P/N 45-N1230M-001
February 2005

Kidde Engineered Fire Suppression System

Designed for use with 3M™ Novec™ 1230 Fire Protection Fluid

Design, Installation, Operation and Maintenance Manual

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Kidde Fire Systems

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FOREWORD

Note: This Manual, P/N 45-N1230M-001, is to be used by qualified and factory-trained personnel, knowledgeable of NFPA standards and any other applicable standards in effect.

This manual is intended to clearly and accurately reflect the Kidde Engineered Fire Suppression System designed for use with 3M™ Novec™ 1230 Fire Protection Fluid. This publication describes the operation, installation and maintenance of the 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.

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TERMS AND ABBREVIATIONS

ADA:	Americans with Disabilities Act	N.C.:	Normally Closed
AH:	Ampere Hour	NFPA:	National Fire Protection Association
AWG:	American Wire Gauge	N.O.:	Normally Open
CO2:	Carbon Dioxide	P/N:	Part Number
DC:	Direct Current	UL/ULI:	Underwriters Laboratories, Inc.
FM:	FM Approvals	ULC:	Underwriters Laboratories of Canada
H_20	Water	V:	Volts
HVAC:	Heating, Venting and Air Conditioning	Vac:	Volts AC
Hz:	Hertz (Frequency)	Vdc:	Volts DC
mA:	Milliamperes		

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SAFETY SUMMARY

Kidde Engineered 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 Kidde Engineered System equipment and follow the instructions used in this manual and in the Safety Bulletin.

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.

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 cylinders 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 Cylinders: Cylinders must be shipped compactly in the upright position, and properly secured in place. Cylinders 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: Cylinders must not be dropped or permitted to strike violently against each other or other surfaces.

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

For additional information on safe handling of compressed gas cylinders, see CGA Pamphlet PI titled “Safe Handling of Compressed Gases in Cylinders”. 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

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

BEFORE handling Kidde system products, all personnel must be thoroughly trained in the safe handling of the cylinders 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

1. Each Kidde Engineered System 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.
2. 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.

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

Protection Cap

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

Installation

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

1. Install cylinder into bracketing.

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

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

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

Removal From Service

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

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

4. Remove cylinder from bracketing.

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

DEFINITIONS

CAUTION **Indicates an imminently hazardous situation which, if not avoided, could result in death, serious bodily injury and/or property damage.**

CAUTION **Indicates a potentiality hazardous situation which, if not avoided, could result in property or equipment damage.**

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CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

The Kidde Engineered Fire Suppression System designed for use with 3M™ Novec™ 1230 Fire Protection Fluid is the newest addition to our vast product line. Kidde Engineered Systems are designed to suppress fires in specific hazards or equipment located where an electrically non-conductive agent is required, where agent cleanup creates a problem, where extinguishing capability with low weight is a factor and where the hazard is normally occupied by personnel. Novec 1230 fluid is an acceptable alternative to Halon and is approved by the EPA and NFPA for use in fire suppression systems. Key features of Novec 1230 fluid are:

- People safe at concentration levels required to suppress fire
- Zero ozone depletion potential
- Atmospheric lifetime of five days
- Colorless, with low odor with no particulate or oily residue allowing for minimal business disruption after a discharge
- Electrically non-conductive
- Space saving; quantity of Novec 1230 fluid needed to suppress fires typically required minimal cylinders, thus minimal space required.

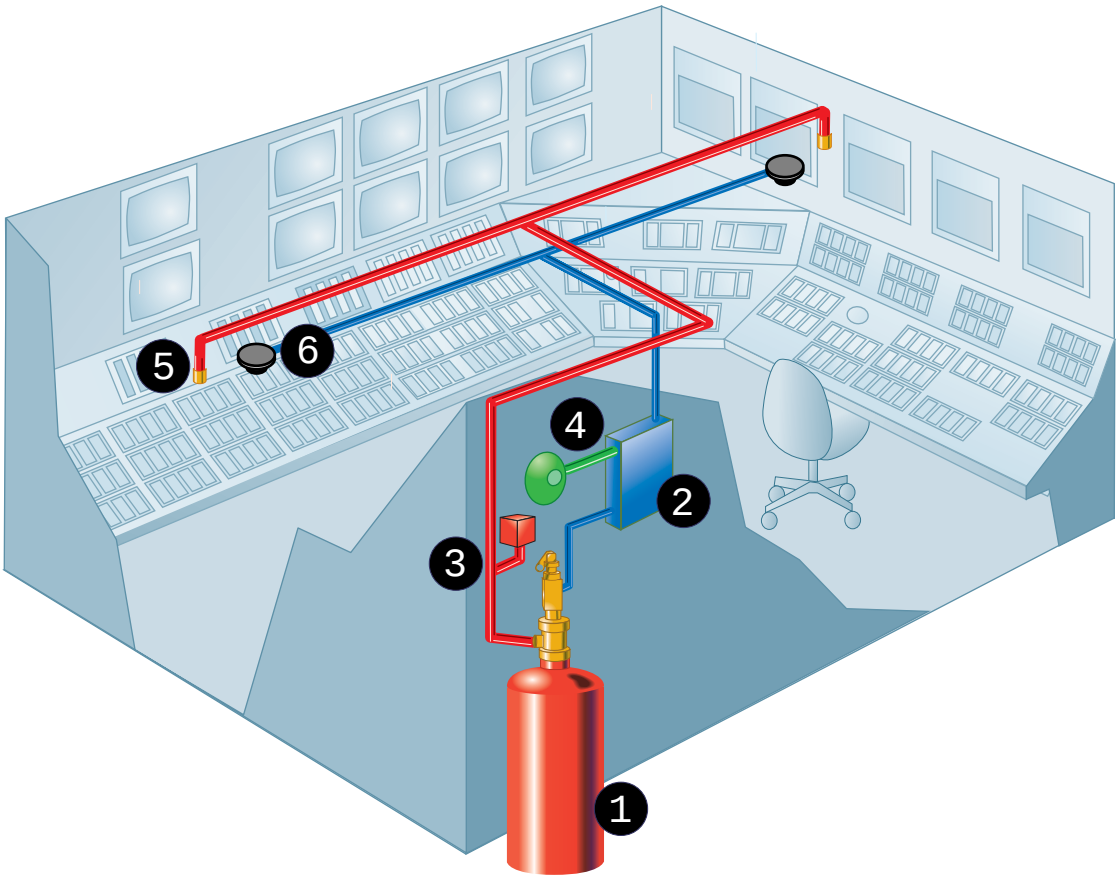
Kidde Engineered Systems are intended to protect the following:

- Petrochemical Installations
- Gas Turbines
- Steam Turbine Generators
- Railway Traffic Controls
- Power Generation Plants
- Electrical Equipment
- Printing Facilities
- Electric Furnaces
- Food Packaging Facilities
- Packaging Plants

1-2 SYSTEM DESCRIPTION

1-2.1 General

Kidde Engineered Systems combine an environmentally safe fire suppression agent (Novec 1230 fluid), highly effective detection devices and specially developed components for fast agent discharge. The resulting rapid suppression of a fire reduces property damage and products of combustion to the lowest possible level. These systems are electrically, pressure and/or cable operated, with a normal design discharge time of less than ten seconds. Agent storage containers can be strategically located throughout a protected zone, eliminating expensive piping.



Key

1. Cylinder and Valve Assembly
2. UL Listed Control Panel (e.g., Kidde PEGAsys)
3. Pressure Switch
4. Alarm
5. Nozzle
6. Detector (e.g., Photoelectric, Ion)

Figure 1-1. Typical Kidde Engineered System

Kidde Engineered Systems are designed for the following classes of fire:

- Class A Surface Type Fires; Wood or other cellulose-type material
- Class B; Flammable liquids (see Table 3-1)
- Class C; Energized electrical equipment

For hazards beyond the scope described in this manual, the designer must consult with Kidde and NFPA 2001 on the suitability of Novec 1230 fluid for the protection, necessary design concentration and personnel exposure effects from that concentration.

Novec 1230 fluid shall not be used on fires involving the following materials, unless they have been tested to the satisfaction of the Authority Having Jurisdiction (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.

1-2.2 Extinguishing Agent

Novec 1230 fluid is a Flurorinaized Ketone (FK-5-1-12) Dodecafluoro-2-methylpentan-3-one) compound of carbon, fluorine and oxygen ($CF_3CF_2C(O)CF(CF_3)_2$). It is colorless, electrically non-conductive and has a low odor. It suppresses fire by a combination of chemical and physical mechanisms with minimal affect on the available oxygen. This allows people to see and breathe, permitting them to leave the fire area safely.

Novec 1230 fluid is acceptable for use in occupied spaces when used in accordance with the United States Environmental Protection Agency (EPA) Significant New Alternatives Policy (SNAP) program rules.

Although Novec 1230 fluid 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 Novec 1230 fluid may create a hazard to people from the undecomposed agent itself and from the decomposition products which result when the agent is exposed to fire or other hot surfaces. Exposure to the agent is generally of less concern than is exposure to the decomposition products. Unnecessary exposure to the agent or the decomposition products should be avoided.

1-2.2.1 TOXICITY

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

Novec 1230 fluid has been evaluated for cardiac sensitization in accordance with test protocols approved by the United States Environmental Protection Agency (U.S. EPA). The EPA's SNAP Program classifies Novec 1230 fluid 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. Novec 1230 fluid 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, Kidde Engineered Systems designed for use with agent vapor concentrations up to ten volume percent in air are permitted. See NFPA 2001, Sect. 1-6, *Safety.* Although Novec 1230 fluid 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 Novec 1230 fluid has negligible toxicity in concentrations needed to suppress most fires, certain safety considerations must be observed when applying and handling the agent. For example, Novec 1230 fluid is a liquid at room temperature and has been superpressurized with dry nitrogen. 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

During combustion of Novec 1230 fluid at high temperatures, hazardous decomposition or by-products (halogen acids) are produced. If Novec 1230 fluid is discharged in 10 seconds or less, flames will be extinguished rapidly and the amount of by-products produced will be minimal.

1-2.2.3 CLEANLINESS

Novec 1230 fluid 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 Novec 1230 fluid.

1-2.2.4 OTHER SAFETY CONSIDERATIONS

The high pressure discharge of Novec 1230 fluid 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 in extreme cases.

Novec 1230 fluid itself is colorless. Discharge of Novec 1230 fluid into a humid atmosphere may cause fog and reduce visibility for a short time.

1-2.2.5 STORAGE

Novec 1230 fluid is stored in steel containers at 360 PSIG at 70°F (25 bar at 21°C) as a liquid with nitrogen added to improve the discharge characteristics. The pressure of the stored Novec 1230 fluid varies substantially with temperature changes, as illustrated in Figure 1-2. When discharged, the Novec 1230 fluid liquid vaporizes at the discharge nozzles and is uniformly distributed as it enters the fire area.

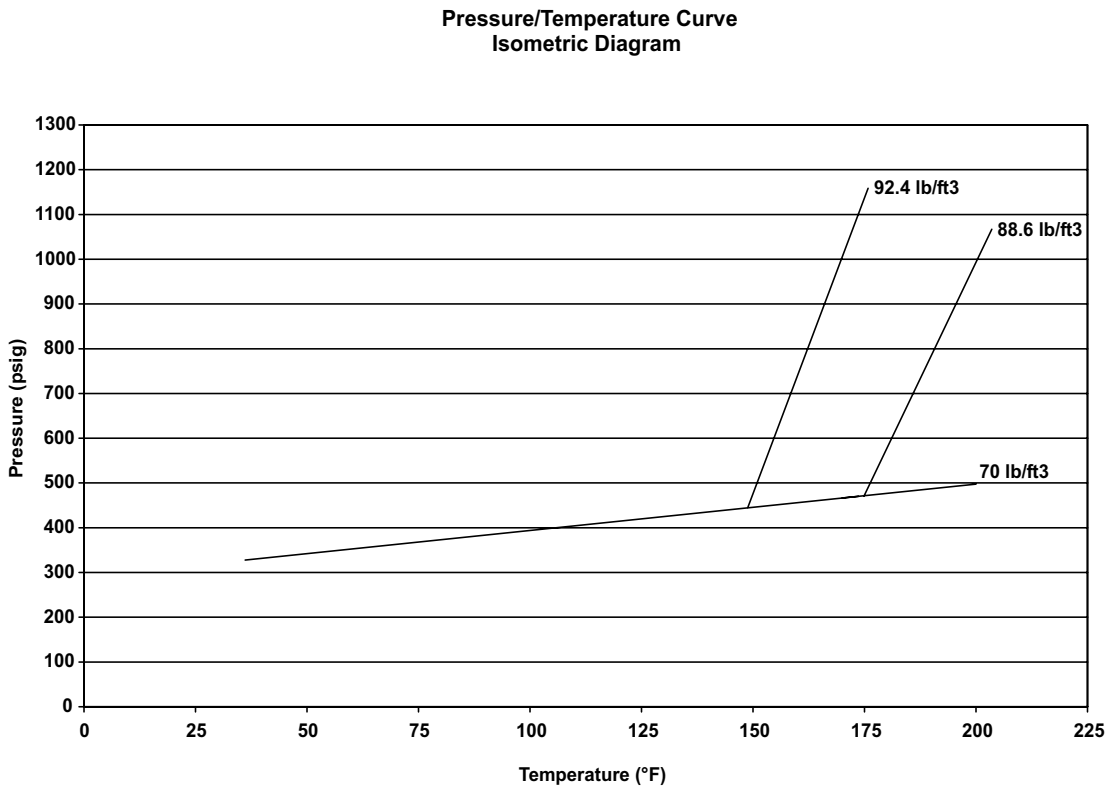


Figure 1-2. Novec 1230 Fluid
Pressure/Temperature Curve Isometric Diagram, Imperial

Table 1-1. Novec 1230 Fluid Physical Properties, Imperial Units

Description	Units	Measurement
Molecular Weight	N/A	316.04
Boiling Point at 1 atm	°F	120.6
Freezing Point	°F	-162.4
Critical Temperature	°F	335.6
Critical Pressure	psia	270.44
Critical Volume	$ft.^3/lbm$	0.0251
Critical Density	$lbm/ft.^3$	39.91
Specific Heat, Liquid at 77°F	Btu/lb-°F	0.2634
Specific Heat, Vapor at Constant Pressure (1 atm) and 77°F	Btu/lb-°F	0.2127
Heat of Vaporization at Boiling Point	Btu/lb	37.9
Relative Dielectric Strength 1 atm at, 77°F (N_2 = 1)	N/A	2.3
Solubility of Water in Novec 1230 fluid @ 77°F	N/A	<0.001% by wt.
Note: NFPA 2001 Reference: FK-5-1-12 Dodecafluoro-2-methylpentan-3-one		

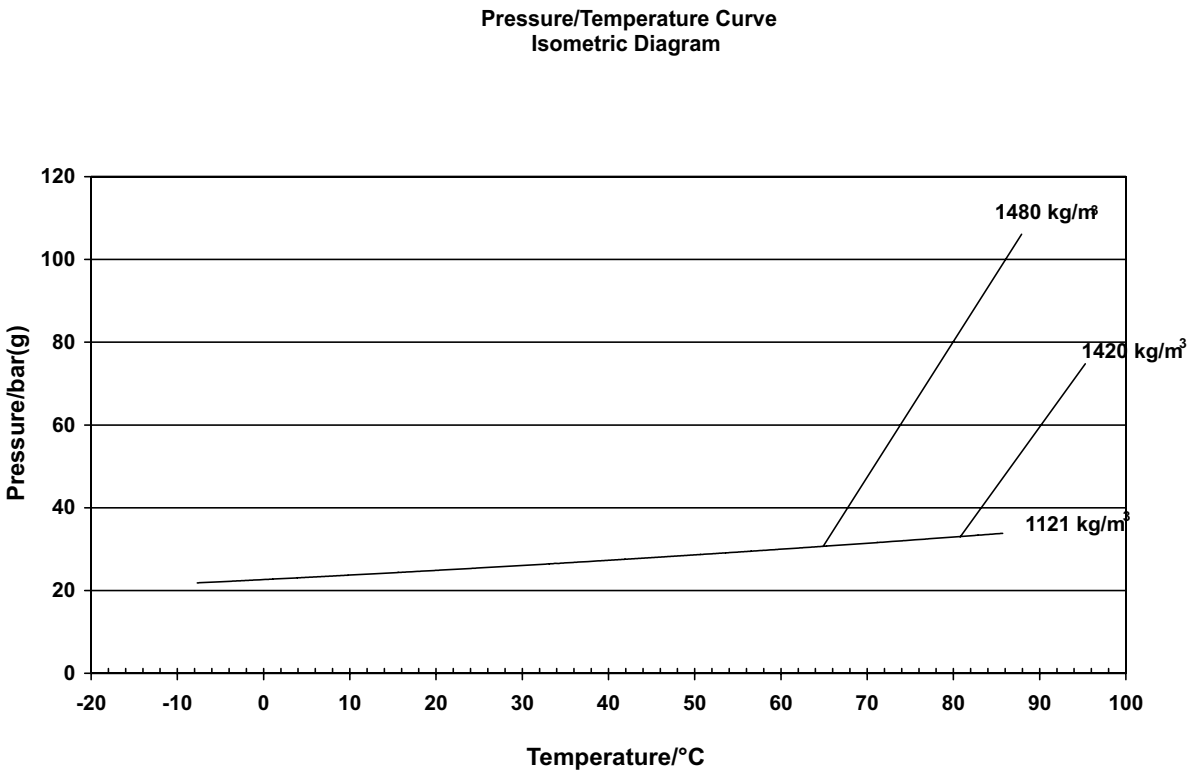


Figure 1-3. Novec 1230 Fluid
Pressure/Temperature Curve Isometric Diagram, Metric

Table 1-2. Novec 1230 Fluid Physical Properties, Metric Units

Description	Units	Measurement
Molecular Weight	N/A	316.04
Boiling Point at 1 atm	°C	49.2
Freezing Point	°C	-108.0
Critical Temperature	°C	168.7
Critical Pressure	kPa	18.65
Critical Volume	cc/mole	494.5
Critical Density	kg/m3	639.1
Specific Heat, Liquid at 25°C	kJ/kg °C	1.103
Specific Heat, Vapor at Constant Pressure (1 atm) and 25°C	kJ/kg °C	0.891
Heat of Vaporization at Boiling Point at 25°C	kJ/kg °C	88.0
Relative Dielectric Strength 1 atm at 734 mm Hg, 25°C (N_2 = 1.0)	N/A	2.3
Solubility of Water in Novec 1230 fluid @ 25°C	N/A	0.001% by weight
Note: NFPA 2001 Reference=FK-5-1-12=Dodecafluoro-2-Methylpentan-3-one		

CHAPTER 2
COMPONENT DESCRIPTIONS

2-1 INTRODUCTION

This chapter provides a functional description of the modules and assemblies in the Kidde Engineered Fire Suppression System designed for use with 3M™ Novec™ 1230 Fire Protection Fluid.

2-2 FUNCTIONAL DESCRIPTION

Novec 1230 fluid is held in the agent storage cylinder by a discharge valve. When the discharge valve is actuated, the superpressurized fluid discharges through the valve outlet and is directed through the distribution piping to the nozzles. The nozzles provide the proper flow rate and distribution of Novec 1230 fluid.

The Kidde Engineered System is composed of the following components and assemblies:

- Cylinder and Valve Assembly
- Liquid Level Indicator (optional)
- Control Head (Electric, Cable Operated, Lever Operated, Pressure Operated and electric and Cable Operated)
- Pressure Gauge
- Straps and Brackets for mounting the cylinder
- Cable Manual Pull Station
- Nitrogen Actuator and Mounting Bracket
- Actuation Hose
- Flexible Discharge Hose
- Master Cylinder Adapter Kit
- Tees, Elbows and Adapters
- Check Valve
- Valve Outlet Adapter
- Discharge Nozzle
- Discharge Indicator
- Corner Pulley
- Supervisory Pressure Switch (optional)
- Hydrostatic Test Adapter
- Cylinder Recharge Adapter
- Cylinder Seating Adapter
- Main-to-Reserve Transfer Switch
- Manifold El-Check
- Detectors
- Pressure Operated Switch and Trip
- Control Panel

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

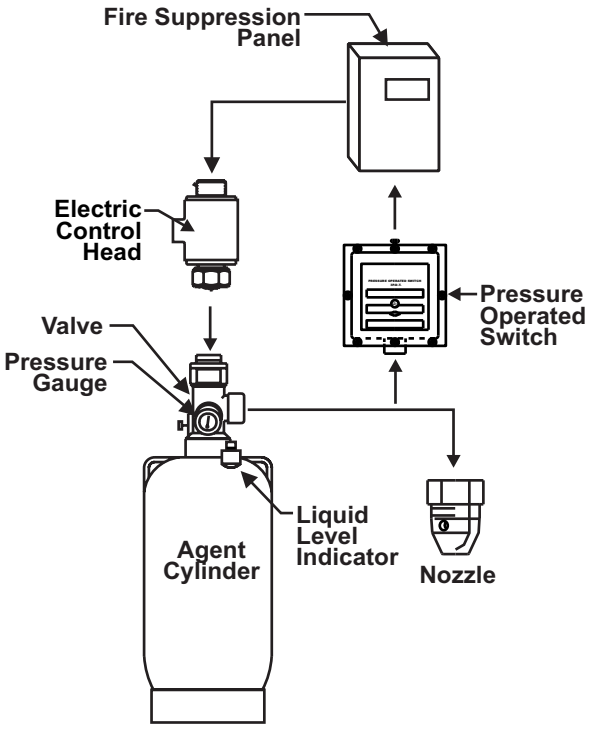


Figure 2-1. Typical Kidde Engineered System with Electric Control Head

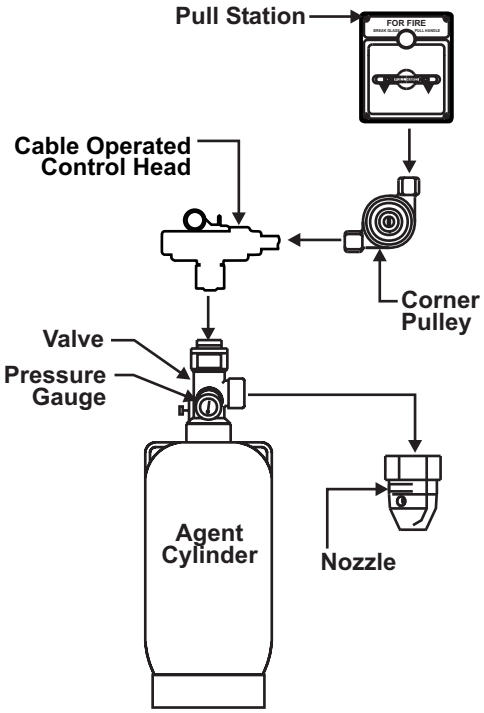


Figure 2-2. Typical Kidde Engineered System with Cable Operated Control Head

2-3 COMPONENT DESCRIPTIONS

2-3.1 Kidde Engineered System Cylinders

2-3.1.1 CYLINDER AND VALVE ASSEMBLIES

Novec 1230 fluid 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 and 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 and valve assembly is not connected to the system piping. Failure to install the safety cap could result in violent movement of the cylinder in the event of inadvertent actuation. Failure to follow these instructions could cause personal injury and/or property damage.

The Kidde Engineered System equipment listed herein is designed for an operating temperature range of 0°F to 130°F (-17°C to 54°C). Table 2-2 shows the cylinder temperature-pressure relationship based on a maximum fill density of 70 lb./ft.^{3} (1121 kg/m^3). The Kidde Engineered Fire Suppression System Flow Calculation Program is designed for a 70°F (21°C) cylinder operating/storage temperature. Therefore, the cylinder 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 cylinder operating and storage temperature is outside this range, and insufficient quantity of agent may be discharged from one or more discharge nozzles.

Figure 2-3 through Figure 2-5 represent typical cylinder assemblies. Table 2-2 identifies cylinder dimensions.

If desired, the 125, 200, 350, 600 and 900 lb. cylinders can be provided with an integral liquid level indicator (see Paragraph 2-3.1.2).

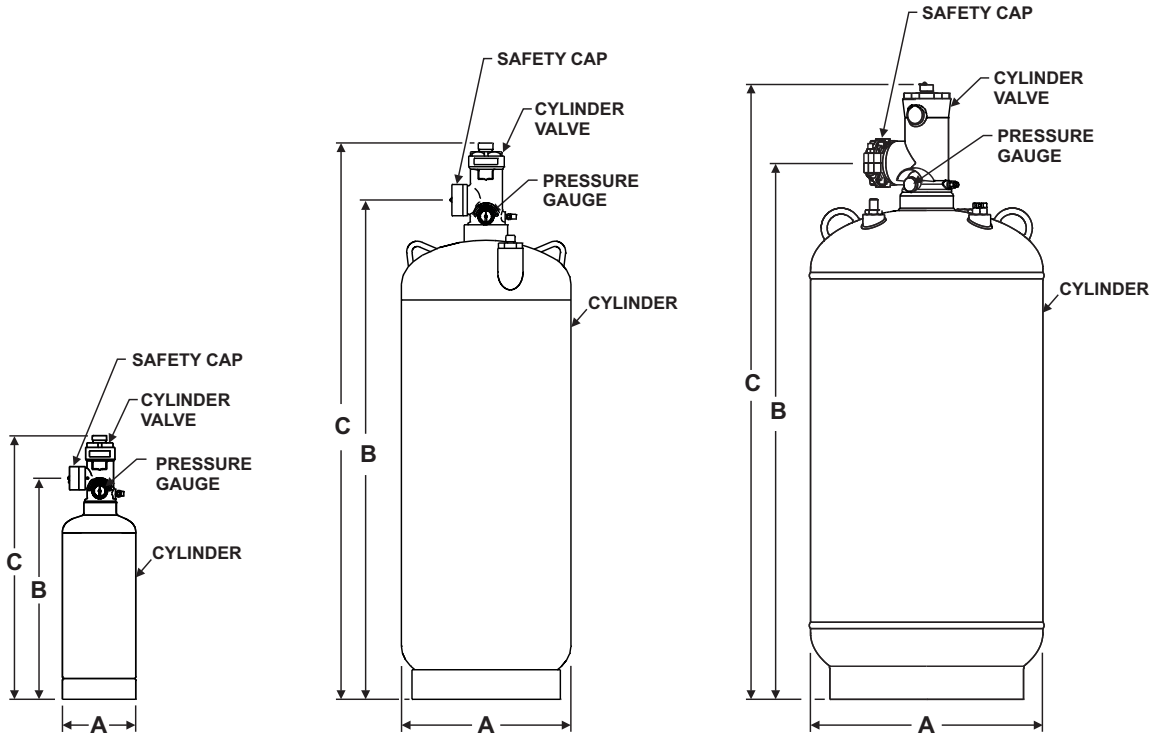


Figure 2-3. Typical Cylinder Assembly, 10 to 900 lb.

Table 2-1. Dimensions. Cylinder and Valve Assemblies for Vertical Installation Only

Part Number	Valve	w/ LLI	Height (C)		Diameter (A)		Volume		Valve Outlet Height	
			C		A				B	
			in.	mm	in.	mm	$ft.^3$	m^3	in.	mm
45-100010-001	1½	No	17.30	439	7.07	180	0.167	0.0047	13.3	338
45-100020-001	1½	No	24.97	634	7.07	180	0.286	0.0081	21.0	533
45-100040-001	1½	No	26.76	680	9.00	229	0.572	0.0162	22.8	579
45-100070-001	1½	No	38.83	986	9.00	229	1.000	0.0283	34.9	887
45-100121-001	1½	Yes	35.93	913	12.75	324	1.788	0.0506	32.0	813
45-100125-001	1½	No	35.93	913	12.75	324	1.788	0.0506	32.0	813
45-100200-001	2	No	52.75	1340	12.75	324	2.859	0.0810	47.5	1207
45-100201-001	2	Yes	52.75	1340	12.75	324	2.859	0.0810	47.5	1207
45-100350-001	2	No	58.36	1482	16.00	406	5.000	0.1416	53.1	1349
45-100351-001	2	Yes	58.36	1482	16.00	406	5.000	0.1416	53.1	1349
45-100600-001	3	No	58.00	1473	22.00	559	8.680	0.2460	50.5	1283
45-100601-001	3	Yes	58.00	1473	22.00	559	8.680	0.2460	50.5	1283
45-100900-001	3	No	70.00	1778	24.00	610	13.000	0.3680	62.0	1575
45-100901-001	3	Yes	70.00	1778	24.00	610	13.000	0.3680	62.0	1575

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

Temperature		Nominal Charge, Pressure	
°F	°C	PSIG	Bar
0	-17.8	310	21.4
10	-12.2	317	21.9
20	-6.7	324	22.3
32	0	333	23.0
40	4.4	339	23.4
50	10.0	346	23.9
60	15.6	353	24.3
70	21.1	360	24.8
80	26.7	367	25.3
90	32.2	374	25.8
100	37.8	381	26.3
110	43.3	388	26.8
120	48.9	396	27.3
130	54.4	403	27.8

As a reference guide, Table 2-3 provides the equivalent lengths for all the Kidde 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 Engineered Fire Suppression System Flow Calculation Program. Table 2-1 and Table 2-4 show the dimensions and fill range for cylinder and valve assemblies in vertical installations.

Table 2-3. Cylinder, Equivalent Lengths

Part Number	Nomenclature	Discharge Outlet	Equivalent Length w/ Valve Outlet Adapter		Equivalent Length w/ Flex Hose	
			ft.	m	ft.	m
45-100010-001	10 lb. Cylinder	1½ in.	40.9	12.5	45.2	13.8
45-100020-001	20 lb. Cylinder	1½ in.	40.9	12.5	45.2	13.8
45-100040-001	40 lb. Cylinder	1½ in.	40.9	12.5	45.2	13.8
45-100070-001	70 lb. Cylinder	1½ in.	40.9	12.5	45.2	13.8
45-10012X-001	125 lb. Cylinder	1½ in.	40.9	12.5	45.2	13.8
45-10020X-001	200 lb. Cylinder	2 in.	19.7	6.0	22.7	6.9
45-10035X-001	350 lb. Cylinder	2 in.	19.7	6.0	22.7	6.9
45-10060X-001	600 lb. Cylinder	3 in.	22.7*	6.9*	36.3	11.1
45-10090X-001	900 lb. Cylinder	3 in.	22.7*	6.9*	36.3	11.1
Note: All equivalent lengths given in Schedule 40, black pipe. 3 in. valve cylinders are equipped with a roll-groove outlet. Use a standard groove-groove connection in lieu of a valve outlet adapter.						

Table 2-4. Range Cylinder and 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
45-100010-001	6–11	2.7–5.0	25	11.4	31	14.1	36	16.3
45-100020-001	12–23	5.4–10.4	31	14.1	43	19.5	54	24.5
45-100040-001	20–40	9.1–18.1	38	17.2	58	26.3	78	35.4
45-100070-001	35–70	15.9–31.8	52	23.6	87	39.5	122	55.3
45-100121-001	63–125	28.6–56.7	98	44.5	161	73.0	223	101.2
45-100125-001	63–125	28.6–56.7	98	44.5	161	73.0	223	101.2
45-100200-001	100–200	45.4–90.7	133	60.3	233	105.7	333	151.1
45-100201-001	100–200	45.4–90.7	133	60.3	233	105.7	333	151.1
45-100350-001	175–350	79.4–158.8	201	91.2	376	170.6	551	249.9
45-100351-001	175–350	79.4–158.8	203	92.1	378	171.5	551	249.9
45-100600-001	300–600	136.1–272.2	362	164.2	662	300.3	962	436.4
45-100601-001	300–600	136.1–272.2	367	166.5	667	300.3	962	436.4
45-100900-001	455–910	206.4–412.8	505	229.1	960	435.5	1415	641.8
45-100901-001	455–910	206.4–412.8	505	229.1	960	435.5	1415	641.8

Figure 2-4 and Figure 2-5 represent the 1½ in. through 3 in. valve arrangements.

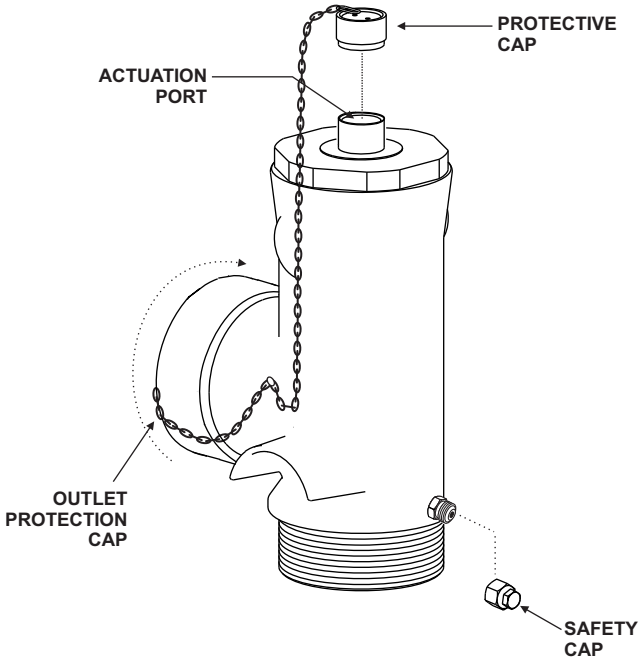


Figure 2-4. 1½ in. and 2 in. Valve General Arrangement
(P/Ns 45-140000-001 and 45-150000-001 Respectively)

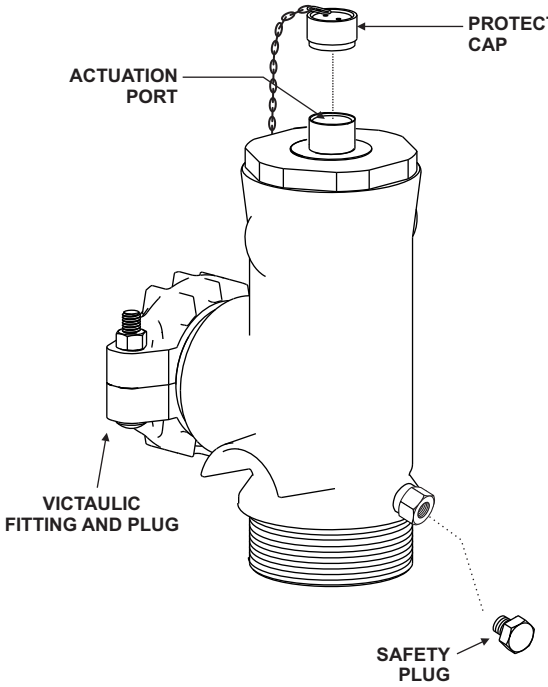


Figure 2-5. 3 in. Valve General Arrangement
(P/N 45-170000-001)

2-3.1.2 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. Kidde Engineered System cylinder. See Table 2-5 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 2-6).

