HFC-227ea CLEAN AGENT FIRE SUPPRESSION ENGINEERED SYSTEM

DESIGN, INSTALLATION, OPERATION AND MAINTENANCE MANUAL

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FOREWORD

This manual is written to be used by qualified fire protection industry professionals and engineers that design, install and maintain HFC-227eaClean Agent Fire Suppression System. It is intended to communicate details and procedures required for proper design, installation, operation and maintenance.

HFC-227ea Clean Agent Fire Suppression System is to be designed, installed, inspected, tested, maintained, and recharged by qualified, trained personnel in accordance to the following.

- This manual
- Information in the agent cylinder nameplate(s)
- NFPA 2001 (Latest Current Edition)
- Underwriters Laboratories, Inc.
- Factory Mutual
- Local Authority Having Jurisdiction

Luke Alexander LLC assumes no responsibilities for the design, function or application of any systems other than those addressed in this manual. The technical data contained herein is limited strictly for informational purposes only. We believe the data presented in this manual to be accurate, but it is published and presented without any guarantee or warranty whatsoever. Luke Alexander LLC may make improvements or changes in the information contained in this manual at any time without notice or liability.

Any questions concerning the information presented in this manual can be addressed to the following.

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SAFETY SUMMARY

Safety precautions are essential when any electrical or mechanical equipment is involved. As the Fire Suppression System uses pressurized equipment, personnel responsible for the fire suppression system must be thoroughly trained in the proper handling, installation, servicing and/or recharging Fire Suppression Unit cylinders and equipment. Failure to understand and to follow the safety precaution may result in the damage of property or personal injury.

The following notations are used throughout this manual. Always heed to these precautions as they are essential to the safe use of the equipment described in this manual.

DANGER - identify immediate hazards and provides specific instructions or procedures, which if not correctly followed WILL result in severe personal injury or death.

WARNING - identify specific instructions or procedures, which if not correctly followed COULD result in severe personal injury or death.

CAUTION - identify specific instructions or procedures, which if not correctly followed COULD result in severe personal injury or death.

The following safety precautions should always be followed as the cylinders are always pressurized (charged).

WARNING: The pressurized cylinders are extremely hazardous and if not handled properly they are capable of causing property damage, bodily injury, or death. Always wear safety glasses and make sure the anti-recoil device is properly in place before unit installation, servicing, or other general handling.

1. Read and understand this manual and the other documents referenced herein.
2. The valve discharge anti-recoil device must be installed on the cylinder valve at all times and only removed when connected into the discharge piping or when performing charging, testing, or salvaging operations in accordance with the procedures contained in this manual.
3. Wear safety glasses and gloves when working with pressurized cylinders and charging equipment.
4. Follow all of the safety procedures included on the cylinder nameplate(s) and in this manual.
5. Never assume that the cylinder is empty. Treat all cylinders as if they are fully charged.

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1 Introduction

With the required phase-out of Halon 1301, the search for the direct replacement for Halon 1301 has eluded the fire protection industry until now. In the past decade, several have offered acceptable solutions that meet with the requirements of zero ozone depletion, life safety, and the protection of high value property.

The HFC-227ea is one of the leading clean agent replacements for Halon 1301 in the special hazards suppression industries worldwide. It is well-known under a brand name FM-200 from DuPont although there are many who make the clean agent available under different brand name. However, the National Fire Protection Association (NFPA) 2001 Clean Agent makes reference only to the generic name of chemical which is HFC-227ea.

Luke Alexander LLC Fire Suppression System usesHFC-227ea fire protection fluid for total flooding applications and is a custom engineered for the specific application using the most effective, yet efficient arrangement of storage, actuation, distribution, and components' discharge. General applications of HFC-227ea Fire Suppression System includes, but not limited to,

- Electrical and electronic hazards
- Telecommunication facilities
- Storage rooms for flammable liquids and gases
- High value assets where the associated down-time is costly

HFC-227ea Fire Suppression System 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 (e.g. cellulose nitrate, gunpowder, etc.)
- Reactive metals, such as Lithium, Sodium, Potassium, Magnesium, Titanium, Zirconium, Uranium and Plutonium
- Metal hydrides (e.g. sodium hydride, lithium aluminum hydride)
- Chemicals capable of undergoing auto thermal decomposition (e.g. organic peroxides, hydrazine)

1.1 HFC-227ea Clean Agent

HFC-227ea (Heptafluoropropane) is referred to in the international standard, such as National Fire Protection Agency (NFPA) 2001, and has IUPAC's name of 1,1,1,2,3,3,3-Heptafluoropropanewith a chemical formula of C_3HF_7. HFC-227ea is acceptable for use in occupied spaces when used in accordance with the United States Environmental Protection Agency (US EPA) Significant New Alternatives Policy (SNAP) Program.

HFC-227ea is colorless, electrically non-conductive, low toxicity and free of residue. It suppresses fires by removing heat energy from the fire to the extent that the combustion reaction cannot sustain itself in addition to the release of free radicals that ultimately inhibiting the chain reaction of combustion.

Although HFC-227ea is considered as non-toxic to humans in concentrations necessary to extinguish most fires, certain safety considerations should be observed when applying and handling the agent. The contact with liquid HFC-227ea may cause frostbite when super-pressurized with dry nitrogen to 360 psig, and Heptafluoropropane would decompose and produce hydrogen fluoride at high temperature. This is observed by the presence of sharp, pungent odor.

1.2 Properties

HFC-227ea is a clean and effective fire extinguishing agent that can be used on Classes A, B, and C fires. It suppresses fire primarily by physically cooling the fires at the molecular level. HFC-227ea is a stable, liquefied gas, and can be used to safely protect electronic equipment. HFC-227ea will completely vaporize and requires no clean up after a system discharge. The general properties and environmental properties of HFC-227ea are available in Table 1-1, Table 1-2, and APPENDIX A: Material Safety Data Sheet (MSDS).

Table 1-1: Properties of HFC-227ea[1]

IUPAC Name	1,1,1,2,3,3,3-Heptafluoropropane
Synonym	HFC-227ea, Heptafluoropropane
CAS Registry Number	431-89-0
Chemical Formula	CF_3CHFCF_3
Molecular Weight	170
Freezing Point	-204°F (-108°C)
Boiling Point at 1 atm	2.4°F (49.2°C)
Critical Temperature	214°F (168.7°C)
Critical Density	35.77 lbm/ft^3 (621 kg/m^3)
Critical Pressure	424 psi (2,912 kPa)
Critical Volume	0.0280 ft^3/lbm (274 cc/mole)
Specific Heat, Liquid at 77°F(25°C)	0.281 Btu/lb-°F (1.184 kJ/kg-°C)
Specific Heat, Vapor at 1 atm and 77°F (25°C)	0.193 Btu/lb-°F (0.808 kJ/kg-°C)
Heat of Vaporization at Boiling Point	56.6 Btu/lb (132.6 kJ/kg)
Thermal Conductivity of Liquid at 77°F (25°C)	0.034 Btu/lb-ft-°F (0.069 W/m-°C)
Viscosity, Liquid at 77°F (25°C)	0.579 lb/ft-hr (0.184 cP)
Solubility in Water	0.06% by weight at 70°F (21.1°C)

Table 1-2: Environmental Property of HFC-227ea

Properties	Halon 1211	Halon 1301	HFC-125	HFC-227ea	FK-5-1-12
Ozone Depletion Potential (ODP)[2]	4	12	0	0	0
Global Warming Potential (GWP)[3]	1,890	7,140	3,500	3,220	1
Atmospheric Lifetime (ATL) (years)	16	65	29	34.2	0.014
SNAP (Yes/No)	No	No	Yes	Yes	Yes

[1] NFPA 2001 Standard on Clean Agent Fire Extinguishing Agent (Latest Edition)
[2] World Meteorological Organization (WMO) 1998, Model-Derived Method
[3] Intergovernmental Panel on Climate Change (IPCC) 2007 Method, 100-Year ITH

1.3 Quality Requirement

Following is the quality requirement of HFC-227ea in accordance to NFPA 2001 (Latest Edition).

Table 1-3: Quality Requirement of HFC-227ea

Property	Requirement
Purity	99.0% (minimum)
Acidity (by weight)	3.0 ppm (maximum)
Water Content (by weight)	0.001%
Non-Volatile Residue (g/100 ml)	0.05

1.4 Personnel Safety

1.4.1 Agent Concentration

The areas into which HFC-227ea is discharged must be evacuated by personnel, and the areas shall be well ventilated after discharge.

HFC-227ea has acceptable toxicity for use in occupied spaces when the guidelines in this manual is followed as well as NFPA and any relevant international standards found applicable by the Authority Having Jurisdiction (AHJ).

HFC-227ea has been evaluated for cardiac sensitization through test protocols approved by the United States Environmental Protection Agency (US EPA). The US EPA Significant New Alternative Policy (SNAP) Program classified HFC-227ea as acceptable for use as a total flooding agent.

NFPA 2001 specifies a “No Observed Adverse Effects Level” (NOAEL) for clean agent concentration. This is the highest concentration for which no adverse physiological or toxicological effect has been observed. NFPA 2001 also specifies a “Lowest Observable Adverse Effects Level” (LOAEL), which is the lowest concentration for which an adverse physiological or toxicological effect has been observed. Table 1-4 indicates the value of NOAEL and LOAEL of HFC-227ea in accordance to NFPA 2001 (Latest Edition).

Table 1-4: NOAEL and LOAEL of HFC-227ea

NOAEL (% volume)	9.0
LOAEL (% volume)	10.5

Consideration shall be given to the possibility of a clean agent migrating to adjacent areas outside of the protected space. Care must be taken to insure that the calculated concentration for normally occupied spaces does not exceed the NOAEL.

CAUTION: HFC-227ea is discharged through the nozzle orifice; DO NOT stand in direct line of the nozzle flow as the force of discharge could cause injury. The nozzles are designed to discharge the HFC-227ea in a horizontal plane. The flow of HFC-227ea should not be obstructed where obstructions are avoidable. Read, understand and follow the precautions and the safety information in the Material Safety Data Sheet (MSDS) of HFC-227ea.

1.4.2 Thermal Decomposition

There is a direct correlation between agent discharge time and the quantity of thermal decomposition products (or by-products) created. The type of fires and the amount of agent exposed to open flame are the critical factors in creation of thermal decomposition products.

Hazardous decomposition or by-products (of halogen acids) can be produced during the combustion of HFC-227ea at high temperatures. Hence, the discharge of HFC-227ea at 70°F (21.1°C) has been established at 10 seconds or less regardless of the weight discharged in order to minimize the amount of by-product produced during the extinguishment of the flames.

1.4.3 Toxicity

Unnecessary exposure to clean agents is to be avoided in accordance with the requirements of NFPA 2001 (Latest Edition). As such, upon operation of a system pre-discharge alarm, all personnel should immediately exit the protected space. In no case shall personnel remain in a room in which there is a

fire. In the event when a clean agent system unexpectedly discharges into an occupied room, all personnel should proceed in a calm and orderly manner to an exit and leave the room.

HFC-227ea has been evaluated for cardiac sensitization in accordance with test protocols approved by the United States Environmental Protection Agency (US EPA). The US EPA's SNAP Program classifies HFC-227ea as acceptable for use as a total flooding agent in occupied spaces with specific limitations. HFC-227ea has been considered to be acceptable by the US EPA for use in occupied spaces when used in accordance with the guidance of NFPA 2001 (Latest Edition).

Although HFC-227ea has negligible toxicity in concentrations needed to suppress most fires, safety considerations must be observed when applying and handling the agent.

1.4.4 Other Safety Consideration

The high pressure discharge of HFC-227ea from a system nozzle can create noise loud enough to be startling. The high velocity discharge can be significant enough to dislodge objects located directly in the discharge path. Enough turbulence may be created in the enclosure to move unsecured paper and other light objects. Direct contact with the vaporizing agent discharged from a nozzle will have a chilling effect on objects and can cause frostbite burns to the skin in extreme cases.

1.5 Storage

HFC-227ea fluid is stored in steel container. Special procedures for handling and transferring of HFC-227ea need to be paid attention. It is highly recommended to always use personal protective equipment (PPE), such as side-shield glasses, gloves, and safety shoes when handling containers of HFC-227ea. When the containers are stored outside, the containers are to be stored under a roof and protect from extreme weathers. Never heat the container to a temperature higher than 125°F (52°C).

2 System Components

The equipment described in this manual is listed by Underwriter Laboratories, Inc. in accordance to the standard for Halocarbon Clean Agent Extinguishing System Unit (UL2166 Latest Edition).Authorities Having Jurisdiction (AHJ) should follow the information specified by this manual, Clean Agent Extinguishing Systems NFPA 2001 and other applicable standards.

2.1 General System Assembly

Figure 2.1 and Figure 2.2 are the HFC-227ea General System Assembly of Automatic Agent Release and Manual Agent Release, respectively. While Automatic Agent Release uses Electric Solenoid for the agent discharge, user(s) has to manually push down the control knob for the agent discharge in the Manual Agent Release (Figure 2.2).

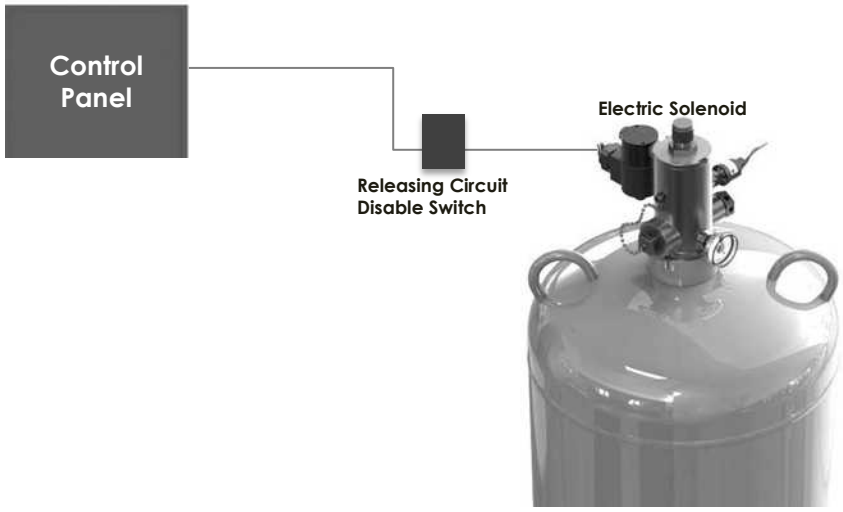


Figure 2.1: General System Assembly of Automatic Agent Release

Figure 2.2: General Assembly of Manual Agent Release

2.2 Cylinders

Cylinders are made of steel pressure vessel that is designed, tested and manufactured strictly in accordance with DOT regulations in addition to undergone extensive pressure and leak test prior to shipment. The cylinders are suitable for use at storage temperature between 32°F (0°C) and 130°F (54.4°C) and the system pressure up to 360 psi (25 bars) at 70°F (21.1°C)

The cylinders are filled with HFC-227ea within the allowable range between 9 lb to 1211 lb. All cylinders are filled in 1 lb (or 0.5 kg) increments in order to meet the exact amount of HFC-227ea required by the user for each cylinder. Each HFC-227ea cylinder is pressurized with dry nitrogen to a working pressure of 360 psig at 70°F (24.8 bars at 21°C) after filling. The fill range and available HFC-227ea cylinders and their dimensions are indicated in Table 2-1and Table 2-2, respectively.

NOTE: HFC-227ea shall be installed in the vertical (the valve direction in up) position

Table 2-1: System Cylinders and Its Fill Range

System Assembly	Fill Range	
Part Number	Minimum Fill	Maximum Fill
LK 7900020-A	9 lb	20 lb
LK 7900035-A	16 lb	35 lb
LK 7900070-A	31 lb	71 lb
LK 7900100-A	44 lb	101 lb
LK 7900150-A	66 lb	152 lb
LK 7900250-A	109 lb	253 lb
LK 7900375-A	163 lb	379 lb
LK 7900560-A	241 lb	561 lb
LK 7900800-A	353 lb	806 lb
LK 7901000-A	439 lb	1,008 lb
LK 7901200-A	519 lb	1,211 lb

Table 2-2: Cylinder with valve assembly dimensions (Refer to Figure 2.3)

Cylinder Complete Assembly Part Number	Description	Total Height (A) (±0.630in)	Discharge Height (B) (±0.394in)	Outside Diameter (OD) (±1.0%)in
LK 7900020-A	20 lb cylinder c/w 1” valve	18.633	13.632	10.750
LK 7900035-A	35 lb cylinder c/w 1” valve	23.678	18.677	10.750
LK 7900070-A	70 lb cylinder c/w 1” valve	33.167	28.166	10.750
LK 7900100-A	100 lb cylinder c/w 1.5” valve	33.172	27.343	12.795
LK 7900150-A	150 lb cylinder c/w 1.5” valve	43.172	37.343	12.795
LK 7900250-A	250 lb cylinder c/w 1.5” valve	45.928	40.099	16.000
LK 7900375-A	375 lb cylinder c/w 2.5” valve	65.351	57.248	16.000
LK 7900560-A	560 lb cylinder c/w 2.5” valve	63.619	55.516	20.000
LK 7900800-A	800 lb cylinder c/w 4.0” valve	57.254	47.404	30.000
LK 7901000-A	1000 lb cylinder c/w 4.0” valve	64.617	54.767	30.000
LK 7901200-A	1200 lb cylinder c/w 4.0” valve	71.985	62.135	30.000

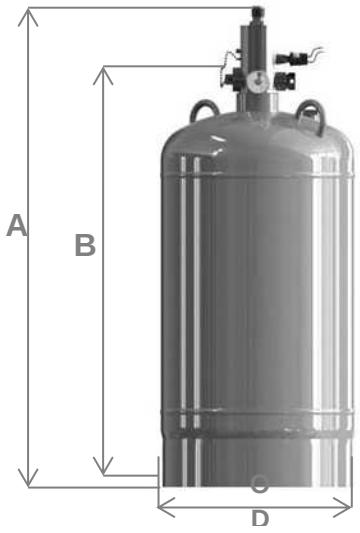


Figure 2.3: Cylinder with valve assembly

2.3 Cylinders Straps

The cylinder straps are manufactured from galvanized steel band. They are formed to the radius of the cylinder with flanges for bolting and continuous slot metal framing channel (12-gauge steel with corrosion-resistant paint or galvanized 1100 H Unistrut). The channel is to be supplied by the installer. The cylinder strap must be secured to a surface such that the strap will withstand a load up to 5 times of the cylinder weight. This precaution is to have the strap safely supports the weight of the cylinder and the reaction force of the clean agent when discharge.

Table 2-3 indicates the part number and the quantity of the strap required for each of the cylinder assembly. For those cylinder models LK 7900800-A, LK 7901000-A and LK 7901200-A have the option of cylinder wall strap or cylinder floor strap (Part Number: LK 7911059-F). All cylinders must be mounted vertically only, with valve up, resting firmly on the floor (Figure 2-4).

Table 2-3: Part Number and Required Quantity of Cylinder Wall Strap

Cylinder Complete Assembly Part Number	Cylinder Floor Strap Part Number	Cylinder Wall Strap Part Number	# of Wall Strap/Bracket
LK 7900020-A	-	LK 7911107-W	1
LK 7900035-A	-	LK 7911107-W	1
LK 7900070-A	-	LK 7911107-W	1
LK 7900100-A	-	LK 7911128-W	1
LK 7900150-A	-	LK 7911128-W	1
LK 7900250-A	-	LK 7911160-W	1
LK 7900375-A	-	LK 7911160-W	2
LK 7900560-A	-	LK 7911200-W	2
LK 7900800-A	LK 7911059-F	LK 7911200-W	2
LK 7901000-A	LK 7911059-F	LK 7911300-W	2
LK 7901200-A	LK 7911059-F	LK 7911300-W	2

NOTE: Cylinder floor strap can be used as an option instead of cylinder wall strap for the cylinder model of LK 7900800-A/B, LK 7901000-A/B and LK 7901200-A.

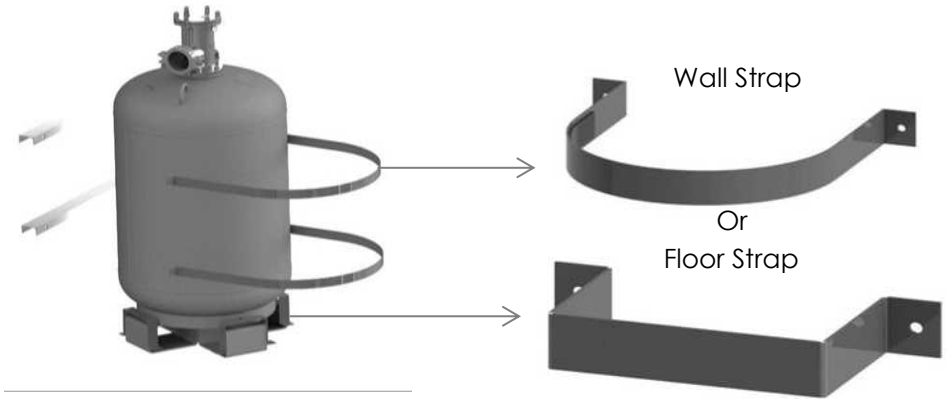


Figure 2.4: Cylinder Straps

2.4 Valves

The HFC-227ea Cylinders are provided with the back pressure type of valves that are used to fill (refill) and pressurize the cylinder. The valve is equipped with a piston that is assembled with a rubber seal to keep the agent under pressure within the cylinder. The piston is designed to have a small hole for allowing the pressure to be equalized on both sides of the piston. When the pressure on the top of the piston is relieved automatically or manually, the piston would slide to its open position allowing the cylinder discharge through the distribution network. The filling and nitrogen pressurization procedures are described separately in the Initial Fill Manual.

Figure 2.5: Valve Assembly (Threaded type outlet)

Figure 2.6: Valve Assembly (Grooved type outlet)

CAUTION:

1. ALL CYLINDER VALVES ARE FACTORY EQUIPPED WITH ANTI-RECOIL DEVICE. THE ANTI-RECOIL DEVICE MUST BE ATTACHED TO THE VALVE OUTLET AT ALL TIMES UNLESS THE OUTLET IS CONNECTED TO THE DISCHARGE PIPING OR RECHARGE ADAPTER.

2. The marking on the valve body represents the component part to be assembled to the valves.

- *"P" marking is the port for Pressure Supervisory Switch*
- *"E" marking is the port for Electric Solenoid*
- *"G" marking is the port for Pressure Gauge*
- *"M" marking is the port for the hose connection from the valve body to Pneumatic Piston Actuator or Pressure Operated Switch*

2.5 Pressure Gauge

The "G" marking is the port of Pressure Gauge that functions to monitor the internal pressure of the filled cylinder. They are available in 360 psig.

Figure 2.7: Pressure Gauge

2.6 Cylinder Valve Control

The purpose of having cylinder valve controls is to release the pressure above the piston in the cylinder valve, which would allow the piston to slide upward and commence system discharge.

2.6.1 Electric Solenoid

The electric solenoid is normally closed, and the valve requires electrical energy to remain open. It is used to vent the pressure from the top of the piston in the cylinder valve, allowing the piston to slide upward and commence cylinder discharge. The electric solenoid is available in 24 VDC with either 11 Watts or 15 Watts (Table 2-4). The source of the electrical energy will determine the number and power rating of the electrical solenoids to be used.

Figure 2.8Electric Solenoid

Table 2-4: Available Electric Solenoid

Part Number of Electric Solenoid	Electrical Rating
LK 7932001	24 VDC, 11 Watts
LK 7932002	24 VDC, 15 Watts

Electric Solenoid is added with a tamper indicator as shown in Figure 2.9 which uses a zip-tie (Part Number: LK 7998003) around the valve coil and vent solenoid. Unless the zip tie is cut, solenoid coil cannot be removed. Tamper Seal shall be permanently installed at all times. For Servicing and Maintenance of Electric Solenoid, refer to Chapter 6 for detailed instruction.

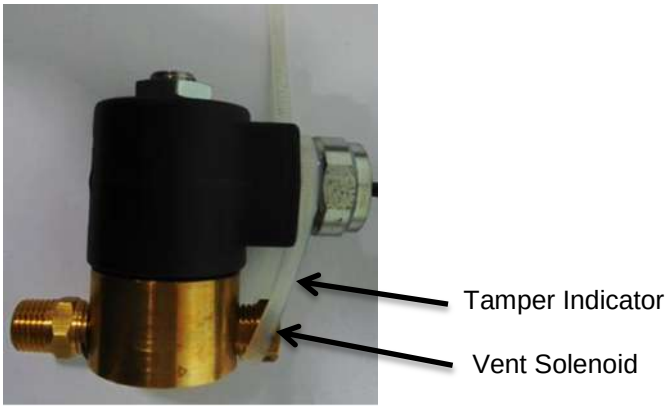


Figure 2.9 Tamper Seal Installation

NFPA 2001 (2015 Edition) requirements to avoid unwanted system operation or unwanted discharge of an electrically actuated clean agent system are compulsory to follow.

1. A supervised disconnect switch shall be provided.
2. The disconnect switch shall interrupt the releasing circuit to the suppression system.
3. The disconnect switch shall cause a supervisory signal at the releasing control unit.
4. The disconnect switch shall be located inside a lockable fire alarm control panel inside a lockable fire alarm control panel, inside a lockable enclosure, or require a key for activation of the switch.
5. When the disconnect switch requires a key for activation, the access key shall not be removable while disconnected so the suppression system can be quickly returned to the operational condition in the event of fire.

Electric Solenoid is coupled to the Releasing Circuit Disable Switch (Part Number: LK 7965004). For details, refer to Section 4.1.4.

Prior to wiring the solenoid to the actuation circuit, make sure that the solenoid rating matches the actuating circuit voltage. Connect solenoid pigtails to the actuation circuit wires with wire nuts within a junction box or by means designated by the Authorities Having Jurisdiction (AHJ).

WARNING:

1. *The 24 VDC solenoid circuit must be supervised for a break in the wiring, a ground or a short circuit.*
2. *Disable the Releasing Circuit Disable Switch (Part Number: LK 7965004) during the filling operation or at any time unless the discharge valve outlet has the anti-recoil fitting installed or the discharge piping is installed.*

The discharge valve equipped with a solenoid valve is actuated from the UL Listed Control Panel for releasing device service and is compatible with equipment in this manual. A suitable control panel shall be specifically UL Listed for releasing device service and/or approved for use with the electric solenoid releasing device for discharge valves. For FM applications, the control panel must have FM Approval. The control panel shall be provided for supervision of the releasing circuits as per NFPA2001 (Latest Ed.) and UL requirements. In addition, 24-hour batteries backup power supply as well as both manual and automatic releasing capabilities shall be provided as per NFPA requirements.

2.6.2 Local Manual Control

The Local Manual Control Lever Type (Part Number: LK 7941101) is assembled directly on the top of the cylinder valve. It is a manual control that requires pushing down the metal knob in order to depress a Schrader valve that is located inside of the removable fitting. The act of depressing the Schrader valve would result in venting the pressure from the top of the piston inside of the cylinder valve. This allows the piston to slide upward and commence the cylinder discharge.

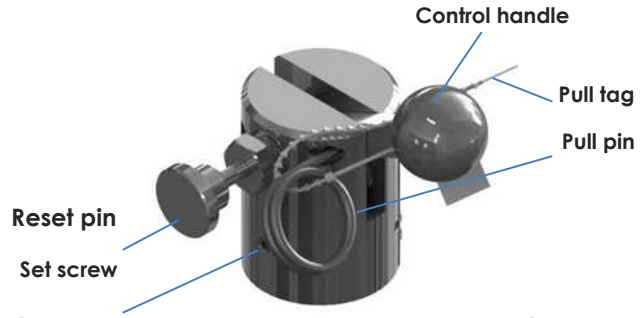


Figure 2.10: Local Manual Control (Lever Type)

CAUTION:

1. *Be sure the safety pull-pin is installed in Local Manual Control of the cylinder at all times. Ensure that the safety pull-pin is correctly installed until system is activated by use of the local manual control.*
2. *When reinstalling the Local Manual Control back onto the Top Plug Adapter, you must ensure that the lock-pin is reset with the handle in the up position. Failure to reset the control head before installation will result in the unwanted discharge of the system during installation. Pulling out the lock-pin, and at the same time, lifting the handle to reset it. The pull-pin and plastic seal should be in place at all times when the Local Manual Control is not in use.*

2.6.3 Piston Actuator

The piston actuator (Part Number: LK 7941201) is a pneumatically driven piston to vent the cylinder valve pressure in order to initiate the agent discharge. It is used in manifold system (i.e. multiple cylinders system) and is assembled on the top of the cylinder valve. The required pneumatic pressure to operate the piston actuator is obtained from the “M” port of the master cylinder. The piston actuator can also be used to actuate a pressure operated switch in the event of the agent discharge.

Figure 2.11: Piston Actuator

Table 2-5 Maximum Number of Cylinders allowed for manifold

Cylinder Complete Assembly	Maximum No. of Actuators	Total Length of Copper Tubing
20 lb cylinder c/w 1” valve	7	50 ft
35 lb cylinder c/w 1” valve	7	50 ft
70 lb cylinder c/w 1” valve	7	50 ft
100 lb cylinder c/w 1.5” valve	7	50 ft
150 lb cylinder c/w 1.5” valve	7	50 ft
250 lb cylinder c/w 1.5” valve	7	50 ft
375 lb cylinder c/w 2.5” valve	6	30 ft
560 lb cylinder c/w 2.5” valve	6	30 ft
800 lb cylinder c/w 4.0” valve	6	30 ft
1000 lb cylinder c/w 4.0” valve	6	30 ft
1200 lb cylinder c/w 4.0” valve	6	30 ft

3 Agent Distribution Devices

3.1 Pipe, Fittings, and Pipe Supports

All piping, fittings and its supports shall be installed in accordance to the latest edition of NFPA 2001, ANSI B 31.1, Power Piping Code and others applicable commercial practices and national standards.

3.1.1 Pipe Requirements

All pipe materials to be used for the distribution shall be in accordance to ASME 31.1 Power Piping Code. The piping shall be a minimum of Schedule 40 steel pipe of ASTM A-106, seamless, Grade A, B or C or ASTM A-53 Electric Resistance Welded (ERW), Grade A or B.

NOTES:

1. *Cast-iron pipe and steel pipe conforming to the ASTM A-120, or non-metallic pipe shall NOT be used.*
2. *All piping must be thoroughly reamed to remove burrs and swabbed with a degreasing solvent to remove all traces of cutting oils and chips.*

3.1.2 Pipe Fittings

Pipe fittings shall be a minimum of Class 300lb malleable iron of ASTM A-197.87 with the dimensions of ANSI B16.3.1998 and have a minimum working pressure of 620 psi (43 bars) up to a maximum size of 4" (Table A.42.3.1(a) of NFPA 2001, Latest Edition. All threaded joints must be in accordance to the ANSI B-1.20.1.1983. Flanges and flanged fittings shall be in accordance with ASME B16.5 and a minimum pressure class of 400lb. The steel grooved-end fitting shall be based on ASTM A47/A 47M malleable iron, ASTM A395/ A395M or ASTM A536 ductile iron with dimensions matching steel pipes and ends shall be factory grooved according to AWWA C606.All reductions in pipe size must be made by using concentric reducer fittings after the tee. Reducing bushings are not acceptable. All tees shall exit in the horizontal plane.

NOTES: Machined groove or roll grooved Victaulic fitting is to be used.
Pipe fittings below Class 300 are strictly prohibited for the distribution piping

3.1.3 Pipe Supports

Pipe supports must be installed with allowance for expansion and contraction. They must be rated to support the dead weight of the pipes and the thrust forces of the agent discharge. The piping for fire-extinguishing system shall be installed in accordance to proper commercial practices and securely supported by the UL Listed hangers. ANSI B-31.1 Codes for bracing requirements shall be followed.

3.2 Flexible Hose

Flexible hoses are used to connect the agent storage containers to the manifold in multiple cylinders arrangement. Flexible hoses are 18 inch (457.20 mm) in length and are constructed of high pressure hydraulic rubber in the 1 inch (25.40 mm) and 1-1/2 inch (38.10 mm) sizes or stainless steel corrugated inner core with stainless steel braided in the 2-1/2 inch (63.50 mm) and 4 inch (101.60 mm) sizes. All sizes except 4 inch (101.60 mm) flexible hose are fitted with male NPT threads on both ends. The 4 inch (101.60 mm) version has a standard grooved ends.

Figure 3.1: Flexible Hoses Assembled with Check Valve

Table 3-1: Flexible Hose and Check Valve Part Numbers

NPT Size	Flexible Hose Part Number	Check Valve Part Number
1”	LK 7953100	LK 7956100
1 ½ ”	LK 7953150	LK 7956150
2 ½ ”	LK 7953250	LK 7956250
4”	LK 7953400	LK 7956400

The recommended assembly configuration is to install a union elbow to the discharge outlet of the cylinder valve. Then, install the flexible hose between the union elbow and a check valve, with the check valve connected to the appropriate fitting in the manifold.

The 800 lb, 1000 lb and 1200 lb cylinders can be provided with a 4 inch (101.60 mm) flexible hose or a flexible hose and check valve assembly for manifold. The 4 inch (101.60 mm) check valve without hoses is also available upon request. The flexible hose and check valve assembly are used when the multiple cylinders are connected to the manifold.

*CAUTION: The 1 inch, 1-1/2 inch, and 2-1/2 inch flex*ible *hoses are to be installed straight and going up into the check valve only. No bends of the flex*ible *hose are to be used at the installation. The 4 inch flex*ible *hose may be mounted horizontally or vertically.*

3.3 Check Valve

Check valves are used when two or more agent storage cylinders are manifold together with one common discharge piping configuration. Their purpose is to prevent the loss of agent in the event that any of the agent storage cylinders are not connected to the manifold at the time of system discharge and to prevent back flow of agent into other cylinders attached to the manifold.

All check valve components are constructed from brass material for durability and protection against corrosion. The metal to metal sealing area of the disc and seat is precision lapped, providing a very tight shut-off of both gas and liquid. The threaded check valves shall be installed vertically only while the grooved check valve assemblies can be installed vertically or horizontally because of the operating methods.

Figure 3.2: Threaded (Left) and Grooved (Right) check valve assembly

CAUTION: The 1 inch (25.40 mm), 1-1/2 inch (38.10 mm), and 2-1/2 inch (63.50 mm) check valves are to be installed vertically only.

3.4 Shuttle Valve

The shuttle valve is used to connect two cylinders to a common discharge pipe in a main-reserve configuration. The shuttle valve contains a shuttle check, which closes off the pipe to the empty cylinder (main) to allow the discharge from the reserve cylinder to flow through the discharge piping. The shuttle valve is available in 1 inch size (for the 20 lb, 35 lb and 70 lb cylinders) and 1-1/2 inchsize (for the 100 lb, 150 lb, 250 lb, and 375 lb) cylinders.

Figure 3.3: Shuttle Valve

3.5 Nozzles

Discharge nozzles are made of aluminum, brass or stainless steel with female pipe threads and are available in two configurations to optimize the flow coverage to different wall types. One is sidewall discharge pattern (e.g. 180°), and another is central discharge pattern (e.g. 360°) as indicated in Figure 3-4. The list of the discharge nozzle including its orifice sizes is summarized in Table 3-2.

