P/N 90-FM200M-000
September 2004

FM-200®

ECS Series Engineered Fire Suppression Systems

Design, Installation, Operation and Maintenance Manual

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Kidde Fire Systems

P/N 90-FM200M-000
September 2004

FM-200®

ECS Series
Engineered
Fire Suppression Systems

Design, Installation,
Operation and
Maintenance Manual

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FOREWORD

This manual is written for those who are installing an FM-200® ECS Series Engineered Fire Suppression System.

IMPORTANT

Kidde-Fenwal assumes no responsibility for the application of any systems other than those addressed in this manual. The technical data contained herein is limited strictly for information purposes only. Kidde-Fenwal believes this data to be accurate, but it is published and presented without any guarantee or warranty whatsoever. Kidde-Fenwal disclaims any liability for any use that may be made of the data and information contained herein by any and all other parties.

Kidde FM-200 Fire Suppression Systems are to be designed, installed, inspected, maintained, tested and recharged by qualified, trained personnel in accordance with the following:

- Standard of the National Fire Protection Association No. 2001, titled *Clean Agent Fire Extinguishing Systems*.
- All instructions, limitations, etc. contained in this manual, P/N 90-FM200M-000.
- All information contained on the system container nameplate(s).

Storage, handling, transportation, service, maintenance, recharge, and test of agent storage containers shall be performed only by qualified and trained personnel in accordance with the information in this manual and Compressed Gas Association pamphlets C-1, C-6 and P-1:

- C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*.
- C-6, *Standards for Visual Inspection of Compressed Gas Cylinders*.
- P-1, *Safe Handling of Compressed Gases In Containers*.

CGA pamphlets are published by the Compressed Gas Association, Crystal Square Two, 1725 Jefferson Davis Highway, Arlington, VA 22202-4102.

The new design concentration for Class A and C fires applies to systems designed to meet and comply with UL 2166 and NFPA 2001 guidelines. As such, our Customers are reminded and advised:

- The applicable best practice that these systems use automatic actuation;
- Designers should also take note of clause 2-3.5.6.1 in NFPA 2001[1] with regard to time delays;
- The designer should also take note of A.3-4.2.4 in NFPA 2001 and confirm that the hazard protected does not include any identifiable fire accelerants[2], which would classify the area as a Class B hazard;
- In addition, the designer should refer to section A.3-6 in NFPA 2001 and confirm that the area does not include a material number of power or energized cables[3] in close proximity that would predicate the usage of a different design concentration. Please contact applications engineering for design guidance in this instance.

1 Clause 2-3.5.6.1 in NFPA 2001, 2000 edition states:

"For clean agent extinguishing systems, a pre-discharge alarm and time delay, sufficient to allow personnel evacuation prior to discharge, shall be provided. For hazard areas subject to fast growth fires, where the provision of a time delay would seriously increase the threat to life and property, a time delay shall be permitted to be eliminated."

2 A.3-4.2.4 in NFPA 2001, 2000 edition states

"…Hazards containing both Class A and Class B fuels should be evaluated on the basis of the fuel requiring the highest design concentration."

3 A.3.6 in NFPA 2001, 2000 edition states in part

"...Energized electrical equipment that could provide a prolonged ignition source shall be de-energized prior to or during agent discharge. If electrical equipment cannot be de-energized, consideration should be given to the use of extended agent discharge, higher initial concentration, and the possibility of formation of combustion and decomposition products. Additional testing can be needed on suppression of energized electrical equipment fires to determine these quantities..."

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

Kidde-Fenwal Inc.
400 Main Street
Ashland, MA 01721
Phone: (508) 881-2000
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SAFETY SUMMARY

FM-200 fire suppression systems use pressurized equipment; therefore, personnel responsible for fire suppression systems must be aware of the dangers associated with the improper handling, installation or maintenance of this equipment.

Fire suppression system service personnel must be thoroughly trained in the proper handling, installation and service of FM-200 equipment and follow the instructions used in this manual and in the Safety Bulletin, on the cylinder nameplate and contained in Appendix A.

Kidde has provided warnings and cautions at appropriate locations throughout the text of this manual. These warnings and cautions are to be adhered to at all times. Failure to do so may result in serious injury to personnel.

In addition, Material Safety Data Sheets for FM-200 and nitrogen are provided. Personnel must also be familiar with the information contained on these data sheets.

SAFETY BULLETIN 1, MARCH 2, 1987

SUBJECT: SAFE CYLINDER HANDLING PROCEDURES

⚠ WARNING

Pressurized (charged) cylinders are extremely hazardous and if not handled properly are capable of violent discharge. This may result in serious bodily injury, death and property damage.

Before handling Kidde system products, all personnel must be thoroughly trained in the safe handling of the containers as well as in the proper procedures for installation, removal, filling, and connection of other critical devices, such as flex hoses, control heads, discharge heads, and anti-recoil devices.

READ, UNDERSTAND and ALWAYS FOLLOW the operation and maintenance manuals, owners manuals, service manuals, etc., that are provided with the individual systems.

The following safety procedures must be observed at all times:

Moving Container: Containers must be shipped compactly in the upright position, and properly secured in place. Containers must not be rolled, dragged or slid, nor allowed to be slid from tailgates of vehicles. A suitable hand truck, fork truck, roll platform or similar device must be used.

Rough Handling: Containers must not be dropped or permitted to strike violently against each other or other surfaces.

Storage: Containers must be stored standing upright where they are not likely to be knocked over, or the containers must be secured.

For additional information on safe handling of compressed gas cylinders, see CGA Pamphlet PI titled “Safe Handling of Compressed Gases in Containers”. CGA pamphlets may be purchased from The Compressed Gas Association, Crystal Square Two, 1725 Jefferson Davis Highway, Arlington, VA 22202.

SAFETY BULLETIN, MAY 1, 1993

SUBJECT: SAFE CYLINDER HANDLING PROCEDURES FOR 360 PSI FM-200 CYLINDERS

⚠ WARNING

Pressurized (charged) cylinders are extremely hazardous and if not handled properly are capable of violent discharge. This will result in serious bodily injury, death and property damage.

BEFORE handling Kidde system products, all personnel must be thoroughly trained in the safe handling of the containers as well as in the proper procedures for installation, removal, filling, and connection of other critical devices, such as flexible hoses, control heads, and safety caps.

READ, UNDERSTAND and ALWAYS FOLLOW the operation and maintenance manuals, owners manuals, service manuals, and other information that is provided with the individual systems.

THESE INSTRUCTIONS MUST BE FOLLOWED IN THE EXACT SEQUENCE AS WRITTEN TO PREVENT SERIOUS INJURY, DEATH OR PROPERTY DAMAGE.

SAFETY CAP

a. Each FM-200 cylinder is factory equipped with a safety cap installed on the valve outlet, and securely chained to the valve to prevent loss. This device is a safety feature, and will provide controlled safe discharge when installed if the cylinder is actuated accidentally.

b. The safety cap must be installed in the valve outlet AT ALL TIMES except when the cylinders are connected into the system piping or being filled.

c. The safety cap is intentionally chained to the cylinder valve to prevent loss while in service and must not be removed from its chain.

Protection Cap.

A protection cap is factory installed on the actuation port and securely chained to the valve to prevent loss. The cap is attached to the actuation port to prevent tampering or depression of the actuating pin. No attachments (control head, pressure control head) are to be connected to the actuation port during shipment, storage, or handling.

INSTALLATION

THIS SEQUENCE FOR CYLINDER INSTALLATION MUST BE FOLLOWED AT ALL TIMES:

1. Install cylinder into bracketing.

⚠ WARNING

Discharge hoses or valve outlet adapter must be connected into system piping before attaching to cylinder valve outlet to prevent injury in the event of discharge.

2. Remove safety cap and connect all cylinder valves into system piping using flex hose or valve outlet adapter.
3. Remove protection cap and attach control heads, pressure control heads, pilot loops, etc. as required.

⚠ WARNING

Control heads must be in the set position before attaching to the cylinder valve actuation port, in order to prevent accidental discharge.

REMOVAL FROM SERVICE

1. Remove all control heads, pressure operated heads, and pilot loops from cylinder valve, and attach protection cap to actuation port.
2. Disconnect cylinders from system piping at the valve outlet. Disconnect valve outlet adapter, if used.
3. Immediately install safety cap on valve outlet.

⚠ WARNING

Do not disconnect the cylinder from system piping if the safety cap is missing. Obtain a new safety cap from Kidde.

4. Remove cylinder from bracketing.

⚠ WARNING

Failure to follow these instructions, and improper use or handling, may cause serious bodily injury, death, and property damage.

CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

Kidde FM-200® ECS Series Engineered Fire Suppression Systems are Listed by Underwriters Laboratories, Inc. (UL) and Approved by Factory Mutual (FM). These systems are designed for total flooding in accordance with NFPA 2001 *Standard on Clean Agent Fire Extinguishing Systems.* These systems have been tested to the limits established jointly by UL and FM. In any situation not specifically covered by this manual, the application and installation of the system must meet the requirements of the standards as stated. In any case, all installations must meet the requirements of the local Authority Having Jurisdiction (AHJ).

The complexity of two-phase flow does not allow for any simple method of manual FM-200 calculation. For this reason, the flow calculations and design criteria described in this manual have been incorporated into a computer software program. The calculations are based on conserving mass, energy and momentum in the pipe network. The routine calculates the flow in quasi-steady state steps from the initiation of the discharge to the final gas blowdown. This is a significantly more rigorous treatment then the traditional Halon NFPA 12A method.

The system designer must become thoroughly familiar with the User's Manual for FM-200 Flow Calculation Program (P/N 90-FM200M-100) in order to learn the proper procedures for applying the input parameters to the FM-200 Flow Program. There are a number of limitations to these input parameters which must be observed if accurate results are to be obtained.

Kidde FM-200 ECS Series Engineered Fire Suppression Systems combine an environmentally safe fire suppression agent, highly effective detection devices and specially developed components for fast agent discharge. The resulting rapid suppression of a fire reduces property damage and products of combustion to the lowest possible level. These systems are electrically, pressure and/or cable operated, with a normal design discharge time of less than ten seconds. Agent storage containers can be strategically located throughout a protected zone, eliminating expensive piping.

1-2 SYSTEM DESCRIPTION

1-2.1 General

Kidde FM-200 systems are used to suppress fires in specific hazards or equipment located where an electrically nonconductive agent is required, where agent cleanup creates a problem, where extinguishing capability with low weight is a factor and where the hazard is normally occupied by personnel. Kidde FM-200 systems are intended to protect the following:

- Data processing facilities
- Telecommunications facilities
- Process control rooms
- High value medical facilities
- High value industrial equipment areas
- Libraries, museums, art galleries
- Anechoic chambers
- Flammable liquid storage areas

FM-200 systems are designed for the following classes of fire:

- Class A Surface Type Fires; Wood or other cellulose-type material
- Class B; Flammable liquids (see Table 4-1)
- Class C; Energized electrical equipment

For hazards beyond the scope described above, the designer must consult with Kidde and NFPA 2001 on the suitability of FM-200 for the protection, necessary design concentration and personnel exposure effects from that concentration.

FM-200 shall not be used on fires involving the following materials, unless they have been tested to the satisfaction of the Authority Having Jurisdiction:

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 and hydrazine.

1-2.1.1 OPERATING TEMPERATURE RANGE LIMITATIONS

The operating temperature range for all components in Kidde FM-200 engineered systems is 32°F to 130°F (0°C to 54°C). The Kidde ECS Series FM-200 Flow Calculation Program is designed for a temperature of 70°F (21°C). Therefore, the container operating and storage temperature must be in the range of 60°F to 80°F (16°C to 27°C) for a single unbalanced system protecting two or more separate hazards. If the container operating/storage temperature is outside this range, an insufficient quantity of agent may be discharged from one or more discharge nozzles.

1-2.2 Extinguishing Agent

FM-200 (1,1,1,2,3,3,3-heptafluoropropane) is a compound of carbon, fluorine and hydrogen (CF_3CHFCF_3). It is colorless, odorless and electrically non-conductive. It suppresses fire by a combination of chemical and physical mechanisms with minimal affect on the available oxygen. This allows people to see and breathe, permitting them to leave the fire area safely.

FM-200 is acceptable for use in occupied spaces when used in accordance with the United States Environmental Protection Agency (EPA) Significant New Alternatives Policy (SNAP) program rules.

Although FM-200 is considered non-toxic to humans in concentrations necessary to extinguish most fires, certain safety considerations should be observed when applying and handling the agent. The discharge of FM-200 may create a hazard to people from the undecomposed agent itself and from the decomposition products which result when the agent is exposed to fire or other hot surfaces. Exposure to the agent is generally of less concern than is exposure to the decomposition products. Unnecessary exposure to the agent or the decomposition products should be avoided.

1-2.2.1 TOXICITY

Unnecessary exposure to clean agents is to be avoided in accordance with the requirements of NFPA-2001. As such, upon operation of a system pre-discharge alarm, all personnel should immediately exit the protected space. In no case shall personnel remain in a room in which there is a fire. In the very unlikely instance where a clean agent system should discharge unexpectedly into an occupied room, all personnel should proceed in a calm and orderly manner to an exit and leave the room.

FM-200 halocarbon clean agent has been evaluated for cardiac sensitization in accordance with test protocols approved by the United States Environmental Protection Agency (U.S. EPA). The EPA's SNAP Program classifies FM-200 as acceptable for use as a total flooding agent in occupied spaces with specific limitations. Refer to the SNAP program rules or NFPA 2001 for more information. FM-200 halocarbon clean agent has been judged acceptable by the U.S. EPA for use in occupied spaces when used in accordance with the guidance of NFPA 2001. In accordance with NFPA 2001, FM-200 halocarbon clean agent systems designed for use with agent vapor concentrations up to nine volume per cent in air are permitted. See NFPA 2001, Sect. 1-6, *Safety.* Although FM-200 has negligible toxicity in concentrations needed to suppress most fires, certain safety considerations must be observed when applying and handling the agent. The discharge of FM-200 halocarbon clean agent has negligible toxicity in concentrations needed to suppress most fires, certain safety considerations must be observed when applying and handling the agent. For example, HFC-227ea is a liquefied compressed gas. Upon release to atmospheric pressure (e.g., from nozzles) the liquid flash evaporates at a low temperature (2°F/-16°C). Thus, nozzles must be located to avoid direct impingement on personnel.

1-2.2.2 DECOMPOSITION

When FM-200 is exposed to temperatures over approximately 1300°F (700°C), products of decomposition (halogen acids) are formed. If the FM-200 is discharged in 10 seconds or less, flames are rapidly extinguished and the amount of by-products produced is minimal.

1-2.2.3 CLEANLINESS

FM-200 is clean and leaves no residue, thereby eliminating costly after-fire clean-up and keeping expensive downtime to a minimum. Most materials such as steel, stainless steel, aluminum, brass and other metals as well as plastics, rubber and electronic components are unaffected by exposure to FM-200.

1-2.2.4 OTHER SAFETY CONSIDERATIONS

The high pressure discharge of FM-200 from a system nozzle can create noise loud enough to be startling. The high velocity discharge can be significant enough to dislodge objects located directly in the discharge path. Enough turbulence may be created in the enclosure to move unsecured paper and other light objects. Direct contact with the vaporizing agent discharged from a nozzle will have a chilling effect on objects, and can cause frostbite burns to the skin. The liquid phase vaporizes rapidly when mixed with air and limits the chilling hazard to the immediate vicinity of a nozzle.

FM-200 itself is colorless. Discharge of FM-200 into a humid atmosphere may cause fog and reduce visibility for a short time.

1-2.2.5 STORAGE

FM-200 is stored in steel containers at 360 PSIG at 70°F (25 bar at 21°C) as a liquid with nitrogen added to improve the discharge characteristics. The pressure of the stored FM-200 varies substantially with temperature changes, as illustrated in Figure 1-1. When discharged, the FM-200 liquid vaporizes at the discharge nozzles and is uniformly distributed as it enters the fire area.

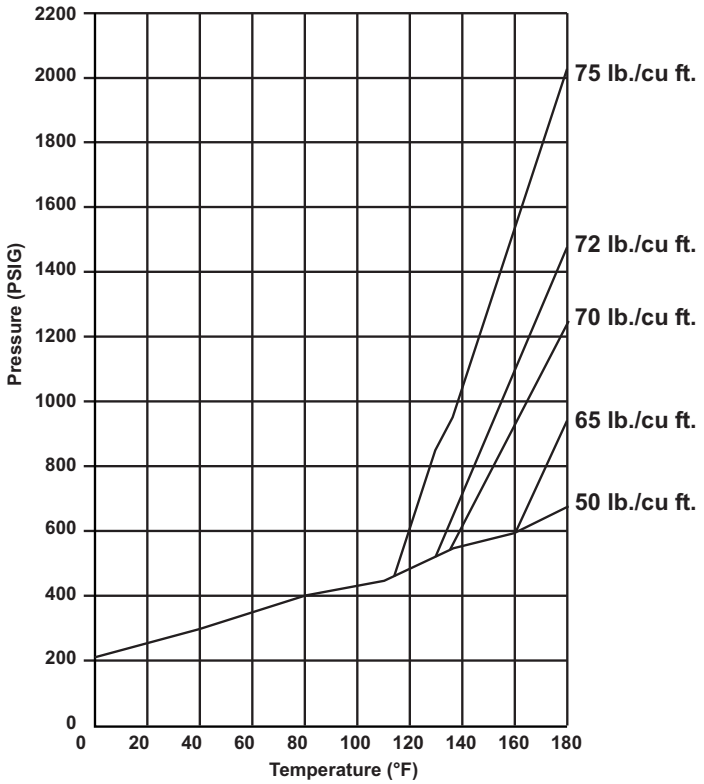

Figure 1-1. FM-200 Pressure/Temperature Curve Isometric Diagram

Table 1-1. FM-200 Physical Properties, Imperial Units

Description	Units	Measurement
Molecular Weight	N/A	170.0
Boiling Point at 19.7 psia	°F	1.9
Freezing Point	°F	-204
Critical Temperature	°F	214
Critical Pressure	psia	422
Critical Volume	ft^3/lb	0.0258
Critical Density	lb/ft^3	38.76
Specific Heat, Liquid at 77°F	Btu/lb-°F	0.282
Specific Heat, Vapor at Constant Pressure (1 atm) and 77°F	Btu/lb-°F	0.185
Heat of Vaporization at Boiling Point	Btu/lb	56.7
Thermal Conductivity of Liquid at 77°F	lb/ft-hr-°F	0.040
Viscosity, Liquid at 77°F	lb/ft-hr-°F	0.433
Relative Dielectric Strength at 1 atm at 734 mm Hg, 77°F (N_2 = 1)	N/A	2.00
Solubility, by Weight, of Water in Agent at 70°F	ppm	0.06%

Table 1-2. FM-200 Physical Properties, Metric Units

Description	Units	Measurement
Molecular Weight	N/A	170.03
Boiling Point at 760 mm Hg	°C	-16.4
Freezing Point	°C	-131
Critical Temperature	°C	101.7
Critical Pressure	kPa	2912
Critical Volume	cc/mole	274
Critical Density	kg/m^3	621
Specific Heat, Liquid at 25°C	kJ/kg°C	1.184
Specific Heat, Vapor at Constant Pressure (1 atm) and 25°C	kJ/kg°C	0.808
Heat of Vaporization at Boiling Point at 25°C	kJ/kg°C	132.6
Thermal Conductivity of Liquid at 25°C	W/m°C	0.069
Viscosity, Liquid at 25°C	centipose	0.184
Relative Dielectric Strength at 1 atm at 734 mm Hg, 25°C (N_2 = 1.0)	N/A	2.00
Solubility, by Weight, of Water in Agent at 21°C	ppm	0.06% by weight

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CHAPTER 2
OPERATION

2-1 INTRODUCTION

This chapter describes the controls and indicators for the Kidde FM-200® ECS Series Engineered Fire Suppression System.

2-2 SYSTEM CONTROLS AND INDICATORS

2-2.1 General

Compressed FM-200 liquid is held in the cylinder by a discharge valve. When the discharge valve is actuated by a control head, the valve piston is displaced and the compressed liquid escapes through the discharge port of the valve and is directed through the distribution piping to the nozzles. The nozzles provide the proper flow rate and distribution of FM-200.

2-2.2 Operating Procedures

2-2.2.1 AUTOMATIC OPERATION

When a system is operated automatically by means of a detection and control system, everyone must evacuate the hazard area promptly upon hearing the predischarge alarm. Make sure no one enters the hazard area. Call the fire department immediately.

2-2.2.2 REMOTE MANUAL OPERATION

Operate as follows:

1. Proceed to the appropriate remote manual pull station for the hazard.
2. Operate the manual pull station.
3. Leave the hazard area immediately.
4. Allow no one to enter the hazard area. Call the fire department immediately.

Note: The above instructions must be displayed in the protected area.

2-2.2.3 LOCAL MANUAL OPERATION

⚠ CAUTION

Manual control is not part of normal system actuation and should only be used in an emergency as a last resort.

1. Proceed to appropriate FM-200 cylinder for the hazard.
2. Remove the safety pull pin from the cylinder control head.
3. Operate the lever, following the instructions on the lever or control head nameplate.
4. Leave the hazard area immediately.
5. Allow no one to enter the hazard area. Call the fire department immediately.

2-2.3 Post-Fire Operation

After an FM-200 discharge, qualified fire suppression system maintenance personnel must perform post-fire maintenance as directed in Chapter 6 of this manual. Observe all warnings, especially those pertaining to the length of elapsed time before entering the hazard area.

⚠ WARNING

Do not enter a hazard area with an open flame or lighted smoking materials. Flammable vapors may cause reignition or explosion.

Ensure the fire is completely extinguished before ventilating the area. Before permitting anyone to enter the hazard area, ventilate the area thoroughly or use a self-contained breathing apparatus.

2-2.4 Cylinder Recharge

Recharge all FM-200 and nitrogen pilot cylinders immediately after use. Return all cylinders to a Kidde Distributor or other qualified refill agency. Refill in accordance with the procedures outlined in Chapter 6 of this manual.

2-2.5 Special System Precautions

2-2.5.1 SYSTEMS ACTUATED WITH A MASTER FM-200 CYLINDER

In systems where a master FM-200 cylinder actuates a pressure operated control head on a slave cylinder, the pressure in the flexible actuation hose line is vented into the discharge manifold following the system discharge. The pressure drop in the pilot line allows the pressure operated control head to automatically reset. However, as a precaution before reinstating the system, ensure that the control head actuating pin is in the retracted (SET) position.

2-2.5.2 SYSTEMS ACTUATED WITH A PILOT NITROGEN CYLINDER

In systems where a pilot nitrogen cylinder actuates a pressure operated control head on a slave FM-200 cylinder, nitrogen pressure is trapped in the pilot manifold when the system actuates and is not self-venting. Therefore, before reattaching a pressure operated control head to a recharged FM-200 cylinder, the following procedure must be performed to ensure that the pilot manifold is vented and the pressure operated control heads have returned to the SET position.

1. Vent any remaining pressure from the pilot line and remove the master control head from the nitrogen pilot cylinder(s). Reset the master control head and remove the pressure operated control head(s) from the slave cylinder(s).
2. Recharge and reinstall the nitrogen pilot cylinders to the correct charged pressure and reinstall the master control head.
3. Before installing a pressure operated control head on an FM-200 cylinder, ensure that the actuator pin is in the retracted (SET) position.
4. Follow all other procedures and cautions as detailed in Chapter 6 of this manual.

CHAPTER 3
FUNCTIONAL DESIGN

3-1 INTRODUCTION

This chapter provides a functional description of the modules and assemblies in the FM-200® ECS Series Engineered Fire Suppression System.

3-1.1 3" Cylinder Valve

In 2001, Kidde Fire Systems added a 3" discharge valve to its product line. This valve replaces the 2½" valves previously used on the 600 lb. cylinder and is a standard fitting for the 900 lb. cylinder assemblies (also new for the year 2001). A number of distinct differences between the 1½", 2" and 2½" valves and the new 3" valve are detailed in this manual (see Paragraphs 3-3.1, 3-3.7.2, 3-3.7.10, 4-3.11, 4-3.21, 6-2.3 and 6-2.7). Data relating to the 600 lb. cylinder assembly with a 2½" valve is included in this manual and is indicated by the reference "old style". For information on the availability of obsolete products, including spare parts, please contact the factory or your Kidde Representative.

3-2 FUNCTIONAL DESCRIPTION

Compressed FM-200 liquid is held in the agent storage container by a discharge valve. When the discharge valve is actuated, the compressed liquid agent discharges through the valve outlet and is directed through the distribution piping to the nozzles. The nozzles provide the proper flow rate and distribution of FM-200.

The ECS Series Engineered Fire Suppression System is composed of the following components and assemblies:

- Cylinder/valve assembly
- Liquid level indicator (optional)
- Control head (electric, cable operated, lever operated, pressure operated and electric and cable operated)
- Pressure gauge
- Straps and brackets for mounting the cylinder
- Cable manual pull station
- Nitrogen actuator and mounting bracket
- Actuation hose
- Flexible discharge hose
- Master cylinder adapter kit
- Tees, elbows and adapters
- Check valve
- Valve outlet adapter
- Discharge nozzle
- Discharge indicator
- Corner pulley
- Supervisory pressure switch (optional)
- Hydrostatic test adapter
- FM-200 cylinder recharge adapter
- FM-200 cylinder seating adapter
- Main to reserve transfer switch
- Manifold El-check
- Detector
- Pressure operated switch and trip
- Control panel

Figures 3-1 and 3-2 show the above components in two typical configurations.

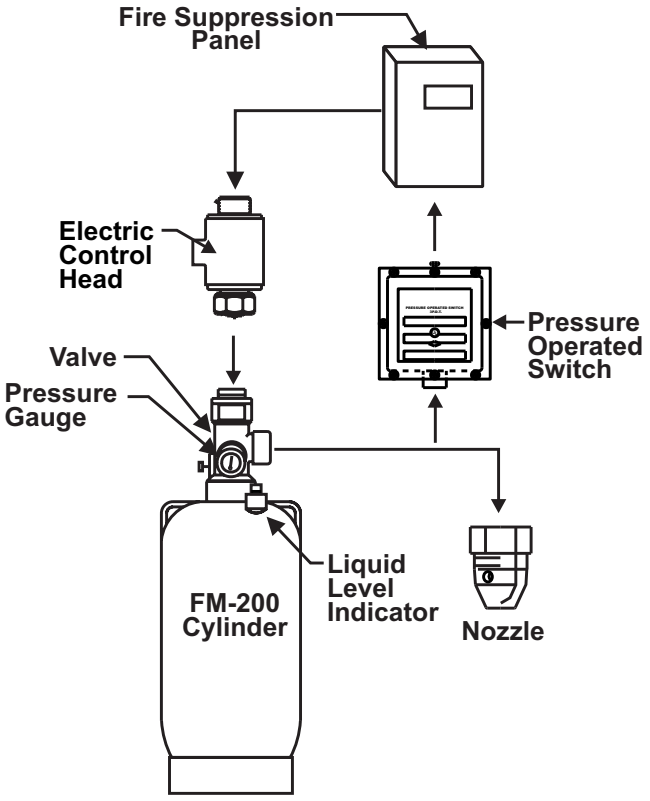


Figure 3-1. Typical FM-200 System with Electric Control Head

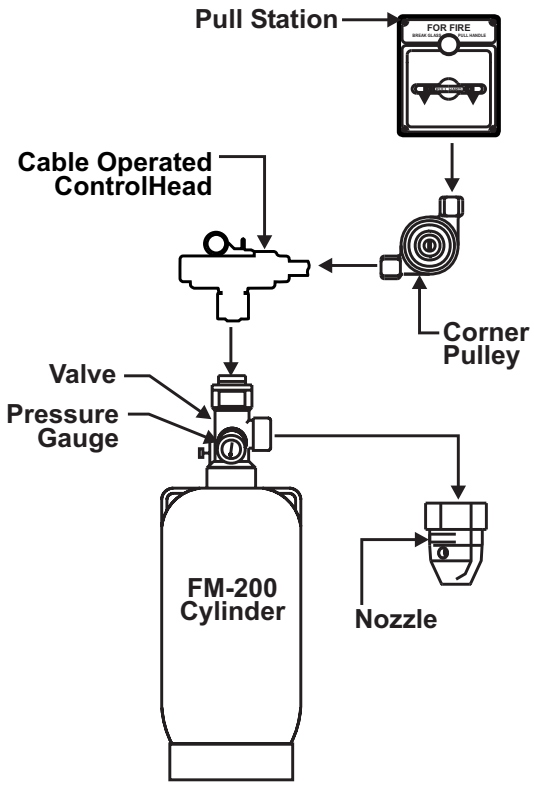


Figure 3-2. Typical FM-200 System with Cable Operated Control Head

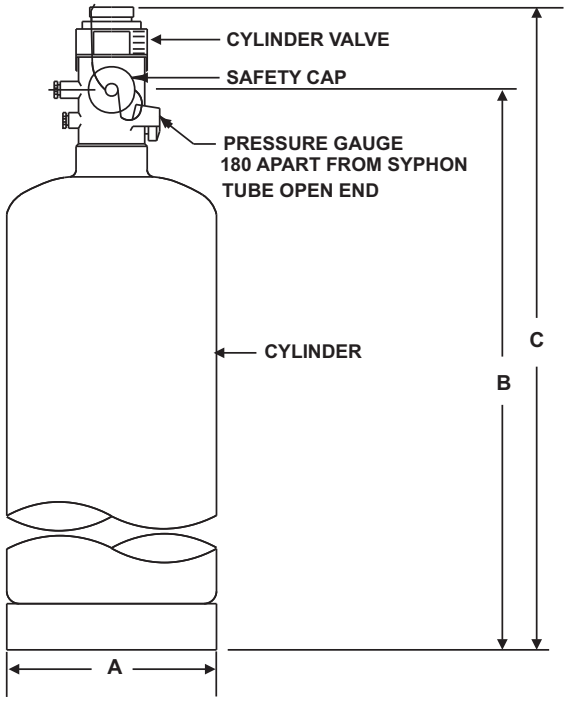


Figure 3-3. Typical Cylinder Assembly, 10 to 70 lb.

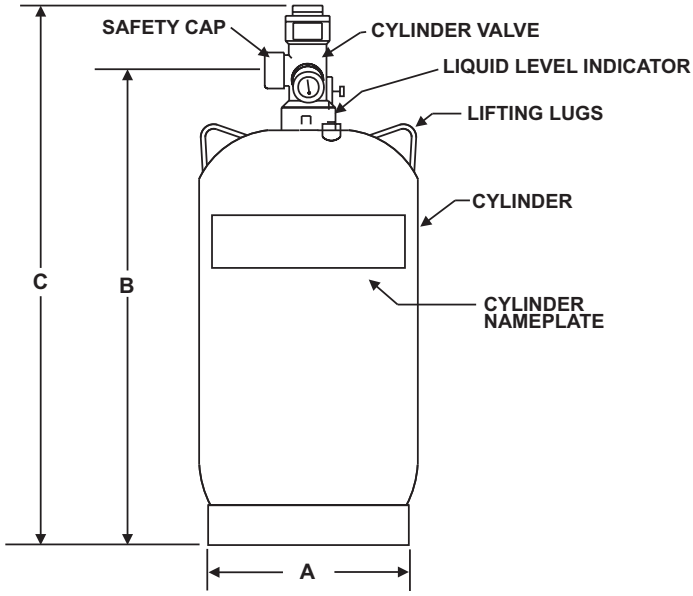


Figure 3-4. Typical Cylinder Assembly, 100 to 350 lb.

3-3 COMPONENT DESCRIPTIONS

3-3.1 FM-200 Cylinder/Valve Assemblies

FM-200 is stored in steel cylinders as a liquid, superpressurized with nitrogen to 360 PSIG at 70°F (25 bar gauge at 21°C). The cylinder valve assembly is equipped with a supervisory pressure switch connection for monitoring cylinder pressure, a pressure gauge and a safety burst disc in compliance with DOT requirements.

In addition, each cylinder/valve assembly is provided with a safety cap and a protection cap which is a safety feature to prevent uncontrolled, accidental discharge.

⚠ WARNING

The safety cap must be installed on the discharge outlet whenever a charged cylinder/ valve assembly is not connected to the system piping. Failure to install the safety cap could result in violent movement of the container in the event of inadvertent actuation. Failure to follow these instructions could cause personal injury and/or property damage.

Figures 3-3 through 3-5 represent typical cylinder assemblies. Table 3-3 on the following pages for cylinder dimensions.

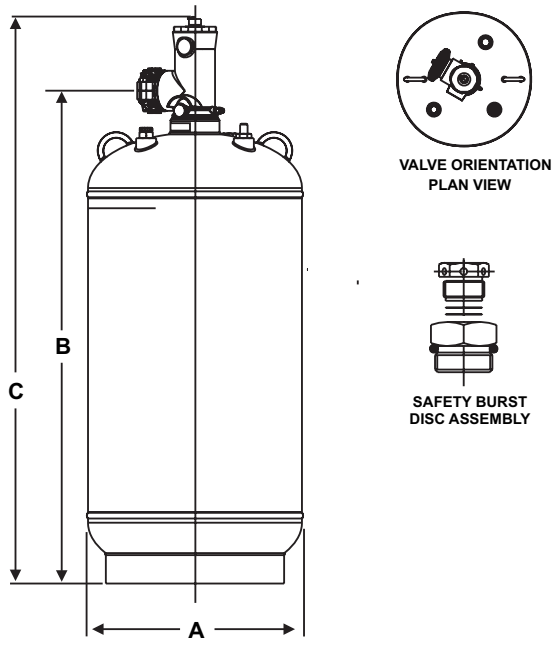


Figure 3-5. 600 and 900 lb. Cylinder with 3" Valve

The Kidde FM-200 ECS Engineered Fire Suppression System equipment listed herein is designed for an operating temperature range of 32°F to 130°F (0°C to 54°C). Table 3-1 shows the container temperature-pressure relationship based on a maximum fill density of 70 lb./ft.^{3} (1121 kg/m^3). The Kidde ECS Series FM-200 Flow Calculation Program is designed for a 70°F (21°C) container operating/storage temperature. Therefore, the container operating and storage temperature must be in the range of 60°F to 80°F (16°C to 27°C) for a single unbalanced system protecting two or more separate hazards. If the container operating and storage temperature is outside this range, an insufficient quantity of agent may be discharged from one or more discharge nozzles.

Table 3-1. Container Temperature-Pressure Correlation (Based on a cylinder fill density of 70 lb./ft.^{3} or 1121 kg/m^3)

Temperature		Nominal Charge, Pressure	
°F	°C	PSIG	Bar
32	0	288	19.9
40	4.4	303	20.9
50	10.0	321	22.2
60	15.6	340	23.5
70	21.1	360	24.8
80	26.7	381	26.3
90	32.2	402	27.7
100	37.8	425	29.3
110	43.3	449	31.0
120	48.9	475	32.7
130	54.4	502	34.6

If desired, the 125, 200, 350, 600 and 900 lb. cylinders can be provided with an integral liquid level indicator (see Paragraph 3-3.2).

As a reference guide, Table 3-2 provides the equivalent lengths for all the Kidde FM-200 ECS Engineered System cylinder and valve assemblies. The numbers shown in the table represent the equivalent length through the cylinder valve with the flex hose or without the flex hose, depending on the application. This table can also be found in the Kidde ECS Series FM-200 Flow Calculation Program. Tables 3-3 and 3-4 (on the following pages) show the dimensions and fill range for cylinder/valve assemblies in vertical installations.

Table 3-2. Cylinder, Equivalent Lengths

Part Number	Nomenclature	Discharge Outlet	Equivalent Length w/o Flex Hose		Equivalent Length w/ Flex Hose	
			ft.	m	ft.	m
90-100010-001	10 lb. Cylinder	1½"	61.8	18.84	65.0	19.81
90-100020-001	20 lb. Cylinder	1½"	61.8	18.84	65.0	19.81
90-100040-001	40 lb. Cylinder	1½"	61.8	18.84	65.0	19.81
90-100070-001	70 lb. Cylinder	1½"	61.8	18.84	65.0	19.81
90-10012X-001	125 lb. Cylinder	1½"	61.8	18.84	65.0	19.81
90-10020X-001	200 lb. Cylinder	2"	59.0	17.98	65.0	19.81
90-10035X-001	350 lb. Cylinder	2"	59.0	17.98	65.0	19.81
90-10060X-001	600 lb. Cylinder (old style)	2½"	59.0	17.98	65.0	19.81
90-10060X-100	600 lb. Cylinder (new style)	3"	50.0	15.00	80.0	24.00
90-10090X-001	900 lb. Cylinder	3"	50.0	15.00	80.0	24.00

Note: All equivalent lengths given in schedule 40, black pipe.

