sigma series systems can be designed in a variety of different arrangements. The most basic will be a single storage rack. The controls used for operation can be manual, automatic, or both.

NOTE

MANUAL-ONLY ACTUATION IS PERMITTED ONLY IF IT IS ACCEPTABLE TO THE AUTHORITY HAVING JURISDICTION (NFPA 2001).

The Chemetron Sigma series systems use FM-200 to suppress fires in specific equipment or hazards requiring an electrically non-conductive agent and that may be occupied. FM-200 may be used in the protection of the following types of facilities:

- Data processing
- Process control rooms
- Telecommunications facilities
- High value assets

FM-200 can be used in the hazards previously listed for Class C electrical fires, Class A surface burning fires where the potential for a deep-seated type fire condition does not exist, or Class B flammable liquid fires.

Clean agents shall not be used on fires involving the following materials unless they have been tested to the satisfaction of the authority having jurisdiction:

1) Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, that are capable of rapid oxidation in the absence of air

2) Reactive metals such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium

3) Metal hydrides

4) Chemicals capable of undergoing autothermal decomposition, such as certain organic peroxides or hydrazine.

1.2 Physical and Chemical Properties

FM-200 (CF_3CHFCF_3 - heptaflouropropane) is a compound that consists of carbon, fluorine and hydrogen. It is colorless, odorless, electrically non-conductive, and suppresses fire by interrupting the combustion process and affecting the available oxygen content in the area of the discharge.

FM-200 is clean, efficient, environmentally acceptable, and leaves no residue, thus minimizing any downtime after a fire. If exposed to temperatures greater than 1300°F, toxic products of decomposition (hydrogen fluoride) are formed. The system should be designed to discharge between a minimum discharge time of 5 seconds and a maximum discharge time of 10 seconds. The amount of toxic by-products formed during extinguishment of flames is greatly reduced by discharging the agent in less than 10 seconds. Most materials contained in areas protected by FM-200, such as aluminum, brass, rubber, plastics, steel, and electronic components, are unaffected when exposed to FM-200.

FM-200 is stored as a liquid in steel containers and superpressurized with nitrogen to 360 psig (2482 kPa) to increase its discharge flow characteristics. When discharged, FM-200 will vaporize at the discharge nozzles and effectively mix with the air throughout the protected area.

Table 1.2 - FM-200 (HFC-227ea) Physical Properties

Chemical Structure	CF_3CHFCF_3
Molecular Weight	170.0
Boiling Point @ 14.7 psia (760 mm Hg)	3°F (-16.4°C)
Freezing Point	-204°F (-131°C)
Critical Temperature	214.0°F (101.7°C)
Critical Pressure	422 psia (2909 kPa)
Critical Volume	0.0258 ft^3/lb (274 cc/mole)
Critical Density	38.76 lb/ft^3 (621 kg/m^3)
Heat of Vaporization @ Boiling Point	56.7 Btu/lb (132.6 kJ/kg)
Vapor Pressure	58.8 psia @ 70°F
Specific Heat, liquid at 77°F (25°C)	0.282 Btu/lb-°F (1.184 kJ/kg-°C)
Specific Heat, vapor at constant pressure (1 atm) and 77°F (25°C)	0.185 Btu/lb-°F (0.808 kJ/kg-°C)
Thermal conductivity of liquid at 77°F (25°C)	0.040 Btu/h-ft-°F (0.069 W/m-°C)
Viscosity, liquid at 77°F (25°C)	0.433 lb/ft-hr (0.184 centipoise)
Relative dielectric strength at 1 atm at 734 mm Hg, 77°F (25°C) (N2=1)	2.00
Solubility, by weight, of water in agent at 70°F (21°C)	0.06% ppm

1.3 Safety Considerations

FM-200 shall be used in accordance with the proposed United States Environmental Protection Agency (EPA) Significant New Alternatives Policy (SNAP) program rules.

FM-200 has acceptable toxicity for use in occupied spaces as a total flooding agent with specific limitations. Refer to the proposed SNAP rules for these limitations.

In accordance with NFPA Standard 2001 the following should apply:

Any unnecessary exposure to FM-200, even at NOAEL concentrations of 9% or below, and FM-200 decomposition products shall be avoided. The requirement for predischarge alarms and time delays are intended to prevent human exposure to agents. The following additional provisions shall apply in order to account for failure of these safeguards:

(a) FM-200 systems for spaces that are normally occupied and designed to concentrations up to the NOAEL shall be permitted.

(b) FM-200 systems for spaces that are normally occupied and designed to concentrations above the NOAEL and up to the LOAEL (above 9% and up to 10.5%) shall be permitted, given that means be provided to limit exposure to no longer than the time specified in Table 1.3 corresponding to the given design concentration.

Table 1.3 - Time for Safe Human Exposure at Stated Concentrations for FM-200

FM-200 Concentration		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.

(c) In spaces that are not normally occupied and protected by an FM-200 system designed to concentrations above the LOAEL of 10.5%, and where personnel could possibly be exposed, means shall be provided to limit exposure times using Table 1.3.

(d) In the absence of the information needed to fulfill the conditions listed, the following provisions shall apply:

(1) 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%.

(2) Concentrations exceeding the LOAEL are permitted only in areas not normally occupied by personnel provided that any personnel in the area can escape within 30 seconds. No unprotected personnel shall enter the area during agent discharge.

The discharge of FM-200 into a hazard may cause a reduction in visibility for a brief period. Any direct contact with the agent can cause frostbite.

A cylinder containing FM-200 should be carefully handled. **All anti-recoil devices must be in place at all times when the cylinder is not restrained.**

The Material Safety Data Sheet (MSDS) (see Appendix) covering FM-200 should be read and understood prior to working with the agent. Safety items such as personnel training, evacuation plans and fire drills should be considered. Personnel should also be acquainted with the fact that FM-200 sometimes presents a noise hazard during discharge.

1.4 Agent Decomposition Consideration

When FM-200 is exposed to a fire or other hot surfaces, the products of decomposition that result are a hazard to personnel. The effects of FM-200 decomposition on equipment should be considered in hazards with high ambient temperatures (e.g., furnaces and ovens).

1.5 Equipment Description

FM-200 systems are intended to be used to suppress fires involving equipment or specific hazards. It is very effective where an inert, electrically non-conductive agent is required, or when clean-up of other agents presents a problem.

1.6 Reference Data

Table 1.6 System Equipment Reference Data

Item	Characteristic	Item	Characteristic
➢ **FM-200 Sigma 600 lb. Cylinder & Valve**		➢ **FM-200 Sigma 750 lb. Cylinder & Valve**	
Stock Number, w/out LLI	10481454	Stock Number, w/out LLI	10481455
Stock Number, with LLI	10481462	Stock Number, with LLI	10481463
FM-200 Capacity	304 to 607 lb (137.9 to 275.3 kg)	FM-200 Capacity	455 to 910 lb. (206.4 to 412.8 kg)
Weight - Empty	356 lb. (161.5 kg)	Weight - Empty	473 lb. (214.6 kg)
Diameter	22 in. (56 cm)	Diameter	24 in. (61 cm)
➢ **FM-200 Sigma 1000 lb. Cylinder & Valve**		**LLI = Liquid Level Indicator**	
Stock Number, w/out LLI	10481456		
Stock Number, with LLI	10481464		
FM-200 Capacity	620 to 1000 lb (281.2 to 562.0 kg)		
Weight - Empty	768 lb. (348.4 kg)		
Diameter	30 in. (76.2 cm)		
➢ **Primary Completer Kit - Sigma**		➢ **Slave Completer Kit - Sigma**	
Stock Number	20480754	Stock Number	20480756
Kit includes: (1) solenoid valve 120 VAC/24 VDC, (1) manual pneumatic actuator, (2) 3/16" flexible hose 28" long, (1) 3" Victaulic connection kit, (1) 1/4" flare x 1/8" MNPT male connector, (1) warning sign, (1) Instruction nameplate		***Kit includes:*** (1) pressure gauge assembly, (1) pneumatic booster assembly, (1) 3" Victaulic connection kit, (3) 3/16" flexible hose 28" long, (1) 1/4" flare x 1/8" MNPT male connector, (3) 1/4" flare x 1/4" MNPT male connector,	

Table 1.6 System Equipment Reference Data

Item	Characteristic	Item	Characteristic
➢ **Primary Completer Kit - Sigma, with Cylinder Supervisory Pressure Switch**		➢ **Slave Completer Kit - Sigma, with Cylinder Supervisory Pressure Switch**	
Stock Number	20480755	Stock Number	20480757
Kit includes: (1) solenoid valve 120 VAC/24 VDC with supervisory pressure switch, (1) manual pneumatic actuator, (2) 3/16" flexible hose 28" long, (1) 3" Victaulic connection kit, (1) 1/4" x 1/8" MNPT male connector, (1) warning sign, (1) instruction nameplate		***Kit includes:*** (1) pressure gauge assembly with supervisory pressure switch, (1) pneumatic booster assembly, (1) 3" Victaulic connection kit, (3) 3/16" flexible hose 28" long, (1) 1/4" flare x 1/8" MNPT male connector, (3) 1/4" flare x 1/4" MNPT male connector	
➢ **Cylinder Decal - Main***		➢ **Cylinder Decal - Reserve***	
Stock Number	50360753	Stock Number	50360752
***** Use these decals plus a Main to Reserve Transfer Switch (listed on the following page) with the appropriate completer kit for cylinders in a main/reserve system.			
➢ **Discharge Connection Kit**		➢ **Pressure Switch**	
Stock Number	20710368	Stock Number	10170089
Material	Steel	Material	Aluminum
Overall Dimensions	See Section 2.1.2	Overall Dimensions	See Section 2.1.9
➢ **Main to Reserve Transfer Switch**		➢ **Pneumatic Booster Assembly**	
Stock Number	20100145	Stock Number	10611067
Material	Steel	Material	Brass
Overall Dimensions	3-1/4 x 5 x 2 in (8.3 x 12.7 x 5 cm)	Overall Dimensions	See Section 2.1.7
➢ **Connector - Flexible 3/16 in.**		➢ **Manual Pneumatic Actuator**	
Stock Number	10260303	Stock Number	10610729
Material	Stainless Steel	Material	Brass
Overall Dimensions	28 in (71.1 cm)	Overall Dimensions	See Section 2.1.6
➢ **Check Valve - Sigma**		➢ **Pressure Gauge Assy w/Supervisory Switch**	
Stock Number	70610549	Stock Number	20610262
Material	Brass	Material	Various
Overall Dimensions	See Section 2.1.2	Overall Dimensions	See Section 2.1.5
➢ **Pressure Gauge Assembly**		➢ **Valve - Solenoid Pilot Assembly 120V-60Hz/24VDC**	
Stock Number	20240041	Stock Number	20610276
Material	Various	Material	Various
Overall Dimensions	See Section 2.1.5	Overall Dimensions	See Section 2.1.4

Table 1.6 System Equipment Reference Data			
Item	**Characteristic**	**Item**	**Characteristic**
➢ **Valve - Solenoid Pilot Assembly with Supervisory Switch 120V-60Hz/24VDC**		This space intentionally left blank	
Stock Number	20610277		
Material	Various		
Overall Dimensions	See Section 2.1.4		
➢ **Nozzle - 360° Radial 3/8 in (10 mm)**		➢ **Nozzle - 360° Radial 1/2 in (13 mm)**	
Stock Number	10371360	Stock Number	10371361
Material	Stainless Steel	Material	Stainless Steel
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ **Nozzle - 360° Radial 3/4 in (19 mm)**		➢ **Nozzle - 360° Radial 1 in (25 mm)**	
Stock Number	10371362	Stock Number	10371363
Material	Stainless Steel	Material	Stainless Steel
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ **Nozzle - 360° Radial 1-1/4 in (32 mm)**		➢ **Nozzle - 360° Radial 1-1/2 in (38 mm)**	
Stock Number	10371364	Stock Number	10371365
Material	Stainless Steel	Material	Stainless Steel
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ **Nozzle - 360° Radial 2 in (51 mm)**		➢ **Nozzle - 360° Radial 3/8 in (10 mm)**	
Stock Number	10371366	Stock Number	10371415
Material	Stainless Steel	Material	Brass
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ **Nozzle - 360° Radial 1/2 in (13 mm)**		➢ **Nozzle - 360° Radial 3/4 in (19 mm)**	
Stock Number	10371416	Stock Number	10371417
Material	Brass	Material	Brass
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ **Nozzle - 360° Radial 1 in (25 mm)**		➢ **Nozzle - 360° Radial 1-1/4 in (32 mm)**	
Stock Number	10371418	Stock Number	10371419
Material	Brass	Material	Brass
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ **Nozzle - 360° Radial 1-1/2 in (38 mm)**		➢ **Nozzle - 360° Radial 2 in (51 mm)**	
Stock Number	10371420	Stock Number	10371421
Material	Brass	Material	Brass
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10

Table 1.6 System Equipment Reference Data			
Item	**Characteristic**	**Item**	**Characteristic**
➢ Nozzle - 180° Radial 3/8 in (10 mm)		**➢ Nozzle - 180° Radial 1/2 in (13 mm)**	
Stock Number	10371407	Stock Number	10371408
Material	Stainless Steel	Material	Stainless Steel
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ Nozzle - 180° Radial 3/4 in (19 mm)		**➢ Nozzle - 180° Radial 1 in (25 mm)**	
Stock Number	10371409	Stock Number	10371410
Material	Stainless Steel	Material	Stainless Steel
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ Nozzle - 180° Radial 1-1/4 in (32 mm)		**➢ Nozzle - 180° Radial 1-1/2 in (38 mm)**	
Stock Number	10371411	Stock Number	10371412
Material	Stainless Steel	Material	Stainless Steel
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ Nozzle - 180° Radial 2 in (51 mm)		**➢ Nozzle - 180° Radial 3/8 in (10 mm)**	
Stock Number	10371413	Stock Number	10371423
Material	Stainless Steel	Material	Brass
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ Nozzle - 180° Radial 1/2 in (13 mm)		**➢ Nozzle - 180° Radial 3/4 in (19 mm)**	
Stock Number	10371424	Stock Number	10371425
Material	Brass	Material	Brass
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ Nozzle - 180° Radial 1 in (25 mm)		**➢ Nozzle - 180° Radial 1-1/4 in (32 mm)**	
Stock Number	10371426	Stock Number	10371427
Material	Brass	Material	Brass
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ Nozzle - 180° Radial 1-1/2 in (38 mm)		**➢ Nozzle - 180° Radial 2 in (51 mm)**	
Stock Number	10371428	Stock Number	10371429
Material	Brass	Material	Brass
Overall Dimensions	See Section 2.1.10	Overall Dimensions	See Section 2.1.10
➢ Manifold - 4 in x 2 cylinders (10.2 cm) 600 lb Cylinders		**➢ Manifold - 4 in x 3 cylinders (10.2 cm) 600 lb Cylinders**	
Stock Number	30370817	Stock Number	30370816
Material	Steel Pipe	Material	Steel Pipe
Overall Dimensions	See Section 2.1.11	Overall Dimensions	See Section 2.1.11

Table 1.6 System Equipment Reference Data			
Item	**Characteristic**	**Item**	**Characteristic**
➢ **Manifold - 6 in x 2 cylinders (15.2 cm) 750 lb Cylinders**		➢ **Manifold - 6 in x 3 cylinders (15.2 cm) 750 lb Cylinders**	
Stock Number	30370819	Stock Number	30370818
Material	Steel Pipe	Material	Steel Pipe
Overall Dimensions	See Section 2.1.11	Overall Dimensions	See Section 2.1.11
➢ **Manifold - 6 in x 2 cylinders (15.2 cm) 1000 lb Cylinders**		➢ **Manifold - 6 in x 3 cylinders (15.2 cm) 1000 lb Cylinders**	
Stock Number	30370821	Stock Number	30370820
Material	Steel Pipe	Material	Steel Pipe
Overall Dimensions	See Section 2.1.11	Overall Dimensions	See Section 2.1.11
➢ **Rack - Wall Mount Kit, 600 lb Cylinders**		➢ **Rack - Wall Mount Kit, 750 lb Cylinders**	
Stock Number	20710264	Stock Number	20710360
Material	Various	Material	Various
Overall Dimensions	See Section 4.2.2	Overall Dimensions	See Section 4.2.2
➢ **Rack - Wall Mount Kit, 1000 lb Cylinders**		**Panel - Control**	
Stock Number	20710361	Stock Number	Various
Material	Various	Material	Steel enclosure
Overall Dimensions	See Section 4.2.2	Overall Dimensions	See individual detail
Detection - Fire		**Alarms - Visual and Audible**	
Stock Number	Various	Stock Number	Various
Material	Various	Material	Various
Overall Dimensions	See individual detail	Overall Dimensions	See individual detail
The control panel, fire detection and visual and audible alarms are described on separate data sheets and not included as part of this manual.			

2 SYSTEM DESCRIPTION AND OPERATION

Each FM-200 system is specifically designed to accommodate the individual demands of the areas to be protected. The wide range and design of available components provides the flexibility necessary for this custom design.

The following sections describe the operation and function of all controls and indicators that are used with Chemetron Fire Systems Sigma Series FM-200 Systems. The flow calculation method has been verified at an ambient temperature of 70°F (21.1°C). When the FM-200 storage temperature varies by ±10°F (5.5°C) from 70°F (21.1°C), there is a risk that the system will not supply the designed quantity of extinguishing agent.

2.1 Sigma System

(Refer to Figure 2.1) The Sigma System permits higher discharge rates and is particularly adaptable to areas requiring larger quantities of FM-200 or discharges of short duration.

A description of the various equipment components unique to the Sigma System follows.

2.1.1 Cylinder Assembly

FM-200 is stored is specially designed cylinder assemblies. Sigma Series cylinders are available in three different sizes: 600, 750 and 1,000 lb. cylinders. All cylinders are superpressurized with dry nitrogen to a pressure of 360 psig (2482 kPa) at 70°F (21°C). Each cylinder is equipped with an identification nameplate indicating the quantity of FM-200.

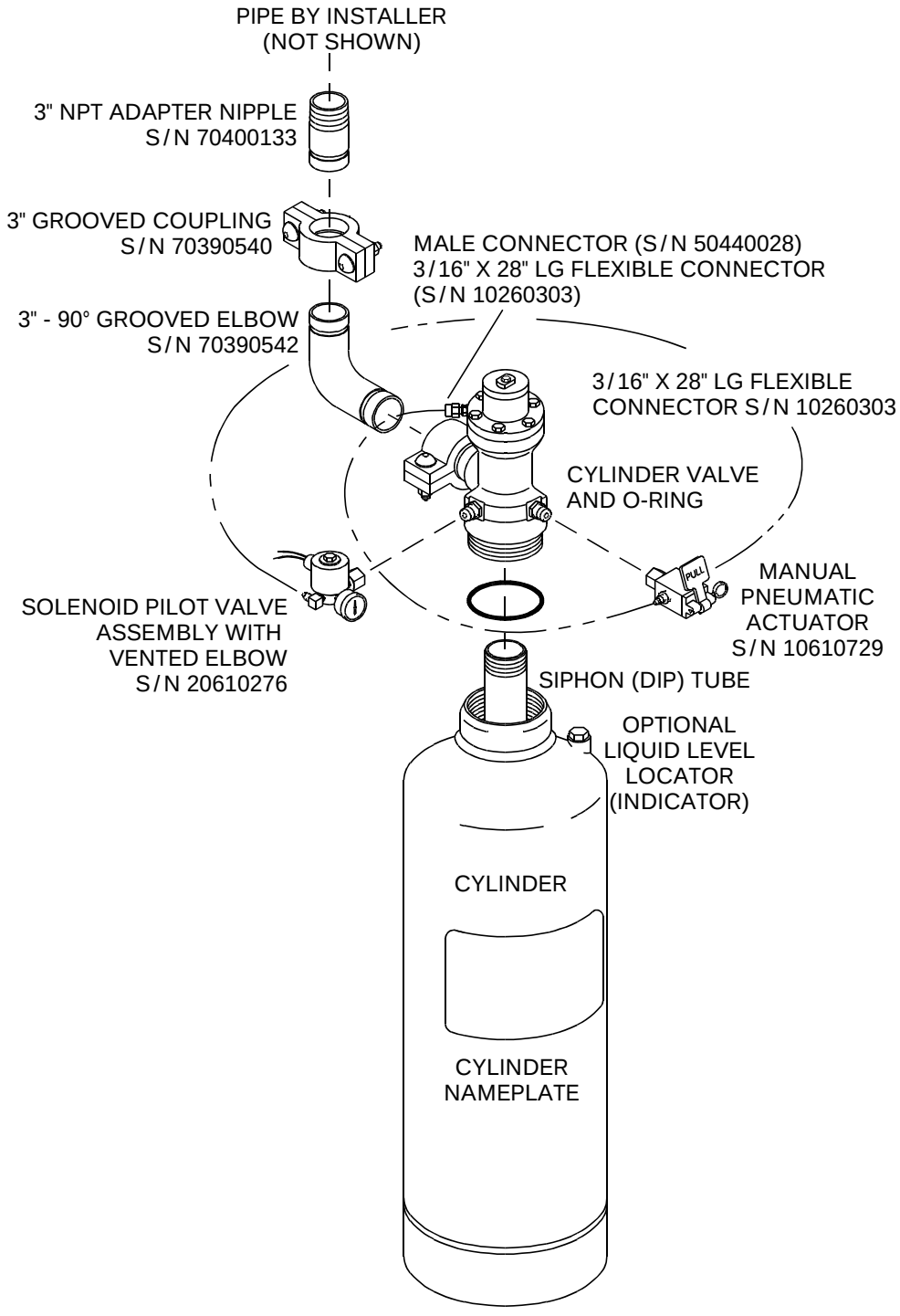
The standard cylinder assembly, having a rigid dip tube, is designed for mounting in a vertical position only. The cylinder assembly is composed of a cylinder, safety disc, dip tube, and cylinder valve.

A. **Cylinder**: The steel cylinders are manufactured to the requirements of the Department of Transportation (DOT) for compressed gas and have internal neck threads for cylinder valve connection. Each Sigma cylinder is provided with a boss to accommodate an optional liquid level locator or indicator. (The indicator must be installed prior to assembly of the cylinder components.)

   Operating instructions and weight conversion charts for the use of liquid level indicators will be included in the Appendix after testing is completed.

B. **Safety Disc**: A frangible safety disc is located on the cylinder collar or valve assembly and serves to protect the cylinder against excessive internal pressure. The disc is designed to burst in a range of 850 psi to 1000 psi (5860 kPa to 6895 kPa).

C. **Dip Tube**: A threaded dip tube extends from the cylinder valve down to within approximately 1 in. (25 mm) of the bottom of the cylinder. The steel tube has a 3-1/2 in. O.D. and 1/8 in. (3.2 mm) wall thickness. The threads are 3-1/2 in. 12UN-2A.