NOTES:

- *Nozzles are rated for a minimum height of 1 ft (0.30 m) and a maximum hazard height of 16 ft (4.88 m). If hazard height exceeds 16 ft (4.88 m), a second tier of nozzles shall be used.*
- *Both configurations of nozzles can be combined in a single enclosure. When multiple nozzles are employed, the coverage of each nozzle shall not exceed its maximum length and coverage area.*

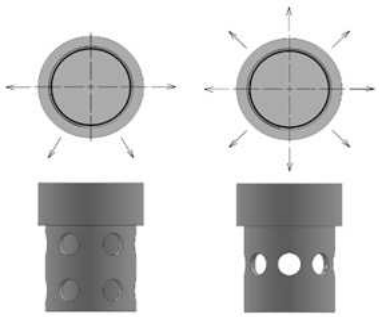


Figure 3.4: Different Type of Discharge Nozzle (Left: Sidewall, Right: Central)

Table 3-2: List of Discharge Nozzles

Part Number	NPT Pipe Size	Discharge Pattern	Drill Size Range
LK 7952050-2-.XXXX	1/2 inch (12.70 mm)	sidewall (180°)	0.0781 to 0.1960
LK 7952050-3-.XXXX	1/2 inch (12.70 mm)	central (360°)	0.0781 to 0.1960
LK 7952075-2-.XXXX	3/4 inch (19.05 mm)	sidewall (180°)	0.1360 to 0.2610
LK 7952075-3.XXXX	3/4 inch (19.05 mm)	central (360°)	0.1360 to 0.2610
LK 7952100-2-.XXXX	1 inch (25.40 mm)	sidewall (180°)	0.1660 to 0.3320
LK 7952100-3-.XXXX	1 inch (25.40 mm)	central (360°)	0.1660 to 0.3320
LK 7952125-2-.XXXX	1-1/4 inch (31.75 mm)	sidewall (180°)	0.2187 to 0.4375
LK 7952125-3-.XXXX	1-1/4 inch (31.75 mm)	central (360°)	0.2187 to 0.4375
LK 7952150-2-.XXXX	1-1/2 inch (38.10 mm)	sidewall (180°)	0.2570 to 0.5000
LK 7952150-3-.XXXX	1-1/2 inch (38.10 mm)	central (360°)	0.2570 to 0.5000
LK 7952200-2-.XXXX	2 inch (50.80 mm)	sidewall (180°)	0.3281 to 0.6563
LK 7952200-3-.XXXX	2 inch (50.80 mm)	central (360°)	0.3281 to 0.6563

NOTES:

- *The term ".XXXX" indicates the nozzle orifice drill size*
- *Nozzles are rated for a minimum height of 1 ft (0.30 m) and a maximum hazard height of 16 ft (4.88 m). If hazard height exceeds 16 ft (4.88 m), a second tier of nozzles shall be used.*
- *Both configurations of nozzles can be combined in a single enclosure. When multiple nozzles are employed, the coverage of each nozzle shall not exceed its maximum length and coverage area.*

360˚CENTRAL NOZZLES			
Nozzle Diameter	Orifice Area (in2)	Drill Size	Part Number
1/2 in	0.0383	0.0781	LK 7952050-3-0.0781
1/2 in	0.0387	0.0785	LK 7952050-3-0.0785
1/2 in	0.0412	0.081	LK 7952050-3-0.0810
1/2 in	0.0422	0.082	LK 7952050-3-0.0820
1/2 in	0.0465	0.086	LK 7952050-3-0.0860
1/2 in	0.0498	0.089	LK 7952050-3-0.0890
1/2 in	0.0549	0.0935	LK 7952050-3-0.0935
1/2 in	0.0552	0.0937	LK 7952050-3-0.0937
1/2 in	0.0579	0.096	LK 7952050-3-0.0960
1/2 in	0.0603	0.098	LK 7952050-3-0.0980
1/2 in	0.0626	0.0998	LK 7952050-3-0.0998
1/2 in	0.0647	0.1015	LK 7952050-3-0.1015
1/2 in	0.068	0.104	LK 7952050-3-0.1040
1/2 in	0.0713	0.1065	LK 7952050-3-0.1065
1/2 in	0.0752	0.1094	LK 7952050-3-0.1094
1/2 in	0.076	0.11	LK 7952050-3-0.1100
1/2 in	0.0774	0.111	LK 7952050-3-0.1110
1/2 in	0.0802	0.113	LK 7952050-3-0.1130
1/2 in	0.0845	0.116	LK 7952050-3-0.1160
1/2 in	0.0905	0.12	LK 7952050-3-0.1200
1/2 in	0.0982	0.125	LK 7952050-3-0.1250
1/2 in	0.1037	0.1285	LK 7952050-3-0.1285
1/2 in	0.1162	0.136	LK 7952050-3-0.1360
1/2 in	0.1242	0.1406	LK 7952050-3-0.1406
1/2 in	0.1303	0.144	LK 7952050-3-0.1440
1/2 in	0.1358	0.147	LK 7952050-3-0.1470
1/2 in	0.1404	0.1495	LK 7952050-3-0.1495
1/2 in	0.1452	0.152	LK 7952050-3-0.1520
1/2 in	0.149	0.154	LK 7952050-3-0.1540
1/2 in	0.1533	0.1562	LK 7952050-3-0.1562
1/2 in	0.1549	0.157	LK 7952050-3-0.1570
1/2 in	0.1588	0.159	LK 7952050-3-0.1590
1/2 in	0.1629	0.161	LK 7952050-3-0.1610
1/2 in	0.1731	0.166	LK 7952050-3-0.1660
1/2 in	0.1805	0.1695	LK 7952050-3-0.1695
1/2 in	0.1857	0.1719	LK 7952050-3-0.1719
1/2 in	0.188	0.173	LK 7952050-3-0.1730
1/2 in	0.1968	0.177	LK 7952050-3-0.1770
1/2 in	0.2036	0.18	LK 7952050-3-0.1800
1/2 in	0.2081	0.182	LK 7952050-3-0.1820
1/2 in	0.215	0.185	LK 7952050-3-0.1850

360˚CENTRAL NOZZLES			
Nozzle Diameter	Orifice Area (in2)	Drill Size	Part Number
1/2 in	0.2209	0.1875	LK 7952050-3-0.1875
1/2 in	0.2244	0.189	LK 7952050-3-0.1890
1/2 in	0.2292	0.191	LK 7952050-3-0.1910
1/2 in	0.2353	0.1935	LK 7952050-3-0.1935
1/2 in	0.2414	0.196	LK 7952050-3-0.1960
3/4 in	0.1162	0.136	LK 7952075-3-0.1360
3/4 in	0.1242	0.1406	LK 7952075-3-0.1406
3/4 in	0.1303	0.144	LK 7952075-3-0.1440
3/4 in	0.1358	0.147	LK 7952075-3-0.1470
3/4 in	0.1404	0.1495	LK 7952075-3-0.1495
3/4 in	0.1452	0.152	LK 7952075-3-0.1520
3/4 in	0.149	0.154	LK 7952075-3-0.1540
3/4 in	0.1533	0.1562	LK 7952075-3-0.1562
3/4 in	0.1549	0.157	LK 7952075-3-0.1570
3/4 in	0.1588	0.159	LK 7952075-3-0.1590
3/4 in	0.1629	0.161	LK 7952075-3-0.1610
3/4 in	0.1731	0.166	LK 7952075-3-0.1660
3/4 in	0.1805	0.1695	LK 7952075-3-0.1695
3/4 in	0.1857	0.1719	LK 7952075-3-0.1719
3/4 in	0.188	0.173	LK 7952075-3-0.1730
3/4 in	0.1968	0.177	LK 7952075-3-0.1770
3/4 in	0.2036	0.18	LK 7952075-3-0.1800
3/4 in	0.2081	0.182	LK 7952075-3-0.1820
3/4 in	0.215	0.185	LK 7952075-3-0.1850
3/4 in	0.2209	0.1875	LK 7952075-3-0.1875
3/4 in	0.2244	0.189	LK 7952075-3-0.1890
3/4 in	0.2292	0.191	LK 7952075-3-0.1910
3/4 in	0.2353	0.1935	LK 7952075-3-0.1935
3/4 in	0.2414	0.196	LK 7952075-3-0.1960
3/4 in	0.2488	0.199	LK 7952075-3-0.1990
3/4 in	0.2538	0.201	LK 7952075-3-0.2010
3/4 in	0.2592	0.2031	LK 7952075-3-0.2031
3/4 in	0.2615	0.204	LK 7952075-3-0.2040
3/4 in	0.2643	0.2051	LK 7952075-3-0.2050
3/4 in	0.2745	0.209	LK 7952075-3-0.2090
3/4 in	0.2851	0.213	LK 7952075-3-0.2130
3/4 in	0.3005	0.2187	LK 7952075-3-0.2187
3/4 in	0.3069	0.221	LK 7952075-3-0.2210
3/4 in	0.3266	0.228	LK 7952075-3-0.2280
3/4 in	0.344	0.234	LK 7952075-3-0.2340
3/4 in	0.3452	0.2344	LK 7952075-3-0.2344

360˚CENTRAL NOZZLES			
Nozzle Diameter	Orifice Area (in2)	Drill Size	Part Number
3/4 in	0.3559	0.238	LK 7952075-3-0.2380
3/4 in	0.368	0.242	LK 7952075-3-0.2420
3/4 in	0.3802	0.246	LK 7952075-3-0.2460
3/4 in	0.3927	0.25	LK 7952075-3-0.2500
3/4 in	0.415	0.257	LK 7952075-3-0.2570
3/4 in	0.428	0.261	LK 7952075-3-0.2610
1 in	0.1731	0.166	LK 7952100-3-0.1660
1 in	0.1805	0.1695	LK 7952100-3-0.1695
1 in	0.1857	0.1719	LK 7952100-3-0.1719
1 in	0.188	0.173	LK 7952100-3-0.1730
1 in	0.1968	0.177	LK 7952100-3-0.1770
1 in	0.2036	0.18	LK 7952100-3-0.1800
1 in	0.2081	0.182	LK 7952100-3-0.1820
1 in	0.215	0.185	LK 7952100-3-0.1850
1 in	0.2209	0.1875	LK 7952100-3-0.1875
1 in	0.2244	0.189	LK 7952100-3-0.1890
1 in	0.2292	0.191	LK 7952100-3-0.1910
1 in	0.2353	0.1935	LK 7952100-3-0.1935
1 in	0.2414	0.196	LK 7952100-3-0.1960
1 in	0.2488	0.199	LK 7952100-3-0.1990
1 in	0.2538	0.201	LK 7952100-3-0.2010
1 in	0.2592	0.2031	LK 7952100-3-0.2031
1 in	0.2615	0.204	LK 7952100-3-0.2040
1 in	0.2653	0.2055	LK 7952100-3-0.2055
1 in	0.2745	0.209	LK 7952100-3-0.2090
1 in	0.2851	0.213	LK 7952100-3-0.2130
1 in	0.3005	0.2187	LK 7952100-3-0.2187
1 in	0.3069	0.221	LK 7952100-3-0.2210
1 in	0.3266	0.228	LK 7952100-3-0.2280
1 in	0.344	0.234	LK 7952100-3-0.2340
1 in	0.3452	0.2344	LK 7952100-3-0.2344
1 in	0.3559	0.238	LK 7952100-3-0.2380
1 in	0.368	0.242	LK 7952100-3-0.2420
1 in	0.3802	0.246	LK 7952100-3-0.2460
1 in	0.3927	0.25	LK 7952100-3-0.2500
1 in	0.415	0.257	LK 7952100-3-0.2570
1 in	0.428	0.261	LK 7952100-3-0.2610
1 in	0.4432	0.2656	LK 7952100-3-0.2656
1 in	0.4446	0.266	LK 7952100-3-0.2660
1 in	0.4649	0.272	LK 7952100-3-0.2720
1 in	0.4821	0.277	LK 7952100-3-0.2770

360˚CENTRAL NOZZLES			
Nozzle Diameter	Orifice Area (in2)	Drill Size	Part Number
1 in	0.4961	0.281	LK 7952100-3-0.2810
1 in	0.4968	0.2812	LK 7952100-3-0.2812
1 in	0.5284	0.29	LK 7952100-3-0.2900
1 in	0.5468	0.295	LK 7952100-3-0.2950
1 in	0.5539	0.2969	LK 7952100-3-0.2969
1 in	0.5731	0.302	LK 7952100-3-0.3020
1 in	0.6136	0.3125	LK 7952100-3-0.3125
1 in	0.6274	0.316	LK 7952100-3-0.3160
1 in	0.6555	0.323	LK 7952100-3-0.3230
1 in	0.6764	0.3281	LK 7952100-3-0.3281
1 in	0.6926	0.332	LK 7952100-3-0.3320
1-1/4 in	0.3005	0.2187	LK 7952125-3-0.2187
1-1/4 in	0.3069	0.221	LK 7952125-3-0.2210
1-1/4 in	0.3266	0.228	LK 7952125-3-0.2280
1-1/4 in	0.344	0.234	LK 7952125-3-0.2340
1-1/4 in	0.3452	0.2344	LK 7952125-3-0.2344
1-1/4 in	0.3559	0.238	LK 7952125-3-0.2380
1-1/4 in	0.368	0.242	LK 7952125-3-0.2420
1-1/4 in	0.3802	0.246	LK 7952125-3-0.2460
1-1/4 in	0.3927	0.25	LK 7952125-3-0.2500
1-1/4 in	0.415	0.257	LK 7952125-3-0.2570
1-1/4 in	0.428	0.261	LK 7952125-3-0.2610
1-1/4 in	0.4432	0.2656	LK 7952125-3-0.2656
1-1/4 in	0.4446	0.266	LK 7952125-3-0.2660
1-1/4 in	0.4649	0.272	LK 7952125-3-0.2720
1-1/4 in	0.4821	0.277	LK 7952125-3-0.2770
1-1/4 in	0.4961	0.281	LK 7952125-3-0.2810
1-1/4 in	0.4968	0.2812	LK 7952125-3-0.2812
1-1/4 in	0.5284	0.29	LK 7952125-3-0.2900
1-1/4 in	0.5468	0.295	LK 7952125-3-0.2950
1-1/4 in	0.5539	0.2969	LK 7952125-3-0.2969
1-1/4 in	0.5731	0.302	LK 7952125-3-0.3020
1-1/4 in	0.6136	0.3125	LK 7952125-3-0.3125
1-1/4 in	0.6274	0.316	LK 7952125-3-0.3160
1-1/4 in	0.6555	0.323	LK 7952125-3-0.3230
1-1/4 in	0.6764	0.3281	LK 7952125-3-0.3281
1-1/4 in	0.6926	0.332	LK 7952125-3-0.3320
1-1/4 in	0.7221	0.339	LK 7952125-3-0.3390
1-1/4 in	0.7422	0.3437	LK 7952125-3-0.3437
1-1/4 in	0.7609	0.348	LK 7952125-3-0.3480
1-1/4 in	0.8053	0.358	LK 7952125-3-0.3580

360˚CENTRAL NOZZLES			
Nozzle Diameter	Orifice Area (in2)	Drill Size	Part Number
1-1/4 in	0.8116	0.3594	LK 7952125-3-0.3594
1-1/4 in	0.8509	0.368	LK 7952125-3-0.3680
1-1/4 in	0.8836	0.375	LK 7952125-3-0.3750
1-1/4 in	0.893	0.377	LK 7952125-3-0.3770
1-1/4 in	0.9362	0.386	LK 7952125-3-0.3860
1-1/4 in	0.9586	0.3906	LK 7952125-3-0.3906
1-1/4 in	0.9903	0.397	LK 7952125-3-0.3970
1-1/4 in	1.0255	0.404	LK 7952125-3-0.4040
1-1/4 in	1.0367	0.4062	LK 7952125-3-0.4062
1-1/4 in	1.0717	0.413	LK 7952125-3-0.4130
1-1/4 in	1.1184	0.4219	LK 7952125-3-0.4219
1-1/4 in	1.2026	0.4375	LK 7952125-3-0.4375
1-1/2 in	0.415	0.257	LK 7952150-3-0.2570
1-1/2 in	0.428	0.261	LK 7952150-3-0.2610
1-1/2 in	0.4432	0.2656	LK 7952150-3-0.2656
1-1/2 in	0.4446	0.266	LK 7952150-3-0.2660
1-1/2 in	0.4649	0.272	LK 7952150-3-0.2720
1-1/2 in	0.4821	0.277	LK 7952150-3-0.2770
1-1/2 in	0.4961	0.281	LK 7952150-3-0.2810
1-1/2 in	0.4968	0.2812	LK 7952150-3-0.2812
1-1/2 in	0.5284	0.29	LK 7952150-3-0.2900
1-1/2 in	0.5468	0.295	LK 7952150-3-0.2950
1-1/2 in	0.5539	0.2969	LK 7952150-3-0.2969
1-1/2 in	0.5731	0.302	LK 7952150-3-0.3020
1-1/2 in	0.6136	0.3125	LK 7952150-3-0.3125
1-1/2 in	0.6274	0.316	LK 7952150-3-0.3160
1-1/2 in	0.6555	0.323	LK 7952150-3-0.3230
1-1/2 in	0.6764	0.3281	LK 7952150-3-0.3281
1-1/2 in	0.6926	0.332	LK 7952150-3-0.3320
1-1/2 in	0.7221	0.339	LK 7952150-3-0.3390
1-1/2 in	0.7422	0.3437	LK 7952150-3-0.3437
1-1/2 in	0.7609	0.348	LK 7952150-3-0.3480
1-1/2 in	0.8053	0.358	LK 7952150-3-0.3580
1-1/2 in	0.8116	0.3594	LK 7952150-3-0.3594
1-1/2 in	0.8509	0.368	LK 7952150-3-0.3680
1-1/2 in	0.8836	0.375	LK 7952150-3-0.3750
1-1/2 in	0.893	0.377	LK 7952150-3-0.3770
1-1/2 in	0.9362	0.386	LK 7952150-3-0.3860
1-1/2 in	0.9586	0.3906	LK 7952150-3-0.3906
1-1/2 in	0.9903	0.397	LK 7952150-3-0.3970
1-1/2 in	1.0255	0.404	LK 7952150-3-0.4040

360˚CENTRAL NOZZLES			
Nozzle Diameter	Orifice Area (in2)	Drill Size	Part Number
1-1/2 in	1.0367	0.4062	LK 7952150-3-0.4062
1-1/2 in	1.0717	0.413	LK 7952150-3-0.4130
1-1/2 in	1.1184	0.4219	LK 7952150-3-0.4219
1-1/2 in	1.2026	0.4375	LK 7952150-3-0.4375
1-1/2 in	1.2899	0.4531	LK 7952150-3-0.4531
1-1/2 in	1.3809	0.4688	LK 7952150-3-0.4688
1-1/2 in	1.4743	0.4844	LK 7952150-3-0.4844
1-1/2 in	1.5708	0.5	LK 7952150-3-0.5000
2 in	0.6764	0.3281	LK 7952200-3-0.3281
2 in	0.6926	0.332	LK 7952200-3-0.3320
2 in	0.7221	0.339	LK 7952200-3-0.3390
2 in	0.7422	0.3437	LK 7952200-3-0.3437
2 in	0.7609	0.348	LK 7952200-3-0.3480
2 in	0.8053	0.358	LK 7952200-3-0.3580
2 in	0.8116	0.3594	LK 7952200-3-0.3594
2 in	0.8509	0.368	LK 7952200-3-0.3680
2 in	0.8836	0.375	LK 7952200-3-0.3750
2 in	0.893	0.377	LK 7952200-3-0.3770
2 in	0.9362	0.386	LK 7952200-3-0.3860
2 in	0.9586	0.3906	LK 7952200-3-0.3906
2 in	0.9903	0.397	LK 7952200-3-0.3970
2 in	1.0255	0.404	LK 7952200-3-0.4040
2 in	1.0367	0.4062	LK 7952200-3-0.4062
2 in	1.0717	0.413	LK 7952200-3-0.4130
2 in	1.1184	0.4219	LK 7952200-3-0.4219
2 in	1.2026	0.4375	LK 7952200-3-0.4375
2 in	1.2899	0.4531	LK 7952200-3-0.4531
2 in	1.3809	0.4688	LK 7952200-3-0.4688
2 in	1.4743	0.4844	LK 7952200-3-0.4844
2 in	1.5708	0.5	LK 7952200-3-0.5000
2 in	1.6703	0.5156	LK 7952200-3-0.5156
2 in	1.7736	0.5313	LK 7952200-3-0.5313
2 in	1.8793	0.5469	LK 7952200-3-0.5469
2 in	1.988	0.5625	LK 7952200-3-0.5625
2 in	2.0998	0.5781	LK 7952200-3-0.5781
2 in	2.2154	0.5938	LK 7952200-3-0.5938
2 in	2.3334	0.6094	LK 7952200-3-0.6094
2 in	2.4544	0.625	LK 7952200-3-0.6250
2 in	2.5784	0.6406	LK 7952200-3-0.6406
2 in	2.7064	0.6563	LK 7952200-3-0.6563

180˚SIDEWALL NOZZLES			
Nozzle Diameter	Orifice Area	Drill Size	Part Number
1/2 in	0.0383	0.0781	LK 7952050-2-0.0781
1/2 in	0.0387	0.0785	LK 7952050-2-0.0785
1/2 in	0.0412	0.081	LK 7952050-2-0.0810
1/2 in	0.0422	0.082	LK 7952050-2-0.0820
1/2 in	0.0465	0.086	LK 7952050-2-0.0860
1/2 in	0.0498	0.089	LK 7952050-2-0.0890
1/2 in	0.0549	0.0935	LK 7952050-2-0.0935
1/2 in	0.0552	0.0937	LK 7952050-2-0.0937
1/2 in	0.0579	0.096	LK 7952050-2-0.0960
1/2 in	0.0603	0.098	LK 7952050-2-0.0980
1/2 in	0.0626	0.0998	LK 7952050-2-0.0998
1/2 in	0.0647	0.1015	LK 7952050-2-0.1015
1/2 in	0.068	0.104	LK 7952050-2-0.1040
1/2 in	0.0713	0.1065	LK 7952050-2-0.1065
1/2 in	0.0752	0.1094	LK 7952050-2-0.1094
1/2 in	0.076	0.11	LK 7952050-2-0.1100
1/2 in	0.0774	0.111	LK 7952050-2-0.1110
1/2 in	0.0802	0.113	LK 7952050-2-0.1130
1/2 in	0.0845	0.116	LK 7952050-2-0.1160
1/2 in	0.0905	0.12	LK 7952050-2-0.1200
1/2 in	0.0982	0.125	LK 7952050-2-0.1250
1/2 in	0.1037	0.1285	LK 7952050-2-0.1285
1/2 in	0.1162	0.136	LK 7952050-2-0.1360
1/2 in	0.1242	0.1406	LK 7952050-2-0.1406
1/2 in	0.1303	0.144	LK 7952050-2-0.1440
1/2 in	0.1358	0.147	LK 7952050-2-0.1470
1/2 in	0.1404	0.1495	LK 7952050-2-0.1495
1/2 in	0.1452	0.152	LK 7952050-2-0.1520
1/2 in	0.149	0.154	LK 7952050-2-0.1540
1/2 in	0.1533	0.1562	LK 7952050-2-0.1562
1/2 in	0.1549	0.157	LK 7952050-2-0.1570
1/2 in	0.1588	0.159	LK 7952050-2-0.1590
1/2 in	0.1629	0.161	LK 7952050-2-0.1610
1/2 in	0.1731	0.166	LK 7952050-2-0.1660
1/2 in	0.1805	0.1695	LK 7952050-2-0.1695
1/2 in	0.1857	0.1719	LK 7952050-2-0.1719
1/2 in	0.188	0.173	LK 7952050-2-0.1730
1/2 in	0.1968	0.177	LK 7952050-2-0.1770
1/2 in	0.2036	0.18	LK 7952050-2-0.1800
1/2 in	0.2081	0.182	LK 7952050-2-0.1820
1/2 in	0.215	0.185	LK 7952050-2-0.1850

180˚SIDEWALL NOZZLES			
Nozzle Diameter	Orifice Area	Drill Size	Part Number
1/2 in	0.2209	0.1875	LK 7952050-2-0.1875
1/2 in	0.2244	0.189	LK 7952050-2-0.1890
1/2 in	0.2292	0.191	LK 7952050-2-0.1910
1/2 in	0.2353	0.1935	LK 7952050-2-0.1935
1/2 in	0.2414	0.196	LK 7952050-2-0.1960
3/4 in	0.1162	0.136	LK 7952075-2-0.1360
3/4 in	0.1242	0.1406	LK 7952075-2-0.1406
3/4 in	0.1303	0.144	LK 7952075-2-0.1440
3/4 in	0.1358	0.147	LK 7952075-2-0.1470
3/4 in	0.1404	0.1495	LK 7952075-2-0.1495
3/4 in	0.1452	0.152	LK 7952075-2-0.1520
3/4 in	0.149	0.154	LK 7952075-2-0.1540
3/4 in	0.1533	0.1562	LK 7952075-2-0.1562
3/4 in	0.1549	0.157	LK 7952075-2-0.1570
3/4 in	0.1588	0.159	LK 7952075-2-0.1590
3/4 in	0.1629	0.161	LK 7952075-2-0.1610
3/4 in	0.1731	0.166	LK 7952075-2-0.1660
3/4 in	0.1805	0.1695	LK 7952075-2-0.1695
3/4 in	0.1857	0.1719	LK 7952075-2-0.1719
3/4 in	0.188	0.173	LK 7952075-2-0.1730
3/4 in	0.1968	0.177	LK 7952075-2-0.1770
3/4 in	0.2036	0.18	LK 7952075-2-0.1800
3/4 in	0.2081	0.182	LK 7952075-2-0.1820
3/4 in	0.215	0.185	LK 7952075-2-0.1850
3/4 in	0.2209	0.1875	LK 7952075-2-0.1875
3/4 in	0.2244	0.189	LK 7952075-2-0.1890
3/4 in	0.2292	0.191	LK 7952075-2-0.1910
3/4 in	0.2353	0.1935	LK 7952075-2-0.1935
3/4 in	0.2414	0.196	LK 7952075-2-0.1960
3/4 in	0.2488	0.199	LK 7952075-2-0.1990
3/4 in	0.2538	0.201	LK 7952075-2-0.2010
3/4 in	0.2592	0.2031	LK 7952075-2-0.2031
3/4 in	0.2615	0.204	LK 7952075-2-0.2040
3/4 in	0.2643	0.2051	LK 7952075-2-0.2050
3/4 in	0.2745	0.209	LK 7952075-2-0.2090
3/4 in	0.2851	0.213	LK 7952075-2-0.2130
3/4 in	0.3005	0.2187	LK 7952075-2-0.2187
3/4 in	0.3069	0.221	LK 7952075-2-0.2210
3/4 in	0.3266	0.228	LK 7952075-2-0.2280
3/4 in	0.344	0.234	LK 7952075-2-0.2340
3/4 in	0.3452	0.2344	LK 7952075-2-0.2344

180˚SIDEWALL NOZZLES			
Nozzle Diameter	Orifice Area	Drill Size	Part Number
3/4 in	0.3559	0.238	LK 7952075-2-0.2380
3/4 in	0.368	0.242	LK 7952075-2-0.2420
3/4 in	0.3802	0.246	LK 7952075-2-0.2460
3/4 in	0.3927	0.25	LK 7952075-2-0.2500
3/4 in	0.415	0.257	LK 7952075-2-0.2570
3/4 in	0.428	0.261	LK 7952075-2-0.2610
1 in	0.1731	0.166	LK 7952100-2-0.1660
1 in	0.1805	0.1695	LK 7952100-2-0.1695
1 in	0.1857	0.1719	LK 7952100-2-0.1719
1 in	0.188	0.173	LK 7952100-2-0.1730
1 in	0.1968	0.177	LK 7952100-2-0.1770
1 in	0.2036	0.18	LK 7952100-2-0.1800
1 in	0.2081	0.182	LK 7952100-2-0.1820
1 in	0.215	0.185	LK 7952100-2-0.1850
1 in	0.2209	0.1875	LK 7952100-2-0.1875
1 in	0.2244	0.189	LK 7952100-2-0.1890
1 in	0.2292	0.191	LK 7952100-2-0.1910
1 in	0.2353	0.1935	LK 7952100-2-0.1935
1 in	0.2414	0.196	LK 7952100-2-0.1960
1 in	0.2488	0.199	LK 7952100-2-0.1990
1 in	0.2538	0.201	LK 7952100-2-0.2010
1 in	0.2592	0.2031	LK 7952100-2-0.2031
1 in	0.2615	0.204	LK 7952100-2-0.2040
1 in	0.2653	0.2055	LK 7952100-2-0.2055
1 in	0.2745	0.209	LK 7952100-2-0.2090
1 in	0.2851	0.213	LK 7952100-2-0.2130
1 in	0.3005	0.2187	LK 7952100-2-0.2187
1 in	0.3069	0.221	LK 7952100-2-0.2210
1 in	0.3266	0.228	LK 7952100-2-0.2280
1 in	0.344	0.234	LK 7952100-2-0.2340
1 in	0.3452	0.2344	LK 7952100-2-0.2344
1 in	0.3559	0.238	LK 7952100-2-0.2380
1 in	0.368	0.242	LK 7952100-2-0.2420
1 in	0.3802	0.246	LK 7952100-2-0.2460
1 in	0.3927	0.25	LK 7952100-2-0.2500
1 in	0.415	0.257	LK 7952100-2-0.2570
1 in	0.428	0.261	LK 7952100-2-0.2610
1 in	0.4432	0.2656	LK 7952100-2-0.2656
1 in	0.4446	0.266	LK 7952100-2-0.2660
1 in	0.4649	0.272	LK 7952100-2-0.2720
1 in	0.4821	0.277	LK 7952100-2-0.2770

180˚SIDEWALL NOZZLES			
Nozzle Diameter	Orifice Area	Drill Size	Part Number
1 in	0.4961	0.281	LK 7952100-2-0.2810
1 in	0.4968	0.2812	LK 7952100-2-0.2812
1 in	0.5284	0.29	LK 7952100-2-0.2900
1 in	0.5468	0.295	LK 7952100-2-0.2950
1 in	0.5539	0.2969	LK 7952100-2-0.2969
1 in	0.5731	0.302	LK 7952100-2-0.3020
1 in	0.6136	0.3125	LK 7952100-2-0.3125
1 in	0.6274	0.316	LK 7952100-2-0.3160
1 in	0.6555	0.323	LK 7952100-2-0.3230
1 in	0.6764	0.3281	LK 7952100-2-0.3281
1 in	0.6926	0.332	LK 7952100-2-0.3320
1-1/4 in	0.3005	0.2187	LK 7952125-2-0.2187
1-1/4 in	0.3069	0.221	LK 7952125-2-0.2210
1-1/4 in	0.3266	0.228	LK 7952125-2-0.2280
1-1/4 in	0.344	0.234	LK 7952125-2-0.2340
1-1/4 in	0.3452	0.2344	LK 7952125-2-0.2344
1-1/4 in	0.3559	0.238	LK 7952125-2-0.2380
1-1/4 in	0.368	0.242	LK 7952125-2-0.2420
1-1/4 in	0.3802	0.246	LK 7952125-2-0.2460
1-1/4 in	0.3927	0.25	LK 7952125-2-0.2500
1-1/4 in	0.415	0.257	LK 7952125-2-0.2570
1-1/4 in	0.428	0.261	LK 7952125-2-0.2610
1-1/4 in	0.4432	0.2656	LK 7952125-2-0.2656
1-1/4 in	0.4446	0.266	LK 7952125-2-0.2660
1-1/4 in	0.4649	0.272	LK 7952125-2-0.2720
1-1/4 in	0.4821	0.277	LK 7952125-2-0.2770
1-1/4 in	0.4961	0.281	LK 7952125-2-0.2810
1-1/4 in	0.4968	0.2812	LK 7952125-2-0.2812
1-1/4 in	0.5284	0.29	LK 7952125-2-0.2900
1-1/4 in	0.5468	0.295	LK 7952125-2-0.2950
1-1/4 in	0.5539	0.2969	LK 7952125-2-0.2969
1-1/4 in	0.5731	0.302	LK 7952125-2-0.3020
1-1/4 in	0.6136	0.3125	LK 7952125-2-0.3125
1-1/4 in	0.6274	0.316	LK 7952125-2-0.3160
1-1/4 in	0.6555	0.323	LK 7952125-2-0.3230
1-1/4 in	0.6764	0.3281	LK 7952125-2-0.3281
1-1/4 in	0.6926	0.332	LK 7952125-2-0.3320
1-1/4 in	0.7221	0.339	LK 7952125-2-0.3390
1-1/4 in	0.7422	0.3437	LK 7952125-2-0.3437
1-1/4 in	0.7609	0.348	LK 7952125-2-0.3480
1-1/4 in	0.8053	0.358	LK 7952125-2-0.3580

180˚SIDEWALL NOZZLES			
Nozzle Diameter	Orifice Area	Drill Size	Part Number
1-1/4 in	0.8116	0.3594	LK 7952125-2-0.3594
1-1/4 in	0.8509	0.368	LK 7952125-2-0.3680
1-1/4 in	0.8836	0.375	LK 7952125-2-0.3750
1-1/4 in	0.893	0.377	LK 7952125-2-0.3770
1-1/4 in	0.9362	0.386	LK 7952125-2-0.3860
1-1/4 in	0.9586	0.3906	LK 7952125-2-0.3906
1-1/4 in	0.9903	0.397	LK 7952125-2-0.3970
1-1/4 in	1.0255	0.404	LK 7952125-2-0.4040
1-1/4 in	1.0367	0.4062	LK 7952125-2-0.4062
1-1/4 in	1.0717	0.413	LK 7952125-2-0.4130
1-1/4 in	1.1184	0.4219	LK 7952125-2-0.4219
1-1/4 in	1.2026	0.4375	LK 7952125-2-0.4375
1-1/2 in	0.415	0.257	LK 7952150-2-0.2570
1-1/2 in	0.428	0.261	LK 7952150-2-0.2610
1-1/2 in	0.4432	0.2656	LK 7952150-2-0.2656
1-1/2 in	0.4446	0.266	LK 7952150-2-0.2660
1-1/2 in	0.4649	0.272	LK 7952150-2-0.2720
1-1/2 in	0.4821	0.277	LK 7952150-2-0.2770
1-1/2 in	0.4961	0.281	LK 7952150-2-0.2810
1-1/2 in	0.4968	0.2812	LK 7952150-2-0.2812
1-1/2 in	0.5284	0.29	LK 7952150-2-0.2900
1-1/2 in	0.5468	0.295	LK 7952150-2-0.2950
1-1/2 in	0.5539	0.2969	LK 7952150-2-0.2969
1-1/2 in	0.5731	0.302	LK 7952150-2-0.3020
1-1/2 in	0.6136	0.3125	LK 7952150-2-0.3125
1-1/2 in	0.6274	0.316	LK 7952150-2-0.3160
1-1/2 in	0.6555	0.323	LK 7952150-2-0.3230
1-1/2 in	0.6764	0.3281	LK 7952150-2-0.3281
1-1/2 in	0.6926	0.332	LK 7952150-2-0.3320
1-1/2 in	0.7221	0.339	LK 7952150-2-0.3390
1-1/2 in	0.7422	0.3437	LK 7952150-2-0.3437
1-1/2 in	0.7609	0.348	LK 7952150-2-0.3480
1-1/2 in	0.8053	0.358	LK 7952150-2-0.3580
1-1/2 in	0.8116	0.3594	LK 7952150-2-0.3594
1-1/2 in	0.8509	0.368	LK 7952150-2-0.3680
1-1/2 in	0.8836	0.375	LK 7952150-2-0.3750
1-1/2 in	0.893	0.377	LK 7952150-2-0.3770
1-1/2 in	0.9362	0.386	LK 7952150-2-0.3860
1-1/2 in	0.9586	0.3906	LK 7952150-2-0.3906
1-1/2 in	0.9903	0.397	LK 7952150-2-0.3970
1-1/2 in	1.0255	0.404	LK 7952150-2-0.4040

180˚SIDEWALL NOZZLES			
Nozzle Diameter	Orifice Area	Drill Size	Part Number
1-1/2 in	1.0367	0.4062	LK 7952150-2-0.4062
1-1/2 in	1.0717	0.413	LK 7952150-2-0.4130
1-1/2 in	1.1184	0.4219	LK 7952150-2-0.4219
1-1/2 in	1.2026	0.4375	LK 7952150-2-0.4375
1-1/2 in	1.2899	0.4531	LK 7952150-2-0.4531
1-1/2 in	1.3809	0.4688	LK 7952150-2-0.4688
1-1/2 in	1.4743	0.4844	LK 7952150-2-0.4844
1-1/2 in	1.5708	0.5	LK 7952150-2-0.5000
2 in	0.6764	0.3281	LK 7952200-2-0.3281
2 in	0.6926	0.332	LK 7952200-2-0.3320
2 in	0.7221	0.339	LK 7952200-2-0.3390
2 in	0.7422	0.3437	LK 7952200-2-0.3437
2 in	0.7609	0.348	LK 7952200-2-0.3480
2 in	0.8053	0.358	LK 7952200-2-0.3580
2 in	0.8116	0.3594	LK 7952200-2-0.3594
2 in	0.8509	0.368	LK 7952200-2-0.3680
2 in	0.8836	0.375	LK 7952200-2-0.3750
2 in	0.893	0.377	LK 7952200-2-0.3770
2 in	0.9362	0.386	LK 7952200-2-0.3860
2 in	0.9586	0.3906	LK 7952200-2-0.3906
2 in	0.9903	0.397	LK 7952200-2-0.3970
2 in	1.0255	0.404	LK 7952200-2-0.4040
2 in	1.0367	0.4062	LK 7952200-2-0.4062
2 in	1.0717	0.413	LK 7952200-2-0.4130
2 in	1.1184	0.4219	LK 7952200-2-0.4219
2 in	1.2026	0.4375	LK 7952200-2-0.4375
2 in	1.2899	0.4531	LK 7952200-2-0.4531
2 in	1.3809	0.4688	LK 7952200-2-0.4688
2 in	1.4743	0.4844	LK 7952200-2-0.4844
2 in	1.5708	0.5	LK 7952200-2-0.5000
2 in	1.6703	0.5156	LK 7952200-2-0.5156
2 in	1.7736	0.5313	LK 7952200-2-0.5313
2 in	1.8793	0.5469	LK 7952200-2-0.5469
2 in	1.988	0.5625	LK 7952200-2-0.5625
2 in	2.0998	0.5781	LK 7952200-2-0.5781
2 in	2.2154	0.5938	LK 7952200-2-0.5938
2 in	2.3334	0.6094	LK 7952200-2-0.6094
2 in	2.4544	0.625	LK 7952200-2-0.6250
2 in	2.5784	0.6406	LK 7952200-2-0.6406
2 in	2.7064	0.6563	LK 7952200-2-0.6563

4 Accessory Equipment

4.1 Control Switches

4.1.1 Manual Control - Electrical Pull Station and Manual Release Station

The cylinder valve can be electrically actuated by means of manual control - electrical pull station and manual release station wired to the UL Listed Control Panel for releasing device service (Figure 4.1). The releasing panel must be compatible with electric solenoids (Section 2.6.1). This configuration can be backed up with local manual control mounted on top of top plug adapter.