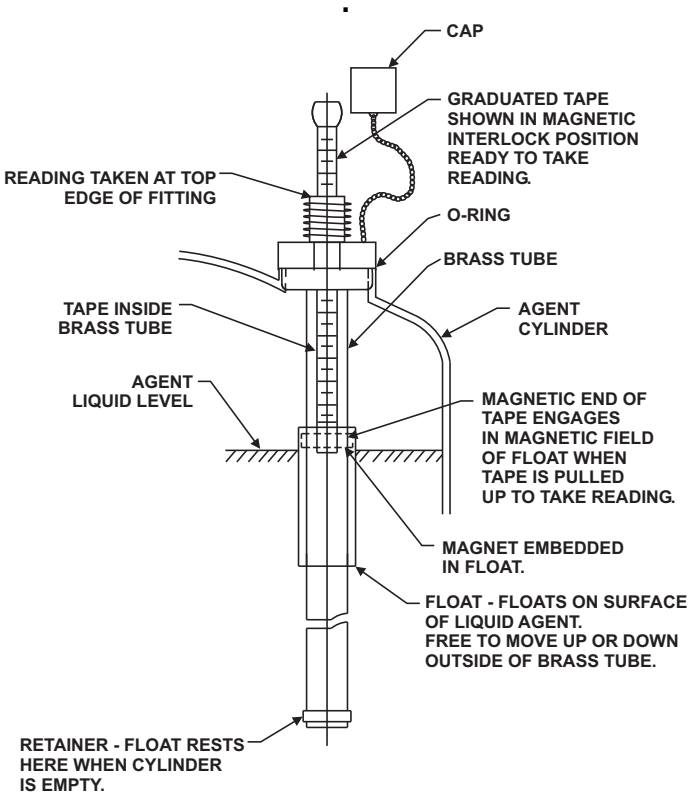


Figure 2-6. Liquid Level Indicator

Table 2-5. Liquid Level Indicator Part Numbers

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

2-3.1.3 CYLINDER MOUNTING EQUIPMENT

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

Cylinder straps (P/N 283945, 283934, 235317, 292971, 281866, 294651 and 236125) are available for all size cylinders (see Figure 2-7 and Table 2-6).

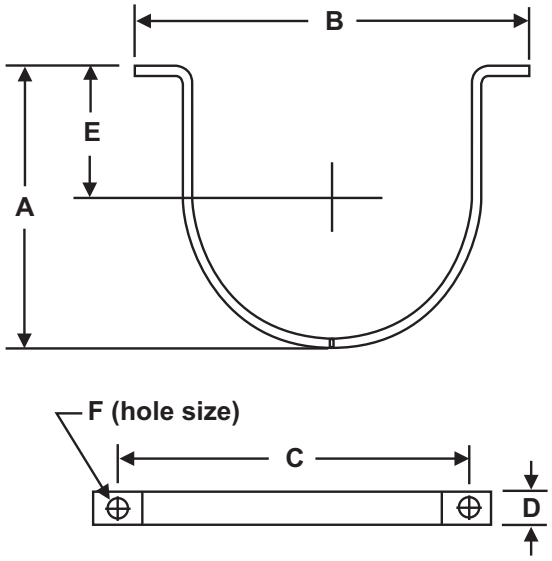


Figure 2-7. Cylinder Mounting Straps

Table 2-6. Dimensions–Cylinder Mounting Straps, Standard

Part Number	Cylinder Size	Cylinder O.D.	Dimensions					
			A	B	C	D	E	F
283945	10 lb., 20 lb.	7.07 in. (180 mm)	6.48 in. (165 mm)	9.62 in. (244 mm)	8.62 in. (219 mm)	1.00 in. (25 mm)	2.78 in. (71 mm)	0.437 in. (11 mm)
283934	40 lb., 70 lb.	9.00 in. (229 mm)	8.16 in. (207 mm)	11.69 in. (297 mm)	10.69 in. (272 mm)	1.00 in. (25 mm)	3.50 in. (89 mm)	0.437 in. (11 mm)
235317	125 lb., 200 lb.	12.75 in. (324 mm)	12.93 in. (328 mm)	16.18 in. (411 mm)	14.56 in. (370 mm)	1.75 in. (45 mm)	5.59 in. (142 mm)	0.625 in. (16 mm)
281866	350 lb.	16.00 in. (406 mm)	15.50 in. (394 mm)	19.50 in. (484 mm)	17.88 in. (454 mm)	1.75 in. (45 mm)	7.25 in. (184 mm)	0.625 in. (16 mm)
294651	600 lb.	22.00 in. (559 mm)	21.56 in. (548 mm)	25.75 in. (654 mm)	24.12 in. (613 mm)	1.75 in. (45 mm)	10.25 in. (260 mm)	0.625 in. (16 mm)
236125	900 lb.	24.00 in. (610 mm)	24.83 in. (610 mm)	27.75 in. (705 mm)	26.00 in. (660 mm)	1.75 in. (45 mm)	12.13 in. (308 mm)	0.625 in. (16 mm)

Wall brackets (P/N 486485, 486486, 486487 and 486488) are available for the 10, 20, 40 and 70 lb. size cylinders (see Figure 2-8 and Table 2-7).

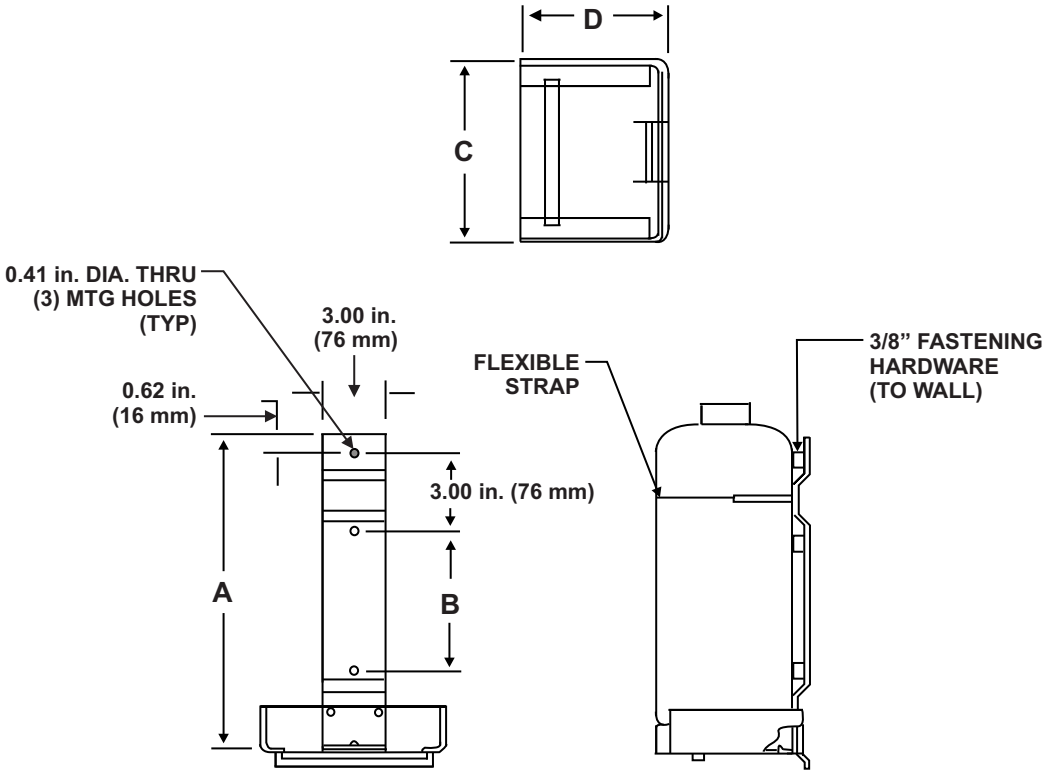


Figure 2-8. Cylinder Wall Brackets

Table 2-7. Dimensions–Cylinder Wall Brackets

Part Number	Cylinder Capacity	Dimensions							
		A		B		C		D	
486485	10 lb.	8.62 in.	219 mm	1.56 in.	40 mm	7.68 in.	195 mm	5.75 in.	146 mm
486486	20 lb.	14.37 in.	265 mm	7.31 in.	186 mm	7.68 in.	195 mm	5.75 in.	146 mm
486487	40 lb.	13.12 in.	333 mm	5.94 in.	151 mm	9.75 in.	248 mm	6.75 in.	146 mm
486488	70 lb.	19.62 in.	498 mm	12.44 in.	316 mm	9.75 in.	248 mm	6.75 in.	146 mm

2-3.1.4 CONTROL HEADS

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

2-3.1.4.1 Electric Control Heads, P/N 890181, P/N 890149 and P/N 890165

CAUTION

The stackable control head (P/N 486500-01) cannot be used with 3 in. valve cylinders (P/Ns 45-100600-001, 45-100601-001, 45-100900-001 and 45-100901-001). The stackable control head does not have sufficient force to activate the 3 in. valve (P/N 45-17000-000) and may result in a system failure. The electric/ manual control heads (P/Ns 890181, 890149, 890165 and 81-100000-001) may be used with the 3 in. valve.

The Electric Control Head provides for electric actuation of the Kidde Engineered System cylinder valve. It is operated electrically from a detection and control system, a remote manual station, or locally with a manual lever on the electric control head (P/N 890181 only). See Figure 2-9 and Table 2-8.

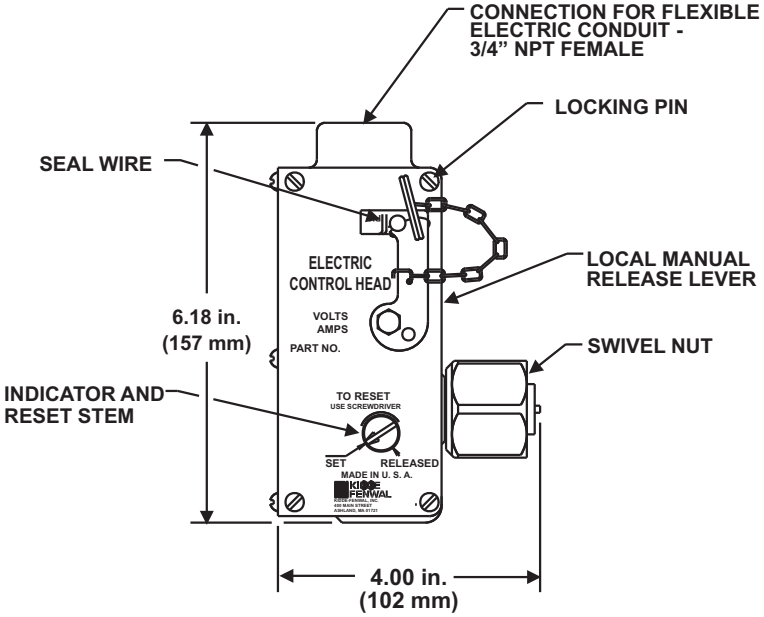


Figure 2-9. Electric Control Head

Table 2-8. Electric Control Head Specifications

Part Number	Control Head	
	Voltage	Current
890181	24 Vdc	2.0 A momentary
890149	125 Vdc	0.3 A momentary
890165	115 Vac	1.0 A momentary

The Stackable Control Head (P/N 486500-01 and P/N 81-10000-001) is rated for use in hazardous (classified) locations Class 1, Div 1, Groups C, D, and Class II, Div II, Groups E, F and G between -40°F to 130°F (-40°C to 54°C). See Figure 2-10 and Table 2-9 and Table 2-10. Use conduit seal within 18 in. (450 mm) of this device.

CAUTION

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

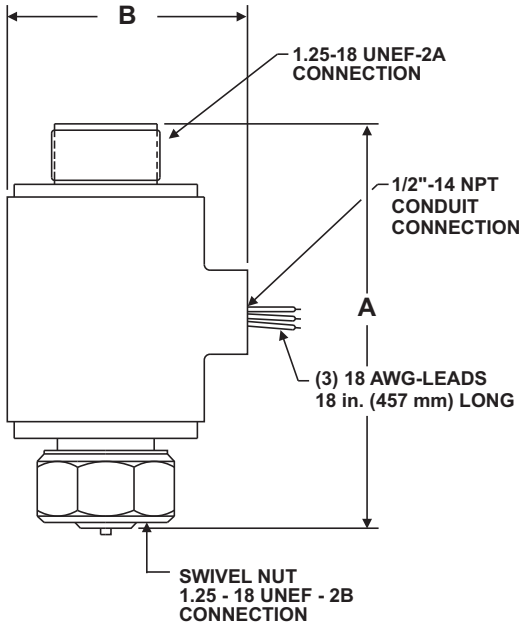


Figure 2-10. Electric Control Head, Stackable

Table 2-9. Electric Control Head References

Part Number	Dimension			
	A		B	
486500-01	5.28 in.	134 mm	3.00 in.	76 mm
81-100000-001	7.80 in.	198 mm	2.90 in.	74 mm

Table 2-10. Electric Control Head, Stackable (Explosion Proof)

Part Number	Voltage	Amps
486500-01	24 Vdc	0.20 continuous
81-100000-001	24 Vdc	0.27 continuous

2-3.1.4.2 Electric/Cable Operated Control Heads, P/N 895630, P/N 895627, P/N 897494, P/N 897560 and P/N 897628

The electric/cable operated control head mounts directly on top of the Kidde Engineered System cylinder valve and provides for both electric actuation or remote cable operation. The control head is operated remotely by an electrical signal from a detection system or electric manual pull station. The control head can also be operated mechanically from a remote cable operated manual pull station or locally using the manual lever on the control head (see Figure 2-11 and Table 2-11).

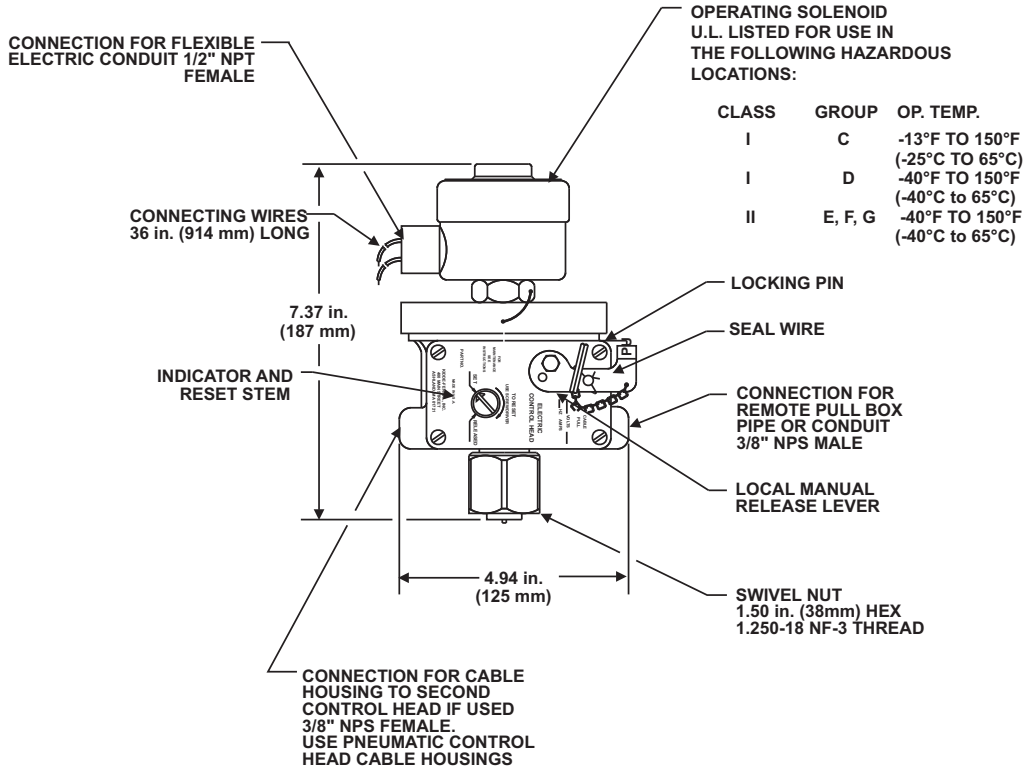


Figure 2-11. Electric/Cable Operated Control Head

Table 2-11. Electric/Cable Operated Control Heads

Part Number	Type	Voltage	Amps	Rating
895630	Standard	24 Vdc	2.00 momentary	N/A
895627(a),(b)	Standard	115 Vac	1.00 momentary	N/A
897494	Explosion Proof	24 Vdc	1.65 continuous	33.0 Watts
897560(a),(b)	Explosion Proof	115 Vac	0.13 continuous	15.4 Watts
895628(b)	Standard	125 Vdc	0.30 momentary	N/A
(a) Not FM Approved for use with Kidde Engineered Systems (b) Not UL Listed for use with Kidde Engineered Systems				

2-3.1.4.3 Cable Operated Control Head, P/N 979469

The Cable Operated Control Head is used for systems designed for manual operation only. It mounts directly on top of the Kidde Engineered System cylinder valve and is operated either remotely from a cable manual pull station or locally using the manual lever on the control head (see Figure 2-12).

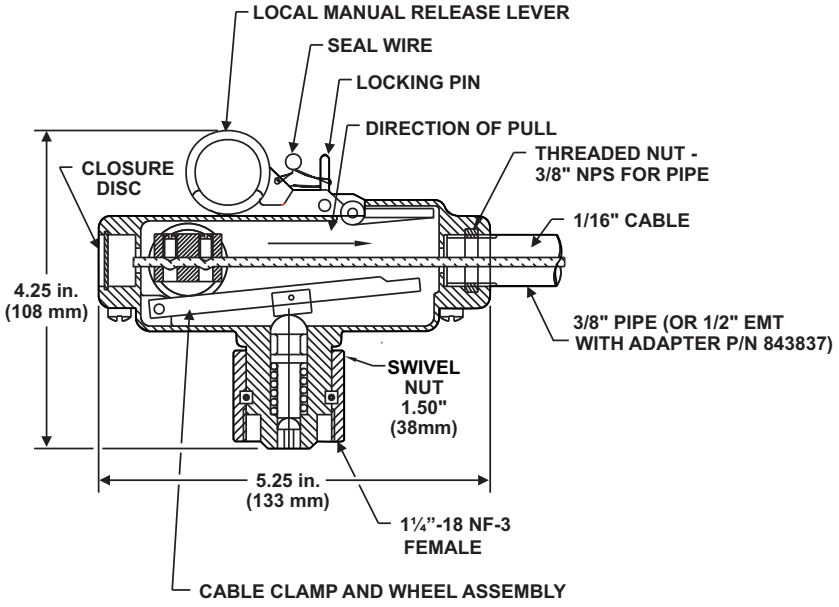


Figure 2-12. Cable Operated Control Head

2-3.1.4.4 Lever Operated Control Head, P/N 870652

The Lever Operated Control Head is equipped with an operating lever, secured in the closed position by a safety pull pin. By removing the safety pin, the lever can be manually rotated to the open position, thereby activating the cylinder or valve on which it is installed (see Figure 2-13).

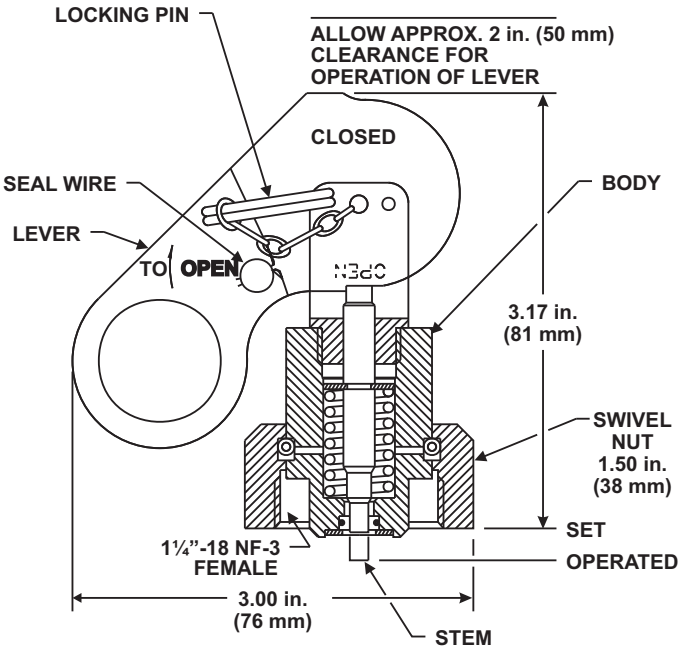


Figure 2-13. Lever Operated Control Head

2-3.1.4.5 Lever/Pressure Operated Control Head, P/N 878751

The Lever/Pressure Operated Control Head allows manual or pressure actuation of several system components, including Kidde Engineered System cylinder valves and nitrogen actuators (see Figure 2-14).

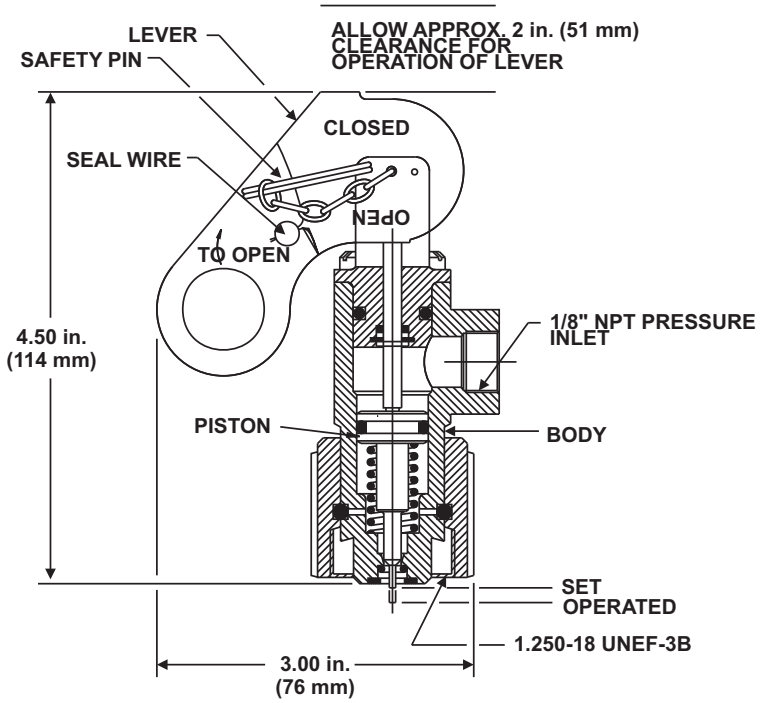


Figure 2-14. Lever/Pressure Operated Control Head

2-3.1.4.6 Pressure Operated Control Head, P/N 878737 and P/N 878750

The Pressure Operated Control Head, P/N 878737, allows for pressure actuation of Kidde Engineered System cylinders and is mounted directly on top of the Kidde Engineered System cylinder valve (see Figure 2-15). 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 2-16).

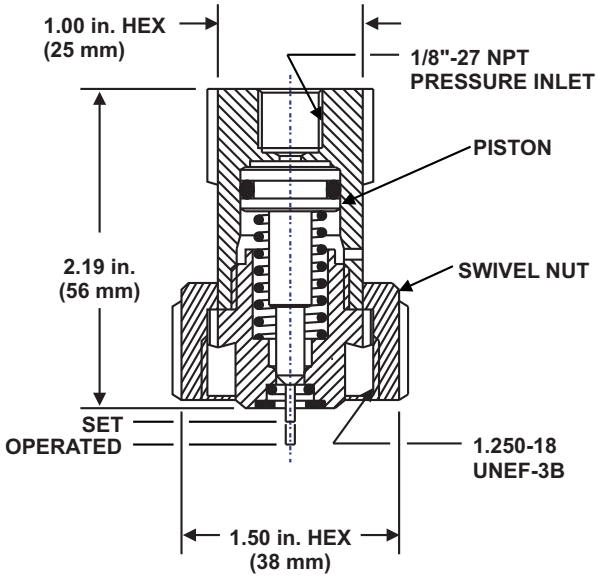


Figure 2-15. Pressure Operated Control Head

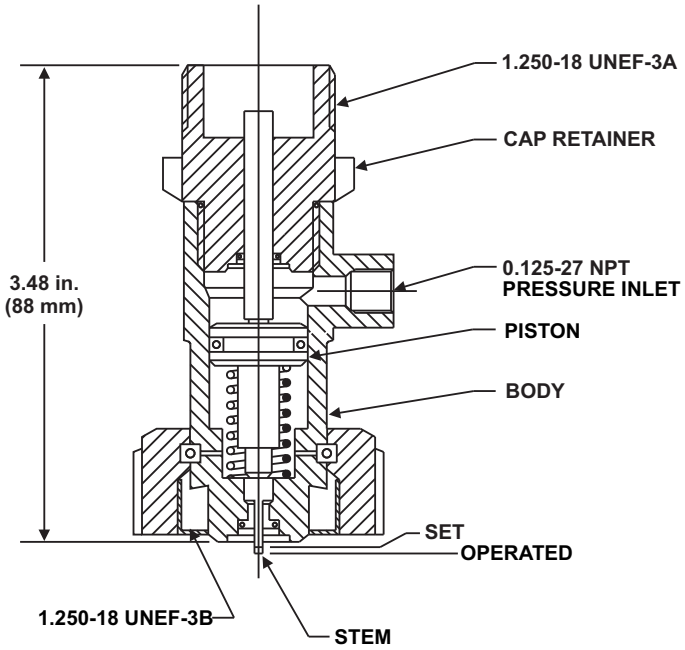


Figure 2-16. Stackable Pressure Operated Control Head

2-3.1.5 REMOTE PULL STATIONS

2-3.1.5.1 Electric Remote Pull Station, P/N 30-195000-002 and P/N 30-195000-004

The Electric Remote Pull Station is an electrically operated device. To actuate the Kidde Engineered System, pull the handle on the front of the box.

Table 2-12. Electric Remote Pull Station

Part Number	Description
30-195000-002	Double Action SPST Pull Station with Label Options
30-195000-004	Double Action DPST Pull Station with Label Options

2-3.1.5.2 Cable Manual Pull Station, Surface, P/N 871403

The surface type remote Cable Manual Pull Station is a cable operated device. To actuate the Kidde Engineered System, break the glass plate on the box using the attached hammer and pull the handle (see Figure 2-17).

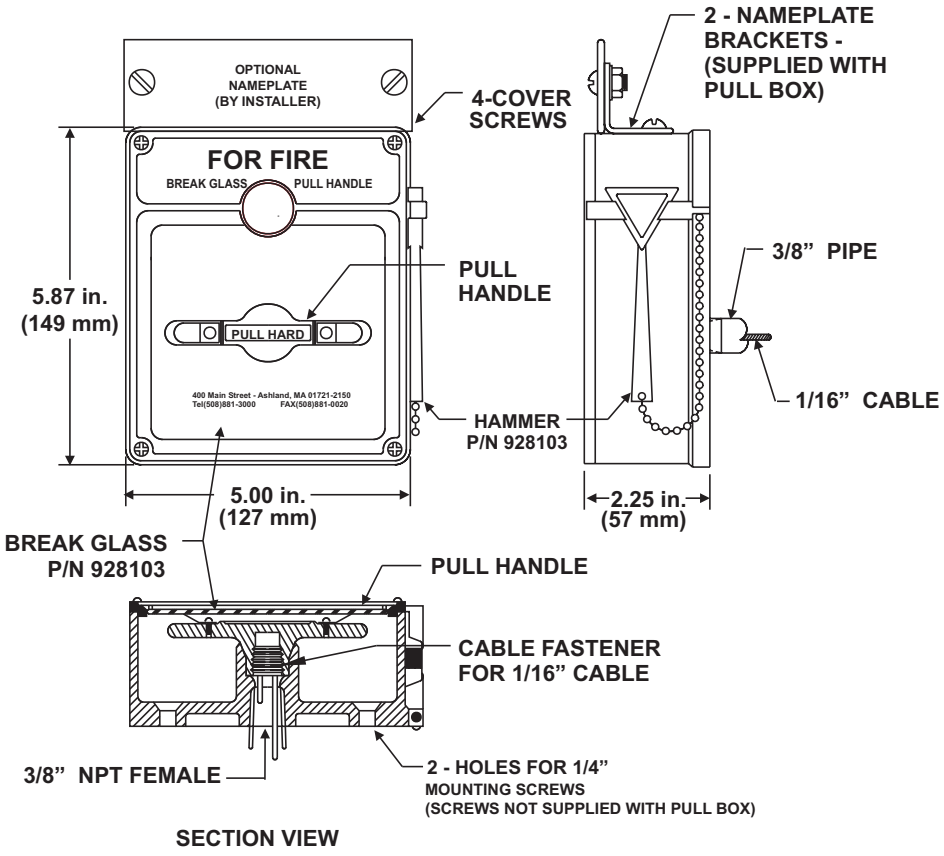


Figure 2-17. Cable Manual Pull Station

2-3.1.6 ACTUATION ACCESSORIES

2-3.1.6.1 Nitrogen Actuator, Mounting Bracket and Adapter, P/N 877940, P/N 877845 and P/N 69920501 Respectively

Gas pressure from a nitrogen cylinder is routed to the pressure operated control head mounted on each Kidde Engineered System cylinder. When the control head on the remote nitrogen cylinder is actuated, the Kidde Engineered System cylinder will be activated, causing the Novec 1230 fluid 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 Kidde Engineered System cylinder, resulting in a complete system discharge (see Figure 2-18).

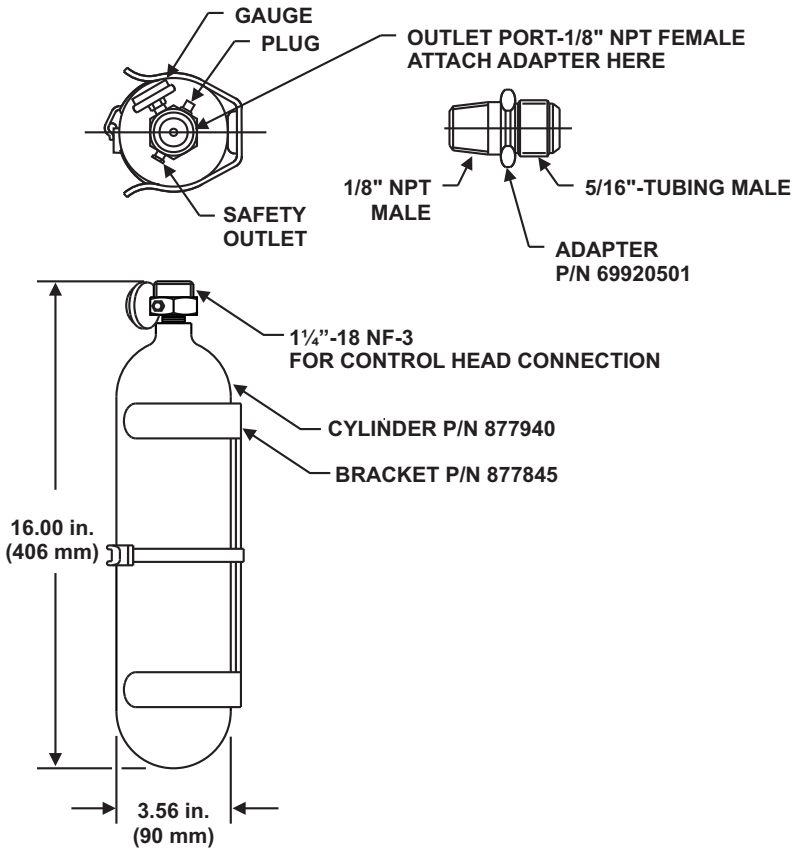


Figure 2-18. Nitrogen Actuator, Mounting Bracket and Adapter

Table 2-13. Nitrogen Actuator, Mounting Bracket and Adapter Specifications

Description	Standard	Metric
Cylinder Capacity	108 cu. in.	1770 cu. cm
Safety Outlet Burst Range	265 PSI to 300 PSI @ 70°F	183 bar to 207 bar @ 21°C
Cylinder Contents	Nitrogen BB-n-411b, Grade A, Type 1 1800 PSI @ 70°F	Nitrogen BB-n-411b, Grade A, Type 1 124 bar @ 21°C

2-3.1.6.2 Flexible Actuation Hose, P/N 264986 and P/N 264987

The Flexible Actuation Hose is used in multiple cylinder systems. Pilot pressure is directed to a pressure operated control head on each Kidde Engineered System cylinder valve using a 1/4-inch actuation hose (see Figure 2-19 and Table 2-14).

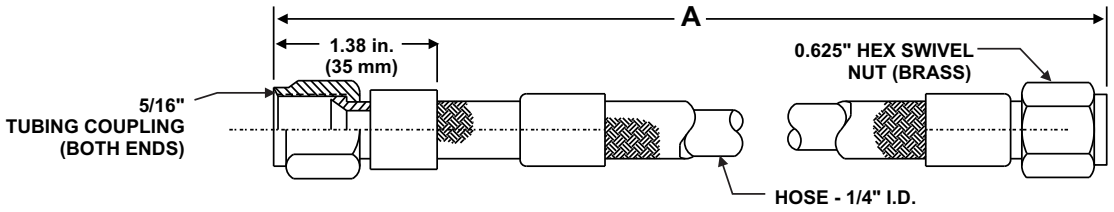


Figure 2-19. Flexible Actuation Hose

Table 2-14. Dimensions, Flexible Actuation Hose

Part Number	Dimension A	
264986	30 in.	762 mm
264987	22 in.	559 mm

2-3.1.6.3 Master Cylinder Adapter Kit, P/N 844895

The Master Cylinder Adapter Kit provides a means of connecting a flexible actuation hose to the master and slave cylinder and 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 2-20).

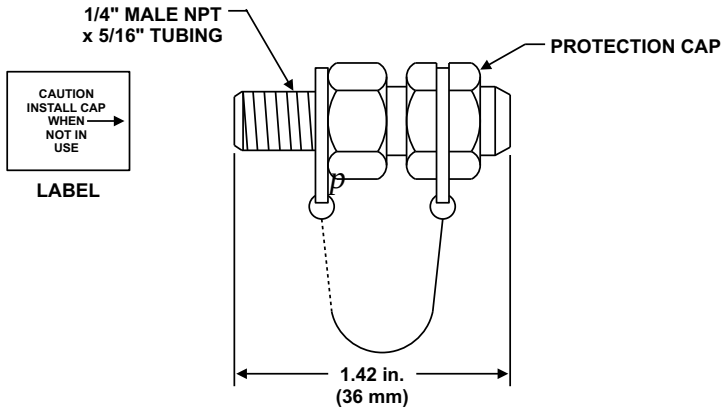


Figure 2-20. Master Cylinder Adapter Kit

2-3.1.6.4 Tees, Elbows and Adapters

Tees, elbows and adapters connect actuation hoses to pressure operated control heads in multiple cylinder system installations (see Figure 2-21).