Sigma Series FM-200 Cylinder Assembly with Primary Completer Kit
Figure 2.1

D. **Cylinder Valve**: A pressure release type cylinder valve having a cast brass body is attached to the cylinder neck and serves to control the flow of FM-200 from the cylinder. The valve is secured to the cylinder by means of 4.5-12UN-2A screw threads and is sealed by a cylinder O-ring. A synthetic rubber seat is attached to a steel seat retainer, which is screwed into the bottom of the valve. The seat retainer also supports the dip tube.

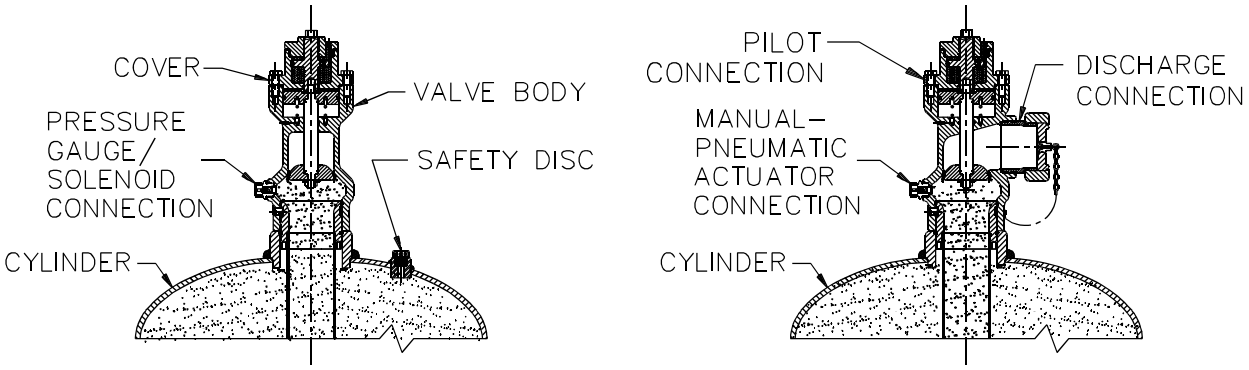


Figure 2.1.1 - Sigma Cylinder Valve

The cylinder valve has four connections, as follows: (Refer to Figure 2.1.1)

1. **Manual-Pneumatic Actuator Connection**: This is a threaded connection housing a check valve and serves as the attachment point for the manual-pneumatic actuator or pneumatic booster.

2. **Pressure Gauge/Solenoid Pilot Valve Assembly Connection**: This is a threaded connection housing a check valve and serves for the attachment of:

   a. Solenoid pilot valve assembly (with pressure gauge) for pilot cylinders.

   b. Pressure gauge assembly for all other system cylinders (slave cylinders).

3. **Pilot Connection**: An 1/8" (4 mm) NPT tap in the side of the cylinder valve cap provides a means of applying pilot pressure above the operating piston.

4. **Discharge Connection**: This connection (3 in. nominal pipe size) (80 mm) is in the form of an outlet fitting that threads into the valve body. The exposed end is grooved for attachment of grooved fittings (Victualic, etc). The outlet fitting can be removed for replacement if necessary. In all cases, the antirecoil cap should remain installed or be installed on the discharge connection until removal of the cap is necessary to complete the connection of the cylinder to the system piping and the cylinder is securely restrained.

2.1.2 Discharge Connection Fittings

A 3 in. (80 mm) grooved elbow, nipple, and companion coupling and gasket are used to extend the discharge outlet fitting of the cylinder valve to the piping system (refer to Figure 2.1.2a).

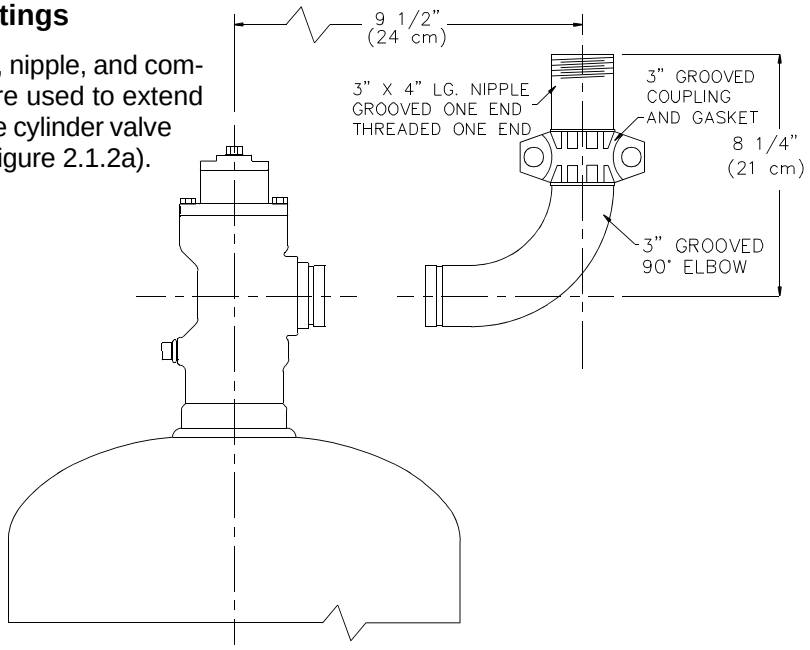


Figure 2.1.2a - Discharge Connection Fitting
Stock Number 20710368

Check Valve

(Refer to Figure 2.1.2b) A check valve is used between the cylinder valve discharge outlet flexible connection and the discharge manifold. The check valve prevents backflow from the manifold in the event that the system is discharged when one or more cylinders are disconnected, such as for weighing or general servicing. A check valve is not required on single cylinder systems.

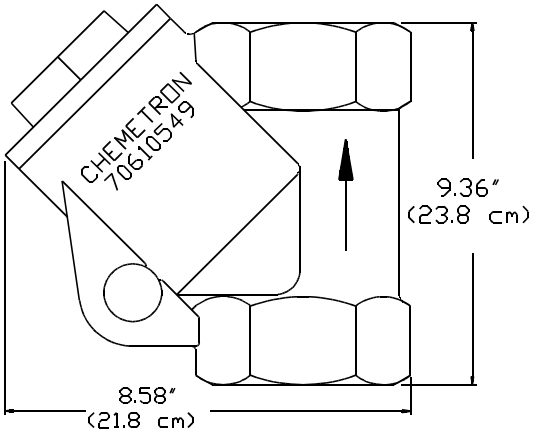


Figure 2.1.2b - Check Valve
Stock Number 70610549

2.1.3 Bleeder

A vented elbow on the outlet side of the solenoid is used to prevent accumulation of pressure due to accidental leakage through the solenoid pilot valve assembly, which, if unvented, could cause a false discharge of the system.

2.1.4 Solenoid Pilot Valve Assembly

(Refer to Figures 2.1.4A & B) The systems utilize a solenoid pilot valve assembly to provide pilot pressure for actuation, whether system actuation is by automatic (detection device) or manual-electric (push-button) means.

The solenoid pilot valve assembly includes a pressure gauge and adapter with swivel nut, vented elbow, and O-ring seal that is attached to the pressure gauge connection of the cylinder valve. The adapter upsets the check valve when the swivel nut is almost tight, at which time the O-ring seal prevents agent loss. With the check valve open, pilot cylinder pressure is applied to the normally closed solenoid valve and the pressure gauge. The pressure gauge provides for visual surveillance of the pressure condition within the cylinder.

Where cylinders are located in areas not readily accessible for pressure gauge observation, or where supervision is a requirement, a supervisory pressure switch can be supplied as part of the solenoid pilot valve assembly to continuously monitor the cylinder pressure and to transmit an alarm signal in the event the pressure falls below an acceptable level.

Stock Number	Description
20610276	Solenoid pilot valve assembly 120V-60Hz/24VDC
20610278	Explosionproof Solenoid pilot valve assembly 24VDC
20610277	Solenoid pilot valve assembly with supervisory pressure switch 120V-60Hz/24VDC

Solenoid Valve Description:

- Two way, normally closed
- Power consumption - 10 watts
- Current drain - .261 amps holding -.174 amps AC; .396 amps DC
- Operating voltage 120 volts, 60 hertz AC or 24 volts DC

Actuation of the solenoid pilot valve assembly permits pressure to be applied through a flexible connector connected to the manual-pneumatic actuator, which in turn applies cylinder pressure to its operating piston.

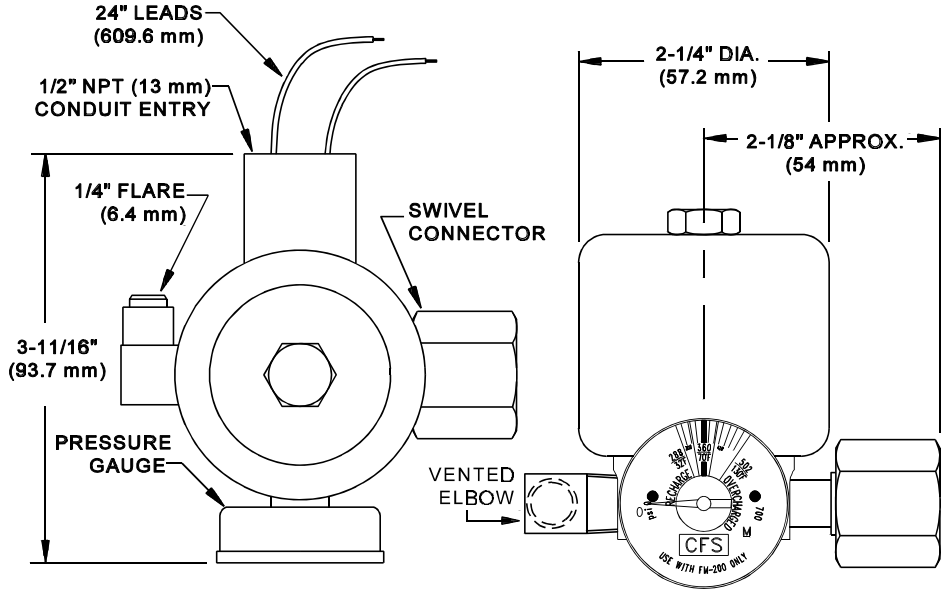


Figure 2.1.4A - Solenoid Pilot Valve Assembly - S/N 20610276

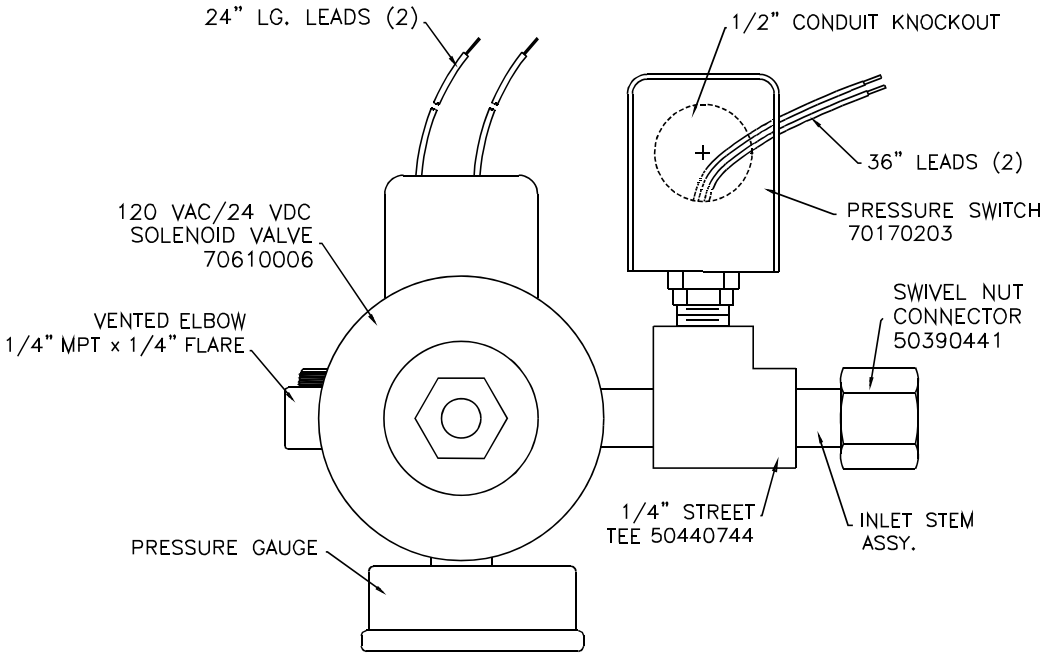


Figure 2.1.4B - Solenoid Pilot Valve Assembly with Supervisory Pressure Switch (Top View) - S/N 20610277

The solenoid pilot valve assembly can be removed for servicing or testing without loss of agent since the check valve will close as the assembly is removed.

A flexible electrical conduit is required for connection of the solenoid pilot valve assembly to the system conduit. The flexibility facilitates removal of the assembly, as well as the cylinder, for servicing.

2.1.5 Pressure Gauge Assembly

(Refer to Figures 2.1.5A & B) In systems requiring more than one cylinder, a pressure gauge assembly is required for each cylinder other than the pilot cylinder as a means of visual surveillance of the pressure condition within the cylinder. The assembly contains a swivel nut and O-ring seal for attachment to the gauge connection of the cylinder valve. A pin in the assembly upsets the gauge check valve when the swivel nut is almost tight, at which time the O-ring seal prevents agent loss. The pressure gauge can be removed for replacement or checking without loss of agent since the gauge check valve closes as the gauge assembly is removed.

When cylinders are located in areas not readily accessible for pressure gauge observation, or where supervision is a requirement, a supervisory pressure switch can be supplied as part of the pressure gauge assembly. It can be used to continuously monitor the cylinder pressure and to transmit an alarm signal in the event the pressure falls below an acceptable level.

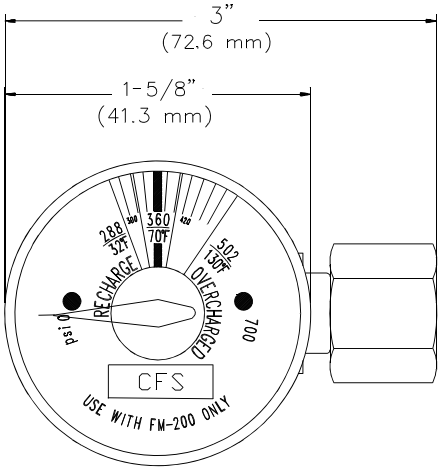


Figure 2.1.5A - Pressure Gauge Assembly Front View - S/N 20240041

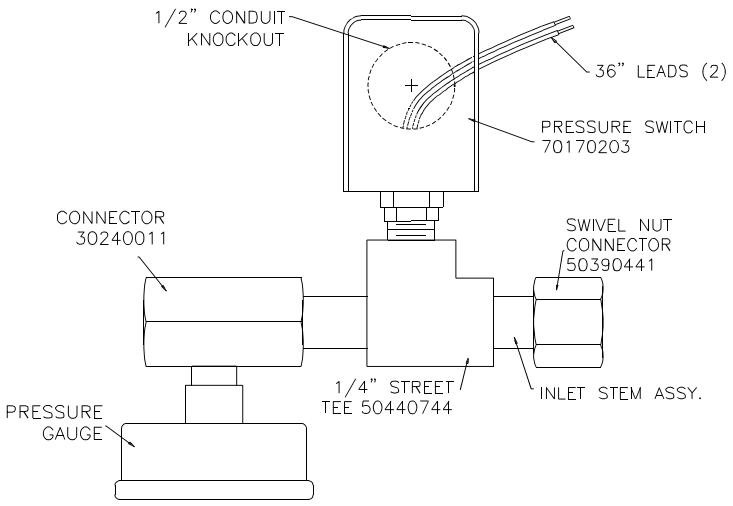


Figure 2.1.5B - Pressure Gauge Assembly with Supervisory Pressure Switch (Top View) - S/N 20610262

2.1.6 Manual-Pneumatic Actuator

(Refer to Figure 2.1.6) This device is required for the manual actuation of a Sigma cylinder and is attached to a check valve connection port. This is a dual purpose device, having an actuating piston connected to a pin to upset the fill check valve when pilot pressure is applied to the piston. With the check valve open, cylinder pressure is applied through the pilot connection to the operating piston of the Sigma valve, thereby opening the cylinder to discharge its contents. It is important to note that Port A is considered the outlet of the actuator and Port B is the inlet. **To insure quick actuation of the valve in a single cylinder system, Port A of the actuator should always be connected to the valve via the 3/16" flexible hose (as indicated in Figure 2.1).**

A manual lever and cam arrangement on the actuator permits actuation of the device on a manual basis, thereby overriding and independent of electric power or pilot pressure. A pullpin and seal prevents accidental operation of the manual lever. A swivel nut and O-ring seal on the device provides for attachment and seal at the connection point.

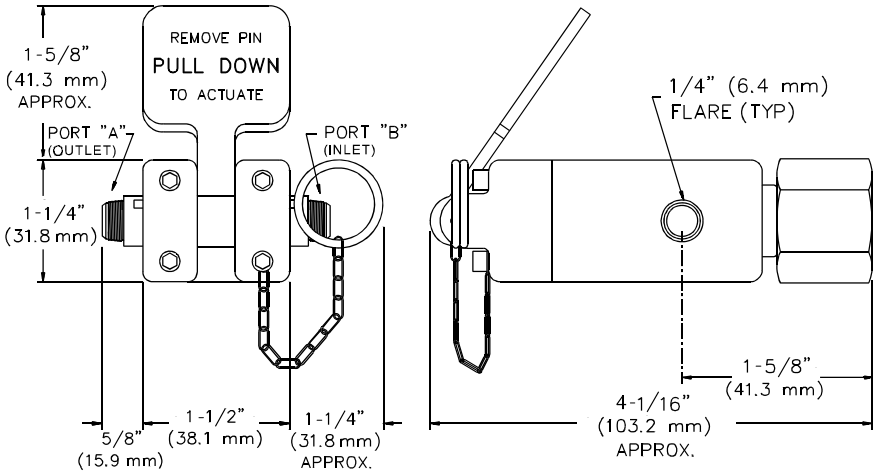


Figure 2.1.6 - Manual-Pneumatic Actuator - Stock Number 10610729

2.1.7 Pneumatic Booster Assembly

(Refer to Figure 2.1.7) This pneumatic actuator is used as a pneumatic booster for all cylinders connected to the manifold downstream of the pilot cylinder. Like the manual-pneumatic actuator, the device is attached to the check valve connection port and the internal operation is identical. Actuation of the booster is initiated by manifold pressure created by the opening of the pilot cylinder.

It is important to note that Port A is considered the outlet of the actuator and Port B is the inlet. **To insure quick actuation of the valve, Port A of the actuator should always be connected to the valve via the 3/16" flexible hose (as indicated in Figure 4.2.11).**

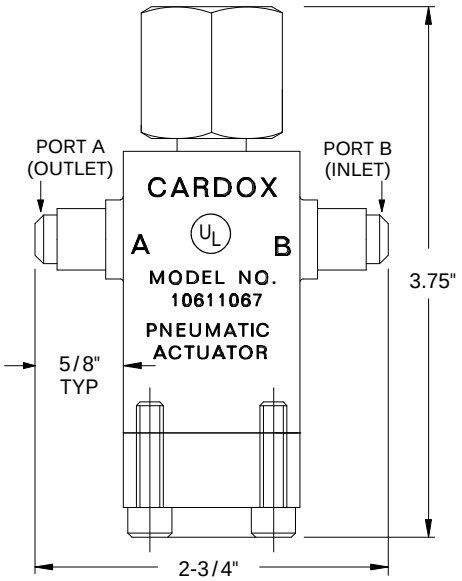


Figure 2.1.7 - Pneumatic Booster Assembly
Stock Number 10611067

2.1.8 Flexible Connector

(Refer to Figure 2.1.8) 3/16 in. (5 mm) flexible connectors are used to interconnect the cylinder valve devices. These hoses have a stainless steel wire braid cover and a Teflon liner, and are fitted at each end with a 1/4 in. swivel flare nut.

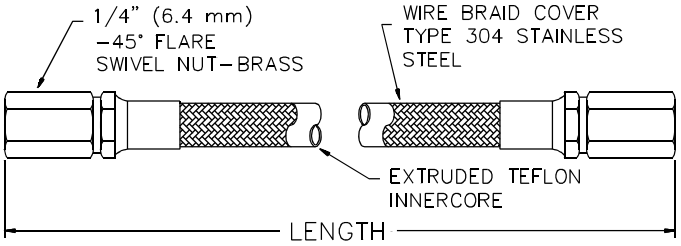


Figure 2.1.8 - Flexible Connector

Stock Number	Description
10260303	3/16 in. (5 mm) Connector 28 in. (71.1 cm) long

2.1.9 Pressure Switch

(Refer to Figure 2.1.9) A pressure switch is used in the system to implement the shut down of power and various items of equipment, such as fans; and for annunciation and alarm purposes. An explosion-proof pressure switch is also available.

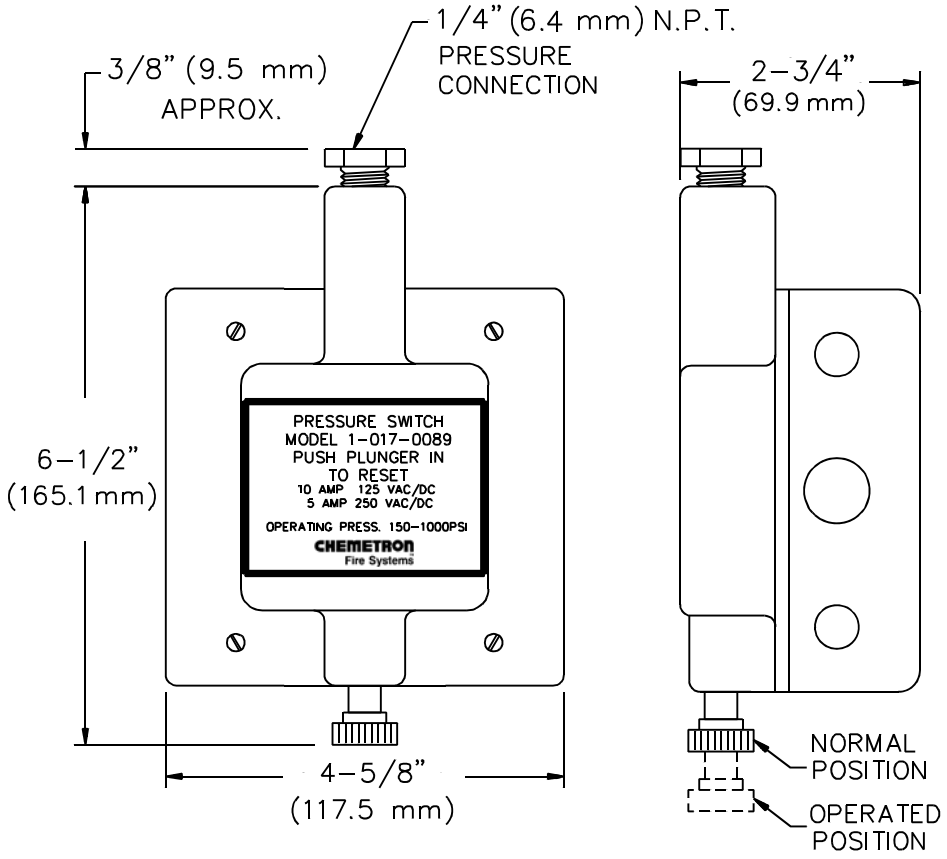


Figure 2.1.9 - Pressure Switch - S/N 10170089

Stock Number	Description
10170089	2 pole pressure switch, *indoor use only*
70170229	Explosionproof 3 pole pressure switch
10170065	4 pole pressure switch, *weatherproof*

2.1.10 Nozzles - Styles F & G

(Refer to Figure 2.1.10) 360° and 180° nozzles (8 port) are used to control the flow of FM-200 to insure it is discharged within 10 seconds and properly distributed in the protected hazard.

