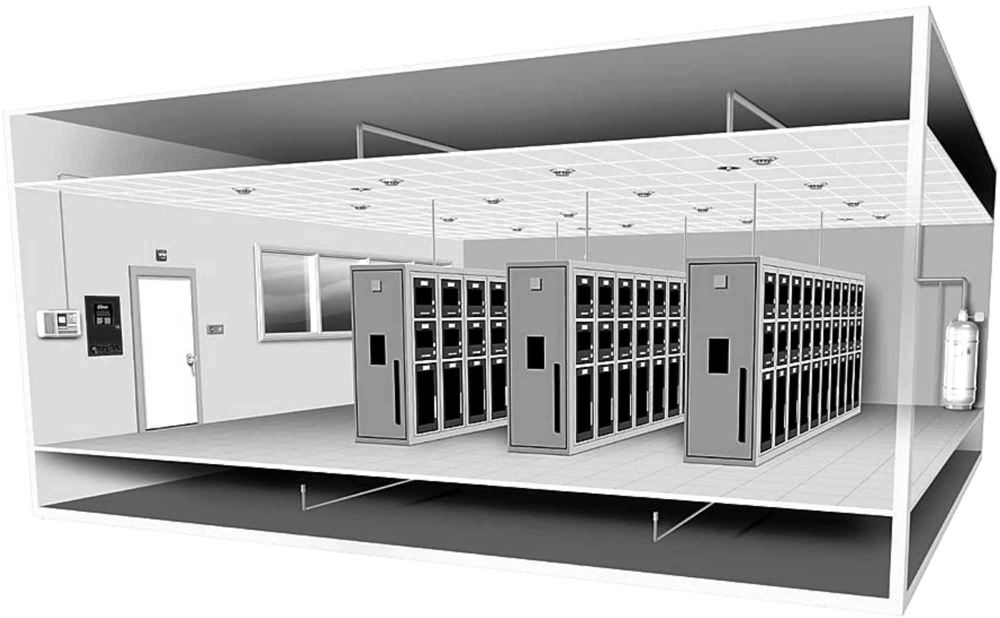

Design, Installation & Maintenance Manual for Fike Clean Agent Systems w/ FM-200™, GCA and DOT / TC Containers

P/N 06-215 (Rev G)
Revision Date: January, 2010

Document Name: **DESIGN, INSTALLATION, AND MAINTENANCE MANUAL FOR ENGINEERED HFC-227ea SYSTEMS**

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Revision / Description of Change **Revision Date**

Revision A.. April, 2002

1) Added reference to 4BW500 containers to Section 1
2) Moved details on 4BA500 containers to Appendix B

Revision B... July, 2003

1) Add low pressure switch to Section 1 & 4
2) Add back to back 180° nozzles to Section 2

Revision C ....March, 2004

1) Changed minimum design concentration in Section 2 for Class A hazards
2) Revised sample problem in Section 3

Revision D ....May, 2005

1) Updated 10, 20 & 35-lb container information in Section 1 and 4

Revision E..June, 2006

1) Add notes to par 2.7.4 on page 15 and par 2.8.5 on page 22, of Design Section regarding 10 pipe dia. limitation for back to back 180 degree nozzles

Revision F..June, 2009

1) Added 3/8" Sch 40 & Sch 80 pipe to paragraph 4.4, Section 4
2) Changed Mounting Bracket information in Section 1 & 4
3) Removed 10 lb. Container from Manual
4) Removed Notes (Class C energized hazards) under paragraph 2.2.2 in Section 2
5) Added reference to ULC and TC to manual
6) Updated information on 1" & 2" Check Valves in Section 1 & 2
7) Reformatted Nozzle information
8) Removed reference to 4B500/4BM500 in paragraph 1.5.2, Section 1

Revision G ....January, 2010

1) Added threaded valve information to Sections 1, 2 and 4

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INTRODUCTION .... **1 PAGE**

SECTION 1 – EQUIPMENT .... **25 PAGES**

1.1 AGENT **1**
1.2 PERFORMANCE **1**
1.3 PHYSICAL PROPERTIES – HFC-227ea (FM-200) **1**
1.4 USE and LIMITATIONS **2**
1.4.1 Exposure 2
1.4.2 Exposure Limits 2
1.4.3 Toxicity 3
1.4.4 Noise 3
1.4.5 Turbulence 3
1.4.6 Chilling 3
1.4.7 Visibility 3
1.4.8 Pressure 3
1.5 AGENT STORAGE CONTAINERS **4**
1.5.1 Rupture Disc 4
1.5.2 Containers w/ 1” (25mm) Valve 5
1.5.3 Containers w/ 2 ½” (65mm) Valve 7
1.5.3.1 Floor Mounting Kits 8
1.5.4 Containers w/ 3” (80mm) Valve 9
1.5.4.1 Mounting Straps 10
1.6 ITEMS FURNISHED W/ CONTAINERS **11**
1.6.1 Nameplate 11
1.6.2 Siphon Tube 11
1.6.3 Victaulic Coupling & Nipple 11
1.6.4 Pressure Gauge 11
1.6.5 Pressure Gauge Adapter 12
1.6.6 Agent Fill Valve 12
1.6.7 Agent Release Module (ARM) 13
1.6.8 Mounting Hardware For GCA & ARM 13
1.7 GAS CARTRIDGE ACTUATOR (GCA) **14**
1.8 CONTAINER ACCESSORIES **15**
1.8.1 Liquid Level Indicator (LLi) 15
1.8.2 Low Pressure Switch 16
1.8.3 Reload Kits 16
1.8.3.1 Reload Kit – 1” Valve 17
1.8.3.2 Reload Kit – 2½ “ Valve 18
1.8.3.3 Reload Kit – 3” Valve 19
1.9 CONTAINER ORDERING FORMAT **20**

1.10 DISCHARGE NOZZLES 21
1.10.1 Pre-Engineered Discharge Nozzles 21
1.10.2 Engineered Discharge Nozzles 22
1.10.3 Nozzle Ordering Format for Engineered Discharge Nozzles 22
1.11 CHECK VALVES 23
1.12 CAUTION / ADVISORY SIGNS 24
1.12.1 Do Not Enter Sign 24
1.12.2 Exit Sign 24
1.12.3 Do Not Enter Sign 24
1.12.4 System Abort Sign 24
1.12.5 System ReleaseSign 24
1.12.6 Main/Reserve Sign 24
1.13 CONTROL SYSTEM & ACCESSORIES 25
1.13.1 Control Panels 25
1.13.2 Manual Acturator 25

SECTION 2 – SYSTEM DESIGN .... 39 PAGES
2.1 DETERMINE HAZARD TYPE 1
2.2 DETERMINE CONCENTRATION PERCENTAGE 1
2.2.1 Class "A" or "C" Hazards – Automatically Activated 1
2.2.2 Class "A" or "C" Hazards – Manually Activated 1
2.2.3 Class B Flammable Liquids-Automatically or Manually Activated System 2
2.3 SAFETY RECOMMENDATIONS 2
2.3.1 Normally Occupied Spaces 2
2.3.2 Normally Non-Occupied Spaces 2
2.3.3 All Spaces 2
2.4 DETERMINE AGENT QUANTITY 3
2.4.1 Determine The Hazard Volume 3
2.4.2 Calculate Agent Required 3
2.4.3 Additional Considerations 6
2.4.3.1 Tee Design Factor 6
2.4.3.2 Altitude Correction Factors 8
2.4.3.3 Determine Actual Concentration at Maximum Temperature 8
2.4.3.4 Leakage 9
2.5 SYSTEM DESIGN CONCEPT 10
2.5.1 Pre-Engineered Systems Concept 10
2.5.2 Engineered Systems Concept 10
2.5.3 Modular Systems 10
2.5.4 Central Storage Systems 10

2.6 CONTAINER SELECTION 11
2.6.1 Container Size and Fill Range 11
2.6.2 Container Location(s) 12
2.6.3 Storage Temperature Limitations 12
2.7 NOZZLE SELECTION 13
2.7.1 System Type 13
2.7.2 Nozzle Flow Rates 13
2.7.2.1 Engineered Nozzles 14
2.7.3 Nozzle Area Coverage 14
2.7.4 Nozzle Placement 15
2.7.4.1 Ceiling Heights Greater Than 16'-0" (4.9 m) 16
2.7.5 Nozzle Discharge Obstructions 17
2.8 PIPING NETWORK LIMITATIONS (ENGINEERED SYSTEMS) 18
2.8.1 Tee Split Ratios 18
2.8.1.1 Bullhead Tee 18
2.8.1.2 Side-Thru Tee 18
2.8.2 Maximum Elevation Differences in Pipe Runs 19
2.8.3 Tee Orientation 20
2.8.4 Estimating Pipe Size (Engineered Systems) 21
2.8.4.1 Discharge Duration 21
2.8.4.2 Minimum Flow Rates 21
2.8.5 Minimum Piping Distance (Engineering Systems) 22
2.8.5.1 Distance from a Tee to an Elbow or Tee 22
2.8.5.2 Distance from an Elbow to a Tee 22
2.8.6 Equivalent Length Values 23
2.9 ENGINEERED SYSTEM DESIGN LIMITS 24
2.9.1 Percent of Agent In Pipe 24
2.9.2 Location of First Tee 24
2.9.3 Liquid Arrival Time 25
2.9.4 Liquid Runout Time 25
2.10 MANIFOLD OPTIONS (ENGINEERED SYSTEMS) 26
2.11 PER-ENGINEERED SYSTEMS DESIGN 29
2.11.1 Piping Layout 29
2.11.2 Determining Pipe Sizes 29
2.11.2.1 Single Nozzle Piping Table – 35 lb. thru 215 lb. Containers 30
2.11.2.2 Two Nozzle Piping Table – 60 lb. thru 375 lb. Containers 31
2.11.2.3 Four Nozzle Piping Table – 60 lb. thru 375 lb. Containers 32

2.11.3 Determining the Total Pressure Drop (TPD) 33
2.11.3.1 Piping Layout Diagram 33
2.11.3.2 Total Pressure Drop (TDP) Calculation 34
2.11.3.2-A Single Nozzle Factors Table 34
2.11.3.2-B Two Nozzle Factors Table 36
2.11.3.2-C Four Nozzle Factors Table 38

SECTION 3 – SAMPLE PROBLEM ..... 17 PAGES
3.1 DETERMINE HAZARD VOLUME 1
3.2 CALCULATE AGENT REQUIRED 2
3.2.1 Determine Concentration At Maximum Temperature 2
3.3 ESTABLISH SYSTEM CONCEPT 3
3.3.1 Container Selection 3
3.3.2 Nozzles Required. 3
3.4 LAYOUT PIPING NETWORK 5
3.5 SAMPLE FLOW CALCULATION 7

SECTION 4 – SYSTEM INSTALLATION ..... 21 PAGES
4.1 AGENT STORAGE CONTAINERS 1
4.1.1 Mounting Details for Vertical / Horizontal Containers 1
4.1.1.1 Mounting Details 20 lb. & 35 lb. (8L & 15L) Container 2
4.1.1.2 Mounting Details 60 lb. (27 L) Container 3
4.1.2 Mounting Details for Inverted (Spherical) Containers 4
4.1.2.1 Mounting Details 125 lb. (51 L) Container 4
4.1.2.2 Mounting Details 215 lb. (90 L) Container 5
4.1.3 Mounting Details for Vertical (Upright) Containers 6
4.2 DISCHARGE PIPING CONNECTIONS 7
4.2.1 1" (25mm) Valve Connections 7
4.2.2 2-1/2" (65mm) Valve Connections 7
4.2.3 3" (80mm) Valve Connections 8
4.3 MANIFOLDS 8
4.3.1 1" NPT Check Valve Installation 10
4.3.2 2" NPT Check Valve Installation 10
4.3.3 3" NPT Check Valve Installation 10
4.4 PIPING AND FITTING MATERIALS 11
4.4.1 Pipe Size Changes 12
4.4.1.1 Pipe Size Change at a Tee 12
4.4.1.2 Pipe Size Change at an Elbow 12
4.4.1.3 Pipe Size Change at a Coupling 12
4.4.2 Installing Main Discharge Piping 12

4.5 NOZZLE INSTALLATION....13
4.5.1 360° Nozzles....14
4.5.2 180° Nozzles....14
4.5.3 Nozzle Set Screw Installation....14
4.6 GAS CARTRIDGE ACTUATOR (GCA) / AGENT RELEASE MODULE (ARM)....15
4.6.1 2-1/2" (65 mm) Valve (Inverted Container) GCA Installation....15
4.6.2 1" & 3" (25 mm & 80 mm) Valve GCA Installation....16
4.7 CONTAINER ELECTRICAL CONNECTIONS....17
4.7.1 Gas Cartridge Actuator (GCA) Safety Recommendations....18
4.7.2 Gas Cartridge Actuator (GCA) Installation Procedure....19
4.8 LOW PRESSURE SWITCH....20
4.8.1 Low Pressure Switch Wiring....21

SECTION 5 – FINAL SYSTEM CHECKOUT....2 PAGES
5.1 HAZARD AREA CHECK....1
5.1.1 Area Configuration....1
5.1.2 Area Leakage....1
5.1.3 Enclosure Integrity - Door Fan Testing....1
5.2 CONTAINERS....2
5.3 DISCHARGE PIPING....2
5.4 NOZZLES....2
5.5 AUXILIARY FUNCTIONS....2

SECTION 6 – SYSTEM MAINTENANCE....3 PAGES
6.1 DISCHARGE PIPING....1
6.2 DISCHARGE NOZZLES....1
6.3 AGENT STORAGE CONTAINERS....1
6.4 GAS CARTRIDGE ACTUATORS....2
6.5 CONTAINER TEST AND INSPECTION....2
6.6 PRESSURE GAUGE & LOW PRESSURE SWITCH MAINTENANCE....3
6.6.1 Replacing a Pressure Gauge or Low Pressure Switch....3
6.6.2 Adding a Low Pressure Switch....3

APPENDIX – MATERIAL SAFETY DATA SHEETS....13 PAGES
Material Safety Data Sheet – HFC-227ea Agent....8 Pages
Material Safety Data Sheet – Gas Cartridge Actuator (GCA)....3 Pages
4BA Container Information....2 Pages

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Fike is pleased to provide a "Design, Installation and Maintenance Manual" for our Clean Agent Fire Suppression systems w/ FM-200™ agent. This document has been revised to incorporate the latest design requirements found in NFPA Standard 2001, as well as the most up-to-date information available for our products.

This manual has been provided for those individuals that are responsible for the design, installation, and/or maintenance of Fike Clean Agent Fire Suppression systems. Others such as architects, engineers, sales and marketing personnel, etc. will find the information herein useful as well.

Fike offers two concepts of system design that are described within the following chapters.

1. Pre-Engineered Systems – These are simple "boilerplate" systems that operate within a pre-determined set of criteria as tested and approved by Underwriters Laboratories Inc. These systems do not require the designer to perform a complicated set of hydraulic flow calculations and they are intended to provide a fast, easy means of designing systems.
2. Engineered Systems – These are the more complicated, elaborate systems that operate within a less restrictive set of criteria as tested and approved by Underwriters Laboratories Inc. These systems are designed within the basic parameters outlined in this manual, and their performance is evaluated with the assistance of the Fike Flow Calculation Program.

   Tests have shown that the Fike Flow Calculation Program can accurately determine the expected performance of the Clean Agent Fire Suppression system when it is discharged. This provides the system designer with the maximum degree of flexibility possible as it pertains to flow imbalance, tee splits, piping configurations, etc.

Fike Clean Agent Fire Suppression systems must be installed and maintained in accordance with the limitations established NFPA Standard no. 2001, Clean Agent Extinguishing Systems, as well as the limitations set forth by Underwriters Laboratories Inc. The information contained within this manual defines these limitations in detail.

Enough information is incorporated into this manual to allow those responsible for designing Fike Clean Agent Fire Suppression systems to properly do so, and for the parties responsible for verifying the system design to determine if the design parameters have in deed been met.

The data contained within this manual is provided for informational purposes only. Fike believes this data to be accurate; however, all dimensions are approximate and this document is presented without any guarantee or warranty whatsoever.

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

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This section covers the hardware utilized by Fike Clean Agent Fire Suppression Systems, including the optional items that are available. All of the information contained herein is believed to be accurate and up-to-date. However, it should be noted that all dimensions shown are approximate and Fike reserves the right to make adjustments as necessary.

1.1 AGENT

The extinguishing agent used in Fike Suppression Systems is Heptafluoropropane – more commonly known by its ASHRAE designation: HFC-227ea. HFC-227ea is a colorless, odorless, liquefied compressed gas. (See the Physical Properties Table below.) It is stored as a liquid, but dispensed into the hazard as a colorless, electrically-nonconductive, gaseous vapor due to its relatively low boiling point. HFC-227ea has been tested and verified to be safe for use in occupied spaces when used as specified in the U.S. EPA Significant New Alternative Policy (SNAP) rules. Tests have proven that exposure to HFC-227ea is safe and effective in extinguishing fires at low concentrations; most of which are well below the EPA's maximum exposure levels. HFC- 227ea is approved for use in occupied areas up to a 10.5% concentration by volume with mandated egress time of five (5) minutes.

1.2 PERFORMANCE

HFC-227ea's mechanism of extinguishing fires is considered active. Its primary action is through physically cooling the fire at the molecular level. HFC-227ea belongs to the same class of agents used in refrigeration and as such, is an efficient heat transfer agent. HFC-227ea removes the thermal energy from the fire to the extent where the combustion reaction cannot sustain itself. Additionally, there is a chemical action that provides a secondary means of extinguishing the fire. Trace amounts of free radicals are released into the fire – thereby inhibiting the chain reaction of combustion. HFC-227ea does not significantly reduce oxygen levels and is safe for use in occupied spaces in accordance with the U.S. EPA guidelines. HFC-227ea can be removed from the protected space by simple means of ventilation after discharge.

1.3 PHYSICAL PROPERTIES OF HFC-227ea (FM-200™)

Chemical Name	1,1,1,2,3,3,3-Heptafluoropropane
Chemical Formula	CF CHFCF
CAS No.	431-89-0
Molecular Wt.	107.03
Boiling Point, 1 atm, °C (°F)	-15.9 °F (3.9)
Freezing Point, °C (°F)	-133 (-204)
Flammable Limits	nonflammable
Critical Temperature, °C (°F)	101.6 (214.9)
Critical Pressure, kPa (psia)	2930.6 (424.7)
Critical Density, kg/m^3 (lb/ft^3)	621 (38.77)
Liquid Density @ 25 °C (77°F), kg/m^3 (lb/ft^3)	1386 (86.53)
Vapor Density @ 25 °C (77°F) and 1atm, kg/m^3 (lb/ft^3)	7.148 (0.4462)
Specific Heat, Liquid (Cp) @ 25°C (77°F), kJ/kg- °C (Btu/lb °F)	1.247 (0.2979)
Specific Heat, Vapor (Cp) @ 25°C (77°F), kJ/kg- °C (Btu/lb °F) and 1 ATM	0.8136 (0.1945)
Vapor Pressure, Saturated @ 25°C (77°F), kPa (psia)	453.3 (65.7)
Heat of Vaporization @ B.P., kJ/kg (Btu/lb)	132.6 (56.7)
Thermal Conductivity, Liquid @ 25°C (77°F),W/m- °C (Btu/hr-ft °F)	0.0533 (0.0308)
Thermal Conductivity, Vapor @ 25°C (77°F),W/m- °C (Btu/hr-ft °F)	0.0127 (0.0073)
Viscosity, Liquid (lb/ft-hr) @ @ 25°C (77°F), cP (lb/ft-hr)	0.2442 (0.5907)
Relative dielectric strength @ 1atm, 25 °C (N_2 =1)	2.00
Solubility of Water in HFC-227ea @ 20 °C (68 °C), ppm	600
Ozone Depletion Potential	0.0 (CFC-11 = 1)
Global Warming Potential, GWP (100 yr. ITH. For CO2, GWP = 1)	2900
Atmospheric Lifetime, years	36.5
TSCA Inventory Status	Reported, Included
European List of New Chemical Substances	EINECS, Listed (207-079-2)
SNAP Status	Listed
Inhalation Exposure Limit	TLV Not Established DuPont AEL = 1000 ppm 8 hr & 12 hr TWA

1.4 USE AND LIMITATIONS

Fike HFC-227ea Systems must be designed and installed in accordance with the requirements outlined in this manual, and in accordance with the requirements of the Standard for Clean Agent Extinguishing Systems, NFPA 2001, latest edition. HFC-227ea systems are primarily used to protect hazards that are enclosed; this provides a means to establish and maintain an effective extinguishing concentration. Typical hazards that can be protected include the following.

- Electrical and electronic hazards
- Telecommunications facilities
- Storage Rooms – Flammable liquids and gases
- High value assets, where the associated down-time would be costly

HFC-227ea systems shall **NOT** be used on fires involving the following materials.

- Chemicals or mixtures of chemicals which are capable of rapid oxidation in the absence of air. Examples include Cellulose Nitrate and Gunpowder.
- Reactive metals such as Lithium, Sodium, Potassium, Magnesium, Titanium, Zirconium, Uranium, and Plutonium
- Metal hydrides such as Sodium Hydride and Lithium Aluminum Hydride
- Chemicals capable of undergoing auto thermal decomposition. Examples include Organic Peroxides and Hydrazine.

1.4.1 EXPOSURE

Although HFC-227ea is considered to be non-toxic, the EPA has established the guidelines controlling the amount (concentration) of agent provided for the protected area. Based on PBPK modeling, the EPA allows HFC-227ea for use where people are normally present (normally occupied spaces) up to concentration of 10.5% by volume with exposure limited to 5 minutes or less.

WARNING: The discharge of clean agent systems to extinguish a fire can result in potential hazard to personnel from the natural form of the clean agent or from the products of combustion that result from exposure of the agent to the fire or hot surfaces. Unnecessary exposure of personnel either to the natural agent or to the products of decomposition shall be avoided.. The requirement for pre-discharge alarms and time delays are intended to prevent unnecessary exposure to humans where their presence is not critical to the operation of the area being protected. Suitable safeguards shall be provided to ensure prompt evacuation of (and prevent entry into) protected areas after discharge.

1.4.2 EXPOSURE LIMITS

HFC-227ea systems provided for ***Normally Occupied Spaces*** can be designed for concentrations above to the NOAEL level of 9% by volume, given that means be provided to limit exposure to design concentrations shown in Table 1.4 that correspond to a maximum permitted human exposure time of five (5) minutes.

HFC-227ea Concentration	ppm	Human Exposure Time (minutes)
9.0%	90,000	5.00
9.5%	95,000	5.00
10.0%	100,000	5.00
10.5%	105,000	5.00
11.0%	110,000	1.13
11.5%	115,000	0.60
12.0%	120,000	0.49

TABLE 1.4

HFC-227ea systems provided for ***Normally Non-Occupied Spaces*** can be designed for concentrations in excess of the LOAEL concentration of 10.5%. Where a possibility exists for personnel to be exposed, means shall be provided to limit exposure times in accordance with the above table. In the absence of the information needed to fulfill the conditions listed above, the following provisions shall apply.

- Where egress takes longer than 30 seconds but less than 1 minute, the HFC-227ea system shall not be designed for a concentration exceeding the LOAEL of 10.5% by volume.
- Where egress takes less than 30 seconds, the HFC-227ea system can be designed for a concentration that exceeds the LOAEL of 10.5% by volume.

1.4.3 TOXICITY

With a database in excess of 70 toxicity tests, HFC-227ea has been extensively tested and approved by institutions and agencies around the world. The LC50 toxicity rating for HFC-227ea is greater than 800,000 ppm. When you consider that most HFC-227ea systems are designed for concentrations providing 105,000 ppm or less, it is evident that HFC- 227ea is safe to use.

HFC-227ea will decompose to form halogen acids when exposed to extremely high temperatures. The formation of these acids is minimized by using fast-acting Fike detection and control systems, and proper system design and installation of the piping system to deliver the agent quickly. The generation of by-products from the HFC-227ea discharge will be minimal when properly applied.

1.4.4 NOISE

The high-pressure discharge from the nozzle(s) of a system can cause noise that is loud enough to be startling, but ordinarily insufficient to cause traumatic injury.

1.4.5 TURBULENCE

The high velocity discharge from the nozzle(s) can be sufficient enough to dislodge substantial objects located directly in the discharge path. Enough general turbulence may be created within the enclosure to move unsecured paper and light objects.

1.4.6 1.4.6 CHILLING

Direct contact with the vaporizing agent being discharged from the nozzle(s) will have a chilling effect on objects and can cause cryogenic burns to the skin. The liquid phase vaporizes rapidly when mixed with air, thus limiting the hazard to the immediate vicinity of the discharge nozzle.

1.4.7 VISIBILITY

Although HFC-227ea is odorless, discharging the agent into a humid atmosphere may cause a reduction in visibility for a brief period of time due to condensation of water vapor normally present in the room atmosphere.

1.4.8 PRESSURE

The normal operating pressure of a Fike HFC-227ea clean agent extinguishing system unit is 360 psig @ 70^{o}F (24.8 bar @ 21^{o}C). This is accomplished by adding a charge of nitrogen to the HFC-227ea agent. Since these are pressurized vessels, care must be observed when handling, filling and transporting storage containers. The anti-recoil devices (baffle plugs or baffle plates) **MUST** be in place whenever the charged container is removed from the piping network.

1.5 AGENT STORAGE CONTAINERS

The Agent Storage Container is a steel pressure vessel designed to hold the HFC-227ea under pressure until it is discharged. All Fike HFC-227ea Containers are suitable for use at storage temperatures of +32^{o}F to +130^{o}F (0^{o}C to 54.4^{o}C). Each container is manufactured in strict accordance with Department of Transportation / Transport Canada (DOT / TC) regulations and undergoes extensive pressure and leak testing before shipment to the field. All Fike HFC-227ea Containers are shipped from the factory fitted with an anti-recoil device installed in the discharge valve outlet – in accordance with DOT / TC requirements. The anti-recoil device ensures the contents of the pressurized container will be released in a slow, controlled, rate of discharge if the valve is opened during the shipping and handling process. HFC-227ea Containers are filled with agent within the allowable range of 40 lbs/ft^3 to 70 lbs./ft^3 (640 kg/m^3 to 1121 kg/m^3) of container volume in accordance with DOT / TC requirements. All containers are filled in 1 lb. (0.5 kg) increments to the user-specified level defined for each container. Each HFC-227ea container is super-pressurized with dry nitrogen to a working pressure of 360 psig at 70^{o}F (24.8 bar at 21^{o}C) after filling. Fike HFC-227ea Containers are available in twelve different sizes (capacities). Each container includes a discharge outlet valve, fill valve, pressure gauge, mounting bracket or mounting strap(s), agent release module, and provisions for the accessories available for that particular container size and/or style.

The Discharge Outlet Valve is a rupture disc (metal diaphram), pressure operated device that allows the agent to be released from the container and into the protected space via the associated piping network and nozzle(s). The Discharge Outlet Valve can be either welded or threaded to the Agent Storage Container (except for the 125i & 215i containers available with welded valves only).

Activation of the Discharge Outlet Valve is accomplished by one of two methods.

- Standard operation of the valve is accomplished by a Gas Cartridge Actuator (GCA) that produces the pressure wave (energy) necessary to open the valve. The GCA is an electrically operated device that is activated by a signal from the control panel or the optional manual actuator device.

- If the contents of the container are subjected to temperatures exceeding 160^{o}F (71^{o}C), the pressure associated with the thermal expansion of the agent will be sufficient to open the valve automatically.

NOTE: The Discharge Valve also fulfills the pressure relief valve requirements in accordance with DOT regulations.

NOTE: Containers manufactured by Fike for use with HFC-227ea to DOT 4BA requirements can be found in Appendix B.

1.5.1 RUPTURE DISC

The Rupture Disc is the heart of the Fike HFC-227ea Discharge Outlet Valve. Each is manufactured to exacting tolerances and standards by Fike to ensure their reliability and performance. The Rupture Disc is a pre-scored metal membrane formed into a domed shape and scored with four pressure-relief lines across the domed surface at right angles to each other. When the pressure in the container rises to the pre-determined level, the rupture disc will open along the score lines – thus allowing the contents to be released into the piping network. The four segments of the rupture disc “fold back” during discharge to produce the minimum amount of flow restriction possible.

1.5.2 CONTAINERS – 1” (25 mm) VALVE

Containers are available in the following sizes (capacities): 20, 35, 60, and 100 lb. (8.5, 15, 27, and 44 L). Each of these containers utilize a 1” NPT (25 mm) discharge outlet valve, consisting of a 1” (25 mm) rupture disc assembly operated by a Gas Cartridge Actuator (GCA).

All containers are designed and fabricated in accordance with DOT 4BW500 requirements. Containers are also available with dual markings that meet the requirement of both DOT and TC; the associated ratings for these containers are 4BW500/4BWM500.

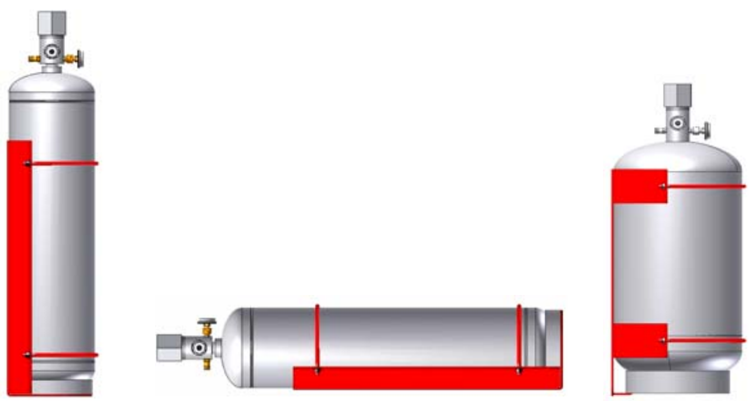
For ordering information, refer to Section 1.9 of this section.

Each container is supplied with a 1” NPT (25 mm) anti-recoil device (pipe plug) installed in the adapter nut (outlet) of the discharge valve. The pipe plug supplied has a 1/8” (4 mm) hole drilled through the plug to allow the container pressure to vent safely to atmosphere in the event that the discharge valve is activated prior to installation.

The 20, 35 and 60 lb. (8.5, 15 and 27 L) containers can be mounted in either the horizontal or upright (valve up) positions.

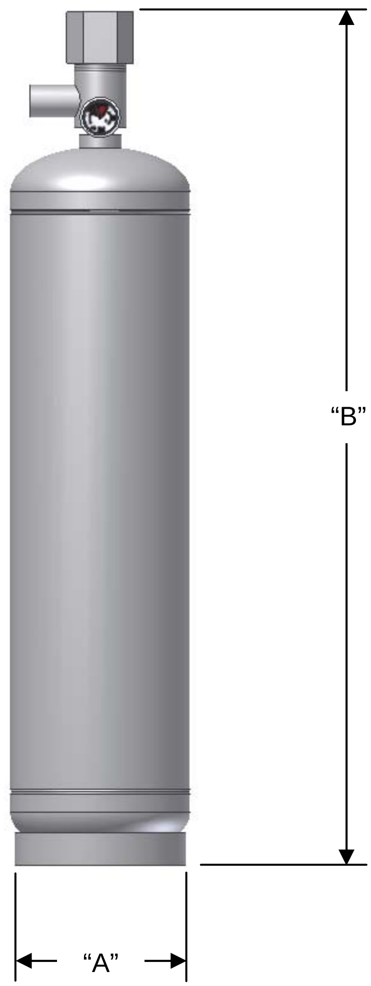
The 100 lb. (44 L) container **MUST** be installed in the upright (valve up) position. Horizontal mounting of the 100 lb. (44 L) container is not allowed. Mounting Brackets are supplied with each container, and each must be anchored to an appropriate load-bearing structure.

NOTE: The 20 lb. (8.5 L) container (P/N 70-098) is approved for **ENGINEERED Systems only**.



CONTAINER DATA TABLES

Container Size	Container Part Number (w/ Welded Valve)	Container Part Number (w/ Threaded Valve)	Fill Range lbs. (kg)	Mounting Position	Valve Size	Approx. Tare Weight
20 lb. (8.5 L)	70-098	70-098T	12.0 – 21.0 (5.5 – 9.5)	Upright - Horizontal	1” NPT (25 mm)	21.0 lbs. (9.5 kg)
35 lb. (15 L)	70-089	70-089T	22.0 – 38.0 (10.0 – 17.0)	Upright - Horizontal	1” NPT (25 mm)	31.0 lbs. (14.1 kg)
60 lb. (27 L)	70-152	70-152T	39.0 – 68.0 (18.0 – 30.5)	Upright - Horizontal	1” NPT (25 mm)	43.0 lbs. (19.5 kg)
100 lb. (44 L)	70-153	70-153T	63.0 – 108.0 (28.5 – 48.5)	Upright (Valve Up)	1” NPT (25 mm)	61.0 lbs. (27.7 kg)



Container Size	Dimension "A"	Dimension "B"	
		Container w/ Welded Valve	Container w/ Threaded Valve
20 lb. (8.5 L)	7" (178 mm)	21-1/2" (546 mm)	23-1/2" (597 mm)
35 lb. (15 L)	7" (178 mm)	32-1/2" (826 mm)	35" (889 mm)
60 lb. (27 L)	10-3/4" (273 mm)	28" (711 mm)	29-1/4" (743 mm)
100 lb. (44 L)	10-3/4" (273 mm)	38-3/4" (984 mm)	40-3/4" (1035 mm)

NOTE: All dimensions shown are approximate

1.5.3 CONTAINERS w/ 2 ½" (65 mm) VALVE

Inverted (Spherical) HFC-227ea Containers are available in the following sizes (capacities): 125 and 215 lb. (51 and 90 L). Both of these containers utilize 2-1/2" NPT (65 mm) discharge outlet valves, consisting of 2-1/2" (65 mm) rupture discs operated by Gas Cartridge Actuators.

All containers are designed and fabricated in accordance with DOT requirements. The associated rating is 4BA500.

Containers are also available with dual markings that meet the requirement of both DOT and TC; the associated ratings for these containers are 4BA500/4BAM500.

For ordering information, refer to Section 1.9 of this section.

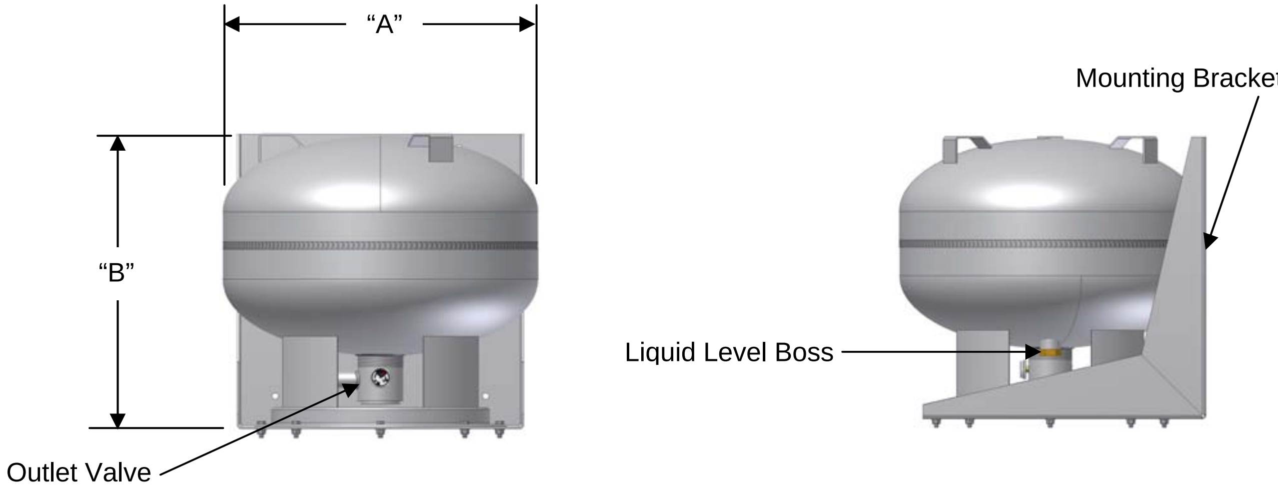
Each container is supplied with 2-1/2" (65 mm) anti-recoil devices consisting of a steel baffle plate with a 3/8" dia. (10 mm) hole drilled through the plate. This allows the container pressure to safely vent to atmosphere if the discharge valve is activated prior to installation. The baffle plate is installed in the Grooved Coupling attached to the discharge outlet valve.

The 125 and 215 lb. (51 and 90 L) Inverted Containers **MUST** be installed in the valve down (inverted) position. Mounting Brackets are supplied with each container, and each must be anchored to an appropriate load-bearing structure.

Both containers are equipped with a Liquid Level Indicator Boss to install the optional Liquid Level Indicator. This device must be installed prior to filling the container with HFC-227ea agent.

CONTAINER DATA TABLES

Container Size	Container Part Number	Fill Range (lbs.)	Mounting Position	Valve Size	Approx. Tare Weight
125 lb. (51 L)	70-041	73 – 126 (33.5 – 57)	Inverted (Valve Down)	2-1/2" NPT (65 mm)	141.0 lbs. (64.0 kg)
215 lb. (90 L)	70-077	128 – 223 (58.5–101.0)	Inverted (Valve Down)	2-1/2" NPT (65 mm)	200.0 lbs. (90.7 kg)



Container Size	Dim. "A" inch (mm)	Dim. "B" inch (mm)
125 lb. (51 L)	20" (508 mm)	20-1/4" (515 mm)
215 lb. (90 L)	24" (610 mm)	23-3/4" (605 mm)

*All dimensions shown are approximate

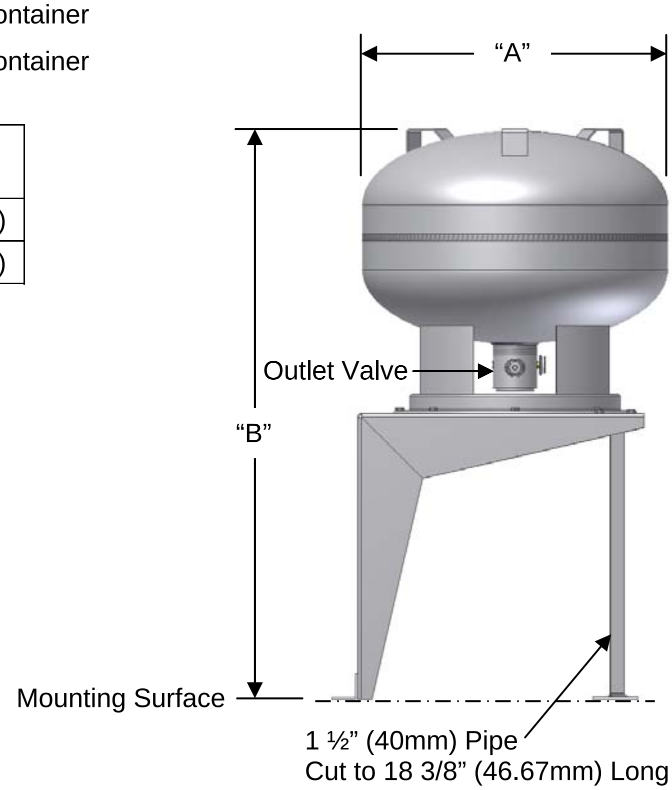
1.5.3.1 FLOOR MOUNTING KIT

An optional Floor Mounting Kit is available for the Inverted Containers that allows the container to be mounted near the floor. Two kits are available as follows:

- P/N 70-1197 Mounting Bracket – 125 lb. (51 L) Container
- P/N 70-1198 Mounting Bracket – 215 lb. (90 L) Container

Container Size	Dim. "A" inch (mm)	Dim. "B" inch (mm)
125 lb. (51 L)	22-1/2" (572)	39-3/4" (1010)
215 lb. (90 L)	26-1/4" (667)	45-3/4" (1162)

All dimensions shown are approximate



1.5.4 CONTAINERS W/ 3" (80 mm) VALVES

Large capacity HFC-227ea Containers are available in the following sizes (capacities): 215, 375, 650 and 1000 lb. (87, 153, 267 and 423 L). Each of these containers utilize a 3" NPT (80 mm) discharge outlet valve, consisting of a 3" (80 mm) rupture disc assembly operated by a Gas Cartridge Actuator (GCA).

All containers are designed and fabricated in accordance with DOT requirements. The associated rating is 4BW500.

Containers are also available with dual markings that meet the requirement of both DOT and TC; the associated rating for these containers is 4BW500/4BWM500.

For ordering information, refer to Section 1.9 of this section.

Each container is supplied with a 3" (80 mm) anti-recoil device consisting of a steel baffle plate with a 1/2" dia. (13 mm) hole drilled through the plate. This allows the container pressure to safely vent to atmosphere if the discharge valve is activated prior to installation. The baffle plate is installed in the Grooved Coupling attached to the discharge outlet valve.

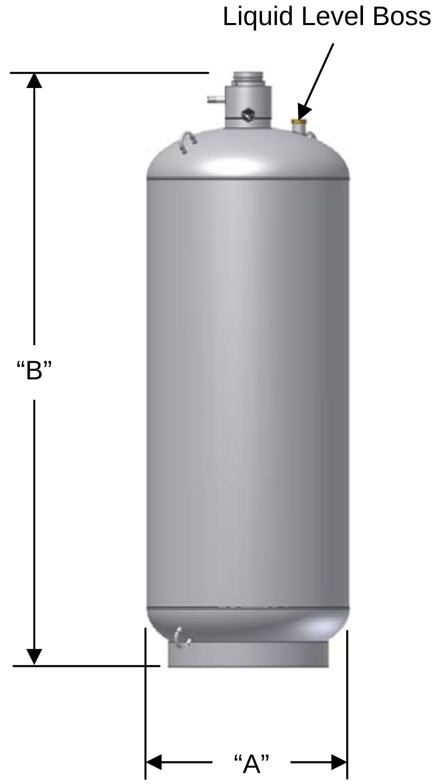
All Large Capacity HFC-227ea Containers **MUST** be installed in the upright (valve up) position on the floor. Mounting Straps are supplied with each container, and each must be anchored to an appropriate load-bearing structure.

Each Large Capacity HFC-227ea Container is equipped with a Liquid Level Indicator Boss to install the optional Liquid Level Indicator. This device must be installed prior to filling the container with HFC-227ea agent.