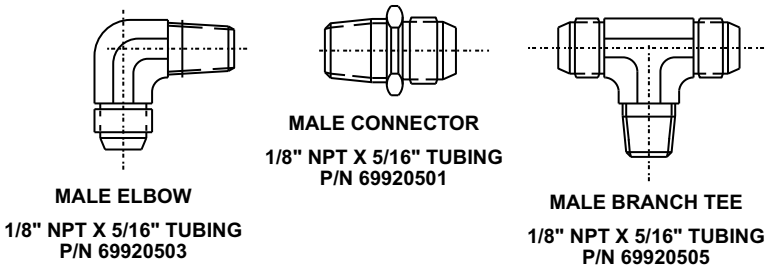


Figure 2-21. Tees, Elbows and Adapters

2-3.1.7 DISCHARGE ACCESSORIES

2-3.1.7.1 Flexible Discharge Hose, P/Ns 283898, 283899 and 06-118225-001

Novec 1230 fluid is routed from the storage cylinders to the discharge piping by a flexible 1½ in. or 2 in. rubber covered hose with wire braided reinforcements. The hose is connected to the discharge outlet of the Kidde Engineered System cylinder valve and terminates at the system piping or discharge manifold (see Figure 2-22 and Table 2-15).

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

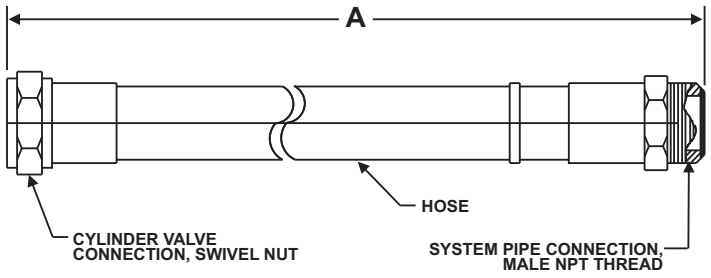


Figure 2-22. Flexible Discharge Hose, 1½ in. or 2 in.

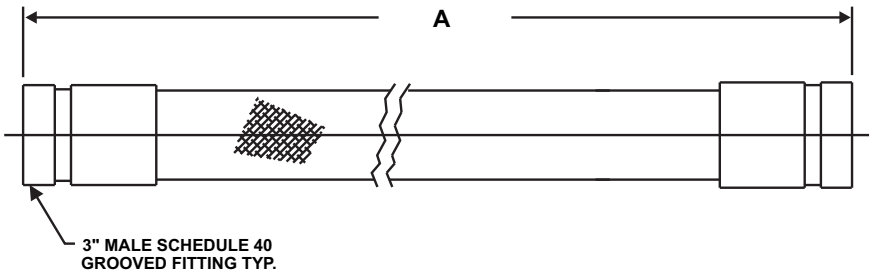


Figure 2-23. Flexible Discharge Hose, 3 in. Victaulic

Table 2-15. Dimensions, Flexible Discharge Hoses

Part Number	Hose Size	Dimension A		Min. Bend Radius	
283898	1½ in.	24.0 in.	610 mm	10.5 in.	267 mm
283899	2 in.	31.0 in.	787 mm	13.5 in.	343 mm
06-118225-001	3 in.	54.0 in.	1372 mm	24.0 in.	610 mm

2-3.1.7.2 Valve Outlet Adapters, P/N 283904 and P/N 283905

A valve outlet adapter connects the cylinder valve outlet to the discharge piping when a flexible discharge hose is not used (see Figure 2-24 and Table 2-16).

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.

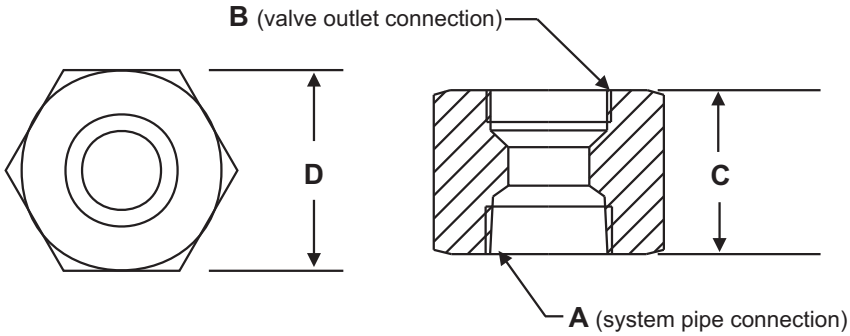


Figure 2-24. Valve Outlet Adapter

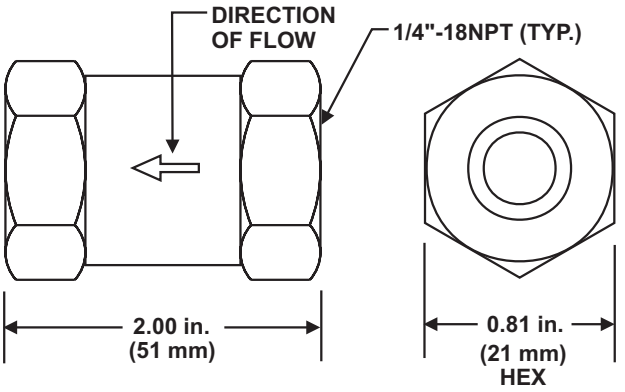
Table 2-16. Dimensions, Valve Outlet Adapter

Part Number	Size	Dimensions					
		A	B	C		D	
283904	1½ in.	1½ in. to 11½ in. NPT	1.874 in.	2.69 in.	68 mm	2.50 in. HEX	64 mm HEX
283905	2 in.	2 in. to 11½ in. NPT	2.500 in. 12 UNJ	3.12 in.	79 mm	3.00 in. HEX	76 mm HEX

2-3.1.7.3 Check Valves

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 (P/N 264985) are installed in the pilot manifold to ensure the proper number of cylinders are discharged (see Figure 2-25).



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

Figure 2-25. Check Valve

Table 2-17. Check Valves, Equivalent Lengths

Part Number	Nomenclature	Pipe Type	Equivalent Length	
800327	Check Valve, 1/2 in. NPT	40 T & 40 W	5.40 ft.	1.70 m
800266	Check Valve, 3/4 in. NPT	40 T & 40 W	16.00 ft.	4.90 m
800443	Check Valve, 1 in. NPT	40 T & 40 W	8.80 ft.	2.70 m
800444	Check Valve, 1¼ in. NPT	40 T & 40 W	36.70 ft.	11.20 m
870152	Check Valve, 1½ in. NPT	40 T & 40 W	57.00 ft.	17.37 m
870151	Check Valve, 2 in. NPT	40 T & 40 W	45.10 ft.	13.80 m
263716	Check Valve, 2½ in. NPT	40 T & 40 W	49.80 ft.	15.20 m
870100	Check Valve, 3 in. NPT	40 T & 40 W	141.30 ft.	43.10 m

2-3.1.7.4 Swing Checks, P/N 06-118213-001 and 06-118058-001

Swing checks are installed at the discharge manifold for a multiple cylinder arrangement to maintain a closed system. See Figures 2-26 and 2-27, as well as Table 2-18 for more information.

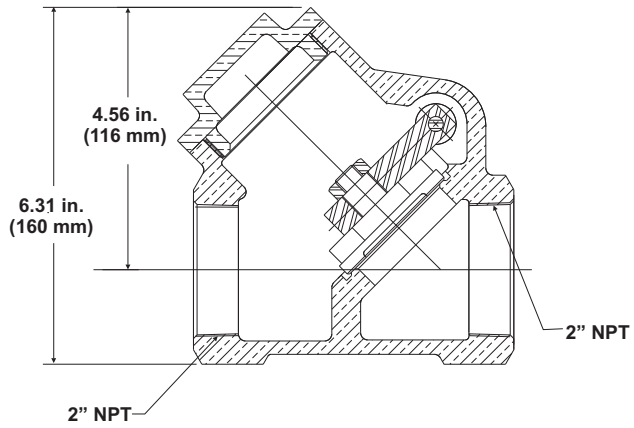


Figure 2-26. 2 in. Swing Check Valve

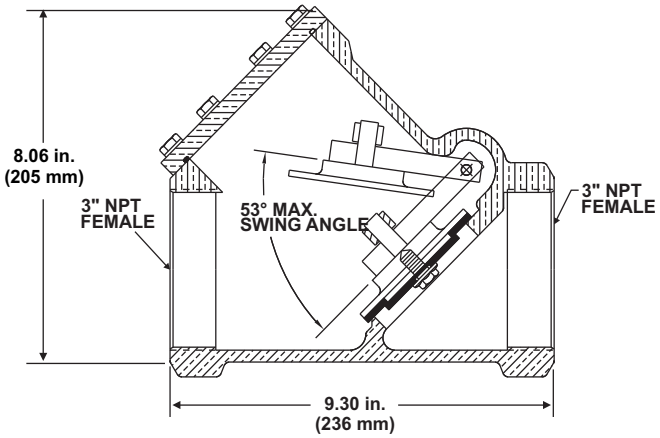


Figure 2-27. 3 in. Swing Check Valve

Table 2-18. Swing Check Valve Equivalent Lengths

Part Number	Nomenclature	Pipe Type	Equivalent Length	
06-118213-001	Swing Check, 2 in.	40T & 40 W	13.40 ft.	4.1 m
06-118058-001	Swing Check, 3 in.	40 T & 40 W	20.80 ft.	6.3 m

2-3.1.7.5 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 Kidde Engineered System 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 2-28 and Table 2-19 and Table 2-17).

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.

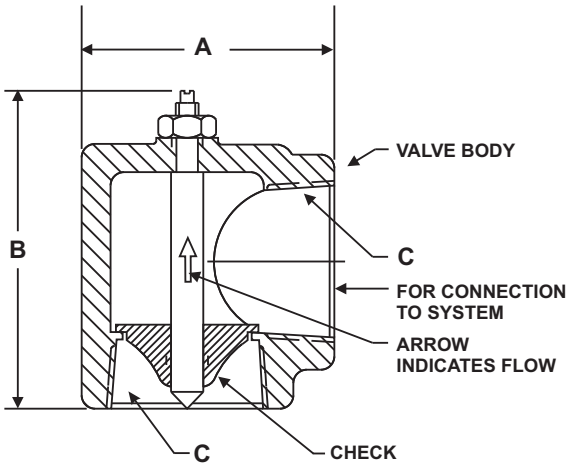


Figure 2-28. Manifold El-Checks Directional Valves (P/Ns 45-118325-00X and 45-118327-00X)

Table 2-19. Dimensions, Manifold El-Checks

Part Number	Size	Dimensions				
		A		B		C
877690	2 in.	3.93 in.	100 mm	4.88 in.	124 mm	2 in. – 11½ in. NPT
878743	2½ in.	4.96 in.	119 mm	5.76 in.	146 mm	2½ in. – 8 in. NPT

2-3.1.7.6 Directional Valves, P/N 90-2200XX-00X

Note: Not FM Approved for use with Kidde Engineered Systems utlizing Novec 1230 fluid.

The stainless steel, 3-way directional ball valves are used for applications where a single bank of cylinders are used to protect multiple hazards (see Chapter 4 for additional information). The directional valves have a factory installed pneumatic, spring loaded actuator and range in sizes from 1/2 in. to 4 in. that are available with or without a solenoid. The directional valves can be installed in the network, provided that they are accounted for in the software calculation. See Figures 2-29 through 2-31 and Tables 2-20 and 2-21 for more information.

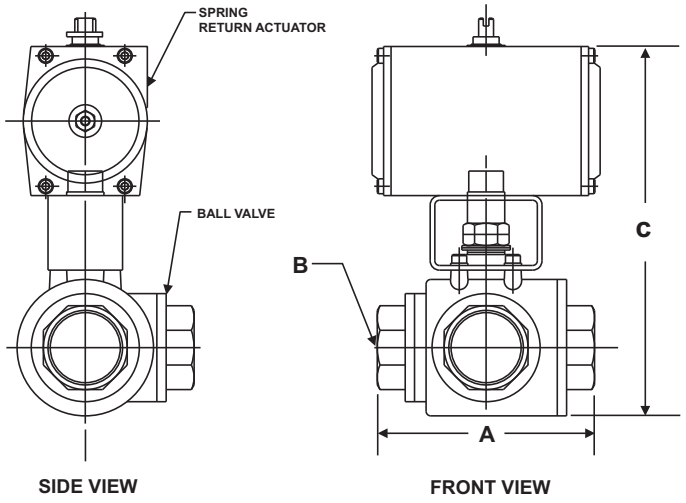


Figure 2-29. Directional Valves

Table 2-20. Directional Valve Specifications

Part Number		Nominal Size	Dimensions			Valve Working Pressure	Breakaway Torque
Without Solenoid	With Solenoid		A	B	C		
90-220027-001	90-220030-001	1/2 in.	3.50 in. (89 mm)	0.69 in. (18 mm)	11.23 in. (285 mm)	400 PSIG	200 in.-lb.
90-220027-002	90-220030-002	3/4 in.	4.00 in. (102 mm)	0.82 in. (21 mm)	12.13 in. (308 mm)	400 PSIG	250 in.-lb.
90-220027-003	90-220030-003	1 in.	4.00 in. (102 mm)	1.00 in. (25 mm)	12.13 in. (308 mm)	400 PSIG	250 in.-lb.
90-220028-001	90-220031-001	1¼ in.	6.00 in. (152 mm)	1.38 in. (35 mm)	13.69 in. (348 mm)	400 PSIG	500 in.-lb.
90-220028-002	90-220031-002	1½ in.	6.00 in. (152 mm)	1.50 in. (38 mm)	13.69 in. (348 mm)	400 PSIG	500 in.-lb.
90-220028-003	90-220031-003	2 in.	7.25 in. (184 mm)	2.00 in. (51 mm)	15.66 in. (398 mm)	400 PSIG	800 in.-lb.
90-220029-001	90-220032-001	3 in.	11.00 in. (279 mm)	3.00 in. (76 mm)	21.44 in. (545 mm)	400 PSIG	3000 in.-lb.
90-220029-002	90-220032-002	4 in.	13.38 in. (340 mm)	4.00 in. (102 mm)	24.68 in. (627 mm)	400 PSIG	4300 in.-lb.

Table 2-21. Directional Valve

Part Number		Material	Body Style	Inlets	Port	T-Flow Equivalent Length	L-Flow Equivalent Length
Without Solenoid	With Solenoid						
90-220027-001	90-220030-001	ENP Carbon Steel	Threaded	NPT	Full	0.19 ft. (0.06 m)	1.83 ft. (0.56 m)
90-220027-002	90-220030-002	ENP Carbon Steel	Threaded	NPT	Full	0.37 ft. (0.11 m)	3.61 ft. (1.10 m)
90-220027-003	90-220030-003	ENP Carbon Steel	Threaded	NPT	Full	1.48 ft. (0.45 m)	9.31 ft. (2.84 m)
90-220028-001	90-220031-001	ENP Carbon Steel	Threaded	NPT	Full	1.19 ft. (0.36 m)	11.65 ft. (3.55 m)
90-220028-002	90-220031-002	ENP Carbon Steel	Bolted	NPT	Full	1.77 ft. (0.54 m)	12.08 ft. (3.68 m)
90-220028-003	90-220031-003	ENP Carbon Steel	Bolted	NPT	Full	1.82 ft. (0.56 m)	13.75 ft. (4.19 m)
90-220029-001	90-220032-001	ENP Carbon Steel	Bolted	Victaulic	Full	5.00 ft. (1.5 m)	26.00 ft. (7.93 m)
90-220029-002	90-220032-002	ENP Carbon Steel	Bolted	Victaulic	Full	7.73 ft. (2.36 m)	32.42 ft. (9.88 m)

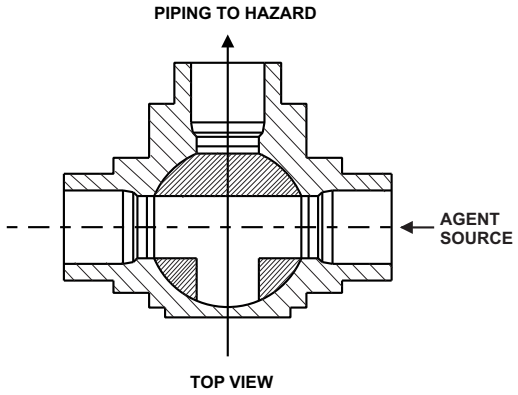


Figure 2-30. T Flow Ball Position

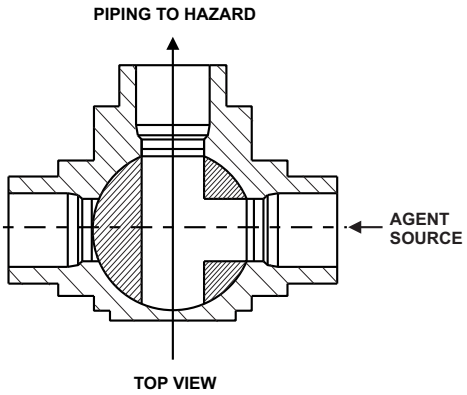


Figure 2-31. L Flow Ball Position

2-3.1.7.7 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 Figures 2-31 and 2-32).

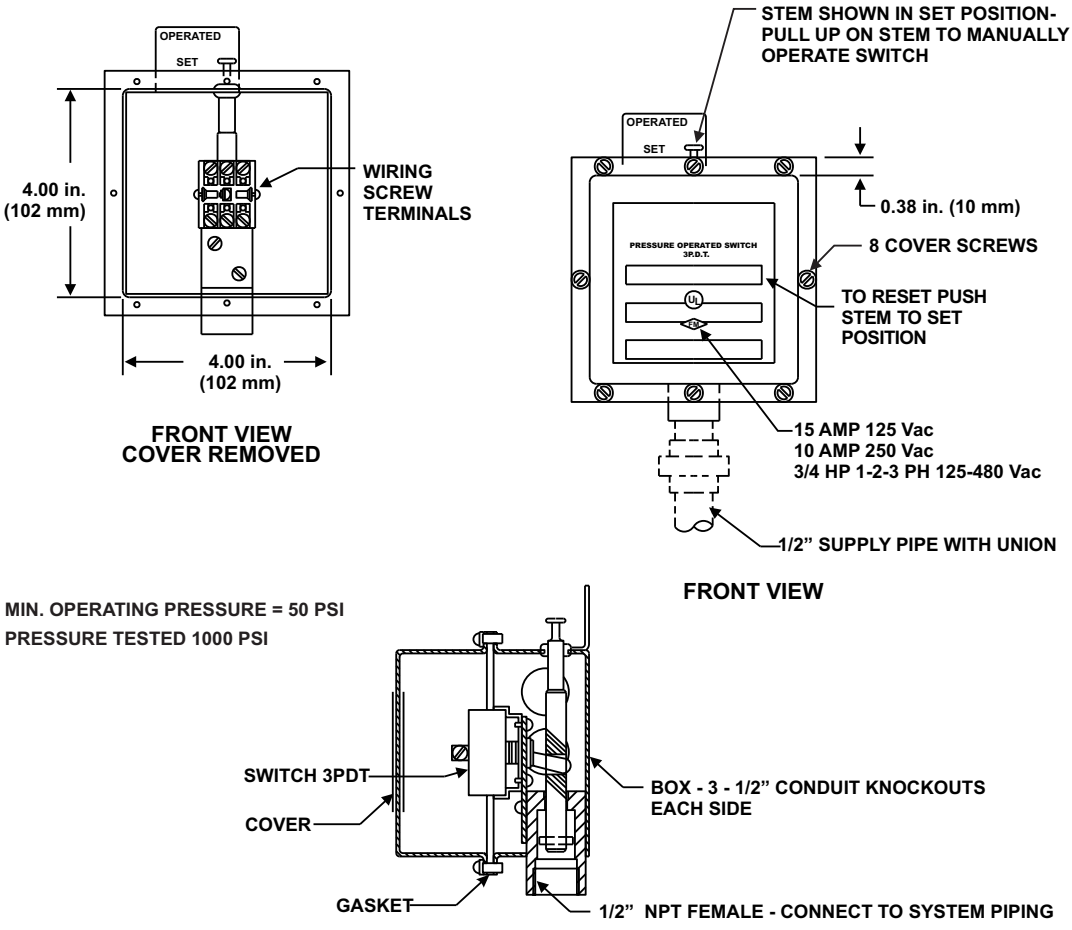


Figure 2-32. Pressure Operated Switch, P/N 486536

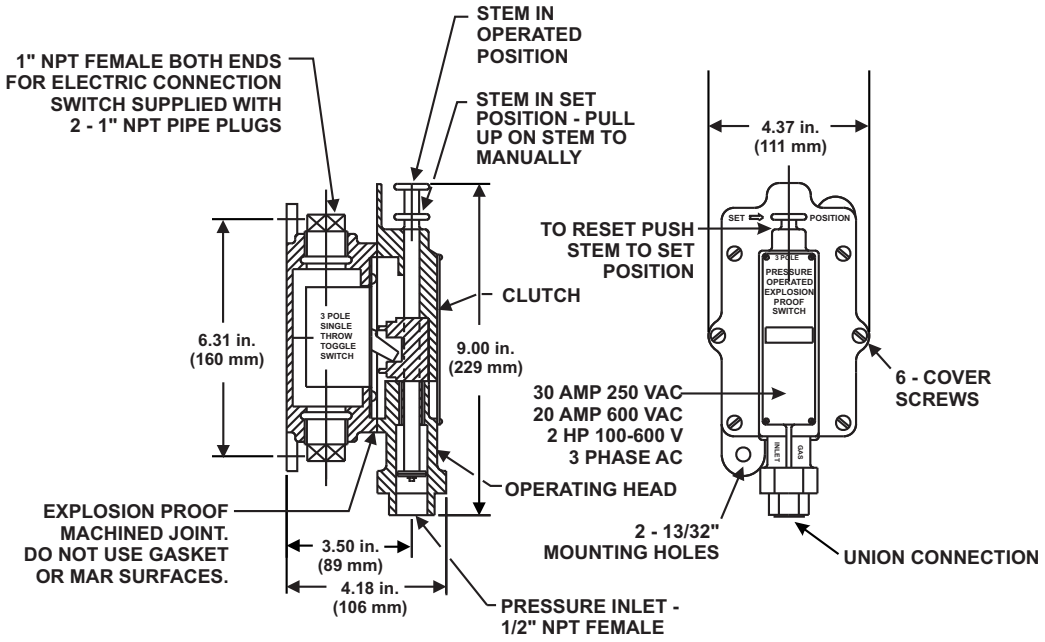


Figure 2-33. Pressure Operated Switch, Explosion Proof, P/N 981332

2-3.1.7.8 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.

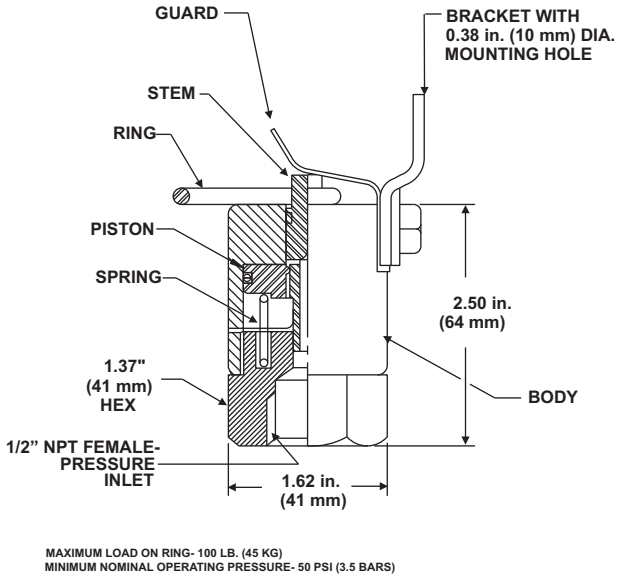


Figure 2-34. Pressure Operated Trip

2-3.1.7.9 Discharge Indicator, P/N 875553

The Discharge Indicator may be installed in the discharge piping to visually indicate a system discharge. When in the SET position, the discharge indicator acts as a vent (see Figure 2-35).

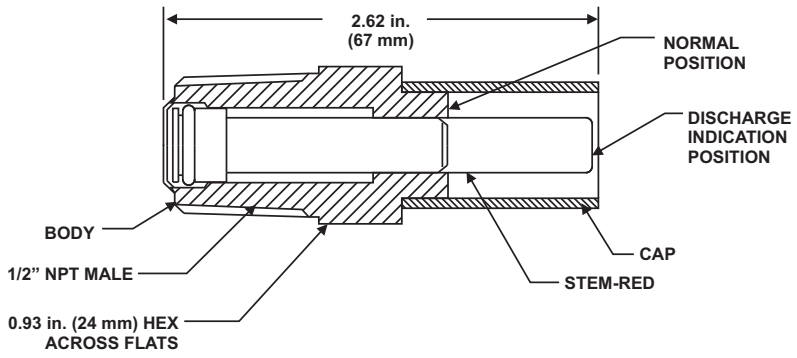


Figure 2-35. Discharge Indicator

2-3.1.7.10 Corner Pulleys, P/N 803808 and P/N 844648

Corner Pulleys change the direction of cable lines without binding to ensure smooth operation. P/N 803808 is used for all watertight applications; P/N 844648 is used for all industrial applications (see Figure 2-36 and Figure 2-37).

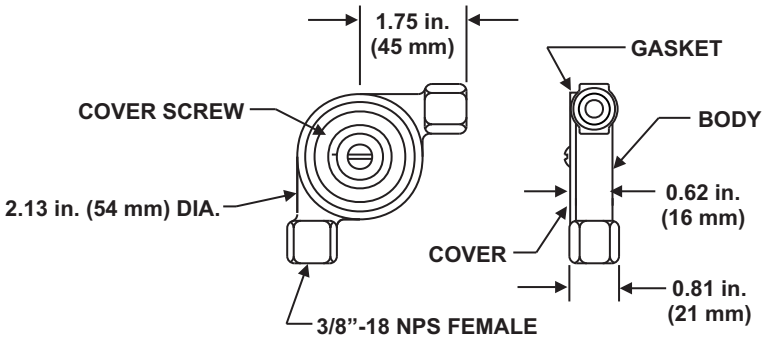


Figure 2-36. Corner Pulleys, Watertight Applications

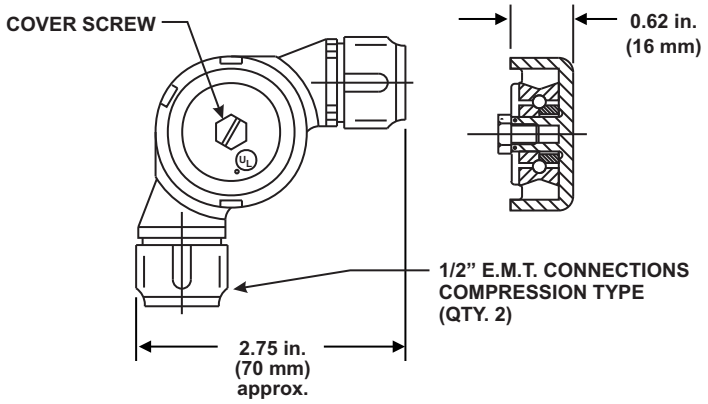


Figure 2-37. 1/2-Inch E.M.T. Corner Pulley, General Applications

2-3.1.7.11 Supervisory Pressure Switch, P/N 06-118262-001

The Cylinder Supervisory Pressure Switch, P/N 06-118262-001, is intended to detect a fall in pressure in the Kidde Engineered System cylinder (see Figure 2-38). 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 Kidde Engineered System cylinders with a 2 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.

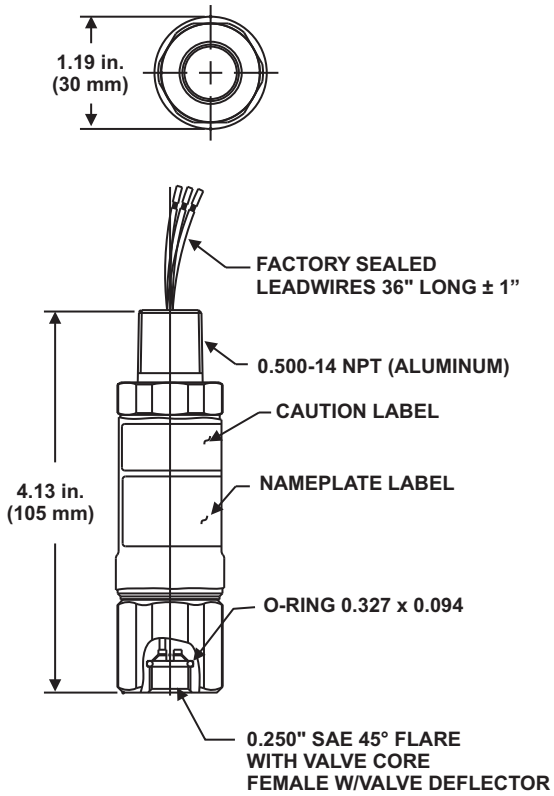


Figure 2-38. Supervisory Pressure Switch, Female Fitting

2-3.1.7.12 Supervisory Pressure Switch, P/N 06-118263-001

The Supervisory Pressure Switch (P/N 06-118263-001) is intended to detect a fall in pressure in the Kidde Engineered System cylinder (see Figure 2-39). The cylinder supervisory pressure switch can be wired for either normally-open or normally-closed operation, depending on installation requirements. The cylinder supervisory pressure switch can be installed on 600 lb. through 900 lb. capacity Kidde Engineered System 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.

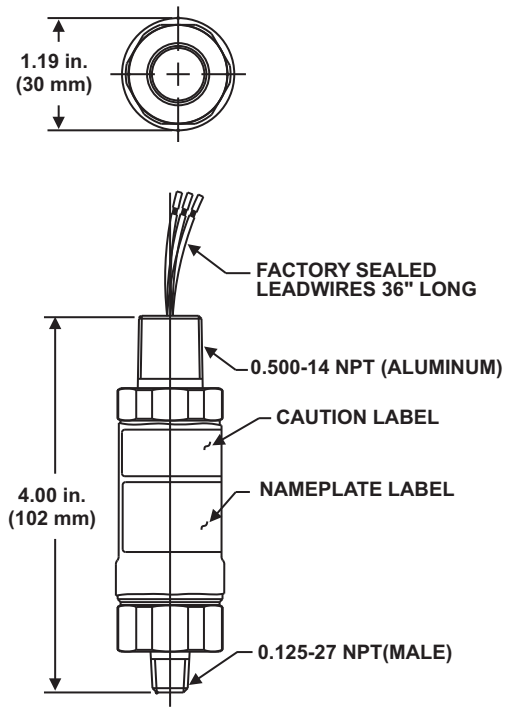


Figure 2-39. Supervisory Pressure Switch, Male Fitting

2-3.1.7.13 Main-to-Reserve Transfer Switch, P/N 802398

The Main-to-Reserve Switch is installed on systems having main and reserve cylinders. Placing the switch in either the MAIN or RESERVE position provides uninterrupted fire protection during system maintenance or in the event of a system discharge (see Figure 2-40).

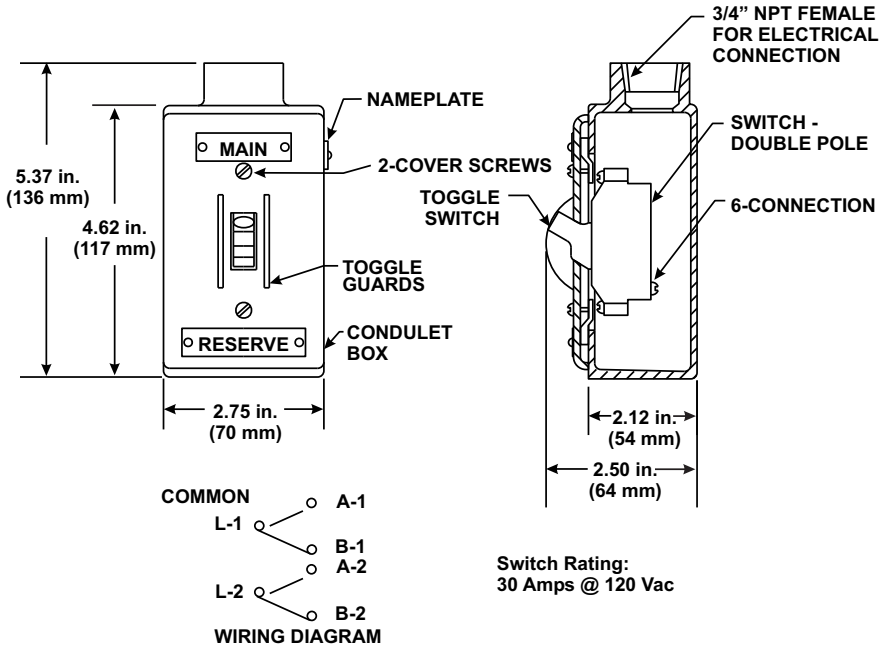


Figure 2-40. Main-to-Reserve Transfer Switch

2-3.1.7.14 Discharge Nozzles

The 180° and 360° discharge nozzles are designed to provide the proper flow rate and distribution of Novec 1230 fluid to flood a hazard area. The 180° nozzle is engineered to provide a 180° discharge pattern for sidewall applications; he 360° nozzle offers a full 360° discharge pattern for installations where nozzles are located in the center of the hazard. The 180° and 360° nozzles are offered in See Figure 2-41 and Figure 2-42 and Tables 2-17 and 2-18 for further information. The complete list of part numbers for the nozzles is located in Chapter 8, Parts List.

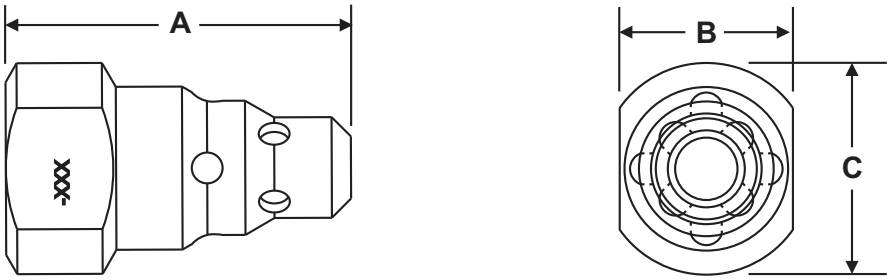


Figure 2-41. 360° Discharge Nozzle

Table 2-22. Dimensions–360° Discharge Nozzle

Pipe Size	Dimensions					
	A		B		C	
1/4 in.* (6 mm)	1.91 in.	49 mm	1.03 in.	26 mm	0.88 in.	22 mm
3/8 in. (10 mm)	2.03 in.	52 mm	1.00 in.	25 mm	1.19 in.	30 mm
1/2 in. (13 mm)	2.25 in.	57 mm	1.13 in.	29 mm	1.38 in.	35 mm
3/4 in. (19 mm)	2.69 in.	68 mm	1.38 in.	35 mm	1.63 in.	41 mm
1 in. (25 mm)	2.88 in.	73 mm	1.63 in.	41 mm	1.94 in.	49 mm
1¼ in. (32 mm)	3.29 in.	83 mm	2.00 in.	51 mm	2.38 in.	60 mm
1½ in. (38 mm)	3.63 in.	92 mm	2.25 in.	57 mm	2.69 in.	68 mm
2 in. (51 mm)	4.50 in.	114 mm	3.00 in.	76 mm	3.50 in.	89 mm
***Note:** 1/4 in. nozzle is non-listed, non-approved.						

