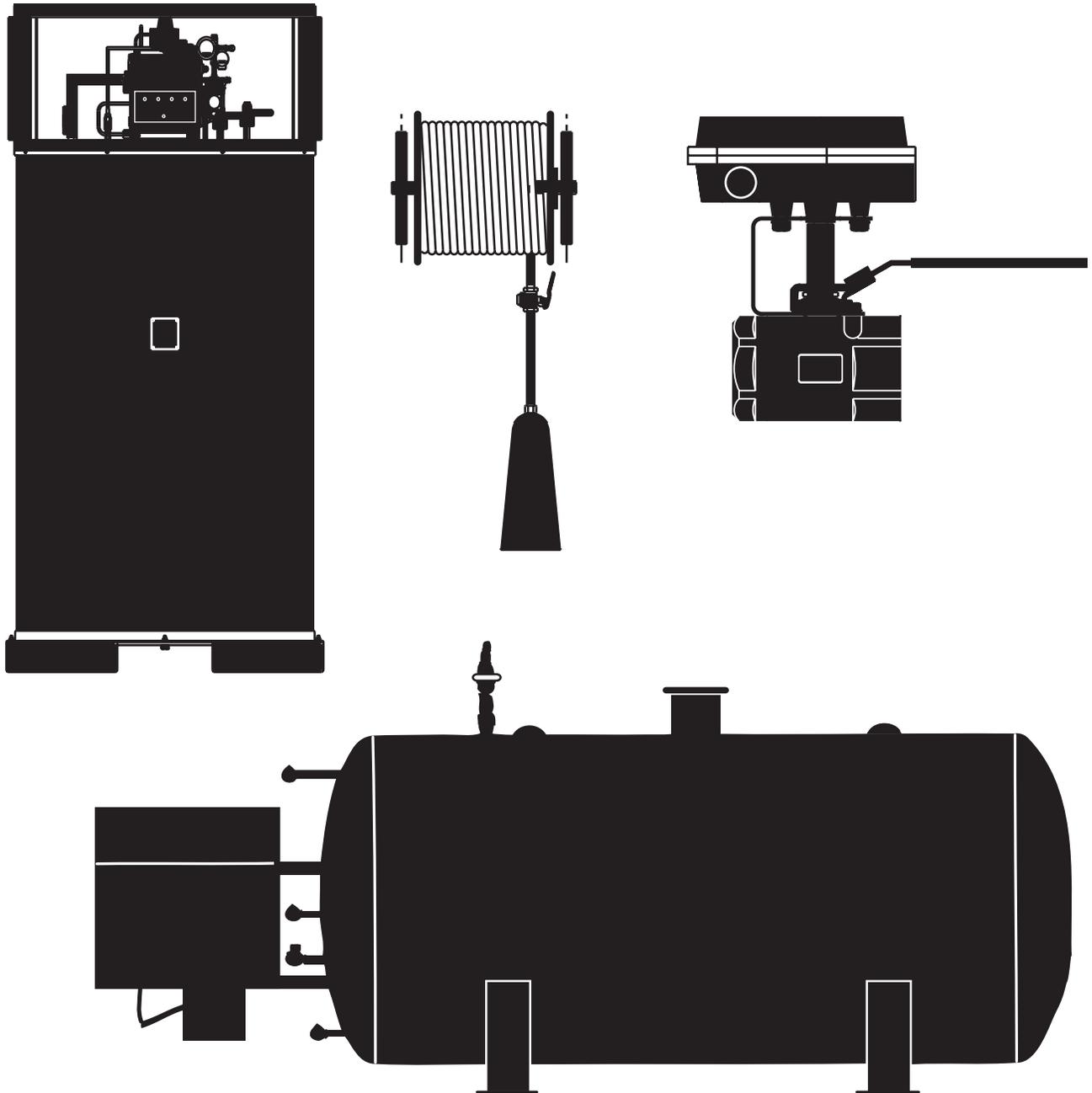


# LOW PRESSURE CARBON DIOXIDE SYSTEMS



## DESIGN, INSTALLATION, RECHARGE, AND MAINTENANCE MANUAL





This manual is intended for use with ANSUL® Low Pressure CO<sub>2</sub> Fire Suppression Systems.

Those who design, install, inspect, operate, or maintain these systems should read the entire manual. Specific sections will be of particular interest depending upon one's responsibilities.

Design, installation and recharge of the system must conform to the limitations detailed in this manual and be performed by an individual who attended an ANSUL Low Pressure training program and became trained to design, install and recharge the ANSUL system.

The system is composed of electrical, mechanical and pneumatic devices, which require periodic care. Maintenance should be conducted at six-month intervals to provide maximum assurance that your fire suppression system will operate effectively and safely. Inspection should be conducted at more frequent intervals to provide assurance that your fire suppression system is charged and operable.

This ANSUL Low Pressure system manual is limited to use with the installations and limitations herein described. For exact details of the piped system and components designed for your hazard, see installation drawings and instructions furnished by Tyco Fire Protection Products, One Stanton Street, Marinette, WI USA 54143, (715) 735-7411.

Part No. 425908-03

Date 2-5-15



**REVISION INDEX**

2-5-15 Page 1

REV. 2

DATE	PAGE	REV. NO.	DATE	PAGE	REV. NO.
2-1-10	1-1	1	2-1-10	2-39	2
2-1-10	2-4	1	2-1-10	2-40	3
2-1-10	2-6	1	2-1-10	2-41	3
2-1-10	2-7	1	2-1-10	2-42	1
2-1-10	2-14	1	2-1-10	2-44	1
2-1-10	2-15	1	2-1-10	2-45	1
2-1-10	2-16	2	2-1-10	2-46	1
2-1-10	2-17	1	2-1-10	2-47	2
2-1-10	2-18	New	2-1-10	2-48	2
2-1-10	2-19	1	2-1-10	2-49	1
2-1-10	2-20	New	2-1-10	2-50	1
2-1-10	2-21	New	2-1-10	Pages 2-47 through 2-50 renumbered	
2-1-10	2-22	1	2-1-10	3-1	1
2-1-10	2-23	4	2-1-10	3-2	1
2-1-10	2-24	2	2-1-10	3-6	1
2-1-10	2-25	2	2-1-10	3-9	1
2-1-10	2-28	New	2-1-10	3-13	1
2-1-10	2-29	2	2-1-10	4-1	1
2-1-10	2-30	2	2-1-10	4-2	1
2-1-10	2-31	3	2-1-10	4-3	1
2-1-10	2-32	2	2-1-10	4-14	1
2-1-10	2-33	2	2-1-10	4-15	1
2-1-10	2-34	2	2-1-10	4-17	1
2-1-10	Pages 2-29 through 2-36 renumbered		2-1-10	4-18	1
2-1-10	2-37	2	2-1-10	4-21	1
2-1-10	2-38	2	2-1-10	4-28	1

**LEGEND FOR MANUAL PAGE** ▶ Indicates revised information.

**REVISION INDICATORS:**

■ Indicates no change to text – change in page sequence only.

**REVISION INDEX**

2-5-15 Page 2

REV. 2

DATE	PAGE	REV. NO.		DATE	PAGE	REV. NO.
2-1-10	4-29	1		8-27-13	4-11	2
2-1-10	4-32	1		8-27-13	4-11.1	New
2-1-10	4-33	1		2-5-15	2-1	2
2-1-10	4-36	1		2-5-15	2-3	2
2-1-10	4-37	1		2-5-15	2-9	2
2-1-10	4-38	1		2-5-15	2-10	2
2-1-10	4-40	1		2-5-15	2-11	3
2-1-10	4-44	1		2-5-15	2-12	5
2-1-10	4-45	1		2-5-15	2-13	4
2-1-10	4-54	1		2-5-15	2-35	New
2-1-10	5-2	1		2-5-15	2-36	Deleted
2-1-10	5-5	1		2-5-15	2-43	3
2-1-10	5-6	1		2-5-15	3-7	1
2-1-10	5-9	1		2-5-15	4-4	3
2-1-10	5-10	1		2-5-15	4-8	2
2-1-11	5-11	1		2-5-15	4-11.2	1
2-1-10	5-12	1		2-5-15	4-19	2
2-1-10	5-13	1		2-5-15	4-20	1
2-1-10	5-14	1		2-5-15	4-26	1
2-1-10	5-15	1		2-5-15	4-31	2
2-1-10	5-16	1		2-5-15	4-39	2
2-1-10	5-17	New		2-5-15	4-41	1
8-27-13	2-26	3		2-5-15	4-43	2
8-27-13	2-27	4		2-5-15	4-49	1
8-27-13	4-5	2		2-5-15	4-50	2
8-27-13	4-6	2		2-5-15	4-51	2

**LEGEND FOR MANUAL PAGE**

► Indicates revised information.

