P/N 90-FM200M-021
March 2008

FM-200®
Marine ECS Series Engineered Fire Suppression System

Design, Installation, Operation and Maintenance Manual

LISTED

UL Listing File No. EX 4674

KiddeFire Systems

A UTC Fire & Security Company

FOREWORD

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

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 informational 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.

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

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Ashland, MA 01721
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IMPORTANT

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Kidde FM-200 Fire Suppression Systems, unless otherwise required by the Authority Having Jurisdiction (AHJ), 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-021.
- 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.

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TERMS AND ABBREVIATIONS

ADA:	Americans with Disabilities Act	NFPA:	National Fire Protection Association
AHJ:	Authority Having Jurisdiction	P/N:	Part Number
CO_2:	Carbon Dioxide	V:	Volts
FM:	FM Approvals	Vac:	Volts AC
H_2O:	Water	Vdc:	Volts DC
HVAC:	Heating, Venting and Air Conditioning		

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, Appendix A and on the cylinder nameplate.

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 PRESSURIZED CYLINDERS

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.

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.

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.

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.

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CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

Kidde FM-200® Marine ECS Series Engineered Fire Suppression Systems are Listed for Marine use by Underwriters Laboratories, Inc. (UL). This manual describes the processes and procedures for the design, installation, operation and maintenance of systems intended for vessels subject to inspection by the United States Coast Guard (USCG) and designed in accordance with the applicable maritime regulations, according to the regulatory Authority Having Jurisdiction (AHJ). This could include the USCG, International Marine Organization (IMO) and/or the National Fire Protection Agency (NFPA) 2001, in addition to local regional flag or administration authority regulations. Refer to the local AHJ for information on the accepted design regulations.

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 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 Marine ECS Series Engineered Fire Suppression Systems combine an environmentally safe fire suppression agent, effective control devices and specially developed components for fast agent discharge. The resulting rapid suppression of a fire reduces physical damage and products of combustion to the lowest possible level. These systems are electrically, pressure and/or cable operated, with a design discharge time of between six and ten seconds.

1-2 SYSTEM DESCRIPTION

1-2.1 General

Kidde FM-200 Marine ECS Series Systems are primarily used to protect critical machinery spaces where fire suppression must be extremely rapid, the risk to personnel minimized and/or on-board space is minimal. The agent is colorless, odorless and electrically non-conductive with an excellent material compatibility profile.

The discharge of FM-200 is achieved in six to ten seconds, in accordance with NFPA 2001. Complete discharge is therefore at least six times faster than CO_2 or inert agents. Rapid discharge and extinguishment limits the risk to personnel, the threat to continued vessel operation and damage to the equipment, structure and property on board.

The Environmental Protection Agency (EPA) has declared FM-200 safe for personnel at fire suppression design concentrations of up to 10.5% v/v within defined exposure limits. Personnel can be exposed to concentrations of up to 9.0% v/v indefinitely without adverse effect (see Paragraph 1-2.2.1).

Knowing that the available space for marine fire suppression systems is generally limited, Kidde FM-200 Marine Systems are designed to be space efficient. A wide range of agent storage cylinder capacities are available. Due to the high efficiency of the agent (requiring typically only 8.7% concentration by volume), a typical system requires considerably less space than a conventional CO_2 system.

Typically protected areas include:

- Engine rooms
- Pump rooms
- Control rooms
- Generator rooms
- Turbine enclosures
- Flammable liquid storage rooms

Kidde FM-200 Marine Systems are designed and extensively tested to extinguish fires of the following classes of fire:

- Class A: Surface fires in wood or other cellulose material (not suitable for use in cargo holds or for deep seated Class A fires)
- Class B: Flammable liquid fires (see Table 4-1)
- Class C: Energized electrical equipment

Note: The USCG IMO testing of Kidde FM-200 Marine ECS Series Systems included Class A materials to prove that the system could protect supplemental risk materials within a predominantly Class B fire scenario. The USCG listing reflects this application scenario per the test protocol of MSC Circular 848.

For hazards beyond the scope described above, the designer must consult Kidde Fire Systems and the AHJ on the suitability of FM-200 for the protection, necessary design concentration and personnel exposure implications.

FM-200 shall not be used on fires involving the following materials, unless they have been tested to the satisfaction of the USCG or the AHJ:

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 nozzles. Marine applications typically protect single- or multiple-hazard areas that have direct volumetric communication, in which case container temperature conditioning is not necessary.

1-2.2 Extinguishing Agent

FM-200 (1,1,1,2,3,3,3-heptafluoropropane) is a compound of carbon, fluorine and hydrogen (CF3CHFCF3) that 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 which 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 U.S. 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 should be avoided in accordance with the requirements of NFPA 2001, 2000 Edition. 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 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 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, 2000 Edition, FM-200 systems designed for use with agent vapor concentrations up to nine volume percent 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, FM-200 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 ten seconds or less, flames are rapidly extinguished and the amount of by-products produced is minimal. Provisions should be made to ensure control stations, escape routes and other access points to a hazard are sufficiently sealed to prevent exposure to leakage of agent decomposition products (HF) and products of combustion (smoke, fumes and particulates).

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 CONSIDERATION

he 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 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 gauge 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 Figures 1-1 and 1-2. When discharged, the FM-200 liquid vaporizes at the discharge nozzles and is uniformly distributed as it enters the fire area.

The maximum fill in a Kidde Marine ECS cylinder is 70 lb./ft.^{3} (1120 kg/m^3).

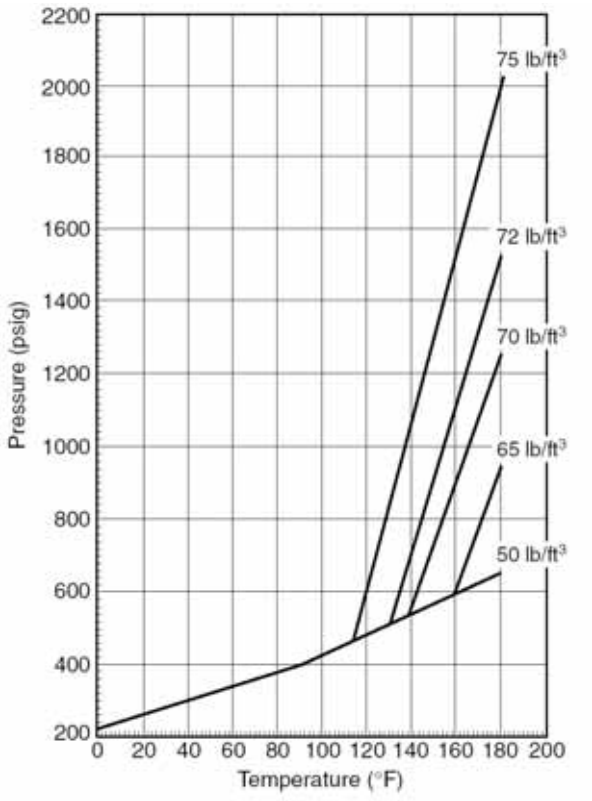

Figure 1-1. FM-200 Pressure/Temperature Curve Isometric Diagram

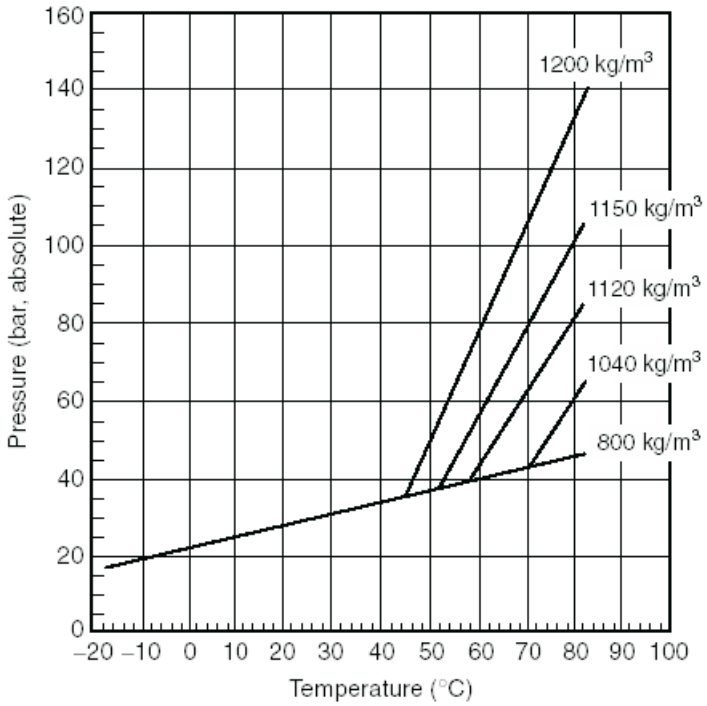

Figure 1-2. FM-200 Pressure/Temperature Curve Isometric Diagram, Metric

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	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%

CHAPTER 2
OPERATION

2-1 INTRODUCTION

This chapter describes the basic operating principle and procedures for the Kidde FM-200® Marine ECS Series Engineered Fire Suppression System.

2-2 SYSTEM CONTROLS AND INDICATORS

2-2.1 General

FM-200 agent, super-pressurized with nitrogen, is stored in welded steel cylinders fitted with fast-acting discharge valves. To initiate a discharge, the valve is opened directly or indirectly by the control system, which vents the top chamber of the valve allowing the valve piston to be displaced. The agent then flows into the discharge pipes as a liquid to the nozzles in the system. The agent rapidly vaporizes at the nozzles, and is dispersed to create a homogeneous mixture of agent and enclosure air. The nozzles provide the proper flow rate and distribution of FM-200. The concentration of the final form of agent is at least equal to the minimum design concentration, and this concentration is maintained in the enclosure for the required hold-time to prevent re-ignition.

2-3 OPERATING PROCEDURES

2-3.1 Remote Manual Operation

Operate as follows:

1. Evacuate the hazard area as quickly and safely as possible.
2. Ensure all personnel have exited the hazard area.
3. Ensure hazard integrity; close all hatches, vents, ducts and other openings into protected space.
4. Proceed to the appropriate remote release station.
5. Operate the release controls.
6. Confirm that the system has been operated.
7. Prevent personnel from re-entering the hazard area.

Note: The above operating instructions must be posted on display in the protected area. These instructions should also indicate the cylinder storage location in the event that the system must be locally operated during an emergency condition.

2-3.2 Local Manual Operation

Operate as follows:

1. Evacuate the hazard area as quickly and safely as possible.
2. Ensure all personnel have exited the hazard area.
3. Ensure hazard integrity; close all hatches, vents, ducts and other openings into protected space.
4. Proceed to the appropriate local release station.
5. Operate the release controls.

6. Confirm that the system has been operated.
7. Prevent personnel from re-entering the hazard area.

Note: The above operating instructions must be posted at the local release station.

2-3.3 Automatic Operation

Note: Where permitted (see Paragraph 4-2.5.4).

When the system is operated automatically, personnel must immediately evacuate the hazard area upon hearing the pre-discharge alarm. Prevent personnel form re-entering the hazard area.

2-4 POST-FIRE OPERATION

WARNING

Do not enter a hazard area with an open flame or lighted cigarette. The possible presence of flammable vapors may cause re-ignition or explosion.

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

After an FM-200 discharge, one must observe all warnings before entering the hazard area. Integrity must be maintained to prevent the migration of products of decomposition to adjacent areas outside of the protected space. After extinguishment, a minimum agent hold time of fifteen minutes must be maintained. When ventilating the protected space of products of combustion, care should be taken to allow smoke, decomposition products, etc., to clear the vessel, away from personnel, muster stations, embarkation areas, etc. Upon arriving in port, qualified fire suppression system maintenance personnel must perform post-fire maintenance, as described in Chapter 6 of this manual.

2-5 CYLINDER RECHARGE

1. Recharge all FM-200 and nitrogen pilot cylinders immediately after use.
2. Return all cylinders to Kidde distributor or qualified refill agency.
3. Refill in accordance with procedures outlined in Paragraph 6-3 of this manual.

2-6 SPECIAL SYSTEM PRECAUTIONS

2-6.1 Resetting Non-Pressure Operated Control Heads

All control heads must be reset prior to reinstallation on FM-200 cylinder valves.

2-6.2 Resetting Pressure Operated Control Heads

Pressure operated and lever/pressure operated control heads reset themselves only after actuation pressure (either from a pilot cylinder or master FM-200 cylinder) is released.

2-6.2.1 PRESSURE OPERATED CONTROL HEADS ACTUATED BY PRESSURE FROM A MASTER FM-200 CYLINDER

Pressure and lever/pressure operated control heads actuated by pressure from a master FM-200 cylinder will automatically reset following system actuation. The master/slave arrangement permits FM-200 pressure to back-bleed into the discharge manifold to release the pressure. As a precaution before reattaching the pressure operated control head(s) to the FM-200 cylinder control port, ensure that the actuating pin(s) is/are in the retracted (SET) position.

2-6.2.2 PRESSURE OPERATED CONTROL HEADS NOT ACTUATED BY PRESSURE FROM A MASTER FM-200 CYLINDER

Pressure and lever/pressure operated control heads NOT actuated by pressure from a master FM-200 cylinder will not automatically reset themselves. In these arrangements, pilot pressure can remain in the pilot manifold upon system actuation, which keeps the control head actuating pin(s) in the "OPERATED" position. Therefore, before re-attaching pressure operated control heads to the recharged FM-200 cylinders, the following procedure must be performed to ensure that the pilot manifold is vented, and the 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 nitrogen pilot cylinders to the correct charged pressure and reinstall master control head.
3. Before installing pressure operated control heads on the FM-200 cylinders, 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.

2-6.2.3 SYSTEMS ACTUATED WITH PILOT NITROGEN CYLINDER(S)

In systems where a pilot nitrogen cylinder actuates a pressure operated control head on a slave FM-200 cylinder, nitrogen pressure can remain in the pilot manifold when the system actuates. 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.

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CHAPTER 3
FUNCTIONAL DESIGN

3-1 INTRODUCTION

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

3-1.1 3 in. Cylinder Valve

In 2001, Kidde Fire Systems added a 3 in. discharge valve to its product line. This valve replaces the 2½ in. 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 in., 2 in. and 2½ in. valves, and the new 3 in. valve, are detailed in this manual (see Paragraph 3-1.1, Paragraph 3-3.10.2, Paragraph 3-3.10.5, Paragraph 3-3.10.11, Paragraph 3-3.12.2, Paragraph 4-3.24.1, Paragraph 4-3.24.2, Paragraph 6-2.3, and Paragraph 6-2.7). Data relating to the 600 lb. cylinder assembly with a 2½ in. 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 DESCRIPTIONS

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

- Cylinder/valve assembly including pressure indicator
- Liquid level indicator (optional on larger capacity cylinders)
- Cylinder mounting hardware
- Control heads (pressure, manual lever, cable and pneumatic)
- Dual-pull mechanism and equalizer
- Corner pulley units
- Pneumatic detector
- Pneumatic tubing and fittings
- Remote pull stations
- Nitrogen pilot cylinder (108 cu. in.), bracket and fitting
- Nitrogen pilot system cylinders (1040 and 2300 cu. in.)
- Nitrogen discharge heads
- Nitrogen discharge hoses
- Nitrogen manifold "Y" fitting
- Nitrogen cylinder straps
- Nitrogen time delay units
- Nitrogen pressure operated siren
- Pilot nitrogen ball valve, 1/4 in.
- Flexible actuation hose
- Master cylinder adapter kit
- Dual-loop bleed kit
- Tees, elbows and adapters

- Pressure actuation fittings
- Flexible discharge hose
- Valve outlet adapters
- Check valves, 1/4 in. and 3/8 in.
- Manifolded EL-Check valves
- Check valves
- Swing check valves
- Stop valves
- Pressure operated switches
- Pressure operated trip
- Discharge indicator
- Supervisory pressure switch
- Discharge nozzles
- Safety Outlets
- Warning and instruction nameplates
- Hydrostatic test adapter
- Recharge adapters
- Seating adapter

Figure 3-1 illustrates a basic marine system.

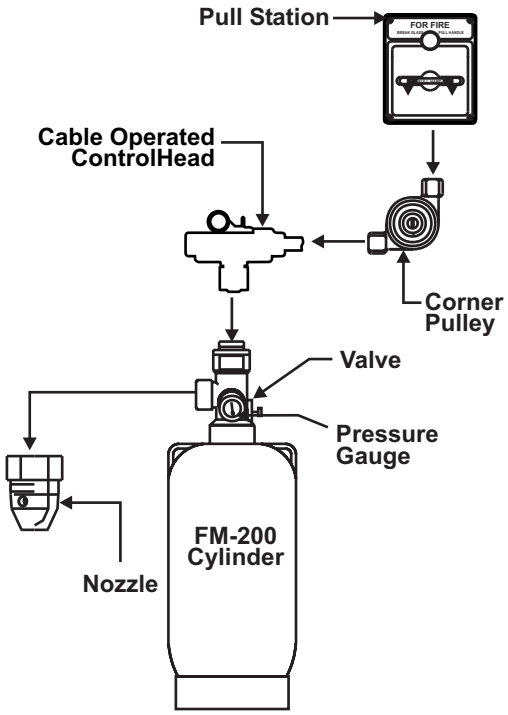


Figure 3-1. Basic Marine System

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.

Figure 3-2 through Figure 3-4 represent typical cylinder assemblies. See Table 3-1 for cylinder dimensions.

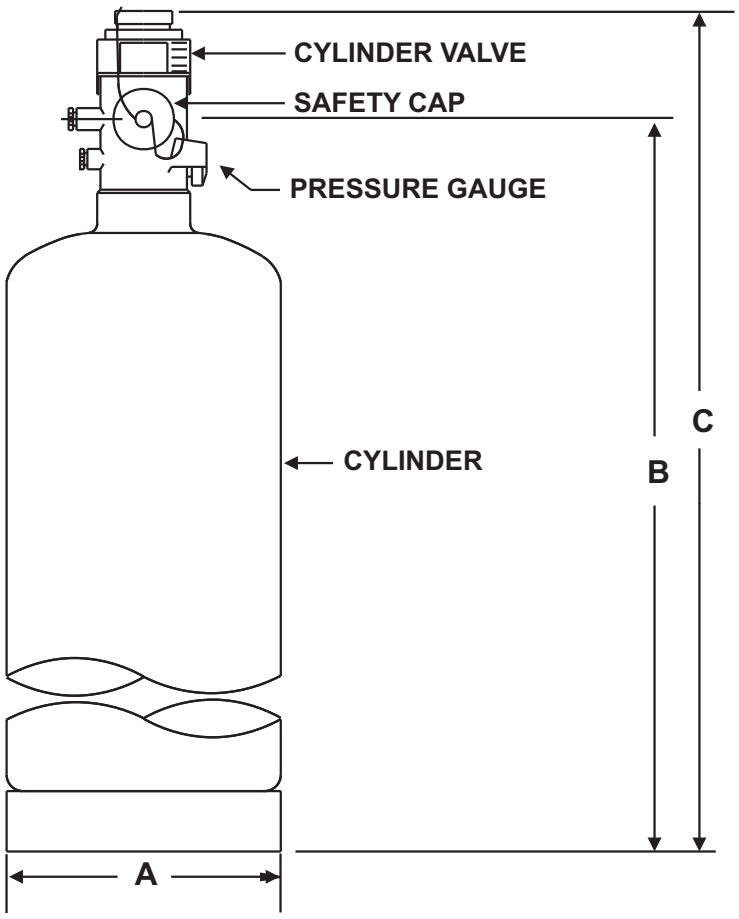


Figure 3-2. Typical Cylinder Assembly, 10 to 70 lb.

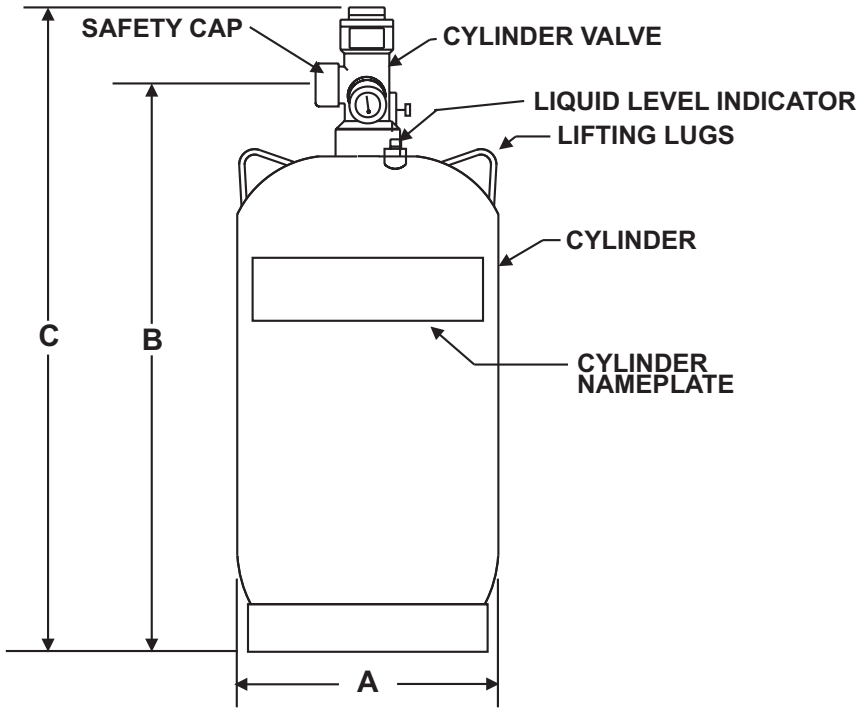


Figure 3-3. Typical Cylinder Assembly, 125 to 350 lb.

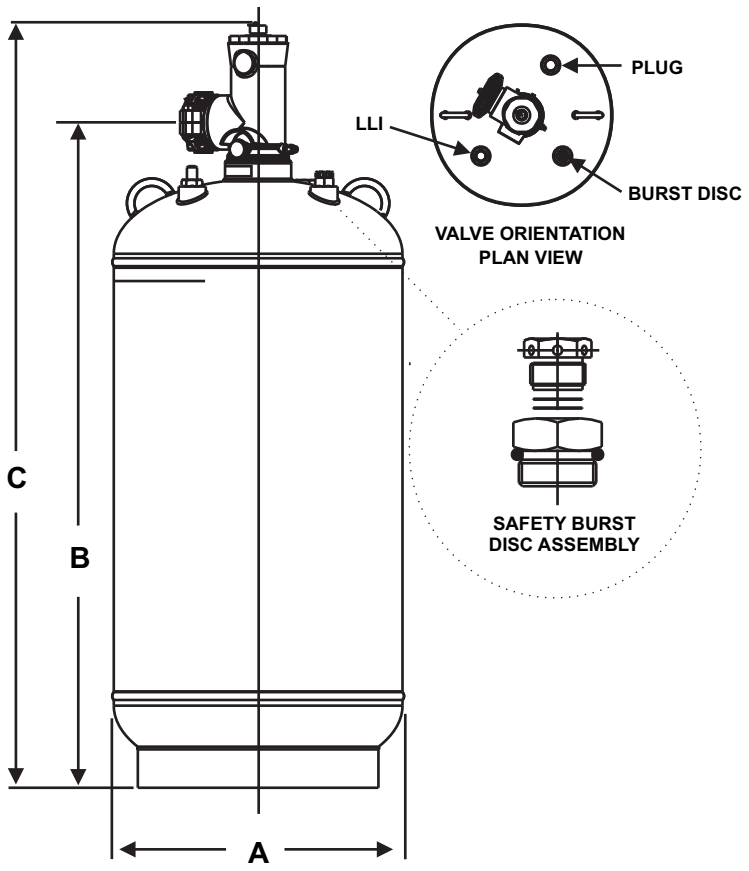


Figure 3-4. 600 to 900 lb. Cylinder with 3 in. Valve

The Kidde FM-200 Marine 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 3-2 shows the container temperature-pressure relationship based on a maximum fill density of 70 lb./ft.3 (1121 kg/m3). The Kidde Marine 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.

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).

Table 3-3 charts the fill range for FM-200 cylinder and valve assemblies in vertical installations.

As a reference guide, Table 3-4 provides the equivalent lengths for all the Kidde FM-200 Marine 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.

Figure 3-5 and Figure 3-6 represent the 1½ in. through 3 in. valve arrangements.

Table 3-1. 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 in.	No	17.3	0.44	7.07	0.18	0.167	0.0047	13.3	0.36
90-10002X-001	1½ in.	No	24.97	0.64	7.07	0.18	0.286	0.0081	21.0	0.53
90-10004X-001	1½ in.	No	26.76	0.68	9.00	0.23	0.572	0.0162	22.8	0.58
90-10007X-001	1½ in.	No	38.83	0.99	9.00	0.23	1.000	0.0283	34.9	0.89
90-100121-001	1½ in.	Yes	35.93	0.92	12.75	0.33	1.788	0.0506	32.0	0.81
90-100125-001	1½ in.	No	35.93	0.92	12.75	0.33	1.788	0.0506	32.0	0.81
90-100200-101	2 in.	No	52.75	1.34	12.75	0.33	2.859	0.0810	47.5	1.21
90-100201-101	2 in.	Yes	52.75	1.34	12.75	0.33	2.859	0.0810	47.5	1.21
90-100350-001	2 in.	No	58.36	1.49	16.00	0.41	5.000	0.1416	53.1	1.35
90-100351-001	2 in.	Yes	58.36	1.49	16.00	0.41	5.000	0.1416	53.1	1.35
90-100600-001*	2½ in.	No	56.72	1.45	22.00	0.56	8.572	0.2427	50.5	1.28
90-100601-001*	2½ in.	Yes	56.72	1.45	22.00	0.56	8.572	0.2427	50.5	1.28
90-100600-100	3 in.	No	58.00	1.47	22.00	0.56	8.680	0.2460	50.5	1.28
90-100601-100	3 in.	Yes	58.00	1.47	22.00	0.56	8.680	0.2460	50.5	1.28
90-100900-001	3 in.	No	70.00	1.78	24.00	0.61	13.000	0.3680	62.0	1.57
90-100901-001	3 in.	Yes	70.00	1.78	24.00	0.61	13.000	0.3680	62.0	1.57
*Note: See Paragraph 3.1.1.										

Table 3-2. Container Temperature-Pressure Correlation
(Based on a cylinder fill density of 70 lb./ft.^{3} or 1121 kg/m^3).

Temperature		Normal 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

Table 3-3. 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	10-20	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

Table 3-4. Cylinder, Equivalent Lengths[1]

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	1-1/2 in.	61.8	18.84	65	19.81
90-100020-001	20 lb. Cylinder	1-1/2 in.	61.8	18.84	65	19.81
90-100040-001	40 lb. Cylinder	1-1/2 in.	61.8	18.84	65	19.81
90-100070-001	70 lb. Cylinder	1-1/2 in.	61.8	18.84	65	19.81
90-10012X-001	125 lb. Cylinder	1-1/2 in.	61.8	18.84	65	19.81
90-10020X-001	200 lb. Cylinder	2 in.	59.0	17.98	65	19.81
90-10035X-001	350 lb. Cylinder	2 in.	59.0	17.98	65	19.81
90-10060X-001	600 lb. Cylinder (old style)	2-1/2 in.	59.0	17.98	65	19.81
90-10060X-100	600 lb. Cylinder (new style)	3 in.	50.0	15.00	80	24.00
90-10090X-001	900 lb. Cylinder	3 in.	50.0	15.00	80	24.00

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

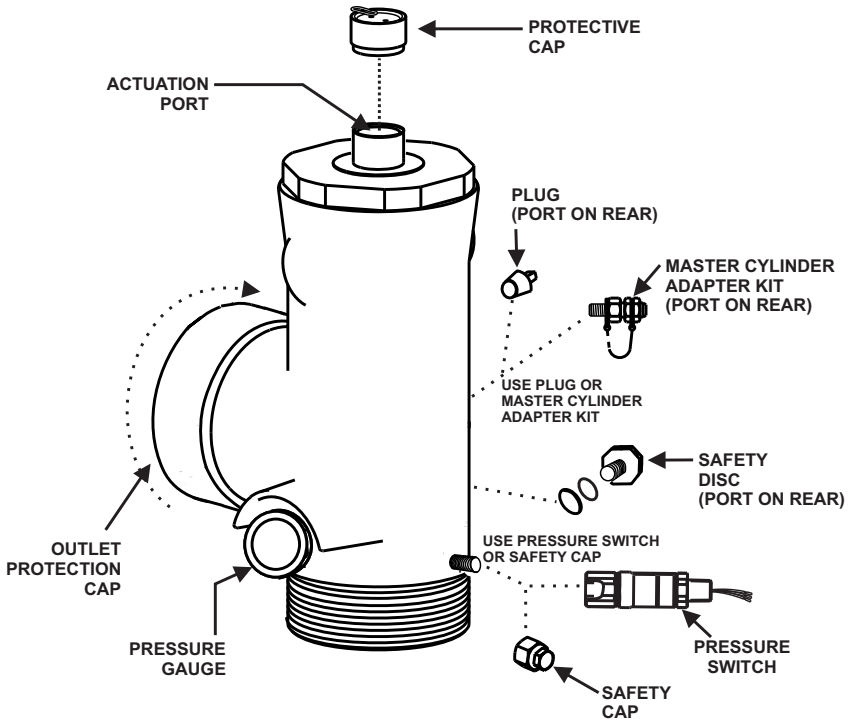


Figure 3-5. 1½ in., 2 in. and 2½ in. Valve General Arrangement

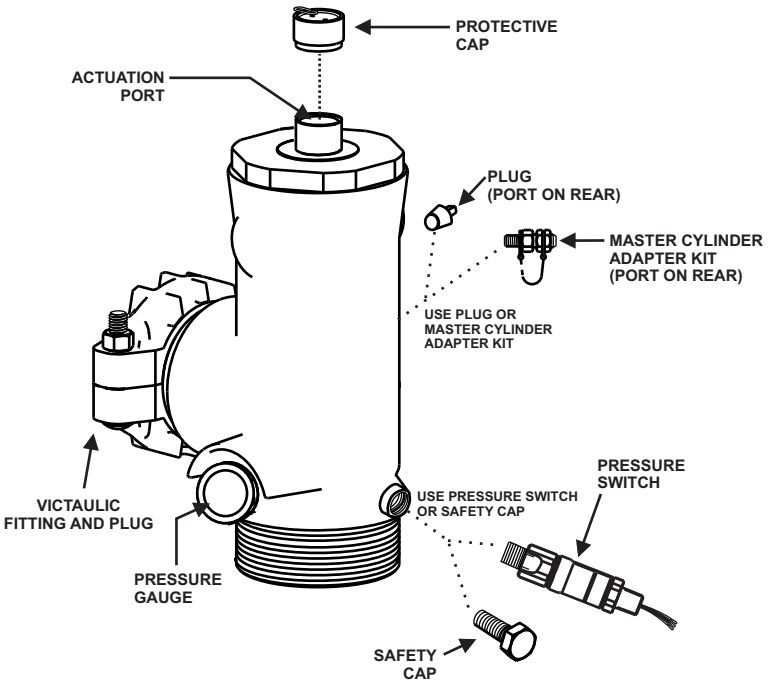


Figure 3-6. 3 in. Valve General Arrangement

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 3-7).

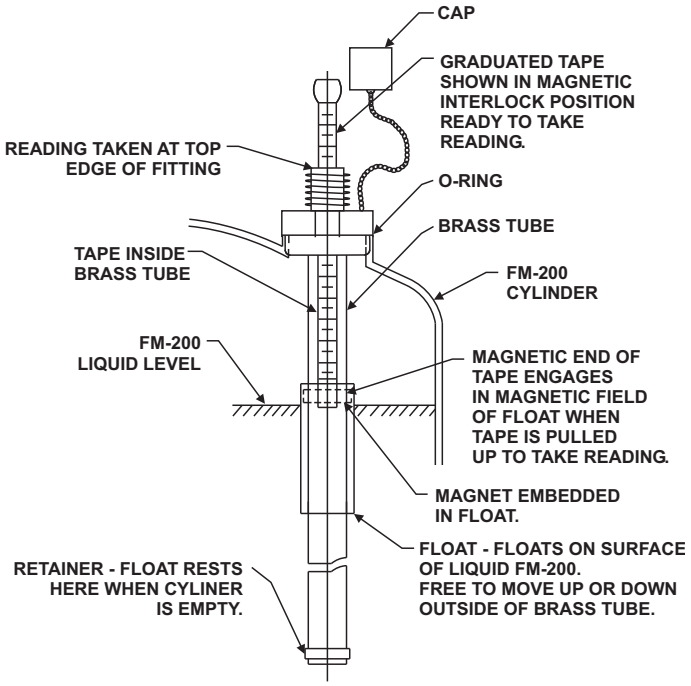


Figure 3-7. Liquid Level Indicator

Table 3-5. Liquid Level Indicator Part Numbers

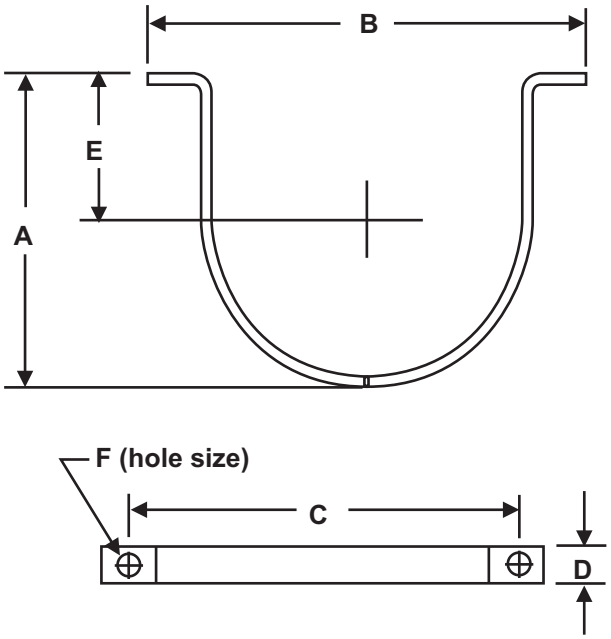
Cylinder	Liquid Level Tape Part Number
125	235681
200	283894
350	283894
600	283894
900	06-118266-001

3-3.3 Cylinder Mounting Equipment

Steel straps and cradles 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 3-8 and Table 3-6 and Table 3-7.

Cylinders of 125 lb. capacity and above are further supported with cylinder cradles (P/N 235431, 281867, 294652 and 06-118300-001). See Figure 3-9 and Table 3-8 and Table 3-9.



Note: Material–Steel, zinc chromate primer and black lacquer.

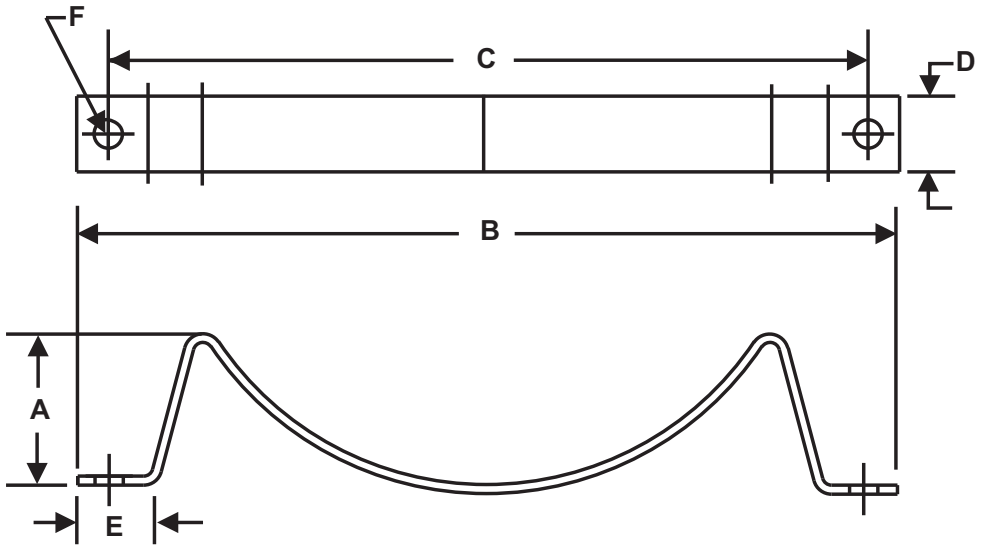
Figure 3-8. Cylinder Mounting Straps

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
235317	125, 200	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	11.1
283934	40, 70	229	207	297	272	25	89	11.1
235317	125, 200	319	329	411	370	44	142	15.9
281866	350	406	394	495	454	44	184	15.9
294651	600	559	548	654	613	44	260	15.9
236125	900	610	619	705	660	44	308	15.9
*Note: Dimensions are in millimeters.								



Materials: Steel, zinc chromate primer and black lacquer

Figure 3-9. Cylinder Cradles

Table 3-8. Dimensions–Cylinder Cradles

Part Number	Cylinder Capacity	Cylinder O.D.	Dimensions					
		lb.	A	B	C	D	E	F
WK-878760-000	70		2.16	11.69	10.69	1.00	1.25	.437
235431	125, 200 new style	12.75	3.20	16.25	15.00	1.50	1.312	0.562
281867	350	16.00	3.58	19.24	18.00	1.50	1.340	0.562
294652	600	22.00	4.75	25.24	24.00	1.75	1.340	0.562
06-118300-001	900	24.00	5.18	27.74	26.00	1.75	1.680	0.625
*Note: Dimensions are in inches.								

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

Part Number	Cylinder Capacity	Cylinder O.D.	Dimensions					
		mm	A	B	C	D	E	F
WK-878760-000	70		55	297	272	25		11
235431	125, 200 new style	324	81	413	381	38	33	14
281867	350	406	91	489	457	38	34	14
294652	600	559	121	641	610	45	34	14
06-118300-001	900	610	132	705	660	45	43	16
*Note: Dimensions are in millimeters.								

3-3.4 Lever/Pressure Control Heads

3-3.4.1 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. When the safety pin is removed, the lever can be manually rotated to the open position, thereby activating the cylinder or valve on which it is installed. The lever operated control head is self-venting to prevent accidental system discharge (see Figure 3-10).

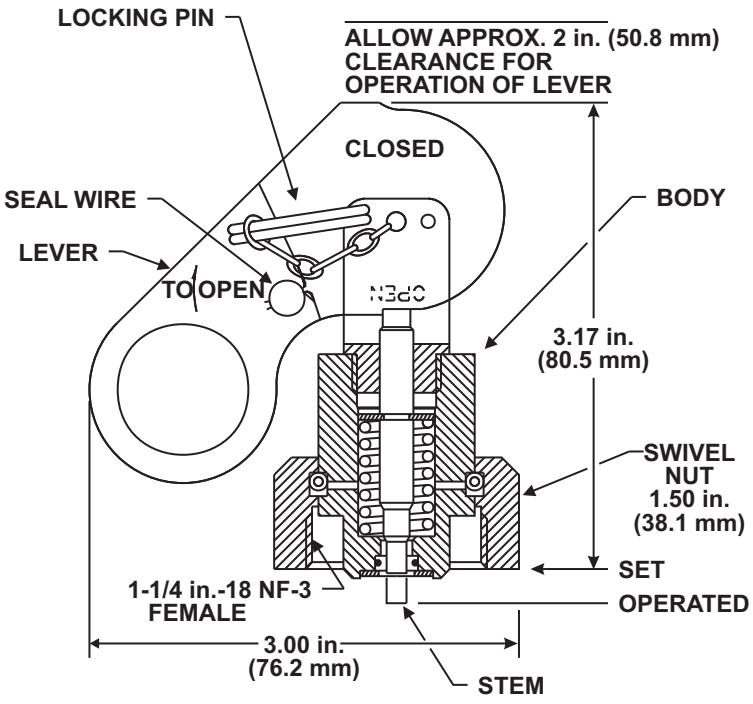


Figure 3-10. Lever Operated Control Head

3-3.4.2 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. The lever/pressure operated control head is self-venting to prevent accidental system discharge (see Figure 3-11).

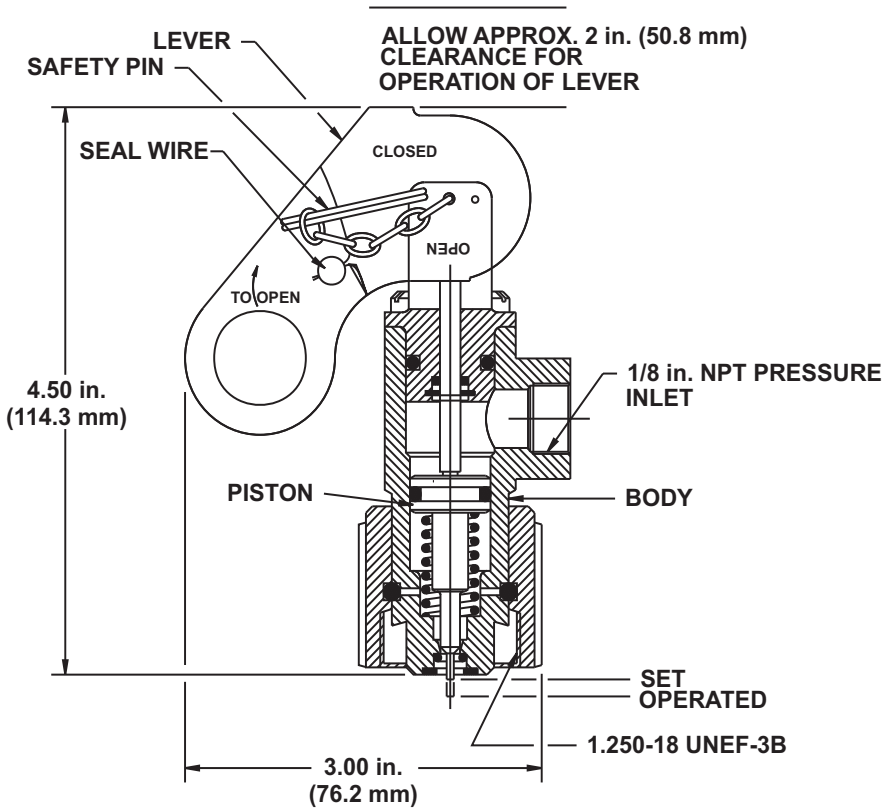


Figure 3-11. Lever/Pressure Operated Control Head

3-3.4.3 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 3-12). 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 3-13). The pressure operated control head is self-venting to prevent accidental system discharge.

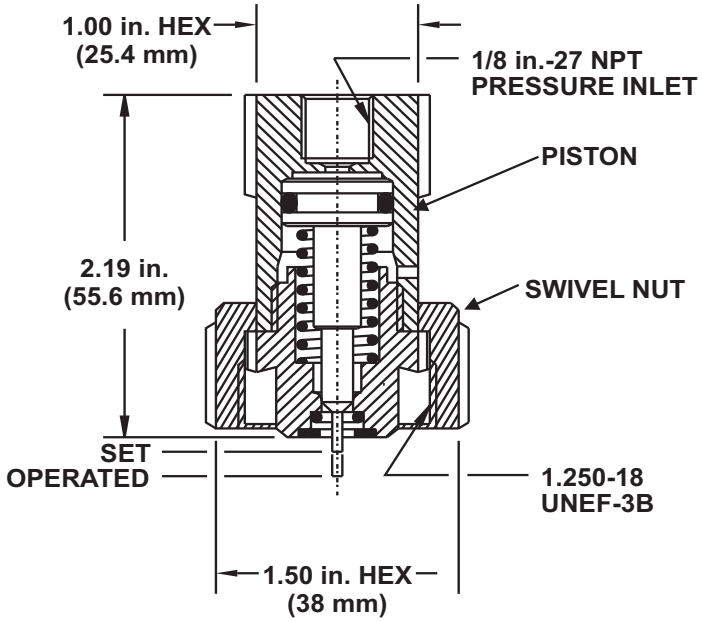


Figure 3-12. Pressure Operated Control Head

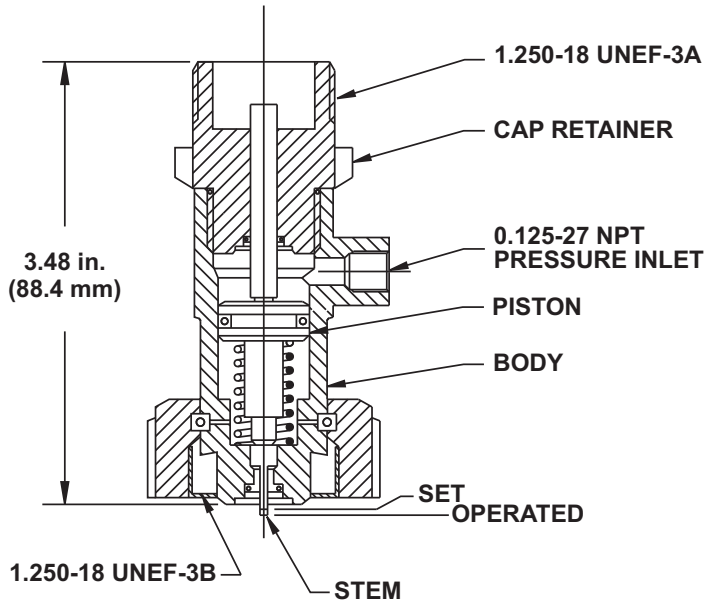


Figure 3-13. Stackable Pressure Operated Control Head

3-3.5 Cable Operated Control Heads and Ancillaries

3-3.5.1 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. The cable operated control head is self-venting to prevent accidental system discharge (see Figure 3-14).

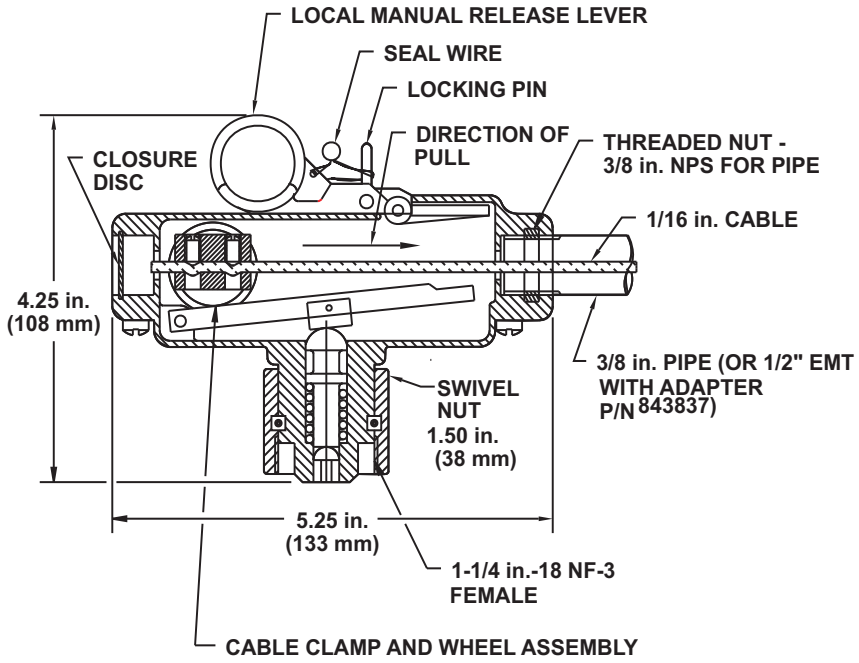


Figure 3-14. Cable Operated Control Head

3-3.5.2 DUAL-PULL MECHANISM, P/N 840058

The dual-pull mechanism is used where two remote cable pull stations are required for a single system. The cables from each station are secured in a clamping block within the unit, allowing a single control cable to be routed to the cylinder control head (see Figure 3-15).

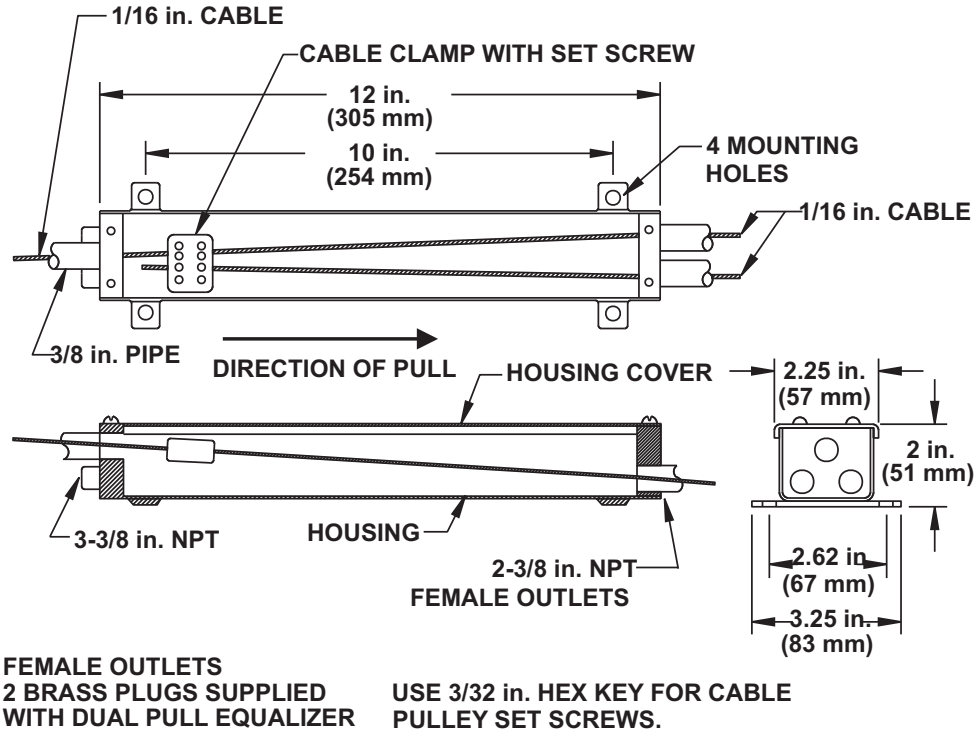


Figure 3-15. Dual-Pull Mechanism

3-3.5.3 DUAL-PULL EQUALIZER, P/N 840051

The dual-pull equalizer is used where two control-heads are to be operated by a single control cable and remote cable pull station. A single cable is routed from the first control head through the pulley installed in the unit, and is terminated in the second control head (see Figure 3-16).

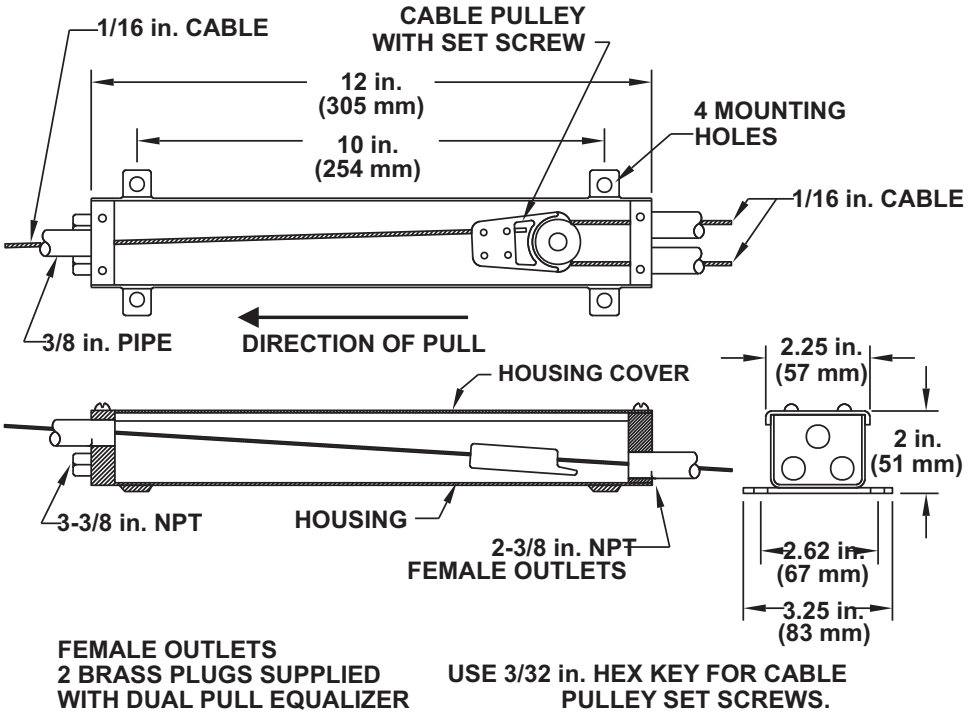


Figure 3-16. Dual-Pull Equalizer

3-3.5.4 CORNER PULLEY, WATERTIGHT, P/N 803808

Corner pulleys are used to change direction of pull cables, therefore preventing binding and ensuring smooth operation. The unit is fitted with a rubber gasket to prevent the ingress of contaminants.

3-3.6 Pneumatic Control and Detection

3-3.6.1 PNEUMATIC CONTROL HEAD, P/NS 872335, 872365, 872362, 872330 and 872360

The pneumatic control head is a non-electrical mechanical device that allows for automatic actuation of pilot cylinder valves, stop valves and FM-200 cylinder valves by means of pressure pulses transmitted from heat-actuated detectors (HADs) via capillary tubing. The pneumatic control head can also be actuated via remote cable or by local manual lever (see Figure 3-17 and Table 3-10 and Table 3-11).

The pneumatic control system incorporates a control head, capillary and tubing plus one or more detectors that operate on the rate-of-rise principle. The system is vented to allow gradual changes of temperature to be accommodated. This means that only rapid increases (i.e., fire) in temperature will result in actuation.

There are three primary pneumatic control head factory settings. A setting is comprised of the pressure setting and vent setting. The pressure setting is expressed in terms of inches of water (either 3 in. or 6 in.). The higher the pressure setting, the higher the rise in pressure within the control circuit needs to be in order for the control head to operate. The vent setting is expressed in seconds and indicates the time taken to relieve a pressure equal to two inches of water. The higher the vent setting, the smaller the vent area and the more sensitive the unit becomes to changes in temperature.

Where two control heads are required, the second unit installed is a tandem unit with an identical pressure setting, but without a vent.

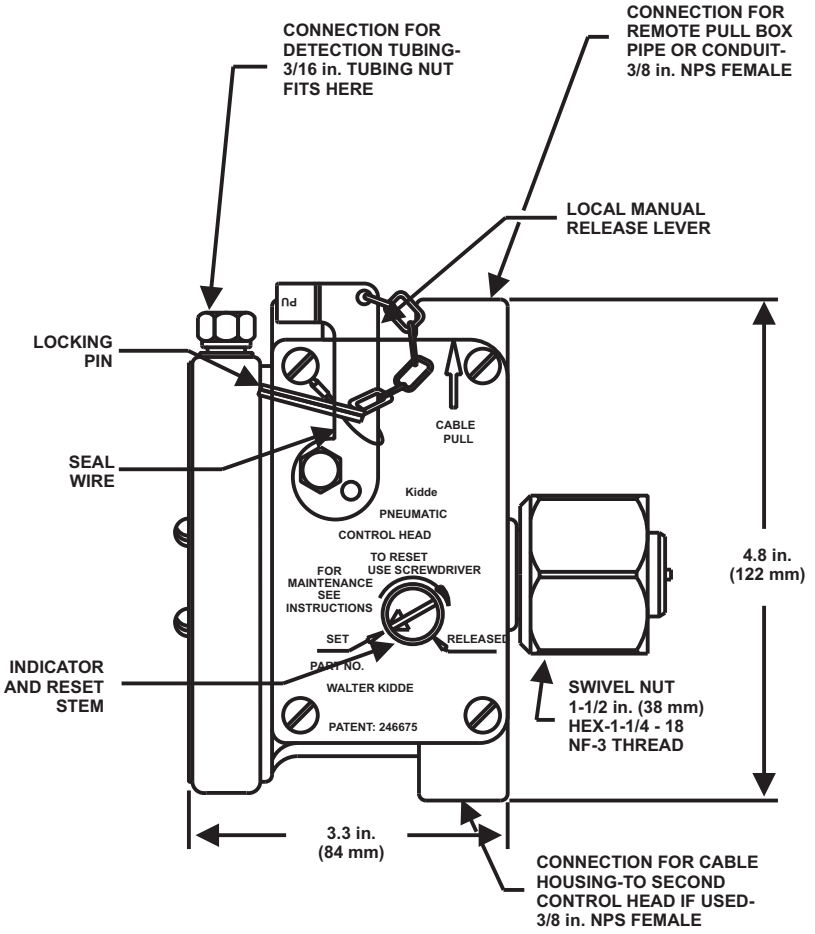


Figure 3-17. Pneumatic Control Head

Table 3-10. Pneumatic Rate of Rise Control Head Setting Information

Part Number of Control Head	Pressure Setting (inches of H_2O)	Vent Number	Temperature (ºF) Rise per Minute for Number of Actuators Exposed to Heat				Part Number of Vent	Application
			1	2	3	4		
872335	3 in.	5	28.2	15.0	10.0	0.6	802745	Moderate Temp. Change Only; Controlled Environment
872365	6 in.	5	56.5	28.2	20.0	15.0	802745	Standard Marine. Outside Weather/ Machinery Spaces
872362	6 in.	2	141.0	70.5	47.0	35.3	802742	Rapidly Changing Temperature. Ex. Ovens, Ductwork, Cold Climates

Table 3-11. Dimensions, Pneumatic Control Head

Part Number	Control Head
872335	3 in. (5 sec.)
872365	6 in. (5 sec.)
872362	6 in. (2 sec.)
Part Number	Tandem Control Head
872330	3 in.
872360	6 in.

3-3.6.2 PNEUMATIC DETECTOR, P/N 841241

The pneumatic heat-actuated detector (HAD) consists of a sealed hollow brass chamber with no moving parts. The detector is connected to the pneumatic control head(s) by copper capillary tubing (see Figure 3-18). To improve performance, the detector can be installed on the heat collector (P/N 31272). The air pressure in the detector increases upon a rapid rate-of-rise in temperature, such as in the event of a fire. This pressure increase is transmitted to the pneumatic control head(s) via the capillary tubing, causing the control head to operate and actuate the system. The control head vent prevents normal ambient temperature fluctuations from causing system operation. Up to four HAD units can be used in a single system (refer to Table 3-10).

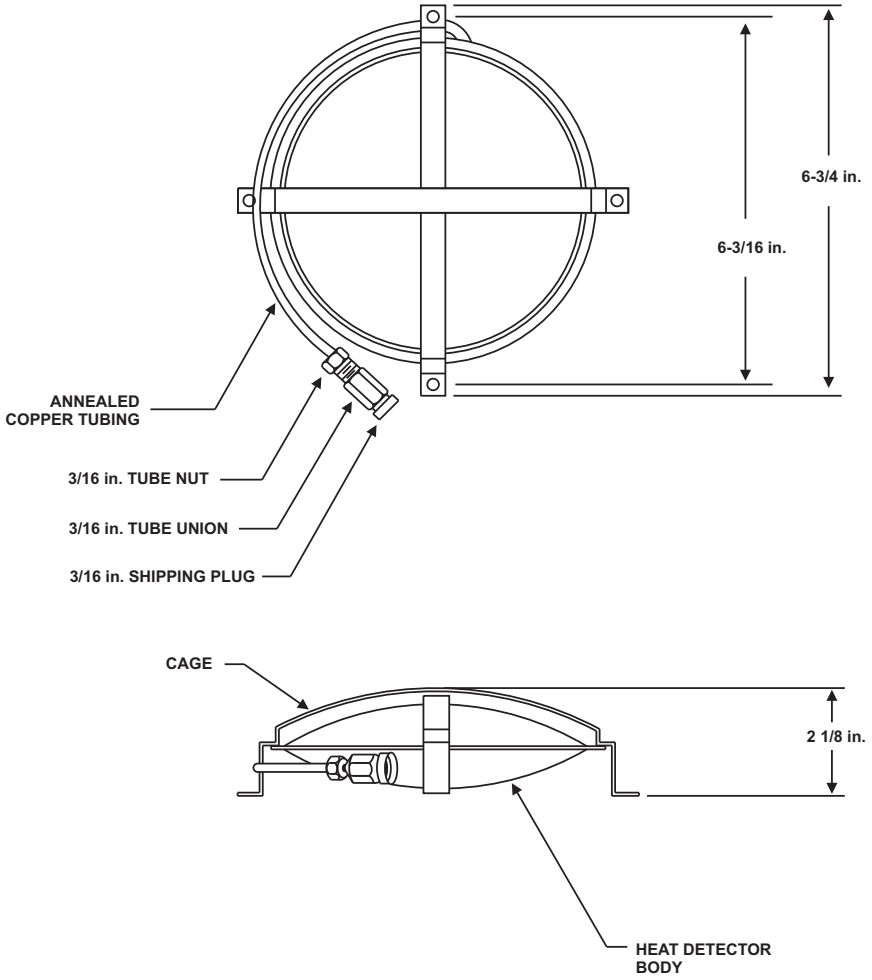


Figure 3-18. Pneumatic Heat-Actuated Detector (HAD)

3-3.6.3 PNEUMATIC DETECTION TUBING AND FITTINGS

Copper Capillary tubing, 3/16-inch, is used to interconnect the pneumatic control head(s) and HAD(s). Four pre-prepared lengths are available measuring 17 in., 36 in., 46 in. and 12 feet. Each length of tubing is flared at each end with tubing nuts installed. Figure 3-19, Figure 3-20 and Table 3-12 detail the tubing and fittings that are available.

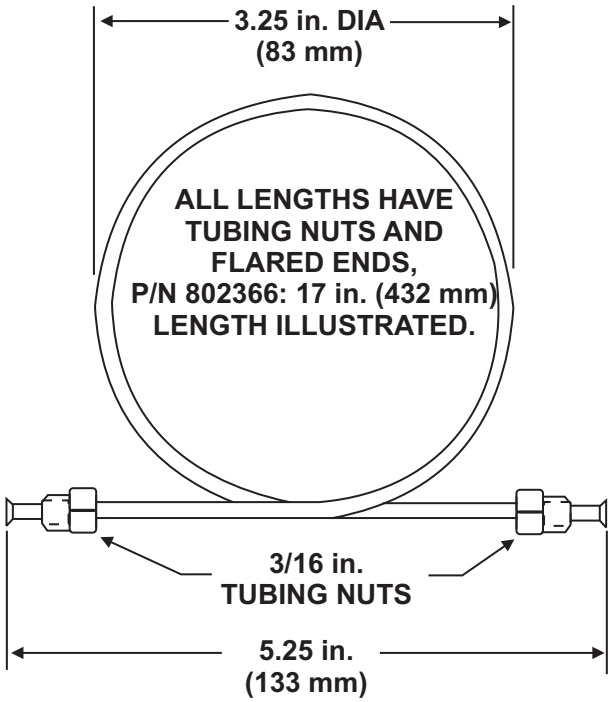


Figure 3-19. Pneumatic Detection System Tubing, 3/16 in.