CONTAINER DATA TABLES

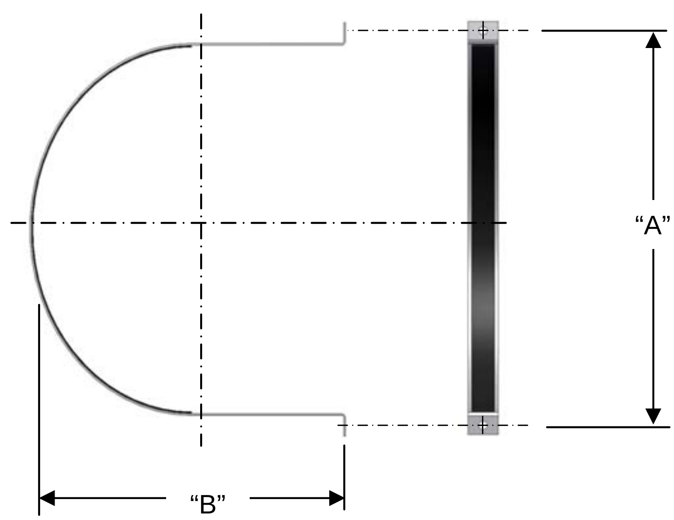
Container Size	**Container Part Number** (w/ Welded Valve)	**Container Part Number** (w/ Threaded Valve)	**Fill Range lbs. (kg)**	**Mounting Position**	**Valve Size**	**Approx. Tare Weight**
215 lb. (87 L)	70-154	70-154T	124.0 – 216.0 (56.5 – 98.0)	Upright (Valve Up)	3" NPT (80 mm)	155.0 lbs. (70.3 kg)
375 lb. (153 L)	70-155	70-155T	217.0 – 378.0 (98.5 – 171.5)	Upright (Valve Up)	3" NPT (80 mm)	225.0 lbs. (102.1 kg)
650 lb. (267 L)	70-156	70-156T	378.0 – 660.0 (171.5 – 299.0)	Upright (Valve Up)	3" NPT (80 mm)	380.0 lbs. (172.4 kg)
1000 lb. (423 L)	70-157	70-157T	598.0 – 1045.0 (271.5 – 474.0)	Upright (Valve Up)	3" NPT (80 mm)	540.0 lbs (244.9 kg)

Container Size	Dim. "A" inch (mm)	Dim. "B" inch (mm)	
		Container w/ Welded Valve	Container w/ Threaded Valve
215 lb. (87 L)	20" (508)	28-7/8" (733)	29-1/4" (743)
375 lb. (153 L)	20" (508)	42-1/2" (1080)	42-1/2" (1080)
650 lb. (267 L)	24" (610)	48-3/4" (1238)	49" (1245)
1000 lb. (423 L)	24" (610)	70" (1778)	71" (1803)



NOTE: All dimensions shown are approximate

1.5.4.1 MOUNTING STRAPS
Mounting Straps are used to secure containers to a wall or other suitable mounting surface. These devices are supplied with each container purchased in accordance with the information shown below.



Part No.	"A"	"B"	Used On	Qty.
70-1310	21-3/4" (552 mm)	19-7/8" (505 mm)	70-154 & 70-155	1
70-1384-W	26" (660 mm)	23-7/8" (606 mm)	70-156 &70-157	1

1.6 ITEMS FURNISHED WITH CONTAINERS

All Fike HFC-227ea Containers are furnished with the following items:

1.6.1 NAMEPLATE

All Fike HFC-227ea Containers are provided with a nameplate that provides the following information that is specific to each container:

- Assembly and serial numbers of the container
- Weight Information: tare, gross and agent
- Installation, operation and safety information

All containers filled at the factory, or at an approved Initial Fill Station, will be provided with a nameplate bearing the UL / ULC and FM markings.

1.6.2 SIPHON TUBE

Siphon Tubes are provided in all HFC-227ea containers that are suitable for mounting in the horizontal and upright (valve up) positions. The purpose of the siphon tube is to ensure the complete dispersal of suppression agent from the container to the protected space(s). Inverted HFC-227ea Containers (P/N 70-041 and 70-077) do not have siphon tubes.

WARNING: **DO NOT** install HFC-227ea Containers with siphon tubes in the inverted (valve down) position. This will result in a system failure due to the majority of the suppression agent remaining in the container after activation.

1.6.3 VICTAULIC COUPLING & NIPPLE

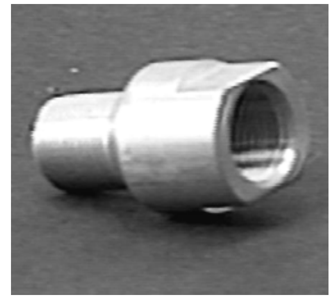
Fike HFC-227ea Containers equipped with 2-1/2" (65 mm) and 3" (80 mm) discharge outlet valves are supplied with a Grooved Coupling and a short (grooved x threaded) nipple to facilitate connection of the container to the discharge piping. For shipping purposes, a baffle plate is inserted into the Grooved Coupling as a safety device (see container section). The baffle plate **MUST** be removed prior to connection to the discharge piping.

	Coupling P/N	Nipple P/N	Nipple Length
2-1/2" (65 mm) Valve	02-1376	02-1388	3" (76 mm)
3" (80 mm) Valve	02-1987	02-2106	4-1/2" (114 mm)

1.6.4 PRESSURE GAUGE

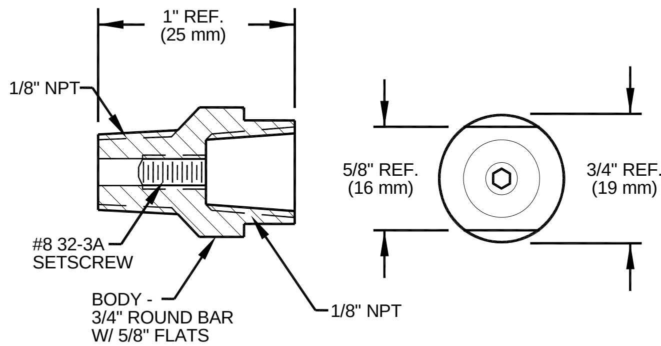
All Fike HFC-227ea Containers are provided with a Pressure Gauge (P/N 02-3594) to indicate the internal container pressure. The Pressure Gauge scale is calibrated to show the actual pressure, as well as a color-coded acceptable operating range, under-pressure range, and over-pressure range.

1.6.5 PRESSURE GAUGE ADAPTER



All Fike HFC-227ea Containers are provided with a Pressure Gauge Adapter (P/N 70-1574) installed in the 1/8” NPT (4 mm) pressure gauge port of the container. This device allows the pressure gauge to be replaced without having to remove the HFC-227ea agent first. The Pressure Gauge Adapter works by allowing a small, controlled amount of leakage past its internal threads. This provides enough “flow” to operate the pressure gauge while being small enough to allow an operator to change the devices on the downstream side safely.

CAUTION: When replacing a gauge on a pressurized container, DO NOT allow the pressure port to remain open (disconnected) for an extended period of time. A significant quantity of HFC-227ea could be lost from the container.

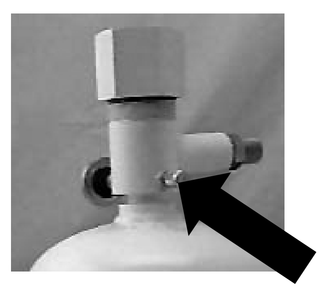


1.6.6 AGENT FILL VALVE

All HFC-227ea Containers are provided with an Agent Fill Valve used to fill (refill) and pressurize the container. The Fill Valve is a brass “Schraeder” type that consists of the following components.

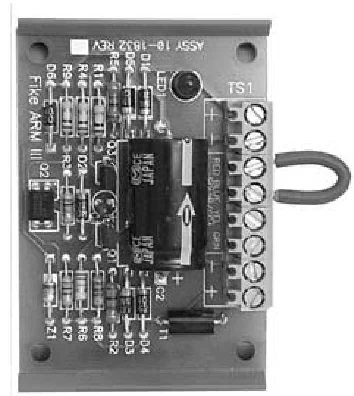
- Valve Body (P/N 02-2406)
- Cap (P/N 02-2407)
- Valve Core (P/N 02-4161)

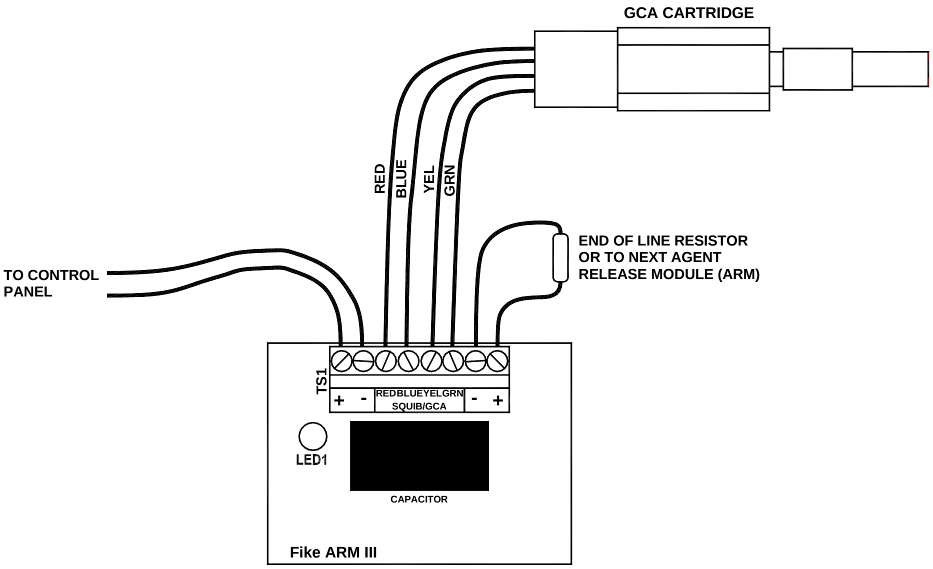
Refer to Fike Recharge/Fill Manual (P/N 06-211) for additional information regarding filling and/or nitrogen pressurization procedures.



1.6.7 AGENT RELEASE MODULE (ARM)

Fike Containers **MUST** utilize an Agent Release Module (P/N 10-1832) to supervise the circuit wiring from the container to the control panel. The ARM also stores the electrical energy needed to actuate the GCA and open the discharge outlet valve. Agent Release Modules are wired in parallel in either a two-wire (Class B), or four-wire (Class A) arrangement with a separate return loop. The ARM provides the means necessary to fully supervise the agent release circuit for open and ground fault conditions.



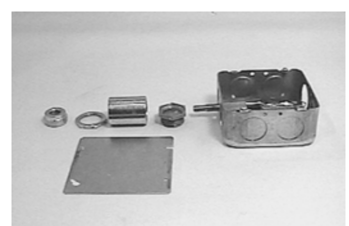


AGENT RELEASE MODULE
P/N 10-1832

1.6.8 MOUNTING HARDWARE FOR GCA & ARM

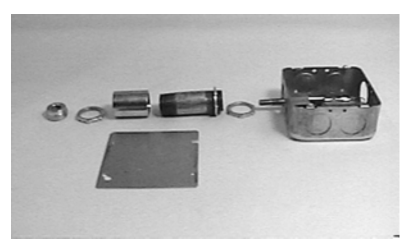
Fike supplies the typical electrical/mounting hardware that can be used for the installation of the GCA and ARM to the Fike discharge valves. For applications requiring longer flex loop connections, rigid pipe connections, etc., the hardware must be supplied by the installing contractor. For installations with 1” (25 mm) and 3” (80 mm) Valves, the following components are supplied:

- 1” x 1/2” (25 mm x 15 mm) Reducing Conduit Bushing
- 1” (25 mm) Lock Nut
- 1” (25 mm) Conduit Coupling
- 1” NPT (25 mm) Chase Nipple
- 4-11/16” (120 mm) Square J-Box w/ 1” NPT (25 mm) knockouts & cover



For installations using 2-1/2” (65 mm) Valves, the following components are supplied:

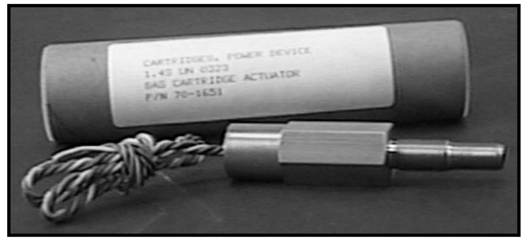
- 1” x 1/2” (25 mm x 15 mm) Reducing Conduit Bushing
- 1” (25 mm) Lock Nut (qty. of 3)
- 1” (25 mm) Conduit Coupling
- 3-1/2” lg. (89 mm) x 1” NPT (25 mm) Pipe Nipple
- 4-11/16” (120 mm) Square J-Box w/ 1” NPT (25 mm) knockouts & cover



The following part numbers can be used to purchase the components listed above for retrofit application:

- GCA Junction Box Assembly for 1” – 3” (25 – 80mm) Valves (P/N 70-1697)
- GCA Junction Box Assembly for 2-1/2” (65mm) Valve (P/N 70-1698)

1.7 GAS CARTRIDGE ACTUATOR (GCA)

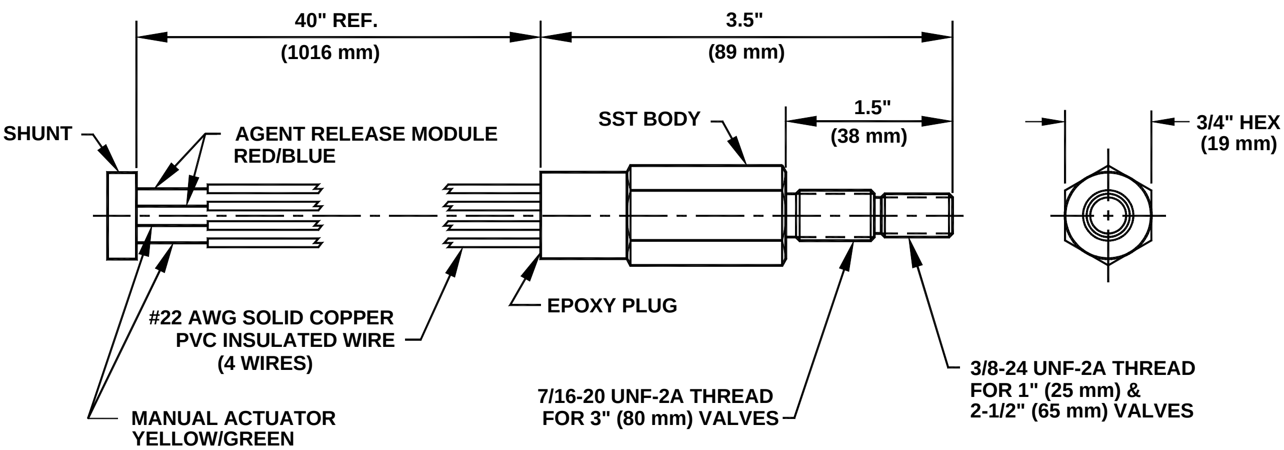


The Gas Cartridge Actuator (P/N 70-1651) is an electrically activated, pressure-producing device used to open the discharge outlet valve on a Fike container. An electrical charge is sent through the device upon activation from the control panel: this overheats the internal bridge wire and ignites the smokeless powder inside the GCA. The resultant burn-off (approximately 10 milliseconds) generates a pressure wave sufficient to burst the rupture disc, thus releasing the agent from the container. The GCA has a stainless steel body with dual thread sizes that enable the device to be installed in any of the container valve sizes. The GCA has a Mylar seal in the discharge end, and an epoxy plug on the wire end to create a "sealed" unit with a de-rated shelf life of 10 years. The GCA will not detonate explosives and it is not considered to be a mass detonating device. Therefore, the GCA has a DOT classification of 1.4, sub-class "S", and a shipping number of UN-0323. GCA's can be transported by any commercial carrier and do not require special handling permits or licensing.

IMPORTANT NOTE: The GCA is **NOT** furnished with the standard container assembly and **MUST** be ordered separately.

WARNING: Both sets of electrical leads (red-to-blue and yellow-to-green) **MUST** be shunted together when the GCA is not installed within the discharge outlet valve, and when testing/troubleshooting the detection and control system. Failure to do so can result in bodily injury or unwanted system activation.

NOTE: The yellow and green leads are provided for Manual Actuator (P/N 10-2225) connections only. Refer to the Installation Section of this manual for the wiring diagrams associated with these devices.



1.8 CONTAINER ACCESSORIES

The following components are optional devices that do not come with the standard HFC-227ea Container assembly and must be ordered separately.

1.8.1 LIQUID LEVEL INDICATOR (LLi)

The Liquid Level Indicator provides a means of verifying the weight of HFC-227ea agent in a container without having to remove the container and weigh it on a calibrated scale. The device enables the inspector to determine the weight of agent with the container safely secured in its installed position. Liquid Level Indicators are available for 100, 125, 215, 375, 650 and 1000 lb. (44, 51, 87, 90, 153, 267 and 423 L) HFC-227ea Containers. Refer to the Liquid Level Indicator Manual (P/N 06-107) for additional information concerning its installation and use.

WARNING: The LLi MUST be installed while the HFC-227ea Container is EMPTY.

Container		Liquid Level Indicator (LLi)
Size lb. (L)	**Part Number**	**Part Number**
Container with Welded Valve		
100 (44)	70-153	70-1353-22
125 (51)	70-041	70-1353-11
215i (90)	70-077	70-1353-15
215 (88)	70-154	70-1353-15
375 (153)	70-155	70-1353-24
650 (267)	70-156	70-1353-38
1000 (423)	70-157	70-1353-44
Container with Threaded Valve		
215 (88)	70-154T	70-1353-18
375 (153)	70-155T	70-1353-27
650 (267)	70-156T	70-1353-38
1000 (423)	70-157T	70-1353-49

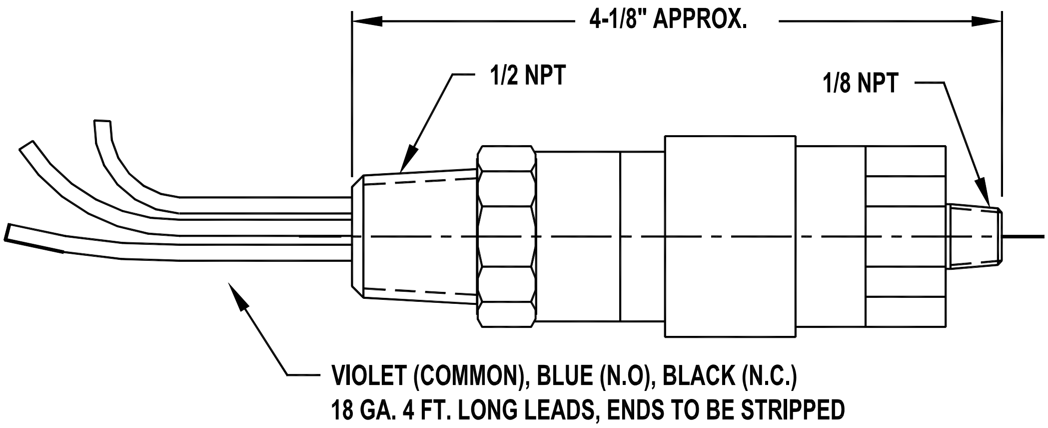
1.8.2 LOW PRESSURE SWITCH

Fike offers an optional Low Pressure Switch for the purpose of continuously monitoring the container pressure for a low-pressure condition. If the pressure inside the container drops below 288 psig (1965 kPa), the switch contacts will transfer and invoke a "trouble" indication on the control panel.

The Low Pressure Switch (P/N 02-9830) has a single pole, double-throw switch that can be wired for normally open or normally closed shelf states.

Specifications:

Temperature Limits:	32 to 130^{o}F (0 to 54.4^{o}C)
Enclosure Classification:	NEMA 4
Contact Rating:	Single pole, double throw; 5 amps resistive, 3 amps inductive @ 30VDC
Body Material:	Aluminum with irridite finish
Weight:	6.5 ounces
Pressure Connection:	1/8" NPT (6 mm)
Electrical Connection:	1/2" NPT (15 mm)
Pressure Setting:	288 psig (20 bar)(decreasing)



1.8.3 RELOAD KITS

After a system discharge, each container valve will need to be reconditioned using the appropriate reload kit before the container can be recharged.

3" RELOAD KIT

2 ½" RELOAD KIT

1" RELOAD KIT

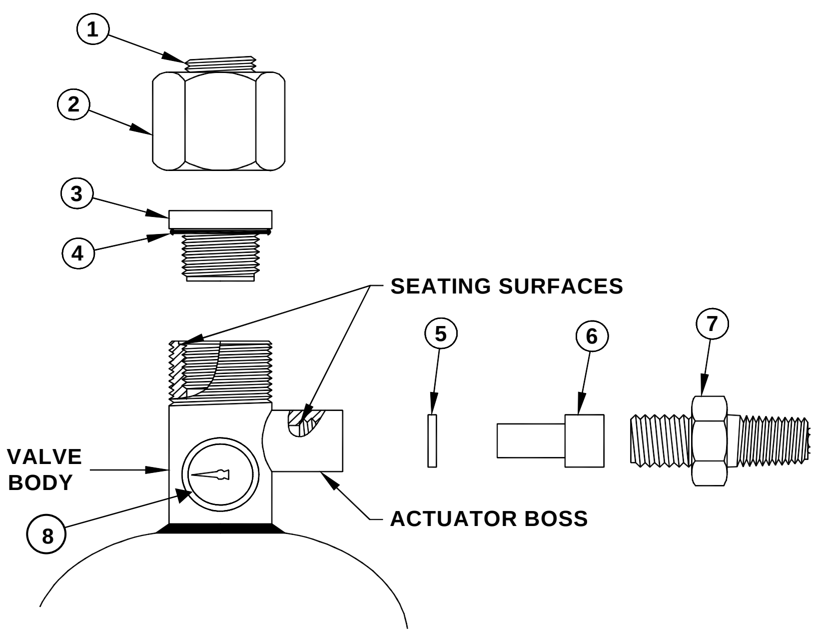
1.8.3.1 RELOAD KIT – 1" VALVE

1" Reload Kit (P/N 85-044-1) is used on the following container sizes: 20, 35, 60, and 100 lb. (8.5, 15, 27 and 44 L). Reload Kit consist of the following items:

RELOAD KIT – 1" VALVE			
ITEM NO.	**PART NO.**	**DESCRIPTION**	**NOTE**
1	80-1046	Baffle Plug	See Note 1
2	80-1034	Adaptor Nut	See Note 1
3	70-1049	Rupture Disc	See Note 2
4	02-1223	O-Ring	See Note 2
5	70-1559	Teflon Washer	See Note 2
6	70-1054	Actuator Housing Assembly	See Note 2
7	70-1044	Retainer Nut	See Note 1
8	02-10279	Pressure Gauge	See Note 2
9	02-4134	Gas Cartridge Actuator (GCA)	See Note 2 (Item not shown)
10	02-4161	Valve Core	See Note 2 (Item not shown)

NOTES: 1. Item furnished with container, not part of 1" Reload Kit, shown for illustration purposes only.

2. Item furnished as part of 1" Reload Kit



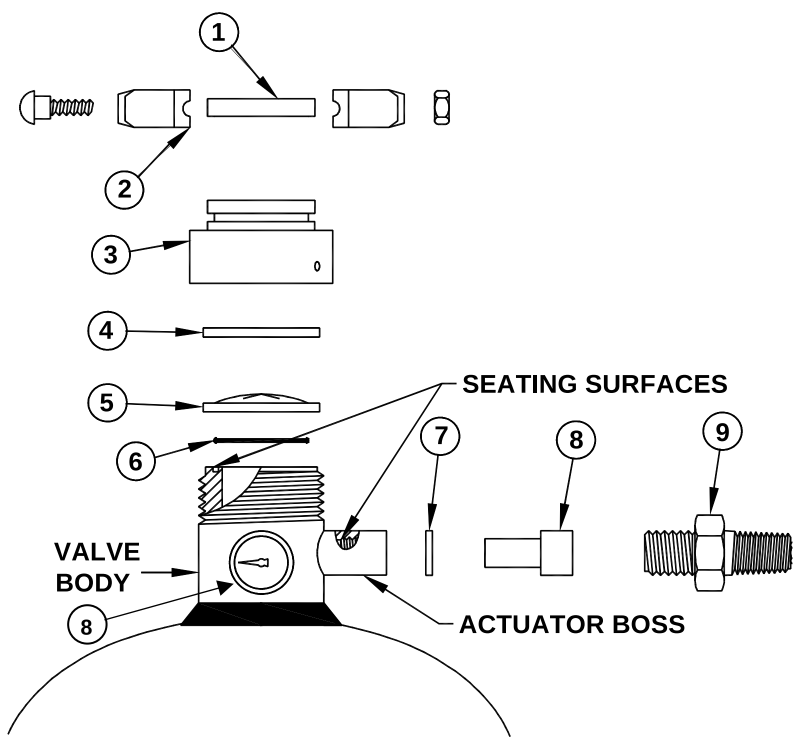
1.8.3.2 RELOAD KIT – 2 1/2" VALVE

2 1/2" Reload Kit (P/N 85-045-1) is used on the following container sizes: 125i and 215i lb. (51 and 90 L). Reload Kit consist of the following items:

RELOAD KIT – 2 1/2" VALVE			
ITEM NO.	**PART NO.**	**DESCRIPTION**	**NOTE**
1	70-1123	Baffle Plate	See Note 1
2	02-1376	Victaulic Coupling (Style No. 77)	See Note 1
3	70-1094	Holddown Nut	See Note 1
4	70-1104	Holddown Ring	See Note 1
5	D1383-1	Rupture Disc	See Note 2
6	02-1375	O-Ring	See Note 2
7	70-1059	Teflon Washer	See Note 2
8	70-1054	Actuator Housing Assembly	See Note 2
9	70-1044	Retainer Nut	See Note 1
10	02-10279	Pressure Gauge	See Note 2
11	02-4134	Gas Cartridge Actuator (GCA)	See Note 2 (Item not shown)
12	02-4161	Valve Core	See Note 2 (Item not shown)

NOTES: 1. Item furnished with container, not part of 2 1/2" Reload Kit, shown for illustration purposes only.

2. Item furnished as part of 2 1/2" Reload Kit.



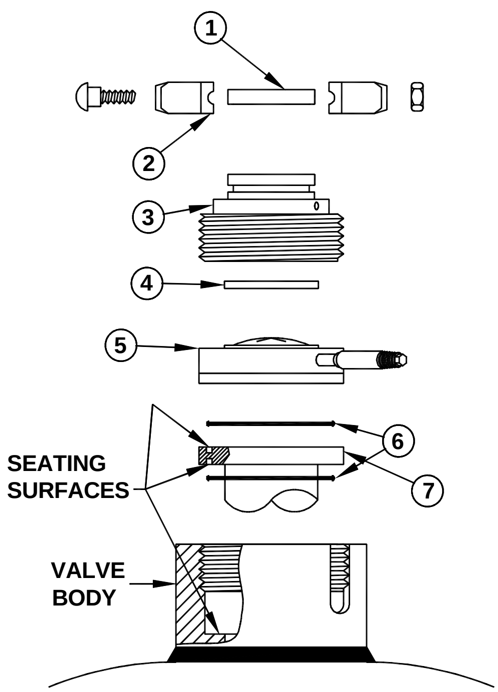
1.8.3.3 RELOAD KIT – 3” VALVE

3” Reload Kit (P/N 85-046-1) is used on the following container sizes: 215, 375, 650, and 1000 lb. (87, 153, 267 and 423 L). Reload Kit consist of the following items:

RELOAD KIT – 3” VALVE			
ITEM NO.	PART NO.	DESCRIPTION	NOTE
1	70-1294	Baffle Plate	See Note 1
2	02-1987	Victaulic Coupling (Style No. 77)	See Note 1
3	70-1393	Holddown Nut	See Note 1
4	70-1331	Holddown Ring	See Note 1
5	70-1661	Rupture Disc	See Note 2
6	02-2114	O-Ring	See Note 2
7	n/a	Siphon Tube Assembly	See Note 1
8	02-10279	Pressure Gauge	See Note 2 (Item not shown)
9	02-4134	Gas Cartridge Actuator (GCA)	See Note 2 (Item not shown)
10	02-4161	Valve Core	See Note 2 (Item not shown)

NOTES: 1. Item furnished with container, not part of 3” Reload Kit, shown for illustration purposes only.

2. Item furnished as part of 3” Reload Kit.



1.9 CONTAINER ORDERING FORMAT

In addition to the basic container part number that identifies the capacity and type of container, there are a series of options that must be defined when placing an order for a Fike Clean Agent Container.

70 – X X X* – X X X X – X X X X – 06

A B C D E F G

A = Basic container part number (i.e. 70-155, 70-041, 70-155 etc.)

* Placing a T after the basic container number indicates the container will be supplied with the discharge valve outlet threaded to the container. Without T indicates the container will be supplied with the discharge valve outlet welded to the container.

EXAMPLES:

70-155 is basic container part number for a 375 lb. container fabricated to meet DOT requirements and the container is stamped with the DOT number.

NOTES:

1) If container being ordered needs to meet Transport Canada (TC) requirements and be dual stamped with appropriate DOT and TC numbers, this requirement must be indicated on your purchase order.

2) Containers are available in the following colors:
   - White
   - CO_2 Red

   This option needs to be indicated on your purchase order.

B = Agent quantity in lbs. (container must be filled in 1 lb. increments)
Agent quantity in kg (container must be filled in 0.5 kg increments)
For “Field Initial Fill”, enter <0000>

C= 0 – Field Initial Fill, container is pressurized to 120 psig with dry nitrogen @ 70^{o}F (8.3 bar @ 21^{o}C)
1 – Factory Fill, container is pressurized to 360 psig with dry nitrogen @ 70^{o}F (24.8 bar @ 21^{o}C)

D = 0 – Pressure Gauge and Liquid Level Indicator required
1 – Pressure Gauge “Only”
2 – Pressure Gauge, Liquid Level Indicator and Low Pressure Switch
3 – Pressure Gauge and Low Pressure Switch

NOTE: LLi is standard on containers with threaded valves (215, 375, 650 & 1000 lb.) LLi is **not** available on the 100 lb. container with threaded valve.

E = 3 – Agent Release Module required for control panel
0 – No ARM, When ordering a replacement container

NOTE: An Agent Release Module is required for each container. Always indicate <3> unless ordering a replacement cylinder.

F = 0 – No Mounting Bracket required
1 – Standard Mounting Bracket required

G = 5 – HFC-227ea

English Units Example: Part Number 70-077-190-1031-05 indicates the following: the customer wants a 70-077, Inverted 215 lb. Container Assembly, factory-filled with 190 lbs. of HFC-227ea, pressurized to 360 psig @ 70^{o}F, with a pressure gauge and liquid level indicator installed, an agent release module, and a standard mounting bracket.

Metric Units Example: Part Number 70-077-086.5-1031-05 indicates the following: the customer wants a 70-077, Inverted 90 L Container Assembly, factory-filled with 86.5 kg of HFC-227ea, pressurized to 24.8 bar @ 21^{o}C, with a pressure gauge and liquid level indicator installed, an agent release module, and a standard mounting bracket.

1.10 DISCHARGE NOZZLES

The Discharge Nozzle is the device that controls the HFC-227ea Agent flow and distributes the agent throughout the protected area. Fike HFC-227ea nozzles are available for either of two system types: Pre-Engineered and Engineered are available in 180^{o} and 360^{o} dispersal patterns.

Fike HFC-227ea Discharge Nozzles are machined from aluminum and anodized with a dull gray finish to prevent corrosion. The nozzles are designed to comply with NFPA 2001 and discharge the agent in ten (10) seconds or less.

NOTE: 180^{o} Nozzles generate a reactive force in the opposite direction from the nozzle orifices. Rigid pipe bracing must be attached to the nozzle drop to counteract the expected movement.

1.10.1 PRE-ENGINEERED DISCHARGE NOZZLES

Pre-Engineered Discharge Nozzles are available in five sizes in either 360^{o} (twelve orifice) or 180^{o} (eleven orifice) configurations, and each has a fixed discharge orifice hole diameter in accordance with the requirements for Pre-Engineered Systems.

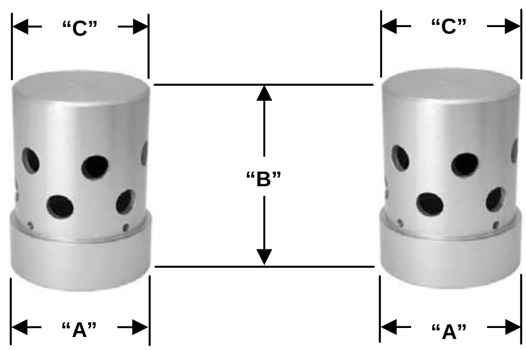
360^{o} Pre-Engineered Nozzles	
Part Number	**Description**
80-052-0625	3/8” (10 mm) Nozzle
80-053-0781	1/2” (15 mm) Nozzle
80-1114	1” (25 mm) Nozzle
80-1116	1-1/2” (40 mm) Nozzle
80-1118	2” (50 mm) Nozzle

180^{o} Pre-Engineered Nozzles	
Part Number	**Description**
80-1113	1” (25 mm) Nozzle
80-1115	1-1/2” (40 mm) Nozzle
80-1117	2” (50 mm) Nozzle

1.10.2 ENGINEERED DISCHARGE NOZZLES

Engineered Discharge Nozzles are available in seven sizes. Nozzle orifice hole diameters are determined by the Fike Engineered Flow Calculation Program……... .

360^o Engineered Nozzles (12 Orifices)				**180^o Engineered Nozzles** (11 Orifices)			
Part Number	**Nozzle Size** (in.-mm)	**Orifice Area** (in^2)		**Part Number**	**Nozzle Size** (in.-mm)	**Orifice Area** (in^2)	
		Minimum	**Maximum**			**Minimum**	**Maximum**
80-052-XXXX	3/8 (10)	0.0423	0.1473	80-060-XXXX	3/8 (10)	0.0388	0.1427
80-053-XXXX	1/2 (15)	0.0618	0.2383	80-061-XXXX	1/2 (15)	0.0639	0.2381
80-054-XXXX	3/4 (20)	0.1069	0.4117	80-062-XXXX	3/4 (20)	0.1103	0.4220
80-055-XXXX	1” (25)	0.1743	0.6669	80-063-XXXX	1” (25)	0.1791	0.6831
80-056-XXXX	1 1/4 (32)	0.3054	1.1414	80-064-XXXX	1 1/4 (32)	0.3037	1.1700
80-057-XXXX	1 1/2” (40)	0.4117	1.6076	80-065-XXXX	1 1/2” (40)	0.4136	1.5378
80-058-XXXX	2 (50)	0.6973	2.6594	80-066-XXXX	2 (50)	0.6831	2.5840



Nozzle Size (NPT-mm)	**“A”** (in.-mm)	**“B”** (in.-mm)	**“C”** (in.-mm)
3/8 (10)	1.25 (32)	1.56 (40)	0.87 (22)
1/2 (15)	1.25 (32)	1.88 (48)	1.00 (25)
3/4 (20)	1.75 (44)	2.19 (56)	1.22 (31)
1 (25)	1.75 (44)	2.50 (64)	1.44 (37)
1-1/4 (32)	2.75 (70)	3.13 (79)	1.80 (47)
1 1/2 (40)	2.75 (70)	3.38 (86)	2.02 (51)
2 (50)	2.75 (70)	3.75 (95)	2.50 (64)

1.10.3 NOZZLE ORDERING FORMAT

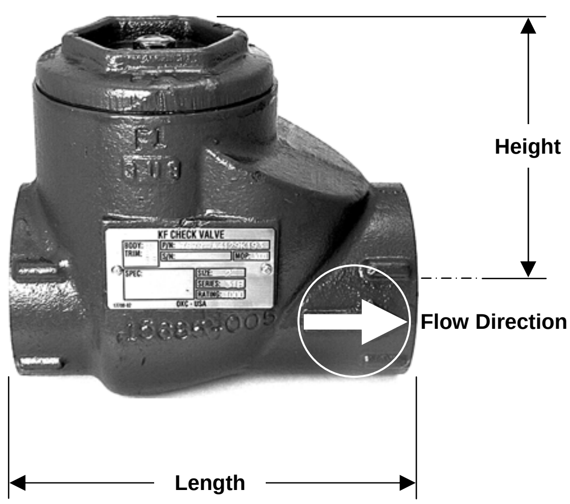
80 – XXX – XXXX **A B**	Orifice hole diameter MUST be specified in addition to the basic part number for the nozzle needed.
A =	Basic nozzle part number (e.g., 80-038 etc.)
B =	Orifice hole diameter (obtained from Engineered Flow Calculation Program)

1.11 CHECK VALVES

Check Valves are required for all HFC-227ea Containers connected in a manifold arrangement. NFPA 2001, Section 2-1.3.5 requires all containers connected to a manifold have an automatic, mechanical, means of preventing agent loss from an open leg of a manifold if the system is activated while a container is removed for maintenance. Therefore, the Check Valves are required for each container in a manifold arrangement.

- 1" NPT (25 mm) Check Valves (P/N 02-2980) are used for manifold arrangements, including connected main-to-reserve systems, that utilize Small Capacity HFC-227ea Containers with the 1" (25 mm) Discharge Outlet Valve.
- 2" NPT (50 mm) Check Valves (P/N 02-4158) are used for manifold arrangements, including connected main-to-reserve systems, that utilize Inverted HFC-227ea Containers with the 2-1/2" (65 mm) Discharge Outlet Valve.
- 3" NPT (80 mm) Check Valves (P/N 02-4157) are used for manifold arrangements, including connected main-to-reserve systems, that utilize Large Capacity HFC-227ea Containers with the 3" (80 mm) Discharge Outlet Valve.

Check Valve Data			Dimensions		Approximate Weight
Part No.	Description	Equivalent Length	Height	Length	
02-2980	1" (25 mm) Check Valve	2 ft. (0.61 m)	3-3/4" (95 mm) (maximum)	4-1/4" (108 mm)	9 lbs. (4.1 kg)
02-4158	2" (50 mm) Check Valve	4 ft. (1.22 m)	4-1/2" (114 mm) (maximum)	6" (152 mm)	12 lbs. (5.4 kg)
02-4157	3" (80 mm) Check Valve	4 ft. (1.22 m)	6" (152 mm)	8" (203 mm)	31 lbs. (14.1 kg)



1.12 CAUTION / ADVISORY SIGNS

Caution / Advisory Signs are provided to comply with NFPA 2001 requirements, and to provide the necessary information to personnel in the area.

1.12.1 "DO NOT ENTER DURING OR AFTER DISCHARGE" SIGN – (P/N 02-10139)

This sign is provided to alert personnel entering the room that the space is protected with an HFC-227ea system. It also alerts personnel not to enter the space during or after a discharge and to keep the doors closed. This sign should be placed on the outside of every door entering/exiting the protected space. The sign is constructed from yellow lexan with black lettering. The sign has the following dimensions: 10" x 13" x 1/16" (254 mm x 356 mm x 16 mm). Each sign is adhesive backed for ease of installation.

1.12.2 "UPON DEVICE ACTIVATION EXIT…" SIGN – (P/N 02-10105)

This sign is provided to explain the presence of notification devices that are located inside the protected space. This sign explains that the HFC-227ea system will soon be discharged if the strobe light is flashing, and appropriate actions should be taken. This sign should be placed at each strobe light location. The sign is constructed from yellow lexan with black lettering. The sign has the following dimensions: 9" x 6" x 1/16" (229 mm x 153 mm x 16 mm). Each sign is adhesive backed for ease of installation.

1.12.3 "UPON DEVICE ACTIVATION DO NOT ENTER…" SIGN – (P/N 02-10138)

This sign is provided to explain the presence of notification devices that are located outside the protected space. This sign explains that the HFC-227ea system has discharged if the strobe light is flashing, and appropriate actions should be taken. This sign should be placed at each strobe light location. The sign is constructed from yellow lexan with black lettering. The sign has the following dimensions: 9" x 6" x 1/16" (229 mm x 153 mm x 16 mm). Each sign is adhesive backed for ease of installation.

1.12.4 "…SYSTEM ABORT- PUSH AND HOLD" SIGN – (P/N 02-10106)

This sign is provided to explain the presence of the Abort button. This sign should be placed at each Abort station. The sign is constructed from red lexan with white lettering. The sign has the following dimensions: 4" x 2-1/4" x 1/16" (102 mm x 51 mm x 16 mm). Each sign is adhesive backed for ease of installation.

1.12.5 "…SYSTEM RELEASE" SIGN – (P/N 02-10137)

This sign is provided to explain the presence of the Manual Release station. This sign should be placed at each station. The sign is constructed from red lexan with white lettering. The sign has the following dimensions: 4" x 2-1/4" x 1/16" (102 mm x 51 mm x 16 mm). Each sign is adhesive backed for ease of installation.

1.12.6 "…SYSTEM MAIN/RESERVE" SIGN – (P/N 02-10107)

This sign is provided to explain the presence of the Main Reserve switch. This sign should be placed at each switch. The sign is constructed from red lexan with white lettering. The sign has the following dimensions: 4" x 2-1/4" x 1/16" (102 mm x 51 mm x 16 mm). Each sign is adhesive backed for ease of installation.

1.13 CONTROL SYSTEM & ACCESSORIES

Fike offers several options to allow the user to interface with the Detection & Control system as needed to suit their specific needs. The following control systems and accessories are considered to be specific to Clean Agent systems, and will be required in various configurations. This is not intended to be a complete reference for the Detection & Control System that will be required. The devices not shown here include detectors (heat & smoke), audio/visual devices, I/O devices, power supplies, etc. Refer to the appropriate Detection & Control Manual for the system and/or device in question for additional information.

1.13.1 CONTROL PANELS

The control panel utilized with a Fike Fire Suppression System MUST be a UL Listed **releasing** device for GCA and/or initiator-operated discharge valves. Fike offers several control panel options, each having both automatic and manual actuation capabilities, and each supplied with battery back-up capabilities.

The following Fike Detection & Control Panels are UL Listed and FM approved for use with Fike Clean Agent Systems:

- SHP Pro
- Cheetah Xi
- Cheetah Xi50

1.13.2 MANUAL ACTUATOR

The Fike Manually Operated Actuator (P/N 10-2225) provides an independent means of operating a Fike Clean Agent System that utilizes GCA's. The unit consists of a manually-operated DC generator and a supervisory module. This device will activate the Clean Agent system without the need for external power or stored energy, thereby providing a fail-safe method of activation. To operate the Manual Actuator, simply pull the break-seal and push the handle up a quarter turn. This action generates the power necessary to activate the GCA..