**REVISION INDICATORS:**

■ Indicates no change to text – change in page sequence only.



**REVISION INDEX**

2-5-15 Page 4



A Tyco International Company

## Low Pressure Carbon Dioxide

<u>Section</u>	<u>Form No.</u>	<u>Page No.</u>
<b>INTRODUCTION</b>		<b>1-1 – 1-3</b>
Purpose		1-1
Description		1-1
Properties of Carbon Dioxide		1-1 – 1-2
Quality of Carbon Dioxide		1-3
Safety		1-3
<b>A&amp;E COMPONENT DESCRIPTIONS</b>		<b>2-1 – 2-11</b>
Mini-Bulk Storage Units		2-1 – 2-2
General		2-1
Pressure Vessel Construction		2-1
Safety		2-1
Refrigeration/Operation		2-1 – 2-2
Instrumentation		2-2
Tank Control Box		2-2
Supervisory Relay Options		2-2
Bulk Storage Unit		2-3 – 2-5
Refrigeration System		2-3 – 2-4
Bleeder Valve		2-4
Main Safety Relief Valve		2-4
Liquid Level Gauge		2-4
Pressure Gauge		2-5
Liquid Fill and Vapor Balancing Valves		2-5
Tank Control Box		2-5
Tank Shut-off Valve		2-5
Supervisory Switch		2-5
Manual Gear Actuator		2-5
Master/Selector Valve Assembly		2-6 – 2-7
Master Selector Valves 1/2 in. – 2 in.		2-6
Master Selector Valves 3 in. – 8 in.		2-6
Pneumatic Actuators		2-7
Solenoid Valve		2-7
In-line Filter		2-7
Lock-Out Valve Assembly		2-8
Actuation Line Supervisory Pressure Switch		2-8
Pressure Regulator		2-8
Pressure Relief Valves		2-8
Manifold		2-9
Pressure Trip		2-9
Discharge Pressure Switch		2-9
Check Valves		2-9
Discharge Nozzles		2-9
Hose Reel Units		2-10
Odorizer		2-10
Warning Signs		2-10
Automatic Timer Cabinet		2-10
1/4 in. Shuttle Valve		2-11
Pressure-Operated Siren/Horn		2-11

## TABLE OF CONTENTS

2-5-15 Page 2

REV. 3

<u>Section</u>	<u>Form No.</u>	<u>Page No.</u>
<b>COMPONENT SHEETS</b>		<b>2-12 – 2-51</b>
Mini-Bulk Storage Tanks	F-96132-5	2-12
3 3/4 – 46 Ton Storage Tanks	F-9684-4	2-13
2 in. Short Discharge Hose	F-200133-1	2-14
CGA 450 Fill Adaptor	F-200161-1	2-15
3 in. – 8 in. Tank Shut-Off Valve With Supervisory Switch	F-9690-2	2-16
1/2 in. – 2 in. Selector Valve with Spring Return Actuator Assembly With Solenoid	F-2003086-1	2-17
1/2 in. through 2 in. Selector Valve with Spring Return Actuator Assembly with Time Delay	F-2009083	2-18
3 in. – 8 in. Selector Valve with Spring Return Actuator Assembly With Solenoid	F-2003085-1	2-19
3, 4, 6, and 8 in. Time Delay	F-2009084	2-20
Time Delay	F-2009086	2-21
1/2 in. – 2 in. Selector Valve with Spring Return Actuator Assembly	F-2002223-1	2-22
3 in. – 8 in. Selector Valve with Spring Return Actuator Assembly	F-96139-4	2-23
1/2 in. – 2 in. Lock-Out Valve with Supervisory Switch	F-200165-2	2-24
3 in. – 8 in. Lock-Out Valve with Supervisory Switch	F-9700-2	2-25
Automatic Timer Cabinet	F-200129-3	2-26
Pressure-Operated Siren	F-96141-4	2-27
Pressure-Operated Air Horn	F-2009082	2-28
1/2 in. Pressure Regulator 100 PSI	F-9696-2	2-29
200 PSI Pressure Gauge	F-200131-2	2-30
Pneumatic Hoses and Fittings	F-96147-3	2-31
1/4 in. Shuttle Valve	F-200132-2	2-32
Actuation Line Supervisory Pressure Switch	F-9697-2	2-33
Supervisory Non-Latching Pressure Switch	F-200162-2	2-34
Pressure Switch – 3PDT	F-2015048	2-35
Blank Page	–	2-36
Pressure Switch DPDT – Explosion Proof	F-200111-2	2-37
Pressure Relief Valve	F-200113-2	2-38
1/2 in. – 3 in. Check Valves	F-9835-2	2-39
Odorizer and Nameplate	F-96143-3	2-40
Pressure Trip	F-96140-3	2-41
Radial Nozzle	F-200114-1	2-42
Discharge Nozzle Regular Type	F-200115-3	2-43
4 in. Short Range (SR) Nozzle	F-200116-1	2-44
Discharge Nozzle Type “D”	F-200117-1	2-45
Discharge Nozzle Type “D” (Corrosion Resistant)	F-200118-1	2-46
Hose Reel Stations	F-200163-2	2-47
Electric Manual Release Stations	F-200130-2	2-48
Warning Signs and Plates	F-200127-1	2-49
Nameplates – Main or Reserve	F-200128-1	2-50

<u>Section</u>	<u>Form No.</u>	<u>Page No.</u>
<b>SYSTEM DESIGN</b>		<b>3-1 – 3-20</b>
General		3-1
Total Flood System Design		3-1 – 3-7
Local Application System Design		3-7 – 3-13
Hose Reel System Design		3-13 – 3-14
Estimating Pipe Size		3-15
Examples of Hazard Protection		3-15 – 3-20
<b>INSTALLATION</b>		<b>4-1 – 4-54</b>
General		4-1
Typical Project Schedule		4-2
Review All Documents Pertaining to Installation		4-2
Inspect & Test All Equipment		4-3
Installing Components		4-3 – 4-39
Check-Out And Start-Up Of Refrigeration System		4-39 – 4-40
Initial Filling Of Storage Tank		4-41 – 4-48
Inspection Of The Installation		4-48
Preliminary Test Of System		4-49 – 4-53
Commission Testing		4-53 – 4-55
<b>OPERATION AND SERVICE</b>		<b>5-1 – 5-16</b>
General		5-1 – 5-2
Control Actuation Operation		5-2 – 5-4
Scheduled Maintenance		5-5 – 5-6
Mini-Bulk System Service – Storage Unit		5-6 – 5-7
Bulk System Storage Unit		5-7 – 5-10
Bulk System Tank Shut-Off Valve Assembly		5-10 – 5-11
Discharge Selector Valve Assembly		5-12 – 5-14
Lock-Out Valve Assembly		5-14 – 5-15
Actuation Line Supervisory Pressure Switch		5-15
Bulk System Pressure Regulator		5-16
Mini-Bulk System Pressure Regulator		5-16
Pressure Relief Valve		5-16
Discharge Nozzles		5-16
Hose Reel		5-17
Odorizer		5-17



## Low Pressure Carbon Dioxide

### 1-1 PURPOSE

The intent of this manual is to provide the user with the information necessary to adequately select, operate and maintain the equipment required to protect a specific hazard using a bulk or mini-bulk low pressure carbon dioxide fire suppression system.