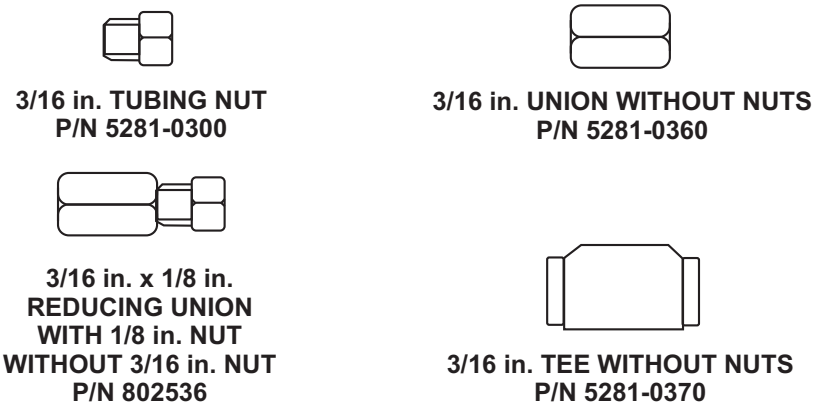


Figure 3-20. Pneumatic Detection System Tubing Fittings

Table 3-12. Dimensions, Flexible Discharge Hoses

Part Number	Description
802366	Pneumatic tubing, 3/16 in., 17 in. (.43 m)
802587	Pneumatic tubing, 3/16 in., 36 in. (.91 m)
802367	Pneumatic tubing, 3/16 in., 46 in. (1.17 m)
802486	Pneumatic tubing, 3/16 in., 12 ft. (3.66 m)
5281-0300	Tubing nut, 3/16 in.
5281-0360	3/16 in. union, w/out nuts
802536	3/16 in. x 1/8 in. reducing union
5281-0370	3/16 in. tee w/out nuts

3-3.7 Remote Pull Stations

3-3.7.1 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 3-21).

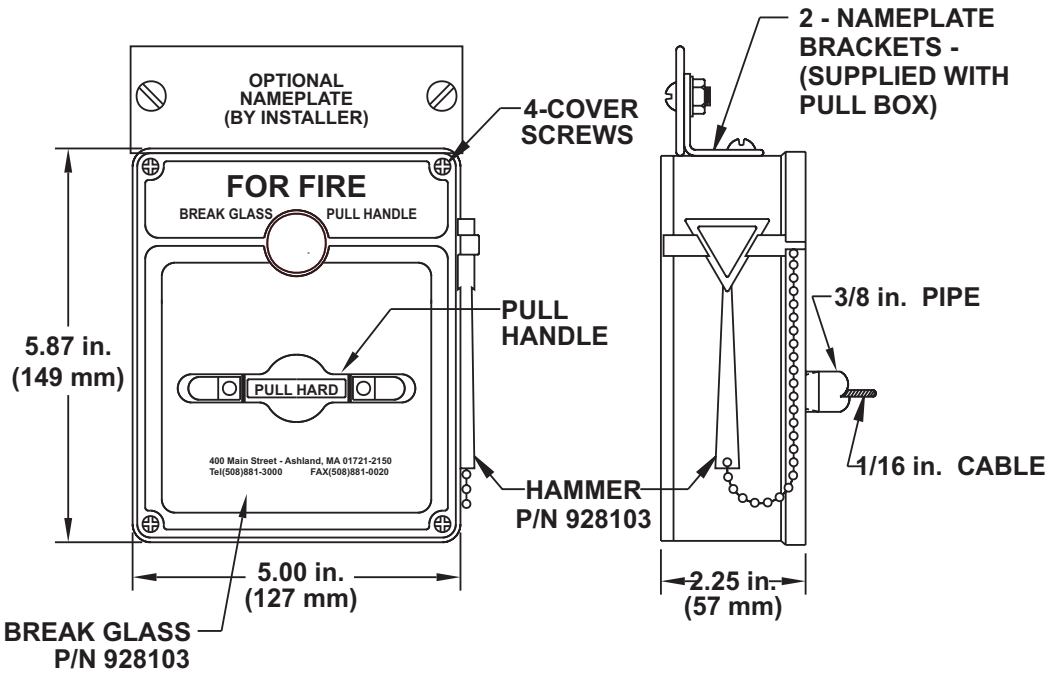


Figure 3-21. Cable Manual Pull Station

3-3.7.1.1 "Z" Bracket for Standard Break Glass Pull Box (P/N 871403), P/N 60532

The “Z” bracket is used to mount the standard break glass pull box (P/N 871403) where clearance is required for the corner pulley (P/N 803808) behind the unit (see Figure 3-22).

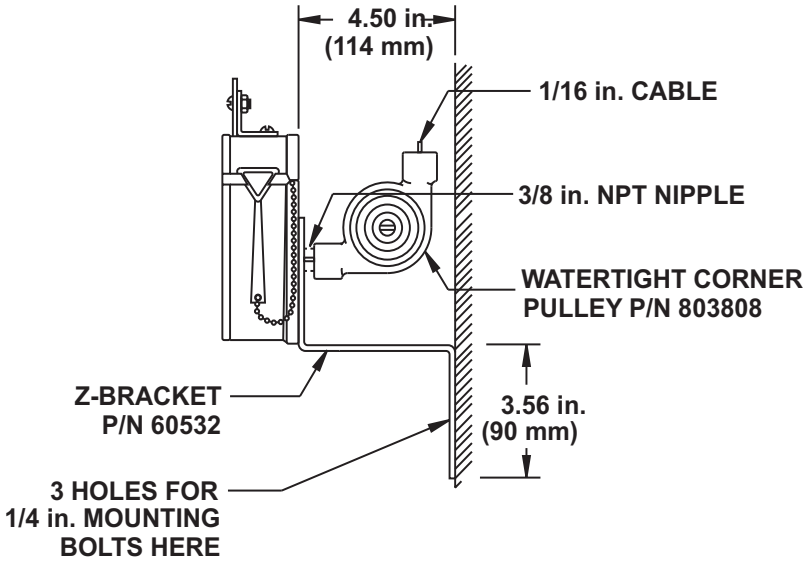


Figure 3-22. Break Glass Pull Box used with "Z" Bracket

3-3.7.2 WATERTIGHT PULL BOX, P/N 870087

The watertight pull box is equipped with a hinged protective cover that protects the unit from the ingress of moisture and accidental damage (see Figure 3-23). To gain entry to unit, the handle is rotated clockwise and the front cover opened. The attached hammer is then used to break the glass as per the Standard Break Glass Pull Box, P/N 871403 (refer to Figure 3-22).

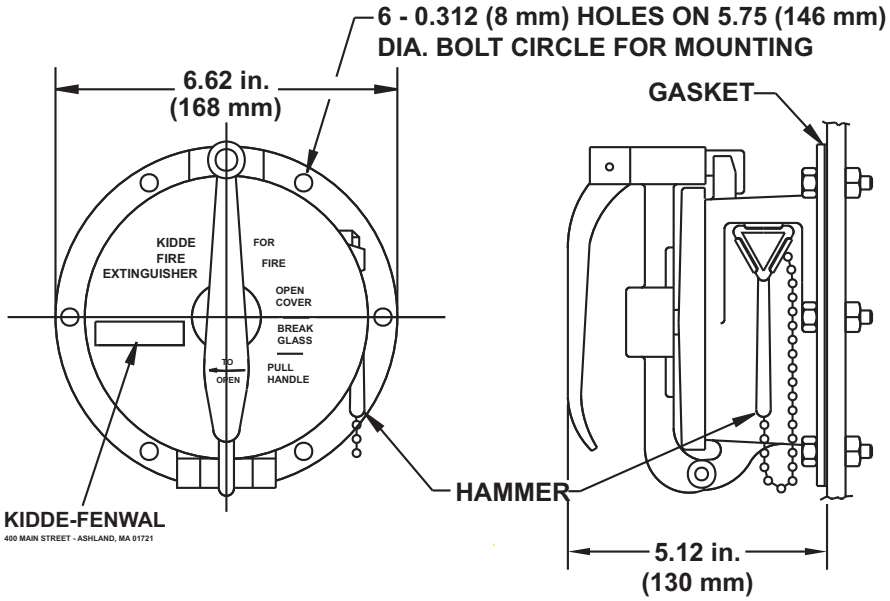


Figure 3-23. Watertight Pull Box

3-3.7.3 FLUSH MOUNT PULL BOX, YACHT TYPE, P/N 870098

The flush mount pull box is a compact unit that can be flush mounted to a bulkhead, provided there is clearance behind for conduit and/or corner pulley(s). The unit is fitted with a transparent frangible shield, through which the handle can be seen and grasped through a cutout. The shield must be broken to pull the handle and attached cable (see Figure 3-24).

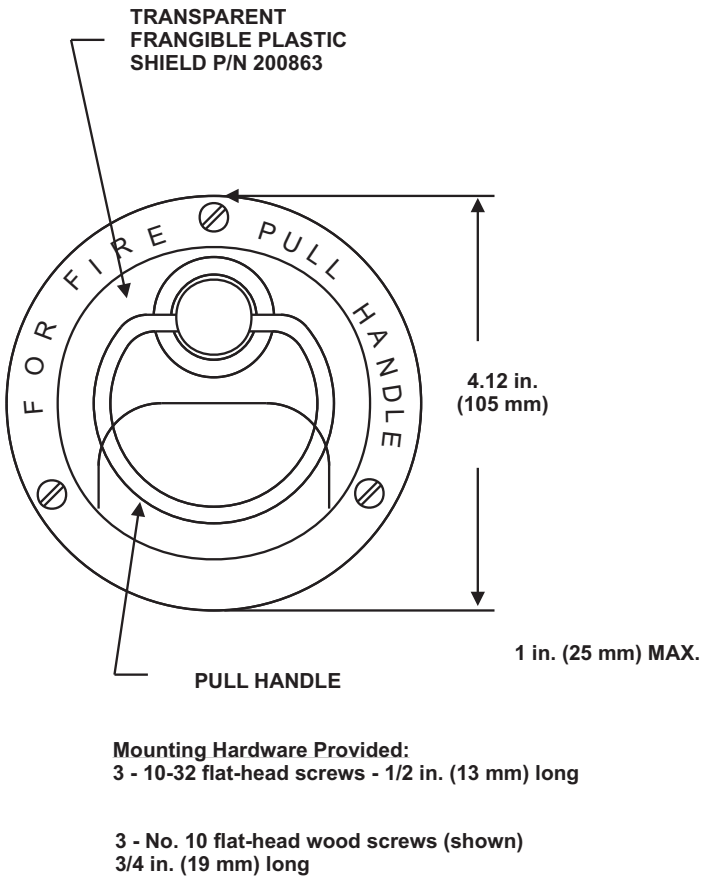


Figure 3-24. Flush Mount Pull Box, Yacht Type

3-3.8 Nitrogen Pilot System and Pressure Driven Accessories

3-3.8.1 NITROGEN ACTUATOR, MOUNTING BRACKET AND ADAPTER, P/N 877940, P/N 877845, P/N 69920501, and WK-877940-200, with SWITCH-IN-GAUGE 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 3-25).

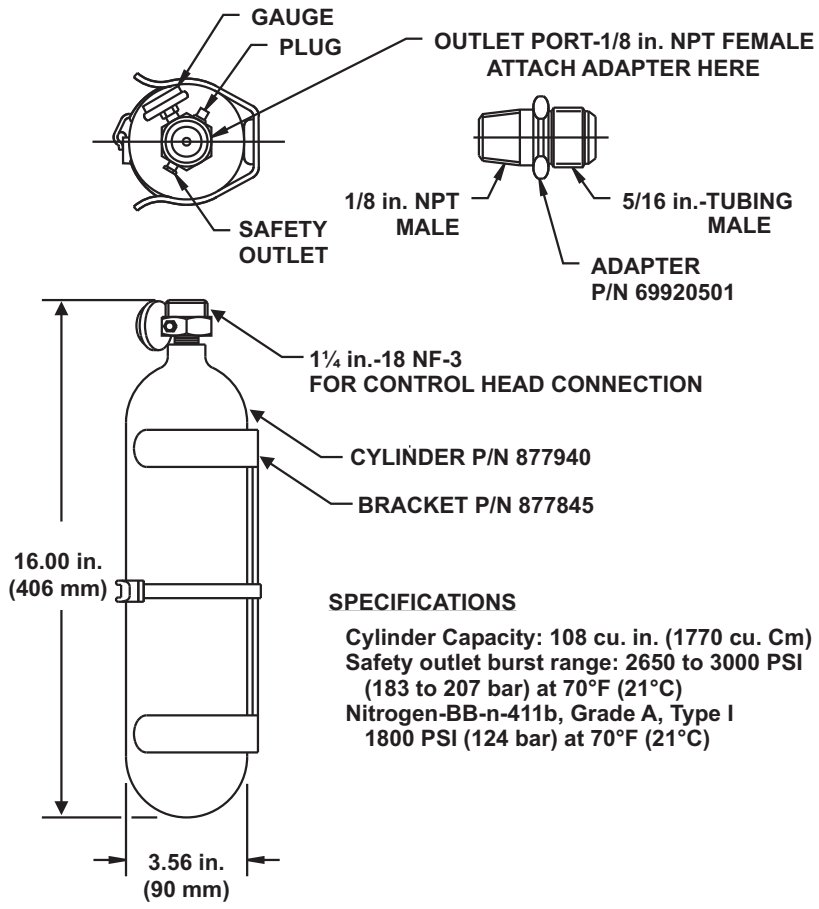


Figure 3-25. Nitrogen Actuator, Mounting Bracket and Adapter

3-3.8.2 NITROGEN PILOT CYLINDER SIREN DRIVERS, 1040 CU. IN. (P/Ns 90-101040-000 and 90-10104-200) AND 2300 CU. IN. (P/Ns 90-102300-100 and 90-102300-200, with SWITCH-IN-GAUGE)

The 1040 cu. in. and 2300 cu. in. pilot nitrogen system cylinders are comprised of seamless steel cylinders manufactured to Department of Transportation (DOT) requirements. The discharge valve is forged brass and has a nominal 5/8 in. discharge path. The assembly is installed without a siphon tube. The nominal charge pressure is 1800 PSIG at 70°F (124 bar gauge at 21°C).

The valve is fitted with a safety burst disc to protect against over-pressurization. A horizontal axial threaded connection on the side of the valve is utilized for filling and for actuation. The threaded portion of the upper valve is where the discharge head is located (see Figure 3-26 and Table 3-13).

WARNING

Pressurized (charged) cylinders are extremely hazardous and, if not handled properly, are capable of violent discharge. This could result in death, personal injury or property damage. Always handle charged cylinders according to the instructions in this manual and applicable federal codes.

Pilot nitrogen cylinders (1040 and 2300 cu. in.) are factory-equipped with a protection cap threaded securely over the valve assembly. The device is a safety feature and provides protection during shipping and handling. The cap must be installed at all times, except when the cylinder is connected into the system piping or is being filled. Do not move or handle a cylinder unless the protection cap is installed. Ensure that the protection cap is retained in a safe place close to the installed cylinder on the vessel.

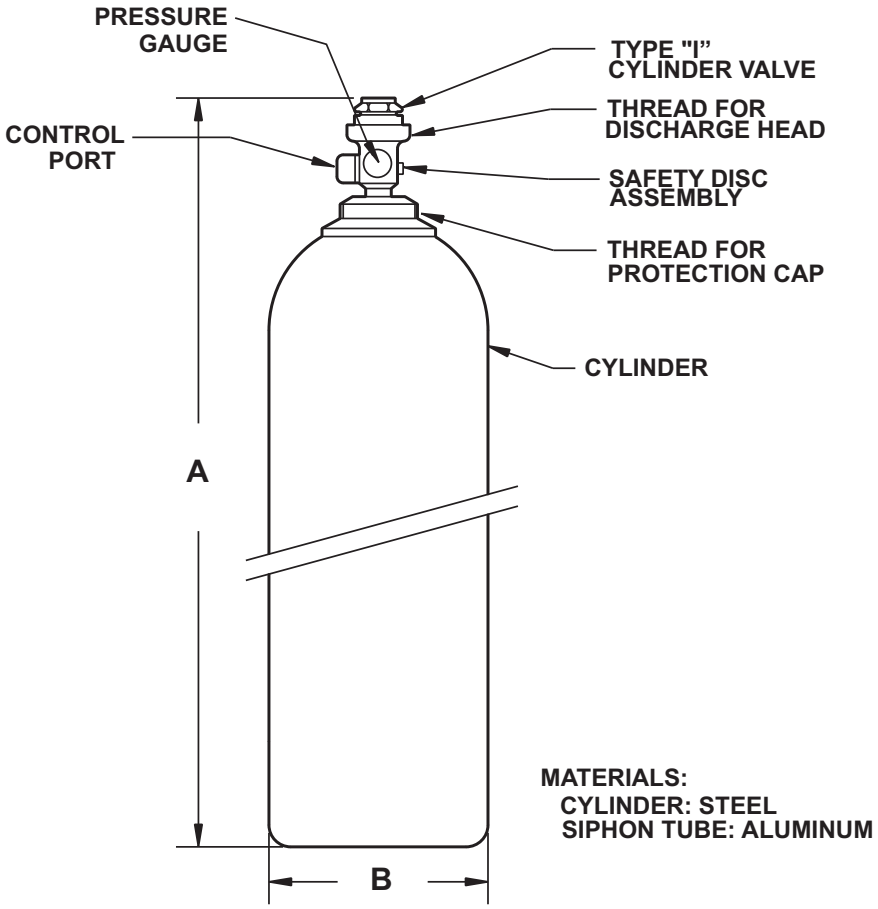


Figure 3-26. Nitrogen Pilot Cylinder (1040 and 2300 cu. in.)

Table 3-13. Nitrogen Pilot System Cylinder Dimensions

Cylinder Size (cu. in.)	Dimension A		Dimension B	
	in.	mm	in.	mm
1040	30	760	8.5	215
2300	55	1390	8.5	215

3-3.8.3 NITROGEN DISCHARGE HEADS, PLAIN NUT, P/N 872450, AND GROOVED NUT, P/N 872442

The plain nut discharge head is installed on the nitrogen discharge valve. It provides an outlet path for the nitrogen with a threaded connection for a discharge hose or swivel. The head is fitted with a piston, check and stem assembly. A pressure tapping in the outlet of the head allows pressure in nitrogen manifold to open the attached nitrogen valve. A second pilot path is provided which connects the actuation port with the discharge head. When a control head operates the pilot check situated at the bottom of the pilot port the escaping pressure is routed to the discharge head, which operates the main valve. See Figure 3-27 and Figure 3-28 for more details.

The grooved nut discharge head is the same as the plain nut discharge head, but the pilot path from the discharge outlet is blocked so that discharge pressure will not operate the head. The unit is differentiated from the plain nut head by two grooves cut in the main body hex (the position of the grooves is indicated in Figure 3-28).

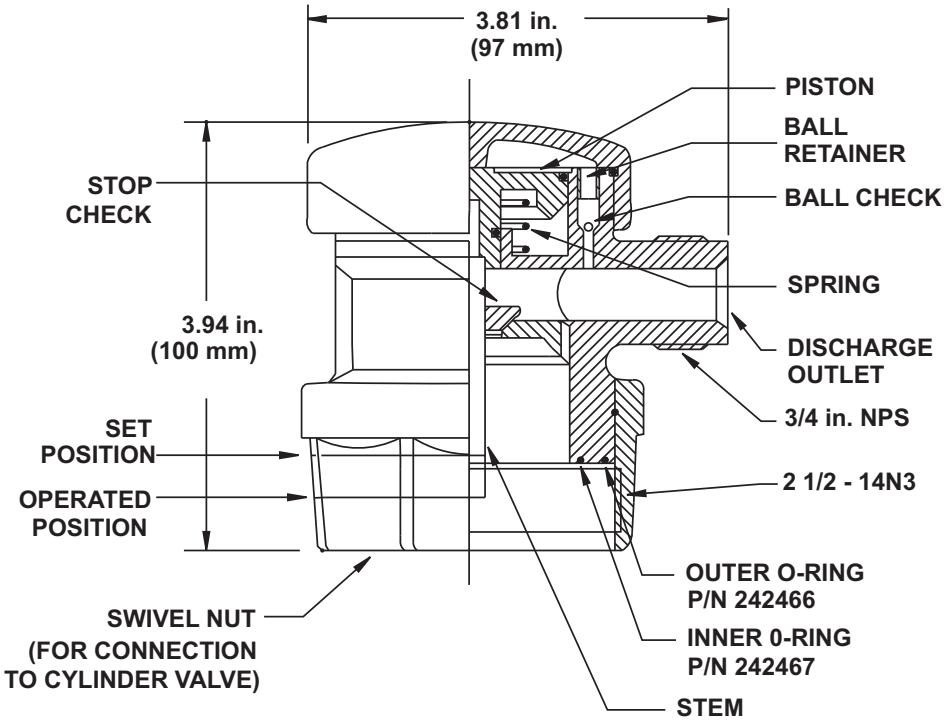


Figure 3-27. Discharge Head, Plain Nut

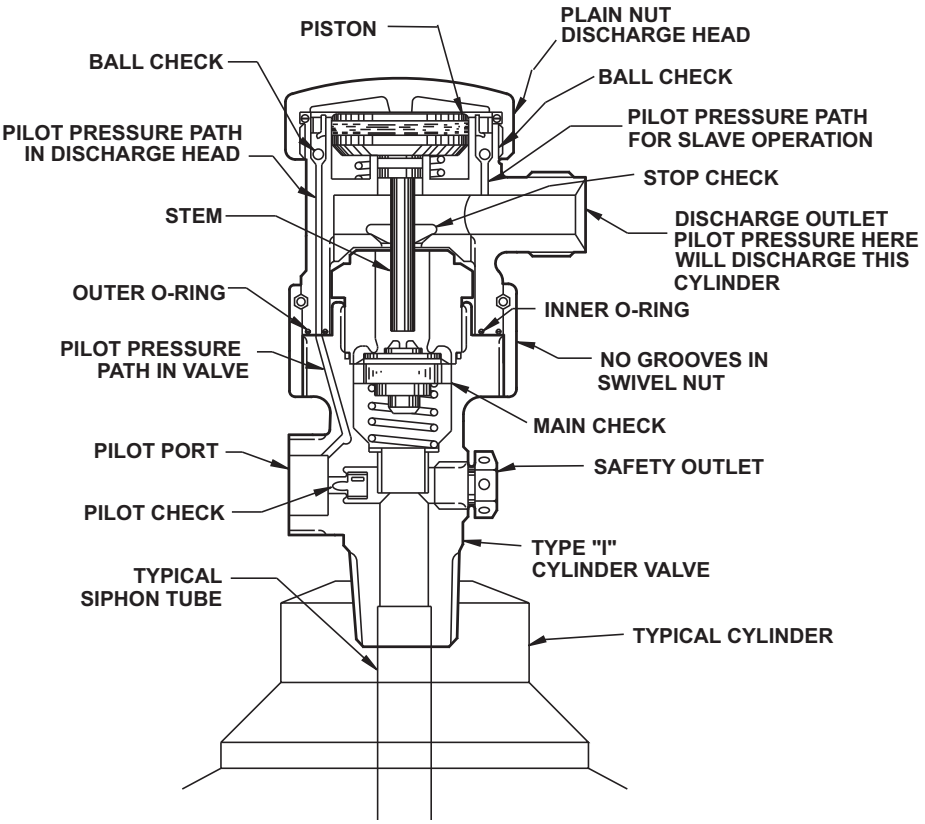


Figure 3-28. Assembly of Plain Nut Discharge Head to Type "I" Cylinder Valve

3-3.8.4 NITROGEN DISCHARGE HOSES, 3/4 IN., P/N 06-118207-00X

The 3/4-inch flexible hose is used to connect the discharge head with the distribution manifold or piping. The hose is manufactured from reinforced rubber and is supplied with crimp-on 3/4-inch NPT fittings, a fixed male and swivel female connector (see Figure 3-29 and Table 3-14).

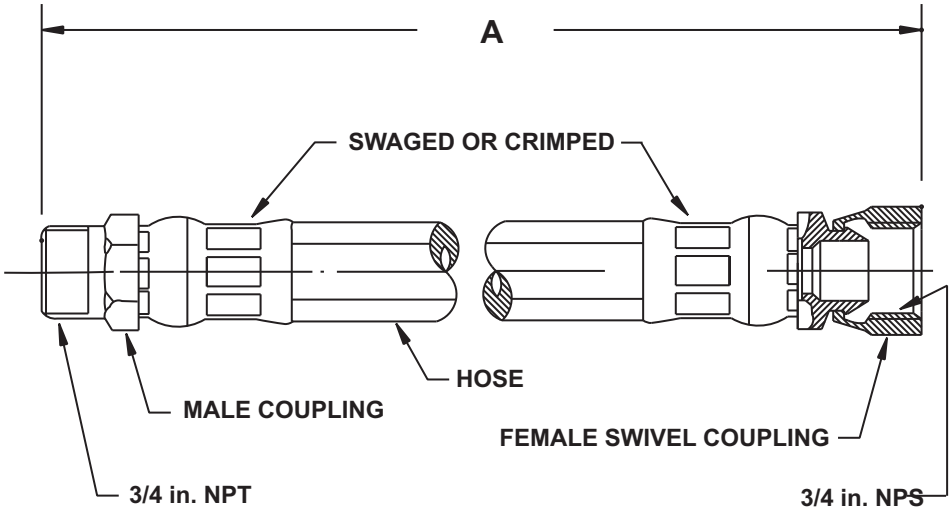


Figure 3-29. Flex Hose, 3/4 in.

Table 3-14. Flex Hose Dimensions

Part Number	Dimension A	
	in.	mm
06-118207-002	14.75	375
06-118207-001	18.00	457

3-3.8.5 NITROGEN MANIFOLD "Y" FITTING, P/N 207877

The manifold “Y” fitting is a three-way fitting made of galvanized malleable iron. This "Y" fitting allows for the connection of two pilot nitrogen cylinders into one point in the manifold or piping (see Figure 3-30).

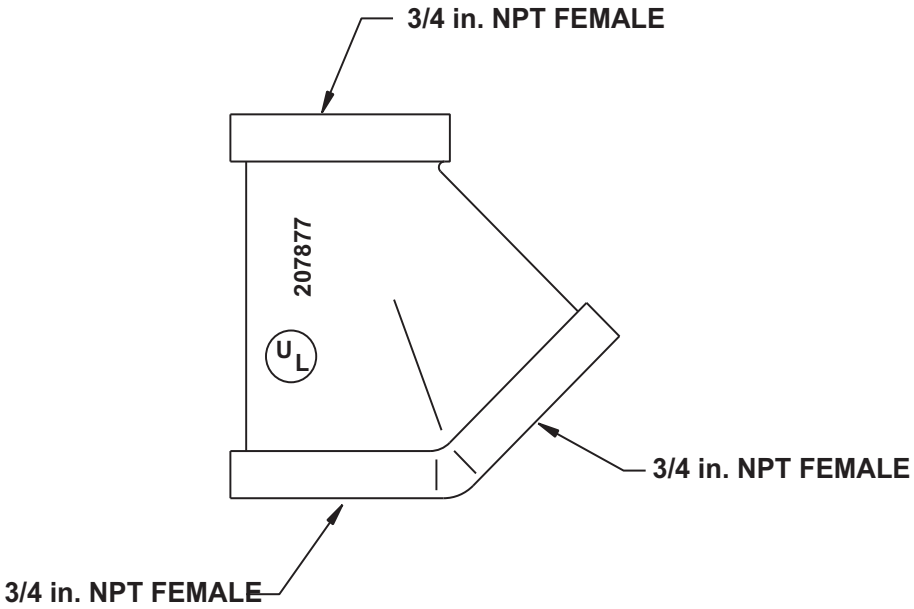


Figure 3-30. Manifold "Y" Fitting

3-3.8.6 CYLINDER STRAPS FOR NITROGEN PILOT CYLINDERS, P/N 270014 AND P/N 241219

A single loop steel strap is used to support single cylinders in a vertical position (P/N 270014, see Figure 3-31) and a double strap unit can be used for two cylinders (P/N 241219, see Figure 3-32).

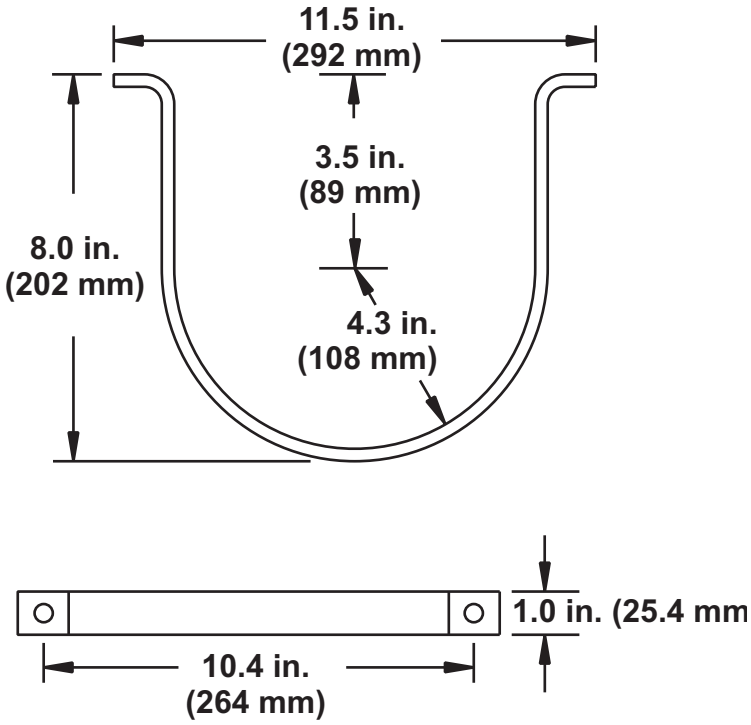


Figure 3-31. Single Cylinder Strap

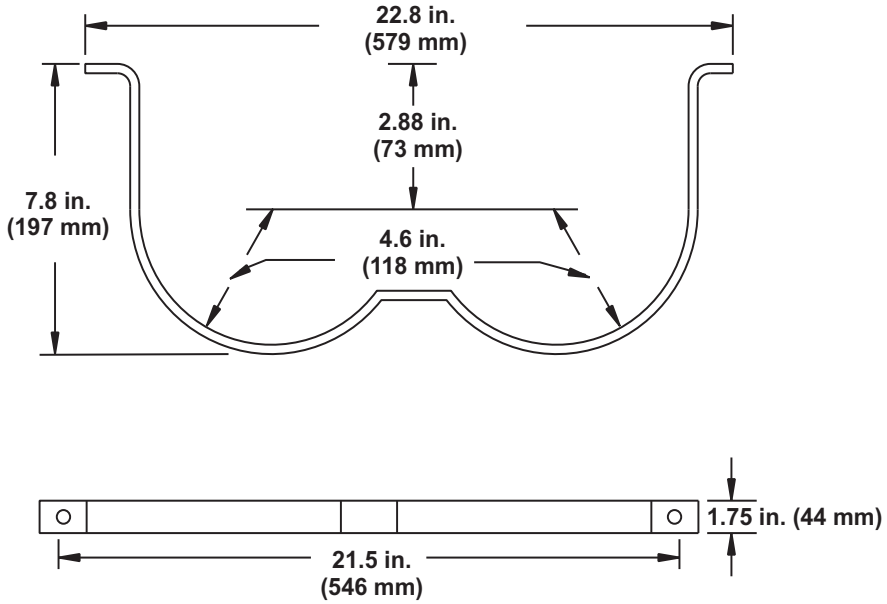


Figure 3-32. Double Cylinder Strap

3-3.8.7 NITROGEN DISCHARGE DELAYS, P/N 81-871072-001, P/N 81-871072-002, P/N 81-871072-003 AND P/N 81-871072-004

This device utilizes nitrogen system pressure to provide a pneumatic (automatic mechanical) means to delay the release of pilot media by a predetermined period following the initial actuation event. The time delay consists of a metering tube, a cylinder and a differential pressure-operated valve with a control port. The control port allows the connection of a lever operated control head that can be operated to bypass the delay.

Four versions are available with factory preset (non-adjustable) delay. See Figure 3-33 and Table 3-15 for more details.Detectors and Control Panels

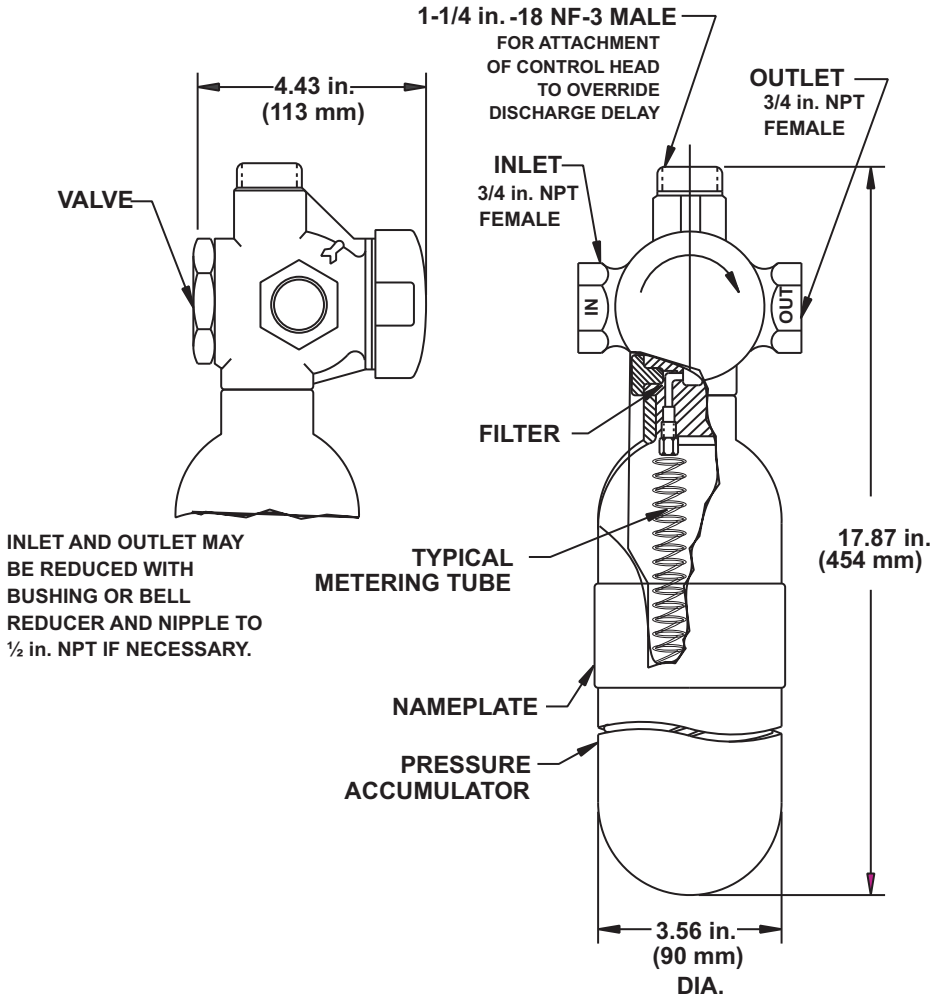


Figure 3-33. Discharge Delays (30/60 sec.)

Table 3-15. Discharge Delays

Part Number	Agent	Nominal Delay Time Approx.	Type of Metering Tube
81-871072-001	Nitrogen	34	Curled
81-871072-002	Nitrogen	61	Curled
81-871072-003	Nitrogen	35	Curled
81-871072-004	Nitrogen	68	Curled

3-3.8.8 NITROGEN PRESSURE OPERATED SIREN, P/N 90-981574-001

The pressure operated siren is connected into the nitrogen manifold and provides a high-pitch, high-decibel sound during discharge as the internal rotor is spun and as nitrogen flows through and out of the unit. The unit is primarily used as a pre-discharge alarm to warn personnel to evacuate the protected space. See Figure 3-34 and Table 3-16 for more details.

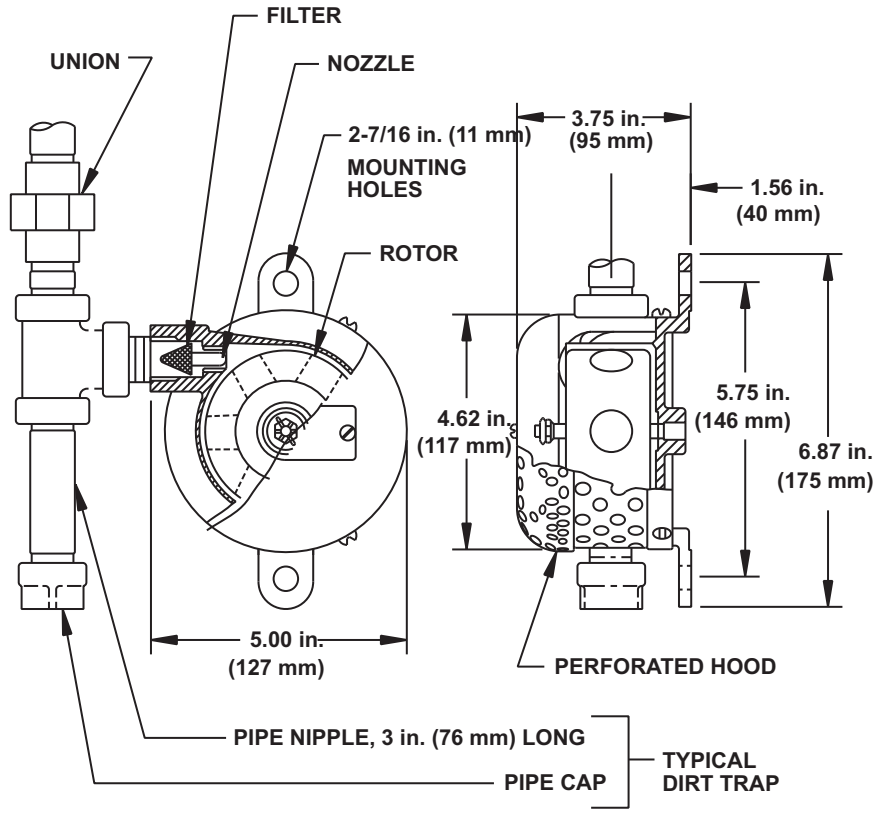


Figure 3-34. Pressure Operated Siren

Table 3-16. Pressure Operated Siren Nominal Flow Rate

Type of Agent	Nominal Flow Rate at 70°F (21°C)
Nitrogen	0.5 to 0.9 lb./min. (0.23 to 0.4 kg/min)

3-3.9 Actuation Accessories

3-3.9.1 FLEXIBLE ACTUATION HOSE, P/N 264986, P/N 264987 AND P/N 06-236215-001

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 ¼-inch actuation hose (see Figure 3-35 and Table 3-17).

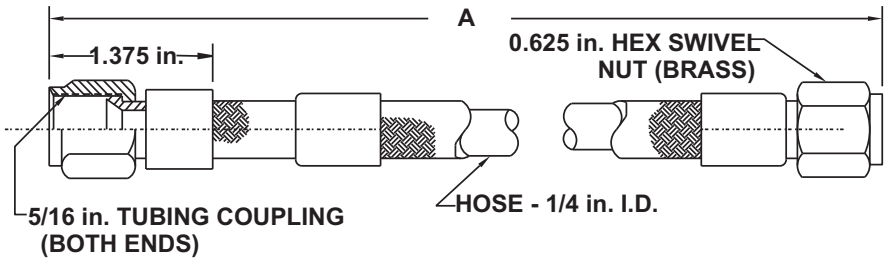


Figure 3-35. Flexible Actuation Hose (P/N 264986 and P/N 264987)

Table 3-17. Dimensions, Flexible Actuation Hose

Part Number	Dimension A	
	in.	mm
264986	30	762
06-236215-001	34	762
264987	22	558.8
Note: For heavy-duty applications, use P/N 06-236215-001 which is constructed of corrugated stainless steel.		

3-3.9.2 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 3-36).

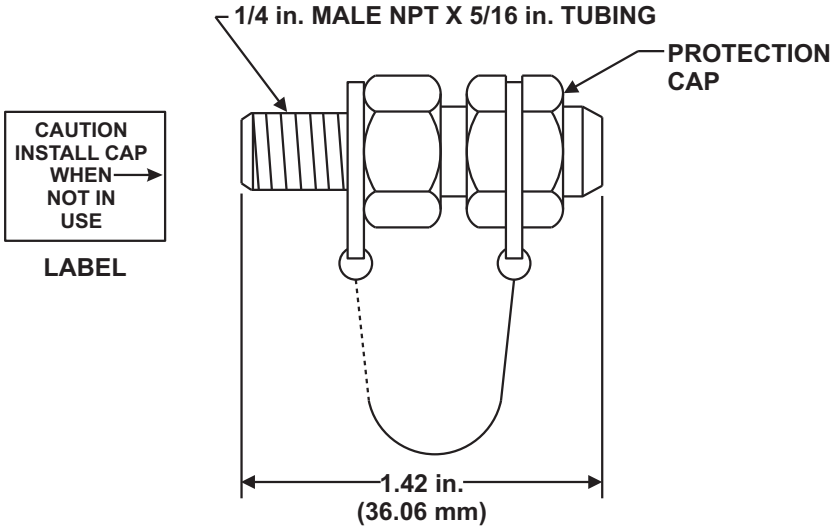


Figure 3-36. Master Cylinder Adapter Kit

3-3.9.3 DUAL-LOOP BLEED KIT, P/N 06-129978-001

Where dual-actuation loops are required, a dual-loop bleed kit is required at each cylinder location. The kit is comprised of a four-way fitting, a bleed valve, two 1/4 in. check valves, a bleed with cap and the necessary adapters to allow the connection of the dual-lines at the agent cylinder location. This assembly allows for the connection of two pilot lines to a single pressure operated control head. The check valves isolate the circuits from each other, and the bleed allows safe relief of pressure from the fittings following discharge. The contents of the kit are illustrated in Figure 3-37; refer to Table 3-18 for individual components.

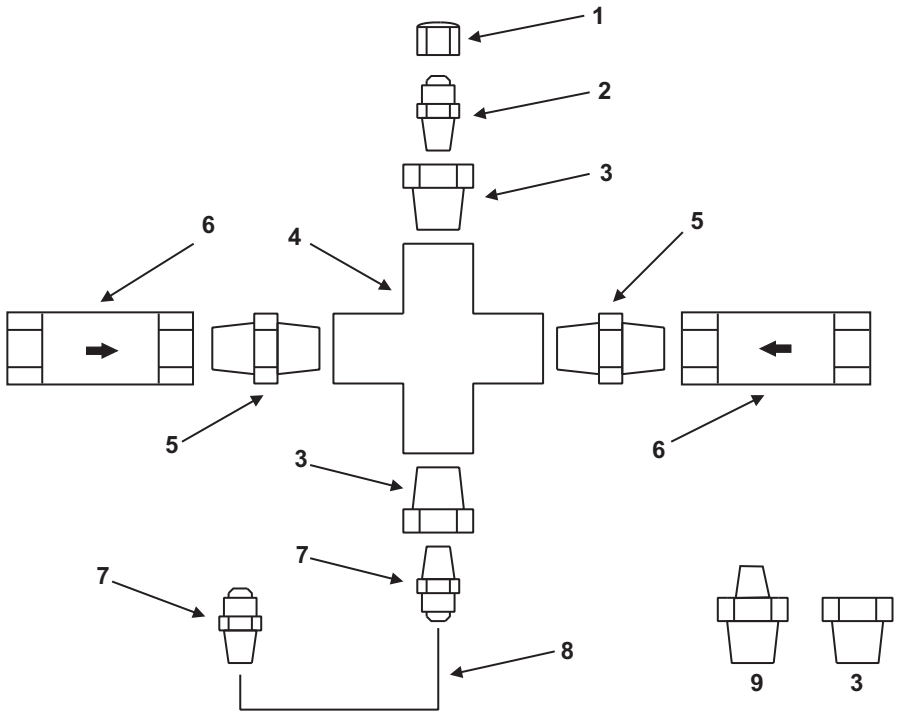


Figure 3-37. Dual-Loop Bleed Kit, Full Kit Contents

Table 3-18. Dual-Loop Bleed Kit Components

Item	Qty. in Kit	Description	Part Number
1	1	Cap, 7/16 in. (1/4 in.SAE Flare) 1/4 in. Tube	WK-263304-000
2	1	Bleed Fitting 1/8 in. NPT x 7/16 in. (1/4 Tube)	WK-263303-000
3	3	1/4 NPT M x 1/8 in. NPT F	06-118318-001
4	1	4-Way 1/4 in. F	06-118319-001
5	2	1/4 NPT M x 1/4 in. NPT M	06-118320-001
6	2	1/4 in. Check Valve	264985
7	2	1/8 in. NPT x 7/16 in. (1/4 in. Tube)	06-118191-001
8	Not Included	1/4 in.Actuation Hose, H. Duty, 34 in. Long	06-236215-001
9	1	1/4 in. NPT M x 1/8 in. NPT M	06-118321-001

3-3.9.4 NITROGEN ACTUATION CIRCUIT VENT, P/N 284051

The nitrogen vent is a 1/4-inch NPT fitting that is installed in closed or partially closed sections of nitrogen actuation circuits. The small orifice allows pressure to bleed from the circuit over time without affecting operation of the system.

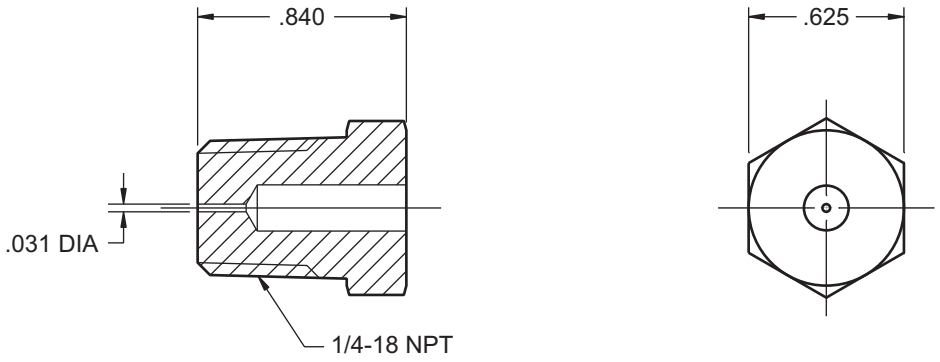


Figure 3-38. Nitrogen Actuation Circuit Vent, P/N 284051

Note: Vents should only be used when Vent Bleed Assembly is not acceptable per the AHJ. The vent bleed (P/Ns 263304 and 263305) is preferable since no pressure is lost until manual bleeding occurs.

3-3.9.5 TEES, ELBOWS AND ADAPTERS

Tees, elbows and adapters connect actuation hoses to pressure operated control heads in multiple cylinder system installations (see Figure 3-39).

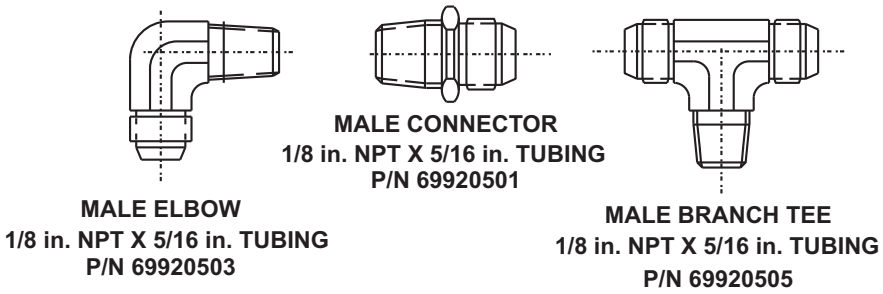


Figure 3-39. Tees, Elbows and Adapters

3-3.9.6 PILOT NITROGEN BALL VALVE, P/N 283888

The pilot valve is a stainless steel high-pressure 1/4 in. ball valve with integral mounting bracket used to isolate pilot nitrogen cylinders from the actuation circuit. A locking pin and a seal wire are provided to ensure the valve can be opened by deliberate action only (see Figure 3-40).

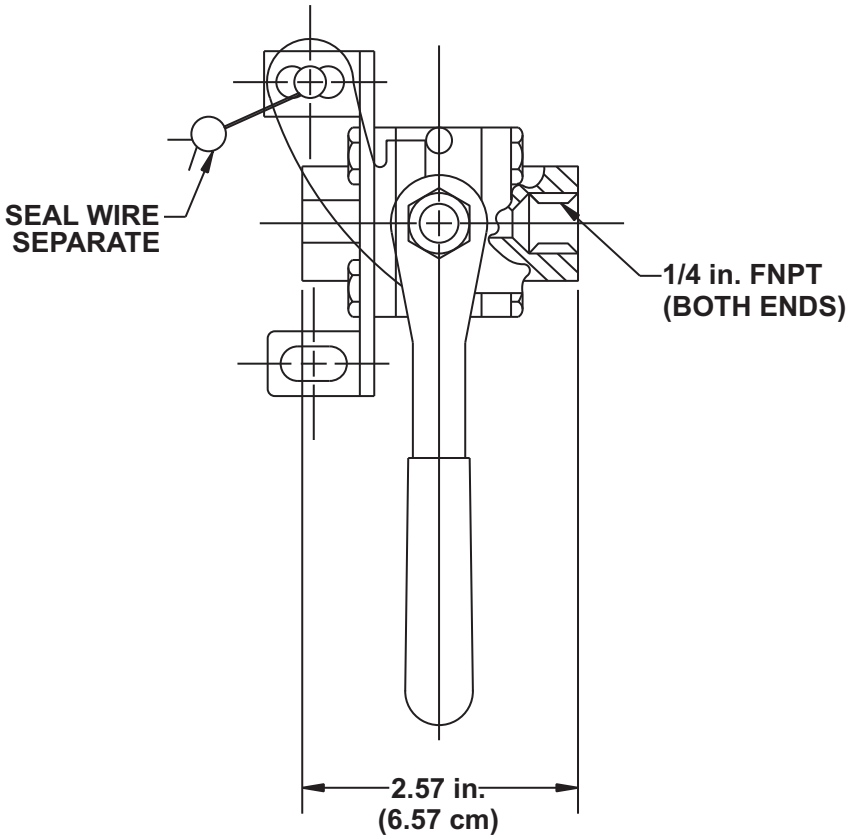


Figure 3-40. Pilot Nitrogen Ball Valve

3-3.10 Discharge Accessories

3-3.10.1 FLEXIBLE DISCHARGE HOSE, P/N 283898, P/N 283899, P/N 283900 and P/N 06-118225-001

FM-200 agent is routed from the storage cylinders to the discharge piping by a flexible 1½ in., 2 in. or 2½ in. 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 3-41 and Table 3-19).

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

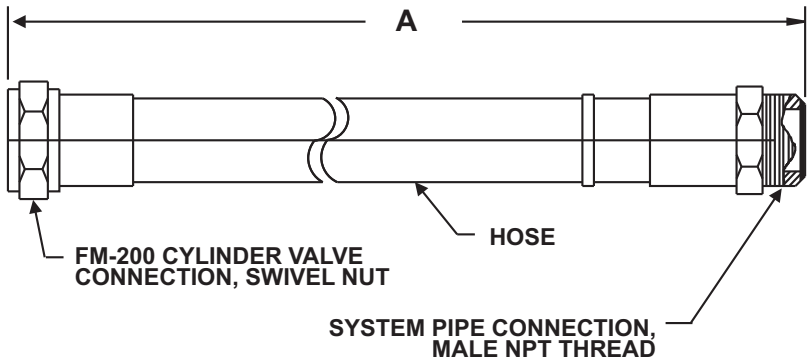


Figure 3-41. Flexible Discharge Hoses (Except P/N 06-118225-001)

Table 3-19. Dimensions, Flexible Discharge Hoses

Part Number	Hose Size	Dimension A		Min. Bend Radius	
		in.	mm	in.	mm
283898	1-1/2	24	609.6	10.5	266.7
283899	2	31	787.4	13.5	342.9
283900	2-1/2	48	1219.2	22.5	571.5
06-118225-001	3	54	1372.0	24.0	610.0

3-3.10.2 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 3-42 and Table 3-20).

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

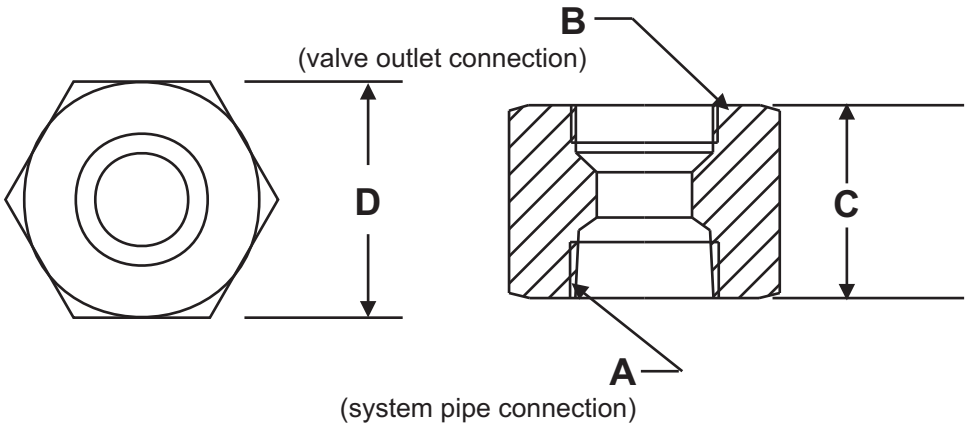


Figure 3-42. Valve Outlet Adapter

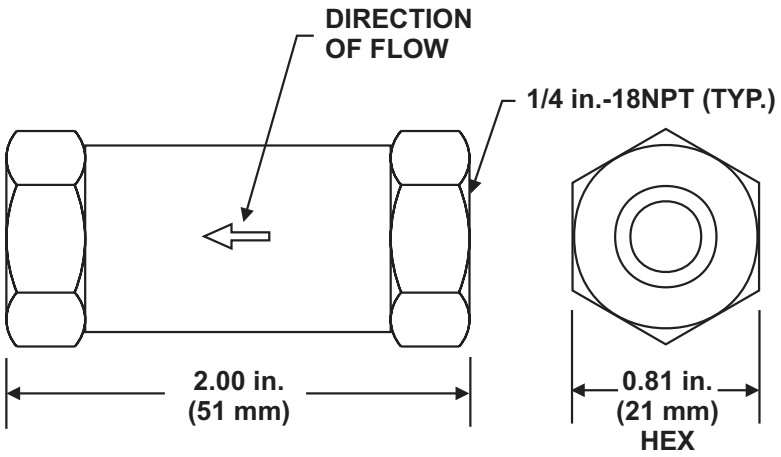
Table 3-20. Dimensions, Valve Outlet Adapter

Part Number	Size	A	B	C		D	
				in.	mm	in.	mm
283904	1-1/2 in.	1-1/2 in. - 11-1/2 NPT	1.874 in.	2.69	68.33	2.50 HEX	63.50
283905	2 in.	2 in. - 11-1/2 NPT	2.500 in. 12 UNJ	3.12	79.25	3.00 HEX	76.20
283906	2-1/2 in.	2-1/2 in. - 8 NPT	3.000 in. 12 UNJ	3.00	76.20	3.75 HEX	96.25

3-3.10.3 CHECK VALVE, 1/4-INCH, P/N 264985 and 3/8-INCH, P/N 261193

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 and in dual-loop actuation arrangements (see Figure 3-43 and 3-43 and Table 3-21).



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

Figure 3-43. 1/4-inch Check Valve

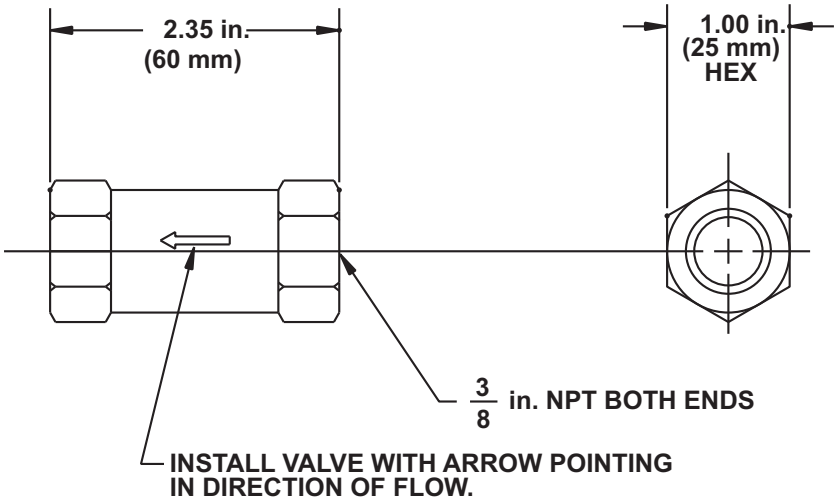


Figure 3-44. 3/8-inch Check Valves

Table 3-21. 1/4-inch and 3/8-inch Check Valve Technical Data

Working Pressure	0 to 5000 PSIG (0 to 345 bar)
Proof Pressure	10,000 PSIG (690 bar)
Cracking Pressure	2 to 4 PSIG (0.14 to 0.28 bar)
Operating Temperature	-40° F to 250 F (-40° C to 121° F)

3-3.10.4 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 3-45 and Table 3-22).

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.

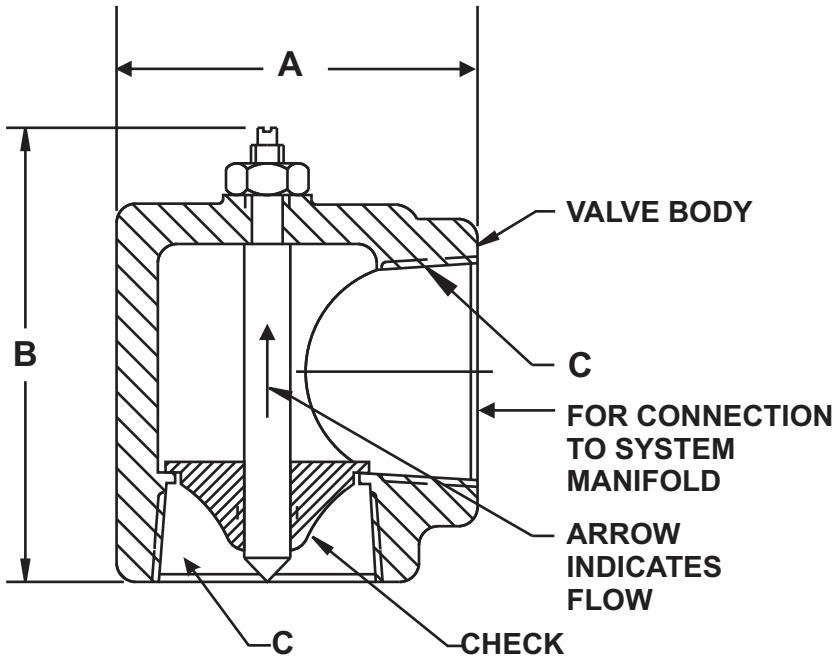


Figure 3-45. Manifold El-Checks

Table 3-22. Dimensions, Manifold El-Checks

Part Number	Size	A	B	C
877690	2 in.	3.93 in. (99.80 mm)	4.88 in. (123.95 mm)	2 in. - 11-1/2 NPT
878743	2-1/2 in.	4.96 in. (119.00 mm)	5.76 in. (146.30 mm)	2-1/2 in. - 8 NPT

3-3.10.5 CHECK VALVES

Note: See Table 3-23 for check valve data.

Check valves are used where a connected main/reserve configuration or multiple pilot containers are required. Check valves are essentially one-way valves and can be used in sections of the pipe network designed to flow CO_2, N2 or FM-200. Pipe size limitations for the media being flowed apply to the selected check valve. If a check valve is used in the FM-200 discharge pipework, then it must be properly modeled in the flow calculation software to ensure accurate discharge prediction.

The following check valve sizes, 1/2-inch, 3/4-inch, 1-inch, 1¼-inch, 1½-inch and 2-inch (P/N 800327, 800266, 800443, 800444, 870152 and 870151), have female threaded outlet ports. The standard 3-inch check valve (P/N 870100) is a flanged valve. Where a 2½-inch check valve is required, a 3-inch check can be used with 2½-inch flanges. Refer to Figures 3-45 and 3-46 for details of available flanges, gasket and fasteners. The piston/check assembly is sprung, and forward bias discharge pressure allows media to flow. Reverse bias pressure applies force to the piston/check preventing flow.