Table 3-3. Dimensions, FM-200 Cylinder/Valve Assemblies for Vertical Installation Only

Part Number	Valve	w/LLI	Height (C)		Diameter (A)		Volume		Valve Outlet Height	
			C		A				B	
			in.	m	in.	m	ft.^{3}	m^3	in.	m
90-10001X-001	1½"	No	17.30	0.44	7.07	0.18	0.167	0.0047	13.3	0.36
90-10002X-001	1½"	No	24.97	0.64	7.07	0.18	0.286	0.0081	21.0	0.53
90-10004X-001	1½"	No	26.76	0.68	9.00	0.23	0.572	0.0162	22.8	0.58
90-10007X-001	1½"	No	38.83	0.99	9.00	0.23	1.000	0.0283	34.9	0.89
90-100121-001	1½"	Yes	35.93	0.92	12.75	0.33	1.788	0.0506	32.0	0.81
90-100125-001	1½"	No	35.93	0.92	12.75	0.33	1.788	0.0506	32.0	0.81
90-100200-101	2"	No	52.75	1.34	12.75	0.33	2.859	0.0810	47.5	1.21
90-100201-101	2"	Yes	52.75	1.34	12.75	0.33	2.859	0.0810	47.5	1.21
90-100350-001	2"	No	58.36	1.49	16.00	0.41	5.000	0.1416	53.1	1.35
90-100351-001	2"	Yes	58.36	1.49	16.00	0.41	5.000	0.1416	53.1	1.35
90-100600-001	2½"	No	56.72	1.45	22.00	0.56	8.572	0.2427	50.5	1.28
90-100601-001	2½"	Yes	56.72	1.45	22.00	0.56	8.572	0.2427	50.5	1.28
90-100600-100	3"	No	58.00	1.47	22.00	0.56	8.680	0.2460	50.5	1.28
90-100601-100	3"	Yes	58.00	1.47	22.00	0.56	8.680	0.2460	50.5	1.28
90-100900-001	3"	No	70.00	1.78	24.00	0.61	13.000	0.3680	62.0	1.57
90-100901-001	3"	Yes	70.00	1.78	24.00	0.61	13.000	0.3680	62.0	1.57

Table 3-4. Fill Range FM-200 Cylinder/Valve Assemblies for Vertical Installation Only

Part Number	Fill Range		Empty Weight		Gross Weight			
					Min. FIll		Max. Fill	
	lb.	kg	lb.	kg	lb.	kg	lb.	kg
90-10001X-001	6-10	3.0-4.5	25	11	30	14	35	16
90-10002X-001	9-20	4.0-9.0	31	14	40	18	51	23
90-10004X-001	18-40	8.0-18.0	38	17	55	25	78	35
90-10007X-001	30-70	14.0-31.5	52	24	82	38	123	56
90-100121-001	54-125	24.5-56.5	98	45	152	69	223	101
90-100125-001	54-125	24.5-56.5	98	45	152	69	223	101
90-100200-101	86-200	39.0-90.5	133	60	219	100	333	151
90-100201-101	86-200	39.0-90.5	133	60	219	100	333	151
90-100350-001	150-350	68.0-158.5	201	91	351	159	555	250
90-100351-001	150-350	68.0-158.5	203	92	341	160	557	251
90-100600-001	258-600	117.0-272.0	335	152	593	270	935	425
90-100601-001	258-600	117.0-272.0	337	153	595	270	937	426
90-100600-100	258-600	117.0-272.0	362	165	620	281	962	437
90-100601-100	258-600	117.0-272.0	362	165	620	281	962	637
90-100900-001	390-900	177.0-408.0	505	230	895	407	1405	639
90-100901-001	390-900	177.0-408.0	505	230	895	407	1405	639

Figures 3-6 and 3-7 represent the 1½" through 3" valve arrangements.

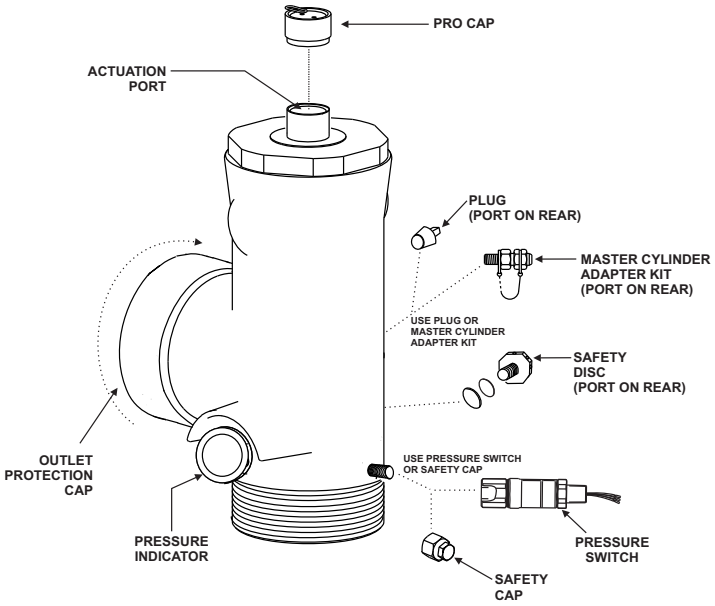


Figure 3-6. 1½", 2" and 2½" Valve General Arrangement

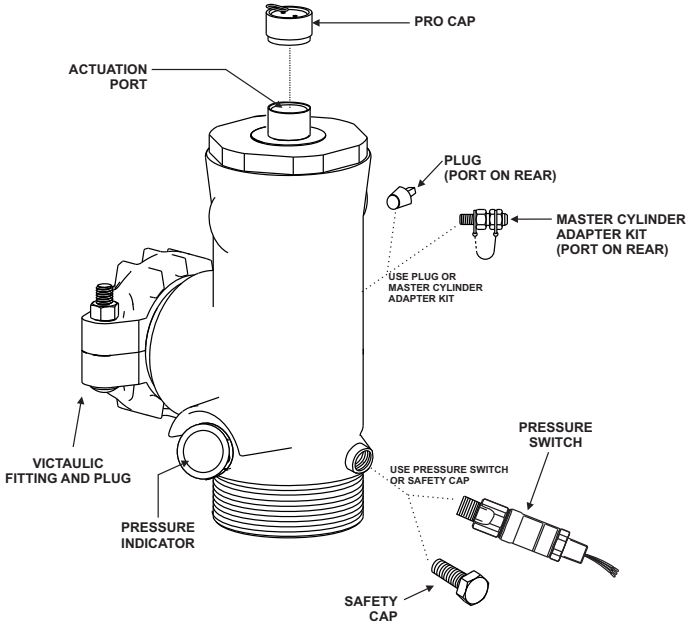


Figure 3-7. 3" Valve General Arrangement

3-3.2 Liquid Level Indicator

The optional liquid level indicator consists of a hollow metal tube inserted into a special fitting in the top of the 125, 200, 350, 600 or 900 lb. FM-200 cylinder. See Table 3-5 for part number information. The indicator is provided with a graduated tape which senses the position of a toroidal magnet encased within an internal float riding on the liquid surface. The graduations on the tape indicate the liquid level within the cylinder (see Figure 3-8).

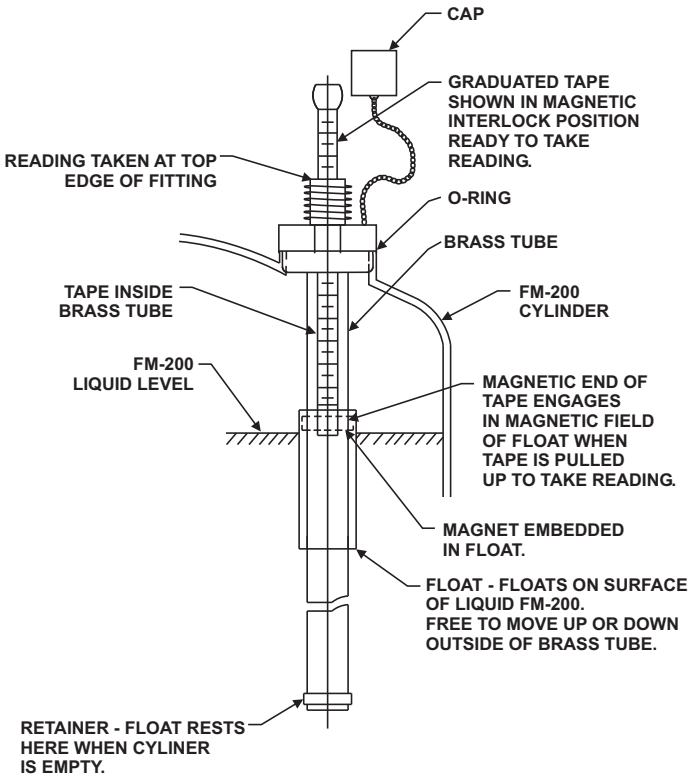


Figure 3-8. Liquid Level Indicator

Table 3-5. Liquid Level Indicator Part Numbers

Cylinder	Liquid Level Tape Part Number
125	235681
200	283894
350	283894
600	283894
900	06-118266-001

3-3.3 Cylinder Mounting Equipment

Steel straps and brackets are used to mount the cylinders in a vertical position.

Cylinder straps (P/N 283945, 283934, 235317, 292971, 281866, 294651 and 236125) are available for all size cylinders (see Figure 3-9 and Tables 3-6 and 3-7).

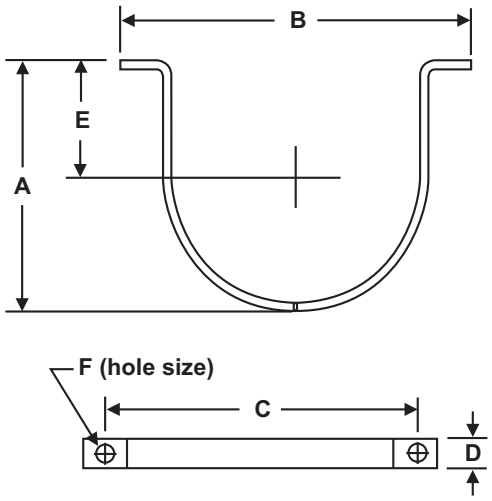


Figure 3-9. Cylinder Mounting Straps

Table 3-6. Dimensions–Cylinder Mounting Straps

Part Number	Cylinder Size	Cylinder O.D.	Dimensions*					
	lb.		A	B	C	D	E	F
283945	10, 20	7.07	6.48	9.62	8.62	1.00	2.78	0.437
283934	40, 70	9.00	8.16	11.69	10.69	1.00	3.50	0.437
292971	125, 200 old style	13.60	13.09	17.06	15.44	1.75	6.06	0.625
235317	125, 200 new style	12.75	12.94	16.18	14.56	1.75	5.59	0.625
281866	350	16.00	15.50	19.50	17.88	1.75	7.25	0.625
294651	600	22.00	21.56	25.75	24.12	1.75	10.25	0.625
236125	900	24.00	24.83	27.75	26.00	1.75	12.13	0.625
***Note:** Dimensions are in inches.								

Table 3-7. Dimensions–Cylinder Mounting Straps, Metric

Part Number	Cylinder Size	Cylinder O.D.	Dimensions*					
	lb.		A	B	C	D	E	F
283945	10, 20	180	165	244	219	25	71	11
283934	40, 70	229	207	297	272	25	89	11
292971	125, 200	345	332	433	392	44	154	16
281866	350	406	394	495	454	44	184	16
294651	600	559	548	654	613	44	260	16
236125	900	610	619	705	660	44	308	16
***Note:** Dimensions are in millimeters.								

Wall brackets (P/N 486485, 486486, 486487 and 486488) are available for the 10, 20, 40 and 70 lb. size cylinders (see Figure 3-10 and Tables 3-8 and 3-9).

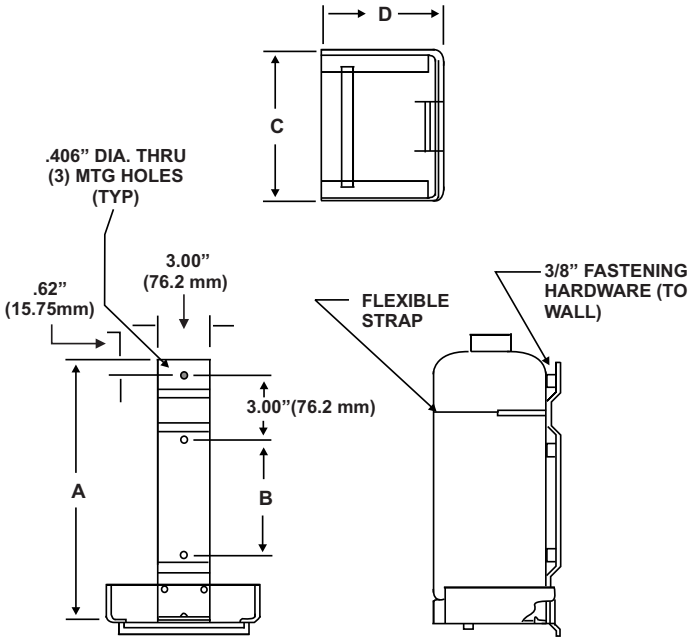


Figure 3-10. Cylinder Wall Brackets

Table 3-8. Dimensions–Cylinder Wall Brackets

Part Number	Cylinder Capacity	Dimensions*			
	lb.	A	B	C	D
486485	10	8.62	1.56	7.68	5.75
486486	20	14.37	7.31	7.68	5.75
486487	40	13.12	5.94	9.75	6.75
486488	70	19.62	12.44	9.75	6.75
***Note:** Dimensions are in inches.					

Table 3-9. Dimensions–Cylinder Wall Brackets, Metric

Part Number	Cylinder Capacity	Dimensions*			
	lb.	A	B	C	D
486485	10	218.95	39.62	194.31	146.05
486486	20	264.99	185.67	195.07	146.05
486487	40	333.25	150.88	247.65	146.05
486488	70	498.35	315.98	247.65	146.02
***Note:** Dimensions are in millimeters.					

3-3.4 Control Heads

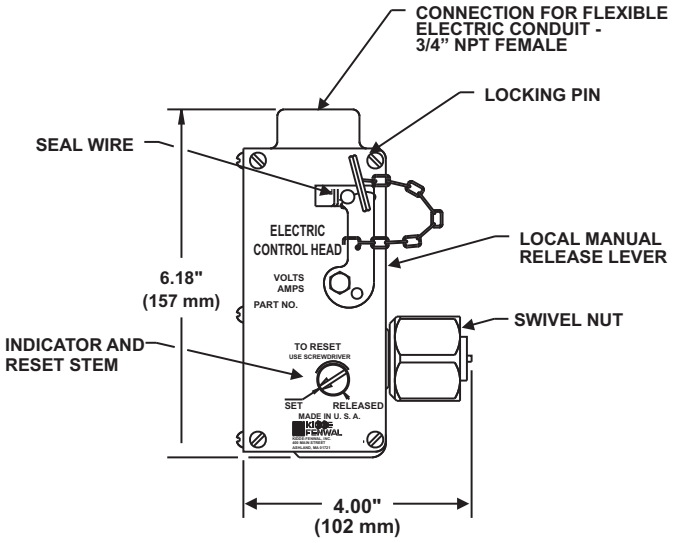
A suitable control unit, specifically Listed and Approved for use with the following electric control heads, shall be provided for supervision of the releasing circuits per NFPA requirements. In addition, a 24-hour back-up power source shall be provided per NFPA requirements.

3-3.4.1 ELECTRIC CONTROL HEADS, P/N 890181, P/N 890149 AND P/N 890165

⚠ CAUTION

The stackable control head (P/N 486500-01) cannot be used with 3" valve cylinders (P/Ns 90-100600-100, 90-100601-100, 90-100900-001 and 90-100901-001). The stackable control head does not have sufficient force to activate the 3" valve (P/N 90-17000-000) and may result in a system failure. The electric/manual control heads (P/Ns 890181, 890149 and 890165) may be used with the 3" valve.

The Electric Control Head provides for electric actuation of the FM-200 cylinder valve. It is operated electrically from a detection and control system, a remote manual station, or locally with a manual lever on the electric control head (P/N 890181 only). See Figure 3-11.



Part Number	Control Head	
	Voltage	Current
890181 890149[a] 890165[a],[b]	24 Vdc 125 Vdc 115 Vac	2.0A 0.3A 1.0A

(a) Not FM Approved for use with FM-200 Systems
(b) Not UL Listed for use with FM-200 Systems

Figure 3-11. Electric Control Head

The Stackable Control Head (P/N 486500-01) is rated for use in hazardous (classified) locations Class 1, Div 1, Groups C, D, and Class II, Div II, Groups E, F and G between -40°F to 130°F (-40°C to 54°C). Use conduit seal within 18 in. (450 mm) of this device.

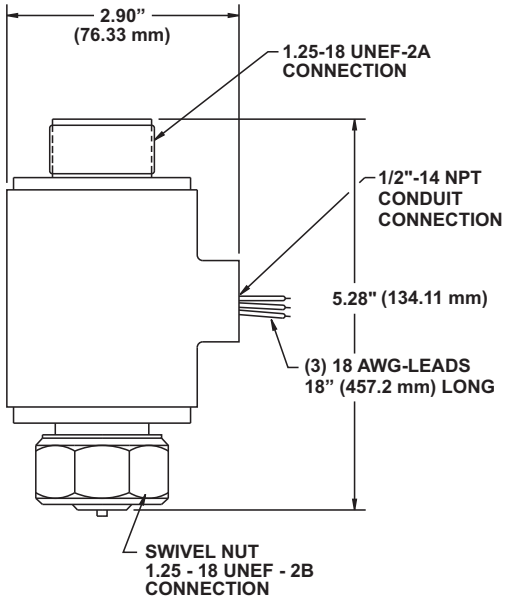


Figure 3-12. Electric Control Head, Stackable

Table 3-10. Electric Control Head, Stackable (Explosion Proof)

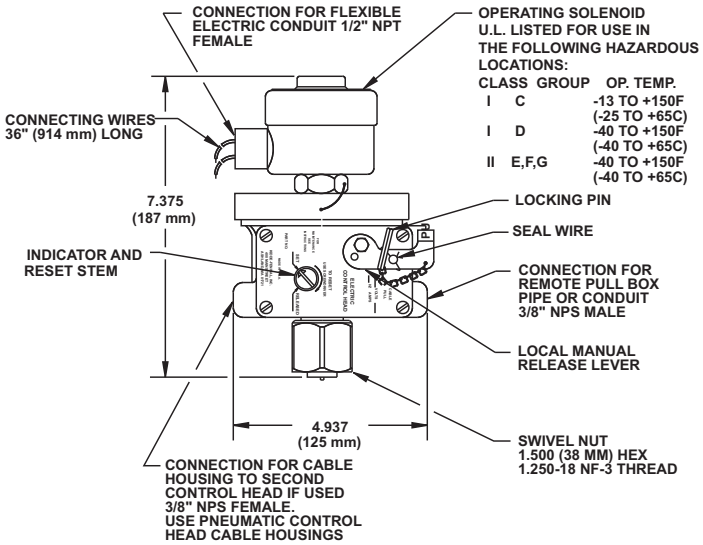
Part Number	Voltage	Amps
486500-01	24 Vdc	0.2 continuous

⚠ CAUTION

Electric Control Head, P/N 486500-01, is designed for installation directly on Kidde FM-200 ECS cylinder valves only. This control head must not be installed on any other type of FM-200 cylinder valve, nitrogen valve or carbon dioxide cylinder valve. Installation of this control head on any other device (for example, a pressure operated control head) will result in failure of the device when the control head is actuated.

3-3.4.2 ELECTRIC/CABLE OPERATED CONTROL HEADS, P/N 895630, P/N 895627, P/N 897494, P/N 897560 AND P/N 897628

The electric/cable operated control head mounts directly on top of the FM-200 cylinder valve and provides for both electric actuation or remote cable operation. The control head is operated remotely by an electrical signal from a detection system or electric manual pull station. The control head can also be operated mechanically from a remote cable operated manual pull station or locally using the manual lever on the control head (see Figure 3-13 and Table 3-11).



PART NUMBER	CONTROL HEAD	
	VOLTAGE	POWER CONSUMPTION
897494	24 Vdc	33 WATTS
897560	120 Vac	15.4 WATTS

Figure 3-13. Electric/Cable Operated Control Head

Table 3-11. Electric/Cable Operated Control Heads

Part Number	Type	Voltage	Amps	Rating
895630	Standard	24 Vdc	2.0 momentary	N/A
895627[(a),(b)]	Standard	115 Vac	1.0 momentary	N/A
897494	Explosion Proof	24 Vdc	1.65 continuous	33.0 Watts
897560[(a),(b)]	Explosion Proof	115 Vac	0.13 continuous	15.4 Watts
895628[(b)]	Standard	125 Vdc	0.3 momentary	N/A

(a) Not FM Approved for use with FM-200 Systems
(b) Not UL Listed for use with FM-200 Systems

3-3.4.3 CABLE OPERATED CONTROL HEAD, P/N 979469

The Cable Operated Control Head is used for systems designed for manual operation only. It mounts directly on top of the FM-200 cylinder valve and is operated either remotely from a cable manual pull station or locally using the manual lever on the control head (see Figure 3-14).

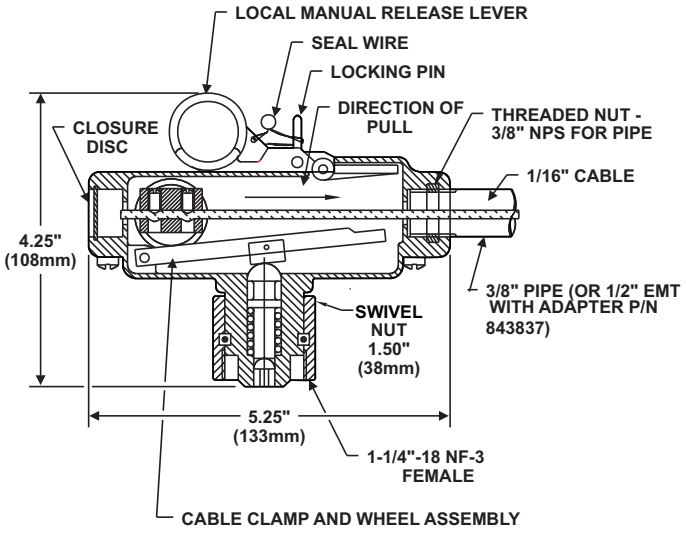


Figure 3-14. Cable Operated Control Head

3-3.4.4 LEVER OPERATED CONTROL HEAD, P/N 870652

The Lever Operated Control Head is equipped with an operating lever, secured in the closed position by a safety pull pin. By removing the safety pin, the lever can be manually rotated to the open position, thereby activating the cylinder or valve on which it is installed (see Figure 3-15).

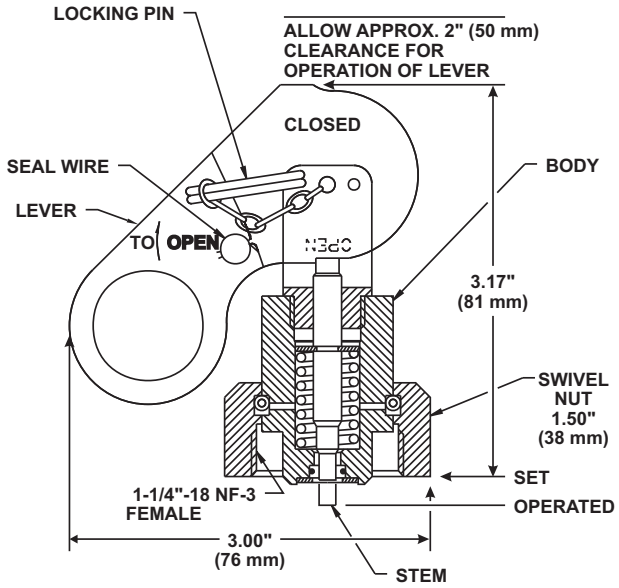


Figure 3-15. Lever Operated Control Head

3-3.4.5 LEVER/PRESSURE OPERATED CONTROL HEAD, P/N 878751

The Lever/Pressure Operated Control Head allows manual or pressure actuation of several system components, including FM-200 cylinder valves and nitrogen actuators (see Figure 3-16).

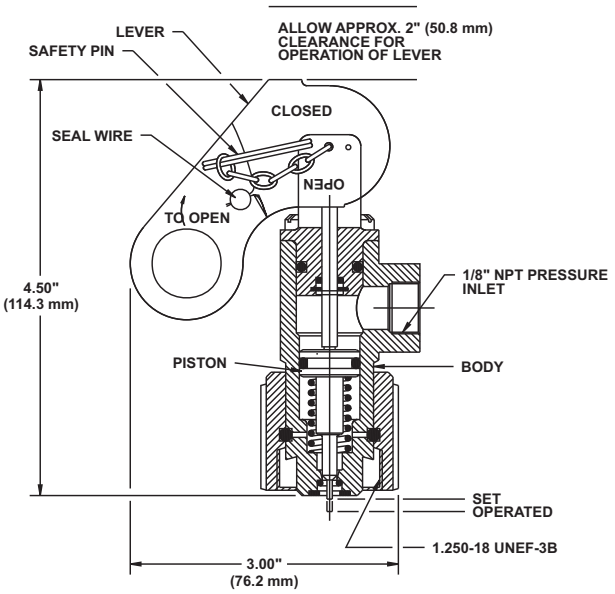


Figure 3-16. Lever/Pressure Operated Control Head

3-3.4.6 PRESSURE OPERATED CONTROL HEAD, P/N 878737 AND P/N 878750

The Pressure Operated Control Head, P/N 878737, allows for pressure actuation of FM-200 cylinders and is mounted directly on top of the FM-200 cylinder valve (see Figure 3-17). The pressure operated control head, P/N 878750, offers a stackable design and is used where an electric/mechanical control head actuation is also required on the same cylinder (see Figure 3-18).

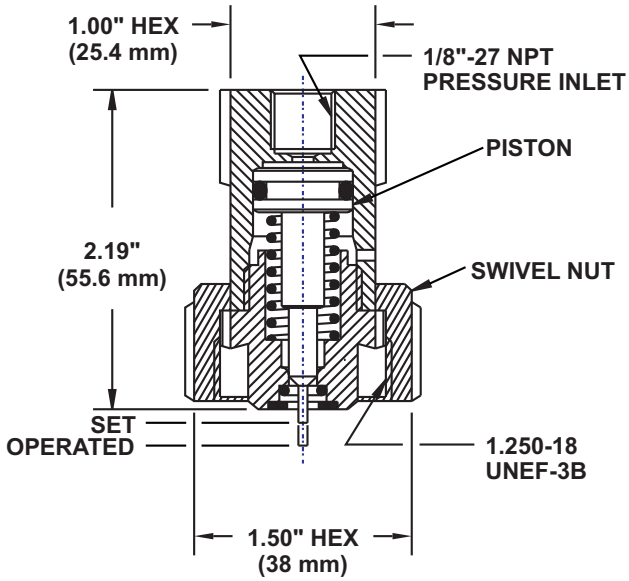


Figure 3-17. Pressure Operated Control Head

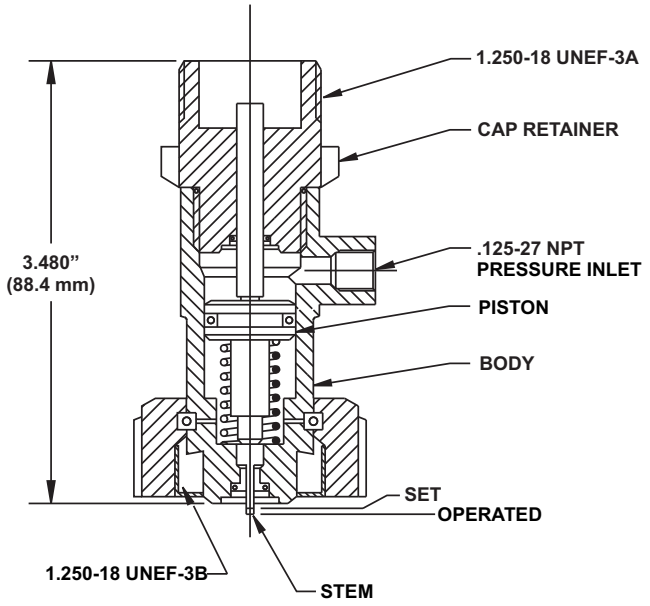


Figure 3-18. Stackable Pressure Operated Control Head

3-3.5 Remote Pull Stations

3-3.5.1 ELECTRIC REMOTE PULL BOX, P/N 893607 AND P/N 893608

The Electric Remote Pull Box is an electrically operated device. To actuate the FM-200 system, pull the handle on the front of the box.

3-3.5.2 CABLE MANUAL PULL STATION, SURFACE, P/N 871403

The surface type remote Cable Manual Pull Station is a cable operated device. To actuate the FM-200 system, break the glass plate on the box using the attached hammer and pull the handle (see Figure 3-19).

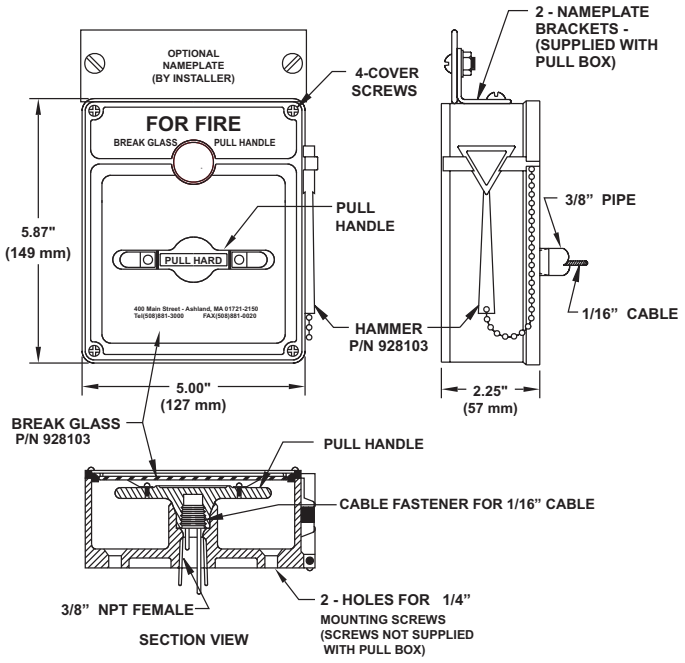


Figure 3-19. Cable Manual Pull Station

3-3.6 Actuation Accessories

3-3.6.1 NITROGEN ACTUATOR, MOUNTING BRACKET AND ADAPTER, P/N 877940, P/N 877845 AND P/N 69920501 RESPECTIVELY

Gas pressure from a nitrogen cylinder is routed to the pressure operated control head mounted on each FM-200 cylinder. When the control head on the remote nitrogen cylinder is actuated, the FM-200 cylinder will be activated, causing FM-200 to be discharged from the cylinder.

The nitrogen cylinder is used in multiple cylinder and main/reserve systems. When activated by a control head, gas pressure is routed from the nitrogen cylinder to pressure operated control heads mounted on each FM-200 cylinder, resulting in a complete system discharge (see Figure 3-20).

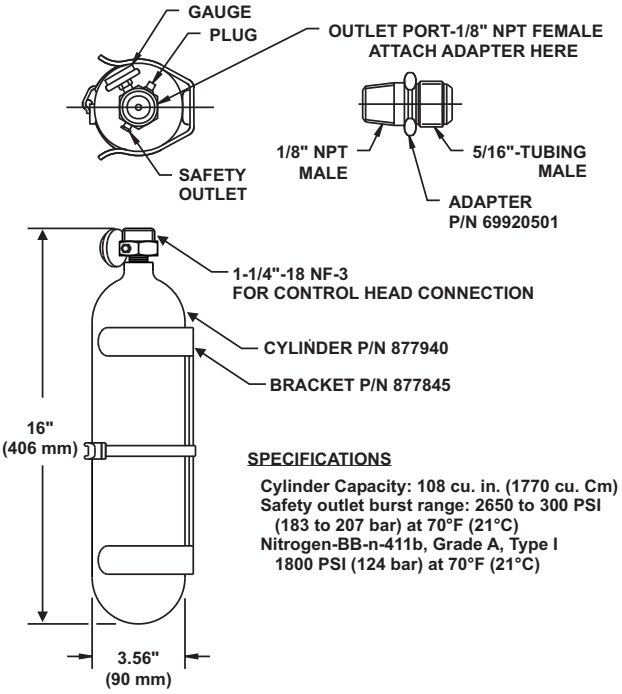


Figure 3-20. Nitrogen Actuator, Mounting Bracket and Adapter

3-3.6.2 FLEXIBLE ACTUATION HOSE, P/N 264986 AND P/N 264987

The Flexible Actuation Hose is used in multiple cylinder systems. Pilot pressure is directed to a pressure operated control head on each FM-200 cylinder valve using a 1/4-inch actuation hose (see Figure 3-21 and Table 3-12).

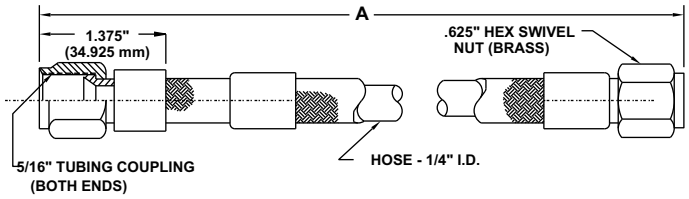


Figure 3-21. Flexible Actuation Hose

Table 3-12. Dimensions, Flexible Actuation Hose

Part Number	Dimension A	
	in.	mm
264986	30	762
264987	22	558.8

3-3.6.3 MASTER CYLINDER ADAPTER KIT, P/N 844895

The Master Cylinder Adapter Kit provides a means of connecting a flexible actuation hose to the master and slave cylinder/valve assemblies. The adapter kit is provided with a cap intentionally chained to the adapter to prevent loss while in service; do not remove the cap from the chain. The kit also contains a pressure sensitive label which is placed on the cylinder valve after adapter installation (see Figure 3-22).

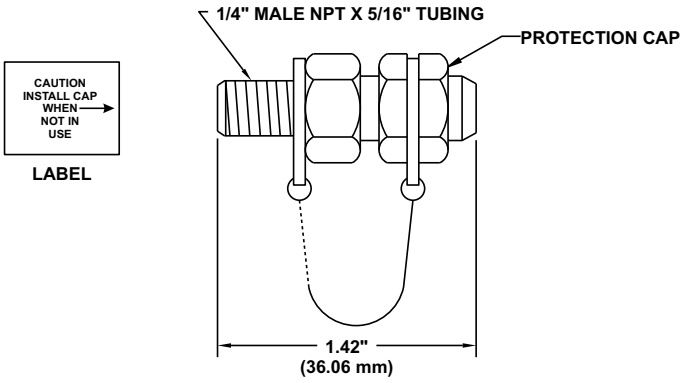


Figure 3-22. Master Cylinder Adapter Kit

3-3.6.4 TEES, ELBOWS AND ADAPTERS

Tees, elbows and adapters connect actuation hoses to pressure operated control heads in multiple cylinder system installations (see Figure 3-23).

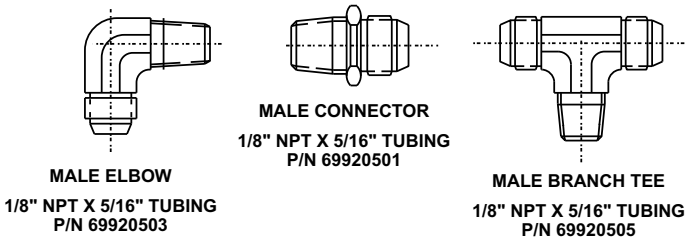


Figure 3-23. Tees, Elbows and Adapters

3-3.7 Discharge Accessories

3-3.7.1 FLEXIBLE DISCHARGE HOSE, P/N 283898, P/N 283899 AND P/N 283900

FM-200 agent is routed from the storage cylinders to the discharge piping by a flexible 1½", 2" or 2½" rubber covered hose with wire braided reinforcements. The hose is connected to the discharge outlet of the FM-200 cylinder valve and terminates at the system piping or discharge manifold (see Figure 3-24 and Table 3-13).