Figure 4.1: Electrical Pull Station

4.1.2 Main-Reserve Selector Switch

The “Main” to “Reserve” Switch (part number: LK 7965001) is used with systems that incorporate main and reserve (bank-up) agent storage as shown in Figure 4.2. The switch may utilize 1 or 2 Form “C” Contact Blocks, which will provide an electrical path to either the “Main” or “Reserve” agent release modules. Following a system discharge, reset any field devices. Once all devices are in a stand-by status, the Main-Reserve Switch may be moved to the “Reserve” position. The Control Panel may then be reset to a normal mode for uninterrupted protection. The empty “Main” container can be removed for recharge. After the container in the “Main” system has been recharged, the switch may be returned to the “Main” position. The switch is mounted on a standard 4” electrical enclosure.

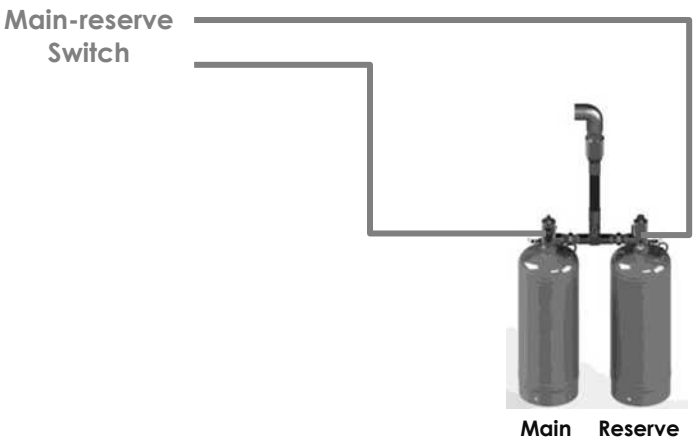


Figure 4.2: Use of Main-Reserve Selector Switch

4.1.3 Abort Station

The Abort Station (Part Number: LK 7965003) is designed to be used in conjunction with other system equipment. It provides a temporary manual means, whereby the system actuation circuit may be interrupted when operated prior to the circuit actuation. The unit employs a momentary contact push button switch. While depressed, the switch causes the agent release circuit to be manually delayed. Upon release of the Abort Station, the release circuit will follow the specific configuration of the UL Listed Control Panel. The Abort Station is mounted on a standard double gang electrical enclosure.

4.1.4 Releasing Circuit Disable Switch

The Releasing Circuit Disable Switch (Part Number: LK 7965004) is a U.L. Listed and has dual functions. One is to cut the circuit continuity of the electric solenoid, and another is to give a signal to the control panel to indicate that there is no circuit continuity in the electric solenoid to initiate the discharge of the agent. This is accomplished by using a keyed lockout to lock the system or to disconnect the electric solenoid electronically during maintenance or inspection.

Following is necessary to comply with the NFPA 2001 (2015 Edition) and UL 2166 requirements.

1. Releasing Circuit - U.L. Listed Fire Control Panel is provided with a disconnect switch to allow the system to be tested without actuating the Electric Solenoid. The function of the releasing circuit is to temporarily disable the function of the system by opening the circuit continuity.
2. Supervisory Zone - Operation of a disconnect switch or a disable function shall cause a supervisory signal at the fire alarm control unit. When the switch is disabled, it will cause the annunciation of a supervisory signal at a required operator interface for the U.L. Listed Control Panel. This is to make sure that the Releasing Circuit Disable Switch is switched back to its normal condition after maintenance/inspection.

Please refer to the U.L. Listed Control Panel Manual and the U.L. Listed Releasing Circuit Disable Switch for proper wiring installation.

4.2 Initiating Devices

4.2.1 Pressure Supervisory Switch

The Pressure Supervisory Switch (Figure 4.3) is to monitor the pressure within the cylinder. It is attached to the port marked “P”. The outlet transmits cylinder pressure to an optional low pressure supervisory switch, which monitors the internal pressure of the cylinder. In the event of leak occurs (e.g. the pressure drops to 291±10 psig or below), the switch contact will operate giving an indication on the control panel that the cylinder has lost pressure. To reinstall the pressure supervisory switch, the cylinder must be emptied with no pressure.

The Pressure Supervisory Switch is available in Normally Closed and Normally Open. In Normally Closed, the Pressure Supervisory Switch will switch to open position when the filled cylinder has the pressure of greater than 291psig. If the pressure of the cylinder is being released, the Pressure Supervisory Switch will change its status from open position to close position when the pressure if less than 291 psig. Likewise, in Normally Open, the Pressure Supervisory Switch will switch to close position when the filled cylinder has the pressure of greater than 291psig. If the pressure of the cylinder is being released, the Pressure Supervisory Switch will change its status from close position to open position when the pressure if less than 291 psig.

Figure 4.3: Low Pressure Supervisory Switch

4.2.2 Pressure Operated Switch

The pressure operated switch is provided to furnish additional electrical contacts for control purposes at time of discharge. The switch may be installed into the same pneumatic tubing for piston actuator (Figure 2.11) provided the maximum length for tubing outlined in Table 2-5 is not exceeded. The pressure operated switch also may be connected to any point of the discharge piping between the cylinder and the nozzle. An external manual reset button is provided on the pressure operated switch.

Figure 4.4: Pressure Operated Switch

After the system is activated, the reset button must be depressed in order to return the device being controlled back to the pre-discharge state.

Following is the specifications of pressure operated switch.

- Electrical Rating : 15 Amp - 125/250 VAC
- Switch : SPDT Snap Action
- Contacts : One is Normally Open (NO) and One is Normally Closed (NC)

4.3 Liquid Level Indicator

The liquid level indicator is manually operated device which provides a means to determine the amount of clean agent by measuring the liquid level of the clean agent. The liquid level indicator is vertically mounted onto the filled cylinders. Once the liquid level is determined, it is converted into pound (or kilogram) of the clean agent present in the agent storage container.

A magnet equipped float moves with the liquid level along the unit stem (Figure 4.5). A level readout is obtained by simply removing the protective cap and pulling out a calibrated tape until magnetic interlock with the float is felt. When the tape is in the position, the readout is obtained at the point in which the tape emerges from the unit housing. The tape reading is then converted to pound (or kilogram), and the calibration graph (weight of the clean agent versus the tape reading) is made accordingly for each size of the cylinder (Section 2.2). Accurate readings can be obtained between 40°F (4.4°C) and 90°F (32.2°C).

NOTE: The graph data is for 70˚F (21.1˚C) operations. From the reading in Y axis (in inches), go over to the line and drop down to the X axis for the reading in lbs. of agent in the cylinder. If the recorded weight lost exceeds 2.5%, it is recommended to use a weighting scale to determine the amount of filled agent.

Table 4-1: List of Liquid Level Indicator

Part Number	Cylinder Size
LK 7912001	150LB AND 250LB
LK 7912002	375 LB AND 560LB
LK 7912004	800LB
LK 7912005	1000LB
LK 7912006	1200LB

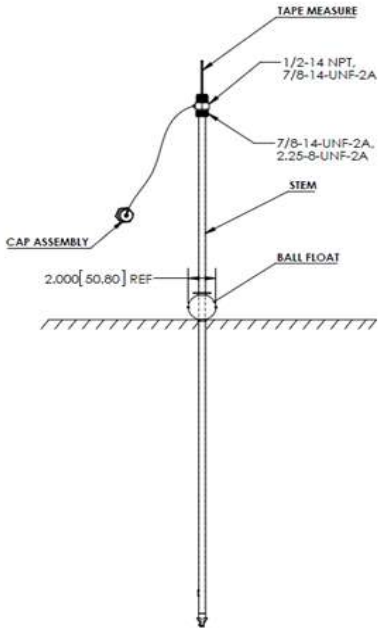


Figure 4.5: Liquid Level Indicator

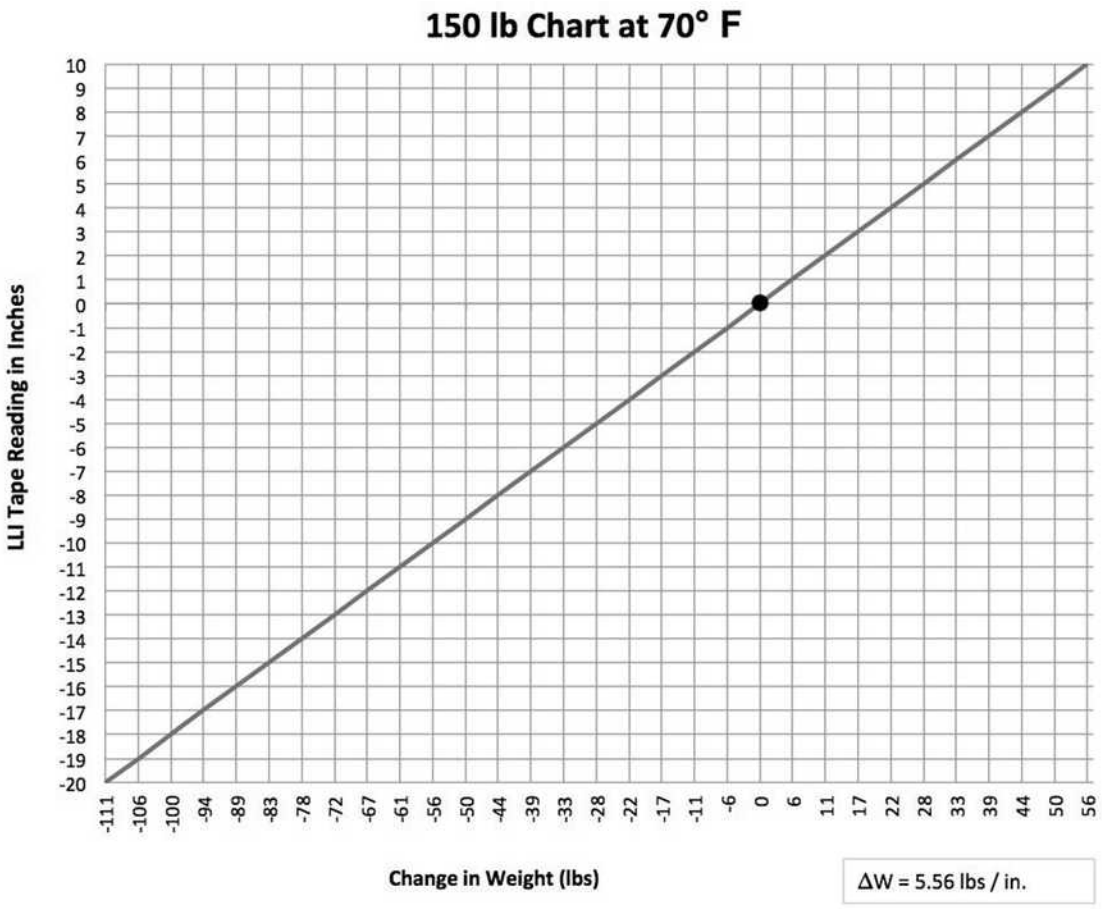


Figure 4.6: LLI Tape Reading (in Inches) versus Weight of HFC-227ea (in lbs) for 150 lb Cylinders at 70˚F

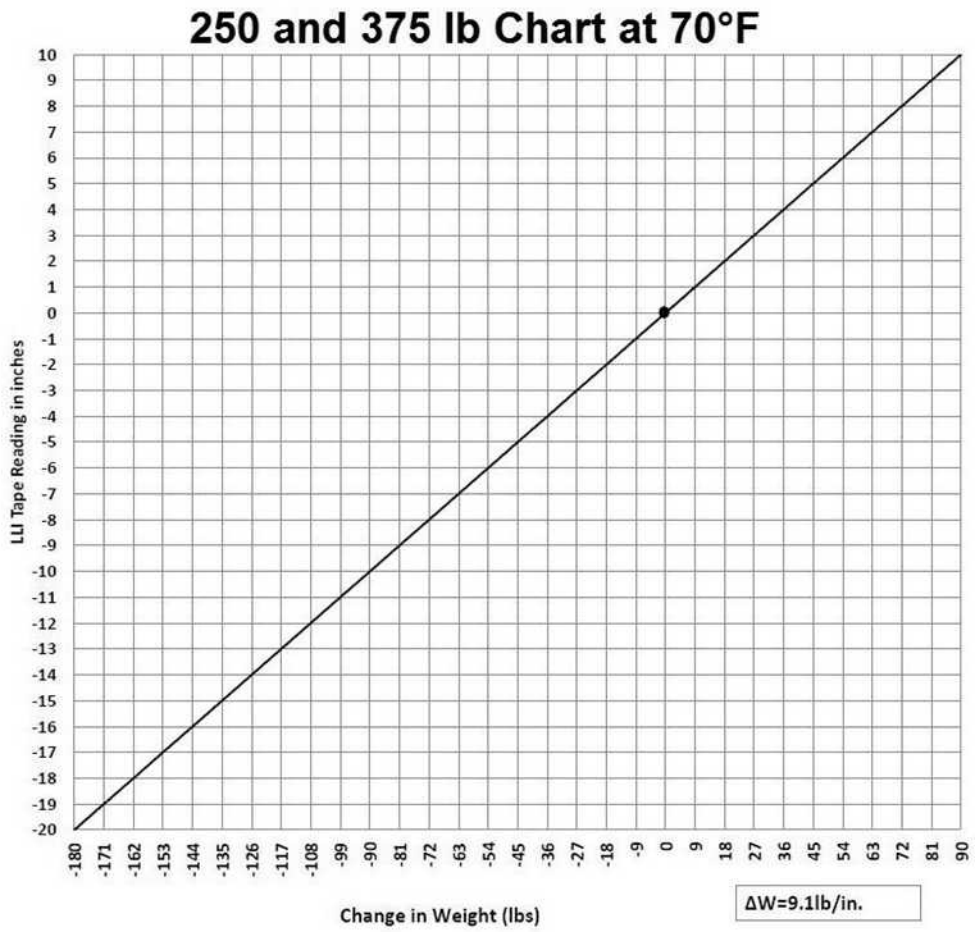


Figure 4.7: LLI Tape Reading (in Inches) versus Weight of HFC-227ea (in lbs) for 250 and 375lb Cylinders at 70˚F

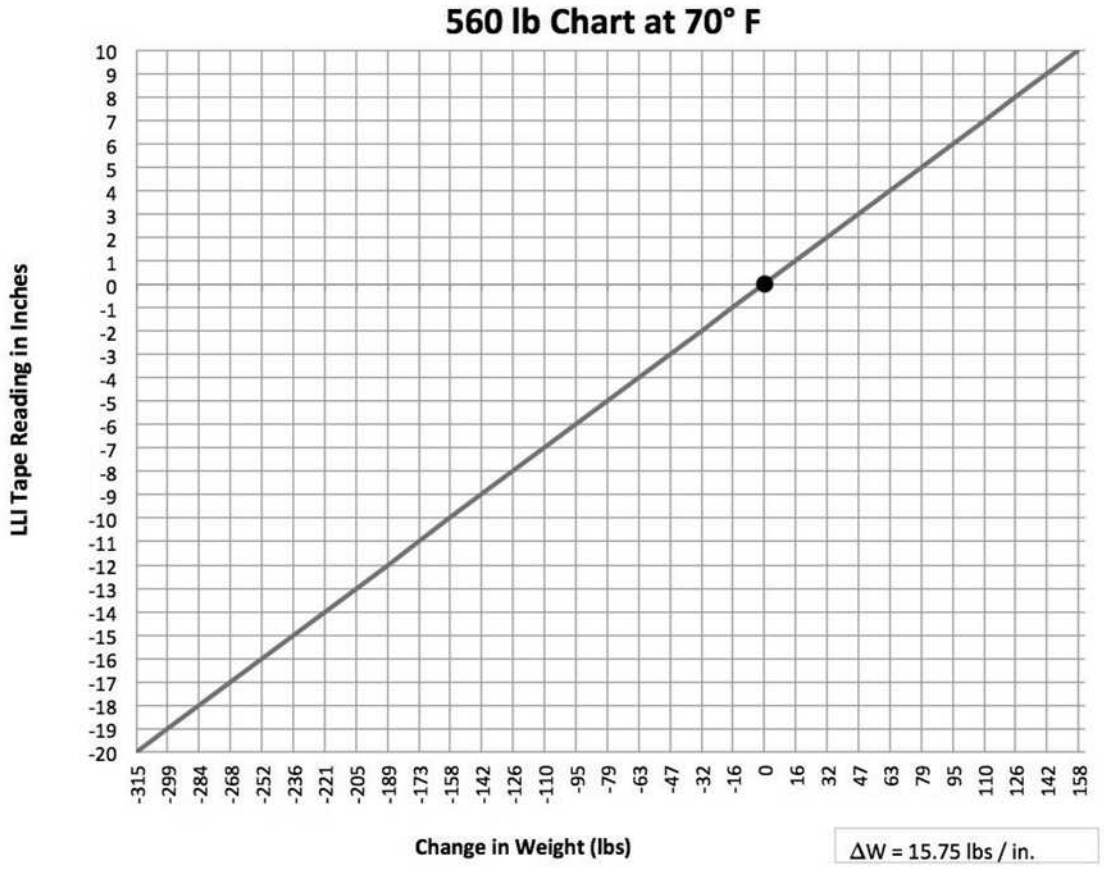


Figure 4.8: LLI Tape Reading (in Inches) versus Weight of HFC-227ea (in lbs) for 560 Cylinder at 70˚F

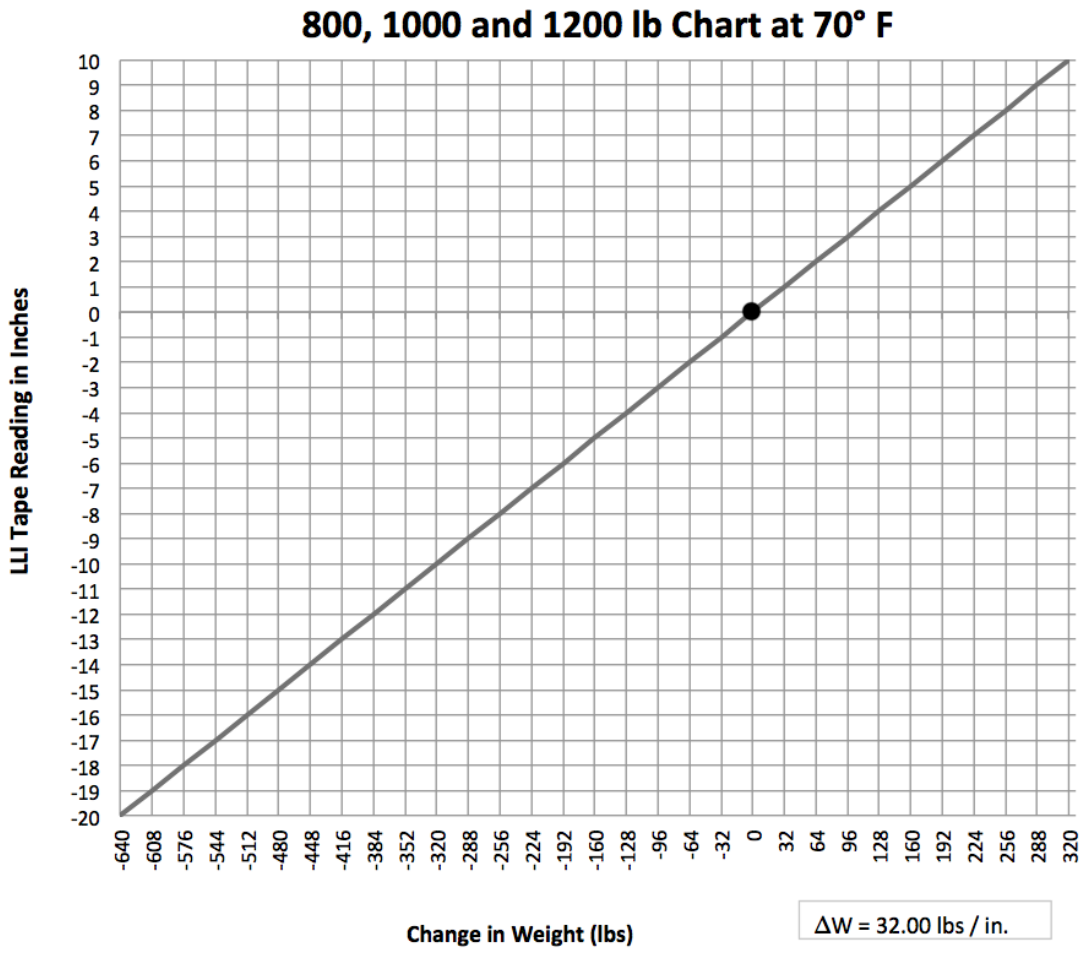


Figure 4.9: LLI Tape Reading (in Inches) versus Weight of HFC-227ea (in lbs) for 800, 1000 and 1200b Cylinders at 70˚F

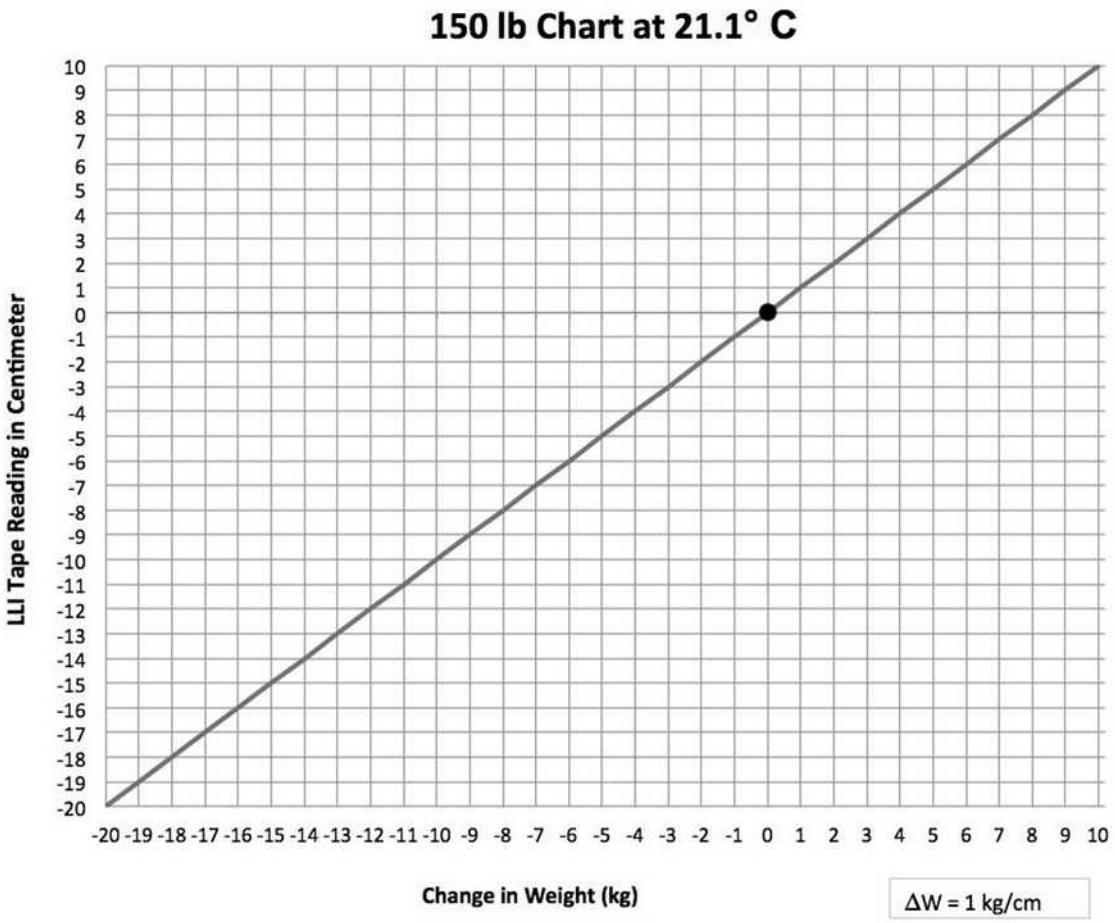


Figure 4.10: LLI Tape Reading (in cm) versus Weight of HFC-227ea (in kg) for 150 lb Cylinder at 21.1˚C

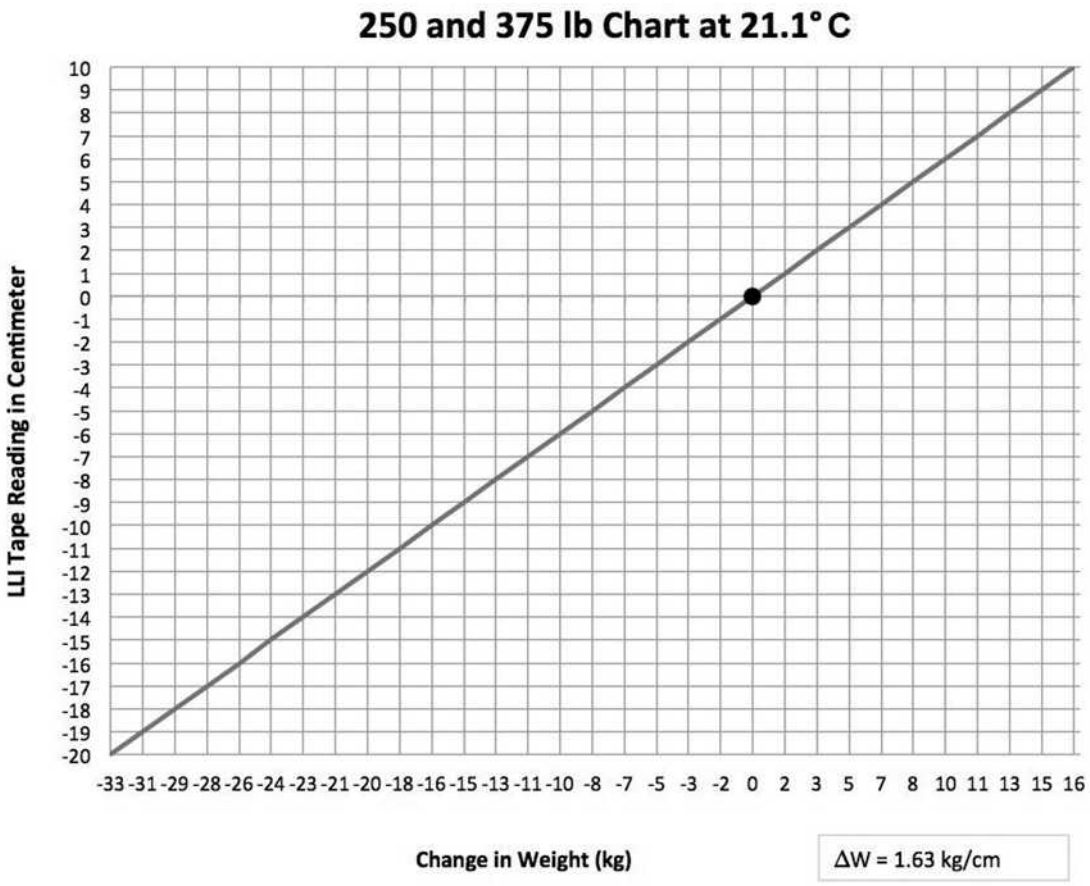


Figure 4.11: LLI Tape Reading (in cm) versus Weight of HFC-227ea (in kg) for 250 and 375 lb Cylinders at 21.1˚C

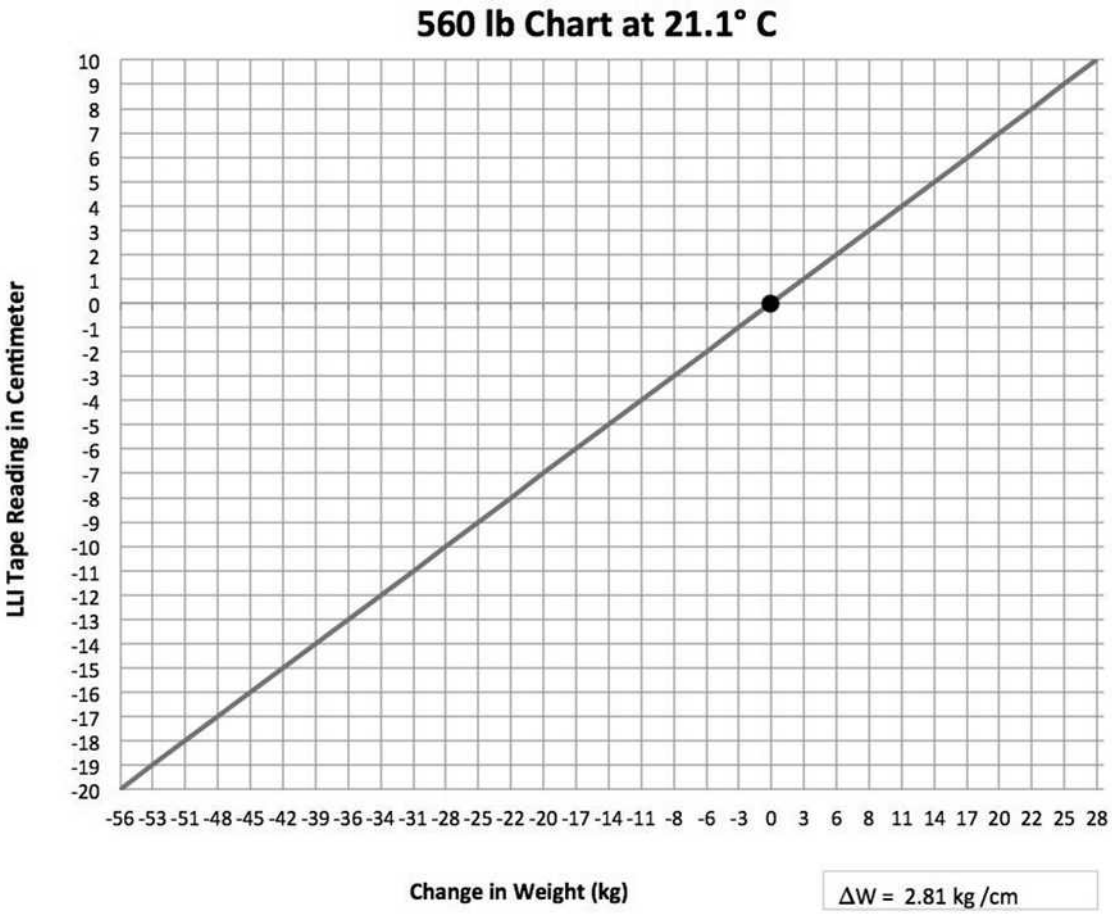


Figure 4.12: LLI Tape Reading (in cm) versus Weight of HFC-227ea (in kg) for 560 Cylinder at 21.1˚C

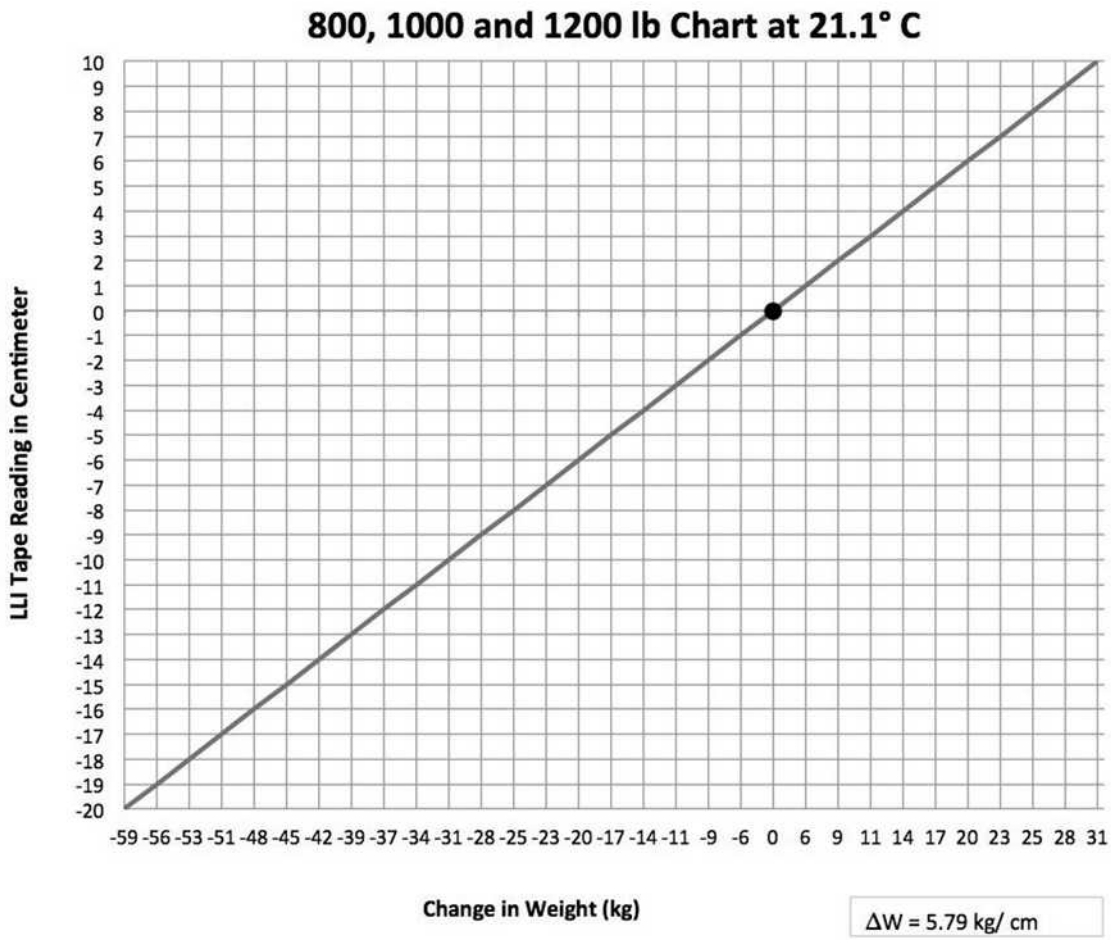


Figure 4.13: LLI Tape Reading (in cm) versus Weight of HFC-227ea (in kg) for 800, 1000 and 1200 lb Cylinders at 21.1˚C

5 System Design

5.1 Introduction

The design section provides an understanding of the characteristics of HFC-227ea in relation to its flow from its storage container, through the piping network, and discharging from the distribution nozzles. Information is also given for the “Authorities Having Jurisdiction” for approving the system installation. Systems shall be installed and maintained in accordance to NFPA 2001 (Latest Edition), this manual, and other applicable codes and regulations. The calculation method has been investigated for the specific types of pipe, fittings, and inner diameter pipe. If the application does violate the limitations mentioned in this chapter, there is a risk that the system will not supply the designated quantity of agent.