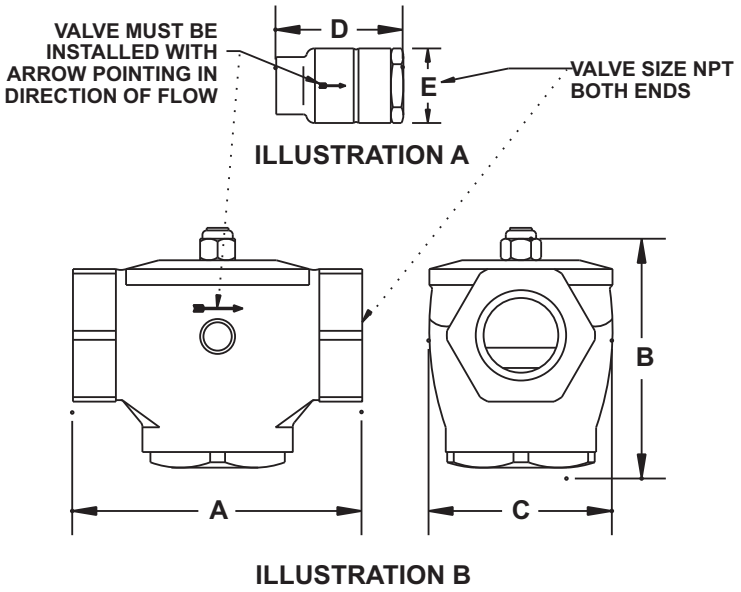


Figure 3-46. Check Valves, 1/2-inch through 2-inch

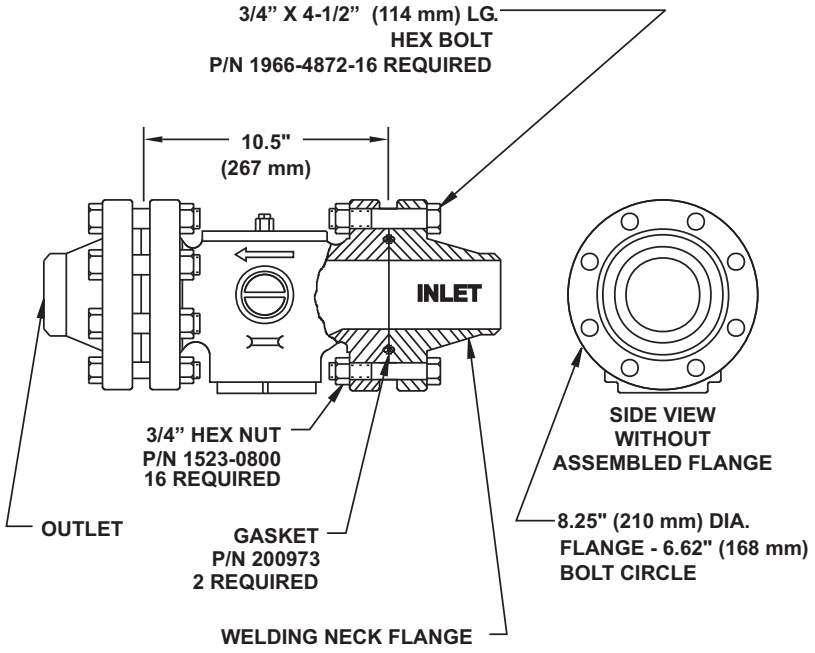


Figure 3-47. Check Valves, 2-1/2-inch and 3-inch

Table 3-23. Check Valve Data

Part Number	Valve Size	Illustration (Figure 3-46)	A		B		C		D		E	
			in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
81-800327-000	1/2 in.	A	-	-	-	-	-	-	3.34	85	2.0	51
81-800266-000	3/4 in.	A	-	-	-	-	-	-	3.34	85	2.0	51
WK-800443-000	1 in.	A	-	-	-	-	-	-	3.97	101	3.18	81
81-800444-000	1-1/4 in.	A	-	-	-	-	-	-	3.97	101	3.18	81
81-870152-000	1-1/2 in.	B	7.50	151	6.28	160	4.75	121	-	-	-	-
81-870151-000	2 in.	B	7.50	151	6.28	160	4.75	121	-	-	-	-

Two low loss swing-check valves are available: the 2 in. (P/N 06-118213-001) and 3 in. (P/N 06-118058-001). These units are equipped with female threaded ports (see Figure 3-48 and Figure 3-49).

Note: These units are for use with FM-200 only.

WARNING

Swing check valves P/N 06-118213-001 and 06-118058-001 must not be used in any section of pipework designed to flow media other than FM-200. Incorrect usage could result in failure of the valve, cause personal injury and/or damage to property.

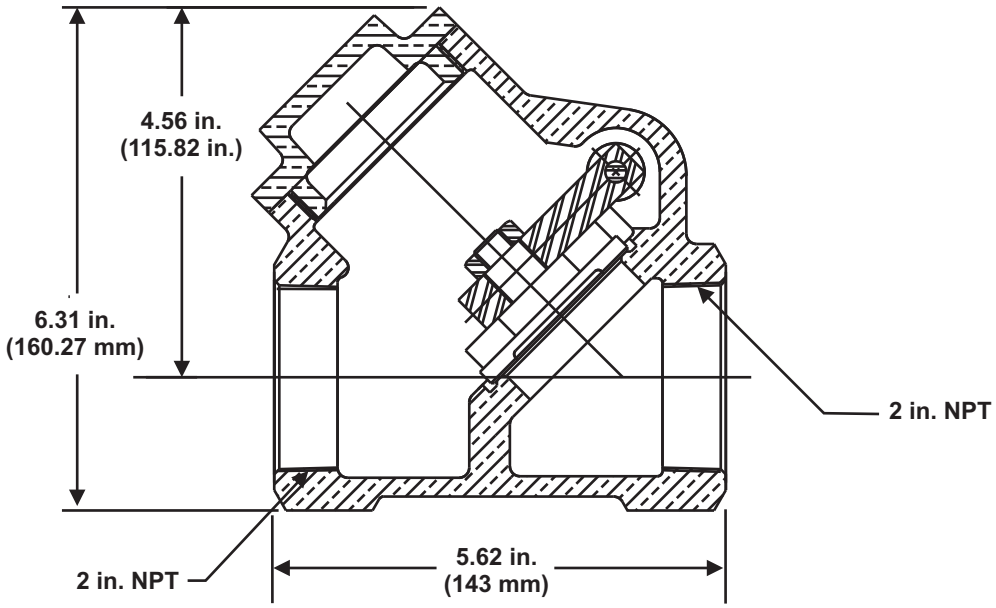


Figure 3-48. 2 in. Swing Check Valve

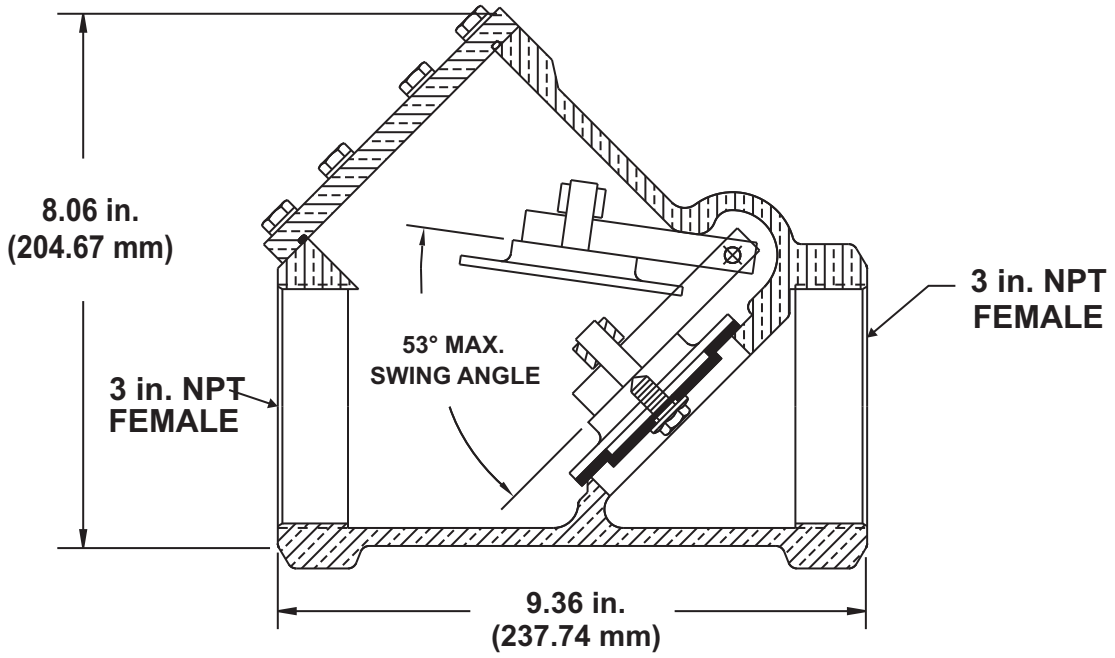


Figure 3-49. 3 in. Swing Check Valve

Table 3-24. Check Valves, Equivalent Lengths

Part Number	Nomenclature	Pipe Type	Equivalent Length	
			ft.	m
800327	Check Valve, 1/2 in. NPT	40 T & 40 W	5.4	1.7
800266	Check Valve, 3/4 in. NPT	40 T & 40 W	16.0	4.9
800443	Check Valve, 1 in. NPT	40 T & 40 W	8.8	2.7
800444	Check Valve, 1 1/4 in. NPT	40 T & 40 W	36.7	11.2
870152	Check Valve, 1/2 in. NPT	40 T & 40 W	19.4	5.9
870151	Check Valve, 2 in. NPT	40 T & 40 W	45.1	13.8
870100	Check Valve, 3 in. NPT	40 T & 40 W	141.3	43.1
06-118213-001	Swing Check, 2 in.	40 T & 40 W	13.4	4.06
06-118058-001	Swing Check, 3 in.	40 T & 40 W	20.8	6.33
877690	2 in. El Check	40 T & 40 W	12.2	3.71
878743	2-1/2 in. El Check	40 T & 40 W	13.5	4.11
877690 and 283899	2 in. El Check and Flex Hose	40 T & 40 W	15.2	4.63
878743 and 283900	2-1/2 in. El Check and Flex Hose	40 T & 40 W	17.5	5.33

3-3.10.6 STOP (DIRECTION) VALVES

Note: See Table 3-25 for stop valve data

Stop (direction) valves are used where isolation of a section of pilot manifold or discharge piping is required, but where the valve must be opened locally or remotely to allow passage of agent. A typical application is where two hazards are protected by a single cylinder or cylinder

bank and stop valves are used to route the agent to only the selected hazard. Stop valves can be used to control CO_2, Nitrogen or FM-200. Pipe size limitations for the media being flowed apply to the selected stop valve. If a stop valve is used in the FM-200 discharge pipework, then it must be properly modeled in the flow calculation software to ensure accurate discharge prediction.

Each stop valve has a control port for the connection of a lever operated, lever/pressure or cable operated control head. The installed control head with lever control facilitates the opening of the valve either locally or remotely and is required by USCG.

CAUTION Always use a control head fitted with a manual local release lever on a stop valve to allow the valve to be opened manually in an emergency. Do not use the pressure (only) control head (P/N 878737) on a stop valve for this reason.

The following stop valve sizes, 1/2 in., 3/4 in., 1 in., 1¼ in., 1½ in. and 2 in. (P/Ns 870023, 870022, 870122, 870032, 870123 and 870049) have female threaded outlet ports. The 3 in. stop valve (P/N 890010) and 4 in. stop valve (P/N 890208) are flanged. Where a 2½ in. stop valve is required, a 3 in. stop can be used with 2½ in. flanges. Refer to Figure 3-50, Figure 3-51 and Figure 3-52 for details of available flanges, gaskets and fasteners.

Note: Stop valves do not prevent backflow; a check valve must be used where this functionality is required.

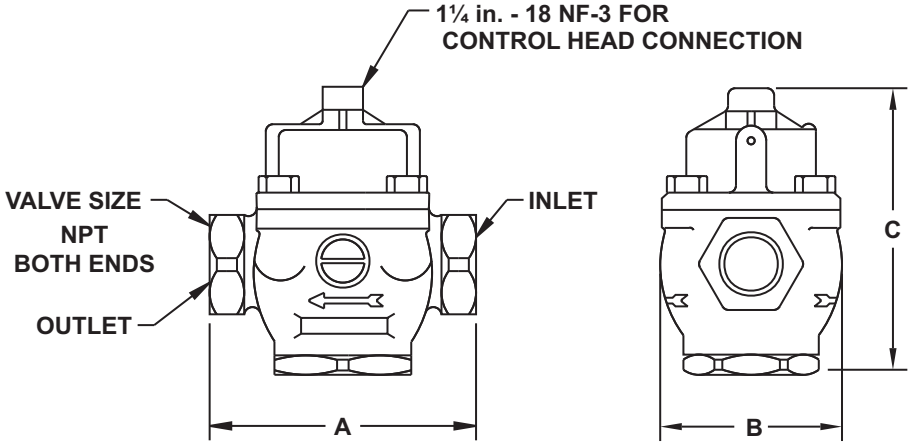


Figure 3-50. 1/2 in. Thru 2 in. Stop (Direction) Valves

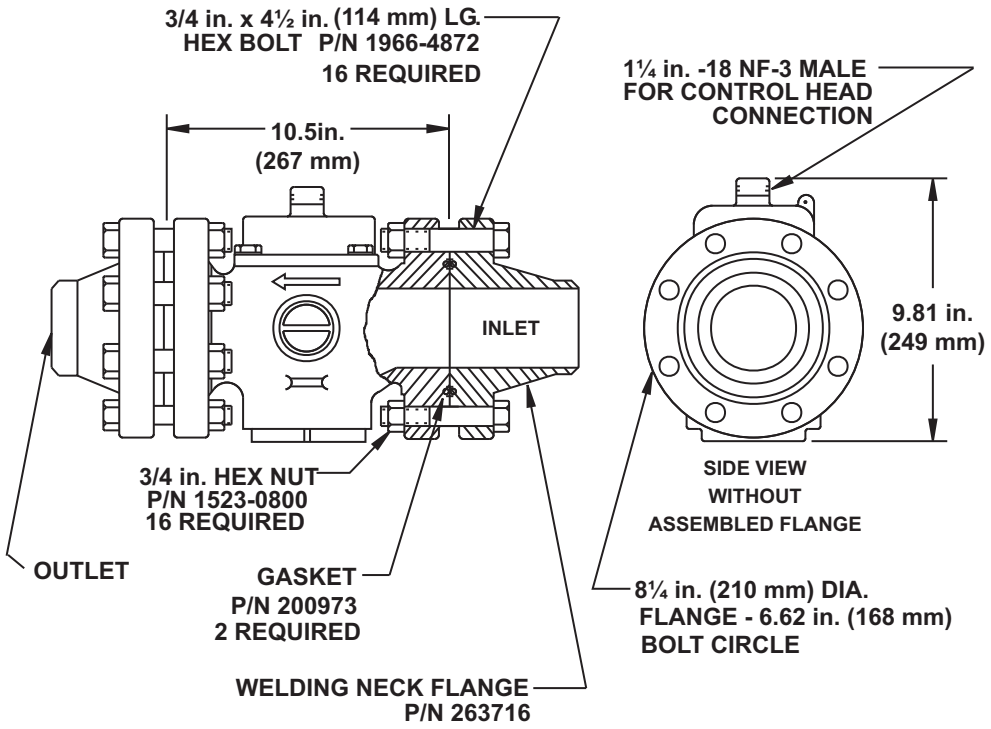


Figure 3-51. 3 in. (2½ in.) Stop (Direction) Valves

Table 3-25. Stop Valves

Part Number	Valve Size NPT	A		B		C		Equivalent Length	
		in.	mm	in.	mm	in.	mm	ft.	m
870023	1/2 in.	3.75	95	2.50	64	4.68	119	11	3.4
870022	3/4 in.	4.25	108	2.81	71	5.68	144	17	5.2
870122	1 in.	5.50	140	3.62	92	6.87	175	21	6.4
870032	1-1/4 in.	5.50	140	3.62	92	6.87	175	52	15.9
870123	1-1/2”	7.50	191	4.75	121	8.43	214	34	10.4
870049	2 in.	7.50	191	4.75	121	8.43	214	76	23.2
890010	2-1/2 in.	See Figure 3-51						69	21.0
890010*	3 in.	See Figure 3-51						216	65.8
890208	4 in.	See Figure 3-52						206	62.8
*Note: 2-1/2 in. valve is a 3 in. valve with 2-1/2 in. flanges.									

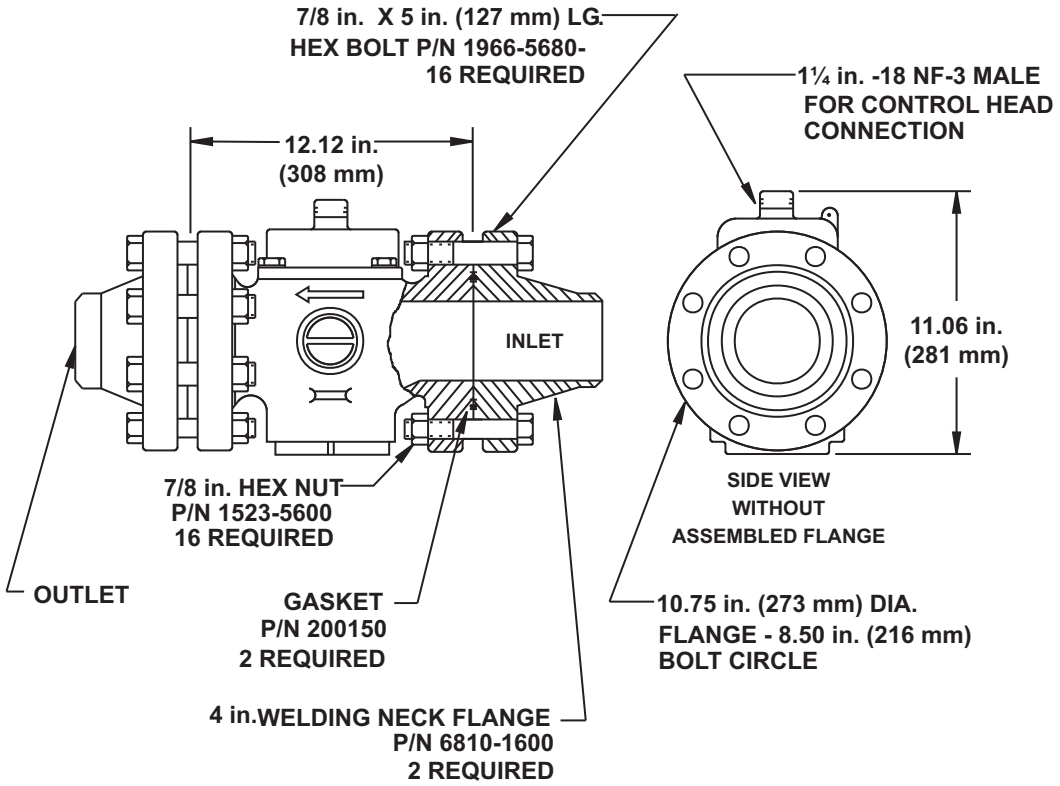


Figure 3-52. 4 in. Stop (Direction) Valve

3-3.10.7 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 Figure 3-53 and Figure 3-54).

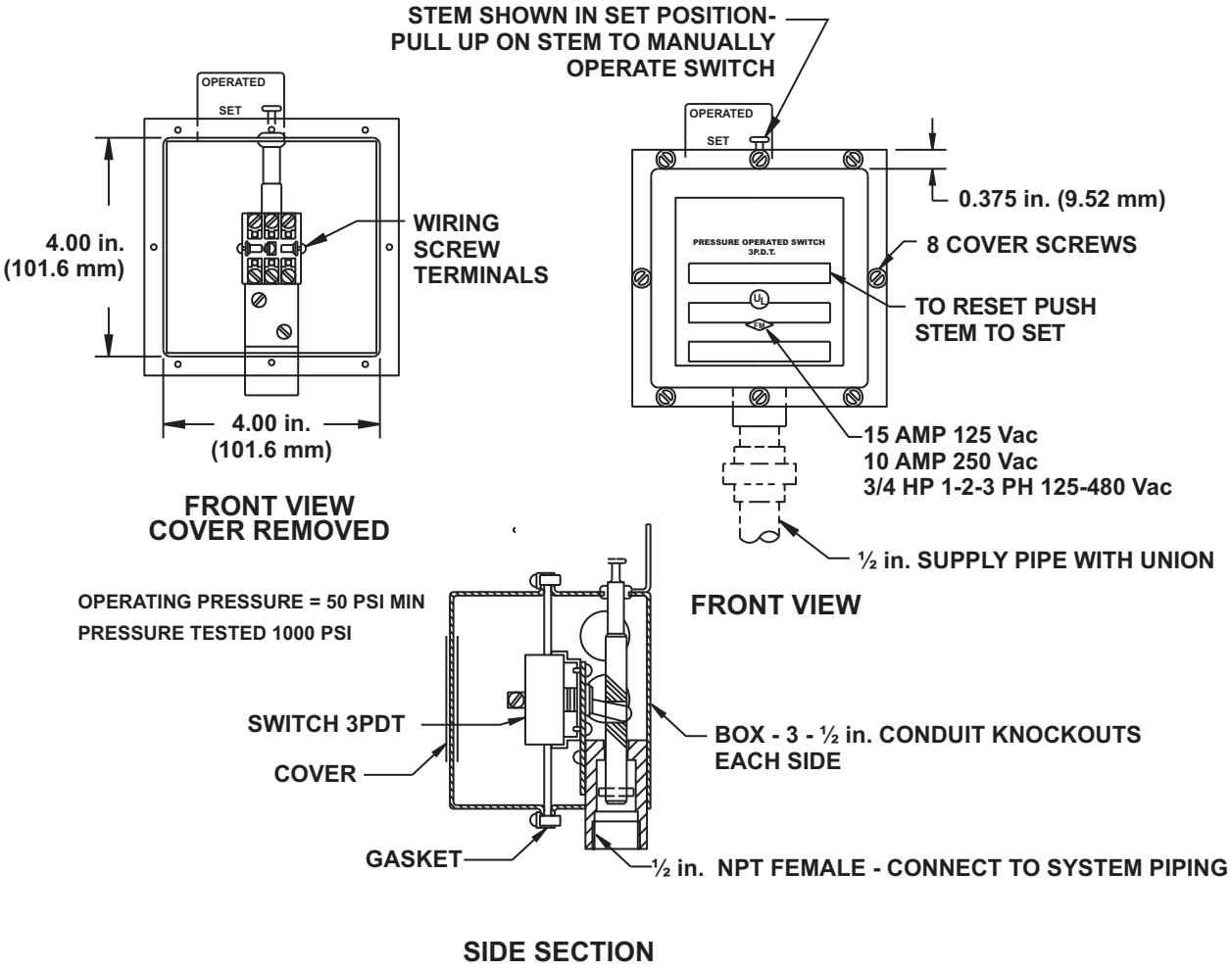


Figure 3-53. Pressure Operated Switch

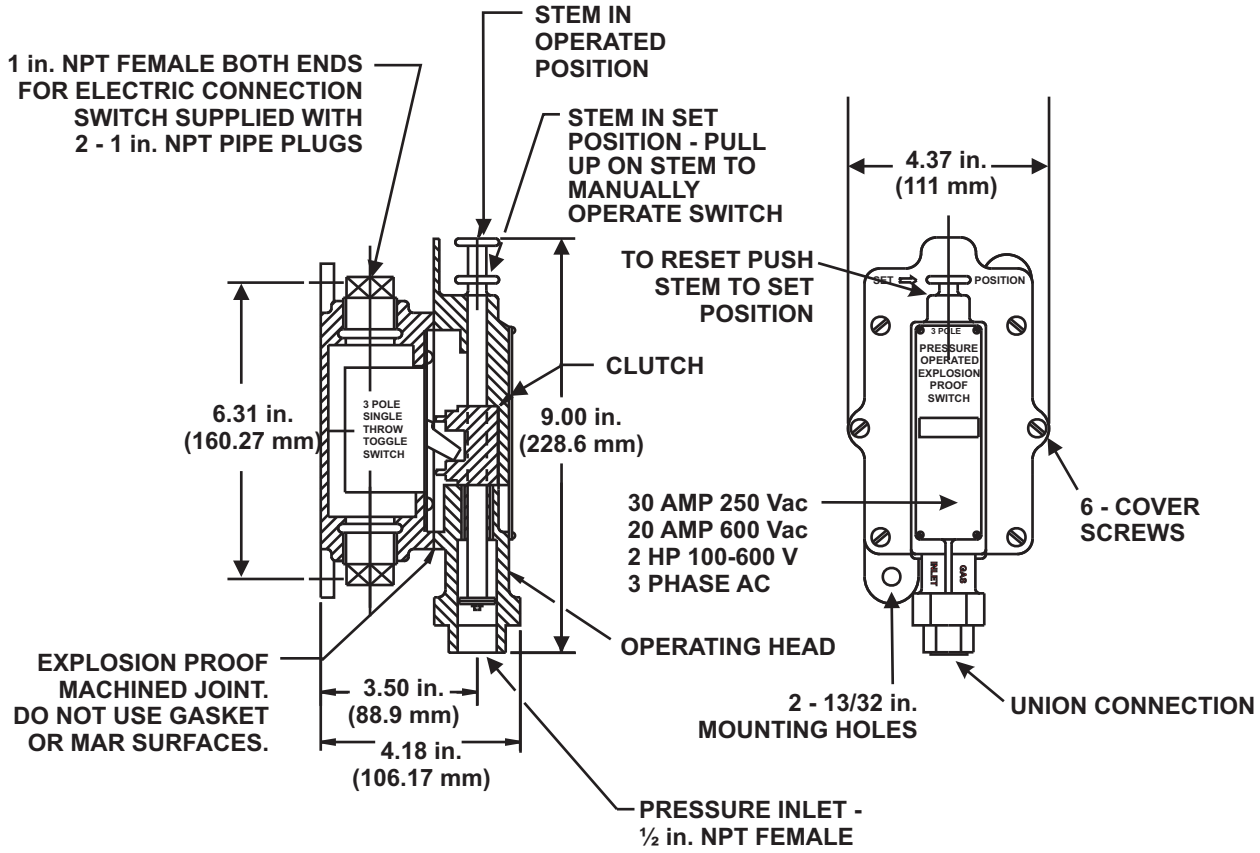


Figure 3-54. Pressure Operated Switch, Explosion Proof

3-3.10.8 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 (see Figure 3-55).

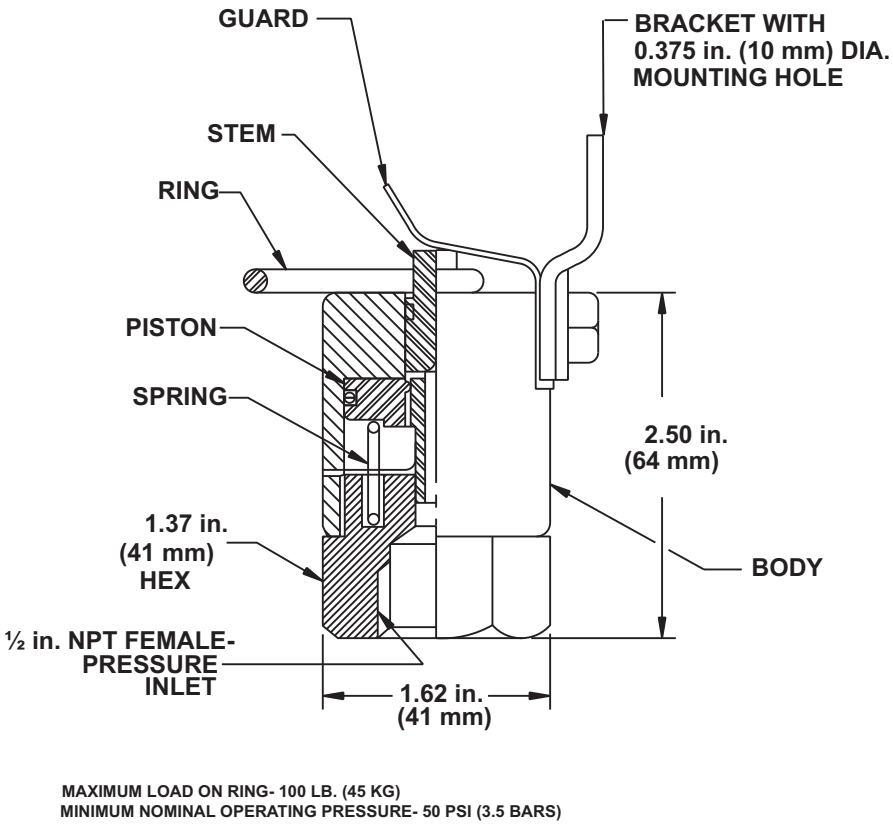


Figure 3-55. Pressure Operated Trip

3-3.10.9 Discharge Indicator, P/N 967082

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 3-56).

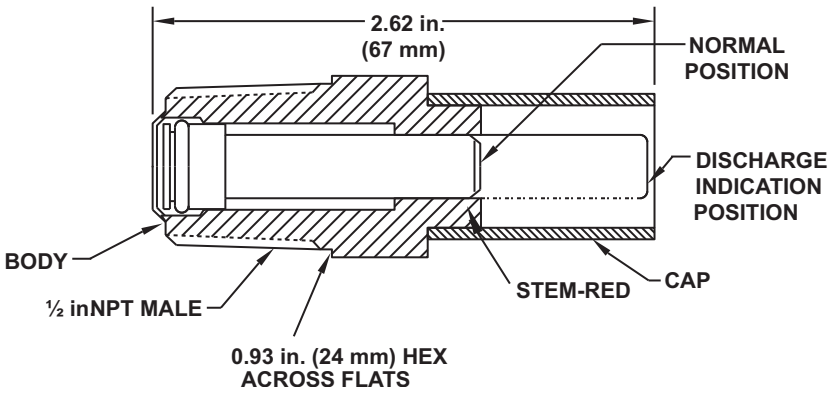


Figure 3-56. Discharge Indicator

3-3.10.10 SUPERVISORY PRESSURE SWITCH,1½ in. TO 2 in. VALVES, P/N 06-118262-001

The supervisory pressure switch is intended to detect a fall in pressure in the FM-200 cylinder (see Figure 3-57). 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.

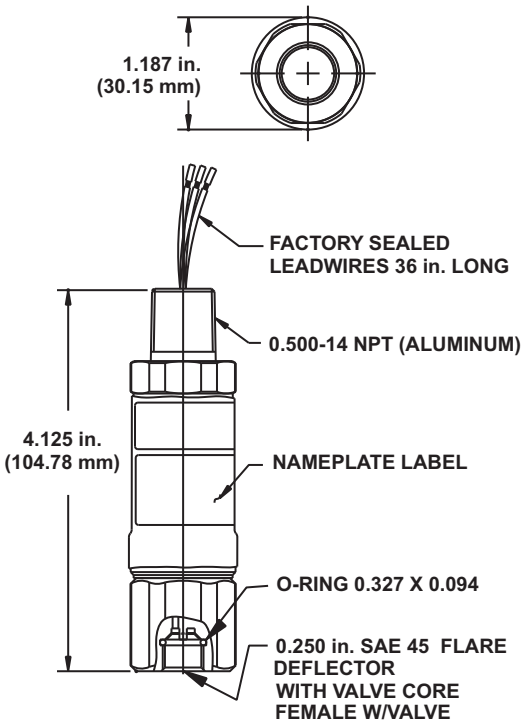


Figure 3-57. Supervisory Pressure Switch, 1½ in. to 2 in. Valves

3-3.10.11 SUPERVISORY PRESSURE SWITCH, 3 in. VALVES, P/N 06-118263-001

The supervisory pressure switch is intended to detect a fall in pressure in the FM-200 cylinder (see Figure 3-58). The 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 in. 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.

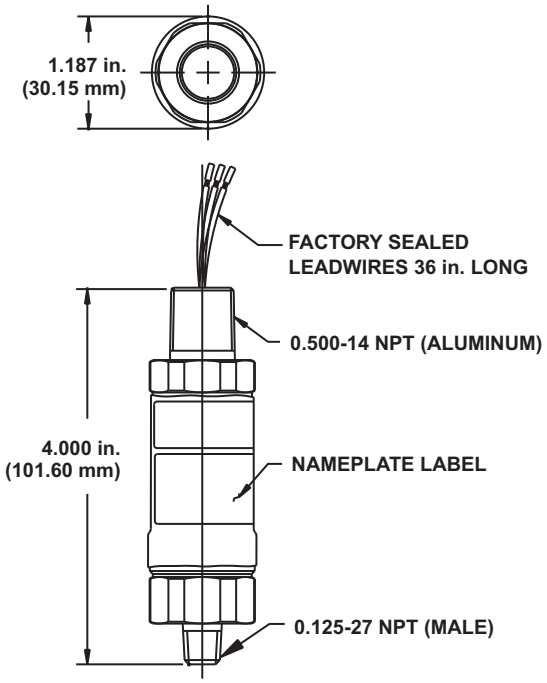


Figure 3-58. Supervisory Pressure Switch, 3 in. Valves

3-3.10.12 SUPERVISORY SWITCH-IN-GAUGE, P/N 06-118328-001

The Switch-in-Gauge unit provides a NO (Normally Open) switched contact that is NC (Normally Closed) under normal operating pressure. It is designed to trip when the pressure within the nitrogen cylinder is outside of the standard operating range (1623 to 2062 PSI [112 to 142 bar]).

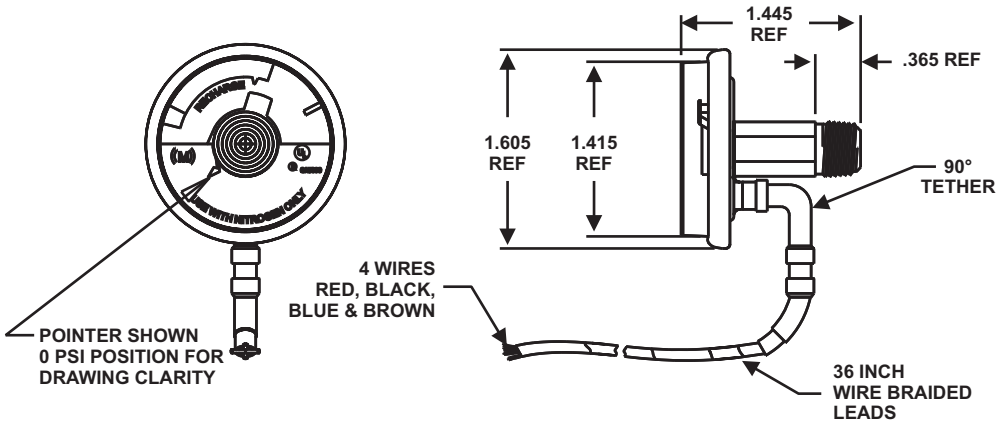


Figure 3-59. Supervisory Switch-In-Gauge

Note: A fault indication is not necessarily an indication of a loss of pressure—all cylinder pressure readings must be corrected for temperature.

3-3.10.13 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 Figure 3-60 and Figure 3-61 and Table 3-26 and Table 3-27 for further information.

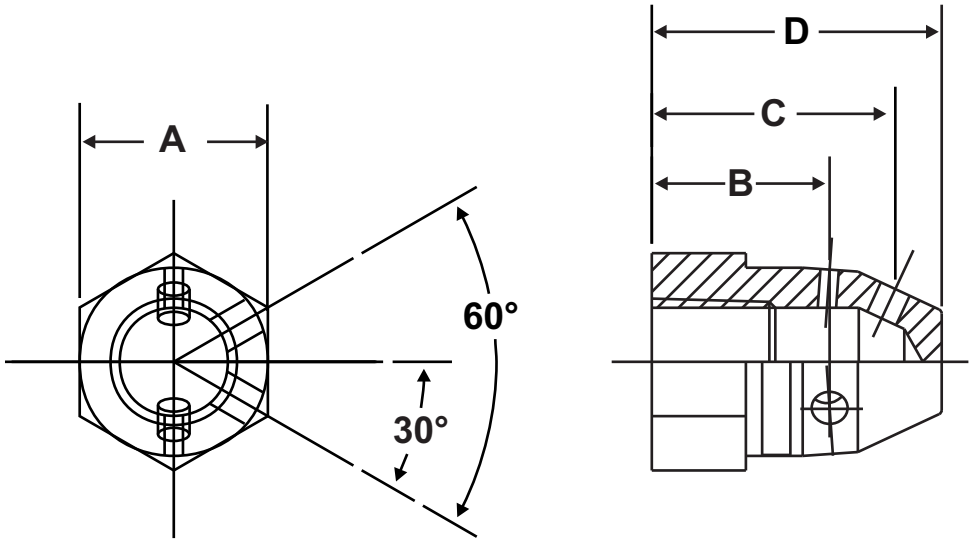


Figure 3-60. 180° Discharge Nozzle

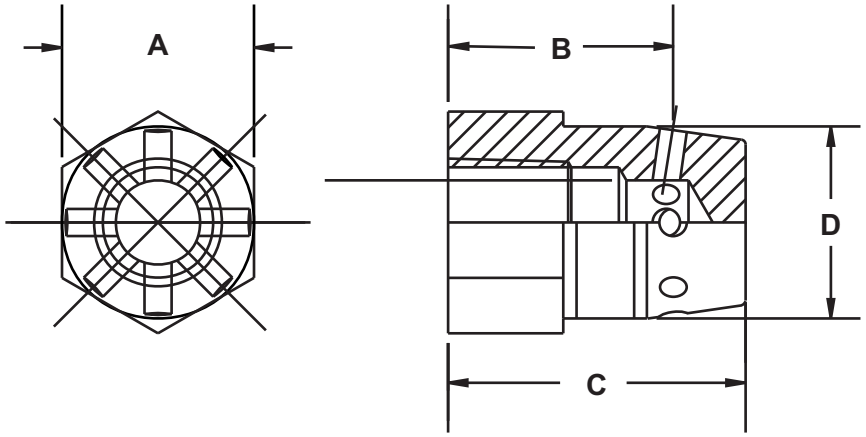


Figure 3-61. 360° Discharge Nozzle

Table 3-26. Dimensions–180° Discharge Nozzle

Pipe Size	A	B	C	D
1/2 in. (15 mm)	1.250 in. (31.75 mm)	1.250 in. (31.75 mm)	1.687 in. (42.84 mm)	2.000 in. (50.80 mm)
3/4 in. (20 mm)	1.500 in. (38.10 mm)	1.375 in. (34.92 mm)	1.950 in. (48.89 mm)	2.296 in. (58.31 mm)
1 in. (25 mm)	1.750 in. (44.45 mm)	1.562 in. (39.67 mm)	2.218 in. (56.33 mm)	2.671 in. (67.84 mm)
1-1/4 in. (32 mm)	2.250 in. (57.15 mm)	1.750 in. (44.45 mm)	2.656 in. (67.46 mm)	3.250 in. (82.55 mm)
1-1/2 in. (40 mm)	2.500 in. (63.5 mm)	1.950 in. (48.89 mm)	2.950 in. (74.93 mm)	3.625 in. (92.07 mm)
2 in. (50 mm)	3.00 in. (76.2 mm)	1.968 in. (49.98 mm)	2.875 in. (73.02 mm)	3.656 in. (92.86 mm)

Table 3-27. Dimensions–360° Discharge Nozzle

Pipe Size	A	B	C	D
1/2 in. (15 mm)	1.250 in. (31.75 mm)	1.468 in. (31.28 mm)	1.937 in. (49.19 mm)	1.250 in. (31.75 mm)
3/4 in. (20 mm)	1.500 in. (38.10 mm)	1.578 in. (40.08 mm)	2.125 in. (53.97 mm)	1.500 in. (38.10 mm)
1 in. (25.40 mm)	1.75 in. (44.45 mm)	1.718 in. (43.63 mm)	2.375 in. (60.32 mm)	1.750 in. (44.45 mm)
1-1/4 in. (32 mm)	2.250 in. (57.15 mm)	1.950 in. 49.53 mm)	2.751 in. (69.85 mm)	2.250 in. (57.15 mm)
1-1/2 in. (40 mm)	2.250 in. (63.5 mm)	2.000 in. (50.80 mm)	2.937 in. (74.59 mm)	2.500 in. (63.50 mm)
2 in. (50 mm)	3.00 in. (76.2 mm)	2.062 in. (52.37 mm)	3.125 in. (79.37 mm)	3.000 in. (76.20 mm)

3-3.10.14 SAFETY OUTLETS, P/N 803242 AND P/N 844346

These units are designed to protect against over-pressurization in closed sections of discharge pipework, i.e., manifolds. The correct unit must be selected for the agent in use. See Figure 3-62 and Table 3-28 for more information.

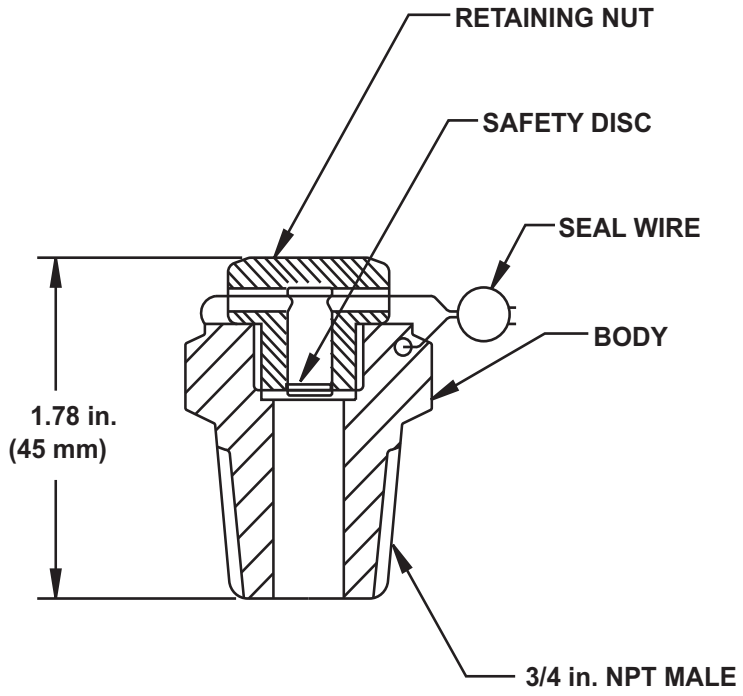


Figure 3-62. Safety Outlets

Table 3-28. Safety Outlets

Part Number	Agent	Pressure Relief Operates at	
		PSIG	Bar
803242	N_2/CO_2	2400 to 2800	166 to 193
844346	FM-200	750 to 900	52 to 62

3-3.11 Warning and Instruction Name Plates

3-3.11.1 FM-200 WARNING NAMEPLATE, P/N 06-231865-739

Figure 3-63 illustrates a the FM-200 warning nameplate. This label should be affixed at the access ways into a protected area.

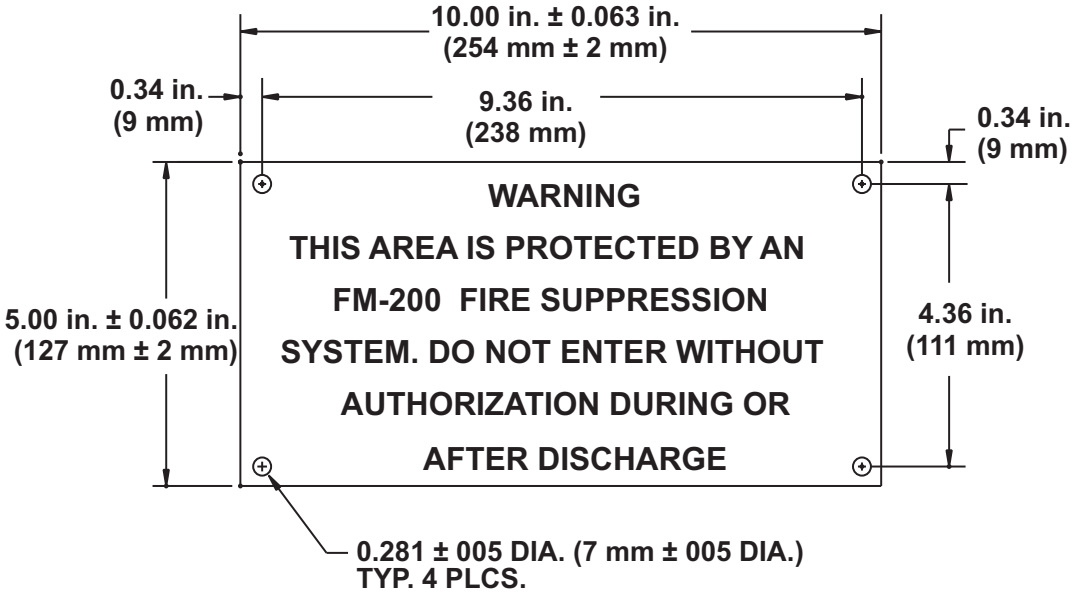
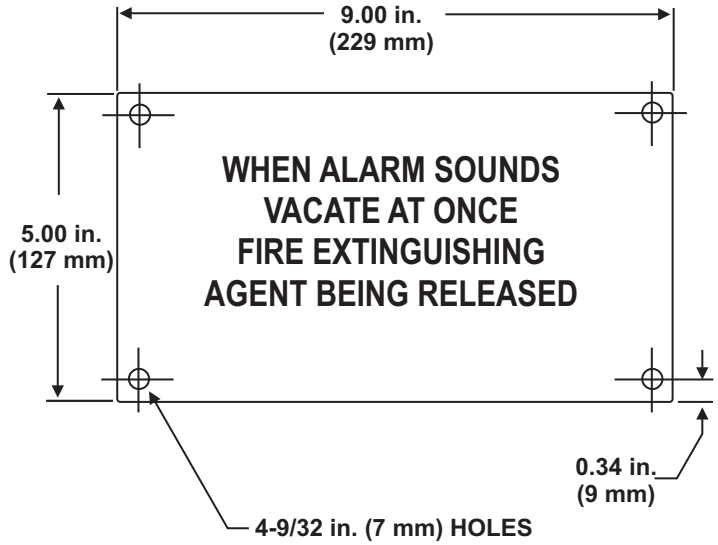


Figure 3-63. FM-200 Warning Nameplate

3-3.11.2 AGENT RELEASE WARNING NAMEPLATE, P/N 218270

Figure 3-64 illustrates the 'Agent Release' warning nameplate. This nameplate is an alternative, non-agent specific warning.



Note: Use 1/4 in. hardware for fastening.
Material: Aluminum with red paint letters.

Figure 3-64. Agent Release Warning Nameplate

3-3.11.3 MAIN AND RESERVE NAMEPLATES, P/N 31033 AND P/N 31034

Figure 3-65 illustrates the Main and Reserve nameplates. These nameplates should be attached at the cylinder location and/or control station(s) to ensure that the individual systems are clearly identified.

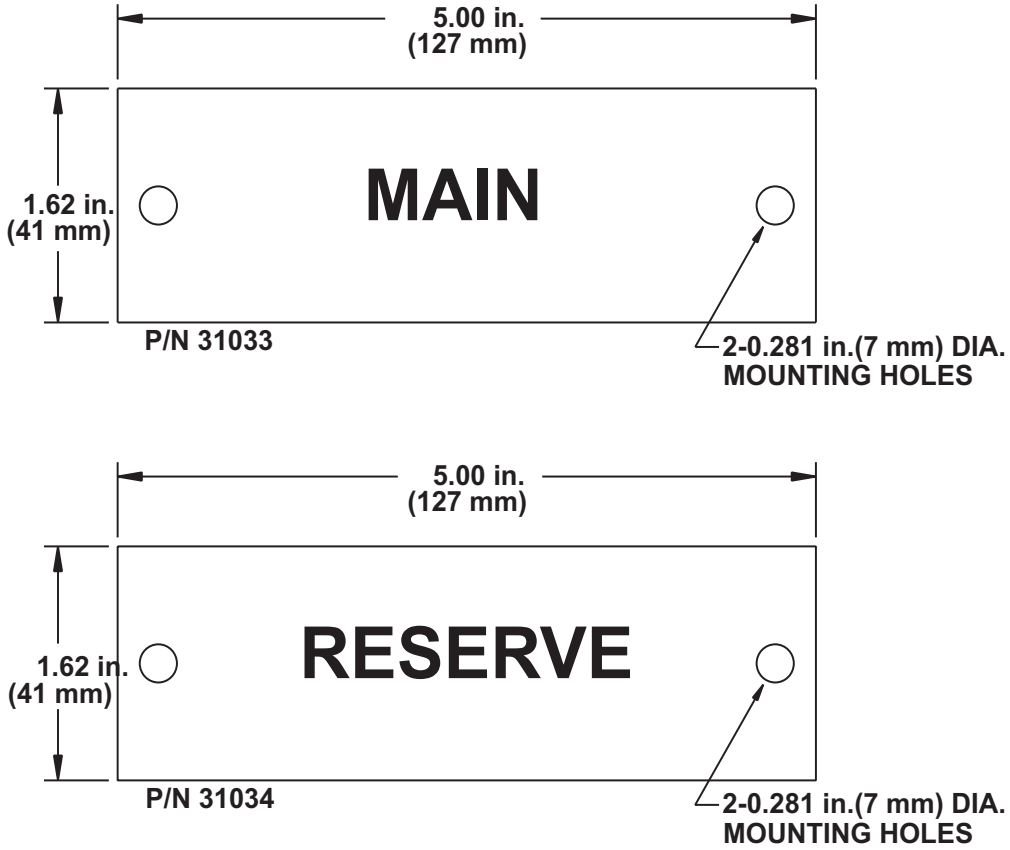


Figure 3-65. Main and Reserve Nameplates

3-3.12 Other Accessories

3-3.12.1 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 5-5.1 and 5-5.3 of this manual.

3-3.12.2 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 3-66 and Table 3-29).

Note: The 3 in. 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 in. NPT connection on the grooved fitting plate on the outlet port.

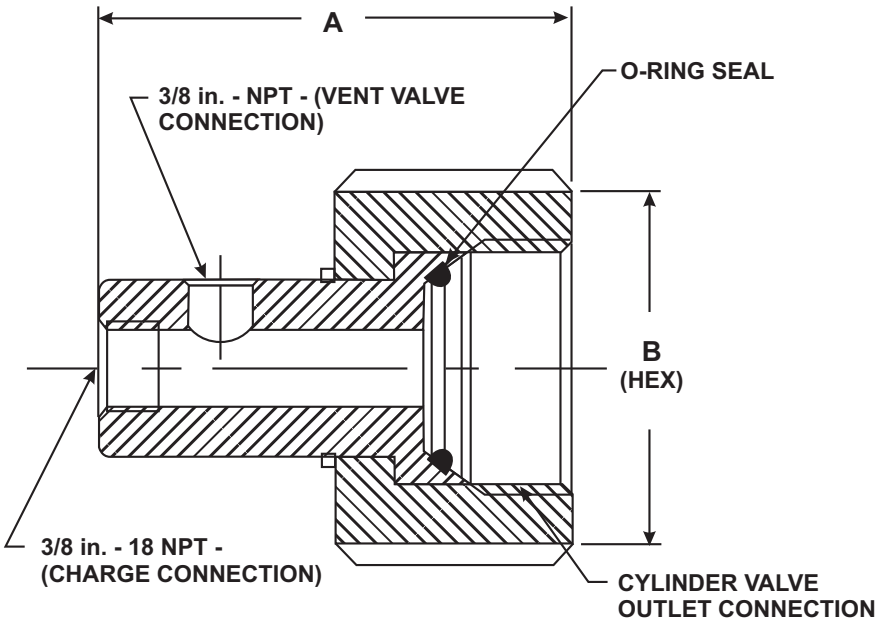


Figure 3-66. Cylinder Recharge Adapters

Table 3-29. 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

3-3.12.3 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.

3-3.12.4 DETECTORS AND CONTROL PANELS

The USCG rules do not allow the use of electrically triggered detection and control systems.

Refer to Kidde Fire Systems for guidance on system design and component selection where the AHJ responsible for the vessel allows or specifies electrical and/or automatic detection and/or control.

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

Unless otherwise stated, the system design information detailed in this chapter meets the requirements of the United States Coast Guard (USCG). The designer is responsible for ensuring compliance with the applicable approval requirements. Design variations that do not meet the restrictions of the USCG requirements are explicitly marked.

4-2.2 Application

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

1. Determine the design concentration required for the hazard. Refer to Table 4-1 for concentrations.
2. Determine the minimum and maximum ambient temperature for the hazard.
3. Determine the volume of the hazard.
4. Determine the integrity of the hazard.
5. 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.

To meet USCG Approval requirements, the volume of the hazard used to calculate agent quantity shall be the gross volume (i.e., no deduction used for impermeable objects within the hazard, refer to MSC circular 848) unless a door fan integrity test is conducted.

The volume of free air contained in the air receivers should be added to the volume of the hazard to provide adequate protection in the event of its release into the space.

The risk areas that are protected by Kidde® FM-200 Marine Systems are predominantly Class B hazards. Class A and Class C materials/hazards are often also present and present a supplemental risk. These hazards should be protected by no less than 7.6% concentration. The USCG Approval reflects this fire risk scenario.

Class B hazards are protected using a design concentration 30% higher than the minimum extinguishing concentration (refer to Table 4-1).

Note: Concentrations of less than 8.7% shall not be used for USCG Approved applications protecting machinery spaces.

- Refer to Tables 4-1, 4-2 and 4-3. The information in Table 4-2 and 4-3 is given for estimating purposes only. The Kidde ECS Series FM-200 Flow Calculation Program calculates the agent quantity based on the volume design concentration and temperature data entered by the designer. Refer to the Kidde ECS Series FM-200 Flow Calculation Program User's Manual (P/N 90-FM200M-100) for further information.

4-2.2.2 DETERMINE REQUIRED COMPONENTS

- Cylinder size, quantity and fill requirements (refer to Table 3-1 and Table 3-3).
- Cylinder framing, mounting brackets, etc.
- Actuation, control and warning system equipment required.
- Other system requirements, such as machinery shutdowns, pressure switches, etc.

4-2.2.3 LOCATE NOZZLES

Locate nozzles based on the following:

- Compartment height (15 ft. 6 in. [4.72 m] maximum, 1 ft. [0.30 m] minimum).
- Nozzle area coverage (see Paragraph 4-2.3.5).
- 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 for loading and removal for refill.
- Deck plate or bulkhead loading.
- AHJ requirements.

4-2.2.5 EVALUATE PIPE ROUTING

Locate cylinders based on the following:

- Nozzle location.
- Obstructions and personnel access within hazard.
- Structural members for bracing the pipe.

Table 4-1. Class B Suppression Design Concentrations*1

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*	8.0	8.5
t-Amyl Alcohol	7.3	9.5	Hydraulic Oil*	7.3	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*	9.1	9.6	JP5	6.9	9.0
2-Butoxyethyl Acetate*	8.5	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	8.2	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*	9.6	10.1	1-Propanol	9.5	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*	7.8	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**	8.9	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

*[1] Design concentration - minimum use concentration for specific fuel

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

Table 4-2. FM-200 Total Flooding Concentration Factors (*W/V*), Imperial

Temp[a] *t* (°F)[c]	Specific Vapor Volume *s* (ft.^{3}/lb.)[d]	Weight Requirements of Hazard Volume, *W/V* (lb./ft.^{3})[b] Design Concentrations (% by Volume)[e]								
		7	8	9	10	11	12	13	14	15
10	1.9264	0.0391	0.0451	0.0513	0.0577	0.0642	0.0708	0.0776	0.0845	0.0916
20	1.9736	0.0381	0.0441	0.0501	0.0563	0.0626	0.0691	0.0757	0.0825	0.0894
30	2.0210	0.0372	0.0430	0.0489	0.0550	0.0612	0.0675	0.0739	0.0805	0.0873
40	2.0678	0.0364	0.0421	0.0478	0.0537	0.0598	0.0659	0.0723	0.0787	0.0853
50	2.1146	0.0356	0.0411	0.0468	0.0525	0.0584	0.0645	0.0707	0.0770	0.0835
60	2.1612	0.0348	0.0402	0.0458	0.0514	0.0572	0.0631	0.0691	0.0753	0.0817
70	2.2075	0.0341	0.0394	0.0448	0.0503	0.0560	0.0618	0.0677	0.0737	0.0799
80	2.2538	0.0334	0.0386	0.0439	0.0493	0.0548	0.0605	0.0663	0.0722	0.0783
90	2.2994	0.0327	0.0378	0.0430	0.0483	0.0538	0.0593	0.0650	0.0708	0.0767
100	2.3452	0.0321	0.0371	0.0422	0.0474	0.0527	0.0581	0.0637	0.0694	0.0752
110	2.3912	0.0315	0.0364	0.0414	0.0465	0.0517	0.0570	0.0625	0.0681	0.0738
120	2.4366	0.0309	0.0357	0.0406	0.0456	0.0507	0.0560	0.0613	0.0668	0.0724
130	2.4820	0.0303	0.0350	0.0398	0.0448	0.0498	0.0549	0.0602	0.0656	0.0711
140	2.5272	0.0298	0.0344	0.0391	0.0440	0.0489	0.0540	0.0591	0.0644	0.0698
150	2.5727	0.0293	0.0338	0.0384	0.0432	0.0480	0.0530	0.0581	0.0633	0.0686
160	2.6171	0.0288	0.0332	0.0378	0.0425	0.0472	0.0521	0.0571	0.0622	0.0674
170	2.6624	0.0283	0.0327	0.0371	0.0417	0.0464	0.0512	0.0561	0.0611	0.0663
180	2.7071	0.0278	0.0321	0.0365	0.0410	0.0457	0.0504	0.0552	0.0601	0.0652
190	2.7518	0.0274	0.0316	0.0359	0.0404	0.0449	0.0496	0.0543	0.0592	0.0641
200	2.7954	0.0269	0.0311	0.0354	0.0397	0.0442	0.0488	0.0535	0.0582	0.0631

a The minimum design temperature in the flooded space.

b *W/V* [agent weight requirements (lb./ft.^{3})] = Pounds of agent required per cubic foot of protected volume to produce indicated concentration at the 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:

$s = 1.885 + 0.0046t$ where t = temperature (°F)

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

Table 4-3. 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 Concentrations (% by Volume)[e]								
		7	8	9	10	11	12	13	14	15
-10	0.1215	0.6196	0.7158	0.8142	0.9147	1.0174	1.1225	1.2301	1.3401	1.4527
-5	0.1241	0.6064	0.7005	0.7967	0.8951	0.9957	1.0985	1.2038	1.3114	1.4216
0	0.1268	0.5936	0.6858	0.7800	0.8763	0.9748	1.0755	1.1785	1.2839	1.3918
5	0.1294	0.5816	0.6719	0.7642	0.8586	0.9550	1.0537	1.1546	1.2579	1.3636
10	0.1320	0.5700	0.6585	0.7490	0.8414	0.9360	1.0327	1.1316	1.2328	1.3364
15	0.1347	0.5589	0.6457	0.7344	0.8251	0.9178	1.0126	1.1096	1.2089	1.3105
20	0.1373	0.5483	0.6335	0.7205	0.8094	0.9004	0.9934	1.0886	1.1859	1.2856
25	0.1399	0.5382	0.6217	0.7071	0.7944	0.8837	0.9750	1.0684	1.1640	1.2618
30	0.1425	0.5284	0.6104	0.6943	0.7800	0.8676	0.9573	1.0490	1.1428	1.2388
35	0.1450	0.519	0.5996	0.6819	0.7661	0.8522	0.9402	1.0303	1.1224	1.2168
40	0.1476	0.5099	0.5891	0.6701	0.7528	0.8374	0.9240	1.0124	1.1029	1.1956
45	0.1502	0.5012	0.5790	0.6586	0.7399	0.8230	0.9080	0.9950	1.0840	1.1751
50	0.1527	0.4929	0.5694	0.6476	0.7276	0.8093	0.8929	0.9784	1.0660	1.1555
55	0.1553	0.4847	0.5600	0.6369	0.7156	0.7960	0.8782	0.9623	1.0484	1.1365
60	0.1578	0.4770	0.5510	0.6267	0.7041	0.7832	0.8641	0.9469	1.0316	1.1183
65	0.1604	0.4694	0.5423	0.6167	0.6929	0.7707	0.8504	0.9318	1.0152	1.1005
70	0.1629	0.4621	0.5338	0.6072	0.6821	0.7588	0.8371	0.9173	0.9994	1.0834
75	0.1654	0.455	0.5257	0.5979	0.6717	0.7471	0.8243	0.9033	0.9841	1.0668
80	0.1679	0.4482	0.5178	0.0589	0.6617	0.7360	0.8120	0.8898	0.9694	1.0509
85	0.1704	0.4416	0.5102	0.5803	0.6519	0.7251	0.8000	0.8767	0.9551	1.0354
90	0.1730	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 the 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:

$$s = 0.1269 + 0.0005t$$

where *t* = temperature (°C)

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

4-2.2.6 Pipe Size and Layout

Identify system layout with the following details:

- Piping isometric.
- Dimensions of all pipe sections.
- Location and specification of all fittings.
- Note all elevation changes.

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 Table 4-2 and Table 4-3 that correspond to the design temperature and concentration desired.

Note: 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 maximum of five minute exposure based on the United States Environmental Protection Agency (U.S.E.P.A.) PBPK model.

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 and modular pipe work (i.e., each cylinder having its own separate discharge pipe work) is not practical or acceptable.
3. A single cylinder does not contain enough nitrogen to discharge the required agent through the pipe network.

When manifolds are used, the following shall be observed:

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

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

- Multiple cylinders are required, and
- A connected reserve supply is required, and
- There is 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 FM-200 Flow Calculation Program (P/N 90-FM200M-100) to determine the proper procedures for applying the input parameters to the Kidde ECS Series FM-200 Flow Calculation 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.

Note: An **s** symbol after a design limitation indicates that the calculation software checks this parameter.

4-2.3.1 FIRST BRANCH FLOW SPLIT

For accuracy of the flow calculations, there are various agent flow limits. The maximum percent agent in pipe for all systems is 80%. There is also a limit on the allowable percent of agent prior to the first tee; Table 4-1 shows these percentages. When these conditions are not met, the computer will display a warning. The system designer must then correct the piping volume before the first branch split to meet the design requirement (see Figure 4-2). 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.

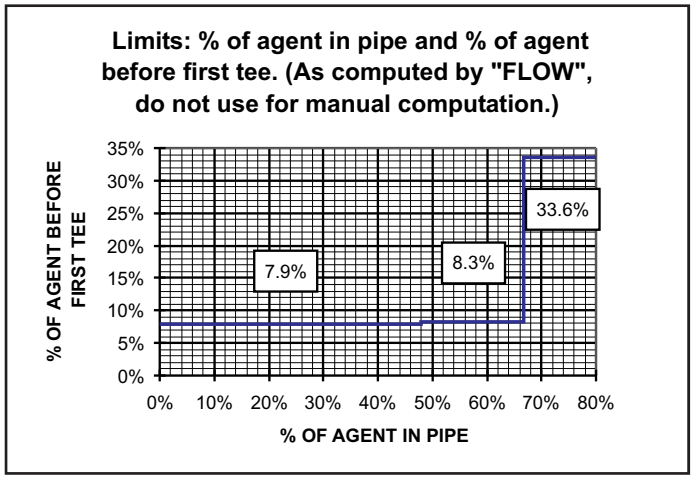


Figure 4-1. Percent Agent Before First Tee as a Function of Percent Agent in Pipe

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.