The 3" discharge hose is a stainless steel braid over convoluted hose, incorporating roll-groove fittings.

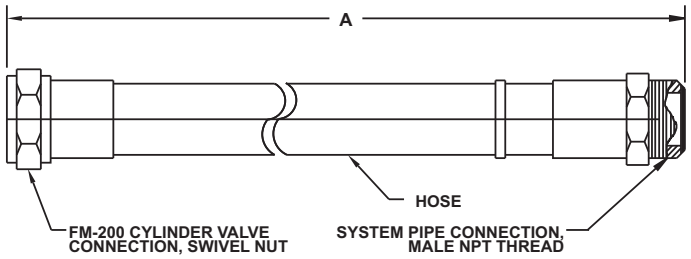


Figure 3-24. Flexible Discharge Hoses

Table 3-13. Dimensions, Flexible Discharge Hoses

Part Number	Hose Size	Dimension A		Min. Bend Radius	
		in.	mm	in.	mm
283898	1½	24	609.6	10.5	266.7
283899	2	31	787.4	13.5	342.9
283900	2½	48	1219.2	22.5	571.5
06-118225-001	3	54	1372.0	24	610.0

3-3.7.2 VALVE OUTLET ADAPTERS, P/N 283904, P/N 283905 AND P/N 283906

A valve outlet adapter connects the cylinder valve outlet to the discharge piping when a flexible discharge hose is not used (see Figure 3-25 and Table 3-14).

Note: 3" valve cylinders are equipped with a roll-groove outlet. Use a standard groove-groove connection in lieu of a valve outlet adapter.

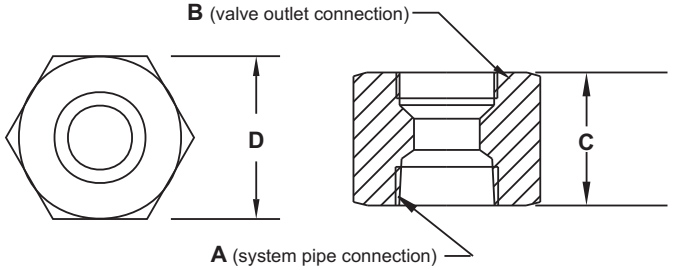


Figure 3-25. Valve Outlet Adapter

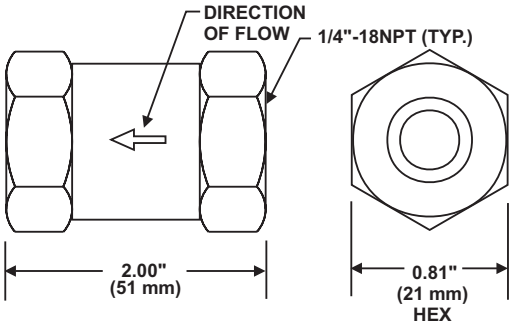
Table 3-14. Dimensions, Valve Outlet Adapter

Part Number	Size	A	B	C		D	
				in.	mm	in.	mm
283904	1½"	1½" to 11½ NPT	1.874"	2.69	68.33	2.50 HEX	63.50
283905	2"	2" to 11½ NPT	2.500" 12 UNJ	3.12	79.25	3.00 HEX	76.20
283906	2½"	2½"to 8 NPT	3.00" 12 UNJ	3.00	76.20	3.75 HEX	96.25

3-3.7.3 CHECK VALVE, 1/4-INCH, P/N 264985

Check Valves are installed in sections of piping in main/reserve systems to prevent the actuation of the reserve system when the main system is discharged.

1/4-inch check valves are installed in the pilot manifold to ensure the proper number of cylinders are discharged (see Figure 3-26).



Note: Install the valve with the arrow pointing in the direction of flow.

Figure 3-26. Check Valve

3-3.7.4 MANIFOLD EL-CHECKS, P/N 877690 AND P/N 878743

Manifold El-Checks are installed at the discharge manifold in a multiple cylinder arrangement to allow removal of any FM-200 cylinder from the manifold while still retaining a closed system. The 2-inch El-check is used on the 10 through 350 lb. size cylinders; the 2½-inch El-check is used with the 600 lb. size cylinder (see Figure 3-27 and Tables 3-15 and 3-16).

⚠ CAUTION

Manifold El-checks are not intended to be used as check valves in main/reserve systems. Improper use of equipment can cause system malfunction.

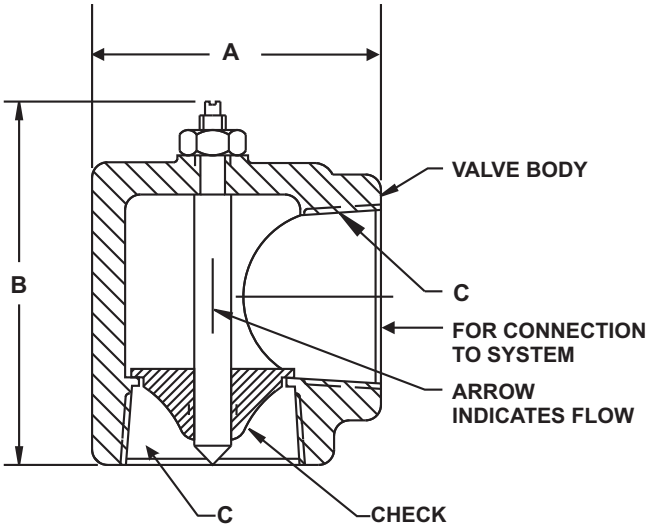


Figure 3-27. Manifold El-Checks

Table 3-15. Dimensions, Manifold El-Checks

Part Number	Size	A	B	C
877690	2"	3.93" (99.8 mm)	4.88" (123.95 mm)	2"–11½ NPT
878743	2½"	4.96" (119 mm)	5.76" (146.3 mm)	2½"–8 NPT

Table 3-16. Check Valves, Equivalent Lengths

Part Number	Nomenclature	Pipe Type	Equivalent Length	
			ft.	m
800327	Check Valve, 1/2" NPT	40 T & 40 W	7.0	2.13
800266	Check Valve, 3/4" NPT	40 T & 40 W	17.0	5.18
800443	Check Valve, 1" NPT	40 T & 40 W	12.0	3.66
800444	Check Valve, 1¼" NPT	40 T & 40 W	51.0	15.54
870152	Check Valve, 1½" NPT	40 T & 40 W	57.0	17.37
870151	Check Valve, 2" NPT	40 T & 40 W	165.0	50.29
870100	Check Valve, 3" NPT	40 T & 40 W	795.0	242.31
06-118213-001	Swing Check, 2"	40T & 40 W	13.4	4.06
06-118058-001	Swing Check, 3"	40 T & 40 W	13.0	3.96
877690 and 283899	2" EI check and Flex Hose	40 T & 40 W	16.0	4.88
878743 and 283900	2½" EI check and Flex Hose	40 T & 40 W	17.5	5.33

3-3.7.5 PRESSURE OPERATED SWITCHES, P/N 486536 AND P/N 981332

Pressure Switches operate from system pressure upon discharge to energize or de-energize electrically operated equipment. Pressure switches may be used to shut down machinery and ventilation or to annunciate system discharge (see Figures 3-31 and 3-32).

3-3.7.6 PRESSURE OPERATED TRIP, P/N 874290

Pressure Operated Trips are used to close off the hazard space upon system discharge. The trips, operated by system pressure, are designed to release self-closing units for doors, windows and dampers. The maximum load to be attached to a pressure trip is 100 lb. (45.36 kg). This is based on a minimum pressure of 75 PSIG (50.7 bar gauge) at the pressure trip.

3-3.7.7 DISCHARGE INDICATOR, P/N 875553

The Discharge Indicator may be installed in the discharge piping to visually indicate a system discharge. When in the SET position, the discharge indicator acts as a vent (see Figure 3-28).

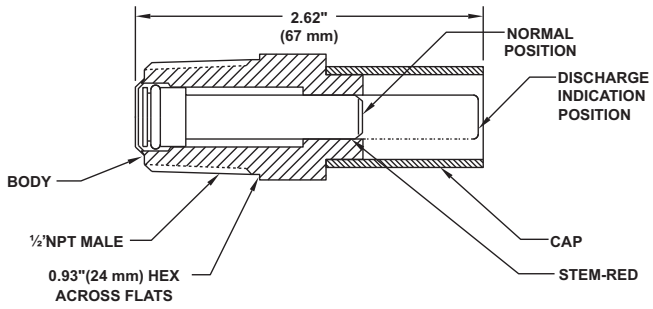


Figure 3-28. Discharge Indicator

3-3.7.8 CORNER PULLEYS, P/N 803808 AND P/N 844648

Corner Pulleys change the direction of cable lines without binding to ensure smooth operation. P/N 803808 is used for all watertight applications; P/N 844648 is used for all industrial applications (see Figures 3-29 and 3-30).

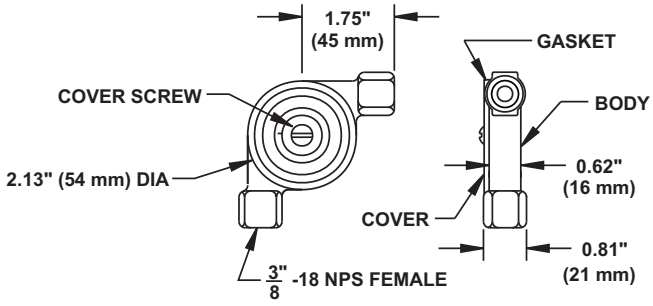


Figure 3-29. Corner Pulleys, Watertight Applications

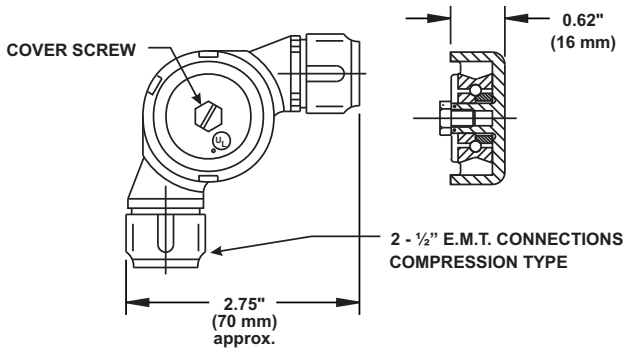


Figure 3-30. 1/2-Inch E.M.T. Corner Pulley, General Applications

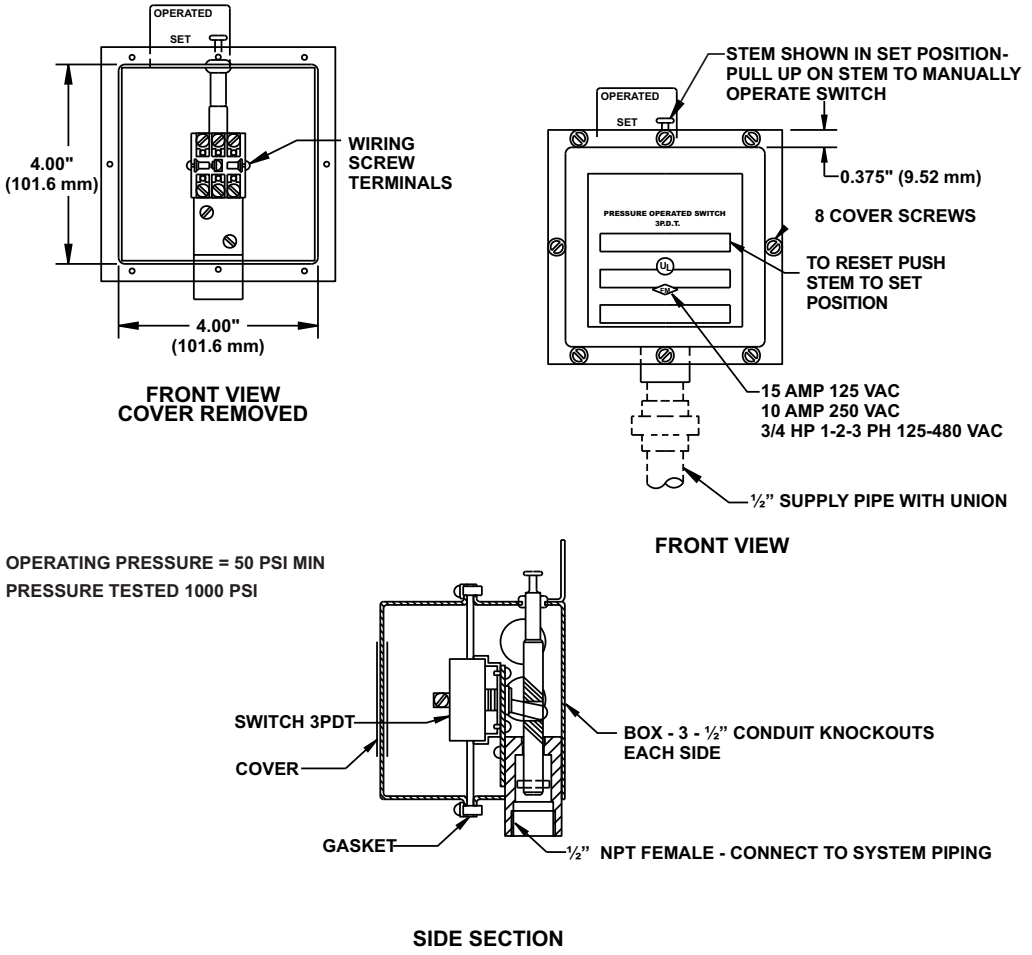


Figure 3-31. Pressure Operated Switch

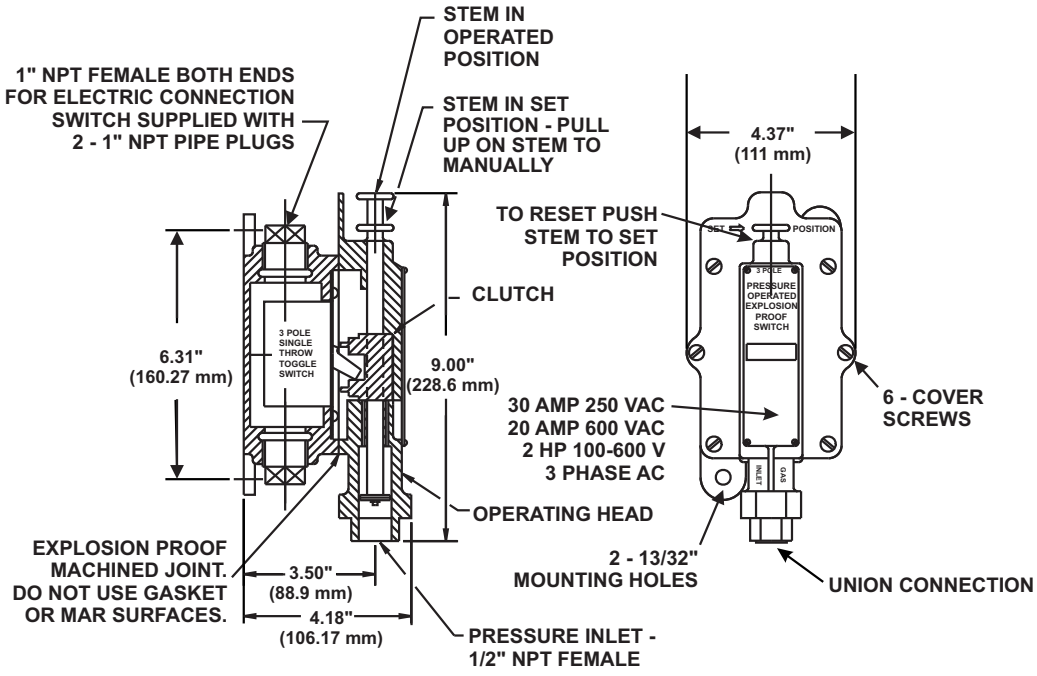


Figure 3-32. Pressure Operated Switch,
Explosion Proof

3-3.7.9 CYLINDER SUPERVISORY PRESSURE SWITCH, P/N 06-118262-001

The Cylinder Supervisory Pressure Switch, P/N 06-118262-001, is intended to detect a fall in pressure in the FM-200 cylinder (see Figure 3-33). The cylinder supervisory pressure switch can be wired for either normally-open or normally-closed operation, depending on installation requirements. The cylinder supervisory pressure switch can be installed on 10 lb. through 350 lb. capacity FM-200 cylinders. If the pressure inside the cylinder falls below 305 PSIG (21 bar gauge), the switch contacts will transfer and invoke a "trouble" signal at the control panel.

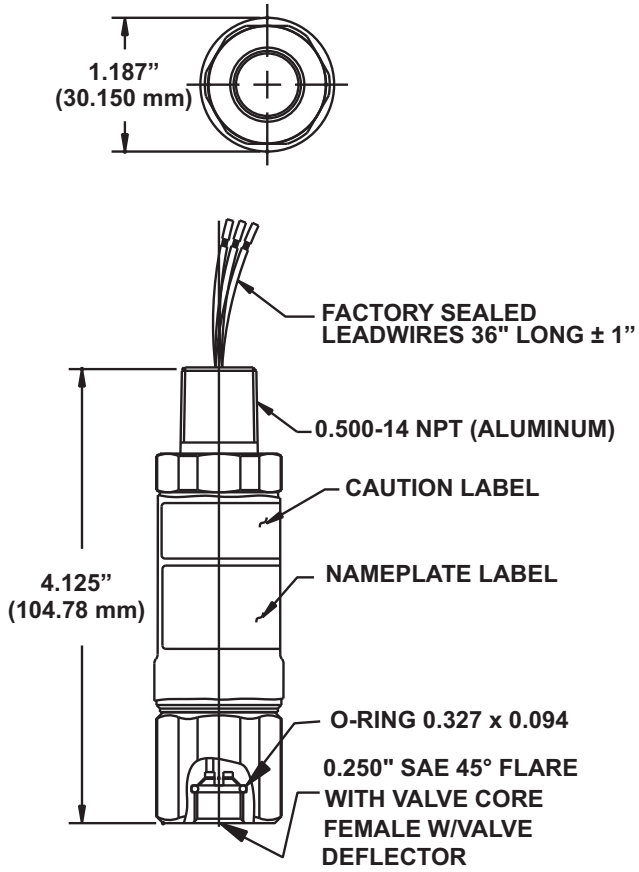


Figure 3-33. Cylinder Supervisory Pressure Switch

3-3.7.10 SUPERVISORY PRESSURE SWITCH, P/N 06-118263-001

The Supervisory Pressure Switch (P/N 06-118263-001) is intended to detect a fall in pressure in the FM-200 cylinder (see Figure 3-34). The cylinder supervisory pressure switch can be wired for either normally-open or normally-closed operation, depending on installation requirements. The cylinder supervisory pressure switch can be installed on 600 lb. through 900 lb. capacity FM-200 cylinders with a 3" discharge valve. If the pressure inside the cylinder falls below 305 PSIG (21 bar gauge), the switch contacts will transfer and invoke a "trouble" signal at the control panel.

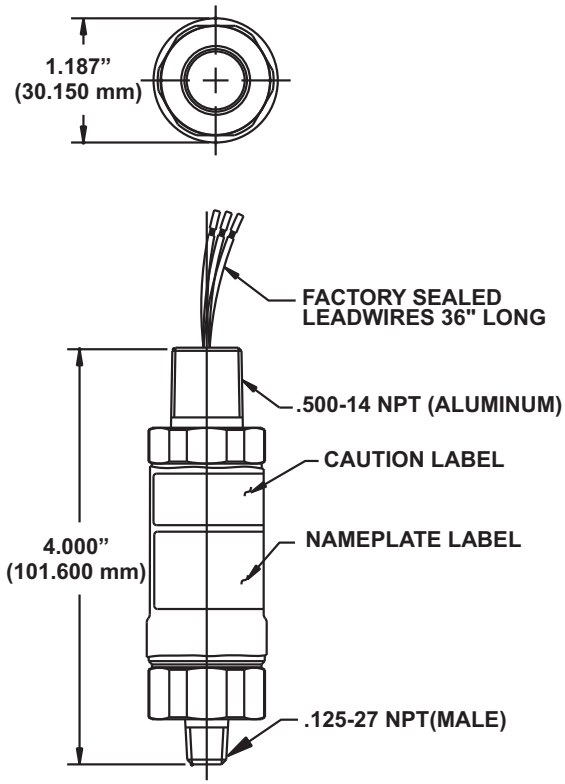


Figure 3-34. Supervisory Pressure Switch

3-3.7.11 MAIN-TO-RESERVE TRANSFER SWITCH, P/N 802398

The Main-to-Reserve Switch is installed on systems having main and reserve cylinders. Placing the switch in either the MAIN or RESERVE position provides uninterrupted fire protection during system maintenance or in the event of a system discharge (see Figure 3-35).

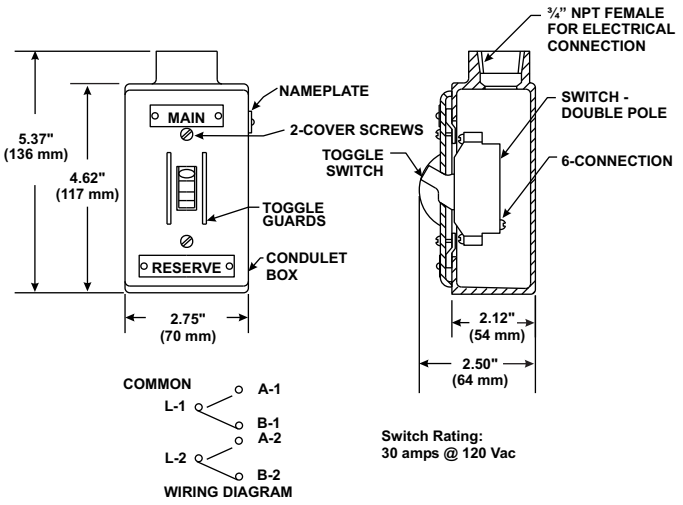


Figure 3-35. Main to Reserve Transfer Switch

3-3.7.12 DISCHARGE NOZZLES

The 180° and 360° discharge nozzles are designed to provide the proper flow rate and distribution of FM-200 to flood a hazard area. The 180° nozzle is engineered to provide a 180° discharge pattern for sidewall applications. The 360° nozzle offers a full 360° discharge pattern for installations where nozzles are located in the center of the hazard. See Figures 3-36 and 3-37 and Tables 3-17 and 3-18 for further information.

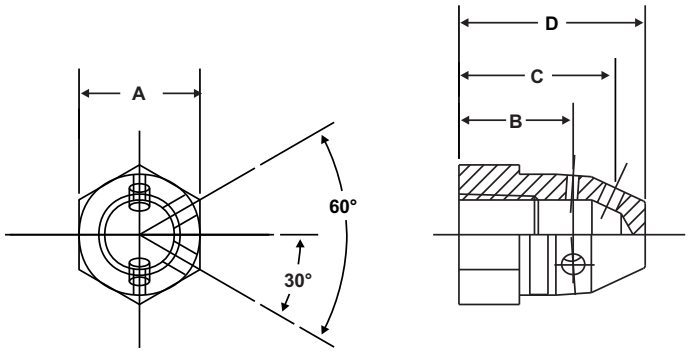


Figure 3-36. 180° Discharge Nozzle

Table 3-17. Dimensions–180° Discharge Nozzle

Pipe Size	A	B	C	D
½" (12.20 mm)	1.25" (31.75 mm)	1.25" (31.75 mm)	1.687" (42.84 mm)	2.0" (50.80 mm)
¾" (19.05 mm)	1.5" (38.10 mm)	1.375" (34.92 mm)	1.95" (48.89 mm)	2.296" (58.31 mm)
1" (25.40 mm)	1.75" (44.45 mm)	1.562" (39.67 mm)	2.218" (56.33 mm)	2.671" (67.84 mm)
1¼" (31.75 mm)	2.25" (57.15 mm)	1.75" (44.45 mm)	2.656" (67.46 mm)	3.25" (82.55 mm)
1½" (38.10 mm)	2.5" (63.5 mm)	1.95" (48.89 mm)	2.95" (74.93 mm)	3.625" (92.07 mm)
2" (50.80 mm)	3.0" (76.2 mm)	1.968" (49.98 mm)	2.875" (73.02 mm)	3.656" (92.86 mm)

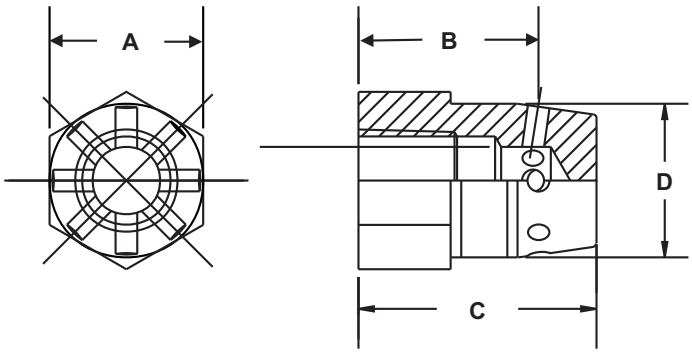


Figure 3-37. 360° Discharge Nozzle

Table 3-18. Dimensions–360° Discharge Nozzle

Pipe Size	A	B	C	D
½" (12.20 mm)	1.250" (31.75 mm)	1.468" (31.28 mm)	1.937" (49.19 mm)	1.250" (31.75 mm)
¾" (19.05 mm)	1.500" (38.10 mm)	1.578" (40.08 mm)	2.125" (53.97 mm)	1.500" (38.10 mm)
1" (25.40 mm)	1.750" (44.45 mm)	1.718" (43.63 mm)	2.375" (60.32 mm)	1.750" (44.45 mm)
1¼" (31.75 mm)	2.250" (57.15 mm)	1.950" (49.53 mm)	2.751" (69.85 mm)	2.250" (57.15 mm)
1½" (38.10 mm)	2.250" (63.50 mm)	2.000" (50.80 mm)	2.937" (74.59 mm)	2.500" (63.50 mm)
2" (50.80 mm)	3.000" (76.20 mm)	2.062" (52.37 mm)	3.125" (79.37 mm)	3.000" (76.20 mm)

3-3.8 Other Accessories

3-3.8.1 HYDROSTATIC TEST ADAPTERS

The hydrostatic pressure test adapter is installed on the FM-200 cylinder in place of the cylinder valve when the cylinder is to be hydrostatically pressure tested. For cylinder test requirements, see Paragraph 5-5.3 of this manual.

3-3.8.2 FM-200 CYLINDER RECHARGE ADAPTERS

The FM-200 recharge adapter is installed in the cylinder discharge outlet during the cylinder charging procedure. This adapter is used for refilling the cylinder with FM-200 agent and super pressurizing the cylinder with nitrogen (see Figure 3-38 and Table 3-19).

Note: The 3" valve and associated cylinders (new style 600 lb. and 900 lb.) do not require a recharge adaptor. Recharge of these cylinders is achieved via the 1/2" NPT connection on the grooved fitting plate on the outlet port.

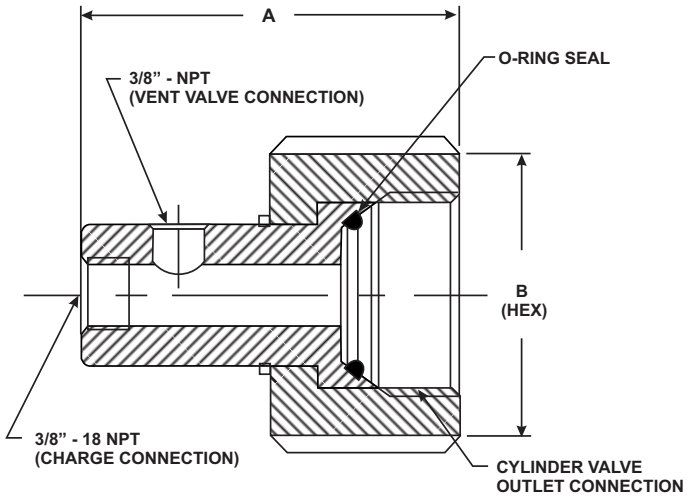


Figure 3-38. Cylinder Recharge Adapters

Table 3-19. Dimensions–Cylinder Recharge Adapters

Part Number	Cylinder Size	A		B	
	lb.	in.	mm	in.	mm
878757	10-125	3.22	81.79	2.50	63.50
878758	200, 350	4.06	103.12	3.25	82.55
878759	600	4.00	101.60	3.62	91.95

3-3.8.3 FM-200 CYLINDER SEATING ADAPTER, P/N 933537

The FM-200 Seating Adapter is installed on the cylinder actuation port during the cylinder charging procedure. This adapter is used for seating the valve assembly after charging and super pressurization is complete.

3-3.9 Detectors and Control Panels

3-3.9.1 DETECTORS

Detectors (ionization, photoelectric, thermal, ultraviolet, ultraviolet/infrared, etc.) interfacing with Kidde FM-200 systems must be UL Listed and/or FM Approved for the intended application.

3-3.9.2 CONTROL PANEL

The control panel must be UL Listed and/or FM Approved for releasing device service and compatible with Kidde FM-200 equipment.

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CHAPTER 4
DESIGN AND INSTALLATION

4-1 INTRODUCTION

This chapter is intended for system designers and installers. It outlines the steps needed to design the system including the limitations imposed on the design by the system hardware. The second part of this chapter explains equipment installation.

4-2 DESIGN PROCEDURE

4-2.1 General

The system design is based on the requirements of National Fire Protection Association (NFPA) Standard 2001, current edition and the Authority Having Jurisdiction (AHJ).

4-2.2 Application

The following steps must be taken to design an FM-200® system:

- Determine the design concentration required for the hazard. Refer to Table 4-2 for Class B hazards.
- For systems that protect Class A or Class C hazards, and incorporate a mechanism of automatic actuation, a minimum design concentration of 6.25% can be used.
- Determine the minimum and maximum ambient temperature for the hazard.
- Determine the volume of the hazard.
- Determine the integrity of the hazard.
- Determine if any additional agent will be required to offset leakage of agent from the hazard.

4-2.2.1 CALCULATE AGENT REQUIRED

Calculate the quantity of FM-200 required to provide the proper design concentration at the minimum expected hazard temperature.

Note: Refer to Tables 4-1, 4-2, 4-3 and 4-4. The information is given for estimating purposes only. The Kidde ECS Series FM-200 Flow Calculation Program calculates this information for the designer. Refer to the Kidde ECS Series FM-200 Flow Calculation Program User's Manual (P/N 90-FM200M-110) for further information.

4-2.2.2 DETERMINE WHAT COMPONENTS ARE REQUIRED

- Cylinder size, quantity and fill requirements. Refer to Tables 4-2 and 4-3.
- Cylinder framing, mounting brackets, etc.
- Detection and control equipment required.
- Other system requirements, such as reserve supply, pressure switches, etc.

4-2.2.3 LOCATE NOZZLES

Locate nozzles based on the following:

- Ceiling height (16 ft. [4.87 m] maximum, 1ft. [0.30 m] minimum).
- Nozzle area coverage.
- Special hazard area layout considerations.

4-2.2.4 LOCATE CYLINDERS

Locate cylinders based on the following:

- Number of cylinders required.
- Storage temperature/environmental considerations, such as weather, area classification and corrosive environment.
- Accessibility.
- Floor loading.

4-2.2.5 LOCATE PIPING

Locate piping based on the following:

- Nozzle location.
- Structural members for bracing the pipe.

4-2.2.6 PIPE SIZE AND LAYOUT

Determine pipe size and layout for the following factors:

- Draw piping isometric.
- Dimensions of all pipe sections.
- Locate all fittings.
- Note all elevation changes.

The preceding information will be entered into the computer program.

4-2.2.7 USING THE FM-200 CONCENTRATION FLOODING FACTORS

To find the total quantity of FM-200 required at a specific temperature and concentration, multiply the hazard area volume by the multiplier from Tables 4-3 and 4-4 that correspond to the design temperature and concentration desired.

Note: NFPA 2001 and the U.S. Environmental Protection Agency *Significant New Alternatives Policy (SNAP)* provide specific guidelines for using FM-200. The minimum use concentration for total flooding applications is 6.25% w/v, unless a higher concentration is required for the specific hazard being protected.

The agent required must be based on the lowest expected ambient temperature in the protected space. Care must be taken that the calculated concentration for normally occupied spaces at the highest expected ambient temperature in the space does not exceed the value of 10.5% per NFPA 2001.

Per NFPA 2001, 2000 edition FM-200 systems with use concentrations below the NOAEL (9% w/v) are permitted for use in occupied areas. FM-200 can be designed between 9% and 10.5% for a five minute exposure using the PBPK model.

Table 4-1. Atmospheric Correction Factors

Equivalent Altitude Factor	Enclosure Pressure	Atmospheric Correction
-3,000 ft. 0.92 km	16.25.psia 84.0 cm Hg	1.11
-2,000 ft. 0.61 km	15.71 psia 81.2 cm Hg	1.07
-1,000 ft. 0.30 km	15.23 psia 78.7 cm Hg	1.04
0 ft. 0.00 km	14.71 psia 76.0 cm Hg	1.00
1,000 ft 0.30 km	14.18 psia 73.3 cm Hg	0.96
2,000 ft 0.61 km	13.64 psia 70.5 cm Hg	0.93
3,000 ft 0.92 km	13.12 psia 67.8 cm Hg	0.89
4,000 ft 1.21 km	12.58 psia 65.0 cm Hg	0.86
5,000 ft 0.92 km	12.04 psia 62.2 cm Hg	0.82
6,000 ft 1.52 km	11.53 psia 59.6 cm Hg	0.78
7,000 ft 1.83 km	11.03 psia 57.0 cm Hg	0.75
8,000 ft. 2.13 km	10.64 psia 55.0 cm Hg	0.72
9,000 ft. 2.44 km	10.22 psia 52.8 cm Hg	0.69
10,000 ft. 3.05 km	9.77 psia 50.5 cm Hg	0.66

4-2.2.8 MANIFOLDS

When multiple cylinders are needed, they may be connected to the same set of distribution piping through a manifold. This is necessary in three circumstances.

1. A connected reserve supply of FM-200 is required.
2. The quantity of agent required is greater than the maximum fill of a single cylinder.
3. A single cylinder does not contain enough nitrogen to discharge the required agent through the pipe network.

In accordance with standards set by NFPA 2001:

- All cylinders are of the same size and quantity.
- Each cylinder must have an El-check or swing-check to prevent back flow of agent through the discharge hose in case the system is discharged while a cylinder is removed for maintenance.

Standard check valves MUST be installed and modeled in the calculation software whenever all of the following conditions exist:

- Multiple cylinders are required, and
- A connected reserve supply is required, and
- Multiple cylinder actuation from a master FM-200 cylinder.

4-2.3 Design Criteria

The complexity of two-phase flow formulas does not allow for any simple method of manual FM-200 calculation. For this reason, the flow calculations and design criteria described in this manual have been programmed into a computer software program.

⚠ CAUTION

Kidde ECS Series FM-200 Flow Calculation Computer Design Software is the only calculation method to be used with Kidde FM-200 equipment. No other calculation method is accepted by Kidde.

The system designer must become thoroughly familiar with the User's Manual for Kidde ECS Series FM-200 Flow Calculation Program (P/N 90-FM200M-100) to determine the proper procedures for applying the input parameters to the Kidde computer program. There are a number of limitations to these input parameters which must be observed if accurate results are to be obtained. Most of these limitations are in the program. However, there are certain restrictions that must be addressed by the system designer before applying the input data. The following paragraphs describe the essential design parameters and design limitations which must be considered.