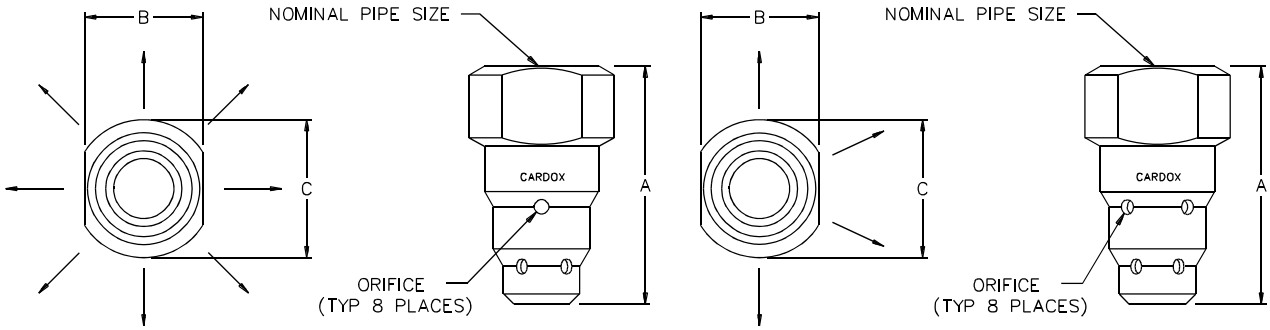


Figure 2.1.10

Stock Number 360° Style F		Nominal Pipe Size	Dimensions					
			A		B		C	
Stainless Steel	Brass		in	mm	in	mm	in	mm
10371360	10371415	3/8 in. (10 mm)	2.031	51.58	1.000	25.40	1.188	30.17
10371361	10371416	1/2 in. (13 mm)	2.250	57.15	1.125	28.57	1.375	34.92
10371362	10371417	3/4 in. (19 mm)	2.688	68.27	1.375	34.92	1.625	41.27
10371363	10371418	1 in. (25 mm)	2.875	73.00	1.625	41.20	1.938	49.20
10371364	10371419	1-1/4 in. (32 mm)	3.290	82.59	2.000	50.80	2.375	60.32
10371365	10371420	1-1/2 in. (38 mm)	3.625	92.00	2.250	57.10	2.688	68.20
10371366	10371421	2 in. (51 mm)	4.500	114.3	3.000	76.20	3.500	88.90

Stock Number 180° Style G		Nominal Pipe Size	Dimensions					
			A		B		C	
Stainless Steel	Brass		in	mm	in	mm	in	mm
10371407	10371423	3/8 in. (10 mm)	2.031	51.58	1.000	25.40	1.188	30.17
10371408	10371424	1/2 in. (13 mm)	2.250	57.15	1.125	28.57	1.375	34.92
10371409	10371425	3/4 in. (19 mm)	2.688	68.27	1.375	34.92	1.625	41.27
10371410	10371426	1 in. (25 mm)	2.875	73.00	1.625	41.20	1.938	49.20
10371411	10371427	1-1/4 in. (32 mm)	3.290	82.59	2.000	50.80	2.375	60.32
10371412	10371428	1-1/2 in. (38 mm)	3.625	92.00	2.250	57.10	2.688	68.20
10371413	10371429	2 in. (51 mm)	4.500	114.3	3.000	76.20	3.500	88.90

2.1.11 Discharge Manifold

The discharge manifold is constructed of welded pipe and fittings and is designed to accumulate the combined flow of two or more containers into a common pipe leading into the protected space.

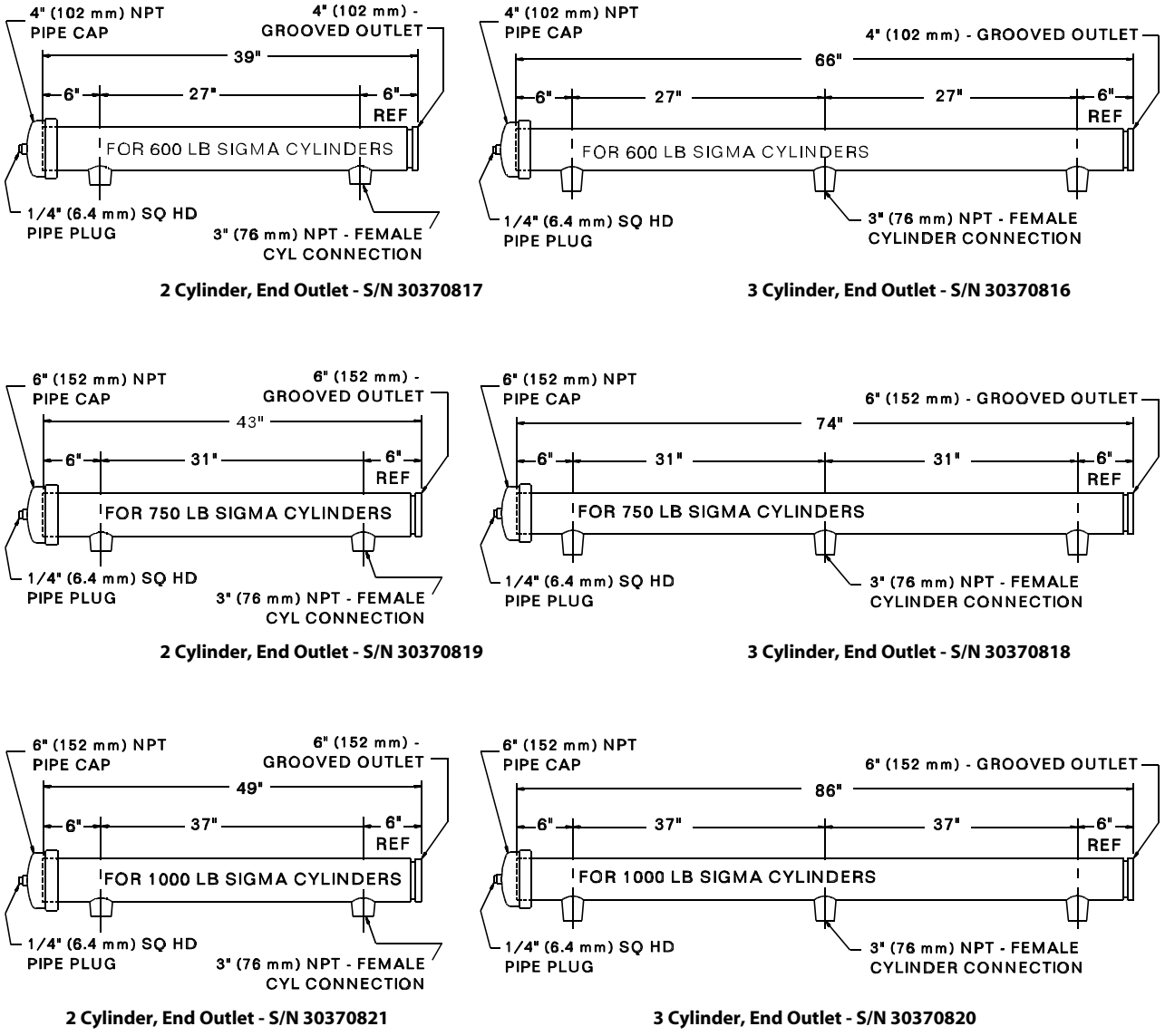


Figure 2.1.11 - Discharge Manifold

2.2 Sigma System Operation

2.2.1 Cylinder Valve Operation

The Sigma cylinder valve is designed to maintain cylinder pressure below the seat assembly (C) (Refer to Figure 2.2.1). The pressure exerted by the spring (B) and the internal pressure forces a seal between the elastomer in the seat assembly (C) and the machined seat ring in the cylinder valve. An O-ring in the bottom of the cylinder valve provides a seal between the cylinder valve and the threaded cylinder outlet.

Figure 2.2.1 illustrates diagrammatically the two valve modes: **standby,** where the valve is awaiting actuation, and **automatic actuation**, where the valve has been electrically actuated.

A. **Standby**

Pilot pressure is applied continuously to a normally closed solenoid pilot valve assembly. The solenoid pilot valve assembly is connected to the check valve (G) through a specially machined adapter fitting. A pressure gauge is part of the assembly to provide visual indication of the pressure in the container. In the standby mode, pressure is maintained below the seat assembly (C) and upstream of the seat of the pilot solenoid valve assembly (E).

B. **Automatic Actuation**

The solenoid pilot valve assembly is energized by the control panel output of the system, causing pressure to flow through a 3/16 in. flexible connector to the B port of the manual pneumatic actuator (F). The pilot pressure is applied to the piston of the manual-pneumatic actuator (F), causing a fill check (G) in the cylinder valve to upset, allowing a greater flow rate of pilot gas to the top of the cylinder head via a 3/16 in. flexible connector (I). The pressure fills the chamber, exerting pressure on the piston (A), causing the seat (C) to be pushed downward, allowing the FM-200 to flow around the seat to the outlet of the cylinder valve. The manual-pneumatic actuator (F) keeps the cylinder valve open until the entire cylinder capacity is discharged.

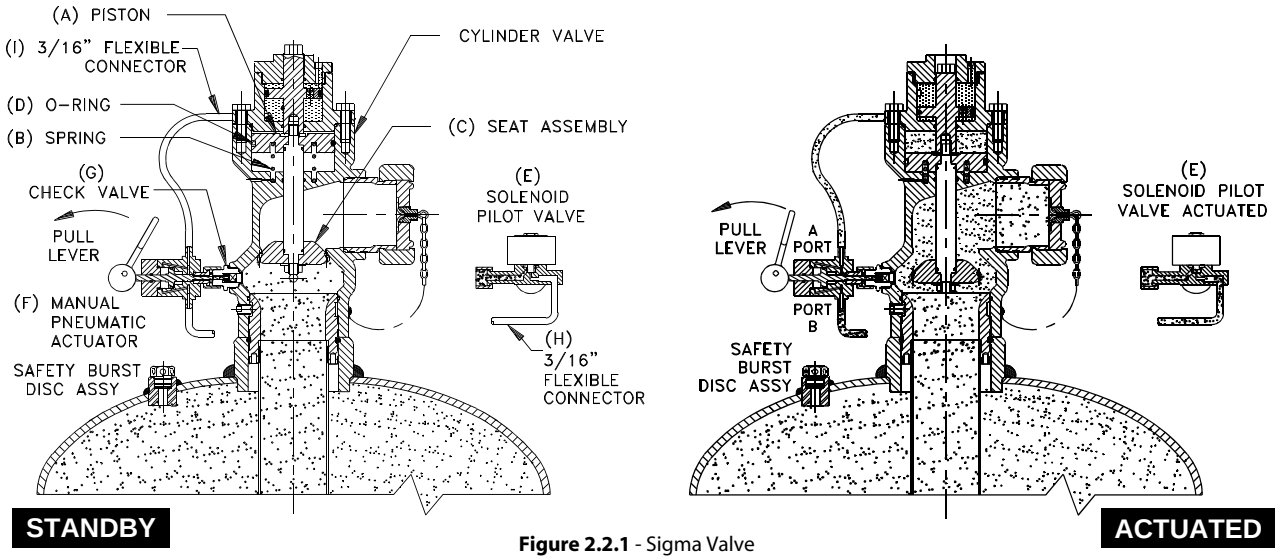


Figure 2.2.1 - Sigma Valve

3 SYSTEM DESIGN

The information contained in this section covers the design of Sigma Series engineered systems.

The inlet and outlets of the tee branches must be in the same horizontal plane to avoid an imbalance from the gravitational effects of the liquid and vapor separation.

The design of the system consists of selection and proper placement of the following equipment:

- Container(s)
- Mounting bracket(s)
- Nozzle(s)
- Pipe and fittings
- Control panel(s)
- Detection
- Optional accessories

Proper FM-200 system design requires completion of the following seven steps to determine the selection, placement and installation of the containers, mounting brackets, nozzle(s), pipe and fittings. Selection and placement of the alarm and control devices are discussed in other publications.

3.1 Step 1 - Agent Requirement

The first step in designing an FM-200 total flooding system is to determine agent weight requirements for the desired concentration in the area(s) protected. The minimum design concentration for a Class A surface fire hazard shall be the extinguishing concentration times a safety factor of 1.2. A minimum 6.25% volumetric concentration is required for Class A surface burning type fires, such as wood or other cellulose type materials. The Class B flammable liquid type fires require a minimum design concentration at 30% above the extinguishing concentration of the fuel or 30% above the cup burner value established for the fuel. Design values for particular fuels are given in the Appendix of this manual. The minimum design concentration for Class C hazards shall be at least that for Class A surface fires and the minimum design concentration for a manually actuated system shall be the extinguishing concentration times a safety factor of 1.3. The agent concentration should be based on the lowest ambient temperature expected within the area. When calculating the concentration levels for normally occupied spaces, care must be taken to insure that at its highest expected ambient temperature, the space does not exceed the NOAEL value of FM-200 of 9% as stated in National Fire Protection Association Standard 2001.

To determine the agent required for any space for a specific concentration, the volume of the area must be known. Any environmental factors that require additional agent for compensation, such as temperature and leakage, also must be known. By using the agent factor from Appendix Tables AP-1 or AP-2, or weight requirement formula, we can determine the quantity of FM-200 for any space volume and select the required equipment. Volume is defined as the capacity of an area and can be found by multiplying its length x its width x its height. Volume = (L x W x H).

The amount of FM-200 required to achieve the design concentration at a specific temperature can be calculated from the following formula.

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

Where: W = Agent weight in pounds
V = Hazard volume in cubic feet
C = FM-200 Agent volumetric concentration, percent by volume
s = Specific vapor volume in cubic feet/pounds
s = 1.885 + (0.0046 x T), where T = temperature °F

Therefore: s = 1.885 + (0.0046 x 70) = 2.207

Using the formula above (a 6.25% design concentration for a 22,150 cubic foot room at 70°F), the equation would look like this:

$$W = \frac{22{,}150}{2.207}\left(\frac{6.25}{100 - 6.25}\right) = 669.08\ lbs.$$

-Or-

Example: To determine the FM-200 agent required to provide a 6.25% concentration using tables AP-1 or AP-2, the factor is matched from the temperature required. In our example, the room temperature is 70°F; using table AP-1, our factor is 0.0302. The volume is multiplied by this factor to determine the amount of FM-200 required for our 6.25% concentration.

22,150 cu.ft. X 0.0302 lbs/ft^3 = 668.93 lbs.

To insure that NOAEL or the maximum concentration level of 9% of FM-200 is not exceeded, a check should be performed using the tables or formula based on the highest expected ambient temperature of the area being protected.

NOTE

THE MINIMUM CONCENTRATION ALLOWED IS 6.25%.

3.2 Step 2 - Number of Containers

When the quantity of agent has been determined, the number of containers and their location are the next consideration. The size and number of containers is based on the agent requirement as determined in step 1. Review the Equipment Reference Table 1.6 to find the container that comes closest to holding the amount of agent required. Once the container(s) has been chosen, its location must be considered. When two or more containers are grouped together on a common manifold, they must be of the same select size and fill.

3.3 Step 3 - Container Location

The container(s) should be mounted on wall frames or columns capable of rigidly supporting the container mounting rail by bolting or welding.

CAUTION

THE CONTAINER IS NOT DESIGNED FOR MOUNTING ON THE CEILING OR IN SHEETROCK MATERIAL. ALL CYLINDERS MUST BE LOCATED TOGETHER IN THE SAME AREA AND AT THE SAME TEMPERATURE.

The container should be placed in an area that permits access for inspection and easy removal. The storage location should also offer some security against acts of vandalism and nature that could damage the containers resulting in harm to personnel. The preferred location is outside the protected space. However, locating the container(s) inside the protected space is an acceptable alternative if not exposed to fire or excessive heat that could impair system operation.

3.4 Step 4 - Nozzle Determination

The nozzles are designed for 180° and 360° coverage. The maximum coverage of a single nozzle is 1,412 ft^2 (131 m^2)

- The 360° nozzle cannot be mounted in a corner or against a wall. The maximum nozzle discharge radius is 26.6 feet (8.1 M), with the longest side not to exceed 37 ft 7 in (11.4 m). These nozzles should be centered in the area of protection when multiple nozzles are discharged into the same hazard. Nozzles must be oriented so that a pair of orifice holes parallels the wall of the enclosure.

- The maximum throw distance of the 180° nozzle is 37.0 feet (11.3 M). The maximum distance between 180° nozzles is 37.6 feet (11.5 M). The maximum coverage distance from the nozzle to a wall is 18.8 feet (5.7 M). The 180° nozzle must be installed at no more than 6 inches (15.2 cm) from the enclosure wall and at a maximum of 9.25 inches (23.5 cm) down from the ceiling.

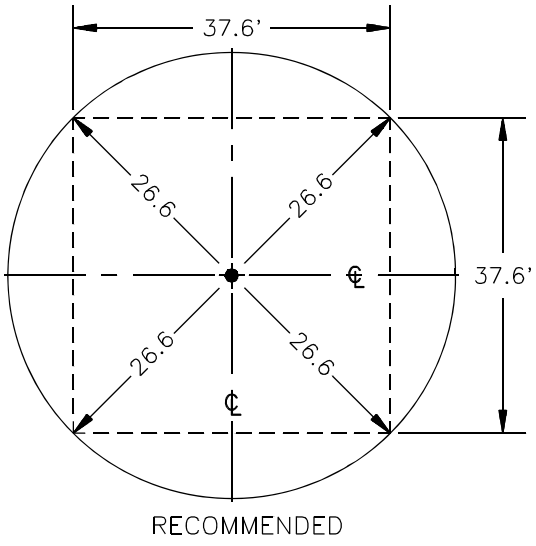


Figure 3.4A - 360° Nozzle Determination

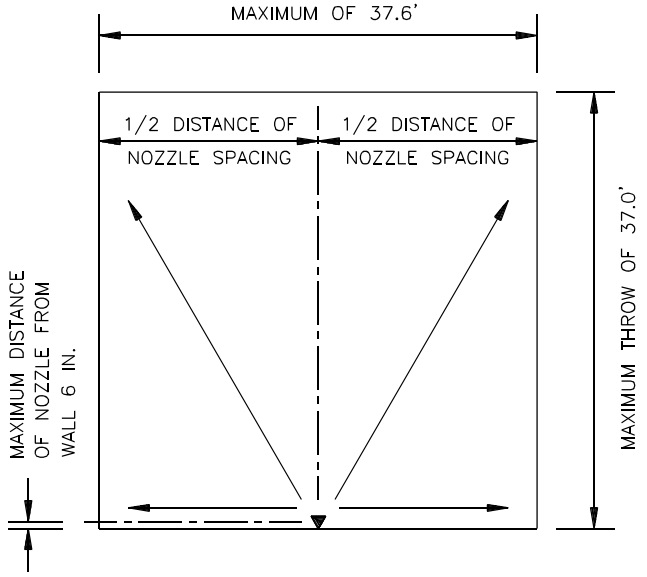


Figure 3.4B - 180° Nozzle Determination

For both the 180° and 360° nozzle: The height of the room shall range between 1 foot (.3 M) and 16 feet (4.88 M) from floor to ceiling. The nozzle should be placed as close or near to the containers as possible to minimize system piping. The ceiling tiles around each nozzle must be clipped to hold them in place during a discharge and prevent damage. The orifices of the nozzle(s) should not be positioned to discharge on nearby objects.

NOTE

THE MAXIMUM ENCLOSURE HEIGHT THAT MAY BE FLOODED BY A SINGLE TIER OF NOZZLES IS 16 FEET (4.88 M). FOR ENCLOSURES WITH CEILING HEIGHTS ABOVE 16' (4.88 M), NOZZLES SHALL BE PLACED AT MULTIPLE LEVELS/ELEVATIONS TO A MAXIMUM HEIGHT PER ELEVATION OF 16 FEET (4.88 M).

The maximum area of coverage for a single nozzle in an underfloor is likewise 1,412 ft^2 (131.2 m^2) with the same limitations on height and positioning noted in the preceding paragraphs. The **MINIMUM** height of an underfloor that may be protected is 12 inches (30.5 cm). The coverage possible in an underfloor is dependent upon the density of cables, runways, and other equipment that might be present in the underfloor space. The maximum figures should be used only for underfloors that will be relatively open. This requires some judgment on the part of the designer, but in general, if the horizontal line of sight is more than 70% obstructed in an underfloor, these maximum figures should be reduced by 50%.

3.5 Step 5 - Nozzle Location

The nozzle(s) may be positioned flush with the ceiling or within 9.25 in. (23.5 cm) of the ceiling with the design radius covering the required area.