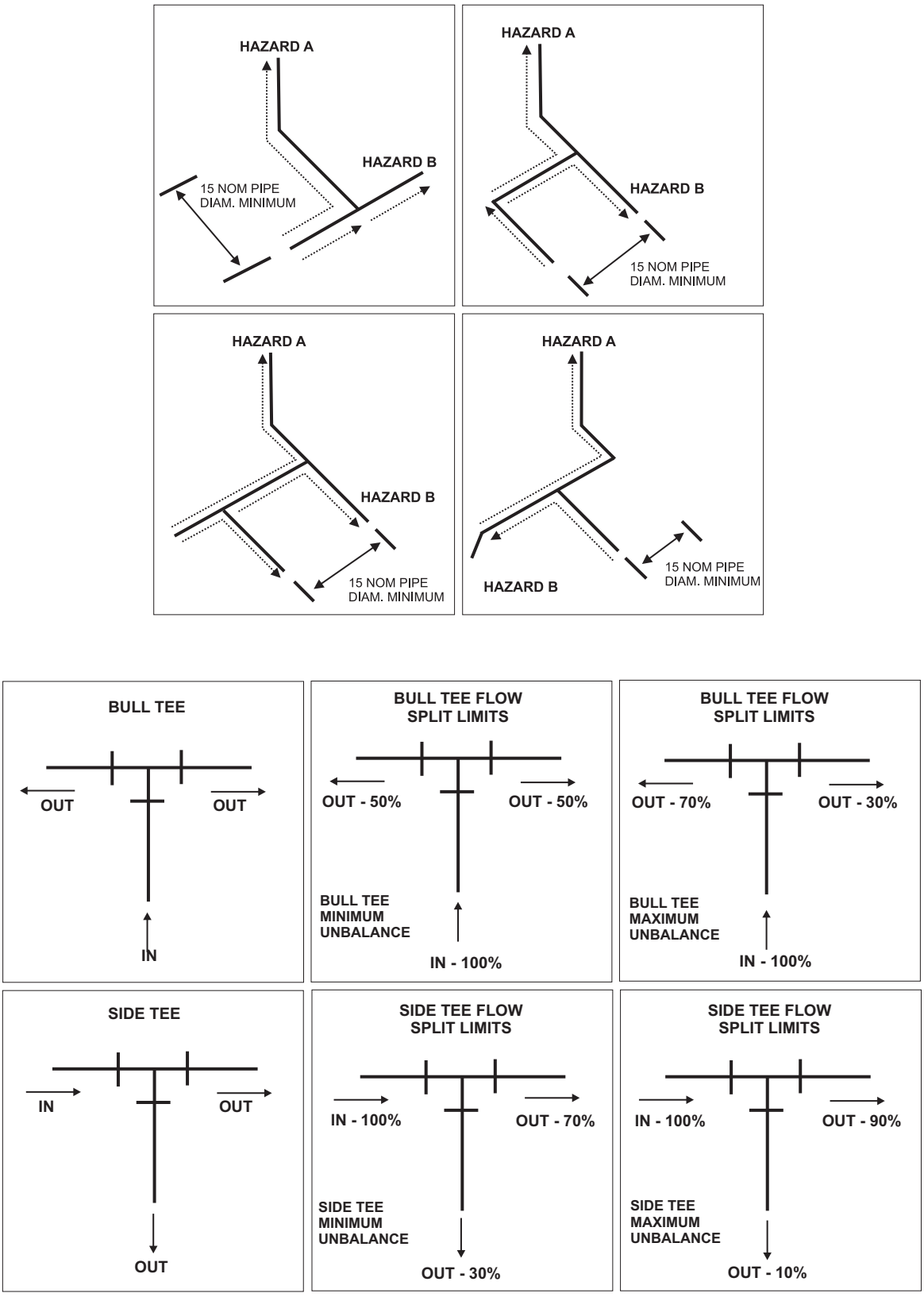


Figure 4-2. Acceptable Tee Flow Splits for FM-200

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 **s** .
7. For flow splits less than 30%, the split shall be achieved through a side tee with the smaller flow exiting the side outlet. The minimum flow through the side outlet is 10%. The corresponding maximum flow through the straight-through outlet is 90% **s** .
8. For flow splits equal to or greater than 30%, the split shall be achieved through a bull head tee. The maximum flow split through either outlet of a bull head tee is 70% **s** .

Table 4-4. 15 Pipe Diameters

Pipe Size	15 Pipe Diameters		
	feet	feet and inches	meters
1/2 in.	0.63	7½ in.	0.192
3/4 in.	0.94	11¼ in.	0.287
1 in.	1.25	1 ft. 3 in.	0.381
1¼ in.	1.56	1 ft. 6 ¾ in.	0.475
1½ in.	1.88	1 ft. 10½ in.	0.573
2 in.	2.50	2 ft. 6 in.	0.762
2½ in.	3.13	3 ft. 1½ in.	0.954
3 in.	3.75	3 ft. 9 in.	1.143
4 in.	5.00	5 ft.	1.524

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 ten seconds are desirable to minimize production of breakdown products. Discharge times as short as six seconds should be considered when circumstances permit **s** .

4-2.3.4 Nozzle Selection and Placement

There are two basic Kidde nozzle configurations:

1. The 360° nozzle provides a full 360° discharge pattern and is designed for placement in the center of the area covered by the nozzle.
2. The 180° nozzle provides a 180° discharge pattern and is designed for placement along the side of the area covered by the nozzle.

Only the FM-200 ECS Series FM-200 Flow Calculation software can be used to determine the required nozzle orifice area.

The maximum orifice area to pipe area ratio is as follows:

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

The minimum orifice area to pipe area ratio is as follows:

- 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% **s** .
- 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% **s** .

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

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.

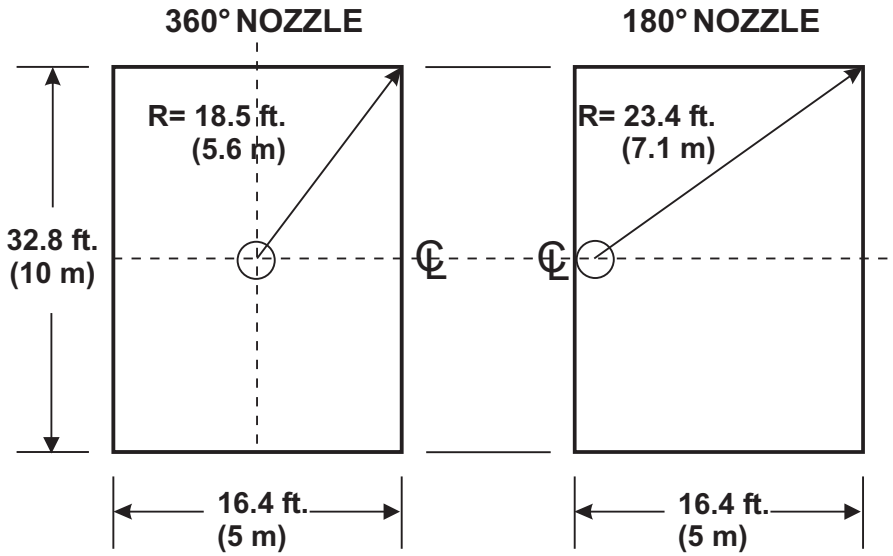


Figure 4-3. Nozzle Placement and Coverage

- Orientation - Nozzles must be mounted perpendicular to the deck or bilge surface and oriented with the orifices radiating symmetrically outward from the pipe network.
- Nozzle Orifice Vertical Clearance - Nozzles must be installed so that the orifices are located 6 ± 2 inches (0.15 ± 0.05 m) below the overhead deck.
- **Maximum** Height - The maximum protected height for a single row of nozzles is 15.5 feet (4.72 m). The 15.5 ft. (4.72 m) coverage height includes the 6 ± 2 inches (0.15 ± 0.05 m) below the deck plate.

  Nozzles may be tiered to accommodate enclosures with ceiling heights greater than 16 ft. (4.87 m).
- Bilge - Where bilges are open (where openings allow free communication into the main protected space), they are part of the protected space and require no additional nozzles. Where bilges are closed, they must be protected with a dedicated nozzle network.

Note: A bilge is open and is protected as part of the enclosure above, the nozzle height coverage shall be measured from the top of the enclosure (above the nozzle) to the lowest section of the bilge.

- Minimum Enclosure Height - The minimum enclosed space protected with one or more nozzles is 12 in. (0.30 m).
- 180° Nozzles - 180° nozzles must be located 12 ± 2 inches (0.3 ± 0.05 m) from a wall, with the orifices directed away from a bulkhead, with the orifices directed away from the bulkhead. 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 within a semicircle of distance 23.4 ft. (7.1 m), i.e., the diagonal of a rectangle that is 16.4 ft. x 16.4 ft. Refer to Figure 4-3.

  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)or subdivision thereof) as possible. 360° nozzles have a maximum coverage area defined as any rectangle that can be inscribed in a circle radius 18.5 ft. (5.6 m), i.e., the diagonal of a rectangle 16.4 ft. x 8.2 ft.). Refer to Figure 4-3.
- Multiple Nozzles - Nozzles whose discharge patterns will intersect must be placed at least 10 ft. (3.3 m) apart to assure adequate agent distribution.
- Bulkheads and Obstructions - To ensure full and rapid atomization of the FM-200, agent nozzles should be placed no closer than 4 to 6 ft. (1.22 to 1.83 m) of significant obstructions or bulkheads, where possible.

Limits on Nozzle Conditions

- Minimum average nozzle pressure - The nozzle pressure must be a minimum of 74 PSIG (5.10 bar gauge) for the nozzle to effectively disperse the agent and mix the agent into the air of the enclosure being protected **s** .
- Maximum arrival time imbalance - The difference between liquid arrival times at two of the nozzles exceed the 0.8 seconds allowed **s** .
- Maximum run-out time imbalance - The difference between nozzle liquid runout times at two of the nozzles exceed the 2.0 seconds allowed maximum **s** .

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 highest position in the network 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 lowest position in the network 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 highest and lowest position in the network shall not exceed 30 ft. (9 m).

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

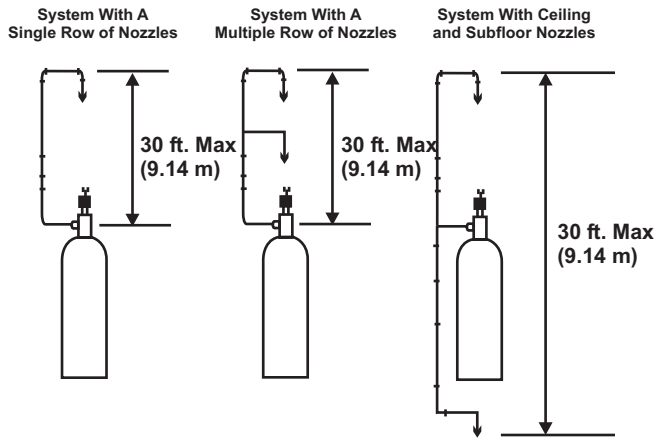


Figure 4-4. Nozzle Limitations

4-2.3.6 PIPE SIZING

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

Table 4-5. Kidde Pipe Size Estimating Table

Nominal Pipe Size (inches)	Flow Rate (lb./sec.)		Flow Rate (kg/s)	
	Minimum Design	Max. Nom. Design	Minimum Design	Max. Nom. Design
1/2	1	3.0	0.5	1.4
3/4	2	5.5	0.9	2.5
1	3.5	8.5	1.6	3.9
1¼	6	12.5	2.7	5.7
1½	9	20.0	4.1	9.0
2	14	30.0	6.4	13.6
2½	20	55.0	9.0	25.0
3	30	90.0	13.6	40.9
4	55	125.0	25.0	56.8
5	90	200.0	40.9	90.9
6	120	300.0	54.5	136.4

This table is intended for use as a guide only. The Kidde FM-200 ECS Series Flow Calculation Computer Program must be used for the final design.

4-2.4 Other Conditions

4-2.4.1 OPERATING/STORAGE TEMPERATURE RANGE

Kidde FM-200 Marine 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.

Marine applications typically protect single- or multiple-hazard areas that have direct volumetric communication, in which case container temperature conditioning is not necessary.

4-2.4.2 STORAGE TEMPERATURE

Kidde FM-200 Marine ECS Series 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 Marine ECS Series Engineered Fire Suppression System equipment is 360 PSIG at 70°F (25 bar gauge at 21°C).

4-2.4.4 CYLINDER STORAGE LOCATIONS

4-2.4.4.1 Cylinder Storage Outside the Protected Space

Cylinders located outside the protected space should be located as close to the space as possible. The cylinders should be readily accessible so as to allow personnel to operate the manual actuation of the cylinder(s). If remote actuation is used, the local manual release must still be accessible for personnel.

The temperature of the cylinders may need to be controlled by heating or cooling to keep the cylinders within the limits specified in Paragraphs 4-2.4.1 and 4-2.4.2.

Cylinders stored outside the space are usually located in a single area, but may be distributed according to the space available on the vessel. The agent storage cylinders may be installed on a common manifold (central storage) or in a modular arrangement. A modular system consists of cylinder(s) with dedicated piping and nozzle(s), with each group being activated simultaneously via a common actuation circuit. If a modular arrangement is required, consult with the local Authority Having Jurisdiction (AHJ) to ensure that this arrangement is permitted for the designated vessel.

Note: All system cylinders discharging into a single space must be configured to operate simultaneously. All system cylinders installed on a common manifold must be the same capacity, be charged to the same pressure and contain the same mass of agent.

4-2.4.4.2 Cylinder Storage Inside the Protected Space

Cylinders can be stored inside the protected space where the volume of the space is less than 6000 $ft.^3$ (170 m^3) and the system is configured per Paragraph 4-2.5.4.

For protected spaces larger than 6000 $ft.^3$ (170 m^3) where the cylinders are installed within the space, specific actuation methodology must be employed in order to comply with the requirements of the USCG (see Paragraph 4-2.6.3).

The temperature of the cylinders may need to be controlled by heating or cooling to keep the cylinders within the limits specified in Paragraphs 4-2.4.1 and 4-2.4.2.

The agent storage cylinders may be installed on a common manifold (central storage) or in a modular arrangement. A modular system consists of cylinder(s) with dedicated piping and nozzle(s), with each group being activated simultaneously via a common actuation circuit. Storage within the space typically requires a modular arrangement. Ensure that this arrangement is permitted by the AHJ for the designated vessel before finalizing the design.

4-2.5 System Arrangement Principles

Kidde FM-200 Marine ECS Series Systems can be configured in a number of different ways. The actuation arrangement chosen will vary according to the individual vessel requirements in conjunction with the requirements of the AHJ. The four primary actuation arrangements are:

1. Local manual operation.
2. Remote manual operation via cable pull.
3. Remote manual operation via stored pressure release pilot cylinders.
4. Automatic operation via mechanical pneumatic detection/control.

Arrangements 2, 3 and 4 must be capable of being actuated by local manual control. Arrangement 4 can only be used for spaces equal to, or smaller than, 6000 ft.^{3} (170 m^3).

Unless the protected space is less than 6000 ft.^{3} (170 m^3), and has an suitable horizontal escape, a predischarge alarm must be provided, as well as a means to shut down ventilation and/or machinery.

In this paragraph, the basic system operating principles have been described. Many installed arrangements include elements from one or more basic arrangements.

Note: All USCG Approved systems must employ two distinct controls to release agent into a hazard. The two actions required for all Kidde actuation components (e.g., lever operated control head) do not satisfy this requirement individually.

4-2.5.1 LOCAL MANUAL OPERATION

In this configuration, the cylinder valve(s) are fitted with lever operated control head(s). The control head requires two distinct actions (removal of safety pin and lever operation) to mechanically operate the valve and release agent.

If a more than one cylinder must be actuated by local manual release (where manual release is the primary release mechanism), it is inadequate to fit manual release heads on each cylinder. In this case, a master cylinder must be selected. The master will be fitted with the manual release and subsequent slave cylinders will be actuated using the stored pressure of the master cylinder. The slave cylinders are fitted with pressure operated control heads to facilitate rapid deployment of agent. See Paragraphs 4-2.7.2 and 4-2.7.3 for details.

4-2.5.2 REMOTE MANUAL OPERATION VIA CABLE PULL

In this configuration, a cable operated control head is fitted to the discharge valve. The control head is a mechanical device that allows local manual operation or a cable pull to release the agent.

Cable operated control heads can also be used to operate pilot Nitrogen or CO_2 cylinders in a pressure release system. Two cable control heads can be installed on adjacent cylinders and operated from one pull station. For systems requiring the actuation of more than two cylinders, a master/slave pressure configuration should be used.

4-2.5.3 REMOTE MANUAL OPERATION VIA STORED PRESSURE RELEASE

In this configuration, a pilot cylinder charged with Nitrogen is connected via tubing to pressure operated control heads installed on the agent storage cylinder(s). A control head is fitted to the pilot cylinder to mechanically operate the system.

4-2.5.4 AUTOMATIC OPERATION VIA MECHANICAL PNEUMATIC DETECTION/CONTROL

In this configuration, a pneumatic control head is installed on the master cylinder or pilot cylinder (depending on the configuration). The pneumatic control head is connected to one or more mechanical rate-of-rise detectors via 3/16 in. tubing. A rapid local rise of temperature causes a pressure differential between the detector circuit and the control head that causes the head to operate and discharge valve. The control head requires two distinct actions to mechanically operate the system.

4-2.6 System Arrangement Detail: Conventional

This section details the component arrangement required to complete typical systems employing either one or more of the operating principles outlined in Paragraph 4-2.5. To determine the actuation circuit limits, refer to Paragraph 4-2.7.

Note: The CO_2 pilot cylinder arrangement previously used for FM-200 Marine ECS has been replaced by a range of nitrogen pilot driver cylinders. The nitrogen actuation arrangement can be configured using 108 cu. in. (1.77 L) or 1040 cu. in. (17 L) nitrogen pilot driver cylinders.

The 108 cu. in. and 1040 cu. in. cylinders each have a dual-purpose: being designed to be used as a pilot cylinders (i.e., used to actuate a number of agent cylinders, a number of siren driver cylinders and ancillary pressure-operated devices) or as a siren driver cylinder(s) to operate one or more pressure operated siren(s) (P/N 90-981574-001, refer to Paragraph 4-2.7.5 for all limitations). A 2300 cu. in. cylinder is designed for siren driving only.

CAUTION

The 108 cu. in. and 1040 cu. in. nitrogen actuation arrangement cylinders are designed to operate either as pilot cylinders or as siren drivers, but not as both. Using a pilot (driver) cylinder to operate agent cylinder control heads, time delays (and any other ancillaries) and drive pressure-operated siren(s) is not permissible and could result in a failure of the system to operate.

4-2.6.1 DISCHARGE DELAY AND PRE-DISCHARGE ALARM

Per USCG, a space protected by FM-200 having a volume in excess of 6000 $ft.^3$ (170 m^3) must be equipped with a time delay and a predischarge alarm. This will allow personnel time to evacuate the protected space and ensure that ventilation and machinery have been shutdown prior to agent release.

If a space of less than 6000 $ft.^3$ (170 m^3) does not have a readily accessible horizontal means of escape, then the system must include a discharge delay.

4-2.6.2 NITROGEN OPERATED MECHANICAL DISCHARGE DELAY AND PRESSURE OPERATED SIREN

Where a mechanical-pneumatic discharge delay is required, a nitrogen discharge delay should be installed. The delay units are driven by pilot nitrogen and are matched to the driving pilot cylinder (108 cu. in. or 1040 cu. in.). Two delay period options are available for each pilot cylinder (see Table 4-6).

WARNING

Nitrogen discharge delay units can only be driven by nitrogen and must only be used with nitrogen pilot cylinder(s). Connecting into the manifold containing other media will prevent the correct delay from being observed.

A pre-discharge mechanical-pneumatic alarm can be provided by using one or more nitrogen pressure-operated siren(s). The siren(s) are driven by separate siren driving cylinder(s) that are actuated using the system pilot circuit. The nitrogen pressure operated siren, P/N 90-981574-001, is not interchangeable with the Kidde CO_2 pressure operated siren, P/N 981574.

CAUTION Only one 90-981574-001 siren can be driven from one 108 cu. in. siren driver cylinder. The connection of more than one siren to a 108 cu. in. cylinder could result in insufficient volume and/or duration being achieved.

Table 4-6. Delay Period Options

Discharge Delay Part Number	Nominal Delay	For Use With	Part Number
81-871072-001	34	108 cu. in.	877940
81-871072-002	61	108 cu. in.	877940
81-871072-003	35	1040 cu. in.	90-101040-000
81-871072-004	68	1040 cu. in.	90-101040-000

4-2.6.3 ACTUATION CIRCUIT CONFIGURATION

4-2.6.3.1 Cylinder Storage Location

4-2.6.3.2 Cylinder Storage Inside the Protected Space

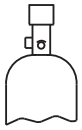
USCG allow cylinders to located within the protected space for hazards of 6,000 $ft.^3$ (170 m^3) or less. In systems of this size actuation must be automatic (see Paragraph 4-2.6.6.)

SOLAS regulations allow agent cylinders to be located inside of the protected space provided the requirements of IMO 848 are met. These requirements include the use of dual actuation lines.

USCG has allowed the use of this application method from 2003 to 2007, however in late 2007 the USCG decided to restrict this practice and move to a case-by-case approval only. Since the USCG is effectively restricting the installation of agent cylinders within the protected space, the relevant design information for this approach has been moved to Appendix D in this manual. Please contact Applications Engineering for more information on the specific requirements for your project.

4-2.6.3.3 Cylinder Storage Outside the Protected Space

Cylinder storage outside the protected space is preferred by most AHJs (Authorities Having Jurisdiction), however most construction rules require a dedicated storage compartment with ventilation, heating/cooling as necessary, and A60 insulation on bulkheads adjacent to Class A spaces.


FM-200 CYLINDER


N_2 PILOT CYLINDER
108 CU. IN.


CONTROL HEAD, CABLE OPERATED*


CONTROL HEAD, LEVER OPERATED*


CONTROL HEAD, PNEUMATICALLY OPERATED*


CONTROL HEAD, LEVER/PRESSURE OPERATED*


CONTROL HEAD, PRESSURE OPERATED


PRESSURE SWITCH


PRESSURE TRIP


STOP VALVE, PRESSURE OPERATED


STOP VALVE, CABLE OPERATED


PNEUMATIC HEAT DETECTOR


CORNER PULLEY


N_2 PILOT CYLINDER
1040 AND 2300 CU. IN.


TIME DELAY


SIREN, PRESSURE OPERATED


DISCHARGE NOZZLE


SAFETY OUTLET


DISCHARGE INDICATOR


EL-CHECK


BALL VALVE


MANUAL STATION, CABLE OPERATED


STOP VALVE, OPTIONAL CONTROL


DUAL-PULL EQUALIZER


CHECK VALVE


BLEED VALVE

*CONTROL HEAD IS EQUIPPED WITH MANUAL
RELEASE LEVER TO ENABLE LOCAL ACTUATION

Figure 4-5. Key to Symbols Used in Arrangements Schematics

4-2.6.4 MANUAL CABLE OPERATION

The cable operating equipment can be combined in many ways to provide manual remote operation points for a number of system configurations. There are three different pull box designs that provide solutions for a variety of control locations. The cable operated control head can be fitted to directly to a FM-200 valve, a nitrogen pilot cylinder valve or a direction (stop) valve, as required.

A single control cable can be used to operate two control heads using a dual-pull equalizer (P/N 840051), and a single control head can be operated by either of two control stations using a dual-pull mechanism (P/N 840058).

4-2.6.4.1 Basic Cable Operation Example

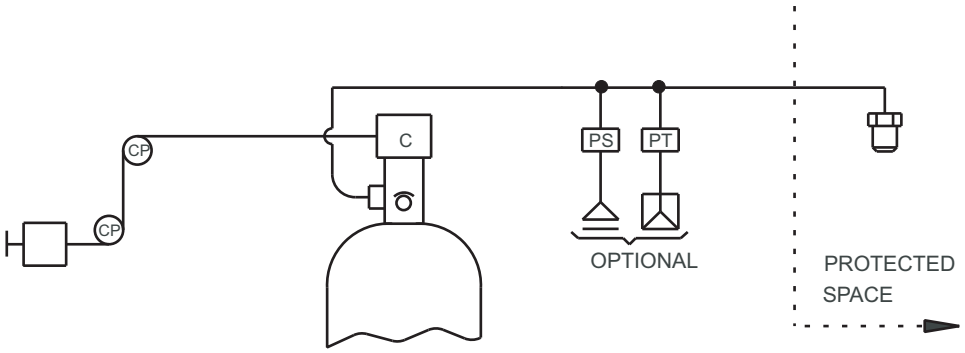


Figure 4-6. Basic Cable Arrangement

In this arrangement, a single FM-200 cylinder is installed outside the protected space. The cylinder is fitted with a cable operated control head connected via corner pulleys to a remote pull station. A pressure switch is installed in the discharge pipework with the option of a discharge indicator and/or pressure trip, depending on the functionality required.

The primary actuation method is via the remote pull station. If this were to fail, the backup manual lever on the cable operated control head installed on the cylinder would operate the system. See Paragraph 4-2.8 for details of the maximum length of cable, and number of pulleys that can be used in one system.

4-2.6.4.2 Complex Cable Operation Example

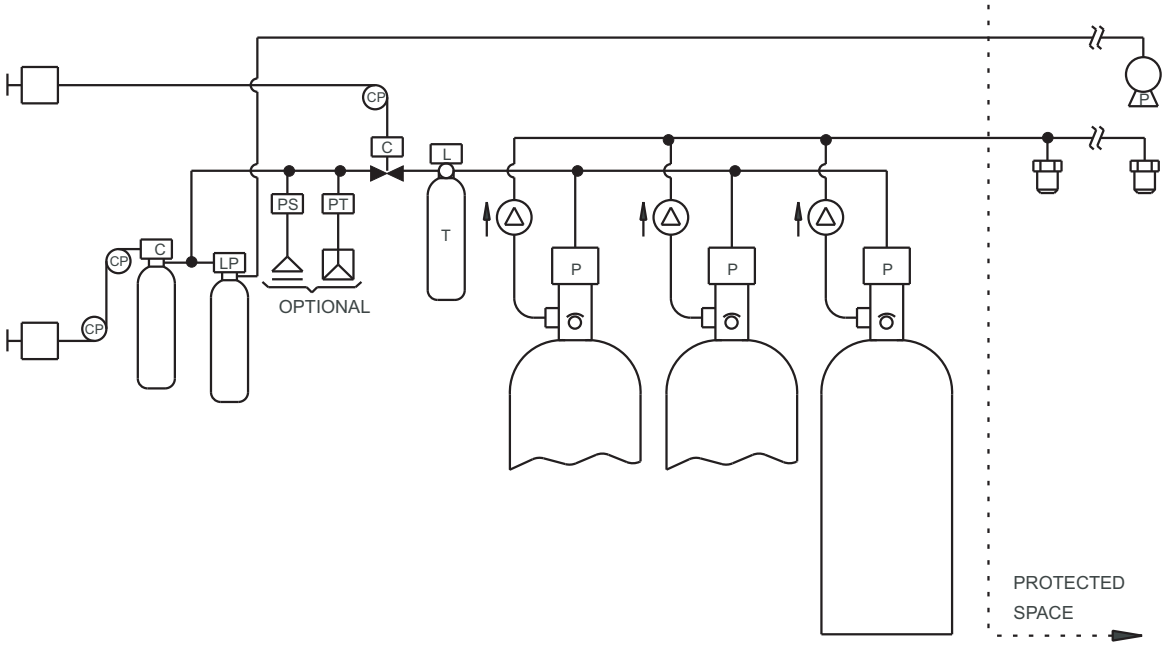


Figure 4-7. Complex Cable Arrangement

In this arrangement, a bank of three FM-200 cylinders are located outside of the protected space. The cylinders are installed on a common manifold and each contains the same mass of agent. A mechanical siren and time delay are required, so a pilot nitrogen configuration would be used. See Paragraph 4-2.7 for actuation limits for pilot nitrogen actuation circuits.

The pilot nitrogen arrangement consists of two nitrogen cylinders. The pilot cylinder is fitted with a cable operated control head that is operated via a remote pull station (control number 1).

A pilot nitrogen manifold connects the pilot cylinder to the siren driver, the discharge delay unit, and any of the following optional equipment: pressure switch, safety outlet, pressure trip and pressure indicator (as required). A second pull station (control number 2) operates a stop valve via a cable operated control head. The stop valve is located upstream of the discharge delay. The discharge delay is equipped with a lever operated control head to enable the delay to be bypassed. The outlet of the discharge delay is routed to pressure operated control heads installed on the agent storage cylinders.

4-2.6.5 MANUAL PILOT PRESSURE OPERATION

Pilot pressure operating equipment can be combined in many ways to provide manual remote operation points for a number of system configurations. Nitrogen pilot cylinders are used to operate the FM-200 cylinder(s) directly, or to operate second stage pilot nitrogen cylinders. They are used to directly actuate FM-200 cylinders or drive pressure operated sirens.

4-2.6.5.1 Basic Pressure Operated Example

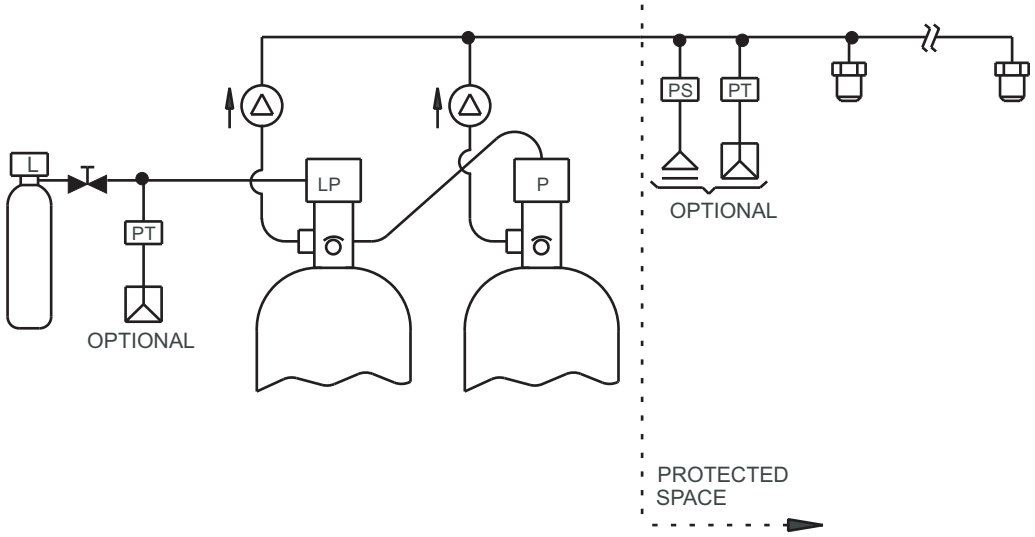


Figure 4-8. Basic Pressure Arrangement

In this arrangement, two FM-200 cylinders are installed outside the protected space. The cylinders are installed on a common manifold, and each contains the same mass of agent. The primary (master) cylinder is fitted with a lever/pressure operated control head connected to a pilot nitrogen circuit. The secondary (slave) cylinder is fitted with a pressure operated control head connected via flexible actuation hose and a master cylinder adapter to the master cylinder slave actuation port. The pilot nitrogen circuit consists of a pilot nitrogen cylinder and valve assembly fitted with a lever operated control head connected via pilot tubing to a 1/4 in. ball valve. A pressure switch can be installed in the circuit outside the space, with the option of a discharge indicator and/or pressure trip installed in the agent pipe work as required.

The primary actuation method is to operate the lever operated control head on the nitrogen pilot cylinder followed by the operation of the ball valve.

Note: This configuration is only suitable for vessels that require USCG Approval when the space is less than 6000 ft.^{3} (170 m^3) and a suitable horizontal egress route is available.

4-2.6.5.2 Complex Pressure Operated Example

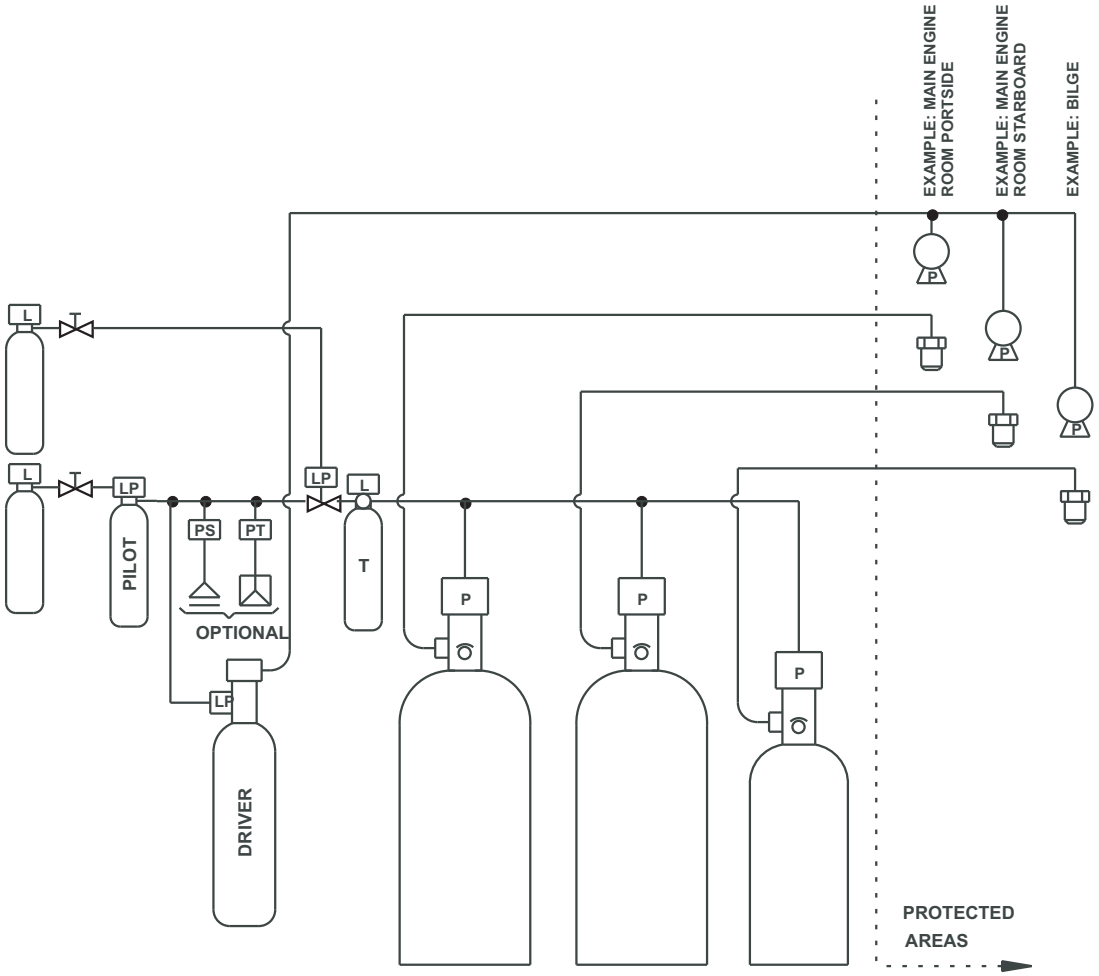


Figure 4-9. Complex Pressure Arrangement

In this arrangement, three FM-200 cylinders are installed outside the protected space. The cylinders are of different capacities and contain different quantities of agent. The pipe work from each cylinder feeds separate nozzles covering separate enclosures of the protected space, or divisions of the protected space that are covered more effectively by using dedicated pipework.

Each cylinder is fitted with a pressure operated control head connected to the pilot circuit. Three mechanical sirens and a time delay are required. The pilot circuit includes two remote primary pilot cylinders, a local primary pilot cylinder and a siren driver cylinder.

The remote stage consists of pilot nitrogen cylinder and valve assemblies fitted with lever operated control heads connected via pilot tubing to 1/4 in. ball valves. The pilot tubing connects to the second stage pilot and stop valve respectively.

The pilot nitrogen manifold connects the pilot cylinder to the discharge delay unit, and any of the following optional equipment: pressure switch, safety outlet, pressure trip and pressure indicator (as required). The stop valve is located upstream of the discharge delay and is fitted with a lever/pressure operated control head. The discharge delay is equipped with a lever operated control head to enable the delay to be bypassed. The outlet of the discharge delay is routed to pressure operated control heads installed on the agent storage cylinders

The primary actuation method is to operate the lever operated control heads on the nitrogen pilot cylinders followed by the operation of the ball valves. A secondary emergency option is to operate the local pilot cylinder, stop valve and control heads directly.

4-2.6.5.3 Two-Stage Extended Circuit Pressure Actuation

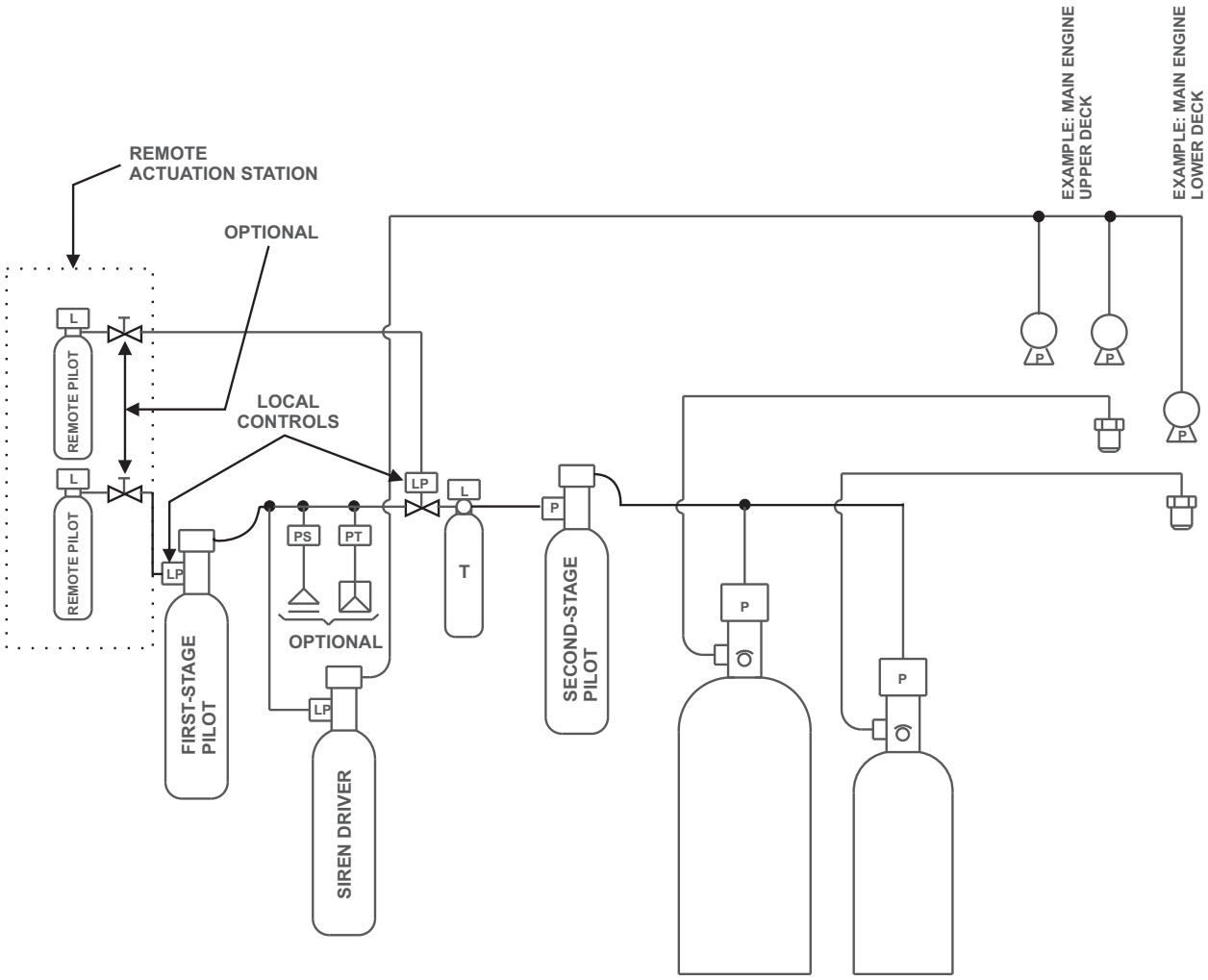


Figure 4-10. Two-Stage Extended Circuit Pressure Operated Example
(Required when single-stage limitations are exceeded)

In this arrangement, the actuation line length and protected space complexity (typical when agent cylinders located in the space - refer to Appendix D) requires a two-stage nitrogen actuation scheme. This entails the use of a second set of pilot cylinders located between the primary pilot cylinders and the agent cylinders. The second-stage is operator transparent, that is, no additional control input is required to operate the system.

4-2.6.6 PNEUMATIC/MECHANICAL AUTOMATIC OPERATION

4-2.6.6.1 Automatic Pneumatic Operated Example

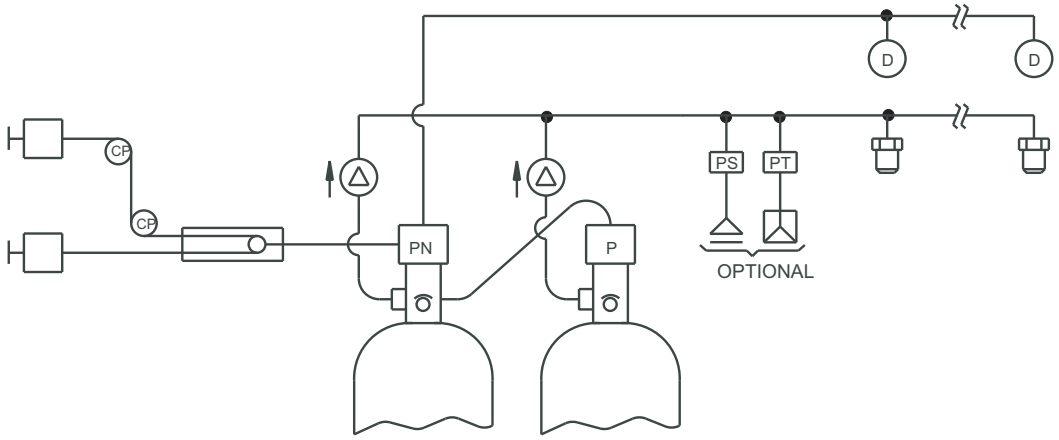


Figure 4-11. Automatic Arrangement

In this arrangement, two single FM-200 cylinders are installed inside the protected space. The primary (master) cylinder is fitted with a pneumatic operated control head. The secondary (slave) cylinder is fitted with a pressure operated control head connected via flexible actuation hose, and a master cylinder adapter to the master cylinder slave actuation port. The pneumatic control cable connection is utilized and is connected to dual-pull mechanism, allowing the connection of two remote manual pull stations.

The pneumatic diaphragm connection on the pneumatic control head is connected via capillary tubing to two pneumatic detectors.

Depending on the functionality required, a pressure switch, discharge indicator and/or pressure trip could be installed in the discharge pipework.

The system will actuate if the rate-of-rise of temperature in the protected space is higher than the design set point. If manual activation is required, the system can be operated from either of the manual pull stations (and locally at the cylinder location provided the cylinder is located outside of the protected space).

4-2.7 Pressure Actuation Limitations

This section details the pressure actuation limitations for the Kidde FM-200 Marine ECS Series Engineered Fire Suppression System. It includes limits for nitrogen cylinder actuation, two-stage nitrogen and master/slave actuation (agent cylinder pressure), siren driver limits and examples of nitrogen actuation circuit design.

4-2.7.1 ACTUATION SCHEMATICS FOR CYLINDERS OPERATED BY NITROGEN PILOT CYLINDERS

The following arrangements, Figure 4-7 through Figure 4-11, illustrate the basic concepts of system operation. Refer to Appendix D.

4-2.7.2 CYLINDERS CLOSE COUPLED USING PRESSURE FROM A MASTER

For cylinders close-coupled (reach of one flex hose, maximum 30 in.) using pressure from one master FM-200 cylinder (see Figure 4-12), 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.

Note: Arrangement suitable for systems where agent cylinders are located outside of the protected space only.

4-2.7.3 CYLINDERS NOT CLOSE COUPLED USING PRESSURE FROM A MASTER

For cylinders not close-coupled using pressure from one master FM-200 cylinder (see Figure 4-13), 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 in. O.D. x 0.032 in. wall stainless steel actuator line having a maximum total length of 100 ft. (30.5 m).

Note: Arrangement suitable for systems where agent cylinders are located outside of the protected space only.

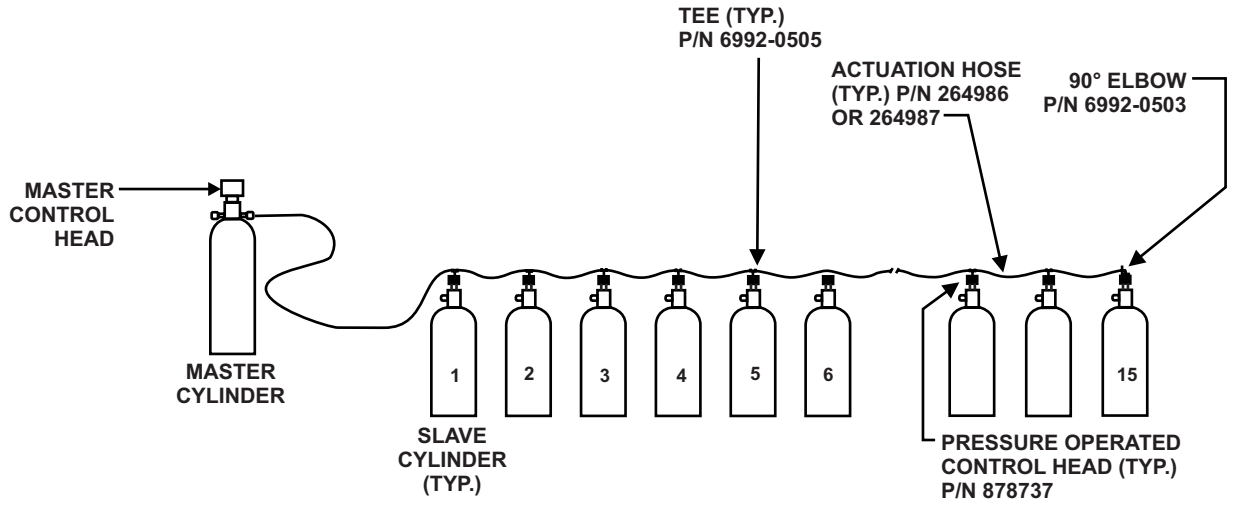


Figure 4-12. Pressure Actuation Using Pressure from One Master FM-200 Cylinder to Actuate a Maximum of Fifteen Slave Cylinders, Close Coupled

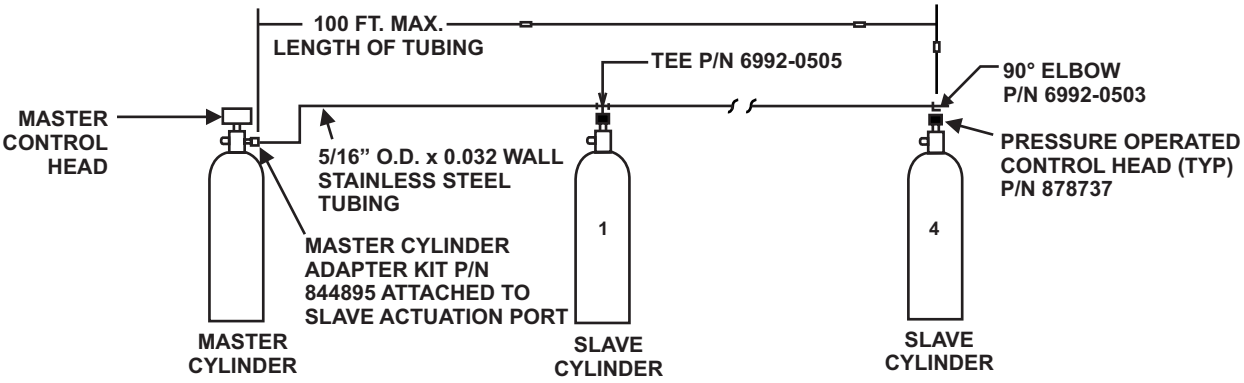


Figure 4-13. Pressure Actuation Using Pressure from One Master FM-200 Cylinder to Actuate a Maximum of Four Slave Cylinders, NOT Closed Coupled

4-2.7.4 NITROGEN PRESSURE OPERATED SIREN LIMITATION AND SIREN DRIVER LIMITATIONS

The pressure operated siren (P/N 90-981574-001) consumes approximately 0.5 to 0.9 lb. (0.23 to 0.5 kg) of nitrogen per minute. Each siren driver cylinder can operate one or more sirens. Table 4-7 indicates the number of sirens that can be installed on a line from any one siren driver; the total length of actuation pipe that can be used must not exceed the limits shown in this table.

Siren driver cylinders cannot be manifolded, with the exception of the 2300 cu. in. siren driver. A maximum of two 2300 cu. in. siren drivers can be manifolded to provide up to twenty sirens. No other manifold combination is permitted.

Table 4-7. Siren Driver Cylinder Actuation Limits

Pilot Cylinder Size	Siren Part Number	Number of Siren Driver	Maximum Length of 1/4 in. Sch 80 Pipe	Maximum Length of 1/4 in. Sch 40 Pipe	Maximum Length of 5/16 in. x 0.032 Wall Tubing
108 cu. in.	90-981574-001	1	90	90	90
1040 cu. in.	90-981574-001	4	500	500	500
2300 cu. in.	90-981574-001	10	500	500	500
2 x 2300 cu. in.	90-981574-001	20	500	500	500

4-2.7.5 USING MULTIPLE NITROGEN CYLINDERS

Two or more remotely located pilot nitrogen cylinders can be used to actuate the FM-200 systems described in Paragraphs 4-2.7.3 and 4-2.7.4, provided that:

- 1/4 in. check valves (P/N 264985) shall be installed at the intersection of each pilot line to the main actuator line (see Figure 4-14).
- The total length of actuator line from each nitrogen pilot cylinder to the FM-200 cylinders shall not exceed the limitation established.

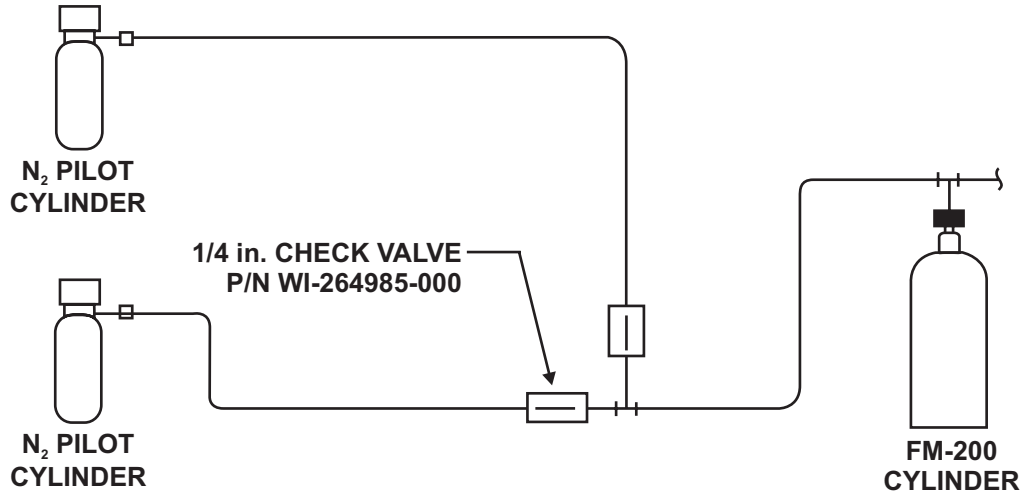


Figure 4-14. Multiple Pilot Nitrogen Actuation Cylinders

4-2.7.6 PRESSURE TRIP LIMITATIONS

The maximum load to be attached to pressure trip (P/N 874290) is 100 lb. (based on a minimum pressure of 75 PSIG [5 bar gauge] at the pressure trip).

4-2.8 Corner Pulley and Cable Limitations

Cable and pneumatic control heads fitted with cable pulls are subject to certain limitations. The pull boxes are connected to the control heads via 1/16-inch stainless steel cable. Corner pulleys are used to change direction of the cable routing. The cable should be routed in 3/8-inch Schedule 40 galvanized pipe. Refer to Table 4-8 for corner pulley and cable length limitations. In addition, the maximum force required to operate a cable pull may not be greater than 40 lb., nor require a movement greater than 14 inches. If any other combinations of corner pulleys and lengths of cable are required, the 40 lb. maximum force and 14-inch maximum travel requirements must not be exceeded.

Table 4-8. Corner Pulley and Cable Limitations

Control Head Type	Control Head Part Number	Maximum Number of P/N 803808	Maximum Cable Length (ft.)
Cable Operated	979469	15	100
Pneumatic	872318	6	100
Pneumatic	872335	6	100
Pneumatic	872365	6	100
Pneumatic	873262	6	100
Pneumatic	872310	6	100
Pneumatic	872360	6	100

Note: Where a dual-pull mechanism or dual-pull equalizer is used, the total cable length and total number of corner pulleys are used to determine compliance with the stated limitations. The dual-pull equalizer further counts as one additional corner pulley.

4-2.9 Automatic Pneumatic Actuation Limitations

The connection between the pneumatic control head and the detector must be made using 3/16 in. tubing and fittings (see Paragraph 3-3.6.3). Each circuit is limited to a maximum of four detectors. If an automatic system is required with a discharge delay and/or pressure operated siren, the pneumatic control head is then fitted to the pilot cylinder, and the remaining actuation circuit is as per a pressure operated system.

4-3 EQUIPMENT INSTALLATION

4-3.1 General

All Kidde FM-200 Marine ECS 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 which could render the equipment inoperative. Equipment must be installed in accordance with NFPA Standard 2001, current edition and with appropriate marine regulations and good engineering practice.

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

Pipe must be galvanized and be either ASTM A-53 seamless or electric resistance welded Grade A or B; ASTM A-53 furnace weld Class F; or ASTM A-106, Grade A, B or C. 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

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 2-inch and smaller, or 1000 lb. ductile iron or forged steel fittings in sizes greater than 2-inch are to be used. Class 300 flanged joints are acceptable for use in all sizes. Minimum rated working pressure must be 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.

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, 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 insure the piping is not subjected to vibration, mechanical or chemical damage. All hangers must be FM Approved or UL Listed and must conform to general industry standards for pipe hangers and conform to ASME B-31.1. Refer to ASME B-31.1 for additional bracing requirements.

USCG requires that a pressure test of the installed discharge pipework be carried out prior to commissioning. The test pressure specified is one and a half times the storage pressure at 70°F (21°C). For FM-200, the test pressure is equal to 540 PSIG (37.3 bar gauge).

Pressurize with air or nitrogen for two minutes; do not use oxygen or water. The maximum allowable loss is 150 PSI/min. (10.3 bar/min.).

WARNING

Extreme caution should be used before, during and after a system pipework pressure test. USCG requires a full pressurization to 1.5 times the normal system cylinder operating pressure. Personnel must vacate all areas through which the system pipework runs. The failure of a system pipework element during a pressure test could result in damage to property, serious injury or death.

Where USCG requirements need not be met (verify with the AHJ), test in accordance with NFPA 2001:Current Edition requirements. That is, pneumatically pressurize for ten minutes at 40 PSIG (2.76 bar gauge) with a pressure loss of less than, or equal to, 20% at the end of the test period being acceptance criteria.

4-3.4 Installation of Check Valves and Stop (Direction) Valves

Install standard check valves and stop valves in horizontal or vertical orientation. Swing checks must be installed in accordance with Figure 4-15.

Apply Teflon® tape or pipe compound to all male threads, except the first two full threads. Non-swing check and stop valves greater than 2 in. are flanged and should be installed with the appropriate gaskets, flanges and fasteners.

CAUTION All check and stop (direction) valves must be installed with the arrow, cast in the valve body, pointing in the direction of flow.

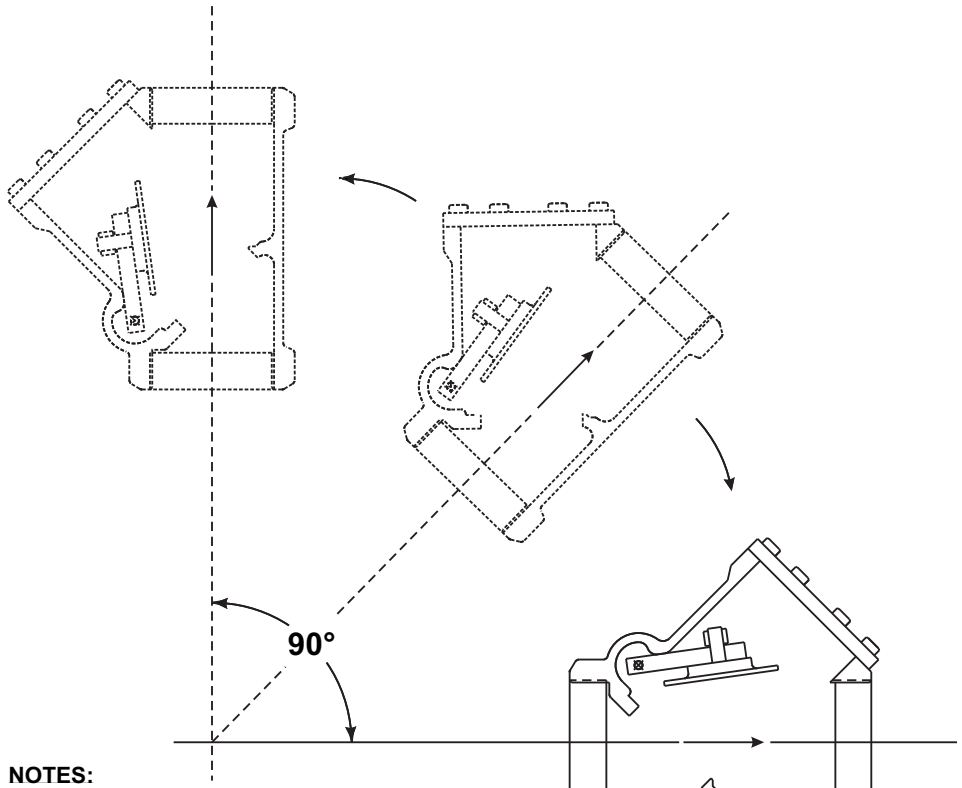


Figure 4-15. Installation Orientation of Swing Check Valves

4-3.4.1 EL-CHECK VALVES

Install El-check valves in accordance with Figure 4-16. Ensure that the check moves freely on the shaft and that it is seated before installing onto the manifold.

WARNING The arrow cast into the El-check valve body indicates the direction of flow, and must be pointing up when installed within the limits shown in Figure 4-16. Failure to install in the correct orientation could result in unobstructed flow through the valve in the event of system actuation.

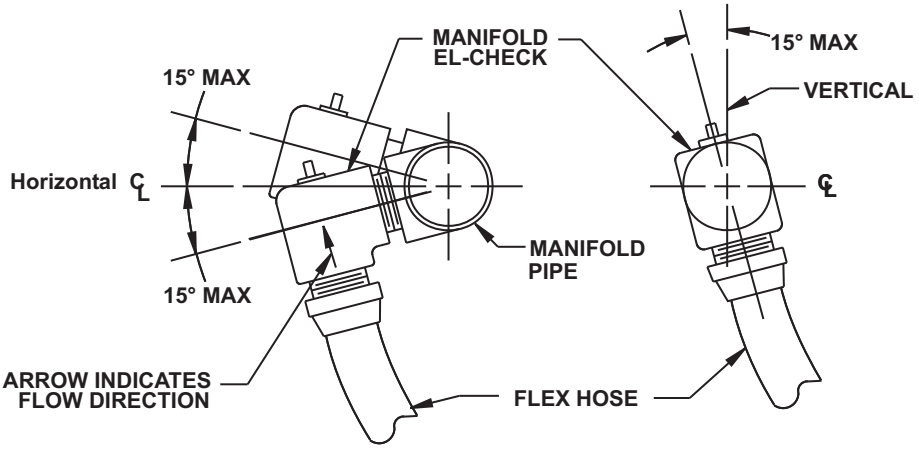


Figure 4-16. El-Check Valve

Note: Adjust El-check valve to achieve the correct radius in the flexible discharge hose. See Paragraph 4-3.8.

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.

A capped tee should be installed at the end of each pipe section to serve as a dirt trap and allow the connection of an air or nitrogen supply for cleaning and testing of the network.

4-3.6 Installation of Pressure Actuation 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, threaded (pipe only) 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 4-17 and Table 4-9 and Table 4-10.