Table 4-2. Class B Suppression Design Concentrations

Fuel	Cup Burner (%v/v)	Design Concentration, 30% Safety Factor[2] (%v/v)	Fuel	Cup Burner (%v/v)	Design Concentration, 30% Safety Factor[2] (%v/v)
Acetone	6.9	9.0	**1-Hexene**	5.8	7.6
Acetonitrile	4.3	7.0	**Hydraulic Fluid***	6.5	8.5
t-Amyl Alcohol	7.3	9.5	**Hydraulic Oil***	5.9	7.7
AV Gas	6.5	8.5	**Hydrogen**	13.2	17.2
Benzene	5.5	7.2	**Isobutyl Alcohol**	7.6	9.9
n-Butane	6.6	8.6	**Isopropanol**	7.5	9.8
n-Butanol	7.6	9.9	**JP4**	6.9	9.0
2-Butoxyethanol*	7.4	9.6	**JP5**	6.9	9.0
2-Butoxyethyl Acetate*	6.9	9.0	**Kerosene**	7.4	9.6
n-Butyl Acetate	7.0	9.1	**Methane**	5.5	7.2
Carbon Disulfide	11.8	15.4	**Methanol**	10.4	13.5
Chloroethane	6.3	8.2	**2-Methoxyethanol**	9.4	12.2
Commercial Grade Heptane	6.7	8.7	**Methyl Ethyl Ketone**	7.4	9.6
Crude Oil*	6.5	8.5	**Methyl Isobutyl Ketone**	7.0	9.1
Cyclohexane	7.2	9.4	**Mineral Spirits**	6.6	8.6
Cyclohexylamine	8.3	8.7	**Morpholine**	7.9	10.3
Cyclopentanone	7.4	9.6	**Nitromethane**	9.9	12.9
1,2-Dichloroethane	5.8	7.6	**n-Pentane**	6.8	8.8
Diesel	6.7	8.7	**Propane**	6.7	8.7
N,N-Diethylethanolamine*	7.8	10.1	**1-Propanol**	7.7	10.0
Diethyl Ether	7.5	9.8	**Propylene**	6.2	8.1
Ethane	6.7	8.7	**Propylene Glycol**	8.6	11.2
Ethanol	8.3	10.8	**Pyrrolidine**	7.3	9.5
Ethyl Acetate	6.8	8.9	**Tetrahydrofuran**	7.4	9.6
Ethyl Benzene*	6.3	8.2	**Tetrahydrothiophene**	6.6	8.6
Ethylene	8.4	10.9	**Toluene**	5.6	7.3
Ethylene Glycol	7.6	9.9	**Tolylene-2, 4-Diisocyanate**	4.0	7.0
Gasoline-no lead	6.9	9.0	**Transformer Oil**	7.3	9.5
n-Heptane	6.7	8.7	**Turbine Oil****	7.2	9.4
n-Hexane	6.9	9.0	**Xylene**	6.0	7.8

* General guideline only–MSDS required to determine proper concentration

** Texaco R+O 32

Note: Cup Burner source data, Great Lakes Chemical Corporation.

Table 4-3. FM-200 Total Flooding
Concentration Factors (W/V), English Units

Temp[a] t (°F)[c] Temp *t* (°F)[c]	Specific Vapor Volume (ft.³/lb.)[d]	Weight Requirements of Hazard Volume, W/V (lb./ft.³)[b] Design Concentrations (% by Volume)[e]										
		6	6.25	7	8	9	10	11	12	13	14	15
30	2.0210	0.0316	0.0330	0.0372	0.0430	0.0489	0.0550	0.0612	0.0675	0.0739	0.0805	0.0873
40	2.0678	0.0309	0.0322	0.0364	0.0421	0.0478	0.0537	0.0598	0.0659	0.0723	0.0787	0.0853
50	2.1146	0.0302	0.0315	0.0356	0.0411	0.0468	0.0525	0.0584	0.0645	0.0707	0.0770	0.0835
60	2.1612	0.0295	0.0308	0.0348	0.0402	0.0458	0.0514	0.0572	0.0631	0.0691	0.0753	0.0817
70	2.2075	0.0289	0.0302	0.0341	0.0394	0.0448	0.0503	0.0560	0.0618	0.0677	0.0737	0.0799
80	2.2538	0.0283	0.0296	0.0334	0.0386	0.0439	0.0493	0.0548	0.0605	0.0663	0.0722	0.0783
90	2.2994	0.0278	0.0290	0.0327	0.0378	0.0430	0.0483	0.0538	0.0593	0.0650	0.0708	0.0767
100	2.3452	0.0272	0.0284	0.0321	0.0371	0.0422	0.0474	0.0527	0.0581	0.0637	0.0694	0.0752
110	2.3912	0.0267	0.0279	0.0315	0.0364	0.0414	0.0465	0.0517	0.0570	0.0625	0.0681	0.0738
120	2.4366	0.0262	0.0274	0.0309	0.0357	0.0406	0.0456	0.0507	0.0560	0.0613	0.0668	0.0724
130	2.4820	0.0257	0.0269	0.0303	0.0350	0.0398	0.0448	0.0498	0.0549	0.0602	0.0656	0.0711
140	2.5272	0.0253	0.0264	0.0298	0.0344	0.0391	0.0440	0.0489	0.0540	0.0591	0.0644	0.0698
150	2.5727	0.0248	0.0259	0.0293	0.0338	0.0384	0.0432	0.0480	0.0530	0.0581	0.0633	0.0686
160	2.6171	0.0244	0.0255	0.0288	0.0332	0.0378	0.0425	0.0472	0.0521	0.0571	0.0622	0.0674
170	2.6624	0.0240	0.0250	0.0283	0.0327	0.0371	0.0417	0.0464	0.0512	0.0561	0.0611	0.0663
180	2.7071	0.0236	0.0246	0.0278	0.0321	0.0365	0.0410	0.0457	0.0504	0.0552	0.0601	0.0652
190	2.7518	0.0232	0.0242	0.0274	0.0316	0.0359	0.0404	0.0449	0.0496	0.0543	0.0592	0.0641
200	2.7954	0.0228	0.0238	0.0269	0.0311	0.0354	0.0397	0.0442	0.0488	0.0535	0.0582	0.0631

[a] The manufacturer's listing specifies the temperature range for operation.

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

$$W = (V/s) \times [c/(100-c)]$$

[c] *t* [temperature (°F)] = the design temperature in the hazard area

[d] *s* [specific volume (ft.³/lb.)] = specific volume of superheated FM-200 vapor can be approximated by the formula:

$$s = 1.885 + 0.0046\ t$$

where *t* = temperature (°F)

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

Table 4-4. FM-200 Total Flooding Concentration Factors (W/V), Metric

Temp[a] *t* (°C)[c]	Specific Vapor Volume *s* (m^3/kg)[d]	Weight Requirements of Hazard Volume, *W/V* (kg/m^3)[b] Design Concentration (% per Volume) [e]										
		6	6.25	7	8	9	10	11	12	13	14	15
0	0.1268	0.5034	0.5258	0.5936	0.6858	0.7800	0.8763	0.9748	1.0755	1.1785	1.2839	1.3918
5	0.1294	0.4932	0.5152	0.5816	0.6719	0.7642	0.8586	0.9550	1.0537	1.1546	1.2579	1.3636
10	0.1320	0.4834	0.5051	0.5700	0.6585	0.7490	0.8414	0.9360	1.0327	1.1316	1.2328	1.3364
15	0.1347	0.4740	0.4949	0.5589	0.6457	0.7344	0.8251	0.9178	1.0126	1.1096	1.2089	1.3105
20	0.1373	0.4650	0.4856	0.5483	0.6335	0.7205	0.8094	0.9004	0.9934	1.0886	1.1859	1.2856
25	0.1399	0.4564	0.4765	0.5382	0.6217	0.7071	0.7944	0.8837	0.9750	1.0684	1.1640	1.2618
30	0.1425	0.4481	0.4678	0.5284	0.6104	0.6943	0.7800	0.8676	0.9573	1.0490	1.1428	1.2388
35	0.1450	0.4401	0.4598	0.5190	0.5996	0.6819	0.7661	0.8522	0.9402	1.0303	1.1224	1.2168
40	0.1476	0.4324	0.4517	0.5099	0.5891	0.6701	0.7528	0.8374	0.9230	1.0124	1.1029	1.1956
45	0.1502	0.4250	0.4439	0.5012	0.5790	0.6586	0.7399	0.8230	0.9000	0.9950	1.0840	1.1751
50	0.1527	0.4180	0.4366	0.4929	0.5694	0.6476	0.7276	0.8093	0.8929	0.9784	1.0660	1.1555
55	0.1553	0.4111	0.4293	0.4847	0.5600	0.6369	0.7156	0.7960	0.8782	0.9623	1.0484	1.1365
60	0.1578	0.4045	0.4225	0.4770	0.5510	0.6267	0.7041	0.7821	0.8410	0.9469	1.0316	1.1183
65	0.1604	0.3980	0.4156	0.4694	0.5412	0.6167	0.6929	0.7707	0.8504	0.9318	1.0152	1.1005
70	0.1629	0.3919	0.4092	0.4621	0.5338	0.6072	0.6821	0.7588	0.8371	0.9173	0.9994	1.0834
75	0.1654	0.3859	0.4031	0.4550	0.5257	0.5979	0.6717	0.7471	0.8243	0.9033	0.9841	1.0668
80	0.1679	0.3801	0.3971	0.4482	0.5178	0.5890	0.6617	0.7360	0.8120	0.8898	0.9694	1.0509
85	0.1704	0.3745	0.3912	0.4416	0.5102	0.5803	0.6519	0.7251	0.800	0.8767	0.9551	1.0354
90	0.1730	0.3690	0.3854	0.4351	0.5027	0.5717	0.6423	0.7145	0.7883	0.8638	0.9411	1.0202

[a] The manufacturer's listing specifies the temperature range for operation.

[b] *W*/*V* [agent weight requirements (kg/m^3)] = kilograms of agent per cubic meter of protected volume to produce indicated concentration at temperature specified.

$$W = (V/s) \times [c/(100-c)]$$

[c] *t* [temperature (°C)] = the design temperature in the hazard area

[d] *s* [specific volume (m^3/kg)] = specific volume of superheated FM-200 vapor can be approximated by the formula:

$$s = 0.1269 + 0.0005\,t$$

where *t* = temperature (°C)

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

4-2.3.1 FIRST BRANCH FLOW SPLIT

To assure accuracy of the flow calculations, there are various agent flow limits. The maximum % agent in pipe for all systems is 80%. There is a limit on the allowable percent of agent prior to the first tee. When these conditions are not met, the computer displays a warning. It is then up to the system designer to correct the piping volume to the first branch split. For example, when reading Figure 4-1, in order to achieve 60% agent in pipe, a minimum of 8.3% agent is required prior to the first tee. When this condition is not met, the computer displays a warning. It is then up to the system designer to correct the piping volume to the first branch split to meet this design requirement (see Figure 4-2).

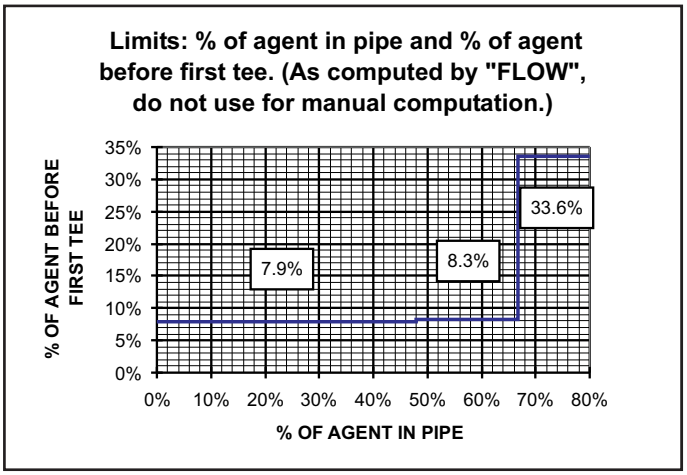


Figure 4-1. Percent Agent Before First Tee as a Function of Percent Agent in Pipe

4-2.3.2 TEE FLOW SPLITS

Flow splits at tee junctions are sensitive to gravity. Even though turbulent flow exists, there is a tendency for the vapor phase to migrate to the upper portion of the pipe leaving a more dense medium at the bottom of the pipe. For this reason, the limitations in Figure 4-2 must be observed.

4-2.3.2.1 Requirements for Tee Flow Splits

1. Bull head tees must have both outlets in the horizontal plane. The inlet to a bull head tee may approach in a horizontal, vertically up or vertically down direction.
2. Side tees must have the inlet and both outlets all in the horizontal plane.
3. Elbows either before a tee, or after, which split to a separate hazard must be located a minimum distance of 15 pipe diameters (nominal) before the tee.
4. Tee splits going to separate hazards from a common supply line must be spaced a minimum of 15 pipe diameters (nominal) apart.
5. Pipe reducers must be the concentric reducer type.
6. Minimum flow out of a side tee branch is 10% of total flow at the tee.
7. For flow splits less than 30%, the split shall be done through a side tee with the smaller flow going through the side tee member. The minimum flow through the side tee member is 10%. The maximum flow through the tee is 90%.
8. For flow splits equal to or greater than 30%, the split shall be done through a bull head tee. The maximum flow split through a bull head tee is 70%.

Table 4-5. 15 Pipe Diameters

Pipe Size	15 Pipe Diameters		
	feet	feet and inches	meters
1/2"	0.63	7½	0.192
3/4"	0.94	11¼	0.287
1"	1.25	1'3"	0.381
1¼"	1.56	1'6¾"	0.475
1½"	1.88	1'10½"	0.573
2"	2.50	2'6"	0.762
2½"	3.13	3'1½"	0.954
3"	3.75	3'9"	1.143
4"	5.00	5'	1.524

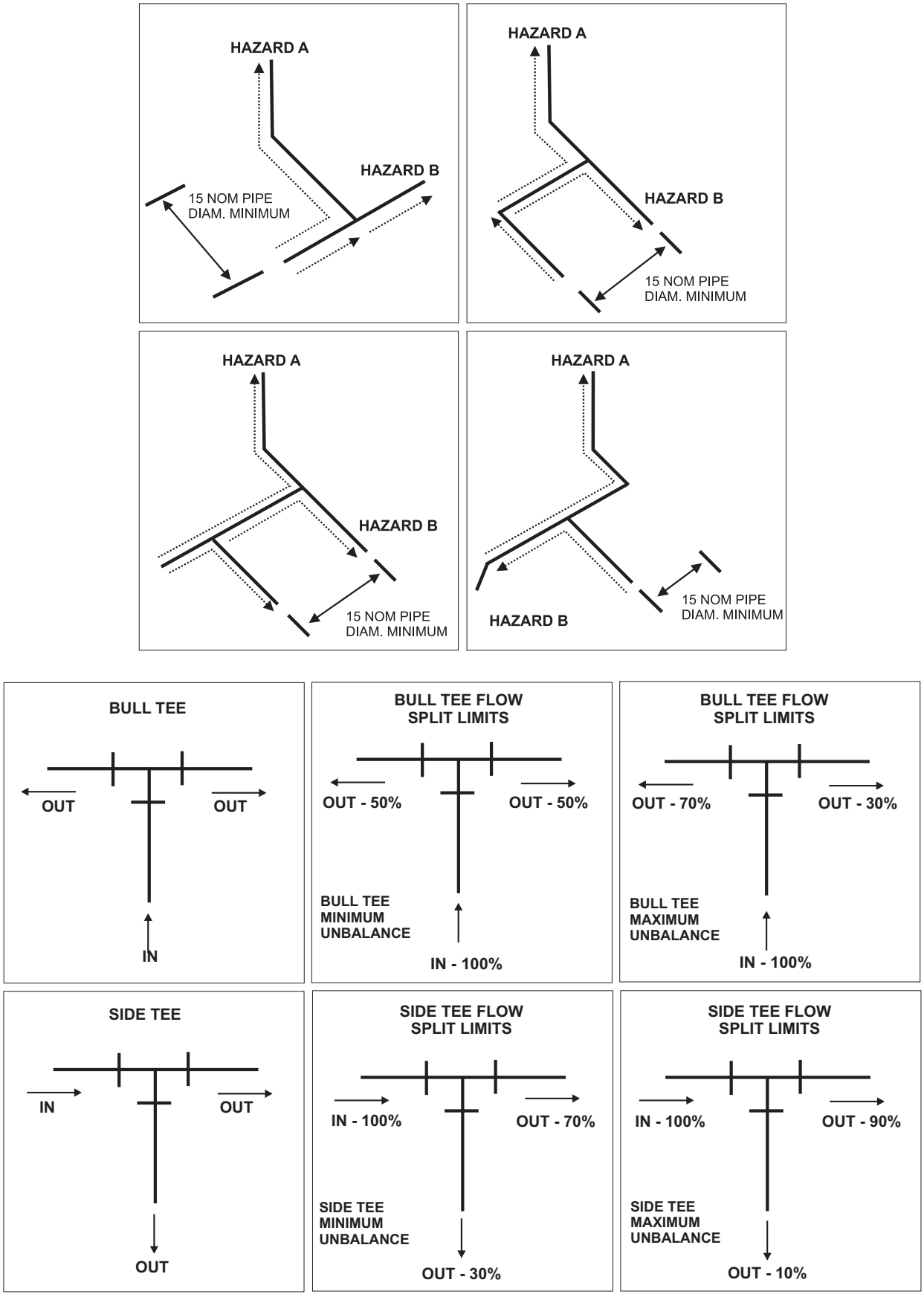


Figure 4-2. Acceptable Tee Flow Splits for FM-200

4-2.3.3 DURATION OF DISCHARGE

Per NFPA 2001, the liquid agent discharge shall be completed in a nominal 10 seconds or less. Discharge times shorter than 10 seconds are desirable to minimize production of breakdown products. Discharge times as short as six seconds should be considered when circumstances permit.

4-2.3.4 NOZZLE SELECTION AND PLACEMENT

There are two basic Kidde nozzle configurations:

1. The 360° nozzle, which provides a full 360° discharge pattern designed for placement in the center of the hazard.
2. The 180° nozzle, which provides a 180° discharge pattern designed for placement adjacent to a side wall of the hazard.

Use ECS Series software as a tool to determine the selection of the required orifice area and nozzle.

Maximum orifice area to pipe area ratio:

- The ratio between the nozzle orifice area for a 360 degree nozzle at the given node and the pipe cross sectional area for the pipe segment preceding that nozzle is 0.72, or 72%,
- The ratio between the nozzle orifice area for a 180 degree nozzle at the given node and the pipe cross sectional area for the pipe segment preceding that nozzle is 0.66, or 66%.

Minimum orifice area to pipe area ratio:

- The ratio between the nozzle orifice area for a 360 degree nozzle at the given node and the pipe cross sectional area for the pipe segment preceding that nozzle is 0.27, or 27%.
- The ratio between the nozzle orifice area for a 180 degree nozzle at the given node and the pipe cross sectional area for the pipe segment preceding that nozzle is 0.27, or 27%.

Nozzles are available in nominal pipe sizes of 1/2", 3/4”, 1", 1¼", 1½" and 2".

4-2.3.5 NOZZLE PLACEMENT

There are certain coverage and height limitations which must be observed with each nozzle configuration to ensure proper agent distribution.

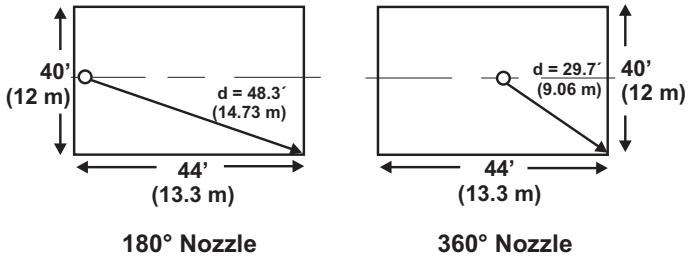


Figure 4-3. Nozzle Placement and Coverage

- **Orientation**-Nozzles must be mounted perpendicular to the ceiling or subfloor surface and oriented with the orifices radiating symmetrically outward from the pipe network.
- **Ceiling Clearance**-Nozzles must be installed so that the orifices are located 6 +/- 2 inches (0.15 +/- 0.05 m) below the ceiling.
- **Maximum Height**-The maximum protected height for a single row of nozzles is 16 feet (4.87 m). The 16 ft. (4.87 m) coverage height includes the 6 +/- 2 inches (0.15 +/- 0.05 m) below the ceiling.

  Nozzles may be tiered to accommodate enclosures with ceiling heights greater than 16 ft. (4.87 m).
- **Minimum Ceiling Height**-The minimum ceiling height for UL Listed/FM Approved systems is 1 ft. (0.3 m).

  Systems designed for enclosures 6 to 12 inches (0.15 m to 0.3 m) are acceptable, but not UL Listed or FM Approved.
- **180° Nozzles**-180° nozzles must be located 12 +/- 2 inches (0.3 +/- 0.05 m) from a wall, with the orifices directed away from the wall. The nozzle shall be located as close to the center of the wall as possible, but at least 1/3 of the way along the wall.

  180° nozzles have a maximum coverage area defined as any rectangle that can be inscribed in a semicircle of distance 48.3 ft. (14.73 m, diagonal of a rectangle 20' x 44'). Refer to Figure 4-3 for further information.

  180° nozzles may be used in a back-to-back configuration. The nozzles should be place 1 to 2 ft. (0.3 m to 0.6 m) apart.
- **360° Nozzles**-360° nozzles must be located as close to the center of the enclosure as possible. 360° nozzles have a maximum coverage area defined as any rectangle that can be inscribed in a circle of radius 29.7 ft. (9.06 m, diagonal of a rectangle 20' x 22'). Refer to Figure 4-3 for further information.
- **Multiple Nozzles**-Nozzles whose discharge patterns will intersect must be placed at least 10 ft. (3.3 m) apart to assure adequate agent distribution.

- **Walls and Obstructions**-FM-200 discharged from the nozzle requires a certain length from the nozzle to atomize into a gas. If the FM-200 comes into contact with a surface before the agent is fully atomized, frosting can occur. As a result, the concentration throughout the enclosure will be less than required to appropriately protect the space. Therefore, nozzles must be located with at least four to six feet of clearance from walls and/or significant obstructions (ex. high rise racking and columns). If this requirement cannot be met, additional agent may be discharged to compensate for this agent "loss".
- **Reduced Coverage Area**-Consideration should be given to reducing nozzle spacing when obstructions that would impede the uniform distribution of FM-200 throughout the area are present. Nozzle coverage area must be reduced to 25 ft. x 25 ft. for enclosure heights six to twelve inches (7.5 m x 7.5 m for heights 0.15 to 0.3 meters).

Limits on Nozzle Conditions:

- **Minimum average nozzle pressure**-The nozzle pressure must be a minimum of 74 PSIG for the nozzle to effectively disperse the agent and mix the agent into the air of the enclosure being protected.
- **Maximum arrival time imbalance**-The difference between liquid arrival times at two of the nozzles exceed the 0.8 seconds allowed.
- **Maximum runout time imbalance**-The difference between nozzle liquid runout times at two of the nozzles exceed the 2.0 second allowed maximum.

Maximum Elevation Differences in Pipe Runs:

- If nozzles are only 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 ft. (9 m).
- 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 ft. (9 m).
- 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 ft. (9 m).

Note: If you have a system design that violates these limits, then you must consult the factory to determine what course of action should be taken (see Figure 4-4 for further clarification).

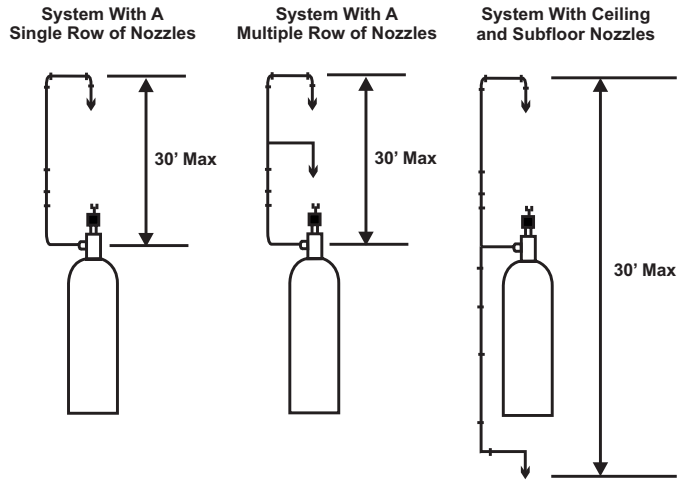


Figure 4-4. Nozzle Limitations

Note: Any system designed for a space less than 12 in. (0.3 m) in height is not a UL Listed or FM Approved design.

4-2.3.6 PIPE SIZING

The following table may be used as an estimating guide for sizing distribution piping.

Table 4-6. Kidde Pipe Size Estimating Table

Nominal Pipe Size (in.)	Flow Rate (lb./sec.)		Flow Rate (kg/sec.)	
	Minimun Design	Max. Nom. Design	Minimum Design	Max. Nom. Design
1/2	1.0	3.0	0.5	1.4
3/4	2.0	5.5	0.9	2.5
1	3.5	8.5	1.6	3.9
1¼	6.0	12.5	2.7	5.7
1½	9.0	20.0	4.1	9.0
2	14.0	30.0	6.4	13.6
2½	20.0	55.0	9.0	25.0
3	30.0	90.0	13.6	40.9
4	55.0	125.0	25.0	56.8
5	90.0	200.0	40.9	90.9
6	120.0	300.0	54.5	136.4

This table is intended for use as a guide only. The Kidde ECS Series Flow Calculation Program must be used for the final design.

4-2.4 Other Conditions

4-2.4.1 OPERATING/STORAGE TEMPERATURE RANGE

Kidde FM-200 ECS Series Engineered Fire Suppression System equipment listed herein is designed to operate within a temperature range of 32°F to 130°F (0°C to 54°C). The Kidde ECS Series FM-200 Flow Calculation Program assumes a temperature of 70°F (21°C). Therefore, the container operating and storage temperature must be in the range of 60°F to 80°F (16°C to 27°C) for a single unbalanced system protecting two or more separate hazards. If the container operating/storage temperature is outside this range, an insufficient quantity of agent may be discharged from one or more discharge nozzles.

4-2.4.2 STORAGE TEMPERATURE

Kidde FM-200 ECS Series Engineered Fire Suppression System equipment is suitable for storage from 32°F to 130°F (0°C to 54°C).

4-2.4.3 SYSTEM OPERATING PRESSURE

The normal system operating pressure for Kidde FM-200 ECS Series Engineered Fire Suppression System equipment is 360 PSIG at 70°F (25 bar gauge at 21°C).

4-2.5 Pressure Actuation Limitations

Four modes of pressure actuation of the Kidde FM-200 ECS Series Engineered Fire Suppression Systems cylinders are available.

Note: When cylinders are all connected to a common manifold, they shall be at the same size and fill density.

4-2.5.1 CYLINDERS CLOSE COUPLED USING PRESSURE FROM A MASTER

Note: See Figure 4-5.

For cylinders close coupled (reach of one flex hose, max. 30 in.) using pressure from one master FM-200 cylinder, a maximum of fifteen slave cylinders close coupled can be actuated from that one master cylinder, using pressure operated control heads on the slave cylinders. The slave cylinder operation will be through pilot flexible hoses.

4-2.5.2 CYLINDERS NOT CLOSE COUPLED USING PRESSURE FROM A MASTER

Note: See Figure 4-6.

For cylinders not close coupled using pressure from one master FM-200 cylinder, a maximum of four slave cylinders (maximum five cylinders in a group) can be actuated by that one master cylinder using pressure operated control heads on the slave cylinders. The slave cylinder operation will be through a 5/16" O.D. x 0.032" wall copper tubing actuator line having a maximum total length of 100 ft. (30.5 m).

4-2.5.3 CYLINDERS NOT CLOSE COUPLED USING NITROGEN PRESSURE

Note: See Figure 4-7.

For cylinders not close coupled using nitrogen pressure from one pilot nitrogen cylinder, from one to fifteen slave FM-200 cylinders can be actuated from the one pilot nitrogen cylinder using pressure operated control heads on the slave cylinders.

Slave operation will be through a 5/16 O.D. x 0.032" wall stainless steel tubing actuator line having the following limitations:

- Maximum total length of tubing is 320 ft. (97.5 m).
- Maximum length of tubing between cylinder #1 and the last cylinder is 220 ft. (67 m).
- The nominal min./max. length of tubing between the nitrogen pilot cylinder and FM-200 cylinder #1 is up to 100 ft. (30.5 m).
- If required, the nitrogen pilot cylinder can be located at a distance greater than 100 ft. (30.5 m) from FM-200 cylinder #1. In this instance, tubing length can be taken from the line between the slave cylinders and added to the line between the nitrogen cylinder and slave cylinder #1, provided that the maximum total length of tubing does not exceed 320 ft. (97.5 m).
- The tubing actuation line must be designed for a minimum working pressure of 1800 PSIG (124 bar gauge).

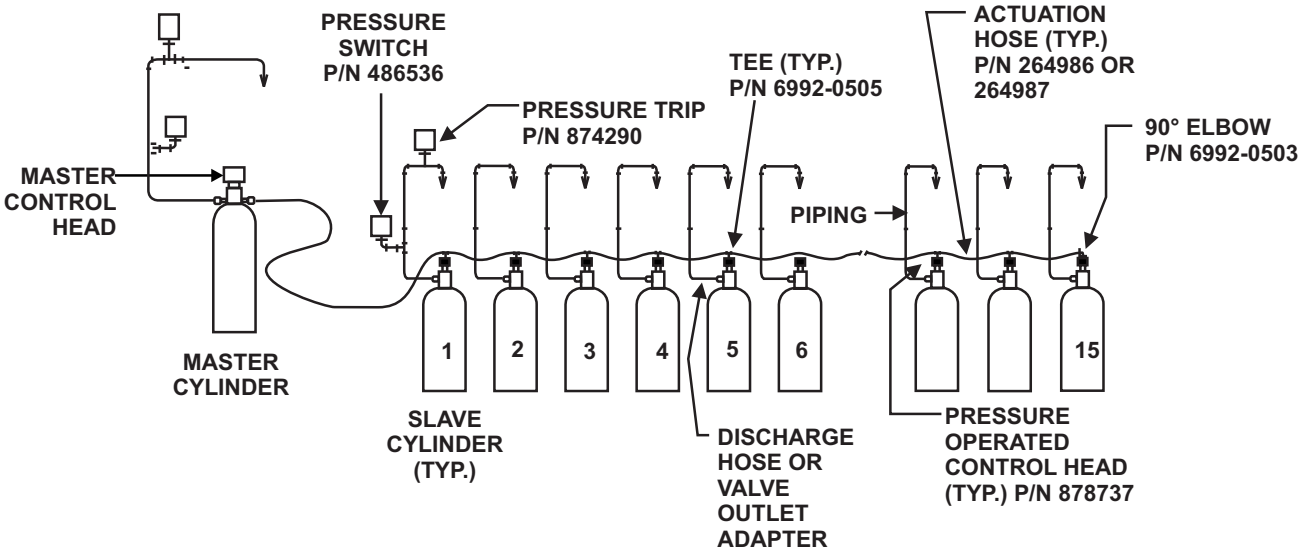


Figure 4-5. Pressure Actuation Using Pressure from 1 Master FM-200 Cylinder to Actuate a Maximum of 15 FM-200 Cylinders Close Coupled

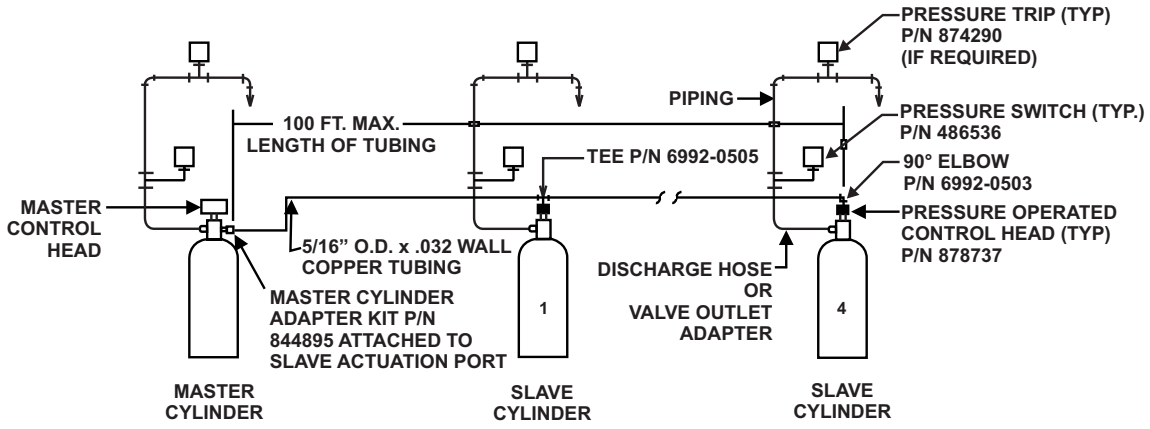


Figure 4-6. Pressure Actuation Using Pressure from 1 Master FM-200 Cylinder to Actuate a Maximum of 4 FM-200 Cylinders NOT Close Coupled

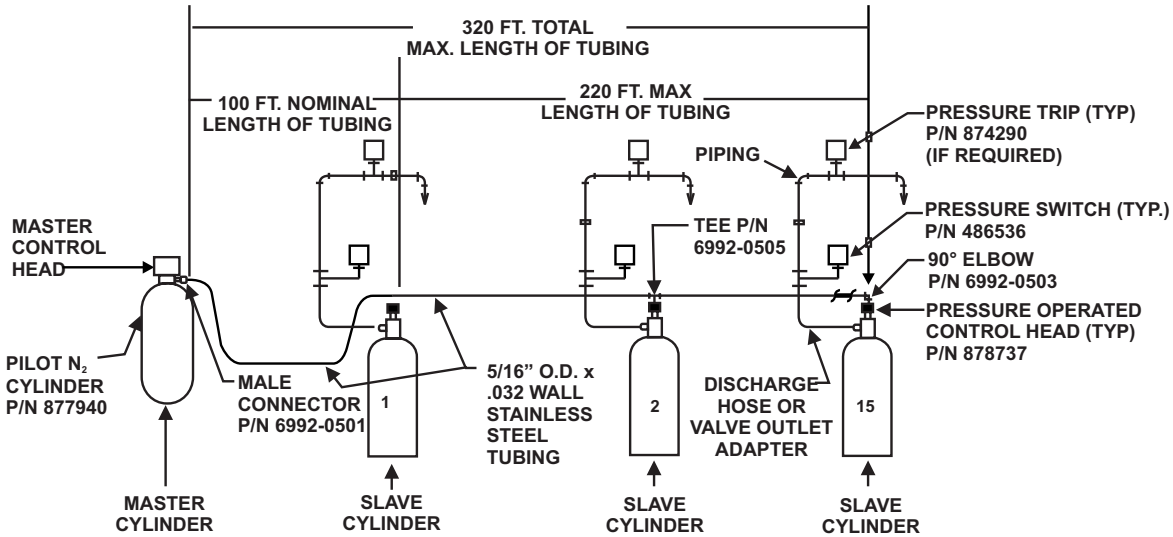


Figure 4-7. Pressure Actuation Using Pressure from 1 Nitrogen Pilot Cylinder to Actuate a Maximum of 15 FM-200 Cylinders NOT Closed Coupled

4-2.5.4 CYLINDERS CLOSE COUPLED USING NITROGEN PRESSURE

Note: See Figure 4-8.

For cylinders close coupled using nitrogen pressure from one pilot nitrogen cylinder , from one to fifteen slave FM-200 cylinders can be actuated from that one pilot nitrogen cylinder using pressure operated control heads on the slave cylinders.

Slave operation will be through a 1/4-inch Schedule 40 steel pipe actuator line having the following limitations:

- Maximum length between nitrogen cylinder and the first FM-200 cylinder 320 ft. (97.5 m).
- Maximum quantity of flexible actuation hoses is fifteen (one at the nitrogen cylinder and one at each FM-200 cylinder).
- All FM-200 cylinders must be located adjacent to one another.