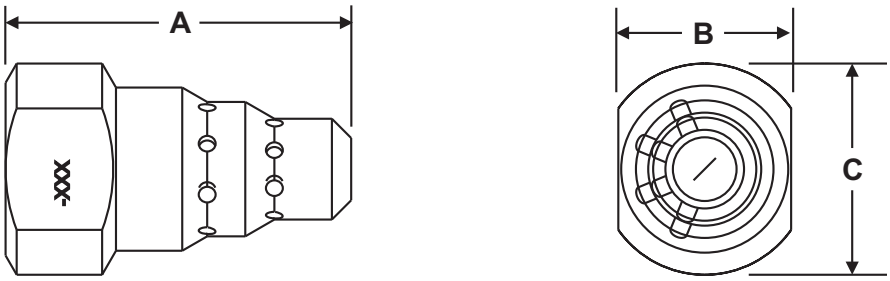


Figure 2-42. 180° Discharge Nozzle

Table 2-23. Dimensions–180° Discharge Nozzle

Pipe Size	Dimensions					
	A		B		C	
1/4 in.* (6 mm)	1.91 in.	49 mm	1.03 in.	26 mm	0.88 in.	22 mm
3/8 in. (10 mm)	2.03 in.	52 mm	1.00 in.	25 mm	1.19 in.	30 mm
1/2 in. (13 mm)	2.25 in.	57 mm	1.13 in.	29 mm	1.38 in.	35 mm
3/4 in. (19 mm)	2.69 in.	68 mm	1.38 in.	35 mm	1.63 in.	41 mm
1 in. (25 mm)	2.88 in.	73 mm	1.63 in.	41 mm	1.94 in.	49 mm
1¼ in. (32 mm)	3.29 in.	83 mm	2.00 in.	51 mm	2.38 in.	60 mm
1½ in. (38 mm)	3.63 in.	92 mm	2.25 in.	57 mm	2.69 in.	68 mm
2 in. (51 mm)	4.50 in.	114 mm	3.00 in.	76 mm	3.50 in.	89 mm
***Note:** 1/4 in. nozzle is non-listed, non-approved.						

2-3.1.8 OTHER ACCESSORIES

2-3.1.8.1 Hydrostatic Test Adapters

The hydrostatic pressure test adapter is installed on the Kidde Engineered System cylinder in place of the cylinder valve when the cylinder is to be hydrostatically pressure tested. For cylinder test requirements, see Paragraph 6-2.5.3 of this manual.

2-3.1.8.2 Kidde Engineered System Cylinder Recharge Adapters

The Kidde Engineered System recharge adapter is installed in the cylinder discharge outlet during the cylinder charging procedure. This adapter is used for refilling the cylinder with Novec 1230 fluid and super pressurizing the cylinder with nitrogen (see Figure 2-43 and Table 2-24).

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.

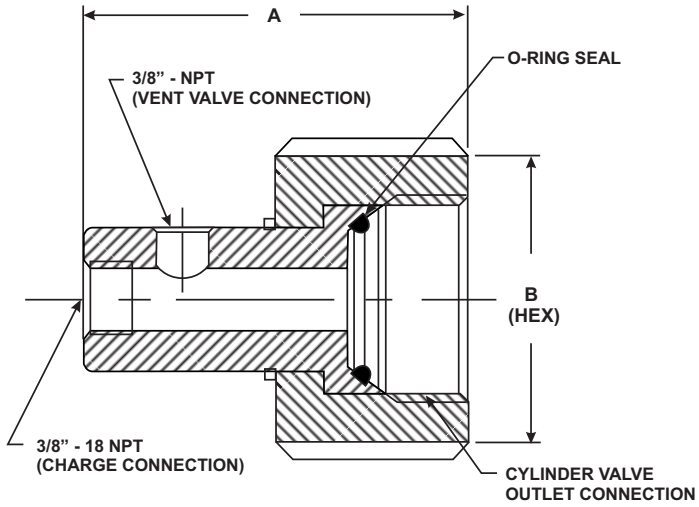


Figure 2-43. Cylinder Recharge Adapters

Table 2-24. Dimensions–Cylinder Recharge Adapters

Part Number	Cylinder Size	Dimensions			
		A		B	
878757	10 lb. - 125 lb.	3.22 in.	82 mm	2.50 in.	64 mm
878758	200 lb., 350 lb.	4.06 in.	103 mm	3.25 in.	83 mm

2-3.1.8.3 Kidde Engineered System Cylinder Seating Adapter, P/N 933537

The Kidde Engineered System 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.

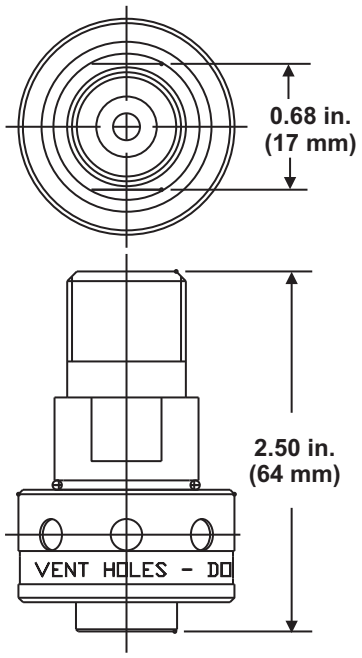


Figure 2-44. Seating Adapter

2-3.1.9 DETECTORS AND CONTROL PANELS

2-3.1.9.1 Detectors

Detectors (ionization, photoelectric, thermal, ultraviolet, ultraviolet/ infrared, etc.) interfacing with Kidde Engineered Systems must be UL Listed for the intended application.

2-3.1.9.2 Control Panel

The control panel must be UL Listed for releasing device service and compatible with Kidde Engineered System equipment.

CHAPTER 3
SYSTEM DESIGN

3-1 INTRODUCTION

Kidde Engineered Fire Suppression System designed for use with 3M™ Novec™ 1230 Fire Protection Fluid are Listed by Underwriters Laboratories, Inc. (UL) and Approved by Factory Mutual (FM). These systems are designed for total flooding in accordance with NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems. These systems have been tested to the limits established jointly by UL and FM. In any situation not specifically covered by this manual, the application and installation of the system must meet the requirements of the standards as stated. In any case, all installations must meet the requirements of the local Authority Having Jurisdiction (AHJ).

The complexity of two-phase flow does not allow for any simple method of manual 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 Kidde Engineered Fire Suppression System Flow Calculation Program (P/N 45-N1230M-100) in order to learn the proper procedures for applying the input parameters to the Kidde Engineered Fire Suppression System Flow Calculation Program. There are a number of limitations to these input parameters which must be observed if accurate results are to be obtained.

3-2 DESIGN PROCEDURE

3-2.1 General

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

3-2.2 Application

The following steps must be taken to design a Kidde Engineered System:

- Determine the design concentration required for the hazard. Refer to Table 3-1.
- Determine the minimum and maximum ambient temperature for the hazard.
- Determine the volume of the hazard.
- Determine the integrity of the hazard.
- Determine if any additional agent will be required to offset leakage of agent from the hazard.

3-2.2.1 CALCULATE AGENT REQUIRED

Calculate the quantity of Novec 1230 fluid required to provide the proper design concentration at the minimum expected hazard temperature.

For systems that protect Class A or Class C hazards, and incorporate a mechanism of automatic actuation, a design concentration of 4.2% can be used.

Note: Refer to Table 3-1, Table 3-2, Table 3-3, and Table 3-4. The information is given for estimating purposes only. The Kidde Engineered Fire Suppression System Flow Calculation Program calculates this information for the designer. Refer to the Kidde Engineered Fire Suppression System Flow Calculation Program User's Manual (P/N 45-N1230M-100) for further information.

Table 3-1. Class B Suppression Design Concentrations

Fuel	Extinguishing Concentration	Design Concentration, % v/v
1-Butanol	4.90	6.37
1-Propanol	5.40	7.02
2,2,4-trimethylpentane	4.70	6.11
2-butoxyethanol	5.20	6.76
Acetone	4.30	5.59
Acetonitrile	2.90	4.20
Commercial Heptane	4.40	5.72
Commercial Hexanes	4.30	5.59
Cyclohexane	4.50	5.85
Cyclopentanone	4.60	5.98
Denatured Alcohol (92.2% EtOH, 4.6% IPA and 3.1% MeOH)	5.30	6.89
Diesel Fuel	3.40	4.42
Diethyl Ether	4.90	6.37
Ethanol	5.50	7.15
Ethyl Acetate	4.70	6.11
Gasoline-87 oct. unleaded	4.50	5.85
Hexene	4.60	5.98
Isooctane	4.70	6.11
Isoprophyl Alcohol	4.90	6.37
Methane	5.60	7.28
Methanol	6.50	8.45
Methyl Ethyl Ketone	4.50	5.85
Methyl Tert Butyl Ether	4.50	5.85
n-Heptane	4.50	5.85
n-Pentane	4.70	6.11
Octane	4.40	5.72
Propane	5.80	7.54
Pyrrolidine	4.70	6.11
Technical (Commercial) Heptane	4.30	5.59
Tetrahydrofuran	5.00	6.50
Toluene	3.50	4.55
Transformer Oil (Voltesso)	4.50	5.85

Table 3-2. Novec 1230 Fluid Total Flooding Quantity

Temp T (°F)[b]	Specific Vapor Volume (ft.^{3}/lb.)[c]	Weight Requirements of Hazard Volume, W/V (lb./ft.^{3})[a] Design Concentrations (% by Volume)[d]										
		3.00	4.00	4.20	5.00	5.72	6.00	7.00	8.00	9.00	10.00	11.00
-20	0.9368	0.0330	0.0445	0.0468	0.0562	0.0648	0.0681	0.0803	0.0928	0.1056	0.1186	0.1319
-10	0.9612	0.0322	0.0433	0.0456	0.0548	0.0631	0.0664	0.0783	0.0905	0.1029	0.1156	0.1286
0	0.9856	0.0314	0.0423	0.0445	0.0534	0.0616	0.0648	0.0764	0.0882	0.1003	0.1127	0.1254
10	1.0100	0.0306	0.0413	0.0434	0.0521	0.0601	0.0632	0.0745	0.0861	0.0979	0.1100	0.1224
20	1.0344	0.0299	0.0403	0.0424	0.0509	0.0587	0.0617	0.0728	0.0841	0.0956	0.1074	0.1195
30	1.0588	0.0292	0.0394	0.0414	0.0497	0.0573	0.0603	0.0711	0.0821	0.0934	0.1049	0.1167
40	1.0832	0.0286	0.0385	0.0405	0.0486	0.0560	0.0589	0.0695	0.0803	0.0913	0.1026	0.1141
50	1.1077	0.0279	0.0376	0.0396	0.0475	0.0548	0.0576	0.0680	0.0785	0.0893	0.1003	0.1116
60	1.1321	0.0273	0.0368	0.0387	0.0465	0.0536	0.0564	0.0665	0.0768	0.0874	0.0981	0.1092
70	1.1565	0.0267	0.0360	0.0379	0.0455	0.0525	0.0552	0.0651	0.0752	0.0855	0.0961	0.1069
80	1.1809	0.0262	0.0353	0.0371	0.0446	0.0514	0.0541	0.0637	0.0736	0.0838	0.0941	0.1047
90	1.2053	0.0257	0.0346	0.0364	0.0437	0.0503	0.0530	0.0624	0.0721	0.0821	0.0922	0.1025
100	1.2297	0.0252	0.0339	0.0357	0.0428	0.0493	0.0519	0.0612	0.0707	0.0804	0.0904	0.1005
110	1.254	0.0247	0.0032	0.0350	0.0420	0.0484	0.0509	0.0600	0.0693	0.0789	0.0886	0.0986
120	1.2785	0.0242	0.0326	0.0343	0.0412	0.0475	0.0499	0.0589	0.0680	0.0774	0.0869	0.0967
130	1.3029	0.0237	0.0320	0.0336	0.0404	0.0466	0.0490	0.0578	0.0667	0.0759	0.0853	0.0949
140	13.3273	0.0233	0.0314	0.0330	0.0397	0.0457	0.0481	0.0567	0.0655	0.0745	0.0837	0.0931
150	1.3518	0.0229	0.0308	0.0324	0.0389	0.0449	0.0472	0.0557	0.0643	0.0732	0.0822	0.0914
160	1.3762	0.0225	0.0303	0.0319	0.0382	0.0441	0.0464	0.0547	0.0632	0.0719	0.0807	0.0898
170	1.4006	0.0221	0.0297	0.0313	0.0376	0.0433	0.0456	0.0537	0.0621	0.0706	0.0793	0.0882
180	1.4250	0.0217	0.0292	0.0308	0.0369	0.0426	0.0448	0.0528	0.0610	0.0694	0.0780	0.0867
190	1.4494	0.0213	0.0287	0.0302	0.0363	0.0419	0.0440	0.0519	0.0600	0.0682	0.0767	0.0853
200	1.4738	0.0210	0.0283	0.0297	0.0357	0.0412	0.0433	0.0511	0.0590	0.0671	0.0754	0.0839
210	1.4982	0.0206	0.0278	0.0293	0.0351	0.0405	0.0426	0.0502	0.0580	0.0660	0.0742	0.0825
220	1.5226	0.0203	0.0274	0.0288	0.0346	0.0398	0.0419	0.0494	0.0571	0.0650	0.0730	0.812

[a] The information was supplied by the manufacturer, 3M Company, USA. This information refers only to V/V (agent weight requirements./ft.^{3})=pounds of agent required per cubic feet of protected volume:
W = (V/s) X [C/100-C)]

b T [Temperature (°F)] = The design temperature in the hazard area.

c s [specific volume (ft.^{3}/lb.] of superheated Novec 1230 fluid (FK-5-1-12) vapor can be approximated by the formula:
s = 0.9856 + 0.002441T
where T is the temperature in °F

d C [Concentration (%)]= Volumetric concentration of Novec 1230 fluid (FK-5-1-12) in air at the temperature indicated.

Table 3-3. Novec 1230 Fluid Total Flooding Quantity, Metric

Temp T (°C)[b]	Specific Vapor Volumes (m^3/kg)[c]	Weight Requirements of Hazard Volume, W/V (kg/m^3)[a] Design Concentration (% per Volume)[d]										
		3.00	4.00	4.20	5.00	5.72	6.00	7.00	8.00	9.00	10.00	11.00
-20	0.0609	0.5077	0.6840	0.7197	0.8640	0.9960	1.0479	1.2357	1.4275	1.6236	1.8241	2.0290
-15	0.0623	0.4965	0.6690	0.7039	0.8450	0.9741	1.0248	1.2084	1.3961	1.5879	1.7839	1.9843
-10	0.0637	0.4859	0.6545	0.6887	0.8268	0.9531	1.0027	1.1824	1.3660	1.5537	1.7455	1.9415
-5	0.0650	0.4756	0.6407	0.6742	0.8094	0.9330	0.9816	1.1575	1.3372	1.5209	1.7087	1.9006
0	0.6640	0.4658	0.6275	0.6603	0.7926	0.9137	0.9613	1.1336	1.3096	1.4895	1.6734	1.8614
5	0.0678	0.4564	0.6148	0.6469	0.7766	0.8952	0.9418	1.1106	1.2831	1.4593	1.6395	1.8237
10	0.0691	0.4473	0.6026	0.6341	0.7612	0.8775	0.9232	1.0886	1.2576	1.4304	1.6070	1.7875
15	0.0705	0.4386	0.5909	0.6217	0.7464	0.8604	0.9052	1.0674	1.2332	1.4026	1.5757	1.7528
20	0.0719	0.4302	0.5796	0.6099	0.7322	0.8440	0.8879	1.0471	1.2096	1.3758	1.5457	1.7193
25	0.0733	0.4222	0.5688	0.5985	0.7184	0.8282	0.8713	1.0275	1.1870	1.3500	1.5167	1.6871
30	0.0746	0.4144	0.5583	0.5875	0.7052	0.8130	0.8553	1.0086	1.1652	1.3252	1.4888	1.6561
35	0.0760	0.4069	0.5482	0.5769	0.6925	0.7983	0.8399	0.9904	1.1442	1.3013	1.4620	1.6262
40	0.0774	0.3997	0.5385	0.5666	0.6802	0.7841	0.8250	0.9728	1.1239	1.2783	1.4361	1.5974
45	0.0787	0.3928	0.5291	0.5568	0.6684	0.7705	0.8106	0.9559	1.1043	1.2560	1.4111	1.5696
50	0.0801	0.3860	0.5201	0.5472	0.6570	0.7573	0.7967	0.9395	1.0854	1.2345	1.3869	1.5427
55	0.0815	0.3795	0.5113	0.5380	0.6459	0.7445	0.7833	0.9237	1.0671	1.2137	1.3636	1.5168
60	0.0829	0.3733	0.5029	0.5291	0.6352	0.7322	0.7704	0.9084	1.0495	1.1936	1.3410	1.4917
65	0.0842	0.3672	0.4947	0.5205	0.6249	0.7203	0.7578	0.8936	1.0324	1.1742	1.3191	1.4674
70	0.0856	0.3613	0.4868	0.5122	0.6148	0.7088	0.7457	0.8793	1.0158	1.1554	1.2980	1.4439
75	0.0870	0.3556	0.4791	0.5041	0.6052	0.6976	0.7339	0.8654	0.9998	1.1372	1.2775	1.4211
80	0.0883	0.3501	0.4716	0.4963	0.5958	0.6868	0.7225	0.8520	0.9843	1.1195	1.2577	1.3990
85	0.0897	0.3447	0.4644	0.4887	0.5866	0.6763	0.7115	0.8390	0.9692	1.1024	1.2385	1.3776
90	0.0911	0.3395	0.4574	0.4813	0.5778	0.6661	0.7008	0.8263	0.9547	1.0858	1.2198	1.3569
95	0.0925	0.3345	0.4507	0.4742	0.5692	0.6562	0.6904	0.8141	0.9405	1.0697	1.2017	1.3368
100	0.0938	0.3296	0.4441	0.4672	0.5609	0.6466	0.6803	0.0802	0.9267	1.0540	1.1842	1.3172

a The information was supplied by the manufacturer, 3M Company, USA. This information refers only to V/V (agent weight requirements (kg/m^3)=kilograms of agent required per cubic meters of protected volume:
W = (V/s) X [C/100-C)]

b T [Temperature (°C)] = The design temperature in the hazard area.

c s [specific volume (m3/kg] of superheated Novec 1230 fluid (FK-5-1-12) vapor can be approximated by the formula:
s = 0.0664 + 0.0002741T
where T is the temperature in °C

d C [Concentration (%)]= Volumetric concentration of Novec 1230 fluid (FK-5-1-12) in air at the temperature indicated.

3-2.2.2 DETERMINE WHAT COMPONENTS ARE REQUIRED

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

3-2.2.3 LOCATE NOZZLES

Locate nozzles based on the following:

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

3-2.2.4 LOCATE CYLINDERS

Locate cylinders based on the following:

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

3-2.2.5 LOCATE PIPING

Locate piping based on the following:

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

3-2.2.6 PIPE SIZE AND LAYOUT

Determine pipe size and layout for the following factors:

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

The preceding information will be entered into the computer program.

Table 3-2 gives the minimum use concentrations for Novec 1230 fluid for various fuels.

3-2.2.7 USING THE KIDDE ENGINEERED SYSTEM CONCENTRATION FLOODING FACTORS

To find the total quantity of Novec 1230 fluid required at a specific temperature and concentration, multiply the hazard area volume by the multiplier from Tables 3-3 and 3-4 that correspond to the design temperature and concentration desired.

Note: NFPA 2001 and the U.S. Environmental Protection Agency *Significant New Alternatives Policy (SNAP)* provide specific guidelines for using Novec 1230 fluid. The minimum use concentration for total flooding applications is 4.2% w/v, unless a higher concentration is required for the specific hazard being protected.

The agent required must be based on the lowest expected ambient temperature in the protected space. Care must be taken that the calculated concentration for normally occupied spaces at the highest expected ambient temperature in the space does not exceed the value of 10% per NFPA 2001.

Per NFPA 2001, 2004 Edition Kidde Engineered Systems with use concentrations below the NOAEL (10% w/v) are permitted for use in occupied areas. Kidde Engineered Systems can be designed between 4.2% and 10.5% for a five minute exposure using the PBPK model.

Table 3-4. Atmospheric Correction Factors

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

3-2.2.8 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 Novec 1230 fluid is required.
2. The quantity of agent required is greater than the maximum fill of a single cylinder.
3. A single cylinder does not contain enough nitrogen to discharge the required agent through the pipe network.

In accordance with standards set by NFPA 2001:

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

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

- Multiple cylinders are required, and
- A connected reserve supply is required, and
- Multiple cylinder actuation from a master Kidde Engineered System cylinder.

3-2.3 Design Criteria

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

CAUTION

The Kidde Engineered Fire Suppression System Flow Calculation Program is the only calculation method to be used with Kidde Engineered System equipment. No other calculation method is accepted by Kidde.

The system designer must become thoroughly familiar with the User's Manual for Kidde Engineered Fire Suppression System Flow Calculation Program (P/N 45-N1230M-100) to determine the proper procedures for applying the input parameters to the Kidde computer program. There are a number of limitations to these input parameters which must be observed if accurate results are to be obtained. Most of these limitations are in the program. However, there are certain restrictions that must be addressed by the system designer before applying the input data. The following paragraphs describe the essential design parameters and design limitations which must be considered.

3-2.3.1 FIRST BRANCH FLOW SPLIT

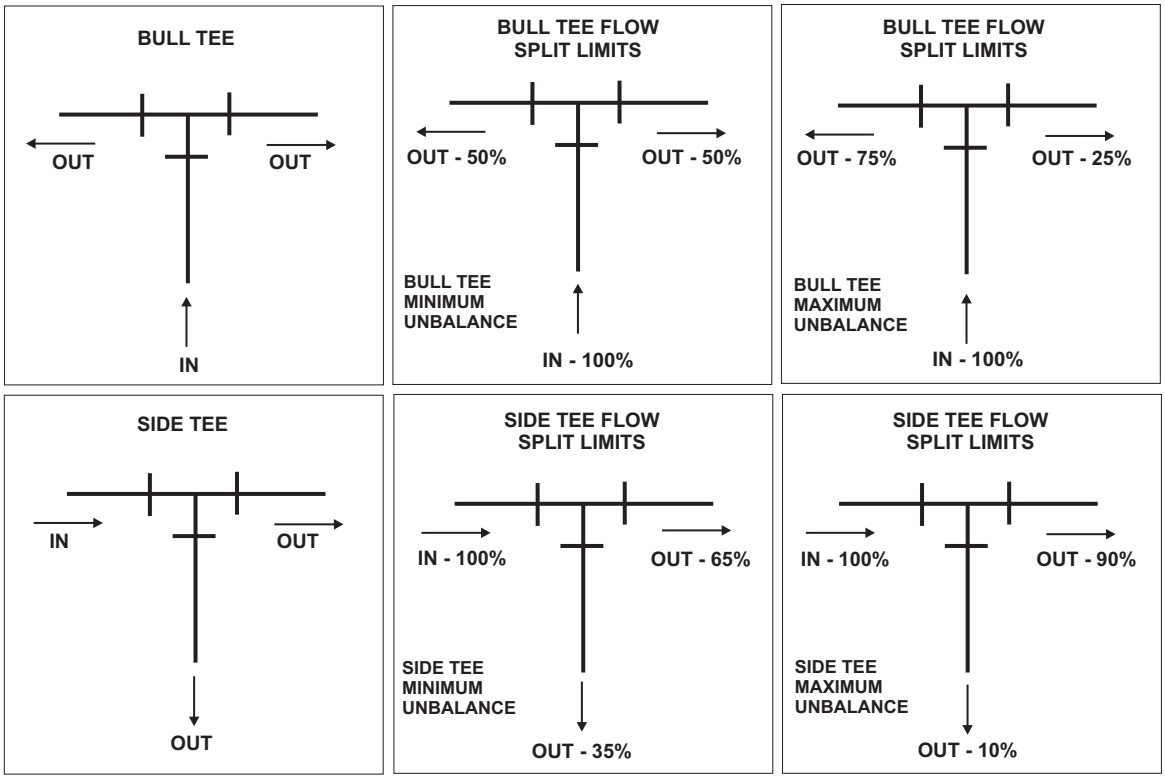


Figure 3-1. Acceptable Tee Flow Splits for a Kidde Engineered System

3-2.3.2 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 3-1 must be observed.

3-2.3.2.1 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 10 pipe diameters (nominal) before the tee.
4. Tee splits going to separate hazards from a common supply line must be spaced a minimum of 10 pipe diameters (nominal) apart.
5. Minimum flow out of a side tee branch is 10% of total flow at the tee.
6. For flow splits less than 25%, the split shall be done through a side tee with the smaller flow going through the side tee member. The minimum flow through the side tee member is 10%. The maximum flow through the tee is 90%.
7. For flow splits equal to or greater than 35%, the split shall be done through a bull head tee. The maximum flow split through a bull head tee is 75%.

Table 3-5. 10 Pipe Diameters

Pipe Size	10 Pipe Diameters		
1/4 in. (6 mm)	0.21 ft.	0 ft., 2½ in.	0.06 m
3/8 in. (10 mm)	0.31 ft.	0 ft., 4 in.	0.10 m
1/2 in. (15 mm)	0.42 ft.	0 ft., 5 in.	0.15 m
3/4 in. (20 mm)	0.63 ft.	0 ft., 7½ in.	0.20 m
1 in. (25 mm)	0.83 ft.	0 ft., 10 in.	0.25 m
1¼ in. (32 mm)	1.04 ft.	1 ft., 1/2 in.	0.32 m
1½ in. (40 mm)	1.25 ft.	1 ft., 3 in.	0.40 m
2 in. (50 mm)	1.67 ft.	1 ft., 8 in.	0.50 m
2½ in. (65 mm)	2.08 ft.	2 ft., 1 in.	0.65 m
3 in. (80 mm)	2.50 ft.	2 ft., 6 in.	0.80 m
4 in. (100 mm)	3.33 ft.	3 ft., 4 in.	1.00 m
5 in. (125 mm)	4.17 ft.	4 ft. 2½ in.	1.25 m
6 in. (150 mm)	5.00 ft.	5 ft., 0 in.	1.50 m

3-2.3.3 DURATION OF DISCHARGE

Per NFPA 2001, the liquid agent discharge shall be completed in a nominal ten seconds or less. Discharge times shorter than 10 seconds are desirable to minimize production of breakdown products. Discharge times are as short as five seconds are permitted.

3-2.3.4 NOZZLE SELECTION AND PLACEMENT

There are two basic Kidde Engineered System nozzle configurations:

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

Use the Kidde Engineered Fire Suppression System Flow Calculation Program as a tool to determine the selection of the required orifice area and nozzle.

Maximum orifice area to pipe area ratio:

- The ratio between the nozzle orifice area for a 360 degree nozzle at the given node and the pipe cross sectional area for the pipe segment preceding that nozzle is 0.85, or 85%, except the 1/4 in. NPT size nozzle. The internal geometries of the 1/4 in. NPT size nozzle are such that the ratio of actual nozzle orifice area to cross sectional area of the feed pipe is 75%.
- 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 0.85, or 85%. Due to geometric constraints and the need to keep a sharp-edged orifice, in sizes up to and including 3/4 in. NPT (19 mm), the 180° sidewall nozzle has a lower ratio of orifice area to feed pipe area. This value is different for each size nozzle through 3/4 in. NPT.

Minimum orifice area to pipe area ratio:

- The ratio between the nozzle orifice area for a 360 degree nozzle at the given node and the pipe cross sectional area for the pipe segment preceding that nozzle is 0.20, or 20%.
- 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 0.20, or 20%.

Nozzles are available in nominal pipe sizes of 1/4 in., 3/8 in., 1/2 in., 3/4 in., 1 in., 1¼ in., 1½ in. and 2 in..

Note: The 1/4 in. nozzle is non-listed, non approved and has a 75% maximum orifice area to pipe area ratio.

3-2.3.5 NOZZLE PLACEMENT

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

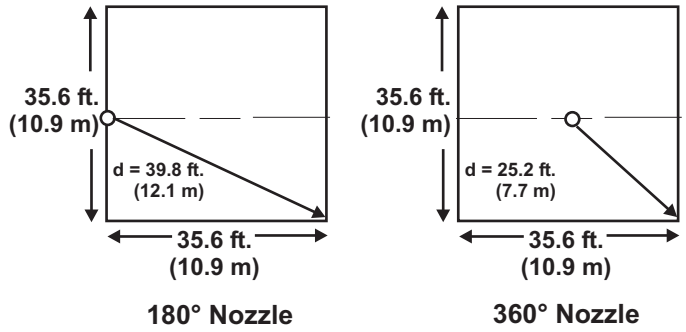


Figure 3-2. Nozzle Placement and Coverage

- **Orientation**-Nozzles must be mounted perpendicular to the ceiling or subfloor surface and oriented with the orifices radiating symmetrically outward from the pipe network.
- **Ceiling Clearance**-Nozzles must be installed so that the orifices are located 6 to 12 in. +/- 2 in. (152 to 483 mm +/- 51 mm) below the ceiling.
- **Maximum Height**-The maximum protected height for a single row of nozzles is 16 feet (4.87 m).
  Nozzles may be tiered to accommodate enclosures with ceiling heights greater than 16 ft. (4.87 m), but no greater than 32 ft. (9.8 m).
- **Minimum Ceiling Height**-The minimum ceiling height for UL Listed/ FM Approved systems is 1 ft. (0.3 m) or 12 in.
  Systems designed for enclosures 6 to 12 in. (152 mm to 305 mm) are acceptable, but not UL Listed or FM Approved.
- **180° Nozzles**-180° nozzles must be located 6 +/- 2 inches (0.3 +/- 0.05 m) from a wall, with the orifices directed away from the wall. The nozzle shall be located as close to the center of the wall as possible, but at least 1/3 of the way along the wall.
  180° nozzles have a maximum coverage area defined as a square that can be inscribed in a semicircle of distance 39.8 ft. (12.1 m, diagonal of a rectangle 17.8' x 35.6'). Refer to Figure 3-2 for further information.
  180° nozzles may be used in a back-to-back configuration. The nozzles should be place 1 to 2 ft. (0.3 m to 0.6 m) apart.

- **360° Nozzles**-360° nozzles must be located as close to the center of the enclosure as possible. 360° nozzles have a maximum coverage area defined as any square that can be inscribed in a circle of radius 25.2 ft. (7.7 m, diagonal of a square 17.8' x 17.8'). Refer to Figure 3-2 for further information.
- **Multiple Nozzles**-Nozzles whose discharge patterns will intersect must be placed at least 10 ft. (3.3 m) apart to assure adequate agent distribution.
- **Walls and Obstructions-**Novec 1230 fluid discharged from the nozzle requires a certain length from the nozzle to atomize into a gas. If the Novec 1230 fluid comes into contact with a surface before the agent is fully atomized, frosting can occur. As a result, the concentration throughout the enclosure will be less than required to appropriately protect the space. Therefore, nozzles must be located with at least 4 to 6 feet of clearance from walls and/or significant obstructions (ex. high rise racking and columns). If this requirement cannot be met, additional agent may be discharged to compensate for this agent "loss."
- **Reduced Coverage Area**-Consideration should be given to reducing nozzle spacing when obstructions that would impede the uniform distribution of Novec 1230 fluid throughout the area are present. Nozzle coverage area must be reduced to 25 ft. x 25 ft. for enclosure heights six to twelve inches (7.5 m x 7.5 m for heights 0.15 to 0.3 meters).

Limits on Nozzle Conditions:

- Minimum average nozzle pressure-The nozzle pressure must be a minimum of 60.3 PSIG (4.2 bar) for the nozzle to effectively vaporize and distribute the agent and mix the agent into the air of the enclosure being protected.
- **Maximum arrival time imbalance**-The difference between liquid arrival times at two of the nozzles must not exceed the 2.0 seconds allowed.
- **Maximum runout time imbalance**-The difference between nozzle liquid runout times at two of the nozzles exceed the 6.3 second allowed maximum.

Maximum Elevation Differences in Pipe Runs:

- If nozzles are only located above the cylinder outlet, then the maximum elevation difference between the cylinder outlet and the furthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 40 ft. (21.3 m).
- If nozzles are only located below the cylinder outlet, then the maximum elevation difference between the cylinder outlet and the furthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 40 ft. (21.3 m).
- If nozzles are located both above and below the cylinder outlet, then the maximum elevation difference between the furthest horizontal pipe runs or discharge nozzles (whichever is furthest) shall not exceed 40 ft. (21.3 m).

Note: If you have a system design that violates these limits, then you must consult the factory to determine what course of action should be taken (see Figure 3-3 for further clarification).

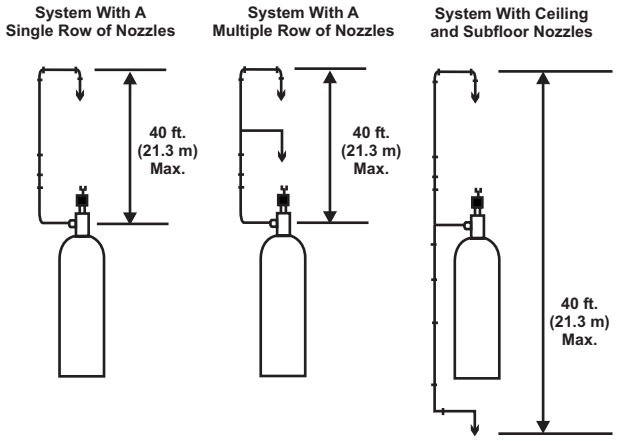


Figure 3-3. Nozzle Limitations

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

3-2.3.6 PIPE SIZING

The following table may be used as an estimating guide for sizing distribution piping. This table is intended for use as a guide only. The Kidde Engineered Fire Suppression System Flow Calculation Program must be used for the final design.