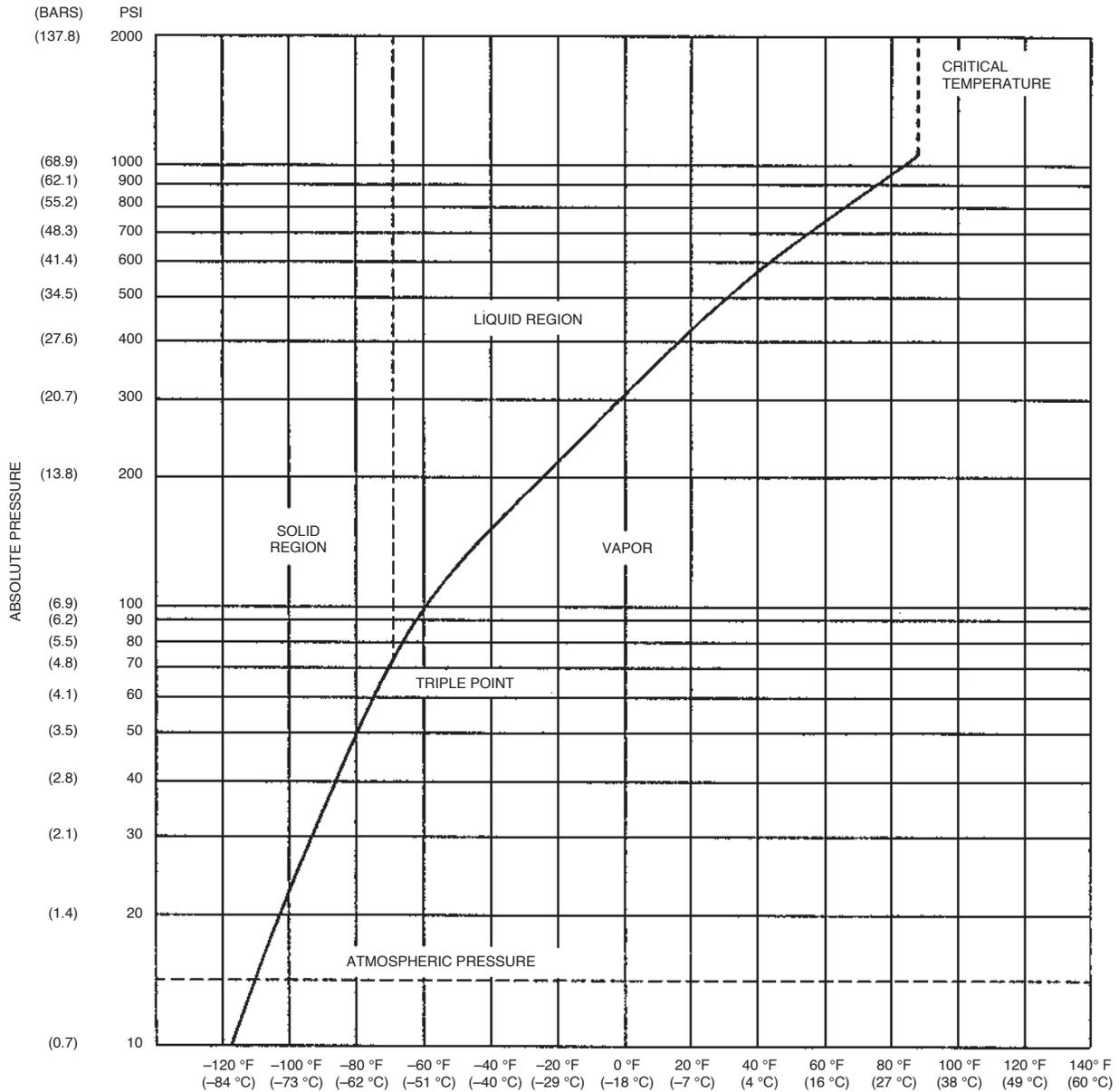
### 1-2 DESCRIPTION

- A. A low pressure CO<sub>2</sub> system is a specialized fire suppression system designed to maintain the carbon dioxide supply at 0 °F (–18 °C) and 300 psi (20.7 bar) in a polyurethane insulated refrigerated pressure container (“Storage Unit”). The storage unit(s) are selected to protect the largest single hazard with the main supply. Back-up discharges required by the authority having jurisdiction are supplied from a larger storage unit or reserve storage unit(s).
- B. Bulk storage units include a tank shut-off valve to provide manual isolation of the storage tank from the piping.
- C. System control valves (selector valves) control the CO<sub>2</sub> flow to a specific hazard in multiple hazard systems through properly sized pipe, terminating in nozzles that apply the CO<sub>2</sub>. Flow rate is controlled by nozzle orifices as well as pipe size.
- D. These system control valves are pressure actuated. The valves are normally closed. They can be automatically and/or manually operated. The valves are available with a factory-installed time delay.
- E. The equipment listed with this low pressure carbon dioxide mini-bulk system has been tested to operate between 0 °F and 110 °F (–18 °C and 43 °C). Bulk systems are tested to operate between 0 °F and 120 °F (–18 °C and 49 °C).
- F. An FM approved releasing panel shall be used to provide automatic actuation that controls the opening of the discharge valve(s) to release the liquid CO<sub>2</sub>. The ANSUL AUTOPULSE system control panel operates the alarm devices, provides shutdown of auxiliary equipment, and supervises all circuits. The control panel also provides a delay so alarms (audible and visual) in the protected area can alert personnel to evacuate before the CO<sub>2</sub> discharges.
- G. The ANSUL Low Pressure CO<sub>2</sub> Automatic Timer Cabinet is an optional pneumatic timer. This device times both the pre-discharge and discharge length. The timer cabinet is activated by a signal from a control panel.

### 1-3 PROPERTIES OF CARBON DIOXIDE

- A. Under normal atmospheric temperature and pressures, carbon dioxide exists as a colorless, odorless gas which is about 1.5 times heavier than air. Carbon dioxide will not burn or support combustion and will not sustain life.
- B. When confined within a suitable pressure vessel and depending on temperature and pressure conditions, carbon dioxide may exist simultaneously as a solid, liquid and gas at a temperature of –69.9 °F (–57 °C) and 60.4 psi (4.2 bar) (see Figure 1-1). This is called the triple point. At temperatures and pressures lower than –69.9 °F (–57 °C) and 60.4 psi (4.2 bar), carbon dioxide may be either a solid or gas, again depending on conditions. Solid carbon dioxide (dry ice) at a temperature of –109.3 °F (–78.5 °C) and atmospheric pressure sublimates (transforms directly from a solid to a gas without the formation of liquid).
- C. The critical point of carbon dioxide is 87.8 °F (31 °C) and 1057.4 psi (72.9 bar). At temperatures and pressures greater than 87.8 °F (31 °C) and 1057.4 psi (72.9 bar), carbon dioxide liquid cannot exist.
- D. At temperatures and pressures above –69.9 °F (–57 °C) and 60.4 psi (4.2 bar), and below 87.8 °F (31 °C) and 1057.4 psi (72.9 bar), carbon dioxide liquid with overlying vapor may exist in equilibrium within a closed vessel. Within this range, there is a definite relationship between temperature, pressure and density.
- E. By comparing the pressure and liquid density at 70 °F (21 °C) (837.8 psi and 47 lb per cubic foot (57.8 bar and 753 kg per cu m)), with the pressure and density at 0 °F (–18 °C) (291.1 psi and 63.65 lb per cubic foot (20.1 bar and 1020 kg per cu m)), it is obvious that relatively large quantities of carbon dioxide liquid can be stored in relatively small, thin walled pressure vessels, hence, low pressure storage of CO<sub>2</sub> (see Figure 1-1).
- F. The term “low pressure” relates to the pressure the CO<sub>2</sub> is stored as compared to high pressure cylinder storage. The normal operating pressures range from 295 psi to 305 psi (20.3 bar to 21.0 bar).

1-3 PROPERTIES OF CARBON DIOXIDE (Continued)



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Figure 1-1 Variation of Pressure of Carbon Dioxide with Change in Temperature (Constant Volume). Below the critical temperature (87.8 °F) (31 °C), carbon dioxide in a closed container is part liquid and part gas. Above the critical temperature it is entirely gas.