The Manual Actuator can be used as a stand-alone device, or in conjunction with a detection & control system as a back-up operator. Each unit is capable of activating up to six GCA's each, and the wiring is supervised when the unit is hooked-up to a suitable control panel.

The Manual Actuator is housed in an 11" x 7" x 6" (279 mm x 178 mm x 152 mm) enclosure that should be mounted as close to the containers as possible.

Refer to Fike Manual 06-152 for additional design, installation, and maintenance information for this device.

Note: This device is not FM approved.

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This section of the manual will detail the steps necessary to design a Fike HFC-227ea System. The first part of this chapter will guide the user through the process of analyzing the requirements of the hazard(s) to be protected and determining the amount of agent needed. The balance of the chapter will then address the specific hardware and system design requirements to install the HFC-227ea system.

Fike offers two types of HFC-227ea systems – Pre Engineered and Engineered. Although similar, the designer **MUST** fully understand the differences between the two concepts in order to apply the correct requirements to their project. Therefore, the two concepts are divided into separate sections within this chapter.

The design of the system and its associated piping network **MUST** be verified by performing the calculations outlined in the Pre Engineered or Engineered sections of this chapter prior to installing any HFC-227ea system. Each calculation method has been investigated for specific types of fittings, piping, and inside pipe diameters. If the specified limitations are not maintained, the system may not supply the required quantity of extinguishing agent.

2.1 DETERMINE HAZARD TYPE

The Hazard Type generally falls into one of the three following categories, and sometimes a combination thereof. The designer must be aware of the Hazard Type to determine the correct design concentration, agent quantity, etc. The three Hazard Types are:

- Class “A” (wood, paper, cloth – anything that leaves an ash residue after combustion)
- Class “B” (flammable liquids)
- Class “C” (electrical)

2.2 DETERMINE CONCENTRATION PERCENTAGE

The following is a guideline to be used in determining the proper agent concentration percentage for the hazard(s) being protected. For combinations of fuels (hazard types) the design value for the fuel requiring the greatest concentration **MUST** be used. (Reference: NFPA 2001, Section 3)

2.2.1 CLASS “A” or Class “C” HAZARDS – AUTOMATICALLY ACTIVATED

Systems that incorporate the use of a Detection & Control System for the purpose of automatically discharging the HFC-227ea into the protected space can be designed for a **6.25% concentration**.

2.2.2 CLASS “A” or Class “C” HAZARDS – MANUALLY ACTIVATED

Systems that DO NOT incorporate the use of a Detection & Control System for the purpose of automatically discharging the HFC-227ea into the protected space MUST be designed for a **6.8% concentration**. This is due to the slower activation times that could be expected from a manually activated system and the potential for a larger fire size to be extinguished.

2.2.3 CLASS "B" FLAMMABLE LIQUIDS – AUTOMATICALLY OR MANUALLY ACTIVATED SYSTEMS

Systems that are protecting hazards containing Class B Flammable Liquids **MUST** be designed for the highest concentration required of the specific fuels listed. Therefore, the designer must perform an audit of the hazard space to identify the flammable liquids involved and their associated design concentrations. The fuel that requires the highest concentration shall be the one that determines the design concentration for the hazard.

All Class B Flammable Liquids fire tests were conducted using commercial grade heptane to obtain a design concentration of **8.7%**. Please contact Fike for the design requirements of all other Class B flammable liquids.

2.3 SAFETY RECOMMENDATIONS

The following are safety recommendations as outlined in NFPA 2001, Section 1. The designer must be aware of the occupancy of the hazard(s) being protected as they complete their evaluation of the project and make adjustments or recommendations as necessary.

2.3.1 NORMALLY OCCUPIED SPACES

Protected spaces that are considered to be Normally Occupied (e.g. computer room, clean room, etc.) can be designed for concentrations shown in Table 2.3.1 that correspond to a maximum permitted human exposure time of five (5) minutes.

	Concentration	Exposure Time
	9.0%	5.00 minutes
	9.5%	5.00 minutes
	10.0%	5.00 minutes
LOAEL ➡	10.5%	5.00 minutes
	11.0%	1.13 minutes
	11.5%	0.60 minutes
	12.0%	0.49 minutes

TABLE 2.3.1

2.3.2 NORMALLY NON-OCCUPIED SPACES

Protected spaces that are considered to be Not Normally Occupied (e.g. flammable liquids storage room) can be designed for concentrations above the LOAEL concentration. Where personnel could possibly become exposed, measures shall be taken to limit their exposure to the times shown in Table 2.3.1.

2.3.3 ALL SPACES

In the absence of the information needed to determine the expected exposure times, the following provisions shall apply.

- Where egress takes longer than 30 seconds, but less than 1 minute, the design concentration **CANNOT** exceed **10.5%** by volume.
- Concentrations exceeding **10.5%** by volume are permitted only in areas that are not normally occupied by personnel – provided that personnel in the area can escape the area in 30 seconds. No unprotected personnel shall enter the area during agent discharge.

2.4 DETERMINE AGENT QUANTITY

The following steps are necessary to determine the amount of HFC-227ea needed to protect the hazard(s).

2.4.1 DETERMINE THE HAZARD VOLUME

The first step in designing the HFC-227ea system is to determine the volume of the space(s) being protected. The volume is calculated by multiplying the length x width x height of the space. Sometimes it is necessary to divide the protected space into smaller segments due to the configuration of the space. Each smaller segment is then added together to determine the total volume.

As a general rule, the volume used to calculate the quantity of HFC-227ea required should be based on the empty (gross) volume. Additional considerations include:

- The volume taken by solid, non-permeable, and non-removable objects can be deducted from the protected volume
- Any volume that is open to the space being protected must be added (i.e. non-dampered ductwork, uncloseable openings, etc.)

NOTE: Any object that can be removed from the protected space **CANNOT** be deducted from the volume.

2.4.2 CALCULATE AGENT REQUIRED

The next step in designing the HFC-227ea system is to determine the base quantity of agent required to provide the desired concentration within the hazard(s) being protected. This calculation must be based upon two important criteria: the lowest expected ambient temperature and the design concentration as discussed in paragraphs 2.2.1, 2.2.2 and 2.2.3.

To determine the agent quantity needed to produce the design concentration level, the Hazard Volume is multiplied by the factors as determined in the formula below. (Reference: NFPA 2001, Section 3)

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

Where:

W = Agent Weight in lbs. (kg)

V = Hazard Volume / ft^3 (m^3)

C = Design Concentration, % by volume

S = Specific Vapor in ft^3/lb (m^3/kg)

$S = k1 + k2\ (t)$

Where: k1 = 1.8850, k2 = 0.0046(t), t = temperature (^{o}F)

or k1 = 0.1269, k2 = 0.0005(t), t = temperature (^{o}C)

NOTE: The equation to calculate S is an approximation. Tables A-3-5.1(k) and A-3-5.1(l) in NFPA 2001 should be used when calculating the amount of agent for a specific volume.

NOTE: As an alternative, the tables on the next page have been compiled to make it an easier process for the system designer. The information provided is derived from the formulas shown above.
(Reference: NFPA 2001, Tables A-3-5.1(k) and (l))

Temp. T (°F)[c]	Specific Vapor Volume s (ft³/lb)[d]	Weight Requirements of Hazard Volume, W/V (lb/ft³)[b] (English Units)									
		HFC-227ea Design Concentration (% by Volume)[e]									
		6	6.25	6.5	6.8	7	8	9	10	11	12
10	1.9264	0.0331	0.0346	0.0361	0.0379	0.0391	0.0451	0.0513	0.0577	0.0642	0.0708
20	1.9736	0.0323	0.0338	0.0352	0.0370	0.0381	0.0441	0.0501	0.0563	0.0626	0.0691
30	2.0210	0.0316	0.0330	0.0344	0.0361	0.0372	0.0430	0.0489	0.0550	0.0612	0.0675
40	2.0678	0.0309	0.0322	0.0336	0.0353	0.0364	0.0421	0.0478	0.0537	0.0598	0.0659
50	2.1146	0.0302	0.0315	0.0329	0.0345	0.0356	0.0411	0.0468	0.0525	0.0584	0.0645
60	2.1612	0.0295	0.0308	0.0322	0.0338	0.0348	0.0402	0.0458	0.0514	0.0572	0.0631
70	2.2075	0.0289	0.0302	0.0315	0.0331	0.0341	0.0394	0.0448	0.0503	0.0560	0.0618
80	2.2538	0.0283	0.0296	0.0308	0.0324	0.0334	0.0386	0.0439	0.0493	0.0548	0.0605
90	2.2994	0.0278	0.0290	0.0302	0.0317	0.0327	0.0378	0.0430	0.0483	0.0538	0.0593
100	2.3452	0.0272	0.0284	0.0296	0.0311	0.0321	0.0371	0.0422	0.0474	0.0527	0.0581
110	2.3912	0.0267	0.0279	0.0291	0.0305	0.0315	0.0364	0.0414	0.0465	0.0517	0.0570
120	2.4366	0.0262	0.0274	0.0285	0.0299	0.0309	0.0357	0.0406	0.0456	0.0507	0.0560
130	2.4820	0.0257	0.0269	0.0280	0.0294	0.0303	0.0350	0.0398	0.0448	0.0498	0.0549
140	2.5272	0.0253	0.0264	0.0275	0.0289	0.0298	0.0344	0.0391	0.0440	0.0489	0.0540
150	2.5727	0.0248	0.0259	0.0270	0.0284	0.0293	0.0338	0.0384	0.0432	0.0480	0.0530
160	2.6171	0.0244	0.0255	0.0266	0.0279	0.0288	0.0332	0.0378	0.0425	0.0472	0.0521
170	2.6624	0.0240	0.0250	0.0261	0.0274	0.0283	0.0327	0.0371	0.0417	0.0464	0.0512
180	2.7071	0.0236	0.0246	0.0257	0.0270	0.0278	0.0321	0.0365	0.0410	0.0457	0.0504
190	2.7518	0.0232	0.0242	0.0253	0.0265	0.0274	0.0316	0.0359	0.0404	0.0449	0.0496
200	2.7954	0.0228	0.0238	0.0249	0.0261	0.0269	0.0311	0.0354	0.0397	0.0442	0.0488

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

[b] W/V [agent weight requirements (lb/ft³)] = pounds of agent required per ft³ of protected volume needed to produce the indicated concentration at the temperature specified.

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

[d] s [specific volume (ft³/lb)] = specific volume of superheated HFC-227ea vapor can be approximated by the formula: $s = 1.8850 + 0.0046(t)$

[e] C [concentration (%)] = volumetric concentration of HFC-227ea in air at the temperature indicated.

Temp. t (°C)[c]	Specific Vapor Volume s (m^3/kg)[d]	Weight Requirements of Hazard Volume, W/V (kg/m^3)[b] (Metric Units)									
		HFC-227ea Design Concentration (% by Volume)[e]									
		6	6.25	6.5	6.8	7	8	9	10	11	12
-10	0.1215	0.5254	0.5487	0.5722	0.6005	0.6196	0.7158	0.8142	0.9147	1.0174	1.1225
-5	0.1241	0.5142	0.5372	0.5602	0.5879	0.6064	0.7005	0.7967	0.8951	0.9957	1.0985
0	0.1268	0.5034	0.5258	0.5483	0.5754	0.5936	0.6858	0.7800	0.8763	0.9748	1.0755
5	0.1294	0.4932	0.5152	0.5372	0.5638	0.5816	0.6719	0.7642	0.8586	0.9550	1.0537
10	0.1320	0.4834	0.5051	0.5267	0.5527	0.5700	0.6585	0.7490	0.8414	0.9360	1.0327
15	0.1347	0.4740	0.4949	0.5161	0.5417	0.5589	0.6457	0.7344	0.8251	0.9178	1.0126
20	0.1373	0.4650	0.4856	0.5063	0.5314	0.5483	0.6335	0.7205	0.8094	0.9004	0.9934
25	0.1399	0.4564	0.4765	0.4969	0.5215	0.5382	0.6217	0.7071	0.7944	0.8837	0.9750
30	0.1425	0.4481	0.4678	0.4879	0.5120	0.5284	0.6104	0.6943	0.7800	0.8676	0.9573
35	0.1450	0.4401	0.4598	0.4794	0.5032	0.5190	0.5996	0.6819	0.7661	0.8522	0.9402
40	0.1476	0.4324	0.4517	0.4710	0.4943	0.5099	0.5891	0.6701	0.7528	0.8374	0.9240
45	0.1502	0.4250	0.4439	0.4628	0.4858	0.5012	0.5790	0.6586	0.7399	0.8230	0.9080
50	0.1527	0.4180	0.4366	0.4553	0.4778	0.4929	0.5694	0.6476	0.7276	0.8093	0.8929
55	0.1553	0.4111	0.4293	0.4476	0.4698	0.4847	0.5600	0.6369	0.7156	0.7960	0.8782
60	0.1578	0.4045	0.4225	0.4405	0.4624	0.4770	0.5510	0.6267	0.7041	0.7832	0.8641
65	0.1604	0.3980	0.4156	0.4334	0.4549	0.4694	0.5423	0.6167	0.6929	0.7707	0.8504
70	0.1629	0.3919	0.4092	0.4268	0.4479	0.4621	0.5338	0.6072	0.6821	0.7588	0.8371
75	0.1654	0.3859	0.4031	0.4203	0.4411	0.4550	0.5257	0.5979	0.6717	0.7471	0.8243
80	0.1679	0.3801	0.3971	0.4140	0.4346	0.4482	0.5178	0.0589	0.6617	0.7360	0.8120
85	0.1704	0.3745	0.3912	0.4080	0.4282	0.4416	0.5102	0.5803	0.6519	0.7251	0.8000
90	0.1730	0.3690	0.3854	0.4018	0.4217	0.4351	0.5027	0.5717	0.6423	0.7145	0.7883

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

[b] W/V [agent weight requirements (kg/m^3)] = pounds of agent required per m^3 of protected volume needed to produce the indicated concentration at the temperature specified.

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

[d] s [specific volume (m^3/kg)] = specific volume of superheated HFC-227ea vapor can be approximated by the formula: s = 0.1269 + 0.0005(t)

[e] C [concentration (%)] = volumetric concentration of HFC-227ea in air at the temperature indicated.

2.4.3 ADDITIONAL CONSIDERATIONS

Additional quantities of agent are required through the use of design factors to compensate for special conditions that may affect the ability of the system to extinguish the fire. Therefore, additional agent may be necessary for either of the following situations: NFPA 2001 Tee Design Factor or altitude adjustments. The system designer **MUST** be aware of these criteria and make adjustments as necessary.

2.4.3.1 TEE DESIGN FACTOR

Where a single agent supply is used to protect multiple hazards, a design factor must be applied in accordance with NFPA 2001, Section 3.

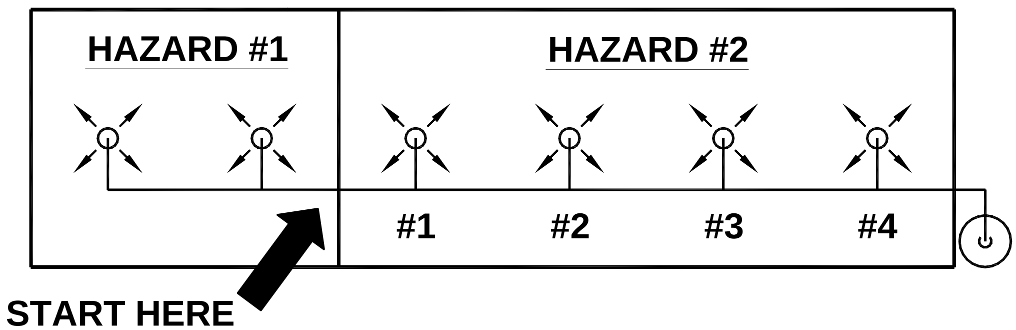
Tee Design Factors (NFPA 2001, Table 3-5.3.1)	
Tee Count	**Design Factor**
0 - 4	0.00
5	0.01
6	0.02
7	0.03
8	0.04
9	0.05
10	0.06
11	0.07
12	0.07
13	0.08
14	0.09
15	0.09
16	0.10
17	0.11
18	0.11
19	0.12

The Tee Design Factor is determined for each hazard protected in accordance with the following.

- Starting from the point where the piping enters the hazard that is located farthest (hydraulically) from the supply tank(s), count the number of tees in the direct flow path as it returns to the supply tank(s). Do Not include the tees that are used in the manifold (if applicable).
- Any tee within the hazard that supplies agent to another hazard shall be included in the tee count.
- After counting the tees, compare that number to the chart above to determine the Tee Design Factor.
- Apply the Tee Design Factor to the Agent Quantity calculations by multiplying the Tee Design Factor by the amount of agent previously determined in the volumetric calculations.

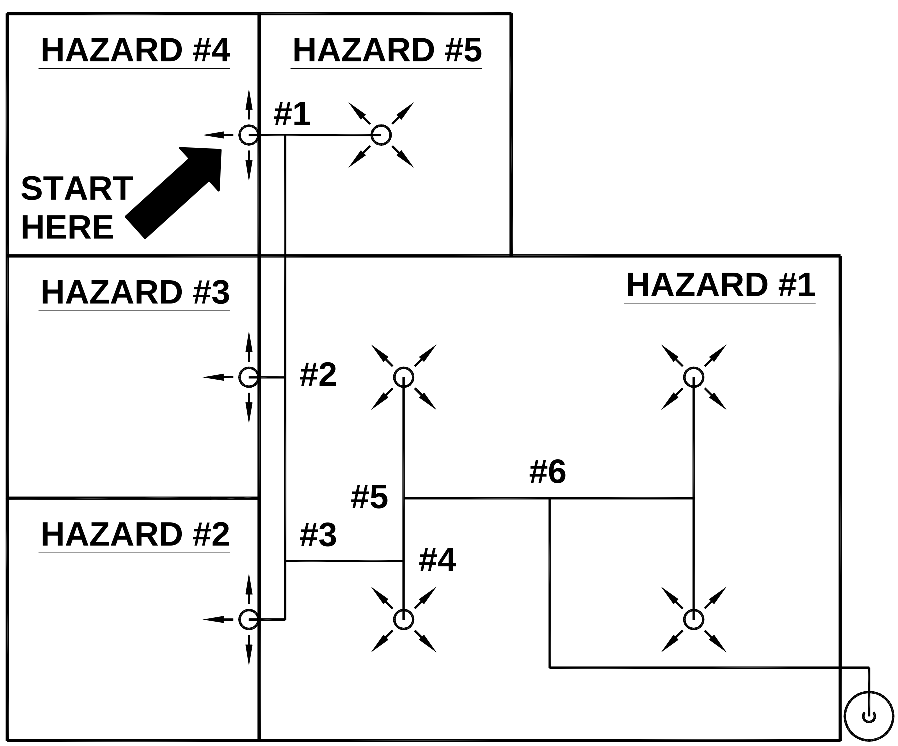
NOTE: If you are not sure which hazard is farther away, count the tees in the flow path from each hazard and use the highest number.

Example No. 1: This example shows a simple, two hazard application. Starting at the point where the piping enters the hazard that is farthest away (hydraulically) from the container, count the number of tees leading back to the supply container.



With a tee count of four (4), refer to the Tee Design Factor Table and determine the multiplier required. With this quantity, an additional 0% (0.00) of agent is required. Therefore, the base quantity of agent calculated is correct.

Example No. 2: This example shows a multi-hazard area arrangement. Starting at the point where the piping enters the hazard farthest away, count the number of tees leading back to the supply container. If you are not sure which hazard is the farthest away, count each hazard and use the highest number.



With a tee count of six (6), refer to the Tee Design Factor Table and determine the multiplier required. With this quantity, an additional 2% (0.02) of agent is required. Therefore, the base quantity of agent is multiplied by 1.02 (2%) to determine the adjusted quantity of agent required.

2.4.3.2 ALTITUDE CORRECTION FACTORS

The design quantity of HFC-227ea shall be adjusted to compensate for ambient pressures that vary more than eleven percent [equivalent to approximately 3000 ft. (915 m) of elevation change] from standard sea level pressures [29.92 in. Hg at 70^{o}F]. (Reference: NPFA 2001, Section 3-5.3.3, 2000 edition)

The amount of agent required must be adjusted using the correction factors shown below to compensate for these effects. (Reference: NFPA 2001, Table 3-5.3.3)

Altitude		Enclosure Pressure		Correction Factor
Feet	Kilometers	psia	mm Hg	
-3,000	-0.92	16.25	840	1.11
-2,000	-0.61	15.71	812	1.07
-1,000	-0.30	15.23	787	1.04
0	0.00	14.71	760	1.00
1,000	0.30	14.18	733	0.96
2,000	0.61	13.64	705	0.93
3,000	0.91	13.12	679	0.89
4,000	1.22	12.58	650	0.86
5,000	1.52	12.04	622	0.82
6,000	1.83	11.53	596	0.78
7,000	2.13	11.03	570	0.75
8,000	2.45	10.64	550	0.72
9,000	2.74	10.22	528	0.69
10,000	3.05	9.77	505	0.66

2.4.3.3 DETERMINE ACTUAL CONCENTRATION AT MAXIMUM TEMPERATURE

The next step is to determine the expected concentration level at the maximum temperature for the hazard(s). This is a necessary step when designing systems for occupied spaces in order to properly evaluate the exposure and egress time limitations discussed in Section 2.3.

The expected concentration can be determined by applying the following formula.

$$C = \frac{100WS}{V + WS}$$

Where:

W = Agent Weight in lbs. (kg)

V = Hazard Volume / ft^3 (m^3)

C = Design Concentration, % by volume

S = Specific Vapor in ft^3/lb (m^3/kg)

Refer to Section 2.4.2 of this Manual for determining the S value.

2.4.3.4 LEAKAGE

The physical characteristics of the protected space(s) must be taken into consideration when designing a HFC-227ea system. The area of uncloseable openings must be kept to a minimum to prevent loss of agent into adjacent areas – thus reducing the effectiveness of the system to extinguish a fire. Simply adding more agent is neither practical, nor effective. Therefore, all openings must be sealed or equipped with automatic closures.

Forced-air ventilating systems shall be shut down or closed automatically where their continued operation would adversely affect the ability of the system to extinguish a fire. Completely self-contained recirculating ventilation systems are not required to be shutdown, but recommended. Dampers should be of the "low smoke" or 100% closing type to ensure an adequate seal and prevent leakage. Where the ventilation system is not shutdown or dampered, the volume of the associated ductwork and ventilation unit(s) shall be considered as part of the total hazard volume when determining the amount of agent needed.

All enclosures must be sealed in order to achieve and maintain the desired concentration for a period of time that is sufficient for emergency personnel to respond. Under normal circumstances, the agent will extinguish the fire rapidly, thereby limiting the potential for fire damage and the creation of dangerous products of decomposition. Therefore, it is critical that the protected space is constructed to prevent any leakage from the protected space(s).

The general guidelines for controlling leakage from the hazard are as follows:

- Doors – All doors entering and/or exiting from the perimeter of the protected space(s) should have drop seals on the bottom, weather-stripping around the jams, latching mechanisms and door closure hardware. In addition, double doors should have a weather-stripped astragal to prevent leakage between the doors, and a coordinator to assure the proper sequence of closure. Doors that cannot be kept normally closed shall be equipped with door closure hardware and magnetic door holders that will release the door(s) upon a system alarm.
- Ductwork – All ductwork leading into, or out of, the protected space(s) should be isolated with sealed, "low smoke" dampers. Dampers should be spring-loaded or motor-operated to provide 100% air shutoff upon activation.
- Air Handling/Ventilation – It is recommended that all air handling/ventilation units be shutdown upon alarm to prevent leakage into other areas. If the air handling unit(s) cannot be shutdown, the volume of the associated ductwork must be added to the total volume of the protected space, and agent must be added to compensate for the additional volume.
- Penetrations – All holes, cracks, gaps or penetrations of the perimeter walls defining the hazard area(s) must be sealed. Less obvious areas of leakage include wire trays, pipe chases, and floor drains. Make certain that floor drains have traps filled with a non-evaporating product to prevent leakage.
- Walls – All perimeter walls that define the hazard area(s) should extend slab-to-slab, and each should be sealed top and bottom on the interior side. Where walls do not extend slab-to-slab, bulkheads will have to be installed to achieve the desired sealing characteristics.
- Block Walls – Porous block walls must be sealed or the HFC-227ea agent will leak through.

A room integrity fan pressurization test is an accepted means of determining how long the protected space will hold the agent (concentration) after a discharge. In conjunction with testing the integrity of the room, the test has a program that predicts the performance of the HFC-227ea system so that the Authority Having Jurisdiction can determine if the system has been designed and installed properly.

The room integrity fan pressurization test must be performed in accordance with the manufacturer's requirements, and NFPA 2001, Appendix C.

2.5 SYSTEM DESIGN CONCEPT

The distribution of HFC-227ea agent to the protected area(s) may be accomplished through one, or more, of the following piping distribution methods:

- Pre-Engineered System
- Engineered System
- Modular System (Pre-Engineered or Engineered)
- Central Storage System (Pre-Engineered for Engineered)

The method used may depend on several factors including: installation time, the quantity of agent involved, economic factors, number of hazard areas, available space for placement of storage containers and customer preferences. Larger projects may require more than one method to address the challenges presented. Therefore, the designer should be familiar with each of these methods, and the advantages and disadvantages of each for any particular application.

2.5.1 PRE-ENGINEERED SYSTEMS CONCEPT

Pre-Engineered Systems are simple, balanced-flow configurations that are simple to design and take less time to install. The Pre-Engineered concept minimizes the engineering effort required to design an effective system by utilizing a fixed series of nozzles and a tightly defined set of design criteria. As long as nozzle selection, pipe size, and pipe length limitations are adhered to, computerized flow calculations are not required.

Pre-Engineered Systems can be designed with the containers arranged in modular or central storage configurations as described below. For more information regarding Pre-Engineered Systems design requirements, refer to Section 2, paragraph 2.11.

2.5.2 ENGINEERED SYSTEMS CONCEPT

Engineered Systems are more complex and flexible configurations that enable the designer to create a custom piping network to suit the individual needs of the project. The piping configurations can be balanced or unbalanced, and the flow splits within the system can vary from point to point. This requires a computerized hydraulic flow calculation to model the system and verify its performance in accordance with NFPA 2001 requirements prior to installation. Therefore, this design concept gives the designer a great deal more flexibility to work with, but it will generally take longer to design these systems. In order to perform hydraulic flow calculations you must have a copy of the Fike HFC-227ea Flow Calculation Software Version 3.0, or higher.

Engineered Systems can be designed with the containers arranged in modular, central storage or manifolded arrangements as described below.

2.5.3 MODULAR SYSTEMS

Modular Systems can be defined as a design concept where the containers are located throughout or around the protected area(s). This keeps the discharge piping requirements down to a minimum, but increases the electrical materials necessary to reach each individual container location.

A modular approach is often desirable (or necessary) for larger applications to reduce the amount of piping materials and installation labor necessary to complete the installation. In some instances, this approach will be necessary in order to make the system flow the agent required within the design guidelines identified for an Engineered or Pre-Engineered System.

2.5.4 CENTRAL STORAGE SYSTEMS

Central Storage Systems can be defined as a design concept where the containers are located in one location, and piped to the protected space(s) from this location. This concept often requires more discharge piping, but it decreases the electrical materials necessary to reach the singular container(s) location. This concept may be more difficult to design due to the increased piping runs involved, and the installation labor will tend to be more costly.

However, the installation may be more aesthetically desirable to the customer, and it is generally easier to maintain and service.

2.6 CONTAINER SELECTION

Generally, the selection of containers is determined by the amount of HFC-227ea required vs. the approved fill ranges for the various container sizes. However, additional factors such as the System Design Concept, container storage location, and flow calculation limitations may have an impact on this decision as well.

2.6.1 CONTAINER SIZE AND FILL RANGE

All containers must be filled within the allowable fill range mandated by DOT and UL Standard 2166. The acceptable fill range for these containers is based upon a minimum fill density of 40 lbs./ft^3 (640 kg/m^3) of container volume, to a maximum of 70 lbs./ft^3 (1121 kg/m^3), in 1 lb. (0.5 kg) increments.

PRE-ENGINEERED CONTAINER DATA TABLE

Container Size	Container Part Number	Minimum Fill lbs. (kg)	Maximum Fill lbs. (kg)	Mounting Position
35 lb. (15 L)	70-089 (T)	22 lbs. (10.0 kg)	38 lbs. (17.0 kg)	Upright - Horizontal
60 lb. (27 L)	70-152 (T)	39 lbs. (18.0 kg)	68 lbs. (30.5 kg)	Upright - Horizontal
100 lb. (44 L)	70-153 (T)	63 lbs. (28.5 kg)	108 lbs. (48.5 kg)	Upright - Horizontal
125 lb. (51 L)	70-041 (T)	73 lbs. (33.5 kg)	126 lbs. (57 kg)	Inverted – Valve Down
215 lb. (90 L)	70-077 (T)	128 lbs. (58.5 kg)	223 lbs. (101 kg)	Inverted – Valve Down
215 lb. (87 L)	70-154 (T)	124 lbs. (56.5 kg)	216 lbs. (98.0 kg)	Upright – Floor Mount
375 lb. (153 L)	70-155 (T)	217 lbs. (98.5 kg)	378 lbs. (171.5 kg)	Upright – Floor Mount
650 lb. (267 L)	70-156 (T)	378 lbs. (171.5 kg)	660 lbs. (299.0kg)	Upright – Floor Mount
1000 lb. (423 L)	70-157 (T)	578 lbs. (271.5 kg)	1,045 lbs. (474.0 kg)	Upright – Floor Mount

ENGINEERED CONTAINER DATA TABLE

Container Size	Container Part Number	Minimum Fill lbs. (kg)	Maximum Fill lbs. (kg)	Mounting Position
20 lb. (8.5 L)	70-098 (T)	12 lbs. (5.5 kg)	21 lbs. (9.5 kg)	Upright - Horizontal
35 lb. (15 L)	70-089 (T)	22 lbs. (10.0 kg)	38 lbs. (17.0 kg)	Upright - Horizontal
60 lb. (27 L)	70-152 (T)	39 lbs. (18.0 kg)	68 lbs. (30.5 kg)	Upright - Horizontal
100 lb. (44 L)	70-153 (T)	63 lbs. (28.5 kg)	108 lbs. (48.5 kg)	Upright - Horizontal
125 lb. (51 L)	70-041 (T)	73 lbs. (33.5 kg)	126 lbs. (57 kg)	Inverted – Valve Down
215 lb. (90 L)	70-077 (T)	128 lbs. (58.5 kg)	223 lbs. (101 kg)	Inverted – Valve Down
215 lb. (87 L)	70-154 (T)	124 lbs. (56.5 kg)	216 lbs. (98.0 kg)	Upright – Floor Mount
375 lb. (153 L)	70-155 (T)	217 lbs. (98.5 kg)	378 lbs. (171.5 kg)	Upright – Floor Mount
650 lb. (267 L)	70-156 (T)	378 lbs. (171.5 kg)	660 lbs. (299.0kg)	Upright – Floor Mount
1000 lb. (423 L)	70-157 (T)	578 lbs. (271.5 kg)	1,045 lbs. (474.0 kg)	Upright – Floor Mount

(T) = Container part number with the suffix T indicates container with threaded valve.

2.6.2 CONTAINER LOCATION(S)

The type and location(s) of the storage container(s) is based on several considerations.

1) Agent Quantity – The agent storage container(s) selected must have the capacity to store the total quantity of agent required for the system.
2) System Type – An area might be protected by several smaller containers with independent nozzles, or it might be protected by a large capacity container that is discharged through a piping network of 2, 4, or more nozzles.
3) Extent of Piping – In systems having an unusually large piping system, the pressure drop may be too great for the location or configuration selected. In some cases, it may be necessary to relocate the container(s) closer to the hazard area(s) being protected. It may also be necessary to sub-divide the piping network into smaller configurations with separate containers.
4) Floor Space – Consideration should be given to the space available to install the container. For example, a 1,300 lb. (590 kg) system could be stored in (2) 650 lb. (295 kg) containers located on the floor. However, if floor space is a problem, the system could be designed to utilize (6) 215 lb. (97.5 kg) Inverted Containers mounted on the wall(s).
5) Cost Factors – In the example above, the (2) 650 lb. (295 kg) containers would be less expensive than the (6) 215 lb. (97.5 kg) containers.
6) Serviceability – In general, the larger the container, the more difficult it will be to remove it from the system for maintenance and service. However, smaller containers that are located in a subfloor space, under a computer bank, or above the ceiling over the same computer bank, can be difficult as well.
7) Floor Loading – This factor must be considered when selecting a container location. Excessive floor loading may require relocating the container(s) to a more suitable location.
8) Proximity – HFC-227ea Containers should be located as close as possible to, or within the hazard(s) that they protect.
9) Environmental Effects – Do not locate containers where they would be subject to physical damage, exposure to corrosive chemicals, or harsh weather conditions

2.6.3 STORAGE TEMPERATURE LIMITATIONS

Fike HFC-227ea systems are UL Listed and FM approved for a service temperature range of +32^{o}F to +130^{o}F (0^{o}F to 54^{o}C). However, the system designer should be aware that the computer flow program for Engineered Systems is based on an ambient temperature of 70^{o}F (21^{o}C). Therefore, the container storage temperature range for an Engineered System must be in the 60^{o}F to 80^{o}F (16^{o}C to 27^{o}C) range. At temperatures outside of this range, the system may not supply the desired quantity of agent.

NOTE: Pre-Engineered Systems have been pre-tested and verified for the full operating range of +32^{o}F to + 130^{o}F (0^{o}F to 54^{o}C).

2.7 NOZZLE SELECTION

The selection of nozzles is generally determined by the amount of HFC-227ea required (flow rate) vs. the flow rate capabilities of the nozzle(s). Additional factors such as area coverage, nozzle placement, discharge path obstructions, etc. will have an impact on this decision as well.

2.7.1 SYSTEM TYPE

The system designer must take into account the type of system to be used. For Pre-Engineered Systems, a balanced flow pattern is required. Therefore, the system is limited to a single nozzle, two nozzle, or four nozzle configuration. For Engineered Systems, multiple nozzle, flow rate, pipe size, and tee split variations are possible.

2.7.2 NOZZLE FLOW RATES

All HFC-227ea Systems are required to discharge the agent into the protected space within a 6-to-10 second time window. Therefore, the number of nozzles provided for any area must be capable of delivering the flow rate required to accomplish this timing criteria.

Each nozzle size is capable of delivering a certain range of flow rates. To determine the number and size of nozzles required for each area, use the flow rate table below. Note – this information is provided for estimation purposes only. The final system design **MUST** be verified using the Fike HFC-227ea Flow Calculation Program.

NOTE: This data is not intended for use when designing a Pre-Engineered System. The flow rates have already been pre-determined (established) and are reflected in their specific design section. Refer to Section 2.11 for Pre-Engineered System design information.

NOZZLE FLOW RATES (ENGLISH UNITS)		
NOMINAL PIPE SIZE	**MINIMUM DESIGN FLOW RATE (System Limitation)**	**MAXIMUM DESIGN FLOW RATE (Estimate only)**
3/8" NPT	0.7 lbs./sec.	2.0 lbs./sec.
1/2" NPT	1.0 lbs./sec.	3.4 lbs./sec.
3/4" NPT	2.0 lbs./sec.	6.0 lbs./sec.
1" NPT	3.4 lbs./sec.	8.5 lbs./sec.
1-1/4" NPT	5.8 lbs./sec.	13.0 lbs./sec.
1-1/2" NPT	8.4 lbs./sec.	19.5 lbs./sec.
2" NPT	13.0 lbs./sec.	33.0 lbs./sec.

NOZZLE FLOW RATES (METRIC)		
NOMINAL PIPE SIZE	**MINIMUM DESIGN FLOW RATE (System Limitation)**	**MAXIMUM DESIGN FLOW RATE (Estimate only)**
10 mm	0.32 kg/sec.	0.91 kg/sec.
15 mm	0.45 kg/sec.	1.54 kg/sec.
20 mm	0.91 kg/sec.	2.72 kg/sec.
25 mm	1.54 kg/sec.	3.86 kg/sec.
32 mm	2.63 kg/sec.	5.90 kg/sec.
40 mm	3.81 kg/sec.	8.85 kg/sec.
50 mm	5.90 kg/sec.	14.97 kg/sec.

Example no.1: A system supplying 1,300 lbs. has a system flow rate requirement of 130 lbs./sec. (1,300 lbs. ÷ 10 sec. = 130 lbs./sec.). Refer to the Nozzle Flow Rate Table. The highest possible flow rate for any nozzle size is 33 lbs./sec. Therefore, a minimum of four (4) 2” NPT nozzles will be required.

Example no. 2: A system supplying 590 kg has a system flow rate requirement of 59 kg/sec. (590 kg ÷ 10 sec. = 59 kg/sec.). Refer to the Nozzle Flow Rate Table. The highest possible flow rate for any nozzle size is 14.97 kg/sec. Therefore, a minimum of four (4) 50 mm nozzles will be required.

NOTE: A maximum nozzle flow rate of 17 lbs./sec. (7.7 kg/sec.) is recommended for all areas with false ceilings or delicate operations where a higher flow rate may dislodge objects or affect a process.

2.7.2.1 ENGINEERED NOZZLES

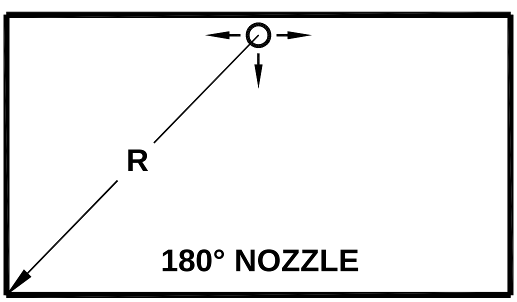
The minimum orifice area that can be utilized for a 180^o or a 360^o Engineered System Nozzle is twenty percent of the pipe cross sectional area. The maximum orifice area that can be utilized must be less than eighty percent of the pipe cross sectional area. Therefore, a computerized flow calculation program is used to select the proper nozzles to meet the orifice size limitations, as well as the minimum pressure requirement of 55 psig (3.8 bar).

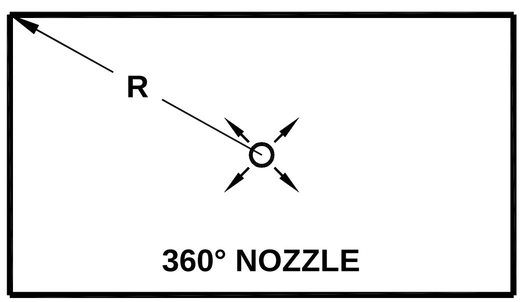
WARNING: System installation **SHALL NOT** begin until the final design of the piping network has been verified using Fike’s Engineered Flow Calculation.

2.7.3 NOZZLE AREA COVERAGE

Nozzle Area Coverage must also be considered when designing a Fike HFC-227ea System. Each nozzle type (180^o or 360^o) has been UL Listed and FM approved for the maximum area coverage limitations listed below. The maximum area coverage is expressed as a radius (“R”) of coverage along the discharge axis for both nozzle types. Nozzle area coverage values are the same for Pre-Engineered and Engineered Nozzles.

Both nozzle types can be located a maximum of one (1) ft. (0.3 m) below the ceiling (or highest point of protection when stacking nozzles). Additionally, 180^o Nozzles can be placed a maximum of one (1) ft. (0.3 m) away from the sidewall.



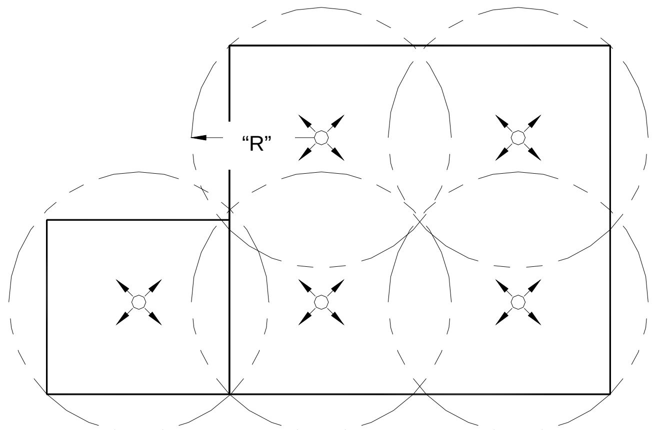


NOZZLE AREA COVERAGE (ENGLISH)		
Nozzle Type	**Radius “R” Dimension**	**Ceiling Height Range**
180^o	45’-8”	12 in. to 16 ft.
360^o	29’-8”	12 in. to 16 ft.

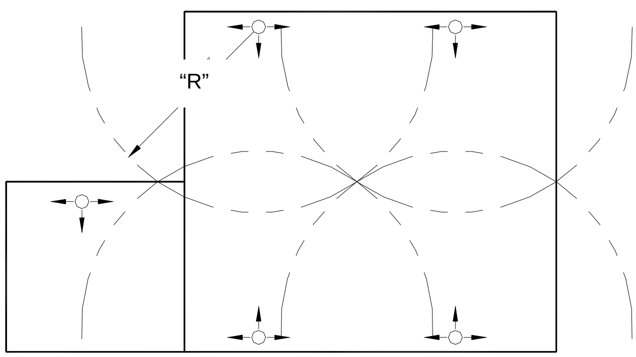
NOZZLE AREA COVERAGE (METRIC)		
Nozzle Type	**Radius “R” Dimension**	**Ceiling Height Range**
180^o	13.92 m	0.3 to 4.88 m
360^o	9.04 m	0.3 to 4.88 m

2.7.4 NOZZLE PLACEMENT

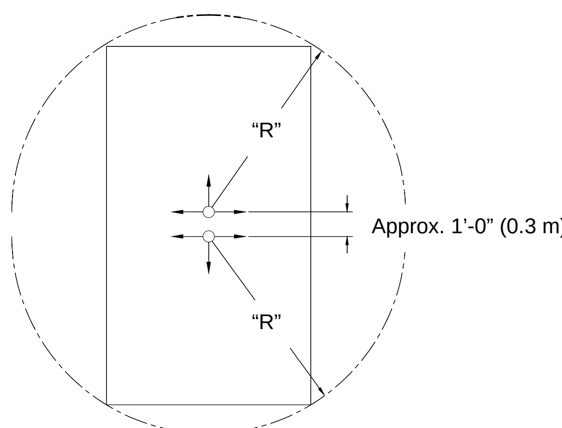
Nozzles should be located in a symmetrical or near symmetrical pattern within the protected area. 360^o Nozzles are designed to be located on, or near, the centerline of the protected area, discharging toward the perimeter of the area being covered. The system designer should layout the nozzles on a floorplan and verify that the entire area being protected is adequately covered without any "blind spots" due to nozzle locations.