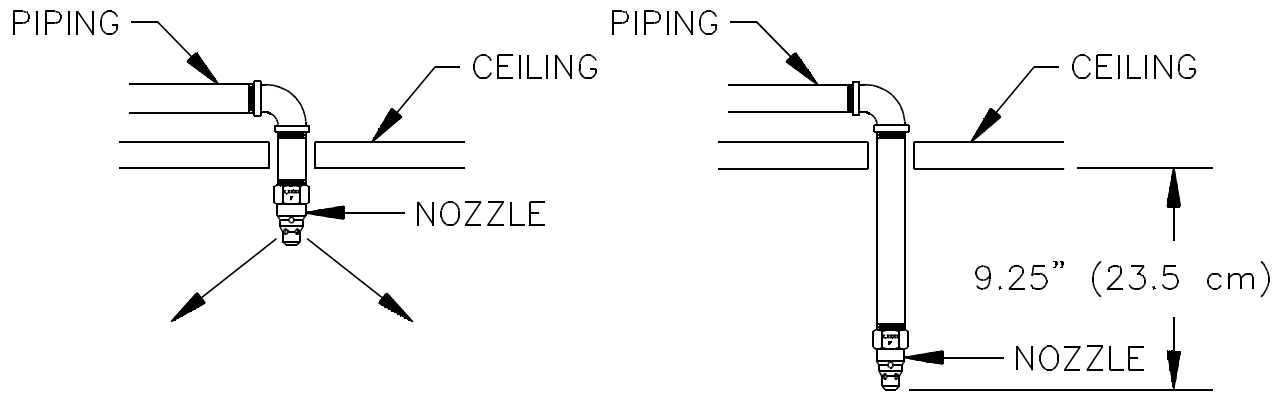


Figure 3.5 - Nozzle Location

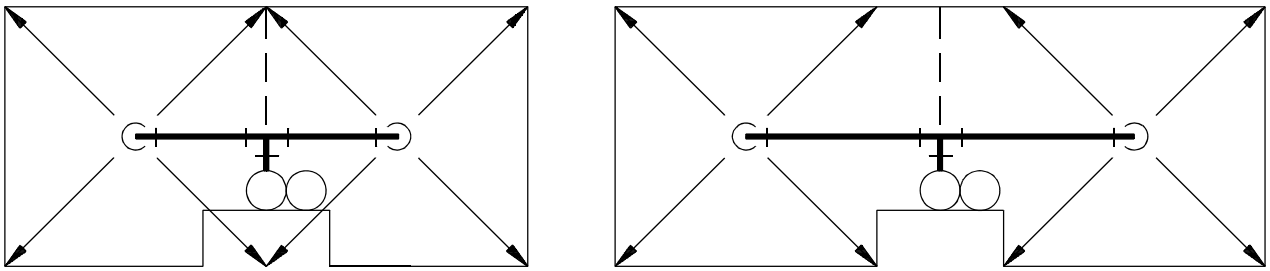
3.6 Step 6 - Piping Configuration

When installed, the distribution pipe and fittings shall not exceed the limitations defined in the Chemetron Fire Systems **FM-200 Systems Design and Flow Calculation Manual, P/N 30000034**, which provides detailed information regarding pipe sizing, discharge time, pipe flow rates and nozzle orifice determination.

NOTE

THE FM-200 FLOW CALCULATION PROGRAM MANUAL, P/N 30000031, IS NOT APPROVED BY FMRC.

THE FLOW CALCULATION METHOD HAS BEEN VERIFIED AT AN AMBIENT TEMPERATURE OF 70°F (21.1°C). WHEN THE FM-200 STORAGE TEMPERATURE VARIES BY ±10°F (5.5°C) FROM 70°F (21.1°C), THERE IS A RISK THAT THE SYSTEM WILL NOT SUPPLY THE DESIGNED QUANTITY OF EXTINGUISHING AGENT.



Acceptable ***Unacceptable***

Figure 3.6 - Piping Configuration

3.6.1 Elevation Changes

When the elevation difference between outlet tees is in excess of 30 feet (9.1 m), consideration should be given to rerouting piping to reduce the elevation difference between tees. Even though sound engineering theory is used to predict pressure changes due to elevation, no actual testing has been performed incorporating the combination of maximum and/or minimum limits with elevations.

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

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

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

3.7 Step 7 - Pipe Size

Pipe sizes are determined with the aid of a computer and the flow calculation software, but the table listed below may be used for estimating. Actual diameter may vary slightly due to distance and software optimization.

Table 3.7 - Pipe Size vs Flow Rate

Schedule 40 Pipe Size Nominal		Minimum Flow Rate For All Sections Leading to a Tee		60% of Flow Rate For All Sections Ending with a Nozzle		Schedule 40 Pipe Size Nominal		Minimum Flow Rate For All Sections Leading to a Tee		60% of Flow Rate For All Sections Ending with a Nozzle	
Inches	(mm)	Lbs/Sec	Kg/Sec	Lbs/Sec	Kg/Sec	Inches	(mm)	Lbs/Sec	Kg/Sec	Lbs/Sec	Kg/Sec
3/8	(10)	1.55	.705	0.93	.42	2	(50)	29.82	13.56	17.89	8.13
1/2	(15)	2.58	1.17	1.55	.71	2-1/2	(65)	44.06	20.03	26.44	12.02
3/4	(20)	4.53	2.06	2.72	1.24	3	(80)	71.34	32.43	42.81	19.46
1	(25)	7.29	3.31	4.37	1.99	4	(100)	129.28	58.76	77.57	32.26
1-1/4	(32)	12.67	5.75	7.60	3.45	5	(125)	205.71	93.50	123.43	56.10
1-1/2	(40)	17.46	7.94	10.48	4.76	6	(150)	286.54	130.25	171.92	78.15

3.8 Control Panel

The control panel shall be listed and/or approved for Releasing Device Service and compatible with Chemetron FM-200 equipment.

When selecting a mounting location for the control panel, a shock and vibration free area should be chosen. If the panel has a hinged door, allowances should be made for it to swing completely open for service. The standards of the National Electrical Code (NFPA 70), Local Protection Signaling (NFPA 72), and any state and local codes should be followed for detection and visual and audible alarms. The control equipment shall supervise the actuating devices and associated wiring. It shall also be provided with a reliable 24-hour minimum standby source of energy.

3.9 Automatic Detection

The automatic detection devices used shall be capable of detecting and indicating heat, smoke, flame, or combustible vapors that are likely to produce a fire. When choosing detectors, the four fire stages should be considered. The stages are incipient, smoldering, flame, and heat.

4. **Incipient Stage** - This stage is when visible products of combustion are present without smoke, flame, or heat.

5. **Smoldering Stage** - During this stage, visible products of combustion and smoke are present; however flame and heat are still not present.

6. **Flame Stage** - When this stage is reached, an actual fire is present but without appreciable heat, which will follow very quickly.

7. **Heat Stage** - This is the final stage, with rapidly expanding gasses and uncontrollable heat present.

The consideration in choosing detector type should be based on vibration, response time, and the amount of dirt or corrosive products in the environment. Ionization (smoke) detectors respond best during the incipient stage and decrease in effectiveness during the smoldering, flame and heat stages. Photoelectric detectors respond best during the early smoldering stage. A thermal type detector gives the best response during the later flame and heat stages of a fire. They are selected by temperature range in conjunction to the area being protected.

3.10 Accessories

Accessories include audible or visual devices used to indicate the operation of the system, hazards to personnel, or failure of supervised devices.

3.11 Leakage

Any enclosure must be sealed to insure that leakage of the agent does not occur during discharge and the required concentration levels can be maintained for the entire holding period. Under most circumstances, the agent will suppress all flames and fire conditions very quickly. However, when leakage does exist, it can sometimes make it difficult for the source of ignition to be extinguished. When a room opening does exist, adding more agent within the room usually increases the rate of loss due to the additional pressure created by the additional agent.

Every effort should be made to insure the tightness of the room. To accomplish this, the following areas should be inspected:

A. Walls: All walls should be caulked and inspected to insure that they extend slab to slab. Bulkheads should be installed in those areas where walls do not extend slab to slab.

B. Ductwork: All ductwork leading out or into the area should contain dampers with smoke seals. Their design should provide 100% air shutoff.

C. Doors: All doors should be weather stripped around jams and sealed at the bottom. Extra precaution and care should be taken with double doors. Any door that is required to remain open should have some type of door holder designed to be released during system alarm.

D. Air Handling: All air handling units should be shut down upon alarm to prevent agent loss or smoke spread into other areas. If the unit cannot be shut down, the unit should be of the recirculating type, or additional loss of agent should be considered.

E. Penetrations: All cracks, holes, or penetrations of the protected area must be sealed, including pipe chases and any wire trays. Floor drains should also have traps filled with water.

F. Block Type Walls: Any porous walls should be sealed, which can be accomplished with two or three coats of paint.

To determine the tightness of any enclosure, a room integrity test should be performed. NFPA 2001 contains information regarding integrity testing of enclosures.

3.12 Effects of Altitude

At elevations above sea level, FM-200 expands to a greater specific vapor. A system designed for sea level will develop a greater concentration level at an elevation above sea level. To correct for the effects of a higher elevation, the quantity of agent used should be reduced. The correction factors are listed in Table 3.12.

Table 3.12 - Elevation Correction Factors

Altitude		Enclosure Pressure		Correction Factor	Altitude		Enclosure Pressure		Correction Factor
Feet	Kilometers	PSIA	cm Hg		Feet	Kilometers	PSIA	cm Hg	
-3,000	-0.92	16.25	84.0	1.11	4,000	1.22	12.58	65.0	0.86
-2,000	-0.61	15.71	81.2	1.07	5,000	1.52	12.04	62.2	0.82
-1,000	-0.30	15.23	78.7	1.04	6,000	1.83	11.53	59.6	0.78
0	0	14.71	76.0	1.00	7,000	2.13	11.03	57.0	0.75
1,000	0.30	14.18	73.3	0.96	8,000	2.44	10.64	55.0	0.72
2,000	0.61	13.64	70.5	0.93	9,000	2.74	10.22	52.8	0.69
3,000	0.92	13.12	67.8	0.89	10,000	3.05	9.77	50.5	0.66

Note: Multiply the correction factor by the sea level design quantity of FM-200 to obtain the correct quantity for a given altitude.

3.13 Equipment List

Sigma Series Equipment List		
Quantity	**Stock #**	**Description**
	10481454	Cylinder assembly filled with 304 to 607 lbs. (137.9 to 275.3 kg) of FM-200 pressurized with nitrogen to 360 psi (2482 kPa) at 70°F (21°C)
	10481462	Cylinder assembly, with Liquid Level Indicator, filled with 304 to 607 lbs. (137.9 to 275.3 kg) of FM-200 pressurized with nitrogen to 360 psi (2482 kPa) at 70°F (21°C)
	10481455	Cylinder assembly filled with 455 to 910 lbs. (206.4 to 412.8 kg) of FM-200 pressurized with nitrogen to 360 psi (2482 kPa) at 70°F (21°C)
	10481463	Cylinder assembly, with Liquid Level Indicator, filled with 455 to 910 lbs. (206.4 to 412.8 kg) of FM-200 pressurized with nitrogen to 360 psi (2482 kPa) at 70°F (21°C)
	10481456	Cylinder assembly filled with 620 to 1000 lbs. (281.2 to 562.0 kg) of FM-200 pressurized with nitrogen to 360 psi (2482 kPa) at 70°F (21°C)
	10481464	Cylinder assembly, with Liquid Level Indicator, filled with 620 to 1000 lbs. (281.2 to 562.0 kg) of FM-200 pressurized with nitrogen to 360 psi (2482 kPa) at 70°F (21°C)
●	10610729	Manual pneumatic actuator
●▲	10260303	3/16 in. Flexible connector, 28 in. (71.1 cm) long
	70610549	Check valve (used with Main/Reserve or multiple cylinder systems)
	10170089	Pressure switch 2-pole (optional)
●▲	70390542	3 in. (80 mm) 90° Grooved elbow (part of Victaulic connection kit)
●▲	70390540	3 in. (80 mm) Grooved coupling (part of Victaulic connection kit)
●▲	70400133	3 in. (80 mm) Adapter nipple (part of Victaulic connection kit)
●	20610276	Pilot solenoid valve assembly with vented elbow 24 VDC / 120 VAC
	20610277	Pilot solenoid valve with vented elbow and supervisory pressure switch 24 VDC / 120 VAC
▲	20240041	Pressure gauge assembly
	20610262	Pressure gauge assembly with supervisory pressure switch
▲	10611067	Pneumatic booster assembly
▲	50440029	Male connector, 1/4” Flare x 1/4” MNPT
●▲	50440028	Male connector, 1/4” Flare x 1/8” MNPT

Sigma Series Equipment List		
Quantity	**Stock #**	**Description**
	Various	Style F & G nozzles (Refer to Table 1.6 in Chapter 1 for nozzle details.)
	20710264	600 lb. Cylinder rack kit
	20710360	750 lb. Cylinder rack kit
	20710361	1000 lb. Cylinder rack kit
●	70360526	Warning sign
	30000049	System manual
●	70360524	Instruction sign

● Denotes item is part of a Sigma primary completer kit, Stock #20480754
▲ Denotes item is part of a Sigma slave completer kit, Stock #20480756

3.14 Design Worksheet

Concentration Required: 6.25%

CHEMETRON Fire Systems

FM-200 Surface Fire Requirements

PROJECT:		**DATE:**	
HAZARD:		**ENGR.**	

➢ **VOLUME**

_____ L x _____ W = _____ Sq Ft x _____ H = _____ Cu Ft

_____ L x _____ W = _____ Sq Ft x _____ H = _____ Cu Ft

_____ L x _____ W = _____ Sq Ft x _____ H = _____ Cu Ft

Total = _____ Sq Ft _____ Cu Ft

➢ **FM-200 REQUIRED (REFER TO TABLES BELOW AND IN APPENDIX)**

_____ Cu Ft x _____ (concentration factor) = _____ Lbs

_____ Lbs x _____ (altitude correction factor) = _____ Lbs

Total Pounds Required = _____

➢ **STORAGE REQUIRED**

_____ Lbs Req'd / _____ # of Cylinders = _____ Lbs/Cylinder

_____ Cylinders Main & _____ Cylinders Reserve

Qty Used	Cylinder Size	Minimum Fill Lbs (Kgs)	Maximum Fill Lbs (Kgs)
	600# Sigma	304 (137.9)	607 (275.3)
	750# Sigma	455 (206.4)	910 (412.8)
	1000# Sigma	620 (281.2)	1,000 (562.0)

4 EQUIPMENT ASSEMBLY INSTRUCTIONS

The installation of FM-200 system equipment requires the completion of four categories and their related steps.

- Equipment inspection
- Container mounting
- Piping and nozzle installation
- Piloting piping installation

TOOLS: No special tools are required to assemble the equipment. Socket wrenches are required for the smaller bolts and nuts. The check valves, male connector, male connector nut, and discharge tube flare nut have hex wrenching surfaces. In order to avoid mutilating these hex surfaces, pipe wrenches should not be used. Instead, use an adjustable hex wrench or crescent wrench to tighten these items. A minimum of an 18 inch wrench should be used in order to obtain sufficient torque.

4.1 Equipment Inspection

The agent container and other components should be inspected for shipping damage and to verify receipt of parts.

4.2 Sigma System Assembly

WARNING

THE FM-200 CYLINDER IS PRESSURIZED TO 360 PSI (2482 KPA) [AT 70°F (21°C)] AND MUST BE HANDLED CAREFULLY. ALTHOUGH THE CYLINDER VALVE IS CONSTRUCTED OF HEAVY FORGED BRASS, IT COULD BE DAMAGED IF THE CYLINDER IS DROPPED. ***DISCHARGE OF AN UNSECURED AND DISCONNECTED CYLINDER COULD BE EXTREMELY DANGEROUS AND MAY RESULT IN INJURY OR DEATH, AND/OR DAMAGE TO PROPERTY.*** *THE CYLINDERS, AS DELIVERED, CANNOT BE DISCHARGED ACCIDENTALLY UNLESS MISHANDLED.*

UNDER NORMAL CONDITIONS, THE CYLINDER VALVE CANNOT BE DISCHARGED WITHOUT HAVING THE VARIOUS PILOT DEVICES ATTACHED AND INTERCONNECTED BY THE FLEXIBLE CONNECTORS. ***NEVER CONNECT THE MANUAL-PNEUMATIC ACTUATOR, PNEUMATIC ACTUATOR, SOLENOID PILOT VALVE ASSEMBLY, OR FLEXIBLE PILOT CONNECTORS TO THE CYLINDERS, OR HAVE THE SOLENOID PILOT VALVE WIRED TO THE SYSTEM'S ELECTRICAL CONTROLS UNTIL THE CYLINDER HAS BEEN PROPERLY SECURED IN THE CYLINDER RACK AND THE DISCHARGE CONNECTION FITTINGS CONNECTED TO THE SYSTEM PIPING.***

A SEVERE LEAK AT THE CHECK VALVE ON TOP OF THE CYLINDER VALVE OR AT THE PISTON O-RING SEAL COULD CAUSE THE VALVE TO OPERATE BY REDUCING THE PRESSURE ABOVE THE PISTON FASTER THAN IT CAN BE SUPPLIED FROM THE CYLINDER. THESE CONDITIONS ARE EXTREMELY REMOTE; HOWEVER, THEIR POSSIBILITY POINTS UP THE NEED ***FOR HAVING THE CAP AND ANTI-RECOIL PLUG IN PLACE AT THE DISCHARGE PORT OF THE VALVE UNTIL REMOVAL IS NECESSARY*** *TO COMPLETE THE CONNECTION OF THE CYLINDER TO THE SYSTEM PIPING.*

4.2.1 Cylinder Weight and Pressure Check

At least semiannually, the agent quantity and cylinder pressure shall be checked. Weigh cylinder and compare weight with cylinder weight information to make sure that no FM-200 has been lost. A weight reduction in excess of 5% is not acceptable. Since the cylinder assembly is shipped without a pressure gauge, a solenoid pilot valve or pressure gauge assembly must be connected to the cylinder.

When the pressure gauge has been connected, check gauge readings. The normal pressure at 70°F (21°C) should be approximately 360 psig (2482 kPa). A pressure drop in excess of 10% of the proper pressure for the temperature condition is not acceptable. The pressure will vary with the temperature. The pressure gauge markings indicate proper pressure for a number of varying temperature conditions. (See Section 6.1.6.1 for the Pressure/Temperature Table).

NOTE

THE FM-200 CYLINDER SHALL BE REFILLED OR REPLACED WHEN IT SHOWS A LOSS OF AGENT QUANTITY OF MORE THAN 5% OR A LOSS IN PRESSURE (ADJUSTED FOR TEMPERATURE) OF MORE THAN 10%.

IN CONSIDERING TEMPERATURE, IT SHOULD BE NOTED THAT THE TEMPERATURE OF THE FM-200 WITHIN THE CYLINDER IS NOT NECESSARILY THE TEMPERATURE OF THE SURROUNDING AIR, ESPECIALLY IF THE SURROUNDING AIR TEMPERATURE IS SUBJECT TO VARIATION, OR IF THE CYLINDERS HAVE NOT BEEN EXPOSED TO THE CONSTANT SURROUNDING AIR TEMPERATURE FOR AT LEAST 24 HOURS.

The solenoid pilot valve assembly connection of the cylinder valve is fitted with an internal check valve, which prevents leakage when the assembly is not attached. The solenoid pilot valve assembly is designed to upset this check valve when its hex nut is engaged with the connection. An O-ring seal prevents leakage when the nut is tightened. As the nut is being run onto the port threads, a slight puff may be experienced. This is **not abnormal.** However, the nut should be tightened quickly to avoid undue loss of pressure.

4.2.2 Cylinder Rack - Vertical Only

The cylinder rack, consisting of a rail, a strap, and miscellaneous hardware for interconnection, is shipped unassembled. The rail is provided with 1-1/8 in (2.85 cm) slots on 2 in (5.0 cm) centers for mounting bolts. Refer to Figure 4.2.2 for the rack details and cylinder clamping arrangement.

CAUTION

THE METHOD OF SECURING THE RAIL TO THE WALL MUST ACCOMMODATE POSSIBLE OPERATIONAL STRESSES. THE CONTAINER IS NOT DESIGNED FOR MOUNTING ON THE CEILING OR IN SHEETROCK MATERIAL.

4.2.3 Cylinder Installation

When it has been determined that weight and pressure are within acceptable limits, install the cylinder in position on the rail, add strap and secure loosely with the spring nuts and spacers provided (Refer to Figure 4.2.2). Rotate the cylinder so that the nameplate is in the front; this should locate the discharge outlet to the left and angled approximately 45° to the rear. At this stage the strap should not be drawn up tight against the cylinder. Some cylinder movement should be permitted while aligning the cylinder valve discharge outlet with the discharge fittings.

4.2.4 Discharge Fittings Installation

The next step involves the discharge connection fittings. These are grooved fittings (Victaulic, etc.) used to mate the cylinder valve discharge outlet connection with the discharge pipe (Refer to Figure 4.2.8). At this time, the cap and antirecoil plug should be removed. These items are to be kept for future use, since they will be needed when a cylinder is removed for servicing or refilling.

Using the 3 in (80 mm) grooved coupling provided, attach a 3 in (80 mm) 90° elbow vertically to the outlet connection.

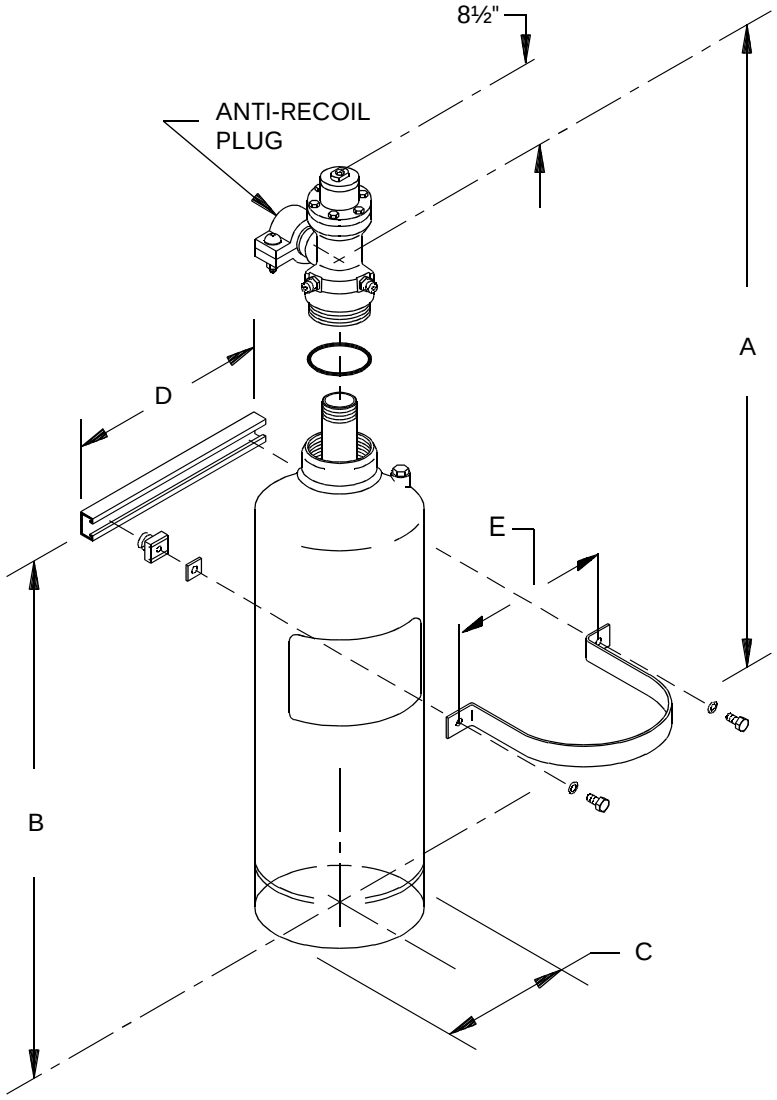


Figure 4.2.2 - FM-200 Sigma Cylinder Rack

NOTE: During actual cylinder installation, rotate the cylinder so that the name-plate is in the front. This should locate the discharge outlet to the left and angled approximately 45° to the rear.