**Figure 1-1**  
Vapor Pressure Curve

#### 1-4 QUALITY OF CARBON DIOXIDE

Carbon dioxide used for initial supply and replenishment shall be of good commercial grade, **free of water and other contaminants** that might cause container corrosion or interfere with free discharge through nozzle orifices. Carbon dioxide obtained by converting dry ice to liquid will not be satisfactory unless it is properly processed to remove excess water and oil. The vapor phase shall be not less than 99.5 percent carbon dioxide with no detectable off-taste or odor. The water content of the liquid phase shall be not more than 0.01 percent by weight (–30 °F (–34 °C) dew point). Oil content shall be not more than 10 PPM by weight.

#### CAUTION

Carbon Dioxide should not be used to protect the following hazards:

1. Chemical compound such as gunpowder or cellulose nitrate which supply their own oxygen.
2. Reactive materials such as sodium, potassium, magnesium, titanium, zirconium, uranium and plutonium.
3. Metal hydrides.
4. Chemicals capable of undergoing auto thermal decomposition (hydrazine and certain organic peroxides).

#### 1-5 SAFETY

#### WARNING

The discharge of carbon dioxide into an enclosed space can create a dangerous oxygen deficiency. It can also reduce visibility to a point where exits are difficult to locate by persons attempting to evacuate the area.

Any use of carbon dioxide in an occupied space should provide for the prompt evacuation of personnel and resuscitation of anyone trapped in the hazard area. Time delays, training, signs, alarms, and breathing apparatus should be provided to the personnel involved.

- A. Pressure Hazard** – The storage tanks covered in this manual may contain pressures up to 350 psi (24 bar/ 2413 kPa). Sudden release of this pressure may cause personal injury by issuing cold gas or liquid, or by expelling parts during servicing. Do not attempt any repairs on these tanks until all pressure is released and the contents have been allowed to vaporize to ensure no pressure buildup can occur.
- B. Extreme Cold** – Cover Eyes and Exposed Skin – Accidental contact of the skin or eyes with carbon dioxide may cause a freezing injury similar to frostbite. Protect your eyes and cover your skin when handling the tank or transferring liquid, or in any instance where the possibility of contact with liquid, cold pipes and cold gas may exist. Safety goggles or a face shield should be worn when withdrawing liquid or gas. Long-sleeved clothing and gloves that can be easily removed are recommended for skin protection.
- C. Keep Equipment Well Ventilated** – Although carbon dioxide is non-toxic and non-flammable, it can cause asphyxiation in a confined area without adequate ventilation. An atmosphere of carbon dioxide does not contain enough oxygen for breathing and will cause dizziness, unconsciousness, or even death. Carbon dioxide cannot be detected by the human senses and will be inhaled normally as if it were air. Ensure there is adequate ventilation where carbon dioxide is used and store tanks in a well ventilated area.
- D. Relief Valves** – When installing piping or extending fill lines, to eliminate the possibility of trapped pressure, make certain a suitable safety relief valve is installed in each section of piping between shut-off and lockout valves. Trapped liquefied gas will expand as it warms and may burst hoses or piping causing property damage or injury to personnel.



## Low Pressure Carbon Dioxide

### 2-1 MINI-BULK STORAGE UNITS

#### 2-1.1 General

The storage units are available in 800, 1000 and 1500 lb (363, 454 and 680 kg) capacities.

Each unit is shipped from the factory complete with:

- CO<sub>2</sub> storage vessel
- Pressure and liquid level indication gauges
- 120 VAC, single phase, 60 hz refrigeration system (compressor, fan, motor, pressure switches, etc.) (voltages of 220V, single phase, 50/60 hz requires customer supplied transformer)
- Safety relief valves
- Storage unit function control valves
- ▶ • Lock-out valve with supervisory switch
- ▶ • Pressure regulator and gauges
- ▶ • Actuation line supervisory pressure switch

The mini-bulk storage unit(s), when piped and wired to other related system components, constitute the CO<sub>2</sub> fire protection system. Related system components may include: check valves, discharge nozzles, discharge pressure switch and indicator, manifold, hose reels, warning signs and devices, system control panel, brackets, detection devices, and electrical release.

Part numbers for all components are listed on individual component sheets in this section.

#### 2-1.2 Pressure Vessel Construction

The pressure vessel is built in accordance with Section 8, Division I of the ASME Code for Unfired Pressure Vessels having a maximum allowable working pressure of 350 psi (24.1 bar).

#### 2-1.3 Safety

The pressure vessel is protected from being subject to pressures greater than the maximum allowable working pressure by means of an ASME approved safety relief valve.

#### 2-1.4 Refrigeration/Operation

Because of the relationship between temperature and pressure, carbon dioxide is most efficiently stored as a liquid at approximately 0 °F (–18 °C). This temperature corresponds with an approximate pressure of 300 psi (20.7 bar). The storage unit is designed to maintain carbon dioxide as a liquid at this approximate pressure regardless of outside influences such as ambient temperature, etc. Generally, ambient air is warmer than 0 °F (–18 °C), therefore the storage unit will be absorbing heat. To minimize the heat entry, the storage unit is polyurethane insulated.

Since liquid carbon dioxide is heavier than carbon dioxide vapor, the liquid accumulates on the bottom of the storage unit. The space inside the storage unit between the liquid level and the top of the storage unit contains carbon dioxide vapor. Maintaining a consistent optimum pressure is accomplished by incorporating a refrigeration system that automatically comes on when the pressure reaches approximately 305 psi (21.0 bar). The refrigerant is circulated through coils in the vapor space. The vapor is cooled to the point where it condenses back to liquid, thereby lowering the pressure. When the pressure is lowered to approximately 295 psi (20.3 bar), the refrigeration shuts off.

The refrigeration system has several major components:

1. The expansion valve to regulate the refrigerant R134A flow into the coils in the storage unit.
2. The evaporation coils in the storage unit.
3. The R134A compressor.
4. The condenser coil to remove heat from the R134A refrigerant.
5. The fan motor and fan.
6. The storage unit control box to operate the preceding system.

## SECTION 2 – SYSTEM COMPONENTS

9-1-03 Page 2-2

### 2-1 MINI-BULK STORAGE UNITS (Continued)

#### 2-1.4 Refrigeration/Operation (Continued)

The refrigeration system uses basic refrigeration principles to control the temperature of the carbon dioxide vapor inside the storage unit. The evaporator coil is located in the vapor space inside the storage unit. Liquid refrigerant passes through the evaporator coil and vaporizes as heat is absorbed from the carbon dioxide vapor. The carbon dioxide vapor condenses and drips into the carbon dioxide as heat is removed, lowering the pressure inside the storage unit.

When the refrigerant vapor leaves the evaporator coil, it must be increased in pressure. This is accomplished by the R134A refrigerant compressor, which boosts the pressure and also adds heat due to the heat of compression.

High pressure and high temperature refrigerant vapor from the compressor must be changed to a liquid before it can be used again to cool the carbon dioxide vapors. This change of state is accomplished inside the condenser. As the refrigerant vapor travels through the condenser coils, it is cooled by atmospheric air, which is circulated over the coils by a fan. This transfer of heat causes the refrigerant to condense into a liquid inside the condenser coils.

Refrigerant leaving the condenser coils is in a liquid state at a pressure too high to vaporize properly inside the evaporator coils. The refrigerant pressure must be lowered before it can be used properly. The expansion valve is an automatically adjusted metering device that lowers the pressure of the refrigerant by passing it through a metering orifice. As the refrigerant passes through this metering orifice, it expands, which lowers the pressure and causes a small amount of refrigerant to vaporize.

At this point, the lower pressure refrigerant is ready to enter the evaporator and start the cycle again.

Control of this refrigeration system is accomplished by monitoring the pressure inside the carbon dioxide storage unit. When the pressure inside the storage unit reaches approximately 305 psi, the Refrigeration System Pressure Switch Controller transfers, which causes the Compressor to start and refrigerant is circulated through the system. When the carbon dioxide is cooled to the extent that storage unit pressure is reduced to approximately 295 psi (20.3 bar), the Refrigeration System Pressure Switch Controller opens and the Compressor stops circulating refrigerant.

#### 2-1.5 Instrumentation

Each storage unit is equipped with a liquid level and two (2) pressure gauges. The pressure gauge scale is calibrated in pounds per square inch with a range of 0-600 psi (0-41.4 bar) for storage unit pressure and 0-200 psi (0-13.8 bar) for the actuation line. Indication is provided when the tank pressure is above 315 psi (21.7 bar) or below 250 psi (17.2 bar). The actuation line is provided with a pressure switch to indicate low actuation line pressure below 80 psi (5.5 bar).