180^o Nozzles are designed to be located along the perimeter of the area, discharging toward the opposite side as shown below. These nozzles **MUST** be located no farther than 1'-0" (0.3 m) away from the wall.



180^o Nozzles can also be installed in back to back applications. Maximum distance between nozzles is approximately 1'-0" (0.3 m) as shown in the following illustration.



The use of 180^o nozzles in a back to back application is U.L. listed, and not listed by FM Approvals.

IMPORTANT NOTE:
The Minimum Piping Distance Rule outlined in Section 2.8.5 **does not** apply when using back-to-back 180º nozzles as long as:

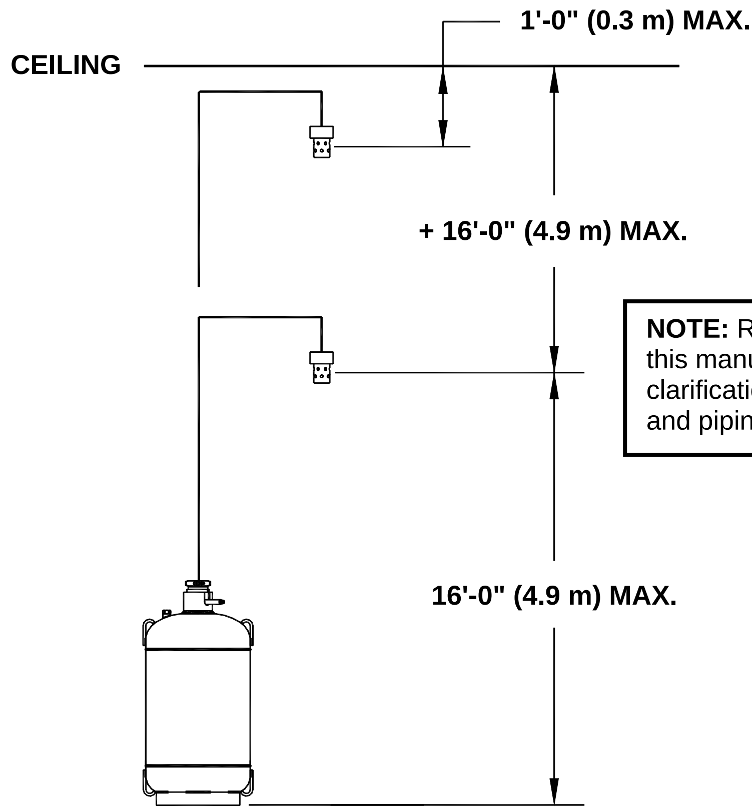
1) Agent supplied and flow rate from both nozzles are the same.
2) Pipe size from tee to both nozzles is the same.
3) Pipe lengths from tee to each nozzle are within 10% of each other.

NOTE: All discharge nozzles may be located a maximum of 1'-0" (0.3 m) below the ceiling.

2.7.4.1 CEILING HEIGHTS GREATER THAN 16'-0" (4.9 m)

Enclosures with ceiling heights greater than 16'-0" (4.9 m) require nozzles to be placed at multiple levels (elevations) in segments no greater than 16'-0" (4.9 m) in elevation. Refer to Section 2.8.2 of this manual for further guidance regarding the maximum elevation differences when installing multiple levels of nozzles in enclosures exceeding 16'-0" (4.9 m).

Example: For an enclosure with a ceiling height of 20'-0" (6.1 m), the lower level of nozzles **MUST** be placed at a maximum height of 16'-0" (4.9 m). A second (upper) level of nozzles **MUST** be placed within 1'-0" (0.3 m) of the ceiling.

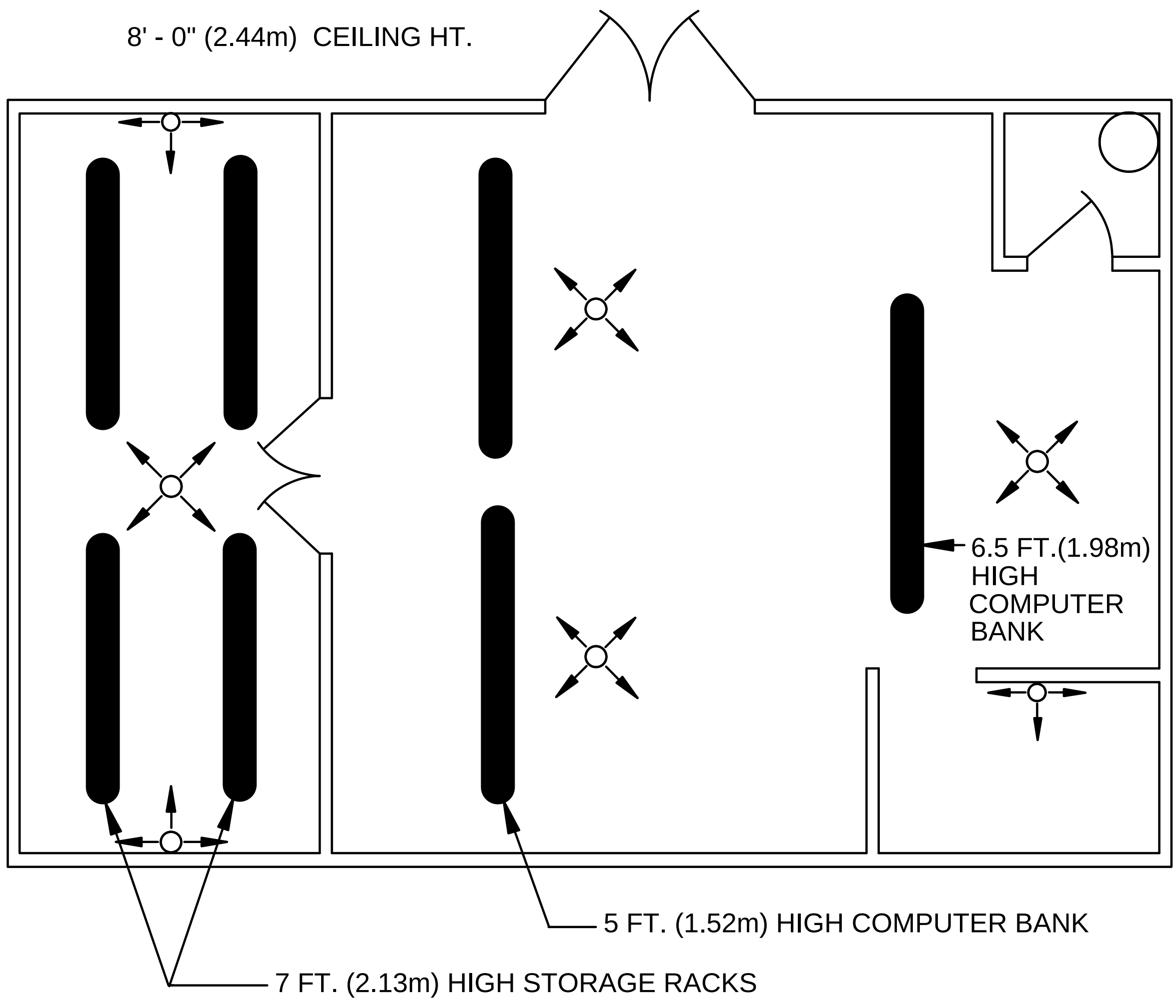


NOTE: Refer to Section 2.8.2 of this manual for further clarification regarding nozzle and piping elevation limitations.

2.7.5 NOZZLE DISCHARGE OBSTRUCTIONS

Walls, partitions, equipment racks, and tall equipment can provide area coverage obstructions for nozzle discharges. For this reason, the discharge "path" of the nozzles must also be taken into account when determining the quantity of nozzles required.

Anytime that solid obstructions extend to where they could interfere with the "line-of-sight" discharge path from the nozzle, they should be treated as separate areas. All nozzles should be located in a manner that will provide a clear discharge path that reaches all of the outer extremes for the protected space.



2.8 PIPING NETWORK LIMITATIONS (ENGINEERED SYSTEMS)

This section will cover the piping limitations that apply to all Fike Engineered HFC-227ea system configurations. This information is intended to give the system designer the information necessary to complete a preliminary piping layout. The following limitations define the parameters that have been verified through testing, but **installation SHALL NOT begin until the design has been verified using Fike's Engineered HFC-227ea Flow Calculation Program**. For program details, refer to the HFC-227ea Flow Calculation User's Manual, P/N 06-208.

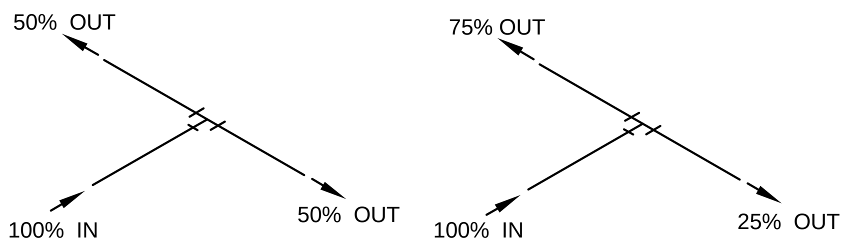
2.8.1 TEE SPLIT RATIOS

The Fike Engineered HFC-227ea System has been tested to define the maximum degree of imbalance that can be predicted at tee splits. This value has been expressed in terms of a split ratio of one outlet branch versus the other. Each ratio indicated is referring to a percentage of the total incoming flow.

2.8.1.1 BULLHEAD TEE

A Bullhead Tee is defined as a tee configuration where the two outlet branches change direction from the incoming piping inlet. See the diagram below for further clarification.

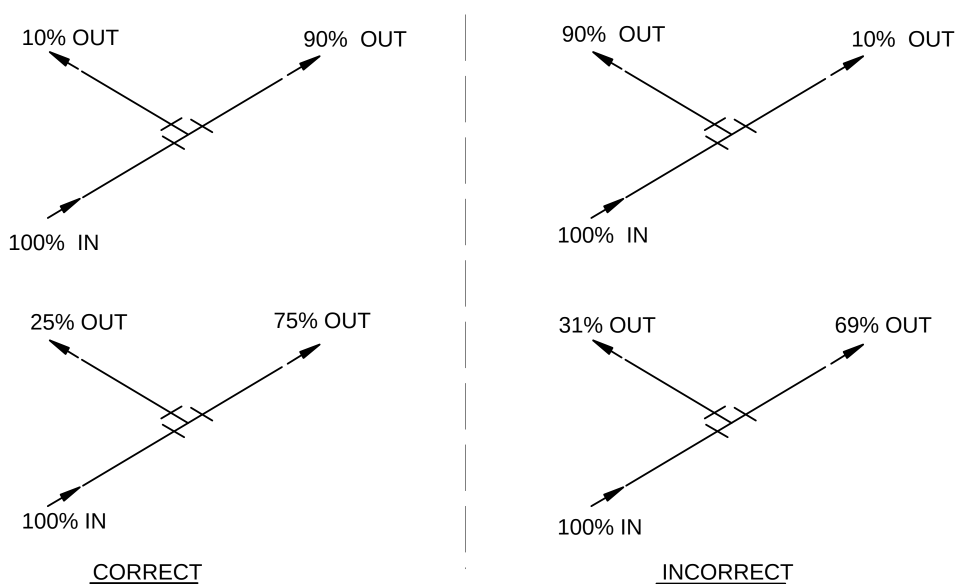
The split ratio range for a Bullhead Tee is 75:25 to 50:50. This means that the major-flow outlet has an acceptable range of 50% minimum to 75% maximum, and the minor-flow outlet has an acceptable range of 25% minimum to 50% maximum. These figures are determined as percentages of the total incoming flow amount through the tee. See the diagram below for further clarification.



2.8.1.2 SIDE-THRU TEE

A Side-Thru Tee is defined as a tee configuration where one outlet branch changes direction from the inlet, and the other continues straight through in the same direction as the inlet. See the diagram below for further clarification.

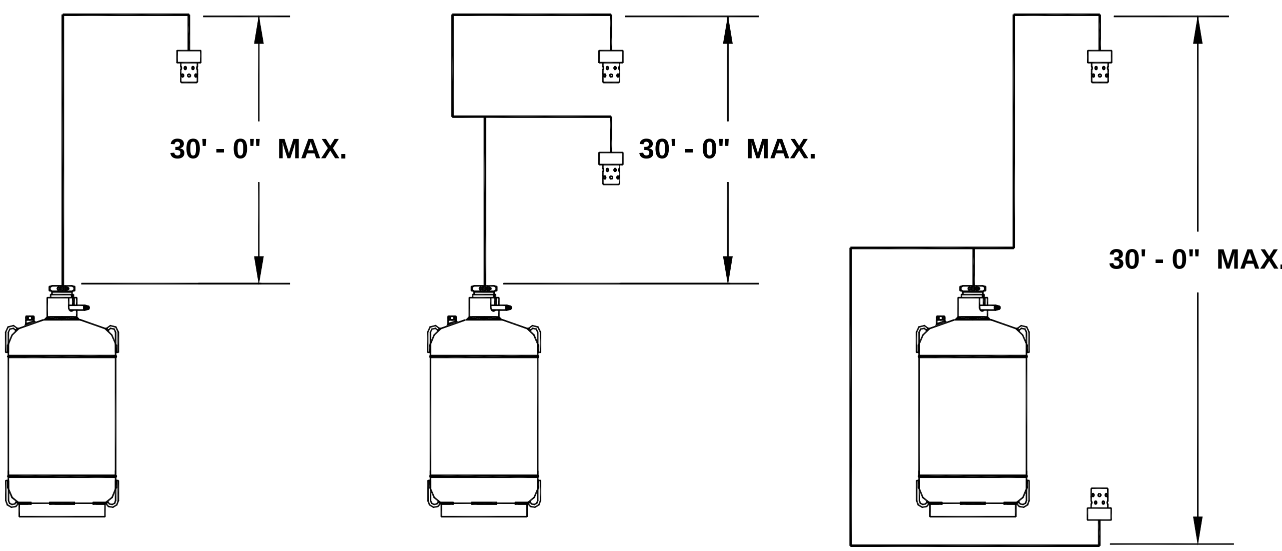
The split ratio range for a Side-Thru Tee is 90:10 to 75:25. This means that the major-flow outlet (the thru branch) has an acceptable range of 75% minimum to 90% maximum, and the minor-flow outlet (the side branch) has an acceptable range of 10% minimum to 25% maximum. These figures are determined as percentages of the total incoming flow amount through the tee. See the diagram below for further clarification.



2.8.2 MAXIMUM ELEVATION DIFFERENCES IN PIPE RUNS

The maximum elevation difference between horizontal pipe runs or nozzles is limited as follows.

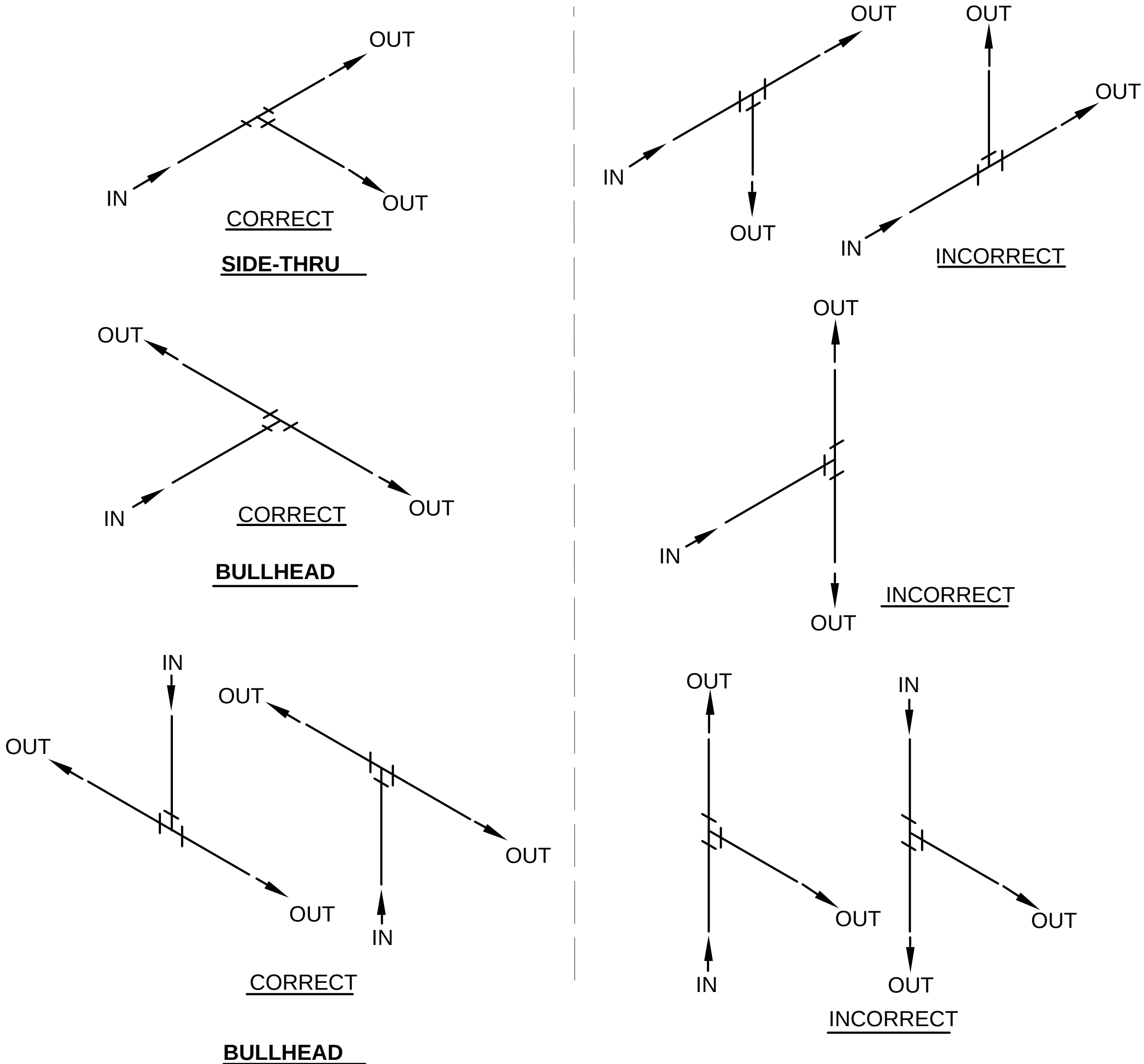
a. If nozzles are only located above the container outlet, the maximum elevation difference between the container outlet and the farthest horizontal pipe run or discharge nozzle (whichever is greater) shall not exceed 30 feet.
b. If nozzles are only located below the container outlet, the maximum elevation difference between the container outlet and the farthest horizontal pipe run or discharge nozzle (whichever is greater) shall not exceed 30 feet.
c. If nozzles are located above and below the container outlet, the maximum elevation difference between the container outlet and the farthest horizontal pipe run or discharge nozzle (whichever is greater) shall not exceed 30 feet.



System with a single level of nozzles | **System with multiple levels of nozzles** | **System with ceiling and subfloor nozzles**

2.8.3 TEE ORIENTATION

The Fike Engineered HFC-227ea System has been tested to define the limitations necessary to accurately predict how the system will perform when discharged. The Tee orientation is an important characteristic in maintaining consistency of flow split percentages. Therefore, a simple rule **MUST** be observed concerning tee orientation: EVERY OUTLET of every tee **MUST** be orientated in the horizontal plane.



2.8.4 ESTIMATING PIPE SIZE (ENGINEERED SYSTEMS)

The proper pipe size for each section of piping is selected based on the design flow rate for each pipe section. Generally, the size selection should be based on the smallest pipe size that will handle the design flow rate for branch lines supplying the discharge nozzles, and the next to smallest size for trunk lines.

2.8.4.1 DISCHARGE DURATION

HFC-227ea Systems must discharge the agent in a manner that will achieve 95% of the design concentration within ten (10) seconds in accordance with NFPA 2001, Section 3. Fike HFC-227ea Systems have been tested by UL and FM in accordance with this requirement, along with an additional requirement that requires the minimum discharge time associated with an HFC-227ea to be no less than six (6) seconds.

Therefore, these time requirements must be taken into account when estimating pipe sizes. The Fike HFC-227ea Flow Calculation Program selects pipe sizes based on these criteria and selects the nozzle orifice hole sizes accordingly. Ultimate control of the discharge time is accomplished through the custom sizing of the discharge nozzles by the Fike Program.

2.8.4.2 MINIMUM FLOW RATES

Flowing HFC-227ea agent actually consists of two phases: liquid and vapor. To accurately predict its flow through a piping network, the piping has to be sized to provide enough resistance to create a turbulent flow effect. When turbulent flow is achieved, the two phases join to form a homogenous mixture that can be accurately calculated. If the pipe size is too large, phase separation will occur and the flow cannot be predicted. Therefore, the pipe sizes selected must be in accordance with the Flow Rate Table below.

To determine the flow rate of a pipe section, divide the amount of agent flowing through that section by the discharge time (10 seconds).

PIPE SIZE ESTIMATING TABLE						
English Pipe Sizes				Metric Pipe Sizes		
Pipe Size NPT	Min. Design Flow Rate (Limitation)	Max. Design Flow Rate (Estimate)		Pipe Size Metric	Min. Design Flow Rate (Limitation)	Max. Design Flow Rate (Estimate)
3/8”	0.7 lbs./sec.	2.0 lbs./sec.		10 mm	0.32 kg/sec.	0.91 kg/sec.
1/2”	1.0 lbs./sec.	3.4 lbs./sec.		15 mm	0.45 kg/sec.	1.54 kg/sec.
3/4”	2.0 lbs./sec.	6.0 lbs./sec.		20 mm	0.91 kg/sec.	2.72 kg/sec.
1”	3.4 lbs./sec.	8.5 lbs./sec.		25 mm	1.54 kg/sec.	3.86 kg/sec.
1-1/4”	5.8 lbs./sec.	13.0 lbs./sec.		32 mm	2.63 kg/sec.	5.90 kg/sec.
1-1/2”	8.4 lbs./sec.	19.5 lbs./sec.		40 mm	3.81 kg/sec.	8.85 kg/sec.
2”	13.0 lbs./sec.	33.0 lbs./sec.		50 mm	5.90 kg/sec.	14.97 kg/sec.
2-1/2”	19.5 lbs./sec.	58.0 lbs./sec.		65 mm	8.85 kg/sec.	26.31 kg/sec.
3”	33.0 lbs./sec.	95.0 lbs./sec.		80mm	15.00 kg/sec.	43.10 kg/sec.
4”	58.0 lbs./sec.	127 lbs./sec.		100 mm	26.31 kg/sec.	57.61 kg/sec.
5”	95 lbs./sec.	222 lbs./sec.		125 mm	43.10 kg/sec.	100.70 kg/sec.
6”	127 lbs./sec.	318 lbs./sec.		150 mm	57.61 kg/sec.	144.24 kg/sec.

WARNING: **DO NOT** install the pipe system based on estimates from this chart. The pipe system design **MUST** be verified by the Fike HFC-227ea Flow Calculation Program prior to installing the system.

2.8.5 MINIMUM PIPING DISTANCE (ENGINEERED SYSTEMS)

A minimum of ten (10) pipe diameters must be maintained between fittings to stabilize the flow and maintain the accuracy of the splits occurring at the tees. The (10) pipe diameter rule applies to the following configurations.

2.8.5.1 DISTANCE FROM A TEE TO AN ELBOW OR TEE

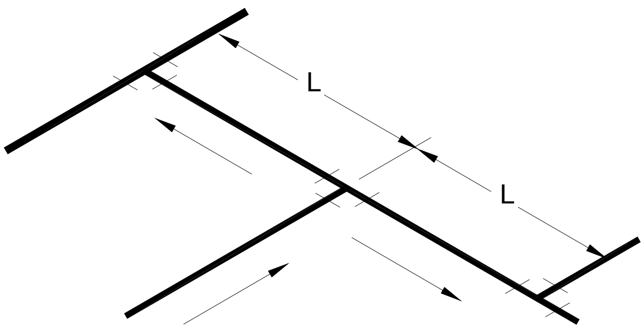
When a Tee is located before an Elbow or another Tee, the minimum distance between the fittings must be ten (10) pipe diameters.

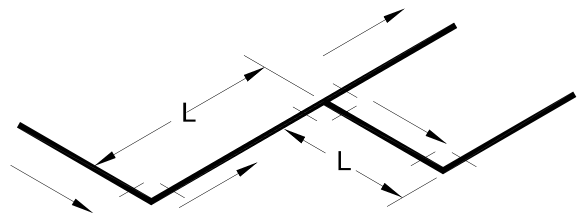
2.8.5.2 DISTANCE FROM AN ELBOW TO A TEE

When an Elbow is located before a Tee, the minimum distance between the Elbow and the Tee must be ten (10) pipe diameters.

NOTE: The ten (10) pipe diameter rule does not apply:

- between an Elbow and another Elbow.
- when using back-to-back 180º nozzles as long as:
  1) Agent supplied and flow rate from both nozzles are the same.
  2) Pipe size from tee to both nozzles is the same.
  3) Pipe lengths from tee to each nozzle are within 10% of each other.





10 PIPE DIAMETERS VS. PIPE SIZE					
Pipe Size	Minimum Length		Pipe Size	Minimum Length
3/8” NPT	4”		10 mm	102 mm
1/2” NPT	5”		15 mm	127 mm
3/4” NPT	8”		20 mm	204 mm
1” NPT	10”		25 mm	254 mm
1-1/4” NPT	12”		32 mm	305 mm
1-1/2” NPT	15”		40 mm	381 mm
2” NPT	20”		50 mm	508 mm
2-1/2” NPT	25”		65 mm	635 mm
3” NPT	30”		80 mm	762 mm
4” NPT	40”		100 mm	1016 mm
5” NPT	50”		125 mm	1270 mm
6” NPT	60”		150 mm	1524 mm

2.8.6 EQUIVALENT LENGTH VALUES

All pipe, fittings, valves and other piping devices have "Equivalent Length" values that have been determined by flow testing to represent the restriction (pressure loss) associated with flowing HFC-227ea through the device. The following table lists the Equivalent Length values that have been established.

EQUIVALENT LENGTH TABLE (ENGLISH UNITS)

Pipe Size NPT	Union (feet)	45^o Elbow (feet)	90^o Elbow (feet)	Thru Tee (feet)	Side Tee (feet)	Check Valve (feet)
3/8"	0.3	0.6	1.3	0.8	2.7	- - -
1/2"	0.4	0.8	1.7	1.0	3.4	- - -
3/4"	0.5	1.0	2.2	1.4	4.5	- - -
1"	0.6	1.3	2.8	1.8	5.7	2.0
1-1/4"	0.8	1.7	3.7	2.3	7.5	- - -
1-1/2"	0.9	2.0	4.3	2.7	8.7	- - -
2"	1.2	2.6	5.5	3.5	11.2	4.0
2-1/2"	1.4	3.1	6.6	4.1	13.4	- - -
3"	1.8	3.8	8.2	5.1	16.6	4.0
4"	2.4	5.0	10.7	6.7	21.8	- - -
5"	3.0	6.3	13.4	8.4	27.4	- - -
6"	3.5	7.6	16.2	10.1	32.8	- - -

EQUIVALENT LENGTH TABLE (METRIC)

Pipe Size (mm)	Union (m)	45^o Elbow (m)	90^o Elbow (m)	Thru Tee (m)	Side Tee (m)	Check Valve (m)
10 mm	0.09	0.18	0.40	0.24	0.82	- - -
15 mm	0.12	0.24	0.52	0.30	1.04	- - -
20 mm	0.15	0.30	0.67	0.43	1.37	- - -
25 mm	0.18	0.40	0.85	0.55	1.74	0.61
32 mm	0.24	0.52	1.13	0.70	2.29	- - -
40 mm	0.27	0.61	1.31	0.82	2.65	- - -
50 mm	0.37	0.79	1.68	1.07	3.41	1.22
65 mm	0.43	0.94	2.01	1.25	4.08	- - -
80 mm	0.55	1.16	2.50	1.55	5.06	1.22
100 mm	0.73	1.52	3.26	2.04	6.64	- - -
125 mm	0.91	1.92	4.08	2.56	8.35	- - -
150 mm	1.07	2.32	4.94	3.08	10.0	- - -

2.9 ENGINEERED SYSTEM DESIGN LIMITS

The Fike Engineered HFC-227ea System has been tested to define the limitations necessary to accurately predict how the system will perform when discharged. The physical limitations covered previously (e.g. tee orientation, flow rate, etc.) are easily seen and managed prior to running a flow calculation. However, the following is a list of physical limitations that are not easily identified until the system designer runs the flow calculation.

2.9.1 PERCENT OF AGENT IN PIPE

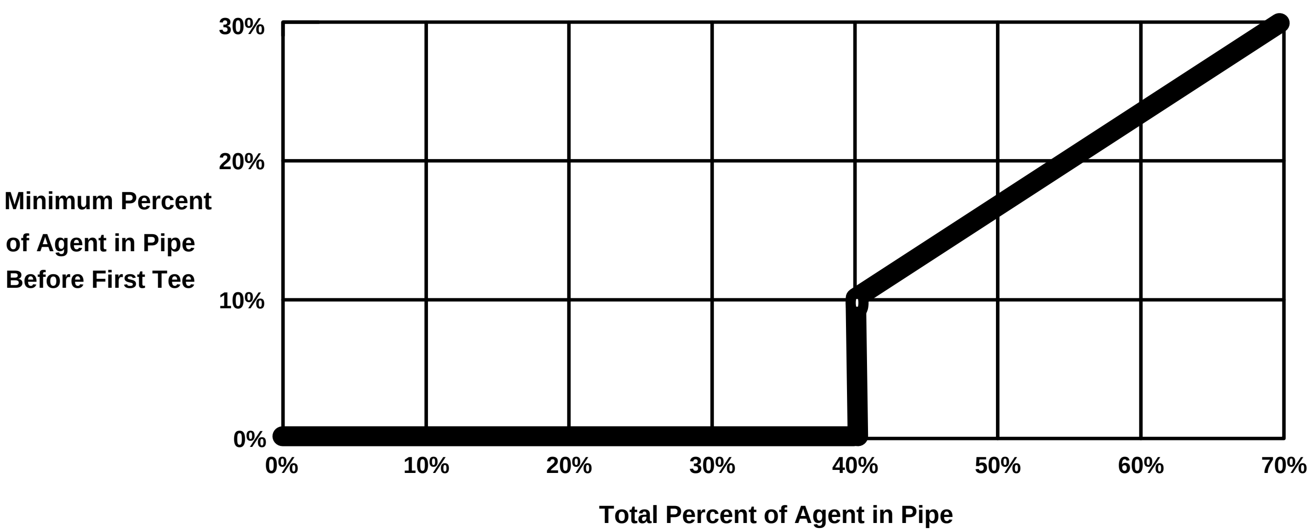
Fike HFC-227ea Systems are pressurized systems that utilize a limited source of pressurization (nitrogen) to expel the extinguishing agent through the piping network and into the protected space. Therefore, there has to be a limit placed on the size (volume) of the associated piping network to ensure that the agent will be delivered to the protected space within the ten (10) second time period allowed. This is a “floating” limitation depends upon the size and fill weight of the container(s) involved. This makes this a difficult design limitation to identify, but it is usually associated with very large pipe systems and multiple tee split arrangements.

Therefore, this limitation is defined as follows: no more than 70% of the total agent weight (liquid) may reside in the piping network during discharge. If the piping volume is too large, the Flow Calculation Program will indicate an error message, [Percent of Agent Greater Than 70%]. The piping network volume must be decreased by reducing pipe sizes, reducing pipe lengths, or a combination of both to correct this error.

2.9.2 LOCATION OF FIRST TEE

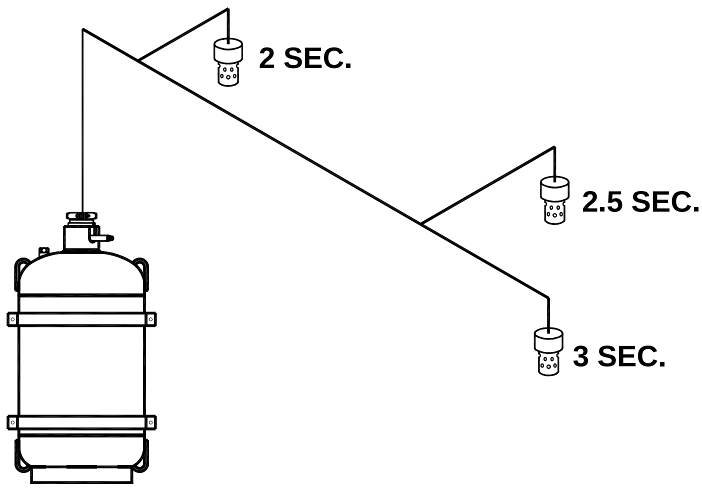
Some piping configurations present timing problems for the system due to the degree of hydraulic imbalance created. For example, a system that splits and supplies agent for the room nozzles and underfloor nozzles is unbalanced because of the difference in pipe size and agent quantities. Therefore, the Flow Program must try to manipulate the orifice hole diameters of the nozzles in an attempt to satisfy all of the timing requirements for the system. When the timing criteria cannot be met, the location of the first tee becomes critical.

The distance from the cylinder to the first tee depends on the size and configuration of the piping system. The distance will vary from system to system, so no exact value can be established that is appropriate for all cases. If the Flow Program determines that the percent of agent in pipe value is 39% or less, no restrictions regarding the location of the first tee apply. If the percent of agent in pipe value is 40% or higher, the first tee must be located far enough downstream (away from the container) for a minimum of 10 to 30% of that value to be located in the piping before the first tee.



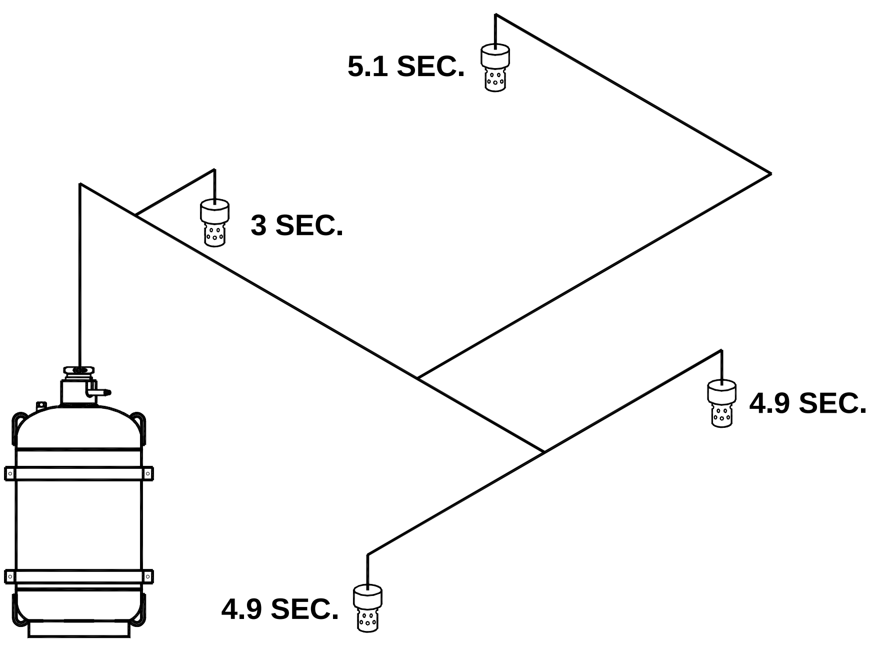
2.9.3 LIQUID ARRIVAL TIME

The amount of time necessary for the liquid HFC-227ea to arrive at each nozzle must be within one (1) second of each other. For example, if the liquid agent takes two (2) seconds to arrive at the first nozzle, (the closest nozzle to the container), the liquid arrival time to all of the remaining nozzles cannot exceed three (3) seconds.



2.9.4 LIQUID RUNOUT TIME

The amount of time necessary for the liquid HFC-227ea to discharge (runout) of each nozzle must be within 2.1 seconds of each other. For example, if the liquid runout time for the first nozzle takes 3 seconds, the runout time for all of the remaining nozzles must not exceed 5.1 seconds.



2.10 MANIFOLD OPTIONS (ENGINEERED SYSTEMS)

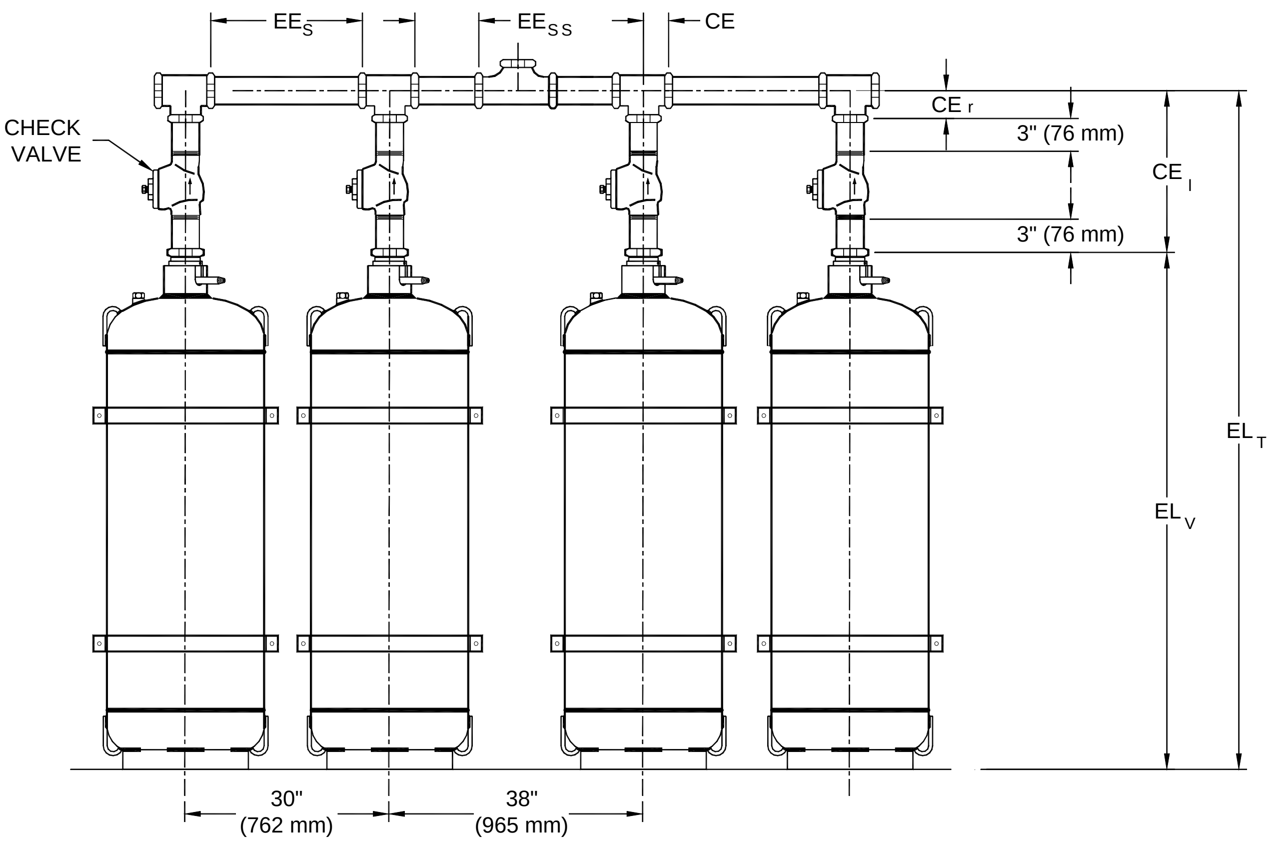
Sometimes, a system will require more agent than a single container can provide. In this case, multiple containers can be connected together via a common manifold arrangement. Main and Reserve supplies of agent are also connected together in this manner.

Manifolds are assembled using a combination of grooved pipe and grooved fittings, or threaded pipe and fittings meeting the pressure requirements of NFPA 2001, Section 2. Every container must be the same type, same size, and identical fill weight in accordance with NFPA 2001, Section 2. 3" NPT (80 mm) Check Valves are required for **EACH** container in accordance with NFPA 2001, Section 2.