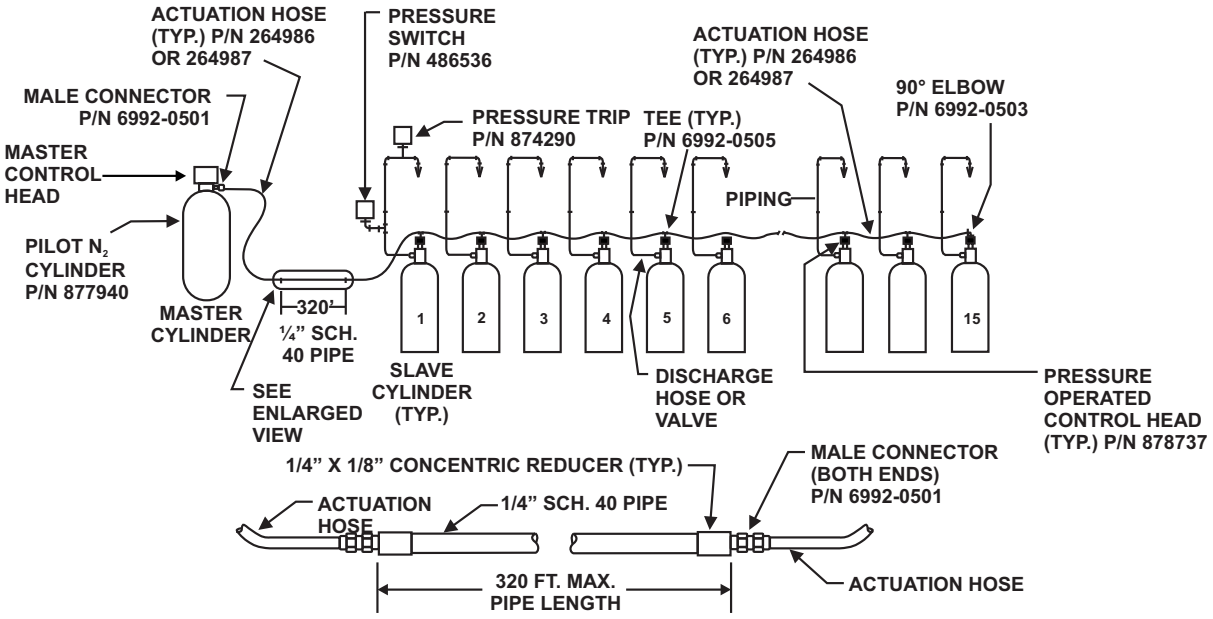


Figure 4-8. Pressure Actuation Using Pressure from 1 Nitrogen Pilot Cylinder to Actuate a Maximum of 15 FM-200 Cylinders Close Coupled

4-2.5.5 USING MULTIPLE NITROGEN CYLINDERS

Two or more remotely located pilot nitrogen cylinders can be used to actuate the FM-200 systems described in Paragraphs 4-2.5.3 and 4-2.5.4, provided that:

- 1/4" check valves (P/N 264985) shall be installed at the intersection of each pilot line to the main actuator line (see Figure 4-9).
- The total length of actuator line, from each nitrogen pilot cylinder to the FM-200 cylinders shall not exceed the limitation established.

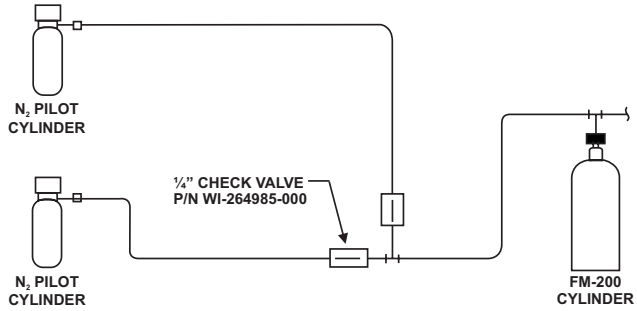


Figure 4-9. Multiple Pilot Nitrogen Actuation Cylinders

4-2.5.6 CORNER PULLEY AND CABLE LIMITATIONS

Table 4-7 lists corner pulley and cable length limitations.

Table 4-7. Corner Pulley and Cable Limitations

Control Head Type	Part Number	Pulley		Max. Cable Length
		P/N 803808	P/N 844648	ft.
Cable Operated	979469	15	30	100
Electric/Cable	895630	6	30	100
Electric/Cable	895627	6	30	100
Electric/Cable, Explosion-Proof	897494	6	30	100
Electric/Cable, Explosion-Proof	897560	6	30	100

4-2.5.7 PRESSURE TRIP LIMITATIONS

The maximum load to be attached to pressure trip (P/N 874290) is 100 lb. (45.3 kg, based on a minimum pressure of 75 PSIG [5.17 bar gauge] at the pressure trip).

4-3 EQUIPMENT INSTALLATION

4-3.1 General

All Kidde FM-200 equipment must be installed to facilitate proper inspection, testing, manual operation, recharging and any other required maintenance as may be necessary. Equipment must not be subject to severe weather conditions or mechanical, chemical or other damage that could render the equipment inoperative. Equipment must be installed in accordance with NFPA Standard 2001, current edition.

⚠ WARNING

The FM-200 cylinder/valve assemblies must be handled, installed and serviced in accordance with the instructions contained in this paragraph and Compressed Gas Association (CGA) pamphlets C-1, C-6 and P-1. CGA pamphlets may be obtained from: Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA 22202. Failure to follow these instructions can cause FM-200 cylinders to violently discharge, resulting in severe injury, death and/or property destruction.

4-3.2 Distribution Piping and Fittings

4-3.2.1 THREADS

Threads on all pipe and fittings must be tapered threads conforming to ANSI Specification 8-20.1. Joint compound, tape or thread lubricant must be applied only to the male threads of the joint.

4-3.2.2 PIPE

Piping must be of noncombustible material having physical and chemical characteristics, such that its integrity under stress can be predicted with reliability. The computer flow program has only been verified for the specific types and schedule of pipe and fittings covered in this manual. There is a risk that the system may not supply the required quantity of agent in unbalanced systems when other pipe types and fittings are used.

4-3.2.2.1 Ferrous Piping

Black steel or galvanized pipe must be either ASTM A-53 seamless or electric resistance welded, Grade A or B, or ASTM A-53 furnace weld Class F (up to 1½" diameter) or ASTM A-106, Grade A, B or C. ASTM B-120 and ordinary cast iron pipe must not be used. The thickness of the pipe wall must be calculated in accordance with ANSI B-31.1, Power Piping Code. The internal pressure for this calculation shall not be less than the minimum piping design pressure of 402 PSIG (28 bar gauge) at 70°F (21°C). The minimum piping design pressure of 402 PSIG at 70°F corresponds to eighty percent of the maximum pressure of 502 PSIG (35 bar gauge) in the agent container at the maximum storage temperature at 130°F (54°C), using the maximum allowable fill density at 70 lb./cu.ft. (1121 kg/cu.m).

⚠ CAUTION

Pipe supplied as dual stenciled A-120/A-53 Class F meets the requirements of Class F furnace welded pipe ASTM A-53 as listed above. Ordinary cast-iron pipe, steel pipe conforming to ASTM A-120, or nonmetallic pipe must not be used.

4-3.2.2.2 Piping Joints

The type of piping joint shall be suitable for the design conditions and shall be selected with consideration of joint tightness and mechanical strength.

4-3.2.2.3 Fittings

Fittings shall conform to the requirements of NFPA 2001, Sections 2-2.3 and A-2-2.3.1. Class 150 and cast iron fittings must not be used. Class 300 lb. malleable or ductile iron fittings in sizes 3-inch and smaller, or 1000 lb. ductile iron or forged steel fittings in sizes greater than 3-inch are to be used. Class 300 flanged joints are acceptable for use in all sizes. All grooved couplings and fittings shall be UL Listed and/or FM Approved (as appropriate) and have a minimum rated working pressure equal to or greater than the minimum piping design pressure of 402 PSIG (28 bar gauge) at 70°F (21°C).

Concentric bell reducers are the only means for reducing pipe size. Reductions can be made after a tee or after a union. Where reducers are used at tees, the reducers must be downstream of each tee. Reductions made after a union are possible only if the next change in direction (tee split) is located a minimum of 15 nominal pipe diameters downstream of the concentric bell reducer. Gaskets for flanged fittings shall be flat gray asbestos, neoprene impregnated.

⚠ CAUTION

The calculation software has only been verified for use with the piping, inside pipe diameter and fittings specified in this manual. When unspecified piping and fittings are used for unbalanced systems, there is a risk that the system will not supply the required quantity of FM-200.

4-3.3 Installation of Pipe and Fittings

Pipe and fittings must be installed in strict accordance with the system drawings and good commercial practices. The piping between the cylinder and the nozzles must be the shortest route possible, with a minimum of fittings. Any deviations in the routing or number of fittings must be approved by the design engineer before installation.

Note: Strict piping rules regarding flow splits to multiple hazards must be adhered to. Please refer to Paragraph 4-2.3.2 of this manual for proper tee installations.

Piping must be reamed free of burrs and ridges after cutting, welding or threading. All threaded joints must conform to ANSI B1-20-1. Joint compound or thread tape must be applied only to the male threads of the joint, excluding the first two threads. Welding must be in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. Each pipe section must be swabbed clean, using a non-flammable organic solvent.

All piping must be blown clear with dry nitrogen or compressed air before installing the discharge nozzles.

The piping must be securely braced to account for discharge reaction forces and thermal expansion/contraction. Care must be taken to ensure the piping is not subjected to vibration, mechanical or chemical damage. All hangers must be UL Listed, must conform to general industry standards for pipe hangers and conform to ANSI B-31.1. Refer to ANSI B-31.1 for additional bracing requirements.

4-3.4 Installation of Check Valves

Install the check valves as shown on the system drawings. Apply Teflon® tape or pipe compound to all the male threads, except the first two threads. Valves greater than two inches in size are provided with flanged outlets. All valves must be installed with the arrow on the valve body pointing in the proper direction of the flow.

4-3.5 Installation of Discharge Nozzles

After the system piping has been blown free of debris, install the discharge nozzles in strict accordance with the system drawings. Orient the nozzles as shown on drawings. Make certain that the correct nozzle type, part number and orifice size are installed in the proper location. See Paragraph 4-2.3.5 for correct nozzle placement and orientation.

4-3.6 Installation of Pressure Actuation Pipe

The pressure actuation pipe must be 1/4-inch Schedule 40 or 80 pipe. The pipe or tubing must be routed in the most direct manner with a minimum of fittings. Pipe and fittings must be in accordance with the requirements listed in Paragraph 4-2.5. Fittings can be flared or compression type. The pressure-temperature ratings of the fitting manufacturer must not be exceeded.

Piping must be reamed free of burrs and ridges after cutting, threading or flaring. Upon assembly, pipes must be blown out with dry nitrogen or compressed air. Piping should be securely braced and isolated from vibration, mechanical or chemical damage.

4-3.7 Installation of Valve Outlet Adapter

⚠ WARNING

Always connect a valve outlet adapter into system piping (union connection) before connecting to an FM-200 cylinder.

Install valve outlet adapter (P/Ns 283904, 283905 and 283906) in system piping. Tighten securely.

Note: A groove-groove fitting is used in place of a valve outlet adapter for the 3-inch valve and associated cylinders.

4-3.8 Installation of Flexible Discharge Hose

⚠ WARNING

Always connect the flexible discharge hose into system piping before connecting to an FM-200 cylinder.

Attach the flexible discharge hose from system piping or El-check in the discharge manifold to the cylinder valve. Tighten securely (see Figure 4-10 and Tables 4-8 and 4-9).

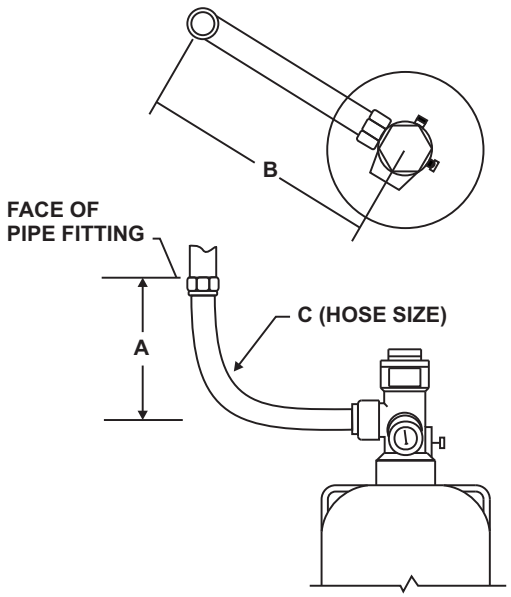


Figure 4-10. Installation of the Flexible Hose Directly Into System Piping

Table 4-8. Installation of the Flexible Hose Directly into System Piping, Inches

Cylinder Capacity	Dimensions in Inches		
	A	B	C*
10 lb.	14 5/8	16 3/4	1 1/2
20 lb.	14 5/8	16 3/4	1 1/2
40 lb.	14 5/8	16 3/4	1 1/2
70 lb.	14 5/8	16 3/4	1 1/2
125 lb.	14 5/8	16 3/4	1 1/2
200 lb.	19	21 3/4	2
350 lb.	19	21 3/4	2
600 lb. (old style)	29 5/8	32 3/4	2 1/2
600 lb. (new style)	33	36	3
900 lb.	33	36	3

Note: Dimensions A and B must be maintained in order to obtain a smooth radius in flexible loop.
* Hose may require an adapter to connect to system piping.

Table 4-9. Installation of the Flexible Hose Directly into System Piping, Millimeters

Cylinder Capacity	Dimensions in Millimeters		
	A	B	C
10 lb.	371	425	38
20 lb.	371	425	38
40 lb.	371	425	38
70 lb.	371	425	38
125 lb.	371	425	38
200 lb.	483	552	51
350 lb.	483	552	51
600 lb. (old style)	752	832	64
600 lb. (new style)	838	914	76
900 lb.	838	914	76

Note: Dimensions A and B must be maintained in order to obtain a smooth radius in flexible loop.
*Hose may require an adapter to connect to system piping.

4-3.9 Installation of Master Cylinder Adapter Kit, P/N 844895

Note: Master cylinder adapter installation can be accomplished safely with a pressurized cylinder.

1. Remove the 1/4-inch pipe plug from the slave actuation port on the master cylinder valve (see Figure 4-11).
2. Before assembling the adapter to the cylinder valve, apply Permacel No. 412D Teflon® tape to the male threads on the adapter.
3. Ensure the cap is screwed onto the adapter outlet port before assembling to the cylinder valve.
4. Install the adapter into the slave actuation port on the master cylinder valve.
5. Attach the label to the valve body.

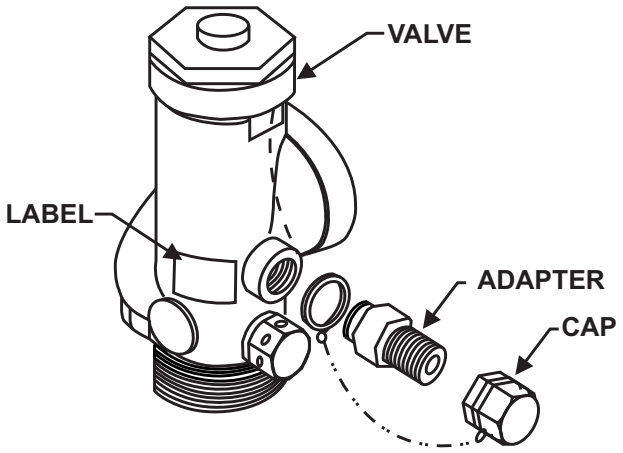


Figure 4-11. Installation of Master Cylinder Adapter Kit

4-3.10 Installation of FM-200 Cylinder/ Valve Assemblies

The FM-200 cylinders should be located as close as possible to the protected hazard area. The assemblies should be located in a place which is readily accessible for manual actuation and inspection, service and maintenance. The cylinders shall be located in an environment protected from the weather, and where the ambient temperature does not exceed 80°F (27°C) or fall below 60°F (16°C). External heating or cooling may be required to maintain this temperature range. The following installation instructions must be followed in the exact sequence outlined below to prevent accidental discharge, bodily injury and property damage.

4-3.10.1 SINGLE CYLINDER SYSTEMS

⚠ WARNING

Cylinders must be located and mounted where they will not be accidently damaged or moved. If necessary, install suitable protection to prevent the cylinder from damage or movement.

1. Position FM-200 cylinder in designated location and secure in place with cylinder strap and attaching hardware (see Figure 4-12 and Tables 4-10, 4-11 and 4-12). Orient cylinder with valve outlet angled toward system piping.
2. Remove the safety cap from the cylinder valve outlet port.
3. Connect a 1½-, 2-, 2½-, or 3-inch flexible discharge hose or valve outlet adapter to the cylinder outlet port.

Note: If a valve outlet adapter is used, a union must be installed in the discharge piping.

⚠ WARNING

Connect the discharge hose to system piping before attaching it to the cylinder valve.

The valve outlet adapter must be connected into system piping (union connection) before attaching it to the cylinder valve.

4. Remove the protection cap from the cylinder valve actuation port.

⚠ WARNING

The control head must be in the SET position (that is, the actuating pin must be in the fully retracted or SET position) before attaching it to an FM-200 cylinder in order to prevent accidental discharge.

5. Install the control head to the cylinder valve actuation port.

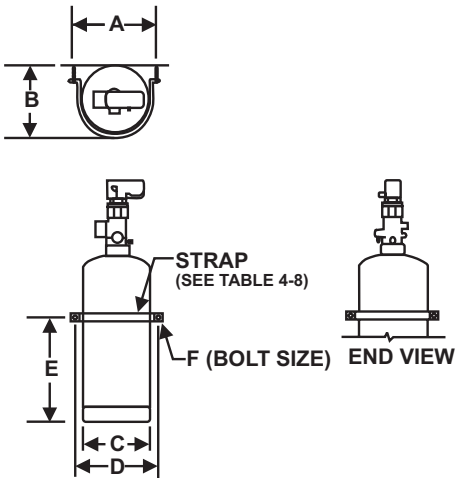


Figure 4-12. Single Cylinder Installation, Vertical Mounting

Table 4-10. Single Cylinder Installation Dimensions, Inches

Cylinder Part Number	Dimensions					
	A	B	C	D	E	F
90-10001X-001	9.62"	7.19"	7.07"	8.52"	7.38"	3/8"
90-10002X-001	9.62"	7.19"	7.07"	8.52"	12.50"	3/8"
90-10004X-001	11.69"	9.13"	9.00"	10.69"	10.63"	3/8"
90-10007X-001	11.69"	9.13"	9.00"	10.69"	27.50"	3/8"
90-100121-001	16.18"	12.94"	12.75"	14.56"	23.75"	9/16"
90-100125-001	16.18"	12.94"	12.75"	14.56"	23.75"	9/16"
90-10020X-001	17.06"	13.78"	13.60"	15.44"	39.00"	9/16"
90-10020X-101	16.18"	12.94"	12.75"	14.56"	39.00"	9/16"
90-10035X-001	19.50"	16.19"	16.00"	17.88"	44.00"	9/16"
90-10060X-001	25.75"	22.25"	22.00"	24.12"	38.50"	9/16"
90-10060X-100	25.75"	22.25"	22.00"	24.12"	38.50"	9/16"
90-10090X-001	27.75"	25.00"	24.00"	26.00"	48.50"	9/16"

Table 4-11. Single Cylinder Installation Dimensions, Millimeters

Cylinder Part Number	Dimensions*					
	A	B	C	D	E	F
90-10001X-001	244	183	180	216	187	M10
90-10002X-001	244	183	180	216	318	M10
90-10004X-001	297	232	229	272	270	M10
90-10007X-001	297	232	229	272	699	M10
90-100121-001	411	329	324	370	597	M14
90-100125-001	411	329	324	370	597	M14
90-10020X-001	433	350	345	392	991	M14
90-10020X-101	411	329	324	370	991	M14
90-10035X-001	495	411	406	454	1118	M14
90-10060X-001	654	565	559	613	978	M14
90-10060X-100	654	565	559	613	978	M14
90-10090X-001	704	635	610	660	1232	M14
***Note:** Dimensions are in millimeters.						

Table 4-12. Strap Part Numbers for Cylinder Installation

Strap Part Number	Cylinder Size
283945	10 and 20 lb.
283934	40 and 70 lb.
292971	125 and 200 lb. (old style)
235317	125 and 200 lb. (new style)
281866	350 lb.
294651	600 lb.
236125	900 lb

4-3.10.2 MULTIPLE CYLINDER SYSTEM

⚠ WARNING

Cylinders must be located and mounted where they will not be accidently damaged or moved. If necessary, install suitable protection to prevent the cylinder from damage or movement.

1. Position the cylinders in the designated location and secure them in place with cylinder straps and attaching hardware (see Figure 4-13 and Tables 4-13 and 4-14). Orient the cylinders so that the valve outlets are angled towards the El-check valves in the manifold.

⚠ WARNING

The discharge hose must be connected into the system piping before attaching it to the cylinder valve.

2. Remove the safety cap from one cylinder outlet port and connect the flexible discharge hose to the cylinder outlet port. Repeat for each cylinder in the system.
3. Remove the protection caps from the cylinder actuation ports.
4. Install the control heads on the cylinder valve actuation ports.

⚠ WARNING

Control heads must be in the SET position (that is, the actuating pin must be in the fully retracted or SET position) before attaching to FM-200 cylinders in order to prevent accidental discharge. Personal injury and/or property damage could occur.

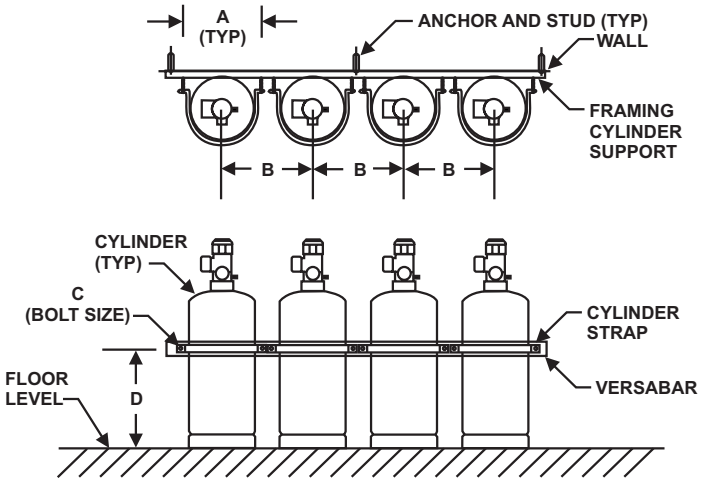


Figure 4-13. Multiple Cylinder Installation, Vertical Mounting (see Tables 4-13 and 4-14 for dimensions)

Table 4-13. Multiple Cylinder Installation Dimensions, Inches

Cylinder Part Number	Dimensions			
	A	B	C	D
90-10001X-001	8.52"	11.00"	3/8"	7.38"
90-10002X-001	8.52"	11.00"	3/8"	12.50"
90-10004X-001	10.69"	13.00"	3/8"	10.63"
90-10007X-001	10.69"	13.00"	3/8"	20.00"
90-100125-001	14.56"	18.00"	9/16"	20.88"
90-10020X-001	15.44"	18.00"	9/16"	29.63"
90-10020X-101	14.56"	18.00"	9/16"	29.63"
90-10035X-001	17.88"	21.00"	9/16"	37.13"
90-10060X-001	24.12"	27.00"	9/16"	34.00"
90-10060X-100	25.75"	27.00"	9/16"	38.50"
90-10090X-001	25.75"	30.00"	9/16"	48.50"

Table 4-14. Multiple Cylinder Installation Dimensions, Millimeters

Cylinder Part Number	Dimensions			
	A	B	C	D
90-10001X-001	216 mm	279 mm	10 mm	187 mm
90-10002X-001	216 mm	279 mm	10 mm	318 mm
90-10004X-001	272 mm	330 mm	10 mm	270 mm
90-10007X-001	272 mm	330 mm	10 mm	699 mm
90-100125-001	370 mm	457 mm	14 mm	597 mm
90-10020X-001	392 mm	457 mm	14 mm	991 mm
90-10020X-101	370 mm	457 mm	14 mm	991 mm
90-10035X-001	454 mm	533 mm	14 mm	1118 mm
90-10060X-001	613 mm	686 mm	14 mm	978 mm
90-10060X-100	654 mm	686 mm	14 mm	978 mm
90-10090X-001	704 mm	762 mm	14 mm	1232 mm

4-3.10.3 MAIN AND RESERVE SYSTEM

Install main and reserve systems as instructed in the previous paragraphs.

4-3.11 Installation of Electric Control Heads

⚠ WARNING

Before installing a control head on an FM-200 cylinder valve, ensure the control head is in the SET position (that is, the actuating pin is in the fully retracted or SET position). Failure to position the control head in the SET position will result in accidental FM-200 cylinder discharge when the control head is installed on cylinder valve. Personal injury and/or property damage could occur.

Electric Control Head, P/N 486500-01 is designed for Kidde 1½", 2" and 2½" FM-200 cylinder valves only. Installing this control head on any other device (for example, pressure operated control head) will cause the device to malfunction when the control head is actuated.

1. Remove the protection cap from the FM-200 cylinder actuation port. Ensure the control head is in SET position (that is, the actuating pin is in the fully retracted or SET position).
2. Install the electric control head on the cylinder actuation port. Tighten the swivel nut.
3. Make all electrical connections.

Note: P/N 486500-01 is a polarized control head. Improper wiring will cause the device to malfunction.

⚠ CAUTION

The stackable control head (P/N 48650001) cannot be used with the 3-inch valve cylinder (P/Ns 90-100600-100, 90-100601-100, 90-100900-001 and 90-100901-001). The stackable control head does not have sufficient force to activate the 3-inch valve (P/N 90-17000-000) and may result in system failure. Use the electric/manual control heads (P/N[s] 8901XX) with the 3-inch valve.

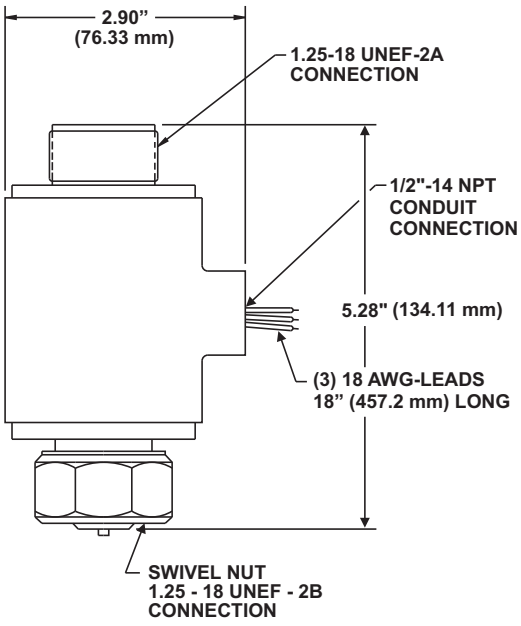


Figure 4-14. Installation of Electric Control Head (Stackable Type), P/N 486500-01

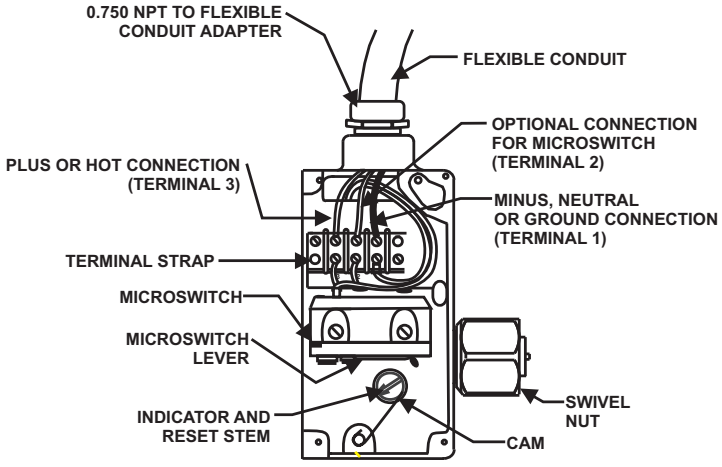


Figure 4-15. Electrical Connections for Control Head, P/Ns 890181, 895630 and 890149

4-3.12 Installation of Pressure Operated Control Heads, P/N 878737

1. Remove the protection cap from the cylinder actuation port (see Figure 4-16).

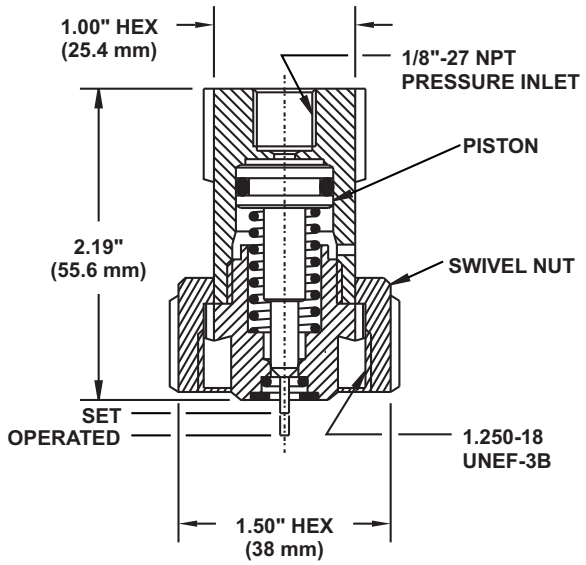


Figure 4-16. Pressure Operated Control Head

2. Install a pressure operated control head with flexible actuation hose attached to the cylinder actuation port.

⚠ WARNING

Ensure that the pilot line is non-pressurized and the actuating pins are in the retracted (SET) position. Failure to follow this procedure will cause the FM-200 cylinder to discharge accidentally when the control head is installed on the cylinder valve.

4-3.13 Installation of Electric/Cable Operated Control Head, P/Ns 895630, 895627 and 895628

The following procedures must be performed before attaching a control head to a cylinder valve (see Figure 4-17):

1. Remove the four screws holding the cable housing cover on the control head. Remove the cover.
2. Position the control head in the approximately installed position at the FM-200 cylinder valve control port but do not assemble onto the actuation port of the FM-200 cylinder valve.
3. Check that the control head is in the SET position.
4. Assemble the pull cable conduit to the conduit connection on the control head.
5. Feed the cable into the control head through the hole in the operating lever.
6. Feed the cable through the cable clamp. Pull the cable taut, allowing approximately 1/4" to 1/2" clearance between the cable clamp and the operating lever. Tighten the set screws in the cable clamp to secure the cable to the clamp.
7. Cut off any excess cable.
8. Verify the manual remote cable operation to ensure control head actuates and all cable clamps are tight.
9. Pull the cable back to its normal set (non-operated) position.
10. Reset the control head.
11. Replace the control head cover.
12. Examine the seal wire at the safety pull pin. Make sure it is intact.
13. Make all electrical connections.
14. Assemble the control head to the cylinder valve actuation port. Tighten the swivel nut securely.

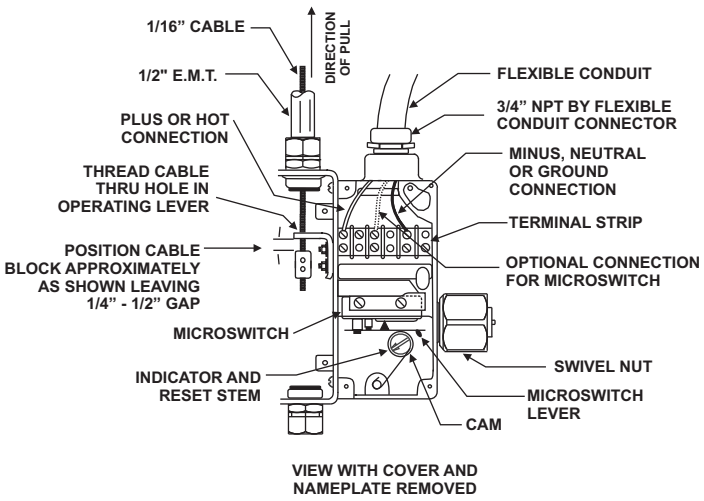


Figure 4-17. Electric/Cable Operated Control Head

4-3.14 Installation of Cable Operated Control Head, P/N 979469

⚠ WARNING

The cable operated control head (P/N 979469) must not be used with the stackable pressure operated control head (P/N 878750). Installing the cable operated control head on the actuation port of the stackable pressure operated control head will cause the device to malfunction.

The following procedures must be performed before attaching the control head to the cylinder valve.

1. Remove the protection cap from the cylinder actuation port.
2. Remove the cover from the control head and take out the wheel assembly, cable pipe locknut and closure disc.
3. Make sure the plunger is below the surface of the control head body. Position the control head at the valve control port with the arrow pointing in the direction of pull.
4. Assemble the cable pipe locknut to the cable pipe and place the cable pipe in the control head body.
5. Slide the wheel assembly on the control cable to the SET position. Tighten the set screws securely. Make sure the wheel assembly is at the start of the stroke.
6. Cut off any excess control cable close to the wheel assembly.
7. Insert the closure disc and replace the cover on the control head. The control head is now armed.

⚠ CAUTION

To ensure the manual lever does not snag or trap the cable, make sure the local manual release lever is in the SET position with the locking pin and seal wire installed before assembling the control head cover to the body.

8. Assemble control head to cylinder valve actuation port. Tighten swivel nut securely.

4-3.15 Installation of Lever Operated Control Head, P/N 870652

1. Ensure the control head is in the SET position with the safety pull pin and seal wire intact.
2. Remove the protection cap from the cylinder valve actuation port.
3. Using a suitable wrench, assemble the control head to the cylinder valve actuation port. Tighten the swivel nut securely.

4-3.16 Installation of Nitrogen Cylinder, P/N 877940, and Mounting Bracket, P/N 877845

1. Locate the nitrogen cylinder mounting bracket in an area where the cylinder valve assembly and control head will be protected from inclement weather by a suitable total or partial enclosure, preferably adjacent to the FM-200 storage cylinders.
2. Install the mounting bracket clamps and hardware. Install the nitrogen cylinder in position in a mounting bracket; tighten sufficiently to hold the cylinder in place while allowing the cylinder enough free play to be rotated.
3. Turn the cylinder until the cylinder valve discharge outlet is in the desired position. The nitrogen cylinder must be positioned so that control head is readily accessible during manual operation.
4. Securely tighten the mounting bracket clamps and hardware.
5. Attach the adapter (P/N 6992-0501) and connect the nitrogen pilot lines.
6. Remove the protective cap from the cylinder valve actuation port.

⚠ WARNING

Ensure the control head is in the SET position (that is, the actuating pin is in the fully retracted or SET position) before attaching it to the cylinder valve. If the control head is not in the SET position, FM-200 will discharge accidentally.

7. Install the control head to the cylinder valve actuation port and tighten securely.

4-3.17 Installation of Pressure Switch, P/N 486536 and P/N 981332

⚠ WARNING

To prevent injury, de-energize all electrical components before installing the pressure switch.

Pressure switches must be connected to the discharge manifold or piping in an upright position as shown on the system drawings. Both the standard and explosion-proof switches have 1/2-inch NPT pressure inlets to connect to the system piping. The electrical connections are either 1/2-inch conduit knockouts for the standard pressure switch or 1-inch NPT fittings for the explosion-proof pressure switch.

4-3.18 Installation of Pressure Trip, P/N 874290

Install the pressure trip on the discharge manifold or piping in the horizontal position as shown on the system drawings. Connect the trip to the piping with 1/2-inch Schedule 40 pipe. The minimum operating pressure required is 75 PSIG (5.17 bar gauge). The maximum allowable load to be attached to the retaining ring is 100 lb. (45.4 kg).

4-3.19 Installation of Manual Pull Station, P/N 871403

1. Locate the remote pull boxes as shown on the system installation drawings.
2. Connect the pull boxes to the control heads using 3/8-inch, Schedule 40 pipe. Do not run more than one cable in each pipe run.
3. Install a corner pulley at each change in pipe direction. Do not bend the pipe. A dual-pull equalizer (P/N 840051) should be installed where one pull box operates two controls. A dual pull mechanism (P/N 840058) should be installed where two pull boxes operate one control.
4. Beginning at the pull boxes, remove the covers of the first corner pulley. Feed the cable through the pulley into the 3/8-inch pipe. Connect one end of the cable to the cable fastener in the pull box, allowing the short end to project at least 1/2-inch. Seat the cable in the groove by pulling on the long end. Screw the fastener and cable into the handle. Route the other end to the control heads, taking up as much slack as possible. Attach the end of the cable to the fastener in the control head.
5. Reattach the corner pulley covers.
6. Check that control head is in SET position. Install the control head to the FM-200 cylinder valve.