Stock Number	Nominal Cylinder Size	Dimension									
		A		B		C		D		E	
		in	cm	in	cm	in	cm	in	cm	in	cm
20710264	600 lb.	53-9/16	136.0	20-1/2	52.1	22	56.0	26	66.0	24-1/4”	61.6
20710360	750 lb.	65-1/8	165.4	38-1/2	97.8	24	61.0	30	76.2	26-1/4”	66.7
20710361	1000 lb.	59-1/4	150.5	29-1/2	74.9	30	76.2	36	91.4	32-1/4”	81.9

At this point, the connection should only be snug, since some movement of the fittings will be necessary for alignment with the system piping. With the above fitting attached, rotate the cylinder so that the grooved elbow is even with the back of the rack. Install the 3" grooved/threaded nipple to the system piping and then interconnect it to the elbow with the coupling provided. With the connection fittings all properly positioned, tighten the nuts at each coupling wrench-tight.

4.2.5 Manual-Pneumatic Actuator Installation

The first step in making the system operational is the connection of the manual-pneumatic actuator to the cylinder valve. The actuator is attached to the fill check port of the cylinder valve (refer to Figure 4.2.8). Prior to connecting the actuator, insure that its lever is in the closed position with the pullpin inserted completely through its body and the breakwire seal secured.

Next, check that the probe inside the connection nut of the actuator is completely retracted. Although the unit is designed so that a spring returns the probe to the nonoperating position, there is the possibility that severe binding within the unit could prevent the probe's return.

In the nonoperated position, the end of the probe should be about 1/8 in (3.2 mm) inside the face of the swivel nut when it is in its fully extended position on the stem.

CAUTION

IF THE PROBE INSIDE THE CONNECTOR NUT IS IN THE OPERATED POSITION WHEN THE ACTUATOR IS APPLIED TO THE CYLINDER PORT, THE CYLINDER CHECK VALVE WILL BE UPSET AND ***A DISCHARGE WILL OCCUR THROUGH PORTS A AND B OF THE MANUAL PNEUMATIC ACTUATOR*** *(REFER TO FIGURE 2.1.6).* ***IF THE FLEXIBLE PILOT CONNECTORS HAVE BEEN INADVERTENTLY ATTACHED TO THESE PORTS, THE SYSTEM WILL BE DISCHARGED.*** *IT IS FOR THIS REASON THAT ALL FLEXIBLE PILOT CONNECTORS ARE LEFT DISCONNECTED UNTIL THE LAST STAGE OF ASSEMBLY.*

Once it has been determined that the manual-pneumatic actuator is in the nonoperated condition (probe retracted), it can be attached to the connection on the cylinder valve. When securing the swivel nut, align the actuator so that port "A" is aligned to the left. This will orient the actuating lever in the up position.

4.2.6 Solenoid Valve Wiring Installation

The next step in making the system operable is to properly wire the solenoid pilot valve assembly. Refer to Section 2.1.4 for the electrical specifications.

NOTE

THE SOLENOID VALVE SHOULD BE WIRED IN FLEXIBLE CONDUIT IN SUCH A MANNER THAT IT WILL NOT CREATE A PROBLEM WHEN IT COMES TIME TO WEIGH OR SERVICE THE CYLINDER.

4.2.7 Solenoid Pilot Valve Installation

The next step (**after making sure the solenoid is not energized**) in making the system operable is to remove the protective cap from the other cylinder valve connection and attach the solenoid pilot valve assembly to this port (refer to Figure 4.2.8). Using the swivel nut, make certain that the nut is tightly secured.

NOTE

THE SOLENOID PILOT VALVE ASSEMBLY HAS AN INTERNAL PROBE THAT UPSETS THE CHECK VALVE WHEN THE SWIVEL NUT IS ALMOST SECURED. AN INTERNAL O-RING IS DESIGNED TO SEAL THE CONNECTION BEFORE THE SWIVEL NUT IS SECURED, THEREBY ELIMINATING ANY APPRECIABLE LEAKAGE WHEN CONNECTION IS BEING MADE. IF THE CYLINDER CHECK VALVE HAS BEEN PROPERLY UPSET BY ATTACHMENT OF THE SOLENOID PILOT VALVE, THE PRESSURE GAUGE SHOULD INDICATE A PRESSURE OF 360 PSI (2482 KPA) WHEN THE CYLINDER CONTENTS ARE AT 70°F (21°C).

Although the solenoid valves are throughly tested for leaks, there is the possibility that a particle of foreign material may enter the assembly during handling or while attaching it to the cylinder valve. The solenoid valve can be tested for leaks while under pressure by attaching a flare cap to the elbow outlet and applying leak detector solution to the small vent hole at the bottom of elbow. **Leak Tec, Formula 372** has been found to be an excellent solution for this purpose. The appearance of bubbles at the vent hole indicates leakage through the solenoid valve. If a leak is found, the solenoid pilot valve assembly should be removed from the cylinder valve to avoid loss of cylinder contents and corrective action taken to eliminate the leak source, or replace the solenoid pilot valve assembly. Other potential sources of leakage can also be checked by application of leak detector solution to other threaded connections of the assembly.

4.2.8 Flexible Connectors Installation

Once all pilot services have been installed, the flexible connectors can be attached. (Refer to Figure 4.2.8).

Attach one end of a 3/16 in. diameter x 28 in. (71.1 cm) long flexible connector to the solenoid valve elbow and the other end to port B of the manual-pneumatic actuator.

Next, attach one end of a 3/16 in. diameter x 28 in. (71.1 cm) long flexible connector to port A of the manual-pneumatic actuator.

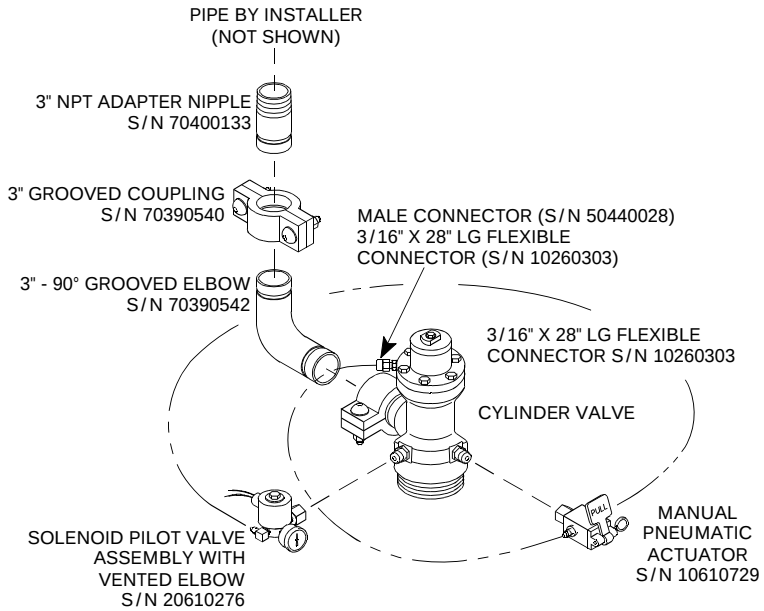


Figure 4.2.8 - Flexible Connectors Installation

4.2.9 Final Connections to Arm System

Connect the loose end of the flexible connector (already connected to port A of the manual-pneumatic actuator) to the cylinder valve (as indicated in Figure 4.2.8) and tighten with a wrench. Insure all other attachments are tight.

CAUTION

AT THIS POINT, THE SYSTEM IS COMPLETELY ARMED AND ACTUATION OF EITHER THE SOLENOID PILOT VALVE OR THE MANUAL-PNEUMATIC ACTUATOR WILL CAUSE THE SYSTEM TO DISCHARGE.

4.2.10 Multiple Cylinder System

If multiple cylinders are needed to protect a hazard, it will be necessary to install a 1/4", Schedule 40 pilot manifold as shown in Figure 4.2.10. When two or more cylinders are grouped together on a common discharge manifold, they must be of the same select size and fill

As an alternative to pilot lines and the actuation of multiple cylinders pneumatically, multiple cylinders protecting a single hazard may be discharged electronically from a releasing control panel with multiple releasing circuit capability. The releasing control panel is required to be listed by UL and ULC and approved by FMRC for the application and all cylinders must be discharged within one second of each other.

All cylinders other than the pilot cylinders are called *slave* cylinders. The valves for these cylinders are identical in operation to those on a pilot cylinder. The slave cylinders include a pressure gauge assembly and a pneumatic booster assembly. They have neither a solenoid pilot valve assembly nor manual-pneumatic actuator. The slave cylinders are operated by the application of pilot pressure from a pilot cylinder to the pneumatic booster located on the side of each cylinder valve. A single pilot cylinder may operate up to 7 slave cylinders. The maximum distance between the pilot cylinder and the last slave cylinder can be no more than 43'-0", with the distance between any two adjacent cylinders not exceeding 25'-0", unless there is only one master and one slave cylinder, then the maximum distance between two adjacent cylinders should not exceed 43'-0".

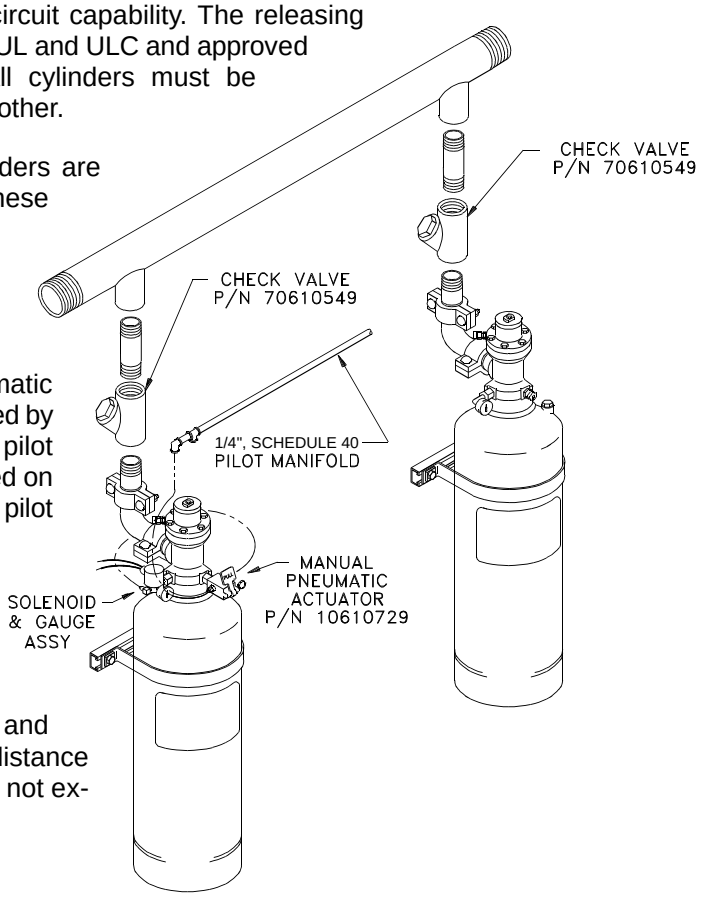


Figure 4.2.10 - Sigma Multiple Cylinder System

4.2.11 Pilot Connections

Install the necessary cylinders as needed to protect the hazard. The pilot connection shown in Figure 4.2.11 reflects the proper installation of the cylinder assemblies to the pilot manifold. It is important to note that for both the manual-pneumatic actuator and the pneumatic booster assembly, Port A is considered the outlet of the actuator and Port B is the inlet. To insure quick actuation of the cylinder valves in a multiple cylinder system, Port A of the manual-pneumatic actuator on the pilot cylinder should always be connected to the pilot manifold via the 3/16" flexible hose, while Port A of the pneumatic booster assembly on the slave cylinder(s) should be connected to the valve(s) (as indicated in Figure 4.2.11).

NOTE

ALL CYLINDERS MUST BE LOCATED TOGETHER IN THE SAME AREA AND AT THE SAME TEMPERATURE WHEN THERE IS MORE THAN ONE SLAVE CYLINDER.

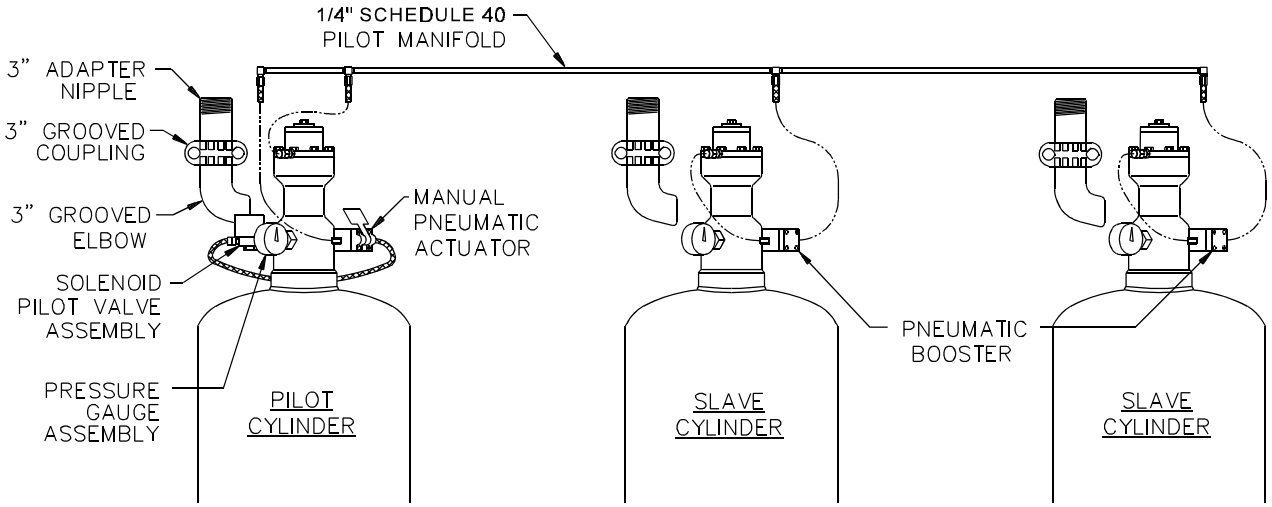


Figure 4.2.11 - Sigma Pilot Connections

4.2.12 Discharge Manifold/Check Valve Assembly

Install check valves to the manifold bottom outlets by means of 3" schedule 40 steel pipe nipples that are of a length that will place the manifold just above the cylinder rack. (These are not furnished, but the suggested length is 9".)

The check valves should be installed so that the large service plug on the valve is facing forward and the 3/8" brass plug is at the top. The flow direction is indicated by an arrow stamped on the body of the valve.

Next, install the 3" nipple to the inlet side of each check valve. Use a good grade pipe dope or Teflon tape on the pipe threads and securely tighten the check valve and pipe nipple assemblies so that they are the same overall length. This is necessary for easy attachment to the cylinders using the grooved fittings.

4.2.13 Manifold/Cylinder Connection

Mount the discharge manifold with the check valves and pipe nipples already installed and connect to the cylinders by means of 3" grooved couplings. During the alignment procedure, it may be necessary to turn the cylinders slightly. When completed, the manifold should be level and the cylinder connection vertical. **Correct alignment is essential for proper mating and an ultimately tight seal.**

When the connection fittings are all properly positioned, tighten the nuts at each grooved coupling wrench-tight. After the fittings are secured, tighten the hex head cap screws to firmly secure the cylinder straps. This will snug the cylinder into position.

In addition to being attached to the cylinders, the manifold must be bracketed to a wall or the rack itself for rigidity during system discharge, or when the cylinders are removed for servicing.

NOTE

WHEN THE GROOVED COUPLINGS ARE TIGHT (NO GAP BETWEEN THE PARTS), THE JOINT WILL BE SUBJECT TO SOME MOVEMENT. THIS IS NORMAL.

IF ANY CYLINDER CONNECTION CANNOT BE MADE, ***REPLACE THE CAP AND RECOIL PLUG*** *AND CORRECT THE PROBLEM.*

5 MECHANICAL AND ELECTRICAL INSTALLATION

The following minimum requirements for installing FM-200 systems shall govern except where the requirements of a specific job site specification are more rigid and take precedence. Materials must be new and of the highest grade, free from defects and imperfections; they must be the products of reputable manufacturers. Workmanship must be in accordance with the best modern standard practices.

5.1 Storage Rack, Cylinder, and Accessories

Whenever possible, the cylinders shall **not** be located within the area which they are designed to protect.

Storage containers and accessories shall be so located and arranged that inspection, testing, recharging, and other maintenance is facilitated and interruption of protection is held to a minimum. Items must not be located where they will be subject to severe weather conditions, or to mechanical, chemical, or other damage which would render them inoperative.

Cylinders should be installed on a level, hard surface in a dry location where the normal surrounding indoor air temperature remains at 70°F ±10°F (21.1°C ±5.5°C). Testing has verified equipment will function between 32°F (0°C) and 130°F (54°C). However, storage at temperatures other than 70°F ±10° (21.1°C ±5.5°) may result in calculations not being accurate, and consequently, designed quantities of agent may not be discharged from one or more nozzles.

NOTE

ALL CYLINDERS MUST BE LOCATED TOGETHER IN THE SAME AREA AND AT THE SAME TEMPERATURE.

5.2 Discharge Nozzle

The discharge nozzle is the ultimate device which delivers the extinguishing agent to the hazard area. The nozzle serves two functions:

1. It controls the agent discharge rate in union with the piping network; and

2. It provides the desired distribution of agent in the protected hazard.

NOTE

CEILING TILES MUST BE CLIPPED IN PLACE WITH APPROVED DEVICES AT NOZZLE LOCATIONS TO AVOID MOVEMENT DURING A DISCHARGE.

5.2.1 Nozzle Use and Installation

The systems covered in this manual are designed for the nozzle to be mounted as described and shown in Sections 3.4 and 3.5 of this manual. Their installation should allow for unobstructed flow of the discharge stream. This means that the orifice alignment should be such that the discharge avoids impingement on obstacles such as duct work or lighting fixtures.

This maximum area information still requires some judgement on the part of the designer, depending in part on the density of equipment or objects that may be present in the protected space.

NOTE

THE DISCHARGE NOZZLES SHALL BE INSTALLED IN A MANNER SO THAT THEY WILL NOT POTENTIALLY CAUSE INJURY TO PERSONNEL. WHEN DISCHARGED FROM THE NOZZLE, THE AGENT SHOULD NOT DIRECTLY IMPINGE ON AREAS WHERE PERSONNEL MIGHT BE FOUND IN THE NORMAL WORK AREA. THE AGENT SHALL NOT IMPINGE ON ANY LOOSE OBJECTS ON SHELVES, CABINET TOPS, OR SIMILAR SURFACES WHERE LOOSE OBJECTS COULD BE PRESENT AND BECOME MISSILES.

Eight port radial nozzles are used for all areas. The nozzles are drilled with two rows of orifices.

5.3 Pipe Installation

The piping between the storage cylinders and the nozzles shown on the system drawing should be the shortest route allowable with a minimum of elbows and fittings.

NOTE

ALL PLANS MUST BE APPROVED BY THOSE AUTHORITIES HAVING JURISDICTION OVER THE PROJECT ***PRIOR TO BEGINNING ANY INSTALLATION WORK.***

5.3.1 Discharge Piping

5.3.1.1 Ferrous Piping

Black or galvanized, ASTM A-53 seamless or electric resistance welded, Grade A or B; or A-106 Grade A, B, or C, ANSI B-36.10 is suitable for use. Ordinary cast iron pipe, steel pipe conforming to ASTM A-120, or non-metallic pipe **MUST NOT** be used.

5.3.1.2 Schedule 40 Pipe

For 360 psig (2482 kPa) storage pressures [maximum storage temperature 130°F (54°C)], Schedule 40 pipe may be used as follows:

A-53, Grade A	ERW, Threaded End	3/8 in. through 6 in.
A-53, Grade A	ERW, Welded Connections	3/8 in. through 6 in.
A-53, Grade A & B	Seamless, Welded or Threaded Connections	3/8 in. through 6 in.
A-106, Grade A, B, & C	Welded or Threaded Connections	3/8 in. through 6 in.

5.3.2 Discharge Piping Joints

A. Pipe fittings shall be black for normal atmospheres and galvanized for moist or corrosive atmospheres. Reduction must be made with reducing fittings, concentric reducers, and reducing couplings. Flush bushings **MUST NOT** be used.

NOTE

DO NOT USE *STREET ELBOWS OR CROSSES.*

B. Class 150 lb and cast iron fittings **MAY NOT BE USED**.

C. 1. Fittings must have a minimum working pressure equal to or greater than the minimum piping design pressure of 402 psig (2772 kPa) at 70°F (21.1°C), as indicated in NFPA 2001.

2. Class 300 lb malleable or ductile iron fittings in sizes 3 inch (76 mm) and smaller or 1000 lb. ductile iron or forged steel fittings in sizes greater than 3 inch (76 mm) are to be used. Class 300 lb flanged joints are acceptable for use in all sizes.

3. Butt-weld welding fittings should be of schedule to match the piping.

4. Grooved fittings with companion gasketed couplings must be Underwriters Laboratories listed or Factory Mutual Research Corporation approved for FM-200 extinguishing systems.

D. The above listed materials do not preclude the use of other materials which would satisfy the requirements set forth in NFPA 2001.

E. Ductile iron fittings must be UL listed, of the appropriate weight, and bear identifying marks.

F. All unions should be of the ground joint type with both seating surfaces matched.

G. Tees shall be side-thru only.

5.3.3 Pipe Hangers and Supports

A. All supports and parts thereof shall conform to the requirements for pressure piping ANSI B31.1, latest issue except as modified and supplemented by the requirements of this specification.

B. Conventional hanger design which is generally accepted as good practice, using standard stock or production units as manufactured by recognized reputable manufacturers, shall be utilized whenever possible but within the limits as set forth hereafter.

C. All piping must be solidly anchored to walls, ceiling structure or columns by angle iron brackets, “Unistrut” [P5500 - .105 in. (2.67 mm) thick] or equivalent brackets where longitudinal or lateral sway may occur. Particular attention must be paid to the bracing of all piping changes in direction and nozzle piping.