The flow of HFC-227ea through the discharge piping is a complex two-phase flow. Engineered Fire Suppression Systems offered by Luke Alexander LLC has been investigated to comply with the UL2166 Test Standards for Halocarbon Clean Agent Extinguishing System Units (Latest Edition). The NFPA 2001 (Latest Edition) Standards shall be followed by the system designer.

The HFC-227ea Fire Suppression System is designed for total flooding applications to extinguish Class A, B and C type fires. It is important that every system is designed to provide the maximum extinguishing characteristics and that the limitations for total flooding are strictly followed.

WARNING:
Clean agent shall not be used on fires involving the following materials.

a. *Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder which are capable of rapid oxidation in the absence of air;*
b. *Reactive metals, such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium;*
c. *Metal hydrides;*
d. *Chemicals capable of undergoing autothermal decomposition, such as certain organic peroxides and hydrazine.*

5.2 Defining Scope of Protection

Prior to performing any calculations, the following hazard information must be established in order to determine the design parameters required for the sufficient protection of the hazard.

(i) Hazard class A, B, and C. The design concentration by volume is determined based on the class of fire.
(ii) Pressure is adjusted based on the design quantity of HFC-227ea to compensate for ambient pressures that vary more than 3000 ft (914.40 m) of elevation from standard sea level. The atmospheric correction factor based on NFPA 2001 (APPENDIX D-1: Atmospheric Correction for HFC-227ea).
(iii) The minimum and maximum ambient temperature in the volume being protected shall be established.
(iv) The minimum and maximum temperature of the agent storage cylinders shall be established.
(v) The exact internal dimension of the hazard (e.g. length, width and height).
(vi) Will materials, stocks, etc. that accrue on a daily basis affect the volume in any appreciable amounts?
(vii) If any air handling equipment(s) is assigned to the hazard, review the equipment’s capacity as to air changes per hour. The hold time of the agent after discharge must be taken into consideration.

(viii) When the calculation method is used for multiple hazards and the temperature of the cylinders varies ±10°F (-12.2°C), there is a risk that the system will not supply the required quantity of fire-extinguishing agent.

Ventilation and Uncloseable Openings

When the system is discharged into a complete enclosure, normal cracks and gaps under doorways shall not impact the system performance. If there are openings in the volume, they must be sealed. Doors and normal vents that are required in the enclosure must be closed prior to or at the time of discharge. Doors or closures that are normally swung to a closed position and are not held open, or will not be opened when HFC-227ea is discharged donot need a system generated mechanism to make them close. Doors and closures including ventilation that is held open or operating must have devices installed to shut them off at the beginning or before the system discharge. Doors should be closed, and ventilation fans should be shut down prior to discharge.

5.3 Amount of Agent Required

5.3.1 Minimum Design Concentration

The minimum design concentration required for Class A, B, and C fire extinguishment is based on NFPA 2001 Edition 2015 (Table A.5.4.2.2.b).

Table 5-1Minimum Design Concentration

Fuel	Concentration by Volume
Class A	6.7%
Class B	Concentration is determined by fuel test using cup burner method. For details information, please see NFPA 2001 Annex B. Design concentration is determined by the highest cup burner extinguishment value of Class B fuel found within protected hazard. The minimum Class B design concentration shall be UL 8.7%.
Class C	7%

For Class B hazards, NFPA 2001 Edition 2015 - Annex B is used for the cup burner extinguishment concentration value for the particular Class B fuel(s) to be protected. Choose the fuel with the highest cup burner extinguishment value and apply a 30% safety factor (multiply this extinguishment concentration value by 1.3) for the design concentration. The minimum design concentration for the protection of all Class B hazards shall be 8.7% based on the UL2166 (Latest Edition) total flooding test program.

CAUTION: Effective fire extinguishing requires introducing the concentration of HFC-227ea between 6.7% and 9%. The enclosure temperature has a great influence on the amount of agent needed. The higher the enclosure temperature, the less HFC-227ea agent is required. Conversely, the lower the enclosure temperature, the more HFC-227ea agent is required. This must be taken into account when calculating agent requirements.

5.3.2 Agent Storage and Shipping

HFC-227ea is a liquefied compressed gas which when packaged under pressure is partially liquid at temperatures above -50°C. Following is the DOT designation for the shipment of HFC-227ea.

Shipping Name : Heptafluoropropane
Hazard Class : 2.2

UN Number : 3296
DOT/IMO Label : Nonflammable Liquefied Compressed Gas

The cylinders or containers of HFC-227ea shall be stored in a dry room within a temperature between 0°C and 50°C. The cylinders/containers of HFC-227ea shall be secured so that they would not fall or roll. It is essential that these cylinders/containers are not exposed to sunlight and/or heat.

5.3.3 Amount of Agent Needed

The minimum amount of agent required can be calculated manually as follows.

Equation 1

$$W = V * C.F. * F.F.$$

Equation 2

$$W = C.F. * \left[\frac{V}{s} * \left(\frac{C}{100 - C} \right) \right]$$

where: W is the weight of agent (in lb or kg)
V is the volume of enclosure to be protected (in ft^3 or m^3)
F.F. is the flooding factor (Refer to APPENDIX D-2: Flooding Factor of HFC-227ea using manual calculation (Metric Unit))
C.F. is the atmospheric correction factor (Refer to APPENDIX D-1: Atmospheric Correction for HFC-227ea)
s is the specific volume of superheated HFC-227ea vapor (in ft^3/lb or m^3/kg)

*** Note: "s" is determined using Equation 3 (US Unit) or Equation 4 (SI Unit)*

Equation 3

$$s = 0.9856 + 0.002441 * T$$

Equation 4

$$s = 0.0664 + 0.0002741 * T$$

where: T is the design temperature in the hazard area (in °F or °C)
C (%) is the volumetric concentration of agent in air at specified temperature

NOTES:
- *The agent required is always rounded up to the nearest number (i.e. whole liter) when determining the agent fill.*
- *Care must be taken that the calculated concentration for normally occupied spaces at the highest expected ambient temperature in the space does not exceed 10% V/V as per NFPA 2001 (Latest Edition).*
- *The calculation includes an allowance for the normal leakage from a "tight" enclosure due to agent expansion.*

5.4 Design Concept

Engineered System gives the engineers to do the system design with more flexibility by creating a custom piping network that is suitable for the customers' needs. The piping configurations can be balanced or unbalance, and the flow splits within the system can vary from one point to another.

Hence, the Engineered System requires a computerized hydraulic flow calculation to model the system.

5.5 Nozzle Coverage

5.5.1 Nozzle Selection

Engineered System nozzles selection can be easily determined by flow calculation software.

5.5.2 Area

All nozzles shall be installed vertically with the inlet of the nozzle perpendicular to the ceiling. When installing the sidewall nozzle (180^{o} configuration), the side holes of the pattern are to be parallel with the wall on which the nozzle is being installed (Figure 5.1).The maximum area coverage per nozzle is 1600 ft^{2} (40 ft x 40 ft). The longest side length is 40 ft. This maximum length limitation applies for a range in hazard height from 1 ft (minimum) to 16 ft (maximum).

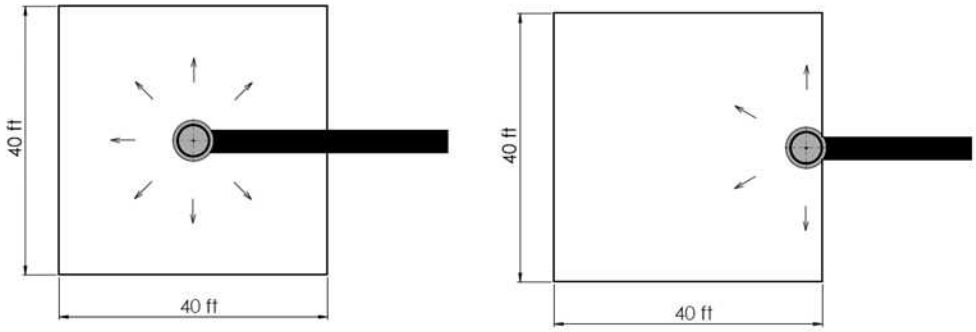


Figure 5.1: Area Coverage per Nozzle

5.5.3 Height of Nozzle

Nozzles shall be installed 2 to 12 inches down from the top of the hazard when referenced from the ceiling. However, the range of installation is from 0 to 12 inches from the wall to the center of the nozzle when referencing the wall to the nozzle.

All nozzles are rated for a maximum hazard height of 16 ft (4.88 m). If hazard exceeds 16 ft (4.88 m) in height, multiple tiers of nozzles must be used for each 16 ft (4.88 m) increment of the height of enclosure.

NOTES:

1. *If nozzles are only located above the cylinder outlet, the maximum elevation difference between the cylinder outlet and the farthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 30 ft.*
2. *If nozzles are only located below the cylinder outlet, the maximum elevation difference between the cylinder outlet and the farthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 30 ft.*
3. *If nozzles are located above and below the cylinder outlet, the maximum elevation difference between the farthest horizontal pipe runs or nozzles (whichever is furthest) shall not exceed 30 ft.*
4. *If a system violates these limits, then consult the manufacturer engineering team for design review, and what course of action should be taken.*
5. *Remember to review the cylinder location, the anticipated piping requirements, and any obstructions that will hinder the distribution of the agent.*

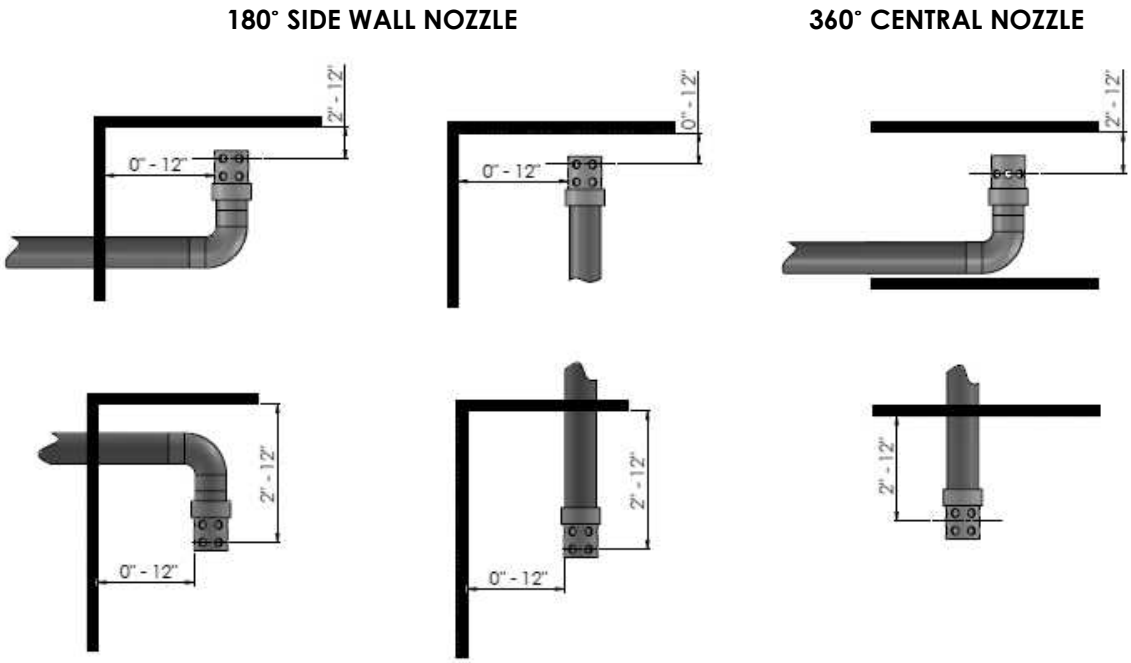


Figure 5.2: Nozzle Location within a Hazard

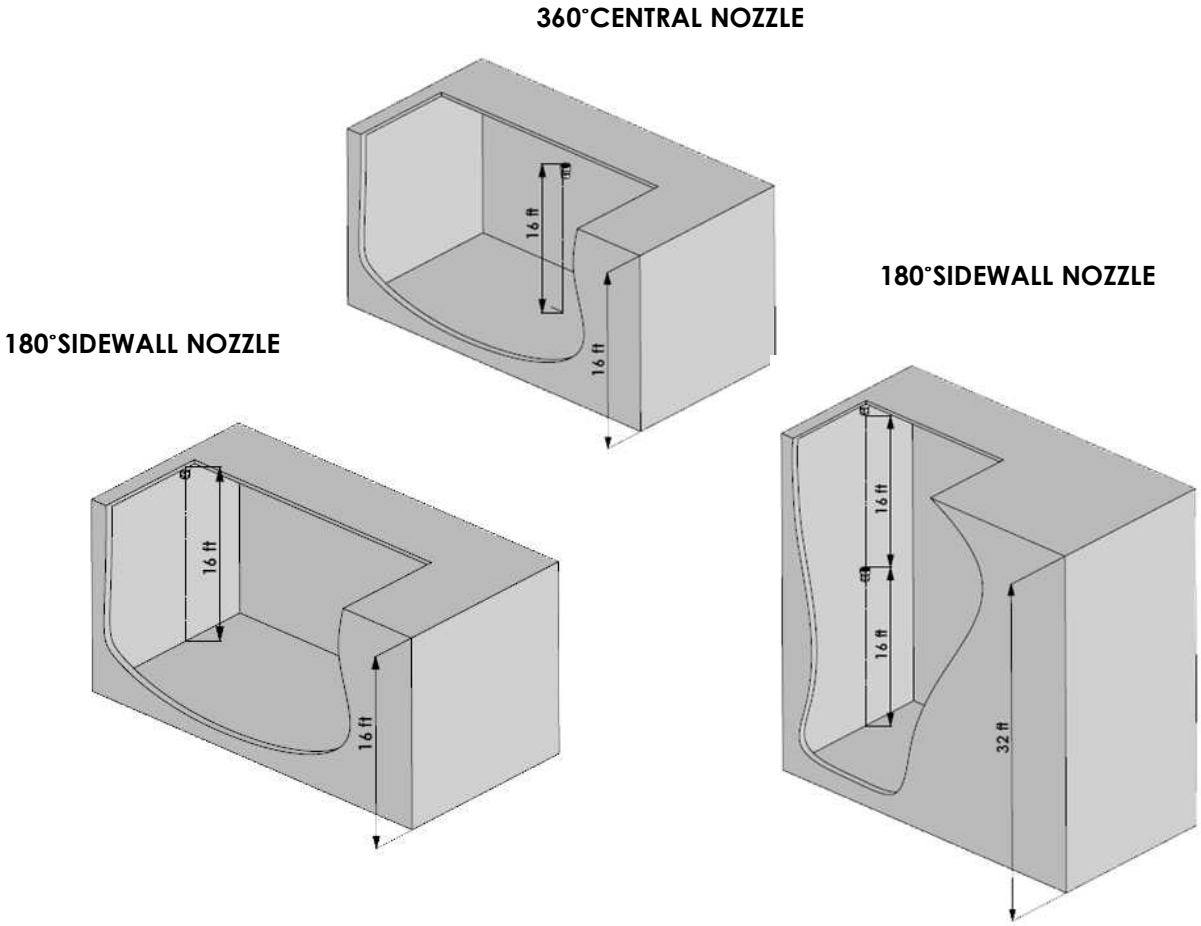


Figure 5.3: Nozzle Elevation

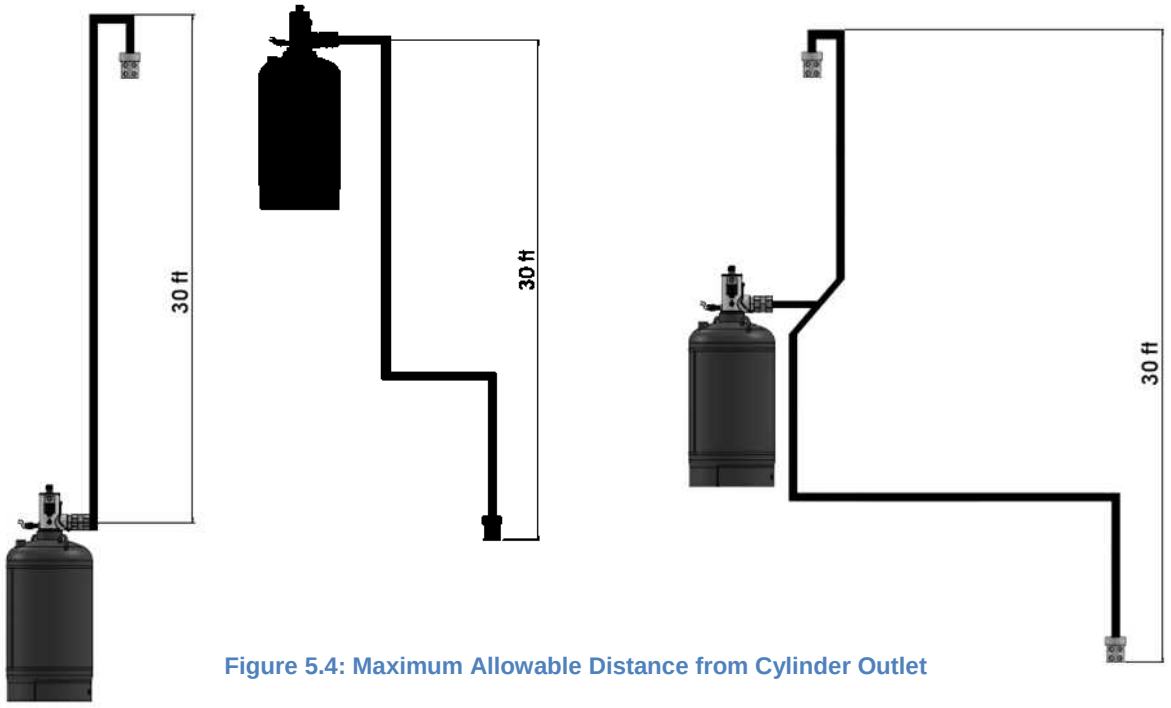


Figure 5.4: Maximum Allowable Distance from Cylinder Outlet

5.6 Flow Limitation

The HFC-227ea discharge from a nozzle shall not exceed 10 seconds in accordance to the NFPA 2001 (Latest Edition).

Table 5-2: Minimum and Maximum Flow Rates Guidelines

Nominal Pipe Size	Pipe Type	Minimum and Maximum Flow Rate	
		lb/s	kg/s
1/2” NPT	SCH 40	0.7 - 3.4	0.32 - 1.54
3/4” NPT	SCH 40	2.0 - 5.8	0.90 - 2.63
1” NPT	SCH 40	3.4 - 8.4	1.54 - 3.81
1-1/4” NPT	SCH 40	5.8 - 13.0	2.63 - 5.90
1-1/2” NPT	SCH 40	8.4 - 19.5	3.81 - 8.85
2” NPT	SCH 40	13.0 - 33.0	5.89 - 14.97
2-1/2” NPT	SCH 40	19.5 - 58.0	8.85 - 26.31
3” NPT	SCH 40	33.0 - 95.0	14.96 - 43.09
4” NPT	SCH 40	58.0 - 127.0	26.30 - 57.61
5” NPT	SCH 40	95.0 - 222.0	43.09 - 100.70
6” NPT	SCH 40	127.0 - 317.8	57.60 - 144.15

NOTES:

1) *Table 5-2 assumes the use of a grade of pipe, which may be used in Schedule 40 wall thickness in the full range of pipe sizes.*
2) *Table 5-2 gives approximate sizes only. The fact that a system may be estimated by this table does not guarantee that sufficient pressure is available to actually develop an acceptable piping network. Long runs of pipe or large numbers of fittings may drop the system pressures below acceptable limits even when pipe sizes fully conform to the table. An actual computer calculation must be done to confirm both pipe sizes and the feasibility of the piping network.*

Table 5-3: Flow Limitations

1. Duration of discharge	The agent discharge from a nozzle shall not exceed 10 seconds in accordance to the NFPA 2001 (Latest Edition). A design discharge time of less than 6 seconds liquid is not to be used
2. Maximum percentage in pipe	82.1 %
3. Minimum orifice area	The minimum orifice area ratio for 1/2" nozzles is 10% of open end pipe. For the remainder of nozzle sizes, the ratio is 20% of open end pipe
4. Limit of agent	Limit of agent before the first tee is 9.3%. The amount of agent in the pipe before the first tee (closest to the agent supply cylinder or cylinders) shall not be less than 9.3%
5. Minimum nozzle pressure	68 psig
6. Maximum nozzle orifice area	81.3% of open end pipe
7. Minimum flow rates	The minimum flow rates must be exceeded
8. Maximum arrival time imbalance	When the difference between liquid arrival times at two of the nozzles exceeds the 1.02 seconds (max.), a warning will be activated
9. Maximum run out time imbalance	The difference between liquid run out times at two of the nozzles exceeds the 2.16 seconds, a warning will be activated

5.7 Equivalent Length

The accepted equivalent length data for commonly used pipe components is given as follows.

Table 5-4: Equivalent Length (in ft) of 300 lb Malleable Threaded Fittings

Pipe Size	90 Elbow	45 Elbow	Thru Tee	Side Tee	Union Coupling	Union Elbow
1/2" (15 mm)	1.7	0.8	1.0	3.4	0.4	2.1
3/4" (20 mm)	2.2	1.0	1.4	4.5	0.5	2.7
1" (25 mm)	2.8	1.3	1.8	5.7	0.6	3.4
1-1/4" (32 mm)	3.7	1.7	2.3	7.5	0.9	5.2
1-1/2" (40 mm)	4.3	2.0	2.7	8.7	0.9	5.2
2" (50 mm)	5.5	2.6	3.5	11.2	1.2	6.7
2-1/2" (65 mm)	6.5	3.1	4.1	13.4	1.4	8.0
3" (80 mm)	8.2	3.8	5.1	16.8	1.8	10.0
4" (100 mm)	10.7	5.0	6.7	21.8	2.4	13.1
5" (125 mm)	13.4	6.3	8.4	27.4	3.0	16.4
6" (150 mm)	16.2	7.6	10.1	32.8	3.5	19.7

Table 5-5: Equivalent Length (in ft) of Victaulic Fittings

Pipe Size	90 Elbow	45 Elbow	Thru Tee	Side Tee
3/4" (20 mm)	1.3	0.6	1.3	3.2
1" (25 mm)	1.7	0.8	1.7	4.2
1-1/4" (32 mm)	2.1	1.0	2.1	5.3
1-1/2" (40 mm)	2.6	1.2	2.6	6.3
2" (50 mm)	3.5	1.8	3.5	8.5
2-1/2" (65 mm)	4.3	2.2	4.3	10.8
3" (80 mm)	5.0	2.6	5.0	13.0
4" (100 mm)	6.8	3.4	6.8	16.0
5" (125 mm)	8.5	4.2	8.5	21.0
6" (150 mm)	10.0	5.0	10.0	25.0

Table 5-6: Equivalent Length (ft) of Welded Fittings

Pipe Size	90 Elbow	45 Elbow	Thru Tee	Side Tee
1/2”	0.8	0.3	0.7	2.1
3/4”	1.1	0.4	0.9	2.8
1”	1.4	0.5	1.1	3.5
1-1/4”	1.8	0.7	1.5	4.6
1-1/2”	2.1	0.8	1.7	5.4
2”	2.8	1.0	2.2	6.9
2-1/2”	3.3	1.2	2.7	8.2
3”	4.1	1.5	3.3	10.2
4”	5.4	2.0	4.4	13.4
5”	6.7	2.5	5.5	16.8
6”	8.1	3.0	6.6	20.2

Table 5-7: Equivalent Length (in ft) of Tubing, Hoses, and Valves

Valve Size	Valve and Siphon	Discharge Flex Hose	Check Valve	Shuttle Valve
1”	16.5	7.0	6.9	8.1
1”	17.5	7.0	6.9	8.1
1-1/2”	28.3	7.6	39.5	12.3
2-1/2”	30.8	11.6	22.0	N/A
		Flex		
4”	75.0	10.0	N/A	N/A
Flex-Check Combination				
4”	75.0	60.5		N/A

5.8 Tee Limitation

To obtain the most economical piping for a given hazard layout, tees are employed to branch the agent flow to the various locations within the hazard or multiple hazards. The exit branches of the tees must be horizontal. The maximum and minimum percentage imbalances permitted are shown in Table 5-8 and Figure 5.5 to Figure 5.8. The system has been tested using Schedule 40 steel pipe and 300 lb. Class ASTM A-197 fittings.

Table 5-8: Tee Limitation

Description	Limitation	Figure
Maximum Bullhead Tee Imbalance	30/70	Figure 5.5
Minimum Bullhead Tee Imbalance	50/50	Figure 5.6
Maximum Side Tee Imbalance	65/35	Figure 5.8
Minimum Side Tee Imbalance	90/10	Figure 5.7

Notes: 1. Bullhead Tees shall have both outlets in the same Horizontal plane
2. Side Tee splits shall have the inlet and both outlets in the same horizontal plane

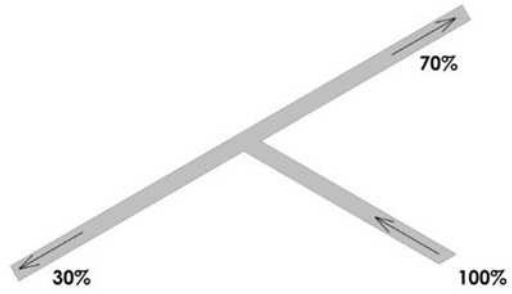


Figure 5.5: Maximum Imbalance for Bull Tee

Figure 5.6: Minimum Imbalance for Bull Tee

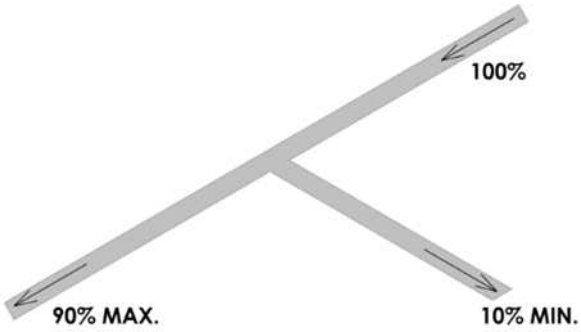


Figure 5.7: Minimum Imbalance for Thru Tee Side Outlet Section

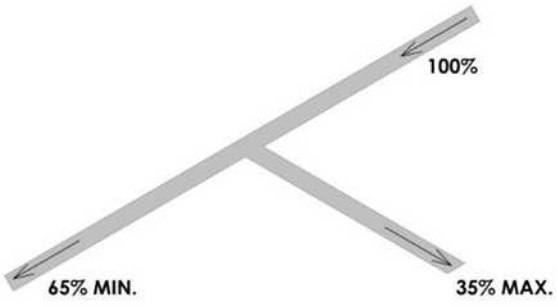


Figure 5.8: Maximum Imbalance for Thru Tee Side Outlet Section

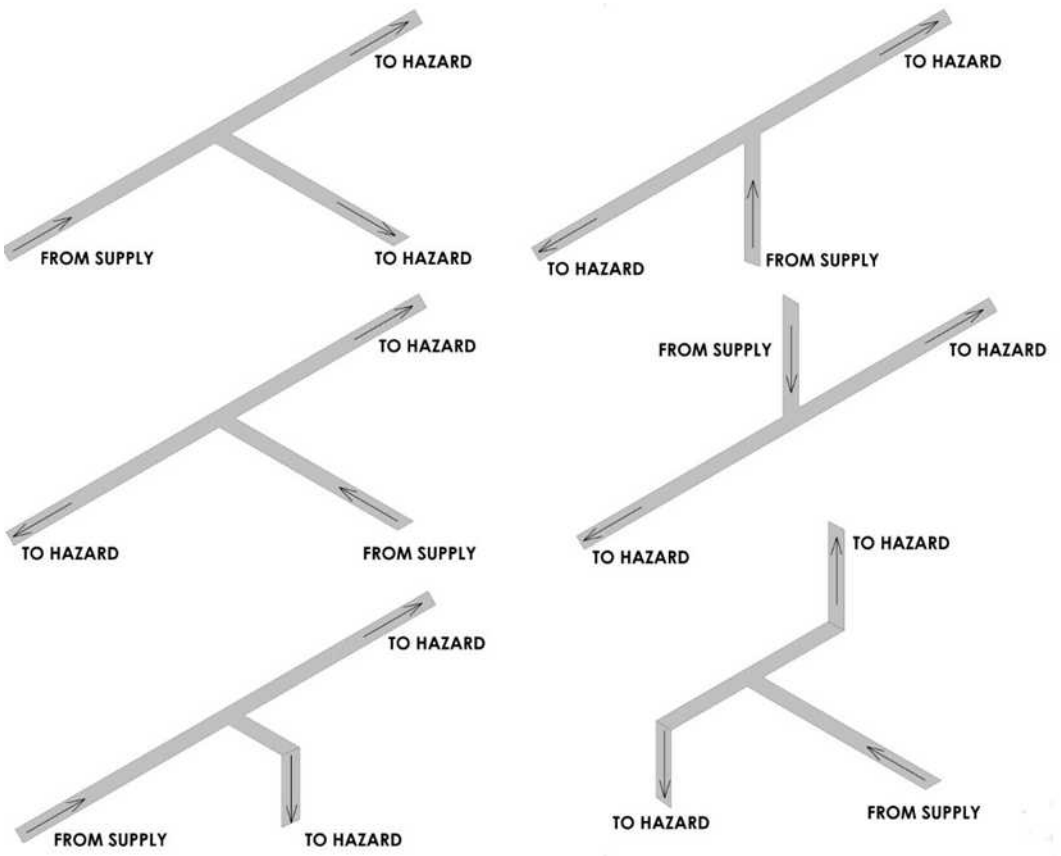


Figure 5.9: Different configurations of Bull Tees and Side Tees (GOOD)

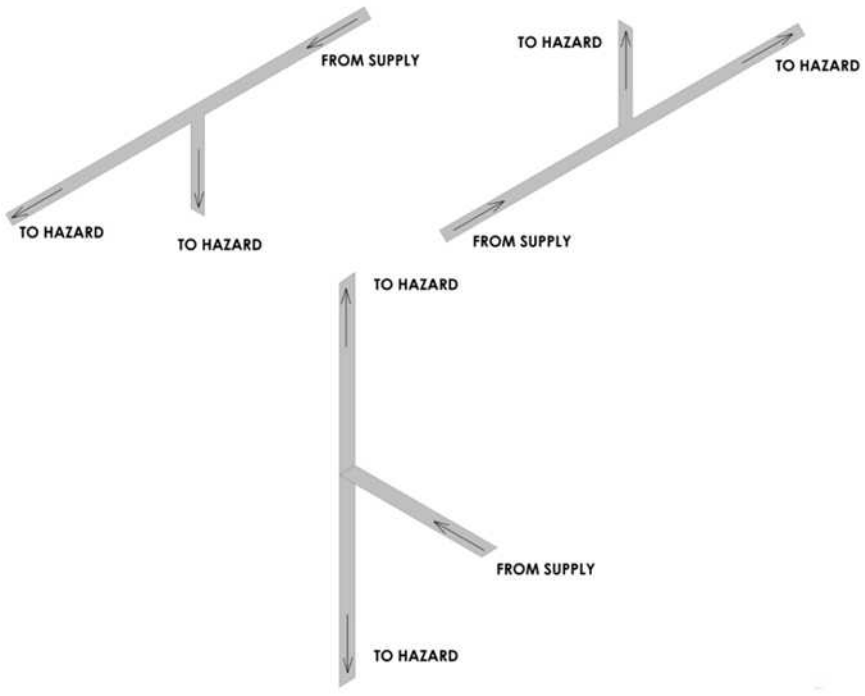


Figure 5.10: Different configurations of Bull Tees and Side Tees (NO GOOD)

5.9 Cylinder(s) Configuration

Following are configurations for cylinder use in the engineered design method.

a) Single hazard with one cylinder and its piping and nozzle system.
b) Single hazard with multiple cylinders, each with their own piping and nozzle system.
c) Single hazard with multiple cylinders discharging through a common piping and nozzle system.
d) Multiple hazards with one cylinder discharging through its piping and nozzle system.