4-3.20 Installation of Discharge Indicator, P/N 875553

The discharge indicator must be installed on the discharge manifold, either in a vertical or horizontal position. The indicator has a 3/4-inch NPT male connection. Make certain the indicator stem is in the normal position.

4-3.21 Installation of Supervisory Pressure Switch, P/Ns 06-118262-001 and 06-118263-001

Installation of the supervisory pressure switch can be accomplished safely on a pressurized cylinder.

⚠ WARNING

Before installing the pressure switch, de-energize all electrical components to prevent injury.

⚠ CAUTION

When attaching or removing the supervisory pressure switch from the cylinder valve, attach a wrench to the fitting and hold securely while tightening or loosening the pressure switch.

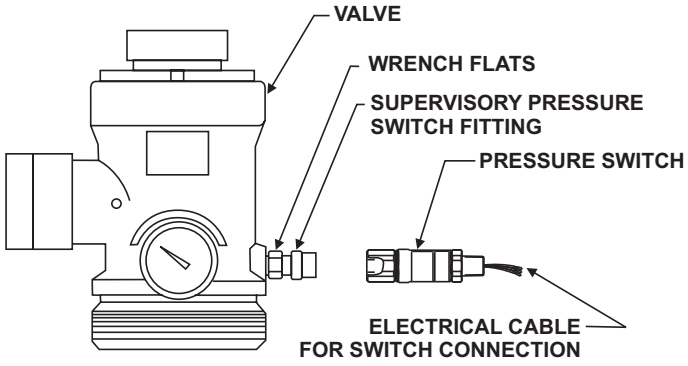


Figure 4-18. Installation of Supervisory Pressure Switch (Up to 2½" Valve)

Note: The control panel must be UL Listed and/or FM Approved for releasing device service and compatible with Kidde FM-200 equipment.

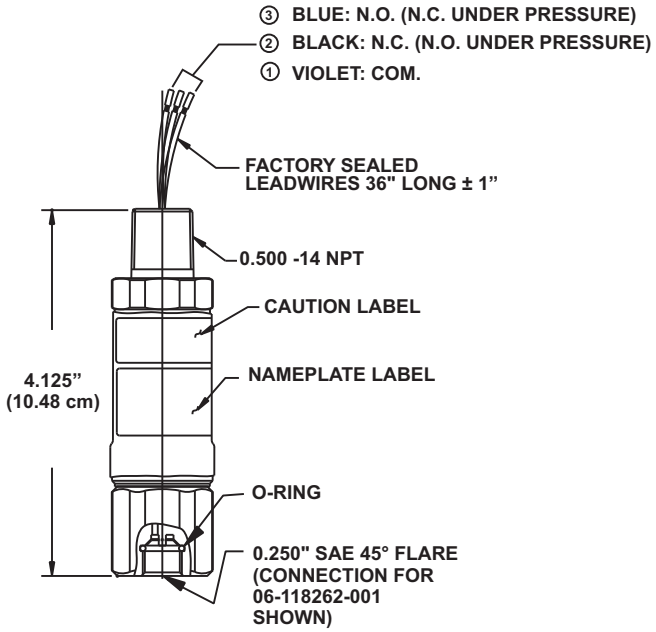
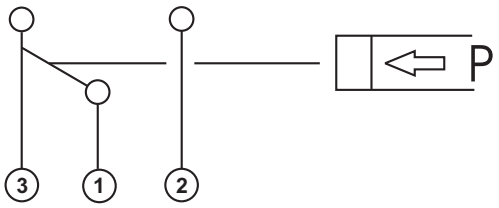


Figure 4-19. Supervisory Pressure Switch Electrical Connections



- 5A 24 Vdc (Resistive)
- 5A 240 Vac (Resistive)

Figure 4-20. Supervisory Pressure Switch Connection Diagram and Electrical Rating

Note: When cylinder supervisory pressure switch (P/N 06-11826X-001) is connected to a supervised control panel circuit, and the switch is wired NC under pressure, it is not possible to distinguish between a wiring fault and a loss of container pressure. This configuration should only be used if accepted by the Authority Having Jurisdiction.

4-3.21.1 INSTALLATION OF PRESSURE SWITCH 06-118262-001

Install the pressure switch as follows:

Note: Do not use with 3" valves.

1. Check that the sealing surface of the flare connection of the supervisory switch is not scratched, dented, scored, etc.
2. Remove the end cap from the pressure switch port of the valve. This is a flare fitting and does not require tape dope or any type of sealant.
3. Install the pressure switch onto the pressure port of the valve. Be sure to secure the pressure port with a wrench so that you are not turning the port fitting further into the valve. Tighten the switch hand-tight and then tighten 1/4-turn further using a wrench.
4. **Important:** Leak test the pressure switch connection with an FM-200 leak detector or a bubbling solution. If the connection leaks, the switch may be tightened further until the leak is eliminated, again, be sure to have a counter wrench on the switch port.

4-3.21.2 INSTALLATION OF PRESSURE SWITCH 06-118263-001

Install the pressure switch as follows:

Note: For 3" valves only.

1. Hold the pressure switch fitting on the valve with a wrench and remove the 1/8-inch plug with a second wrench. Ensure that the fitting does not rotate in the valve body. The fitting contains a check valve that will prevent the escape of the cylinder contents.
2. Before fitting the switch, apply Permacel® No. 412D Teflon® tape to the male threads of the pressure switch.
3. Install the pressure switch into the port of the valve. Be sure to secure the pressure port fitting with a wrench. Tighten the switch hand-tight and then tighten 1¼-turns further using a wrench.
4. **Important:** Leak test the pressure switch connection with an FM-200 leak detector or a bubbling solution. If the connection leaks, the switch may be tightened further a 1/4-inch turn at a time until the leak is eliminated, again, be sure to have a counter wrench on the switch port. Do not exceed two turns from hand-tight. Refer to ANSI B1.20.3 for NPT thread engagement details.

4-3.22 Post-Installation Checkout

After an FM-200 system installation has been completed, perform the following inspections and tests.

1. Verify that the cylinders of correct weight and pressure are installed in accordance with installation drawings.
2. Verify that the cylinder brackets and straps are properly installed and all fittings are tight.
3. The piping distribution system must be inspected for compliance with the system drawings, NFPA 2001, design limitations within this manual and the computerized hydraulic calculations associated with each independent piping and nozzle configuration.
4. Check that the discharge manifold, discharge piping and actuation piping are securely hung. Ensure all fittings are tight and securely fastened to prevent agent leakage and hazardous movement during discharge. The means of pipe size reduction and installation position of the tees must be checked for conformance to the design requirements.
5. The piping distribution system must be cleaned, blown free of foreign material and inspected internally to ensure that oil or particulate matter will not soil the hazard area or reduce the nozzle orifice area and affect agent distribution.
6. System piping should be pressure tested in accordance with the requirements of NFPA 2001.

7. Ensure that the check valves are installed in the proper location as indicated on the installation drawings and that the equipment is installed with the arrow pointing in the direction of flow.
8. Verify the nozzles are installed in the correct locations and have the correct part numbers and orifice sizes as indicated on installation drawings. Discharge nozzles must be oriented such that optimum agent dispersal can be achieved. Check the nozzle orifices for any obstructions.
9. The discharge nozzles, piping and mounting brackets must be installed such that they will not cause injury to personnel. The agent must not be discharged at head height or below where people in a normal work area could be injured by the discharge. The agent must not directly impinge on any loose objects or shelves, cabinet tops or similar surfaces where loose objects could be propelled by the discharge.
10. For systems with a main/reserve capability, the MAIN/RESERVE switch must be clearly identified and properly installed where it is readily accessible.
11. Manual pull stations must also be clearly identified and properly installed where they are readily accessible. All manual stations that activate FM-200 systems should be properly identified as to their purpose. Particular care should be taken where manual pull stations for more than one system are in close proximity and could be confused and the wrong system actuated. In this case, manual stations should be clearly identified as to which hazard area they affect.
12. Perform the electric control head test outlined in Paragraph 5-4.3.2 on all cylinders equipped with electric control heads.
13. Perform the pressure switch test outlined in Paragraph 5-4.3.1 for all pressure switches installed.
14. All acceptance testing shall be in accordance with NFPA 2001 current edition.

CHAPTER 5
MAINTENANCE

5-1 INTRODUCTION

This chapter contains maintenance instructions for the Kidde FM-200® ECS Series Engineered Fire Suppression System. These procedures must be performed regularly in accordance with regulations. If problems arise, corrective action must be taken.

5-2 MAINTENANCE PROCEDURES

⚠ WARNING

FM-200 and nitrogen cylinder valve assemblies must be handled, installed, inspected and serviced only by qualified and trained personnel in accordance with the instructions contained in this manual and Compressed Gas Association (CGA) pamphlets C-1, C-6 and P-1. CGA pamphlets my be obtained from Compressed Gas Association, Crystal Square Two, 1725 Jefferson Davis Highway, Arlington, VA 22202-4102.

Before performing these maintenance procedures, refer to the Material Safety Data Sheets and Safety Bulletins in the appendices of this manual.

5-2.1 General

A regular program of systematic maintenance is essential for continuous, proper operation of all FM-200 systems. A periodic maintenance schedule must be followed and an inspection log maintained for ready reference. As a minimum, the log must record:

1. Inspection interval,
2. The inspection procedure performed,
3. Maintenance performed, if any, as a result of inspection, and
4. The name of inspector performing the task.

If the inspection indicates areas of rust or corrosion, immediately clean and repaint the area. Perform cylinder hydrostatic pressure testing in accordance with Paragraph 5-5 of this manual.

5-3 PREVENTIVE MAINTENANCE

Perform preventive maintenance per Table 5-1.

Table 5-1. Preventive Maintenance Schedule

Schedule	Requirement	Paragraph
Daily	Check FM-200 cylinder pressures	5-4.1
	Check nitrogen cylinder pressures	
Monthly	Inspect hazard area system components	5-4.2
	Check FM-200 cylinder weights and pressures	
Semi-Annually	Test pressure switches	5-4.3
	Test electric control heads	
Every 2 Years	Blow out distribution piping	5-4.4
Every 5 Years	FM-200 and nitrogen cylinder and flexible hose hydrostatic pressure test and/or inspection	5-5 and 6-4.1

5-4 INSPECTION PROCEDURES

5-4.1 Daily

5-4.1.1 CHECK FM-200 CYLINDER PRESSURE

Check the FM-200 cylinder pressure gauges for proper operating pressure (refer to Table 3-1). If the pressure gauge indicates a pressure loss (adjusted for temperature) of more than 10%, or loss in agent quantity shown on cylinder valve of more than 5%, it shall be refilled. Remove and recharge the cylinder as instructed in Paragraphs 5-7 and 6-3.

5-4.1.2 CHECK NITROGEN CYLINDER PRESSURE

Check the nitrogen cylinder for proper operating pressure. If the pressure loss (adjusted for temperature) exceeds 10%, recharge with nitrogen to 1800 PSIG at 70°F (124 bar gauge at 21°C).

5-4.2 Monthly

5-4.2.1 GENERAL INSPECTION

Make a general inspection survey of all cylinders and equipment for damaged or missing parts. If the equipment requires replacement, refer to Paragraph 5-6.3.

5-4.2.2 HAZARD ACCESS

Ensure access to hazard areas, manual pull stations, discharge nozzles, and cylinders are unobstructed and that nothing obstructs the operation of the equipment or distribution of FM-200 agent.

5-4.2.3 INSPECT HOSES

Inspect 1/4-inch flexible actuation hoses for loose fittings, damaged threads, cracks, distortion, cuts, dirt and frayed wire braid. Tighten loose fittings and replace hoses with stripped threads or other damage. If necessary, clean parts as directed in Paragraph 5-6.1. Inspect the adapters, couplings and tees at the FM-200 cylinder pilot outlets and tighten couplings if necessary. Replace any damaged parts.

5-4.2.4 INSPECT PRESSURE CONTROL HEADS

Inspect FM-200 cylinder pressure operated control heads for physical damage, deterioration, corrosion, distortion, cracks, dirt and loose couplings. Tighten loose couplings. Replace damaged caps. Replace the control head if damaged. If necessary, clean as directed in Paragraph 5-6.1.

5-4.2.5 INSPECT ELECTRIC CONTROL HEADS

Inspect the FM-200 cylinder electric control heads for damage, corrosion, and dirt. Check the control heads' flexible electrical line for wear and damage. Check the control head for loose coupling and tighten if necessary. Check that the indicator is in the SET position, the pull pin is installed in the manual lever, and the seal wire is intact. Replace the control head if damaged. If necessary, clean as directed in Paragraph 5-6.1.

5-4.2.6 INSPECT CYLINDER AND VALVE ASSEMBLY

Inspect the FM-200 cylinder and valve assembly for leakage and physical damage such as cracks, dents, distortion and worn parts. Check the burst disc and pressure gauges for damage. Replace damaged gauges or burst disc per Paragraph 6-2.4. If the gauge pressure is not normal (360 PSIG at 70°F [25 bar gauge at 21°C]), remove and recharge the cylinder as instructed in Paragraphs 5-7 and 6-3. If damaged parts are found on the FM-200 cylinder or cylinder valve, replace the FM-200 cylinder. If necessary, clean the cylinder and associated parts as directed in Paragraph 5-6.1.

5-4.2.7 INSPECT BRACKETS, STRAPS, CRADLES AND MOUNTING HARDWARE

Inspect the FM-200 cylinder brackets, straps, cradles and mounting hardware for loose, damaged or broken parts. Check the cylinder brackets, straps and associated parts for corrosion, oil, grease and grime. Tighten any loose hardware. Replace damaged parts. If necessary, clean as directed in Paragraph 5-6.1.

5-4.2.8 INSPECT DISCHARGE HOSES

Inspect he flexible discharge hoses for loose fittings, damaged threads, cracks, rust, kinks, distortion, dirt and frayed wire braid. Tighten loose fittings and replace hoses with stripped threads. If necessary, clean as directed in Paragraph 5-6.1.

5-4.2.9 INSPECT ACTUATION LINE

Inspect the nitrogen actuation line (if used) and support brackets for continuity, physical damage, loose fittings, distortion, cracks or cuts. Tighten loose fittings. Replace damaged parts. If necessary, clean as directed in Paragraph 5-6.1.

5-4.2.10 INSPECT DISCHARGE NOZZLES

Inspect discharge nozzles for dirt and physical damage. Replace damaged nozzles. If nozzles are dirty or clogged, refer to Paragraph 5-6.1.

⚠ CAUTION

Nozzles must never be painted.

Nozzles must be replaced by nozzles of the same part number. (A part number is located on each nozzle.) Nozzles must never be interchanged since random interchanging of nozzles could adversely affect proper FM-200 distribution and concentration within a hazard area.

5-4.2.11 INSPECT PULL STATIONS

Inspect all manual pull stations for cracks, broken or cracked glass plate, dirt or distortion. Inspect the station for signs of physical damage. Replace damaged glass. Replace the station if damaged. If necessary, clean as directed in Paragraph 5-6.1.

5-4.2.12 INSPECT PRESSURE SWITCHES

Inspect pressure switches for deformations, cracks, dirt or other damage. Replace the switch if damaged. If necessary, clean the switch as directed in Paragraph 5-6.1.

5-4.2.13 WEIGHING FM-200 CYLINDERS

Weigh 10 through 900 lb. FM-200 cylinders as follows:

⚠ WARNING

Install a protection cap on the FM-200 cylinder valve actuation port and safety cap on the cylinder valve outlet port.

Disconnect all cylinder control heads, discharge hoses, and flexible pilot hoses to prevent accidental system discharge.

1. Remove the cylinder as instructed in Paragraph 5-7.
2. Place the cylinder on a scale.
3. Record the weight and date on a record card and attach it to the cylinder. The gross weight and tare (empty) weight are metal stamped on the FM-200 cylinder valve label. Therefore, subtract tare weight from the gross weight to determine net weight of the original charge. Then, subtract tare weight from the scale reading to determine net weight of the FM-200 agent remaining in the cylinder. If the recorded agent net weight is less than 95% of original charge net weight, replace the cylinder with a fully charged FM-200 cylinder (recharging the cylinders is explained in Paragraph 6-3).
4. Reinstall the cylinder (see Paragraph 5-8 for reinstallation instructions).

5-4.2.14 CYLINDERS EQUIPPED WITH A FLEXIBLE TAPE LIQUID LEVEL INDICATOR

The following procedure explains how to determine the FM-200 weight of 125, 200, 350, 600 and 900 lb. cylinders equipped with a flexible tape liquid level indicator. This procedure can be performed without removing the FM-200 cylinders from the system.

1. Remove the protective cap to expose the tape.
2. Raise the flexible tape slowly until it latches.
3. Note the reading at the point where the tape emerges from the fitting.

⚠ CAUTION

Take care to not pull the flexible tape upwards after it latches to ensure an accurate reading.

4. To determine the final, more precise reading, repeat the above procedure. About two inches before the tape should latch, raise the tape very slowly until it latches.
5. While supporting the weight of the tape, record the liquid level measurement.

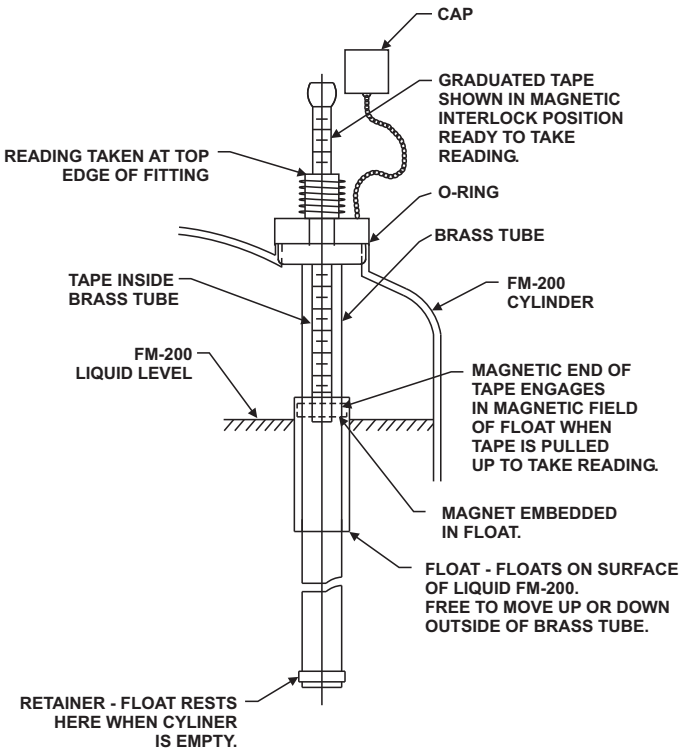


Figure 5-1. Liquid Level Indicator

6. Check the ambient temperature where the FM-200 cylinders are stored and record the temperature.
7. Refer to the appropriate calibration charts (see Figures 5-2 through 5-7) and locate the level reading on the vertical axis (labeled Flexible Tape Reading). Trace horizontally to the right to the appropriate temperature line. Read the weight of FM-200 from the scale at the bottom of the chart. Record the weight and date on the record tag attached to the cylinder.
8. After taking the reading, carefully push the tape down into the liquid level housing. Replace the protective cap.

Note: If the weight measured by the liquid level indicator indicates the cylinder should be recharged, we recommend the cylinder first be removed from service and the weight loss verified using a weigh scale before recharging.

All FM-200 cylinders must be filled or recharged by weight using a platform scale or equivalent. If weight loss is more than 5% of the FM-200 charge, the unit must be recharged.

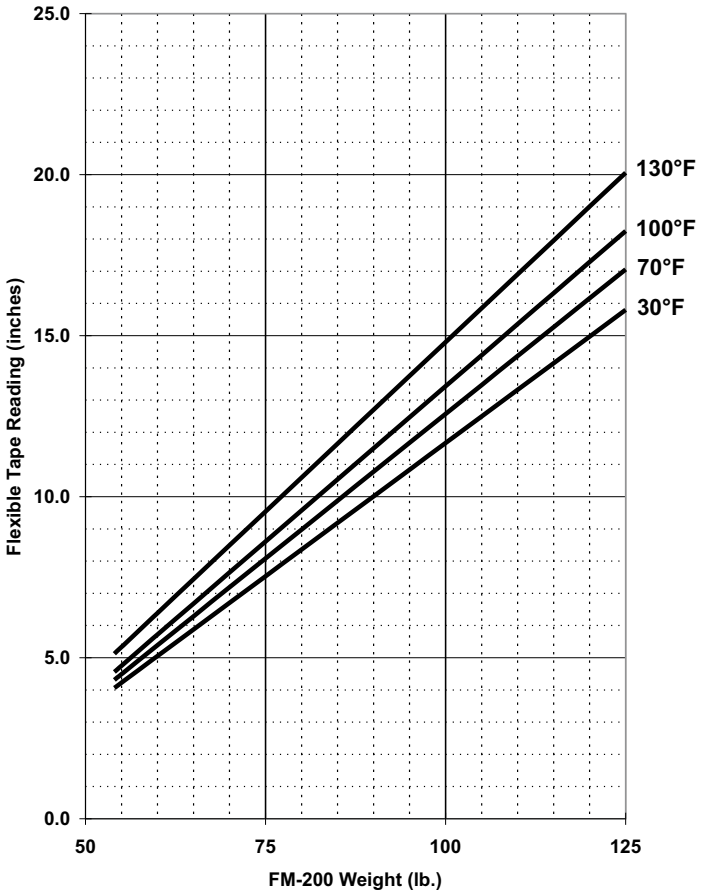


Figure 5-2. Calibration Chart 125# Cylinder

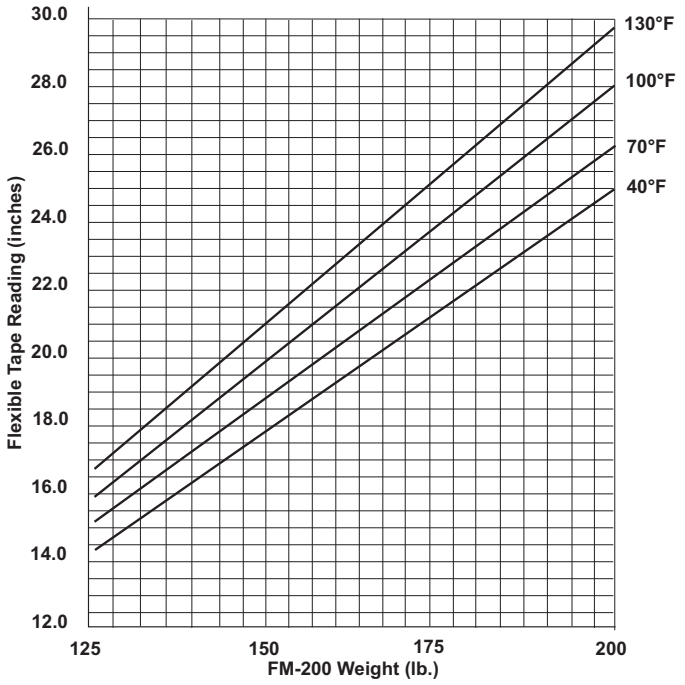


Figure 5-3. Calibration Chart for Old 200# Cylinder

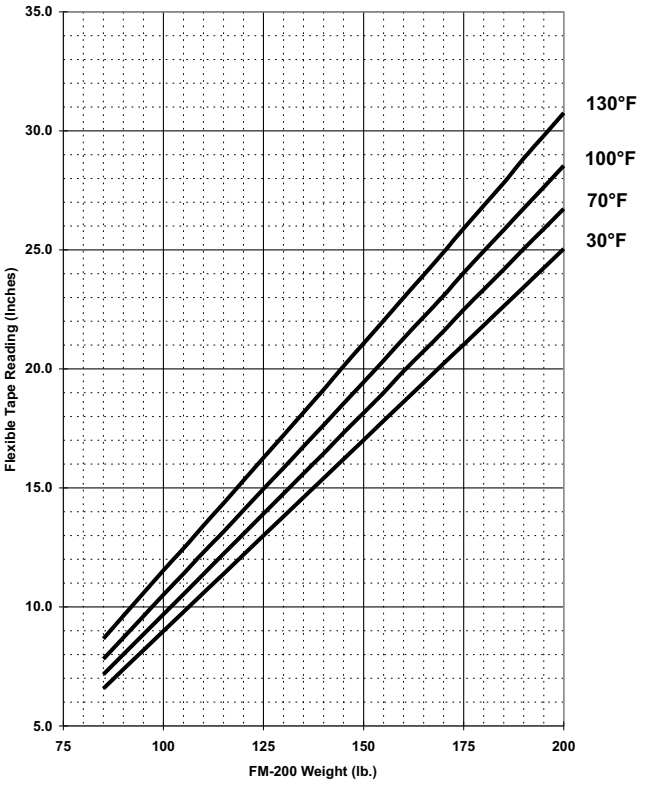


Figure 5-4. Calibration Chart for a New 200# Cylinder (New Design Ellipsoidal Head Manufactured After 3/98)

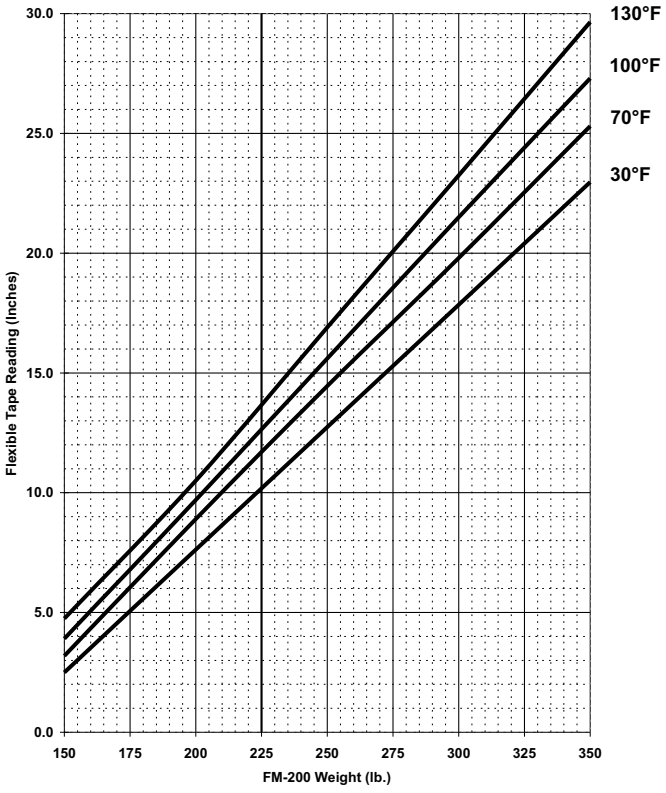


Figure 5-5. Calibration Chart for 350# Cylinder

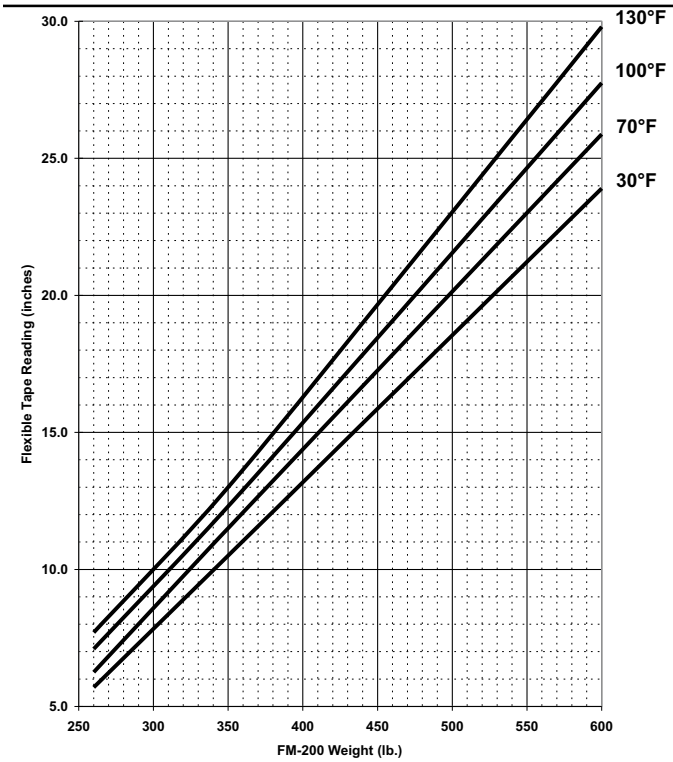


Figure 5-6. Calibration Chart for 600# Cylinder

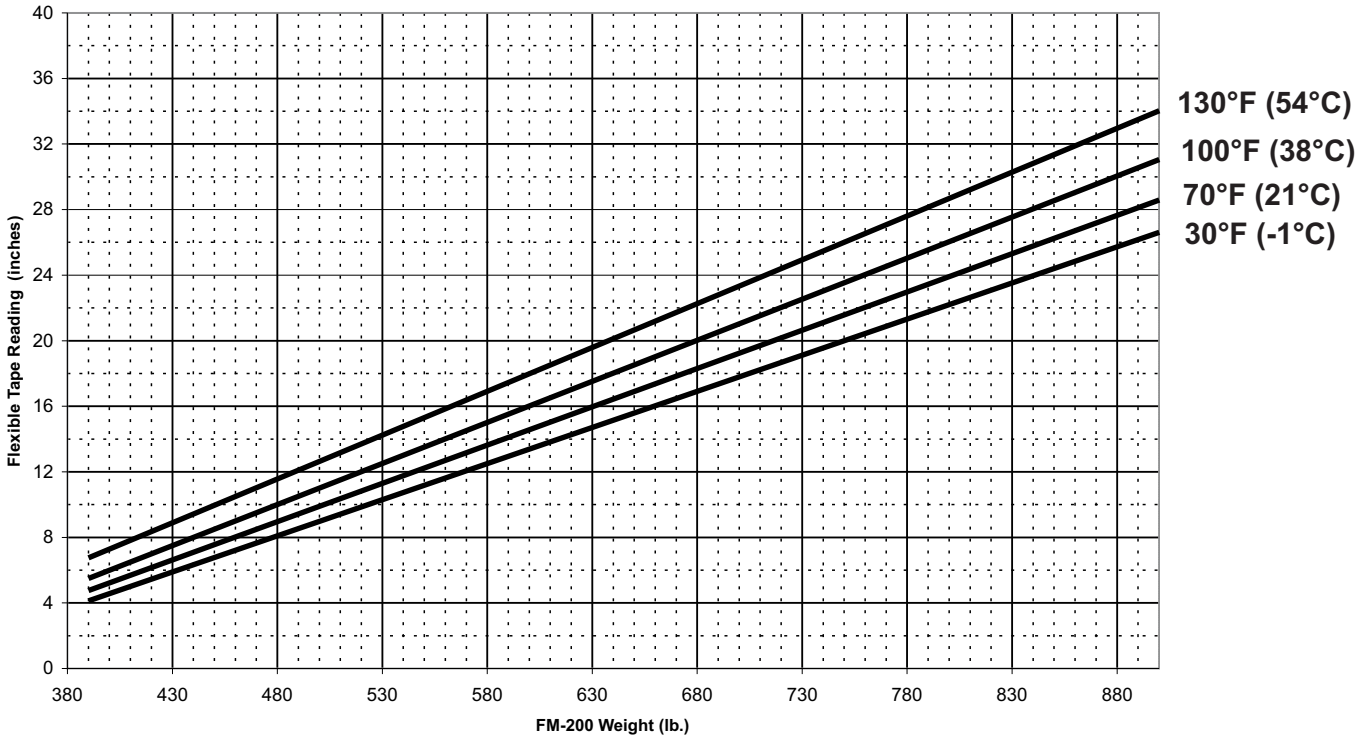


Figure 5-7. Calibration Chart for 900# Cylinder

5-4.3 Inspection Procedures, Semi-Annual

5-4.3.1 PRESSURE SWITCH TEST

1. Contact the appropriate personnel and obtain authorization for a shutdown.
2. Ensure that the hazard area operations controlled by the pressure switch are operative.
3. Manually operate the switch by pulling up on the plunger and verify that the hazard area operations controlled by the pressure switch shut down.
4. Return the pressure switch to the SET position.
5. Reactivate all systems that were shut down by the pressure switch (such as power, ventilation systems and compressors).

5-4.3.2 ELECTRIC CONTROL HEAD TEST

Electric control heads must be tested semiannually for proper operation. This test can be performed without discharging the FM-200 cylinders. Test one hazard area at a time before proceeding to the next, as follows:

⚠ CAUTION

All control heads must be removed from FM-200 cylinders and nitrogen pilot cylinders prior to testing to prevent accidental cylinder discharge.

1. Remove all electric control heads from all FM-200 cylinders and nitrogen pilot cylinders serving the hazard area being tested. Let the electric control heads hang freely from the flexible electric conduit connections. Leave all pressure operated control heads and pilot actuation hoses attached to the cylinders.
2. Operate FM-200 system electrically. This can be accomplished by actuation of the FM-200 system at the system control panel or by manual operation of an electric pull station.
3. Ensure all electric control heads have operated, that is, the indicator on the electric control head has moved to the RELEASED position, or in the case of a control head (P/N 486500-01) observe that the actuating pin has moved to the fully actuated position. If any control heads have not operated, check the circuit for electric continuity to these particular heads and repeat the test. Replace all damaged heads. Repeat the test if any control heads have been replaced.

⚠ CAUTION

Electric control heads must be reset manually before reconnecting to the cylinder valves.

4. Observe the instructions on the caution label attached to each electric control head (P/N 486500-01). Replace any damaged heads which fail to reset properly before reconnecting to cylinders. Reattach all electric control heads to the threaded port on the cylinder valve or pressure operated control head. Tighten the swivel nut securely. Make certain each electric control head is in SET position before reconnecting to cylinders. Failure to follow this procedure will result in accidental FM-200 discharge.

5-4.4 Inspection Procedures-2 Year

⚠ WARNING

Do not use water or oxygen to blow out pipe lines. Using oxygen is especially dangerous since even a minute quantity of oil may cause an explosion.

1. Remove any nozzles from the piping to allow foreign matter to blow clear.
2. Remove all pressure operated control heads from the FM-200 cylinders.

⚠ WARNING

Do not disconnect the flexible hose from the pressure operated control head. If FM-200 accidentally discharges, the unattached flexible hose will whip around and may damage equipment and cause severe bodily injury.

3. Open the distributing valves and keep them open long enough to ensure the pipes are clean.
4. Blow out all distribution piping with air or nitrogen to ensure it is not obstructed.
5. Reconnect all control heads.

5-5 INSPECTION AND RETEST PROCEDURES FOR FM-200 CYLINDERS

A cylinder that is damaged or corroded should be emptied, retested and restamped in accordance with DOT CFR Title 49, Section 173.34 (retesting is explained in Paragraph 5-5.3).

⚠ CAUTION

These guidelines do not apply to cylinders containing a commodity other than FM-200.

All Kidde FM-200 cylinders are designed, fabricated, and factory tested at 1000 PSIG (68.9 bar gauge) in compliance with DOT CFR 49 4BA-500 or 4BW-500 as stamped on each cylinder.

Two sets of regulations will apply to periodic inspection and test procedures depending on the following:

5-5.1 Cylinders Continuously in Service Without Discharge

These cylinders are governed by NFPA 2001 regulations. Cylinders in continuous service without discharge require a complete external visual inspection every five years in accordance with Compressed Gas Association Pamphlet C-6, Section 3 except that the cylinders need not be emptied or stamped while under pressure. Record date of inspection on record tag attached to each cylinder. Where the visual inspection shows damage or corrosion, the cylinder shall be emptied, retested and restamped in accordance with DOT CFR Title 49, Section 173.34.

5-5.2 Discharged Cylinders of Charged Cylinders that are Transported

These cylinders may come under NFPA 2001 requirements, or, in the case of shipment of charged cylinders, DOT, federal or state regulations may apply. In either case, the cylinders shall not be charged and shipped if more than five years have elapsed from the date of the last test date stamped on the cylinder. The cylinders shall be retested and restamped in accordance with DOT Code of Federal Regulations (CFR) Title 49, Section 173.34.