Table 3-6. Pipe Size vs. Flow Rate

Pipe Size Nominal	Schedule 40 Pipe				Schedule 80 Pipe			
	Minimum Flow Rate for All Sections Leading to a Tee		60% of Flow Rates for All Sections Ending With a Nozzle		Minimum Flow Rate for All Sections Leading to a Tee		60% of Flow Rates for All Sections Ending With a Nozzle	
	lb./sec.	kg/sec.	lb./sec.	kg/sec.	lb./sec.	kg/sec.	lb./sec.	kg/sec.
1/4 in. (9 mm)	0.68	0.31	0.41	0.19	0.30	0.14	0.18	0.08
3/8 in. (10 mm)	1.55	0.70	0.93	0.42	1.06	0.48	0.64	0.29
1/2 in. (15 mm)	2.58	1.17	1.55	0.70	1.95	0.88	1.17	0.53
3/4 in. (20 mm)	4.53	2.05	2.72	1.23	3.68	1.67	2.21	1.00
1 in. (25 mm)	7.29	3.31	4.37	1.98	6.08	2.76	3.65	1.65
1¼ in. (32 mm)	12.67	5.75	7.60	3.45	10.83	4.91	6.50	2.95
1½ in. (40 mm)	17.46	7.92	10.48	4.75	15.06	6.83	9.04	4.10
2 in. (50 mm)	29.82	13.53	17.89	8.12	25.96	11.78	15.58	7.07
2½ in. (65 mm)	44.06	19.99	26.44	11.99	38.51	17.47	23.11	10.48
3 in. (80 mm)	71.34	32.36	42.80	19.42	62.96	28.56	37.78	17.13
3½ in. (90 mm)	98.32	44.60	58.99	26.76	87.46	39.67	52.48	23.80
4 in. (100 mm)	129.28	58.64	77.57	35.18	115.87	52.56	69.52	31.53
5 in. (125 mm)	205.71	93.31	123.43	55.99	187.31	84.96	112.39	50.98
6 in. (150 mm)	286.54	129.97	171.92	77.98	262.77	119.19	157.66	71.51

Note: The pipe friction factor embodied in the energy conservation equation used to calculate pressure drop for two-phase flow in fire protection systems is based on the premise that highly turbulent flow is present in the pipeline. Also, a high degree of turbulence must be maintained in pipe sections that approach dividing points. The pipe size that can be used for a given flow rate is thus based upon the minimum flow rate required to maintain complete turbulence.

This limitation is tabulated in the Table and is automatically taken into consideration when the computer selects pipe sizes for the system. Flow rates as low as 60% of the tabulated minimum rates may be used in branch lines that lead directly to nozzles with no intervening flow division.

3-2.4 Other Conditions

3-2.4.1 OPERATING/STORAGE TEMPERATURE RANGE

Kidde Engineered System equipment listed herein is designed to operate within a temperature range of 0°F to 130°F (-17°C to 54°C). The Kidde Engineered Fire Suppression System Flow Calculation Program assumes a temperature of 70°F (21°C). Therefore, the cylinder 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 cylinder operating/storage temperature is outside this range, an insufficient quantity of agent may be discharged from one or more discharge nozzles.

3-2.4.2 STORAGE TEMPERATURE

Kidde Engineered System equipment is suitable for storage from 0°F to 130°F (-17°C to 54°C).

3-2.4.3 SYSTEM OPERATING PRESSURE

The normal system operating pressure for Kidde Engineered System equipment is 360 PSIG at 70°F (25 bar gauge at 21°C).

3-2.5 Pressure Actuation Limitations

Four modes of pressure actuation of the Kidde Engineered System cylinders are available.

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

3-2.5.1 CYLINDERS CLOSE COUPLED USING PRESSURE FROM A MASTER

Note: See Figure 3-4.

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

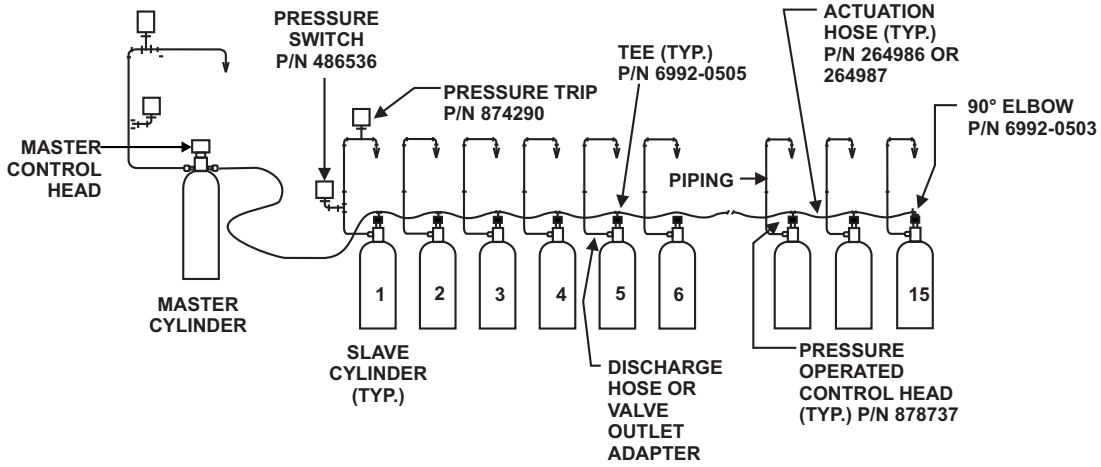


Figure 3-4. Pressure Actuation Using Pressure from 1 Master Kidde Engineered System Cylinder to Actuate a Maximum of 15 Kidde Engineered System Cylinders Close Coupled

3-2.5.2 CYLINDERS NOT CLOSE COUPLED USING PRESSURE FROM A MASTER

Note: See Figure 3-5.

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

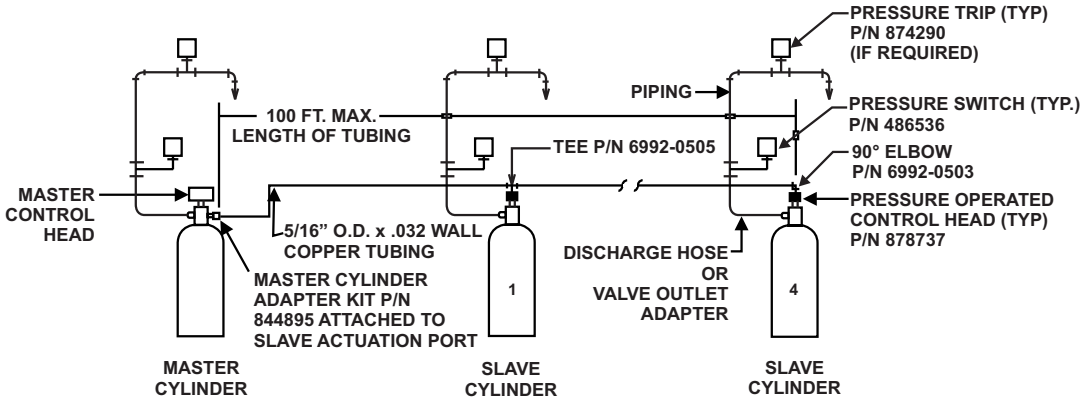


Figure 3-5. Pressure Actuation Using Pressure from 1 Master Kidde Engineered System Cylinder to Actuate a Maximum of 4 Kidde Engineered System Cylinders NOT Close Coupled

3-2.5.3 CYLINDERS NOT CLOSE COUPLED USING NITROGEN PRESSURE

Note: See Figure 3-6.

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

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

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

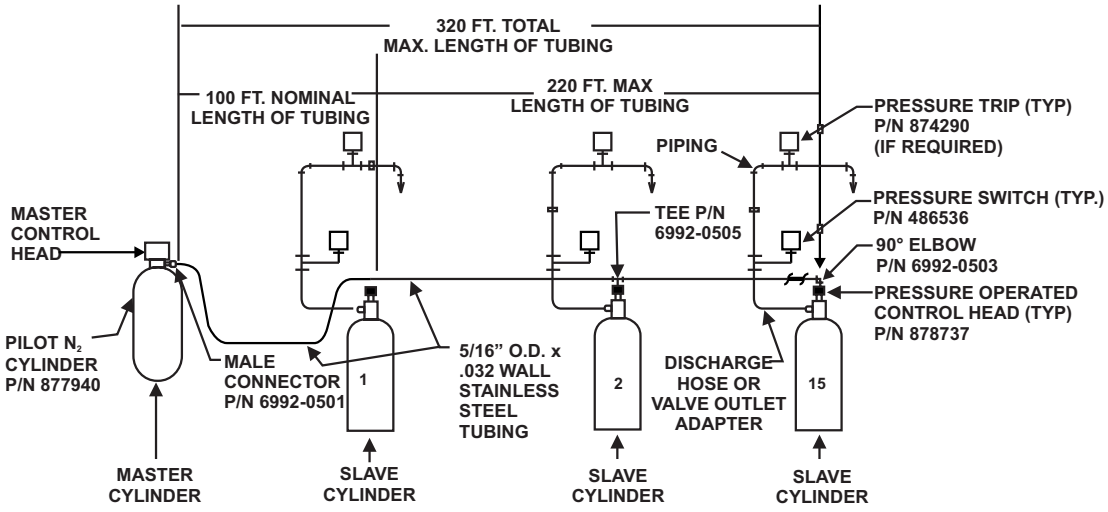


Figure 3-6. Pressure Actuation Using Pressure from 1 Nitrogen Pilot Cylinder to Actuate a Maximum of 15 Kidde Engineered System Cylinders NOT Closed Coupled

3-2.5.4 CYLINDERS CLOSE COUPLED USING NITROGEN PRESSURE

Note: See Figure 3-7.

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

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

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

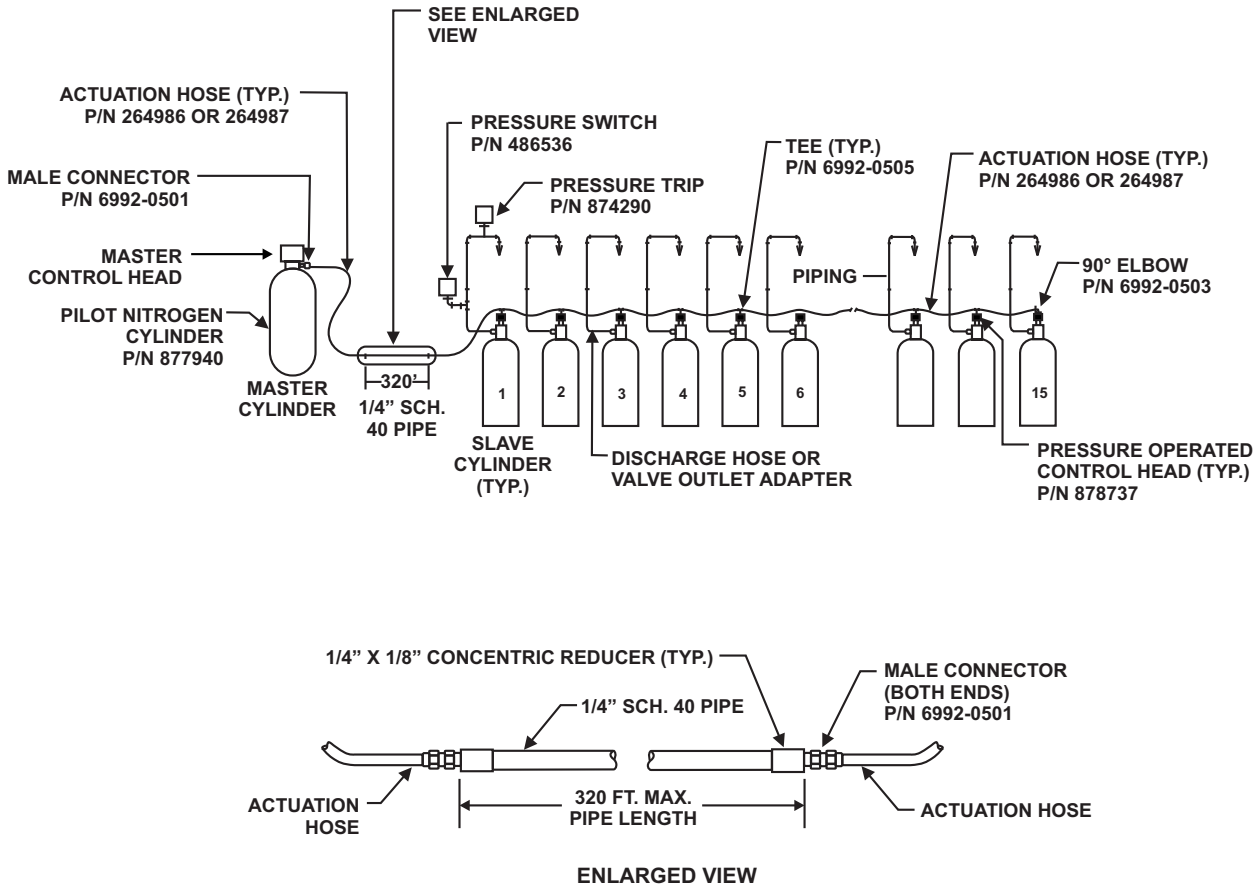


Figure 3-7. Pressure Actuation Using Pressure from 1 Nitrogen Pilot Cylinder to Actuate a Maximum of 15 Kidde Engineered System Cylinders Close Coupled

3-2.5.5 USING MULTIPLE NITROGEN CYLINDERS

Two or more remotely located pilot nitrogen cylinders can be used to actuate the Kidde Engineered Systems described in Paragraph 3-2.5.3 and Paragraph 3-2.5.4, 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 3-8).
- The total length of actuator line, from each nitrogen pilot cylinder to the Kidde Engineered System cylinders shall not exceed the limitation established.

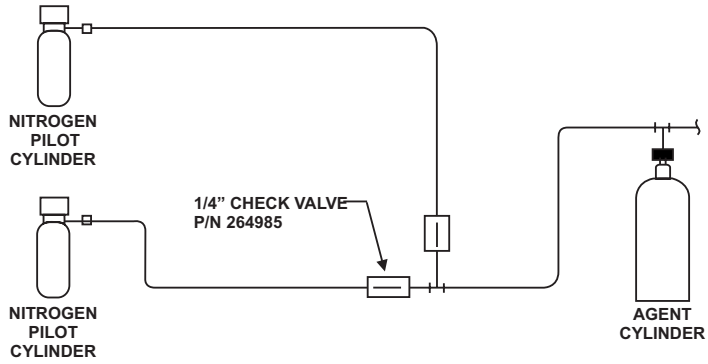


Figure 3-8. Multiple Pilot Nitrogen Actuation Cylinders

3-2.5.6 CORNER PULLEY AND CABLE LIMITATIONS

Table 3-7 lists corner pulley and cable length limitations.

Table 3-7. Corner Pulley and Cable Limitations

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

3-2.5.7 PRESSURE TRIP LIMITATIONS

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

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CHAPTER 4
INSTALLATION

4-1 GENERAL EQUIPMENT INSTALLATION

All Kidde Engineered Fire Suppression System designed for use with 3M™ Novec™ 1230 Fire Protection Fluid equipment must be installed to facilitate proper inspection, testing, manual operation, recharging and any other required maintenance as may be necessary. Equipment must not be subject to severe weather conditions or mechanical, chemical or other damage that could render the equipment inoperative. Equipment must be installed in accordance with NFPA Standard 2001, current edition.

CAUTION

The Kidde Engineered System cylinder and 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 Kidde Engineered System cylinders to violently discharge, resulting in severe injury, death and/or property destruction.

4-1.1 Distribution Piping and Fittings

4-1.1.1 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.

4-1.1.2 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.

4-1.1.2.1 Ferrous Piping

Black steel or galvanized pipe must be either ASTM A-53 seamless or electric resistance welded, Grade A or B, or ASTM A-53 furnace weld Class F (up to 1½ in. diameter) or ASTM A-106, Grade A, B or C. ASTM B-120 and ordinary cast iron pipe must not be used. The thickness of the pipe wall must be calculated in accordance with ANSI B-31.1, Power Piping Code. The internal pressure for this calculation shall not be less than the minimum piping design pressure of 402 PSIG (28 bar gauge) at 70°F (21°C). The minimum piping design pressure of 340 PSIG (23.45 bar gauge) at 70°F corresponds to eighty percent of the maximum pressure of 425 PSIG (29.3 bar-g) in the agent container at the maximum storage temperature at 130°F

CAUTION

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

4-1.1.2.2 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.

4-1.1.2.3 Fittings

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

Concentric bell reducers are the only means for reducing pipe size. Reductions can be made after a tee or after a union. Where reducers are used at tees, the reducers must be downstream of each tee. Reductions made after a union are possible only if the next change in direction (tee split) is located a minimum of 10 nominal pipe diameters downstream of the concentric bell reducer. Gaskets for flanged fittings shall be flat gray asbestos, neoprene impregnated.

CAUTION

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

4-1.2 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 3-2.3.2 of this manual for proper tee installations.

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

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

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

4-1.3 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 3-2.3.5 for correct nozzle placement and orientation.

4-2 INSTALLATION OF KIDDE ENGINEERED SYSTEM CYLINDERS

4-2.1 Installation of Check Valves

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

4-2.2 Installation of Pressure Actuation Pipe

The pressure actuation pipe must be 1/4-inch Schedule 40 or 80 pipe. The pipe or tubing must be routed in the most direct manner with a minimum of fittings. Pipe and fittings must be in accordance with the requirements listed in Paragraph 3-2.5. Fittings can be flared or compression type. The pressure-temperature ratings of the fitting manufacturer must not be exceeded.

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

4-2.3 Installation of Valve Outlet Adapter

WARNING

If a Flexible Discharge Hose is not used, always connect a valve outlet adapter into system piping (union connection) before connecting to a Kidde Engineered System cylinder.

Install valve outlet adapter (P/Ns 283904 and 283905) 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.

4-2.4 Installation of Flexible Discharge Hose

WARNING

If a Flexible Discharge Hose is not use, always connect the flexible discharge hose into system piping before connecting to a Kidde Engineered System cylinder.

Attach the flexible discharge hose from system piping or El-check in the discharge manifold to the cylinder valve. Tighten securely (see Figure 4-1 and Table 4-1).

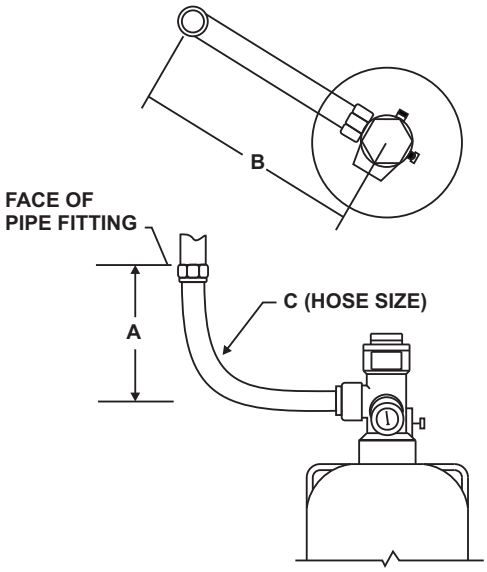


Figure 4-1. Installation of the Flexible Hose Directly Into System Piping

Table 4-1. Installation of the Flexible Hose Directly into System Piping

Cylinder Capacity	Dimensions					
	A		B		C*	
10 lb.	14 5/8 in.	371 mm	16 3/4 in.	425 mm	1 1/2 in.	38 mm
20 lb.	14 5/8 in.	371 mm	16 3/4 in.	425 mm	1 1/2 in.	38 mm
40 lb.	14 5/8 in.	371 mm	16 3/4 in.	425 mm	1 1/2 in.	38 mm
70 lb.	14 5/8 in.	371 mm	16 3/4 in.	425 mm	1 1/2 in.	38 mm
125 lb.	14 5/8 in.	371 mm	16 3/4 in.	425 mm	1 1/2 in.	38 mm
200 lb.	19 in.	483 mm	21 3/4 in.	552 mm	2 in.	51 mm
350 lb.	19 in.	483 mm	21 3/4 in.	552 mm	2 in.	51 mm
600 lb.	33 in.	838 mm	36 in.	914 mm	3 in.	76 mm
900 lb.	33 in.	838 mm	36 in.	914 mm	3 in.	76 mm
***Note:** Hose may require an adapter to connect to system piping.						

Note: Dimensions A and B must be maintained in order to obtain a smooth radius in flexible loop.

4-2.5 Installation of Kidde Engineered System Cylinder and Valve Assemblies

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

4-2.5.1 SINGLE CYLINDER SYSTEMS

WARNING

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

1. Position Kidde Engineered System cylinder in designated location and secure in place with cylinder strap and attaching hardware (see Figure 4-2 and Table 4-2 and Table 4-3). Orient cylinder with valve outlet angled toward system piping.
2. Remove the safety cap from the cylinder valve outlet port.

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.

3. Connect a 1½-, 2- 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.

4. Install supervisory pressure switches (if applicable). Refer to Paragraph 4-2.13 for installation instructions.
5. 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 a Kidde Engineered System cylinder in order to prevent accidental discharge.

6. Install the control head to the cylinder valve actuation port. Refer to appropriate paragraph for control head installation.

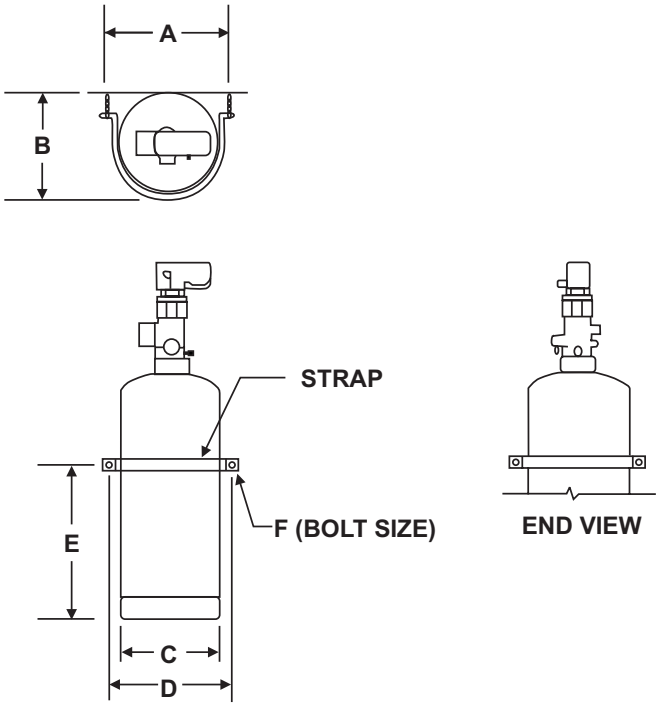


Figure 4-2. Single Cylinder Installation, Vertical Mounting

Table 4-2. Single Cylinder Installation Dimensions

Cylinder Part Number	Dimensions					
	A	B	C	D	E	F
45-100010-001	9.62 in. (244 mm)	7.19 in. (183 mm)	7.07 in. (180 mm)	8.52 in. (216 mm)	7.38 in. (187 mm)	3/8 in. (M10)
45-100020-001	9.62 in. (244 mm)	7.19 in. (183 mm)	7.07 in. (180 mm)	8.52 in. (216 mm)	12.50 (318 mm)	3/8 in. (M10)
45-100040-001	11.69 in. (297 mm)	9.13 in. (232 mm)	9.00 in. (229 mm)	10.69 in. (272 mm)	10.63 in. (270 mm)	3/8 in. (M10)
45-100070-001	11.69 in. (297 mm)	9.13 in. (232 mm)	9.00 in. (229 mm)	10.69 in. (272 mm)	27.50 (699 mm)	3/8 in. (M10)
45-10012X-001	16.18 in. (411 mm)	12.94 in. (329 mm)	12.75 in. (324 mm)	14.56 in. (370 mm)	23.75 in. (597 mm)	9/16 in. (M14)
45-10020X-001	16.18 in. (411 mm)	12.94 in. (329 mm)	12.75 in. (324 mm)	14.56 in. (370 mm)	39.00 in. (991 mm)	9/16 in. (M14)
45-10035X-001	19.50 in. (495 mm)	16.19 in. (411 mm)	16.00 in. (406 mm)	17.88 in. (454 mm)	44.00 in. (1118 mm)	9/16 in. (M14)
45-10060X-001	25.75 in. (654 mm)	22.25 in. (565 mm)	22.00 in. (559 mm)	24.12 in. (613 mm)	38.50 in. (978 mm)	9/16 in. (M14)
45-10090X-001	27.75 in. (704 mm)	25.00 in. (635 mm)	24.00 in. (610 mm)	26.00 in. (660 mm)	48.50 in. (1232 mm)	9/16 in. (M14)

Table 4-3. Strap Part Numbers for Cylinder Installation

Strap Part Number	Cylinder Size
283945	10 and 20 lb.
283934	40 and 70 lb.
235317	125 and 200 lb.
281866	350 lb.
294651	600 lb.
236125	900 lb

4-2.5.2 MULTIPLE CYLINDER SYSTEMS

WARNING

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

1. Position the cylinders in the designated location and secure them in place with cylinder straps and attaching hardware (see Figure 4-3 and Table 4-4). Orient the cylinders so that the valve outlets are angled towards the El-check valves in the manifold.

WARNING

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

2. Remove the safety cap from one cylinder outlet port and connect the flexible discharge hose to the cylinder outlet port. Repeat for each cylinder in the system.
3. Install supervisory pressure switches (if applicable). Refer to Paragraph 4-2.13 for installation instructions.
4. Remove the protection caps from the cylinder actuation ports.
5. 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 Kidde Engineered System cylinders in order to prevent accidental discharge. Personal injury and/or property damage could occur.

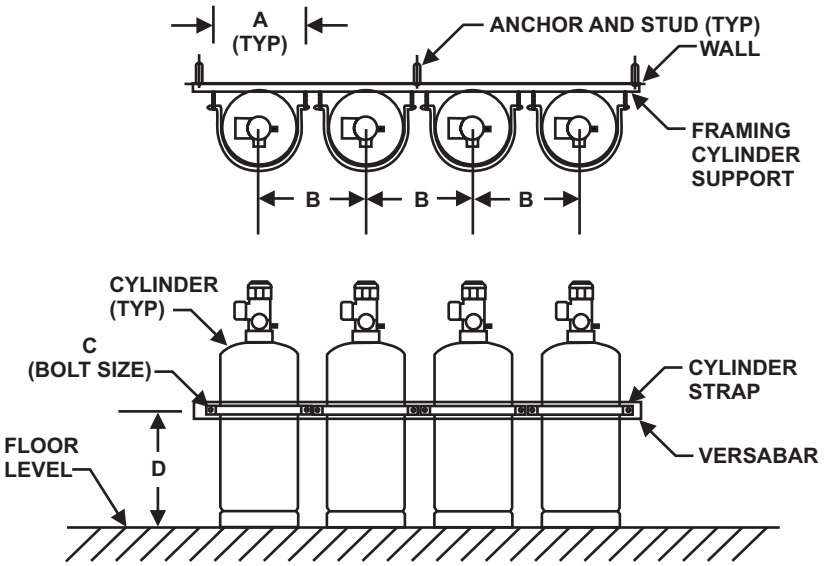


Figure 4-3. Multiple Cylinder Installation, Vertical Mounting
(see Table 4-4 for dimensions)

Table 4-4. Multiple Cylinder Installation Dimensions

Cylinder Part Number	Dimensions							
	A		B		C		D	
45-100010-001	8.52 in.	216 mm	11.00 in.	279 mm	3/8 in.	10 mm	7.38 in.	187 mm
45-100020-001	8.52 in.	216 mm	11.00 in.	279 mm	3/8 in.	10 mm	12.50 in.	318 mm
45-100040-001	10.69 in.	272 mm	13.00 in.	330 mm	3/8 in.	10 mm	10.63 in.	270 mm
45-100070-001	10.69 in.	272 mm	13.00 in.	330 mm	3/8 in.	10 mm	20.00 in.	699 mm
45-10012X-001	14.56 in.	370 mm	18.00 in.	457 mm	9/16 in.	14 mm	20.88 in.	597 mm
45-10020X-001	14.56 in.	370 mm	18.00 in.	457 mm	9/16 in.	14 mm	29.63 in.	991 mm
45-10035X-001	17.88 in.	454 mm	21.00 in.	533 mm	9/16 in.	14 mm	37.13 in.	1118 mm
45-10060X-001	25.75 in.	654 mm	27.00 in.	686 mm	9/16 in.	14 mm	38.50 in.	978 mm
45-10090X-001	25.75 in.	654 mm	30.00 in.	762 mm	9/16 in.	14 mm	48.50 in.	1232 mm

4-2.5.3 MASTER/SLAVE CYLINDER INSTALLATION

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 Kidde Engineered System cylinder in designated location and secure in place with cylinder strap and attaching hardware (see Figure 4-2 and Table 4-2 and Table 4-3). Orient cylinder with valve outlet angled toward system piping.
2. Remove the safety cap from the cylinder valve outlet port.

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.

3. Connect a 1½-, 2- 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.

4. Install supervisory pressure switches (if applicable). Refer to Paragraph 4-2.13 for installation instructions.
5. Install the master cylinder adapter kit. Refer to Paragraph 4-2.6 for installation instructions.
6. 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 a Kidde Engineered System cylinder in order to prevent accidental discharge.

7. Install pressure operated control heads and actuation tubing; do not attach control head to slave cylinder valve actuation port at this time.
8. Install control heads and actuation tubing to slave cylinder.

4-2.6 Installation of Master Cylinder Adapter Kit, P/N 844895

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

1. Remove the 1/4-inch pipe plug from the slave actuation port on the master cylinder valve (see Figure 4-4).
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.

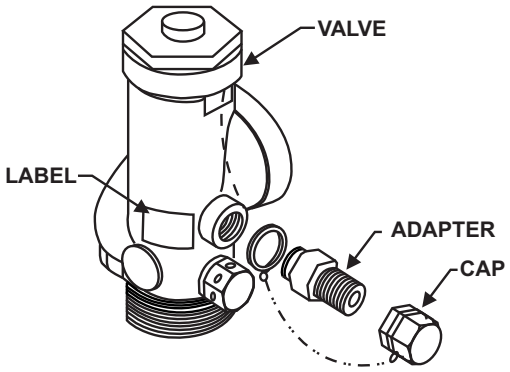


Figure 4-4. Installation of Master Cylinder Adapter Kit

6. Remove the cap.
7. Attach the actuation hose or thread the copper tubing to the adapter.

4-2.7 Installation of Electric Control Heads

WARNING

Before installing a control head on a Kidde Engineered System cylinder valve, ensure the control head is in the SET position (that is, the actuating pin is in the fully retracted or SET position). Failure to position the control head in the SET position will result in accidental Kidde Engineered System cylinder discharge when the control head is installed on cylinder valve. Personal injury and/or property damage could occur. Electric Control Head, P/N 486500-01 is designed for Kidde 1½ in. and 2 in. Kidde Engineered System cylinder valves only. Installing this control head on any other device (for example, pressure operated control head) will cause the device to malfunction when the control head is actuated.

1. Remove the protection cap from the Kidde Engineered System cylinder actuation port.

WARNING

Ensure the control head is in SET position (that is, the actuating pin is in the fully retracted or SET position).

2. Install the electric control head on the cylinder actuation port. Tighten the swivel nut.
3. Make all electrical connections.

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

CAUTION

The stackable control head (P/N 48650001) cannot be used with the 3-inch valve cylinder (P/Ns 45-100600-001, 45-100601-001, 45-100900-001 and 45-100901-001). The stackable control head does not have sufficient force to activate the 3-inch valve (P/N 45-17000-000) and may result in system failure. Use the electric/manual control heads (P/N[s] 890181, 895630, 890149 or 81-100000-001) with the 3-inch valve.

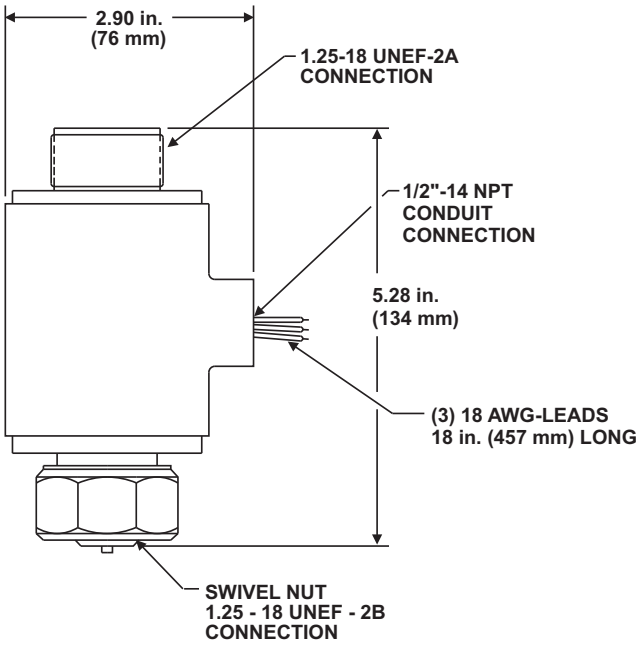


Figure 4-5. Installation of Electric Control Head (Stackable Type), P/N 486500-01

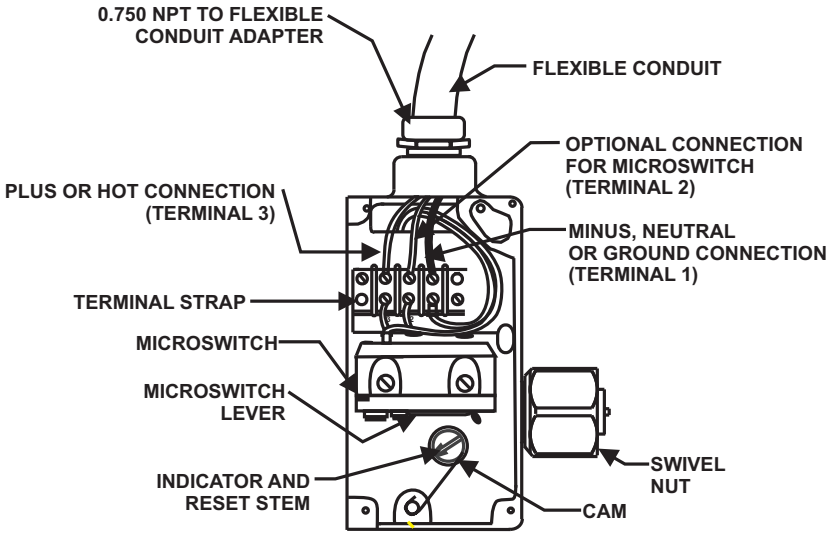


Figure 4-6. Electrical Connections for Control Head, P/Ns 890181, 895630 and 890149

4-2.8 Installation of Pressure Operated Control Heads, P/N 878737

1. Remove the protection cap from the cylinder actuation port (see Figure 4-7).

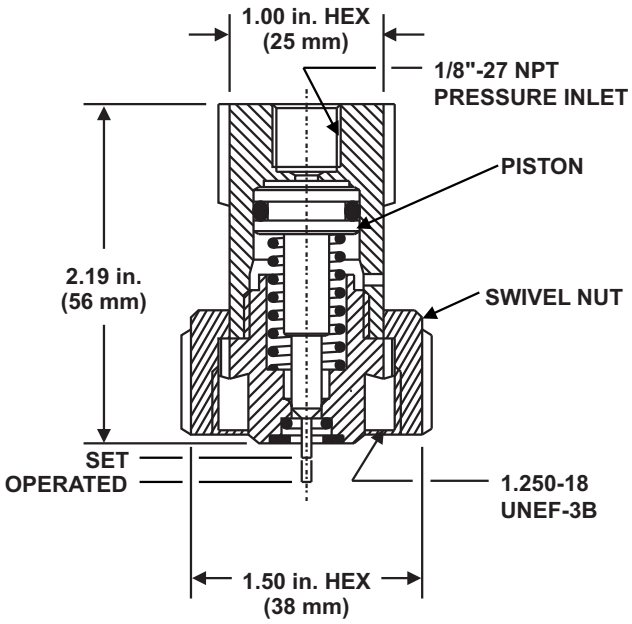


Figure 4-7. Pressure Operated Control Head

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

WARNING

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

4-2.9 Installation of Electric/Cable Operated Control Head, P/Ns 895630, 895627 and 895628

The following procedures must be performed before attaching a control head to a cylinder valve (see Figure 4-8):

1. Check that the control head is in the SET position.
2. Ensure all lockout/tagout procedures are followed.
3. Make all internal electrical connections per system schematic.
4. Remove the four screws holding the cable housing cover on the control head. Remove the cover.
5. Position the control head in the approximately installed position at the Kidde Engineered System cylinder valve control port but do not assemble onto the actuation port of the Kidde Engineered System cylinder valve.
6. Assemble the pull cable conduit to the conduit connection on the control head.
7. Feed the cable into the control head through the hole in the operating lever.
8. Feed the cable through the cable clamp. Pull the cable taut, allowing approximately 1/4 in. to 1/2 in. clearance between the cable clamp and the operating lever. Tighten the set screws in the cable clamp to secure the cable to the clamp.