Multiple hazards with multiple cylinders are discharged through a common piping and nozzle system.

5.10 Unbalance System

Unbalance systems usually occur due to one or more of the following conditions.

a) Unequal flow rates at one or more nozzles.
b) Unequal orifice areas in multiple nozzle systems
c) Unequal pipe sizes and/or lengths of branch legs.
d) Odd number of nozzles.
e) Both Bull tees and Side/Thru tee applications are used. The tee exits must be in the horizontal plane.

CAUTION: Calculation is based on agent storage temperature of 70°F. Therefore, the operating/storage temperature of the container must be in the range between 60°F and 80°F for a single unbalanced system protecting two or more separate hazards. If the container operating/storage temperature is outside this range, an insufficient quantity of agent may be discharged from one or more discharge nozzles.

5.11 Manifold System

When required by hazard size, multiple cylinders may be made to manifold together to feed the common piping network. Typical manifolds use threaded fittings (Figure 5.11, Victaulic fittings (Figure 5.12, and welded fittings. When installing Victaulic fittings manifold, only machined groove piping is to be used. Use one of these whenever making of manifold is required and follow the guidelines listed below and sample illustrations.

MANIFOLD DIMENSIONS
Wall Space required for
Cylinder Storage.
A. 4.83 ft
B. 7.25 ft
C. 9.67 ft

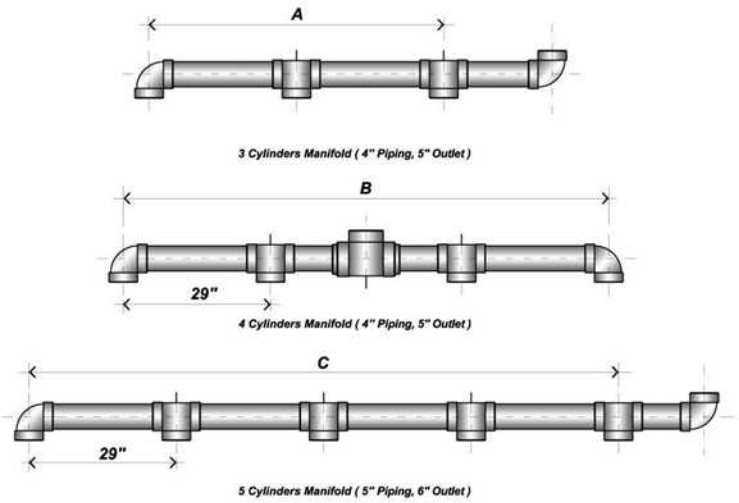


Figure 5.11: Cylinder Manifolds (Screwed Type)

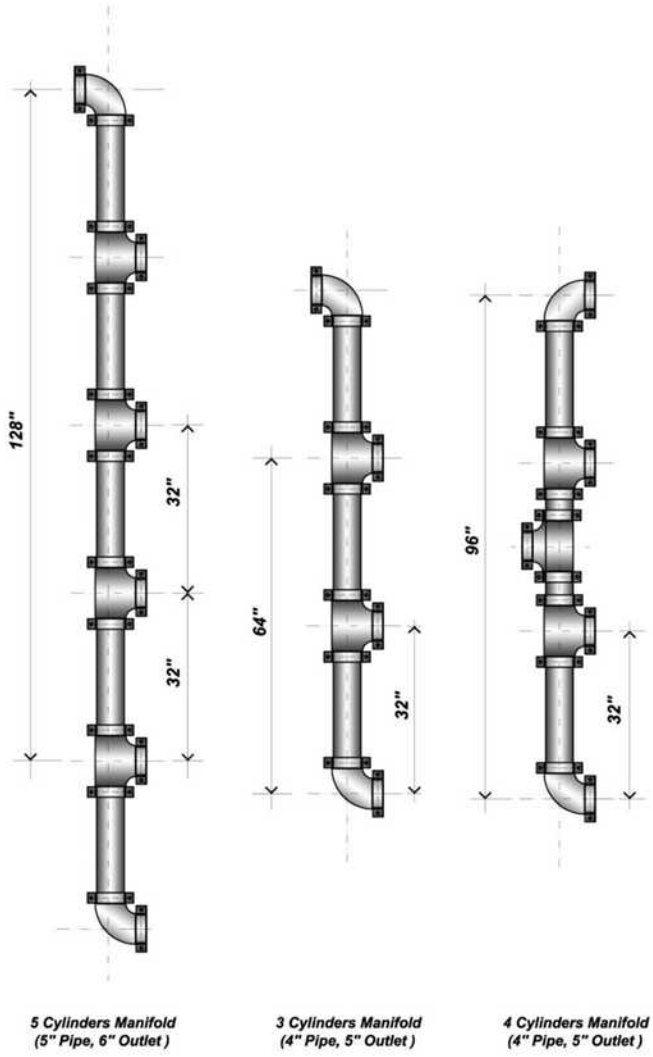


Figure 5.12: Cylinder Manifolds (Grooved-End Fittings)

The check valve for 4 inch (101.6mm) stainless steel valve systems can be installed vertically and horizontally while the check valves for the 1 inch (25mm), 1-1/2" (40mm) and 2-1/2" (65mm) stainless steel valve systems shall only be installed vertically due to the working principle of that specific type of check valves.

Figure 5.13: Grooved-End Fittings and Horizontal Check Valve Arrangement

NOTE: The 4 inch check valve can be installed horizontally.

Figure 5.14: Grooved-End Fittings and Vertical Check Valve Arrangement

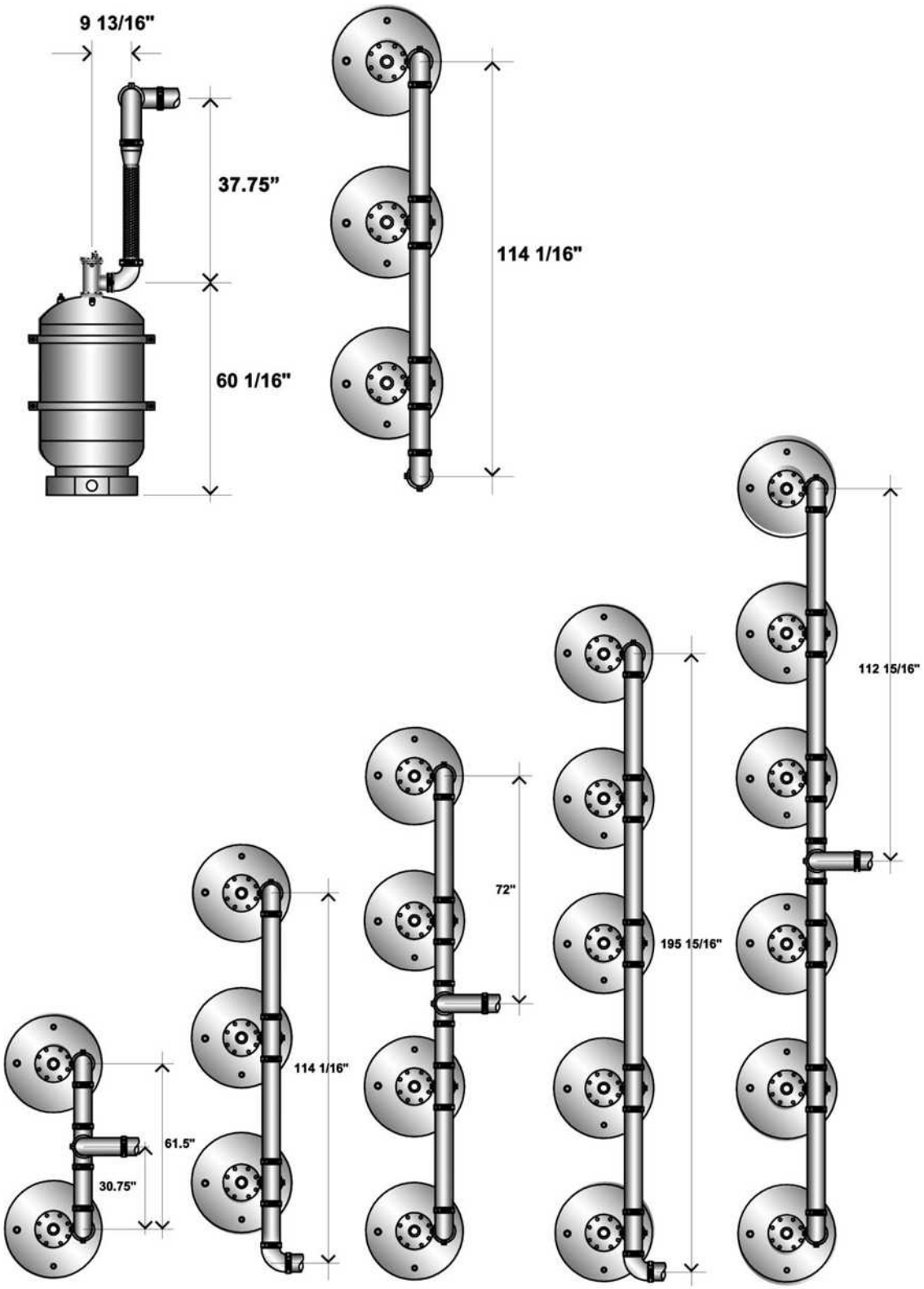


Figure 5.15: 1200 lb Cylinder Manifolds (Victaulic Fittings and Vertical Outlet)

Alternatively, due to space constraint, the following examples (Figures 5.16 – 5.35) are provided.

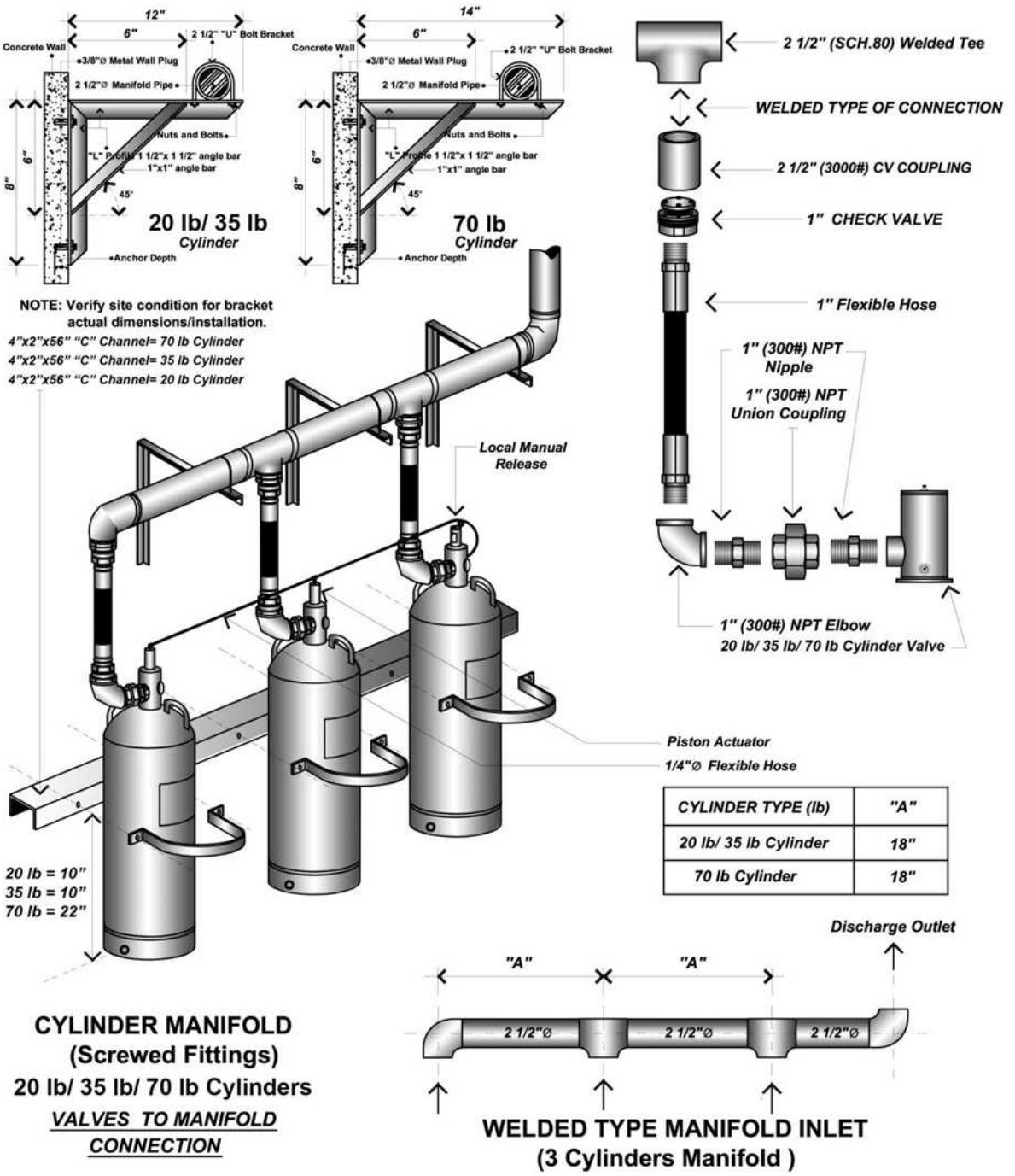


Figure 5.16: Welded Type with Flexible Hose Manifold and Bracketing Details of LK 7900020-A, LK 7900035-A and LK 7900070-A

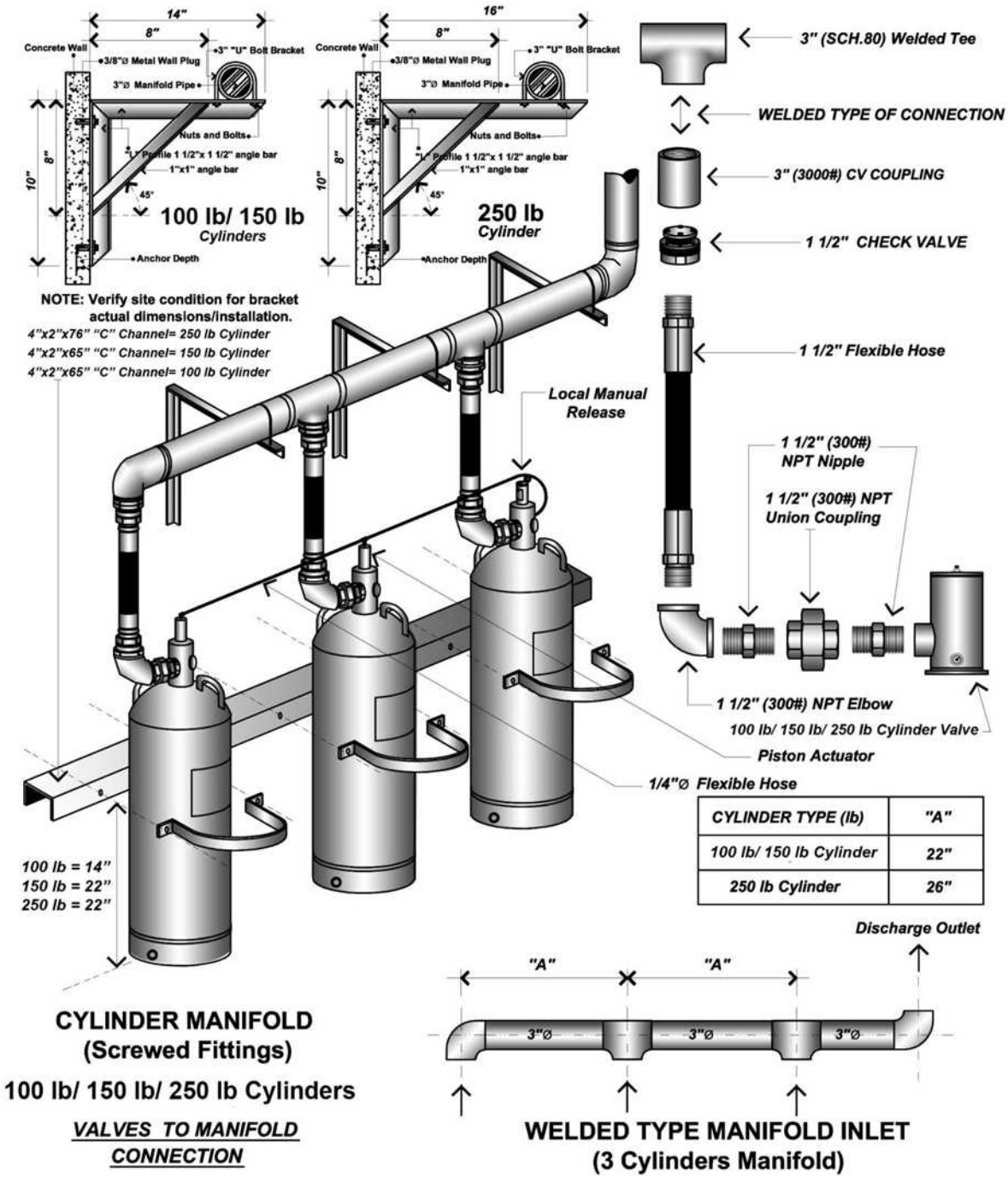


Figure 5.17: Welded Type with Flexible Hose Manifold and Bracketing Details of LK 7900100-A, LK 7900150-A and LK 7900250-A

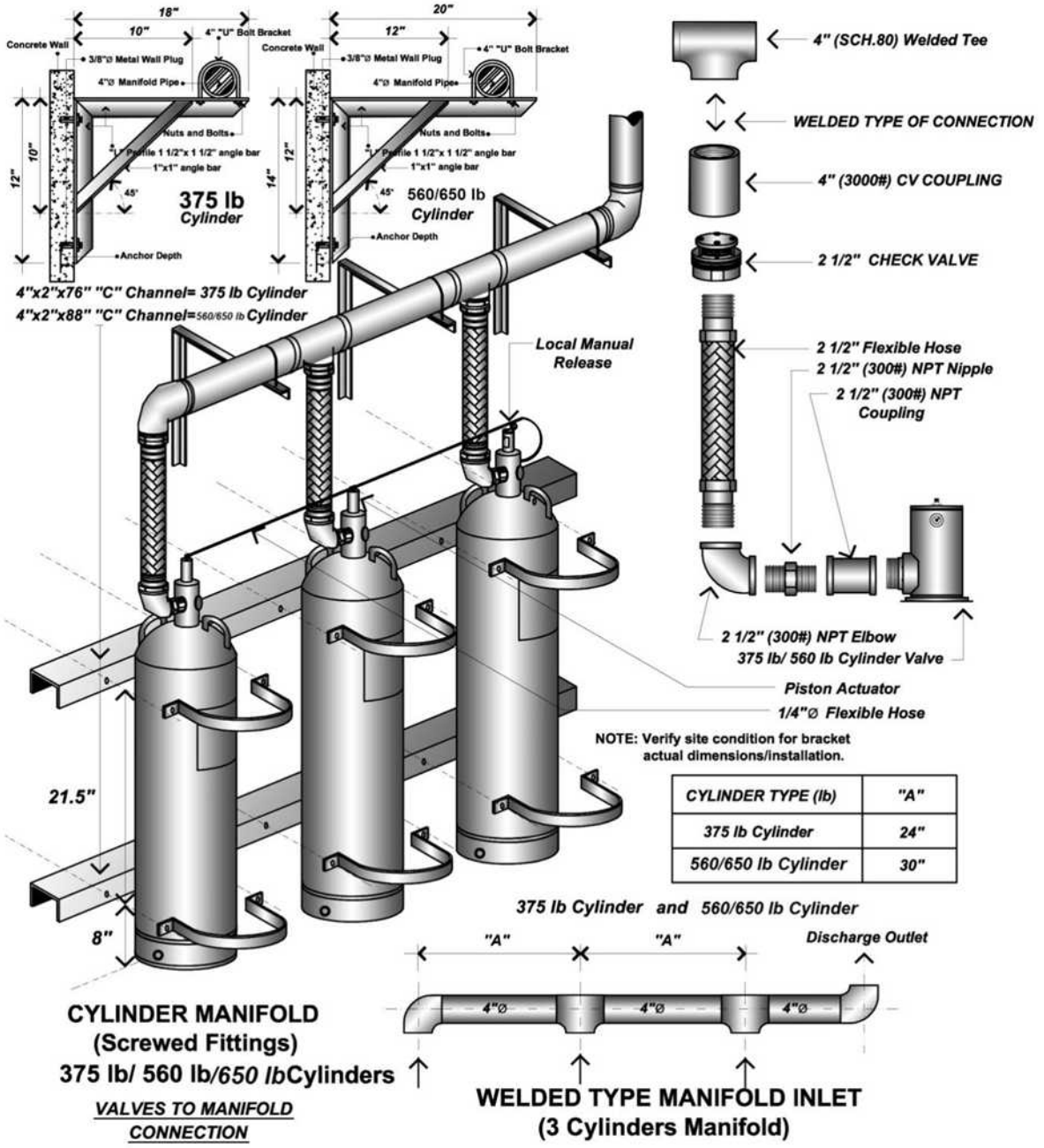


Figure 5.18: Welded Type with Flexible Hose Manifold and Bracketing Details of LK 7900375-A and LK 7900560-A

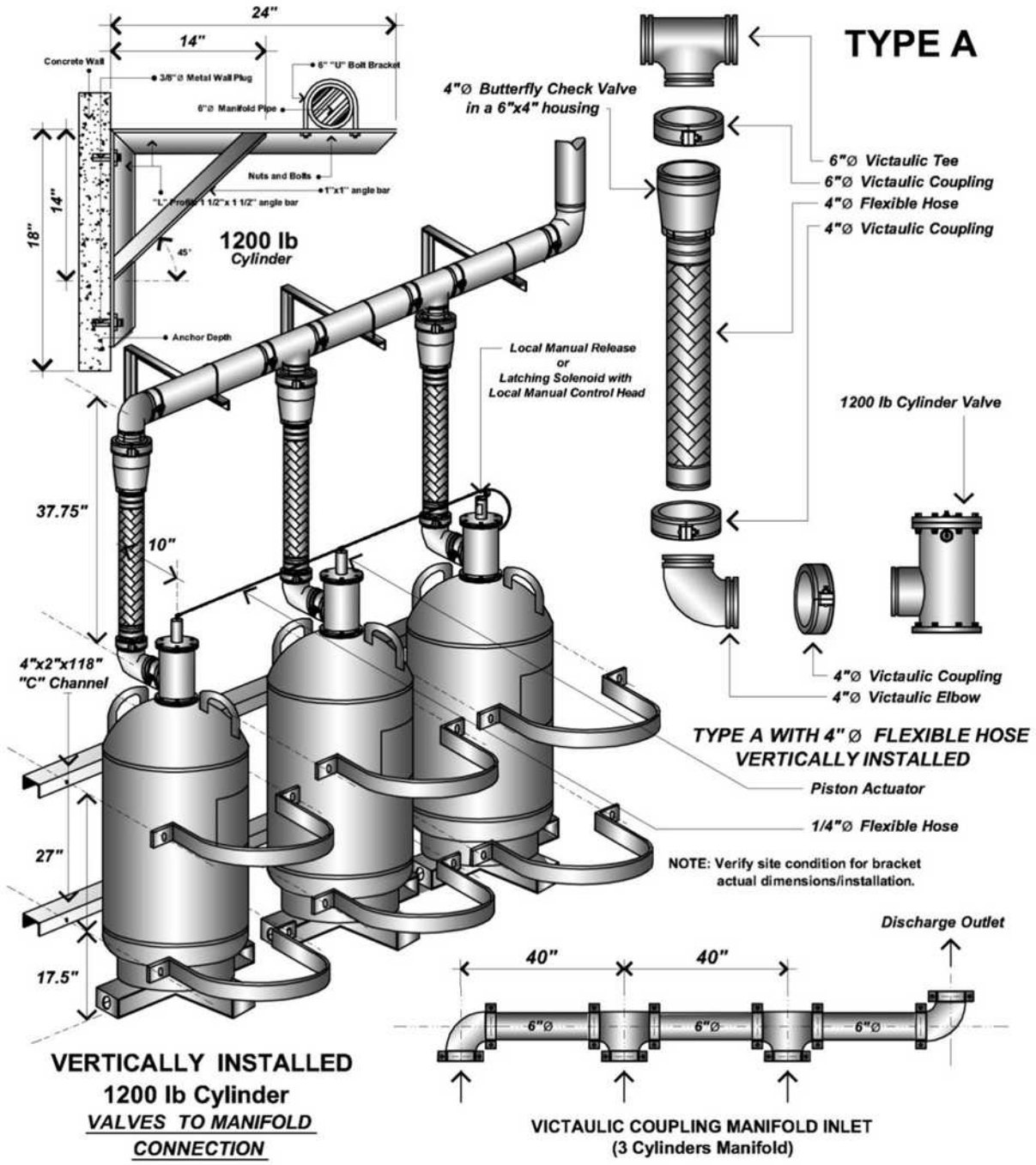


Figure 5.19: Vertical Arrangement with Flexible Hose Manifold and Bracketing Details of LK 7901200-A

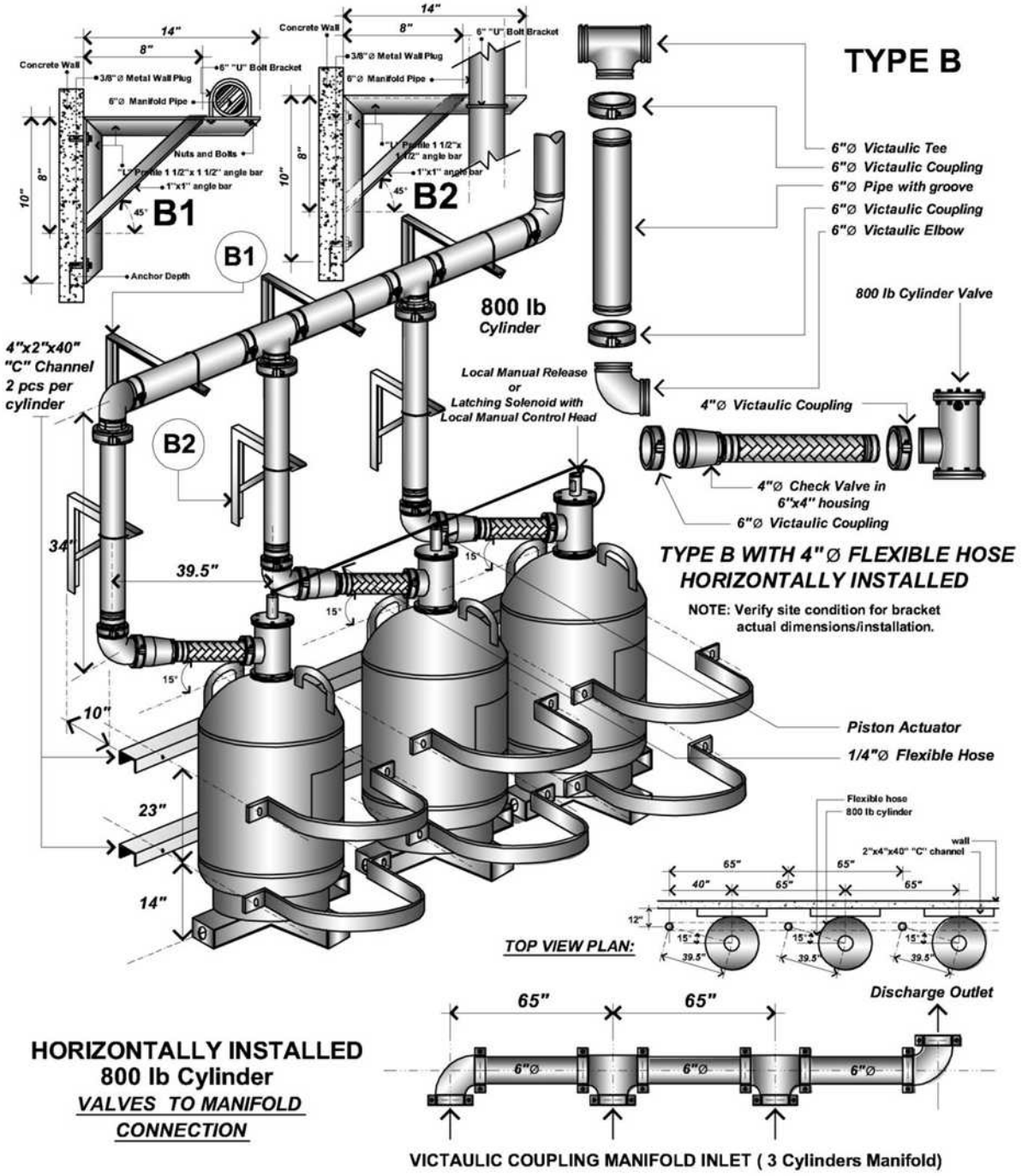


Figure 5.20: Horizontal Arrangement with Flexible Hose Manifold and Bracketing Details of LK 7900800-A

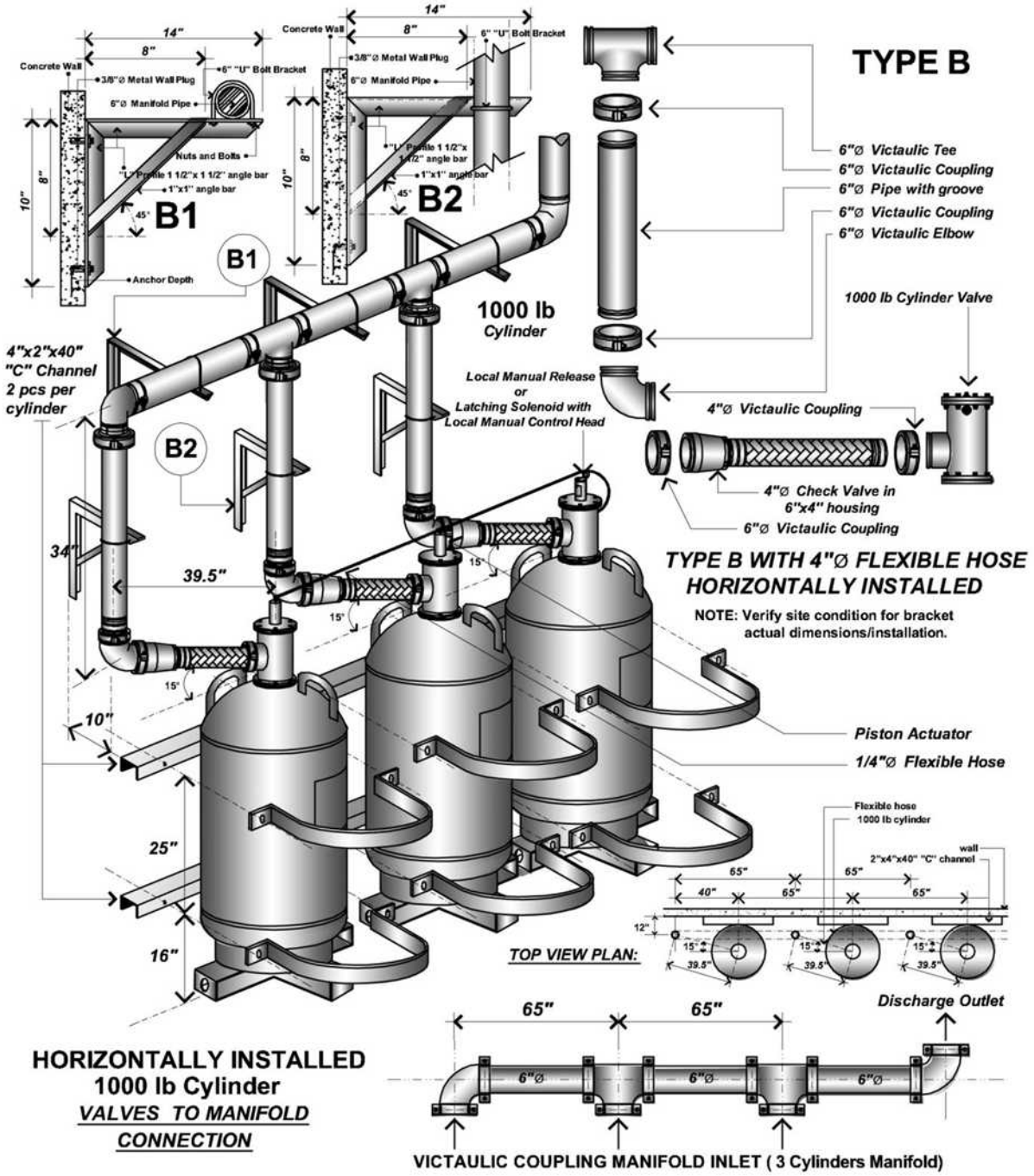


Figure 5.21: Horizontal Arrangement with Flexible Hose Manifold and Bracketing Details of LK 7901000-A