5-5.3 Retest

DOT 4BA and 4BW cylinders used exclusively in FM-200 services that are commercially free from corroding components are required to be hydrostatically retested and restamped every five years, in accordance with DOT CFR Title 4, Paragraph 173.37(e), prior to recharge and shipment. An alternate option is an external visual inspection performed in lieu of the hydrostatic test at the time the periodic retest becomes due (this option is in accordance with CFR 49, Paragraph 173.34[e] [13]). Table 5-2 highlights the two options for retesting FM-200 cylinders.

Table 5-2. Retest Schedule

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

5-5.4 Flexible Hoses

In accordance with NFPA 2001, all system hoses shall be examined annually for damage. If the visual examination shows any deficiencies, the hose shall be replaced or tested.

5-6 SERVICE

5-6.1 Cleaning

Remove dirt from metallic parts using a lint-free cloth moistened with dry cleaning solvent. Dry parts with a clean, dry, lint-free cloth, or air blow dry. Wipe non-metallic parts with a clean, dry lint-free cloth. Remove corrosion with a crocus cloth.

5-6.2 Nozzle Service

Service nozzles after use as follows:

1. Clean the outside of the nozzles with a rag or soft brush.
2. Examine the discharge orifices for damage or blockage. If the nozzles appear to be obstructed, unscrew the nozzles and clean by immersing them in cleaning solvent. Dry thoroughly with lint-free cloth. Replace damaged nozzles. Nozzles must be replaced with the same part number in the same location. See Paragraph 4-2.3.5 for the correct nozzle placement and orientation.

5-6.3 Repairs

Replace all damaged parts found during inspection. Replacement procedures for FM-200 cylinders are provided below. Since replacement for other system components are similar, refer to the installation drawings and FM-200 system assembly drawings for guidance.

FM-200 cylinders must be recharged when the cylinder pressure gauge indicates the pressure is below normal (360 PSIG at 70°F [25 bar gauge at 21°C]), immediately after discharge, when a loss in weight is in excess of 5% of the original charged net weight or when there is a loss of pressure (adjusted for temperature) of more than 10%.

5-7 Removing an FM-200 Cylinder

Remove an FM-200 cylinder as follows:

⚠ WARNING

Do not disconnect the flexible discharge hose or valve outlet adapter prior to removing pressure and electric control heads from the FM-200 cylinders. Before replacing an FM-200 cylinder in a hazard area group, ensure that the pilot line is completely vented of all pressure.

5-7.1 Single Cylinder System

1. Remove the supervisory pressure switch (where installed) by disconnecting the electrical connection at the switch, then remove the wire lead protection or conduit. Unscrew the switch from the cylinder valve and install the protection cap on the switch connection port.
2. Disconnect the swivel nut on the control head from the cylinder valve actuation port Remove the control head from the FM-200 cylinder.
3. Install a protection cap on the FM-200 cylinder valve actuation port.
4. Remove the valve outlet adapter or loosen the swivel nut and remove the flexible discharge hose from the discharge outlet port adapter.
5. Immediately install a safety cap on the cylinder valve outlet port.
6. Remove the cylinder strap. Remove the FM-200 cylinder from the bracket. Weight the cylinder using a platform scale.

5-7.2 Multiple Cylinder System

⚠ WARNING

Remove all control heads from the FM-200 cylinders.

1. Remove the supervisory pressure switches (where installed) by disconnecting the electrical connection at the switch, then remove the wire lead protection or conduit. Unscrew the switch from the cylinder valve and install the protection cap on the switch connection port.
2. Disconnect the swivel nut on the pressure operated control heads from the cylinder valve actuation port. Remove the control heads from all FM-200 cylinder valves, leaving the flexible actuation hose or tubing attached to the pressure operated control heads.
3. Immediately install a protection cap on all FM-200 cylinder valve actuation ports.
4. Remove the tubing from the master cylinder adapter on the master cylinder (if used).

⚠ WARNING

To prevent injury in the event of discharge, the master cylinder adapter cap must be installed on the adapter whenever tubing is not connected to the master cylinder valve. Under no circumstances is the protection cap to be removed from its chain.

5. Immediately install the protection cap on the master cylinder adapter port.
6. Loosen swivel nut and remove flexible discharge hose from discharge outlet port.

⚠ WARNING

To prevent injury, all cylinders must have safety caps installed immediately on the outlet ports when discharge hoses or the valve outlet adapter is disconnected.

7. Immediately install the safety cap on the cylinder valve outlet port.
8. Remove the attaching hardware or cylinder straps. Remove the FM-200 cylinder from the bracket. Weigh the cylinders using a platform scale.

5-8 REINSTALLING AN FM-200 CYLINDER

Install an FM-200 cylinder as follows:

5-8.1 Single Cylinder System

1. Position the FM-200 cylinder in the designated location. Secure it in place with a cylinder strap or wall bracket and mounting hardware. Orient the cylinder with the valve outlet angled toward the cylinder discharge piping (refer to the installation drawings).

⚠ WARNING

Discharge hoses or valve outlet adapters must be connected into system piping (union connection) before attaching to cylinder valves.

2. Remove the safety cap from the cylinder valve outlet port.
3. Immediately reconnect the valve outlet adapter or flexible discharge hose to the cylinder outlet port.
4. Remove the protection cap from the FM-200 cylinder actuation port.

⚠ WARNING

The control head must be in the SET position (that is, the actuating pin must be in the fully retracetd or SET position) before being attached to the cylinder valve. Control heads not in the SET position will cause discharge of FM-200 when installed on the cylinder valve.

5. Install the control head.
6. If required, install the supervisory pressure switch, as instructed in Paragraph 4-3.21.

5-8.2 Multiple Cylinder System

1. Position the FM-200 cylinders in the designated locations. Secure it in place with a cylinder strap or wall bracket and mounting hardware. Orient the cylinder with the valve outlet angled toward the cylinder discharge piping (refer to the installation drawings).

⚠ WARNING

Discharge hoses or valve outlet adapters must be connected into system piping (union connection) before attaching to cylinder valves.

2. Remove the safety caps from the cylinder valve outlet ports.
3. Immediately reconnect the flexible discharge hoses or valve outlet adapters to the cylinder valve outlet ports.
4. Remove the protection cap from the master cylinder adapter port (if used) and reconnect the tubing to the slave port on the master cylinder. Tighten the swivel nut.
5. Remove the protection caps from the FM-200 cylinder valve actuation ports.

⚠ WARNING

The control head must be in the SET position (that is, the actuating pin must be in the fully retracetd or SET position) before being attached to the cylinder valve. Control heads not in the SET position will cause discharge of FM-200 when installed on the cylinder valve.

6. Reinstall electric and pressure operated control heads with flexible actuation hoses or tubing on the cylinder valve actuation ports. Tighten the swivel nuts.
7. If required, install the supervisory pressure switches as explained in Paragraph 4-3.21.

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CHAPTER 6
POST-DISCHARGE MAINTENANCE

6-1 INTRODUCTION

Follow these procedures after the system has been activated and FM-200® has been discharged.

6-2 POST FIRE MAINTENANCE

6-2.1 FM-200 Valve Inspection and Service

Inspect and service the FM-200 valve as follows:

Note: **Important–**Because FM-200 tends to dissolve and wash out lubricant, certain components in the FM-200 valve assembly will have to be inspected and serviced before recharging the cylinder/valve assembly. Part numbers for items which may require replacement are listed in Table 6-1.

6-2.2 Valve Disassembly (1½", 2" and 2½")

Refer to Figures 6-1 and 6-2 and Table 6-1.

⚠ WARNING

Before removing the valve, make sure that all pressure has been relieved from the cylinder. To relieve any remaining pressure, depress the pressure switch Schraeder valve until all pressure is relieved.

1. Remove the valve with the siphon tube from the cylinder.
2. Remove the O-ring. Examine the O-ring for cuts or nicks and replace if necessary. Before reinstalling the O-ring, apply a lubricant.
3. Remove the valve cap, spring and piston assembly.

Note: All internal components of FM-200 valves are removed from the top of the assembly. However, if there is excessive piston O-ring friction, the siphon tube may have to be removed and the piston assembly pressed out from the bottom.

4. Remove the O-rings and examine for cuts or nicks; replace if necessary. Examine the O-ring grooves for foreign matter. Before reinstalling the O-rings, apply a lubricant.
5. Examine the exposed surface of the O-ring for nicks and cuts. Also, ensure that the O-ring protrudes a minimum or 0.020 in. (0.5 mm) above the conical seating surface of the piston assembly. Replace this O-ring if necessary by removing the seat retainer. Before reassembly, apply a lubricant to the O-ring.
6. Examine the valve core pin for any evidence of bending or other damage. Depress the pin and make certain it snaps back freely. Replace the valve core if necessary using a standard Schraeder core wrench. When reinstalling a new Schraeder core element, torque to 1½ to 3 in. lb. (0.17 to .37 N-m).

⚠ CAUTION

After reinstalling a Schraeder core, the distance from the top of the core pin to the control head seating surface must fall between the dimensions of 0.515 in. to 0.565 in. (13 mm to 14 mm) when in the "shut" or non-actuated position (see Figure 6-1).

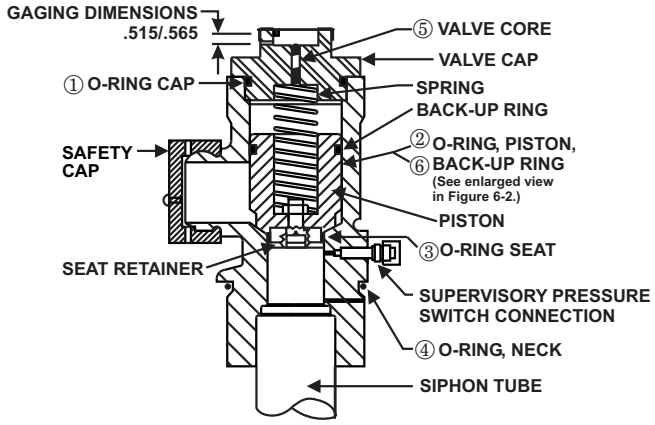

Figure 6-1. Valve Assembly (1½", 2" and 2½")

Figure 6-2. Piston O-Ring

Table 6-1. Valve Components

Figure Item No.	Description	10-125 lb. cylinders	200-350 lb. cylinders	600 lb. cylinders
1	O-ring, cap	5661-0225	5661-0230	5661-0234
2	O-ring, piston	5661-0325	5661-0330	5661-0334
3	O-ring, seat	5661-0215	5661-0326	5661-0331
4	O-ring, neck	5661-0932	5661-0335	5661-0339
5	Schraeder core	220278	220278	220278
6	Back-up ring	554003-250	554003-300	554003-340

Table 6-2. Other Valve Component Materials

Other Materials	Manufacturer and Nomenclature
Lubricant	Parker Seal Co. Super-O-Lube or equivalent
Loctite Sealant	Loctite Corp. Sealant, Grade CV or equivalent
Locquic Primer	Loctite Corp. Primer, Grade N or equivalent

6-2.3 Valve Disassembly (3")

Note: Refer to Figure 6-3 for items.

1. Remove the valve with the siphon tube from the cylinder.
2. Remove the O-ring and examine it for cuts and nicks; replace if necessary. Before reinstalling the O-ring, apply lubricant.
3. Remove the valve cap, spring and piston assembly.

Note: Remove all internal components of the FM-200 valve from the top of the assembly. However, if there is excessive piston O-ring friction, the siphon tube may have to be removed and the piston assembly pressed out from the bottom.

4. Remove the O-rings and examine them for cuts and nicks; replace if necessary. Examine the O-ring grooves for foreign matter. Before reinstalling the O-rings, apply lubricant.
5. Examine the exposed surface of O-ring for nicks and cuts. Also, ensure that the O-ring protrudes a minimum of 0.020 in. (0.5 mm) above the conical seating surface of the piston assembly. Replace this O-ring if necessary by removing the seat retainer. Before reassembling, apply lubricant to the O-ring.
6. Examine the pilot check for any evidence of bending or other damage. Depress the check and make certain it snaps back freely. Replace pilot check if necessary.

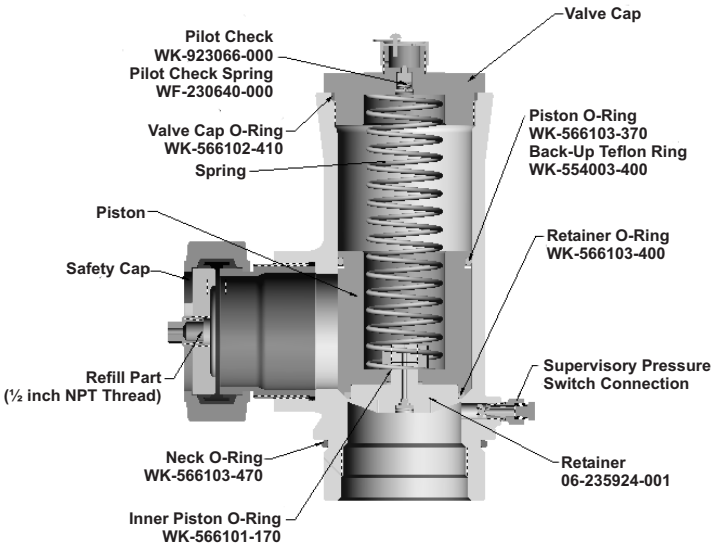

Figure 6-3. 3" Valve Assembly

Table 6-3. 3" Valve Components

Description	600 lb. Cylinders	900 lb. Cylinders
O-ring, Cap	566102410	566102410
O-ring, Piston	566103370	566103370
O-ring, seat	566103400	566103400
O-ring, Neck	566103470	566103470
Pilot Check Assembly	923066	923066
Back-up Ring	554003400	554003400

6-2.4 Valve Assembly (1½", 2", and 2½")

Note: The items refer to Figure 6-1.

1. Install an O-ring in the piston groove.

⚠ CAUTION

Make certain the Teflon® back-up ring is below this O-ring as shown in Figure 6-2.

2. Press the piston (Item 6) back into the valve body.
3. Install the spring.
4. Install the O-ring (Item 1) onto the groove in the valve cap, screw the cap into the valve body and torque to 250 in. lb. (28.2 N-m).
5. If the siphon tube had to be removed to disassemble the valve, wire brush the siphon tube threads to remove the old Loctite® residue.
6. Apply a film of Loctite® primer to the siphon tube threads and allow three to five minutes to dry.
7. Apply a film of Loctite® sealant to the threads and reinstall the siphon tube.
8. Install the O-ring onto the valve neck groove, screw the valve and siphon tube into the cylinder, and torque to 50 to 55 ft. lb. (68 to 75 N-m).

6-2.5 Valve Assembly (3")

Note: Refer to Figure 6-3.

1. Install the O-ring (Item 2 in Figure 6-3) in the piston groove.

⚠ CAUTION

Make certain that the Teflon® back-up ring is below the O-ring as shown in Figure 6-3.

2. Press the piston back into the valve body.
3. Install the spring.
4. Install the O-ring onto the groove in the valve cap. Screw the cap onto the valve body and torque to 360 in. lb. (41 N-m).
5. If the siphon tube had to be removed for valve disassembly, wire brush the siphon tube threads to remove the old Loctite residue.
6. Apply a film of Loctite® primer to the siphon tube threads and allow three to five minutes to dry.
7. Apply a film of Loctite® sealant to the threads and reinstall the siphon tube.

Install the O-ring onto the valve neck groove, screw the valve and siphon tube onto the cylinder, and torque to 600 to 660 in. lb. (68 to 75 N-m).

6-2.6 Safety Disc Replacement (1½", 2" and 2½")

Note: Refer to Figure 6-4.

1. Remove the safety disc retainer with safety disc and safety disc washer from the valve body. Discard the safety disc and washer.
2. Assemble the safety disc retainer with new safety disc and safety disc washer to the valve body. Torque to the appropriate value listed in Table 6-4.

⚠ WARNING

Never install any type disc other than specified above for the appropriate cylinder. Installing the incorrect disc could result in violent rupture of the cylinder and serious injury.

Never reinstall a used safety disc and/or washer. Once the retainer has been removed, the disc and washer must be replaced with new components.

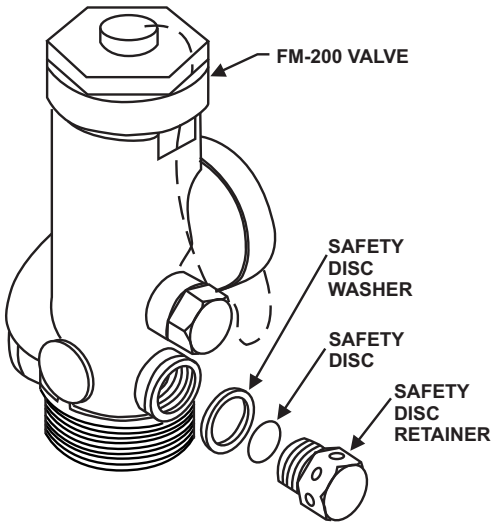

Figure 6-4. Safety Disc Replacement

Table 6-4. Safety Disc Replacement Table (1½", 2" and 2½")

Cylinder Size	Safety Disc P/N	Safety Disc Washer P/N	Torque Value	PSIG @ 70°F
10-125 lb.	242461	294500	33 ft. lb.	750-900
200-350 lb.	264925	220360	38 ft. lb.	800-975
600 lb. (old)	264929	220362	48 ft. lb.	800-975

6-2.7 Safety Disc Replacement (3")

The safety disc for the 3" valve is located on the cylinder head, not on the cylinder valve.

1. Remove the safety disc retainer (see Figure 6-5) including safety disc and safety disc washer from the cylinder body. Discard the safety disc and washer.
2. Reassemble the safety disc retainer with a new safety disc and safety disc washer to the valve body. Torque to the appropriate value listed in Table 6-5.

⚠ WARNING

Never install any type of disc other than specified in Table 6-5 for the corresponding cylinder. Installing the incorrect disc could result in a violent rupture of the cylinder and serious injury.

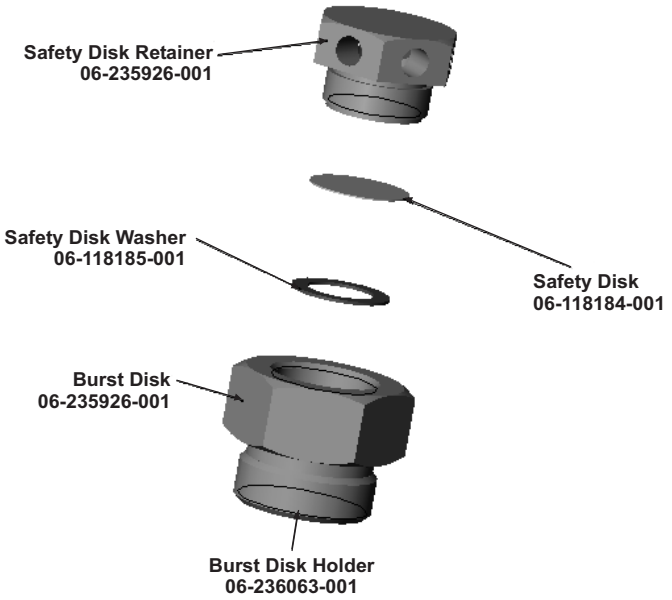

Figure 6-5. Burst Disc

Table 6-5. Safety Disc Replacement Table (3")

Cylinder Size	Safety Disc P/N	Torque Value	PSIG @ 70° F
600 lb.	06-118184-001	90 ft. lb.	800-975
900 lb.	06-118184-001	90 ft. lb.	800-975

6-3 RECHARGING FM-200 CYLINDERS

⚠ CAUTION

FM-200 cylinders may require retest before recharging (see Paragraph 5-5 for details on cylinder retest). FM Approval is based upon the usage of factory filled FM-200 cylinders.

⚠ WARNING

Under no circumstances while performing either cylinder recharge or leak test, should a charged cylinder be allowed to stand freely without either the charging apparatus attached or the safety cap installed. Whenever these devices are not installed, a charged cylinder must be securely clamped to a rigid structure capable of sustaining the full thrust that would result should the valve inadvertently open. The clamping device and supports must be capable of withstanding a thrust force of 1800 lb. (816.5 kg). This approximates the thrust force generated out of the FM-200 cylinder valve outlet on a full, wide-open discharge.

FM-200 charging equipment consists of an FM-200 storage container, piping adapter, control valves, strainer, pressure gauge, flexible hoses, seating adapter, recharge adapter, pump, regulated nitrogen supply, scale and interconnecting plumbing. Recharge equipment must be suitable for the purpose intended and must be compatible with FM-200. A typical FM-200 charging system schematic is shown in Figure 6-6.

Note: During recharge, cylinder pressure gauge is not to be used to determine charging pressure.

Locate the charging equipment in a clean, well-ventilated area near the FM-200 supply and cylinder storage. There should be sufficient room for moving the cylinders to and from the charging equipment.

6-3.1 Charging Equipment Installation

Before assembling the charging equipment, apply Permacel No. 412D Teflon® tape to all pipe threads.

6-3.2 Charging FM-200 Cylinder and Valve Assembly

Recharge FM-200 cylinder and valve assembly as follows (see Figure 6-6 and Table 6-6):

⚠ WARNING

Only qualified, designated personnel should operate the charging equipment. Exercise extreme care when working with pressure equipment to prevent injury to people and damage to property, resulting from careless handling or possible equipment failure. Perform all operations in an assigned area cleared of all unauthorized personnel. Make sure all equipment is properly secured. Never attempt to adjust or disassemble pressurized equipment.

1. Check the cylinder for the last hydrostatic test date prior to charging. Perform any required DOT hydrostatic tests (see Paragraph 5-5).
2. Check the cylinder valve assembly for any unacceptable physical defects (for example, cracks of any kind, elongated pits of any length, inclusions of any size, pitting, bulging, dents, corrosion, fire damage, mechanical defects, scratches, nicks or gouges if more than superficial in nature). These defects shall be cause for rejection.

⚠ WARNING

Dangerously high pressures may be generated if FM-200 is introduced into a cylinder containing nitrogen at a pressure above 10 PSIG (0.7 bar gauge).

3. Weigh the cylinder/valve assembly to verify the quantity of agent in the cylinder. Ensure that no more than 10 PSIG (0.7 bar gauge) of nitrogen is in cylinder before beginning the fill procedures.

⚠ CAUTION

FM-200 is a colorless, odorless gas, low in toxicity, and is an extremely effective fire suppression agent. FM-200 can be liquefied by compression, and is normally shipped and stored in this condition. Being a liquefied and compressed gas, FM-200 is stored and handled under saturated conditions (that is, the liquid and vapor coexist in equilibrium). Reducing the pressure without reducing the temperature causes the liquid to flash into vapor with accompanying refrigeration effects. By understanding the physical properties of FM-200 and safe handling techniques, the agent may be transferred from shipping cylinders to the desired end-use container safely.

4. Connect the FM-200 supply and return lines to the FM-200 shipping container valves (Items 19 and 22). Close all valves in the charging system.
5. Open the FM-200 supply valves (Items 8, 9, 10, 11, 19, 21 and 27). DO NOT open valve (Item 22) at this time. The pressure gauge (Item 28) should indicate the supply pressure. Crack the vent valve (Item 30) until FM-200 liquid is present. Close valve (Item 30).
6. Turn the 3-way valve (Item 9) to the return line position. Open valve (Item 24). Crack vent valve (Item 23) until FM-200 liquid is present. Close valve (Item 23). Open valve (Item 22). The charging system is now ready for use.
7. Position the FM-200 cylinder/valve assembly (Item 26) (with safety cap and pilot actuation port protection cap in place and properly connected) on a weigh scale (Item 3). Record the weight from the scale. The empty weight of cylinder assembly must be stamped on the cylinder valve nameplate.
8. Remove the safety cap and immediately connect the cylinder assembly into the charging system by assembling the recharge adapter with O-ring packing (Item 1) to the cylinder assembly outlet port.

Note: The main piston in the cylinder valve assembly will unseat, permitting flow into the assembly when a 10 PSIG (0.7 bar gauge) differential (approximate) exists at the outlet port. Initial valve assembly seating occurs with pressure equalization. Final valve assembly seating occurs with removal of pressure from valve assembly outlet port and subsequent momentary application of 450 to 600 PSIG (31 to 41 bar gauge) of nitrogen discussed below.

9. Monitor the scale, record the empty cylinder assembly weight as A. Determine the charge weight with the equation C=A+B+N2, where B is weight of FM-200 agent indicated on valve nameplate.
10. Open valve (Item 29) and start the pump (Item 14). Monitor the weigh scale (Item 3). When the scale indicates a charge weight C, shut off the pump and close the FM-200 supply valves (Items 29 and 8).

Note: The 360 PSIG (25 bar gauge) pressure applies to the filling procedure with nitrogen and FM-200 at 70°F ± 10°F (21°C ± -12°C). When the temperature is other than 70°F (21°C), refer to Table 6-5 for required total pressure. Do not fill FM-200 cylinders at temperatures below 60°F (16°C) or above 90°F (27°C).

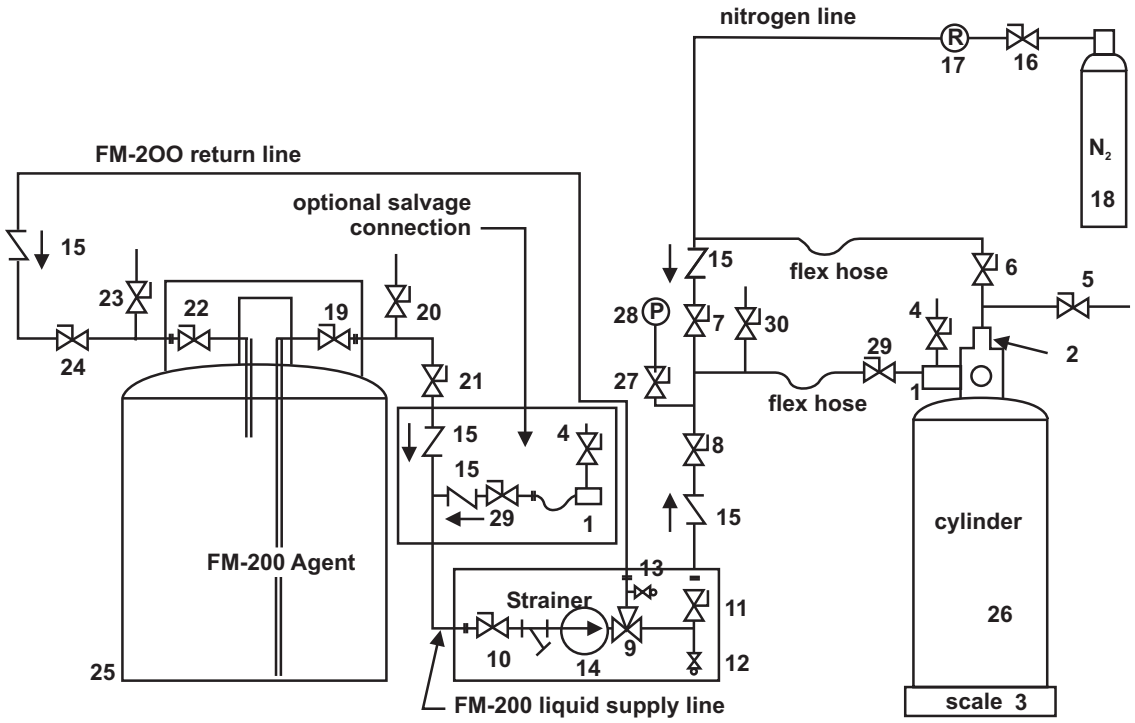

Figure 6-6. Typical FM-200 Charging System Schematic

Table 6-6. Typical FM-200 Charging System Schematic

1	Recharge Adapter	**16**	Ball Valve
2	Seating Adapter	**17**	Regulator
3	Scale	**18**	Nitrogen Cylinder
4	Vent Valve - Recharge	**19**	FM-200 Shipping Container, Liquid
5	Vent Valve - Seating	**20**	Vent Valve
6	Ball Valve	**21**	Ball Valve
7	Ball Valve	**22**	FM-200 Shipping Container, Vapor
8	Ball Valve	**23**	Vent Valve
9	3- Way Valve	**24**	Ball Valve
10	Ball Valve	**25**	FM-200 Shipping Container, Vapor
11	Ball Valve	**26**	FM-200 Agent Storage Container
12	Safety Relief, Liquid	**27**	Ball Valve, Gauge
13	Safety Relief, Vapor	**28**	Master Pressure Gauge
14	Pump	**29**	Ball Valve
15	Check Valve	**30**	Vent Valve

Table 6-7. Pressure vs. Temperature

Pressure versus Temperature	
Temperature °F (°C)	**Pressure PSIG (bar gauge)**
60 (15.6)	340 (23.5)
70 (21.1)	360 (24.8)
80 (26.7)	381 (26.3)
90 (32.2)	402 (27.7)

360 PSIG + 25, - 0 PSIG, at 70°F (25 bar gauge +1.7, -0 bar gauge at 21°C) is the final pressure required after the charged container has had sufficient time to stabilize. Nitrogen topping may be required to attain the 360 PSIG (25 bar gauge) after the stabilization period has elapsed.

Nitrogen charge weight for Kidde FM-200 ECS Series Engineered Fire Suppression cylinders at 70 lb./ft.^{3} (1121 kg/m^3) fill density is based on 1.88 lb. (0.85 kg) of nitrogen per 100 lb. (45.3 kg) of FM-200.

11. If nitrogen is required, open the handwheel valve on the nitrogen supply valve (Item 16) and nitrogen valve (Item 7). Adjust the regulator (Item 17) until the master gauge shows a pressure indication of 360 PSIG + 25, -0 PSIG (25 bar gauge + 1.7, -0 bar gauge).
12. Open the hose control valve (Item 29) and let the nitrogen flow into the cylinder until the master gauge indicates 360 PSIG (25 bar gauge). Cylinder agitation will assist with the equilibrium of nitrogen and FM-200. Additional nitrogen may be necessary as the cylinder equilibrates.
13. Close the hose control valve (Item 29). Remove the pilot actuation port protection cap and assemble the seating adapter (Item 2) with the flexible hose to the cylinder valve actuation port. Open valve (Item 6), then adjust the regulator to momentarily apply 450 to 600 PSIG (31 to 41 bar gauge) nitrogen pressure to the actuation port to firmly seat the cylinder valve piston .
14. While momentarily maintaining pressure on the actuation port, open vent valve (Item 4) on the recharge adapter (Item 1) to rapidly vent FM-200 from the valve assembly outlet port. The sudden pressure decrease at the valve outlet will ensure the valve seat stays in the closed position.
15. Leave vent valve (Item 4) open. Close valve (Item 6) and open valve (Item 5) to vent nitrogen from the seating adapter.

⚠ CAUTION

Any hissing or discharge coming from vent valve (Item 4) indicates that the piston is not seated properly or has opened. If this occurs, repeat Step 16. Verify that the cylinder valve piston remains closed.

16. Keep vent valve (Item 4) open. Close valve (Item 5), and once again open valve (Item 6) to reapply nitrogen pressure to the actuation port. While momentarily maintaining pressure on the actuation port, remove the recharge adapter (Item 1) from the cylinder valve outlet port and immediately install the safety cap. Close the vent valve (Item 4).

⚠ WARNING

Nitrogen pressure must be maintained on the actuation port while removing the charging adapter and installing the safety cap to ensure that the cylinder valve does not inadvertently actuate while the valve outlet port is wide open. Failure to follow this could result in injury and damage to property.

17. Close the nitrogen supply valve (Item 16) and open vent valve (Item 5) to vent nitrogen from the supply line.
18. Remove the seating adapter (Item 2) from the cylinder valve and reinstall the actuation port protection cap. Close valves (Items 5 and 6).
19. Weigh the fully charged cylinder. The weight must agree with the weight stamped on the cylinder valve nameplate. Record the date of recharge on the cylinder record tag.
20. Monitor the cylinder valve gauge. The gauge indicator must read 360 PSIG + 25 -0 PSIG at 70°F (25 bar +1.7, -0 bar gauge at 21°C) after the stabilization period.
21. The cylinder is now ready for the leak test (refer to Paragraph 6-3.3).

⚠ CAUTION

The Kidde FM-200 series agent containers have been designed for a maximum fill density of 70 lb./cu. ft. (1121 kg/m^3) and super pressurized with nitrogen to 360 PSIG + 25 PSIG at 70°F (25 bar gauge +1.7, -0 bar gauge at 21°C). It is important that these values not be exceeded.

The pressure in the agent container is significantly affected by fill density and temperature. At elevated temperatures, the rate of increase in pressure is very sensitive to fill density (see Figure 1-1). If the maximum fill density is exceeded, the pressure will increase rapidly with temperature increase so as to present a hazard to personnel and property. Adherence to the limits on fill density and pressurization levels will prevent excessively high pressures from occurring if the agent container is exposed to elevated temperature, minimizing the possibility of an inadvertent discharge of agent through the pressure relief device.

Note: When charging more than one FM-200 cylinder, it may be advantageous to leave the pump (Item 14) running. In this case, when a cylinder is full, rotate the 3-way valve (Item 9) to direct the flow back to the supply tank through the FM-200 return line. To resume charging operations, return the 3-way valve (Item 9) back to the "Filling" position.

To change the FM-200 shipping container (Item 25) close cylinder valves (Items 19 and 22) close valves (Items 21 and 24). Carefully open vent valves (Items 20 and 23) to bleed pressure. Disconnect charging lines from FM-200 supply cylinder. Position new FM-200 supply cylinder in place. Connect charging lines to new FM-200 supply cylinder, ensuring vapor and liquid lines are connected to proper valves. Close vent valves (Items 20 and 23). Open valves (Items 21 and 24).

6-3.3 FM-200 Cylinder Leak Test

⚠ WARNING

Clamp FM-200 cylinder securely in place. The clamping device and supports must be capable of withstanding a thrust force of 1800 lb. (816.5 kg). This approximates the thrust force generated out of the FM-200 cylinder valve outlet on a full, wide open discharge.

⚠ CAUTION

FM-200 cylinder leak tests must be conducted in a well-ventilated area, away from the charging station so as not to be influenced by extraneous FM-200 vapors released during the filling operations. Kidde recommends the Yokogawa Type H25C leak detector for FM-200, with the Yokogawa Type LS-20 leak standard for FM-200 for calibrating the leak detector.

1. Warm up the leak detector for 30 minutes before proceeding with Step 2.
2. Calibrate the detector against the LS-20 leak standard by holding the probe about 1/8 in. (3 mm) away, and noting the meter deflection for the leakage allowance of the standard. Maximum allowable leak rates are shown in Table 6-8.
3. Remove the safety cap from the discharge outlet. Blow nitrogen on the surface where the plug was removed.
4. Move the probe back and forth slowly about 1/8 in. (3 mm) away from all potential leak points (such as the discharge outlet area, pilot check, valve bonnet, supervisory pressure switch connection, safety outlet, liquid level indicator, valve-to-cylinder connections, gauge and container welds).
5. Meter deflections greater than indicated during calibration are considered excessive and will be cause for rejection.
6. Replace the safety cap immediately after the test.
7. If excess leakage is detected, salvage the FM-200 agent, perform the required maintenance on the container and recharge.
8. After the leak test is complete, reassemble the protection cap to the actuation port of the valve assembly. Unclamp the cylinder.

Table 6-8. Maximum Permitted Leakage Rates

Part Number	Cylinder Size	Cylinder Fill Weight	Maximum Allowable Leakage
	lb.	lb.	oz./yr.
90-100010-001	10	6-11	0.11
90-100020-001	20	9-23	0.20
90-100040-001	40	17 - 40	0.37
90-100070-001	70	30 - 70	0.67
90-100125-001	125	54 - 125	1.20
90-100200-001	200	86 - 200	1.81
90-100201-001 *	200	86 - 200	1.81
90-100200-101	200	86 - 200	1.81
90-100201-101*	200	86 - 200	1.81
90-100350-001	350	150 - 350	3.34
90-100351-001*	350	150 - 350	3.34
90-100600-001	600	258 - 600	5.74
90-100601-001*	600	258 - 600	5.74
90-10090X-001	900	390-900	8.68
***Note:** Includes liquid level indicator			

6-3.4 Salvaging FM-200 from a Leaking Cylinder Assembly

⚠ WARNING

Target container must be significantly larger than the source container to prevent dangerous pressure buildup.