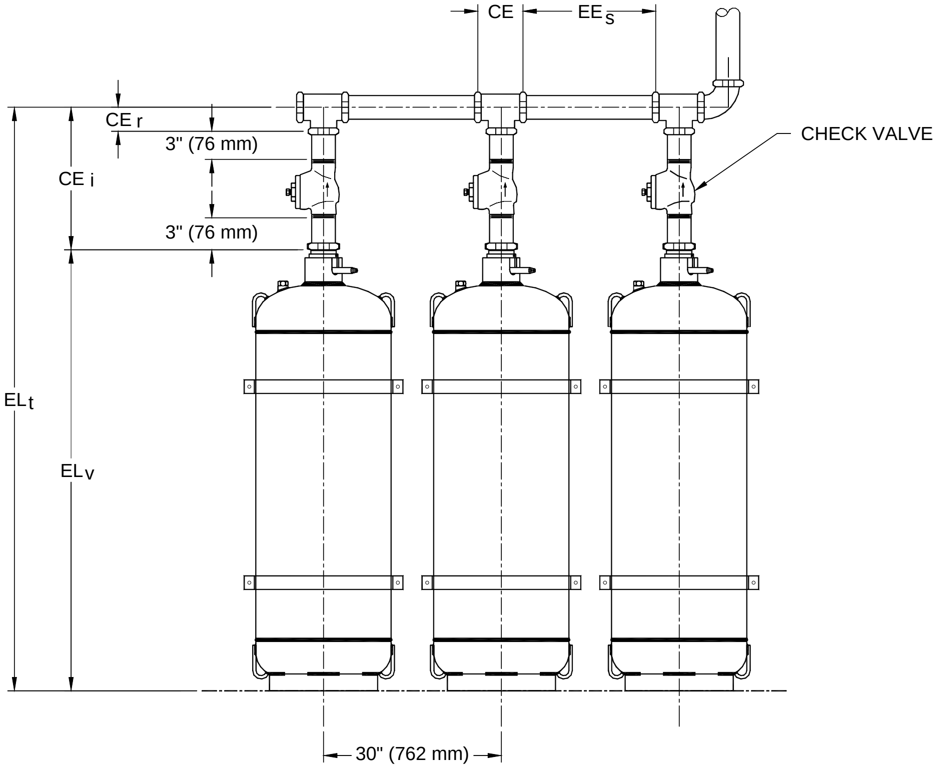
Manifold assemblies are configured using 3" (80 mm) through 6" (150 mm) pipe sizes, depending upon the amount of agent being supplied. The common manifold types are as follows:

- Center Exit Manifold
- End Exit Manifold
- Center Exit Manifold / Main and Reserve
- End Exit Manifold / Main and Reserve

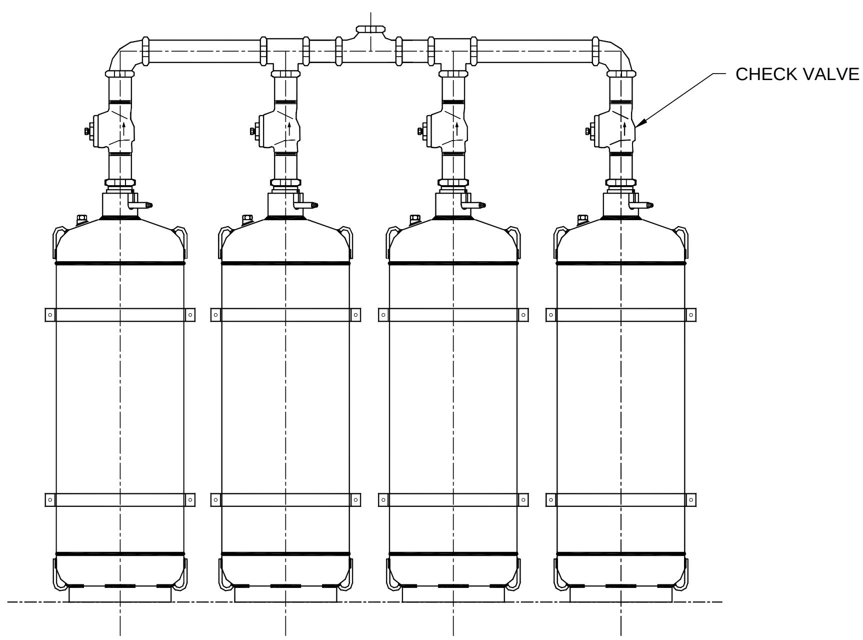
The following diagrams and table show the basic manifold configurations and dimensions. Refer to Section 4 for additional installation information.



CENTER EXIT MANIFOLD / 3" THRU 6" (80 mm thru 150 mm)
OR
MAIN & RESERVE MANIFOLD / 3" THRU 6" (80 mm thru 150 mm)



END EXIT MANIFOLD / 3” THRU 6” (80 mm thru 150 mm)



THREADED MANIFOLD
(NOT RECOMMENDED FOR LARGER THAN 3” NPT (80 mm)

MANIFOLD DIMENSIONS (ENGLISH UNITS)								
Container	Manifold	Dimensions (inches)						
Size	Size	EL_v	EL_t	CE_i	CE_r	CE	EE_s	EE_{ss}
215 lb.	3”	28.87	47.87	18.25	4.25	4.25	13.63	5.50
(20” OD)	4”	28.87	48.62	19.00	5.00	5.00	12.13	4.00
375 lb.	3”	42.50	61.50	18.25	4.25	4.25	13.63	5.50
(20” OD)	4”	42.50	62.25	19.00	5.00	5.00	12.13	4.00
	6”	42.50	63.75	20.50	6.50	6.50	9.13	- - -
650 lb.	4”	48.69	68.44	19.00	5.00	5.00	16.13	9.00
(24” OD)	6”	48.69	69.94	20.50	6.50	6.50	13.13	6.00
1000 lb.	4”	70.00	89.75	19.00	5.00	5.00	16.13	9.00
(24” OD)	6”	70.00	91.25	20.50	6.50	6.50	13.13	6.00

MANIFOLD DIMENSIONS (METRIC)								
Container	Manifold	Dimensions (mm)						
Size	Size	EL_v	EL_t	CE_i	CE_r	CE	EE_s	EE_{ss}
87 L	80	733	1216	464	108	108	346	140
(508 mm)	100	733	1235	483	127	127	308	102
153 L	80	1080	1563	464	108	108	346	140
(508 mm)	100	1080	1582	483	127	127	308	102
	150	1080	1620	521	165	165	232	- - -
267 L	100	1237	1739	483	127	127	410	229
(610 mm)	150	1237	1777	521	165	165	334	152
423 L	100	1778	2280	483	127	127	410	229
(610 mm)	150	1778	2318	521	165	165	334	152

2.11 PRE-ENGINEERED SYSTEMS DESIGN

Pre-Engineered Systems are simple 1, 2 or 4 nozzle configurations that have been pre-tested in accordance with NFPA 2001, UL and FM requirements. The Pre-Engineered concept minimizes the engineering effort required to design an effective system. As long as nozzle selection, pipe size and pipe length limitations are adhered to, hydraulic flow calculations are not required. The designer will perform a simple hand calculation to determine a Total Pressure Drop (TPD) value. If the TPD value is less than 100 (35 for 10 lb/4 L cylinders), the system is acceptable.

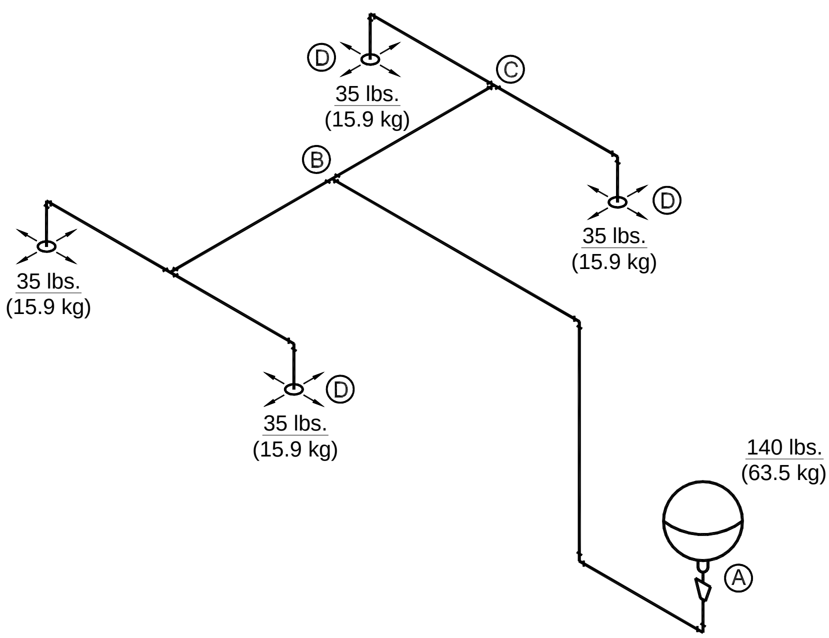
Fike Pre-Engineered Systems **MUST** be designed and installed within the limitations that follow.

2.11.1 PIPING LAYOUT

After the quantity of nozzles and container locations have been selected, the piping system layout can be determined. The configuration can be as simple as a single nozzle, or additional nozzles can be added in a two (2) or four (4) nozzle configuration. Storage containers shall be located as close as possible to or within the hazard or hazards they protect. (Reference: NFPA 2001, Section 2)

When designing a two or four nozzle Pre-Engineered System, the nozzle and piping layout **MUST** be installed in a balanced configuration. To accomplish this, the flow path from the container to each nozzle must be the same length, using the same pipe sizes, the same quantity and type of fittings, and the nozzles must discharge the same amount of agent from each nozzle. A piping network is considered to be balanced if the total length from the container to each nozzle is within 10% of each other.

In addition, all tee splits **MUST** be made using a Bullhead Tee configuration, and each outlet must be oriented in the horizontal plane. Refer to the diagram below.

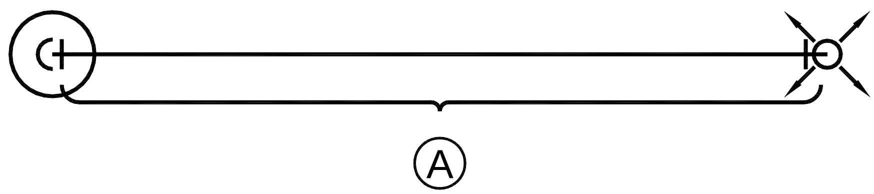


2.11.2 DETERMINING PIPE SIZES

Pipe Sizes have already been pre-determined for Pre-Engineered Systems depending upon the size of the container and the number of nozzles needed for each system. Refer to one of the following tables.

- Single Nozzle Piping Table, 35 lb. thru 215 lb. (15 thru 87 L) Containers
- Two Nozzle Piping Table, 60 lb. thru 375 lb. (27 thru 153 L) Containers
- Four Nozzle Piping Table, 100 lb. thru 1000 lb. (44 thru 423 L) Containers

2.11.2.1 SINGLE NOZZLE PIPING TABLE – 35 lb. THRU 215 lb. (15 L thru 90 L) CONTAINERS

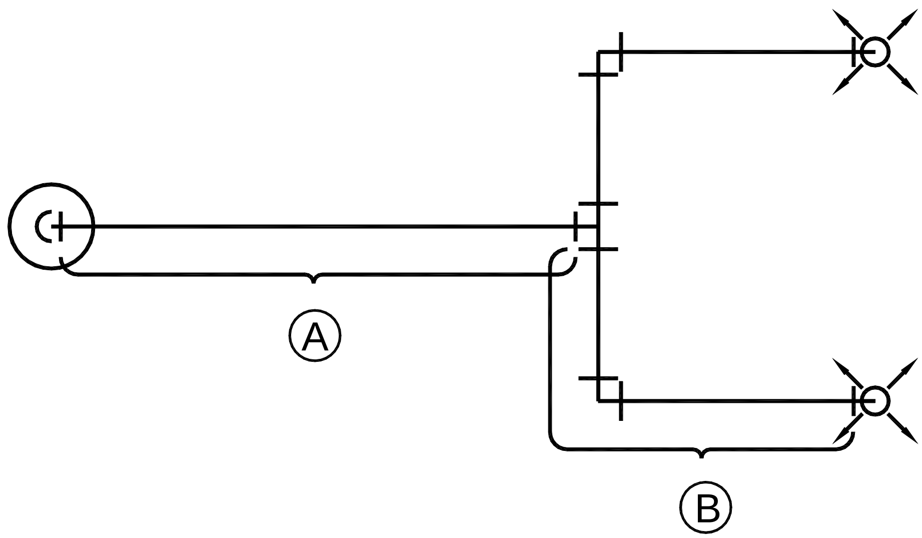


PIPE SIZE TABLE (ENGLISH)		
Container Size	**Fill Range**	**Section "A" Pipe Size**
35 lb.	22 – 38 lbs.	1" NPT
60 lb.	39 – 68 lbs.	1" NPT
100 lb.	63 – 108 lbs.	1-1/2" NPT
125 lb.	73 – 126 lbs.	1-1/2" NPT
215 lb. (inverted)	128 – 223 lbs.	2" NPT
215 lb. (floor mount)	124 – 216 lbs.	2" NPT

PIPE SIZE TABLE (METRIC)		
Container Size	**Fill Range**	**Section "A" Pipe Size**
15 L	10.0 – 17.0 kg	25 mm
27 L	18.0 – 30.5 kg	25 mm
44 L	28.5 – 48.5 kg	40 mm
51 L	33.5 – 57 kg	40 mm
90 L (inverted)	58.5 – 101 kg	50 mm
87 L (floor mount)	56.5 – 98.0 kg	50 mm

NOTE: The Pipe Size and Nozzle Size are dependent upon the container size. The pipe sizes shown for each container size **MUST** be used.

2.11.2.2 TWO NOZZLE PIPING TABLE – 60 lb. THRU 375 lb. (27 L thru 153 L) CONTAINERS

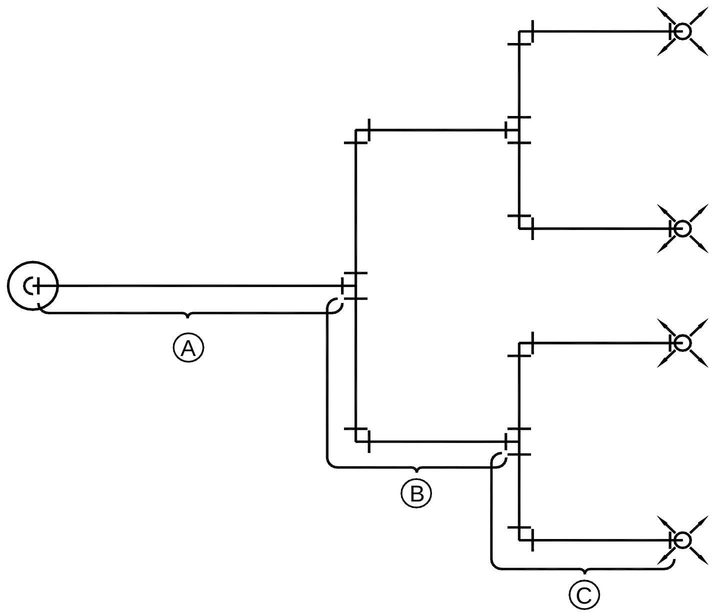


PIPE SIZE TABLE (ENGLISH)			
Container Size	**Fill Range**	**Section "A" Pipe Size**	**Section "B" Pipe Size**
60 lb.	39 – 68 lbs.	1" NPT	1" NPT
100 lb.	63 – 108 lbs.	1-1/2" NPT	1" NPT
125 lb. (inverted)	73 – 126 lbs.	1-1/2" NPT	1" NPT
215 lb. (inverted)	128 – 223 lbs.	2" NPT	1-1/2" NPT
215 lb. (floor mount)	1243 – 216 lbs.	2" NPT	1-1/2" NPT
375 lb.	217 – 378 lbs.	2-1/2" NPT	2" NPT

PIPE SIZE TABLE (METRIC)			
Container Size	**Fill Range**	**Section "A" Pipe Size**	**Section "B" Pipe Size**
27 L	18.0 – 30.5 kg	25 mm	25 mm
44 L	28.5 – 48.5 kg	40 mm	25 mm
51 L	33.5 – 57.0 kg	40 mm	25 mm
90 L (inverted)	58.5 – 101.0 kg	50 mm	40 mm
87 L (floor mount)	56.5 – 98.0 kg	50 mm	40 mm
153 L	98.5 – 171.5 kg	65 mm	50 mm

NOTE: The Pipe Size and Nozzle Size are dependent upon the container size. The pipe sizes shown for each container size **MUST** be used.

2.11.2.3 FOUR NOZZLE PIPING TABLE – 100 lb. THRU 1000 lb. (44 L thru 423 L) CONTAINERS



PIPE SIZE TABLE (ENGLISH)				
Container Size	**Fill Range**	**Section "A" Pipe Size**	**Section "B" Pipe Size**	**Section "C" Pipe Size**
100 lb.	63 – 108 lbs.	1-1/2" NPT	1-1/4" NPT	1" NPT
125 lb. (inverted)	73 – 126 lbs.	1-1/2" NPT	1-1/4" NPT	1" NPT
215 lb. (inverted)	128 – 223 lbs.	2" NPT	1-1/2" NPT	1" NPT
215 lb. (floor mount)	124 – 216 lbs.	2" NPT	1-1/2" NPT	1" NPT
375 lb.	217 – 378 lbs.	2-1/2" NPT	2" NPT	1-1/2" NPT
650 lb.	378 – 660 lbs.	3" NPT	2-1/2" NPT	2" NPT
1000 lb.	598 – 1045 lbs.	3" NPT	2-1/2" NPT	2" NPT

PIPE SIZE TABLE (METRIC)				
Container Size	**Fill Range**	**Section "A" Pipe Size**	**Section "B" Pipe Size**	**Section "C" Pipe Size**
44 L	28.5 – 48.5 kg	40 mm	32 mm	25 mm
51 L (inverted)	33.5 – 57 kg	40 mm	32 mm	25 mm
90 L (inverted)	58.5 – 101.0 kg	50 mm	40 mm	25 mm
87 L kg (floor mount)	56.5 – 98.0 kg	50 mm	40 mm	25 mm
153 L	98.5 – 171.5 kg	65 mm	50 mm	40 mm
267 L	171.5 – 299.0 kg	80 mm	65 mm	50 mm
423 L	271.5 – 474.0 kg	80 mm	65 mm	50 mm

NOTE: The Pipe Size and Nozzle Size are dependent upon the container size. The pipe sizes shown for each container size **MUST** be used.

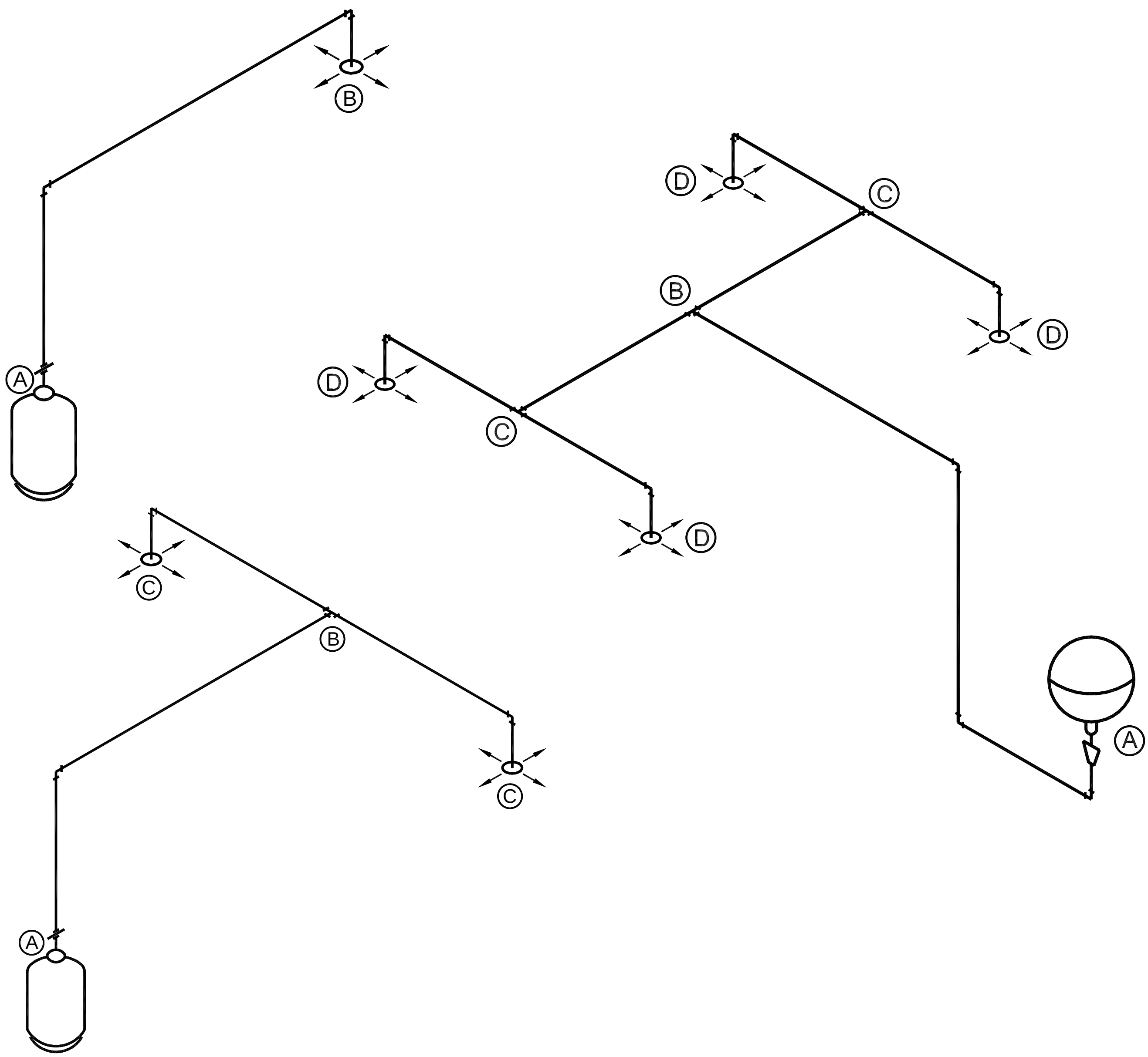
2.11.3 DETERMINING THE TOTAL PRESSURE DROP (TPD)

The maximum Total Pressure Drop (TPD) value for any Fike Pre-Engineered System is <100>. Systems with a TPD of 100 or less are acceptable designs that will discharge in ten (10) seconds or less, therefore meeting the performance criteria required by NFPA 2001, Section 3.

The Total Pressure Drop (TPD) value is determined as described in the following paragraphs.

2.11.3.1 PIPING LAYOUT DIAGRAM

A piping isometric or layout diagram is often desirable when determining the TPD value for a Pre-Engineered System. The diagram should be labeled to provide identification points (junction numbers) for each pipe segment, however, the designer will determine the TPD value for only one nozzle. Because two and four nozzle system configurations are balanced, when the designer determines that one nozzle will perform as required, the remaining nozzles will discharge similarly.



2.11.3.2 TOTAL PRESSURE DROP (TPD) CALCULATION

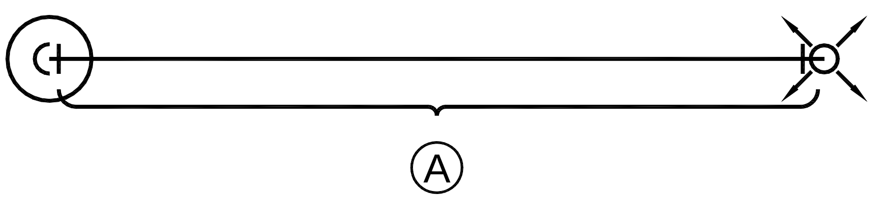
Refer to the appropriate factor table, (based on the number of nozzles & container size), and calculate the following:

- Length Factor – Multiply the length of each pipe section by the Length Factor (based on the pipe size for each section)
- 90^o Elbow Factor – Multiply the quantity of 90^o Elbows in each pipe section by the 90^o Elbow Factor (based on the pipe size for each section)
- 45^o Elbow Factor – Multiply the quantity of 45^o Elbows in each pipe section by the 45^o Elbow Factor (based on the pipe size for each section)
- Tee Factor – Multiply the quantity of Tees (this should always be <1>) in each pipe section by the Tee Factor (based on the pipe size for each section). The Tee Factor **MUST** be counted in the INLET section.
- Check Valve Factor – Add the equivalent length of the Check Valve (based on the discharge outlet valve size) for Main & Reserve system configurations
- Figure the Total Pressure Drop Factor – The TPD is the SUM of the Length, Elbow, Tee and Check Valve Factors for each section

NOTE: The TPD is based upon the flow to one (1) nozzle only. Since the Pre-Engineered System requires a balanced flow arrangement, it is assumed that if one (1) nozzle will discharge in the ten (10) second discharge requirement, the others will discharge similarly. However, the TPD **MUST** be based on the nozzle that is located farthest from the container.

WARNING: The Total Pressure Drop (TPD) **MUST** be <100> or less for the design/installation to be acceptable.

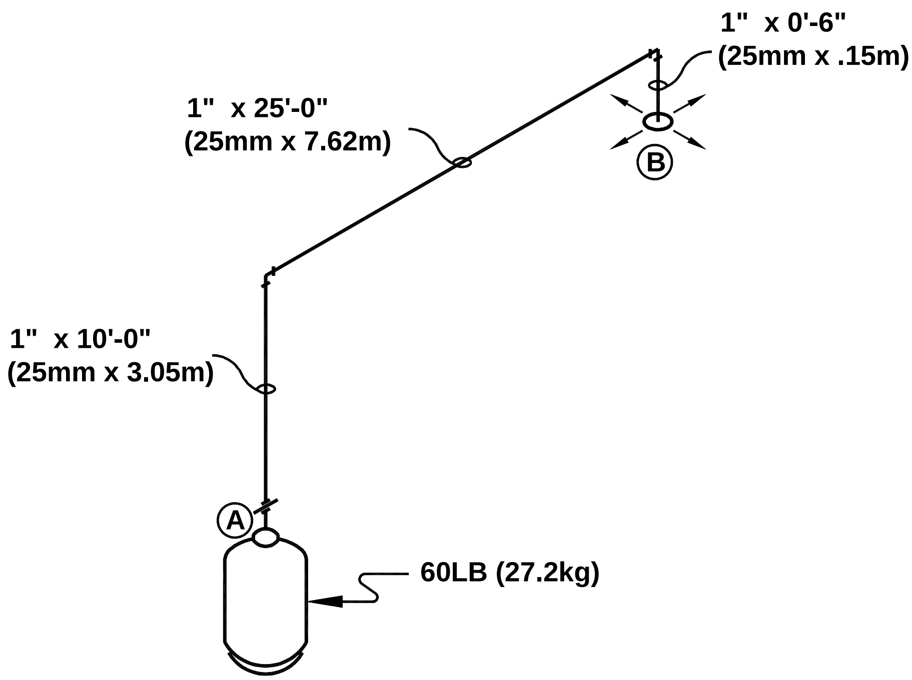
2.11.3.2-A SINGLE NOZZLE FACTORS TABLE



TPD FACTORS TABLE (ENGLISH)			
Pipe Size	**Length Factor**	**90^o Elbow Factor**	**45^o Elbow Factor**
1" NPT	1.00	2.80	1.30
1-1/2" NPT	0.85	3.66	1.70
2" NPT	0.80	4.40	2.08

TPD FACTORS TABLE (METRIC)			
Pipe Size	**Length Factor**	**90^o Elbow Factor**	**45^o Elbow Factor**
25 mm	3.28	2.80	1.30
40 mm	2.79	3.66	1.70
50 mm	2.62	4.40	2.08

EXAMPLE: SINGLE NOZZLE CONFIGURATION

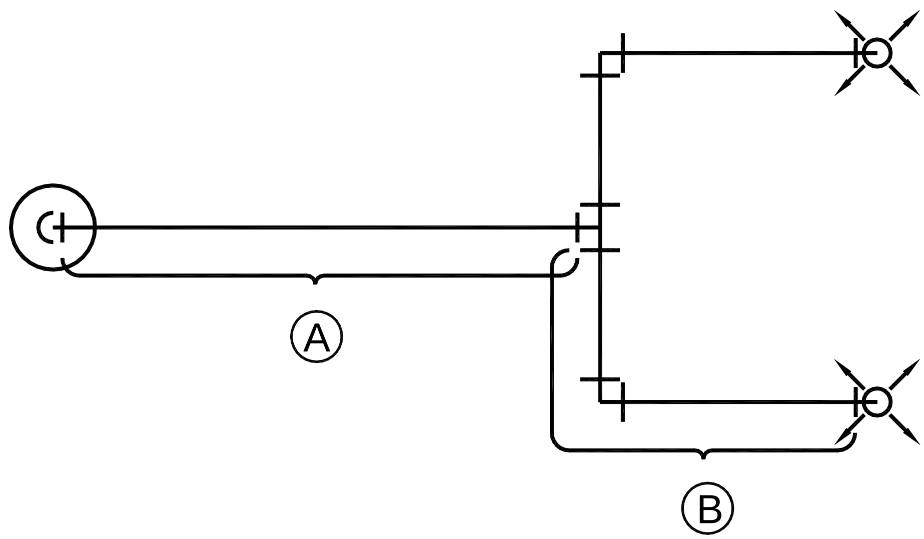


EXAMPLE (ENGLISH)				
Section A - B	35.5' x 1.00 (1" NPT)	=	35.50	(Length Factor)
	2 x 2.80 (1" x 90° Elbow)	=	5.60	(90° Elbow Factor)
	TPD	**=**	**41.10**	

EXAMPLE (METRIC)				
Section A - B	10.82 m x 3.28 (15 mm)	=	35.49	(Length Factor)
	2 x 2.80 (15 mm x 90° Elbow)	=	5.60	(90° Elbow Factor)
	TPD	**=**	**41.09**	

NOTE: TPD **MUST** be <100> or less.

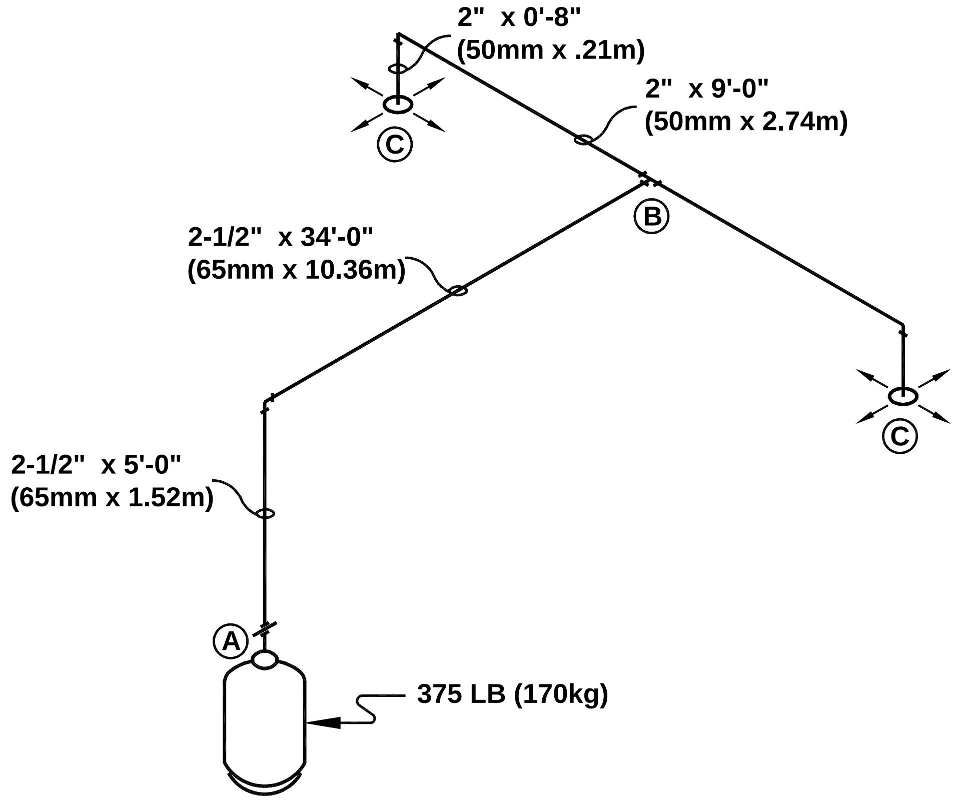
2.11.3.2-B TWO NOZZLE FACTORS TABLE



TPD FACTORS TABLE (ENGLISH)				
Pipe Size	Length Factor	90^o Elbow Factor	45^o Elbow Factor	Bullhead Tee Factor
1” NPT	1.00	2.80	1.30	5.70
1-1/2” NPT	0.85	3.66	1.70	7.40
2” NPT	0.80	4.40	2.08	8.96
2-1/2” NPT	0.77	5.08	2.39	10.32

TPD FACTORS TABLE (METRIC)				
Pipe Size	Length Factor	90^o Elbow Factor	45^o Elbow Factor	Bullhead Tee Factor
25 mm	3.28	2.80	1.30	5.70
40 mm	2.79	3.66	1.70	7.40
50 mm	2.62	4.40	2.08	8.96
65 mm	2.53	5.08	2.39	10.32

EXAMPLE: TWO NOZZLE CONFIGURATION

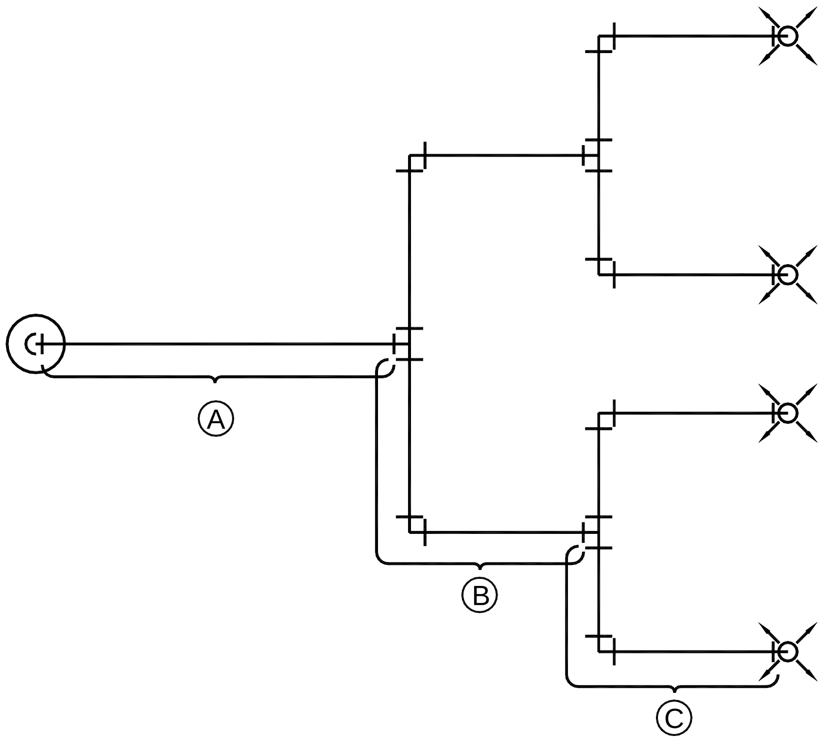


EXAMPLE (ENGLISH)				
Section A - B	39.0' x 0.77 (2-1/2" NPT)	=	30.03	(Length Factor)
	1 x 5.08 (2-1/2" x 90^o Elbow)	=	5.08	(90^o Elbow Factor)
	1 x 10.32 (2-1/2" NPT Tee)	=	10.32	(Tee Factor)
Section B – C	9.67' x 0.80 (2" NPT)	=	7.74	(Length Factor)
	1 x 4.40 (2" x 90^o Elbow)	=	4.40	(90^o Elbow Factor)
	TPD	**=**	**57.57**	

EXAMPLE (METRIC)				
Section A - B	11.88 m x 2.53 (65 mm)	=	30.06	(Length Factor)
	1 x 5.08 (65 mm x 90^o Elbow)	=	5.08	(90^o Elbow Factor)
	1 x 10.32 (65 mm Tee)	=	10.32	(Tee Factor)
Section B – C	2.95 m x 2.62 (50 mm)	=	7.73	(Length Factor)
	1 x 4.40 (50 mm x 90^o Elbow)	=	4.40	(90^o Elbow Factor)
	TPD	**=**	**57.59**	

NOTE: TPD **MUST** be <100> or less.

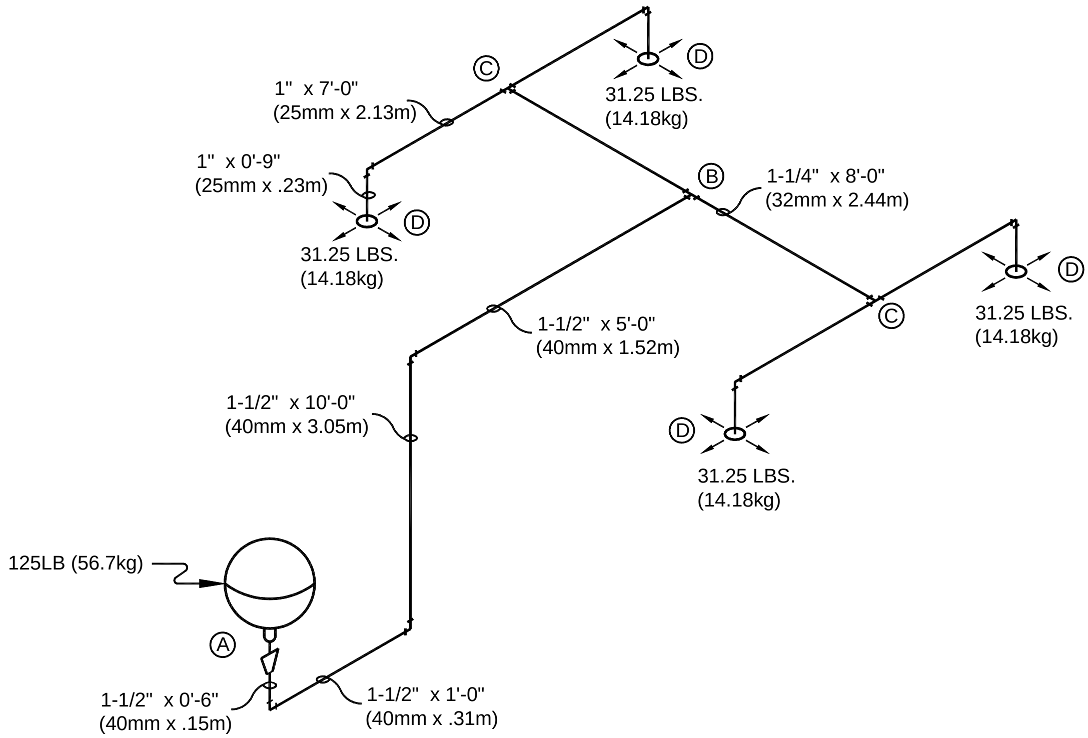
2.11.3.2-C FOUR NOZZLE FACTORS TABLE



TPD FACTORS TABLE (ENGLISH)				
Pipe Size	**Length Factor**	**90° Elbow Factor**	**45° Elbow Factor**	**Bullhead Tee Factor**
1” NPT	1.00	2.80	1.30	- - -
1-1/4” NPT	0.95	3.52	1.62	7.13
1-1/2” NPT	0.85	3.66	1.70	7.40
2” NPT	0.80	4.40	2.08	8.96
2-1/2” NPT	0.77	5.08	2.39	10.32
3” NPT	0.77	6.31	2.93	12.78

TPD FACTORS TABLE (METRIC)				
Pipe Size	**Length Factor**	**90° Elbow Factor**	**45° Elbow Factor**	**Bullhead Tee Factor**
25 mm	3.28	2.80	1.30	- - -
32 mm	3.12	3.52	1.62	7.13
40 mm	2.79	3.66	1.70	7.40
50 mm	2.62	4.40	2.08	8.96
65 mm	2.53	5.08	2.39	10.32
80 mm	2.53	6.31	2.93	12.78

EXAMPLE: FOUR NOZZLE CONFIGURATION



EXAMPLE (ENGLISH)				
Section A - B	16.5’ x 0.85 (1-1/2” NPT)	=	14.03	(Length Factor)
	3 x 3.66 (1-1/2” x 90^o Elbow)	=	10.98	(90^o Elbow Factor)
	1 x 7.40 (1-1/2” NPT Tee)	=	7.40	(Tee Factor)
Section B - C	8.0’ x 0.95 (1-1/4” NPT)	=	7.60	(Length Factor)
	1 x 7.13 (1-1/4” NPT Tee)	=	7.13	(Tee Factor)
Section C - D	7.75’ x 1.00 (1” NPT)	=	7.75	(Length Factor)
	1 x 2.80 (1” x 90^o Elbow)	=	2.80	(90^o Elbow Factor)
	TPD	**=**	**57.69**	

EXAMPLE (METRIC)				
Section A - B	5.03 m x 2.79 (40 mm)	=	14.03	(Length Factor)
	3 x 3.66 (40 mm x 90^o Elbow)	=	10.98	(90^o Elbow Factor)
	1 x 7.40 (40 mm Tee)	=	7.40	(Tee Factor)
Section B - C	2.44 m x 3.12 (32 mm)	=	7.61	(Length Factor)
	1 x 7.13 (32 mm Tee)	=	7.13	(Tee Factor)
Section C - D	2.36 m x 3.28 (25 mm)	=	7.74	(Length Factor)
	1 x 2.80 (25 mm x 90^o Elbow)	=	2.80	(90^o Elbow Factor)
	TPD	**=**	**57.69**	

NOTE: TPD **MUST** be <100> or less.

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This section is intended to illustrate a step by step procedure for designing a Fike HFC-227ea system. The sample system will be designed to comply with the guidelines and limitations discussed in the previous sections.

For detailed instructions, consult Fike's HFC-227ea Engineered System Flow Calculation Program manual for the use and operation of the program.

The following example consists of a computer room, U.P.S. room and operations room with a common sub-floor.

3.1 DETERMINE HAZARD VOLUME

The first step is to determine the hazard area and volume for each enclosure involved. Refer to Figure 3.1 for details.