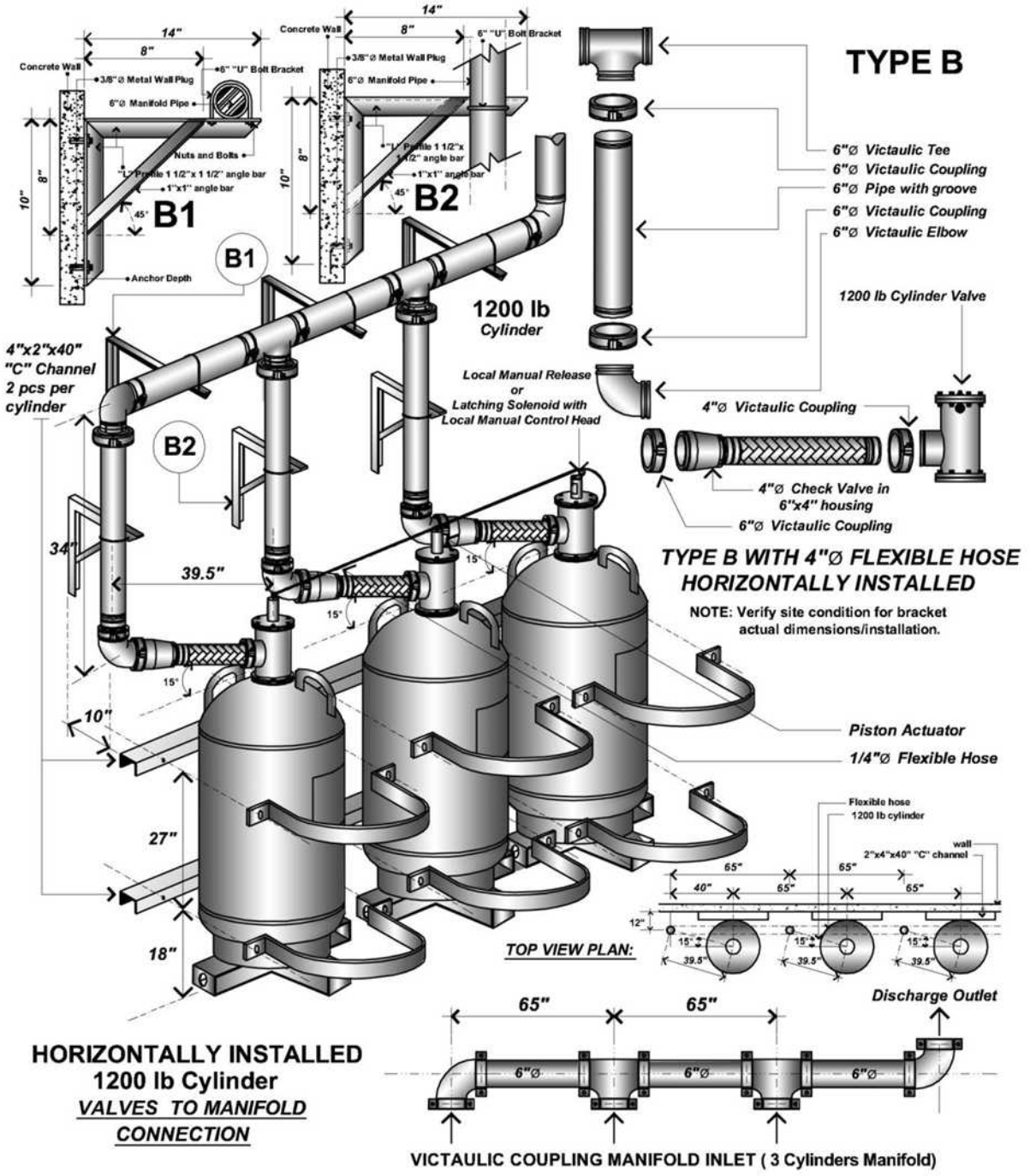


Figure 5.22: Horizontal Arrangement with Flexible Hose Manifold and Bracketing Details of LK 7901200-A

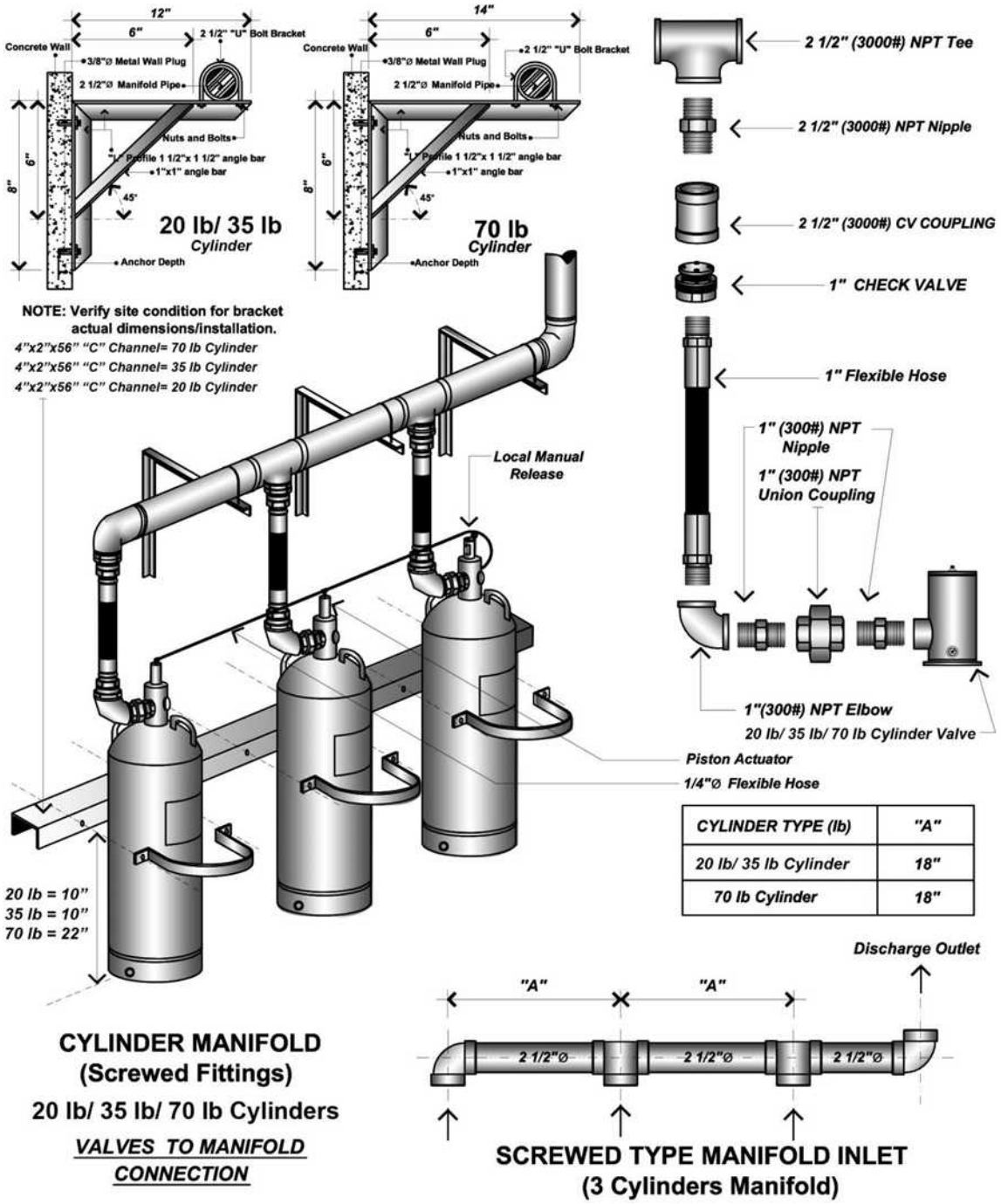


Figure 5.23: Screwed Type with Flexible Hose Manifold and Bracketing Details of LK 7900020-A, LK 7900035-A and LK 7900070-A

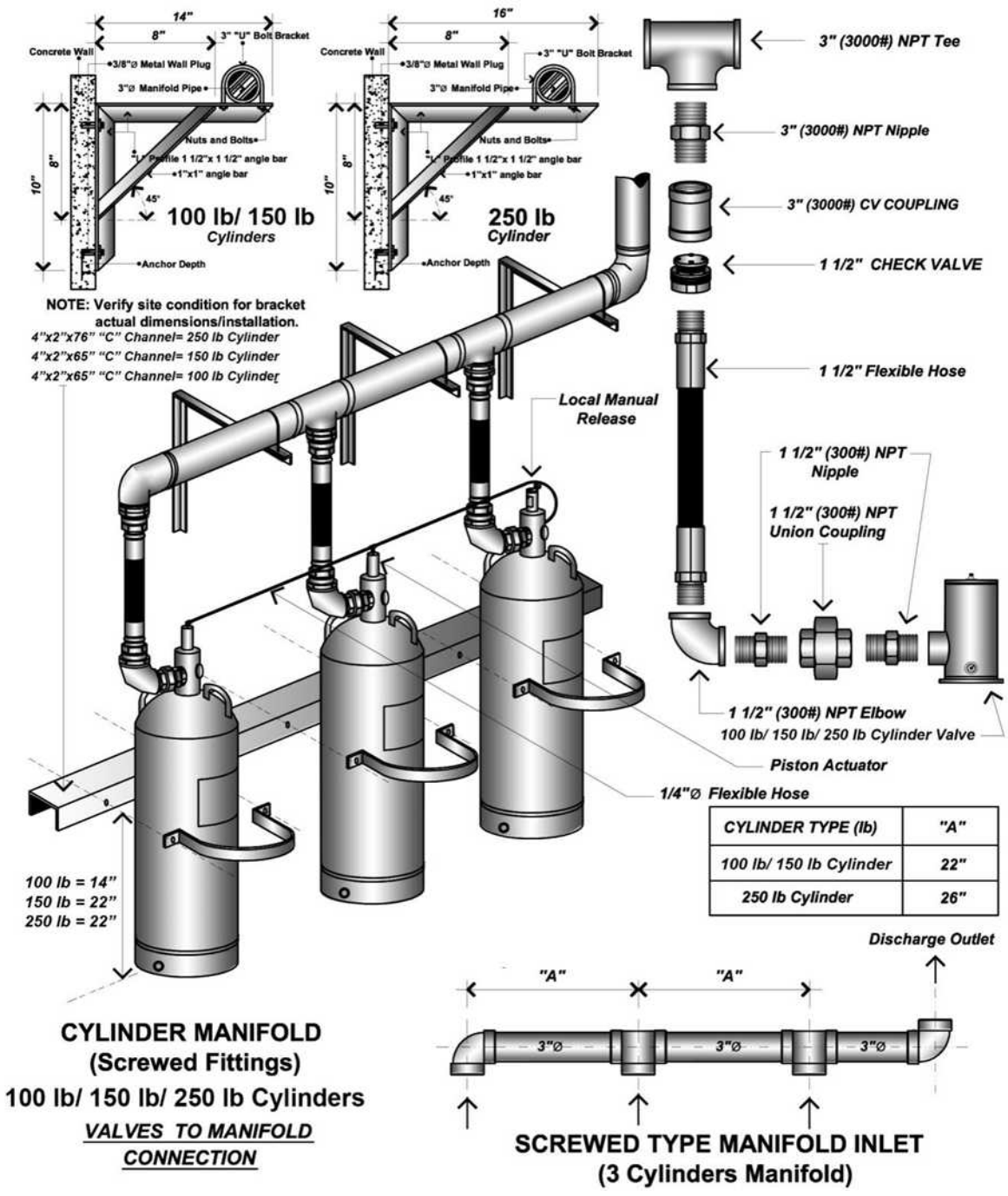


Figure 5.24: Screwed Type with Flexible Hose Manifold and Bracketing Details of LK 7900100-A, LK 7900150-A and LK 7900250-A

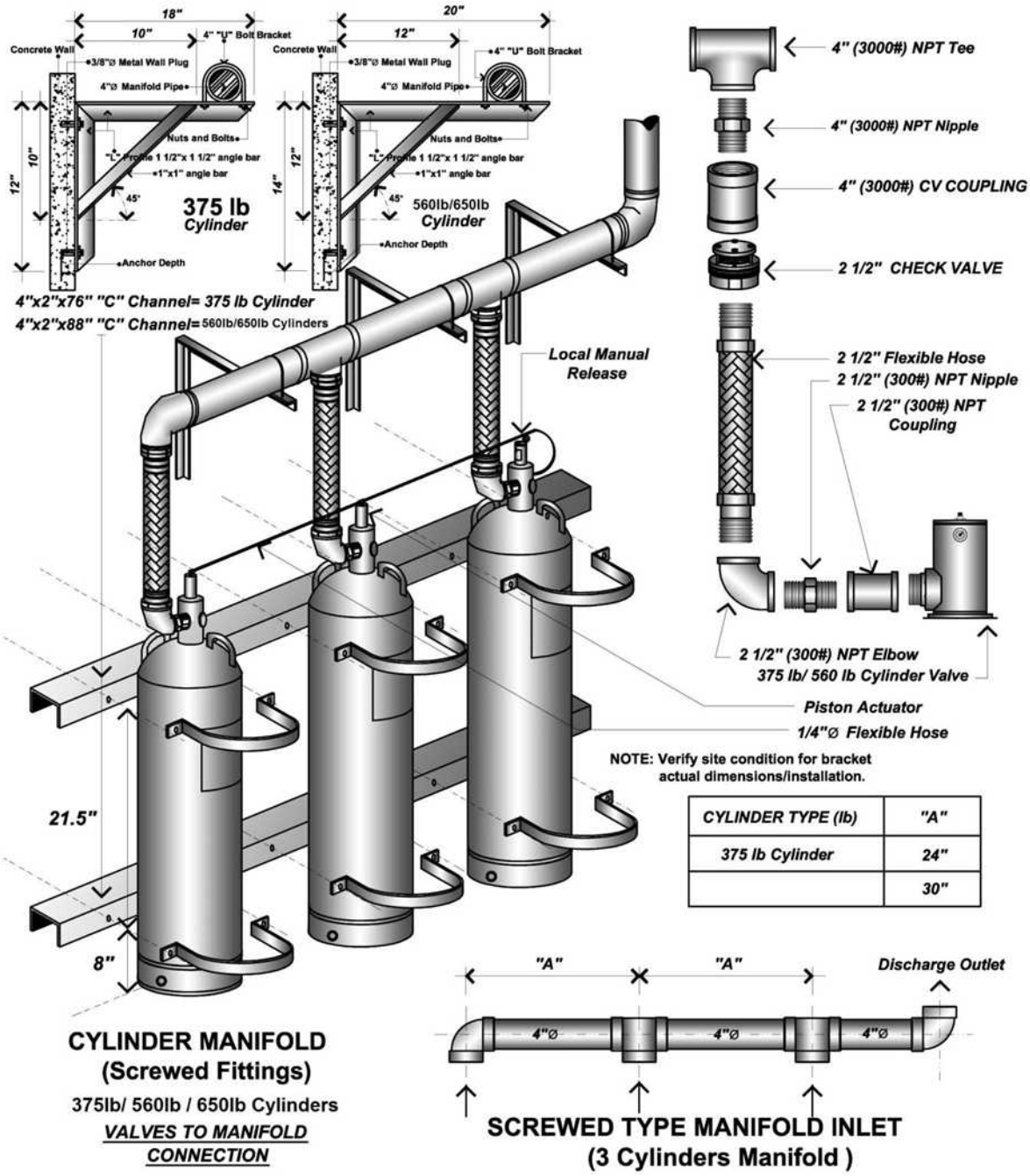


Figure 5.25: Screwed Type with Flexible Hose Manifold and Bracketing Details of LK 7900375-A and LK 7900560-A

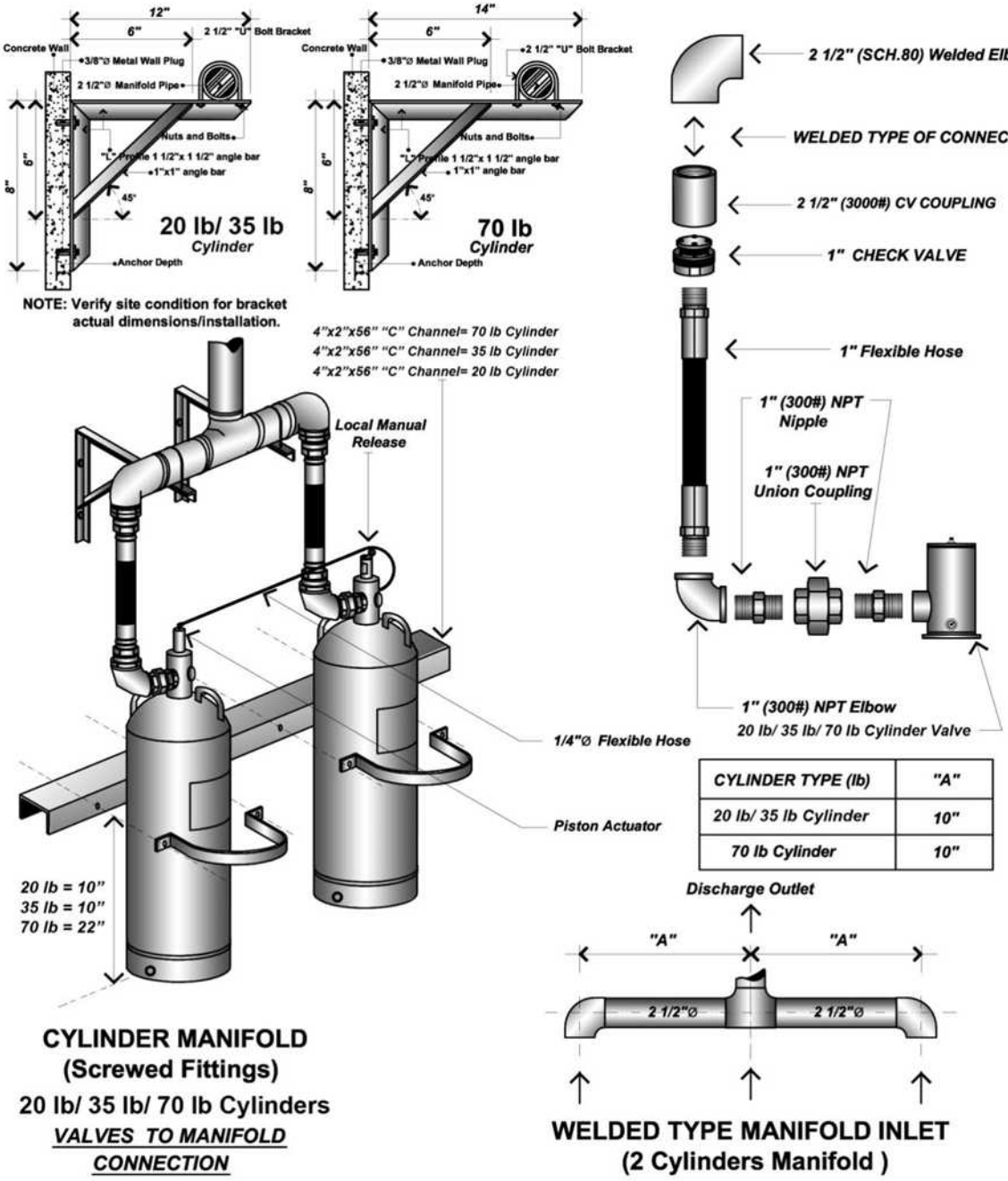


Figure 5.26: Welded Type with Flexible Hose Manifold and Bracketing Details of LK 7900020-A, LK 7900035-A and LK 7900070-A

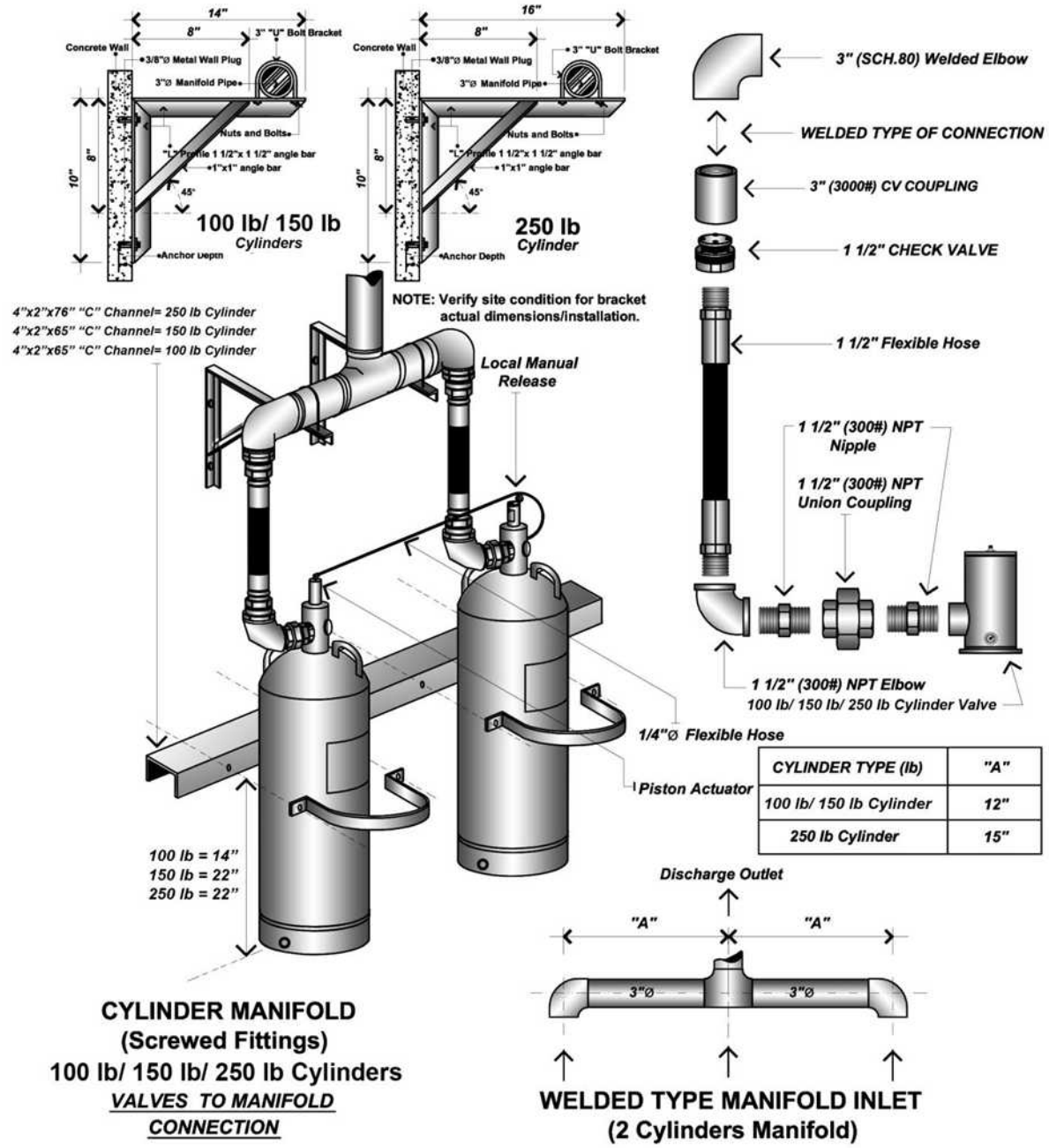


Figure 5.27: Welded Type with Flexible Hose Manifold and Bracketing Details of LK 7900100-A, LK 7900150-A and LK 7900250-A

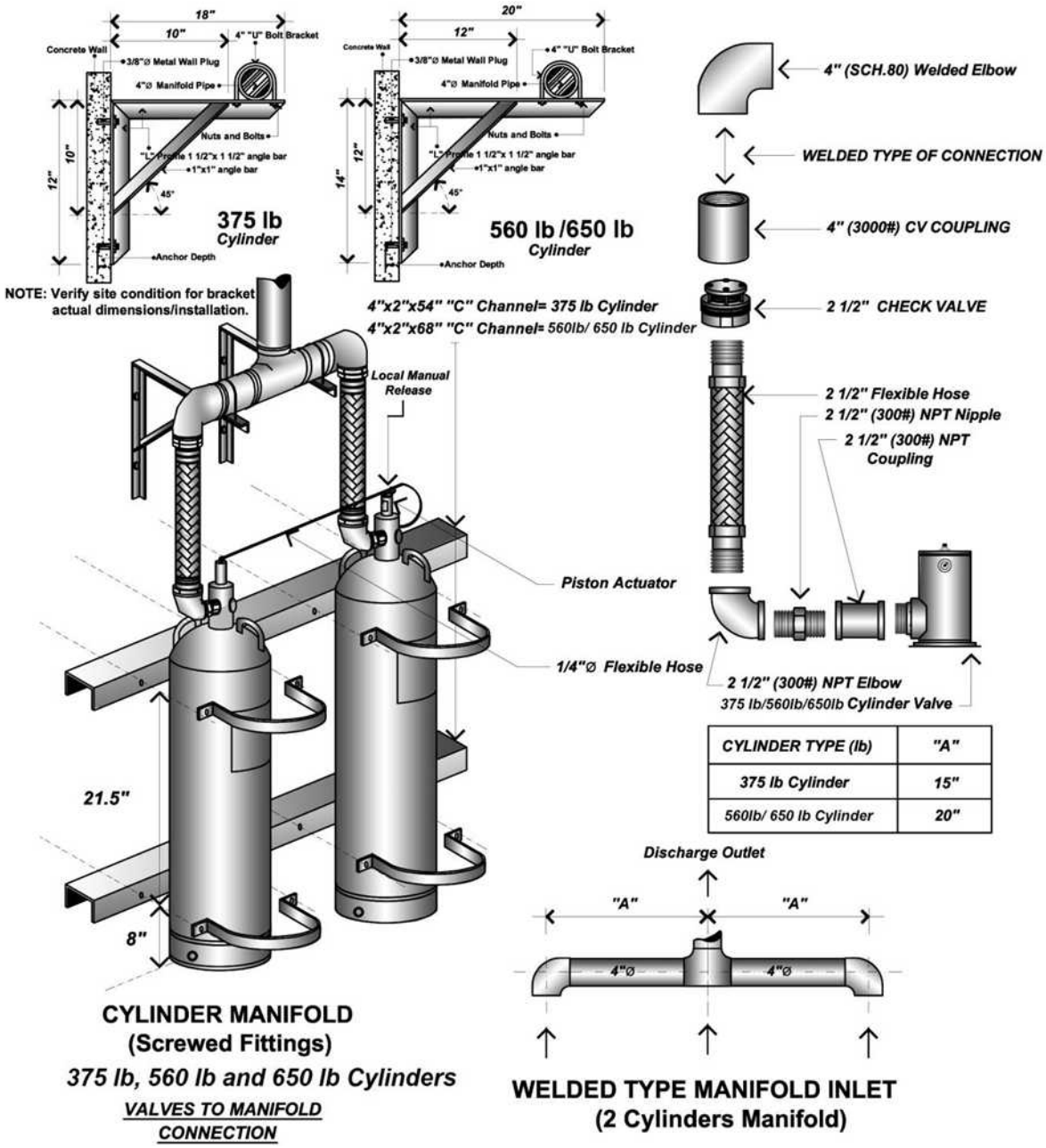


Figure 5.28: Welded Type with Flexible Hose Manifold and Bracketing Details of LK 7900375-A and LK 7900560-A

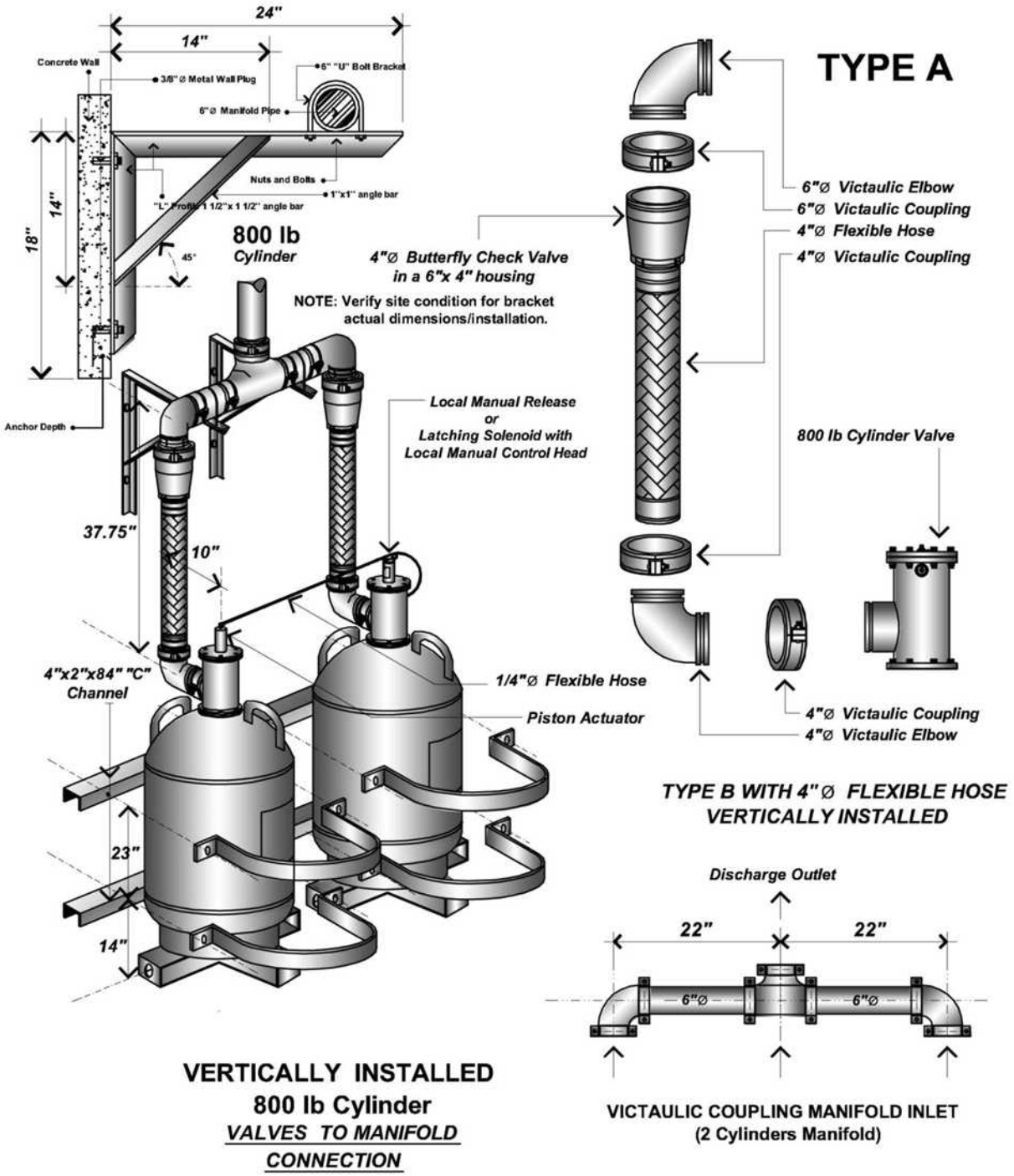


Figure 5.29: Vertical Arrangement with Flexible Hose Manifold and Bracketing Details of LK 7900800-A

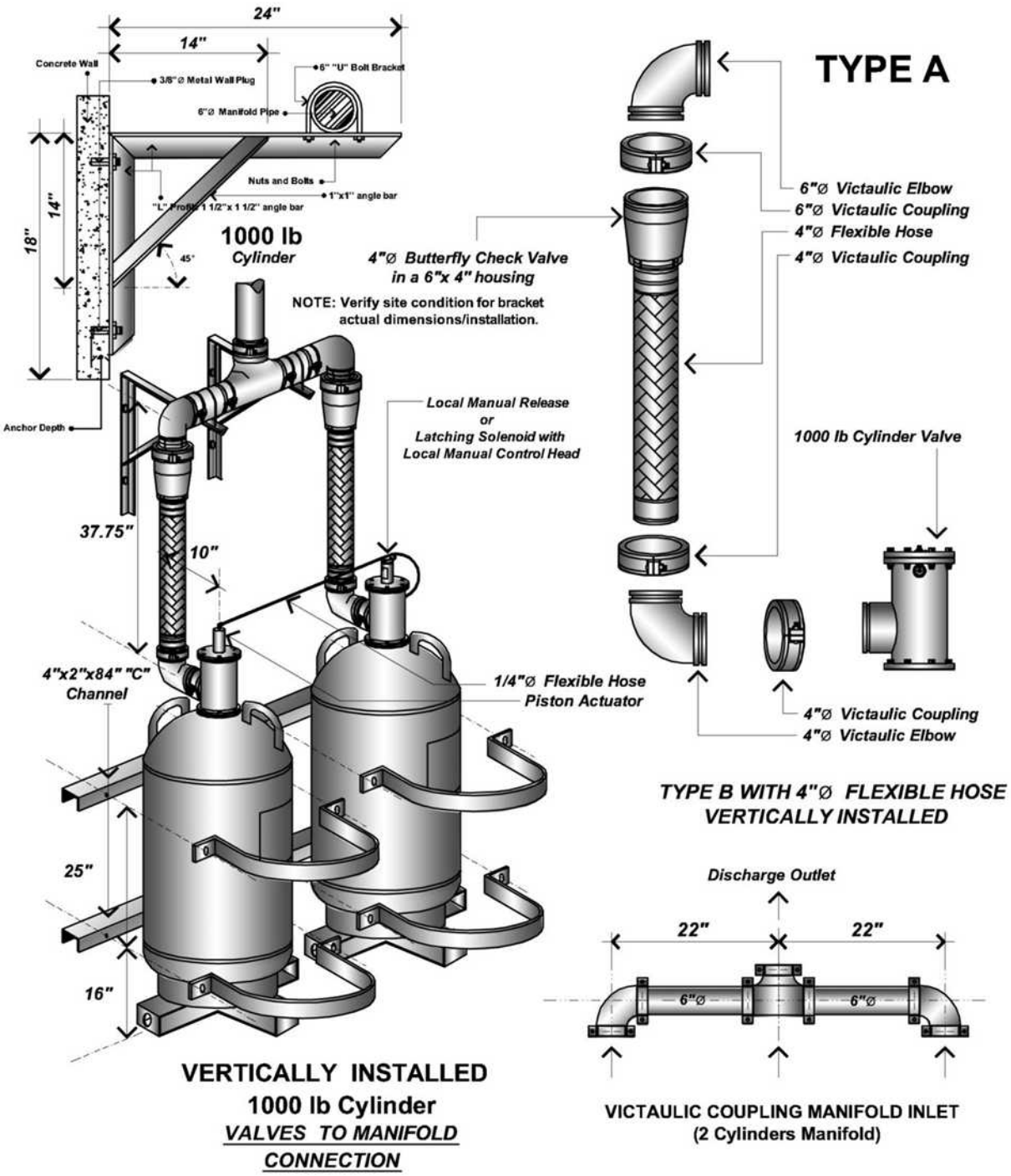


Figure 5.30: Vertical Arrangement with Flexible Hose Manifold and Bracketing Details of LK 7901000-A