1. Close the FM-200 supply valve (Item 19) and close valve (Item 21). Open valve (Item 20) to vent pressure. Disconnect the charging flexible hose from the FM-200 supply valve (Item 19).
2. Connect the salvage discharge assembly to the flexible hose coupling. Then assemble the discharge assembly to the outlet port of the leaking cylinder assembly (not shown).
3. Position an empty cylinder assembly of suitable size for FM-200 storage on the scale. Record the empty weight.
4. Connect the recharge adapter (Item 1) to the empty cylinder outlet port.
5. Assemble a manually operated control head onto the cylinder valve actuation port of the leaking cylinder assembly.
6. Check that all charging system valves are closed. Open valves (Items 8, 9, 10, 11, 21 and 27). Set the manually operated control head to the OPEN position. The pressure gauge (Item 28) should indicate the supply pressure. Crack vent valve (Item 30) until FM-200 liquid is present. Shut valve (Item 30).
7. If the cylinder assembly on the scale is of sufficient size and is being used to store FM-200, monitor the scale, open the valve (Item 29) and start the pump. Continue pumping until a maximum of FM-200 is transferred from the leaking cylinder assembly as indicated by a pressure drop on the pressure gauge.
8. If the cylinder assembly on the scale is being charged, fill with the required weight of FM-200 by adding the required pounds to the empty cylinder weight. Follow the charging procedure outlined in steps 9 through 21 of Paragraph 6-3.2. Conduct a cylinder leak test as described in Paragraph 6-3.3.
9. Continue to transfer the FM-200 agent until the leaking cylinder assembly is empty as indicated by pressure drop as measured by the pressure gauge. Shut off the pump and close the hose control valve (Item 29) and valve (Item 21).
10. Open valve (Item 20) to vent pressure, then disassemble the adapter from the outlet port of the leaking cylinder assembly and from the flexible hose hookup. Reassemble the flexible hose to the FM-200 supply valve (Item 19).
11. If the cylinder assembly being recharged, is not charged sufficiently, continue the charging procedure as indicated in Paragraph 6-3.2 using the FM-200 supply.

6-4 NITROGEN PILOT CYLINDER SERVICE AND MAINTENANCE

⚠ WARNING

Any area in which nitrogen is used or stored must be properly ventilated. A person working in an area where air has become enriched with nitrogen can become unconscious without sensing the lack of oxygen. Remove the victim to fresh air. Administer artificial respiration if necessary and summon a physician. Never dispose of liquefied nitrogen in an indoor work or storage area.

6-4.1 Nitrogen Pilot Cylinder Hydrostatic Pressure Test

A hydrostatic test must be performed in accordance with DOT regulations CFR Title 49, Section 173.34.

Nitrogen cylinders shall not be recharged and shipped without hydrostatic test if more than five years has elapsed from the date of the last test.

Nitrogen cylinders continuously in service without discharging can be retained in service for a maximum of five years from the date of the last hydrostatic test. At the end of five years the cylinder shall be visually inspected per CGA pamphlet C-6.

Cylinders must also be hydrostatic pressure tested immediately if the cylinder shows evidence of distortion, cracking, corrosion or mechanical or fire damage.

6-4.2 Nitrogen Cylinder Replacement

⚠ WARNING

When removing a pressurized cylinder due to pressure loss, the control head must be in the SET position with the safety pull pin installed. A control head in the released position will cause the remaining contents of cylinder to discharge resulting in a system activation which may damage property and cause bodily injury.

Replace the nitrogen cylinder when expended or when loss of pressure occurs, as follows:

1. Remove the control head from the nitrogen cylinder valve.
2. Immediately install the protection cap on the nitrogen cylinder actuation port.
3. Remove the flexible actuation hose or tubing and adapter (P/N 6992-0501) from the cylinder valve outlet.
4. Remove the clamps and hardware that secure the nitrogen cylinder to the mounting bracket.

6-4.3 Nitrogen Cylinder Recharge

Nitrogen cylinders must be recharged when the cylinder pressure gauge indicates pressure is below normal (1800 PSIG at 70°F [124 bar gauge at 21°C] or as adjusted for temperature) or immediately after discharge. Nitrogen used for charging must comply with Federal Specification BB-N-411C, Grade A, Type 1. Copies of this specification may be obtained from: Global Engineering Documents, 2625 S. Hickory St., Santa Ana, CA 92707.

⚠ WARNING

Before recharging, the cylinder must be firmly secured by chains, clamps or other devices to an immovable object such as a wall, structural I-beam or permanently mounted holding rack.

Recharge the nitrogen cylinders as follows:

1. Remove the protection cap from the cylinder valve actuation port.
2. Install the nitrogen cylinder recharge adapter (P/N 933537) to the cylinder valve actuation port and plug valve outlet port with 1/8" NPT pipe plug.
3. Connect the nitrogen recharging supply hose to the adapter. Tighten securely.
4. Open the nitrogen recharging control valve slowly until full nitrogen flow is obtained.
5. Monitor the recharging supply pressure gauge. Close the charging control valve when the gauge indicates the proper cylinder pressure (1800 PSIG at 70°F [124 bar gauge at 21°C]).
6. Allow the cylinder to cool to ambient temperature and recheck the nitrogen cylinder pressure.
7. Open the valve and add additional nitrogen as necessary to obtain a full cylinder charge at ambient temperature (1800 PSIG at 70°F [124 bar gauge at 21°C]). Refer to Figure 6-5.
8. Close the valve and remove the supply hose and charging adapter from the nitrogen cylinder.
9. Using a soap solution, thoroughly check the nitrogen cylinder valve for leakage. Bubbles in the soap solution indicate leakage and shall be cause for rejection of the cylinder.
10. At the completion of the leak test, thoroughly clean and dry the cylinder valve.
11. Ensure the cylinder valve control head port is clean and dry.
12. Immediately install the protective cap to the actuation port of the cylinder valve.
13. Install the charged cylinder as described below.

6-4.4 Nitrogen Cylinder Installation

1. Install the nitrogen cylinder in position in the mounting bracket.
2. Tighten sufficiently to hold cylinder in place while allowing cylinder enough free play to be manually rotated.
3. Turn the cylinder until the cylinder valve discharge outlet is in the desired position.

⚠ CAUTION

The nitrogen cylinder must be positioned so that the control head, when installed, is readily accessible and cannot be obstructed during manual operation.

4. Securely tighten the mounting bracket clamps and hardware.
5. Remove the pipe plug, reconnect the adapter (P/N 6992-0501) and flexible actuation hose or tubing to the cylinder valve outlet port.
6. Remove the protective cap from the cylinder valve actuation port.

⚠ WARNING

Ensure the control head is in the SET position (that is, the actuating pin is in the fully retracted or SET position). Failure to do so will cause the nitrogen cylinder to discharge when the control head is installed.

7. Install the control head to the cylinder valve and tighten securely.

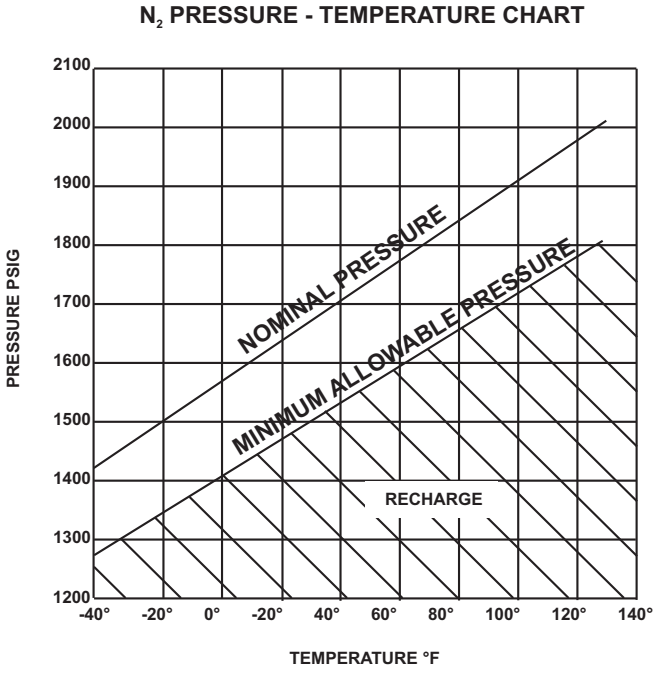

Figure 6-7. Nitrogen Temperature vs. Pressure Data

CHAPTER 7
PARTS LIST

7-1 INTRODUCTION AND PARTS LIST

The table below, and on the following pages, provides a complete list of FM-200® parts and associated system equipment. FM-200 equipment can be ordered as complete assemblies or as individual items. In most situations, when ordering a system, it will be easier and more cost effective to order by assembly part numbers.

Table 7-1.Parts List

NOMENCLATURE	PART NUMBER
CYLINDER/VALVE ASSEMBLIES	
Vertical Mount Only	
10 lb. STD	90-100010-001
20 lb. STD	90-100020-001
40 lb. STD	90-100040-001
70 lb. STD	90-100070-001
125 lb. STD	90-100125-001
125 lb. W/LLI	90-100121-001
200 lb. STD Old Style Hemispherical Head before 3/98	90-100200-001
200 lb. W/LLI Old Style Hemispherical Head before 3/98	90-100201-001
200 lb. STD New Style Ellipsoidal Head after 3/98	90-100200-101
200 lb. W/LLI New Style Ellipsoidal Head after 3/98	90-100201-101
350 lb. STD	90-100350-001
350 lb. W/LLI	90-100351-001
600 lb. STD (old style supplied before 9/01)	90-100600-001
600 lb. W/LLI (old style supplied before 9/01)	90-100601-001
600 lb. STD (new style supplied after 9/01)	90-100600-100
600 lb. W/LLI (new style supplied after 9/01)	90-100601-100
900 lb. STD	90-100900-001
900 lb. W/LLI	90-100901-001
(STD = Standard Cylinder Assembly, W/LLI = Cylinder with liquid level indicator)	
FLEXIBLE DISCHARGE HOSES	
10-125 lb. Cylinders	283898
200-350 lb. Cylinders	283899
600 lb. Cylinders (old style supplied before 9/01)	283900
600 lb. Cylinders (new style after 9/01)	06-118225-001
900 lb. Cylinders	06-118225-001

Table 7-1. Parts List (continued)

NOMENCLATURE	PART NUMBER
VALVE OUTLET ADAPTERS	
10-125 lb. Cylinders	283904
200-350 lb. Cylinders	283905
600 lb. Cylinders	283906
CYLINDER STRAPS	
10-20 lb.	283945
40-70 lb.	283934
125-200 lb. (old style cylinder, before 3/98)	292971
125-200 lb. (new style cylinder, after 3/98)	235317
200 lb.	292971
350 lb.	281866
600 lb. (old and new style)	294651
900 lb.	236125
BRACKETS, WALL MOUNTING	
10 lb.	486485
20 lb.	486486
40 lb.	486487
70 lb.	486488
CRADLES	
125 lb. and 200 lb.	235431
200 lb.	292938
350 lb.	281867
600 lb.	294652
FRONT CLAMPS	
125 lb. and 200 lb.	235432
200 lb.	293457
350 lb.	281868
600 lb.	294653
CONTROL HEADS	
Electric, Stackable (Explosion Proof) 24 Vdc	486500-01
Electric, Standard 24 Vdc	890181*
Electric, Standard 115 Vac	890165*
Electric, Standard 125 Vdc	890149*
Electric/Cable, Standard 24 Vdc	895630
Electric Cable, Standard 115 Vac	895627*
Electric/Cable (Explosion Proof) 24 Vdc	897494
Lever Operated	870652

Table 7-1. Parts List (continued)

NOMENCLATURE	PART NUMBER
Pressure Operated	878737
Pressure Operated, Stackable	878750
Lever/Pressure Operated	878751
Cable Operated	979469
Electric/Cable (Explosion Proof) 115 Vac	897560*
***Note:** UL Listed but not FM Approved for use with FM-200 systems.	
PRESSURE CONTROL EQUIPMENT	
Master Cylinder Adapter Kit	844895
Male Branch Tee, 5/16" Flare x 1/8" NPT	6992-0505
Male Elbow, 5/16" Flare x 1/8" NPT	6992-0503
Male Connector, 5/16" Flare x 1/8" NPT	6992-0501
Actuation Hose, 22" (10-200 lb. cylinder)	264987
Actuation Hose, 30" (350-600 lb. cylinder)	264986
Nitrogen Pilot Cylinder	877940
Mounting Bracket, N_2 Pilot Cylinder	877845
¼" Check Valve	264985
Safety Outlet, FM-200	844346
Safety Outlet, N_2/CO_2	803242
REMOTE CONTROL EQUIPMENT, ELECTRIC OPERATED	
Pull Box, Electric Remote 24 Vdc	893607
Pull Box, Electric Remote 125 Vac	893608
REMOTE CONTROL EQUIPMENT, CABLE OPERATED	
Pull Box, Break Glass	871403
Corner Pulley, Watertight	803808
Corner Pulley, 1/2” EMT	844648
1/16" Cable	1593-0002
Z-Bracket	60532
Cable Housing, 125, 200	260702
Cable Housing, 350	260951
Cable Housing, 600	263602
Adapter, 1/2” EMT	843837
Dual Pull Equalizer	840051
Dual Pull Mechanism	840058
AUXILIARY EQUIPMENT	
Supervisory Pressure Switch (10-350 lb. cylinders)	06-118262-001
Supervisory Pressure Switch (600-900 lb. cylinder)	06-118263-001

Table 7-1. Parts List (continued)

NOMENCLATURE	PART NUMBER
Pressure Operated Switch, Standard	486536
Pressure Operated Switch, Ex Proof	981332
Pressure Trip	874290
Transfer Switch, Main to Reserve	802398
Discharge Indicator ½" (Al)	845553
Discharge Indicator ¾" (Brass)	967082
CHECK VALVES	
Check Valve, 3/8" NPT	261193
Check Valve, 1/2” NPT	800327
Check Valve, 3/4” NPT	800266
Check Valve, 1” NPT	800443
Check Valve, 1¼” NPT	800444
Check Valve, 1½” NPT	870152
Check Valve, 2” NPT	870151
Check Valve, 2½" NPT	263716
Check Valve, 3” NPT	870100
Swing Check Valve, 2" NPT	06-118213-001
Swing Check Valve, 3" NPT	06-118058-001
Manifold El-Check Valve, 2” NPT	877690
Manifold El-Check Valve, 2½” NPT	878743
CYLINDER RECHARGE ADAPTERS	
Cylinder Size, 10-125	878757
Cylinder Size, 200, 350	878758
Cylinder Size, 600 (old style)	878759
NAME PLATE	
"Main"	31033
"Reserve"	31034
"Warning FM-200"	06-231865-739

7-2 DISCHARGE NOZZLES

⚠ WARNING

Only listed Kidde FM-200 nozzles are to be used on Kidde ECS Series Engineered Fire Suppression Systems. Failure to comply with this WARNING can result in unpredictable agent distribution.

7-2.1 Listed 360 Degree Nozzles

Note: An additional nozzle finish has been added for a special application. This is a nickel plated nozzle designed to the specifications of the brass version which is FM Approved. The part numbers are exact to that above except for the sixth digit which is a “3” instead of a “0”.

Area (in^2)	1/2" NPT	3/4" NPT	1" NPT	1-1/4" NPT	1-1/2" NPT	2" NPT
0.0774	90-194023-111					
0.0802	90-194023-113					
0.0845	90-194023-116					
0.0905	90-194023-120					
0.0982	90-194023-125					
0.1037	90-194023-129					
0.1162	90-194023-136					
0.1240	90-194023-141					
0.1303	90-194023-144					
0.1358	90-194023-147	90-194024-147				
0.1404	90-194023-150	90-194024-150				
0.1534	90-194023-156	90-194024-156				
0.1629	90-194023-161	90-194024-161				
0.1731	90-194023-166	90-194024-166				
0.1856	90-194023-172	90-194024-172				
0.1968	90-194023-177	90-194024-177				
0.2035	90-194023-180	90-194024-180				
0.2080	90-194023-182	90-194024-182				
0.2150	90-194023-185	90-194024-185				
0.2244		90-194024-189	90-194025-189			
0.2353		90-194024-194	90-194025-194			
0.2488		90-194024-199	90-194025-199			
0.2653		90-194024-206	90-194025-206			
0.2851		90-194024-213	90-194025-213			
0.3007		90-194024-219	90-194025-219			
0.3069		90-194024-221	90-194025-221			
0.3266		90-194024-228	90-194025-228			
0.3440		90-194024-234	90-194025-234			
0.3559		90-194024-238	90-194025-238			
0.3802			90-194025-246	90-194026-246		
0.3927			90-194025-250	90-194026-250		
0.4150			90-194025-257	90-194026-257		
0.4280			90-194025-261	90-194026-261		
0.4433			90-194025-266	90-194026-266		

Area (in^2)	1/2" NPT	3/4" NPT	1" NPT	1-1/4" NPT	1-1/2" NPT	2" NPT
0.4649			90-194025-272	90-194026-272		
0.4821			90-194025-277	90-194026-277		
0.5284			90-194025-290	90-194026-290	90-194027-290	
0.5468			90-194025-295	90-194026-295	90-194027-295	
0.5731			90-194025-302	90-194026-302	90-194027-302	
0.6136			90-194025-313	90-194026-313	90-194027-313	
0.6274				90-194026-316	90-194027-316	
0.6555				90-194026-323	90-194027-323	
0.6765				90-194026-328	90-194027-328	
0.6926				90-194026-332	90-194027-332	
0.7221				90-194026-339	90-194027-339	
0.7424				90-194026-344	90-194027-344	
0.8053				90-194026-358	90-194027-358	
0.8115				90-194026-359	90-194027-359	
0.8509				90-194026-368	90-194027-368	90-194028-368
0.8836				90-194026-375	90-194027-375	90-194028-375
0.8930				90-194026-377	90-194027-377	90-194028-377
0.9362				90-194026-386	90-194027-386	90-194028-386
0.9587				90-194026-391	90-194027-391	90-194028-391
0.9903				90-194026-397	90-194027-397	90-194028-397
1.0255				90-194026-404	90-194027-404	90-194028-404
1.0717					90-194027-413	90-194028-413
1.1183					90-194027-422	90-194028-422
1.2026					90-194027-438	90-194028-438
1.2901					90-194027-453	90-194028-453
1.3806					90-194027-469	90-194028-469
1.4742						90-194028-484
1.5708						90-194028-500
1.6705						90-194028-516
1.7733						90-194028-531
1.8791						90-194028-547
1.9880						90-194028-563
2.1000						90-194028-578
2.2151						90-194028-594
2.3332						90-194028-609

7-2.2 Listed 180 Degree Nozzles

Note: An additional nozzle finish has been added for a special application. This is a nickel plated nozzle designed to the specifications of the brass version which is FM Approved. The part numbers are exact to that above except for the sixth digit which is a “3” instead of a “0”.

Area (in^2)	1/2" NPT	3/4" NPT	1" NPT	1-1/4" NPT	1-1/2" NPT	2" NPT
0.0770	90-194013-109					
0.0810	90-194013-111					
0.0820	90-194013-113					
0.0875	90-194013-116					
0.0931	90-194013-120					
0.1030	90-194013-125					
0.1072	90-194013-129					
0.1190	90-194013-136					
0.1289	90-194013-141					
0.1342	90-194013-144	90-194014-144				
0.1384	90-194013-147	90-194014-147				
0.1428	90-194013-150	90-194014-150				
0.1605	90-194013-156	90-194014-156				
0.1694	90-194013-161	90-194014-161				
0.1779	90-194013-166	90-194014-166				
0.1909	90-194013-172	90-194014-172				
0.2049		90-194014-177				
0.2113		90-194014-180				
0.2177		90-194014-182	90-194015-182			
0.2215		90-194014-185	90-194015-185			
0.2313		90-194014-189	90-194015-189			
0.2405		90-194014-194	90-194015-194			
0.2597		90-194014-199	90-194015-199			
0.2744		90-194014-206	90-194015-206			
0.3005		90-194014-213	90-194015-213			
0.3080		90-194014-219	90-194015-219			
0.3128		90-194014-221	90-194015-221			
0.3364		90-194014-228	90-194015-228			
0.3504			90-194015-234			
0.3623			90-194015-238			
0.4039			90-194015-246	90-194016-246		
0.4056			90-194015-250	90-194016-250		
0.4233			90-194015-257	90-194016-257		
0.4400			90-194015-261	90-194016-261		
0.4485			90-194015-266	90-194016-266		
0.4734			90-194015-272	90-194016-272		
0.4954			90-194015-277	90-194016-277		
0.5379			90-194015-290	90-194016-290	90-194017-290	
0.5636				90-194016-295	90-194017-295	

Area (in^2)	1/2" NPT	3/4" NPT	1" NPT	1-1/4" NPT	1-1/2" NPT	2" NPT
0.5967				90-194016-302	90-194017-302	
0.6382				90-194016-313	90-194017-313	
0.6439				90-194016-316	90-194017-316	
0.6787				90-194016-323	90-194017-323	
0.6875				90-194016-328	90-194017-328	
0.7254				90-194016-332	90-194017-332	
0.7401				90-194016-339	90-194017-339	
0.7884				90-194016-344	90-194017-344	
0.8439				90-194016-358	90-194017-358	90-194018-358
0.8439				90-194016-359	90-194017-359	90-194018-359
0.8767				90-194016-368	90-194017-368	90-194018-368
0.9047				90-194016-375	90-194017-375	90-194018-375
0.9311				90-194016-377	90-194017-377	90-194018-377
0.9588				90-194016-386	90-194017-386	90-194018-386
0.9896					90-194017-391	90-194018-391
1.0140					90-194017-397	90-194018-397
1.0498					90-194017-404	90-194018-404
1.1081					90-194017-413	90-194018-413
1.1699					90-194017-422	90-194018-422
1.2368					90-194017-438	90-194018-438
1.3374						90-194018-453
1.4146						90-194018-469
1.5114						90-194018-484
1.6264						90-194018-500
1.7045						90-194018-516
1.8205						90-194018-531
1.9075						90-194018-547
2.0304						90-194018-563
2.1566						90-194018-578

7-3 LIMITED WARRANTY STATEMENT

Kidde represents that this product is free from defects in material and workmanship, and it will repair or replace any product or part thereof which proves to be defective in workmanship or material for a period of twelve (12) months after shipment to the Seller.

For a full description of Kidde's LIMITED WARRANTY, which, among other things, limits the duration of warranties of MERCHANTABILITY and FITNESS FOR A PARTICULAR PURPOSE and EXCLUDES liability for CONSEQUENTIAL DAMAGES, please read the entire LIMITED WARRANTY on the Kidde Quotation., Acceptance of Order and/or Original Invoice which will become a part of your sale agreement. Defective units should be returned to the factory, Ashland, Massachusetts, shipment prepaid. Kidde will repair or replace and ship prepaid.

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APPENDIX A
MATERIAL SAFETY DATA SHEETS

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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.

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.

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.

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

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

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.

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

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Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name: Nitrogen, compressed (MSDS No. P-4631-F)

Trade Name: Nitrogen

Chemical Name: Nitrogen

Synonyms: Dinitrogen

Formula: N_2

Chemical Family: Permanent gas

Telephone:
Emergencies: 1-800-645-4633*
CHEMTREC: 1-800-424-9300*
Routine: 1-800-PRAXAIR

Company Name: Praxair, Inc.
39 Old Ridgebury Road
Danbury, CT 06810-5113

** Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier, Praxair sales representative, or call 1-800-PRAXAIR (1-800-772-9247).*

2. Composition/Information on Ingredients

See section 16 for important information about mixtures.

INGREDIENT	CAS NUMBER	CONCEN-TRATION	OSHA PEL	ACGIH TLV-TWA (2001)
Nitrogen	7727-37-9	>99%*	None currently established	Simple asphyxiant

** The symbol > means "greater than"; the symbol <, "less than."*

3. Hazards Identification

EMERGENCY OVERVIEW

CAUTION! High-pressure gas.
Can cause rapid suffocation.
May cause dizziness and drowsiness.
Self-contained breathing apparatus may be required by rescue workers.
Odor: None

THRESHOLD LIMIT VALUE: TLV-TWA, simple asphyxiant (ACGIH, 2001). TLV-TWAs should be used as a guide in the control of health hazards and not as fine lines between safe and dangerous concentrations.

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Revised

EFFECTS OF A SINGLE (ACUTE) OVEREXPOSURE:

INHALATION–Asphyxiant. Effects are due to lack of oxygen. Moderate concentrations may cause headache, drowsiness, dizziness, excitation, excess salivation, vomiting, and unconsciousness. Lack of oxygen can kill.

SKIN CONTACT–No harm expected.

SWALLOWING–An unlikely route of exposure. This product is a gas at normal temperature and pressure.

EYE CONTACT–No harm expected.

EFFECTS OF REPEATED (CHRONIC) OVEREXPOSURE: No harm expected.

OTHER EFFECTS OF OVEREXPOSURE: Asphyxiant. Lack of oxygen can kill.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: The toxicology and the physical and chemical properties of nitrogen suggest that overexposure is unlikely to aggravate existing medical conditions.

SIGNIFICANT LABORATORY DATA WITH POSSIBLE RELEVANCE TO HUMAN HEALTH HAZARD EVALUATION: None known.

CARCINOGENICITY: Nitrogen is not listed by NTP, OSHA, or IARC.

4. First Aid Measures

INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, qualified personnel may give oxygen. Call a physician.

SKIN CONTACT: Flush with water. If discomfort persists, seek medical attention.

SWALLOWING: An unlikely route of exposure. This product is a gas at normal temperature and pressure.

EYE CONTACT: Flush eyes thoroughly with water. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. If discomfort persists, seek medical attention.

***NOTES TO PHYSICIAN*:** *There is no specific antidote. Treatment of overexposure should be directed at the control of symptoms and the clinical condition of the patient.*

5. Fire Fighting Measures

FLASH POINT (test method)**:**	Not applicable	
AUTOIGNITION TEMPERATURE:	Not applicable	
FLAMMABLE LIMITS IN AIR, % by volume**:**	**LOWER:** Not applicable	**UPPER:** Not applicable

EXTINGUISHING MEDIA: Nitrogen cannot catch fire. Use media appropriate for surrounding fire.

SPECIAL FIRE FIGHTING PROCEDURES: CAUTION! High-pressure gas. Asphyxiant. Lack of oxygen can kill. Evacuate all personnel from danger area. Immediately deluge cylinders with water from maximum distance until cool; then move them away from fire area if without risk. Shut off flow if you can do so without risk. Self-contained breathing apparatus may be required by rescue workers. (See section 16.) On-site fire brigades must comply with OSHA 29 CFR 1910.156.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Heat of fire can build pressure in cylinder and cause it to rupture. No part of cylinder should be subjected to a temperature higher than 125°F (52°C). Nitrogen cylinders are equipped with a pressure relief device. (Exceptions may exist where authorized by DOT.)

HAZARDOUS COMBUSTION PRODUCTS: None known.

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: CAUTION! High-pressure gas. Asphyxiant. Lack of oxygen can kill. Evacuate all personnel from danger area. Use self-contained breathing apparatus where needed. Shut off flow if you can do so without risk. Ventilate area or move cylinder to a well-ventilated area. Test for sufficient oxygen, especially in confined spaces, before allowing reentry.

WASTE DISPOSAL METHOD: Prevent waste from contaminating the surrounding environment. Keep personnel away. Discard any product, residue, disposable container, or liner in an environmentally acceptable manner, in full compliance with federal, state, and local regulations. If necessary, call your local supplier for assistance.

7. Handling and Storage

PRECAUTIONS TO BE TAKEN IN STORAGE: Store and use with adequate ventilation. Firmly secure cylinders upright to keep them from falling or being knocked over. Screw valve protection cap firmly in place by hand. Store only where temperature will not exceed 125° F (52° C). Store full and empty cylinders separately. Use a first-in, first-out inventory system to prevent storing full cylinders for long periods.

PRECAUTIONS TO BE TAKEN IN HANDLING: Protect cylinders from damage. Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. Never insert an object (e.g., wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Open valve slowly. If valve is hard to open, discontinue use and contact your supplier. For other precautions in using nitrogen, see section 16.

For additional information on storage and handling, refer to Compressed Gas Association (CGA) pamphlet P-1, *Safe Handling of Compressed Gases in Containers*, available from the CGA. Refer to section 16 for the address and phone number along with a list of other available publications.

8. Exposure Controls/Personal Protection

VENTILATION/ENGINEERING CONTROLS:

LOCAL EXHAUST–Use a local exhaust system, if necessary, to prevent oxygen deficiency.

MECHANICAL (general)–General exhaust ventilation may be acceptable if it can maintain an adequate supply of air.

SPECIAL–None

OTHER–None

RESPIRATORY PROTECTION: None required under normal use. Air-supplied respirators must be used in confined spaces or in an oxygen-deficient atmosphere. Respiratory protection must conform to OSHA rules as specified in 29 CFR 1910.134.

SKIN PROTECTION: Wear work gloves when handling cylinders.

EYE PROTECTION: Wear safety glasses when handling cylinders. Select in accordance with OSHA 29 CFR 1910.133.

OTHER PROTECTIVE EQUIPMENT: Metatarsal shoes for cylinder handling. Select in accordance with OSHA 29 CFR 1910.132 and 1910.133. Regardless of protective equipment, never touch live electrical parts.

9. Physical and Chemical Properties

MOLECULAR WEIGHT:	28.01
SPECIFIC GRAVITY (air = 1) at 70°F (21.1°C) and 1 atm**:**	0.967
GAS DENSITY at 70°F (21.1°C) and 1 atm**:**	0.072 lb/ft^3 (1.153 kg/m^3)
SOLUBILITY IN WATER, vol/vol at 32°F (0°C) and 1 atm**:**	0.023
PERCENT VOLATILES BY VOLUME:	100
BOILING POINT at 1 atm**:**	-320.44°F (-195.80°C)
MELTING POINT at 1 atm**:**	-345.8°F (-209.9°C)

APPEARANCE, ODOR, AND STATE: Colorless, odorless, tasteless gas at normal temperature and pressure.

10. Stability and Reactivity

STABILITY: ☐ **Unstable** ☒ **Stable**

INCOMPATIBILITY (materials to avoid): None known.

HAZARDOUS DECOMPOSITION PRODUCTS: None known.

HAZARDOUS POLYMERIZATION: ☐ **May Occur** ☒ **Will Not Occur**

CONDITIONS TO AVOID: Under certain conditions, nitrogen can react violently with lithium, neodymium, titanium, and magnesium to form nitrides. At high temperature it can also combine with oxygen and hydrogen.

11. Toxicological Information

Nitrogen is a simple asphyxiant.

12. Ecological Information

No adverse ecological effects expected. Nitrogen does not contain any Class I or Class II ozone-depleting chemicals. Nitrogen is not listed as a marine pollutant by DOT.

13. Disposal Considerations

WASTE DISPOSAL METHOD: Do not attempt to dispose of residual or unused quantities. Return cylinder to supplier. For emergency disposal, secure cylinder in a well-ventilated area or outdoors, and then slowly discharge gas to the atmosphere.

14. Transport Information

DOT/IMO SHIPPING NAME: Nitrogen, compressed

HAZARD CLASS: 2.2	**IDENTIFICATION NUMBER:** UN 1066	**PRODUCT RQ:** None
SHIPPING LABEL(s):	NONFLAMMABLE GAS	
PLACARD (when required):	NONFLAMMABLE GAS	

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. Cylinders transported in an enclosed, nonventilated compartment of a vehicle can present serious safety hazards.

Shipment of compressed gas cylinders that have been filled without the owner's consent is a violation of federal law [49 CFR 173.301(b)].

15. Regulatory Information

The following selected regulatory requirements may apply to this product. Not all such requirements are identified. Users of this product are solely responsible for compliance with all applicable federal, state, and local regulations.

U.S. FEDERAL REGULATIONS:

EPA (ENVIRONMENTAL PROTECTION AGENCY)

CERCLA: COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (40 CFR Parts 117 and 302):

Reportable Quantity (RQ): None

SARA: SUPERFUND AMENDMENT AND REAUTHORIZATION ACT:

SECTIONS 302/304: Require emergency planning based on Threshold Planning Quantity (TPQ) and release reporting based on Reportable Quantities (RQ) of Extremely Hazardous Substances (EHS) (40 CFR Part 355):

Threshold Planning Quantity (TPQ): None
EHS RQ (40 CFR 355): None

SECTIONS 311/312: Require submission of MSDSs and reporting of chemical inventories with identification of EPA hazard categories. The hazard categories for this product are as follows:

IMMEDIATE: No
DELAYED: No
PRESSURE: Yes
REACTIVITY: No
FIRE: No

SECTION 313: Requires submission of annual reports of release of toxic chemicals that appear in 40 CFR Part 372.

Nitrogen does not require reporting under Section 313.

40 CFR 68: RISK MANAGEMENT PROGRAM FOR CHEMICAL ACCIDENTAL RELEASE PREVENTION: Requires development and implementation of risk management programs at facilities that manufacture, use, store, or otherwise handle regulated substances in quantities that exceed specified thresholds.

Nitrogen is not listed as a regulated substance.

TSCA: TOXIC SUBSTANCES CONTROL ACT: Nitrogen is listed on the TSCA inventory.

OSHA: OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION**:**

29 CFR 1910.119: PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS: Requires facilities to develop a process safety management program based on Threshold Quantities (TQ) of highly hazardous chemicals.

Nitrogen is not listed in Appendix A as a highly hazardous chemical.

STATE REGULATIONS:

CALIFORNIA: Nitrogen is not listed by California under the SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (Proposition 65).

PENNSYLVANIA: Nitrogen is subject to the PENNSYLVANIA WORKER AND COMMUNITY RIGHT-TO-KNOW ACT (35 P.S. Sections 7301-7320).

16. Other Information

Be sure to read and understand all labels and instructions supplied with all containers of this product.

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

OTHER HAZARDOUS CONDITIONS OF HANDLING, STORAGE, AND USE: ***High-pressure gas.*** Use piping and equipment adequately designed to withstand pressures to be encountered. ***Gas can cause rapid suffocation due to oxygen deficiency.*** Store and use with adequate ventilation. Close valve after each use; keep closed even when empty. ***Never work on a pressurized system.*** If there is a leak, close the cylinder valve. Blow the system down in a safe and environmentally sound manner in compliance with all federal, state, and local laws; then repair the leak***. Never place a compressed gas cylinder where it may become part of an electrical circuit.***

MIXTURES: When you mix two or more gases or liquefied gases, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist or other trained person when you evaluate the end product. Remember, gases and liquids have properties that can cause serious injury or death.

HAZARD RATING SYSTEMS:

NFPA RATINGS:		**HMIS RATINGS:**	
HEALTH	= 0	HEALTH	= 0
FLAMMABILITY	= 0	FLAMMABILITY	= 0
REACTIVITY	= 0	REACTIVITY	= 0
SPECIAL	= SA (CGA recommends this to designate Simple Asphyxiant.)		

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED:	0-3000 psig	CGA-580
	3001-5500 psig	CGA-680
	5001-7500 psig	CGA-677
PIN-INDEXED YOKE:	0-3000 psig	CGA-960 (medical use)
ULTRA-HIGH-INTEGRITY CONNECTION:	0-3000 psig	CGA-718

Use the proper CGA connections. **DO NOT USE ADAPTERS.** Additional limited-standard connections may apply. See CGA pamphlet V-1 listed below.

Ask your supplier about free Praxair safety literature as referred to in this MSDS and on the label for this product. Further information about this product can be found in the following pamphlets published by the Compressed Gas Association, Inc. (CGA), 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923, Telephone (703) 788-2700.

AV-1	*Safe Handling and Storage of Compressed Gases*
G-10.1	*Commodity Specification for Nitrogen*
P-1	*Safe Handling of Compressed Gases in Containers*
P-9	*Inert Gases – Argon, Nitrogen, and Helium*
P-14	*Accident Prevention in Oxygen-Rich, Oxygen-Deficient Atmospheres*
SB-2	*Oxygen-Deficient Atmospheres*
V-1	*Compressed Gas Cylinder Valve Inlet and Outlet Connections*
—	*Handbook of Compressed Gases, Third Edition*

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

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

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http://www.kiddefiresystems.com

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