D. All piping must be securely anchored to rigid support by means of "U" bolts locked with double nuts. Pipe supports and parts shall be steel and adequate to support the pipe in a sub-cold condition, and to allow for free and ample movement for contraction except where anchored, thereby preventing excessive stress. Pipe shall be supported and anchored as the piping system requires.

E. Grooved pipe, fittings, and couplings must be supported and anchored exactly per the manufacturer's specification. Installation shall be such as to allow for contraction over the anticipated temperature range and pressure thrusts.

F. Cast iron supports, half clamps, conduit clamps, malleable iron ring-type hangers, single beam clamps, or "C" clamps **shall NOT be used** to support piping.

G. All parts of the supporting equipment must be fabricated and installed so that they will not be disengaged or distorted by movement of the supported pipe. **A pipe line must NOT be supported from another pipe line.**

H. All pipe supports shall be installed to avoid interference with other piping, hangers, electrical conduit, and supports or building structure and equipment.

I. Supports shall be sufficiently close together to avoid excessive bending stresses from concentrated loads between supports. Spacing between supports is shown in Table 5.3.3-I. No grooved pipe length should be left unsupported between any two couplings.

J. Where rod type hangers are permitted for intermediate support between rigid supports, they shall be a steel clevis hanger of the proper size for the supported pipe and with solid bar-type hanger rod. Hanger rods shall not be subjected to stresses due to bending.

Table 5.3.3-I
Maximum Spacing Between Pipe Supports for Screwed, Welded or Grooved Pipe

Nominal Pipe Size		Maximum Span	
NPS In.	DN MM	Feet	Meters
.25	8	5	1.5
.5	15	5	1.5
.75	20	6	1.8
1	25	7	2.1
1.25	32	8	2.4
1.5	40	9	2.7
2	50	10	3.0
2.5	65	11	3.3
3	80	12	3.6
4	100	14	4.3

NOTE

"C" CLAMPS ARE NOT ACCEPTABLE TO SUPPORT ROD HANGERS.

Generally it is acceptable to alternate hangers on rods. Where an intermediate hanger is used between two rigid supports, the distance between hangers shall be reduced to approximately 75 percent of the distances shown in Table 5.3.3-I. "Unistrut" channel P5500 or HS or equal may be used as an intermittent hanger regardless of pipe size.

5.3.4 Pilot Manifold Piping and Fittings

A. Fittings shall have a minimum rated working pressure equal to or greater than 502 psi, which is the maximum pressure in the container at 130°F (54.4°C).

B. Threaded fittings shall be either Class 300 malleable or ductile iron. Cast iron fittings shall not be used.

C. Pipe shall be steel, Schedule 40, ASTM A-53 seamless or electric resistance welded, Grade A or B; or A-106 Grade A, B, or C, ANSI B-36.10. Ordinary cast iron pipe, steel pipe conforming to ASTM A-120, or non-metallic pipe **must NOT be used**. If tubing is used, it should be 3/8 in. (9.5 mm) soft copper with .035 in. (.89 mm) wall.

D. Support manifold with straps or brackets to prevent sagging.

E. All threaded pilot piping connections shall be treated with a suitable pipe sealant or teflon tape.

5.3.5 Workmanship and Fabrication

A. The contractor must provide the necessary tools and materials that will allow him to complete the installation without delay and in conformance with this specification.

B. Pipe tees supplying branch lines are to be installed with both outlets discharging horizontally. This does not apply to manifold piping for groups of cylinders.

C. Screwed pipe and fittings should have clean cut and full length threads.

D. Screwed pipe joints should conform to ANSI B-2.1 and should be treated with teflon tape, teflon pipe dope, or equal. When applying tape or pipe dope, do not apply to first two threads from end.

E. Where used, all welded joints must permit full flow. Miter weld fittings are **not acceptable.**

F. Piping and tubing should be reamed free of burrs and ridges.

G. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, utilizing a suitable nonflammable cleaner. The pipe network shall be free of particulate matter and oil residue before installation of nozzles or discharge devices.

5.3.6 Venting Considerations

Venting of an enclosure may be necessary to relieve pressure build-up due to the rapid discharge of large quantities of FM-200. Appropriate pressure relief depends on the injection rate of the FM-200 and the strength of the enclosure.

5.3.7 Warning Signs and Nameplates

Warning and instruction signs must be properly located at all entrances to, and inside of, protected areas. A permanent nameplate should be located on each cylinder specifying the part number, filling weight, and pressurization level of the cylinders. (Refer to Figures 5.3.7A, 5.3.7B, 5.3.7C).

Figure 5.3.7A - Warning Sign
Stock Number 70360526

Figure 5.3.7B - Warning Sign
Stock Number 70360525

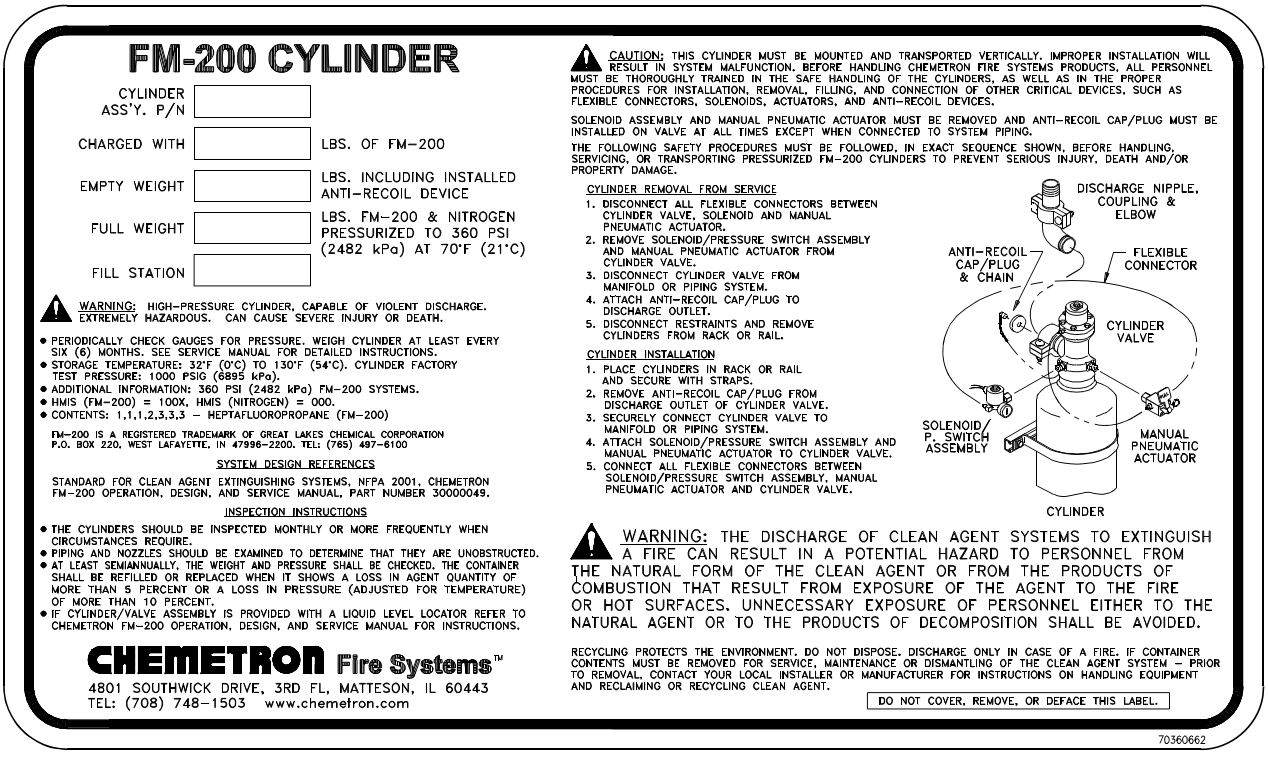


Figure 5.3.7C - Cylinder Nameplate - Stock Number 70360662

5.3.8 Operating Alarms

A sufficient number of alarms should be installed to adequately cover all parts of the protected area, and they should be of sufficient decibel rating to be readily heard above the maximum noise level.

5.3.9 Manual

An Instruction and Maintenance Manual that includes a full sequence of operation must be maintained in a clearly identified protective enclosure at or near the system control panel.

5.3.10 Leakage Consideration

If they are not normally closed, it is fundamental that major wall openings, such as doors and windows, be closed upon system actuation, unless the system has been designed with these openings in mind.

All total flooding systems shall have the enclosure examined and tested to locate and then effectively seal any significant air leaks that could result in a failure of the enclosure to hold the specified agent concentration level for the specified holding period. The currently preferred method is using a blower door fan unit and smoke pencil. If quantitative results are recorded, these could be useful for comparison at future tests. (For guidance, refer to Appendix C of NFPA Standard 2001.)

5.3.11 Painting

The equipment provided and as shown in this manual does not require painting.

5.3.12 Test of Pipe Installation

Field installed piping shall be tested as follows:

A. The piping shall be pneumatically tested in a closed circuit for a period of 10 minutes at 40 psig (276 kPa). Hold the pressure for at least 10 minutes in order to be assured that the pipe and fittings used and their assembly will withstand the operating pressure, as well as be able to overcome the "water hammer" effect occurring at the start of the discharge. At the end of 10 minutes, the pressure drop shall not exceed 20 percent of the test pressure. Any pilot manifold shall be bubble tight at 360 psig (2482 kPa). **EXCEPTION**: *It shall be permissible to omit the pressure test if the total piping contains no more than one change in direction fitting between the storage container and the discharge nozzle, and if all piping is physically checked for tightness.*

CAUTION

PNEUMATIC PRESSURE TESTING CREATES A POTENTIAL RISK OF INJURY TO PERSONNEL IN THE AREA AS A RESULT OF AIRBORNE PROJECTILES IF RUPTURE OF THE PIPING SYSTEM OCCURS. PRIOR TO THE PNEUMATIC PRESSURE TEST BEING CONDUCTED, THE PROTECTED AREA SHALL BE EVACUATED AND APPROPRIATE SAFEGUARDS SHALL BE PROVIDED FOR TEST PERSONNEL.

B. With nozzles removed, blow out the lines with carbon dioxide or nitrogen; then replace nozzles. Any pilot manifold should be disconnected from the cylinders and the lines blown clean.

WARNING

TESTING OF THE PIPING WITH WATER ***IS PROHIBITED AND MUST NOT BE DONE.***

5.4 Electrical Installation

All wiring systems shall be properly installed in conduit and in compliance with local codes.

5.4.1 Codes

Wiring and equipment must be installed in accordance with NFPA 70 - The National Electrical Code, NEMA, Local Electrical Codes, or Owner's specifications, whichever has the more restrictive requirements.

5.4.2 Detection

Detection, actuation, alarm, and control systems shall be installed, tested, and maintained in accordance with appropriate NFPA protective signaling systems standards. *(See NFPA 70,* ***National Electrical Code****, and NFPA 72,* ***National Fire Alarm Code****. In Canada refer to CAN/ULC S524-M86,* ***Standard for the Installation of Fire Alarm Systems****, and CAN/ULC S529-M87,* ***Smoke Detectors for Fire Alarm Systems****.)*

6 TESTING, INSPECTION AND MAINTENANCE INSTRUCTIONS

6.1 Periodic Inspection

The entire fire extinguishing system shall be completely inspected annually - preferably, every six months - by competent personnel using an approved schedule and procedure. Visual inspection of all system components and cylinder pressures should occur **monthly**. Cylinder weight and pressure must be inspected **semi-annually** per NFPA 2001. Any pilot hoses should be examined annually for damage. Any problems should be corrected at once by competent personnel.

The purpose of periodic inspection is to assure that the system is in full operating condition at all times; also, to identify problems due to wear and tear, accidental and environmental damage, tampering, changes to room contents, changes in room use, changes in air handling equipment, changes in openings into the room, or any other related changes that could adversely affect the proper performance of the fire protection system.

During an inspection, the hazard should be checked against the original layout to make sure there have not been additions or alterations that might require system alteration or additional coverage.

A cylinder continuously in service without having been discharged must be given an external visual inspection every five years. This inspection must be done by an approved inspector in accordance with Compressed Gas Association Pamphlet C-6, Section 3, except that the cylinders need not be emptied or stamped while under pressure.

6.1.1 Detection and Actuation System

The detectors should be checked (and cleaned, if necessary) to assure that they are free of foreign substances.

If the detection system is supervised, the supervisory features should be checked to determine that the detection system is in satisfactory condition. Refer to the manufacturer's manual on detectors for proper inspection procedures.

6.1.2 Piping and Nozzles

Piping should be examined for any evidence of corrosion. Nozzles should be checked to determine that the orifices are clear and unobstructed; they should be checked for proper position and orientation.

6.1.3 Auxiliary Equipment

All auxiliary components such as pressure switches, door closures, dampers, and air handling shutdown equipment should be inspected to ensure that they are in proper operating condition. Check that provisions have been made for prompt ventilation of a hazard following a discharge.

NOTE

ALL SHUTDOWNS OR CLOSINGS MUST OCCUR WHETHER THE SYSTEM IS ACTUATED BY AUTOMATIC DETECTION, BY REMOTE MANUAL, OR BY DIRECT MANUAL MEANS.

6.1.4 Storage Rack and Cylinder Assemblies

Inspect the storage rack for tightness, including wall mounting bolts and other hardware, if included.

The cylinder(s) should be examined for evidence of corrosion and the cylinder valves for mechanical damage. The cylinder strap(s) and the outlet fittings connected to the piping should be checked for tightness.

6.1.5 Electrical Components

A functional operational test shall be performed on all electrical components annually in accordance with the National Fire Alarm Code (NFPA 72) and the manufacturer's recommendations.

6.1.6 General Maintenance

The system should be maintained in full operating condition at all times. In particular, the pressure and weight of the cylinders must be maintained. All hoses shall be examined annually for damage, and if visual inspection shows any deficiency, the hoses must be replaced or tested as specified in NFPA Standard 2001 on Clean Fire Extinguishing Systems.

6.1.6.1 Cylinder Storage Pressure

The pressure in the storage container(s) should be noted on a monthly basis. If the temperature in the storage container is about 70°F (21°C), the pressure should be 360 psig (2482 kPa).

If the temperature is lower or higher then 70°F (21°C), the pressure will be somewhat lower or higher in accordance with the following pressure table. If the pressure shows a loss between monthly readings, the container should be inspected for possible leaks using soap suds or some other sensitive method of leak detection. If the loss in pressure is more than 10%, the cylinder must be refilled or replaced.

Table 6.1.6.1 - Isometrics for FM-200 at Fill Density 70 lb/ft^3 (1121 kg/m^3) Superpressurized with Nitrogen to 360 PSIG (2482 kPa) at 70°F (21°C)

Temperature		Gauge Pressure	
°F	°C	PSIG	kPa
32	0.0	288	1987
40	4.4	303	2091
50	9.9	321	2215
60	15.6	340	2346
70	21.0	360	2482
80	26.8	381	2629
90	32.1	402	2774
100	37.7	425	2933
110	43.0	449	3099
120	49.0	475	3278
130	54.0	502	3464

6.1.6.2 Cylinder Content (Weight) Check

At least **semi-annually**, the agent quantity and pressure of refillable container shall be checked. A container shall be refilled or replaced when it shows a loss in agent quantity of more than 5% or a loss in pressure (adjusted for temperature) of more than 10%.

The cylinder contents can be checked by weighing.

The weight can be checked by using a standard platform scale having suitable capacity. When weighing, it will be necessary to remove the cylinder restraining strap from the rack assembly.

IMPORTANT

PREPARING A CYLINDER(S) FOR WEIGHING

BEFORE ANY SIGMA CYLINDER RESTRAINING STRAPS ARE LOOSENED OR DISCHARGE PIPING DISCONNECTED, **DO THE FOLLOWING:**

1. DISCONNECT THE SOLENOID PILOT VALVE ASSEMBLY OR PRESSURE GAUGE ASSEMBLY AND MANUAL-PNEUMATIC ACTUATOR FROM THE CYLINDER(S).
2. DISCONNECT THE FLEXIBLE CONNECTOR FROM THE TOP OF THE CYLINDER(S).
3. THEN DISCONNECT THE DISCHARGE TUBE AT THE CYLINDER VALVE CONNECTION.
4. THE VALVE ANTIRECOIL CAP SHOULD BE ATTACHED TO THE CYLINDER VALVE DISCHARGE OUTLET.

HANDLE CYLINDERS WITH EXTREME CARE!

6.1.6.3 Refilling or Replacing of Cylinders

Cylinder servicing shall be performed by Chemetron Fire Systems. Please contact our office for shipping instructions.

6.1.6.4 Complete Cylinder Recharge

If more than five years have elapsed since the date of the last test and inspection, the cylinder shall not be recharged without first retesting. This retest must include an external and internal visual inspection in accordance with the Code of Federal Regulation, Title 49, Section 173.34(e)(10) and NFPA 2001.

Cylinder servicing shall be performed by Chemetron Fire Systems. Please contact our office for shipping instructions.

6.1.6.5 Hose Test

A. All system hoses shall be examined annually for damage. If visual examination shows any deficiency, the hose shall be immediately replaced or tested as specified in NFPA 2001.

B. All hose shall be tested every 5 years.

TABLE AP-1 (US STANDARD)
FM-200 (HFC-227EA) TOTAL FLOODING QUANTITY

Temperature (*t*) [°F] (2)	FM-200 Specific Vapor Volume(*s*) [ft³/lb] (3)	FM-200 Weight Requirements of Hazard Volume $\left(\frac{W}{V}\right)$ [lb/ft³] (1)								
		FM-200 Design Concentration (*C*) [% by Volume] (4)								
		6.25%	7%	8%	9%	10%	11%	12%	13%	14%
10	1.9264	**0.0346**	0.0391	0.0451	0.0513	0.0577	0.0642	0.0708	0.0776	0.0845
20	1.9736	**0.0338**	0.0381	0.0441	0.0501	0.0563	0.0626	0.0691	0.0757	0.0825
30	2.0210	**0.0330**	0.0372	0.0430	0.0489	0.0550	0.0612	0.0675	0.0739	0.0805
40	2.0678	**0.0322**	0.0364	0.0421	0.0478	0.0537	0.0598	0.0659	0.0723	0.0787
50	2.1146	**0.0315**	0.0356	0.0411	0.0468	0.0525	0.0584	0.0645	0.0707	0.0770
60	2.1612	**0.0308**	0.0348	0.0402	0.0458	0.0514	0.0572	0.0631	0.0691	0.0753
70	2.2075	**0.0302**	0.0341	0.0394	0.0448	0.0503	0.0560	0.0618	0.0677	0.0737
80	2.2538	**0.0296**	0.0334	0.0386	0.0439	0.0493	0.0548	0.0605	0.0663	0.0722
90	2.2994	**0.0290**	0.0327	0.0378	0.0430	0.0483	0.0538	0.0593	0.0650	0.0708
100	2.3452	**0.0284**	0.0321	0.0371	0.0422	0.0474	0.0527	0.0581	0.0637	0.0694
110	2.3912	**0.0279**	0.0315	0.0364	0.0414	0.0465	0.0517	0.0570	0.0625	0.0681
120	2.4366	**0.0274**	0.0308	0.0357	0.0406	0.0456	0.0507	0.0560	0.0613	0.0668
130	2.4820	**0.0269**	0.0303	0.0350	0.0398	0.0448	0.0498	0.0549	0.0602	0.0656
140	2.5272	**0.0264**	0.0298	0.0344	0.0391	0.0440	0.0489	0.0540	0.0591	0.0644
150	2.5727	**0.0259**	0.0293	0.0338	0.0384	0.0432	0.0480	0.0530	0.0581	0.0633
160	2.6171	**0.0255**	0.0288	0.0332	0.0378	0.0425	0.0472	0.0521	0.0571	0.0622
170	2.6624	**0.0250**	0.0283	0.0327	0.0371	0.0417	0.0464	0.0512	0.0561	0.0611
180	2.7071	**0.0246**	0.0278	0.0321	0.0365	0.0410	0.0457	0.0504	0.0552	0.0601
190	2.7518	**0.0242**	0.0274	0.0316	0.0359	0.0404	0.0449	0.0496	0.0543	0.0592
200	2.7954	**0.0238**	0.0269	0.0311	0.0354	0.0397	0.0442	0.0488	0.0535	0.0582

(1) $\frac{W}{V}$ [Agent Weight Requirements (lb/ft³)] - Pounds of agent required per cubic foot of protected volume to produce indicated concentration at temperature specified.

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

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

(3) *s* [Specific Volume (ft³/lb)] - Specific volume of superheated FM-200 vapor may be approximated by the formula:

$s = 1.885 + 0.0046\,t$
where t = temperature, °F

(4) *C* [Concentration (%)] - Volumetric concentration of FM-200 in air at the temperature indicated.

TABLE AP-2 (METRIC)
FM-200 (HFC-227EA) TOTAL FLOODING QUANTITY

Temperature (*t*) [°C] (2)	FM-200 Specific Vapor Volume(*s*) [m^3/kg] (3)	FM-200 Weight Requirements of Hazard Volume $\left(\frac{W}{V}\right)$ [kg/m^3] (1)								
		FM-200 Design Concentration (*C*) [% by Volume] (4)								
		6.25%	7%	8%	9%	10%	11%	12%	13%	14%
-10	0.1215	**0.5487**	0.6196	0.7158	0.8142	0.9147	1.0174	1.1255	1.2301	1.3401
-5	0.1241	**0.5372**	0.6064	0.7005	0.7967	0.8951	0.9957	1.0985	1.2038	1.3114
0	0.1268	**0.5258**	0.5936	0.6858	0.7800	0.8763	0.9748	1.0755	1.1785	1.2839
5	0.1294	**0.5152**	0.5816	0.6719	0.7642	0.8586	0.9550	1.0537	1.1546	1.2579
10	0.1320	**0.5051**	0.5700	0.6585	0.7490	0.8414	0.9360	1.0327	1.1316	1.2328
15	0.1347	**0.4949**	0.5589	0.6457	0.7344	0.8251	0.9178	1.0126	1.1096	1.2089
20	0.1373	**0.4856**	0.5483	0.6335	0.7205	0.8094	0.9004	0.9934	1.0886	1.1859
25	0.1399	**0.4765**	0.5382	0.6217	0.7071	0.7944	0.8837	0.9750	1.0684	1.1640
30	0.1425	**0.4678**	0.5284	0.6104	0.6943	0.7800	0.8676	0.9573	1.0490	1.1428
35	0.1450	**0.4598**	0.5190	0.5996	0.6819	0.7661	0.8522	0.9402	1.0303	1.1224
40	0.1476	**0.4517**	0.5099	0.5891	0.6701	0.7528	0.8374	0.9240	1.0124	1.1029
45	0.1502	**0.4439**	0.5012	0.5790	0.6586	0.7399	0.8230	0.9080	0.9950	1.0840
50	0.1527	**0.4367**	0.4929	0.5694	0.6476	0.7276	0.8093	0.8929	0.9784	1.0660
55	0.1553	**0.4293**	0.4847	0.5600	0.6369	0.7156	0.7960	0.8782	0.9623	1.0484
60	0.1578	**0.4225**	0.4770	0.5510	0.6267	0.7041	0.7832	0.8641	0.9469	1.0316
65	0.1604	**0.4156**	0.4694	0.5423	0.6167	0.6929	0.7707	0.8504	0.9318	1.0152
70	0.1629	**0.4092**	0.4261	0.5338	0.6072	0.6821	0.7588	0.8371	0.9173	0.9994
75	0.1654	**0.4031**	0.4550	0.5257	0.5979	0.6717	0.7471	0.8243	0.9033	0.9841
80	0.1679	**0.3971**	0.4482	0.5178	0.5890	0.6617	0.7360	0.8120	0.8898	0.9694
85	0.1704	**0.3912**	0.4416	0.5102	0.5803	0.6519	0.7251	0.8000	0.8767	0.9551
90	0.1730	**0.3854**	0.4351	0.5027	0.5717	0.6423	0.7145	0.7883	0.8638	0.9411

(1) $\frac{W}{V}$ [Agent Weight Requirements (kg/m^3)] - Kilograms of agent required per cubic meter of protected volume to produce indicated concentration at temperature specified.