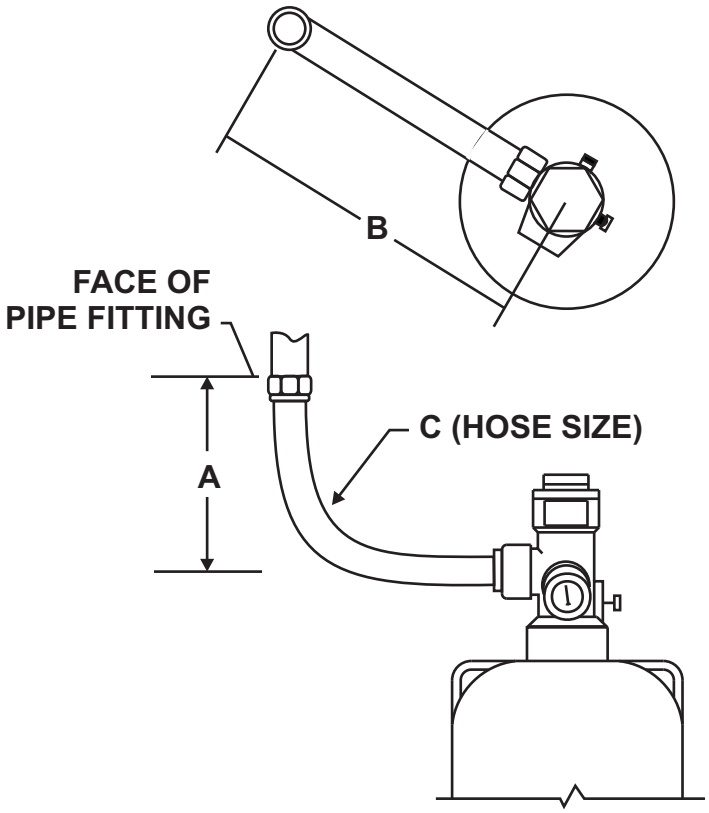


Figure 4-17. Installation of the Flexible Hose Directly into System Piping

Table 4-9. Installation of the Flexible Hose Directly into System Piping, English (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 4-10. Installation of the Flexible Hose Directly into System Piping, English (millimeters)

Cylinder Capacity	Dimensions in inches		
	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.
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.

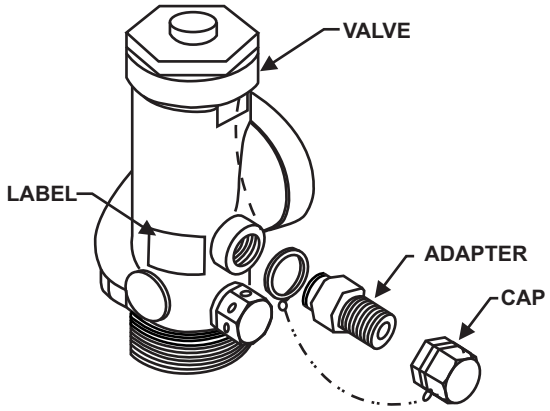


Figure 4-18. Installation of Master Cylinder Adapter Kit

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 130°F (54°C) or fall below 32°F (0°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. Cylinders should be raised at least 2 in. (50 mm) from the deck using a suitable bracket or blocks if the area is regularly washed down or is subject to environmental wetting.

4-3.10.1 SINGLE 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 FM-200 cylinder in designated position, and secure in place with the cylinder mounting straps and associated hardware. For cylinders of 125 lb. capacity and above, a cradle is used to support between the cylinder and the unistrut or bulkhead. See Figure 4-19 and Table 4-11 and Table 4-12 for the relevant installation dimensions. Ensure the valve outlet is correctly orientated for connection to the system pipework.

Note: The valve pressure indicator and/or liquid level indicator should be accessible for service and inspection.

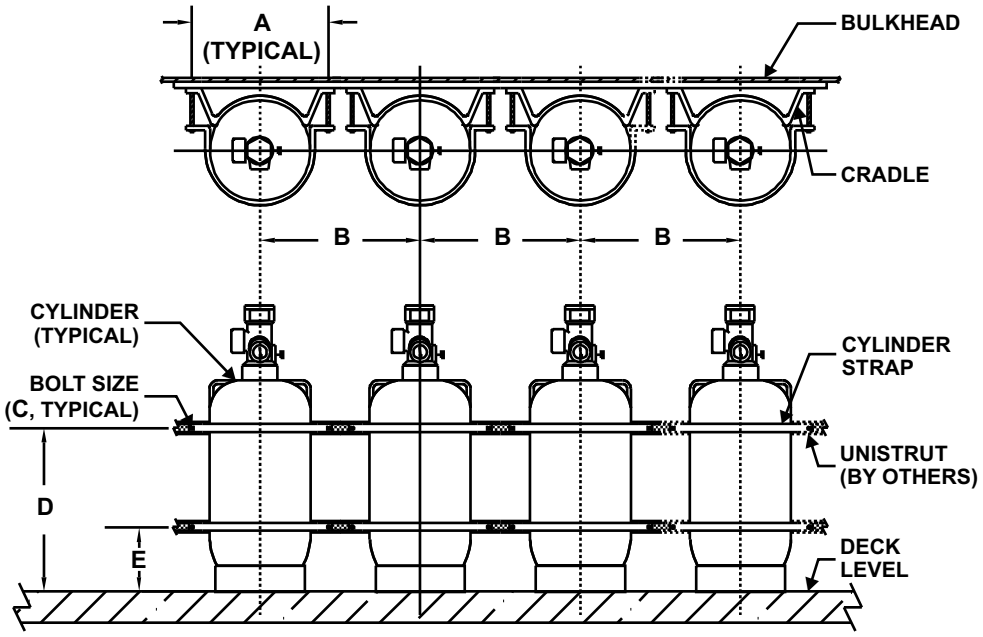


Figure 4-19. Typical Cylinder Installation, Vertical Mounting

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.

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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.

Table 4-11. Single Cylinder Installation Dimensions, English (inches)

Cylinder Size	Strap Part Number	Cradle Part Number	A	B	C	D	E
10 lb.	283945	N/A	8.8	11.0	3/8	7.4	1.4
20 lb.	283945	N/A	8.8	11.0	3/8	12.5	1.4
40 lb.	283934	N/A	10.8	13.0	1/2	10.4	4.1
70 lb.	283934	N/A	10.8	13.0	1/2	21.9	8.3
125 lb.	235317	235431	15.0	18.0	3/8	20.9	8.3
200 lb.	292971	292938	15.5	18.0	3/8	29.6	12.0
350 lb.	281866	281867	18.0	21.0	1/2	36.0	16.0
600 lb.	294651	294652	24.0	27.0	1/2	36.0	16.0
900 lb.	236125	06-118300-001	26.0	29.5	1/2	48.0	16.0

Table 4-12. Single Cylinder Installation Dimensions, English (millimeters)

Cylinder Size	Strap Part Number	Cradle Part Number	A	B	C	D	E
10 lb.	283945	N/A	224	280	10	188	36
20 lb.	283945	N/A	224	280	10	318	36
40 lb.	283934	N/A	274	330	12	264	104
70 lb.	283934	N/A	274	330	12	556	211
125 lb.	235317	235431	381	457	10	531	211
200 lb.	292971	292938	394	457	10	752	305
350 lb.	281866	281867	457	533	12	914	406
600 lb.	294651	294652	610	686	12	914	406
900 lb.	236125	06-118300-001	660	750	12	1220	406

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 FM-200 cylinders in the designated location and secure them in place with cylinder mounting straps and attaching hardware. For cylinders of 125 lb. capacity and above, a cradle is used to support between the cylinder and the unistrut or bulkhead. See Figure 4-17 and Table 4-12 and Table 4-13 for the relevant installation dimensions. Orient the cylinders so that the valve outlets are angled towards the El-check valves in the manifold.

Note: The valve pressure indicators and/or liquid level indicators should be accessible for service and inspection.

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.

4-3.10.3 MAIN AND RESERVE SYSTEM

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

4-3.11 Installation of Pressure Operated Control Head P/N 878737

1. Remove the protection cap from the cylinder actuation port (see Figure 4-20).

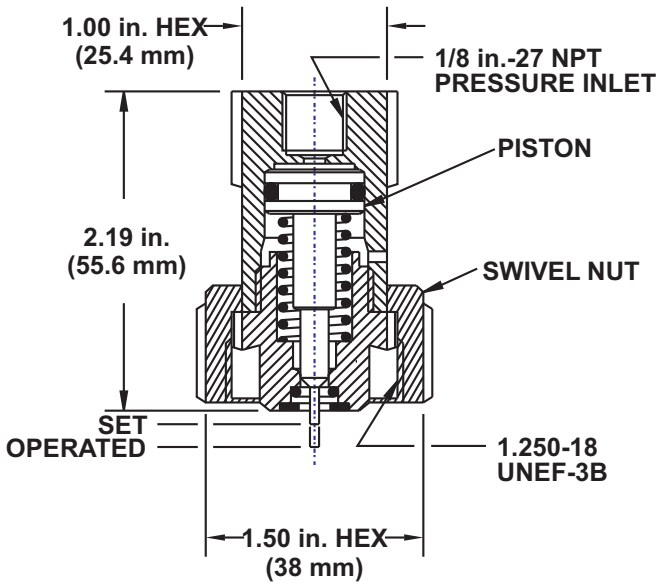


Figure 4-20. Pressure Operated Control Head

2. Install the pressure operated control head using a suitable wrench. Tighten securely. Connect the actuation line to the pressure port using the appropriate adapter.

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.

4-3.12 Installation of Lever Operated Control Heads, 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.

4-3.13 Installation of Lever/Pressure Operated Control Head, P/N 878851

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. Install the lever/pressure operated control head using a suitable wrench. Tighten securely. Connect the actuation line to the pressure port using the appropriate adapter.

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.

4-3.14 Installation of Cable Operated Control Head and Ancillaries

4-3.14.1 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.

4-3.14.2 INSTALLATION OF DUAL-PULL MECHANISM, P/N 840058, AND DUAL-PULL EQUALIZER, P/N 840051

Install the dual-pull mechanism or equalizer on a flat surface and ensure that the cable and conduit can be routed and connected squarely to the unit. Secure using the four mounting holes with suitable fasteners. Ensure that the cables move freely into the unit and that each cable is correctly tensioned. Test the pull cable arrangement to ensure that the pull force and travel limitations referenced in Paragraph 4-2.8 are not exceeded.

4-3.14.3 INSTALLATION OF CORNER PULLEY, P/N 803808

Apply Teflon® tape or pipe compound to the male thread on the cable conduit. Leave the first two full threads clean. Ensure conduit connects squarely to the pulley.

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 Pneumatic Control and Detection

4-3.16.1 INSTALLATION OF PNEUMATIC CONTROL HEAD

The following procedures are to be performed before attaching control head to the cylinder valve (see Figure 4-21):

1. Remove pilot outlet protection cap from valve of cylinder to be equipped with control head.
2. Be sure the control head is in the "SET" position.
3. The arrow on the reset stem should line up with the "SET" arrow on the nameplate.
4. Connect the heat detector tubing securely to the diaphragm chamber of the control head.
5. If a tandem pneumatic control head is required, both control heads must be connected using 3/16 in. tubing (P/N 802366). See Figure 4-22.

Note: If a mechanical pull box is supplied, proceed with Steps 6 through 8.

6. Connect the control cable conduit to the control head. Remove the control head nameplate, exposing the manual release chamber.
7. Loosen the screws on the cable clamp, and feed the cable through the hole. Tighten the set screws securely, allowing the cable to have approximately 3/16 in. free play. Do not pull the cable taut. Cut off any excess cable.
8. Make certain that the locking pin and seal wire have been assembled to the nameplate. The local control lever should be parallel with the nameplate. Assemble the nameplate to the control head, being sure to fit the small shaft into the cover bearing and the large pin under the trip lever.

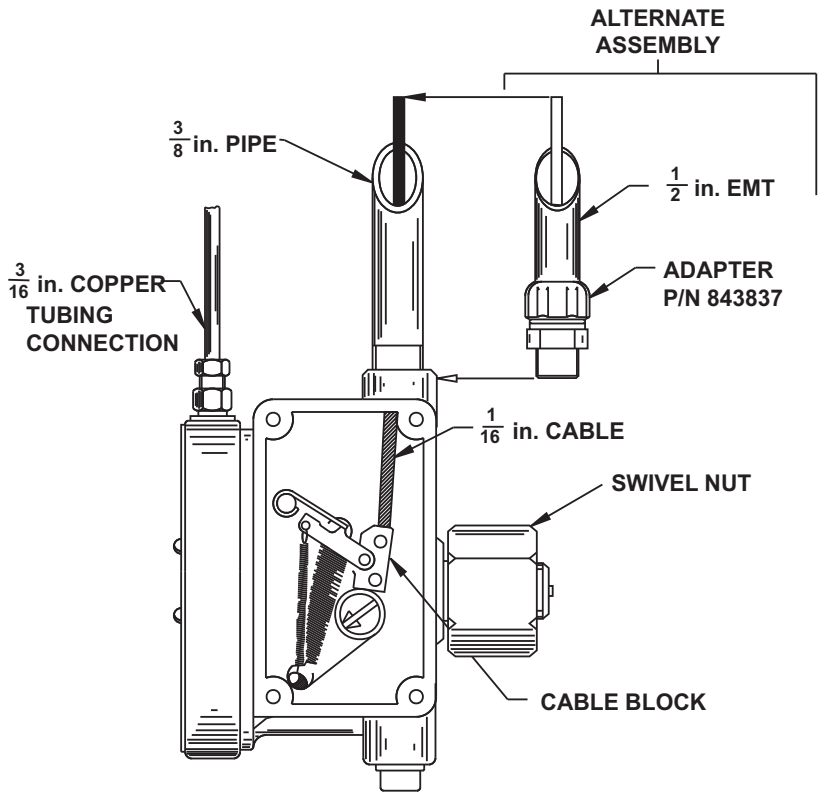


Figure 4-21. Single Pneumatic Control Head

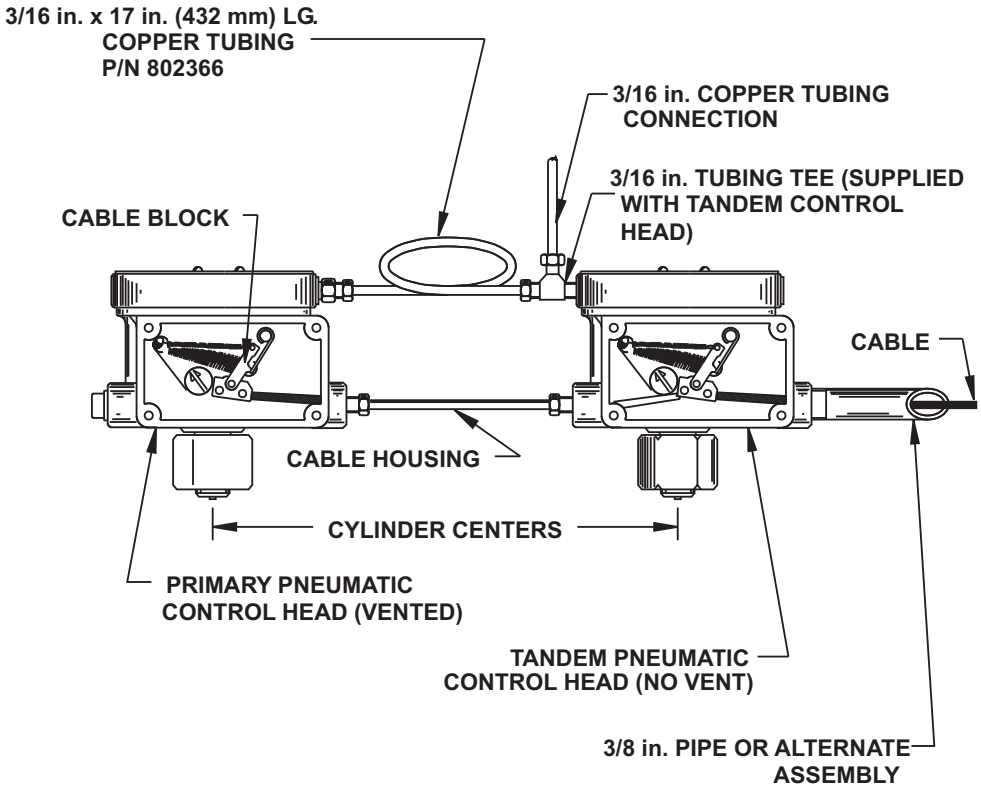


Figure 4-22. Tandem Pneumatic Control Head

WARNING

Before installing the control head on the carbon dioxide cylinder valve, ensure that the control head is in the "SET" position (the actuating pin is in the fully retracted, or "SET" position). Failure to position the control head to the "SET" position will result in accidental cylinder discharge when the control head is installed on the cylinder valve.

9. Assemble the control head to the pilot control port. Tighten the swivel coupling nut securely.

4-3.16.2 INSTALLATION OF PNEUMATIC DETECTOR

4-3.16.2.1 Positioning Heat Actuated Detector (HAD) Units

HADs are to be installed in the anticipated path of convective heat flow that would accompany fire within the protected space. Do not install detectors on the underside of beams or other projections and consider the use of a heat-collecting baffle.

The maximum center to center spacing shall not exceed 25 ft. (7.6 m) or an area of coverage of 625 sq. ft. (58 sq. m). No more than four detectors can be used in a single actuation system.

Note: Consult Kidde for applications where enclosure heights exceed 15 ft., 10 in.

4-3.16.2.2 Installing HAD and Control Head Tubing

The sensitivity and resulting response time of a pneumatic detection and control system is dependent on a number of factors, the primary factors are:

- Fire intensity and growth profile.
- HAD spacing and location.
- Control head pressure setting and vent size.
- Volume of capillary connective tubing.

The system will actuate when the entire sensing volume (HADs, copper tubing and the diaphragm chamber) is pressurized to a level equal to the control head pressure setting (e.g., 3 in. of water). To ensure a rapid response, the overall tubing length must not exceed 200 ft. (61 m). The connection between the main pneumatic tubing material and the system devices is made using the Kidde supplied 3/16 in. tube lengths and fittings.

4-3.17 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.

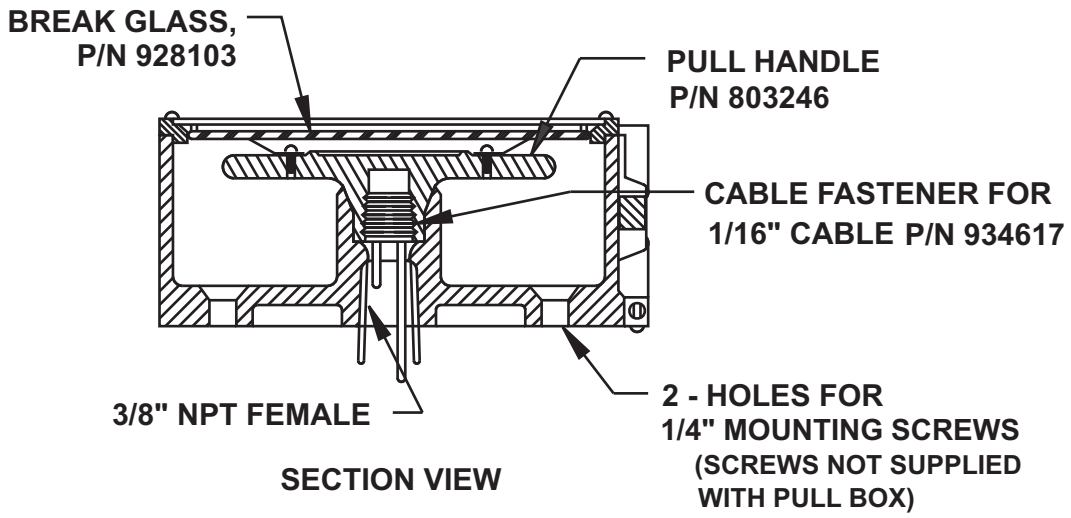


Figure 4-23. Pull Box, Break Glass

4-3.17.1 INSTALLATION OF PULL STATION, P/N 871403

Where clearance behind the manual pull station does not allow the cable/conduit and corner pulley to be installed the behind the mounting surface a "Z" bracket, P/N 60532, can be used. This bracket allows the unit to be installed 4.5 in. (114 mm) from the mounting surface.

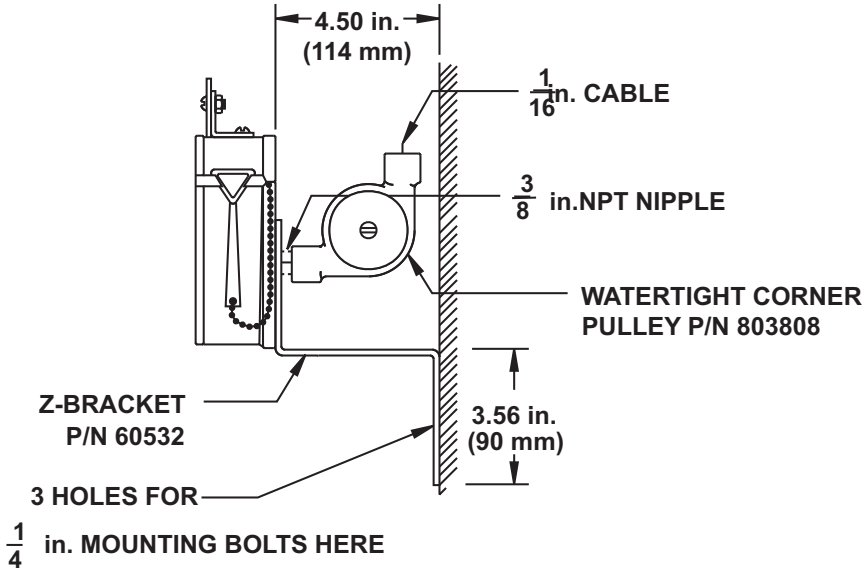


Figure 4-24. Pull Box, Break Glass used with Z-Bracket

4-3.17.2 INSTALLATION OF WATERTIGHT PULL BOX, P/N 870087

Mount the watertight pull box against a flat section of bulkhead using a suitable gasket. Ensure that all six 5/16 in. mounting holes are utilized. Allow adequate clearance around the unit,

particularly below the unit where the cover must be able to fully clear the unit to allow access to the break glass. Install the unit with the cover instruction horizontal.

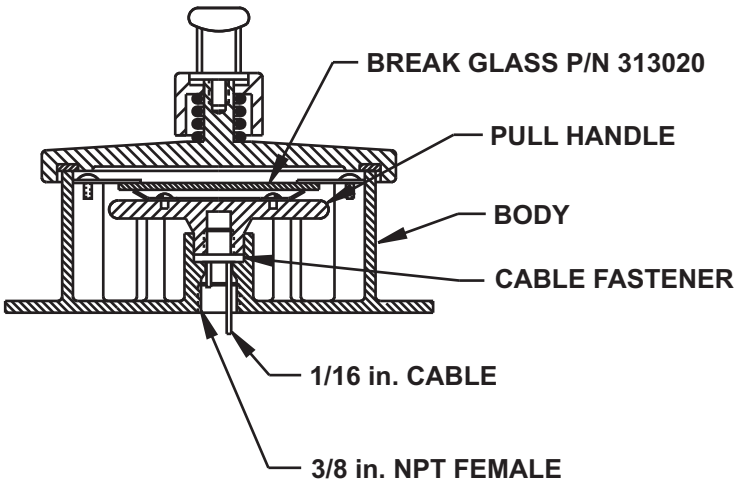
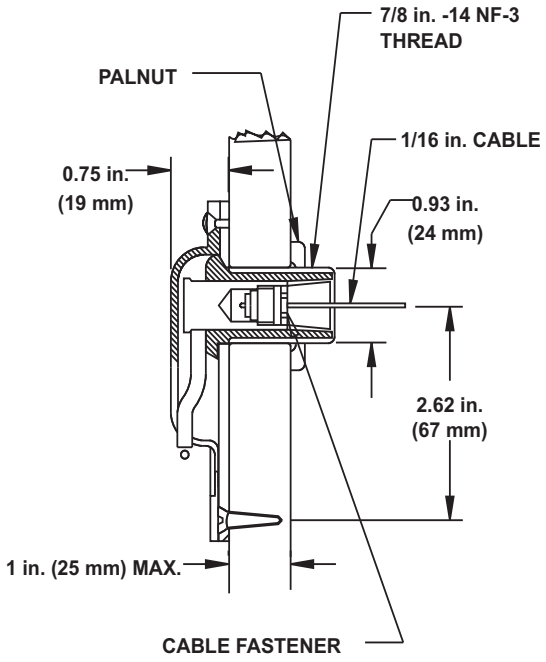


Figure 4-25. Watertight Pull Box

4-3.17.3 INSTALLATION OF FLUSH PULL BOX, P/N 840098

The flush pull box, yacht type, should only be installed on surfaces where the material thickness is 1 in. (25 mm) or less. This is so that the male 7/8 in.-14 NF-3 thread of the cable entry has sufficient engagement for the connection of the cable conduit fittings. All three mounting holes must be used to install the unit. The unit is supplied with two sets of fixing screws.



Mounting Hardware Provided:
3– 10-32 Flat Head Screws (½ in. [13 mm] long)
3– No. 10 Flat Head Wood Screws (3/4 in. [19 mm] long)

Figure 4-26. Flush Pull Box, Yacht Type

4-3.18 Nitrogen Pilot Cylinder Installation, 108 cu. in., P/N 877940

4-3.18.1 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. If the cylinder is being used to drive a pressure operated siren, P/N 90-981574-001, then the add-on label P/N 06-231866-518 (supplied with the cylinder) should be affixed over the area at the center of the cylinder main label (bounded by a dotted line). This ensures the cylinder function is adequately indicated.

4-3.18.2 INSTALLATION OF 1/4 in. BALL VALVE, P/N 283888, AND PILOT LINES

1. Mount the 1/4 in. ball valve on to the bulkhead using the integral mounting points.
2. Ensure the valve is in the closed position. Install the seal wire.
3. Install the upstream 1/4 in. pipe section with 1/4 in. coupling from the ball valve and secure it to the bulkhead.
4. Attach the nitrogen cylinder outlet adapter, P/N 6992-501.
5. Connect a flexible actuation hose, P/N 264986 or 264987 from the 1/4 in. coupling to the outlet of the nitrogen pilot cylinder.
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.

4-3.19 Nitrogen Pilot Cylinder Installation, 1040 cu. in. and 2300 cu. in., P/Ns 90-101040-000 and 90-102300-100 Respectively

WARNING Nitrogen cylinders must not be moved unless the discharge and control heads have been removed and the protection caps are installed. Failure to follow these instructions could result in inadvertent discharge, serious bodily injury, death or property damage.

The nitrogen pilot cylinders must be located as close to the hazard area as possible. The storage location must be protected from the elements and maintained at a temperature between 32°F (0°C) and 130°F (54°C). External heating and/or cooling may be required to maintain this temperature range. Cylinders should be raised at least 2 in. (50 mm) from the deck using a suitable bracket or blocks if the area is regularly washed down or is subject to environmental wetting.

Single cylinders should be installed using two straps, P/N 270014, installed at the heights shown in Figure 4-27. See Table 4-13 for strap dimensions. Where two cylinders are installed, two double straps, P/N 241219 can be used. Install at the same heights defined for single cylinder straps.

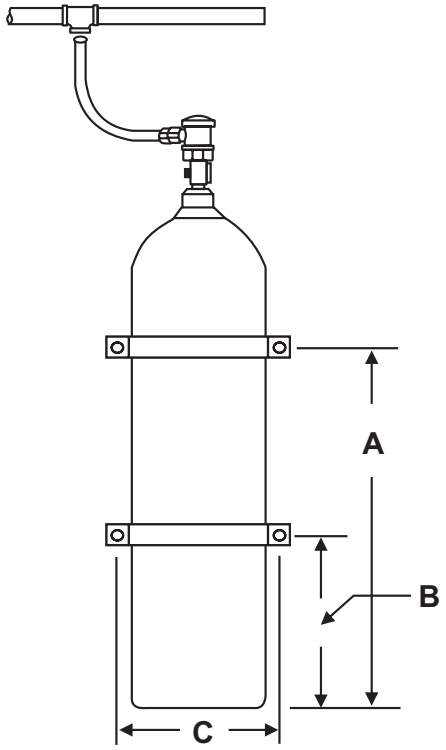


Figure 4-27. Typical 1040 and 2300 cu. in. Pilot (Driver) Cylinder Strap Installation (P/N 90-101040-000 and 90-102300-100)

Table 4-13. 1040 and 2300 cu. in. Nitrogen Pilot (Driver) Cylinder Strap Installation Dimensions

Part Number	Description	A		B		C	
		in.	mm	in.	mm	in.	mm
90-101040-000	1040 cu. in.	21 to 22	533 to 559	6 to 8	152 to 203	10.4	263
90-102300-100	2300 cu. in.	42 to 44	1067 to 1118	12 to 14	305 to 356	10.4	263

Before connecting cylinders into the discharge pipework, tighten straps until there is clearance enough to allow the cylinders to be rotated in place if required. Tighten fully when all components are correctly positioned.

1040 cu. in. cylinders being installed as a pilot cylinder (in a single stage system), or as first stage pilots, do not require add-on label(s) to be affixed. However, 1040 cu. in. cylinders being installed as second-stage pilot cylinders, or as siren drivers, should have the add-on label P/N 06-231866-519 (second-stage) or P/N 06-231866-518 (siren driver) affixed to the area at the center of the cylinder label (rectangle with the dotted line) to indicate the function of the unit.

Note: Both labels are supplied with the unit.

The 2300 cu. in. cylinder is only used as a siren driver, and therefore requires no additional labeling.

4-3.19.1 INSTALLATION OF FLEXIBLE DISCHARGE HOSE, P/N 06-118207-00X

Connect the discharge hose to the piping or manifold as shown on the system drawings. Apply Teflon tape or pipe jointing compound to the male threads. Ensure that the manifold or system piping is at the correct height and the cylinder is correctly positioned such that the hose, when installed, will not be kinked or flattened when installed.

WARNING

Discharge hoses must always be connected to the system piping and to the discharge heads before attaching the discharge heads to the cylinder valves, in order to prevent injury in the event of an inadvertent discharge.

4-3.19.2 INSTALLATION OF DISCHARGE HEAD, P/N 872450 AND P/N 872442

Attach the discharge head to the flexible discharge hose. The hose must be already attached to the system piping. Do not connect discharge head(s) to the cylinder valve(s) until all flex hoses and discharge heads are installed on a common manifold. Install the discharge head to the cylinder valve as follows:

1. Remove protective cap from the cylinder valve and ensure that the sealing surfaces are clean.
2. Verify that the discharge head o-rings are correctly seated in their grooves in the swivel nut. O-rings must be free of dirt and other contaminants. The o-rings are lightly lubricated at the factory and should not require further lubrication.
3. Ensure that the pilot orifice, located between the inner and outer o-ring seals, is unobstructed,
4. Install the discharge head on the cylinder valve and tighten securely.

WARNING

The discharge head must be permanently connected into the system piping. Never install the discharge head(s) to the cylinder valves until the appropriate brackets secure the cylinders. Under no circumstances is the discharge head to remain attached to the cylinder valve after removal from service or during handling, storage or shipment. Failure to follow these instructions could result in serious bodily injury, death or property damage.

4-3.19.3 INSTALLATION OF TIME DELAY, P/Ns 81-871072-001, 81-871072-002, 81-871072-003 and 81-871072-004

The discharge time delay must be installed in either the pilot line or the discharge manifold, as shown on the system drawings. The time delay must be securely mounted to a structural member by securing the attached pipework (use channel mount pipe clamp or equivalent with a load rating equal to or greater than 400 lb.). Make certain the inlet and outlet ports are properly oriented and the arrow is in the direction of flow. Both ports have 3/4 in. NPT fittings for connection to the pipe. A lever or cable operated control head must be installed on each time delay. Operation of the control head will override the timing cycle. Make certain the control heads are installed in their "SET" or non-operated position.

Note: The time delay units are factory set to give the nominal rating minus zero, plus 20% per NFPA 2001:2000 Edition and UL-2166. The nominal ratings are indicated in Table 4-14. Due to the wide operating temperature range of the units, the delay at 70°F is greater than the nominal value. The actual delay achieved in service is dependant on the ambient conditions.

Table 4-14. Nitrogen Discharge Delay Rating

Part Number	Cylinder	Nominal Rating (seconds)	Nominal Delay @ 70ºF (seconds)
90-871072-001	108 cu. in.	34	37
90-871072-002	108 cu. in.	61	68
90-871072-003	1040 cu. in.	35	40
90-871072-004	1040 cu. in.	68	74

4-3.19.4 INSTALLATION OF PRESSURE OPERATED SIREN, P/N 81-981574-001

The siren should be installed within the protected space connected to the siren driver using the pipe specified in Table 4-7. Install a dirt trap and union as per Figure 4-28.

Each siren consumes approximately 0.5 to 0.9 lb. (0.23 to 0.5 kg) of nitrogen per minute at 70°F (21°C).

Refer to Paragraph 4-2.7.5 for siren driver limitations.

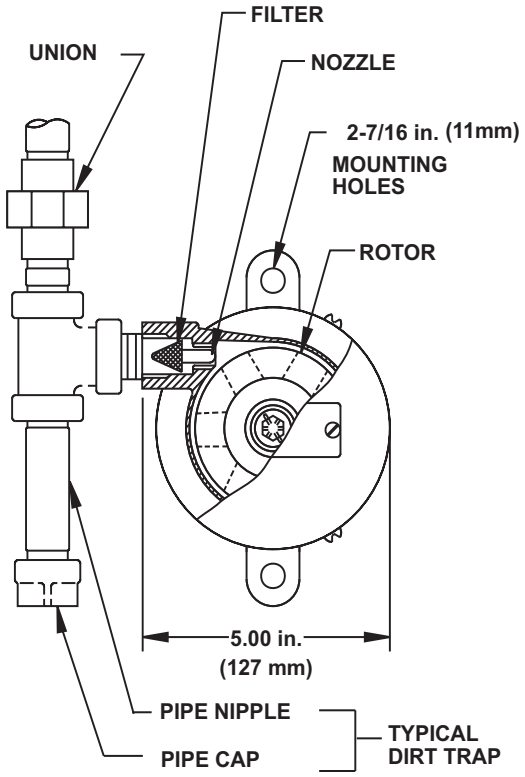


Figure 4-28. Pressure Operated Siren

4-3.20 Dual-Loop Bleed Kit, P/N 06-129978-001

The dual-loop actuation kit, P/N 06-129978-001, can be installed in two configurations. A configuration is chosen by the space available in the cylinder storage location.

In configuration 1, see Figure 4-29, the four-way fitting is secured to a bulkhead or suitable structural member, and a single actuation hose is used to connect to the pressure operated control head on the agent cylinder. The actuation piping is screwed directly into the 1/4 in.

check valves. It is recommended that a union be installed in each connection to the dual-loop fitting. In configuration 2, see Figure 4-30, the four-way fitting is connected directly to the pressure operated control head. The connection in to the actuation piping of both circuits is made using a single actuation hose.

Male tapered threads must be prepared with Teflon® tape or pipe compound (excluding first two threads). Do not use tape or compound on flared fittings.

Refer to Table 4-15 for component part detail.

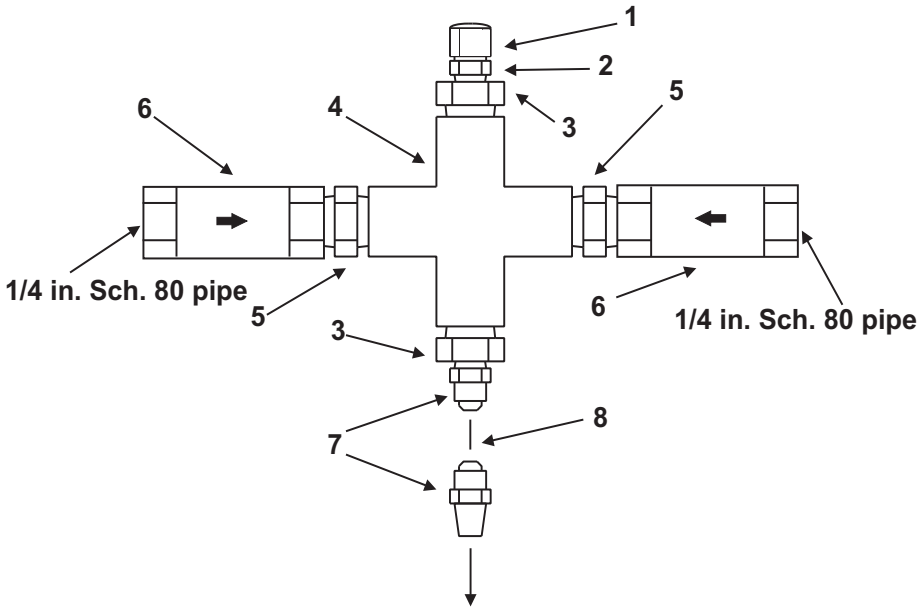


Figure 4-29. Dual-Loop Bleed Kit, Configuration 1

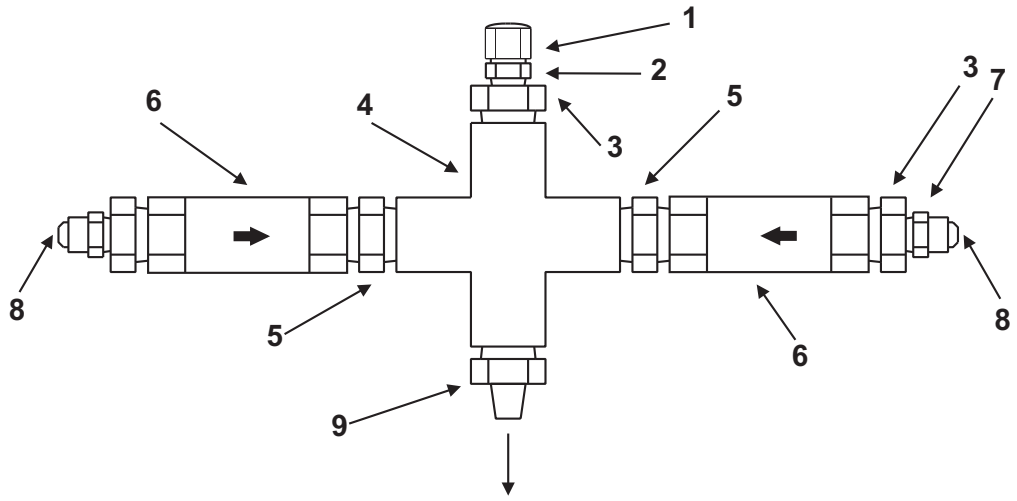


Figure 4-30. Dual-Loop Bleed Kit, Configuration 2

Table 4-15. Dual-Loop Kit Components

Item	Qty. in Kit	Description	Part Number
1	1	Cap 7/16 in. (1/4 in.SAE Flare) 1/4 in. Tube	WK-263304-000
2	1	Bleed Fitting 1/8 in. NPT x 7/16 in. (1/4 in. Tube)	WK-263303-000
3	3	1/4 in. NPT M x 1/8 in. NPT F	06-118318-001
4	1	4-Way 1/4 in. F	06-118319-001
5	2	1/4 in IN.NPT M x 1/4 in. NPT M	06-118320-00
6	2	1/4 in. Check Valve	264985
7	2	1/8 in. NPT x 7/16 in. (1/4 in. Tube)	06-118191-001
8	Not Included	1/4 in. Actuation Hose, H. Duty, 34 in. Long	06-236215-001
9	1	1/4 in. NPT M x 1/8 in. NPT M	06-118321-001

4-3.21 Installation of Discharge Pressure Switches, 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 in. NPT pressure inlets to connect to the system piping. The electrical connections are either 1/2 in. conduit knockouts for the standard pressure switch or 1 in. NPT fittings for the explosion-proof pressure switch.

4-3.22 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 in. Schedule 40 pipe. The minimum operating pressure required is 75 PSIG (5 bar gauge). The maximum allowable load to be attached to the retaining ring is 100 lb. (45.4 kg).

4-3.23 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 in. NPT male connection. Make certain the indicator stem is in the normal position.

4-3.24 Installation of Supervisory Pressure Switches, P/Ns 06-118262-001 and 06-118263-001

Installation of the supervisory pressure switch can be accomplished safely on a pressurized cylinder (see Figure 4-31).

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.

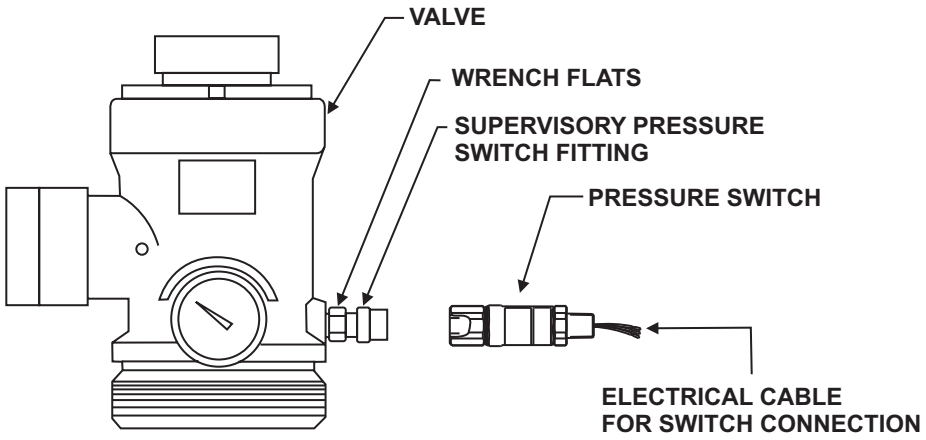


Figure 4-31. Installation of Supervisory Pressure Switch (Up to 2½ in. Valve)

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

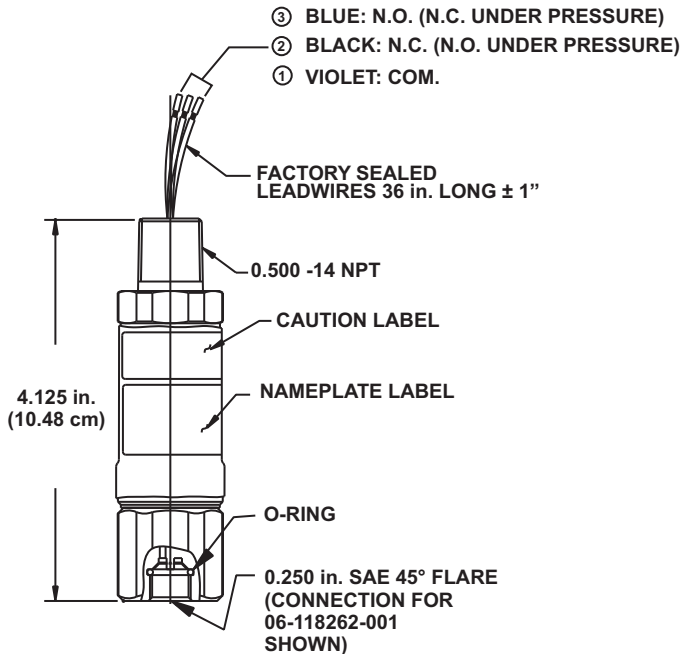
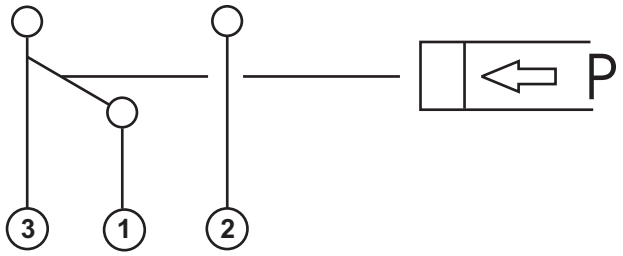


Figure 4-32. Supervisory Pressure Switch Electrical Connections



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

Figure 4-33. 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.

4-3.24.1 INSTALLATION OF PRESSURE SWITCH, P/N 06-118262-001

Install the pressure switch as follows:

Note: Do not use with 3 in. 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.

4-3.24.2 INSTALLATION OF PRESSURE SWITCH, P/N 06-118263-001

Install the pressure switch as follows:

Note: Do not use with 3 in. valves.

1. Hold the pressure switch fitting on the valve with a wrench and remove the 1/8 in. 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 in. 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.

4-3.25 Installation of Safety Outlets, P/N 803242 and P/N 844346

The safety outlet must be installed upstream of any closed section of piping (i.e., between the cylinder(s) and a stop valve). The connection is made using a 3/4 in. NPT fitting. Attach the unit and tighten using a wrench.

CAUTION Do not hold the wrench on the safety disc-retaining nut during installation or removal. Use the main body hex. Apply Teflon® tape or jointing compound to the male thread.

4-3.26 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 and USCG rules (see Paragraph 4-3.3).

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 controls 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 pressure switch test outlined in Paragraph 5-4.3.1 for all pressure switches installed.

Note: 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® Marine 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 PROCEDURE

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.

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:

- Inspection interval,
- Inspection procedure performed,
- Maintenance performed, if any, as a result of inspection, and
- Name of inspector performing 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 PREVENTATIVE 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[1] and pressures	
	Check Nitrogen cylinder pressure	
Semi-Annually[2]	Test pressure switches	5-4.3
	Test Pneumatic Detection System	5-4.4.1
	Check FM-200/CO_2 cylinder weights and pressures	
	Actuation circuit functional test	
Every 2 Years	Blow out distribution piping	5-4.4
Every 5 Years	FM-200, nitrogen, and CO_2 hydrostatic cylinder pressure test and/or inspection	5-5, 6-5.1, and 6-6.1.1
	Flexible hose pressure test	

[1] Check weight if LLI unit is installed.

[2] Annually if accepted by Authority Having Jurisdiction (AHJ).

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 3-2). 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 Paragraph 5-7 and Paragraph 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. Inspect all system component plates. If any show signs of damage or deterioration, replace immediately.

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 pneumatic detection tubing and fittings for cracks, dents, distortion or corrosion. Tighten loose fittings and replace damaged sections of pipe/tubing or fittings.

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 and Paragraph 6-2.5. 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 Paragraph 5-7 and Paragraph 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 the 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. Paint can obstruct the holes on the nozzle, thereby causing system malfunction.

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-220 CYLINDERS

Weigh 10 through 900 lb.

5-4.2.14 CYLINDERS NOT EQUIPPED WITH FLEXIBLE TAPE LIQUID LEVEL INDICATOR

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

5-4.2.14.1 Check FM-200 Agent Quantity

WARNING

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

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

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. 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).

5-4.2.14.2 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 Do 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.

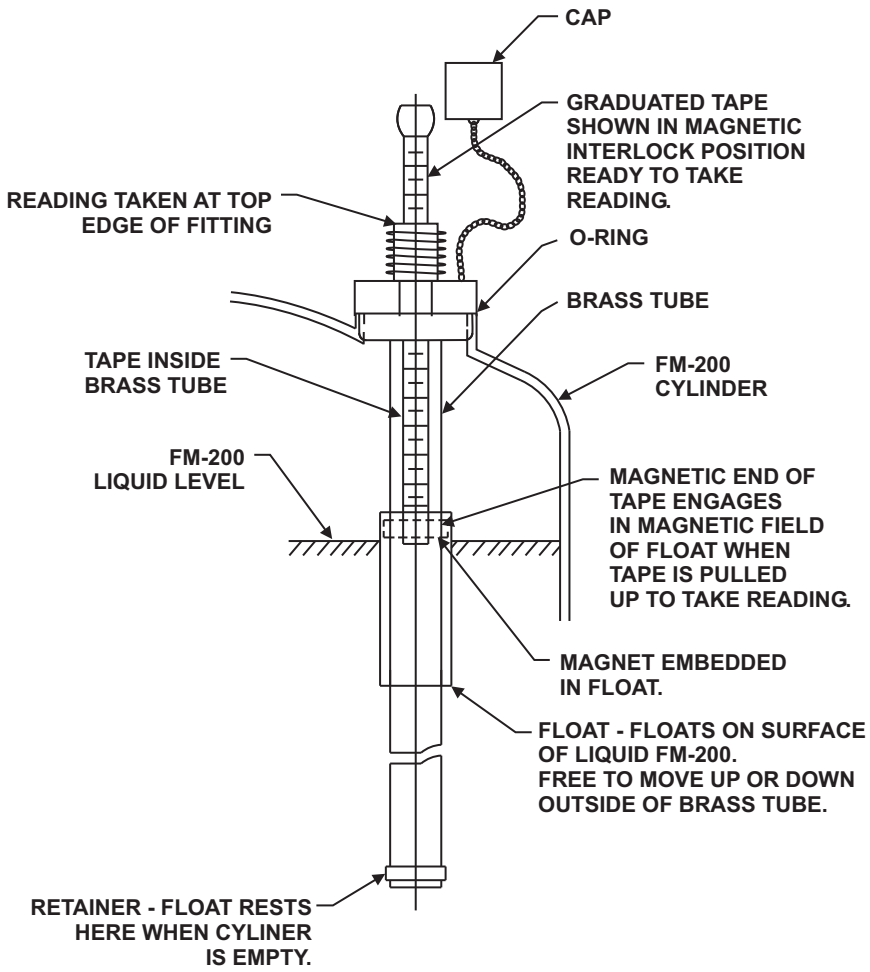


Figure 5-1. Liquid Level Indicator

6. Check the ambient temperature where the FM-200 cylinders are stored and record the temperature.

7. Refer to the appropriate calibration charts (see Figure 5-2 through Figure 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.

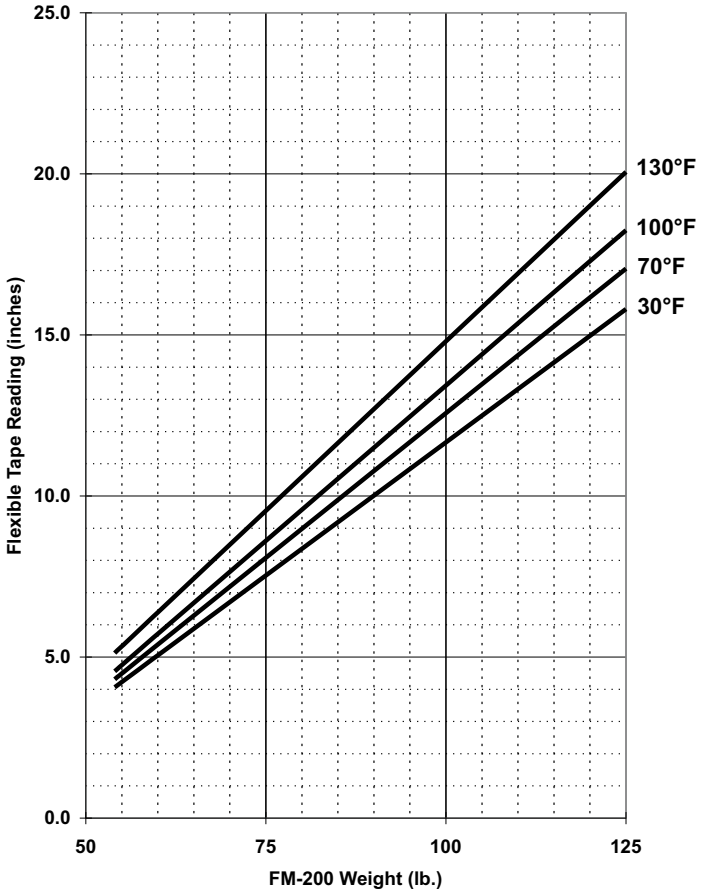


Figure 5-2. Calibration Chart 125 lb. Cylinder

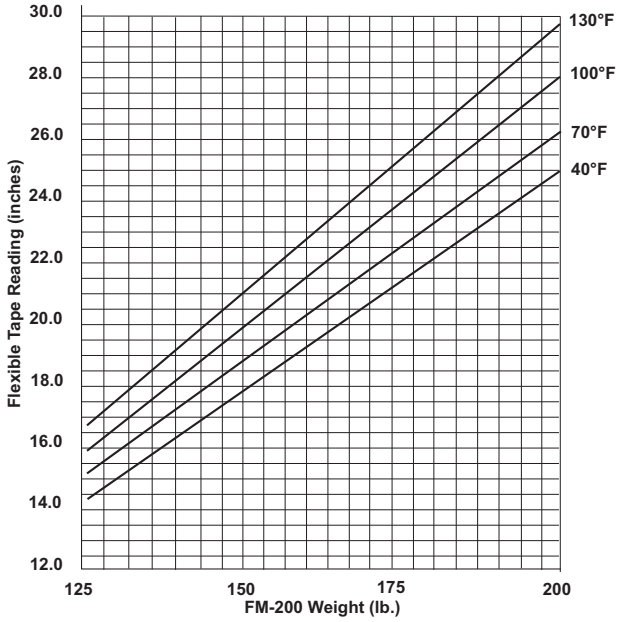


Figure 5-3. Calibration Chart for Old 200 lb. Cylinder

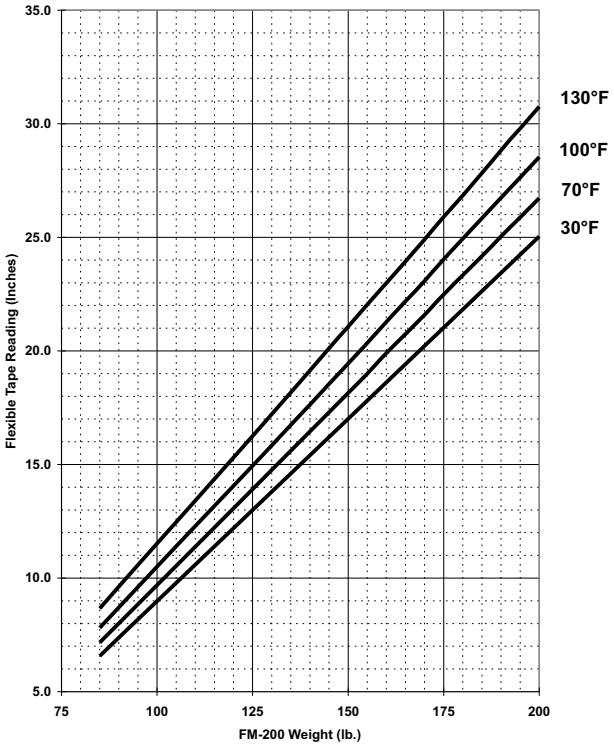


Figure 5-4. Calibration Chart for a New 200 lb. Cylinder
(New Design Ellipsoidal Head Manufactured After 3/98)

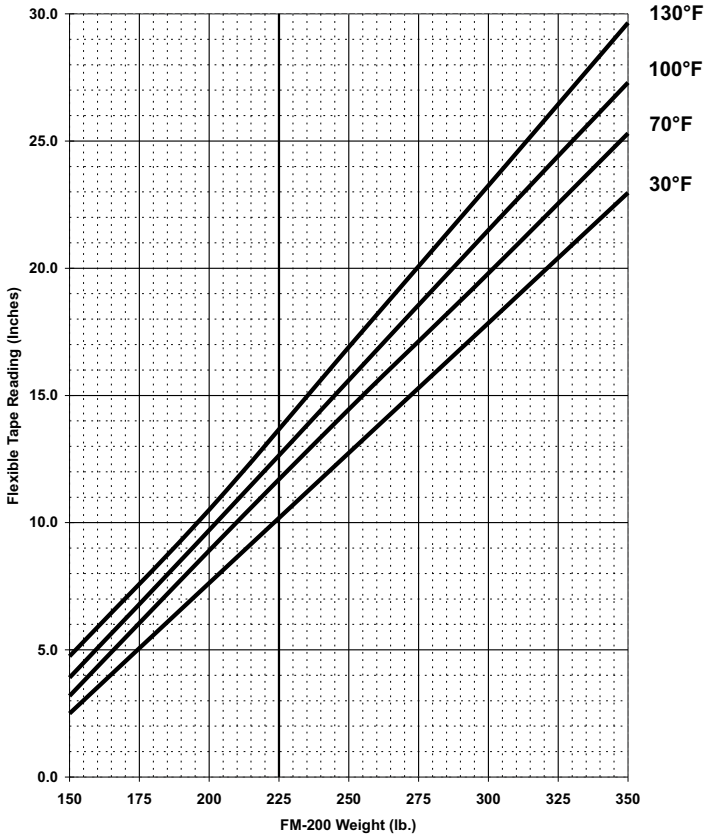


Figure 5-5. Calibration Chart for 350 lb.Cylinder

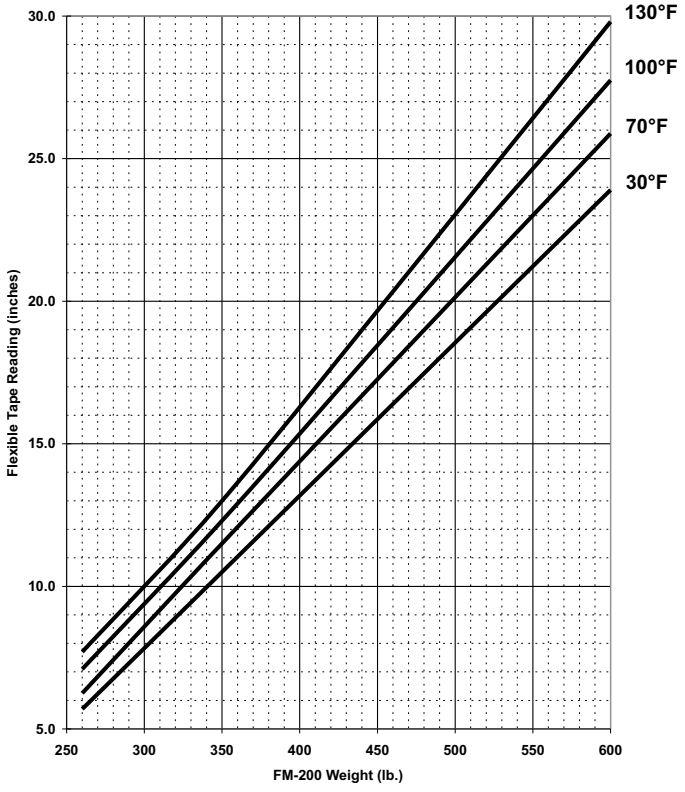


Figure 5-6. Calibration Chart for 600 lb. Cylinder

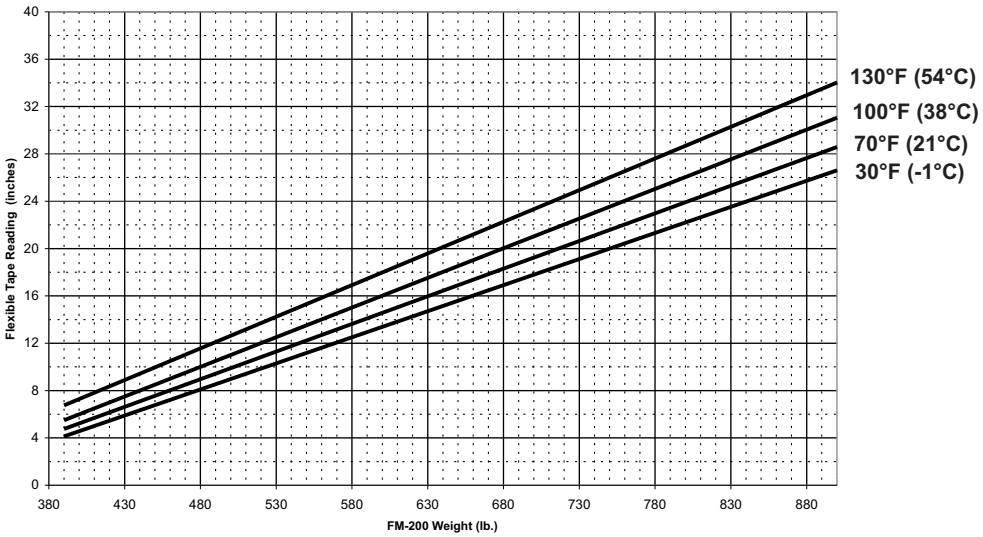


Figure 5-7. Calibration Chart for 900 lb. Cylinder

5-4.3 Inspection Procedures, Semi-Annual

5-4.3.1 PRESSURE SWITCH TEST

Perform the pressure switch test as follows:

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 WEIGHING CO_2 CYLINDERS

WARNING

The carbon dioxide cylinders are equipped with a high rate discharge valve, which, when actuated, will open, remain open and cannot be closed. Accidental actuation of the discharge valve on an unsecured, disconnected cylinder will result in a discharge thrust capable of propelling the cylinder to velocities that can cause death, personal injury or property damage. It is extremely important that the exact sequence of cylinder removal always be followed. Further cylinder removal or cylinder replacement must always be supervised to assure full compliance with the instructions in this manual.

1. Remove control heads at the coupling nut only.
2. Disconnect flexible hose from discharge head.
3. Loosen cylinder framing so cylinders are free.
4. Hook scale on weighing angle and slip yoke under discharge head. Adjust lever as shown in Figure 5-8.

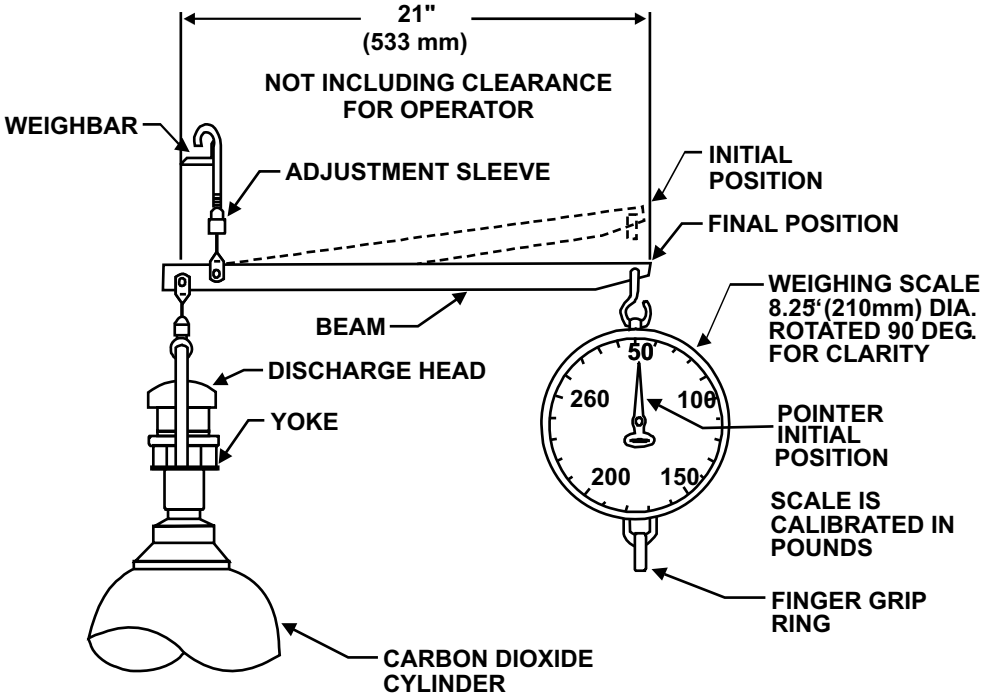


Figure 5-8. Weighing Carbon Dioxide Cylinder Using Scale, P/N 982505

5. Pull down until cylinder is just clear of floor and the lever is horizontal.
6. Read weight directly off the scale (the scale is calibrated to take care of leverage). Empty cylinder weight is stamped on the cylinder valve body. Deduct the empty weight from scale reading, as well as 3.75 lb. for weight of discharge head. The result is the amount (charge weight) of liquid carbon dioxide in the cylinder.
7. If the charge weight loss exceeds 10%, forward the charged cylinder to a authorized Kidde distributor.