9. Cut off any excess cable.
10. Verify the manual remote cable operation to ensure control head actuates and all cable clamps are tight.
11. Pull the cable back to its normal set (non-operated) position.
12. Reset the control head.
13. Replace the control head cover.
14. Examine the seal wire at the safety pull pin. Make sure it is intact.
15. Make all external electrical connections.
16. Assemble the control head to the cylinder valve actuation port. Tighten the swivel nut securely. Remove safety cap.

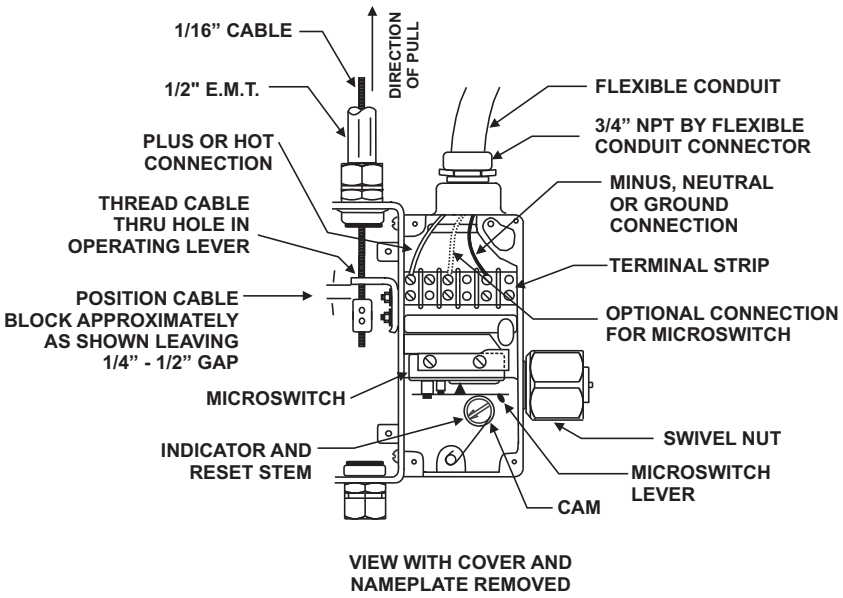


Figure 4-8. Electric/Cable Operated Control Head

4-2.10 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.

4-2.11 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.

4-2.12 Installation of Nitrogen Pilot 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 Kidde Engineered System storage cylinders.
2. Install the mounting bracket clamps and hardware. Install the nitrogen cylinder in position in a mounting bracket; tighten sufficiently to hold the cylinder in place while allowing the cylinder enough free play to be rotated.
3. Turn the cylinder until the cylinder valve discharge outlet is in the desired position. The nitrogen cylinder must be positioned so that control head is readily accessible during manual operation.
4. Securely tighten the mounting bracket clamps and hardware.
5. Attach the adapter (P/N 6992-0501) and connect the nitrogen pilot lines.
6. Remove the protective cap from the cylinder valve actuation port.

WARNING

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

7. Install the control head to the cylinder valve actuation port and tighten securely.
8. Install control head on nitrogen pilot cylinder.

4-2.13 Installation of Pressure Switch, P/N 486536 and P/N 981332

WARNING

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

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

4-2.14 Installation of Pressure Trip, P/N 874290

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

4-2.15 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 Kidde Engineered System cylinder valve.

4-2.16 Installation of Discharge Indicator, P/N 875553

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

4-2.17 Installation of Supervisory Pressure Switch, P/Ns 06-118262-001 and 06118263-001

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

WARNING

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

CAUTION

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

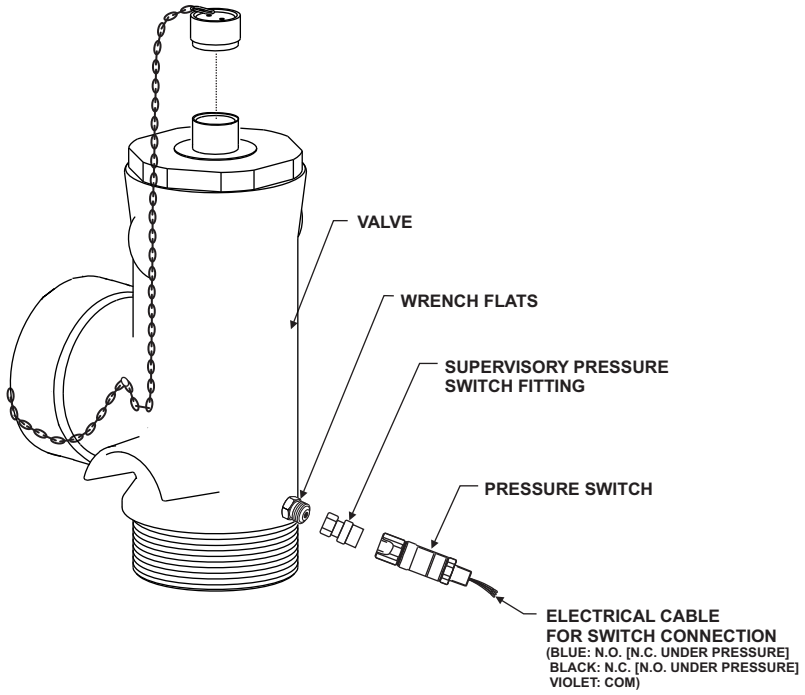
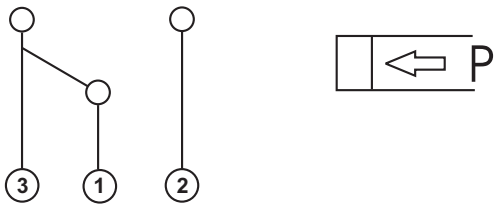


Figure 4-9. Installation of Supervisory Pressure Switch
(2 in. Valve with Supervisory Pressure Switch 06-118262-001 Shown)

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



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

Figure 4-10. 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 cylinder pressure. This configuration should only be used if accepted by the Authority Having Jurisdiction (AHJ).

4-2.17.1 INSTALLATION OF PRESSURE SWITCH 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 a Kidde Engineered System 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.

4-2.17.2 INSTALLATION OF PRESSURE SWITCH 06-118263-001

Install the pressure switch as follows:

Note: For 3 in. valves only.

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

4-2.18 Nitrogen Pilot Cylinder Installation, 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 Kidde Engineered System 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.

4-3 POST-INSTALLATION PROCEDURES

After the Kidde Engineered System installation has been completed, perform the following inspections and tests.

1. Verify that the cylinders of correct weight and pressure are installed in accordance with installation drawings.
2. Verify that the cylinder brackets and straps are properly installed and all fittings are tight.
3. The piping distribution system must be inspected for compliance with the system drawings, NFPA 2001, design limitations within this manual and the computerized hydraulic calculations associated with each independent piping and nozzle configuration.
4. Check that the discharge manifold, discharge piping and actuation piping are securely hung. Ensure all fittings are tight and securely fastened to prevent agent leakage and hazardous movement during discharge. The means of pipe size reduction and installation position of the tees must be checked for conformance to the design requirements.
5. The piping distribution system must be cleaned, blown free of foreign material and inspected internally to ensure that oil or particulate matter will not soil the hazard area or reduce the nozzle orifice area and affect agent distribution.
6. System piping should be pressure tested in accordance with the requirements of NFPA 2001.
7. Ensure that the check valves are installed in the proper location as indicated on the installation drawings and that the equipment is installed with the arrow pointing in the direction of flow.
8. Verify the nozzles are installed in the correct locations and have the correct part numbers and orifice sizes as indicated on installation drawings. Discharge nozzles must be oriented such that optimum agent dispersal can be achieved. Check the nozzle orifices for any obstructions.
9. The discharge nozzles, piping and mounting brackets must be installed such that they will not cause injury to personnel. The agent must not be discharged at head height or below where people in a normal work area could be injured by the discharge. The agent must not directly impinge on any loose objects or shelves, cabinet tops or similar surfaces where loose objects could be propelled by the discharge.
10. For systems with a main/reserve capability, the MAIN/RESERVE switch must be clearly identified and properly installed where it is readily accessible.

11. Manual pull stations must also be clearly identified and properly installed where they are readily accessible. All manual stations that activate Kidde Engineered Systems should be properly identified as to their purpose. Particular care should be taken where manual pull stations for more than one system are in close proximity and could be confused and the wrong system actuated. In this case, manual stations should be clearly identified as to which hazard area they affect.
12. Perform the electric control head test outlined in Paragraph 6-2.3.2 on all cylinders equipped with electric control heads
13. Perform the pressure switch test outlined in Paragraph Paragraph 6-2.3.1 for all pressure switches installed.
14. All acceptance testing shall be in accordance with NFPA 2001 current edition.

CHAPTER 5
OPERATION

5-1 INTRODUCTION

This chapter describes the controls and indicators for the Kidde Engineered Fire Suppression System designed for use with 3M™ Novec™ 1230 Fire Protection Fluid .

5-2 SYSTEM CONTROLS AND INDICATORS

5-2.1 General

Compressed Novec 1230 fluid is held in the cylinder by a discharge valve. When the discharge valve is actuated by a control head, the valve piston is displaced and the compressed liquid escapes through the discharge port of the valve and is directed through the distribution piping to the nozzles. The nozzles provide the proper flow rate and distribution of Novec 1230 fluid.

5-2.2 Operating Procedures

5-2.2.1 AUTOMATIC OPERATION

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

5-2.2.2 REMOTE MANUAL OPERATION

Operate as follows:

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

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

5-2.2.3 LOCAL MANUAL OPERATION

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

1. Proceed to appropriate Kidde Engineered System cylinder for the hazard.
2. Remove the safety pull pin from the cylinder control head.
3. Operate the lever, following the instructions on the lever or control head nameplate.
4. Leave the hazard area immediately.

Note: Allow no one to enter the hazard area. Call the fire department immediately.

5-2.3 Post-Fire Operation

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

WARNING

Do not enter a hazard area with an open flame or lighted smoking materials.

Flammable vapors may cause reignition or explosion. Ensure the fire is completely extinguished before ventilating the area. Ventilate the area thoroughly before permitting anyone to enter the hazard area, or use a self-contained breathing apparatus.

5-3 CYLINDER RECHARGE

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

5-3.1 Special System Precautions

5-3.1.1 SYSTEMS ACTUATED WITH A MASTER KIDDE ENGINEERED SYSTEM CYLINDER

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

5-3.1.2 SYSTEMS ACTUATED WITH A PILOT NITROGEN CYLINDER

In systems where a pilot nitrogen cylinder actuates a pressure operated control head on a slave Kidde Engineered System cylinder, nitrogen pressure is trapped in the pilot manifold when the system actuates and is not self-venting. Therefore, before reattaching a pressure operated control head to a recharged Kidde Engineered System 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.

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).

Recharge and reinstall the nitrogen pilot cylinders to the correct charged pressure and reinstall the master control head.

Before installing a pressure operated control head on a Kidde Engineered System cylinder, ensure that the actuator pin is in the retracted (SET) position.

Follow all other procedures and cautions as detailed in Chapter 6 of this manual.

CHAPTER 6
MAINTENANCE

6-1 INTRODUCTION

This chapter contains maintenance instructions for the Kidde Engineered Fire Suppression System designed for use with 3M™ Novec™ 1230 Fire Protection Fluid. These procedures must be performed regularly in accordance with regulations. If problems arise, corrective action must be taken.

Take note of the following precautions:

- This Kidde Engineered System must be serviced by qualified personnel only.
- Any environmental or operating condition which causes shorting or grounding of system components can cause system malfunctions or actual discharge.
- Before servicing any component, disarm the protection system by removing all AC and DC power from the control unit.
- Wait 45 seconds after disarming system to bleed capacitor in control unit.
- Do not check external wiring or system components with any instrument other than a blasting galvanometer or device with a maximum current output of 50 mA.

6-1.1 Agent Storage Cylinders

Agent storage cylinders, approved by the Department of Transportation (DOT), are pressurized vessels containing Novec 1230 fluid superpressurized with nitrogen to 360 PSIG at 70°F (24.8 bar gauge at 21°C). This pressure causes considerable thrust if the discharge valve is actuated, thus, the safety cap supplied with the cylinder must be installed when handling or storing the cylinder, or whenever it is not securely fastened down. The safety cap prevents objects from striking the burst disc valve, and reduces and redirects the thrust if the cylinder is accidentally discharged.

Handle the cylinder carefully to prevent damaging the gauge and other attached fixtures. The cylinder must not be subjected to temperatures above 130°F (54°C), or the pressure relief device may operate, releasing the agent.

6-2 MAINTENANCE PROCEDURES

WARNING

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

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

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

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

If the inspection indicates areas of rust or corrosion, immediately clean and repaint the area. Perform cylinder hydrostatic pressure testing in accordance with Paragraph 6-2.5 of this manual. Perform scheduled maintenance per Table 6-1.

Table 6-1. Maintenance Schedule

Schedule	Requirement	Paragraph
Daily	Check Kidde Engineered System cylinder pressures Check nitrogen cylinder pressures	Paragraph 6-2.1
Monthly	Inspect hazard area system components Check Kidde Engineered System cylinder weights and pressures	Paragraph 6-2.2
Semi-Annually	Test pressure switches Test electric control heads	Paragraph 6-2.3
Every 2 Years	Blow out distribution piping	Paragraph 6-2.4
Every 5 Years	Kidde Engineered System and nitrogen cylinder hydrostatic pressure test and inspection Flexible hose hydrostatic pressure test and inspection	Paragraph 6-2.5
Every 12 Years	Nitrogen cylinder hydrostatic pressure test	Paragraph 6-3.1

6-2.1 Daily

6-2.1.1 CHECK KIDDE ENGINEERED SYSTEM CYLINDER PRESSURE

Check the Kidde Engineered System cylinder pressure gauges for proper operating pressure (refer to Table 2-2). 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 7-3.

6-2.1.2 CHECK NITROGEN DRIVER CYLINDER PRESSURE

Check the nitrogen driver cylinder pressure gauge for proper operating pressure (see Table 2-4). If the pressure gauge indicates a pressure loss (adjusted for temperature) of more than 10%, it shall be refilled. Remove and recharge the cylinder with nitrogen to 1800 PSIG @ 70°F (124 bar gauge @ 21°C).

6-2.2 Monthly

6-2.2.1 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 6-2.6.3.

6-2.2.2 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 Novec 1230 fluid.

6-2.2.3 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 6-2.7.1. Inspect the adapters, couplings and tees at the Kidde Engineered System cylinder pilot outlets and tighten couplings if necessary. Replace any damaged parts.

6-2.2.4 INSPECT PRESSURE CONTROL HEADS

Inspect the Kidde Engineered System 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 6-2.6.1.

6-2.2.5 INSPECT ELECTRIC CONTROL HEADS

Inspect the Kidde Engineered System cylinder electric control heads for damage, corrosion, and dirt. Check the control heads' flexible electrical line for wear and damage. Check the control head for loose coupling and tighten if necessary. Check that the indicator is in the SET position, the pull pin is installed in the manual lever, and the seal wire is intact. Replace the control head if damaged. If necessary, clean as directed in Paragraph 6-2.6.1.

6-2.2.6 INSPECT CYLINDER AND VALVE ASSEMBLY

Inspect the Kidde Engineered System 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 7-2.4. If the gauge pressure is not normal (360 PSIG at 70°F [25 bar gauge at 21°C]), remove and recharge the cylinder as instructed in Paragraph 6-2.7 and Paragraph 7-3. If damaged parts are found on the Kidde Engineered System cylinder or cylinder valve, replace the Kidde Engineered System cylinder. If necessary, clean the cylinder and associated parts as directed in Paragraph 6-2.6.1.

6-2.2.6.1 Inspect Brackets, Straps, Cradles and Mounting Hardware

Inspect the Kidde Engineered System 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 6-2.6.1.

6-2.2.6.2 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 6-2.6.1.

6-2.2.6.3 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 6-2.6.1.

6-2.2.6.4 Inspect Discharge Nozzles

Inspect discharge nozzles for dirt and physical damage. Replace damaged nozzles. If nozzles are dirty or clogged, refer to Paragraph 6-2.6.1.

Nozzles must never be painted.

CAUTION

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 Novec 1230 fluid distribution and concentration within a hazard area.

6-2.2.6.5 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 6-2.6.1.

6-2.2.6.6 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 6-2.6.1.

6-2.2.6.7 Weighing Kidde Engineered System Cylinders

Weigh 10 through 900 lb. Kidde Engineered System cylinders as follows:

WARNING

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

Install a protection cap on the Kidde Engineered System cylinder valve actuation port and safety cap on the cylinder valve outlet port.

Note: Ensure all warnings are followed prior to proceeding with Step 1.

1. Remove the cylinder as instructed in Paragraph 6-2.7.
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 Kidde Engineered System cylinder valve label. Therefore, subtract tare weight from the gross weight to determine net weight of the original charge. Then, subtract tare weight from the scale reading to determine net weight of the Novec 1230 fluid 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 Kidde Engineered System cylinder (recharging the cylinders is explained in Paragraph 7-3).
4. Reinstall the cylinder (see Paragraph 6-2.8 for reinstallation instructions).

6-2.2.6.8 Cylinders Equipped with a Flexible Tape Liquid Level Indicator

The following procedure explains how to determine the Kidde Engineered System 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 Kidde Engineered System cylinders from the system.

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

CAUTION

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

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

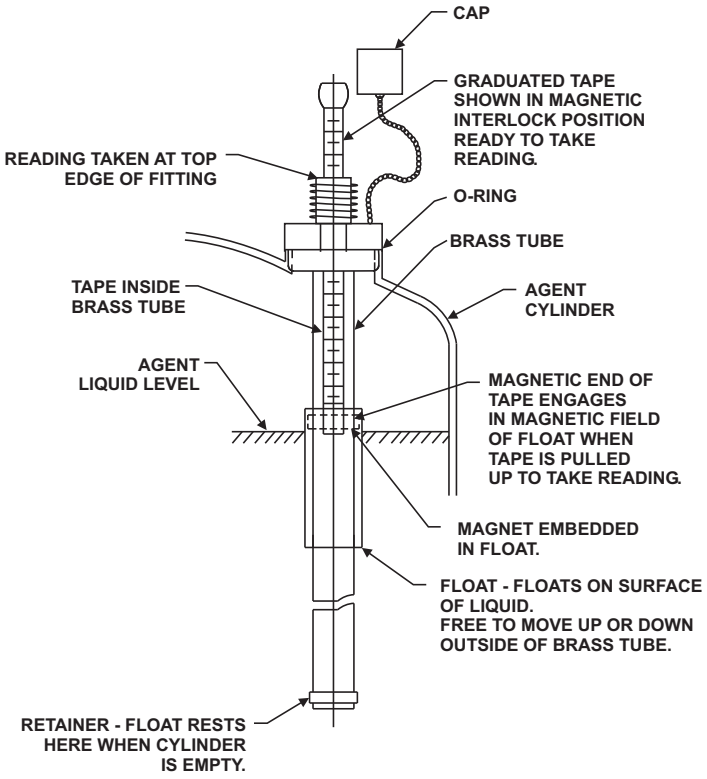


Figure 6-1. Liquid Level Indicator

6. Check the ambient temperature where the Kidde Engineered System cylinders are stored and record the temperature.
7. Refer to the appropriate calibration charts (see Figures 6-2 through 6-7) 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 the Kidde Engineered System 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 Kidde Engineered System cylinders must be filled or recharged by weight using a platform scale or equivalent. If weight loss is more than 5% of the Kidde Engineered System charge, the unit must be recharged.

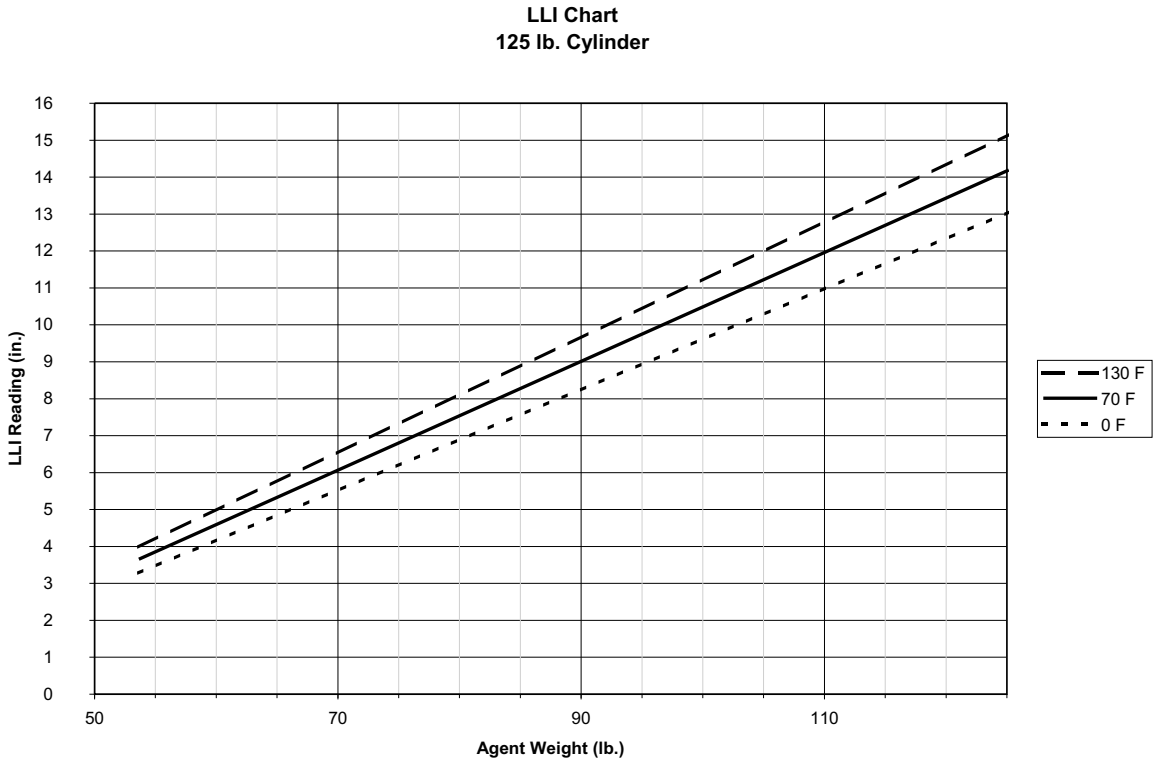


Figure 6-2. LLI Calibration Chart 125 lb. Cylinder

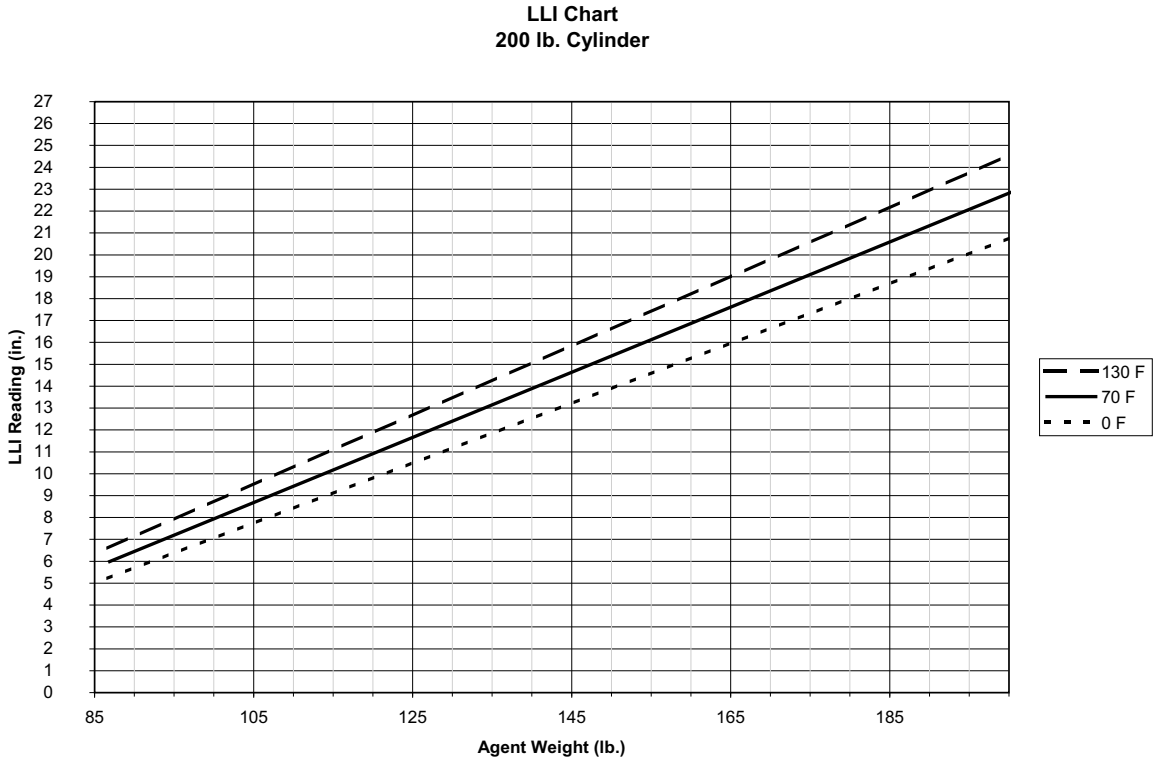


Figure 6-3. LLI Calibration Chart for 200 lb. Cylinder

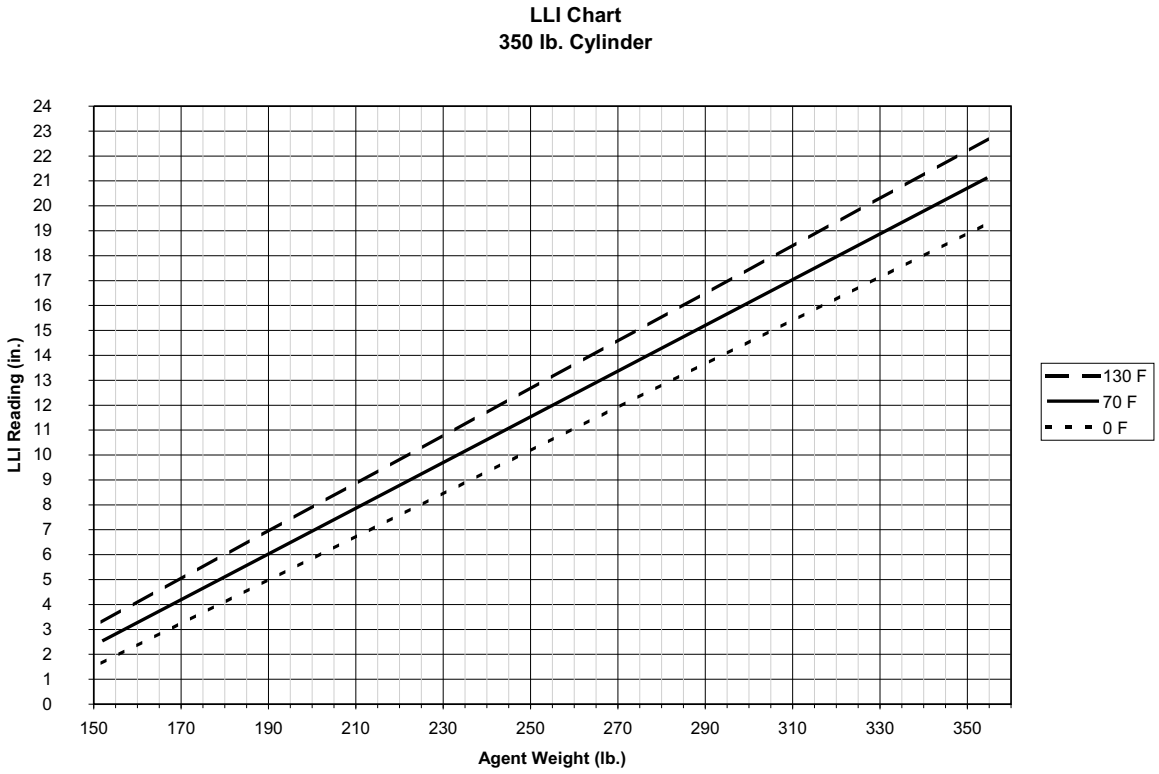


Figure 6-4. LLI Calibration Chart for 350 lb. Cylinder

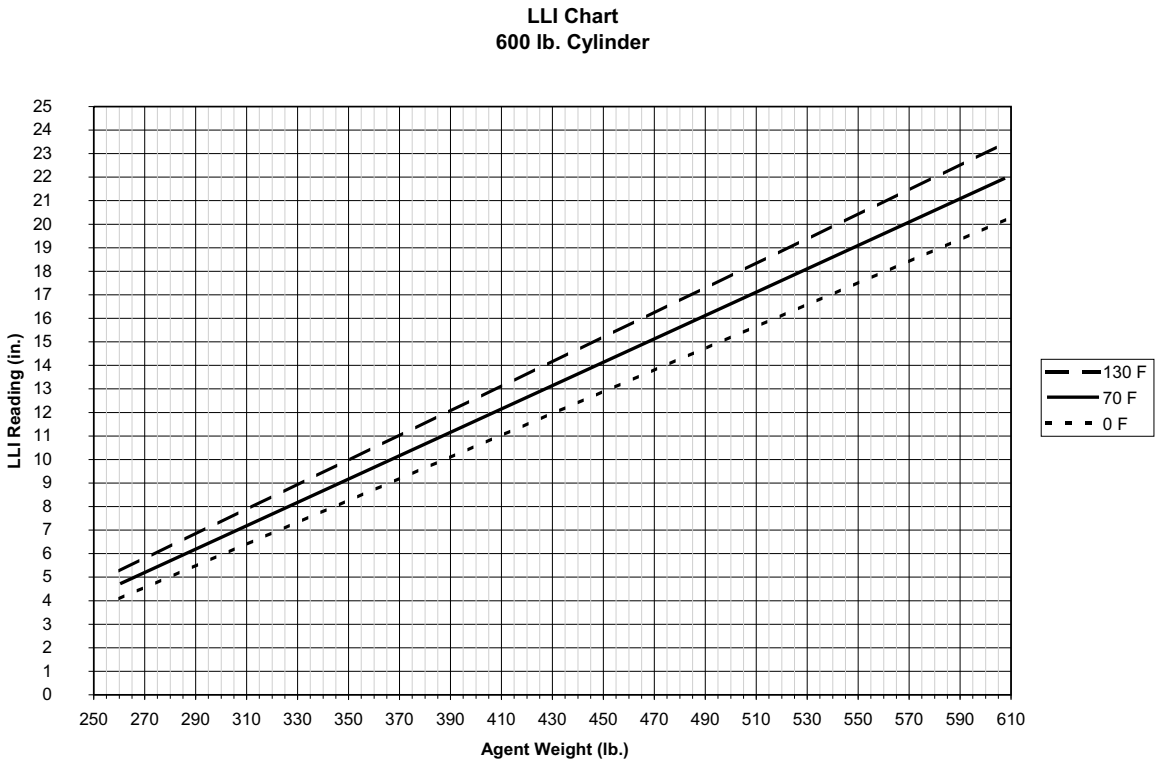


Figure 6-5. LLI Calibration Chart for 600 lb. Cylinder

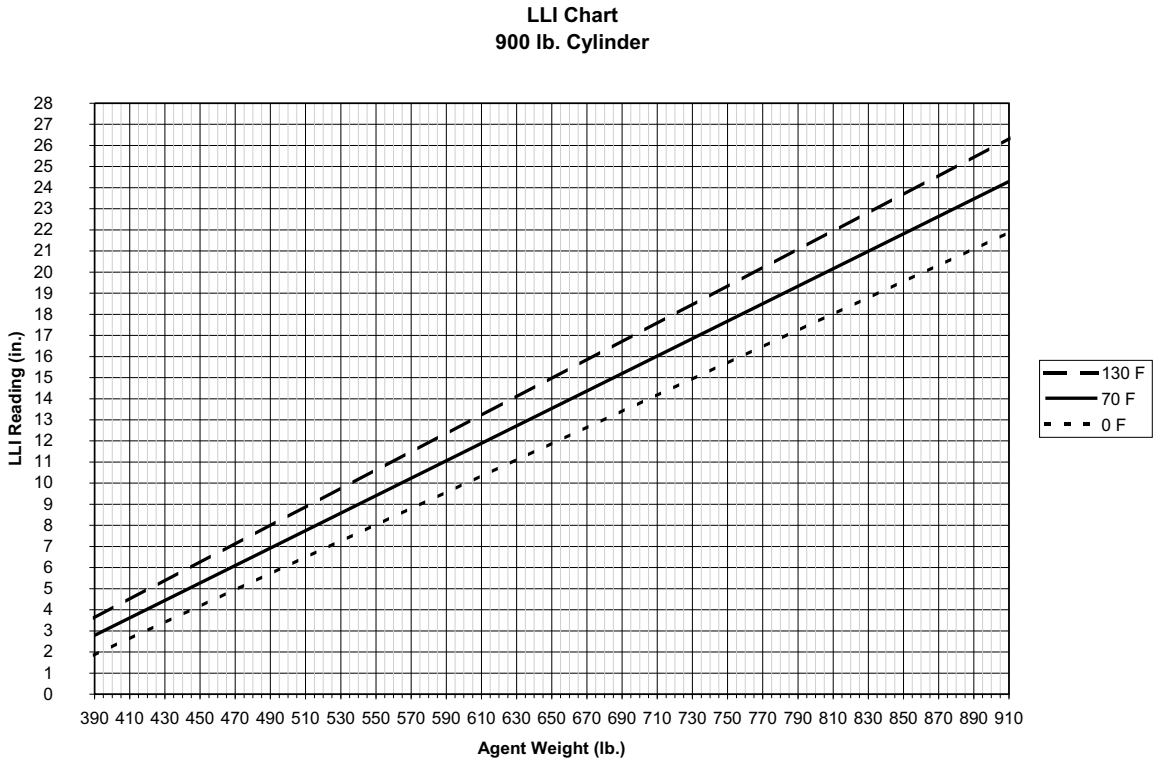


Figure 6-6. LLI Calibration Chart for 900 lb. Cylinder

6-2.3 Inspection Procedures, Semi-Annual

6-2.3.1 PRESSURE SWITCH TEST

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

6-2.3.2 ELECTRIC CONTROL HEAD TEST

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

CAUTION

All control heads must be removed from the Kidde Engineered System cylinders and nitrogen pilot cylinders prior to testing to prevent accidental cylinder discharge.