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

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

(3) *s* [Specific Volume (m^3/kg)] - Specific volume of superheated FM-200 vapor may be approximated by the formula:

$s = .1269 + 0.0005\,t$
where t = temperature, °C

(4) *C* [Concentration (%)] - Volumetric concentration of FM-200 in air at the temperature indicated.

Below are the Cup Burner Extinguishing Concentrations established by Great Lakes Chemical Corporation for the listed fuels. Please note that these values have not been tested or recognized by UL, ULC, or FMRC to be the extinguishing concentrations as published.

HFC-227ea Cup Burner Extinguishing Concentrations

FUEL	Extinguishing Concentration % v/v	Design Concentration % v/v	FUEL	Extinguishing Concentration % v/v	Design Concentration % v/v
Acetone	6.9	8.97	Ethylene Glycol	7.6	9.88
Acetonitrile	4.3	7.00	Gasoline	6.9	8.97
t-Amyl Alcohol	7.3	9.49	n-Heptane	6.7	8.71
AV Gas	6.5	8.45	n-Hexane	6.9	8.97
Benzene	5.5	7.15	I-Hexene	5.8	7.54
n-Butane	6.6	8.58	Hydraulic Fluid	6.5	8.45
n-Butanol	7.6	9.88	Hydraulic Oil	5.9	7.67
2-Butoxyethanol	7.4	9.62	Hydrogen	13.2	17.16
2-Butoxyethyl Acetate	6.9	8.97	Isobutyl Alcohol	7.6	9.88
n-Butyl Acetate	7.0	9.10	Isopropanol	7.5	9.75
Carbon disulfide	11.8	15.34	JP4	6.9	8.97
Chloroethane	6.3	8.19	JP5	6.9	8.97
Crude Oil	6.5	8.45	Kerosene	7.4	9.62
Cyclohexane	7.2	9.36	Methane	5.5	7.15
Cyclohexylamine	6.7	8.71	Methanol	10.4	13.52
Cyclopentanone	7.4	9.62	2-Methoxyethanol	9.4	12.22
1,2-Dichloroethane	2.6	7.00	Methyl Ethyl Ketone	7.4	9.62
Diesel	6.7	8.71	Methyl Isobutyl Ketone	7.0	9.10
N,N-Diethylethanolamine	7.8	10.14	Mineral Spirits	6.6	8.58
Diethyl Ether	7.5	9.75	Morpholine	7.9	10.27
Ethane	6.7	8.71	Nitromethane	9.9	12.87
Ethanol	8.3	10.79	n-Pentane	6.8	8.84
Ethyl Acetate	6.8	8.84	Propane	6.7	8.71
Ethyl Benzene	6.3	8.19	I-Propanol	7.7	10.01
Ethylene	8.4	10.92	Propylene	6.2	8.06

HFC-227ea Cup Burner Extinguishing Concentrations					
FUEL	Extinguishing Concentration % v/v	Design Concentration % v/v	FUEL	Extinguishing Concentration % v/v	Design Concentration % v/v
Propylene Glycol	8.6	11.18	Toluene	5.6	7.28
Pyrrolidine	7.3	9.49	Tolylene-2,4-diisocyanate	4.0	7.00
Tetrahydrofuran	7.4	9.62	Transformer Oil	7.3	9.49
Tetrahydrothiophene	6.6	8.58	Xylene	6.0	7.80
102 mm chimney; 30 mm cup; 5 cm/s air linear velocity					

FM-200 Inerting Concentrations		
FUEL	**INERTING CONCENTRATION % v/v FM-200**	**DESIGN CONCENTRATION % v/v**
i-Butane	11.3	14.69
1-Chloro-1,1,-difluoroethane (HCFC-142b)	2.6	7.00
1,1-Difluoroethane (HFC-152a)	8.6	11.18
Difluoromethane (HFC-32)	3.5	4.55
Ethylene oxide	13.6	17.68
Hydrogen	24.0	31.20
Methane	8.0	10.40
Pentane	11.6	15.08
Propane	11.6	15.08

Liquid Level Indicator - Operating Instructions

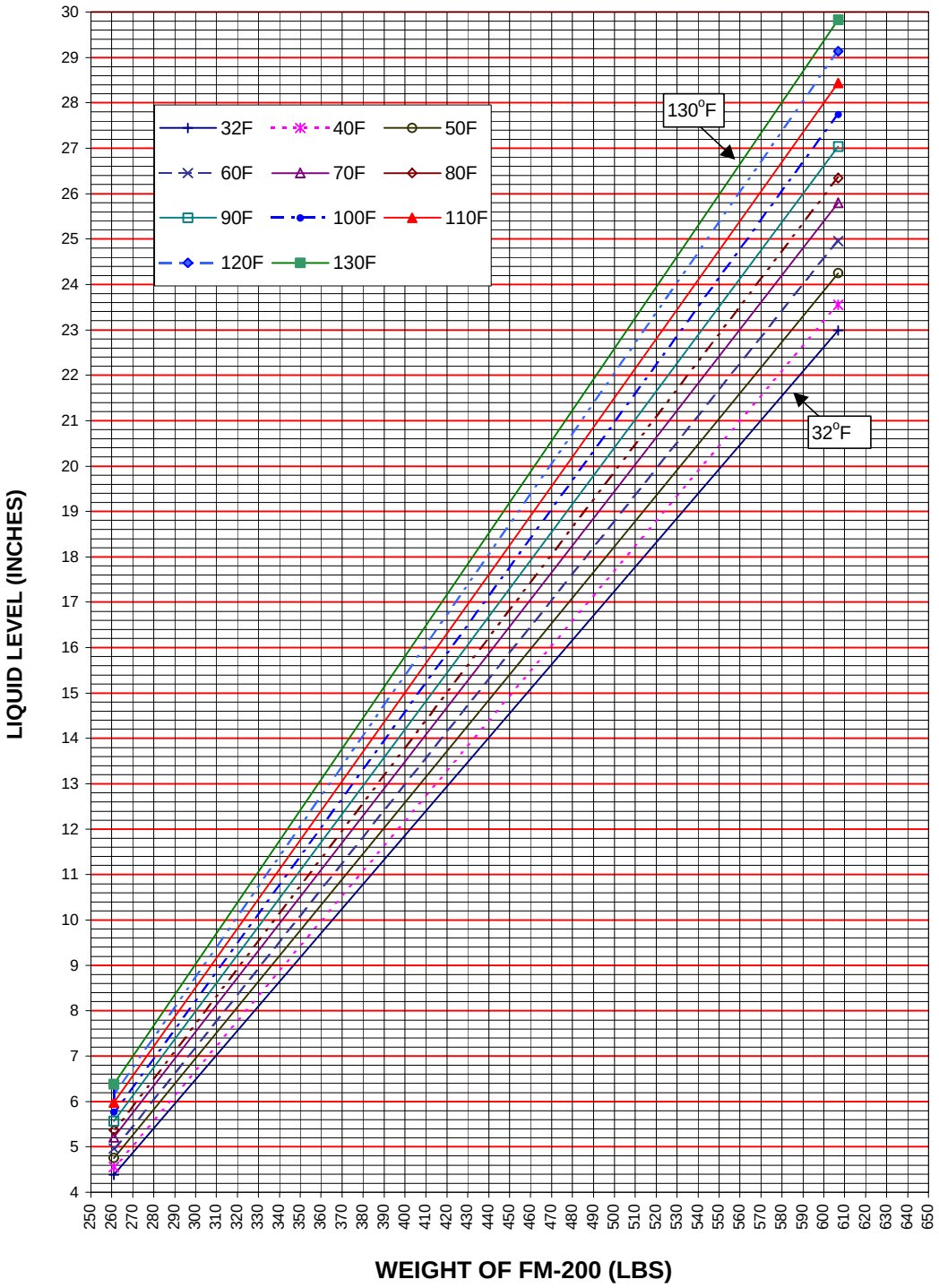
1. Measure cylinder temperature (ambient) °F and record this temperature.

NOTE

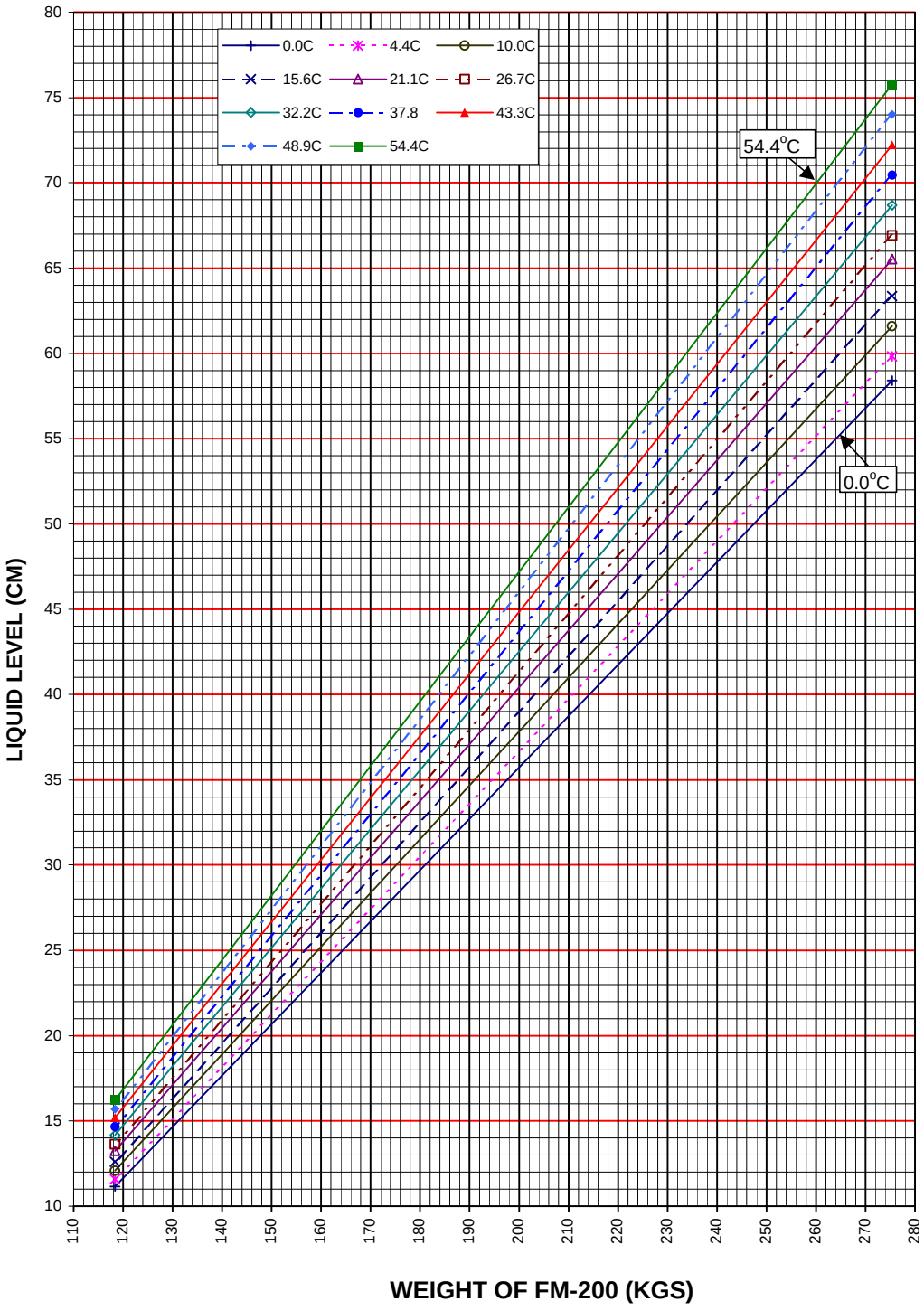
CYLINDER MUST BE STORED AT THIS AMBIENT TEMPERATURE FOR AT LEAST 24 HOURS TO OBTAIN AN ACCURATE LIQUID LEVEL READING.

2. Remove the protective tape cap.
3. Slowly lift the tape until the float magnet is engaged.
4. Read the level on the tape to the nearest eighth of an inch and record the measurement.
5. Reinsert the tape by lifting the tape to disengage the magnet. Then slide the tape back into the cylinder and replace the protective cap.
6. Using the calibration graphs on the following pages, follow the tape reading across the graph to the cylinder temperature point and read the FM-200 weight directly below.
7. Compare this weight from the graph to the FM-200 weight on the nameplate. If the measurement shows a net loss of FM-200 greater than 5%, the cylinder must be weighed to verify the liquid level measurement. If, after weighing, the weight loss still exceeds 5%, the cylinder must be recharged.

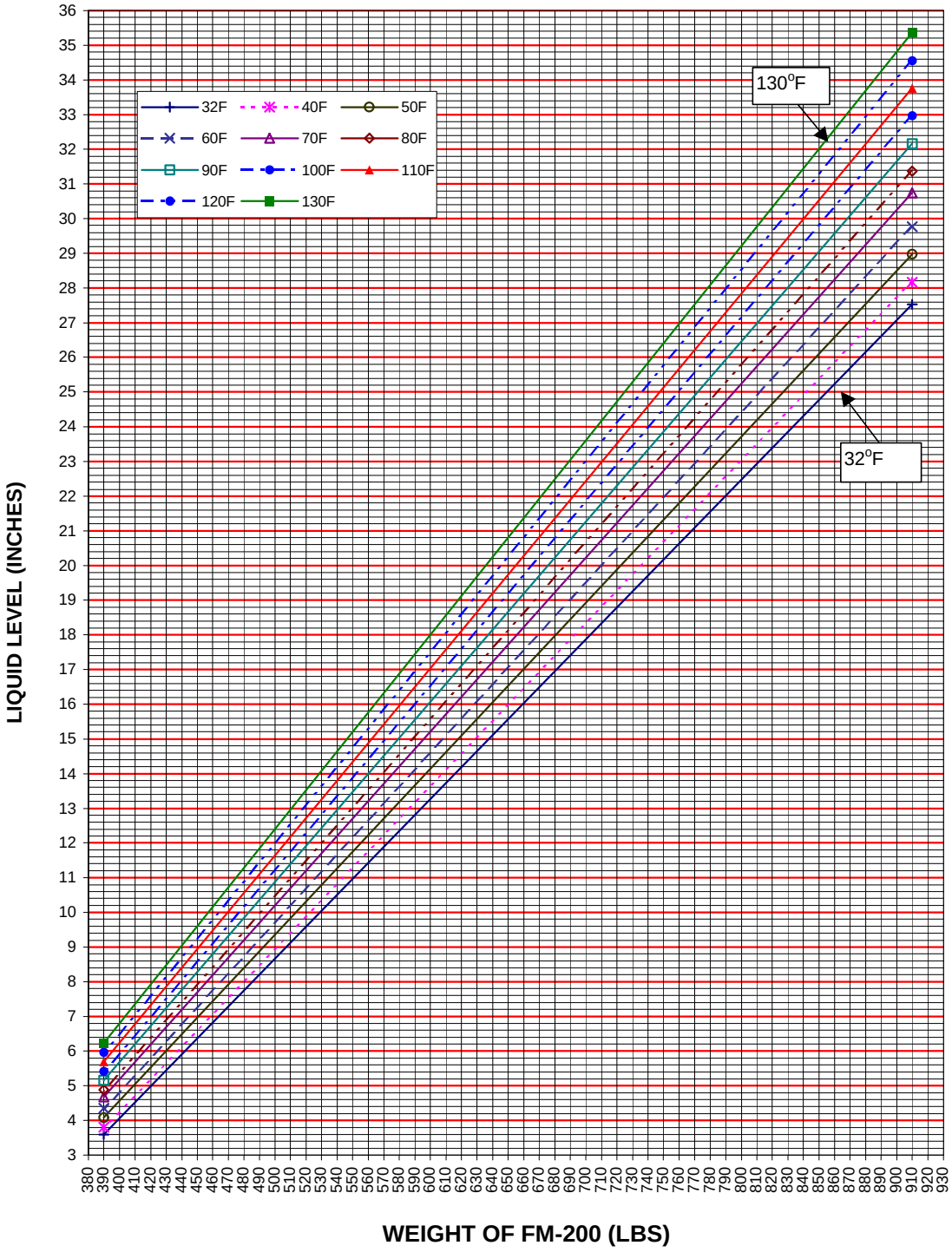
CHEMETRON SIGMA 600
Liquid Level vs Weight of FM-200



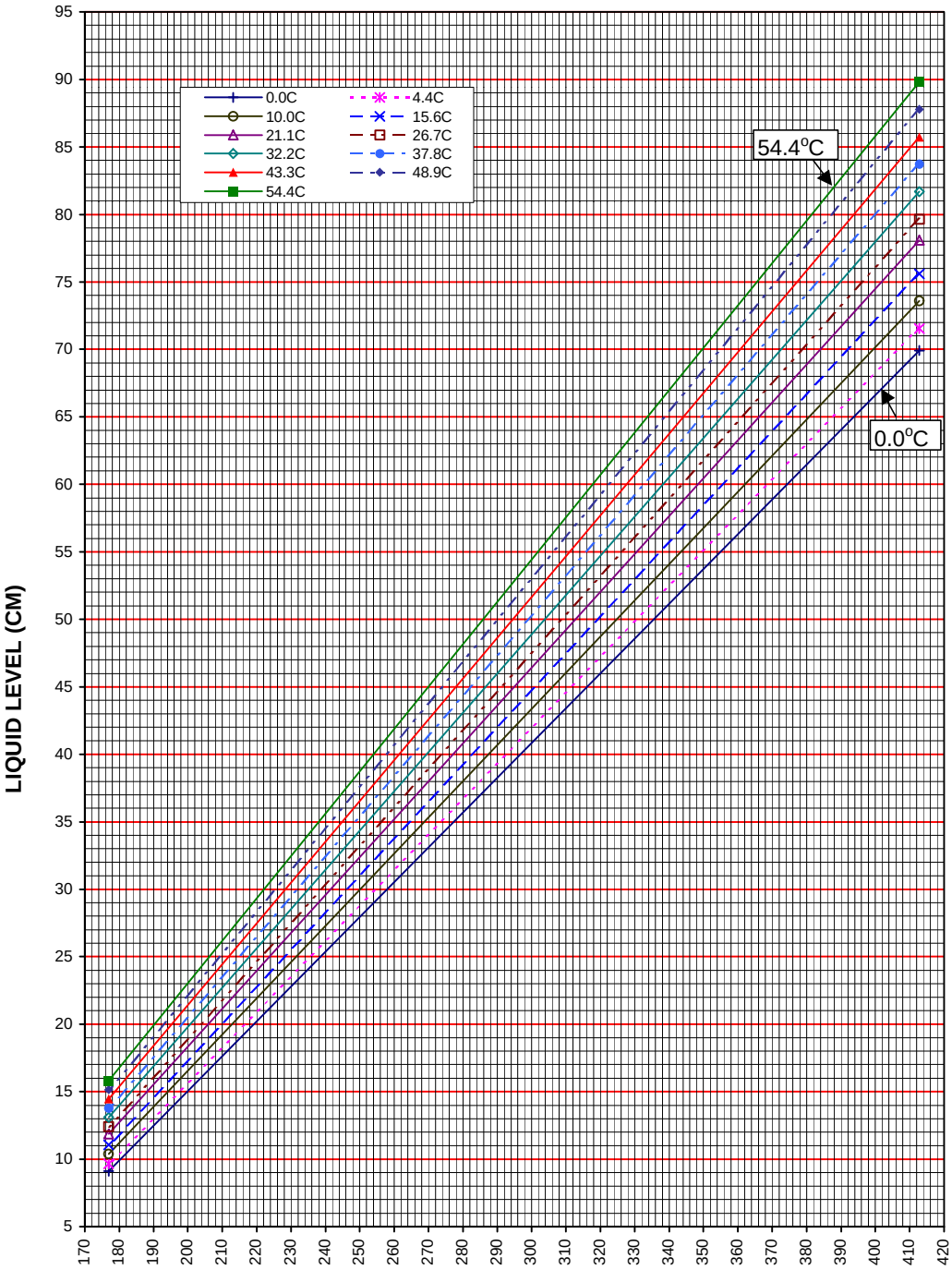
CHEMETRON SIGMA 600 (METRIC)
Liquid Level vs Weight of FM-200