WARNING **Do not transport CO_2 cylinders unless the discharge and control heads have been removed and the safety cap and protection cap are installed.**

8. After all carbon dioxide cylinders have been weighed, tighten clamps, reconnect flexible hose from discharge head and reinstall the control heads on the cylinders. Tighten the control head coupling nuts securely.

CAUTION All control heads must be removed from FM-200 cylinders and pilot cylinders prior to testing to prevent accidental cylinder 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 piping to allow any foreign matter to blow clear.
2. Remove all pressure operated control heads from the FM-200 cylinders.

WARNING

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

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.

5-4.4.1 TEST PNEUMATIC DETECTION SYSTEM

Before conducting any of these tests outlined in the following sections, remove the pneumatic control head(s) from the cylinder(s).

WARNING

When disconnecting control heads (tandem mounted), do not let heads turn (only possible if the interconnecting cable housing is a loose fit). This will reduce the likelihood of accidental discharge.

5-4.4.1.1 Pneumatic Control Head Test

Pressure setting; see Figure 5-9.

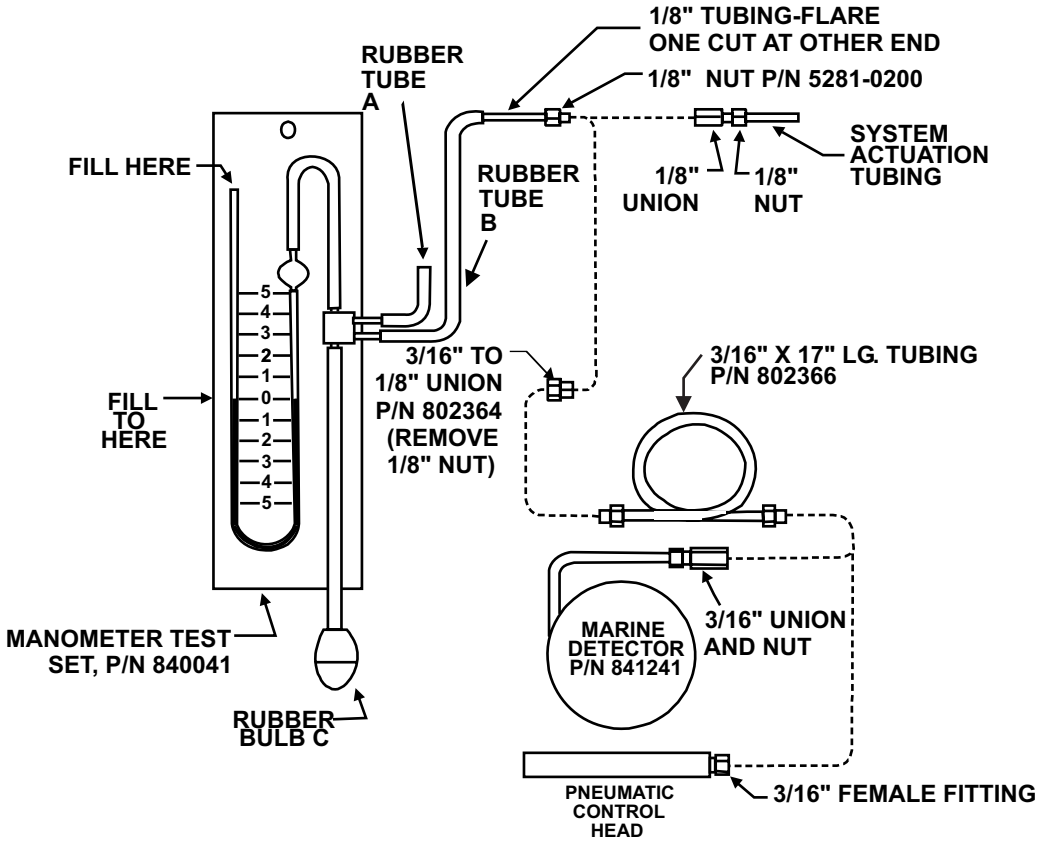


Figure 5-9. Manometer Test Set

1. Connect the test fitting of the manometer test set to the diaphragm chamber of the control head.
2. Make certain sufficient clearance is provided at mounting unit so the control head will not be damaged upon operation.
3. If the control head has been operated, reset it by placing a screwdriver in the reset stem and turning clockwise until stem locks in position (with arrow on reset stem lined up with "SET" arrow on nameplate).

Note: Slight resistance will be met just before stem locks.

4. Use manometer test set (P/N 840041, Figure 5-9) and pour water into the open tube until the water level in both tubes is exactly at the zero mark. (The test set is not furnished as part of the system.)
5. Close off the rubber "A" by squeezing tightly with the fingers or use a crimp clamp, and then apply pressure by gradually squeezing the rubber bulb "C." The control head must operate at the factory pressure setting, plus or minus the 10% tolerance allowed. The pressure required to operate the control head is the difference in inches between the water levels in the two tubes, and is equal to twice the reading of either tube (i.e., 3-inches both tubes or 1½-inches on one tube).

CAUTION

After the control head has operated, be sure to release rubber tube "A" first before allowing the rubber bulb "C" to expand to normal; otherwise water may be sucked into the tubing and control head, which can cause system malfunction.

5-4.4.1.2 Control Head Vent Test

Before disconnecting the manometer from the control head, the vent must be tested. To test the vent for correct calibration, perform the following steps:

1. Squeeze the rubber bulb "C" about halfway, or enough to achieve sufficient vacuum for test, then close tube "A" by pinching with fingers or crimp clamp.
2. Let the bulb expand gradually to its normal shape. This creates a partial vacuum, causing the water level to change which indicates the inches of vacuum applied to the control head (the vacuum must be more than a minimum of 3 inches in order to observe drop from 3 inches to 1 inch).
3. The water column will recede to "0" level as air passes through the vent. The time required (number of seconds) for the water column to recede 2 inches reading from 3 inches to 1 inch on both legs or 1½- inch to ½ inch on either leg is the number of the vent (the calibrated rate of flow), i.e., if the time required to pass the above amount of water is five seconds the control head vent is "No. 5." When vents are tested, the time will vary due to the added volume in the control head diaphragm chamber. A No. 5 vent may test at five to seven seconds, which is acceptable. If a vent time reads much higher, it will increase system sensitivity and may not be acceptable. Table 5-2 shows the acceptable times allowed when testing for vent sensitivity using manometer method with vent installed in the control head.

Table 5-2. Pneumatic Control Head Calibration Chart

Control Head Vent Setting	Allowable Time (Seconds)
40 seconds	40 to 60 seconds
20 seconds	20 to 27 seconds
10 seconds	10 to 15 seconds
5 seconds	5 to 7 seconds

4. Repeat above procedure for testing tandem control head if installed. Since there is no vent in the tandem control head, the vacuum must hold (same as tubing tightness test).
5. Disconnect manometer test set from the control head (test fitting “A”). Reset the control head by turning the reset stem to its “SET” position.

Note: For accuracy, Kidde Fire Systems manometer test set, P/N 840041, must be used.

5-4.4.1.3 Test for Leakage of System Tubing and Detectors

1. Connect the test fitting of the manometer to the pneumatic detector tubing (at the control head connection nut).
2. Squeeze the rubber bulb “C” fully and then close off the open rubber tube “A.” Very gradually, release the rubber bulb to its normal shape. This will cause the water level in the two tubes to change, at which time a maximum vacuum will develop. Hold a minimum 8 inch vacuum (difference between two sides of “U” tube, or 4 inches on each side of “U” tube).
3. If all connections are absolutely tight, the water level will remain in the position taken in Step 2 above and will not change as long as the rubber tube “A” is held closed. Observe the level of the water for at least one minute and then release the rubber tube “A.” It is absolutely essential that the water level remain the same as long as the rubber tube is held closed. Even a slow, steady fall of the water level is serious, for it indicates a leak which may prevent automatic operation of the system. Disconnect the test set from the detector tubing. After tests have been completed, reset the control heads.

WARNING When using hot or boiling water, exercise care when immersing the actuating chamber. Do not stand directly beneath the container.

4. Functional Test of System. Hold a container of hot or boiling water under the heat detector, immersing the actuating chamber into the water. At least 50% of the detector must be immersed. The water must be at least 100°F above the ambient temperature. Take note of the time between the application of the hot water to the detector and the operation of the control head. The control head must operate in approximately fifteen seconds. Do not apply heat for more than fifteen seconds. The detector is not functioning if the control head has not operated within this time.

   When testing two control heads connected in tandem, both may not operate simultaneously. Both control heads must operate within fifteen seconds if the heat is sustained.
5. The heat test must be performed on each heat detector. Between each test, wait about five minutes for the system to return to normal and then reset the control head. To reset, insert a screwdriver in the reset stem and turn clockwise until the stem locks in position with the arrow or reset stem lining up with the “SET” arrow on the nameplate (slight resistance will be met just before the stem locks).
6. If the application of heat does not cause the control head to operate within fifteen seconds, remove the container of water and investigate cause:
   a. Heat differential was inadequate.
   b. Leakage in the tubing system (tubing connections not tight).
   c. Obstruction in the tubing.

5-4.5 Troubleshooting the Pneumatic Detection System

Failure of system to operate pneumatic detection system testing when applying heat to the detectors may be caused by insufficient heat applied, obstructions in tubing or leaks in system. The manometer can be used to assist in troubleshooting the system as follows:

1. Install manometer in system tubing at pneumatic control head connection. Replace union connection with a control heat “T.” Close open tube “A” of the manometer (see Figure 5-9) with crimp clamp. The manometer is now an integral part of the system and provides a visual record of pressure to which system is subjected by heat or cold at the detector.
2. The installation of the manometer, as described above, provides a visual indication of the pressure buildup within the system, and will assist in determining if there is sufficient or insufficient pressure buildup during test of the system.

5-5 INSPECTION AND RETEST PROCEDURES FOR FM-200 CYLINDERS, PILOT CYLINDERS AND FLEXIBLE HOSES

5-5.1 Inspection and Test of 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 5-5.1.3).

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:

5-5.1.1 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.

5-5.1.2 DISCHARGED CYLINDERS OR 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 CFR (Code of Federal Regulation) Title 49, Section 173.34.

5-5.1.3 RETEST

DOT 4BA and 4BW cylinders used exclusively in FM-200 service which are commercially free from corroding components are required to be hydrostatically retested and restamped every five years in accordance with DOT CFR Title 49, Paragraph 173.34(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 in accordance with CFR 49, Paragraph 173.34(e) (13). Therefore, the retest can be performed by either of the following methods:

Table 5-3. Retest Schedule

Retest Method	First Retest Due	Subsequent Retest Due	Special Marketing
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"

5-5.2 Flexible Hoses

In accordance with NFPA 2001, all system hoses shall be examined annually for damage. If visual examination shows any deficiency, the hose shall be replaced or tested. In accordance with NVIC 3-95, Enclosure (1), flex hoses shall be visually examined annually for damage. If the inspection shows any deficiency, the hose shall be replaced or tested.

5-5.3 Inspection and Test of Nitrogen and CO_2 Pilot Cylinders

CAUTION

These guidelines do not apply to cylinders containing commodities other than CO_2 or nitrogen.

All Kidde CO_2 cylinders are designed, fabricated, factory tested and stamped in compliance with DOT CFR 49 Regulations 3A-2015 or 3AA-2300. All Kidde nitrogen pilot actuation cylinders are designed, fabricated, factory tested and stamped in compliance with DOT CFR 49 Regulations 3A-1800 or 3AA-1800.

CO_2 and nitrogen cylinders must be hydrostatic tested and marked in accordance with DOT CFR 49 Section 173.34 as follows:

1. All CO_2 and N_2 cylinders which have been discharged subsequent to five (5) years from the date of the last hydrostatic test, as indicated by the marking on the cylinder shoulder, must be tested and remarked. DOT requires that these cylinders shall not be recharged and transported without retest if more than five years have elapsed from the last test date.

Note: CO_2 and N_2 cylinders continuously in service without being discharged do not have to be retested every five years.

2. All CO_2 and N_2 system cylinders continuously in service without being discharge may be retained in service for a maximum of twelve years from the date of the last hydrostatic test. At the end of twelve years, these cylinders must be removed from service, discharged, retested, and remarked in accordance with DOT 49 CFR Section 173.34 before NFPA 12/10 or CFR 173.301 through 308 and 173.34, reference 147.65 returning to service.
3. A cylinder must be hydrostatic tested immediately if the cylinder shows evidence of distortion, damage, cracks, corrosion or mechanical damage. Any cylinder failing the visual inspection or hydrostatic pressure test must be destroyed.

5-5.4 Records

In accordance with NVIC 3-95, Enclosure (1), records of all inspections and tests shall be maintained on the vessel and shall be available for inspection. See NVIC 3-95 for more details.

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 clean, dry, lint-free cloth. Remove corrosion with 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. Install a protection cap on the nitrogen driver cylinder valve actuation 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. Weigh the cylinder using a platform scale.

5-7.2 Multiple Cylinder System

WARNING Remove all control heads from 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 retracted 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 before attaching to the cylinder valve. A control head in the released position will cause discharge of FM-200 when it is installed on the cylinder valve.

6. Reinstall control head(s) and tighten the swivel nut(s). Refit the flexible actuation hoses or tubing (where fitted) to the valve actuation port(s) and/or control head ports.
7. If required, install supervisory pressure switches, as explained in Paragraph 4-3.24.

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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.

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
*Note: Old style 2-1/2 in. valve				

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

6-2.2 Valve Disassembly (1½ in., 2 in. and 2½ inch Valve)

Refer to Figure 6-1, Figure 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.

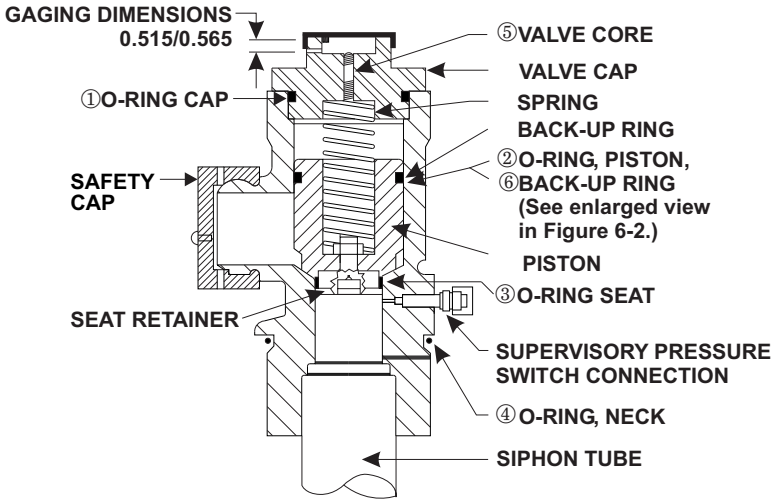

Figure 6-1. Valve Assembly (1½ in., 2 in. and 2½ in.)

Figure 6-2. Piston O-Ring

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.

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).

6-2.3 Valve Disassembly (3-inch Valve)

Note: Refer to Figure 6-3 and Table 6-3 for items.

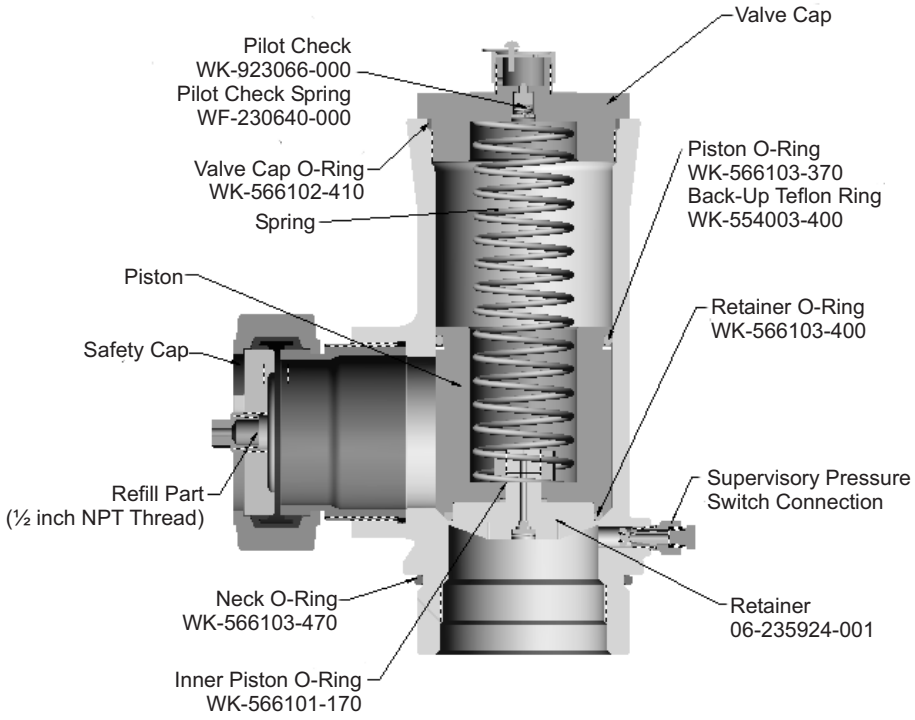

Figure 6-3. 3-inch Valve Assembly

Table 6-3. 3-inch Valve Components

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

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.

6-2.4 Valve Assembly (1-1/2 in. 2 in., and 2-1/2 in. Valve)

Note: The items refer to Figure 6-1.

1. Install the o-ring in the piston groove.

CAUTION Make certain that the Teflon back-up ring is below the 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-inch)

Note: The items refer to Figure 6-3.

1. Install the piston O-ring 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.
8. 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 (1 1/2 in., 2 in. and 2 1/2 in.)

Note: Refer to Figure 6-4.

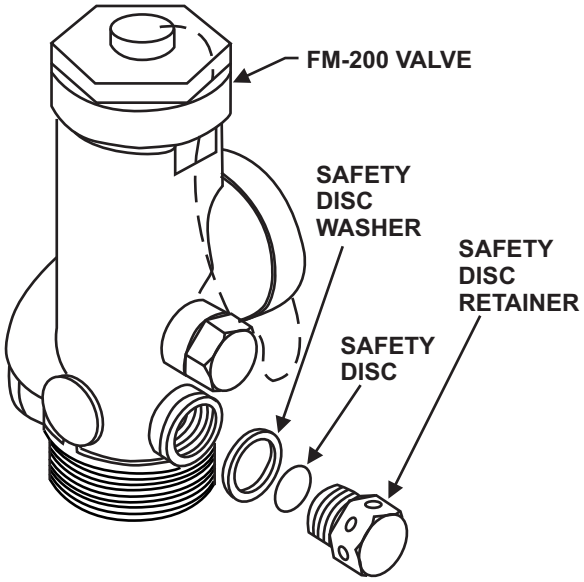

Figure 6-4. Safety Disc Replacement

Table 6-4. Safety Disc Replacement (1-1/2 in, 2 in., and 2-1/2 in.)

Cylinder Size	Safety Disc P/N	Safety Disc Washer P/N	Torque Valve	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

1. Remove the safety disc retainer including safety disc and safety disc washer from the cylinder body. See Figure 6-4. Discard the safety disc and washer.
2. Reassemble the safety disc retainer with a new safety disc and safety disc washer to the cylinder 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.

6-2.7 Safety Disc Replacement (3-inch)

The safety disc for the 3-inch 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 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.

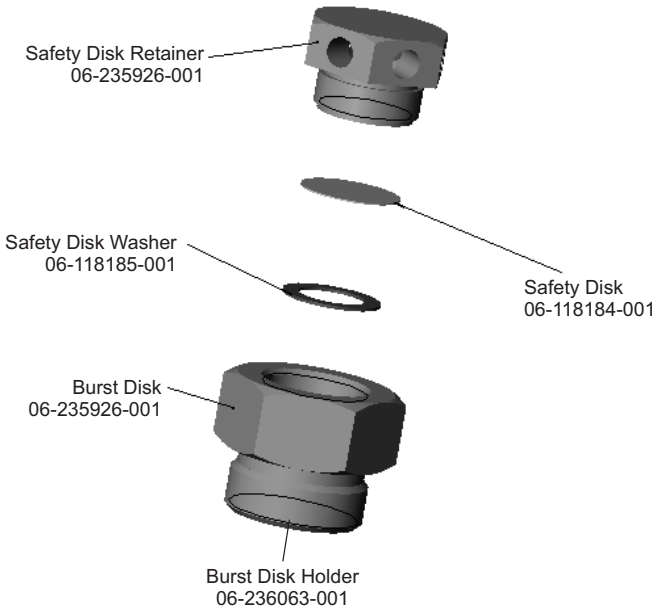

Figure 6-5. Burst Disc

Table 6-5. Safety Disc Replacement Table (3-inch Valve)

Cylinder Size	Safety Disc P/N	Torque	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 retesting before recharging. (See Paragraph 5-5 for details on cylinder retest.)

WARNING

Under no circumstances while performing either cylinder recharge or leak test should a charged cylinder be allowed to free stand 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 kg) for the 2-inch valve or 2800 (1270 kg) for the 3-inch valve. 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, 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.

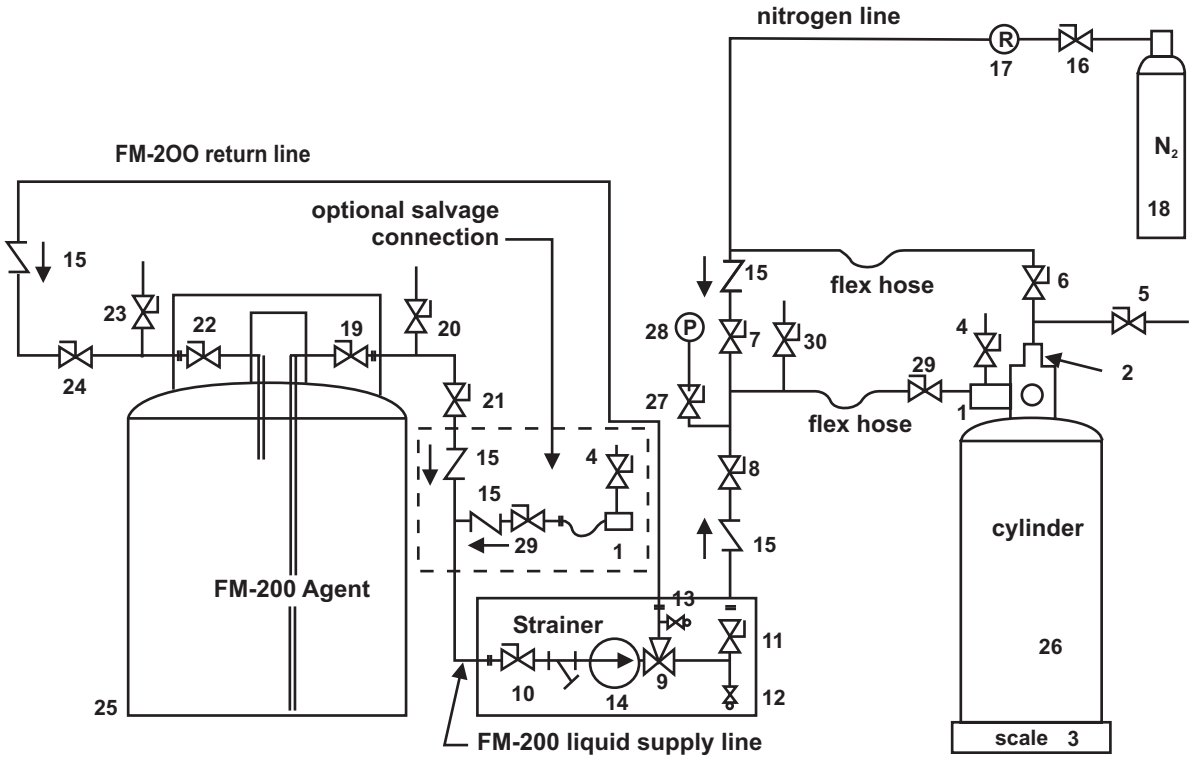

Figure 6-6. Typical FM-200 Charging System Schematic

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.

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

Item	Description	Item	Description
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

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 the FM-200 cylinder and valve assembly as follows (see Figure 6-6 and Table 6-6).

WARNING

Only qualified, designated personnel should operate charging equipment. Exercise extreme care when working with pressure equipment to prevent personnel death, injury and/or 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).

Table 6-7. Pressure vs. Temperature

Pressure versus Temperature	
Temperature °F (°C)	Pressure PSIG (bar)
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./ft.^{3} (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. If the maximum fill density is exceeded, the pressure will increase rapidly with temperature increase and 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. (817 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 and 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 to Step 2.
2. Calibrate the detector against the LS-20 leak standard by holding the probe about 1/8-inch (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.

Table 6-8. Maximum Permitted Leakage Rates

Part Number	Cylinder Size (lb.)	Cylinder Fill Weight (lb.)	Maximum Allowable Leakage (ounces/year)
90-100010-001	10	6-11	0.11
90-100020-001	20	9-23	.020
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
90-100350-001	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
90-100900-001	900	390-900	8.68
*Note: Includes liquid level indicator			

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.

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, 108 cu. in., 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 in. 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 6-6.
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.

WARNING 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.

6-5 NITROGEN PILOT (SIREN DRIVER) CYLINDER SERVICE AND MAINTENANCE, P/Ns 90-102300-100 and 90-101040-000

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 victim to fresh air. Administer artificial respiration if necessary and call a physician. Never dispose of nitrogen in an indoor work or storage area.

6-5.1 Nitrogen Cylinder Hydrostatic Pressure Test

Hydrostatic test must be performed in accordance with DOT regulations CFR Title 49, Paragraph 173.34. Nitrogen pilot cylinders must not be recharged and shipped without hydrostatic test if more than five years has elapsed from the date of the last test. Nitrogen pilot 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 must 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 and/or fire damage.

6-5.2 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 pin installed. A control head in the released position will cause the remaining contents of cylinder to discharge resulting in a system activation which can cause property damage and/or bodily injury.

Replace the nitrogen pilot 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 pilot cylinder actuation port.
3. Remove discharge head from cylinder valve.
4. Remove clamps and hardware securing nitrogen cylinder to the mounting bracket.

6-5.3 Nitrogen Cylinder Recharge

Nitrogen cylinders must be recharged when the cylinder pressure gauge indicates pressure is 10% below normal (1800 PSIG at 70°F [124 bar gauge @ 21°C] as adjusted for temperature as shown in Figure 6-10) 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, 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 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 in. NPT pipe plug.

Note: The pressure gauge attached to the extinguishing system is not to be used to determine when the intended charging pressure has been reached.

A pressure regulator is to be used per UL-2166.

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 proper cylinder pressure (1800 PSIG @ 70°F [124 bar gauge @ 21°C]) or until the mass of nitrogen reaches the number referenced in Table 6-9.

Table 6-9. Nitrogen Fill Weights

Part Number	Description	Fill Weight (lb.) Nominal
90-101040-000	1040 cu. in. nitrogen cylinder	5.7
90-102300-100	2300 cu. in. nitrogen cylinder	12.2

6. Allow the cylinder to cool to ambient temperature and recheck nitrogen cylinder indicated pressure.
7. Open valve and add additional nitrogen as needed to obtain full cylinder charge at ambient temperature (1800 PSIG @ 70°F [124 bar gauge @ 21°C]).
8. Close the valve and remove the supply hose and charging adapter from the nitrogen pilot cylinder.
9. Check the nitrogen cylinder valve for leakage using a soap solution. Bubbles appearing in the soap solution indicate leakage and shall be cause for rejection of cylinder.
10. After the leak test is completed, 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 directed in Paragraph 5-8.

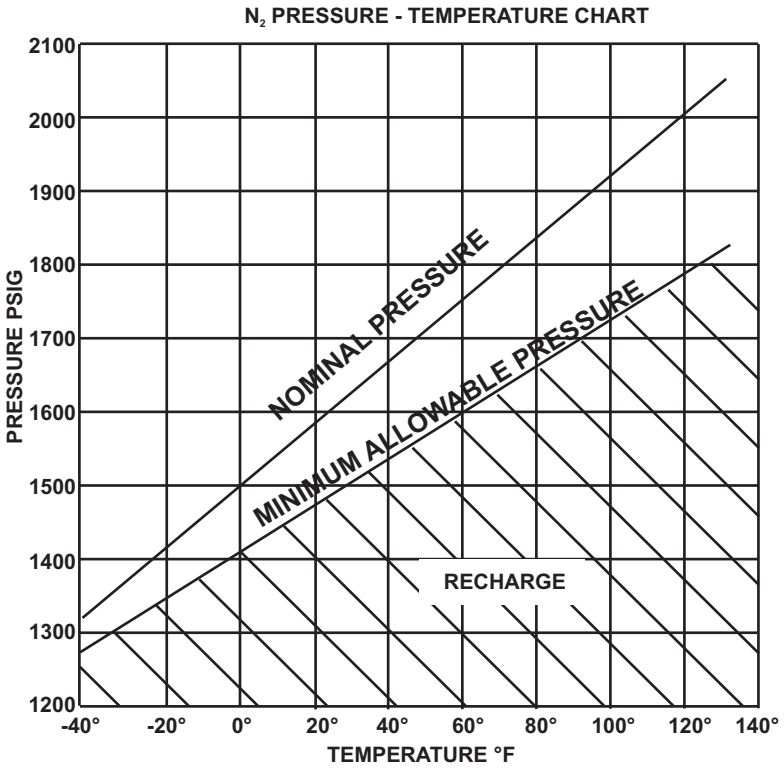

Figure 6-7. Nitrogen Temperature vs. Pressure Data

6-5.4 Nitrogen Cylinder I-Valve Inspection and Services

Inspect and service the Nitrogen I-Valve as follows:

Note: After every discharge, certain components in the Nitrogen I-Valve assembly will have to be serviced and inspected before recharging the Cylinder/Valve Assembly. Part numbers for items which may require replacement are listed in Table 6-10.

6-5.4.1 VALVE DISASSEMBLY

Note: Refer to Figure 6-8 and Table 6-10.

WARNING Before disassembly of valve, relieve all pressure from the cylinder. Contents under pressure can cause personal injury or property damage.

1. Remove valve seat (P/N 202490).
2. Remove copper sealing gasket (P/N 32642).
3. Remove main check assembly and spring (P/Ns 800760 and 32641).
4. Remove sleeve retainer, brass sleeve and pilot check assembly (P/Ns 202804, 202805 and 923066 respectively).
5. Examine rubber portions of main check and pilot check assemblies. If any nicks, chips or dirt is found, the checks should be replaced with new parts before the cylinder and valve assembly is recharged.

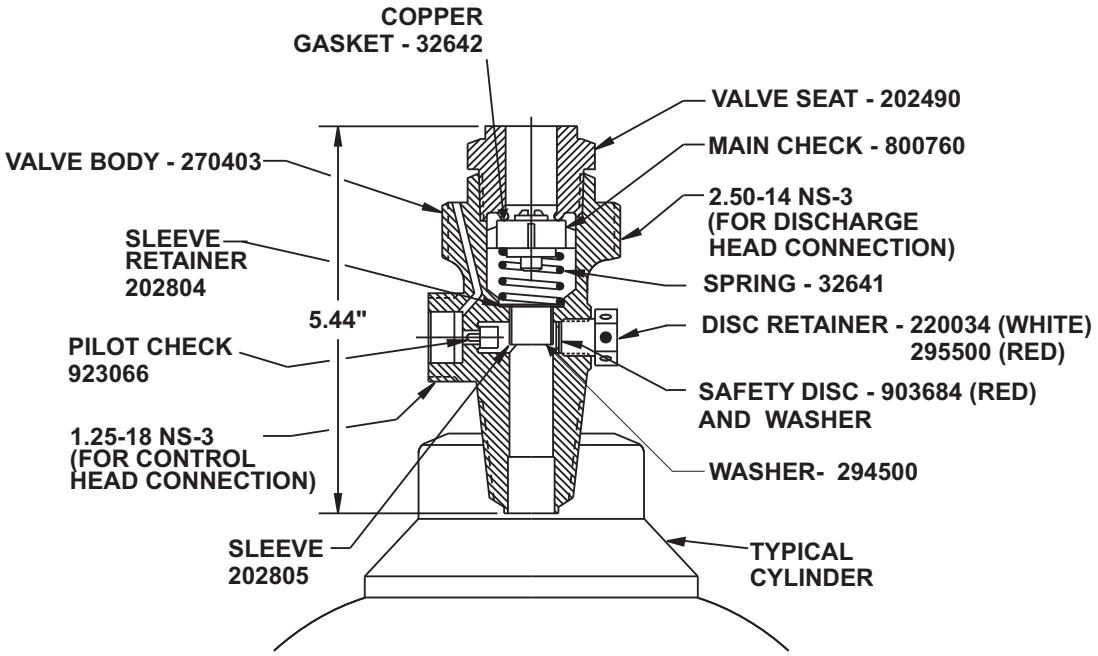

Figure 6-8. 5/8-inch I-Valve for Nitrogen Cylinder

Table 6-10. I-Valve Components

Part Number	Description	Quantity
923066	Pilot Check Assembly	1
202805	Brass Sleeve	1
202804	Sleeve Retainer	1
32641	Spring	1
800760	Main Check Assembly-5/8 in. I-Valve	1
32642	Copper Gasket	1
202490	Valve Seat	1
368200	Safety Disc (White for 2300 cu. in. driver)	1
294500	Washer	1

6-5.4.2 NITROGEN CYLINDER I-VALVE ASSEMBLY

After each part has been thoroughly inspected, assemble the valve in the following order:

1. Pilot Check Assembly.
2. Brass Sleeve.
3. Sleeve Retainer.
4. Spring.

Note: The main check assembly is installed with the rubber seat facing up. The copper sealing gasket MUST be replaced when the valve seat is removed. Refer to Figure 6-8.

5. Main Check Assembly.
6. New Copper Gasket (rounded side up). Apply a lubricant to the gasket before replacing.
7. Valve Seat. Torque to 150 ± 15 ft. lb. (203 ± 20 N-m).

6-5.4.3 SAFETY DISC REPLACEMENT

1. Remove the safety disc retainer, along with the safety disc and safety disc washer from the valve body.
2. Assemble the safety disc retainer, the new safety disc and the new safety disc washer to the valve body. Refer to Table 6-11 for torque valves.

WARNING

Never install any type disc other than the specified compliment for the cylinder. Installing the incorrect disc could result in violent rupture of the cylinder causing serious personal 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 parts.

Table 6-11. Safety Disc Replacements for the I-Valve

Nitrogen Cylinder	Safety Disc and Washer P/N	Safety Disc Retainer Nut P/N	Torque Value	PSIG @ 70°F
90-102300-100	902048 (white)	220034	350 ± 35 in. lb.	2900-3250
90-101040-000	902048 (white)	220034	350 ± 35 in. lb.	2900-3250

6-5.4.4 DISCHARGE HEAD INSPECTION AND SERVICE

Note: After every discharge, certain components in the Discharge Head Assembly MUST be inspected and serviced before recommissioning the Nitrogen Cylinder. Part numbers for the items which may require replacement are listed in Table 6-12.

1. Remove top cap using a suitable wrench.
2. Inspect packing o-ring (P/N 209180). Replace if o-ring shows any sign of damage or deterioration.
3. Lubricate packing o-ring (P/N 209180) and reinstall top cap. Tighten to 25 to 50 ft. lb. (35 to 70 N-m).
4. Examine inner and outer packing o-ring (P/N 242466 and 242467 respectively) located concentrically on the bottom of the discharge head body.
5. Apply lubricant to both o-rings prior to attaching to I-valve (refer to Table 6-2 for lubricant recommendations).

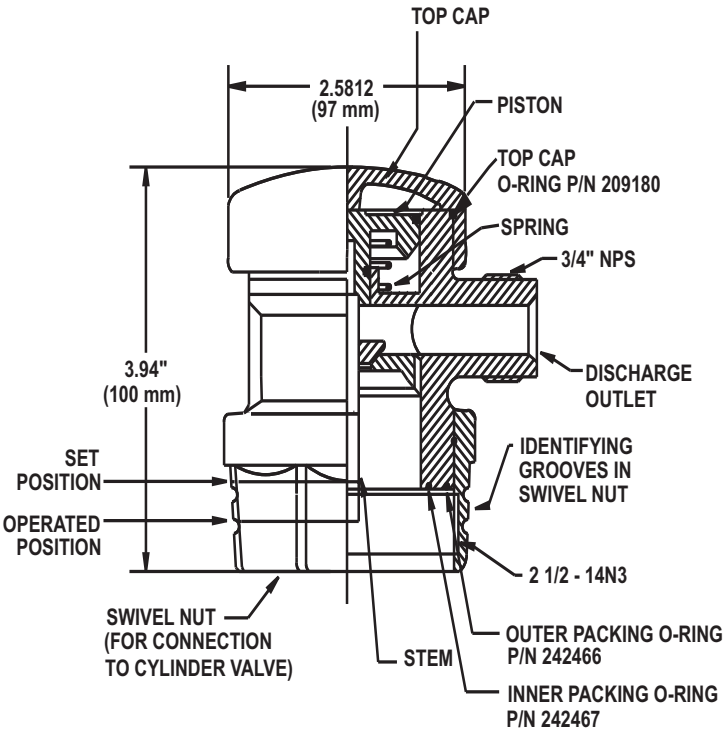

Figure 6-9. Discharge Head (Grooved Nut Shown)

Table 6-12. Discharge Head O-Ring Part Numbers

Part Number	Description	Quantity
242466	Outer Packing O-Ring	1
242467	Inner Packing O-Ring	1
209180	Packing O-ring, Top Cap	1

6-6 CO_2 PILOT CYLINDER SERVICE AND MAINTENANCE

6-6.1 Inspection and Test of CO_2 Cylinder Assemblies

6-6.1.1 CO_2 CYLINDER INSPECTION AND TEST GUIDELINES

CAUTION These guidelines do not apply to cylinders containing commodities other than CO_2.

All Kidde Fire Systems CO_2 cylinders are designed, fabricated and factory tested to comply with DOT CFR 49 Regulations 2A-2015, 3AA-1800 or 3AA-2300, as stamped on each cylinder.

CO_2 cylinders must be hydrostatically tested and marked in accordance with DOT 49 CFR 173.301 through 173.308 and 49 CFR 173.34, Ref. 46 CFR 147.65.

1. Any cylinder which has been discharged or removed from the vessel subsequent to five (5) years from the date of the last hydrostatic test, as indicated by the marking on the cylinder shoulder, must be emptied, retested and remarked.
2. A cylinder continuously in place on board a vessel for a period of time exceeding five (5) years must, after twelve (12) years have elapsed from the date of the previous test and marking, be removed from the vessel, its contents discharged, and the cylinder retested and remarked.
3. A cylinder must also be hydrostatic tested and remarked immediately if the cylinder shows evidence of distortion, damage, cracks, corrosion, or mechanical damage. Any cylinder failing the hydrostatic pressure test must be destroyed.

6-6.1.2 INSPECTION AND SERVICE OF I-VALVE

Inspect and service the CO_2 I-Valve as follows:

Note: After every discharge, certain components of the I-Valve assembly must be inspected and serviced before recharging and subsequent recommissioning. Refer to Table 6-13 for a full list of service parts.

6-6.1.2.1 I-Valve Disassembly

WARNING Before attempting to service the valve, ensure that the cylinder is empty and any remaining pressure is released. Contents under pressure can cause personal injury or property damage.

1. Remove valve seat (P/N 202490).
2. Remove sealing gasket (P/N 32642).
3. Remove main check assembly and spring (P/N 932636 and 32641).
4. Remove sleeve retainer, brass sleeve and pilot check assembly (P/N 202804, 202805 and 923066 respectively).
5. Examine rubber seal face of the main check and pilot check assemblies. If any dirt, asymmetric deformation or damage is found, the affected assembly must be replaced prior to recharge.

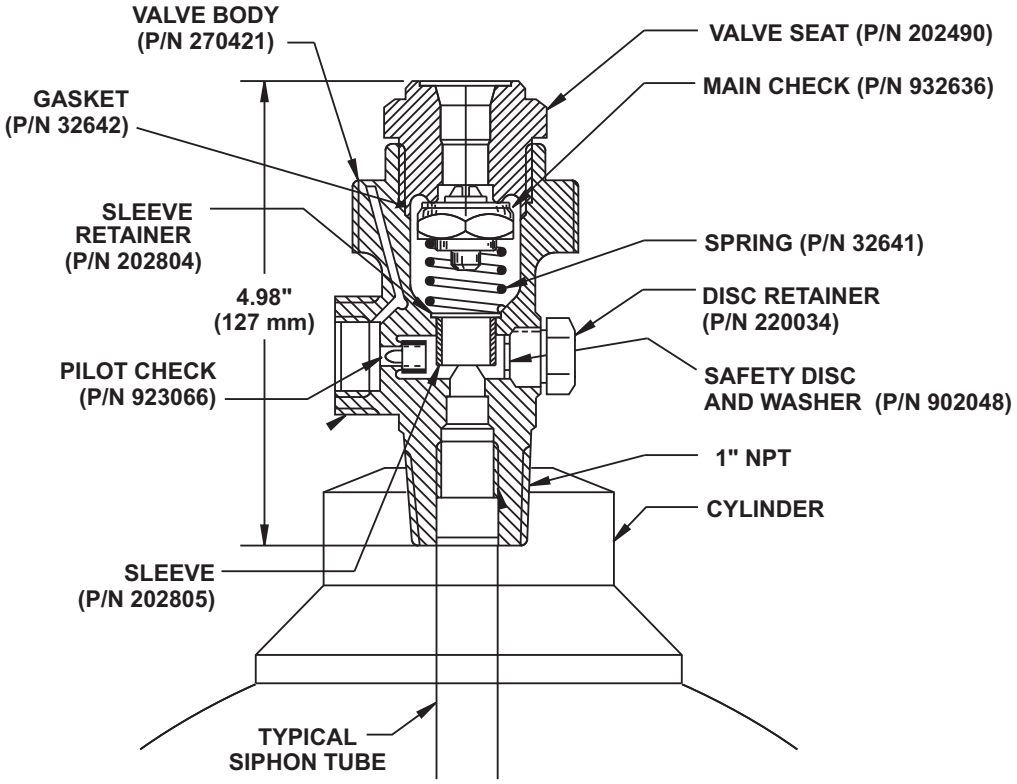

Figure 6-10. Type “I” Cylinder Valve, 1/2 in.

6-6.1.2.2 Valve Reassembly

After thorough inspection and replacement as necessary, assemble the valve in the following order:

1. Pilot Check Assembly
2. Brass Sleeve
3. Sleeve Retainer
4. Spring

5. Main Check Assembly
6. Copper Gasket. Apply a lubricant to the gasket before replacing.

Note: The main check assembly is installed with the rubber seat facing up (with the valve in installed orientation). The copper sealing gasket MUST be replaced if the valve seat is removed.

Table 6-13. I-Valve Components

Part Number	Description	Quantity
Note: 981372	Complete 1/2 in. Valve Assembly	1
923066	Pilot Check	1
202805	Brass Sleeve	1
202804	Sleeve Retainer	1
32641	Spring	1
932636	Main Check (1/2 in.)	1
32642	Copper Gasket	1
202490	Valve Seat	1
902048	Safety Disc and Washer	1

6-6.1.2.3 Safety Disc Replacement

1. Remove the safety disc retainer, along with the safety disc and washer from the valve body.
2. Assemble the safety disc retainer, the new safety disc and the new safety disc washer to the valve body. Torque the fitting to 26 to 32 ft. lb. (36.4 to 44.8 N-m).

WARNING

Never install any type of disc, washer or retainer other than the factory specified components. Installing the incorrect components could result in violent and unexpected rupture of the cylinder, which could cause serious personal injury or death.

Never reuse a safety disc and/or washer. If the assembly has been discharged or the retainer removed, replace both parts.

6-6.1.3 INSPECTION AND SERVICE OF PLAIN NUT DISCHARGE HEAD

Note: Following discharge, the Discharge Head Assembly must be inspected and serviced before the system is recommissioned.

1. Remove the discharge head from the cylinder and then from the flexible discharge hose.
2. Examine the inner and outer o-ring seals (located on the bottom sealing face inside the main nut).
3. Replace if the o-rings show any sign of damage, distortion or deterioration (see Figure 6-11).
4. Apply lubricant to both o-rings prior to attachment to the valve.

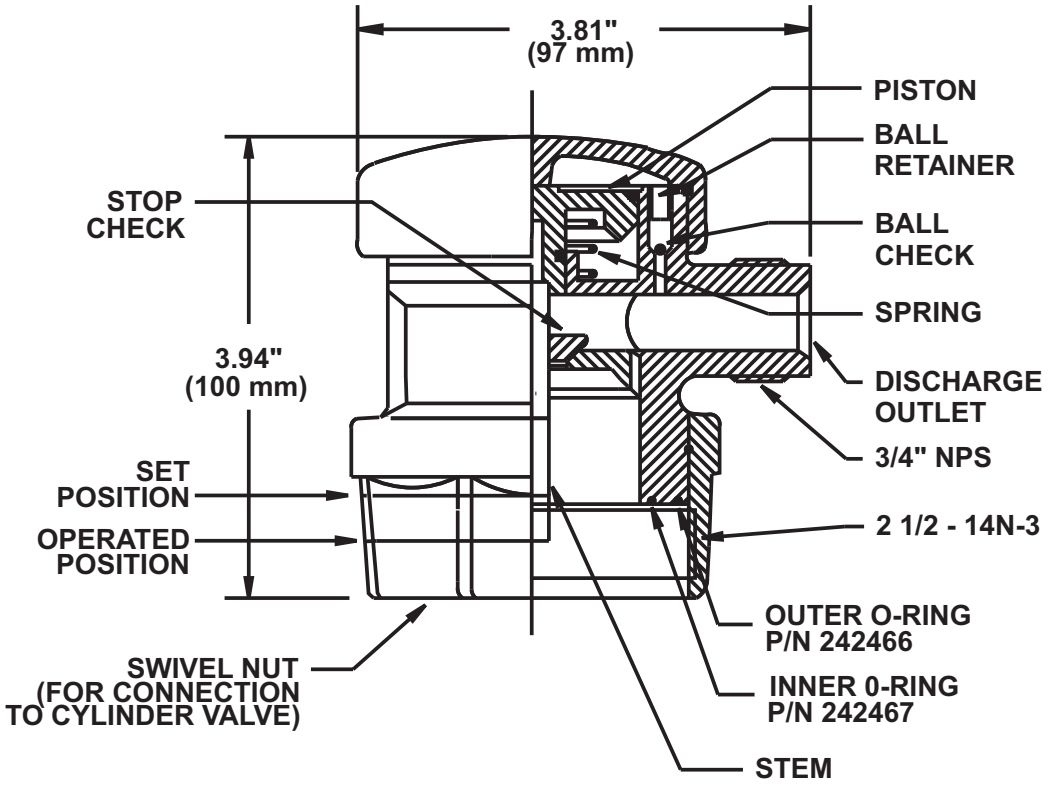

Figure 6-11. Discharge Head, Plain Nut

6-6.2 Recharging CO_2 Pilot Cylinders

CO_2 cylinders must not be recharged without a retest if more than five (5) years have elapsed since the last test. Retest shall be in accordance with the requirements of 49 CFR, Paragraph 173.301 through 173.308 and 173.324. After retest, cylinder must be thoroughly dried and free of any water vapor (see Figure 6-12).

WARNING

Under no circumstances while performing either cylinder recharge or leak test should a carbon dioxide cylinder have a discharge head or control head attached to the cylinder valve. When removing carbon dioxide cylinders, observe the following:

1. Each cylinder is factory equipped with a valve protection cap threaded securely over the valve assembly. This cap is a safety device which protects the valve from damage during cylinder handling.
2. This device must be installed at all times, except when the cylinder is connected into the system piping or being filled.
3. The valve protection cap must be stored in a secure space and made readily available for use. Never move or handle the cylinder without the cap installed.

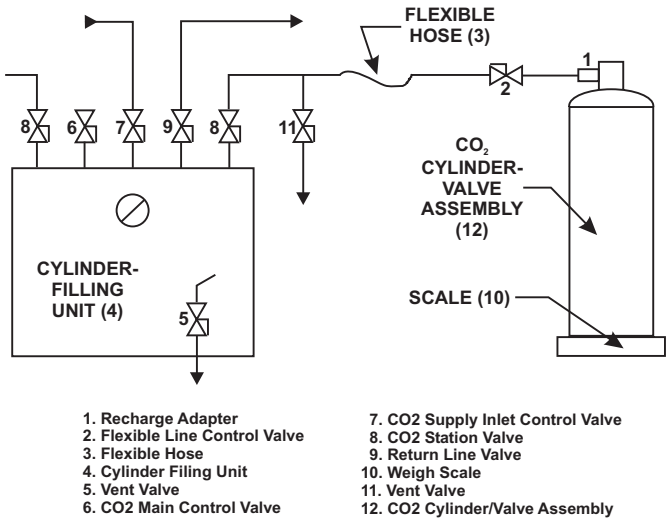

Figure 6-12. Typical Carbon Dioxide Recharge Schematic

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; before 9/01)	90-100600-001
600 lb. w/LLI (old style; before 9/01)	90-100601-001
600 lb. STD (new style; after 9/01)	90-100600-100
600 lb. w/LLI (new style; after 9/01)	90-100601-100
900 lb. STD	90-100900-001
900 lb. w/LLI	90-100901-001
Note: (STD=Standard Cylinder Assembly, w/LLI=cylinder with a liquid level indicator)	
Flexible Discharge Hoses	
10-125 lb. Cylinders	283898
200-350 lb. Cylinders	283899
600 lb. Cylinders (old style; before 9/01)	283900
600 lb. Cylinders (new style; after 9/01)	06-118225-001
900 lb. Cylinders	06-118225-001
Valve Outlet Adapters	
10-125 lb. Cylinders	283904

Table 7-1. Parts List (Continued)

Nomenclature	Part Number
200-350 lb. Cylinders	283905
600 lb. Cylinders (old style; before 9/01)	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
Cradles	
125 lb. and 200 lb. (old style cylinder; before 3/98)	292938
125 lb. and 200 lb. (new style cylinder; after 3/98)	235431
350 lb.	281867
600 lb.	294652
900 lb.	06-118300-001
Brackets, Wall Mounting	
10 lb.	486485
20 lb.	486486
40 lb.	486487
70 lb.	486488
Front Clamps (Side-by-Side Clamp)	
125 lb. and 200 lb.	235432
200 lb.	293457
350 lb.	281868
600 lb.	294653
Control Heads	
Pneumatic 3 in. (5 sec.)	872335
Pneumatic 6 in. (5 sec.)	872365
Pneumatic 6 in. (2 sec.)	872362
Pneumatic 3 in. (Tandem)	872330
Pneumatic 6 in. (Tandem)	872360
Lever Operated	870652
Pressure Operated	878737
Pressure Operated, Stackable	878750
Lever/Pressure Operated	878751
Cable Operated	979469

Table 7-1. Parts List (Continued)

Nomenclature	Part Number
Pressure Control Equipment	
Master Cylinder Adapter Kit	844895
Male Branch Tee, 5/16 in. Flare x 1/8 in. NPT	6992-0505
Male Elbow, 5/16 in. Flare x 1/8 in. NPT	6992-0503
Male Connector, 5/16 in. Flare x 1/8 in. NPT	6992-0501
Actuation Hose, 22 in. (10 to 200 lb. Cylinder)	264987
Actuation Hose, 30 in. (350 to 900 lb. Cylinder)	264986
Nitrogen Pilot Cylinder	877940
	WK-877940-200
Mounting Bracket, Nitrogen Pilot Cylinder	877845
1040 cu. in. Nitrogen Cylinder (Pilot, Siren Driver)	90-101040-000
	90-101040-200
2300 cu. in. Nitrogen Siren Driver Cylinder	90-102300-100
	90-102300-200
Pressure Operated Siren	90-981574-001
Nitrogen Time Delay for use with 108 cu. in. Pilot Cylinder (nom. 34 sec. delay)	81-871072-001
Nitrogen Time Delay for use with 108 cu. in. Pilot Cylinder (nom. 61 sec. delay)	81-871072-002
Nitrogen Time Delay for use with 1040 cu. in. Pilot Cylinder (nom. 35 sec. delay)	81-871072-003
Nitrogen Time Delay for use with 1040 cu. in. Pilot Cylinder (nom. 68 sec. delay)	81-871072-004
Flexible Nitrogen Discharge Hose, 14.75 in. long, 3/4 in. NPT	06-118207-002
Flexible Nitrogen Discharge Hose, 18.00 in. long, 3/4 in. NPT	06-118207-001
Heavy-Duty Actuation Hose, Stainless Steel 34.00 in. long	06-236215-001
Dual-Loop Fitting Kit	06-129978-001
Fitting: 1/4 in. NPT M x 1/8 in. NPT F	06-118318-001
Fitting: 4-Way 1/4 in. NPT F	06-118319-001
Fitting: 1/4 in. NPT M x 1/4 in. NPT M	06-118320-001
Fitting: 1/8 in. NPT M x 1/8 in. NPT M	06-118321-001
Fitting: 1/8 in. NPT M x 7/16 in. SAE Flare	06-118191-001
Bleed: 1/8 in. NPT M x 7/16 in. SAE Flare	WK-263303-000
Bleed Cap: 7/16 in. SAE Flare	WK-263304-000
Safety Outlet, FM-200	844346
Safety Outlet, Nitrogen/Carbon Dioxide	803242
Nitrogen Actuation Circuit Vent	284051
Supervisory Switch-In-Gauge	06-118328-001
Remote Control Equipment, Cable Operated	
Pull Box, Break Glass	871403
Corner Pulley, Watertight	803808
1/16 in. Cable	1593-0002

Table 7-1. Parts List (Continued)

Nomenclature	Part Number
Z-Bracket	60532
Adapter, 1/2 in. EMT	843837
Dual Pull Equalizer	840051
Dual Pull Mechanism	840058
Cable Pull Station, Watertight	870087
Cable Pull Station, Yacht Type	840098
Pneumatic Control Equipment	
Pneumatic Heat Detector	841241
Pneumatic Tubing, 3/16 in. (17 in.)	802366
Pneumatic Tubing, 3/16 in. (36 in.)	820587
Pneumatic Tubing, 3/16 in. (46 in.)	802367
Pneumatic Tubing, 3/16 in. (12 ft.)	802486
Tubing Nut, 3/16 in.	5271-0300
3 x 16 in. Union, without Nuts	5281-0360
3/16 in. x 1/8 in. Reducing Union	802536
3/16 in. Tee without Nuts	5281-0370
Ancillary Equipment	
Supervisory Pressure Switch (10 to 350 lb. Cylinders)	06-118262-001
Supervisory Pressure Switch (600 to 900 lb. Cylinders)	06-118263-001
Pressure Operated Switch, Standard	486536
Pressure Operated Switch, Explosion Proof	981332
Pressure Trip	874290
Discharge Indicator, 3/4 in. (Brass)	967082
Carbon Dioxide Actuation Equipment (refer to 90-FM200M-021, Version 1, May 1998)	
50 lb. (Pilot) CO_2 Cylinder	982548
3/4 in. CO_2 Discharge Hose	251821
CO_2 Time Delay, 30 second	897567
CO_2 Time Delay, 60 second	897636
Manifold “Y” Fitting	207877
Plain Nut Discharge Head	872450
Strap, Single 50 lb. Cylinder	270014
Strap, Twin 50 lb. Cylinder	241219
Check Valves	
Check Valve, 1/4 in. NPT	264985
Check Valve, 3/8 in. NPT	261193
Check Valve, 1/2 in. NPT	800327
Check Valve, 3/4 in. NPT	800266
Check Valve, 1 in. NPT	800443

Table 7-1. Parts List (Continued)

Nomenclature	Part Number
Check Valve, 1 1/4 in. NPT	800444
Check Valve, 1 1/2 in. NPT	870152
Check Valve, 2 in. NPT	870151
Check Valve, 2 1/2 in. NPT	263716
Check Valve, 3 in. NPT	870100
Swing Check Valve, 2 in. NPT	06-118213-001
Swing Check Valve, 3 in. NPT	06-118058-001
Manifold El-Check Valve, 2 in. NPT	877690
Manifold El-Check Valve, 2 1/2 in. NPT	878743
Stop Valves	
Stop Valve, 1/2 in. NPT	870023
Stop Valve, 3/4 in. NPT	870022
Stop Valve, 1 in. NPT	870122
Stop Valve, 1 1/4 in. NPT	870032
Stop Valve, 1 1/2 in. NPT	870123
Stop Valve, 2 in. NPT	870049
Stop Valve, 2 1/2 and 3 in.	870123
Stop Valve, 4 in. Flanged	890208
Cylinder Recharge Adapters	
Cylinder Size: 10 to 125 lb.	878757
Cylinder Size: 200 and 350 lb.	878758
Cylinder Size: 600 lb. (old style)	878759
Name Plate	
“Main”	31033
“Reserve”	31034
“Warning FM-200”	06-231865-739
“Vacate at once”	218270
“CO_2 Warning”	206561

7-2 DISCHARGE NOZZLES

WARNING Only listed Kidde FM-200 nozzles are to be used on Kidde Marine 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".

Table 7-2. UL Listed 360 Degree Nozzles

Area ($in.^2$)	UL Listed 360 Degree Nozzles					
	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. 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			

Table 7-2 (continued). UL Listed 360 Degree Nozzles

Area ($in.^2$)	UL Listed 360 Degree Nozzles (continued)					
	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
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		
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

Table 7-2 (continued). UL Listed 360 Degree Nozzles

Area ($in.^2$)	UL Listed 360 Degree Nozzles (continued)					
	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
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”.

Table 7-3. UL Listed 180 Degree Nozzles

Area ($in.^2$)	UL Listed 180 Degree Nozzles					
	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. 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			

Table 7-3 (continued). UL Listed 180 Degree Nozzles

Area ($in.^2$)	UL Listed 180 Degree Nozzles (continued)					
	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
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	
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

Table 7-3 (continued). UL Listed 180 Degree Nozzles

Area ($in.^2$)	UL Listed 180 Degree Nozzles (continued)					
	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
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.

APPENDIX A

MATERIAL SAFETY DATASHEETS

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

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.

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.

Praxair MSDSs are furnished on sale or delivery by Praxair or the independent distributors and suppliers who package and sell our products. To obtain current Praxair MSDSs for these products, contact your Praxair sales representative or local distributor or supplier. If you have questions regarding Praxair MSDSs, would like the form number and date of the latest MSDS, or would like the names of the Praxair suppliers in your area, phone or write the Praxair Call Center (**Phone:** 1-800-PRAXAIR; **Address:** Praxair Call Center, Praxair, Inc., PO Box 44, Tonawanda, NY 14151-0044).

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

Printed in USA

APPENDIX B

USCG CERTIFICATE

U. S. Department of Homeland Security
United States Coast Guard
Certificate of Approval

Coast Guard Approval Number: 162.161/1/0 Expires: 31 March 2013

ENGINEERED HALOCARBON FIRE EXT. SYSTEM

KIDDE-FENWAL INC.
400 MAIN STREET
ASHLAND MA 01721

Kidde-Fenwal FM-200 Marine ECS Series Engineered Fixed Fire Extinguishing System.

Total flooding clean agent fire extinguishing system for the protection of machinery spaces, cargo pump rooms, and other enclosed spaces with flammable liquid hazards. Acceptable for use as an equivalent to total flooding carbon dioxide systems required by 46 CFR. Complies with IMO MSC/Circ.848. Not acceptable for cargo hold protection.

Identifying Data: Underwriters Laboratories, Inc. Report Project 02NK28507, File EX 4674, dated 15 November 2002, Kidde-Fenwal Marine Design, Installation, Operation, and Maintenance Manual 90-FM200M-021 dated March 2008, Kidde-Fenwal Flow Calculation Software Manual 90-FM200-100, and USCG letters dated 31 December 2002, 8 November 2007, 18 December 2007, 1 February 2008, and 31 March 2008.

Must be in accordance with Manual P/N 90-FM200M-021 dated March 2008.

Follow-up Program: UL

Approval valid only for equipment manufactured at the above location.

Extends Appr. No. 162.161/1/0 dated 1 February 2008, and reflects revised instruction manual.

*** END ***

THIS IS TO CERTIFY THAT the above named manufacturer has submitted to the undersigned satisfactory evidence that the item specified herein complies with the applicable laws and regulations as outlined on the reverse side of this Certificate, and approval is hereby given. This approval shall be in effect until the expiration date hereon unless sooner canceled or suspended by proper authority.

GIVEN UNDER MY HAND THIS 31ST DAY OF MARCH 2008, AT WASHINGTON D.C.

K. J. HEINZ
Chief, Lifesaving and Fire Safety Division
BY DIRECTION OF THE COMMANDANT

TERMS: The approval of the item described on the face of the Certificate has been based upon the submittal of satisfactory evidence that the item complies with the applicable provisions of the navigation and shipping laws and the applicable regulations in Title 33 and/or Title 46 of the Code of Federal Regulations. The approval is subject to any conditions noted on this Certificate and in the applicable laws and regulations governing the use of the item on vessels subject to Coast Guard inspection or on other vessels and boats.