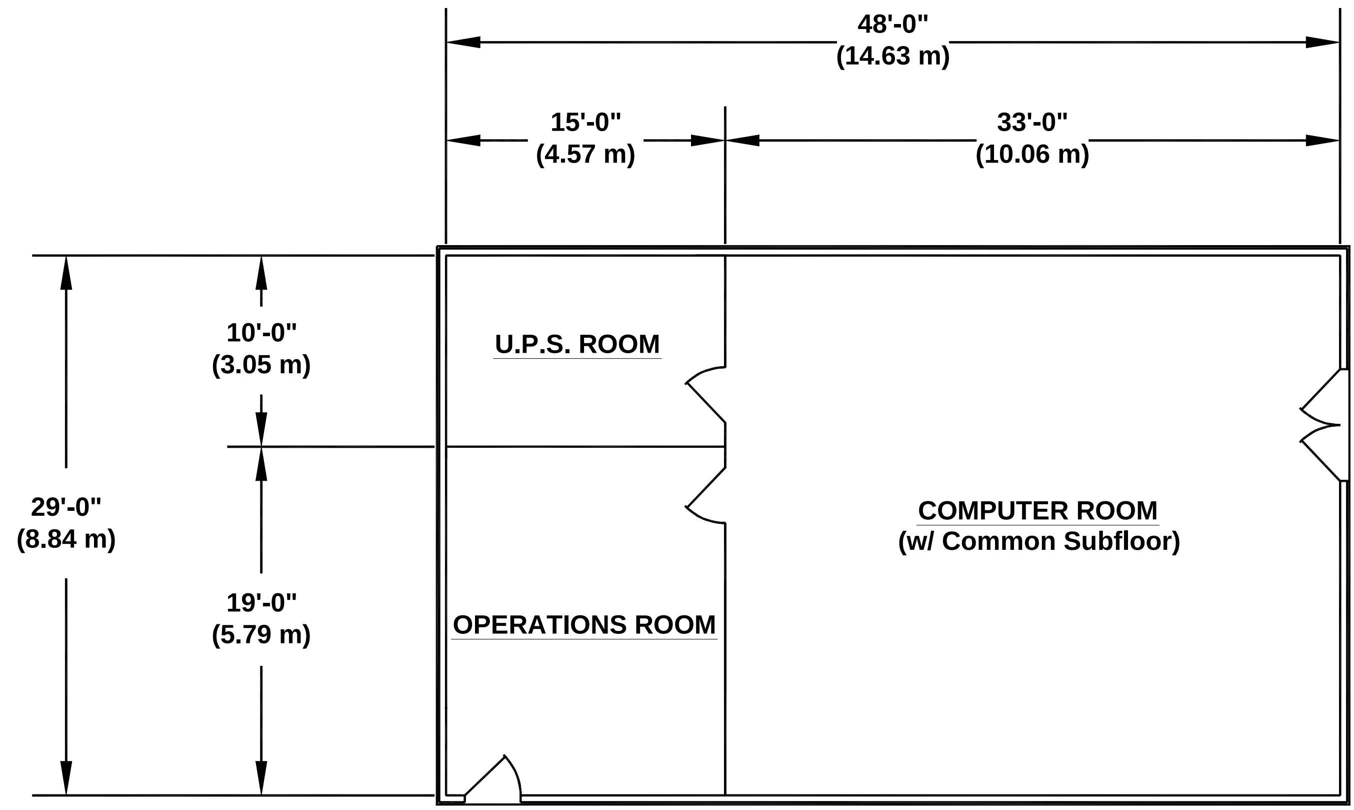


FIGURE 3.1

English Values							Metric Units					
Computer Rm:	29.0 x 33.0 =	957 sf	x	9.0	=	8613.0 cf	8.84 x 10.06 =	88.93 m^2	x	2.743	=	243.86m^3
UPS Room:	10.00 x 15.0 =	150 sf	x	9.0	=	1350.0 cf	3.05 x 4.57 =	13.94 m^2	x	2.743	=	38.22 m^3
Operations Room:	14.0 x 15.0 =	210 sf	x	9.0	=	1890.0 cf	4.27 x 4.57 =	19.51 m^2	x	2.743	=	53.51 m^3
Sub-Floor:	29.0 x 48.0 =	1393 sf	x	1.2	=	1670.4 cf	8.84 x 14.63 =	129.33 m^2	x	0.381	=	47.30 m^3

3.2 CALCULATE AGENT REQUIRED

The 6.25% minimum design concentration has been adjusted to 6.5% due to multiple hazards being protected from a common agent supply. The minimum expected storage temperature of the container in this example is 70° F (21°C).

Note:
Adjusting the design concentration from 6.25% to 6.5% when protecting multiple hazards from a common agent supply is to help achieve the 6.25% minimum concentration required (in each hazard) when adjusting from a theoretical orifice size to an actual drill size. This concentration adjustment is a recommendation not a requirement.

English Units	Metric Units
Computer Room / 8613 cf: $W = \frac{8613}{2.2075} \times \frac{6.5}{(100 - 6.5)} = 272$ lbs	Computer Room / 243.9m^3 $W = \frac{243.9}{.13781} \times \frac{6.5}{(100 - 6.5)} = 123.5$ kg
UPS Room / 1350 cf: $W = \frac{1350}{2.2075} \times \frac{6.5}{(100 - 6.5)} = 43$ lbs	UPS Room / 38.23m^3 $W = \frac{38.23}{.13781} \times \frac{6.5}{(100 - 6.5)} = 19.5$ kg
Operations Room / 2565 cf: $W = \frac{2565}{2.2075} \times \frac{6.5}{(100 - 6.5)} = 81$ lbs	Operations Room / 53.52m^3 $W = \frac{72.63}{.13781} \times \frac{6.5}{(100 - 6.5)} = 37.0$ kg
Sub-Floor / 1740.0 cf: $W = \frac{1670.4}{2.2075} \times \frac{6.5}{(100 - 6.5)} = 53$ lbs	Sub-Floor / 49.27m^3 $W = \frac{47.30}{.13781} \times \frac{6.5}{(100 - 6.5)} = 24.0$ kg

3.2.1 DETERMINE CONCENTRATION AT MAXIMUM TEMPERATURE

The next step is to check the concentration level, at the maximum temperature that is anticipated within all the hazard enclosures being protected, in order to verify the concentration achieved is not above the human exposure limits show in Section 2.3. For this example, we are utilizing a maximum temperature of 90° F.

English Units	Metric Units
Computer Room $C = \frac{100\ (272 \times 2.2994)}{8613 + (272 \times 2.2994)} = 6.509\%$	$C = \frac{100\ (123.5 \times 0.14355)}{243.89 + (123.5 \times 0.14355)} = 6.509\%$
UPS Room: $C = \frac{100\ (43 \times 2.2994)}{1350 + (43 \times 2.2994)} = 6.511\%$	$C = \frac{100\ (19.5 \times 0.14355)}{38.23 + (19.5 \times 0.14355)} = 6.511\%$
Operations Room: $C = \frac{100\ (81 \times 2.2994)}{1890 + (81 \times 2.2994)} = 6.508\%$	$C = \frac{100\ (37 \times 0.14355)}{72.63 + (37 \times 0.14355)} = 6.508\%$
Sub-Floor: $C = \frac{100\ (53 \times 2.2994)}{1670.4 + (53 \times 2.2994)} = 6.521\%$	$C = \frac{100\ (24 \times 0.14355)}{47.30 + (24 \times 0.14355)} = 6.521\%$

3.3 ESTABLISH SYSTEM CONCEPT

This system has four areas that need fire protection – each with a different amount of agent for each enclosure and different nozzle requirements. Of the three types of systems that we can apply to these hazard areas, the most flexible is the unbalanced system.

3.3.1 CONTAINER SELECTION

This system requires a total of 448 lbs. (203.5 kg) of HFC-227ea to protect all four hazard areas, which allows us to utilize a common agent supply. Refer to Table 2.4.2 for the container selections available.

Container size = 650 lb. (295 kg) with a 448 lb. (203.5 kg) fill weight

3.3.2 NOZZLES REQUIRED

Step 1: Determine the correct number and size of nozzle(s) required for each hazard area and calculate the nozzle flow rate required to discharge the system in a maximum of 10 seconds.

Computer Room =	272 lbs./(123.5 kg) / 10 seconds	= 27.2 lbs. (12.35 kg) / sec ÷ 2 = 13.6 lbs. (6.17 kg) / sec Use 2 nozzles to get the flow rate under 20 lbs. (9 kg) / sec
UPS Room =	43 lbs./(19.5 kg) / 10 seconds	= 4.3 lbs. (1.95 kg) / second Use 1 nozzle
Operations Room =	81 lbs./(37 kg) / 10 seconds	= 8.1 lbs. (3.7 kg) / second Use 1 nozzle
Sub-Floor =	53 lbs./(24 kg) / 10 seconds	= 5.3 lbs. (2.4 kg) / second Use 1 nozzle

Step 2: Determine the nozzle sizes based on the minimum and maximum pipeline flow rate and from the flow rate established in Step 1.

Computer Room	=	13.6 lbs. (6.17 kg) / second - Use (2) 2" (50 mm) nozzles
UPS Room	=	4.3 lbs. (1.95 kg) / second - Use (1) 1" (25 mm) nozzle
Operations Room	=	8.1lbs. (3.7 kg) / second - Use (1) 1 1/2" (40 mm) nozzle
Sub-Floor	=	5.3 lbs. (2.4 kg) / second - Use (1) 1 1/4" (32 mm) nozzles

Step 3: Locate the nozzle(s) on a scaled plan view of the hazard areas being protected. This will allow you to check the area coverage of each nozzle being used. This will also determine if you use 180° or 360° nozzles, or a combination of the two.

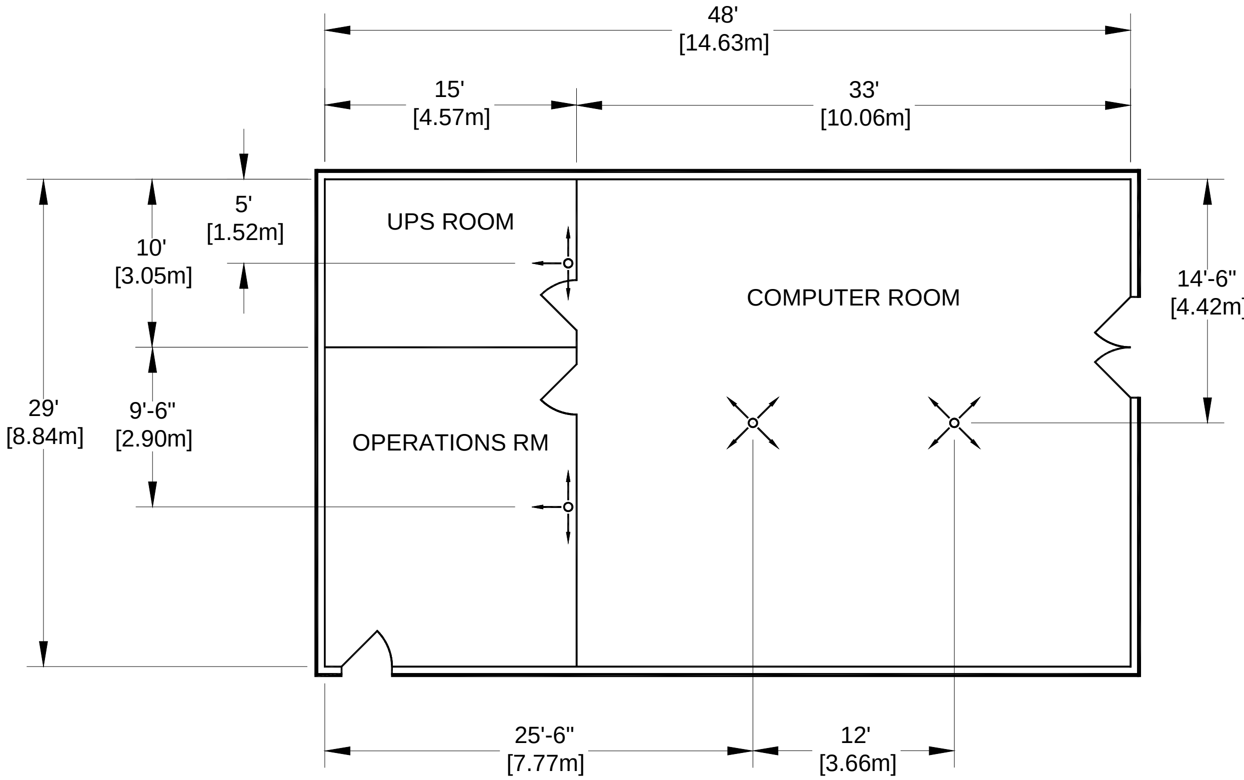


FIGURE 3.3.2-A

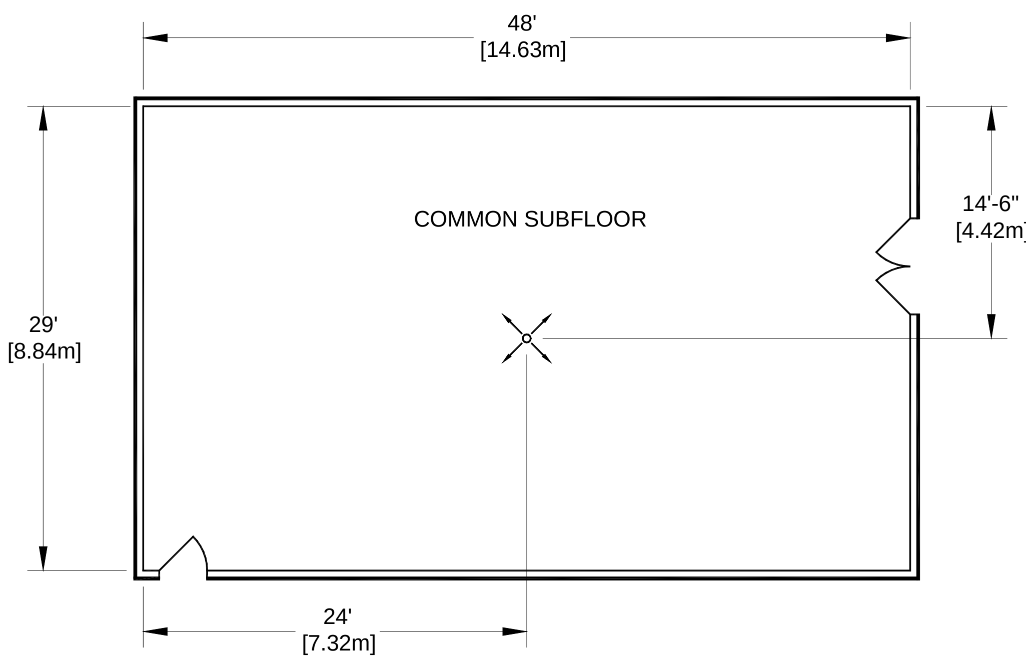


FIGURE 3.3.2-B

3.4 LAYOUT PIPING NETWORK

Step 1: Layout pipe network and container location(s) on a scaled plan view. While many methods of pipe routing may exist in any given system, it is best to supply nozzles, or groups of nozzles, from central points along the trunk line to avoid high degrees of piping imbalance.

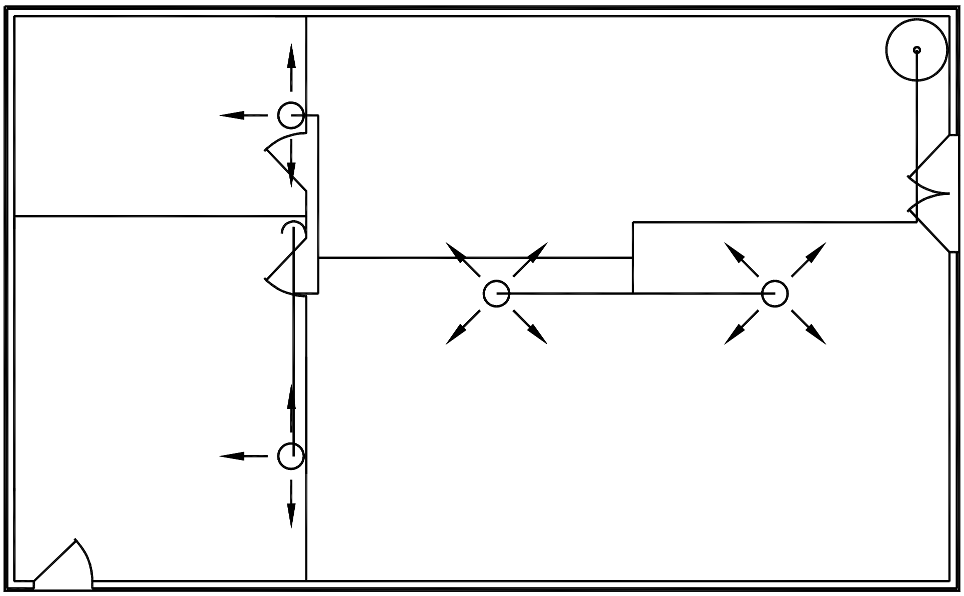


FIGURE 3.4-A

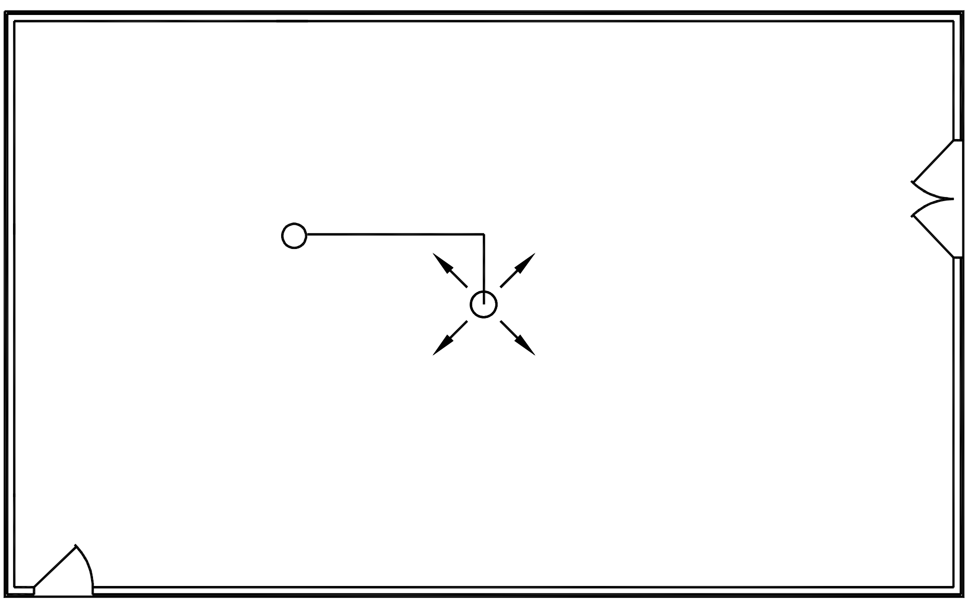


FIGURE 3.4-B

Step 2: Layout a piping isometric to show all elevation changes, fittings, pipe sizes and lengths. Pipe sizes will be based on the flow rate for each section and selected from Table 2.6.3. Check the piping network for tee split ratios, tee orientation, minimum piping distances, proper nozzle screen quantity and location, etc.

IMPORTANT: Your final design **"must"** be checked by using Fike's HFC-227ea Engineered System Flow Calculation Program before installation starts. When using the "Isometric" input portion of the flow calculation program, it is not necessary to assign "Node" points to the piping isometric as the isometric input will automatically assign node point numbers as you draw the piping system.

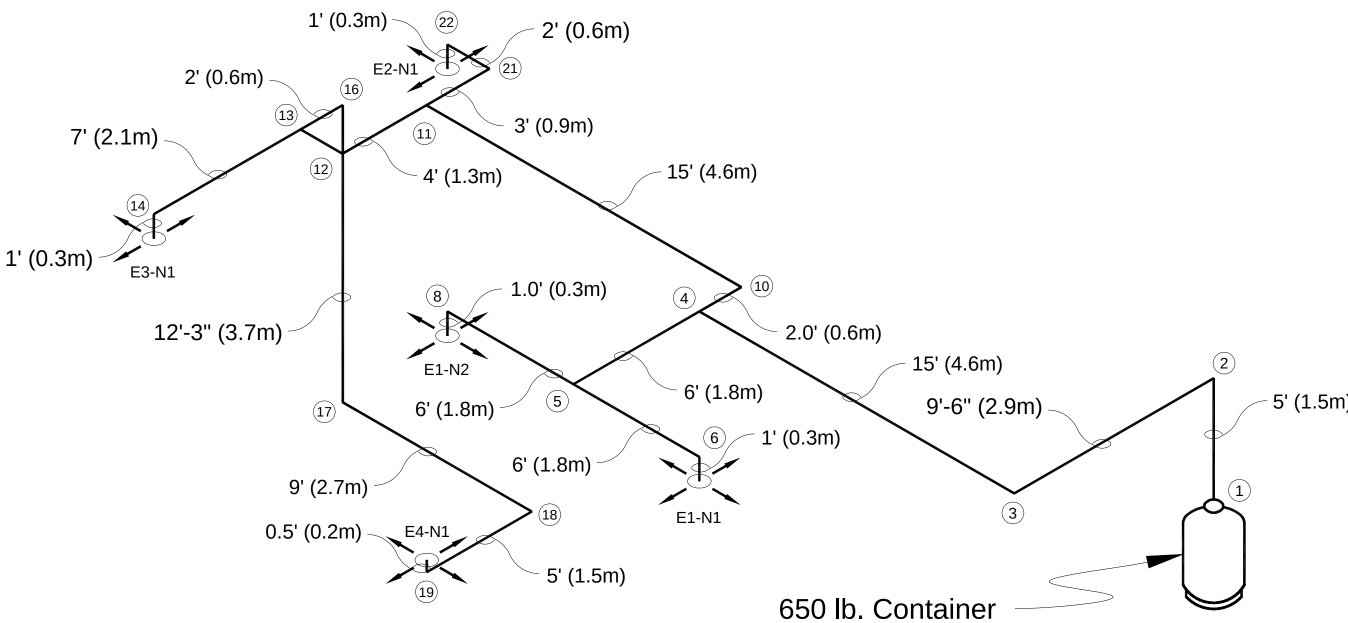


FIGURE 3.4-C

The following pages are a copy of the Fike's HFC-227ea Engineered System Flow Calculation Program printout showing the inputs and outputs of the program.

3.5 SAMPLE FLOW CALCULATION

Fike Corporation

704 South 10th Street
Blue Springs, MO 64015
Phone: (800) 979-3453
Fike HFC-227ea FlowCalc FIK3.00
UL: EX4623 FM: OY4A8.AF
Project: Data Center
File Name: section 3 sample problem 625.FLC

Consolidated Report

Customer Information

Company Name:	ABC International
Address:	1220 East 4th Street Kansas City, MO
Phone:	(816) 229-7570
Contact:	S.M. Ferrier
Title:	Manager - Information Systems

Project Data

Project Name:	Data Center
Designer:	Kolten Andrew
Number:	
Account:	
Location:	
Description:	3 rooms with common sub-floor

Page: 1 of 11
Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1
Enclosure Number:	1
Name:	Computer Room
Enclosure Temperature...	
Minimum:	70 F
Maximum:	70 F
Maximum Concentration:	6.509 %
Design Concentration...	
Adjusted:	6.508 %
Minimum:	6.250 %
Minimum Agent Required:	260.2 lbs
Width:	29.0 ft
Length:	33.0 ft
Height:	9.0 ft
Volume:	8613.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	8613.0 cubic ft
Adjusted Agent Required:	271.7 lbs
Number of Nozzles:	2

Page: 2 of 11

Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1
Enclosure Number:	2
Name:	UPS Room
Enclosure Temperature...	
Minimum:	70 F
Maximum:	70 F
Maximum Concentration:	6.511 %
Design Concentration...	
Adjusted:	6.510 %
Minimum:	6.250 %
Minimum Agent Required:	40.8 lbs
Width:	15.0 ft
Length:	10.0 ft
Height:	9.0 ft
Volume:	1350.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	1350.0 cubic ft
Adjusted Agent Required:	42.6 lbs
Number of Nozzles:	1

Page: 3 of 11

Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1
Enclosure Number:	3
Name:	Operations Room
Enclosure Temperature...	
Minimum:	70 F
Maximum:	70 F
Maximum Concentration:	6.508 %
Design Concentration...	
Adjusted:	6.507 %
Minimum:	6.250 %
Minimum Agent Required:	77.5 lbs
Width:	15.0 ft
Length:	19.0 ft
Height:	9.0 ft
Volume:	2565.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	2565.0 cubic ft
Adjusted Agent Required:	80.9 lbs
Number of Nozzles:	1

Page: 4 of 11
Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Consolidated Report
Enclosure Information

Elevation:	0 ft (relative to sea level)
Atmospheric Correction Factor:	1
Enclosure Number:	4
Name:	Common Sub-floor
Enclosure Temperature...	
Minimum:	70 F
Maximum:	70 F
Maximum Concentration:	6.521 %
Design Concentration...	
Adjusted:	6.521 %
Minimum:	6.250 %
Minimum Agent Required:	50.5 lbs
Width:	29.0 ft
Length:	48.0 ft
Height:	1.2 ft
Volume:	1670.4 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	1670.4 cubic ft
Adjusted Agent Required:	52.8 lbs
Number of Nozzles:	1

Page: 5 of 11
Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Consolidated Report
Agent Information

Agent: HFC-227ea / Propellant N2

Adjusted Agent Required: 448.0 lbs
Cylinder Name: 650 lb. Cylinder, Upright
Cylinder Part Number: 70-083
Number of Main Cylinders: 1
Number of Reserve Cylinders: 0
Manifold: No Manifold

Pipe Take Off Direction: Up
Agent Per Cylinder: 448.0 lbs
Fill Density: 48.2 lbs / cubic ft
Cylinder Empty Weight: 456.0 lbs
Weight, All Cylinders + Agent: 904.0 lbs
Floor Area Per Cylinder: 2.18 square ft
Floor Loading Per Cylinder: 415 lbs / square ft

Pipe Network

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Main Cyl. X 1	0	1		3 in	5.48 ft	5.48 ft
Pipe	1	2	40T	2 in	5.00 ft	5.00 ft
Pipe	2	3	40T	2 in	9.50 ft	0.00 ft
Pipe	3	4	40T	2 in	15.00 ft	0.00 ft
Pipe	4	5	40T	2 in	6.00 ft	0.00 ft
Pipe	5	6	40T	2 in	6.00 ft	0.00 ft
Pipe/E1-N1	6	7	40T	2 in	1.00 ft	-1.00 ft
Pipe	5	8	40T	2 in	6.00 ft	0.00 ft
Pipe/E1-N2	8	9	40T	2 in	1.00 ft	-1.00 ft
Pipe	4	10	40T	1-1/2 in	2.00 ft	0.00 ft
Pipe	10	11	40T	1-1/2 in	15.00 ft	0.00 ft

Page: 6 of 11
Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Fike

Consolidated Report

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Pipe	11	12	40T	1-1/2 in	4.00 ft	0.00 ft
Pipe	12	13	40T	1-1/2 in	2.00 ft	0.00 ft
Pipe	13	14	40T	1-1/2 in	7.00 ft	0.00 ft
Pipe/E3-N1	14	15	40T	1-1/2 in	1.00 ft	-1.00 ft
Pipe	13	16	40T	1-1/4 in	2.00 ft	0.00 ft
Pipe	16	17	40T	1-1/4 in	12.25 ft	-12.25 ft
Pipe	17	18	40T	1-1/4 in	9.00 ft	0.00 ft
Pipe	18	19	40T	1-1/4 in	5.00 ft	0.00 ft
Pipe/E4-N1	19	20	40T	1-1/4 in	0.50 ft	0.50 ft
Pipe	11	21	40T	1 in	3.00 ft	0.00 ft
Pipe	21	22	40T	1 in	2.00 ft	0.00 ft
Pipe/E2-N1	22	23	40T	1 in	1.00 ft	-1.00 ft

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
0	1	0	0	0	0	0		0.00 ft	6.5 ft
1	2	0	0	0	0	0		0.00 ft	5.0 ft
2	3	1	0	0	0	0		0.00 ft	15.0 ft
3	4	1	0	0	0	0		0.00 ft	20.5 ft
4	5	0	0	0	1	0		0.00 ft	17.2 ft
5	6	0	0	0	1	0		0.00 ft	17.2 ft
6	7	1	0	0	0	0		0.00 ft	6.5 ft
5	8	0	0	0	1	0		0.00 ft	17.2 ft
8	9	1	0	0	0	0		0.00 ft	6.5 ft
4	10	0	0	0	1	0		0.00 ft	10.7 ft
10	11	1	0	0	0	0		0.00 ft	19.3 ft
11	12	0	0	0	1	0		0.00 ft	12.7 ft
12	13	1	0	0	0	0		0.00 ft	6.3 ft
13	14	0	0	0	1	0		0.00 ft	15.7 ft
14	15	1	0	0	0	0		0.00 ft	5.3 ft
13	16	0	0	0	1	0		0.00 ft	9.5 ft
16	17	1	0	0	0	0		0.00 ft	16.0 ft
17	18	1	0	0	0	0		0.00 ft	12.7 ft

Page: 7 of 11

Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Consolidated Report

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
18	19	1	0	0	0	0		0.00 ft	8.7 ft
19	20	1	0	0	0	0		0.00 ft	4.2 ft
11	21	0	0	0	1	0		0.00 ft	8.7 ft
21	22	1	0	0	0	0		0.00 ft	4.8 ft
22	23	1	0	0	0	0		0.00 ft	3.8 ft

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	448.0 lbs				
1	2	448.0 lbs				
2	3	448.0 lbs				
3	4	448.0 lbs				
4	5	271.7 lbs				
5	6	135.9 lbs				
6	7	135.9 lbs	E1-N1	2 in	360 Degree	0.9411 square in
5	8	135.8 lbs				
8	9	135.8 lbs	E1-N2	2 in	360 Degree	0.9411 square in
4	10	176.3 lbs				
10	11	176.3 lbs				
11	12	133.7 lbs				
12	13	133.7 lbs				
13	14	80.9 lbs				
14	15	80.9 lbs	E3-N1	1-1/2 in	180 Degree	1.0212 square in
13	16	52.8 lbs				
16	17	52.8 lbs				
17	18	52.8 lbs				
18	19	52.8 lbs				
19	20	52.8 lbs	E4-N1	1-1/4 in	360 Degree	0.7926 square in
11	21	42.6 lbs				
21	22	42.6 lbs				
22	23	42.6 lbs	E2-N1	1 in	180 Degree	0.3235 square in

Parts Information

Page: 8 of 11

Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Consolidated Report

Total Agent Required: 448.0 lbs
Cylinder Name: 650 lb. Cylinder, Upright (Part: 70-083)
Number Of Cylinders: 1
Field1

Nozzle	Type	Diameter	Nozzle Area	Part Number
E1-N1	360 Degree	2 in	0.9411 square in	80-058-3160
E1-N2	360 Degree	2 in	0.9411 square in	80-058-3160
E2-N1	180 Degree	1 in	0.3235 square in	80-063-1935
E3-N1	180 Degree	1-1/2 in	1.0212 square in	80-065-3438
E4-N1	360 Degree	1-1/4 in	0.7926 square in	80-056-2900

Nozzle	Drill Diameter	Drill Size
E1-N1	0.3160 inches	O
E1-N2	0.3160 inches	O
E2-N1	0.1935 inches	10
E3-N1	0.3438 inches	11/32
E4-N1	0.2900 inches	L

Pipe:	Type	Diameter	Length
	40T	1 in	6.00 ft
	40T	1-1/4 in	28.75 ft
	40T	1-1/2 in	31.00 ft
	40T	2 in	49.50 ft

List of 90 degree elbows:
2 - 1 in
3 - 1-1/2 in
4 - 1-1/4 in
4 - 2 in

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

Page: 9 of 11
Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Consolidated Report
System Acceptance

System Discharge Time: 8.0 seconds
Percent Agent In Pipe: 37.7%
Percent Agent Before First Tee: 13.4%

Enclosure Number: 1
Enclosure Name: Computer Room

Minimum Design Concentration: 6.250%
Adjusted Design Concentration: 6.508%
Predicted Concentration: 6.370%
Maximum Expected Agent Concentration: 6.370% (At 70 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	130.1 lbs	135.9 lbs	132.8 lbs	121 psig
E1-N2	130.1 lbs	135.8 lbs	132.8 lbs	121 psig

Enclosure Number: 2
Enclosure Name: UPS Room

Minimum Design Concentration: 6.250%
Adjusted Design Concentration: 6.510%
Predicted Concentration: 7.278%
Maximum Expected Agent Concentration: 7.278% (At 70 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E2-N1	40.8 lbs	42.6 lbs	48.0 lbs	96 psig

Enclosure Number: 3
Enclosure Name: Operations Room

Minimum Design Concentration: 6.250%
Adjusted Design Concentration: 6.507%
Predicted Concentration: 6.388%
Maximum Expected Agent Concentration: 6.388% (At 70 F)

Page: 10 of 11
Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

Fike

Consolidated Report

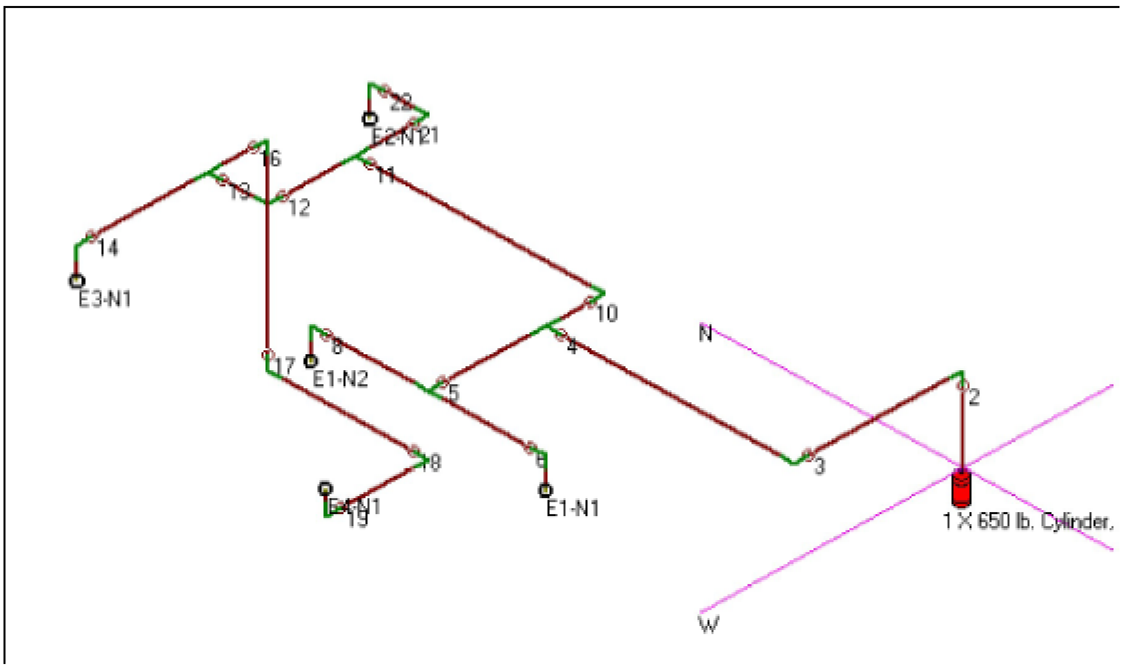
Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E3-N1	77.5 lbs	80.9 lbs	79.3 lbs	77 psig

Enclosure Number: 4
Enclosure Name: Common Sub-floor

Minimum Design Concentration: 6.250%
Adjusted Design Concentration: 6.521%
Predicted Concentration: 6.794%
Maximum Expected Agent Concentration: 6.794% (At 70 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E4-N1	50.5 lbs	52.8 lbs	55.2 lbs	59 psig

Drawing View: 1



Page: 11 of 11
Calculation Date/Time: Monday, March 01, 2004, 10:23:29 AM

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The system installation must comply with the requirements of this manual; NFPA 2001, latest edition; all applicable local codes, regulations, and standards and the authority having jurisdiction (AHJ).

4.1 AGENT STORAGE CONTAINERS

The following sections provide pictorial clarification and procedures for the correct installation and mounting positions of Fike containers and associated hardware.

Make certain that each container has been installed in the correct location. Each container should have a nameplate with an identifying part number. Check the container part number against those listed on the system plans to verify their locations.

Containers should be located in clean, dry, and relatively vibration-free areas. Avoid aisleways and other high traffic areas where physical damage or tampering is more likely. Containers should never be mounted where the container could potentially be splashed with, or submerged in any liquid.

Container brackets must be mounted securely to solid load-bearing surfaces that will support the container load. Some installations may require additional mounting support not supplied by Fike.

WARNING: The Gas Cartridge Actuator (GCA) should **always** be the last component installed on a Fike Clean Agent system.

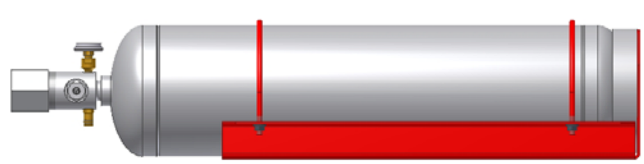
4.1.1 MOUNTING DETAILS FOR VERTICAL / HORIZONTAL CONTAINERS

20 – 60 lb. (8 – 27 L) Containers are supplied with mounting brackets that must be secured to a solid, load-bearing surface using a minimum of four fasteners. As an option, the brackets may be welded into place. These containers can be mounted in the following configurations:

- Floor or wall mounted in the vertical (valve up) position
- Floor mounted in the horizontal (pressure gauge up) position

CAUTION: These containers have siphon tubes. **DO NOT** mount the containers in the inverted (valve down) position. Failure to comply with this requirement will result in an incomplete discharge.

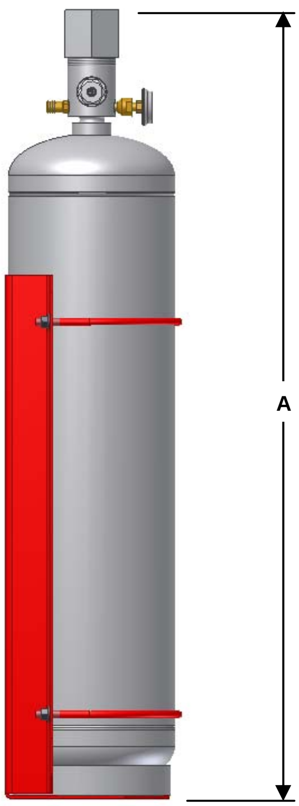
Vertical (Upright)



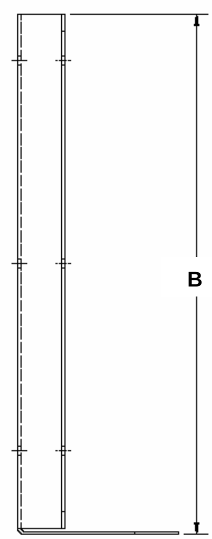
Horizontal Floor

4.1.1.1 MOUNTING DETAILS FOR 20 lb. AND 35 LB. (8.5L & 15L) CONTAINER P/N 70-098, 70-098T, 70-089 AND 70-089T

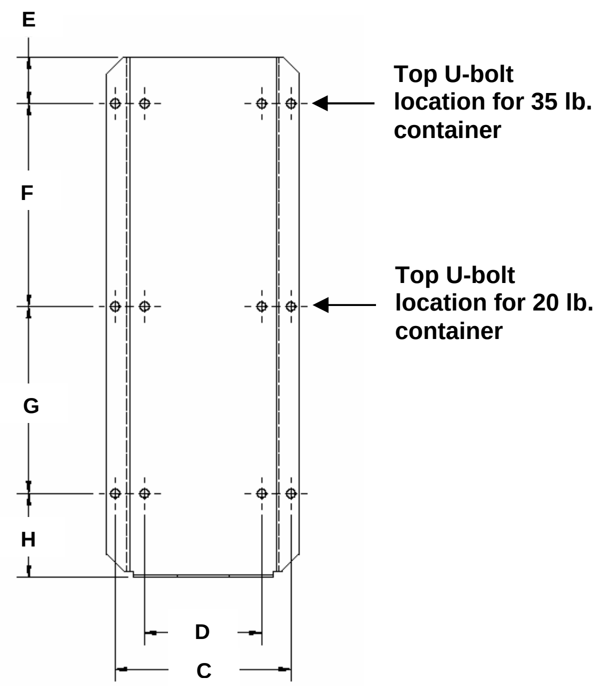
IMPORTANT NOTE: When mounting the 20 lb. or 35 lb. containers in the horizontal positions (wall mount or sub-floor mount), the container pressure gauge MUST point up.



Dimension	20 lb. Container		35 lb. Container	
	w/ Welded Valve in (mm)	w/ Threaded Valve in (mm)	w/ Welded Valve in (mm)	w/ Threaded Valve in (mm)
A	21-1/2 (546)	23-1/2 (597)	32-1/2 (826)	35 (889)

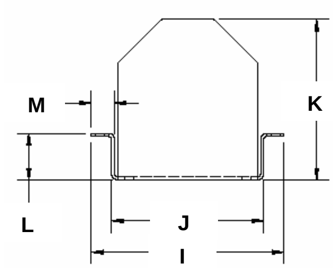


Side View



Front View

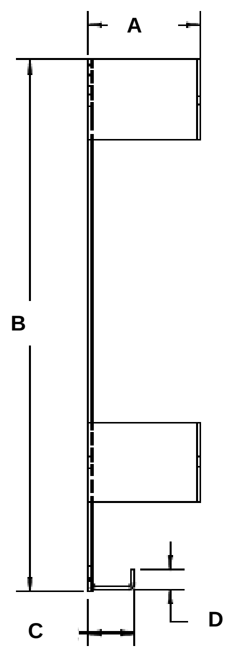
Dimension	(in)	(mm)
B	22-9/32	566
C	7-1/2	191
D	5	127
E	2	51
F	8-11/16	221
G	8	203
H	3-19/32	91
I	8-7/32	209
J	6-1/2	165
K	6-7/8	175
L	2	51
M	1	25



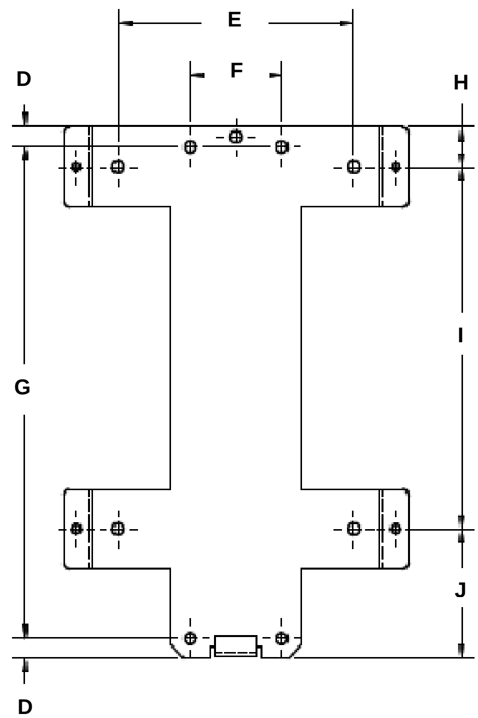
Bottom View

ALL DIMENSIONS ARE APPROXIMATE

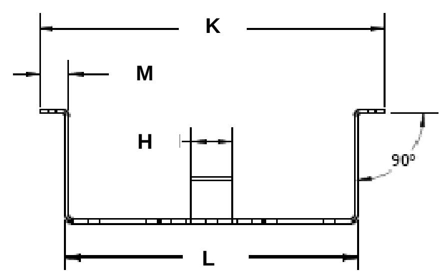
4.1.1.2 MOUNTING DETAILS FOR 60 lb. (27 L) CONTAINER, P/N 70-152 & 70-152T



Side View



Front View



Bottom View

Dimensions	Inch (mm)
A	4 ¼ (108)
B	20 (508)
C	1 ¾ (44)
D	¾ (19)
E	9 (229)
F	3 ½ (89)
G	18 ½ (470)
H	1 ½ (38)
I	13 5/8 (346)
J	4 7/8 (124)
K	13 3/16 (335)
L	11 5/32 (283)
M	1 5/32" (29)

Overall Height – 60 lb. Container	
w/ Welded Valve in (mm)	w/ Threaded Valve in (mm)
28 (711)	29-1/4 (743)

ALL DIMENSIONS ARE APPROXIMATE

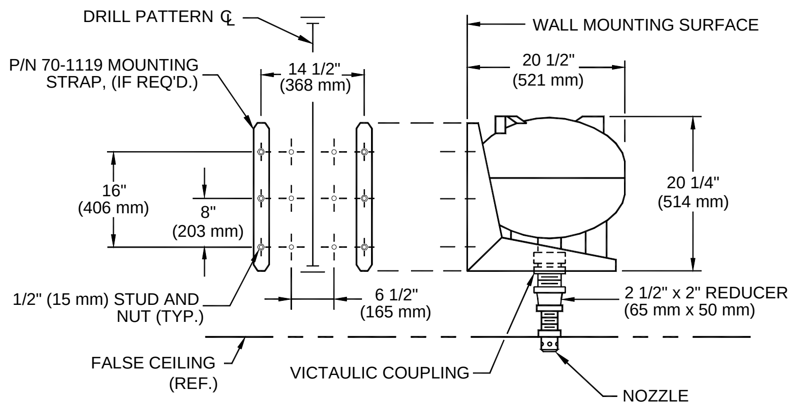
4.1.2 MOUNTING DETAILS FOR INVERTED (SPHERICAL) CONTAINERS

125 & 215 lb. (51 & 90 L) Inverted Containers are supplied with mounting brackets that must be secured to a solid, load-bearing wall. These containers DO NOT have siphon tubes; therefore, they MUST be mounted in the inverted (valve down) position.