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

CAUTION

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

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

6-2.4 Inspection Procedures-2 Year

WARNING

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

1. Remove any nozzles from the piping to allow foreign matter to blow clear.
2. Remove all pressure operated control heads from the Kidde Engineered System cylinders.

WARNING

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

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

6-2.5 Inspection and Retest Procedures for Kidde Engineered System 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 6-2.5.3).

CAUTION

These guidelines do not apply to cylinders containing a commodity other than Kidde Engineered System.

All Kidde Engineered System 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:

6-2.5.1 CYLINDERS CONTINUOUSLY IN SERVICE WITHOUT DISCHARGE

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

6-2.5.2 DISCHARGED CYLINDERS OF CHARGED CYLINDERS THAT ARE TRANSPORTED

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

6-2.5.3 RETEST

DOT 4BA and 4BW cylinders used exclusively in Kidde Engineered System services that are commercially free from corroding components are required to be hydrostatically retested and restamped every five years, in accordance with DOT CFR Title 4, Paragraph 173.37(e), prior to recharge and shipment. An alternate option is an external visual inspection performed in lieu of the hydrostatic test at the time the periodic retest becomes due (this option is in accordance with CFR 49, Paragraph 173.34[e] [13]). Table 6-2 highlights the two options for retesting Kidde Engineered System cylinders.

Table 6-2. Retest Schedule

Retest Method	First Retest Due	Subsequent Retest Due	Special Marketing
Fully 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”

6-2.5.4 FLEXIBLE HOSES

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

6-2.6 Service

6-2.6.1 CLEANING

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

6-2.6.2 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 3-2.3.5 for the correct nozzle placement and orientation.

6-2.6.3 REPAIRS

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

Kidde Engineered System 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%.

6-2.7 Removing a Kidde Engineered System Cylinder

Remove a Kidde Engineered System 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 Kidde Engineered System cylinders. Before replacing a Kidde Engineered System cylinder in a hazard area group, ensure that the pilot line is completely vented of all pressure.

6-2.7.1 SINGLE CYLINDER SYSTEM

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

6-2.7.2 MULTIPLE CYLINDER SYSTEM

CAUTION

Remove all control heads from the Kidde Engineered System 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 Kidde Engineered System cylinder valves, leaving the flexible actuation hose or tubing attached to the pressure operated control heads.
3. Immediately install a protection cap on all Kidde Engineered System 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 Kidde Engineered System cylinder from the bracket. Weigh the cylinders using a platform scale.

6-2.8 Reinstalling a Kidde Engineered System Cylinder

Install a Kidde Engineered System cylinder as follows:

6-2.8.1 SINGLE CYLINDER SYSTEM

1. Position the Kidde Engineered System 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 Kidde Engineered System 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 the Kidde Engineered System when installed on the cylinder valve.

5. Install the control head.
6. If required, install the supervisory pressure switch, as instructed in Paragraph 4-2.17.

6-2.8.2 MULTIPLE CYLINDER SYSTEM

1. Position the Kidde Engineered System 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 Kidde Engineered System cylinder valve actuation ports.

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 the Kidde Engineered System when installed on the cylinder valve.

6. Reinstall electric and pressure operated control heads with flexible actuation hoses or tubing on the cylinder valve actuation ports. Tighten the swivel nuts.
7. If required, install the supervisory pressure switches as explained in Paragraph 4-2.17.

6-3 NITROGEN PILOT CYLINDER SERVICE AND MAINTENANCE

WARNING

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

6-3.1 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.

6-3.2 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.

6-3.3 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 6-7.
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.

6-3.4 Nitrogen Cylinder Installation

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

CAUTION

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

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

WARNING

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

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

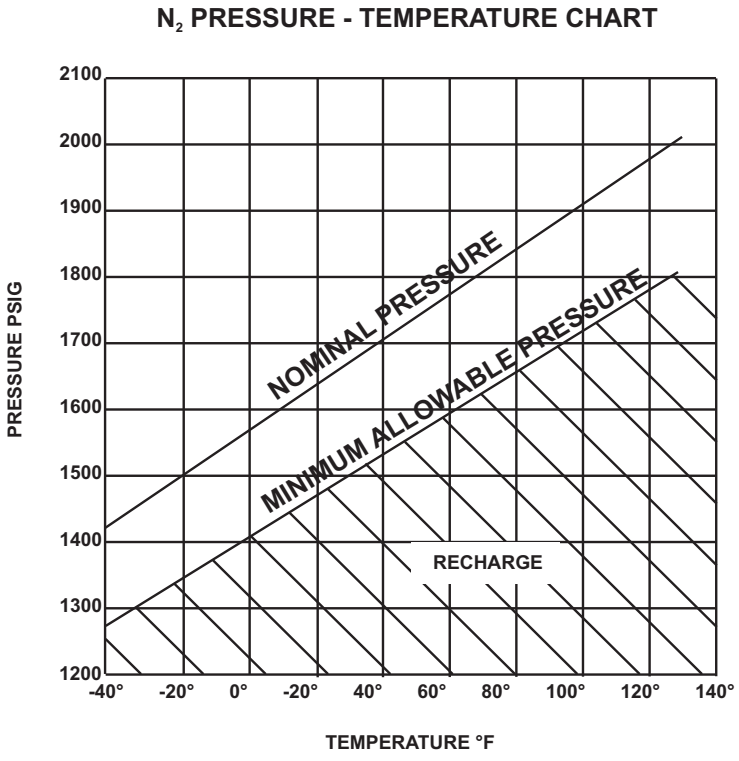


Figure 6-7. Nitrogen Temperature vs. Pressure Data

6-4 TOP OFF PROCEDURES FOR THE KIDDE ENGINEERED SYSTEM CYLINDERS WITH NITROGEN

The procedure for adding Nitrogen to a charge a Kidde Engineered System cylinder is listed below:

Note: All precautions for care and handling of pressurized vessels shall be followed.

1. Disconnect the Flexible Discharge Hose (or Valve Outlet adapter) from the valve outlet and attach the anti-recoil cap (or recharge adapter with shutoff valve) to the outlet.
2. Remove the Supervisory Pressure Switch, if present.
3. Attach an accurate pressure gauge to the supervisory pressure switch port with a refrigeration hose or fitting equipped with an insert to push to Schraeder valve down.
4. Attach Seating Adapter (P/N 933537) to the control head port on the top of the valve. Ensure that the O-ring is in place on the adapter.
5. Attach threaded end of adapter to a regulated source of nitrogen.
6. Set nitrogen regulator to approximately 500 PSIG (34.5 bar gauge).
7. Introduce nitrogen into cylinder until gauge attached to supervision pressure switch port indicates proper pressure for ambient temperature.
8. With nitrogen source closed, quickly vent pressure in section from regulator to Seating Adapter (P/N 933537).
9. Detach gauge from supervisory pressure switch port.
10. Attach supervisory pressure switch in accordance with Paragraph 4-2.17.
11. Perform leak check on valve with sniffer or soapy solution.
12. Reattach cylinder to system.
13. This procedure is only effective if no agent has been lost from the tank. If agent has leaked, the tank should be emptied and refilled with the appropriate amount of agent as described in Paragraph 7-3.2.

CHAPTER 7
POST-DISCHARGE MAINTENANCE

7-1 INTRODUCTION

Follow these procedures after the system has been activated and the Kidde Engineered Fire Suppression System designed for use with 3M™ Novec™ 1230 Fire Protection Fluid has been discharged.

7-2 POST-DISCHARGE MAINTENANCE

7-2.1 Kidde Engineered System Valve Inspection and Service

Inspect and service the Kidde Engineered System valve as follows:

Note: Important–Because the Novec 1230 fluid tends to dissolve and wash out lubricant, certain components in the Kidde Engineered System valve assembly will have to be inspected and serviced before recharging the cylinder and valve assembly. Part numbers for items which may require replacement are listed in Table 8-1.

7-2.2 Valve Disassembly (1½ in. and 2 in.)

Refer to Figure 7-1 and Figure 7-2 and Table 7-1. All item number references are drawn from Figure 7-1.

WARNING

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

1. Remove the valve with the siphon tube from the cylinder.
2. Remove the O-ring (4). Discard and replace O-ring.
3. Remove the valve cap, spring and piston assembly.

Note: All internal components of Kidde Engineered System 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 remaining O-rings and examine for cuts or nicks; replace if necessary. Examine the O-ring grooves for foreign matter. O-Ring (3) will require a spanner wrench for removal.
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.
6. Replace the valve core if necessary using a standard Schraeder core wrench.

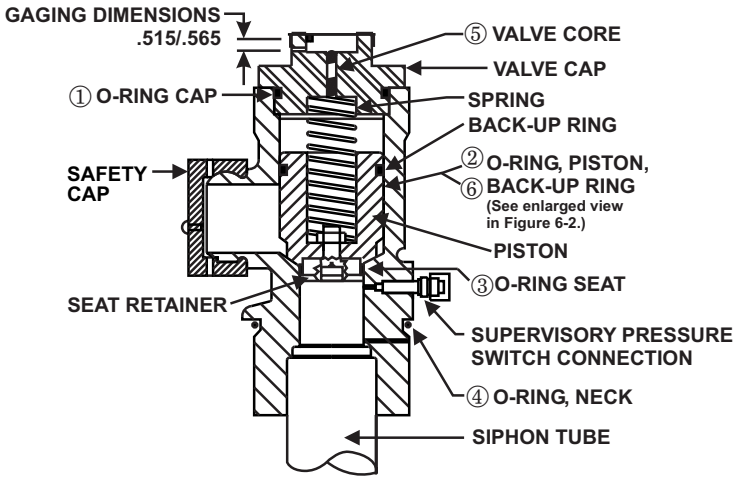


Figure 7-1. Valve Assembly (1½ in. and 2 in.)

Table 7-1. Valve Components

Figure Item Number	Description	10-125 lb. Cylinders	200-350 lb. Cylinders
1	O-ring, cap	5661-0225	5661-0230
2	O-ring, piston	5661-0325	5661-0330
3	O-ring, seat	5661-0215	5661-0326
4	O-ring, neck	5661-0932	5661-0335
5	Valve core	220278	220278
6	Back-up ring	554003-250	554003-300

Figure 7-2. Piston O-Ring

Table 7-2. 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

7-2.3 Valve Disassembly (3 in.)

Note: Refer to Figure 7-3 for items.

1. Remove the valve with the siphon tube from the cylinder.
2. Remove the Neck O-ring and discard.
3. Remove the valve cap, spring and piston assembly.

Note: Remove all internal components of the Kidde Engineered System 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 remaining O-rings and examine them for cuts and nicks; replace if necessary. Examine the O-ring grooves for foreign matter.
5. Examine the exposed surface of the Piston O-ring for nicks and cuts. Also, ensure that the Piston 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.
6. Examine the pilot check for any evidence of bending or other damage. Depress the check and make certain it snaps back freely. Replace pilot check if necessary.

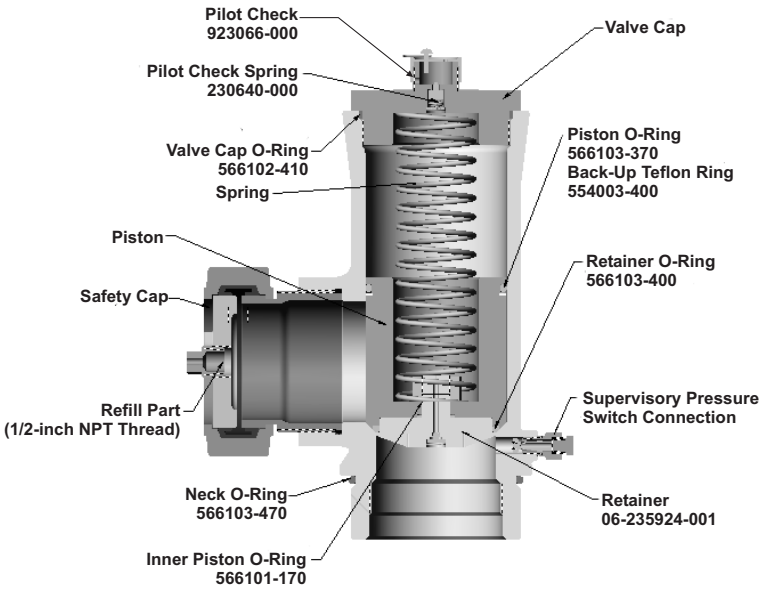


Figure 7-3. 3 in. Valve Assembly

Table 7-3. 3 in. Valve Components

Part Number	Description
554003-400	O-Ring, Backup Teflon
566101-170	O-Ring, Inner Piston
566102-410	O-ring, Valve Cap
566103-370	O-ring, Piston
566103-400	O-ring, Retainer
566103-470	O-ring, Neck
923066-000	Pilot Check Assembly
230640-000	Pilot Check Spring
06-235924-001	Retainer

7-2.4 Valve Assembly (1½ in. and 2 in.)

Note: The items refer to Figure 7-1.

CAUTION

Make certain the Teflon® back-up ring is below this O-ring as shown in Figure 7-2.

1. Install an O-ring in the piston groove. Apply a lubricant to the O-Ring before reinstalling.
2. Reassemble the piston and install a new Seat O-Ring (Item 3). Apply a lubricant to the O-Ring prior to installation.
3. Press the piston back into the valve body.
4. Reassemble the Schraeder core.
5. Install the spring.
6. Install the Cap 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). Apply a lubricant to the O-Ring prior to installation.
7. If the siphon tube had to be removed to disassemble the valve, wire brush the siphon tube threads to remove the old Loctite® residue.
8. Apply a film of Loctite® primer to the siphon tube threads and allow three to five minutes to dry.
9. Apply a film of Loctite® sealant to the threads and reinstall the siphon tube.
10. Install the Neck O-ring (Item 4) 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). Apply a lubricant to the O-Ring prior to installation.

7-2.5 Valve Assembly (3 in.)

Note: Refer to Figure 7-3.

CAUTION

Make certain that the Teflon® back-up ring is below the O-ring as shown in Figure 7-3.

1. Install the Piston O-ring in the piston groove. Apply a lubricant to the O-Ring prior to installation.
2. Press the piston back into the valve body.
3. Install the spring.
4. Install the Valve Cap 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). Apply a lubricant to the O-Ring prior to installation.
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 Neck 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). Install the Piston O-ring in the piston groove. Apply a lubricant to the O-Ring prior to installation.

7-2.6 Safety Disc Replacement (1½ in. and 2 in.)

Note: Refer to Figure 7-4.

1. Remove the safety disc retainer with safety disc and safety disc washer from the valve body. Discard the safety disc and washer.
2. Assemble the safety disc retainer with new safety disc (printed side out) and safety disc washer to the valve body. Apply a lubricant to the printed side of the safety disc to ensure the disc does not crack or tear. Torque to the appropriate value listed in Table 7-4.

WARNING

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

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

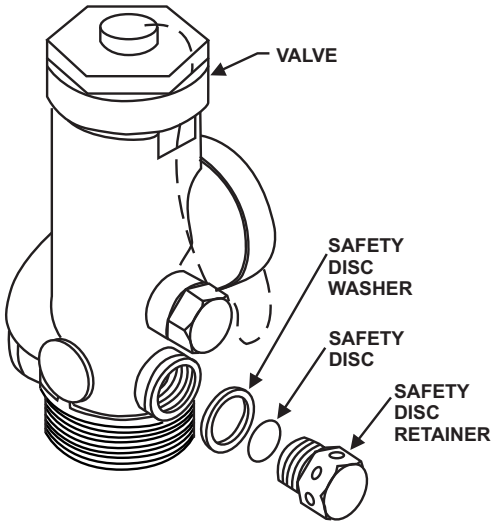


Figure 7-4. Safety Disc Replacement

Table 7-4. Safety Disc Replacement Table (1½ in., 2 in. and 2½ in.)

Cylinder Size	Safety Disc Part Number	Safety Disc Washer Part Number	Torque Value	PSIG @ 70°F
10-125 lb.	242461	294500	33 ft. lb.	750-900
200-350 lb.	264925	220360	38 ft. lb.	800-975

7-2.7 Safety Disc Replacement (3 in.)

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

1. Remove the safety disc retainer (see Figure 7-5) 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 (printed side out) and safety disc washer to the valve body. Apply a lubricant to the printed side of the safety disc to ensure the disc does not crack or tear. Torque to the appropriate value listed in Table 7-5.

WARNING

Never install any type of disc other than specified in Table 7-5 for the corresponding cylinder. Installing the incorrect disc could result in a violent rupture of the cylinder and serious injury.

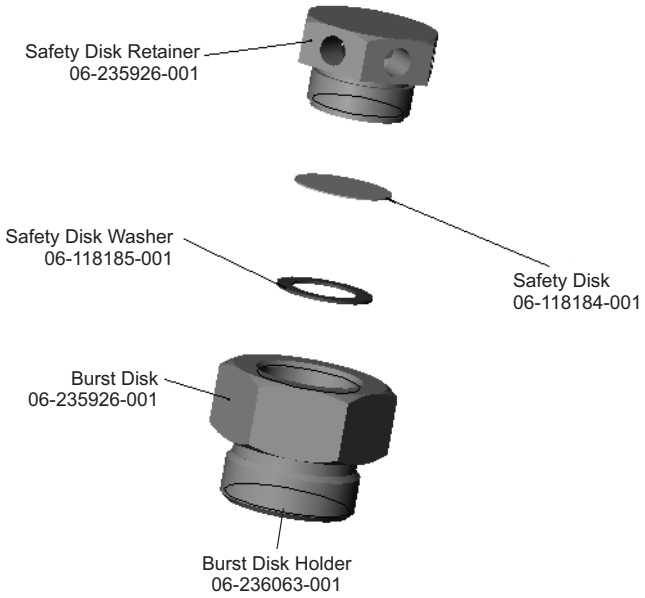


Figure 7-5. Burst Disc

Table 7-5. Safety Disc Replacement Table (3 in.)

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

7-3 RECHARGING KIDDE ENGINEERED SYSTEM CYLINDERS

CAUTION

Kidde Engineered System cylinders may require retest before recharging (see Paragraph 6-2.5 for details on cylinder retest). FM Approval is based upon the usage of factory filled Kidde Engineered System cylinders.

WARNING

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

Kidde Engineered System charging equipment consists of a Kidde Engineered System storage cylinder, piping adapter, control valves, strainer, pressure gauge, flexible hoses, seating adapter, recharge adapter, pump, regulated nitrogen supply, scale and interconnecting plumbing. Recharge equipment must be suitable for the purpose intended and must be compatible with Kidde Engineered System. A typical Kidde Engineered System charging system schematic is shown in Figure 7-6.

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

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

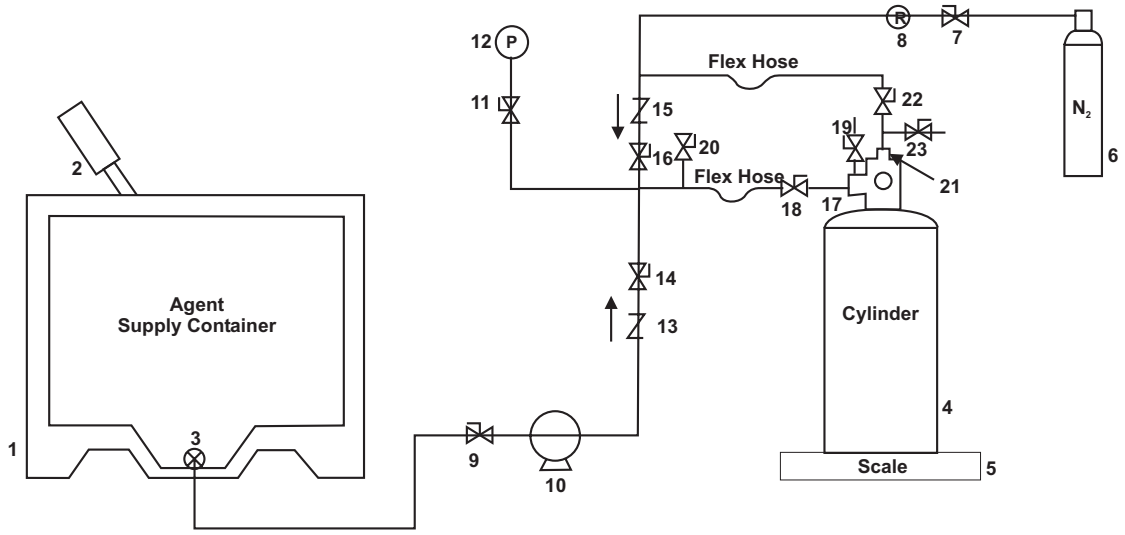


Figure 7-6. Typical Kidde Engineered System Charging System Schematic

Table 7-6. Typical Kidde Engineered System Charging System Schematic

1	Agent Supply Container	13	Check Valve
2	Drierite Filter	14	Ball Valve
3	Container Supply Valve	15	Check Valve
4	Cylinder	16	Ball Valve
5	Scale	17	Recharge Adapter
6	Nitrogen Cylinder	18	Ball Valve
7	Ball Valve	19	Vent Valve
8	Regulator	20	Vent Valve
9	Ball Valve	21	Seating Adapter
10	Pump	22	Ball Valve
11	Ball Valve	23	Vent Valve
12	Master Pressure Gauge		

7-3.1 Charging Equipment Installation

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

7-3.2 Charging Kidde Engineered System Cylinder and Valve Assembly

Recharge Kidde Engineered System cylinder and valve assembly as follows (see Figure 7-6 and Table 7-6):

WARNING

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

1. Check the cylinder for the last hydrostatic test date prior to charging. Perform any required DOT hydrostatic tests (see Paragraph 6-2.5).
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.
3. Weigh the cylinder and 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

Novec 1230 fluid is a colorless, odorless gas, low in toxicity, and is an extremely effective fire suppression agent. Novec 1230 fluid can be liquefied by compression, and is normally shipped and stored in this condition. Being a liquefied and compressed gas, Novec 1230 fluid 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 Novec 1230 fluid and safe handling techniques, the agent may be transferred from shipping cylinders to the desired end-use cylinder safely.

Note: Drierite filter (Item 2) should be installed on agent supply container (Item 1) prior to beginning filling. Drierite filters are designed to remove moisture/humidity from the air to prevent contamination of fluid.

4. Connect the Novec 1230 fluid supply line to the Novec 1230 fluid supply cylinder valve (Item 3). Close all valves in the charging system.
5. Open the supply valves (Items 3, 9, and 14). Start the pump (Item 10), then crack the vent valve (Item 20) until Novec 1230 fluid is present. Close vent valve (Item 20) and shut off pump (Item 10).
6. Position the Kidde Engineered System cylinder and valve assembly (Item 4) (with safety cap and pilot actuation port protection cap in place and properly connected) on a weigh scale (Item 5). Record the weight from the scale. The empty weight of the cylinder and valve assembly must be stamped on the cylinder valve nameplate.

7. Remove the safety cap and immediately connect the cylinder assembly into the charging system by assembling the recharge adapter (Item 17) with o-ring packing 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.

8. Open valve (Item 18) and start the pump (Item 10). Monitor the weigh scale (Item 5). When the scale indicates the correct charge weight, shut off the pump (Item 10) and close the supply valves (Item 18 and 14).

Note: The 360 PSIG (25 bar gauge) pressure applies to the filling procedure with nitrogen and Kidde Engineered System at 70°F ± 10°F (21°C ± -12°C). When the temperature is other than 70°F (21°C), refer to Table 7-5 for required total pressure. Do not fill Kidde Engineered System cylinders at temperatures below 60°F (16°C) or above 90°F (27°C).

Table 7-7. Pressure vs. Temperature

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

Note: 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 cylinder 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.

9. If nitrogen is required, open the handwheel valve on the nitrogen supply valve (Item 7), nitrogen valve (Item 16), and valve (Item 11). Adjust the regulator (Item 8) until the master pressure gauge (Item 12) shows a pressure indication of 360 PSIG + 25, -0 PSIG (25 bar gauge + 1.7, -0 bar gauge).
10. Open the hose control valve (Item 18) and let the nitrogen flow into the cylinder until the master pressure gauge indicates 360 PSIG (25 bar gauge). Cylinder agitation will assist with the equilibrium of nitrogen and Novec 1230 fluid Additional nitrogen may be necessary as the cylinder equilibrates.
11. Close the hose control valve (Item 18). Remove the pilot actuation port protection cap and assemble the seating adapter (Item 21) with the flexible hose to the cylinder valve actuation port. Adjust the regulator to 450 to 600 PSIG. Open valve (Item 22) to momentarily apply nitrogen pressure to the actuation port to firmly seat the cylinder valve piston.
12. While momentarily maintaining pressure on the actuation port, open vent valve (Item 19) on the recharge adapter (Item 17) to rapidly vent Novec 1230 fluid from the valve assembly outlet port. The sudden pressure decrease at the valve outlet will ensure the valve seat stays in the closed position.
13. Leave vent valve (Item 19) open. Close valve (Item 22) and open valve (Item 23) to vent nitrogen from the seating adapter.

CAUTION

Any hissing or discharge coming from vent valve (Item 19) indicates that the piston is not sealed properly or has opened. If this occurs, close valve (Item 19) and repeat steps 12 and 13. Verify that the cylinder valve piston remains closed.

14. Keep vent valve (Item 19) open. Close valve (Item 23), and once again open valve (Item 22) to reapply nitrogen pressure to the actuation port. While momentarily maintaining pressure on the actuation port, remove the recharge adapter (Item 17) from the cylinder valve outlet port and immediately install the safety cap. Close the vent valve (Item 19).

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.

15. Close the nitrogen supply valve (Item 7) and open vent valve (Item 23) to vent nitrogen from the supply line.
16. Remove the seating adapter (Item 21) from the cylinder valve and reinstall the actuation port protection cap. Close valves (Items 22 and 23).
17. 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.
18. 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.
19. The cylinder is now ready for the leak test (refer to Paragraph 7-3.3).

CAUTION

The Kidde Engineered System cylinders have been designed for a maximum fill density of 70 lb./cu. ft. (1121 kg/cu. m) 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 cylinder 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 so as to present a hazard to personnel and property. Adherence to the limits on fill density and pressurization levels will prevent excessively high pressures from occurring if the agent cylinder is exposed to elevated temperature, minimizing the possibility of an inadvertent discharge of agent through the pressure relief device.

Note: To change the Kidde Engineered System supply container (Item 1) close container valve (Items 3) and valve (Item 9). Disconnect filling line from Novec 1230 fluid supply container. Position new Kidde Engineered System supply container in place. Connect filling line to the new Kidde Engineered System supply container. Open valves (Items 3 and 9).

7-3.3 Kidde Engineered System Cylinder Leak Test

WARNING

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

WARNING

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

1. Warm up the leak detector for 30 minutes before proceeding with Step 2.
2. Calibrate the detector against the LS-20 leak standard by holding the probe about 1/8 in. (3 mm) away, and noting the meter deflection for the leakage allowance of the standard. Maximum allowable leak rates are shown in Table 7-8.
3. Remove the safety cap from the discharge outlet. Blow nitrogen on the surface where the plug was removed.
4. Move the probe back and forth slowly about 1/8 in. (3 mm) away from all potential leak points (such as the discharge outlet area, pilot check, valve bonnet, supervisory pressure switch connection, safety outlet, liquid level indicator, valve-to-cylinder connections, gauge and cylinder 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 Novec 1230 fluid, perform the required maintenance on the cylinder and recharge.
8. After the leak test is complete, reassemble the protection cap to the actuation port of the valve assembly. Unclamp the cylinder.

Table 7-8. Maximum Permitted Leakage Rates

Part Number	Cylinder Size	Cylinder Fill Weight	Maximum Allowable Leakage
45-100010-001	10 lb.	6 lb. - 11 lb.	0.11 oz./yr.
45-100020-001	20 lb.	9 lb. - 23 lb.	0.20 oz./yr.
45-100021-001	20 lb.	9 lb. - 23 lb.	0.20 oz./yr.
45-100040-001	40 lb.	17 lb. - 40 lb.	0.37 oz./yr.
45-100070-001	70 lb.	30 lb. - 70 lb.	0.67 oz./yr.
45-100125-001	125 lb.	54 lb. - 125 lb.	1.20 oz./yr.
45-100200-001	200 lb.	86 lb. - 200 lb.	1.81 oz./yr.
45-100201-001*	200 lb.	86 lb. - 200 lb.	1.81 oz./yr.
45-100200-001	200 lb.	86 lb. - 200 lb.	1.81 oz./yr.
45-100201-001*	200 lb.	86 lb. - 200 lb.	1.81 oz./yr.
45-100350-001	350 lb.	150 lb. - 350 lb.	3.34 oz./yr.
45-100351-001*	350 lb.	150 lb. - 350 lb.	3.34 oz./yr.
45-100600-001	600 lb.	258 lb. - 600 lb.	5.74 oz./yr.
45-100601-001*	600 lb.	258 lb. - 600 lb.	5.74 oz./yr.
45-10090X-001	900 lb.	390 lb. - 900 lb.	8.68 oz./yr.
*__Note:__ Includes liquid level indicator			

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CHAPTER 8
PARTS LIST

8-1 INTRODUCTION AND PARTS LIST

The table below, and on the following pages, provides a complete list of Kidde Engineered Fire Suppression System designed for use with 3M™ Novec™ 1230 Fire Protection Fluid parts and associated system equipment. Kidde Engineered System 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 8-1. Parts List

Nomenclature	Part Number
Cylinder and Valve Assemblies (Vertical Mount Only)	
10 lb. Cylinder and Valve Assembly	45-100010-001
20 lb. Cylinder and Valve Assembly	45-100020-001
40 lb. Cylinder and Valve Assembly	45-100040-001
70 lb. Cylinder and Valve Assembly	45-100070-001
125 lb. Cylinder and Valve Assembly	45-100121-001
125 lb. Cylinder and Valve Assembly with Liquid Level Indicator (LLI)	45-100125-001
200 lb. Cylinder and Valve Assembly	45-100200-001
200 lb. Cylinder and Valve Assembly with Liquid Level Indicator (LLI)	45-100201-001
350 lb. Cylinder and Valve Assembly	45-100350-001
350 lb. Cylinder and Valve Assembly with Liquid Level Indicator (LLI)	45-100351-001
600 lb. Cylinder and Valve Assembly	45-100600-001
600 lb. Cylinder and Valve Assembly with Liquid Level Indicator (LLI)	45-100601-001
900 lb. Cylinder and Valve Assembly	45-100900-001
900 lb. Cylinder and Valve Assembly with Liquid Level Indicator (LLI)	45-100901-001
1½ in. Cylinder Valve	45-140000-001
2 in. Cylinder Valve	45-150000-001
3 in. Cylinder Valve	45-170000-001
Liquid Level Indicator (LLI) for 125 lb. Cylinder and Valve Assembly	235681
Liquid Level Indicator (LLI) for 200 lb., 350 lb. and 600 lb. Cylinder and Valve Assembly	283894
Liquid Level Indicator (LLI) for 900 lb. Cylinder and Valve Assembly	06-118266-001
Cylinder Mounting Equipment	
10 lb., 20 lb. Cylinder Mounting Straps	283945
40 lb., 70 lb. Cylinder Mounting Straps	283934
125 lb., 200 lb. Cylinder Mounting Straps	235317
350 lb. Cylinder Mounting Straps	281866
600 lb. Cylinder Mounting Straps	294651

Table 8-1. Parts List (Continued)

Nomenclature	Part Number
900 lb. Cylinder Mounting Straps	236125
10 lb. Cylinder Wall Brackets	486485
20 lb. Cylinder Wall Brackets	486486
40 lb. Cylinder Wall Brackets	486487
70 lb. Cylinder Wall Brackets	486488
125 lb. and 200 lb. Cylinder Cradle	235431
125 lb. and 200 lb. Front Clamp	235432
350 lb. Cylinder Cradle	281867
350 lb. Front Clamp	281868
600 lb. Cylinder Cradle	294652
600 lb. Front Clamp	294653
900 lb. Cylinder Cradle	06-118300-001
Control Heads	
Electric Control Head, 24 Vdc	890181
Electric Control Head, 125 Vdc	890149
Electric Control Head, 115 Vac	890165
Electric Control Head, Stackable, Explosion Proof (for use with 1½ in. and 2 in. Valve)	486500-01
Electric Control Head, Stackable, Explosion Proof (for use with 3 in. Valve)	81-100000-001
Electric/Cable Operated Control Head, 24 Vdc	895630
Electric/Cable Operated Control Head, 115 Vac	895627*
Electric/Cable Operated Control Head, Explosion Proof, 24 Vdc	897494
Electric/Cable Operated Control Head, 25 Vdc	895628
Electric/Cable Operated Control Head, Explosion Proof, 115 Vac	897560*
Cable Operated Control Head	979469
Lever Operated Control Head	870652
Lever/Pressure Operated Control Head	878751
Pressure Operated Control Head	878737
Pressure Operated Control Head, Stackable	878750
Remote Pull Stations	
Electric Remote Pull Station, Double Action SPST with Label Options	30-195000-002
Electric Remote Pull Station, Double Action DPST with Label Options	30-195000-004
Cable Manual Pull Station, Surface	871403
Actuation Accessories	
Nitrogen Pilot Cylinder, 108 cu. in., No Pressure Switch	877940
Mounting Bracket, Nitrogen Pilot Cylinder	877845
Actuation Hose, 22 in. (10-200 lb. Cylinders)	264987
Actuation Hose, 30 in. (350-600 lb. Cylinders)	264986
Master Cylinder Adapter Kit	844895

Table 8-1. Parts List (Continued)

Nomenclature	Part Number
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
Discharge Accessories	
Flexible Discharge Hose, 10-125 lb. Cylinders	283898
Flexible Discharge Hose, 200-350 lb. Cylinders	283899
Flexible Discharge Hose (3 in. Stainless Steel), 600 and 900 lb. Cylinders	06-118225-001
Valve Outlet Adapter, 1½ in., 10-125 lb. Cylinders	283904
Valve Outlet Adapter, 2 in., 200-350 lb. Cylinders	283905
Manifold El-Check, 2 in.	877690
Manifold El-Check, 2½ in.	878743
Check Valve, 1/4 in. NPT	264985
Check Valve, 1/2 in. NPT	800327
Check Valve, 3/4 in. NPT	800266
Check Valve, 1 in. NPT	800443
Check Valve, 1¼ in. NPT	800444
Check Valve, 1½ in. NPT	870152
Check Valve, 2 in. NPT	870151
Check Valve, 2½ in. NPT	263716
Check Valve, 3 in. NPT	870100
Swing Check, 2 in.	06-118213-001
Swing Check, 3 in.	06-118058-001
3-Way Directional Valve, 1/2 in. NPT without Solenoid	90-220027-001*
3-Way Directional Valve, 1/2 in. NPT with Solenoid	90-220030-001*
3-Way Directional Valve, 3/4 in. NPT without Solenoid	90-220027-002*
3-Way Directional Valve, 3/4 in. NPT with Solenoid	90-220030-002*
3-Way Directional Valve, 1 in. NPT without Solenoid	90-220027-003*
3-Way Directional Valve, 1 in. NPT with Solenoid	90-220030-003*
3-Way Directional Valve, 1¼ in. NPT without Solenoid	90-220028-001*
3-Way Directional Valve, 1¼ in. NPT with Solenoid	90-220031-001*
3-Way Directional Valve, 1½ in. NPT without Solenoid	90-220028-002*
3-Way Directional Valve, 1½ in. NPT with Solenoid	90-220031-002*
3-Way Directional Valve, 2 in. NPT without Solenoid	90-220028-003*
3-Way Directional Valve, 2 in. NPT with Solenoid	90-220031-003*
3-Way Directional Valve, 3 in. NPT without Solenoid	90-220029-001*
3-Way Directional Valve, 3 in. NPT with Solenoid	90-220032-001*
3-Way Directional Valve, 4 in. NPT without Solenoid	90-220029-002*
3-Way Directional Valve, 4 in. NPT with Solenoid	90-220032-002*

Table 8-1. Parts List (Continued)

Nomenclature	Part Number
Supervisory Pressure Switch (10-350 lb. Cylinders)	06-118262-001
Supervisory Pressure Switch (600-900 lb. Cylinders)	06-118263-001
Pressure Operated Switch	486536
Pressure Operated Switch, Explosion Proof	981332
Pressure Operated Trip	874290
Discharge Indicator	875553
Corner Pulleys, Watertight	803808
Corner Pulley, 1/2 in. EMT	844648
Main-to-Reserve Transfer Switch	802398
Other Accessories	
Hydrostatic Test Adapters	878755
Cylinder Recharge Adapter, 10 to 125 lb. Cylinder	878757
Cylinder Recharge Adapter, 200 lb., 350 lb. Cylinder	878758
Cylinder Seating Adapter	933537
Nameplate, “Main”	31033
Nameplate, “Reserve”	31034
Nameplate, “Warning”	06-231866-760
* Not FM Approved.	