Consideration will be given to an extension of this approval provided application is made 3 months prior to the expiration date of this Certificate.

The approval holder is responsible for making sure that the required inspections or tests of materials or devices covered by this approval are carried out during production as prescribed in the applicable regulations.

The approval of the item covered by this certificate is valid only so long as the item is manufactured in conformance with the details of the approved drawings, specifications, or other data referred to. No modification in the approved design, construction, or materials is to be adopted until the modification has been presented for consideration by the Commandant and confirmation received that the proposed alteration is acceptable.

NOTICE: Where a manufacturer of safety-at-sea equipment is offering for sale to the maritime industry, directly or indirectly, equipment represented to be approved, which fails to conform with either the design details or material specifications, or both, as approved by the Coast Guard, immediate action may be taken to invoke the various penalties and sanctions provided by law including prosecution under 46 U.S.C. 3318, which provides:

"A person that knowingly manufactures, sells, offers for sale, or possesses with intent to sell, any equipment subject to this part *(Part B. of Subtitle II of Title 46 U.S.C.).* and the equipment is so defective as to be insufficient to accomplish the purpose for which it is intended, shall be fined not more than $10,000, imprisoned for not more than 5 years or both."

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APPENDIX C

TYPICAL SYSTEM LAYOUTS

C-1 CYLINDERS LOCATED OUTSIDE THE PROTECTED SPACE

The material in this section is intended to illustrate a typical system and includes the drawings and flow calculation reports that would form part of the system documentation package.

Note: This form is a sample only and need not be followed exactly in order to comply with Approval requirements.

In the following example, the agent cylinders are located outside the protected space. This is typical of small to medium sized vessels.

BILL OF MATERIALS

NO.	DESCRIPTION	QTY	PART NO.
1	600# FM-200 CYLINDER W/ LLI, FILLED TO 449#	2	90-100601-100
2	CYLINDER STRAP	4	294651
3	CYLINDER CRADLE	4	294652
4	3" SWING CHECK	2	06-118058-001
5	PULL BOX, SURFACE, 3/8" PIPE (BREAK GLASS)	2	871403
6	CORNER PULLEY, 3/8" PIPE (WATERTIGHT)	30	60532
7	1/16" CABLE, 100 FT ROLL	2	06-118316-100
8	CABLE OPERATED CONTROL HEAD	2	979469
9	NITROGEN PILOT CYLINDER, 108 CU.IN., NO PRESS SWITCH	2	877940
10	MOUNTING BRACKET, NITROGEN PILOT CYLINDER	2	877845
11	MALE CONNECTOR, 5/16" FLARE x 1/8" NPT	8	69920501
12	ACTUATION HOSE, 30"	5	264986
13	SAFETY OUTLET (N2 & CO2)	1	803242
14	1/2" STOP VALVE	1	870023
15	PRESSURE OPERATED SWITCH	1	486536
16	NITROGEN TIME DELAY (108 CU.IN. PILOT, 34 S DELAY)	1	81-871072-001
17	LEVER OPERATED CONTROL HEAD	1	870652
18	LEVER AND PRESSURE OPERATED CONTROL HEAD	2	878751
19	MALE ELBOW, 5/16" FLARE x 1/8" NPT	1	69920503
20	MASTER CYLINDER ADAPTER KIT	1	844895
21	PRESSURE OPERATED CONTROL HEAD	1	878737
22	180° FM-200 DISCHARGE NOZZLE, 1-1/4" NPT, 0.7254	1	90-194016-332
23	360° FM-200 DISCHARGE NOZZLE, 2" NPT, 1.3806	4	90-194028-469
24	360° FM-200 DISCHARGE NOZZLE, 2" NPT, 1.5708	1	90-194028-500
25	SIREN NITROGEN PRESSURE OPERATED	1	90-981574-001

FM-200 SYSTEM DATA

HAZARD INFORMATION

HAZARD: TUGBOAT
FIRE TYPE: CLASS B - DIESEL
CONSTRUCTION: STEEL
DESCRIPTION: UPPER AND LOWER ENGINE ROOM

SYSTEM INFORMATION

SYSTEM: MANIFOLDED SYSTEM
MAIN ONLY SYSTEM
CONTAINER: 600-LB CYLINDER W/ 3" VALVE AND LLI
QTY: 2 P/N: 90-100601-100 FILL WEIGHT: 450 LBS.
NOZZLES: SEE PLANS & NOZZLE CHART FOR TYPE, SIZE, LOCATION, AND PART NUMBER

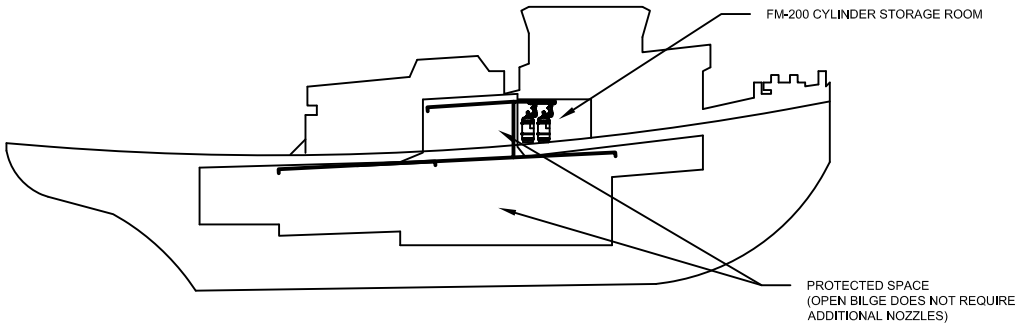
ENCLOSURE INFORMATION

ENCLOSURE: FIDLEY / UPPER ENGINE ROOM

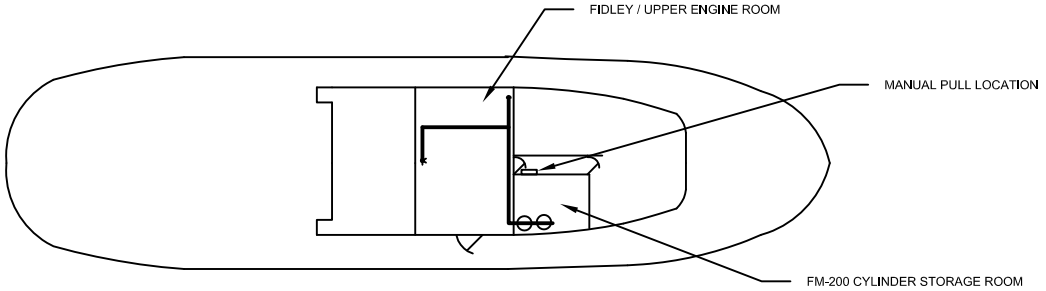
AREA:	N/A SQ.FT.	MIN. TEMP:	32 °F
HEIGHT:	N/A FT.	MAX. TEMP:	130 °F
VOLUME:	1,950 CU.FT.	MIN. AGENT REQ'D:	91.5 LBS.
DESIGN CONC.:	8.7 %	AGENT SUPPLIED:	91.7 LBS.

ENCLOSURE: LOWER ENGINE ROOM

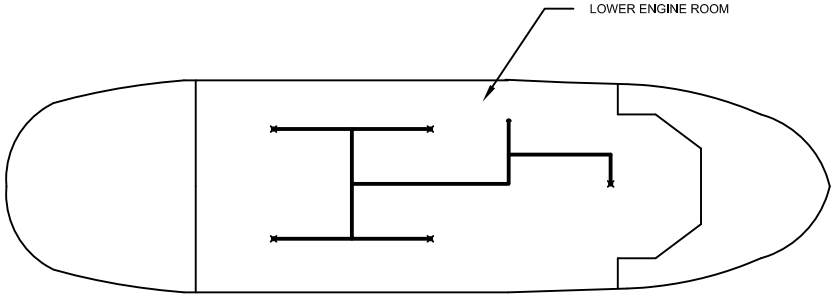
AREA:	N/A SQ.FT.	MIN. TEMP:	32 °F
HEIGHT:	N/A FT.	MAX. TEMP:	130 °F
VOLUME:	17,100 CU.FT.	MIN. AGENT REQ'D:	801.9 LBS.
DESIGN CONC.:	8.7 %	AGENT SUPPLIED:	806.2 LBS.



ELEVATION VIEW
NOT TO SCALE



PLAN VIEW - FIDLEY / UPPER ENGINE ROOM
NOT TO SCALE



PLAN VIEW - LOWER ENGINE ROOM
NOT TO SCALE

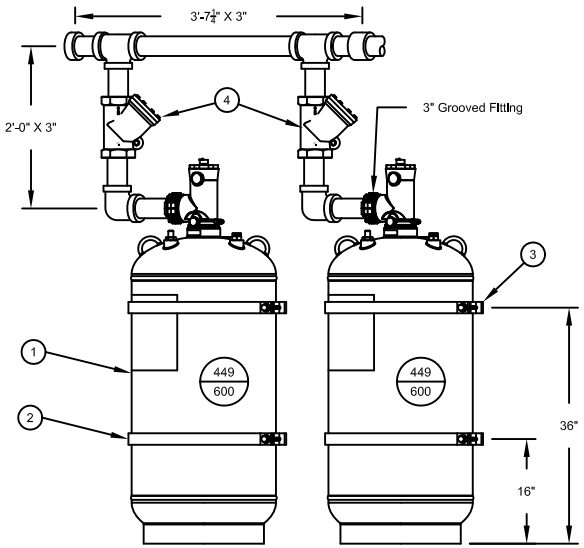
NOTE: THE SYSTEM SHOWN IN THIS DRAWING IS AN EXAMPLE ONLY AND IS NOT INTENDED TO PRECLUDE OTHER SYSTEM CONFIGURATIONS SHOWN IN THE USCG APPROVED MANUAL.

Kidde
FIRE SYSTEMS
400 MAIN STREET
ASHLAND, MA 01721

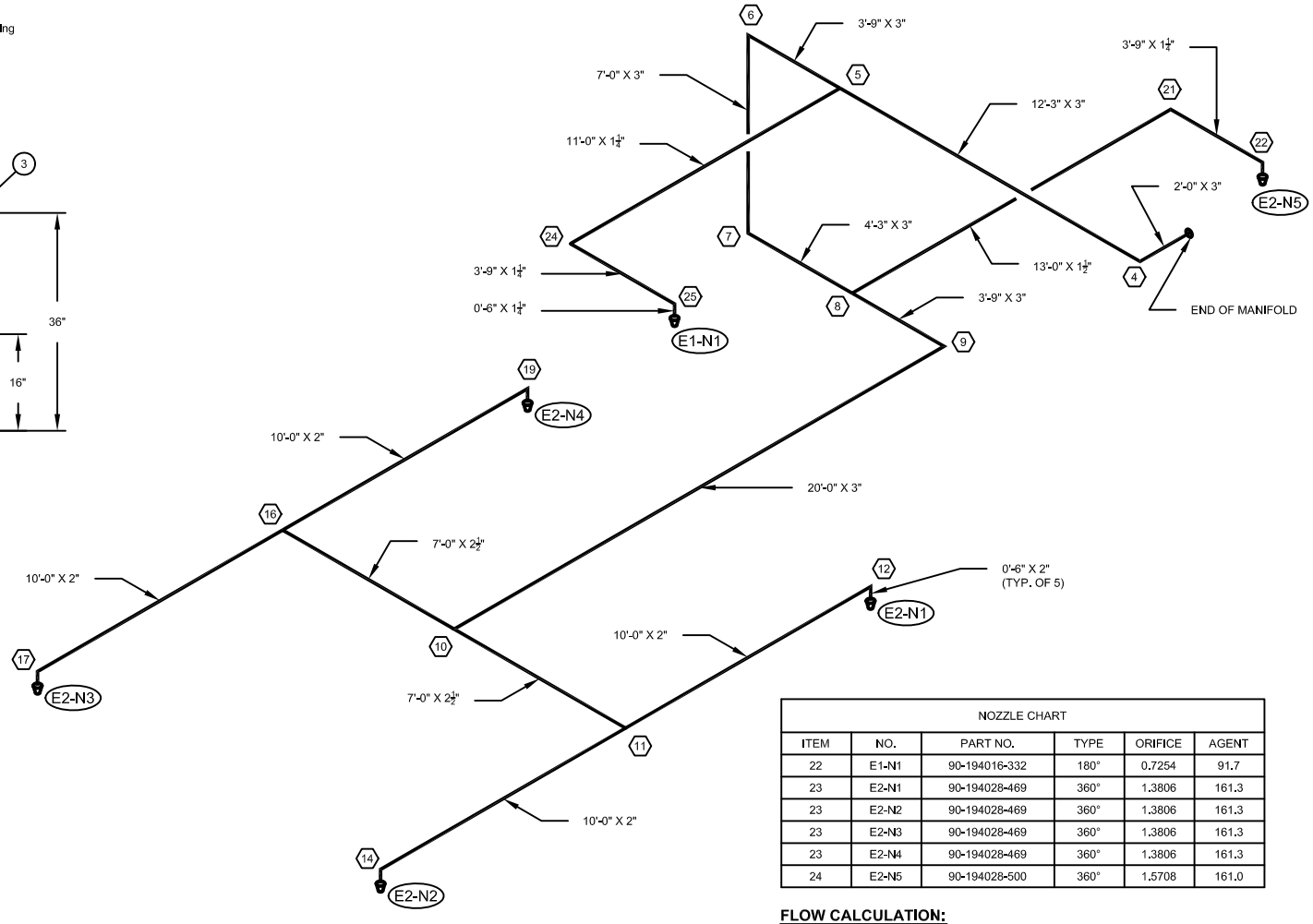
MANUAL P/N 90-FM200M-021

TYPICAL FM-200 SYSTEM WITH CYLINDERS OUTSIDE THE PROTECTED SPACE - FOR U.S.C.G. APPROVAL

DRN: BDC 01MAY03	SIZE	DWG. NO.	REV
CHK'D:	A	LI-2464013-I	A
ISSUED:			
SCALE: NOTED	UNITS: FEET-INCHES	SHEET: 1 OF 3	



CYLINDER MANIFOLD SETUP



FM-200 MECHANICAL NOTES

1. FOR INSTALLATION REQUIREMENTS, REFER TO NFPA 2001 AND THE KIDDE FIRE SYSTEMS DESIGN, INSTALLATION, OPERATION AND MAINTENANCE MANUAL.
2. GALVANIZED PIPE SHALL CONFORM TO ASTM A-53 CLASS F, ASTM A-53 ERW GRADES A OR B, OR ASTM A-106 SEAMLESS GRADES A, B OR C. ALL PIPE SHALL BE SCHEDULE 40 MINIMUM. FITTINGS SHALL BE CLASS 300 MALLEABLE OR DUCTILE IRON FOR SIZES UP TO AND INCLUDING 3" AND 1000-LB RATED DUCTILE IRON OR FORGED STEEL FITTINGS FOR ALL LARGER SIZES. ALL FLANGED JOINTS SHALL BE CLASS 300. ALL GROOVED FITTINGS AND COUPLINGS SHALL BE 500-LB RATED AND LISTED. GROOVED COUPLINGS SHALL BE VICTAULIC STYLE 07, STYLE 77, OR EQUIVALENT
3. ALL PIPE SIZE REDUCTIONS MUST BE MADE USING CONCENTRIC REDUCING COUPLINGS OR REDUCING TEES. BUSHINGS SHALL NOT BE USED.
4. ALL PIPE SHALL BE REAMED AND CLEANED PRIOR TO ASSEMBLY, AND AFTER ASSEMBLY THE ENTIRE PIPING SYSTEM SHALL BE BLOWN OUT USING NITROGEN OR COMPRESSED AIR PRIOR TO NOZZLE OR EQUIPMENT INSTALLATION.
5. PIPE SHALL BE SECURED IN ACCORDANCE WITH 46 CFR AND THESE DRAWINGS.
6. PIPE NETWORK SHALL BE PRESSURE TESTED AT 540 PSI FOR A PERIOD OF 2 MINUTES WITH MAXIMUM ALLOWABLE PRESSURE LOSS OF 150 PSI.

NOZZLE CHART					
ITEM	NO.	PART NO.	TYPE	ORIFICE	AGENT
22	E1-N1	90-194016-332	180°	0.7254	91.7
23	E2-N1	90-194028-469	360°	1.3806	161.3
23	E2-N2	90-194028-469	360°	1.3806	161.3
23	E2-N3	90-194028-469	360°	1.3806	161.3
23	E2-N4	90-194028-469	360°	1.3806	161.3
24	E2-N5	90-194028-500	360°	1.5708	161.0

FLOW CALCULATION:
FILE NAME: C1-2464013-01.FLC
CALCULATION DATE/TIME: JUN 6, 2003, 10:48:07 AM

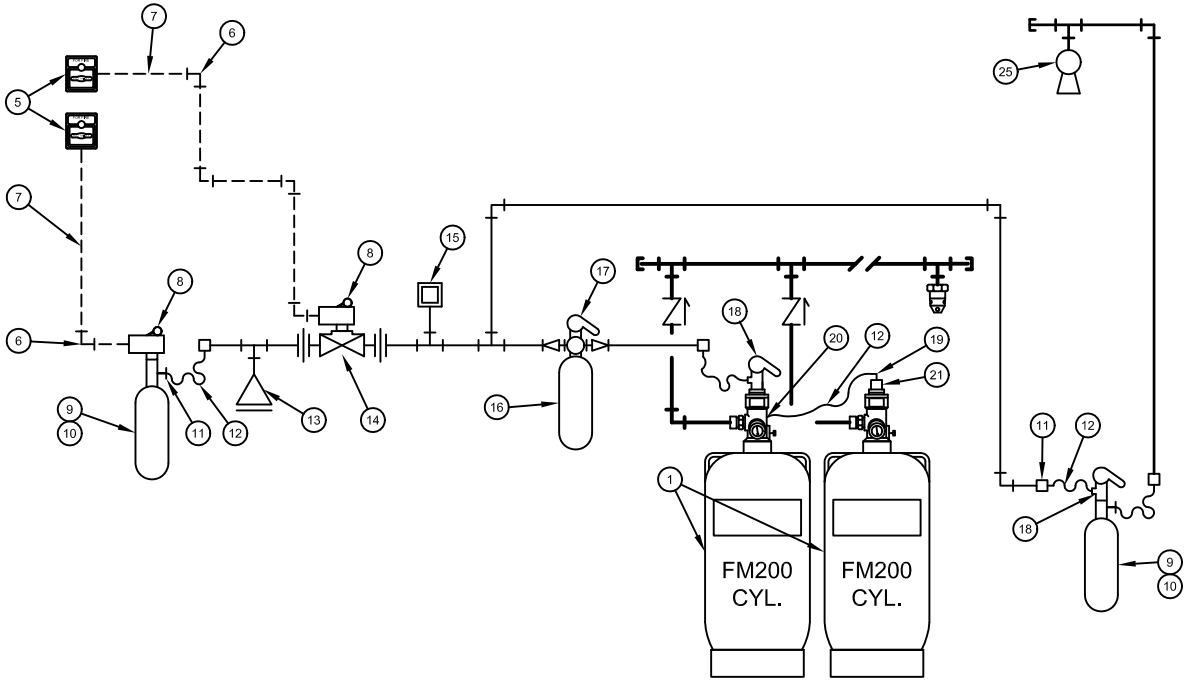
NOTE: THE SYSTEM SHOWN IN THIS DRAWING IS AN EXAMPLE ONLY AND IS NOT INTENDED TO PRECLUDE OTHER SYSTEM CONFIGURATIONS SHOWN IN THE USCG APPROVED MANUAL.

Kidde
FIRE SYSTEMS
400 MAIN STREET
ASHLAND, MA 01721

MANUAL P/N 90-FM200M-021

TYPICAL FM-200 SYSTEM WITH CYLINDERS OUTSIDE THE PROTECTED SPACE - FOR U.S.C.G. APPROVAL

DRN: BDC 01MAY03	SIZE	DWG. NO.	REV
CHK'D:	A	LI-2464013-I	A
ISSUED:			
SCALE: NOTED	UNITS: FEET-INCHES	SHEET: 2 OF 3	



ACTUATION SETUP
NOT TO SCALE

ACTUATION SYSTEM NOTES:

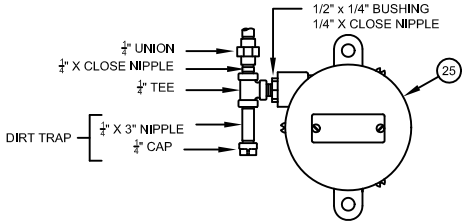
1) CYLINDERS ARE LOCATED OUTSIDE THE PROTECTED SPACE
2) ALL CABLE, ACTUATION PILOT LINES, AND SIREN DRIVER PIPE TO BE ROUTED AS REQUIRED
3) ROUTINGS AND INSTALLATION SHALL BE IN ACCORDANCE WITH THE LIMITATIONS AND RECOMMENDATIONS IN MANUAL P/N 90-FM200M-021

SEQUENCE OF OPERATION:

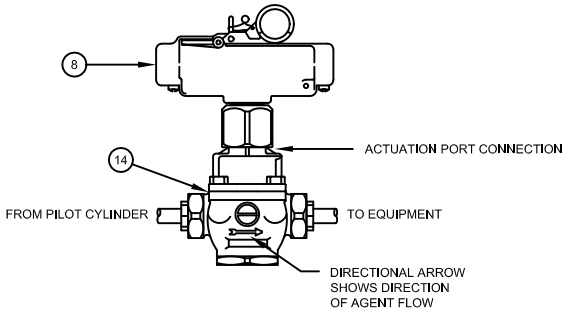
-PULL MANUAL STATION FOR NITROGEN PILOT TO RELEASE PRESSURE INTO THE PILOT LINE
-PULL MANUAL STATION FOR STOP VALVE TO ALLOW ACTUATION OF THE NITROGEN SIREN DRIVER AND OPERATION OF THE TIME DELAY
-AFTER TIME DELAY PERIOD, FM-200 CYLINDERS ARE ACTUATED

-SYSTEM MAY ALSO BE ACTUATED BY PULLING THE RESPECTIVE MANUAL RELEASE HANDLES ON THE CABLE OPERATED CONTROL HEADS

-THE FM-200 CYLINDERS MAY ALSO BE LOCALLY ACTUATED FOR IMMEDIATE RELEASE BY OPERATING THE MANUAL LEVER ON THE MASTER CYLINDER
-ACTUATION BY THIS METHOD WILL PRECLUDE THE OPERATION OF THE PRESSURE OPERATED SIREN, UNLESS THE NITROGEN SIREN DRIVER IS MANUALLY ACTUATED



PRESSURE OPERATED SIREN INSTALLATION DETAIL
NOT TO SCALE



STOP VALVE INSTALLATION DETAIL
NOT TO SCALE

NOTE: THE SYSTEM SHOWN IN THIS DRAWING IS AN EXAMPLE ONLY AND IS NOT INTENDED TO PRECLUDE OTHER SYSTEM CONFIGURATIONS SHOWN IN THE USCG APPROVED MANUAL.

Kidde Fire Systems 400 MAIN STREET ASHLAND, MA 01721	TYPICAL FM-200 SYSTEM WITH CYLINDERS OUTSIDE THE PROTECTED SPACE - FOR U.S.C.G. APPROVAL				
	DRN: BDC 01MAY03	SIZE	DWG. NO.	REV	
	CHK'D:	A	L1-2464013-1	A	
MANUAL P/N 90-FM200M-021	ISSUED:				
	SCALE: NOTED	UNITS: FEET-INCHES		SHEET: 3 OF 3	

Applications Engineering

Kidde Fenwal Inc.
400 Main Street
Ashland, MA 01721
ECS Series - KID3.01
UL: EX4674
Project: USCG FM-200 Manual, P/N 90-FM200M-021
File Name: C1-2464013-01.FLC

Consolidated Report

Customer Information

Company Name:	Kidde-Fenwal, Inc.
Address:	400 Main Street Ashland, MA
Phone:	(508) 881-2000
Contact:	
Title:	

Project Data

Project Name:	USCG FM-200 Manual, P/N 90-FM200M-021
Designer:	
Number:	1-2464013
Account:	
Location:	
Description:	Typical FM-200 System for USCG Approval - Cylinders Located Outside Protected Space

Calculation Date/Time: Friday, June 06, 2003, 10:48:07 AM

Kidde Fire Systems

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1

Enclosure Number:	1
Name:	Fidley / Upper Engine Room
Enclosure Temperature...	
Minimum:	32 F
Maximum:	130 F
Maximum Concentration:	10.476 %
Design Concentration...	
Adjusted:	8.740 %
Minimum:	8.700 %
Minimum Agent Required:	91.5 lbs
Width:	0.0 ft
Length:	0.0 ft
Height:	0.0 ft
Volume:	1950.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	1950.0 cubic ft
Adjusted Agent Required:	91.9 lbs
Number of Nozzles:	1

Calculation Date/Time: Friday, June 06, 2003, 10:48:07 AM

Kidde Fire Systems

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1

Enclosure Number:	2
Name:	Lower Engine Room
Enclosure Temperature...	
Minimum:	32 F
Maximum:	130 F
Maximum Concentration:	10.478 %
Design Concentration...	
Adjusted:	8.742 %
Minimum:	8.700 %
Minimum Agent Required:	801.9 lbs
Width:	0.0 ft
Length:	0.0 ft
Height:	0.0 ft
Volume:	17100.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	17100.0 cubic ft
Adjusted Agent Required:	806.1 lbs
Number of Nozzles:	5

Kidde Fire Systems

Consolidated Report
Agent Information

Agent: FM-200 / Propellant N2
(FM-200 is a Trademark of Great Lakes Chemical Corp.)

Adjusted Agent Required:	898.0 lbs
Container Name:	600 lb Cylinder, 3 in. Valve, w/LLI
Container Part Number:	90-100601-100
Number of Main Containers:	2
Number of Reserve Containers:	0
Manifold:	End, 2 x 600 lb Cyls, Up, No Flex, Horizontal Out
Pipe Take Off Direction:	Horizontal
Agent Per Container:	449.0 lbs
Fill Density:	52.4 lbs / cubic ft
Container Empty Weight:	362.0 lbs
Weight, All Containers + Agent:	1622.0 lbs
Floor Area Per Container:	2.64 square ft
Floor Loading Per Container:	307 lbs / square ft

Pipe Network

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Main Cyl. X 2	0	1		3 in	4.00 ft	4.00 ft
Manifold X 2	1	2	40T	3 in	2.25 ft	2.00 ft
Manifold X 1	2	3	40T	3 in	3.60 ft	0.00 ft
Pipe	3	4	40T	3 in	2.00 ft	0.00 ft
Pipe	4	5	40T	3 in	12.25 ft	0.00 ft
Pipe	5	6	40T	3 in	3.75 ft	0.00 ft
Pipe	6	7	40T	3 in	7.00 ft	-7.00 ft
Pipe	7	8	40T	3 in	4.25 ft	0.00 ft
Pipe	8	9	40T	3 in	3.75 ft	0.00 ft
Pipe	9	10	40T	3 in	20.00 ft	0.00 ft
Pipe	10	11	40T	2-1/2 in	7.00 ft	0.00 ft

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Pipe	11	12	40T	2 in	10.00 ft	0.00 ft
Pipe/E2-N1	12	13	40T	2 in	0.50 ft	-0.50 ft
Pipe	11	14	40T	2 in	10.00 ft	0.00 ft
Pipe/E2-N2	14	15	40T	2 in	0.50 ft	-0.50 ft
Pipe	10	16	40T	2-1/2 in	7.00 ft	0.00 ft
Pipe	16	17	40T	2 in	10.00 ft	0.00 ft
Pipe/E2-N3	17	18	40T	2 in	0.50 ft	-0.50 ft
Pipe	16	19	40T	2 in	10.00 ft	0.00 ft
Pipe/E2-N4	19	20	40T	2 in	0.50 ft	-0.50 ft
Pipe	8	21	40T	2 in	13.00 ft	0.00 ft
Pipe	21	22	40T	2 in	3.75 ft	0.00 ft
Pipe/E2-N5	22	23	40T	2 in	0.50 ft	-0.50 ft
Pipe	5	24	40T	1-1/4 in	11.00 ft	0.00 ft
Pipe	24	25	40T	1-1/4 in	4.25 ft	0.00 ft
Pipe/E1-N1	25	26	40T	1-1/4 in	0.50 ft	-0.50 ft

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
0	1	0	0	0	0	0		0.00 ft	50.0 ft
1	2	1	0	0	0	0	3in SChk	0.00 ft	23.5 ft
2	3	0	0	0	2	0		0.00 ft	36.8 ft
3	4	0	0	0	0	0		0.00 ft	2.0 ft
4	5	1	0	0	0	0		0.00 ft	20.5 ft
5	6	0	0	1	0	0		0.00 ft	8.9 ft
6	7	1	0	0	0	0		0.00 ft	15.2 ft
7	8	1	0	0	0	0		0.00 ft	12.5 ft
8	9	0	0	1	0	0		0.00 ft	8.9 ft
9	10	1	0	0	0	0		0.00 ft	28.2 ft
10	11	0	0	0	1	0		0.00 ft	20.4 ft
11	12	0	0	0	1	0		0.00 ft	21.2 ft
12	13	1	0	0	0	0		0.00 ft	6.0 ft
11	14	0	0	0	1	0		0.00 ft	21.2 ft
14	15	1	0	0	0	0		0.00 ft	6.0 ft

Calculation Date/Time: Friday, June 06, 2003, 10:48:07 AM

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
10	16	0	0	0	1	0		0.00 ft	20.4 ft
16	17	0	0	0	1	0		0.00 ft	21.2 ft
17	18	1	0	0	0	0		0.00 ft	6.0 ft
16	19	0	0	0	1	0		0.00 ft	21.2 ft
19	20	1	0	0	0	0		0.00 ft	6.0 ft
8	21	0	0	0	1	0		0.00 ft	24.2 ft
21	22	1	0	0	0	0		0.00 ft	9.3 ft
22	23	1	0	0	0	0		0.00 ft	6.0 ft
5	24	0	0	0	1	0		0.00 ft	18.5 ft
24	25	1	0	0	0	0		0.00 ft	8.0 ft
25	26	1	0	0	0	0		0.00 ft	4.2 ft

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	449.0 lbs				
1	2	449.0 lbs				
2	3	898.0 lbs				
3	4	898.0 lbs				
4	5	898.0 lbs				
5	6	806.1 lbs				
6	7	806.1 lbs				
7	8	806.1 lbs				
8	9	645.2 lbs				
9	10	645.2 lbs				
10	11	322.6 lbs				
11	12	161.3 lbs				
12	13	161.3 lbs	E2-N1	2 in	360°	1.3806 square in
11	14	161.3 lbs				
14	15	161.3 lbs	E2-N2	2 in	360°	1.3806 square in
10	16	322.6 lbs				
16	17	161.3 lbs				
17	18	161.3 lbs	E2-N3	2 in	360°	1.3806 square in
16	19	161.3 lbs				

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
19	20	161.3 lbs	E2-N4	2 in	360°	1.3806 square in
8	21	160.9 lbs				
21	22	160.9 lbs				
22	23	160.9 lbs	E2-N5	2 in	360°	1.5708 square in
5	24	91.9 lbs				
24	25	91.9 lbs				
25	26	91.9 lbs	E1-N1	1-1/4 in	180°	0.7254 square in

Parts Information

Total Agent Required: 898.0 lbs
Container Name: 600 lb Cylinder, 3 in. Valve, w/LLI (Part: 90-100601-100)
Number Of Containers: 2
Manifold: End, 2 x 600 lb Cyls, Up, No Flex, Horizontal Out

Nozzle	Type	Nozzle Area	Part Number
E1-N1	180°	0.7254 square in	90-194016-332
E2-N1	360°	1.3806 square in	90-194028-469
E2-N2	360°	1.3806 square in	90-194028-469
E2-N3	360°	1.3806 square in	90-194028-469
E2-N4	360°	1.3806 square in	90-194028-469
E2-N5	360°	1.5708 square in	90-194028-500

Pipe:	Type	Diameter	Length
	40T	1-1/4 in	15.75 ft
	40T	2 in	59.25 ft
	40T	2-1/2 in	14.00 ft
	40T	3 in	56.60 ft

'Other' Items:
2 - 3 in. Swing Check Valve (Part: 06-118058-001)

List of 90 degree elbows:
2 - 1-1/4 in

6 - 2 in
4 - 3 in

List of Tees:
2 - 2-1/2 in
3 - 3 in

System Acceptance

System Discharge Time: 9.4 seconds
Percent Agent In Pipe: 54.2%
Percent Agent Before First Tee: 15.2%

Enclosure Number: 1
Enclosure Name: Fidley / Upper Engine Room

Minimum Design Concentration: 8.700%
Adjusted Design Concentration: 8.740%
Predicted Concentration: 8.726%
Maximum Expected Agent Concentration: 10.459% (At 130 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	91.5 lbs	91.9 lbs	91.7 lbs	102 psig

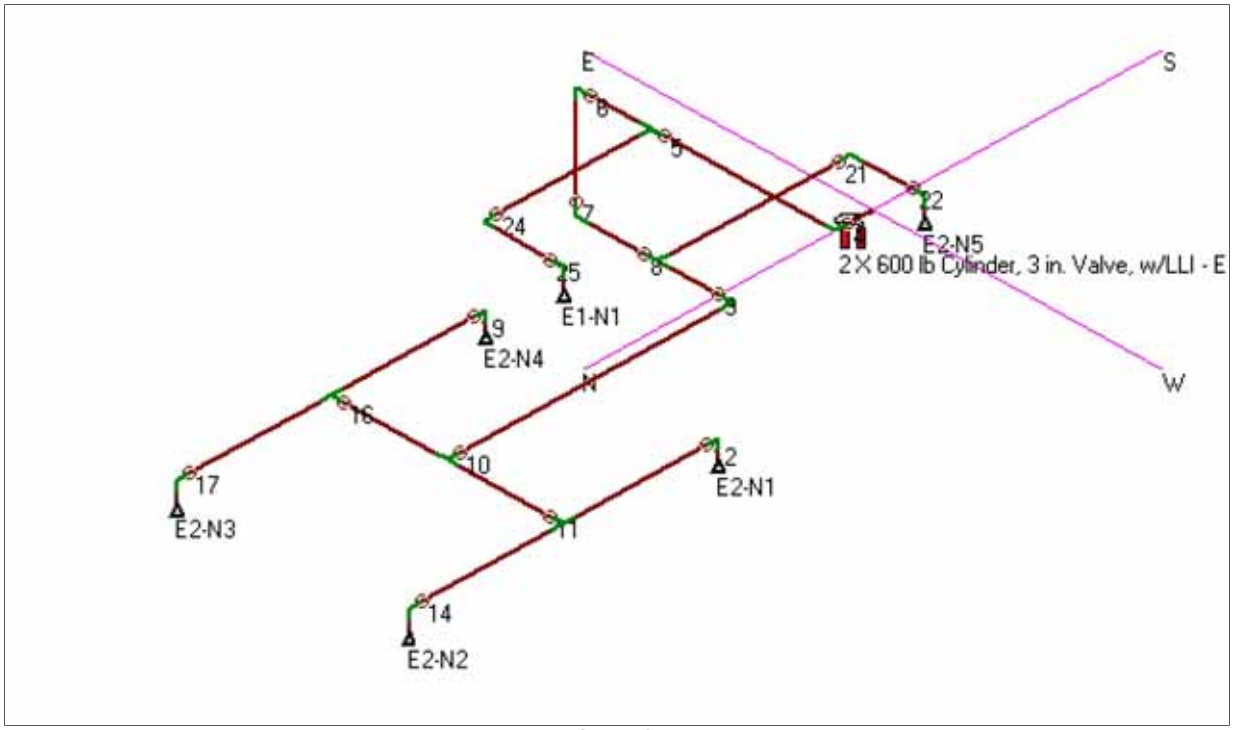
Enclosure Number: 2
Enclosure Name: Lower Engine Room

Minimum Design Concentration: 8.700%
Adjusted Design Concentration: 8.742%
Predicted Concentration: 8.744%
Maximum Expected Agent Concentration: 10.480% (At 130 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E2-N1	160.5 lbs	161.3 lbs	161.3 lbs	77 psig
E2-N2	160.5 lbs	161.3 lbs	161.3 lbs	77 psig
E2-N3	160.5 lbs	161.3 lbs	161.3 lbs	77 psig
E2-N4	160.5 lbs	161.3 lbs	161.3 lbs	77 psig
E2-N5	160.1 lbs	160.9 lbs	161.0 lbs	91 psig

Consolidated Report

Drawing View: 2



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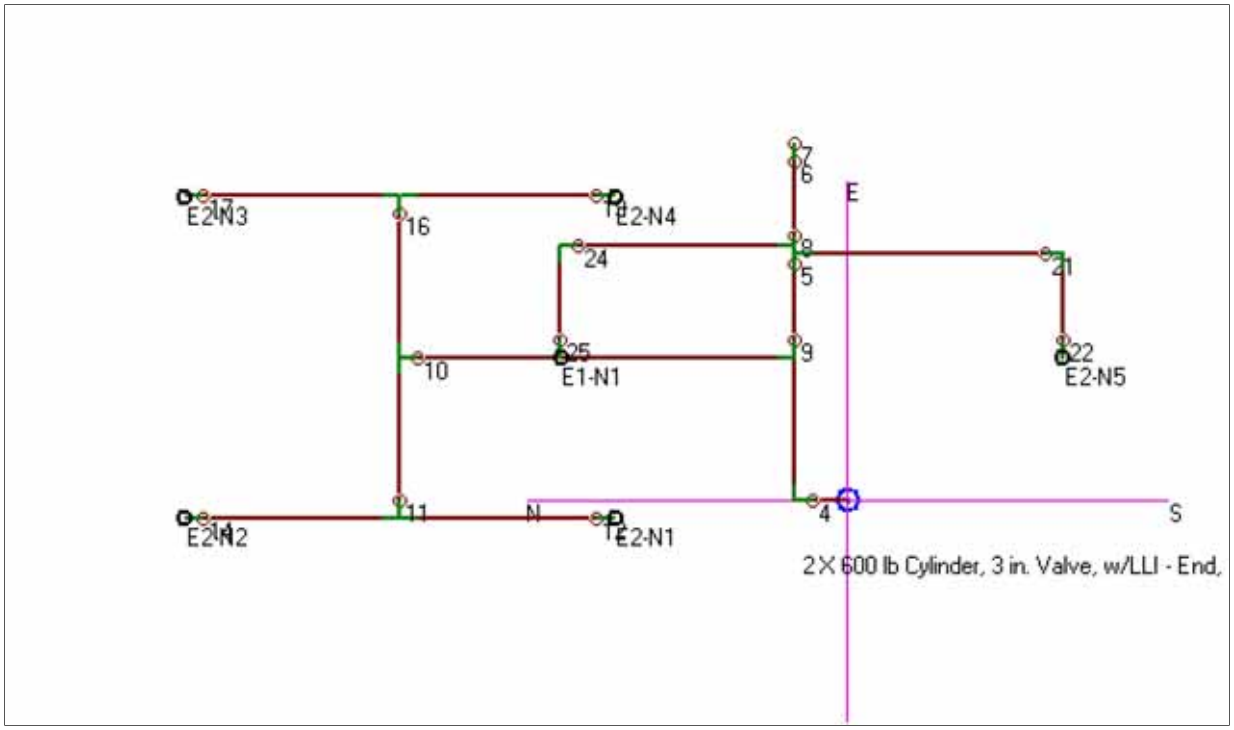

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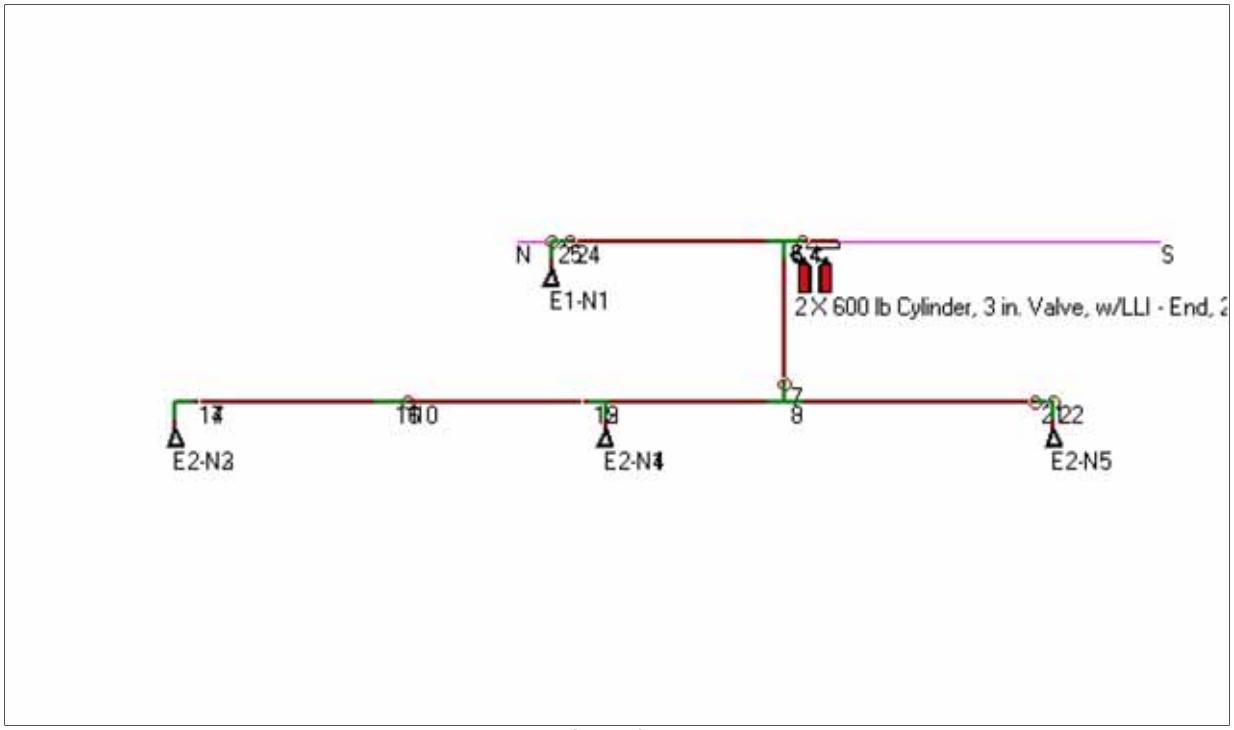
Consolidated Report

Drawing View: 10



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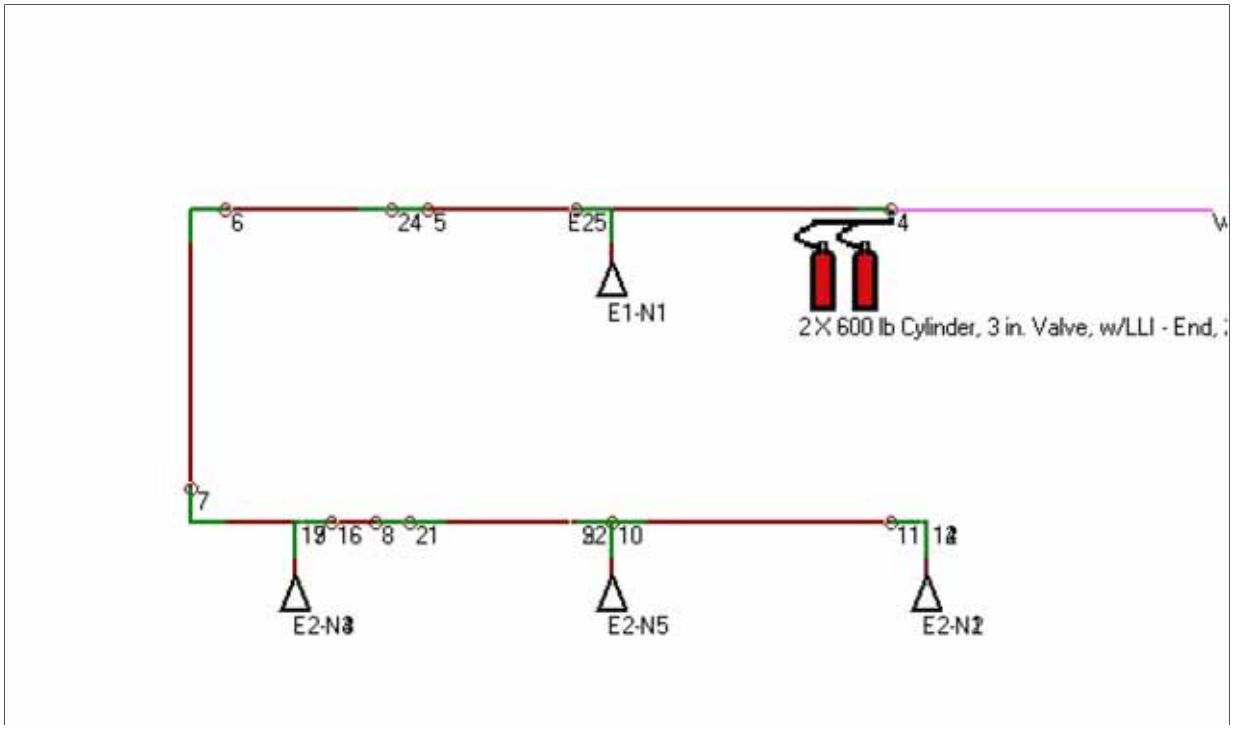


Calculation Date/Time: Friday, June 06, 2003, 10:48:07 AM

C-2 CYLINDERS LOCATED INSIDE THE PROTECTED SPACE

United States Coast Guard (USCG) has discontinued the approval of cylinders inside protected spaces of greater than 6,000 ft.^{3}. USCG had previously issued a certificate of approval to Kidde (Approval Number: 162.161/1/0) which allowed FM-200 cylinders to be located inside protected spaces of greater than 6,000 ft.^{3}. The period of the approval was from 2003 to 2007, including projects contracted, but not completed prior to 2008. USCG will still consider requests for systems with agent cylinders inside protected spaces of greater than 6,000 ft.^{3} on a vessel-by-vessel basis.

In order to maintain USCG approval, the material in the following sections has been deleted:

- 4-2.6.3.1
- 4-2.6.3.2
- 4-2.7.2

Refer to FM-200 Marine ECS Series Engineered Fire Suppression System Design, Installation, Operation, and Maintenance Manual, P/N 90-FM200M-021, dated January 2003 for this information. Please contact USCG for further information on this subject.

FM-200 SYSTEM DATA

HAZARD INFORMATION

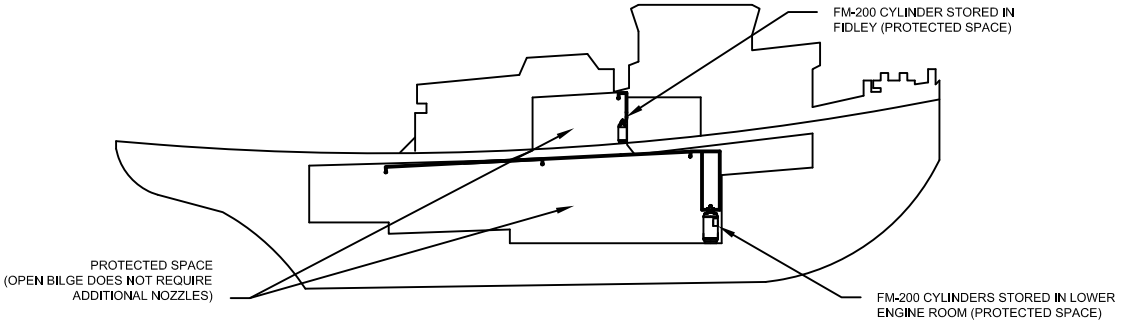
HAZARD:	TUGBOAT
FIRE TYPE:	CLASS B - DIESEL
CONSTRUCTION:	STEEL
DESCRIPTION:	FIDLEY / UPPER ENGINE ROOM

SYSTEM INFORMATION

SYSTEM:	MODULAR SYSTEM MAIN ONLY SYSTEM
CONTAINER:	125-LB CYLINDER W/ VALVE AND LLI QTY: 1 P/N: 90-100121-001 FILL WEIGHT: 91 LBS.
NOZZLES:	SEE PLANS & NOZZLE CHART FOR TYPE, SIZE, LOCATION, AND PART NUMBER

ENCLOSURE INFORMATION

ENCLOSURE:	FIDLEY / UPPER ENGINE ROOM		
AREA:	N/A SQ.FT.	MIN. TEMP:	32 °F
HEIGHT:	N/A FT.	MAX. TEMP:	130 °F
VOLUME:	1,930 CU.FT.	MIN. AGENT REQ'D:	90.5 LBS.
DESIGN CONC.:	8.7 %	AGENT SUPPLIED:	91 LBS.



ELEVATION VIEW
NOT TO SCALE

FM-200 SYSTEM DATA

HAZARD INFORMATION

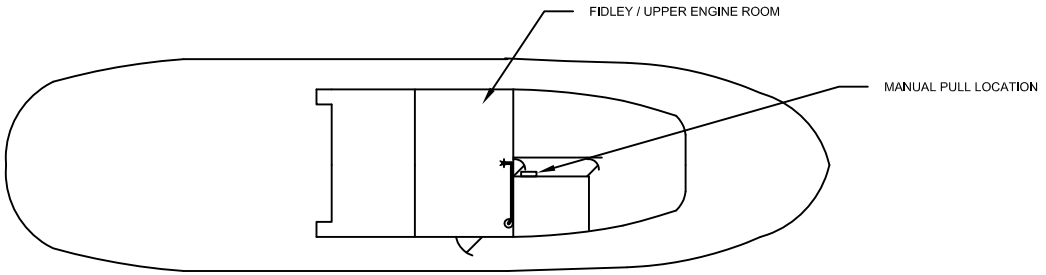
HAZARD:	TUGBOAT
FIRE TYPE:	CLASS B - DIESEL
CONSTRUCTION:	STEEL
DESCRIPTION:	UPPER AND LOWER ENGINE ROOM

SYSTEM INFORMATION

SYSTEM:	MODULAR SYSTEM MAIN ONLY SYSTEM
CONTAINER:	600-LB CYLINDER W/ 3" VALVE AND LLI QTY: 1 P/N: 90-100601-100 FILL WEIGHT: 402 LBS.
NOZZLES:	SEE PLANS & NOZZLE CHART FOR TYPE, SIZE, LOCATION, AND PART NUMBER

ENCLOSURE INFORMATION

ENCLOSURE:	LOWER ENGINE ROOM (PORT)		
AREA:	N/A SQ.FT.	MIN. TEMP:	32 °F
HEIGHT:	N/A FT.	MAX. TEMP:	130 °F
VOLUME:	17,100 CU.FT.	MIN. AGENT REQ'D:	401 LBS.
DESIGN CONC.:	8.7 %	AGENT SUPPLIED:	402 LBS.



PLAN VIEW - FIDLEY / UPPER ENGINE ROOM
NOT TO SCALE

FM-200 SYSTEM DATA

HAZARD INFORMATION

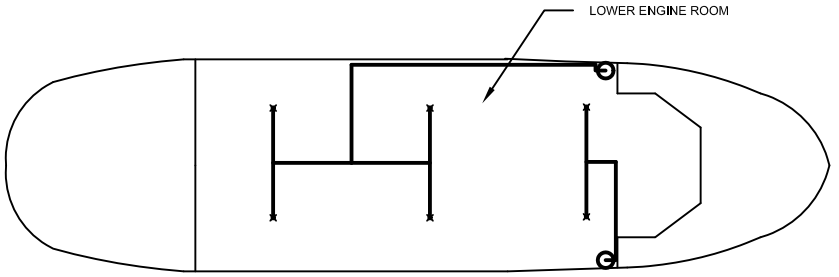
HAZARD:	TUGBOAT
FIRE TYPE:	CLASS B - DIESEL
CONSTRUCTION:	STEEL
DESCRIPTION:	UPPER AND LOWER ENGINE ROOM

SYSTEM INFORMATION

SYSTEM:	MODULAR SYSTEM MAIN ONLY SYSTEM
CONTAINER:	600-LB CYLINDER W/ 3" VALVE AND LLI QTY: 1 P/N: 90-100601-100 FILL WEIGHT: 402 LBS.
NOZZLES:	SEE PLANS & NOZZLE CHART FOR TYPE, SIZE, LOCATION, AND PART NUMBER

ENCLOSURE INFORMATION

ENCLOSURE:	LOWER ENGINE ROOM (STARBOARD)		
AREA:	N/A SQ.FT.	MIN. TEMP:	32 °F
HEIGHT:	N/A FT.	MAX. TEMP:	130 °F
VOLUME:	17,100 CU.FT.	MIN. AGENT REQ'D:	401 LBS.
DESIGN CONC.:	8.7 %	AGENT SUPPLIED:	402 LBS.



PLAN VIEW - LOWER ENGINE ROOM
NOT TO SCALE

NOTE: THE SYSTEM SHOWN IN THIS DRAWING IS AN EXAMPLE ONLY AND IS NOT INTENDED TO PRECLUDE OTHER SYSTEM CONFIGURATIONS SHOWN IN THE USCG APPROVED MANUAL.

Kidde
FIRE SYSTEMS
400 MAIN STREET
ASHLAND, MA 01721

MANUAL P/N 90-FM200M-021

TYPICAL FM-200 SYSTEM WITH CYLINDERS INSIDE THE PROTECTED SPACE - FOR U.S.C.G. APPROVAL

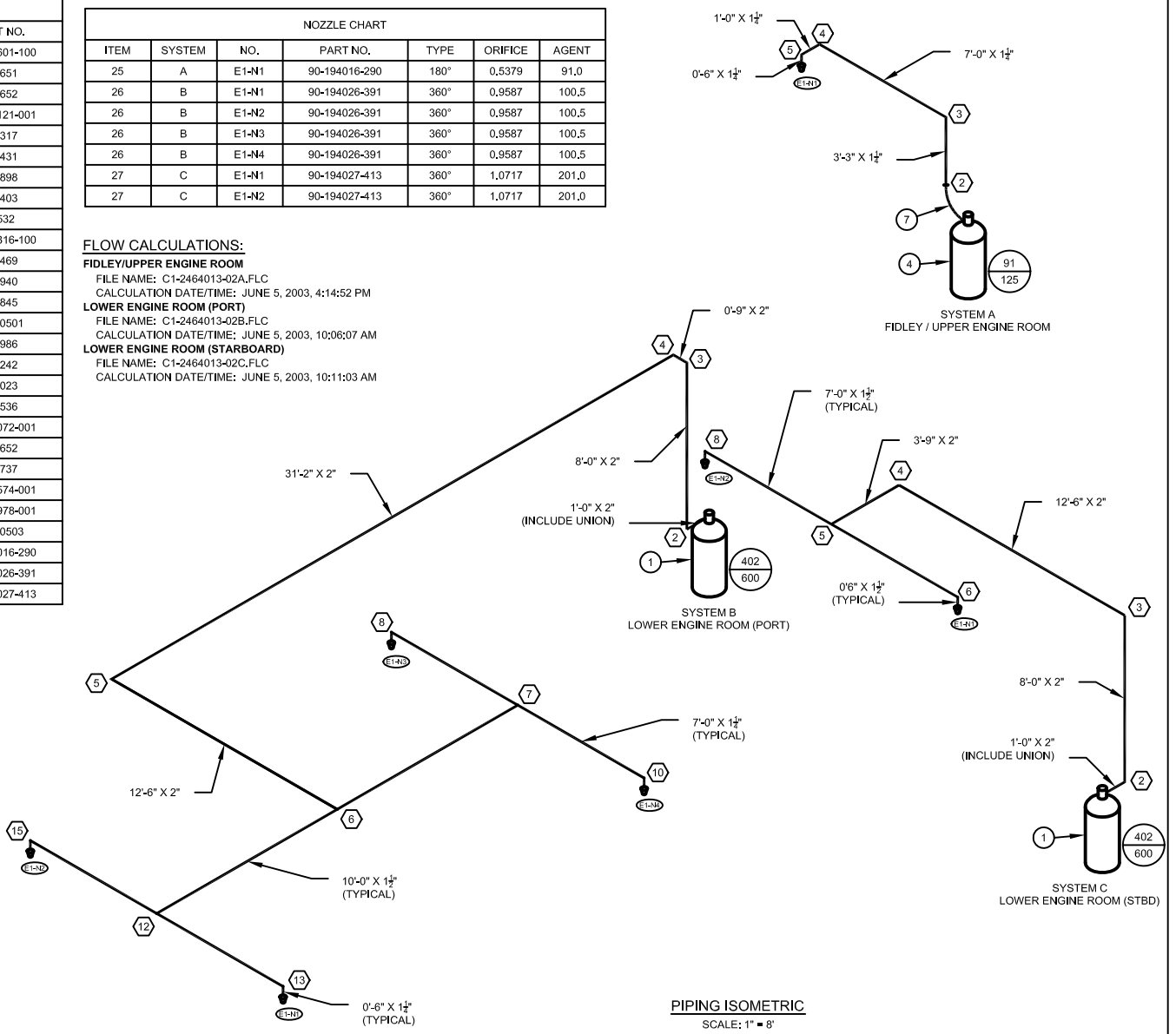
DRN: BDC 01MAY03	SIZE	DWG. NO.	REV
CHK'D:	A	LI-2464013-2	A
ISSUED:			
SCALE: NOTED	UNITS: FEET-INCHES	SHEET: 1 OF 3	

BILL OF MATERIALS			
NO.	DESCRIPTION	QTY	PART NO.
1	600# FM-200 CYLINDER W/ LLI, FILLED TO 402#	2	90-100601-100
2	CYLINDER STRAP, 600-LB CYLINDER	4	294651
3	CYLINDER CRADLE, 600-LB CYLINDER	4	294652
4	125# FM-200 CYLINDER W/ LLI, FILLED TO 91#	1	90-100121-001
5	CYLINDER STRAP, 125-LB CYLINDER	2	235317
6	CYLINDER CRADLE, 125-LB CYLINDER	2	235431
7	1-1/2" FLEXIBLE DISCHARGE HOSE	1	283898
8	PULL BOX, SURFACE, 3/8" PIPE (BREAK GLASS)	2	871403
9	CORNER PULLEY, 3/8" PIPE (WATERTIGHT)	30	60532
10	1/16" CABLE, 100 FT ROLL	2	06-118316-100
11	CABLE OPERATED CONTROL HEAD	2	979469
12	NITROGEN PILOT CYLINDER, 108 CU.IN., NO PRESS SWITCH	5	877940
13	MOUNTING BRACKET, NITROGEN PILOT CYLINDER	5	877845
14	MALE CONNECTOR, 5/16" FLARE x 1/8" NPT	8	69920501
15	ACTUATION HOSE, 30"	6	264986
16	SAFETY OUTLET (N2 & CO2)	2	803242
17	1/2" STOP VALVE	2	870023
18	PRESSURE OPERATED SWITCH	2	486536
19	NITROGEN TIME DELAY (108 CU.IN. PILOT, 34 S DELAY)	1	81-871072-001
20	LEVER OPERATED CONTROL HEAD	5	870652
21	PRESSURE OPERATED CONTROL HEAD	4	878737
22	SIREN NITROGEN PRESSURE OPERATED	1	90-981574-001
23	DUAL-LOOP BLEED KIT	4	06-129978-001
24	MALE ELBOW, 5/16" FLARE X 1/8" NPT	1	69920503
25	180° FM-200 DISCHARGE NOZZLE, 1-1/4" NPT, 0.5379	1	90-194016-290
26	360° FM-200 DISCHARGE NOZZLE, 1-1/4" NPT, 0.9587	4	90-194026-391
27	360° FM-200 DISCHARGE NOZZLE, 1-1/2" NPT, 1.0717	2	90-194027-413

NOZZLE CHART						
ITEM	SYSTEM	NO.	PART NO.	TYPE	ORIFICE	AGENT
25	A	E1-N1	90-194016-290	180°	0.5379	91.0
26	B	E1-N1	90-194026-391	360°	0.9587	100.5
26	B	E1-N2	90-194026-391	360°	0.9587	100.5
26	B	E1-N3	90-194026-391	360°	0.9587	100.5
26	B	E1-N4	90-194026-391	360°	0.9587	100.5
27	C	E1-N1	90-194027-413	360°	1.0717	201.0
27	C	E1-N2	90-194027-413	360°	1.0717	201.0

FLOW CALCULATIONS:

FIDLEY/UPPER ENGINE ROOM
FILE NAME: C1-2464013-02A.FLC
CALCULATION DATE/TIME: JUNE 5, 2003, 4:14:52 PM
LOWER ENGINE ROOM (PORT)
FILE NAME: C1-2464013-02B.FLC
CALCULATION DATE/TIME: JUNE 5, 2003, 10:06:07 AM
LOWER ENGINE ROOM (STARBOARD)
FILE NAME: C1-2464013-02C.FLC
CALCULATION DATE/TIME: JUNE 5, 2003, 10:11:03 AM



PIPING ISOMETRIC

SCALE: 1" = 8'

FM-200 MECHANICAL NOTES

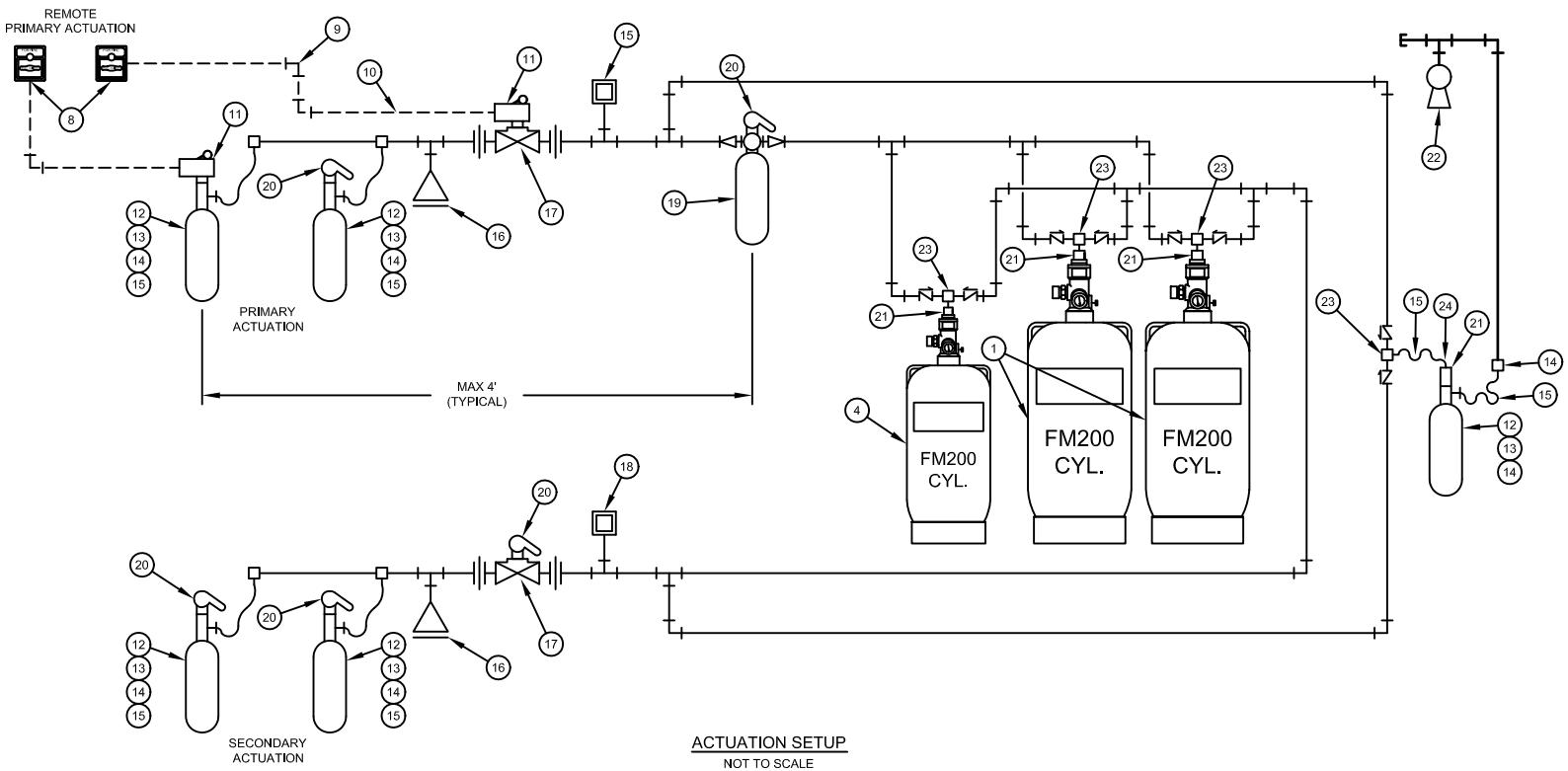
1. FOR INSTALLATION REQUIREMENTS, REFER TO NFPA 2001 AND THE KIDDE FIRE SYSTEMS DESIGN, INSTALLATION, OPERATION AND MAINTENANCE MANUAL.
2. GALVANIZED PIPE SHALL CONFORM TO ASTM A-53 CLASS F, ASTM A-53 ERW GRADES A OR B, OR ASTM A-106 SEAMLESS GRADES A, B OR C. ALL PIPE SHALL BE SCHEDULE 40 MINIMUM. FITTINGS SHALL BE CLASS 300 MALLEABLE OR DUCTILE IRON FOR SIZES UP TO AND INCLUDING 3" AND 1000-LB RATED DUCTILE IRON OR FORGED STEEL FITTINGS FOR ALL LARGER SIZES. ALL FLANGED JOINTS SHALL BE CLASS 300. ALL GROOVED FITTINGS AND COUPLINGS SHALL BE 500-LB RATED AND LISTED. GROOVED COUPLINGS SHALL BE VICTAULIC STYLE 07, STYLE 77, OR EQUIVALENT
3. ALL PIPE SIZE REDUCTIONS MUST BE MADE USING CONCENTRIC REDUCING COUPLINGS OR REDUCING TEES. BUSHINGS SHALL NOT BE USED.
4. ALL PIPE SHALL BE REAMED AND CLEANED PRIOR TO ASSEMBLY, AND AFTER ASSEMBLY THE ENTIRE PIPING SYSTEM SHALL BE BLOWN OUT USING NITROGEN OR COMPRESSED AIR PRIOR TO NOZZLE OR EQUIPMENT INSTALLATION.
5. PIPE SHALL BE SECURED IN ACCORDANCE WITH 46 CFR AND THESE DRAWINGS.
6. PIPE NETWORK SHALL BE PRESSURE TESTED AT 540 PSI FOR A PERIOD OF 2 MINUTES WITH MAXIMUM ALLOWABLE PRESSURE LOSS OF 150 PSI.