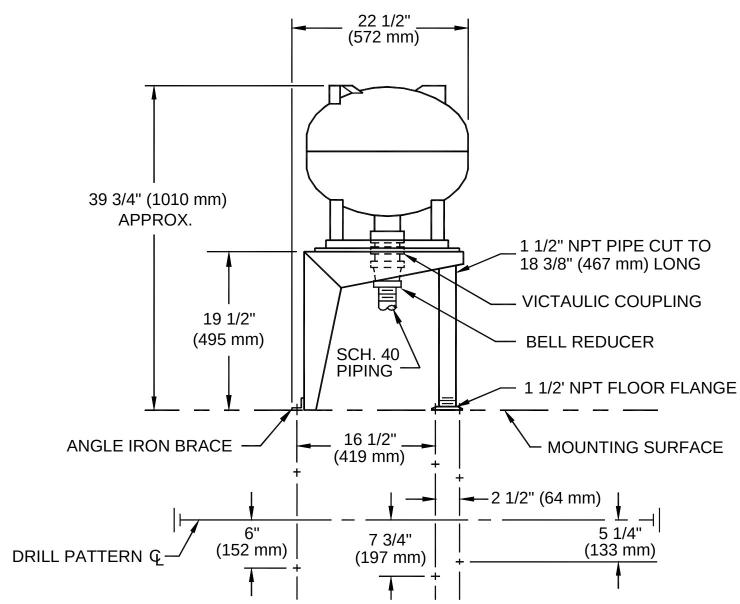
Additional hardware such as the optional backing/mounting straps (P/N 70-1119) is required when mounting Inverted Containers to porous block walls. For this application, the anchor bolts must run through the wall and through the backing/mounting brackets on the opposite side to provide structural integrity.

An optional Floor Mounting Kit is available for both container sizes. When using this option, the floor mounting kit must be anchored to a solid, load-bearing floor or similar surface.

4.1.2.1 MOUNTING DETAILS FOR: 125 lb. (51 L) CONTAINER, P/N 70-041

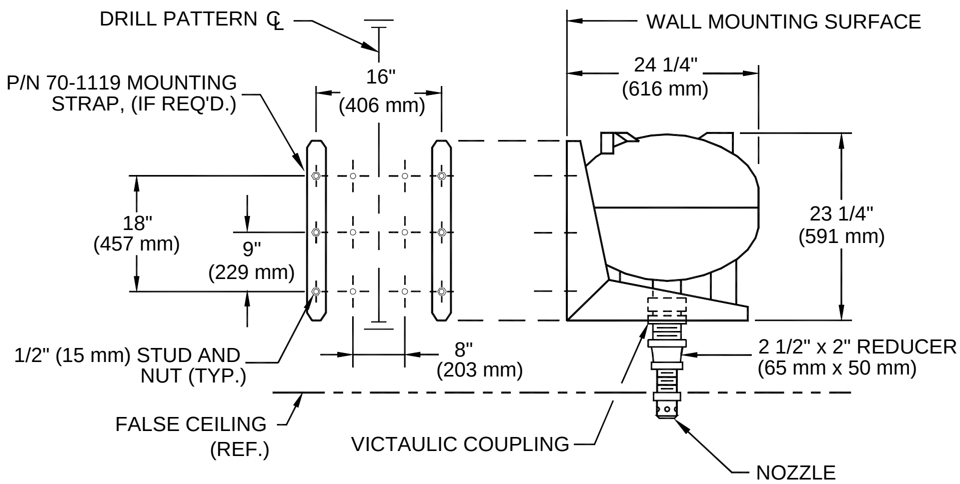


WALL MOUNT DETAIL

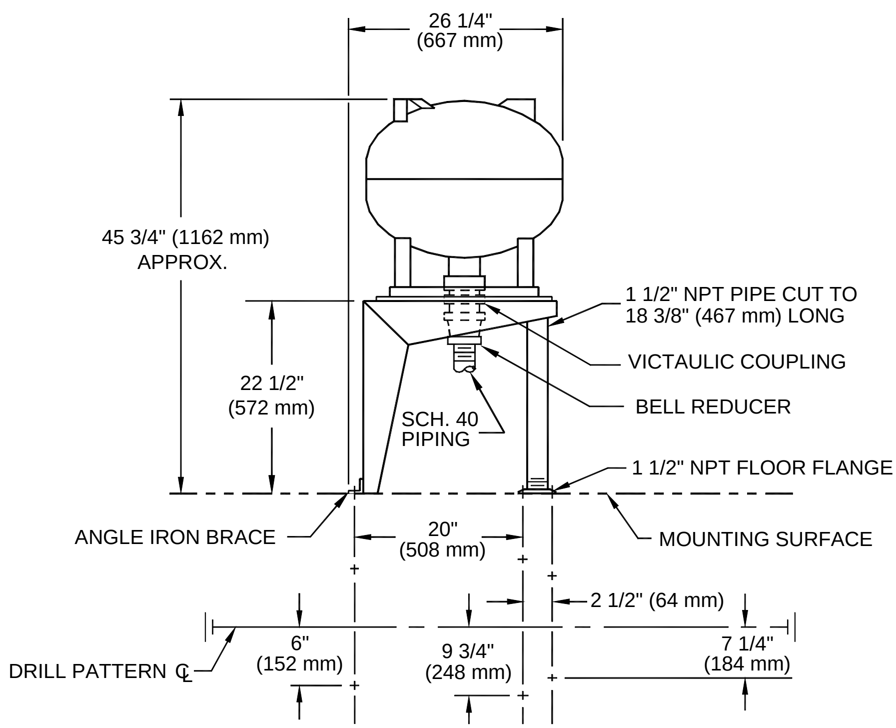


ALL DIMENSIONS ARE APPROXIMATE

4.1.2.2 MOUNTING DETAILS FOR 215 lb. (90 L) CONTAINER, P/N 70-077



WALL MOUNT DETAIL



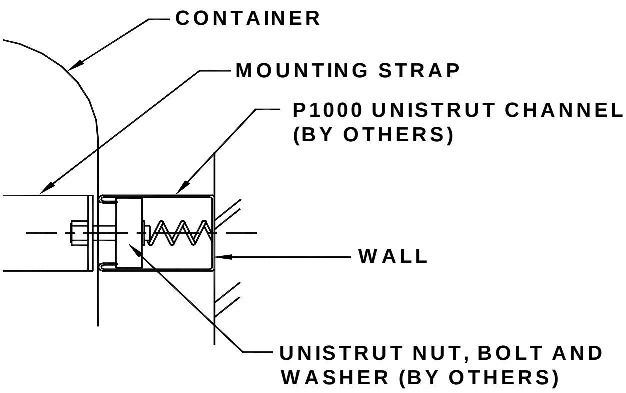
FLOOR MOUNT DETAIL

ALL DIMENSIONS ARE APPROXIMATE

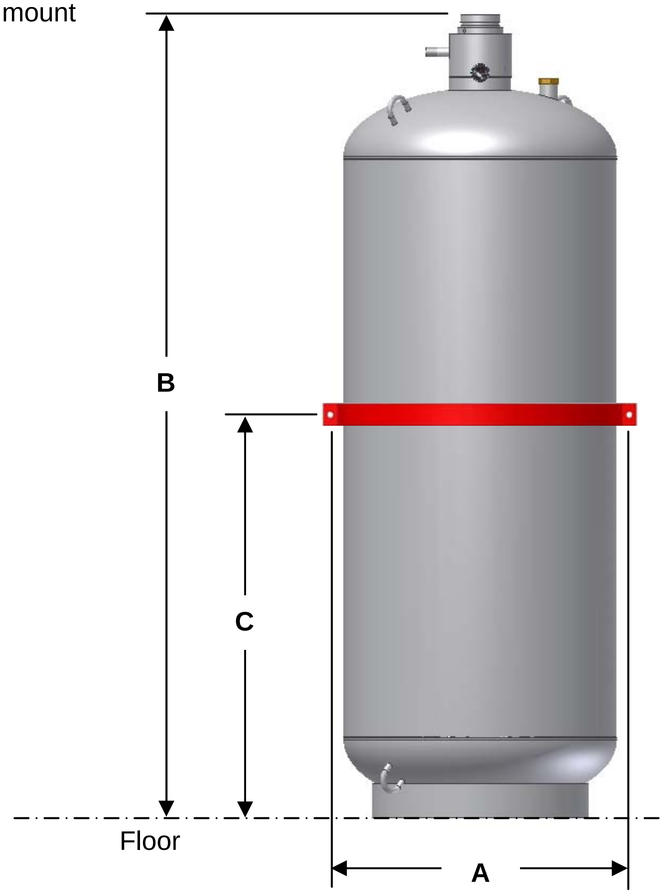
4.1.3 MOUNTING DETAILS FOR VERTICAL (UPRIGHT) CONTAINERS, P/N 70-153, 70-153T, 70-154, 70-154T, 70-155, 70-155T, 70-156, 70-156T, 70-157 & 70-157T

100, 215, 375, 650 & 1000 lb. (44, 87, 153, 267 & 423 L) Containers are supplied with mounting straps that must be anchored to a wall or other suitable surface. Typical mounting is accomplished by anchoring Unistrut channel to the wall and securing the mounting straps to the Unistrut as shown.

All containers must be mounted in the upright (valve up) position on a solid, load-bearing surface such as a floor. **DO NOT** mount these containers in the horizontal position.



Mounting Strap Detail



Container Size	Dimension			
	A	B w/ Welded Valve	B w/ Threaded Valve	C
100 lb. (44 L)	14” (356 mm)	38-3/4” (984 mm)	40-3/4 (1035 mm)	20” (508 mm)
215 lb. (87 L)	21-3/4” (552 mm)	28-7/8” (733 mm)	29-1/4” 9743)	12” (305 mm)
375 lb. (153 L)	21-3/4” (552 mm)	42-1/2” (1080 mm)	42-1/2” (1080 mm)	26” (660 mm)
650 lb. (267 L)	26” (660 mm)	48-3/4” (1238 mm)	49” (1245)	28” (711 mm)
1000 lb. (423 L)	26” (660 mm)	70” (1778 mm)	71” (1803)	40” (1016 mm)

ALL DIMENSIONS ARE APPROXIMATE

4.2 DISCHARGE PIPING CONNECTIONS

The discharge piping is connected to the discharge valves in the various manners that follow. A basic installation would involve direct connection to the valve via a pipe union or grooved coupling to facilitate removal of the container for service purposes. More advanced installations will be accomplished by using a discharge manifold to join multiple containers into a common piping supply network.

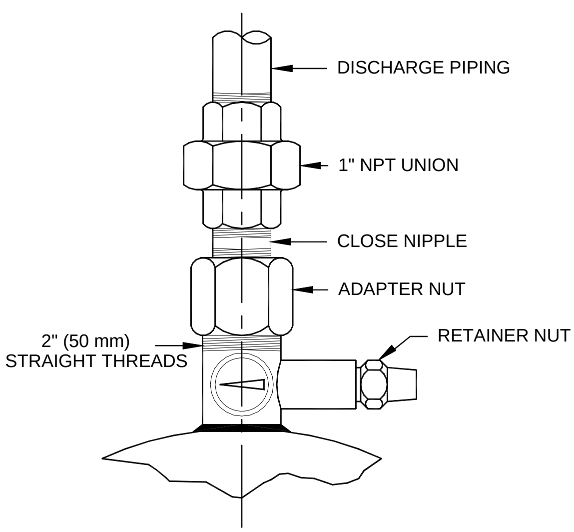
Refer to the sections that follow for additional information regarding pipe and fitting materials, installation requirements, configurations, etc.

4.2.1 1" (25 mm) VALVE CONNECTIONS

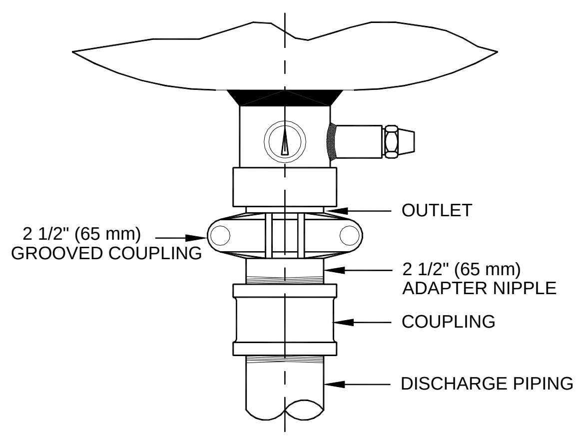
The 1" (25 mm) valve used on the 20, 35, 60 & 100 lb. (8, 15, 27 and 44 L) containers has an Adapter Nut with 1" NPT female threads that accept 1" NPT male threaded pipe. Prior to installing the discharge piping, remove the Adapter Nut and coat the 2" (50 mm) straight threads of the container valve body with teflon tape or thread sealant and replace the Adapter Nut.

IMPORTANT: Remove the Baffle Plug before installing the discharge piping to the Adapter Nut. The Baffle Plug is an anti-recoil device that is required to be installed whenever transporting or handling charged containers that are not connected to the discharge piping.

A pipe union should be installed close to the adapter nut. This makes removal of the container for service purposes much easier.



1" (25 mm) DISCHARGE VALVE



2 1/2" (65 mm) DISCHARGE VALVE

4.2.2 2-1/2" (65 mm) VALVE CONNECTIONS

The 2-1/2" (65 mm) valves used on the 125 & 215 lb. (15 & 90 L) containers have 2-1/2" (65 mm) grooves machined into the outlets of the valves. The transition from the grooved outlet to pipe thread is made through the use of an adapter nipple (supplied by Fike) that receives 2-1/2" (65mm) female pipe thread.

It is not necessary to supply a pipe union after the grooved coupling to facilitate removal of the container for service or maintenance purposes.

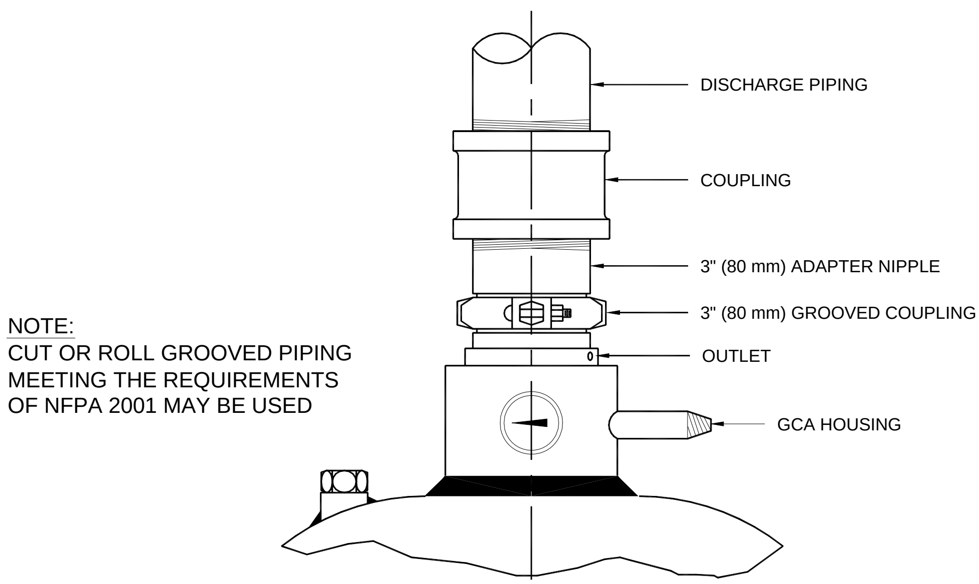
IMPORTANT: Remove the Baffle Plate located inside the grooved coupling before connecting the discharge piping to the container. The Baffle Plate is an anti-recoil device that must be installed whenever transporting or handling charged containers that are not connected to the discharge piping.

4.2.3 3" (80mm) VALVE CONNECTIONS

The 3" (80 mm) valve used on the 215, 375, 650 & 1000 lb. (87, 153, 267 and 423 L) containers has a 3" (80 mm) groove machined into the outlet of the valve. The transition from the grooved outlet to pipe thread is made through the use of an adapter nipple (supplied by Fike) that receives 3" (80mm) female pipe thread.

It is not necessary to supply a pipe union after the grooved coupling to facilitate removal of the container for service or maintenance purposes.

IMPORTANT: Remove the Baffle Plate located inside the grooved coupling before connecting the discharge piping to the container. The Baffle Plate is an anti-recoil device that must be installed whenever transporting or handling charged containers that are not connected to the discharge piping.



3" (80 mm) DISCHARGE VALVE

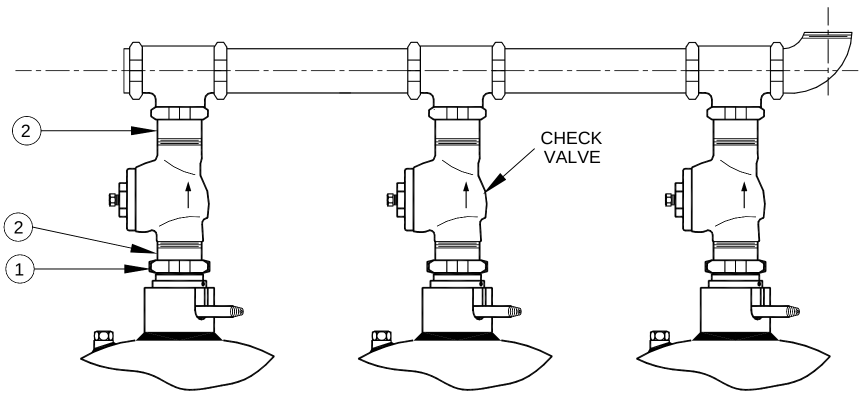
4.3 MANIFOLDS

Discharge manifolds are used to connect multiple containers into a common supply and discharge piping network. Simple two container manifolds may be used to create Main & Reserve systems without the need for redundant piping systems. Larger multiples of containers are often manifolded to create larger bulk supplies of agent for areas that require more than 1,045 lbs. (474 kg) of agent.

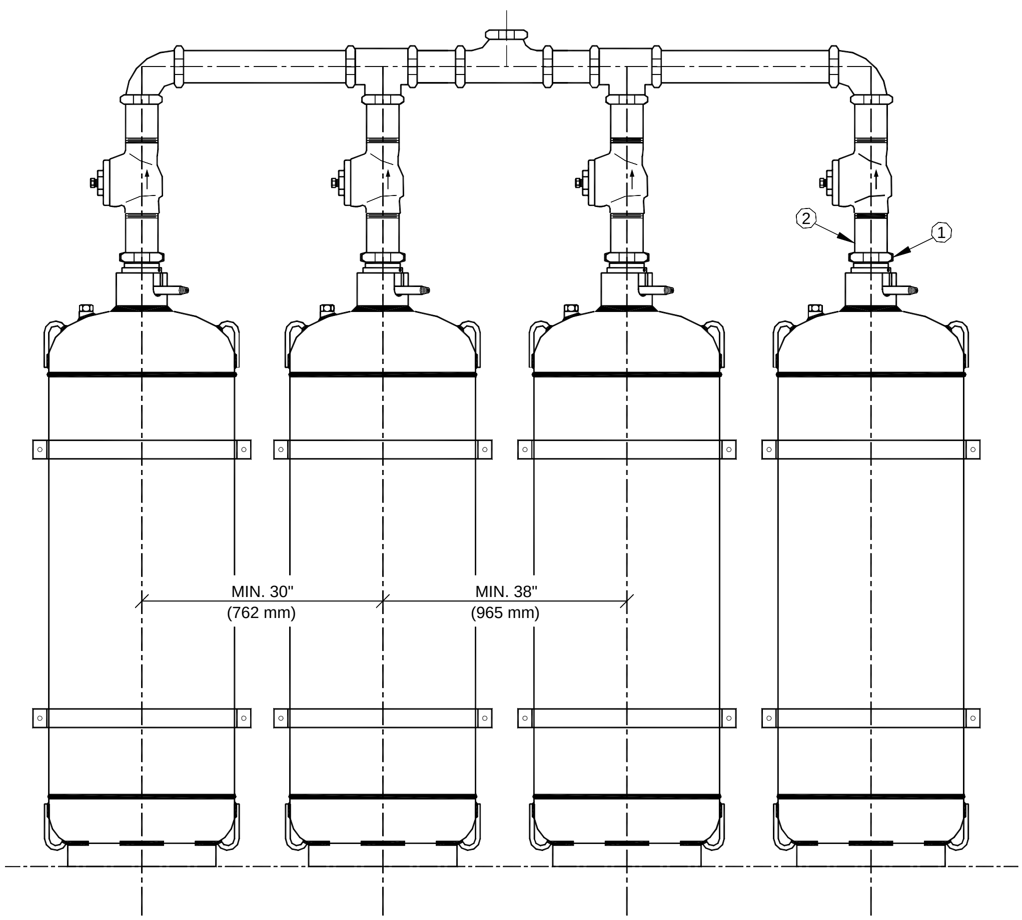
Manifolds are assembled in the field using approved fittings meeting the requirements of NFPA 2001. Larger manifolds are commonly assembled using grooved fittings, but threaded, welded or flanged fittings can be used as well. If grooved couplings are used, the gaskets must be lubricated with a non-petroleum base lubricant as recommended by the fitting manufacturer.

Once the manifold is assembled and the containers connected, the manifold should not be supported by the containers. The manifold piping should be secured with pipe hangers or brackets to support the manifold when the containers are removed for service.

NOTE: In the details that follow, Item 1 is a Grooved Coupling that is supplied by Fike with each Large Capacity Container. Item 2 is a 3” NPT x 4-1/2” (115 mm) long Adapter Nipple. Fike supplies one Adapter Nipple with each Large Capacity Container; however, two each will be required for manifolded arrangements.



TYPE “A”
End Exit Manifold (Threaded or Grooved)

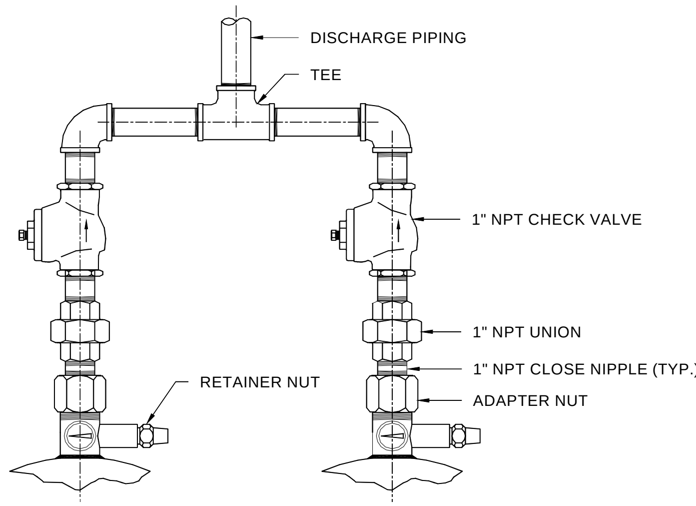


TYPE “B”
Center Exit Manifold (Threaded or Grooved)

4.3.1 1" NPT CHECK VALVE INSTALLATION

1" NPT check valves are installed in the piping network when 20, 35, 60 or 100 lb. (8, 15, 27 or 44 L) containers are grouped into a manifold or form a "Main & Reserve" system. The check valves have threaded bodies; therefore, the piping leading into and exiting from each check valve must be threaded as well.

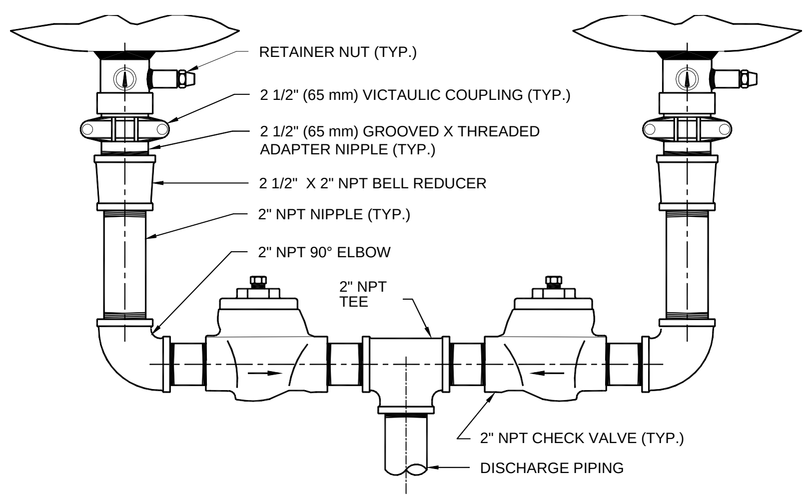
NOTE:
The Check Valves **must** be installed with the flow arrow pointing in the direction of discharge. If reversed, the system will not discharge properly.



4.3.2 2" NPT CHECK VALVE INSTALLATION

2" NPT check valves are installed in the piping network when 125 or 215 lb. (51 or 90 L) Inverted Containers are grouped into a manifold or form a "Main & Reserve" system. The check valves have threaded bodies; therefore, the piping leading into and exiting from each check valve must be threaded as well.

NOTE:
The check valves must be installed with the flow arrow pointed in the direction of discharge. If reversed, the system will not discharge properly.



4.3.3 3" NPT CHECK VALVE INSTALLATION

3" NPT check valves are installed in the piping network when 215, 375, 650 or 1000 lb. (87, 153, 267 or 423 L) Large Capacity Containers are grouped into a manifold or form a "Main & Reserve" system. The check valves have threaded bodies; therefore, the piping leading into and exiting from each check valve must be threaded as well.

NOTE: The check valves must be installed with the flow arrow pointed in the same direction as the discharge. If reversed, the system will not discharge properly.

4.4 PIPING AND FITTING MATERIALS

Piping materials must conform to the requirements as outlined in NFPA 2001, latest edition. The thickness of the piping wall shall be calculated in accordance with ASME B31.1 Power Piping Code based on a minimum piping design pressure of 500 psig (34.4 bar) at 70°F (21°C).

CAUTION: Cast iron pipe, steel pipe conforming to ASTM A120, or nonmetallic pipe **shall not** be used.

The following piping materials and configurations are acceptable:

- Schedule 40 Threaded
- Schedule 40 Welded
- Schedule 40 Grooved
- Schedule 80 Threaded
- Schedule 80 Welded

The following piping types and grades are acceptable for pipe configurations utilizing threaded, welded or grooved end connections:

Pipe Schedule	NPS Pipe Size	Wall Thickness	Grade:	A-106C	A-53B A-106B	A-53B	A-53A A-106A	A-53A	A-53F
			Type:	Seamless	Seamless	ERW	Seamless	ERW	Furnace
40	3/8	.091		X	X	X	X	X	X
	1/2	.109		X	X	X	X	X	X
	3/4	.113		X	X	X	X	X	X
	1	.133		X	X	X	X	X	X
	1-1/4	.140		X	X	X	X	X	X
	1-1/2	.145		X	X	X	X	X	X
	2	.154		X	X	X	X	X	X
	2-1/2	.203		X	X	X	X	X	X
	3	.216		X	X	X	X	X	X
	4	.237		X	X	X	X	X	X
	5	.258		X	X	X	X	X	X
	6	.280		X	X	X	X	X	X
	8	.322		X	X	X	X	X	-
80	3/8	.126		X	X	X	X	X	X
	1/2	.147		X	X	X	X	X	X
	3/4	.154		X	X	X	X	X	X
	1	.179		X	X	X	X	X	X
	1-1/4	.191		X	X	X	X	X	X
	1-1/2	.200		X	X	X	X	X	X
	2	.218		X	X	X	X	X	X
	2-1/2	.276		X	X	X	X	X	X
	3	.300		X	X	X	X	X	X
	4	.337		X	X	X	X	X	X
	5	.375		X	X	X	X	X	X
	6	.432		X	X	X	X	X	X
	8	.500		X	X	X	X	X	X

Fitting materials must conform to the requirements as outlined in NFPA 2001, latest edition. In general, Class 300 malleable or ductile iron fittings are acceptable through 3" NPT sizes. 1000 lb. ductile or forged steel fittings are required for all sizes greater than 3" NPT. Class 300 flanged fittings are acceptable for all pipe sizes.

All grooved fittings must be UL Listed and conform to the pressure requirements outlined in NFPA 2001, latest edition. Cast Iron fittings are **NOT** acceptable.

4.4.1 PIPE SIZE CHANGES

Pipe size changes, to increase or decrease the size, can be done at three different locations in the piping network:

- At a tee,
- At an elbow,
- At a coupling

4.4.1.1 PIPE SIZE CHANGE AT A TEE:

When the change in pipe size is done at a tee, this is accomplished by using either a reducing tee or a standard tee and reducing fittings. All reducers must be concentric bell reducers or concentric reducing couplings.

4.4.1.2 PIPE SIZE CHANGE AT AN ELBOW:

When the change in pipe size is done at an elbow, this is accomplished by using either reducing elbows or a standard elbow with concentric bell reducers or concentric reducing couplings.

4.4.1.3 PIPE SIZE CHANGE AT A COUPLING:

When the change in pipe size accomplished at a coupling, only concentric bell reducers or concentric reducing couplings can be used.

NOTE: Reducing bushings, weld-o-let, and hole-cut fittings **"ARE NOT"** acceptable.

4.4.2 INSTALLING MAIN DISCHARGE PIPING

Each pipe section shall be cleaned internally before installation with a nonflammable cleaner such as Perchlorethylene in accordance with NFPA 2001, latest edition.

Teflon tape or joint compound shall be used on all threaded joints. All grooved coupling gaskets shall be lubricated per the manufacturer's specifications.

The piping system should be securely supported with due allowance for agent thrust forces, thermal expansion, and contraction, and should not be subject to mechanical, chemical, vibration, or other damage.
The maximum horizontal spacing for screwed, welded or grooved pipe are as indicated on the following table:

Pipe Size (inches)	Distance Between Supports (feet)	Rod Diameter (inches)
3/8"	7	3/8
½"	7	3/8
¾"	7	3/8
1"	7	3/8
1 ¼"	7	3/8
1 ½"	9	3/8
2"	10	3/8
2 ½"	11	1/2
3"	12	1/2
4"	14	5/8
5"	16	5/8
6"	17	3/4
8"	19	3/4

Note: "C" Clamps are not acceptable to support rod hangers

Rigid pipe supports are required to support the "live load" of the pipe system during discharge. Rigid bracing is required at each directional change, fitting, tee and nozzle. All drops to 180° nozzles require back bracing in the opposite direction of the discharge. Earthquake bracing **shall** be used where required by local code. (Refer to ANSI B31.1 *Power Piping Code* for additional information)

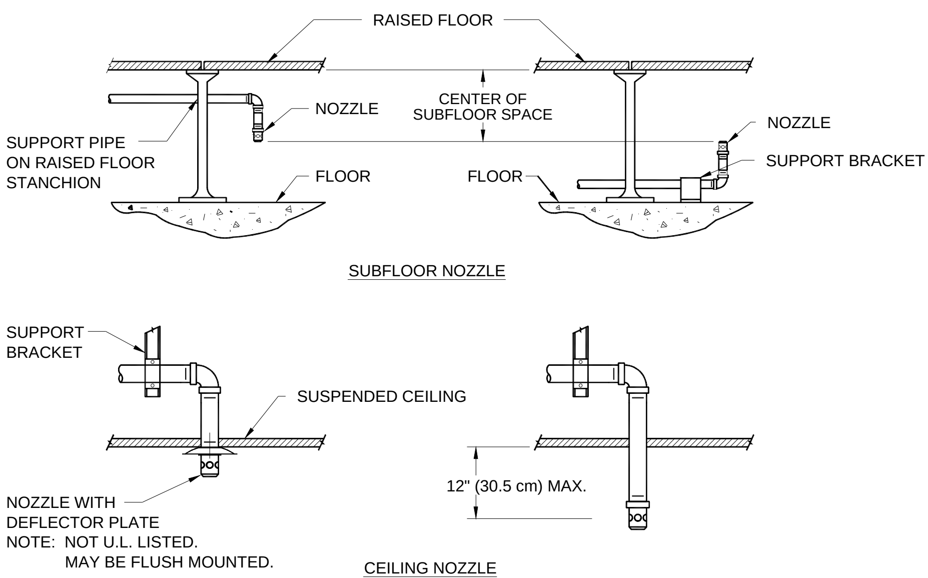
For additional information on pressure rating of pipe and fittings, plus recommended pipe supports and hangers, refer to FSSA's Pipe Design Handbook, FSSA PDH-01.

All system piping shall be installed in strict accordance to system plans. If piping changes are necessary, they must be recalculated on Fike's Flow Calculation Program.

4.5 NOZZLE INSTALLATION

Many nozzles look the same. Always verify the nozzle identification number (stamped on the closed end of the nozzle) matches the nozzle part number listed on the system installation plans. All nozzle locations should be within 1'- 0" (0.3m) of their intended locations on the system plans. Discharge Nozzles must be mounted in the vertical position and can face either up or down.

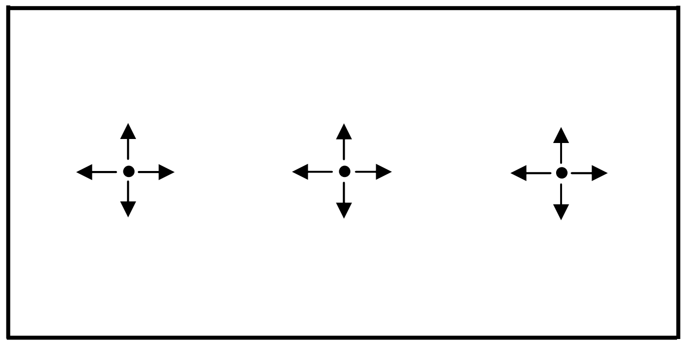
CAUTION: The piping should be blown clear to remove chips, mill scale, or metal shavings before the nozzles are installed.



NOZZLE MOUNTING DETAILS

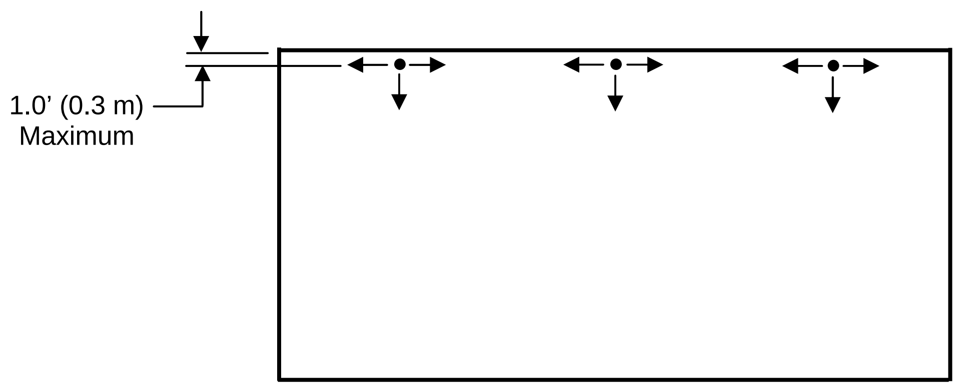
4.5.1 360° NOZZLES

360° Nozzles should be located in a symmetrical, or near symmetrical, pattern within the protected area. 360° Nozzles should be located near the area centerline – discharging toward the perimeter and/or other nozzles.



4.5.2 180° NOZZLES

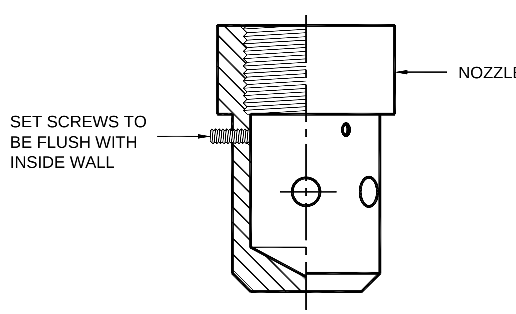
180° Nozzles should be located in a symmetrical, or near symmetrical, pattern within the protected area. 180° Nozzles should be located along the perimeter of the area – discharging along the perimeter and toward the opposite side. These nozzles can be located a maximum of 1'-0" (0.3 m) out from the wall.



NOTE: 180° Nozzles can also be installed in back to back applications. Maximum distance between nozzles is 1'-0" (0.3 m) as shown in the illustration on page 15 of 48, Section 2 / Design.

4.5.3 NOZZLE SET SCREW INSTALLATION

WARNING: Verify the Set Screws found on the side of the nozzle are in place after system installation. Failure to have the setscrews in place will affect agent distribution and possibly the system's ability to suppress the fire.

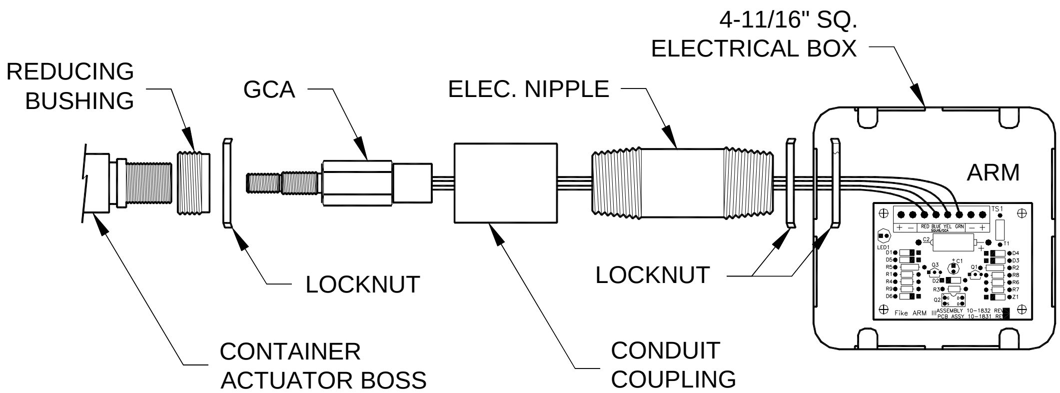


4.6 GAS CARTRIDGE ACTUATOR (GCA) / AGENT RELEASE MODULE (ARM)

The GCA/ARM installation and electrical connection should be the last items completed before the system is placed into operation. The following sections show the standard hardware required and the procedures necessary to complete this part of the installation.

4.6.1 2-1/2” (65 mm) VALVE (INVERTED CONTAINER) GCA INSTALLATION

The following components are provided with all Inverted containers. Use the following procedure to install the GCA and ARM for these containers. The electrical hardware (conduit, junction box, etc.) can be changed to suit special conditions or customer preference as needed.



1. Install the 1” x 1/2” (25mm x 15mm) conduit reducing bushing on the Container Actuator Boss. Assemble a 1” (25mm) locknut on the conduit bushing.

2. Insert the GCA into the Actuator Boss and tighten to approximately 50-90 inch-pounds. Unwrap and straighten the GCA leads. Be certain that the lead ends are shunted together. Remove all bends, twists and/or kinks from
the wires. Do not remove shunts.

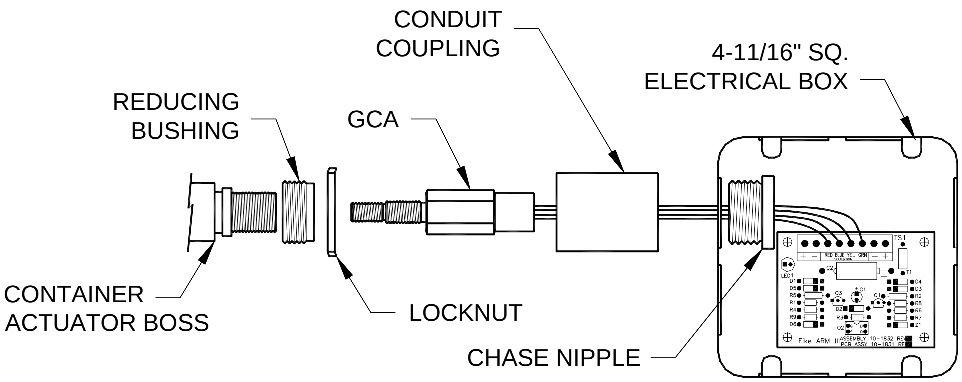
3. Install the 1” (25mm) coupling with the nipple attached onto the bushing, allowing the GCA leads to pass through the grouping. Tighten the coupling/nipple to the locknut. The face of the bushing and locknut assembly should be flush with the face end of coupling.

4. Install a second locknut to the open end of the nipple. Remove the knockout blank from upper left side of the 4-11/16” (120 mm) square conduit box. Pass the GCA leads through the knockout hole and install the assembly to the box using the third locknut, which is inserted from the inside of the box. Align the box and tighten securely.