8-2 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.

8-3 DISCHARGE NOZZLES

WARNING

Only listed Kidde Engineered System nozzles are to be used on Kidde Engineered Systems. Failure to comply with this WARNING can result in unpredictable agent distribution.

8-3.1 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.”

8-3.2 Listed 180 Degree Nozzles

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 8-2. 180 Degree Stainless Steel Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
53	0.0223	45-194611-100							
1/16	0.0246	45-194611-101							
52	0.0254	45-194611-102							
51	0.0283	45-194611-103							
50	0.0308	45-194611-104							
49	0.0335	45-194611-105							
48	0.0363	45-194611-106							
5/64	0.0384	45-194611-107	45-194612-107						
47	0.0388	45-194611-108	45-194612-108						
46	0.0413	45-194611-109	45-194612-109						
45	0.0423	45-194611-110	45-194612-110						
44	0.0465		45-194612-111						
43	0.0498		45-194612-112						
42	0.055		45-194612-113						
3/32	0.0553		45-194612-114						
41	0.058		45-194612-115						
40	0.0604		45-194612-116						
39	0.0623		45-194612-117	45-194613-117					
38	0.0648		45-194612-118	45-194613-118					
37	0.068		45-194612-119	45-194613-119					
36	0.0713		45-194612-120	45-194613-120					
7/64	0.0752		45-194612-121	45-194613-121					
35	0.0761		45-194612-122	45-194613-122					
34	0.0775		45-194612-123	45-194613-123					
33	0.0803		45-194612-124	45-194613-124					
32	0.0846		45-194612-125	45-194613-125					
31	0.0905		45-194612-126	45-194613-126					
1/8	0.0982		45-194612-127	45-194613-127					
30	0.1038		45-194612-128	45-194613-128					
29	0.1163		45-194612-129	45-194613-129	45-194614-129				
28	0.1241			45-194613-130	45-194614-130				
9/64	0.1243			45-194613-131	45-194614-131				
27	0.1303			45-194613-132	45-194614-132				
26	0.1358			45-194613-133	45-194614-133				
25	0.1405			45-194613-134	45-194614-134				
24	0.1452			45-194613-135	45-194614-135				
23	0.1491			45-194613-136	45-194614-136				
5/32	0.1534			45-194613-137	45-194614-137				
22	0.1549			45-194613-138	45-194614-138				
21	0.1589			45-194613-139	45-194614-139				
20	0.1629			45-194613-140	45-194614-140				
19	0.1732			45-194613-141	45-194614-141	45-194615-141			
18	0.1806			45-194613-142	45-194614-142	45-194615-142			

Table 8-2. 180 Degree Stainless Steel Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
11/64	0.1857			45-194613-143	45-194614-143	45-194615-143			
17	0.1881			45-194613-144	45-194614-144	45-194615-144			
16	0.1969			45-194613-145	45-194614-145	45-194615-145			
15	0.2036			45-194613-146	45-194614-146	45-194615-146			
14	0.2082			45-194613-147	45-194614-147	45-194615-147			
13	0.2151				45-194614-148	45-194615-148			
3/16	0.2209				45-194614-149	45-194615-149			
12	0.2245				45-194614-150	45-194615-150			
11	0.2293				45-194614-151	45-194615-151			
10	0.2353				45-194614-152	45-194615-152			
9	0.2414				45-194614-153	45-194615-153			
8	0.2489				45-194614-154	45-194615-154			
7	0.2539				45-194614-155	45-194615-155			
13/64	0.2592				45-194614-156	45-194615-156			
6	0.2615				45-194614-157	45-194615-157			
5	0.2654				45-194614-158	45-194615-158			
4	0.2745				45-194614-159	45-194615-159			
3	0.2851				45-194614-160	45-194615-160			
7/32	0.3008				45-194614-161	45-194615-161	45-194616-161		
2	0.3069				45-194614-162	45-194615-162	45-194616-162		
1	0.3267				45-194614-163	45-194615-163	45-194616-163		
A	0.3441				45-194614-164	45-194615-164	45-194616-164		
15/64	0.3453				45-194614-165	45-194615-165	45-194616-165		
B	0.356				45-194614-166	45-194615-166	45-194616-166		
C	0.368				45-194614-167	45-194615-167	45-194616-167		
D	0.3803				45-194614-168	45-194615-168	45-194616-168		
E	0.3927				45-194614-169	45-194615-169	45-194616-169		
F	0.415				45-194614-170	45-194615-170	45-194616-170	45-194617-170	
G	0.4281					45-194615-171	45-194616-171	45-194617-171	
17/64	0.4433					45-194615-172	45-194616-172	45-194617-172	
H	0.4446					45-194615-173	45-194616-173	45-194617-173	
I	0.4649					45-194615-174	45-194616-174	45-194617-174	
J	0.4822					45-194615-175	45-194616-175	45-194617-175	
K	0.4962					45-194615-176	45-194616-176	45-194617-176	
9/32	0.4969					45-194615-177	45-194616-177	45-194617-177	
L	0.5285					45-194615-178	45-194616-178	45-194617-178	
M	0.5468					45-194615-179	45-194616-179	45-194617-179	
19/64	0.5539					45-194615-180	45-194616-180	45-194617-180	
N	0.5731					45-194615-181	45-194616-181	45-194617-181	
5/16	0.6136					45-194615-182	45-194616-182	45-194617-182	
O	0.6275					45-194615-183	45-194616-183	45-194617-183	
P	0.6556					45-194615-184	45-194616-184	45-194617-184	
21/64	0.6764					45-194615-185	45-194616-185	45-194617-185	45-194618-185
Q	0.6926					45-194615-186	45-194616-186	45-194617-186	45-194618-186

Table 8-2. 180 Degree Stainless Steel Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
R	0.7221					45-194615-187	45-194616-187	45-194617-187	45-194618-187
11/32	0.7427						45-194616-188	45-194617-188	45-194618-188
S	0.761						45-194616-189	45-194617-189	45-194618-189
T	0.8053						45-194616-190	45-194617-190	45-194618-190
23/64	0.8116						45-194616-191	45-194617-191	45-194618-191
U	0.8509						45-194616-192	45-194617-192	45-194618-192
3/8	0.8836						45-194616-193	45-194617-193	45-194618-193
V	0.8931						45-194616-194	45-194617-194	45-194618-194
W	0.9362						45-194616-195	45-194617-195	45-194618-195
25/64	0.9587						45-194616-196	45-194617-196	45-194618-196
X	0.9903						45-194616-197	45-194617-197	45-194618-197
Y	1.0256						45-194616-198	45-194617-198	45-194618-198
13/32	1.0368						45-194616-199	45-194617-199	45-194618-199
Z	1.0718						45-194616-200	45-194617-200	45-194618-200
27/64	1.1185						45-194616-201	45-194617-201	45-194618-201
7/16	1.2027						45-194616-202	45-194617-202	45-194618-202
29/64	1.29							45-194617-203	45-194618-203
15/32	1.3809							45-194617-204	45-194618-204
31/64	1.4744							45-194617-205	45-194618-205
1/2	1.5708							45-194617-206	45-194618-206
33/64	1.6704							45-194617-207	45-194618-207
17/32	1.773								45-194618-208
35/64	1.8794								45-194618-209
9/16	1.9881								45-194618-210
37/64	2.0999								45-194618-211
19/32	2.2155								45-194618-212
39/64	2.3334								45-194618-213
5/8	2.4544								45-194618-214
41/64	2.5785								45-194618-215
21/32	2.7056								45-194618-216
43/64	2.8366								45-194618-217

Table 8-3. 360 Degree Stainless Steel Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
53	0.0223	45-194621-100							
1/16	0.0246	45-194621-101							
52	0.0254	45-194621-102							
51	0.0283	45-194621-103							
50	0.0308	45-194621-104							
49	0.0335	45-194621-105							
48	0.0363	45-194621-106							
5/64	0.0384	45-194621-107	45-194622-107						
47	0.0388	45-194621-108	45-194622-108						
46	0.0413	45-194621-109	45-194622-109						
45	0.0423	45-194621-110	45-194622-110						
44	0.0465	45-194621-111	45-194622-111						
43	0.0498	45-194621-112	45-194622-112						
42	0.055	45-194621-113	45-194622-113						
3/32	0.0553	45-194621-114	45-194622-114						
41	0.058	45-194621-115	45-194622-115						
40	0.0604	45-194621-116	45-194622-116						
39	0.0623	45-194621-117	45-194622-117	45-194623-117					
38	0.0648	45-194621-118	45-194622-118	45-194623-118					
37	0.068	45-194621-119	45-194622-119	45-194623-119					
36	0.0713	45-194621-120	45-194622-120	45-194623-120					
7/64	0.0752	45-194621-121	45-194622-121	45-194623-121					
35	0.0761	45-194621-122	45-194622-122	45-194623-122					
34	0.0775	45-194621-123	45-194622-123	45-194623-123					
33	0.0803		45-194622-124	45-194623-124					
32	0.0846		45-194622-125	45-194623-125					
31	0.0905		45-194622-126	45-194623-126					
1/8	0.0982		45-194622-127	45-194623-127					
30	0.1038		45-194622-128	45-194623-128					
29	0.1163		45-194622-129	45-194623-129	45-194624-129				
28	0.1241		45-194622-130	45-194623-130	45-194624-130				
9/64	0.1243		45-194622-131	45-194623-131	45-194624-131				
27	0.1303		45-194622-132	45-194623-132	45-194624-132				
26	0.1358		45-194622-133	45-194623-133	45-194624-133				
25	0.1405		45-194622-134	45-194623-134	45-194624-134				
24	0.1452		45-194622-135	45-194623-135	45-194624-135				
23	0.1491		45-194622-136	45-194623-136	45-194624-136				
5/32	0.1534		45-194622-137	45-194623-137	45-194624-137				
22	0.1549		45-194622-138	45-194623-138	45-194624-138				
21	0.1589		45-194622-139	45-194623-139	45-194624-139				
20	0.1629		45-194622-140	45-194623-140	45-194624-140				
19	0.1732			45-194623-141	45-194624-141	45-194625-141			
18	0.1806			45-194623-142	45-194624-142	45-194625-142			

Table 8-3. 360 Degree Stainless Steel Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
11/64	0.1857			45-194623-143	45-194624-143	45-194625-143			
17	0.1881			45-194623-144	45-194624-144	45-194625-144			
16	0.1969			45-194623-145	45-194624-145	45-194625-145			
15	0.2036			45-194623-146	45-194624-146	45-194625-146			
14	0.2082			45-194623-147	45-194624-147	45-194625-147			
13	0.2151			45-194623-148	45-194624-148	45-194625-148			
3/16	0.2209			45-194623-149	45-194624-149	45-194625-149			
12	0.2245			45-194623-150	45-194624-150	45-194625-150			
11	0.2293			45-194623-151	45-194624-151	45-194625-151			
10	0.2353			45-194623-152	45-194624-152	45-194625-152			
9	0.2414			45-194623-153	45-194624-153	45-194625-153			
8	0.2489			45-194623-154	45-194624-154	45-194625-154			
7	0.2539			45-194623-155	45-194624-155	45-194625-155			
13/64	0.2592			45-194623-156	45-194624-156	45-194625-156			
6	0.2615				45-194624-157	45-194625-157			
5	0.2654				45-194624-158	45-194625-158			
4	0.2745				45-194624-159	45-194625-159			
3	0.2851				45-194624-160	45-194625-160			
7/32	0.3008				45-194624-161	45-194625-161	45-194626-161		
2	0.3069				45-194624-162	45-194625-162	45-194626-162		
1	0.3267				45-194624-163	45-194625-163	45-194626-163		
A	0.3441				45-194624-164	45-194625-164	45-194626-164		
15/64	0.3453				45-194624-165	45-194625-165	45-194626-165		
B	0.356				45-194624-166	45-194625-166	45-194626-166		
C	0.368				45-194624-167	45-194625-167	45-194626-167		
D	0.3803				45-194624-168	45-194625-168	45-194626-168		
E	0.3927				45-194624-169	45-194625-169	45-194626-169		
F	0.415				45-194624-170	45-194625-170	45-194626-170	45-194627-170	
G	0.4281				45-194624-171	45-194625-171	45-194626-171	45-194627-171	
17/64	0.4433				45-194624-172	45-194625-172	45-194626-172	45-194627-172	
H	0.4446				45-194624-173	45-194625-173	45-194626-173	45-194627-173	
I	0.4649					45-194625-174	45-194626-174	45-194627-174	
J	0.4822					45-194625-175	45-194626-175	45-194627-175	
K	0.4962					45-194625-176	45-194626-176	45-194627-176	
9/32	0.4969					45-194625-177	45-194626-177	45-194627-177	
L	0.5285					45-194625-178	45-194626-178	45-194627-178	
M	0.5468					45-194625-179	45-194626-179	45-194627-179	
19/64	0.5539					45-194625-180	45-194626-180	45-194627-180	
N	0.5731					45-194625-181	45-194626-181	45-194627-181	
5/16	0.6136					45-194625-182	45-194626-182	45-194627-182	
O	0.6275					45-194625-183	45-194626-183	45-194627-183	
P	0.6556					45-194625-184	45-194626-184	45-194627-184	
21/64	0.6764					45-194625-185	45-194626-185	45-194627-185	45-194628-185
Q	0.6926					45-194625-186	45-194626-186	45-194627-186	45-194628-186

Table 8-3. 360 Degree Stainless Steel Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
R	0.7221					45-194625-187	45-194626-187	45-194627-187	45-194628-187
11/32	0.7427						45-194626-188	45-194627-188	45-194628-188
S	0.761						45-194626-189	45-194627-189	45-194628-189
T	0.8053						45-194626-190	45-194627-190	45-194628-190
23/64	0.8116						45-194626-191	45-194627-191	45-194628-191
U	0.8509						45-194626-192	45-194627-192	45-194628-192
3/8	0.8836						45-194626-193	45-194627-193	45-194628-193
V	0.8931						45-194626-194	45-194627-194	45-194628-194
W	0.9362						45-194626-195	45-194627-195	45-194628-195
25/64	0.9587						45-194626-196	45-194627-196	45-194628-196
X	0.9903						45-194626-197	45-194627-197	45-194628-197
Y	1.0256						45-194626-198	45-194627-198	45-194628-198
13/32	1.0368						45-194626-199	45-194627-199	45-194628-199
Z	1.0718						45-194626-200	45-194627-200	45-194628-200
27/64	1.1185						45-194626-201	45-194627-201	45-194628-201
7/16	1.2027						45-194626-202	45-194627-202	45-194628-202
29/64	1.29							45-194627-203	45-194628-203
15/32	1.3809							45-194627-204	45-194628-204
31/64	1.4744							45-194627-205	45-194628-205
1/2	1.5708							45-194627-206	45-194628-206
33/64	1.6704							45-194627-207	45-194628-207
17/32	1.773								45-194628-208
35/64	1.8794								45-194628-209
9/16	1.9881								45-194628-210
37/64	2.0999								45-194628-211
19/32	2.2155								45-194628-212
39/64	2.3334								45-194628-213
5/8	2.4544								45-194628-214
41/64	2.5785								45-194628-215
21/32	2.7056								45-194628-216
43/64	2.8366								45-194628-217

Table 8-4. 180 Degree Brass Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
53	0.0223	45-194711-100							
1/16	0.0246	45-194711-101							
52	0.0254	45-194711-102							
51	0.0283	45-194711-103							
50	0.0308	45-194711-104							
49	0.0335	45-194711-105							
48	0.0363	45-194711-106							
5/64	0.0384	45-194711-107	45-194712-107						
47	0.0388	45-194711-108	45-194712-108						
46	0.0413	45-194711-109	45-194712-109						
45	0.0423	45-194711-110	45-194712-110						
44	0.0465		45-194712-111						
43	0.0498		45-194712-112						
42	0.055		45-194712-113						
3/32	0.0553		45-194712-114						
41	0.058		45-194712-115						
40	0.0604		45-194712-116						
39	0.0623		45-194712-117	45-194713-117					
38	0.0648		45-194712-118	45-194713-118					
37	0.068		45-194712-119	45-194713-119					
36	0.0713		45-194712-120	45-194713-120					
7/64	0.0752		45-194712-121	45-194713-121					
35	0.0761		45-194712-122	45-194713-122					
34	0.0775		45-194712-123	45-194713-123					
33	0.0803		45-194712-124	45-194713-124					
32	0.0846		45-194712-125	45-194713-125					
31	0.0905		45-194712-126	45-194713-126					
1/8	0.0982		45-194712-127	45-194713-127					
30	0.1038		45-194712-128	45-194713-128					
29	0.1163		45-194712-129	45-194713-129	45-194714-129				
28	0.1241			45-194713-130	45-194714-130				
9/64	0.1243			45-194713-131	45-194714-131				
27	0.1303			45-194713-132	45-194714-132				
26	0.1358			45-194713-133	45-194714-133				
25	0.1405			45-194713-134	45-194714-134				
24	0.1452			45-194713-135	45-194714-135				
23	0.1491			45-194713-136	45-194714-136				
5/32	0.1534			45-194713-137	45-194714-137				
22	0.1549			45-194713-138	45-194714-138				
21	0.1589			45-194713-139	45-194714-139				
20	0.1629			45-194713-140	45-194714-140				
19	0.1732			45-194713-141	45-194714-141	45-194715-141			
18	0.1806			45-194713-142	45-194714-142	45-194715-142			

Table 8-4. 180 Degree Brass Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
11/64	0.1857			45-194713-143	45-194714-143	45-194715-143			
17	0.1881			45-194713-144	45-194714-144	45-194715-144			
16	0.1969			45-194713-145	45-194714-145	45-194715-145			
15	0.2036			45-194713-146	45-194714-146	45-194715-146			
14	0.2082			45-194713-147	45-194714-147	45-194715-147			
13	0.2151				45-194714-148	45-194715-148			
3/16	0.2209				45-194714-149	45-194715-149			
12	0.2245				45-194714-150	45-194715-150			
11	0.2293				45-194714-151	45-194715-151			
10	0.2353				45-194714-152	45-194715-152			
9	0.2414				45-194714-153	45-194715-153			
8	0.2489				45-194714-154	45-194715-154			
7	0.2539				45-194714-155	45-194715-155			
13/64	0.2592				45-194714-156	45-194715-156			
6	0.2615				45-194714-157	45-194715-157			
5	0.2654				45-194714-158	45-194715-158			
4	0.2745				45-194714-159	45-194715-159			
3	0.2851				45-194714-160	45-194715-160			
7/32	0.3008				45-194714-161	45-194715-161	45-194716-161		
2	0.3069				45-194714-162	45-194715-162	45-194716-162		
1	0.3267				45-194714-163	45-194715-163	45-194716-163		
A	0.3441				45-194714-164	45-194715-164	45-194716-164		
15/64	0.3453				45-194714-165	45-194715-165	45-194716-165		
B	0.356				45-194714-166	45-194715-166	45-194716-166		
C	0.368				45-194714-167	45-194715-167	45-194716-167		
D	0.3803				45-194714-168	45-194715-168	45-194716-168		
E	0.3927				45-194714-169	45-194715-169	45-194716-169		
F	0.415				45-194714-170	45-194715-170	45-194716-170	45-194717-170	
G	0.4281					45-194715-171	45-194716-171	45-194717-171	
17/64	0.4433					45-194715-172	45-194716-172	45-194717-172	
H	0.4446					45-194715-173	45-194716-173	45-194717-173	
I	0.4649					45-194715-174	45-194716-174	45-194717-174	
J	0.4822					45-194715-175	45-194716-175	45-194717-175	
K	0.4962					45-194715-176	45-194716-176	45-194717-176	
9/32	0.4969					45-194715-177	45-194716-177	45-194717-177	
L	0.5285					45-194715-178	45-194716-178	45-194717-178	
M	0.5468					45-194715-179	45-194716-179	45-194717-179	
19/64	0.5539					45-194715-180	45-194716-180	45-194717-180	
N	0.5731					45-194715-181	45-194716-181	45-194717-181	
5/16	0.6136					45-194715-182	45-194716-182	45-194717-182	
O	0.6275					45-194715-183	45-194716-183	45-194717-183	
P	0.6556					45-194715-184	45-194716-184	45-194717-184	
21/64	0.6764					45-194715-185	45-194716-185	45-194717-185	45-194718-185
Q	0.6926					45-194715-186	45-194716-186	45-194717-186	45-194718-186

Table 8-4. 180 Degree Brass Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
R	0.7221					45-194715-187	45-194716-187	45-194717-187	45-194718-187
11/32	0.7427						45-194716-188	45-194717-188	45-194718-188
S	0.761						45-194716-189	45-194717-189	45-194718-189
T	0.8053						45-194716-190	45-194717-190	45-194718-190
23/64	0.8116						45-194716-191	45-194717-191	45-194718-191
U	0.8509						45-194716-192	45-194717-192	45-194718-192
3/8	0.8836						45-194716-193	45-194717-193	45-194718-193
V	0.8931						45-194716-194	45-194717-194	45-194718-194
W	0.9362						45-194716-195	45-194717-195	45-194718-195
25/64	0.9587						45-194716-196	45-194717-196	45-194718-196
X	0.9903						45-194716-197	45-194717-197	45-194718-197
Y	1.0256						45-194716-198	45-194717-198	45-194718-198
13/32	1.0368						45-194716-199	45-194717-199	45-194718-199
Z	1.0718						45-194716-200	45-194717-200	45-194718-200
27/64	1.1185						45-194716-201	45-194717-201	45-194718-201
7/16	1.2027						45-194716-202	45-194717-202	45-194718-202
29/64	1.29							45-194717-203	45-194718-203
15/32	1.3809							45-194717-204	45-194718-204
31/64	1.4744							45-194717-205	45-194718-205
1/2	1.5708							45-194717-206	45-194718-206
33/64	1.6704							45-194717-207	45-194718-207
17/32	1.773								45-194718-208
35/64	1.8794								45-194718-209
9/16	1.9881								45-194718-210
37/64	2.0999								45-194718-211
19/32	2.2155								45-194718-212
39/64	2.3334								45-194718-213
5/8	2.4544								45-194718-214
41/64	2.5785								45-194718-215
21/32	2.7056								45-194718-216
43/64	2.8366								45-194718-217

Table 8-5. 360 Degree Brass Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
53	0.0223	45-194721-100							
1/16	0.0246	45-194721-101							
52	0.0254	45-194721-102							
51	0.0283	45-194721-103							
50	0.0308	45-194721-104							
49	0.0335	45-194721-105							
48	0.0363	45-194721-106							
5/64	0.0384	45-194721-107	45-194722-107						
47	0.0388	45-194721-108	45-194722-108						
46	0.0413	45-194721-109	45-194722-109						
45	0.0423	45-194721-110	45-194722-110						
44	0.0465	45-194721-111	45-194722-111						
43	0.0498	45-194721-112	45-194722-112						
42	0.055	45-194721-113	45-194722-113						
3/32	0.0553	45-194721-114	45-194722-114						
41	0.058	45-194721-115	45-194722-115						
40	0.0604	45-194721-116	45-194722-116						
39	0.0623	45-194721-117	45-194722-117	45-194723-117					
38	0.0648	45-194721-118	45-194722-118	45-194723-118					
37	0.068	45-194721-119	45-194722-119	45-194723-119					
36	0.0713	45-194721-120	45-194722-120	45-194723-120					
7/64	0.0752	45-194721-121	45-194722-121	45-194723-121					
35	0.0761	45-194721-122	45-194722-122	45-194723-122					
34	0.0775	45-194721-123	45-194722-123	45-194723-123					
33	0.0803		45-194722-124	45-194723-124					
32	0.0846		45-194722-125	45-194723-125					
31	0.0905		45-194722-126	45-194723-126					
1/8	0.0982		45-194722-127	45-194723-127					
30	0.1038		45-194722-128	45-194723-128					
29	0.1163		45-194722-129	45-194723-129	45-194724-129				
28	0.1241		45-194722-130	45-194723-130	45-194724-130				
9/64	0.1243		45-194722-131	45-194723-131	45-194724-131				
27	0.1303		45-194722-132	45-194723-132	45-194724-132				
26	0.1358		45-194722-133	45-194723-133	45-194724-133				
25	0.1405		45-194722-134	45-194723-134	45-194724-134				
24	0.1452		45-194722-135	45-194723-135	45-194724-135				
23	0.1491		45-194722-136	45-194723-136	45-194724-136				
5/32	0.1534		45-194722-137	45-194723-137	45-194724-137				
22	0.1549		45-194722-138	45-194723-138	45-194724-138				
21	0.1589		45-194722-139	45-194723-139	45-194724-139				
20	0.1629		45-194722-140	45-194723-140	45-194724-140				
19	0.1732			45-194723-141	45-194724-141	45-194725-141			
18	0.1806			45-194723-142	45-194724-142	45-194725-142			

Table 8-5. 360 Degree Brass Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
11/64	0.1857			45-194723-143	45-194724-143	45-194725-143			
17	0.1881			45-194723-144	45-194724-144	45-194725-144			
16	0.1969			45-194723-145	45-194724-145	45-194725-145			
15	0.2036			45-194723-146	45-194724-146	45-194725-146			
14	0.2082			45-194723-147	45-194724-147	45-194725-147			
13	0.2151			45-194723-148	45-194724-148	45-194725-148			
3/16	0.2209			45-194723-149	45-194724-149	45-194725-149			
12	0.2245			45-194723-150	45-194724-150	45-194725-150			
11	0.2293			45-194723-151	45-194724-151	45-194725-151			
10	0.2353			45-194723-152	45-194724-152	45-194725-152			
9	0.2414			45-194723-153	45-194724-153	45-194725-153			
8	0.2489			45-194723-154	45-194724-154	45-194725-154			
7	0.2539			45-194723-155	45-194724-155	45-194725-155			
13/64	0.2592			45-194723-156	45-194724-156	45-194725-156			
6	0.2615				45-194724-157	45-194725-157			
5	0.2654				45-194724-158	45-194725-158			
4	0.2745				45-194724-159	45-194725-159			
3	0.2851				45-194724-160	45-194725-160			
7/32	0.3008				45-194724-161	45-194725-161	45-194726-161		
2	0.3069				45-194724-162	45-194725-162	45-194726-162		
1	0.3267				45-194724-163	45-194725-163	45-194726-163		
A	0.3441				45-194724-164	45-194725-164	45-194726-164		
15/64	0.3453				45-194724-165	45-194725-165	45-194726-165		
B	0.356				45-194724-166	45-194725-166	45-194726-166		
C	0.368				45-194724-167	45-194725-167	45-194726-167		
D	0.3803				45-194724-168	45-194725-168	45-194726-168		
E	0.3927				45-194724-169	45-194725-169	45-194726-169		
F	0.415				45-194724-170	45-194725-170	45-194726-170	45-194727-170	
G	0.4281				45-194724-171	45-194725-171	45-194726-171	45-194727-171	
17/64	0.4433				45-194724-172	45-194725-172	45-194726-172	45-194727-172	
H	0.4446				45-194724-173	45-194725-173	45-194726-173	45-194727-173	
I	0.4649					45-194725-174	45-194726-174	45-194727-174	
J	0.4822					45-194725-175	45-194726-175	45-194727-175	
K	0.4962					45-194725-176	45-194726-176	45-194727-176	
9/32	0.4969					45-194725-177	45-194726-177	45-194727-177	
L	0.5285					45-194725-178	45-194726-178	45-194727-178	
M	0.5468					45-194725-179	45-194726-179	45-194727-179	
19/64	0.5539					45-194725-180	45-194726-180	45-194727-180	
N	0.5731					45-194725-181	45-194726-181	45-194727-181	
5/16	0.6136					45-194725-182	45-194726-182	45-194727-182	
O	0.6275					45-194725-183	45-194726-183	45-194727-183	
P	0.6556					45-194725-184	45-194726-184	45-194727-184	
21/64	0.6764					45-194725-185	45-194726-185	45-194727-185	45-194728-185
Q	0.6926					45-194725-186	45-194726-186	45-194727-186	45-194728-186

Table 8-5. 360 Degree Brass Nozzles

Drill	Area	1/4 in. NPT	3/8 in. NPT	1/2 in. NPT	3/4 in. NPT	1 in. NPT	1-1/4 in. NPT	1-1/2 in. NPT	2 in. NPT
R	0.7221					45-194725-187	45-194726-187	45-194727-187	45-194728-187
11/32	0.7427						45-194726-188	45-194727-188	45-194728-188
S	0.761						45-194726-189	45-194727-189	45-194728-189
T	0.8053						45-194726-190	45-194727-190	45-194728-190
23/64	0.8116						45-194726-191	45-194727-191	45-194728-191
U	0.8509						45-194726-192	45-194727-192	45-194728-192
3/8	0.8836						45-194726-193	45-194727-193	45-194728-193
V	0.8931						45-194726-194	45-194727-194	45-194728-194
W	0.9362						45-194726-195	45-194727-195	45-194728-195
25/64	0.9587						45-194726-196	45-194727-196	45-194728-196
X	0.9903						45-194726-197	45-194727-197	45-194728-197
Y	1.0256						45-194726-198	45-194727-198	45-194728-198
13/32	1.0368						45-194726-199	45-194727-199	45-194728-199
Z	1.0718						45-194726-200	45-194727-200	45-194728-200
27/64	1.1185						45-194726-201	45-194727-201	45-194728-201
7/16	1.2027						45-194726-202	45-194727-202	45-194728-202
29/64	1.29							45-194727-203	45-194728-203
15/32	1.3809							45-194727-204	45-194728-204
31/64	1.4744							45-194727-205	45-194728-205
1/2	1.5708							45-194727-206	45-194728-206
33/64	1.6704							45-194727-207	45-194728-207
17/32	1.773								45-194728-208
35/64	1.8794								45-194728-209
9/16	1.9881								45-194728-210
37/64	2.0999								45-194728-211
19/32	2.2155								45-194728-212
39/64	2.3334								45-194728-213
5/8	2.4544								45-194728-214
41/64	2.5785								45-194728-215
21/32	2.7056								45-194728-216
43/64	2.8366								45-194728-217

TECHNICAL MANUAL USER FEEDBACK FORM

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7. USER EVALUATION

MANUAL IS: ❑ **EXCELLENT** ❑ **GOOD** ❑ **FAIR** ❑ **POOR** ❑ **COMPLETE** ❑ **INCOMPLETE**

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9. RECOMMENDED CHANGE TO PUBLICATION

PAGE NO.	**PARAGRAPH NO.**	**LINE NO.**	**FIGURE NO.**	**TABLE NO.**	**RECOMMENDED CHANGES AND REASON (Use Blank Continuation Sheets as Required)**

10. ORIGINATOR	**11. COMPANY NAME**

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