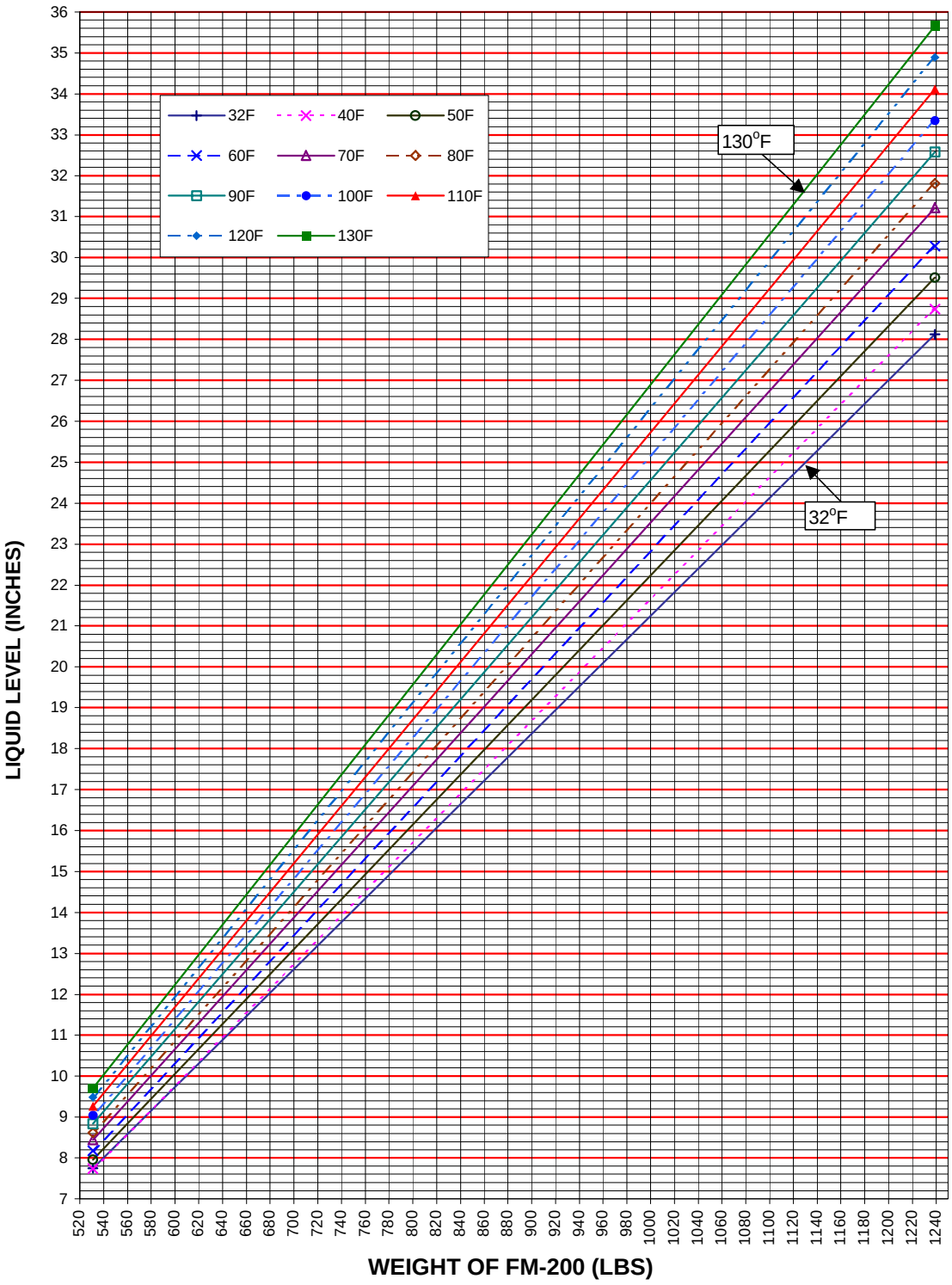
CHEMETRON SIGMA 750
Liquid Level vs Weight of FM-200



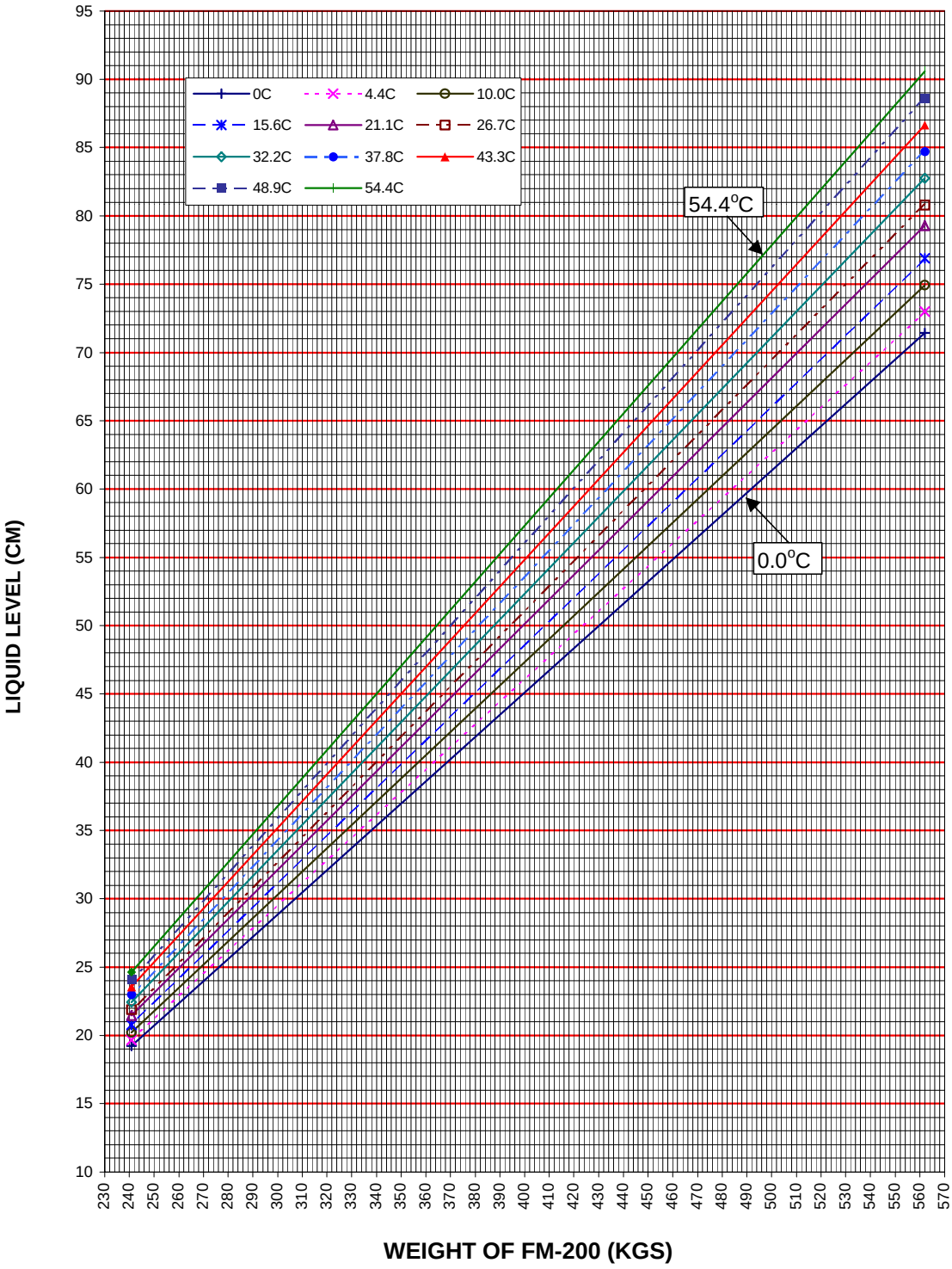
CHEMETRON SIGMA 750 (METRIC)
Liquid Level vs Weight of FM-200



CHEMETRON SIGMA 1000
Liquid Level vs Weight of FM-200



CHEMETRON SIGMA 1000 (METRIC)
Lquid Level vs Weight of FM-200



Great Lakes Chemical Corporation

MATERIAL SAFETY DATA SHEET

MSDS Number: 00057
Product Name: **FM-200**

Effective Date: 04/20/2001
Page: 1 of 7

SECTION I - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name:	**FM-200**		
Manufacturer:	Great Lakes Chemical Corporation		
Address:	P.O. Box 2200	**City:**	West Lafayette
State:	Indiana	**Zip:**	47996-2200
Emergency Telephone Number:	**1-800-949-5167**		
Information Telephone Number:	1-765-497-6100	**Fax:**	1-765-497-6123
Chemtrec Phone:	**1-800-424-9300**		
Effective Date:	04/20/2001	**Supercede Date:**	4/7/98
MSDS Prepared By:	Regulatory Affairs Department/Great Lakes Chemical Corporation		
Synonyms:	1,1,1,2,3,3,3-Heptafluoropropane, 2H-Heptafluoropropane		
Product Use:	Fire extinguishing, fire suppression, explosion suppression and inerting agent		
Chemical Name:	1,1,1,2,3,3,3-Heptafluoropropane		
Chemical Family:	Halogenated alkane		

Additional Information

No information available

SECTION II - COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENT NAME	CAS NO.	%	EXPOSURE LIMITS
1,1,1,2,3,3,3-Heptafluoropropane	431890	> or = 99.9	Y (Hazardous) Not established (OSHA PEL TWA) Not established (OSHA PEL STEL) Not established (OSHA PEL CEIL) Not established (ACGIH TLV TWA) Not established (ACGIH TLV STEL) Not established (ACGIH TLV CEIL)

*Indented chemicals are components of previous ingredient.

Additional Information

No information available

SECTION III - HAZARDS IDENTIFICATION

Emergency Overview:
Colorless gas
Odorless
Direct eye or skin contact with the liquid or cold gas can cause chilling or possibly frostbite of exposed tissues.
May cause central nervous system effects.
Inhalation of high concentrations can be harmful or fatal due to oxygen deprivation and/or heart irregularities.

Relevant Routes of Exposure: Inhalation

Signs and Symptoms of Overexposure:
Symptoms similar to oxygen deprivation (headache, nausea, dizziness or loss of consciousness) may result from overexposure by inhalation. Heart irregularities such as irregular pulse or heart palpitations may indicate cardiac sensitivity. Cold, white or discolored skin or in severe cases blistering, can be a sign of frostbite caused by cold liquids or gases.

MATERIAL SAFETY DATA SHEET

MSDS Number: 00057 **Effective Date:** 04/20/2001
Product Name: **FM-200** **Page:** 2 of 7

SECTION III - HAZARDS IDENTIFICATION

Medical Conditions Generally Aggravated By Exposure: Persons with preexisting cardiac, respiratory, or central nervous system disorders may be more susceptible to effects of an overexposure. The use of epinephrine or similar compounds can increase susceptibility to heart irregularities caused by excessive exposure to these types of compounds.

Potential Health Effects: See Section XI for additional information.

Eyes: Direct eye contact with the liquid or cold gas can cause chilling or possibly frostbite of exposed tissues.

Skin: Direct skin contact with the liquid or cold gas can cause chilling or possibly frostbite of exposed tissues.

Ingestion: Not expected to be a hazard in normal industrial use.

Inhalation: Inhalation of high concentrations can be harmful or fatal due to oxygen deprivation and/or heart irregularities (arrhythmias). Misuse of the product by deliberately inhaling high concentrations of this gas could cause death without warning.

Chronic Health Effects: None known

Carcinogenicity:

NTP:	No	**ACGIH:**	No
IARC:	No	**OTHER:**	No
OSHA:	No		

Additional Information

No information available

SECTION IV - FIRST AID MEASURES

Eyes: Flush with water. Get medical attention.

Skin: Flush with water; if frostbite occurs get medical attention.

Ingestion: No information available

Inhalation: Remove person to fresh air; if not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Antidotes: No information available

Notes to Physicians and/or Protection for First-Aiders: The use of epinephrine or similar compounds can increase susceptibility to heart irregularities caused by excessive exposure to these types of compounds.

Additional Information

No information available

SECTION V - FIRE FIGHTING MEASURES

Flammable Limits in Air (% by Volume): Not applicable

Flash Point: Nonflammable gas

Autoignition Temperature: Not available

Extinguishing Media: All conventional media are suitable.

Fire Fighting Instructions: Keep cylinders cool with a water spray applied from a safe distance. Use a self-contained breathing apparatus if containers rupture or release under fire conditions. Do not allow reentry into areas where this material has been released without first ventilating to remove products of combustion/decomposition.

MATERIAL SAFETY DATA SHEET

MSDS Number: 00057 **Effective Date:** 04/20/2001
Product Name: **FM-200** **Page:** 3 of 7

SECTION V - FIRE FIGHTING MEASURES

Unusual Fire and Explosion Hazards:	Although containers of our product are provided with pressure and temperature relief devices, containers can rupture if exposed to localized heat. Thermal decomposition will generate toxic and corrosive gases.
Flammability Classification:	Nonflammable gas
Known or Anticipated Hazardous Products of Combustion:	Decomposition by elevated temperatures (fire conditions, glowing metal surfaces) may generate hazardous decomposition products common to other CFCs, HCFCs or HBFCs. These can include hydrogen fluoride (ACGIH TLV = 3 ppm), carbon monoxide, carbon dioxide and others.

Additional Information

No information available

SECTION VI - ACCIDENTAL RELEASE MEASURES

Accidental Release Measures:	Evacuate the area and ventilate. Do not enter areas where high concentrations may exist (especially confined or poorly ventilated areas) without appropriate protective equipment including a self-contained breathing apparatus.
Personal Precautions:	See Section VIII.
Environmental Precautions:	No information available

Additional Information

No information available

SECTION VII - HANDLING AND STORAGE

Handling:	Use the same type of precautions as would be used in handling any cryogenic gas. Protect container from damage. Handle in well-ventilated areas. When this material is used as a firefighting agent in fixed or portable extinguishing systems, follow manufacturer's instructions for operation, inspection, maintenance and repair of the system.
Storage:	Store in a cool, dry, well-ventilated area away from incompatible materials. Keep container tightly closed.
Other Precautions:	No information available

Additional Information

No information available

SECTION VIII - EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls:	No information available
Ventilation Requirements:	Use local ventilation to minimize exposure to gas. Use mechanical ventilation for general area control.
Personal Protective Equipment:	
Eye/Face Protection:	Chemical splash goggles when handling liquid
Skin Protection:	Use lined neoprene gloves if handling liquid. Clothing designed to minimize skin contact
Respiratory Protection:	Wear a NIOSH/MSHA approved self-contained breathing apparatus in emergency situations.

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SECTION VIII - EXPOSURE CONTROLS/PERSONAL PROTECTION

	Consult the OSHA respiratory protection information located at 29CFR 1910.134 and the American National Standard Institute's Practices of Respiratory Protection Z88.2.
Other Protective Clothing or Equipment:	No information available
Exposure Guidelines:	See Section II.
Work Hygienic Practices:	Wash thoroughly after handling. Wash contaminated clothing before reuse. Make sure piping is empty before doing maintenance work.

Additional Information

No information available

SECTION IX - PHYSICAL & CHEMICAL PROPERTIES

Appearance:	Colorless gas	**Percent Volatile:**	Not available
Boiling Point:	-16.4 degrees C (3 degrees F)	**pH Value:**	Not available
Bulk Density:	Not available	**pH Concentration:**	Not available
Color:	Colorless	**Physical State:**	Gas
Decomposition Temperature:	Not available	**Reactivity in Water:**	Not water reactive
Evaporation Rate:	Not available	**Saturated Vapor Concentration:**	Not available
Freezing Point:	Not available	**Softening Point:**	Not available
Heat Value:	Not available	**Solubility in Water:**	260 mg/L
Melting Point:	-131 degrees C (-204 degrees F)	**Specific Gravity or Density (Water=1):**	1.46
Molecular/Chemical Formula:	C3HF7	**Vapor Density:**	6.04
Molecular Weight:	170	**Vapor Pressure:**	58.8 psia at 70 degrees F (21 degrees C)
Octanol/Water Partition Coefficient:	Not available	**Viscosity:**	Not available
Odor:	Odorless	**Volatile Organic Compounds:**	Not available
Odor Threshold:	Not available	**Water/Oil Distribution Coefficient:**	Not available
Particle Size:	Not available	**Weight Per Gallon:**	Not available

Additional Information

No information available

SECTION X - STABILITY AND REACTIVITY

Stability:	Stable under normal conditions of handling and use.
Conditions to Avoid:	None
Incompatibility With Other Materials:	Powdered metals (ex. Al, Mg, or Zn) and strong alkalis, oxidizers or reducing agents are not compatible with this and most other halogenated organic compounds.
Hazardous Decomposition Products:	Thermal decomposition may produce the following: Hydrogen fluoride Carbon monoxide and carbon dioxide
Hazardous Polymerization:	Will not occur
Conditions to Avoid:	None

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SECTION X - STABILITY AND REACTIVITY

Additional Information

No information available

SECTION XI - TOXICOLOGICAL INFORMATION

VALUE (LD50 OR LC50)	ANIMAL	ROUTES	COMPONENTS
>788,696 ppm/4H	Rat	Acute Inhalation	1,1,1,2,3,3,3-Heptafluoropropane

Toxicological Information:
The human health hazards of this product are expected to be similar to other liquefied gases including N2, CO2, CFCs, HCFCs, and HBFCs. Therefore, direct eye or skin contact with the liquid or cold gas can cause chilling or possibly frostbite of exposed tissues. Inhalation of high concentrations can be harmful or fatal due to oxygen deprivation and/or heart irregularities (arrhythmias). Misuse of the product by deliberately inhaling high concentrations of this gas could cause death without warning. Persons with preexisting cardiac or central nervous system disorders may be more susceptible to effects of an overexposure.

When tested with and without metabolic activation over a concentration range of 43.9-93.5%, heptafluoropropane was not mutagenic in S. typhimurium. Neither toxicity nor mutagenicity was observed in a mouse lymphoma assay when heptafluoropropane was tested to a concentration of 56.8%. Neither toxicity nor an increase in micronuclei was observed in mice exposed to 10.5% heptafluoropropane. Therefore, there is no evidence that heptafluoropropane is capable of inducing gene or chromosomal mutations in vitro or chromosomal effects in vivo. In other studies, heptafluoropropane did not show genotoxicity or cytotoxicity.

Animal studies have found the rat 4 hour LC50 to be >788,696 ppm (~80%), the highest level tested. A cardiac sensitization study in dogs found the No Observable Adverse Effect Level (NOAEL) to be 9.0%. The Lowest Observable Adverse Effect Level (LOAEL) for this study was reported to be 10.5%. A 90 day inhalation study did not find any exposure related effects at 105,000 ppm (10.5% vol./vol.), the highest level tested. Inhalation studies looking for developmental effects on pregnant rabbits and rats or their offspring did not show any exposure related effects at the highest concentrations tested (105,000 ppm).

Additional Information

No information available

SECTION XII - ECOLOGICAL INFORMATION

Ecological Information: No information available

Additional Information

No information available

SECTION XIII - DISPOSAL CONSIDERATIONS

Disposal Considerations: Non-contaminated product is reclaimable. Contact Great Lakes Chemical Corporation for information. Otherwise, dispose of waste in an approved chemical incinerator equipped with a scrubber as allowed by current Local, State/Province, Federal/Canadian laws and regulations.

Additional Information

No information available

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SECTION XIV - TRANSPORT INFORMATION

U.S. DOT

Proper Shipping Name:	Heptafluoropropane		
Hazard Class:	2.2	**ID Number:**	UN3296
Packing Group:	N/A	**Labels:**	Nonflammable gas
Special Provisions:	N/A	**Packaging Exceptions:**	306
Non-Bulk Packaging:	304	**Bulk Packaging:**	314, 315
Passenger Air/Rail Limit:	75 kg	**Air Cargo Limit:**	150 kg
Vessel Stowage:	A	**Other Stowage:**	N/A
Reportable Quantity:	N/A		

AIR - ICAO OR IATA

Proper Shipping Name:	Heptafluoropropane		
Hazard Class:	2.2	**ID Number:**	UN3296
Subsidiary Risk:	N/A	**Packing Group:**	N/A
Hazard Labels:	Nonflammable gas	**Packing Instructions:**	200
Air Passenger Limit Per Package:	75 kg	**Packing Instruction - Cargo:**	200
Air Cargo Limit Per Package:	150 kg	**Special Provisions Code:**	N/A

WATER - IMDG

Proper Shipping Name:	Heptafluoropropane		
Hazard Class:	2.2	**ID Number:**	UN3296
Packing Group:	N/A	**Subsidiary Risk:**	N/A
Medical First Aid Guide Code:	350		

Additional Information

EmS No. 2-09

SECTION XV - REGULATORY INFORMATION

U.S. Federal Regulations:
The components of this product are either on the TSCA Inventory or exempt (i.e. impurities, a polymer complying with the exemption rule at 40 CFR 723.250) from the Inventory.

State Regulations:
None known

International Regulations:
This material (or each component) is listed on the following inventories:
Canada - NDSL
EU - EINECS
Australia - AICS
Japan - ENCS
Korea - ECL
China - List I

Canadian WHMIS Hazard Class and Division = A.

SARA Hazards:

Acute:	Yes	**Chronic:**	No
Reactive:	No	**Fire:**	No
Pressure:	No		

Additional Information

The above regulatory information represents only selected regulations and is not meant to be a complete list.

MATERIAL SAFETY DATA SHEET

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SECTION XVI - OTHER INFORMATION

NFPA Codes:

Health:	1	**Flammability:**	0
Reactivity:	0	**Other:**	0

HMIS Codes: * indicates chronic health hazard.

Health:	1	**Flammability:**	0
Reactivity:	0	**Protection:**	X

Label Statements: Not available

Other Information:

Abbreviations:
(L) = Loose bulk density in g/ml
LOEC = Lowest observed effect concentration
MATC = Maximum acceptable toxicant concentration
NA = Not available
N/A = Not applicable
NL = Not limited
NOAEL = No observable adverse effect level
NOEC = No observed effect concentration
NOEL = No observable effect level
NR = Not rated
(P) = Packed bulk density in g/ml
PNOC = Particulates Not Otherwise Classified
PNOR = Particulates Not Otherwise Regulated
REL = Recommended exposure limit
TS = Trade secret

Additional Information

Information on this form is furnished solely for the purpose of compliance with OSHA's Hazard Communication Standard, 29CFR 1910.1200 and The Canadian Environmental Protection Act, Canada Gazette Part II, Vol. 122, No. 2 and shall not be used for any other purpose.

Revision Information:
Section II - Purity
Section XV - International inventories

Metric Conversion Factors (Approximate)				
Symbol	**When you Know Number of**	**Multiply By**	**To Find Number of**	**Symbol**
		Length		
in	inches	2.54	Centimeters	cm
ft	feet	30.48	Centimeters	cm
ft	feet	.3048	meters	m
		Area		
in^2	square inches	6.452	square centimeters	cm^2
ft^2	square feet	0.0929	square meters	m^2
		Weight (mass)		
oz	ounces	28.349	grams	g
lb	pounds	0.4536	kilograms	kg
		Volume		
in^3	cubic inches	16.39	Milliliters	mL
fl oz	fluid ounces	29.57	milliliters	mL
ft^3	cubic feet	0.0283	cubic meters	m^3
		Pressure		
inHg	inches of Mercury	3.453	kilopascals	kPa
psi	pounds per square inch	6.895	kilopascals	kPa
		Temperature (exact)		
°F	degrees Fahrenheit	5/9 (after subtracting 32)	degrees Celsius	°C

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CHEMETRON Fire Systems™
A World of Protection

These instructions do not purport to cover all the details or variations in the equipment described, nor do they provide for every possible contingency to be met in connection with design, installation, operation and maintenance. All specifications subject to change without notice. Should further information be desired or should particular problems arise that are not covered sufficiently for the purchaser's purposes, the matter should be referred to CHEMETRON FIRE SYSTEMS, Matteson, IL.

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