#### 2-1.6 Tank Control Box

Each storage unit has a control box containing the high tank pressure, low tank pressure, and the actuation line pressure switches. The front of the box contains the following advisory lights:

- A.C. power.
- High tank pressure.
- Low tank pressure.
- Low actuation line pressure.

The front of the box also contains the following:

- Audible warning device.
- Silence button.

#### 2-1.7 Supervisory Relay Options

Each storage unit control box is provided with relays to monitor:

- High tank pressure, above 315 psi (21.7 bar).
- Low tank pressure, below 250 psi (17.2 bar).
- Actuation line low pressure, below 80 psi (5.5 bar).
- Loss of AC power.

## ▸ 2-2 BULK STORAGE UNIT

The following section is comprised of the most commonly used components. If a specialty component is required, consult Technical Services for availability.

- A. Capacity – Short tons, 2000 lb (97 kg)
  - 1. Horizontal – 3 3/4 Ton through 46 Ton
  - 2. Vertical (optional) – 6 Ton through 34 Ton (not listed for use with FM Approved systems)
- B. All horizontal storage units are provided with saddles.
- C. All piping, except instrumentation, is black schedule 80 A106 or A53-B seamless, fittings are screw type 2000 lb forged steel and valves are ball type. Instrumentation lines are copper refrigeration tubing. Flanged discharge outlet is ANSI 300 lb class.
- D. The pressure vessel is insulated with a minimum of 4 in. (102 mm) of urethane foam insulation (classified UL723 maximum flame spread of 25) having a thermal conductivity not greater than 0.03 BTU per square foot of surface area per hour per degree Fahrenheit temperature difference. The insulation is covered with a white aluminum housing. All overlapping seams are sealed with a silicone sealant.
- E. The storage units are equipped with the same basic type of components and controls, and differ only in storage capacity.
- F. The storage units consist of a fully insulated pressure vessel protected with an aluminum housing, refrigeration system, relief valve, pressure and liquid level gauges, fill connections and various process connections.
- G. The pressure vessel is designed, built and tested to meet code requirements for ASME unfired pressure vessels, Section VIII Division I. All design parameters are stamped on the nameplate. The maximum allowable working pressure is 350 psi (24.1 bar). All vessels are hydrostatically tested to 525 psi (36.2 bar).
- H. The refrigeration system automatically maintains the carbon dioxide at approximately 0 °F (–17.8 °C) and a corresponding vapor pressure of 300 psi (20.7 bar). The system consists of a low temperature, air cooled condensing unit and automatic controls.
- I. The hermetic condensing unit consists of a compressor, cooling fan, condensing coils, and receiver tank. The refrigeration coil consists of the patented manifolded U-tube design to greatly increase the efficiency of the system.
- J. The refrigeration system is automatically controlled by the pre-wired storage unit control box designed to maintain proper operating pressure. The control box consists of pressure switches to start and stop the refrigeration system and to send a signal to the control panel in case of high or low tank pressure.

### 2-2.1 Refrigeration System

- A. Because of the relationship between temperature and pressure, carbon dioxide is most efficiently stored as a liquid at approximately 0 °F (–18 °C). This temperature corresponds with an approximate pressure of 300 psi (20.7 bar). The storage unit is designed to maintain carbon dioxide as a liquid at this approximate pressure regardless of outside influences such as ambient temperature, etc. Generally, ambient air is warmer than 0 °F (–18 °C), therefore the storage unit will be absorbing heat. To minimize the heat entry, the storage unit is polyurethane insulated.

Since liquid carbon dioxide is heavier than carbon dioxide vapor, the liquid accumulates on the bottom of the storage unit. The space inside the storage unit between the liquid level and the top of the storage unit contains carbon dioxide vapor.

## SECTION 2 – SYSTEM COMPONENTS

2-1-10 Page 2-4

REV. 1

### 2-2 BULK STORAGE UNIT (Continued)

#### 2-2.1 Refrigeration System (Continued)

The refrigeration system has several major components:

1. The expansion valve to regulate the refrigerant R404A flow into the coils in the storage unit.
  2. The evaporation coils in the storage unit.
  3. The R404A compressor.
  4. The condenser coil to remove heat back from the R404A refrigerant.
  5. The fan motor and fan.
  6. The tank control box to operate the preceding system.
    - The fan motor and fan.
    - The automatic controls to operate the system.
- B. Bulk storage unit refrigeration systems are similar to the Mini-Bulk systems except that they use R404A refrigerant and also employ additional controls to provide a “pump-down” cycle for the refrigeration system. This “pump-down” cycle returns most of the refrigerant to the Expansion Tank during the off cycle.
- C. During the refrigeration cycle, when pressure inside the storage unit reaches 305 psi (21 bar), the Refrigeration System Pressure Switch Controller transfers, which opens a Solenoid Valve. This causes an increase in the suction line pressure to the Compressor. A Compressor Pressure Switch Controller senses this increase and starts the Compressor to begin the refrigeration cycle. When carbon dioxide inside the storage unit is cooled to the extent that storage unit pressure is reduced to approximately 295 psi (20.3 bar), the Refrigeration System Pressure Switch Controller opens causing the Solenoid Valve to close. As pressure in the suction line to the Compressor drops to approximately 8 psi (0.55 bar), the Compressor Pressure Switch Controller transfers and shuts off power to the Compressor.
- D. Occasionally there may be a need to build vapor pressure, if for example, the ambient temperature is less than  $-10\text{ }^{\circ}\text{F}$  ( $-23\text{ }^{\circ}\text{C}$ ) for a prolonged period of time, or if the end use primarily involves removing vapor from the storage unit. An optional pressure building system removes liquid carbon dioxide from the storage unit, heats it by one or more methods (electric heating elements, steam, or water), and returns the heated vapor to the storage unit (not listed for use with FM Approved systems). Pressure switches provide automatic operation of the system.
- E. The front panel of the storage unit contains a pressure gauge and a liquid level gauge. These measure the liquid contents of the storage unit, in pounds, and kilograms, and the pressure inside the storage unit, in pounds-per-square-inch and kilopascals. The gauges are non-electric and continue to work if the power is lost.
- F. The storage units are provided with a series of vapor pressure relief valves that are designed to vent the vapor pressure should the storage units be without electrical power to operate the refrigeration system for an extended period of time.

#### 2-2.2 Bleeder Valve

The bleeder valve is set to open at a pressure of 330 psi (22.8 bar). When the storage unit pressure slowly rises, the bleeder valve will open and allow the carbon dioxide vapor to escape from the vessel. If the pressure continues to rise, the bleeder valve will continue to open allowing additional carbon dioxide to escape. If the pressure continues to rise, the main safety relief valve will open. If the storage unit is located in an enclosed space, the valve should be piped to an outside volume sufficient to prevent collecting which creates a serious hazard to personnel, such as suffocation or reduced visibility.

#### 2-2.3 Main Safety Relief Valve

The pressure vessel is protected from being subject to pressures greater than the maximum allowable working pressure by means of an ASME approved direct spring loaded or pilot operated safety relief valve, set to open at a pressure of 350 psi (24.1 bar). Relief valves are sized for inside installation, which are the more stringent requirements. If the storage unit is located in an enclosed space, the valve should be piped to an outside volume sufficient to prevent collecting which creates a serious hazard to personnel, such as suffocation or reduced visibility.

#### 2-2.4 Liquid Level Gauge

The 6 in. liquid level gauge is a differential pressure indicator that measures the height of the liquid inside the storage unit by measuring the pressures at the top and the bottom; the net result is a pressure in direct proportion to the height of the liquid. The gauge is graduated in thousands of pounds  $\text{CO}_2$ .

## 2-2 BULK STORAGE UNIT (Continued)

### 2-2.5 Pressure Gauge

The 6 in. pressure gauge is calibrated from 0 to 600 psi (0 to 41.4 bar). Service or replacement of pressure gauge parts should not be attempted. In case of damage or faulty operation of the gauge, the entire gauge should be replaced.