NOTE: THE SYSTEM SHOWN IN THIS DRAWING IS AN EXAMPLE ONLY AND IS NOT INTENDED TO PRECLUDE OTHER SYSTEM CONFIGURATIONS SHOWN IN THE USCG APPROVED MANUAL.

Kidde
FIRE SYSTEMS
400 MAIN STREET
ASHLAND, MA 01721

TYPICAL FM-200 SYSTEM WITH CYLINDERS INSIDE THE PROTECTED SPACE - FOR U.S.C.G. APPROVAL

DRN: BDC 01MAY03	SIZE	DWG. NO.	REV
CHK'D:	A	LI-2464013-2	A
ISSUED:			
MANUAL P/N 90-FM200M-021	SCALE: NOTED	UNITS: FEET-INCHES	SHEET: 2 OF 3



ACTUATION SETUP
NOT TO SCALE

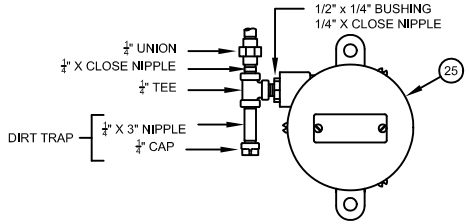
ACTUATION SYSTEM NOTES:

1) CYLINDERS ARE LOCATED INSIDE THE PROTECTED SPACE
2) ALL CABLE, ACTUATION PILOT LINES, AND SIREN DRIVER PIPE TO BE ROUTED AS REQUIRED
3) ROUTINGS AND INSTALLATION SHALL BE IN ACCORDANCE WITH THE LIMITATIONS AND RECOMMENDATIONS IN MANUAL P/N 90-FM200M-021 (MOST RECENT REVISION)
4) NITROGEN ACTUATION LINES SHALL BE ¼" SCHEDULE 80 STAINLESS STEEL

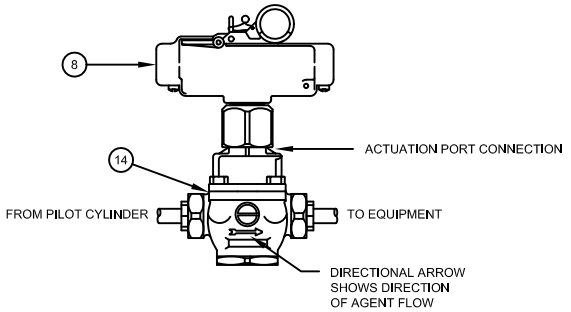
SEQUENCE OF OPERATION:

-PULL MANUAL STATION FOR NITROGEN PILOT TO RELEASE PRESSURE INTO THE PILOT LINE
-PULL MANUAL STATION FOR STOP VALVE TO ALLOW ACTUATION OF THE NITROGEN SIREN DRIVER AND OPERATION OF THE TIME DELAY
-AFTER TIME DELAY PERIOD, FM-200 CYLINDERS ARE ACTUATED
-IF ACTUATION DOES NOT OCCUR, OPERATE SECONDARY MANUAL CONTROLS TO EFFECT IMMEDIATE ACTUATION

-PRIMARY ACTUATION MAY ALSO BE OPERATED BY PULLING THE RESPECTIVE MANUAL RELEASE HANDLES ON THE CABLE OPERATED CONTROL HEADS



PRESSURE OPERATED SIREN
INSTALLATION DETAIL
NOT TO SCALE



STOP VALVE INSTALLATION DETAIL
NOT TO SCALE

NOTE: THE SYSTEM SHOWN IN THIS DRAWING IS AN EXAMPLE ONLY AND IS NOT INTENDED TO PRECLUDE OTHER SYSTEM CONFIGURATIONS SHOWN IN THE USCG APPROVED MANUAL.

Kidde Fire Systems 400 MAIN STREET ASHLAND, MA 01721	TYPICAL FM-200 SYSTEM WITH CYLINDERS INSIDE THE PROTECTED SPACE - FOR U.S.C.G. APPROVAL			
	DRN: BDC 01MAY03	SIZE	DWG. NO.	REV
	CHK'D:	A	LI-2464013-2	A
MANUAL P/N 90-FM200M-021	ISSUED:			
	SCALE: NOTED	UNITS: FEET-INCHES	SHEET: 3 OF 3	

Applications Engineering

Kidde Fenwal Inc.
400 Main Street
Ashland, MA 01721
ECS Series - KID3.01
UL: EX4674
Project: USCG FM-200 Manual, P/N 90-FM200M-021
File Name: C1-2464013-02A.FLC

Consolidated Report

Customer Information

Company Name:	Kidde-Fenwal, Inc.
Address:	400 Main Street Ashland, MA
Phone:	(508) 881-2000
Contact:	
Title:	

Project Data

Project Name:	USCG FM-200 Manual, P/N 90-FM200M-021
Designer:	
Number:	1-2464013
Account:	
Location:	
Description:	Typical FM-200 System for USCG Approval - Cylinders Located Inside Protected Space

Calculation Date/Time: Thursday, June 05, 2003, 4:14:52 PM

Kidde Fire Systems

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1

Enclosure Number:	1
Name:	Fidley / Upper Engine Room
Enclosure Temperature...	
Minimum:	32 F
Maximum:	130 F
Maximum Concentration:	10.480 %
Design Concentration...	
Adjusted:	8.744 %
Minimum:	8.700 %
Minimum Agent Required:	90.5 lbs
Width:	0.0 ft
Length:	0.0 ft
Height:	0.0 ft
Volume:	1930.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	1930.0 cubic ft
Adjusted Agent Required:	91.0 lbs
Number of Nozzles:	1

Calculation Date/Time: Thursday, June 05, 2003, 4:14:52 PM

Kidde Fire Systems

Consolidated Report
Agent Information

Agent: FM-200 / Propellant N2
(FM-200 is a Trademark of Great Lakes Chemical Corp.)

Adjusted Agent Required:	91.0 lbs
Container Name:	125 lb Cylinder
Container Part Number:	90-100125-001
Number of Main Containers:	1
Number of Reserve Containers:	0
Manifold:	No Manifold
Pipe Take Off Direction:	Horizontal
Agent Per Container:	91.0 lbs
Fill Density:	50.9 lbs / cubic ft
Container Empty Weight:	96.0 lbs
Weight, All Containers + Agent:	187.0 lbs
Floor Area Per Container:	0.89 square ft
Floor Loading Per Container:	210 lbs / square ft

Pipe Network

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Main Cyl. X 1	0	1		1-1/2 in	2.99 ft	2.99 ft
Flex Hose	1	2		1-1/2 in	2.00 ft	1.22 ft
Pipe	2	3	40T	1-1/4 in	3.25 ft	3.25 ft
Pipe	3	4	40T	1-1/4 in	7.00 ft	0.00 ft
Pipe	4	5	40T	1-1/4 in	1.00 ft	0.00 ft
Pipe/E1-N1	5	6	40T	1-1/4 in	0.50 ft	-0.50 ft

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
0	1	0	0	0	0	0		0.00 ft	50.0 ft
1	2	1	0	0	0	0	1-1/2in Flx 90	0.00 ft	15.0 ft

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
2	3	0	0	0	0	0		0.00 ft	3.3 ft
3	4	1	0	0	0	0		0.00 ft	10.7 ft
4	5	1	0	0	0	0		0.00 ft	4.7 ft
5	6	1	0	0	0	0		0.00 ft	4.2 ft

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	91.0 lbs				
1	2	91.0 lbs				
2	3	91.0 lbs				
3	4	91.0 lbs				
4	5	91.0 lbs				
5	6	91.0 lbs	E1-N1	1-1/4 in	180°	0.5379 square in

Parts Information

Total Agent Required: 91.0 lbs
Container Name: 125 lb Cylinder (Part: 90-100125-001)
Number Of Containers: 1

Nozzle	Type	Nozzle Area	Part Number
E1-N1	180°	0.5379 square in	90-194016-290

Pipe:	Type	Diameter	Length
	40T	1-1/4 in	11.75 ft

'Other' Items:
1 - 1-1/2 in. Flex Hose - 90° Bend (Part: 283898)

List of 90 degree elbows:
3 - 1-1/4 in

System Acceptance

Kidde Fire Systems

Consolidated Report

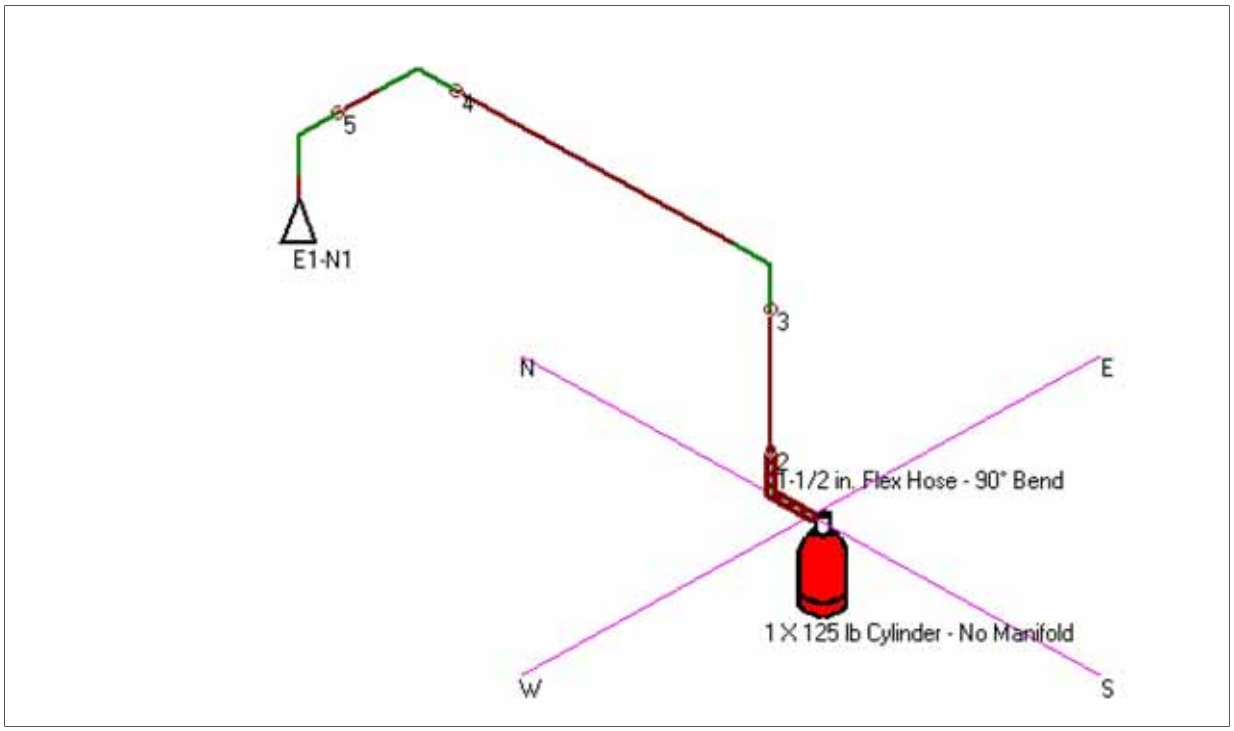
System Discharge Time: 9.1 seconds
Percent Agent In Pipe: 16.7%
Percent Agent Before First Tee: 0.0%

Enclosure Number: 1
Enclosure Name: Fidley / Upper Engine Room

Minimum Design Concentration: 8.700%
Adjusted Design Concentration: 8.744%
Predicted Concentration: 8.744%
Maximum Expected Agent Concentration: 10.480% (At 130 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	90.5 lbs	91.0 lbs	91.0 lbs	152 psig

Drawing View: 2



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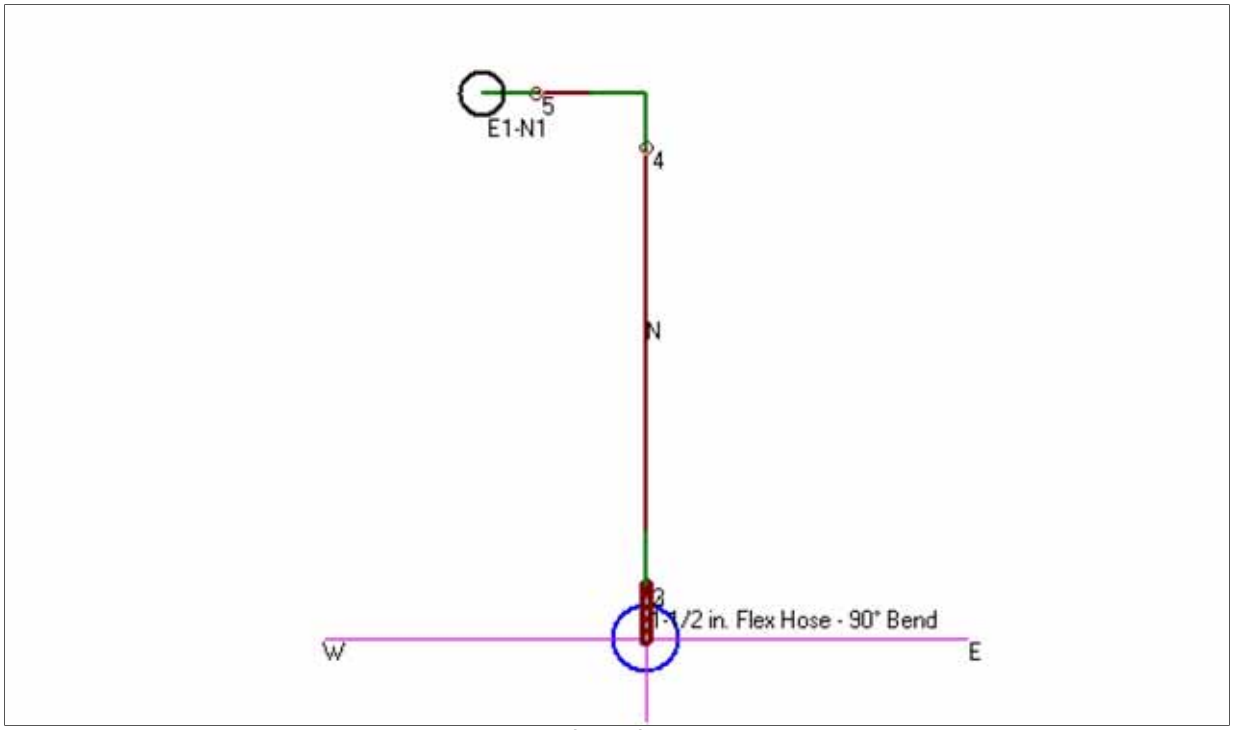
Consolidated Report

Drawing View: 6



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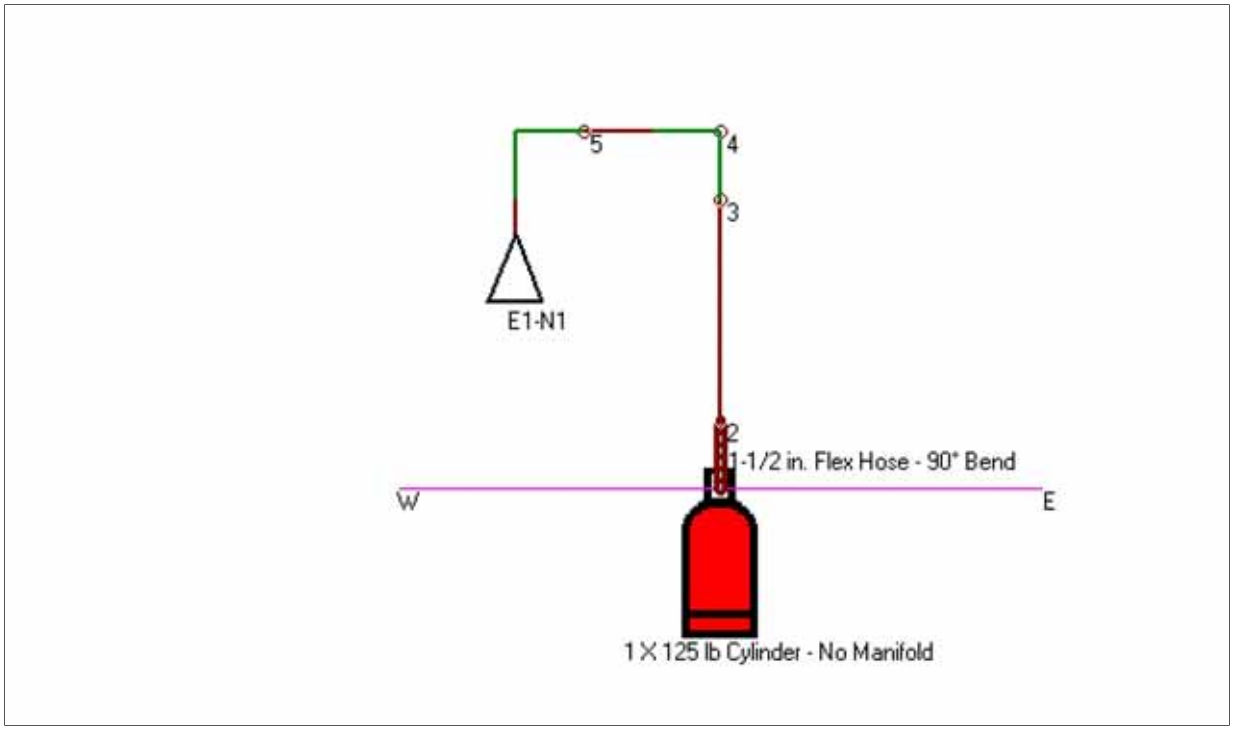

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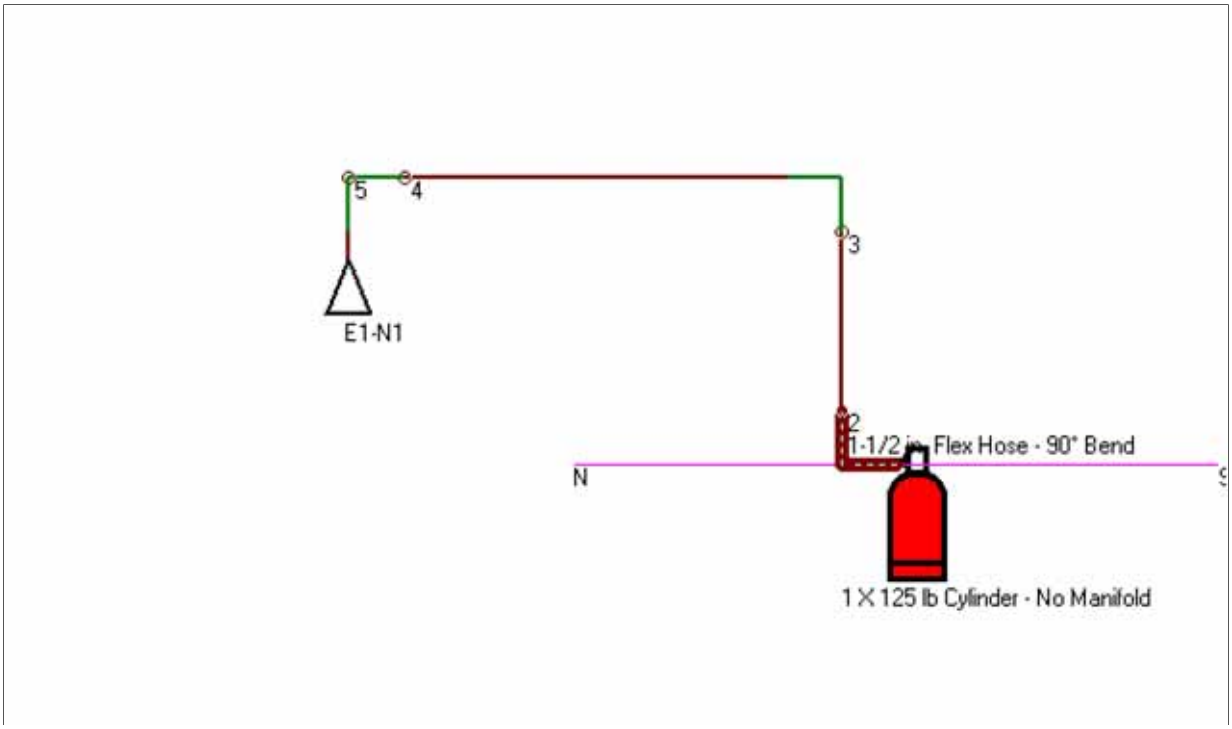
Consolidated Report

Drawing View: 11



Calculation Date/Time: Thursday, June 05, 2003, 4:14:52 PM

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Applications Engineering

Kidde Fenwal Inc.
400 Main Street
Ashland, MA 01721
ECS Series - KID3.01
UL: EX4674
Project: USCG FM-200 Manual, P/N 90-FM200M-021
File Name: C1-2464013-02B.FLC

Consolidated Report

Customer Information

Company Name:	Kidde-Fenwal, Inc.
Address:	400 Main Street Ashland, MA
Phone:	(508) 881-2000
Contact:	
Title:	

Project Data

Project Name:	USCG FM-200 Manual, P/N 90-FM200M-021
Designer:	
Number:	1-2464013
Account:	
Location:	
Description:	Typical FM-200 System for USCG Approval - Cylinders Located Inside Protected Space

Calculation Date/Time: Thursday, June 05, 2003, 10:06:07 AM

Kidde Fire Systems

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1

Enclosure Number:	1
Name:	Lower Engine Room - Port
Enclosure Temperature...	
Minimum:	32 F
Maximum:	130 F
Maximum Concentration:	10.454 %
Design Concentration...	
Adjusted:	8.721 %
Minimum:	8.700 %
Minimum Agent Required:	401.0 lbs
Width:	0.0 ft
Length:	0.0 ft
Height:	0.0 ft
Volume:	8550.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	8550.0 cubic ft
Adjusted Agent Required:	402.0 lbs
Number of Nozzles:	4

Kidde Fire Systems

Consolidated Report
Agent Information

Agent: FM-200 / Propellant N2
(FM-200 is a Trademark of Great Lakes Chemical Corp.)

Adjusted Agent Required:	402.0 lbs
Container Name:	600 lb Cylinder, 3 in. Valve
Container Part Number:	90-100600-100
Number of Main Containers:	1
Number of Reserve Containers:	0
Manifold:	No Manifold
Pipe Take Off Direction:	Horizontal
Agent Per Container:	402.0 lbs
Fill Density:	46.9 lbs / cubic ft
Container Empty Weight:	360.0 lbs
Weight, All Containers + Agent:	762.0 lbs
Floor Area Per Container:	2.64 square ft
Floor Loading Per Container:	289 lbs / square ft

Pipe Network

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Main Cyl. X 1	0	1		3 in	4.00 ft	4.00 ft
Pipe	1	2	40T	2 in	1.00 ft	0.00 ft
Pipe	2	3	40T	2 in	8.00 ft	8.00 ft
Pipe	3	4	40T	2 in	0.75 ft	0.00 ft
Pipe	4	5	40T	2 in	31.12 ft	0.00 ft
Pipe	5	6	40T	2 in	12.50 ft	0.00 ft
Pipe	6	7	40T	1-1/2 in	10.00 ft	0.00 ft
Pipe	7	8	40T	1-1/4 in	7.00 ft	0.00 ft
Pipe/E1-N3	8	9	40T	1-1/4 in	0.50 ft	-0.50 ft
Pipe	7	10	40T	1-1/4 in	7.00 ft	0.00 ft
Pipe/E1-N4	10	11	40T	1-1/4 in	0.50 ft	-0.50 ft

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Pipe	6	12	40T	1-1/2 in	10.00 ft	0.00 ft
Pipe	12	13	40T	1-1/4 in	7.00 ft	0.00 ft
Pipe/E1-N1	13	14	40T	1-1/4 in	0.50 ft	-0.50 ft
Pipe	12	15	40T	1-1/4 in	7.00 ft	0.00 ft
Pipe/E1-N2	15	16	40T	1-1/4 in	0.50 ft	-0.50 ft

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
0	1	0	0	0	0	0		0.00 ft	50.0 ft
1	2	0	0	0	0	0		0.00 ft	1.0 ft
2	3	1	0	0	0	0		0.00 ft	13.5 ft
3	4	1	0	0	0	0		0.00 ft	6.3 ft
4	5	1	0	0	0	0		0.00 ft	36.6 ft
5	6	1	0	0	0	0		0.00 ft	18.0 ft
6	7	0	0	0	1	0		0.00 ft	18.7 ft
7	8	0	0	0	1	0		0.00 ft	14.5 ft
8	9	1	0	0	0	0		0.00 ft	4.2 ft
7	10	0	0	0	1	0		0.00 ft	14.5 ft
10	11	1	0	0	0	0		0.00 ft	4.2 ft
6	12	0	0	0	1	0		0.00 ft	18.7 ft
12	13	0	0	0	1	0		0.00 ft	14.5 ft
13	14	1	0	0	0	0		0.00 ft	4.2 ft
12	15	0	0	0	1	0		0.00 ft	14.5 ft
15	16	1	0	0	0	0		0.00 ft	4.2 ft

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	402.0 lbs				
1	2	402.0 lbs				
2	3	402.0 lbs				
3	4	402.0 lbs				
4	5	402.0 lbs				
5	6	402.0 lbs				

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
6	7	200.8 lbs				
7	8	100.4 lbs				
8	9	100.4 lbs	E1-N3	1-1/4 in	360°	0.9587 square in
7	10	100.4 lbs				
10	11	100.4 lbs	E1-N4	1-1/4 in	360°	0.9587 square in
6	12	201.2 lbs				
12	13	100.6 lbs				
13	14	100.6 lbs	E1-N1	1-1/4 in	360°	0.9587 square in
12	15	100.6 lbs				
15	16	100.6 lbs	E1-N2	1-1/4 in	360°	0.9587 square in

Parts Information

Total Agent Required: 402.0 lbs
Container Name: 600 lb Cylinder, 3 in. Valve (Part: 90-100600-100)
Number Of Containers: 1

Nozzle	Type	Nozzle Area	Part Number
E1-N1	360°	0.9587 square in	90-194026-391
E1-N2	360°	0.9587 square in	90-194026-391
E1-N3	360°	0.9587 square in	90-194026-391
E1-N4	360°	0.9587 square in	90-194026-391

Pipe:	Type	Diameter	Length
	40T	1-1/4 in	30.00 ft
	40T	1-1/2 in	20.00 ft
	40T	2 in	53.37 ft

List of 90 degree elbows:
4 - 1-1/4 in
4 - 2 in

List of Tees:

2 - 1-1/2 in
1 - 2 in

System Acceptance

System Discharge Time: 9.2 seconds
Percent Agent In Pipe: 44.5%
Percent Agent Before First Tee: 31.6%

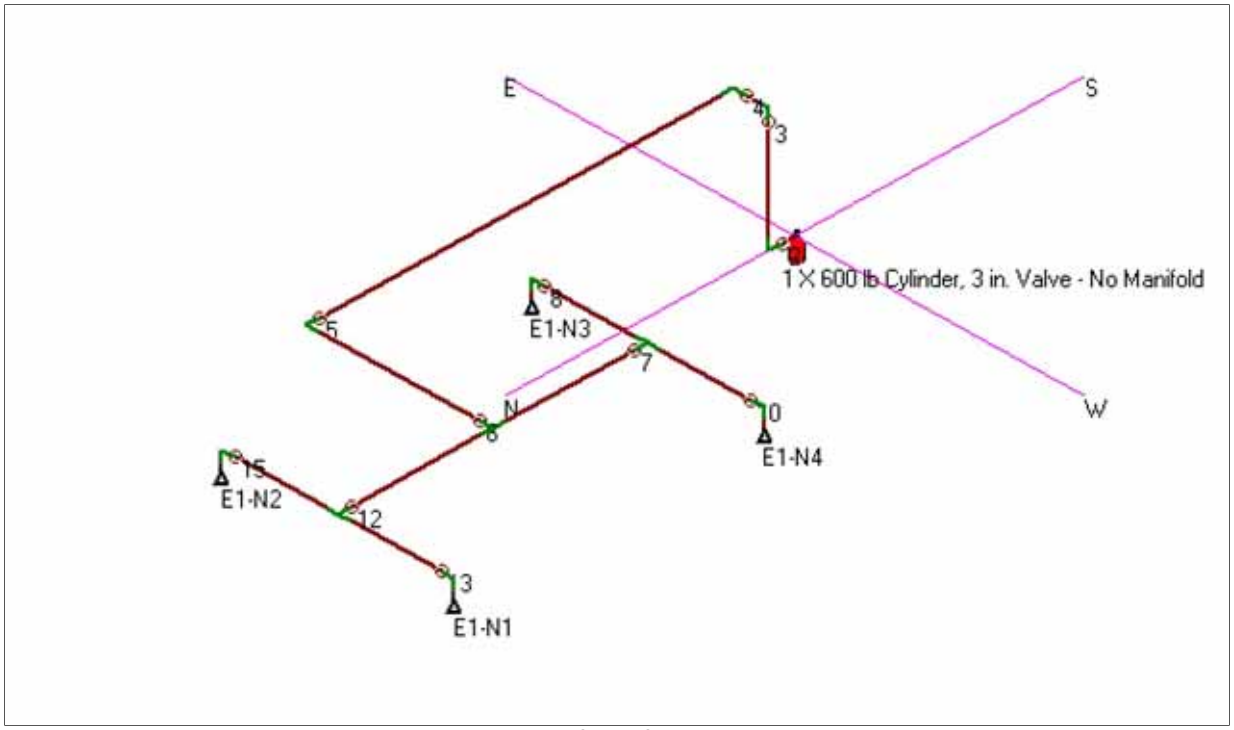
Enclosure Number: 1
Enclosure Name: Lower Engine Room - Port

Minimum Design Concentration: 8.700%
Adjusted Design Concentration: 8.721%
Predicted Concentration: 8.722%
Maximum Expected Agent Concentration: 10.454% (At 130 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	100.3 lbs	100.6 lbs	100.5 lbs	82 psig
E1-N2	100.3 lbs	100.6 lbs	100.5 lbs	82 psig
E1-N3	100.2 lbs	100.4 lbs	100.5 lbs	82 psig
E1-N4	100.2 lbs	100.4 lbs	100.5 lbs	82 psig

Consolidated Report

Drawing View: 2



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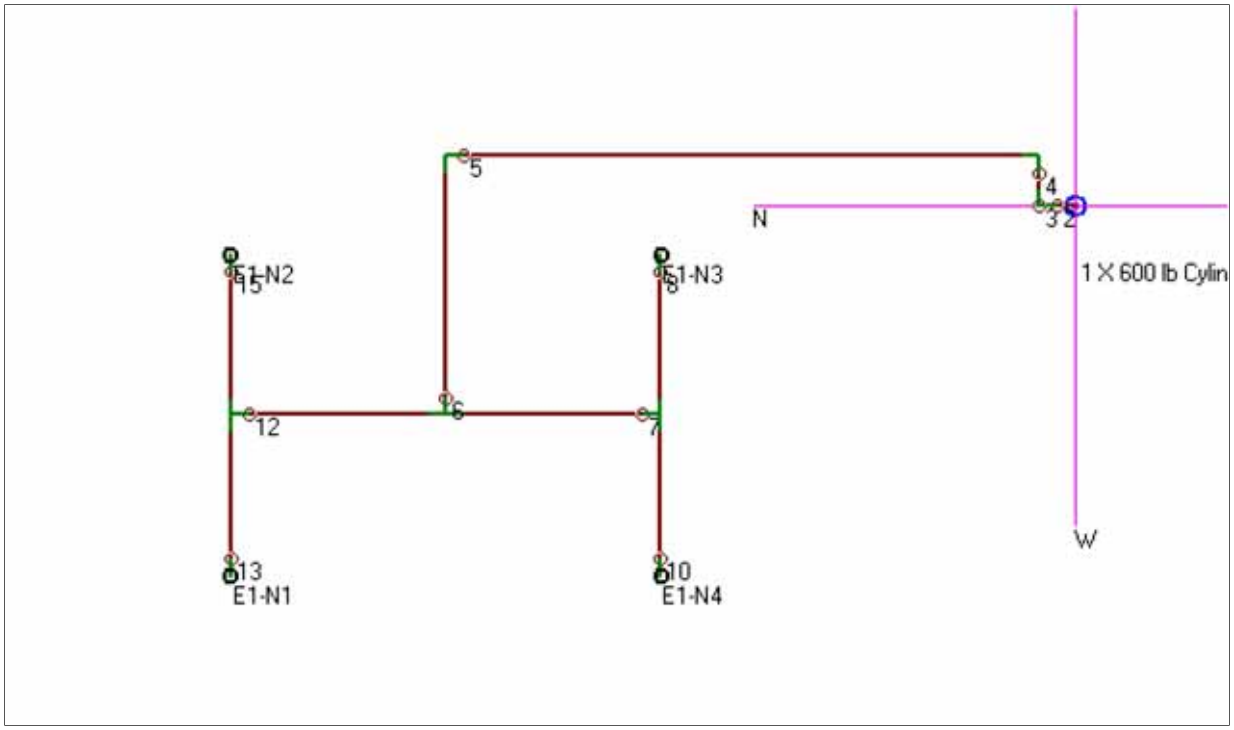
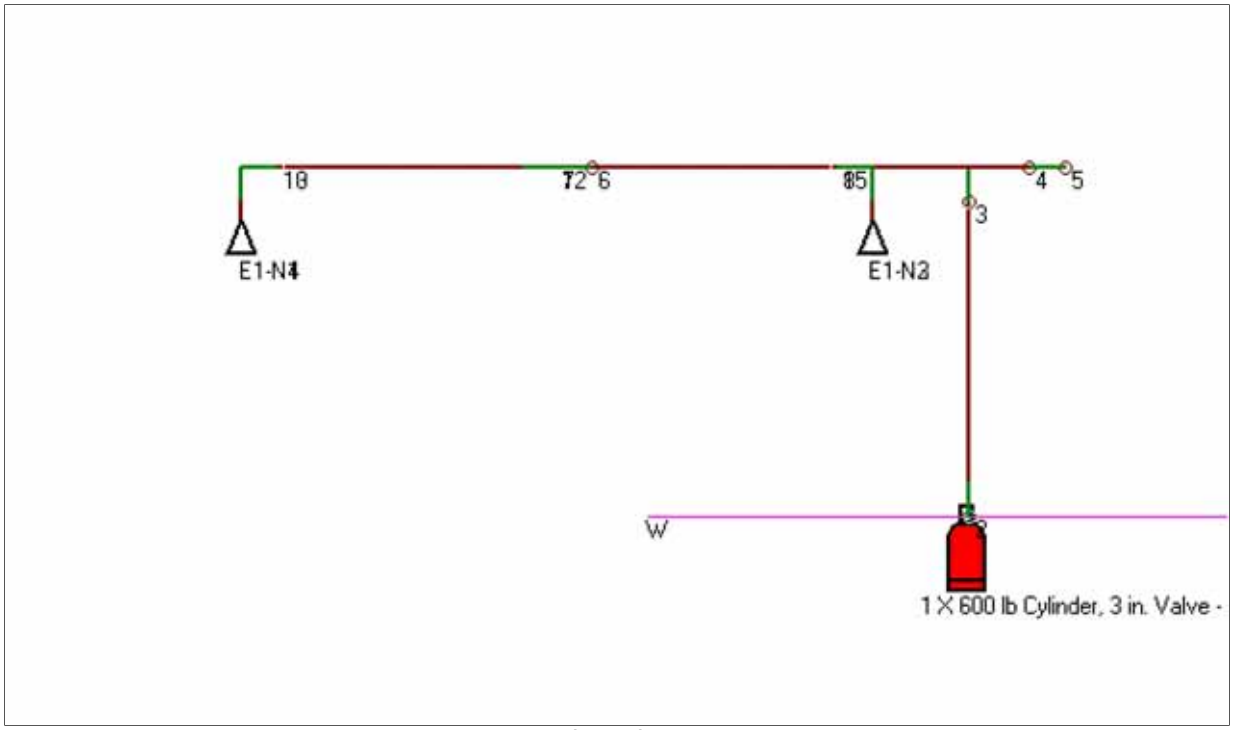


Calculation Date/Time: Thursday, June 05, 2003, 10:06:07 AM

Consolidated Report

Drawing View: 10



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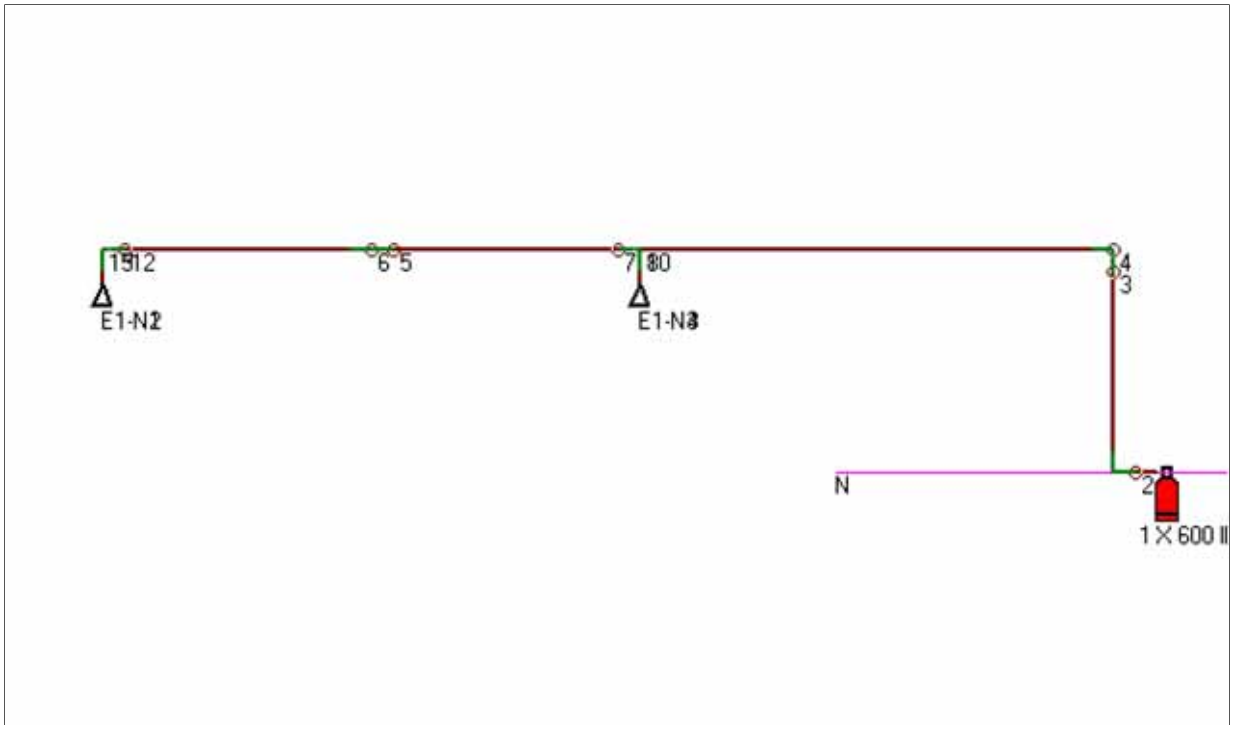


Calculation Date/Time: Thursday, June 05, 2003, 10:06:07 AM

Applications Engineering

Kidde Fenwal Inc.
400 Main Street
Ashland, MA 01721
ECS Series - KID3.01
UL: EX4674
Project: USCG FM-200 Manual, P/N 90-FM200M-021
File Name: C1-2464013-02C.FLC

Consolidated Report

Customer Information

Company Name:	Kidde-Fenwal, Inc.
Address:	400 Main Street Ashland, MA
Phone:	(508) 881-2000
Contact:	
Title:	

Project Data

Project Name:	USCG FM-200 Manual, P/N 90-FM200M-021
Designer:	
Number:	1-2464013
Account:	
Location:	
Description:	Typical FM-200 System for USCG Approval - Cylinders Located Inside Protected Space

Calculation Date/Time: Thursday, June 05, 2003, 10:11:03 AM

Kidde Fire Systems

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1

Enclosure Number:	1
Name:	Lower Engine Room - Starboard
Enclosure Temperature...	
Minimum:	32 F
Maximum:	130 F
Maximum Concentration:	10.454 %
Design Concentration...	
Adjusted:	8.721 %
Minimum:	8.700 %
Minimum Agent Required:	401.0 lbs
Width:	0.0 ft
Length:	0.0 ft
Height:	0.0 ft
Volume:	8550.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	8550.0 cubic ft
Adjusted Agent Required:	402.0 lbs
Number of Nozzles:	2

Consolidated Report
Agent Information

Agent: FM-200 / Propellant N2
(FM-200 is a Trademark of Great Lakes Chemical Corp.)

Adjusted Agent Required:	402.0 lbs
Container Name:	600 lb Cylinder, 3 in. Valve
Container Part Number:	90-100600-100
Number of Main Containers:	1
Number of Reserve Containers:	0
Manifold:	No Manifold
Pipe Take Off Direction:	Horizontal
Agent Per Container:	402.0 lbs
Fill Density:	46.9 lbs / cubic ft
Container Empty Weight:	360.0 lbs
Weight, All Containers + Agent:	762.0 lbs
Floor Area Per Container:	2.64 square ft
Floor Loading Per Container:	289 lbs / square ft

Pipe Network

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Main Cyl. X 1	0	1		3 in	4.00 ft	4.00 ft
Pipe	1	2	40T	2 in	1.00 ft	0.00 ft
Pipe	2	3	40T	2 in	8.00 ft	8.00 ft
Pipe	3	4	40T	2 in	12.50 ft	0.00 ft
Pipe	4	5	40T	2 in	3.75 ft	0.00 ft
Pipe	5	6	40T	1-1/2 in	7.00 ft	0.00 ft
Pipe/E1-N1	6	7	40T	1-1/2 in	0.50 ft	-0.50 ft
Pipe	5	8	40T	1-1/2 in	7.00 ft	0.00 ft
Pipe/E1-N2	8	9	40T	1-1/2 in	0.50 ft	-0.50 ft

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
0	1	0	0	0	0	0		0.00 ft	50.0 ft
1	2	0	0	0	0	0		0.00 ft	1.0 ft
2	3	1	0	0	0	0		0.00 ft	13.5 ft
3	4	1	0	0	0	0		0.00 ft	18.0 ft
4	5	1	0	0	0	0		0.00 ft	9.3 ft
5	6	0	0	0	1	0		0.00 ft	15.7 ft
6	7	1	0	0	0	0		0.00 ft	4.8 ft
5	8	0	0	0	1	0		0.00 ft	15.7 ft
8	9	1	0	0	0	0		0.00 ft	4.8 ft

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	402.0 lbs				
1	2	402.0 lbs				
2	3	402.0 lbs				
3	4	402.0 lbs				
4	5	402.0 lbs				
5	6	201.0 lbs				
6	7	201.0 lbs	E1-N1	1-1/2 in	360°	1.0717 square in
5	8	201.0 lbs				
8	9	201.0 lbs	E1-N2	1-1/2 in	360°	1.0717 square in

Parts Information

Total Agent Required: 402.0 lbs
Container Name: 600 lb Cylinder, 3 in. Valve (Part: 90-100600-100)
Number Of Containers: 1

Nozzle	Type	Nozzle Area	Part Number
E1-N1	360°	1.0717 square in	90-194027-413
E1-N2	360°	1.0717 square in	90-194027-413

Pipe:	Type	Diameter	Length

Calculation Date/Time: Thursday, June 05, 2003, 10:11:03 AM

Pipe:	Type	Diameter	Length
	40T	1-1/2 in	15.00 ft
	40T	2 in	25.25 ft

List of 90 degree elbows:
2 - 1-1/2 in
3 - 2 in

List of Tees:
1 - 2 in

System Acceptance

System Discharge Time: 9.4 seconds
Percent Agent In Pipe: 21.9%
Percent Agent Before First Tee: 17.3%

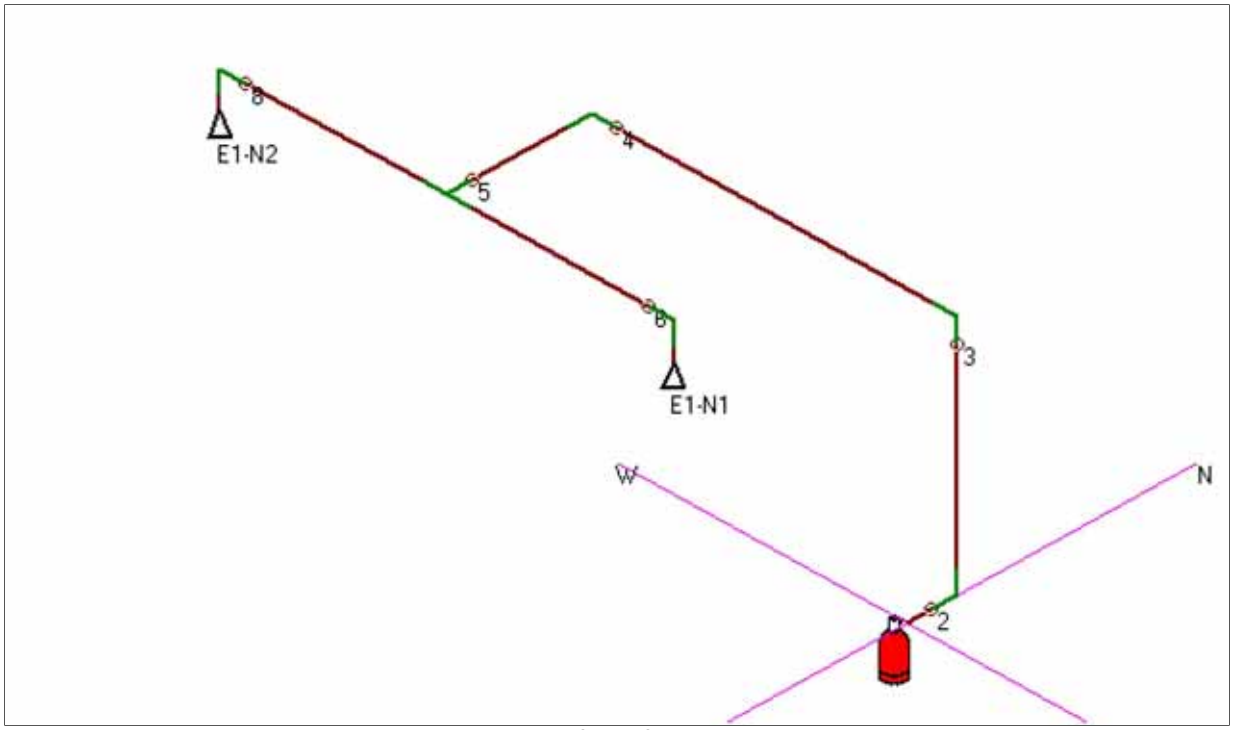
Enclosure Number: 1
Enclosure Name: Lower Engine Room - Starboard

Minimum Design Concentration: 8.700%
Adjusted Design Concentration: 8.721%
Predicted Concentration: 8.722%
Maximum Expected Agent Concentration: 10.454% (At 130 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	200.5 lbs	201.0 lbs	201.0 lbs	138 psig
E1-N2	200.5 lbs	201.0 lbs	201.0 lbs	138 psig

Consolidated Report

Drawing View: 2



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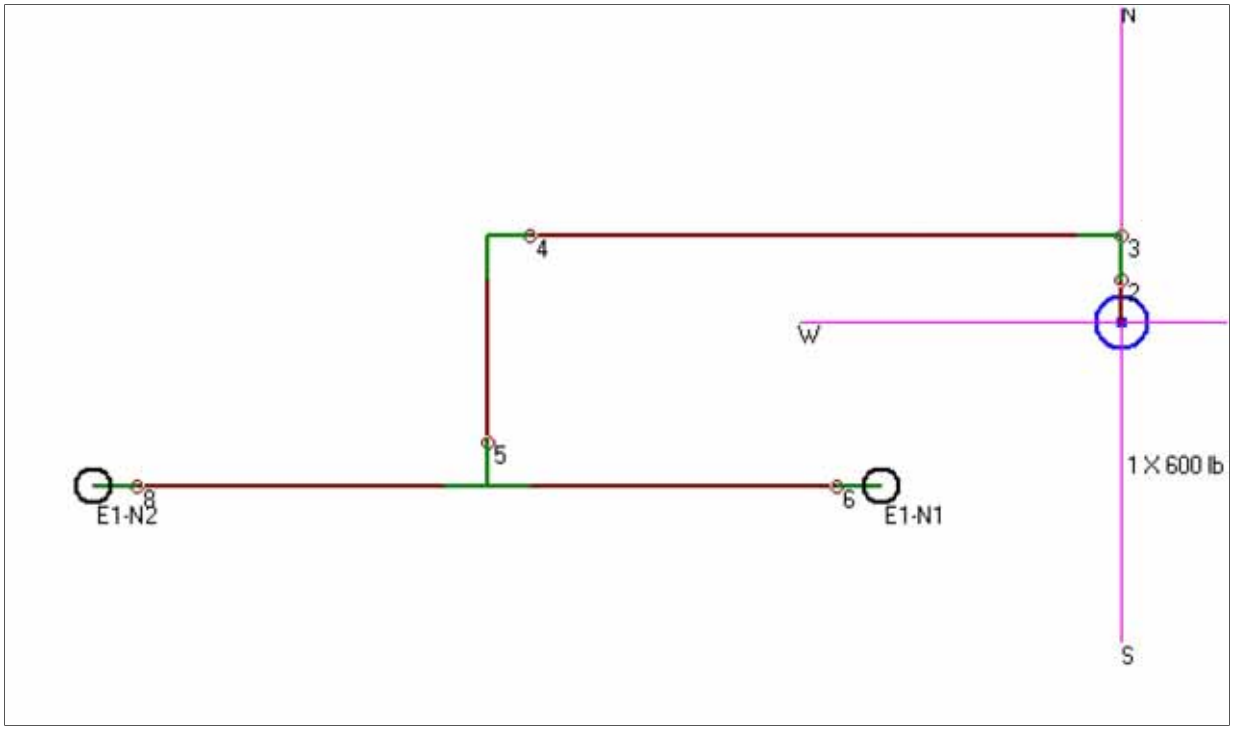
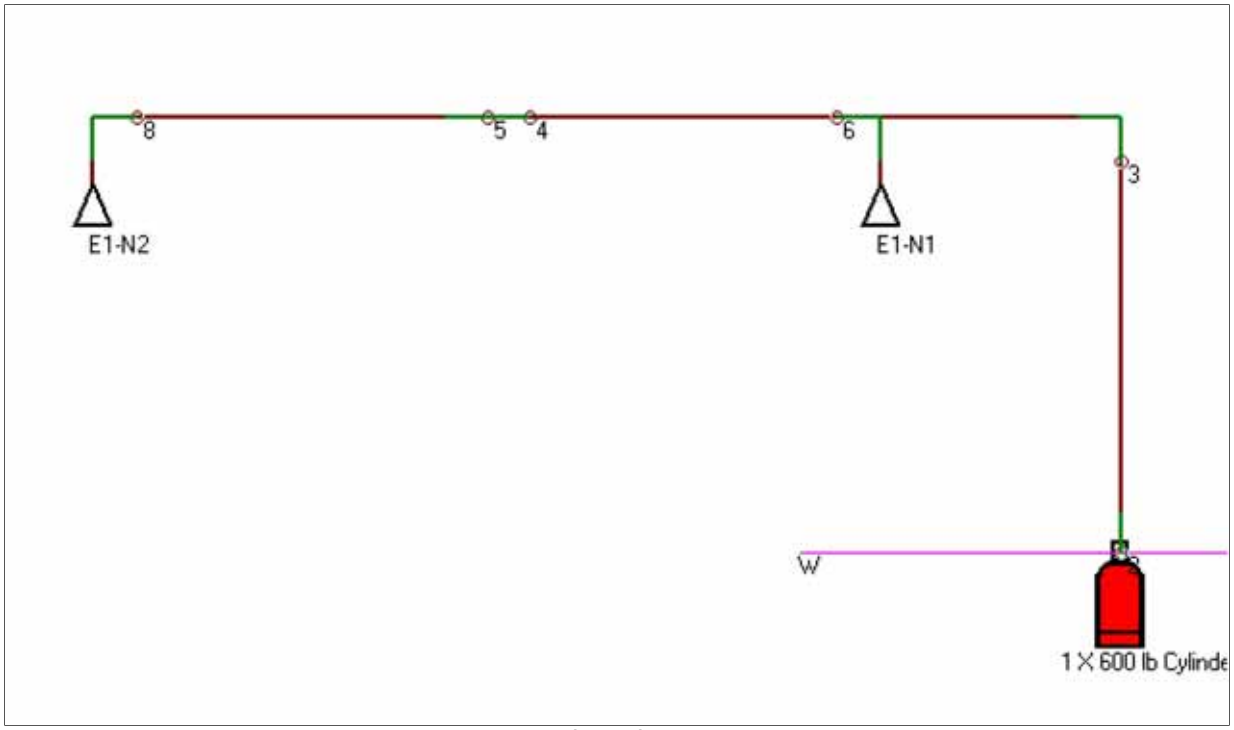


Calculation Date/Time: Thursday, June 05, 2003, 10:11:03 AM

Consolidated Report

Drawing View: 10



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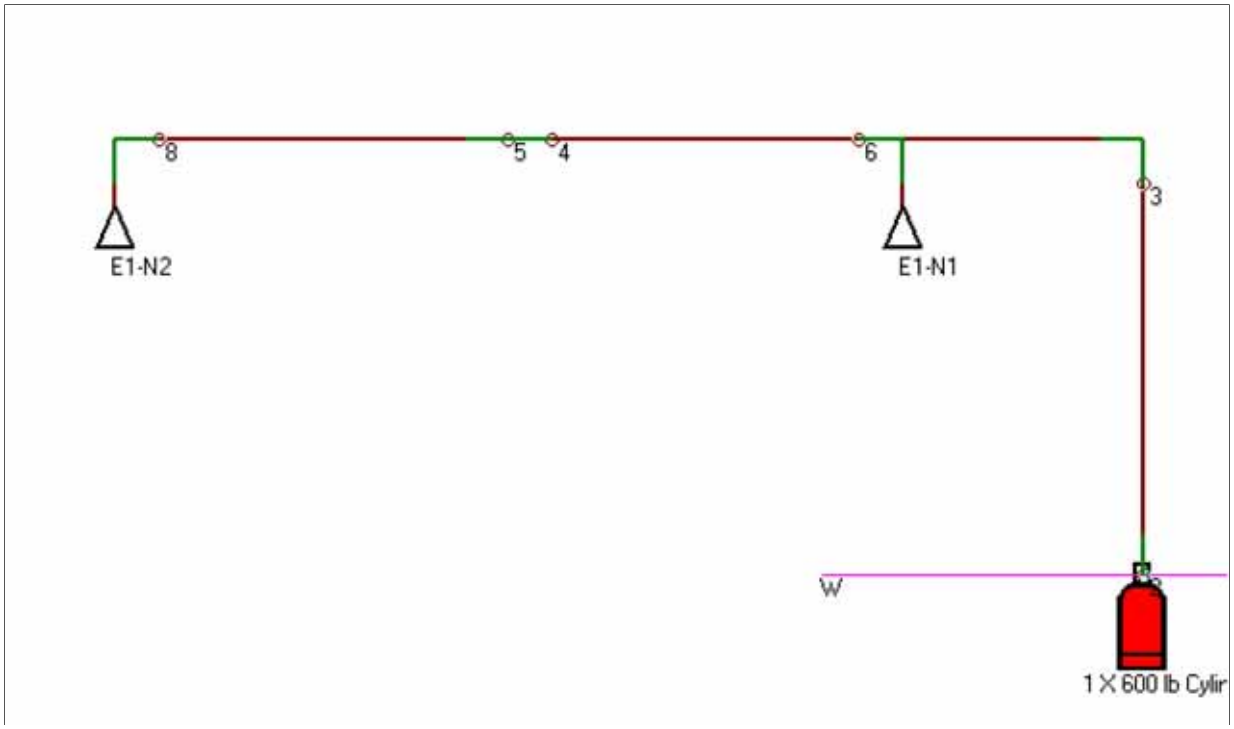

Calculation Date/Time: Thursday, June 05, 2003, 10:11:03 AM

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APPENDIX D

ACTUATION CIRCUIT CONFIGURATION

D-1 CYLINDER STORAGE LOCATION

United States Coast Guard (USCG) has discontinued the approval of cylinders inside protected spaces of greater than 6,000 ft.^{3}. USCG had previously issued a certificate of approval to Kidde (Approval Number: 162.161/1/0) which allowed FM-200 cylinders to be located inside protected spaces of greater than 6,000 ft.^{3}. The period of the approval was from 2003 to 2007, including projects contracted, but not completed prior to 2008. USCG will still consider requests for systems with agent cylinders inside protected spaces of greater than 6,000 ft.^{3} on a vessel-by-vessel basis.

In order to maintain USCG approval, the material in the following sections has been deleted:

- 4-2.6.3.1
- 4-2.6.3.2
- 4-2.7.2

Refer to FM-200 Marine ECS Series Engineered Fire Suppression System Design, Installation, Operation, and Maintenance Manual, P/N 90-FM200M-021, dated January 2003 for this information. Please contact USCG for further information on this subject.

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Kidde Fire Systems

A UTC Fire & Security Company

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Ashland, MA 01721
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Fax: 508.881.8920
www.kiddefiresystems.com

06-236225-001 Rev. AB