5. Install ARM in the lower right corner of the box using the adhesive strips provided on the back.

4.6.2 1” (25 mm) and 3” (80 mm) VALVE GCA INSTALLATION

The following components are provided with all containers utilizing 1” & 3” (25 mm & 80 mm) valves. Use the following procedure to install the GCA and ARM for these containers. The electrical hardware (conduit, junction box, etc.) can be changed to suit special conditions or customer preference as needed.



1. Install the 1” x 1/2” (25mm x 15mm) conduit bushing on the Container Actuator Boss. Assemble a 1” (25mm) locknut on the conduit bushing.

2. Insert the GCA into the Actuator Boss and tighten to 50-90 inch-pounds. Unwrap and straighten the GCA leads. Be certain that the lead ends are shunted together. Remove all bends, twists and/or kinks from wires. Do not remove shunts.

3. Install the 1” (25mm) conduit coupling onto the bushing, allowing the GCA leads to pass through the coupling. Tighten all parts. The face of the bushing and locknut should be flush with the face end of coupling.

4. Remove a 1” (25mm) knockout blank from upper left side of 4-11/16” (120mm) square box. Pass the leads through the knockout hole. Now pass the leads through the chase nipple, make sure the threaded end is facing GCA.

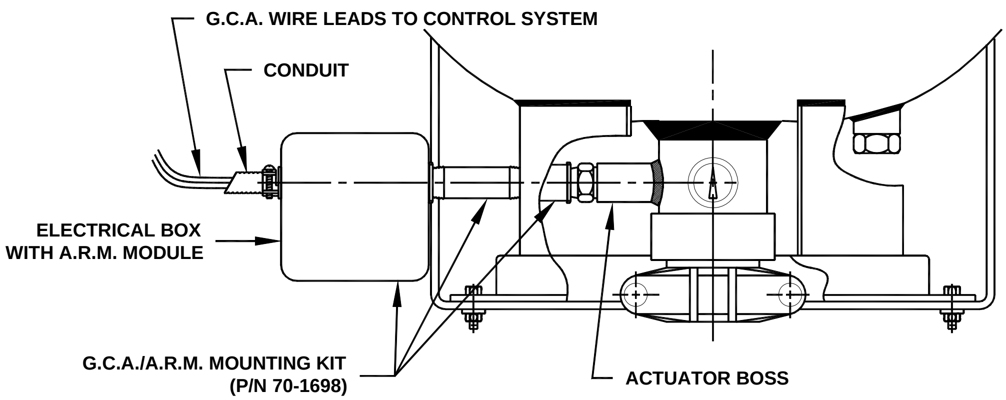
5. Secure the chase nipple to the coupling by passing through the knockout hole in the box. Tighten securely, after aligning the box in an accessible position.

6. Install ARM in the lower right corner of box using the adhesive strips provided on the back.

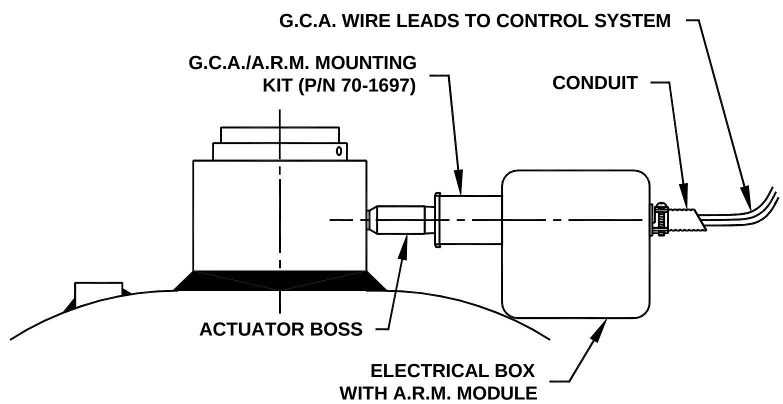
4.7 CONTAINER ELECTRICAL CONNECTIONS

Each container must have an Agent Release Module (ARM). The ARM is mounted in the container junction box using the adhesive strips located on the back of the module.

Wiring will vary from system to system, depending on the type of control system used. Consult the system plans and control panel manual for specific wiring information.



2 1/2" VALVE
ELECTRICAL CONNECTION



1" AND 3" VALVE
ELECTRICAL CONNECTION

4.7.1 GAS CARTRIDGE ACTUATOR (GCA) SAFETY RECOMMENDATIONS

Before proceeding with the Gas Cartridge Actuator (GCA) lead installation, all system components must be installed, and the electrical and control systems thoroughly checked out by a factory-trained technician. The following safety procedures must be observed when handling Gas Cartridge Actuators.

1. Disable the Control Panel and allow ten minutes for the ARM to bleed off all energy before disconnecting the GCA leads.

2. Gas Cartridge Actuators **MUST** remain shunted at all times when they are not installed in the container discharge valve.

3. Approved eye protection must be worn when handling and/or installing Gas Cartridge Actuators.

4. Never handle more than one gas cartridge actuator at any given time.

5. DO NOT handle this device when wearing static producing clothes or shoes.

6. DO NOT expose Gas Cartridge Actuators to high heat sources – this may greatly affect their service life.

7. DO NOT check Gas Cartridge Actuator continuity using any type of Ohmmeter or other device.

8. If a GCA is suspected of being defective, return it to the factory or to a Fike "Authorized" distributor for proper disposal.

9. The Gas Cartridge Actuator fits all (3) Fike container valves.

10. **DO NOT install gas cartridge actuators if ground faults are present on the control system**.

11. **DO NOT install gas cartridge actuators if voltage is present on conduit or equipment**.

12. Connect GCA leads only after installing the device in the container discharge valve.

4.7.2 GAS CARTRIDGE ACTUATOR (GCA) INSTALLATION PROCEDURE

After the electrical and control systems have been checked out, proceed with the gas cartridge actuator installation as follows.

Step 1: Move the “armed/disabled” switch on the control panel to the “disabled” position.

Step 2: Wait a minimum of 10 minutes to allow capacitors on agent release modules to dissipate their electrical charge.

Step 3: Stretch all the leads and find the proper length required for the installation. Remember to allow extra length for the possibility of servicing the system and the need to shunt in the future. However, do not allow a quantity that will not safely store within the space provided within the ARM box.

Step 4: With shunts intact, strip about 1/2" (15mm) of insulation from the red and the blue lead, but keep the shunt intact. In the middle of the stripped portion, use small pliers to fold the wires in half and crimp.

Step 5: Insert the stripped sections of the gas cartridge actuator’s red and blue leads under their respective screws on the terminal of the agent release module and tighten each screw. For ARM Rev.1, use the center two terminals. For Fike ARM III, terminate the yellow and green leads in the same manner as the red and blue leads. The yellow and green terminals are shunted internally and connection to these terminals provides safety for this pair. **DO NOT** use these terminals for the red and blue leads. (See figure below)

Step 6: Repeat steps 3 through 5 for all containers in the system.

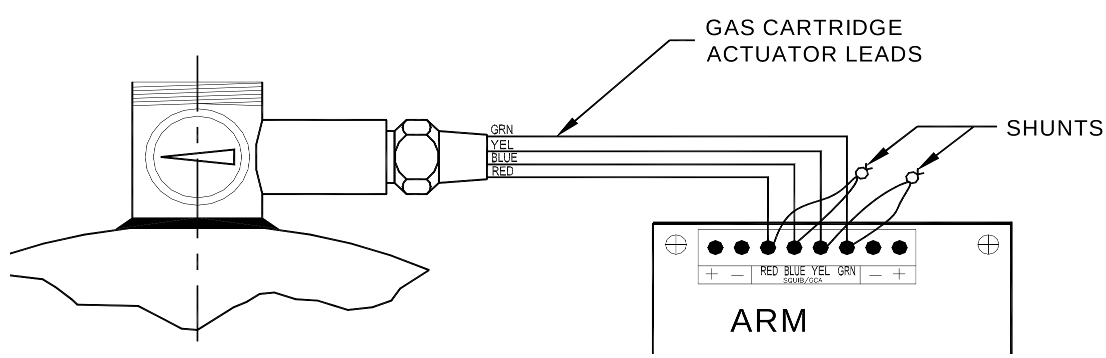
Step 7: Remove the shunts from the pigtails and isolate each wire. If the wire ends are exposed, cover with electrical tape and secure against ground faults. These pigtails can be used at a later date to recreate a shunt and safely remove the wires from the ARM when servicing the system. Install covers on all electrical boxes.

Step 8: Check the control panel for any trouble indication, other than the one caused by the “disable” position of the “armed/disabled” switch.

WARNING: DO NOT ARM THE SYSTEM IF A GROUND FAULT INDICATION IS PRESENT.

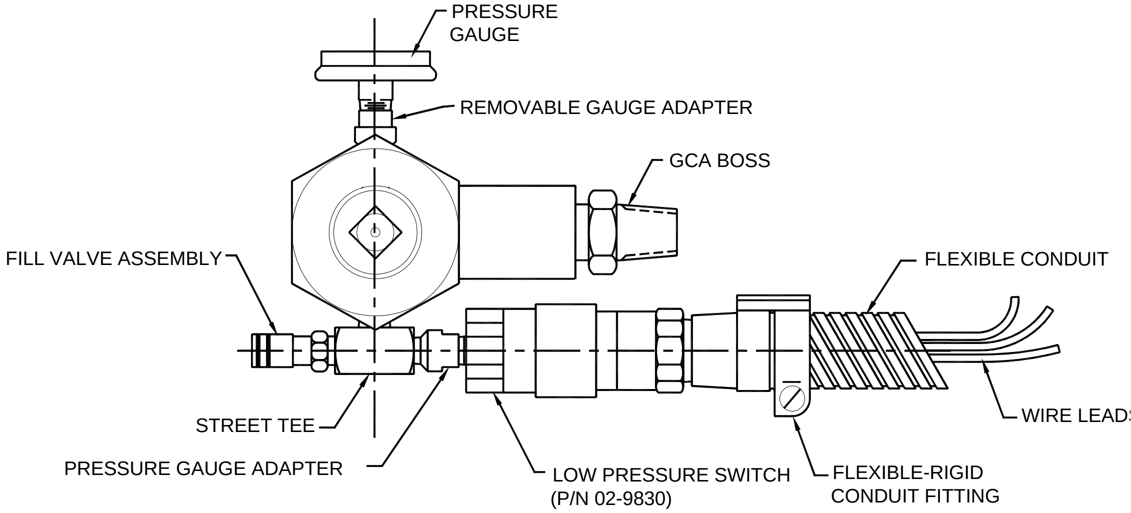
Step 9: If no other trouble condition exist, move the “armed/disabled” switch to the “armed” position and reset the control panel.

WARNING: The Container(s) is/are **“NOW ARMED”**

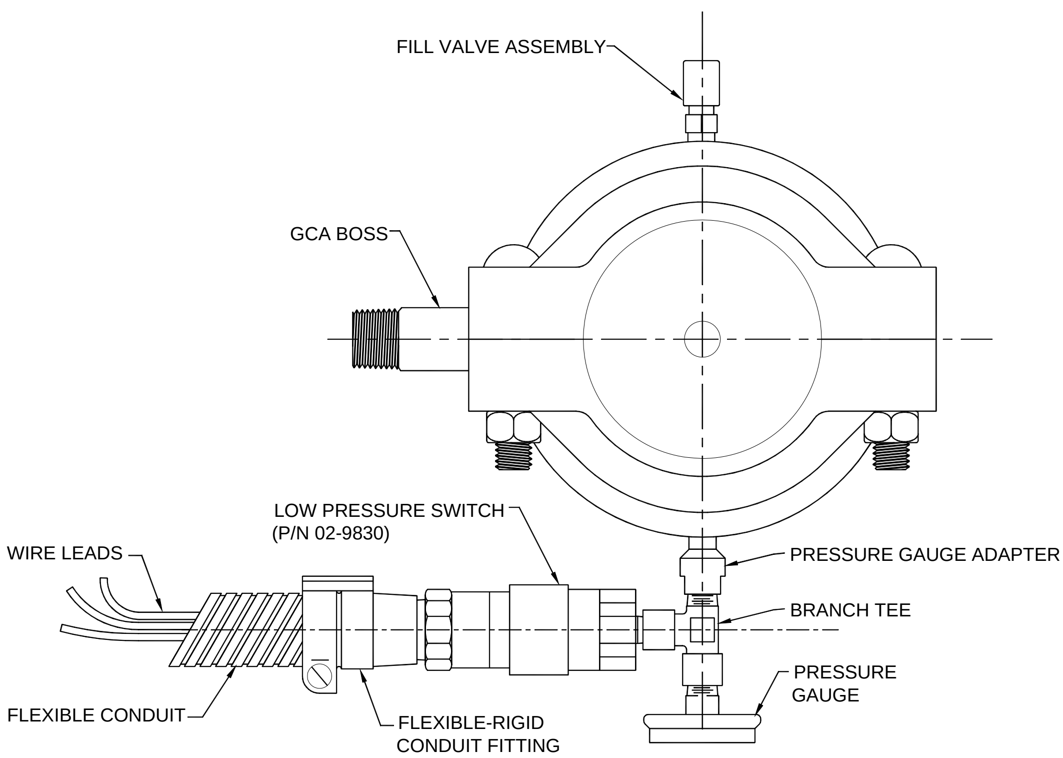


4.8 LOW PRESSURE SWITCH – P/N 02-9830

To facilitate the connection to the Low Pressure Switch, 1/2" NPT threads are provided. This allows for the connection of conduit, flexible conduit, seal tight, or similar. Refer to the following details.



Installation Detail – Top View
10 lb. Container Only
Assembly P/N: 70-1650



Installation Detail – Top View
For: 20 – 1000 lb. Containers
Assembly P/N: 70-1121

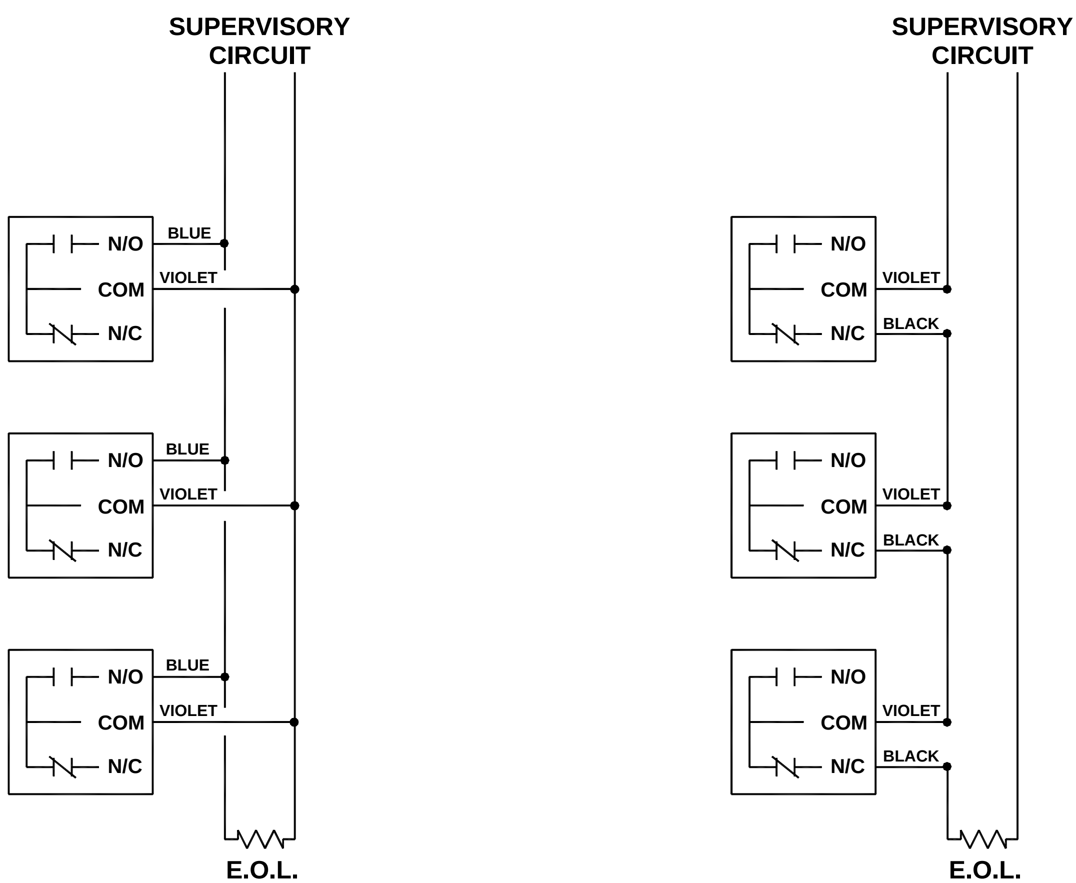
4.8.1 LOW PRESSURE SWITCH WIRING

The Low Pressure Switch can be wired for either of two configurations: normally open or normally closed shelf-state (de-energized) conditions. When the container is filled and pressurized, the contacts change state. For example, a normally open switch configuration will be closed when the container is pressurized. If the pressure in the container drops below 288 psig (196.5 bar kPa), the contact will return to the open (de-energized) position.

The pressure switch should be wired into a supervised circuit in the control panel used to provide a trouble signal if the container sees a low-pressure condition. The preferred method would be to wire the switch normally open (closed under pressure).

For applications utilizing a U.L. listed and FMRC approved Cheetah panel, one switch per FRCM (Fast Response Contact Module) is recommended. Refer to the Installation, Operation & Maintenance Manual for the control panel being used for specific wiring criteria.

Note:
When the cylinder low pressure switch (p/n 02-9830) is connected to a standard supervisory input circuit, there will be no distinction between a wiring fault and device actuation. This device is to only be utilized when accepted by the authority having jurisdiction.



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The checkout procedures outlined in this section are intended to represent the minimum requirement for the extinguishing portion of the system. Additional procedures may be required by the authority having jurisdiction (AHJ).

The control portion of the system should be thoroughly checked out according to the manufacturer's recommendations and the requirements of the authority having jurisdiction (AHJ).

5.1 HAZARD AREA CHECK

A good review of the hazard area is just as important as the proper operation of system components. Certain aspects about the hazard may have changed, or been overlooked, which could affect overall system performance. The following points should be thoroughly checked.

5.1.1 AREA CONFIGURATION

The area dimensions should be checked against those shown on the system plan(s). If the area volume has changed, the agent weight should be recalculated and compared with the agent weight supplied.

The area should also be checked for walls or movable partitions which have been added or changed. If walls or partitions have been added, check to see that all areas within the hazard still receive adequate nozzle coverage and agent distribution.

5.1.2 AREA LEAKAGE

The hazard area should be checked for openings which could allow agent leakage after system discharge. Openings, such as cable and duct penetrations into the area, should be permanently sealed.

Other sources of leakage should be checked for and sealed, especially in subfloor areas, where potential leak points are easily overlooked. Door(s) entering the hazard area(s) should be checked for tightness. Door seals and door sweeps should be installed to minimize leakage. Joints where walls contact floors, or other walls, should be sealed as these are potential leak points most often overlooked. Wall switch and receptacle boxes should be sealed. Sub-floor drains must have “P”- traps and be sealed with a non-evaporating liquid, such as anti-freeze or mineral oil. All penetrations between floors must be sealed.

5.1.3 ENCLOSURE INTEGRITY - DOOR FAN TESTING

Door fan testing provides a method to estimate worst-case room leakage. The door fan calculation method makes it possible to predict the timeline for a decending interface to fall to a given height and estimate how long an extinguishing concentration will be maintained within the protected space. This procedure is limited to door fan technology. This is not intended to preclude alternative technology such as acoustic sensors.

Enclosure integrity testing is not intended to verify other aspects of Clean Agent system reliability; i.e., hardware operability, agent mixing, hydraulic calculations, and piping integrity. Refer to NFPA Standard 2001, Section 4 for additional test requirements.

The door fan testing procedure should not be considered to be an exact model of a discharge test. The complexity of this procedure should not obscure the fact that most failures to hold concentration are due to the leaks in the lower surfaces of the enclosure, but the door fan does not differentitate between upper and lower leaks. The door fan provides a worst-case leakage estimate that is very useful for enclosures with complex hidden leaks, but will generally require more sealing than is necessary to pass a discharge test.

Refer to NFPA Standard 2001, Section 4 and Appendix “C” for additional information and door fan test precedures.

5.2 CONTAINERS
Check to make sure all containers and brackets are securely fastened. Check the mounting position of all horizontally-mounted containers. The brass fill valve [located on the discharge valve] must be pointing down.

Check all container pressure gauges. They should be reading 360 PSIG at 70^{o}F (24.8 bar at 21^{o}C). For temperatures other than 70^{o}F(21^{o}C), consult Table 6.3, Section 6.

The container firing circuit should be checked by connecting an AG1 flashbulb [or equal] in place of each valve initiator or gas cartridge actuator. Activate the control system automatically. All flashbulbs should flash. This procedure should be repeated for manual actuation of the control system.

5.3 DISCHARGE PIPING
The discharge piping should be checked to see that it is securely supported and free from any lateral movement. All joints should be checked for mechanical tightness. Discharge piping shall be pressure tested in accordance with NFPA 2001, latest eition.

5.4 NOZZLES
Check to see that all nozzles are installed in the proper locations, according to system plans. Refer to Section I.5 for nozzle identification. Make sure all nozzle set screws are in place and that 180^{o} nozzle discharge orifices are properly oriented.

Check all nozzle orifices for obstructions and make sure large objects have not been placed in front of the nozzles that would block the discharge.

If the piping system was changed from the original system plans, make sure the nozzles calculated were done so using the "as installed" piping configuration.

5.5 AUXILIARY FUNCTIONS
Operation of auxiliary functions such as door closures, damper closures, air handling shutdown, etc. should be verified when the control system is activated, both manually and automatically.

WARNING: If the air handling system is **NOT** being shut down during system discharge, it must be of the recirculating type, and enough agent should have been added to compensate for the duct and plenum volumes.

After all checkout functions have been performed, and the control system checked out according to the manufacturer's recommendations, proceed with the gas cartridge actuator installation and arming of the system, as outlined in Section 4.

The following maintenance procedures and intervals indicated are meant to represent the minimum requirements for Fike Clean Agent Fire Suppression systems. These procedures do not preclude those required by NFPA 2001 and the authority having jurisdiction. More frequent service intervals may be necessary if systems are installed in more severe service applications. This section does not cover maintenance and service procedures for the electrical and control portions of the system. Consult the appropriate product manuals for those products.

6.1 DISCHARGE PIPING

Every six months:
Check the system discharge piping for corrosion and damage. Check all piping supports to make sure they are tight and all piping is securely supported.

Every year:
Same as six month inspection. The piping should also be blown out with compressed air or nitrogen to check for obstructions.

6.2 DISCHARGE NOZZLES

Every six months:
Check to see that nozzle orifices are clear and unobstructed, and verify that the orifices are not showing signs of corrosion.

Make sure the nozzles are aimed or positioned correctly. Verify that the correct nozzle part number is installed at the proper location in accordance with the system plans.

6.3 AGENT STORAGE CONTAINERS

Every three months:
Check the pressure gauge on each container. The nominal pressure should be 360 PSIG at 70°F (24.8 bar @ 21°C); however, the pressure will vary with temperature. In the range of 50°F to 80°F (10°C to 27°C) the difference is approximately 2 psig (15 kPa) per degree. If the pressure loss indicated exceeds ten percent of the nominal pressure, check the container for leaks and repair as necessary.

CONTAINER PRESSURE VS. TEMPERATURE				
US Standard			Metric	
Temp. (°F)	Pressure (psig)		Temp. (°C)	Pressure (bar)
32	288		0	19.9
40	303		4	20.9
50	321		10	22.1
60	340		16	23.4
70	360		21	24.8
80	381		27	26.2
90	402		32	27.7
100	425		38	29.3
110	449		43	31.0
120	475		49	32.8
130	502		54	34.6

Every six months:
Verify the weight of the agent in each container matches the agent weight stamped on the label. If the weight indicates a shortage exceeding five percent of required weight, the container must be removed from service for repair and/or recharge.

NOTE: If the container has a liquid level indicator installed, weight verification can be made without the need for cylinder removal.

WARNING: The control panel must be disabled and the GCA must be shunted – BEFORE removing any container to be weighed.

After system discharge:
The containers should be removed and sent to the factory or an “authorized” Fike distributor for valve reconditioning and container recharge.

6.4 GAS CARTRIDGE ACTUATORS

WARNING: Gas Cartridge Actuators are pyrotechnic devices that can cause bodily injury and equipment damage if improperly handled. Refer to Section 4.6.1 for proper handling of these devices.

Before checking or servicing GCA’s, disable the system control panel or interface firing module releasing circuit. Allow ten minutes for the capacitor(s) on the agent release module(s) to dissipate their electrical charge.

Every six months:
Check gas cartridge actuator leads and wiring to agent release modules for corrosion. Check for loose or broken wires.

Every Ten Years:
Replace gas cartridge actuators. Refer to 4.6.1 for gas cartridge actuator installation procedures.

6.5 CONTAINER TEST AND INSPECTION

Containers shall not be recharged without a retest if more than five years have elapsed since the last test. The retest consists of a complete external and internal visual inspection in accordance with the Code of Federal Regulations, Title 49, Section 173.34(e)(10). The CFR requirements also refer to the Compressed Gas Association (CGA) Pamphlet C-6, Section 3.

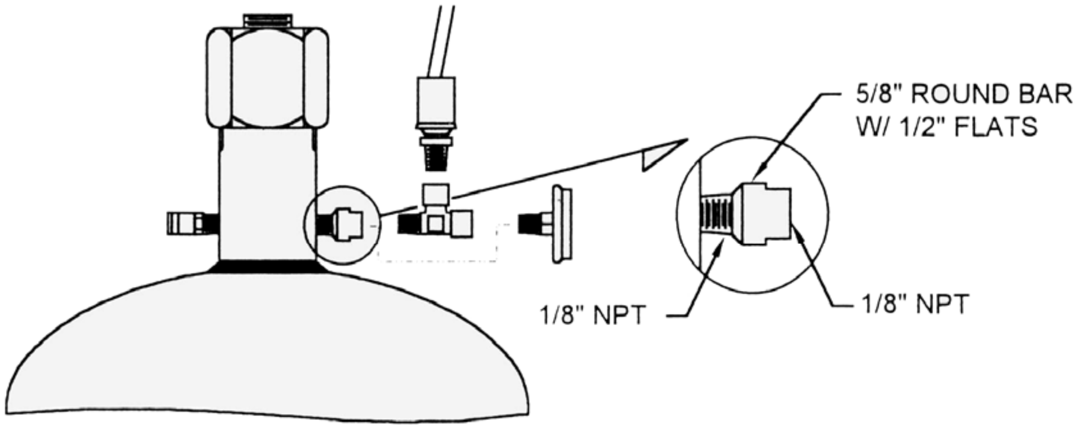
Cylinders continuously in service without discharging shall receive a complete external [visual] inspection every five years. The cylinder does not need to be emptied for this inspection.

All visual inspections must be performed according to the regulations of CFR Title 49 and CGA Pamphlet C-6, Section 3. All inspections are to be done by CGA / DOT approved inspectors only.
(Reference: NFPA No. 2001, Section 4)

6.6 PRESSURE GAUGE & LOW PRESSURE SWITCH MAINTENANCE

All Fike Containers provided with a Removable Gauge Adapter (P/N 70-1574) allow the user to add or replace the pressure gauge and/or low pressure switch – even when the container is charged. This can be accomplished easily with a little planning and preparation. If you have the parts ready and the tools that you need on-hand, the process is easy.

CAUTION: When replacing a gauge or switch on a charged container (or adding a Low Pressure switch), do not allow the pressure port to remain open (disconnected) for an extended period of time. A significant quantity of HFC-227ea could be lost from the container.



6.6.1 REPLACING A PRESSURE GAUGE OR LOW PRESSURE SWITCH

Follow these procedures to replace a pressure gauge or low pressure switch on a charged container.

1. Place Teflon tape on the male thread connection of the device(s) being replaced. DO NOT overlap the end of the connection – the first thread should be uncovered.
2. Remove the device to be replaced.
3. Install the replacement device. It may be necessary to have a second wrench on hand to hold the tee or removable gauge adapter in place while you perform this step.
4. Check the assembly for leaks using a suitable leak test device. (Refer to the Recharge Manual for recommendations and leak test procedures.)

6.6.2 ADDING A LOW PRESSURE SWITCH

Follow these procedures to add a low pressure switch to a charged container.

1. Place Teflon tape on the male thread connections of the pressure switch and street tee provided with the assembly. DO NOT overlap the end of the connections – the first thread should be uncovered.
2. Remove the pressure gauge from the removable gauge adapter. You will need to have a second wrench on hand to hold the removable gauge adapter in place while you perform this step. DO NOT allow the adapter to turn – this may cause a leakage problem.
3. Thread the street tee into the adapter and tighten – the tee should be positioned in the horizontal plane when complete. A second wrench is required for this step as well. DO NOT allow the gauge adapter to turn.
4. Install the low pressure switch in the side outlet of the tee. Tighten the switch with a wrench. Use a second wrench to hold the tee in place during this operation.
5. Install the pressure gauge in the tee. The gauge should be facing you and positioned where it can be read correctly. Use a second wrench to hold the tee in place during this operation.
6. Check the assembly for leaks using a suitable leak test device. (Refer to the Recharge Manual for recommendations and leak test procedures.)

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

DuPont
Material Safety Data Sheet

FM-200

6402FR Revised 28-FEB-2008

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

FM-200 is a registered trademark of DuPont.

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

Tradenames and Synonyms

FM200
FE-227
2-Hydroperfluoropropane
Propane, 1,1,1,2,3,3,3-Heptafluoro-
HFC-227eaHP
2-Hydroheptafluoropropane
Heptafluoropropane
2-H-heptafluoropropane
1,1,1,2,3,3,3-Heptafluoropropane
R-227
R227
HFC-227ea

Company Identification

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

PHONE NUMBERS

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

COMPOSITION/INFORMATION ON INGREDIENTS

Components

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

HAZARDS IDENTIFICATION

Potential Health Effects

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

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

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

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

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

Carcinogenicity Information

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

FIRST AID MEASURES

First Aid

INHALATION

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

SKIN CONTACT

Treat for frostbite if necessary by gently warming affected area.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

(FIRST AID MEASURES - Continued)

INGESTION

Ingestion is not considered a potential route of exposure.

FIRE FIGHTING MEASURES

Flammable Properties

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

Non-flammable.

Extinguishing Media

Use media appropriate for surrounding material.

Fire Fighting Instructions

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

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

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

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

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

Initial Containment

Use forced ventilation to disperse vapors.

HANDLING AND STORAGE

Handling (Personnel)

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

Storage

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

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use only with adequate ventilation. Keep container tightly closed.

Personal Protective Equipment

EYE/FACE PROTECTION

Wear safety glasses or coverall chemical splash goggles.

RESPIRATORS

Wear NIOSH approved respiratory protection, as appropriate.

PROTECTIVE CLOTHING

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

Exposure Guidelines

Exposure Limits
FM-200
AEL * (DuPont) : 1000 ppm, 8 & 12 Hr. TWA

* AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

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

(PHYSICAL AND CHEMICAL PROPERTIES - Continued)

Form : Liquified Gas

STABILITY AND REACTIVITY

Chemical Stability

Stable at normal temperatures and storage conditions.

Avoid sources of heat or open flame.

Incompatibility with Other Materials

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

Decomposition

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

Polymerization

Polymerization will not occur.

TOXICOLOGICAL INFORMATION

Animal Data

FM-200:

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

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

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

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

(TOXICOLOGICAL INFORMATION - Continued)

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

DISPOSAL CONSIDERATIONS

Waste Disposal

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

TRANSPORTATION INFORMATION

Shipping Information

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

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Listed.

TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

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

OTHER INFORMATION

NFPA, NPCA-HMIS

NFPA Rating
Health : 1
Flammability : 0
Reactivity : 1

NPCA-HMIS Rating
Health : 1
Flammability : 0

(Continued)

Reactivity : 0

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

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

Responsibility for MSDS : MSDS Coordinator
> : DuPont Fluoroproducts
Address : Wilmington, DE 19898
Telephone : (800) 441-7515

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

End of MSDS

CARTRIDGE ACTUATED DEVICES, INC.
51 Dwight Place, Fairfield, New Jersey 07004

HAZARDOUS CHEMICAL MATERIAL SAFETY DATA SHEET

(Conforms to the requirements of 29 CFR 1910.1200)

I. PRODUCT IDENTITY:

Cartridges, power device, UN0323
1.4S, Pkg. Gr. II
US DOT EX-9609043
(Cartridge Assembly, CAD P/N: 074055,
Fike P/N: 02-4134)
Net Explosive Weight 1.500 grams per unit

CARTRIDGE ACTUATED DEVICES, INC.
51 Dwight Place
Fairfield, N.J. 07004
Telephone Number: 973-575-1312
Prepared by CAD Engineering

24 HOUR EMERGENCY PHONE #
IN U.S.A.: **800-424-9300**
OUTSIDE U.S.A.:
202-483-7616 CALL COLLECT
FIRE, SPILL, EMERGENCY ONLY

Material(s) described is/are: Electro-Pyrotechnic device and by-products of initiation.

II. HAZARDOUS INGREDIENTS AND EXPOSURE LIMITS: N/A

Chemical and common name of Hazardous chemical ingredients:

** COMMON NAME	CAS NO.
Nitroglycerin	000055-63-0
Nitrocellulose	009004-70-0
Potassium Chlorate	003811-04-9
Lead Thiocyanate	000592-87-0

III. PHYSICAL AND CHEMICAL CHARACTERISTICS

Boiling point:	N/A	Solubility in water:	N/A
Specific gravity:	N/A	pH:	N/D
Vapor Pressure:	N/D	Evaporation Rate:	N/A
% Volatile:	Negligible.		

IV. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

DANGER Extremely Flammable --EXPLOSIVE--
Keep away from heat and keep shunted.

Flash Point:	N/D
Flammable Limits:	None, Explosive Device
Auto-Ignition Temperature:	225º F
Extinguishing Media:	Dry, Chemical Extinguisher
Special Fire-Fighting Procedures:	None.
Grounding Procedure:	Insure that the device is shunted and handlers are grounded.
Stability Considerations:	None
Incompatibility:	Shock, Flame, Friction, Temperature high heat and static sources.
Hazardous decomposition products:	None
Hazardous products of combustion:	Flame, high heat, carbon monoxide, carbon dioxide, oxides of nitrogen, hydrogen chloride, trace cyanide compounds, oxides and salts of lead. Under certain conditions, device can propel high velocity particles on initiation.
Hazardous Polymerization:	None

V. HEALTH HAZARD DATA

Emergency and First Aid Procedure:

Treat burns and any laceration by cleaning and applying sterile bandages. Transport individual for further medical treatment.

Primary Route of Entry:	N/A (cartridge is intact) Inhalation of actuation fumes.
Cancer Information:	Not listed as carcinogen by N.T.P. if cartridge is intact
Reported effects on Humans:	Respiratory irritant.
Other:	N/A (cartridge is intact)

VI. SPILL AND LEAK PROCEDURES

Steps to be taken if material is spilled: (applies only if cartridge is ruptured)
Clean spill after liberally wetting down with solvent (Acetone, Butyl Acetate or Alcohol) by wiping material up with paper towels or with cotton rag. Keep a fire extinguisher present. Wear safety glasses, protective gloves, and non-static generating clothing during clean up or transfer operation.

Waste Disposal Method:
Disposal must be in accordance with local, state, and Federal regulations.

VII. APPLICABLE CONTROL MEASURES

Appropriate Hygienic Practices:	N/A
Personal Protective Equipment:	Safety glasses & grounding devices (ground straps and/or conductive footwear). When firefighting, wear NIOSH approved gas respirator.
Work Practices:	Avoid high temperatures; keep the cartridge shunted and wear personal protective equipment. Work behind shielding.
Handling and Storage precaution:	Recommended storage, 70°F
Engineering Controls:	Work with device in a shielded area, keep shunted until installed.
Protective Measures during Repair and Maintenance:	Eliminate static discharge sources. Avoid flame or high heat. Shield the device when working with the device.

DISCLAIMER: The above information was taken from various published and unpublished sources and is believed to be accurate and to represent the best information currently available to us. However, we make no warranty, expressed or implied, of the accuracy of such information, and assume no liability resulting from its use. Users should make their own investigation to determine suitability of the information for their particular purposes.

THIS UNIT IS NOT USER SERVICEABLE. DO NOT ATTEMPT DOWNLOADING OR DISASSEMBLING.

Net Reactive Material Content: 1.5 grams maximum per unit.

CONTAINER DATA TABLES

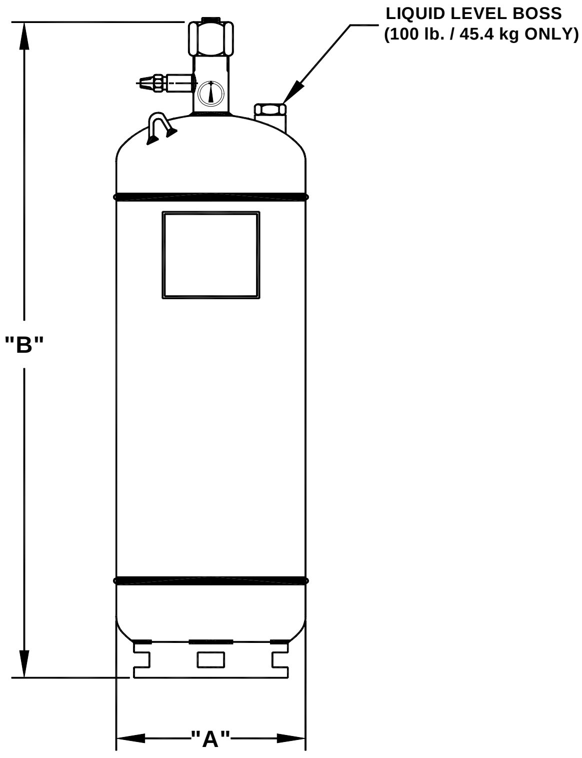
Container Size	Container Part Number	Fill Range (lbs.)	Mounting Position	Valve Size	Approx. Tare Weight
60 lb.	70-022	37 – 64	Upright - Horizontal	1” NPT	80 lbs.
100 lb.	70-088	58 - 100	Upright (Valve Up)	1” NPT	90 lbs.

Container Size	Container Part Number	Fill Range (kg)	Mounting Position	Valve Size	Approx. Tare Weight
27 kg	70-022	17.0 – 29.0	Upright - Horizontal	25 mm	36.3 kg
45 kg	70-088	26.5 – 45.0	Upright (Valve Up)	25 mm	40.8 kg

Container Size	Dim. “A” (inch)	Dim. “B” (inch)
60 lb.	10-3/4”	28”
100 lb.	10-3/4”	38-3/4”

Container Size	Dim. “A” (mm)	Dim. “B” (mm)
27 kg	273	711
45 kg	273	984

***All dimensions shown are approximate**



60 and 100 lb. (27 and 45 kg) Containers

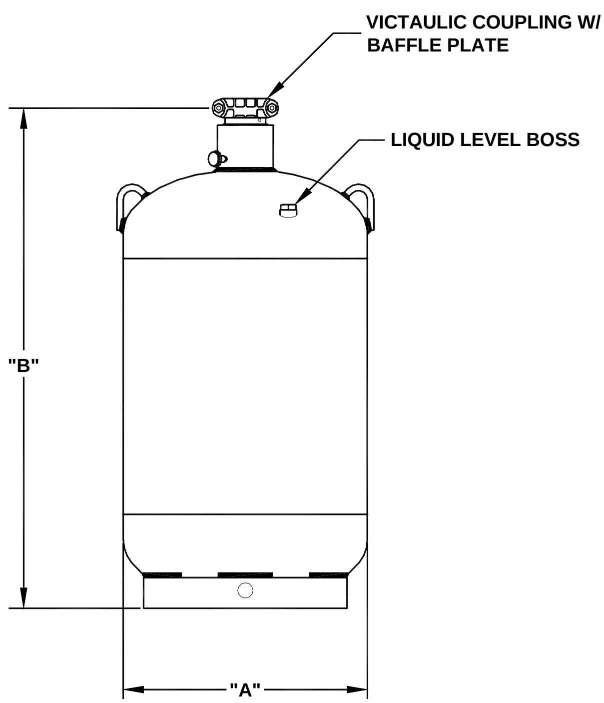
CONTAINER DATA TABLES

Container Size	Container Part Number	Fill Range (lbs.)	Mounting Position	Valve Size	Approx. Tare Weight
215 lb.	70-087	123 – 215	Upright (Valve Up)	3” NPT	285 lbs.
375 lb.	70-086	215 – 375	Upright (Valve Up)	3” NPT	375 lbs.
650 lb. (20” dia.)	70-083	372 – 650	Upright (Valve Up)	3” NPT	455 lbs.
650 lb. (24” dia.)	70-083A	372 – 650	Upright (Valve Up)	3” NPT	430 lbs.
1000 lb.	70-090	573 - 1002	Upright (Valve Up)	3” NPT	673 lbs.

Container Size	Container Part Number	Fill Range (kg)	Mounting Position	Valve Size	Approx. Tare Weight
97.5 kg	70-087	56.0 – 97.5	Upright (Valve Up)	80 mm	129.3 kg
170 kg	70-086	97.5 – 170.0	Upright (Valve Up)	80 mm	170.1 kg
295 kg (508 mm)	70-083	169.0 – 294.5	Upright (Valve Up)	80 mm	206.4 kg
295 kg (610 mm)	70-083A	169.0 – 294.5	Upright (Valve Up)	80 mm	195.1 kg
454 kg	70-090	260 – 454.5	Upright (Valve Up)	80 mm	305.3 kg

Container Size	Dim. “A” (inch)	Dim. “B” (inch)
215 lb.	20”	28-7/8”
375 lb.	20”	42-1/2”
650 lb.	20”	65-3/4”
650 lb.	24”	48-3/4”
1000 lb.	24”	70”

Container Size	Dim. “A” (mm)	Dim. “B” (mm)
97.5 kg	508	733
170 kg	508	1080
295 kg	508	1670
295 kg	610	1237
454 kg	610	1778



***All dimensions shown are approximate**

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