### 2-2.6 Liquid Fill And Vapor Balancing Valves

The 1 1/2 in. liquid fill and 1 in. vapor valves are ball valves. The valves are coupled to CGA fittings.

### 2-2.7 Tank Control Box

A. Pressure control is provided to control the starting and stopping of the compressor to maintain storage unit pressure at between 295 and 305 psi (20.3 and 21 bar). The compressor will start when storage unit pressure increases to 305 psi (21 bar), and stop when storage unit pressure is lowered to 295 psi (20.3 bar).

B. Two pressure switches are provided to activate when the storage unit pressure increases above 315 psi (21.7 bar) or decreases below 250 psi (17.2 bar).

C. Supervisory Conditions

All storage units are provided with contacts to monitor:

- High pressure.
- Low pressure.
- Power failure to compressor.

All storage units can be provided with optional contacts to monitor:

- Low liquid level.
- High liquid level.

## 2-3 TANK SHUT-OFF VALVE – 3 IN., 4 IN., 6 IN. & 8 IN.

A. A manually operated butterfly valve located between the dip tube and discharge header is maintained in the open position. Closing this valve takes the system out of service. The valve position should be continuously monitored at the control panel and is equipped with a means to lock the valve in the open or closed position. The valve can also serve as a lock-out device as required by NFPA 12.

B. The tank shut-off valve is a high performance butterfly type valve. It is equipped with a gear driven manual actuator and is normally maintained in the fully open position. The valve carries a Class 300 ANSI rating. The valve body is carbon steel while the valve stem and disc are stainless steel. The valve seat and packing are Teflon. Special backing materials in the seat compensate for the tendency of Teflon to “cold flow” over a period of time. The valve can be installed in either direction; however, installation with the seat retainer upstream will give longer service life.

C. Each tank shut-off valve is factory tested to be bubble tight at 300 psi (20.7 bar).

D. The bolt pattern on the lugged valve body conforms to standard Class 300 ANSI flange ratings. The design of this valve provides high strength, light weight and easy operation. The light weight design allows for easy installation while the compact design is particularly advantageous when space is limited.

### 2-3.1 Supervisory Switch

Each tank shut-off valve can be equipped with a monitoring switch to provide constant supervision of the position of the valve at the control panel. In addition to the two S.P.D.T. contacts the switch is equipped with a high visibility position monitor that displays the position of the valve.

### 2-3.2 Manual Gear Actuator

The manual gear actuator is designed for use with a 90 degree butterfly valve. In the actuator, torque is transmitted from the hand wheel through the hand wheel input shaft to a worm and drive sleeve gear sector. The worm and drive sleeve gear multiplies the torque and transmits it to the valve shaft. The gear actuators are equipped with a position indicator to indicate the position of the valve.

## SECTION 2 – SYSTEM COMPONENTS

2-1-10 Page 2-6

REV. 1

### 2-4 MASTER/SELECTOR VALVE ASSEMBLY

- ▶ A. ANSUL Low Pressure CO<sub>2</sub> valves may be used in various locations in the fire suppression system. Therefore, the valve name is derived from the location of the valve within the system. The terms master and selector will be used to describe location of the valve in the system. The valves will be only available as a factory assembled unit complete with valve, brackets, couplings, actuator, manual override and solenoid assembly.
- B. MASTER VALVE – When the valve is used as a master valve, it is located at the storage unit and controls the flow of carbon dioxide to one or more selector valves. In this position, the valve is constantly under pressure and the solenoid is normally de-energized. If there is loss of power, the valve will remain closed.
- C. SELECTOR VALVE – When the valve is used as a selector valve, it is located near the hazard area and controls the flow of carbon dioxide into a specific hazard. When the master valve is opened, it will permit carbon dioxide to flow through the system up to the selector valve. Selector valves can also be located on the main header to serve different hazards. Each selector valve remains closed until actuated by its associated control function.
- D. MASTER/SELECTOR VALVE – When the valve is used as a master/selector valve, it is located at the storage unit and controls the flow of carbon dioxide directly to a single hazard.
- E. The valves are of the same design, regardless of its use in the system. The valves consist of ball valves in 1/2 in. through 2 in. and butterfly valves in 3 in. through 8 in. The valve actuators are of the “fail-safe” design whereby loss of actuation pressure will not cause the valves to open. Upon activation of the solenoid the pneumatic actuators will be pressurized causing the valves to open. The valves are also equipped with a manual override to open the valves in the event the valves fail to operate under normal conditions.
- ▶ F. All of the ANSUL Low Pressure CO<sub>2</sub> pressure operated master and selector valves are capable of being manually operated. By means of the override, the discharge valves may still be operated even if control power to the system is lost.



#### WARNING

The selector valves shall be installed in an easily accessible location to allow operation of the emergency mechanical operator. The valves shall not be exposed to the protected area.

#### 2-4.1 Master/Selector Valves – 1/2 In. Through 2 In.

- A. Electric/Pneumatic operated valves in the 1/2 in., 3/4 in., 1 in., 1 1/4 in., 1 1/2 in. and 2 in. sizes are of the ball valve type. Each valve is equipped with an electric/pneumatic actuator designed to function with CO<sub>2</sub> pressure.
- B. The valve body, the stem, and the ball are stainless steel. The valves are rated to a minimum working pressure of 1000 psi (68.95 bar). Each valve is factory tested and shown to be leak proof and bubble tight at 300 psi (20.7 bar).

#### 2-4.2 Master/Selector Valves – 3 In. Through 8 In.

- A. The design of the 3 in., 4 in., 6 in. and 8 in. butterfly valves are similar to that of the tank shut-off valve body. Each valve is equipped with a double acting or spring return electric/pneumatic actuator. The valves are designed to be bolted between two Class 300 ANSI flanges with appropriate gasketing. These valves can be easily installed without the need for costly rigging equipment.
- B. The valves carry a Class 300 ANSI rating. Each valve is factory tested to be bubble tight at 300 psi (20.7 bar). The valve body is carbon steel while the valve stem and disc are stainless steel. The valve seat and packing are Teflon. The valve seat contains a special backing material to compensate for any tendency of the Teflon to “cold flow” over a period of time. The stem seals are reinforced to compensate for seal wear.

**2-4 MASTER/SELECTOR VALVE ASSEMBLY (Continued)****2-4.3 Pneumatic Actuators****2-4.3.1 Introduction**

- A. The rack and pinion design provides constant torque in the double acting version, as required in some valve types and a linear characteristic in the spring return version.
- B. The actuators are equipped with low friction seals consisting of “O” rings with Teflon rings which do not require frequent lubrication.
- C. Manual operation of the actuator is provided by a pneumatic override feature of the solenoid valve. To operate the override feature, remove the ring pin, push the knob in and rotate the knob clockwise 90° to lock the valve open. To close the valve, rotate the knob counterclockwise 90°.

**2-4.3.2 Description**

- A. The spring return actuator is housed in an anodized, extruded aluminum alloy housing, with a steel drive shaft, rack and pinion with spring return. It is pressure operated in one direction, which compresses the spring. Upon venting the actuator, the valve closes. The actuation is designed for 80 psi (5.5 bar) service, and should not be subjected to pressures above 150 psi (10.3 bar).
- B. The double-acting actuator is housed in an anodized, extruded aluminum housing with a steel drive shaft and rack and pinion drive mechanism. It is pressure operated in both directions. The actuator is designed for 80 psi (5.5 bar) service, and should not be subjected to pressures above 150 psi (10.3 bar).
- C. Manual operation of the actuator is provided by a pneumatic override feature of the solenoid valve. To operate the override feature, remove the ring pin, push the knob in and rotate the knob clockwise 90° to lock the valve open. To close the valve, rotate the knob counterclockwise 90°.

**2-4.4 Solenoid Valve**

- A. The solenoid valve is a 24 VDC normally closed valve drawing less than 0.5 amps. When the solenoid is energized, pneumatic pressure is directed through the valve body, directly into the pneumatic actuator or through a time delay assembly, if equipped, to open the master/selector valve. After the solenoid is de-energized, the solenoid valve redirects or exhausts the pressure in the pneumatic actuator and closes the appropriate valve. The exhaust port on the solenoid valve is provided with a filter.

**CAUTION**

Clogging of this filter will adversely affect the performance of the solenoid valve. Inspect and replace on a regular basis.