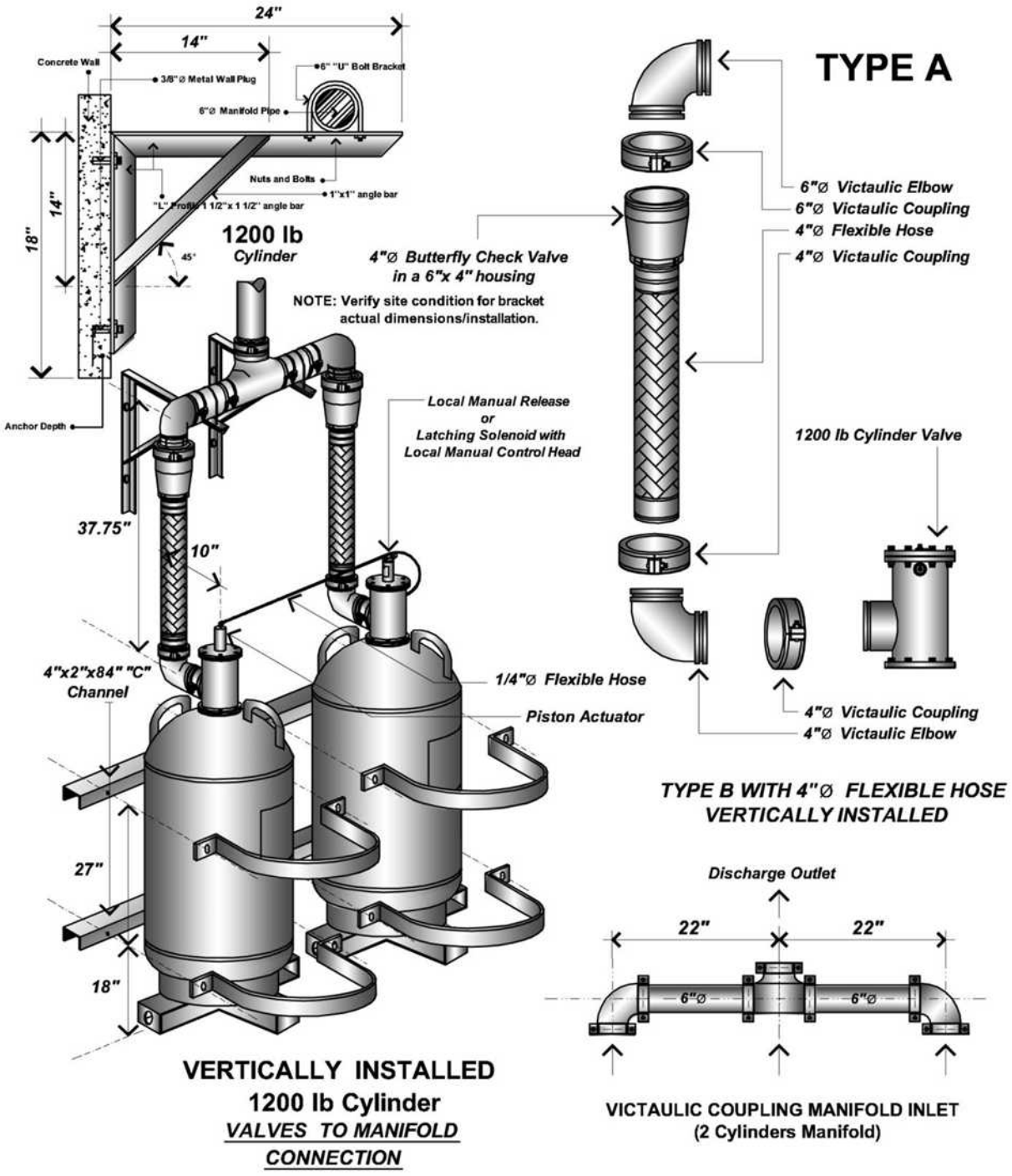


Figure 5.31: Vertical Arrangement with Flexible Hose Manifold and Bracketing Details of LK 7901200-A

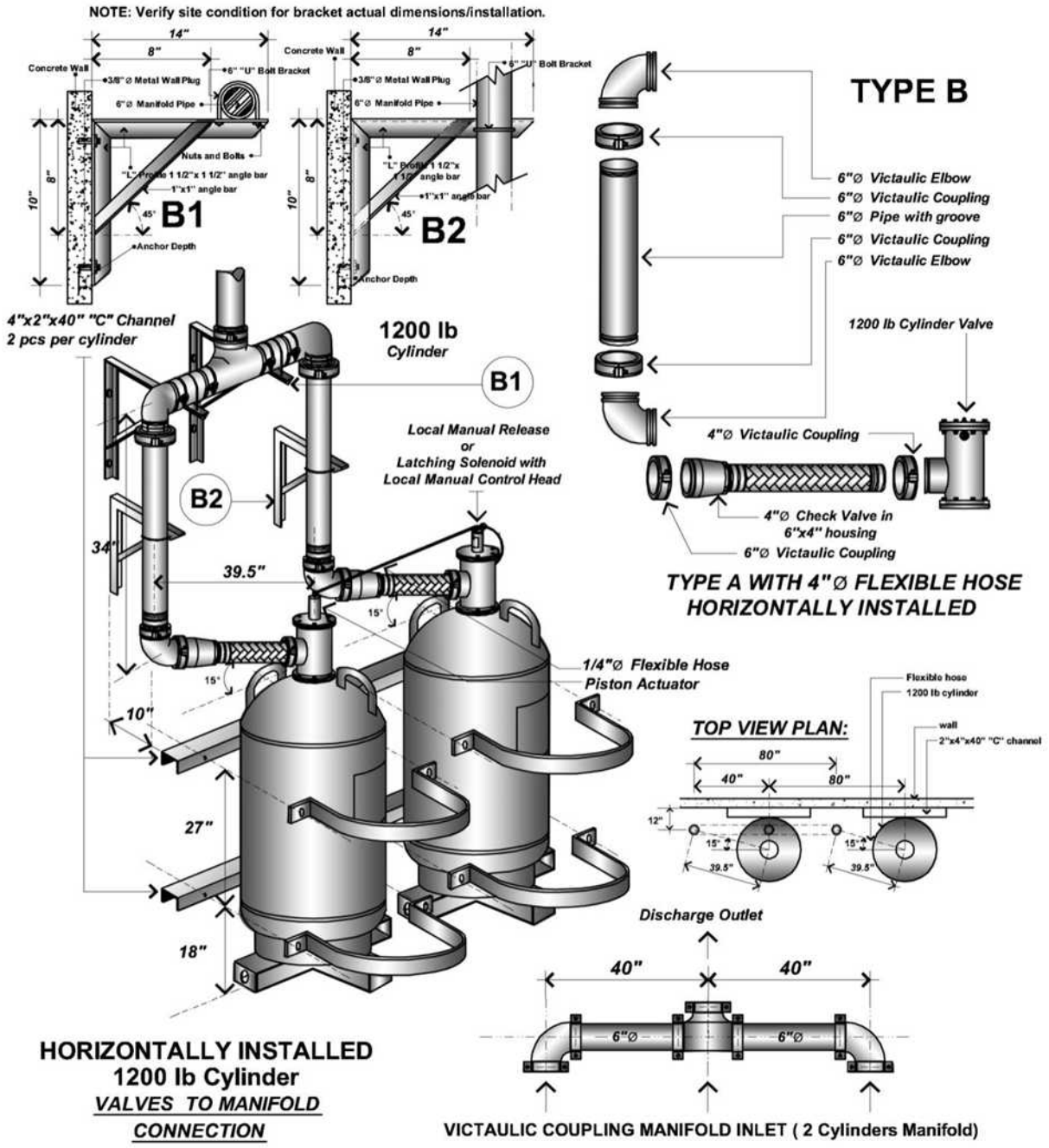


Figure 5.32: Horizontal Arrangement with Flexible Hose Manifold and Bracketing Details of LK 7901200-A

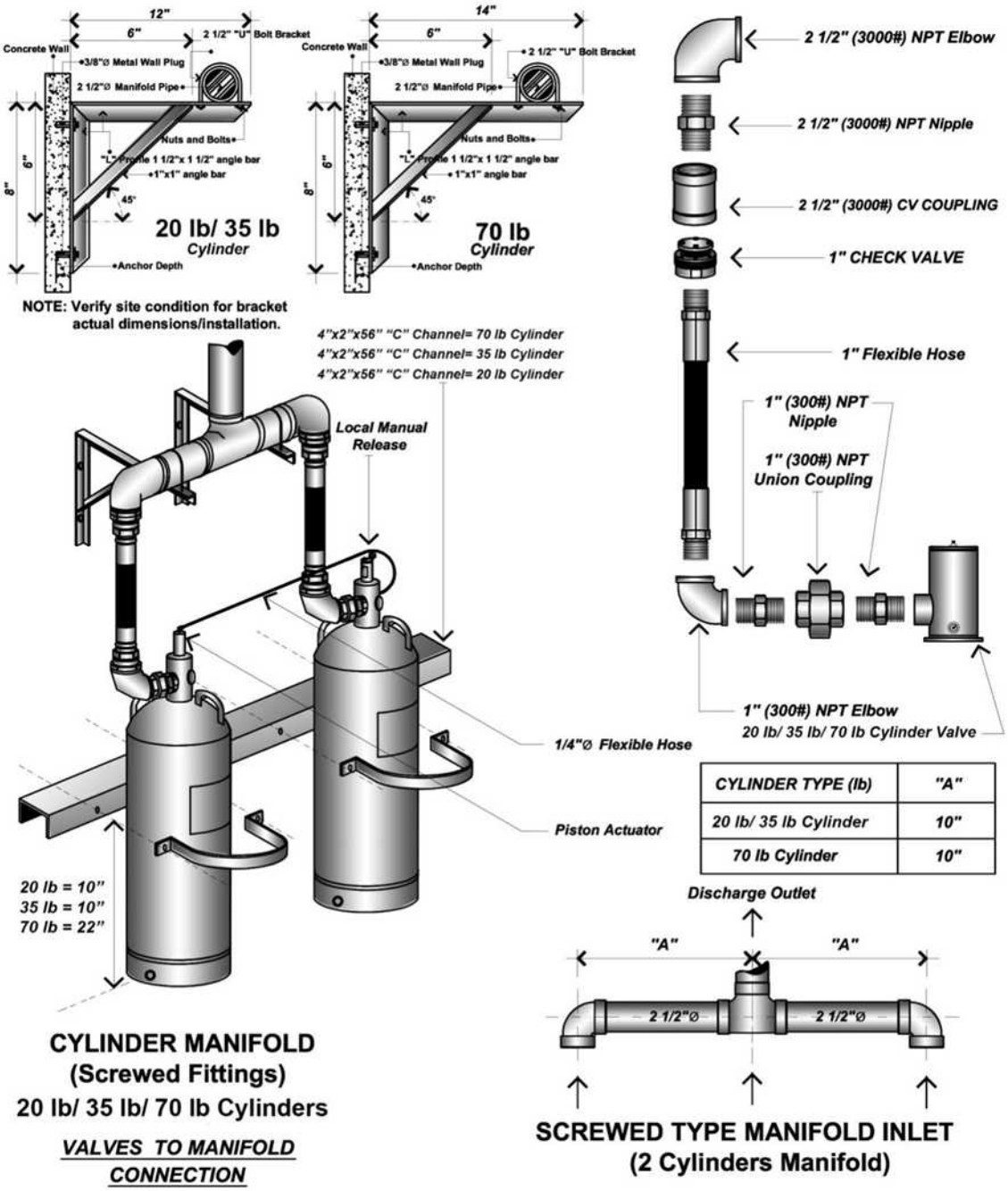


Figure 5.33: Screwed Type with Flexible Hose Manifold and Bracketing Details of LK 7900020-A, LK 7900035-A and LK 7900070-A

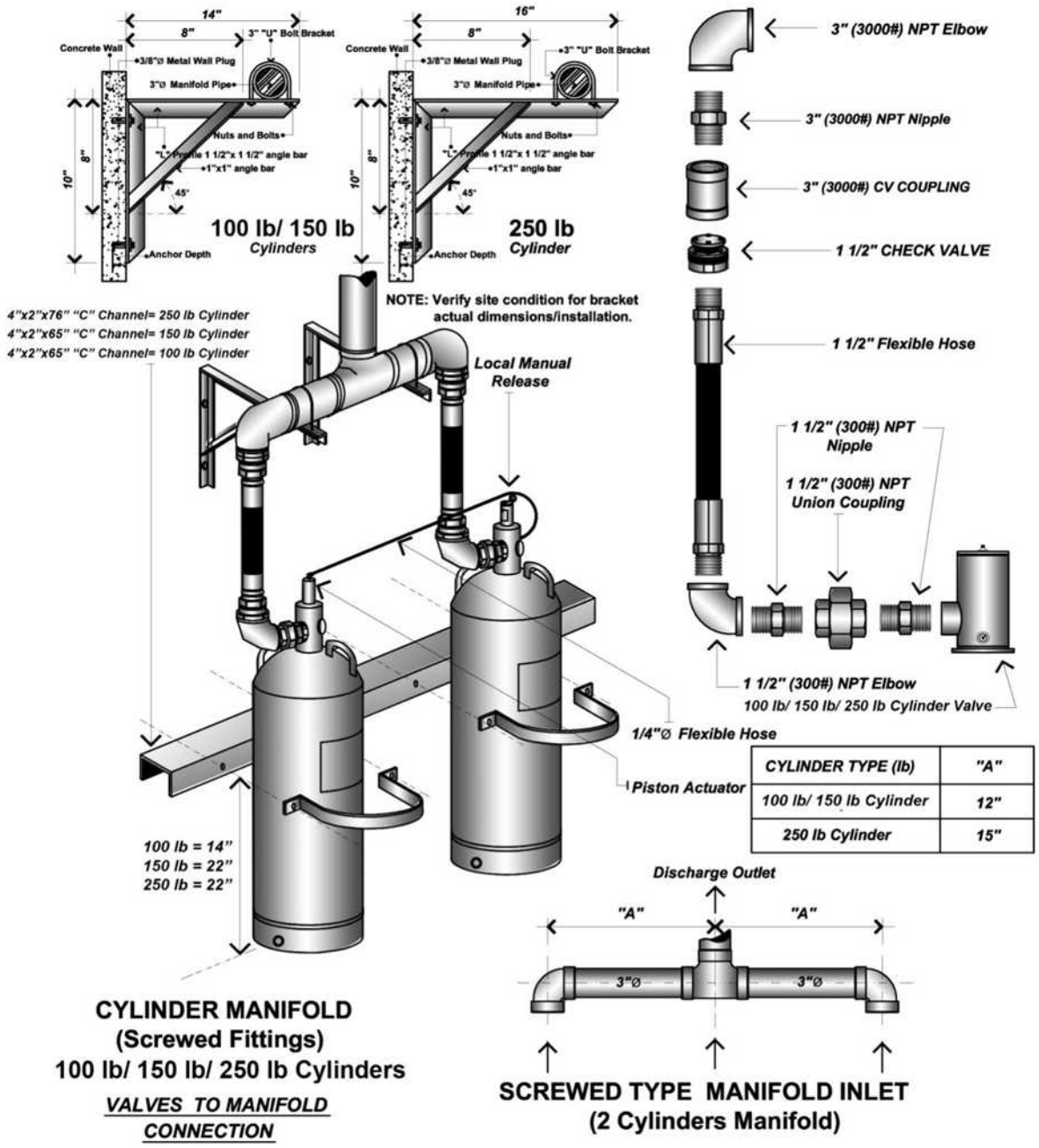


Figure 5.34: Screwed Type with Flexible Hose Manifold and Bracketing Details of LK 7900150-A and LK 7900250-A

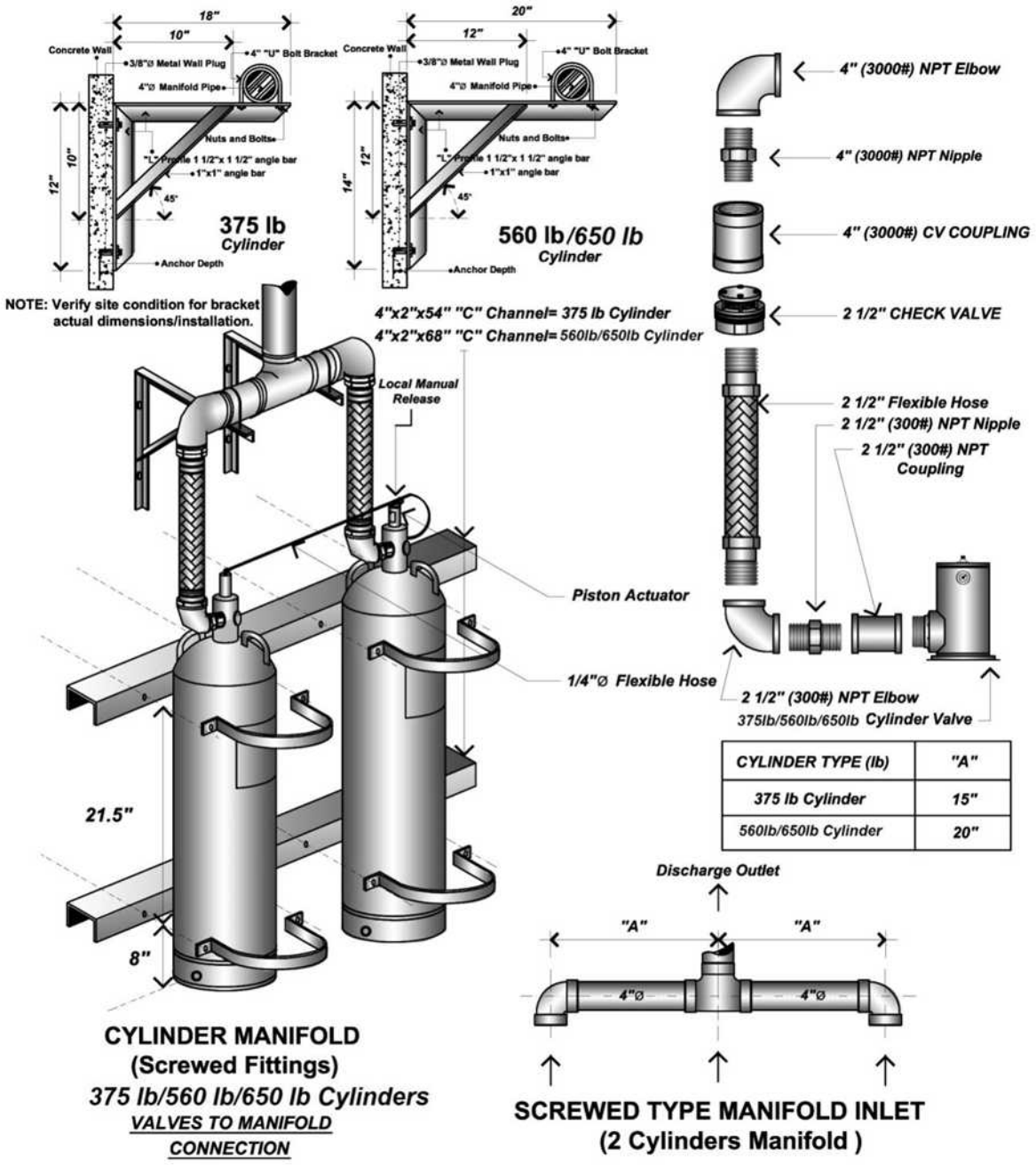


Figure 5.35: Screwed Type with Flexible Hose Manifold and Bracketing Details of LK 7900375-A and LK 7900560-A

5.12 Design Example

(i) Equipment room

- Length : 25 ft
- Width : 15 ft
- Height : 9.5 ft

The room is to be design for hazard Class A.

Amount of Agent Required

For hazard Class A, the design concentration of 7% at ambient temperature of 70^{o}F shall be used in this calculation. Based on NFPA 2001 (Latest Edition) Table A.5.5.1 (i) HFC-227ea Total Flooding Quantity (US Units), the weight requirements of hazard volume is 0.0341lb/ft^3

Volume of cabinet = L x W x H = 25 ft x 15 ft x 9.5 ft = 3562.5 ft^3
Minimum Amount of HFC-227ea required = Volume x Weight requirement
= 3562.5 ft^{3}x 0.0341 lb/ft^3 = 121.48 lb

Since the minimum amount of agent required is 122 lb (rounded up from 121.48 lb***), one set of 150 lb cylinder (LK 7900150-A)*** shall be used in this design.

Nozzle Required

Discharge time (for calculation purposes only): 9.0 seconds
Estimate flow rate = min. amount of agent required / discharge time
= 121.48 lb / 9 seconds = 13.5 lb/s

Based on

Table 3-2, ***the size of required nozzle is 1-1/2" NPT.*** The type of nozzle (e.g. central or sidewall) is determined based on the location of the agent cylinder to be installed in the room.

(ii) Multiple Rooms

Example Output using Flow Calculation

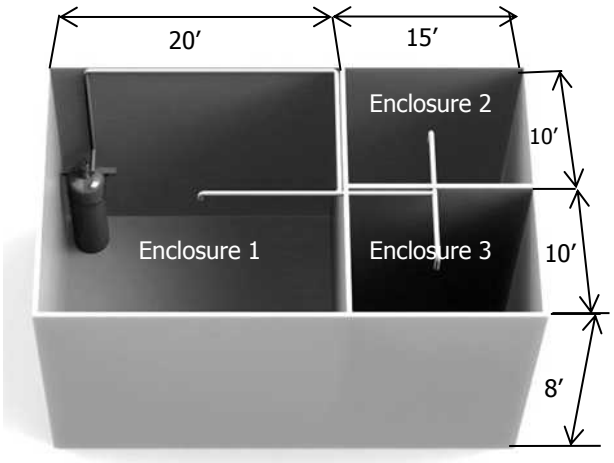


Figure 5.36: Flow Calculation Example - Output Statement

Luke Alexander Clean Agent System Flow Calculation Software (HFC-227ea)
EX26826

Luke Alexander LLC
No. 29 Loyang Drive
Singapore 508944
Phone: Tel:+(65)-6543-0070 Fax: +(65)-6543-9949
File Name: Luke Alex Project1.FC4.FC4

Consolidated Report

Customer Information

Company Name: ABC Company
Address: 123 Washington Street
BigiCity, CA
98765-9999
Phone: (123)-456-7890
Contact: Mr Smith
Title: Safety Manager

Project Data

Project Name: Computer Addition
Designer: John Doe
Number: ABC-3
Account: 123-45
Location: 2nd Floor
Description: Protection for new computer equipment

Enclosure Report

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

Enclosure 1 Front Computer Room
Enclosure Temperature: Number of Nozzles: 1

Calculation Date/Time: Thursday, September 3, 2015, 6:03:21 PM

Key ID: 1322383982

Consolidated Report

Minimum:	70 F	Width:	0.0 ft
Maximum:	70 F	Length:	0.0 ft
Max. Concentration:	7.20 %	Height:	0.0 ft
Design Concentration:		Volume:	3201.0 ft ³
Adjusted:	7.20 %	Non-permeable:	0.0 ft ³
Minimum:	7.00 %	Total Volume:	3201.0 ft ³
Min. Agent Required:	109.2 lb		
Adjusted Agent Required:	112.6 lb		

Enclosure 2 Section II

Enclosure Temperature:		Number of Nozzles:	1
Minimum:	70 F	Width:	10.0 ft
Maximum:	70 F	Length:	15.0 ft
Max. Concentration:	7.22 %	Height:	8.0 ft
Design Concentration:		Volume:	1200.0 ft ³
Adjusted:	7.22 %	Non-permeable:	0.0 ft ³
Minimum:	7.00 %	Total Volume:	1200.0 ft ³
Min. Agent Required:	41.0 lb		
Adjusted Agent Required:	42.3 lb		

Enclosure 3 Section III

Enclosure Temperature:		Number of Nozzles:	1
Minimum:	70 F	Width:	10.0 ft
Maximum:	70 F	Length:	15.0 ft
Max. Concentration:	7.19 %	Height:	8.0 ft
Design Concentration:		Volume:	1200.0 ft ³
Adjusted:	7.19 %	Non-permeable:	0.0 ft ³
Minimum:	7.00 %	Total Volume:	1200.0 ft ³
Min. Agent Required:	41.0 lb		
Adjusted Agent Required:	42.1 lb		

Agent Source Report

Calculation Date/Time: Thursday, September 3, 2015, 6:03:21 PM

Key ID: 1322383982

Consolidated Report

Agent:	HFC-227ea / Propellant N2
Cylinder Name:	250 lb. Cylinder
Cylinder Part Number:	LK 7900250-A
Agent Per Cylinder:	197.0 lb
Fill Density:	54.4 lbs / cubic ft
Number of Main Cylinders:	1
Number of Reserve Cylinders:	0
Cylinder Empty Weight:	154.8 lb
Weight, All Cylinders + Agent:	351.8 lb
Floor Area Per Cylinder:	1.40 ft ^{2}
Floor Loading Per Cylinder:	252 lbs / ft ^{2}

Calculation Date/Time: Thursday, September 3, 2015, 6:03:21 PM

Key ID: 1322383982

Consolidated Report

Parts Report

Total Agent Required: 197.0 lb

Cylinder Name: 250 lb. Cylinder (Part: LK 7900250-A)

Number of Cylinders: 1

Nozzle	Type	Nozzle Diameter	Drill Size	Nozzle Area	Part Number
E1-N1	Central	1-1/2 in	0.323	0.6555 in ^{2}	LK 7952150-3-0.3230
E2-N1	Central	3/4 in	0.246	0.3802 in ^{2}	LK 7952075-3-0.2460
E3-N1	Central	3/4 in	0.246	0.3802 in ^{2}	LK 7952075-3-0.2460

Nozzle	Drill Diameter	Drill Size
E1-N1	0.3230 inches	0.323
E2-N1	0.2460 inches	0.246
E3-N1	0.2460 inches	0.246

Pipe & Fittings	Type	Diameter	Length	Elbows (90)	Elbows (45)	Tees	Unions
	40T	3/4 in	14.00 ft	4	0	0	0
	40T	1 in	5.00 ft	0	0	1	0
	40T	1-1/2 in	22.00 ft	3	0	1	0

Other Objects	Name	Quantity	Part Number

System Acceptance Report

System Discharge Time: 9.7 seconds
Percent Agent In Pipe: 19.6%
Percent Agent Before First Tee: 12.2%
Dead Volume: 0.0% (0.0 lb)

Calculation Date/Time: Thursday, September 3, 2015, 6:03:21 PM

Key ID: 1322383982

Consolidated Report

Enclosure Number: 1
Enclosure Name: Front Computer Room
Minimum Design Concentration: 7.00%
Adjusted Design Concentration: 7.20%
Predicted Concentration: 7.30%
Maximum Expected Agent Concentration: 7.30% (At 70 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Average Nozzle Pressure
E1-N1	109.2 lb	112.6 lb	114.2 lb	120 psig

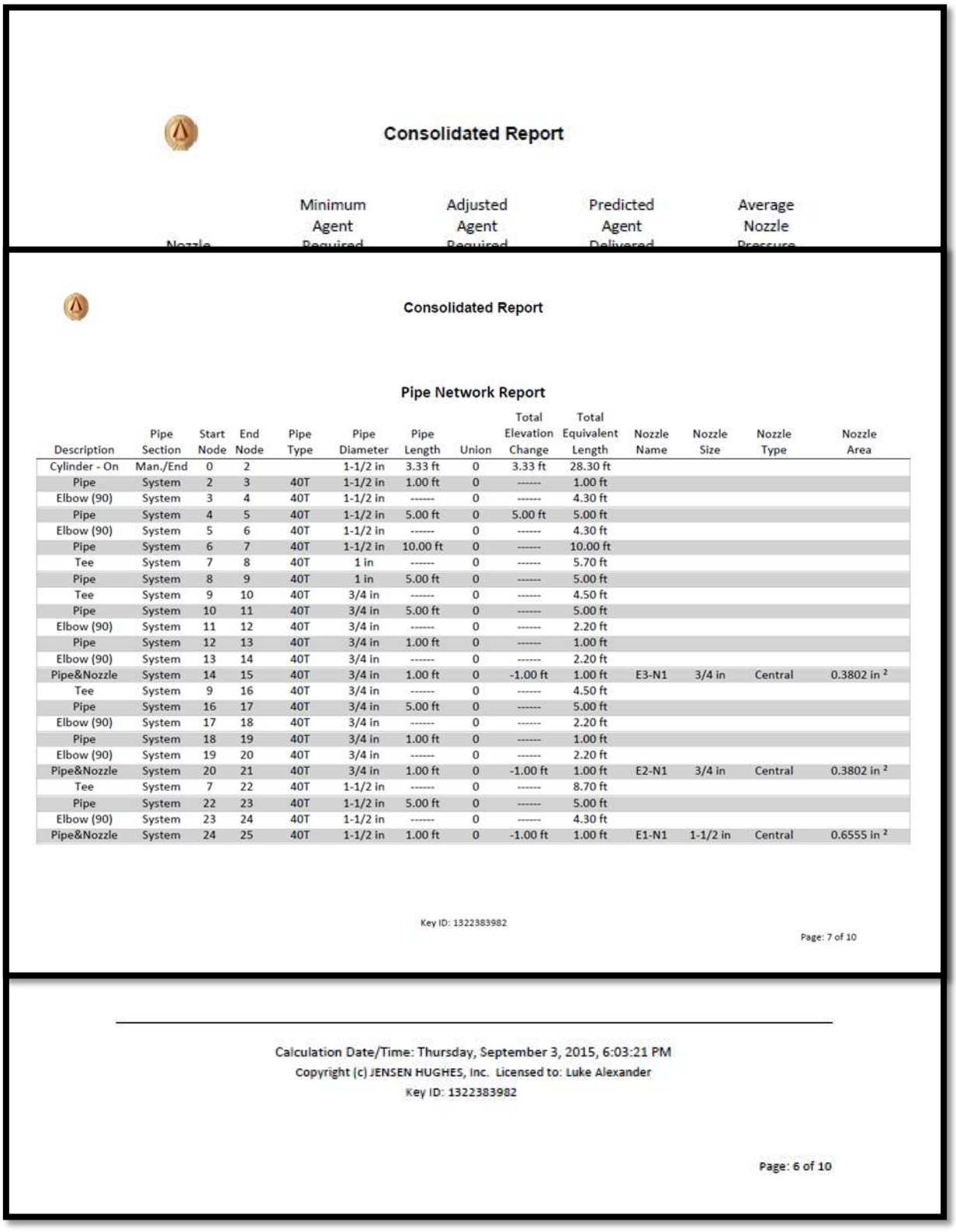
Enclosure Number: 2
Enclosure Name: Section II
Minimum Design Concentration: 7.00%
Adjusted Design Concentration: 7.22%
Predicted Concentration: 7.07%
Maximum Expected Agent Concentration: 7.07% (At 70 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Average Nozzle Pressure
E2-N1	41.0 lb	42.3 lb	41.4 lb	81 psig

Enclosure Number: 3
Enclosure Name: Section III
Minimum Design Concentration: 7.00%
Adjusted Design Concentration: 7.19%
Predicted Concentration: 7.07%
Maximum Expected Agent Concentration: 7.07% (At 70 F)

Calculation Date/Time: Thursday, September 3, 2015, 6:03:21 PM

Key ID: 1322383982



Consolidated Report

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Average Nozzle Pressure

Consolidated Report

Pipe Network Report

Description	Pipe Section	Start Node	End Node	Pipe Type	Pipe Diameter	Pipe Length	Union	Total Elevation Change	Total Equivalent Length	Nozzle Name	Nozzle Size	Nozzle Type	Nozzle Area
Cylinder - On	Man./End	0	2		1-1/2 in	3.33 ft	0	3.33 ft	28.30 ft				
Pipe	System	2	3	40T	1-1/2 in	1.00 ft	0	------	1.00 ft				
Elbow (90)	System	3	4	40T	1-1/2 in	------	0	------	4.30 ft				
Pipe	System	4	5	40T	1-1/2 in	5.00 ft	0	5.00 ft	5.00 ft				
Elbow (90)	System	5	6	40T	1-1/2 in	------	0	------	4.30 ft				
Pipe	System	6	7	40T	1-1/2 in	10.00 ft	0	------	10.00 ft				
Tee	System	7	8	40T	1 in	------	0	------	5.70 ft				
Pipe	System	8	9	40T	1 in	5.00 ft	0	------	5.00 ft				
Tee	System	9	10	40T	3/4 in	------	0	------	4.50 ft				
Pipe	System	10	11	40T	3/4 in	5.00 ft	0	------	5.00 ft				
Elbow (90)	System	11	12	40T	3/4 in	------	0	------	2.20 ft				
Pipe	System	12	13	40T	3/4 in	1.00 ft	0	------	1.00 ft				
Elbow (90)	System	13	14	40T	3/4 in	------	0	------	2.20 ft				
Pipe&Nozzle	System	14	15	40T	3/4 in	1.00 ft	0	-1.00 ft	1.00 ft	E3-N1	3/4 in	Central	0.3802 in ^{2}
Tee	System	9	16	40T	3/4 in	------	0	------	4.50 ft				
Pipe	System	16	17	40T	3/4 in	5.00 ft	0	------	5.00 ft				
Elbow (90)	System	17	18	40T	3/4 in	------	0	------	2.20 ft				
Pipe	System	18	19	40T	3/4 in	1.00 ft	0	------	1.00 ft				
Elbow (90)	System	19	20	40T	3/4 in	------	0	------	2.20 ft				
Pipe&Nozzle	System	20	21	40T	3/4 in	1.00 ft	0	-1.00 ft	1.00 ft	E2-N1	3/4 in	Central	0.3802 in ^{2}
Tee	System	7	22	40T	1-1/2 in	------	0	------	8.70 ft				
Pipe	System	22	23	40T	1-1/2 in	5.00 ft	0	------	5.00 ft				
Elbow (90)	System	23	24	40T	1-1/2 in	------	0	------	4.30 ft				
Pipe&Nozzle	System	24	25	40T	1-1/2 in	1.00 ft	0	-1.00 ft	1.00 ft	E1-N1	1-1/2 in	Central	0.6555 in ^{2}

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Calculation Date/Time: Thursday, September 3, 2015, 6:03:21 PM

Key ID: 1322383982

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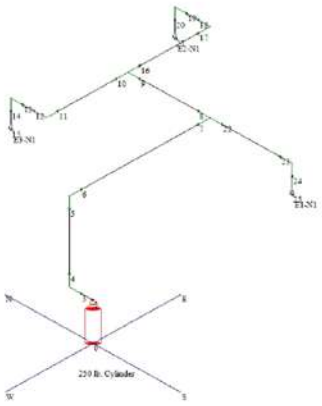
Consolidated Report

View #: 1 - Isometric View-Node



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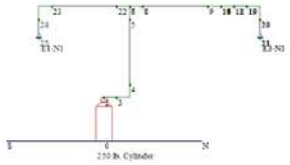
Consolidated Report

View#: 5 - Standard Elevation View



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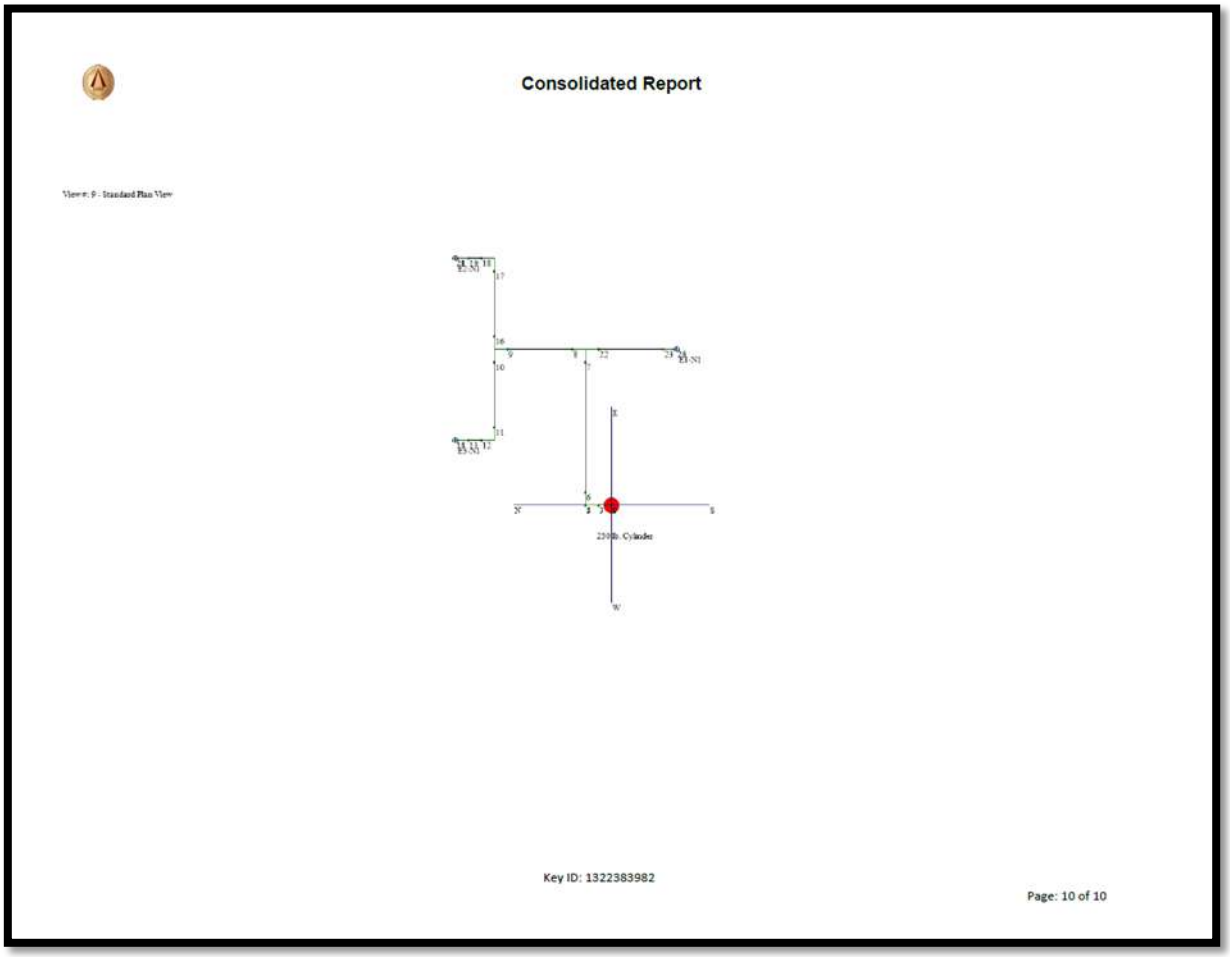
Consolidated Report
Key ID: 1322383982
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6 Operation and Maintenance

6.1 System Inspection after Installation

The inspection procedure illustrated in this chapter is intended for the use of Engineered Fire Suppression System offered by Luke Alexander LLC only.