- B. A solenoid valve is a combination of two basic functional units:
  1. A solenoid (electro-magnet) with its core.
  2. A valve body containing one or more orifices.
- C. Standard solenoid valves have a NEMA Type 4 rating.
- D. Valves are available for use in hazardous locations, Class I, DIV I Groups A, B, C or D; Class 2 DIV I Groups E, F and G (not listed for use with FM Approved systems).

**2-4.5 In-Line Filter**

An in-line filter is provided with each electro-pneumatically controlled master or selector valve in the pneumatic actuation line before the solenoid. The filter cartridge should be checked and replaced periodically if necessary.

## SECTION 2 – SYSTEM COMPONENTS

9-1-03 Page 2-8

### 2-5 LOCK-OUT VALVE ASSEMBLY

A manually operated lock-out valve located in the discharge supply line inhibits the discharge of CO<sub>2</sub>. The valve shall be maintained in the open position. Closing this valve takes the system out of service. The valve is equipped with a pad locking device to lock the valve in the open or closed position. The valve position is continuously monitored at the system control panel by a supervisory switch.

#### 2-5.1 Lock-Out Valves – 1/2 In. Through 2 In.

- A. Manually operated valves in the 1/2 in., 3/4 in., 1 in., 1 1/4 in., 1 1/2 in. and 2 in. sizes are of the ball valve type. Each valve is equipped with a lever actuator and is normally maintained in the fully open position.
- B. The valve body, valve stem, and ball are stainless steel. The valves are rated to a working pressure of 1000 psi (68.9 bar) WOG. Each valve is factory tested and shown to be leak proof and bubble tight at 300 psi (20.7 bar).

#### 2-5.2 Lock-Out Valves – 3 In. Through 8 In.

- A. The design of the 3 in., 4 in., 6 in. and 8 in. butterfly valves are similar to that of the tank shut-off valve. Each valve is equipped with a manual actuator and is normally maintained in the fully open position. The valves are designed to be bolted between two Class 300 ANSI flanges with appropriate gasketing.
- B. The valves carry a Class 300 ANSI rating. Each valve is factory tested to be bubble tight at 300 psi (20.7 bar). The valve body is carbon steel while the valve stem and disc are stainless steel. The valve seat and packing are Teflon. The valve seat contains a special backing material to compensate for any tendency of the Teflon to “cold flow” over a period of time. The stem seals are reinforced to compensate for seal wear. The valve can be installed in either direction; however, installation with the seat retainer upstream will give longer service life.

#### 2-5.3 Supervisory Switch

Each lock-out valve is equipped with a monitoring switch to provide constant supervision of the position of the valve at the control panel. In addition to the two SPDT contacts the switch is equipped with a high visibility position monitor that displays the position of the valve.

### 2-6 ACTUATION LINE SUPERVISORY PRESSURE SWITCH

A self restoring pressure switch is installed in the pneumatic actuation line. A contact will transfer upon loss of pneumatic pressure below 80 psi (5.5 bar). This conforms to the NFPA 12 requirement for pilot line supervision for low pressure CO<sub>2</sub> systems.

### 2-7 PRESSURE REGULATOR

The pressure regulator is installed in the pneumatic actuation line. The 300 psi (20.7 bar) tank pressure is reduced to a nominal 100 or 110 psi (6.9 or 7.6 bar) operating pressure for the pneumatic actuation (pilot) supply to the discharge valves. The regulator is installed on a vapor supply connection on the top of the storage tank.

### 2-8 PRESSURE RELIEF VALVES

There are two (2) styles of pressure relief valves that will be provided with the system. A 150 psi (10.3 bar) pressure relief valve is installed in the actuation line at any point between the regulator and the supervisory pressure switch. A 350 psi pressure relief valve is included for excessive pressure in the tank. In addition, a 450 psi (31.0 bar) pressure relief valve should be installed within the closed system distribution piping network, where trapped CO<sub>2</sub> pressure could exist. The pressure relief valves are equipped with a filter to prevent blockage of the relief port. Additional pressure relief valves can be installed in any section of closed pipe.



Clogging of this filter will adversely affect the performance of the relief valve.

### ▶ 2-9 MANIFOLD

The system manifold is part of the discharge piping and provided by others. Manifold requirements are covered in the installation section of this manual. In all systems using selector valves, a 450 psi (31.0 bar) relief valve must be used. Tanks connected to a common manifold must be of the same size. A check valve shall be installed after each storage tank in multiple tank systems. Refer to Section 2-12.

### ▶ 2-10 PRESSURE TRIP

The function of the pressure trip is to set off a counter weight or spring-loaded mechanical device which closes dampers, doors, or windows upon actuation of the system.

### ▶ 2-11 DISCHARGE PRESSURE SWITCH

The discharge pressure switch can be used to activate alarms for system discharge annunciation or to shut down ventilation and other equipment.

Pressure switches operate from system pressure upon discharge to energize or de-energize operated equipment.

Discharge pressure switches should be piped from a connection in the discharge supply line after the discharge or selector valve. One switch should be provided for each hazard zone protected.

### ▶ 2-12 CHECK VALVES

A. A check valve shall be installed after each mini-bulk storage tank when multiple tanks are used when a remote fill is not connected. The check valve prevents CO<sub>2</sub> discharge from the manifold if a mini-bulk tank is removed from the storage bank for servicing. Manifold check valves are available in 1/2 in. and 3 in. sizes.

B. Check valves are available in 1/2 in. through 3 in. sizes for various other applications as needed.

### ▶ 2-13 DISCHARGE NOZZLES

Nozzle sizes and orifice codes for each system are determined by the hydraulic calculations to control the required flow rate as well as agent distribution in the hazard area. These nozzles shall conform to the spacing requirements and height limitations set forth by listing agencies and the approval authority.

Nozzles have been optimized to discharge carbon dioxide in the most efficient manner to provide protection for any hazard. There are three basic types of discharge nozzles used in the design of an ANSUL Low Pressure CO<sub>2</sub> system: radial, Short Range (SR), and orifice nozzles.

#### ▶ 2-13.1 Radial Nozzle

Limited to use on total flood systems, specifically for rooms, vaults, and larger enclosures. Refer to Design Section for spacing and limitations. Radial nozzles are available in sizes 1/2 in., 3/4 in., 1 in., 1 1/4 in., 1 1/2 in., and 2 in.

#### ▶ 2-13.2 Short Range Nozzle

SR nozzles can be used in total flood or local application systems. SR nozzles are used with rate by area and rate by volume method for local application. Refer to the nozzle chart in the Design Section.

SR nozzles used in total flooding cushion the discharge for areas like underfloors.

The SR nozzle consists of a 4 in. diameter shell with a brass discharge tip. There are two sizes of SR nozzles, 1/2 in. NPT and 3/4 in. NPT.

#### ▶ 2-13.3 Regular Type Nozzle

Regular Type nozzles are limited to total flood applications in duct work, small enclosures, and covered trenches. The nozzle has a 1/2 in. NPT connection and a frangible seal to protect the orifice.

#### ▶ 2-13.4 Specialty Nozzles (Not Listed for Use with FM Approved Systems)

Specialty nozzles are available. Consult factory for details.

## SECTION 2 – SYSTEM COMPONENTS

2-5-15 Page 2-10

REV. 2

### ► 2-14 HOSE REEL UNITS

The hose reels activate by pushing the start button which causes the discharge valve or master selector valve to open and charge the hose up to the manual valve on the playpipe. The actual discharge of carbon dioxide is then controlled by the operator by means of the manual playpipe valve. The act of resetting the button on the station causes the discharging valve to close. Any liquid carbon dioxide trapped in the hose reel between the tank discharge valve and the manual playpipe valve should be released by opening the playpipe valve until the line is de-pressurized. The playpipe valve should then be closed.

The hose reel manual playpipe valve provides a “positive” shut-off and the operator must close the discharge valve to stop the CO<sub>2</sub> discharge. The valve may be reopened to discharge additional CO<sub>2</sub> if the start/stop button has not been reset. Each hose reel has an effective range of projection of approximately 15 to 20 ft (4.6 to 6.1 m) from the nozzle. The hose reel unit can provide manual fire protection in excess of that obtainable from the “portable” extinguishing units.