NOTE: All detection devices, auxiliary alarms, and control devices must be electrically compatible with Engineered Fire Suppression System available at Luke Alexander LLC, and they must be UL Listed by the authorities having jurisdiction.

6.1.1 Electric Solenoid

During Electric Solenoid maintenance or inspection, always follow the following precautions to avoid unwanted discharge of HFC-227ea clean agent:

CAUTION:

1. *DO NOT disconnect solenoid coil from solenoid body.*
2. *DO NOT remove the Zip-Tie (Tamper Seal) from Electric Solenoid. Inspect the Zip-Tie (Tamper Seal) to confirm that it's intact at all times.*
3. *When Electric Solenoid needs to be replaced or repaired, always disable the Releasing Circuit Disable Switch (SYTEM DISABLED condition). Always replace Zip-Tie (Tamper Seal) whenever it is broken. Zip-Tie must be tightly fit when installing to avoid removal of Solenoid Coil.*
4. *During inspection or maintenance, always DISABLE the Releasing Circuit Disable Switch (SYTEM DISABLED condition) and ENABLE (SYSTEM NORMAL condition) after.*
5. *During the Electric Solenoid coil function test, Releasing Circuit Disable Switch must be in SYSTEM NORMAL condition.*

6.1.2 Local Manual Control

Following is the general procedure for the test of local manual control.

1. Remove the local manual control from the top plug adapter.
2. Remove safety pull-pin.
3. Operate push button and observe the lock-pin full travel across the top of the control handle.
4. After the test, reset the local manual control pulling out the lock-pin. At the same time, pull up the control handle.
5. Replace the pull-pin and reseal with breakaway plastic seal.
6. Replace Local Manual Control onto the Top Plug Adapter.

Please refer to Figure 2.10 for the Local Manual control parts.

CAUTION(S):

a. *Ensure that the safety pull pin is correctly installed and secured in the control operating push-button until the system is to be activated by use of the device.*
b. *When reinstalling the local manual control back onto the top plug adapter, ensure that the locking pin is reset with the handle in the original position (in the up position) and the safety pull pin is installed. Failure to fully reset the control head prior to installation will result in an unwanted discharge of the system during installation.*

6.1.3 Piston Actuator

The Piston Actuator (Part Number: LK 7941201) checkout process consists of the following steps.

1. Detach 1/4” flex hose or 1/4” copper tubing from the top of the Piston Actuator.
2. Remove Piston Actuator from the Top Plug Adapter.
3. Attach a regulated nitrogen source of 20-25 psi to the top of the Piston Actuator.
4. Apply 20-25 psi pressure to the top of the Piston Actuator. The piston rod must travel a full stroke, as seen by the piston going flush with the top of the lower piston body.
5. Relieve pressure to the top of the Piston Actuator. After the test, the piston must be manually pushed to the top of the piston body. Do not return the piston actuator to the Top Plug Adapter without resetting the piston.
7. Once the piston is reset, return the piston actuator to the Top Plug Adapter.
8. Re-assemble 1/4” flex hose or 1/4” copper tubing to the top of the Piston Actuator.

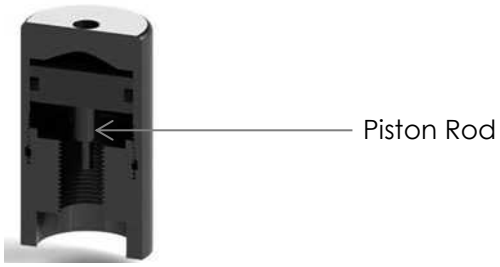

Figure 6.1: Return method by pushing the rod

WARNING(S):

a) DO NOT APPLY PRESSURE WHILE THE UPPER BODY IS NOT ATTACHED TO THE LOWER BODY. The lower body must be the brake for the piston.

b) If you do not reset the piston, the valve will discharge.

6.2 Regular Maintenance

6.2.1 Weekly Check and Maintenance

Weekly maintenance is recommended to be conducted to ensure that the fire extinguishing system is operative. Following is the procedure for the weekly maintenance which is to be performed by authorized personnel. Signed records shall be kept for monitoring and follow-up purposes.

(i) Check the pressure gauge(s) of the cylinder valve(s) in order to ensure that there is no loss pressure. If the pressure is 10% below the required pressure for the temperature of the cylinder at the time of inspection, the cylinder must be serviced by an authorized distributor of Luke Alexander LLC. It is recommended that a copy of Table 6-1 is made with all pertinent information filled-in and be located in the vicinity of the installed cylinder location.

Table 6-1: Minimum Charge Pressure at Specified Temperature

Temperature		Nominal Charged Pressure	
°F	°C	psig	bar
32	0	288	19.9
40	4.4	303	20.9
50	10.0	321	22.1
60	15.6	340	23.4
70	21.1	360	24.8
80	26.7	381	26.3
90	32.2	402	27.7
100	37.8	425	29.3
110	43.3	449	31.0
120	48.9	475	32.8
130	54.4	502	34.6

Note: The pressure tolerance at full operation is +15 psig.

(ii) Check for physical damage or missing parts from the EngineeredSystem hardware.
(iii) Check the orientation and tightness of the discharge nozzles.
(iv) Check for obstructions that would interfere with nozzle discharge pattern or mechanical operation of the system.
(v) Check that all tamper seals are still intact and secure.

6.2.2 Semi-Annual Check and Maintenance

Semi-annual maintenance shall be performed by an authorized distributor of Luke Alexander LLC. In this inspection,

(i) The procedure in Section 6.2.1 Weekly Check and Maintenance is repeated.
(ii) The quality of the clean agent and the pressure of refillable containers shall be checked semi-annually. If the container shows a loss in net weight of more than 5% or a loss in pressure (adjusted for temperature) of more than 10%, the container shall be refilled or replaced.
(iii) Procedure in Section 6.1 shall be performed to ensure that all components in the systems are functional.

6.3 System Discharge

After the discharge of HFC-227ea, it is recommended to ventilate thoroughly prior to entering the enclosure. An authorized installer or system designer must be consulted after the system has discharged. The cylinder must be removed from the bracket to be recharged with HFC-227ea and re-pressurized with nitrogen.

The following procedure shall be followed when removing the system from the service.

1. Disable the Releasing Circuit Disable Switch (Part Number: LK 7965004) (SYSTEM DISABLED condition) to deactivate electronically the Electric Solenoid/system.
2. When piston actuators are being used, no venting of the actuator tubing is required.
3. Remove all pressure actuating tubes from cylinder adapters.
4. Remove all pressure actuating tubes and the piston actuators from the top plug adapters. The pistons are to be manually pushed back to the top of the piston actuators.

CAUTION: Failure to reset the piston actuator before returning it to service will result in an unwanted discharge of the system.

5. Remove all Local Manual Controls from the cylinder adapters. The Local Manual Control is reset by pulling out the lock-pin, and at the same time, lifting the handle. The pull-pin and plastic seal must be in place at all times when the control is not in use.

CAUTION: Failure to reset the Local Manual Control before returning it to service will result in an unwanted discharge of the system during installation.

6. Remove cylinder piping from cylinder valves.
7. Attach anti-recoil plugs on all cylinders.
8. Loosen cylinder brackets and remove the cylinders.
9. Have all cylinders recharged only by a qualified Luke Alexander LLC recharge facility.

NOTE: Only qualified HFC-227ea recharge personnel shall inspect cylinder, valve, and controls for nicks, corrosion, and impairment of parts.

10. Replace all parts as necessary. Check nozzles for any damages, misalignment or foreign matters. After system discharges through a shuttle valve, functionally test the shuttle valve for free movement. Follow all instructions on the cylinder nameplate. If the valve is to be disassembled to lubricate the “o” ring, make sure the pressure within the cylinder is at ZERO psig. To make sure there is no residual pressure within the cylinder, install the anti-recoil fittings on the discharge outlet, and actuate the cylinder valve.

CAUTION: DO NOT BREATHE THE GAS VENTING FROM THE ANTI-RECOIL.

Only the bore of the valve and the piston “o” ring shall be greased with the LK 7970007 grease. The seating surface in the valve and the rubber piston seat shall NOT be greased. Only theLK 7970007 grease shall be used.

11. After the recharging has been completed, replace cylinders in brackets and re-fasten the brackets.
12. Remove anti-recoil plugs.
13. Re-connect discharge piping.
14. Reset control panel.
15. Reconnect all mechanical controls.
16. Enable the Releasing Circuit Disable Switch (Part Number: LK 7965004) (SYSTEM NORMAL condition) to activate electronically the Electric Solenoid/System. Check that Tamper Seal (Part Number: LK 7998003) if it is intact.
17. Reconnect all pressure actuators and pressure actuation tubing.

NOTE: This system consists of components tested within limitations contained in this manual. The designer of this system must be consulted prior to any planned changes to either the system or the area being protected. An authorized distributor of Luke Alexander LLC must be consulted after the system has discharged.

7 Appendices

APPENDIX A: Material Safety Data Sheet (MSDS)

HMIS	
Health	1
Flammability	0
Reactivity	0
Personal Protection	x

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name : HFC-227ea Fire Extinguishing Agent

Intended Use : Streaming and Flooding Fire Protection

Manufacturer/Supplier Name and Address

Company's Name : LUKE ALEXANDER LLC

Address : 5 Centerpointe Dr. Suite 400
Portland OR 97035 USA

Date of Issue : May 5, 2015

Information Contact : 1-503-204-0371

Fax : 1-971-204-0230

Emergency Contact : 1-800-424-9300 *(CHEMTREC within USA and Canada)*

1-703-527-3887 *(CHEMTREC outside USA and Canada)*

2. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS #	% w/w
1,1,1,2,3,3,3–Heptafluoropropane	431-89-0	≥99.96%

3. HAZARDSIDENTIFICATION

3.1 EMERGENCY OVERVIEW

Physical Form	:	Liquefied Gas
Odor	:	Odorless
Color	:	Colorless

3.2 POTENTIAL HEALTH EFFECT

Acute Exposure

Eye Contact	:	Contact with the eyes directly may result in cold burns or frostbite
Skin Contact	:	Contact with the skin directly may result in cold burns or frostbite
Inhalation	:	Prolonged or repeated exposure, above recommended guidelines, may be absorbed following inhalation and cause target organ effects
Ingestion	:	No health effects are expected
Chronic Exposure	:	While chronic health effects are unknown, person with cardiac, respiratory or central nervous system disorder may be susceptible to the effects of an over exposure. The use of epinephrine or sympathomimetic drugs may increase susceptibility to cardiac irregularities upon exposure.
Carcinogenicity	:	None of the components present in this material at concentrations equal to or greater than 0.1% is listed by IARC, NTP or OSHA as carcinogen.

4. FIRST AID MEASURES

Eye Contact	:	Flush eyes with plenty of water. If sign or symptom persists, get medical attention
Skin Contact	:	Treat frostbite immediately by gently warming the affected area. If sign or symptom persists, get medical attention
Inhalation	:	Move the person to get fresh air. If sign or symptom persists, get medical attention
Ingestion	:	No information available

5. FIRE FIGHTING MEASURES

This is a product of fire extinguishing agent. Fire fighters should wear full protective equipment (Bunker Gear) and self-contained breathing apparatus (SCBA). See Section 10 (STABILITY AND REACTIVITY) for hazardous combustion and thermal decomposition information.

6. ACCIDENTAL RELEASE MEASURES

6.1 PERSONAL PRECAUTIONS, PROTECTIVE EQUIPMENT AND EMERGENCY PROCEDURE

Ventilate the area with fresh air. For large spill, or spills in confined spaces, provide mechanical ventilation to disperse or exhaust vapors, in accordance with good industrial hygiene practice. Warning! A motor could be an ignition source and could cause flammable gases or vapors in the spill area to burn or explode.

6.2 ENVIRONMENTAL PRECAUTIONS

For larger spills, cover drains and build dikes to prevent entry into sewer systems or bodies of water. Place in a metal container approved for transportation by appropriate authorities. Dispose of collected material as soon as possible.

6.3 CLEAN-UP METHOD

Observe precautions from other sections. Contain spill. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Collect as much of the spilled material as possible. Clean up residue. Seal the container.

In the event of a release of this material, the user should determine if the release qualifies as reportable according to local, state, and federal regulations.

7. HANDLING AND STORAGE

7.1 HANDLING

Avoid eye contact with vapors, mists, or spray. Avoid breathing of vapors, mists or spray. Contents may be under pressure, open carefully

7.2 STORAGE

Keep container in well-ventilated area. See incompatibility information in Heading 10 STABILITY AND REACTIVITY. Store in original container. Keep tightly closed until used. There is minimal danger to the environment from a storage release.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 EXPOSURE LIMIT

Chemical Name	TWA Limit
1,1,1,2,3,3,3–Heptafluoropropane	1000 ppm

8.2 EXPOSURE CONTROL

8.2.1 Respiratory Protection

Avoid breathing of vapors, mists or spray
Under normal use conditions, airborne concentrations are not expected to be significant enough to require respiratory protection
If thermal decomposition occurs, wear supplied air respiratory protection (e.g. NIOSH approved respirators, OSHA regulations)

8.2.2 Skin Protection

Use gloves

8.2.3 Eye Protection

While the use of wear safety glass (google) is not mandatory, it is recommended to use it

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Clear, colorless liquefied gas
Odor	:	Odorless
Molecular weight	:	170.03
Boiling point at 760 mm Hg	:	2.7°F (-16.3°C)
Freezing point	:	-204°F (-131°C)
Flash point	:	Not Applicable
pH	:	Not Applicable
Specific gravity (Water = 1)	:	1.46
Solubility in water at 68°F (20°C)	:	260 mg/L
Evaporation rate (Butyl Acetate = 1)	:	No Information Available
Vapor density (Air = 1)	:	6.04
Viscosity	:	No Information Available
Auto-ignition temperature	:	Not Applicable

10. STABILITY AND REACTIVITY

Stability	:	Stable
Conditions to avoid	:	Avoid source of heat and open flame
Materials to avoid	:	Alkali metals, Alkaline earth metals, powdered aluminum or zinc
Hazardous Polymerization	:	Will NOT Occur
Hazardous Decomposition	:	Thermal decomposition may produce hydrogen fluoride, carbon monoxide and carbon dioxide

11. TOXICOLOGICAL INFORMATION

Toxicological Data:

Inhalation 4 hours, LC50 > 788,698 ppm (rats)

12. ECOLOGICAL INFORMATION

12.1 Ecotoxicity

Not determined

12.2 Degradability

Photolytic half-life is 34.2 years

12.1 Bioaccumulative potential

Not determined

12.2 Others

Ozone Depletion Potential : 0
Global Warming Potential : 3,220 for a 100-year time horizon

13. DISPOSAL CONSIDERATIONS

Incinerate in industrial or commercial facility. Facility must be capable of handling halogenated materials.
As a disposal alternative, dispose of waste product in a facility permitted to accept chemical waste. Reclaim if feasible. For information of product return, contact your distributor.

It is strongly recommended to consult and follow the local applicable regulations/authorities for disposal

14. TRANSPORTATION INFORMATION

Hazard Class or Division	: Not hazardous
Label	: No special label required
UN Number	: UN3296

15. REGULATORY INFORMATION

U.S. Federal Regulations

SARA Title III Hazard Classifications under Sections 313

16. OTHER INFORMATION

NFPA HAZARD CLASSIFICATION

Heath	: 1	Reactivity	: 1
Flammability	: 0	Special Hazard	: None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to materials under conditions of fire, spill or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

HMIS HAZARD CLASSIFICATION

Heath	: 1	Reactivity	: 0
Flammability	: 0	PPE	: X *(Section 8)*

Hazardous Material Identification System (HMIS) hazard ratings are designed to inform employees of chemical hazard in the workplace. The provided ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS ratings are to be used with a fully implemented HMIS program.

NFPA/HMIS HAZARD DEFINITION

4 - Severe Hazard
3 - Serious Hazard
2 - Moderate Hazard
1 - Slight Hazard
0 - Minimal Hazard

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

To the best of our knowledge, the information contained herein is accurate. However, the above named manufacturer, supplier or any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

APPENDIX B: List of Part Numbers

MANUALS

LK 79M0227-A	HFC-227ea CLEAN AGENT FIRE SUPPRESSION SYSTEM DESIGN, INSTALLATION, OPERATION AND MAINTENANCE MANUAL

CYLINDER C/W VALVE ASSEMBLIES

(Note: Add "-SS" to the part number when Stainless Steel Valve is used except for 4 inch valve)

LK 7900020-A	20 LBS CYLINDER C/W 1" VALVE ASSEMBLY
LK 7900035-A	35 LBS CYLINDER C/W 1" VALVE ASSEMBLY
LK 7900070-A	70 LBS CYLINDER C/W 1" VALVE ASSEMBLY
LK 7900100-A	100 LBS CYLINDER C/W 1.5" VALVE ASSEMBLY
LK 7900150-A	150 LBS CYLINDER C/W 1.5" VALVE ASSEMBLY
LK 7900250-A	250 LBS CYLINDER C/W 1.5" VALVE ASSEMBLY
LK 7900375-A	375 LBS CYLINDER C/W 2.5" VALVE ASSEMBLY
LK 7900560-A	560 LBS CYLINDER C/W 2.5" VALVE ASSEMBLY
LK 7900800-A	800 LBS CYLINDER C/W 4.0" VALVE ASSEMBLY
LK 7901000-A	1000 LBS CYLINDER C/W 4.0" VALVE ASSEMBLY
LK 7901200-A	1200 LBS CYLINDER C/W 4.0" VALVE ASSEMBLY

CYLINDER BRACKETS AND STRAPS

LK 7911107-W	20,35,70LBS STRAP
LK 7911128-W	100,150LB STRAP
LK 7911160-W	250,375LB STRAP
LK 7911200-W	560 STRAP
LK 7911300-W	800,1000,1200LB WALL STRAP
LK 7911059-F	800,1000,1200LB FLOOR STRAP

LIQUID LEVEL INDICATORS

LK 7912001	150-250LB LIQUID LEVEL INDICATOR
LK 7912002	375-560LB LIQUID LEVEL INDICATOR
LK 7912004	800LB LIQUID LEVEL INDICATOR
LK 7912005	1000LB LIQUID LEVEL INDICATOR
LK 7912006	1200LB LIQUID LEVEL INDICATOR

VALVE ASSEMBLIES

LK 7920010-B	1" BRASS VALVE ASSEMBLY
LK 7920010-SS	1" STAINLESS STEEL VALVE ASSEMBLY
LK 7920015-B	1 ½ " BRASS VALVE ASSEMBLY
LK 7920015-SS	1 ½ " STAINLESS STEEL VALVE ASSEMBLY
LK 7920025-B	2 ½ " BRASS VALVE ASSEMBLY
LK 7920025-SS	2 ½ " STAINLESS STEEL VALVE ASSY
LK 7920040-SS	4 "STAINLESS STEEL VALVE ASSEMBLY

BURST DISC ASSEMBLIES

LK 7923001	1"-20 UNEF BURST DISC
LK 7923102	BURST DISC WITH 1/2" NPT ADAPTER
LK 7923103	BURST DISC WITH 3/4" NPT ADAPTER

SOLENOIDS

LK 7932001	24V 11 WATTS ELECTRIC SOLENOID
LK 7932002	24V 15 WATTS ELECTRIC SOLENOID

PRESSURE SUPERVISORY SWITCHES

LK 7930240-NPT	PRESSURE SUPERVISORY SWITCH 240 PSI (N/C)
LK 7931240-NPT	PRESSURE SUPERVISORY SWITCH 240 PSI (N/O)
LK 7930360-NPT	PRESSURE SUPERVISORY SWITCH 360 PSI (N/C)
LK 7931360-NPT	PRESSURE SUPERVISORY SWITCH 360 PSI (N/O)

PRESSURE GAUGE

LK 7940360-NPT	PRESSURE GAUGE 360 PSI

VALVE CONTROLS

LK 7941101	LOCAL MANUAL CONTROL(LEVER TYPE)
LK 7941102	LOCAL MANUAL CONTROL(PLUNGER TYPE)
LK 7941201	PISTON ACTUATOR

NOZZLES

LK 7952050-2	1/2” NOZZLE 180 (SIDEWALL)
LK 7952050-3	1/2” NOZZLE 360 (CENTRAL)
LK 7952075-2	3/4” NOZZLE 180 (SIDEWALL)
LK 7952075-3	3/4” NOZZLE 360 (CENTRAL)
LK 7952100-2	1” NOZZLE 180 (SIDEWALL)
LK 7952100-3	1” NOZZLE 360 (CENTRAL)
LK 7952125-2	1-1/4” NOZZLE 180 (SIDEWALL)
LK 7952125-3	1-1/4” NOZZLE 360 (CENTRAL)
LK 7952150-2	1-1/2” NOZZLE 180 (SIDEWALL)
LK 7952150-3	1-1/2” NOZZLE 360 (CENTRAL)
LK 7952200-2	2” NOZZLE 180 (SIDEWALL)
LK 7952200-3	2” NOZZLE 360 (CENTRAL)

FLEXIBLE HOSES

LK 7953025-20	1/4" X 20" METAL FLEXIBLE HOSE
LK 7953025-12	1/4" X 12" METAL FLEXIBLE HOSE
LK 7953025-24	1/4" X 24" METAL FLEXIBLE HOSE
LK 7953025-36	1/4" X 36" METAL FLEXIBLE HOSE
LK 7953100	1” NPT FLEXIBLE CYLINDER HOSE
LK 7953150	1-1/2” NPT FLEXIBLE CYLINDER HOSE
LK 7953250	2-1/2” NPT CYLINDER METAL FLEXIBLE HOSE
LK 7953400	4" METAL FLEXIBLE HOSE
LK 7953400-A	4" FLEXIBLE HOSE AND CHECK VALVE ASSY

SHUTTLE VALVES

LK 7954100	1" SHUTTLE VALVE ASSEMBLY
LK 7954150	1-1/2" SHUTTLE VALVE ASEMBLY

CHECK VALVES

LK 7956100	1" CHECK VALVE ASSEMBLY
LK 7956150	1-1/2" CHECK VALVE ASSEMBLY
LK 7956250	2-1/2" CHECK VALVE ASSEMBLY
LK 7956400	4" CHECK VALVE ASSEMBLY C/W REDUCER

CONTROL SWITCHES

LK 7965001	MAIN-RESERVE SELECTOR SWITCH
LK 7965002	PRESSURE OPERATED SWITCH
LK 7965003	ABORT STATION
LK 7966001	WEATHER PROOF MANUAL CONTROL – ELECTRICAL PULL STATION
LK 7966002	PULL STATION FOR LUKE 227
LK 7966003	PULL STATION FOR DOOR RELEASE
LK 7966004	SINGLE ACTION PULL STATION
LK 7965004	RELEASING CIRCUIT DISABLE SWITCH

TESTING AND MAINTENANCE TOOLS

LK 7970010	1” valve service kit
LK 7970015	1 ½” valve service kit
LK 7970025	2 ½” valve service kit
LK 7970040	4” valve service kit
LK 7998003	Zip Tie (Tamper Seal)
LK 7971001	Piston grease fortified
LK 7972010	Recharge adapter for 1” valve
LK 7972015	Recharge adapter for 1 ½” valve
LK 7972025	Recharge adapter for 2 ½” valve
LK 7972040	Recharge adapter for 4” valve
LK 7973010	Hydrostatic test adapter for 1”valve
LK 7973015	Hydrostatic test adapter for 1 ½”valve
LK 7973025	Hydrostatic test adapter for 2 ½”valve
LK 7973040	Hydrostatic test adapter for 4”valve
LK 7974001	Test dowel for solenoid

APPENDIX C: Service Kit Part Numbers

LK 7970010 (1" valve service kit)

LK 7922010-8	*1" Valve Seat*
LK 7925004	*Vent Check*
LK 7925003	*Filter Vent*
LK 7928001	*Schrader Valve*
LK 7997107	*1" Valve Top Plug O-ring*
LK 7997111	*1" Valve to Cylinder O-ring*
LK 7997106	*1" Valve Piston O-ring*

LK 7970015 (1 ½ " valve service kit)

LK 7922015-8	*1½" Valve Seat*
LK 7925004	*Vent Check*
LK 7925003	*Filter Vent*
LK 7928001	*Schrader Valve*
LK 7997111	*1½" Valve Top Plug O-ring*
LK 7997110	*1½" Valve to Cylinder O-ring*
LK 7997116	*1½" Valve Piston O-ring*

LK 7970025 (2 ½ " valve service kit)

LK 7922025-8	*2½" Valve Seat*
LK 7925004	*Vent Check*
LK 7925003	*Filter Vent*
LK 7928001	*Schrader Valve*
LK 7997114	*2½" Valve Top Plug O-ring*
LK 7997113	*2½" Valve to Cylinder O-ring*
LK 7997113	*2½" Valve Piston O-ring*
LK 7997113	*2½" Valve Outlet Adapter O-ring (for brass valve only)*

LK 7970040 (4" valve service kit)

LK 7922040-8	*4" Valve Seat*
LK 7925004	*Vent Check*
LK 7925002	*Valve Filter/Orifice*
LK 7928001	*Schrader Valve*
LK 7997129	*4" Valve Top Plug O-ring*
LK 7997129	*4" Valve Body to Cylinder O-ring*
LK 7997131	*4" Valve Piston O-ring*

APPENDIX D: Factors

APPENDIX D-1: Atmospheric Correction for HFC-227ea

Altitude	Enclosure Pressure	Correction Factor
-3,000 ft (-0.91 km)	16.25 psia (84.0 cmHg)	1.11
-2,000 ft (-0.61 km)	15.71 psia (81.2 cmHg)	1.07
-1,000 ft (-0.30 km)	15.23 psia (78.8 cmHg)	1.04
0	14.71 psia (76.1 cmHg)	1.00
1,000 ft (0.30 km)	14.18 psia (73.3 cmHg)	0.96
2,000 ft (0.61 km)	13.64 psia (70.5 cmHg)	0.93
3,000 ft (0.91 km)	13.12 psia (67.8 cmHg)	0.89
4,000 ft (1.22 km)	12.58 psia (65.1 cmHg)	0.86
5,000 ft (1.52 km)	12.04 psia (62.3 cmHg)	0.82
6,000 ft (1.83 km)	11.53 psia (59.6 cmHg)	0.78
7,000 ft (2.13 km)	11.03 psia (57.0 cmHg)	0.75
8,000 ft (2.43 km)	10.64 psia (55.0 cmHg)	0.72
9,000 ft (2.74 km)	10.22 psia (52.9 cmHg)	0.69
10,000 ft (3.05 km)	9.77 psia (50.5 cmHg)	0.66

APPENDIX D-2: Flooding Factor of HFC-227ea using manual calculation (Metric Unit)

Temp (˚F)	Specific vapor volume (m3/kg)	Weight Requirements of Hazard Volume, W/V (lb/ft^3) Design Concentration (% by Volume)									
		6	7	8	9	10	11	12	13	14	15
10	1.9264	0.0331	0.0391	0.0451	0.0513	0.0570	0.0642	0.0708	0.0776	0.0845	0.0916
20	1.9736	0.0323	0.0381	0.0441	0.0501	0.0563	0.0626	0.0691	0.0757	0.0825	0.0894
30	2.0210	0.0316	0.0372	0.0430	0.0489	0.0550	0.0612	0.0675	0.0739	0.0805	0.0873
40	2.0678	0.0309	0.0364	0.0421	0.0478	0.0537	0.0598	0.0659	0.0723	0.0787	0.0853
50	2.1146	0.0302	0.0356	0.0411	0.0468	0.0525	0.0584	0.0645	0.0707	0.0770	0.0835
60	2.1612	0.0295	0.0348	0.0402	0.0458	0.0514	0.0572	0.0631	0.0691	0.0753	0.0817
70	2.2075	0.0289	0.0341	0.0394	0.0448	0.0503	0.0560	0.0618	0.0677	0.0737	0.0799
80	2.2538	0.0283	0.0334	0.0386	0.0439	0.0493	0.0548	0.0605	0.0663	0.0722	0.0783
90	2.2994	0.0278	0.0327	0.0378	0.0430	0.0483	0.0538	0.0593	0.0650	0.0708	0.0767
100	2.3452	0.0272	0.0321	0.0371	0.0422	0.0474	0.0527	0.0581	0.0637	0.0694	0.0752
110	2.3912	0.0267	0.0315	0.0364	0.0414	0.0465	0.0517	0.0570	0.0625	0.0681	0.0738
120	2.4366	0.0262	0.0309	0.0357	0.0406	0.0456	0.0507	0.0560	0.0613	0.0668	0.0724
130	2.4820	0.0257	0.0303	0.0350	0.0398	0.0448	0.0498	0.0549	0.0602	0.0656	0.0711
140	2.5272	0.0253	0.0298	0.0344	0.0391	0.0440	0.0489	0.0540	0.0591	0.0644	0.0698
150	2.5727	0.0248	0.0293	0.0338	0.0384	0.0432	0.0480	0.0530	0.0581	0.0633	0.0686
160	2.6171	0.0244	0.0288	0.0332	0.0378	0.0425	0.0472	0.0521	0.0571	0.0622	0.0674
170	2.6624	0.0240	0.0283	0.0327	0.0371	0.0417	0.0464	0.0512	0.0561	0.0611	0.0663
180	2.7071	0.0236	0.0278	0.0321	0.0365	0.0410	0.0457	0.0504	0.0552	0.0601	0.0652
190	2.7518	0.0232	0.0274	0.0316	0.0359	0.0404	0.0449	0.0496	0.0543	0.0592	0.0641
200	2.7954	0.0228	0.0269	0.0311	0.0354	0.0397	0.0442	0.0488	0.0535	0.0582	0.0631

APPENDIX D-3: Flooding Factor of HFC-227ea using manual calculation (SI Unit)

Temp (˚C)	Specific vapor volume (m3/kg)	Weight Requirements of Hazard Volume, W/V (kg/m3) Design Concentration (% by Volume)									
		6	7	8	9	10	11	12	13	14	15
-10	0.1215	0.5254	0.6196	0.7158	0.8142	0.9147	1.0174	1.1225	1.2301	1.3401	1.4527
-5	0.1241	0.5142	0.6064	0.7005	0.7987	0.8951	0.9957	1.0985	1.2038	1.3114	1.4216
0	0.1268	0.5034	0.5936	0.6858	0.7800	0.8763	0.9748	1.0755	1.1785	1.2839	1.3918
5	0.1294	0.4932	0.5816	0.6719	0.7642	0.8586	0.9550	1.0537	1.1546	1.2579	1.3636
10	0.1320	0.4834	0.5700	0.6585	0.7490	0.8414	0.9360	1.0327	1.1316	1.2328	1.3264
15	0.1347	0.4740	0.5589	0.6457	0.7344	0.8251	0.9178	1.0126	1.1096	1.2089	1.3105
20	0.1373	0.4650	0.5483	0.6335	0.7205	0.8094	0.9004	0.9934	1.0886	1.1859	1.2856
25	0.1399	0.4564	0.5382	0.6217	0.7071	0.7944	0.8837	0.9750	1.0684	1.1640	1.2618
30	0.1425	0.4481	0.5284	0.6104	0.6943	0.7800	0.8676	0.9573	1.0490	1.1428	1.2388
35	0.1450	0.4401	0.5190	0.5996	0.6819	0.7661	0.8522	0.9402	1.0303	1.1224	1.2168
40	0.1476	0.4324	0.5099	0.5891	0.6701	0.7528	0.8374	0.9230	1.0124	1.1029	1.1956
45	0.1502	0.4250	0.5012	0.5790	0.6586	0.7399	0.8230	0.9080	0.9950	1.0840	1.1751
50	0.1527	0.4180	0.4929	0.5694	0.6476	0.7276	0.8093	0.8929	0.9784	1.0660	1.1555
55	0.1553	0.4111	0.4847	0.5600	0.6369	0.7156	0.7960	0.8782	0.9623	1.0484	1.1365
60	0.1578	0.4045	0.4770	0.5510	0.6267	0.7041	0.7832	0.8641	0.9469	1.0316	1.1183
65	0.1604	0.3980	0.4694	0.5423	0.6167	0.6929	0.7707	0.8504	0.9318	1.0152	1.1005
70	0.1629	0.3919	0.4621	0.5338	0.6072	0.6821	0.7588	0.8371	0.9173	0.9994	1.0834
75	0.1654	0.3859	0.4550	0.5257	0.5979	0.6717	0.7471	0.8243	0.9033	0.9841	1.0668
80	0.1679	0.3801	0.4482	0.5178	0.5890	0.6617	0.7360	0.8120	0.8898	0.9694	1.0509
85	0.1704	0.3745	0.4416	0.5102	0.5803	0.6519	0.7251	0.8000	0.8767	0.9551	1.0354
90	0.1730	0.3690	0.4351	0.5027	0.5717	0.6423	0.7145	0.7883	0.8638	0.9411	1.0202

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