Hose reel units are available complete with 100 ft (30.5 m) or 150 ft (45.7 m) of 1 in. hose. Hose reels and mini-bulk tanks can be placed on a wheeled skid for portability or permanently installed as a standard hose reel. The units are designed according to customer specifications. Consult factory for details.

### ► 2-15 ODORIZER

The odorizer is used to inject a small amount of wintergreen scent into the carbon dioxide while flowing through the piping network. When the carbon dioxide discharges into the hazard area, it will carry a scent of wintergreen with it. Personnel should be instructed to vacate or not enter an area that has this smell.

### ► 2-16 WARNING SIGNS

- A. Appropriate warning signs shall be affixed outside of those spaces where concentrations of carbon dioxide gas can accumulate, not only in protected spaces but in adjacent areas where the carbon dioxide could migrate.
- B. Appropriate warning signs shall be placed at every location where manual operation of the system may occur.
- C. In any use of carbon dioxide, consideration shall be given to the possibility that personnel could be trapped in or enter into an atmosphere made hazardous by a carbon dioxide discharge. Suitable safeguards shall be provided to ensure prompt evacuation, to prevent entry into such atmospheres, and provide means for prompt rescue of any trapped personnel. Personnel training shall be provided. Pre-discharge alarms shall be provided.
- D. All persons that may at any time enter a space protected by carbon dioxide shall be warned of the hazards involved.
- E. The pre-discharge warning signal shall be provided, along with a time delay of sufficient duration, to allow for evacuation under “worst case” conditions. Dry runs shall be made to determine the minimum time that shall be allowed for persons to remove themselves from the hazard area after allowing time to identify the warning signal.
- F. Audible pre-discharge and discharge signals shall be provided. Visual signals shall be provided if the ambient noise level is high, or if persons with hearing impairment are involved.

### ► 2-17 AUTOMATIC TIMER CABINET

The ANSUL Automatic Timer Cabinet (Part No. 425443) is a pneumatically operated assembly. One timer cabinet should be provided for each selector valve within the carbon dioxide system and should be located at or near the valve being controlled. Two separate timer cycles manage the carbon dioxide discharge. The first cycle delays the release of carbon dioxide while alarms sound and personnel exit the area. A pressure port is provided to supply CO<sub>2</sub> vapor to a pneumatic siren as soon as the cabinet is activated. The second time cycle allows only the required amount of carbon dioxide to be discharged into the protected space according to the allotted time period.

**► 2-18 1/4 IN. SHUTTLE VALVE**

The 1/4 in. Shuttle Valve (Part No. 427266) is a mechanical device which allows the inlet pressure from either of two supply sources to flow to a common outlet. When pressurized, the center ball travels within the center chamber. This permits flow out of a common outlet port, while blocking the opposing inlet port.

The shuttle valve is often used to integrate multiple actuation (pilot) lines for a common storage source. Other applications include pressure supply transfer to pressure trips and pressure switches.

The shuttle valve has a brass body and is suitable for 1/4 in. NPT connections on all three ports.

**► 2-19 PRESSURE-OPERATED SIREN/HORN**

To meet the requirements of NFPA 12, a pneumatic audible alarm is required for all carbon dioxide systems that protect “Normally Occupied” or “Occupiable” spaces protected with total flooding systems, or by local application systems where the discharge exposes personnel to concentrations of carbon dioxide in excess of 7.5 percent. These are areas where it is necessary to warn and evacuate personnel prior to the discharge of a carbon dioxide system.

The pneumatic audible alarm is operated with the carbon dioxide pressure from the control line coming off of the storage tank. A time delay allows the siren/horn to operate before the system is discharged. The siren/horn will continue to operate through most of the discharge time. Either an air horn or a siren may be used as the audible alarm. The minimum decibel level of the air horn at 10 ft (3.0 m) is 115 dB.

## SECTION 2 – SYSTEM COMPONENTS

NOTES:

## Low Pressure Carbon Dioxide

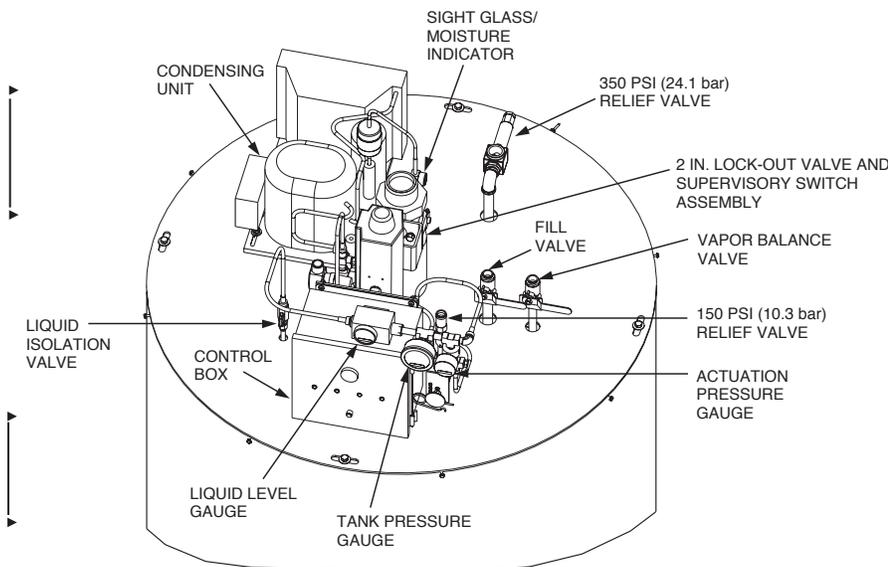
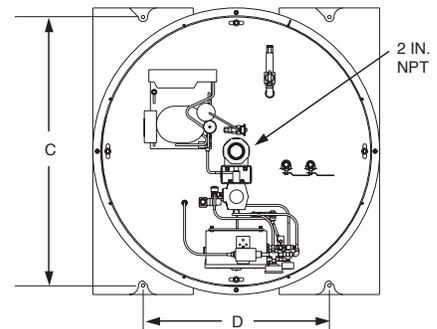
## Mini-Bulk Storage Tanks

The mini-bulk storage tanks are available in 1000 lb and 1500 lb (454 kg and 680 kg) capacities. The tank is built in accordance with Section 8, Division 1 of the ASME Code for Unfired Pressure Vessels having a maximum allowable pressure of 350 psi (24.1 bar). Tanks include a 4 in. (10.2 cm) polyurethane foam insulation.

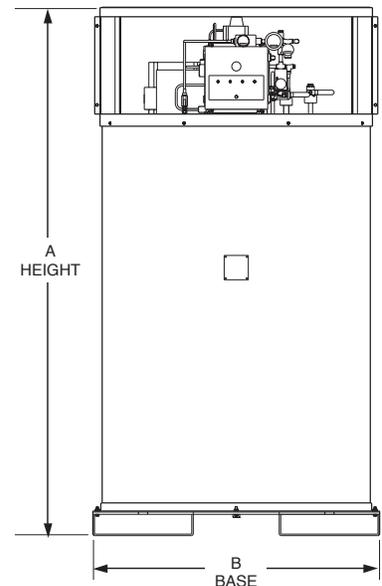
The tank is designed to maintain carbon dioxide as a liquid at approximately 0 °F (-18 °C). This temperature corresponds with an approximate pressure of 300 psi (20.7 bar). This is accomplished by incorporating a refrigeration system that automatically comes on when the pressure reaches approximately 305 psi (21.0 bar) and off at approximately 295 psi (20.3 bar). The refrigerant is circulated through evaporator coils inside the vapor space at the top of the tank. The mini-bulk tank operates from a dedicated 120 V, 1 ph, 60 HZ source. For alternate electrical sources, consult factory for details. Listed for use with FM Approved systems.

The tank assembly includes:

- CO<sub>2</sub> storage vessel
- Pressure and liquid level indication gauges
- 120 V, 1 ph, 60 HZ refrigeration system (compressor, fan, motor, pressure switches, etc.)
- Safety relief valves
- Tank function control valves
- ▶ • Lock-out valve with supervisory switch
- Pressure regulator and gauges
- ▶ • Actuation line supervisory pressure switch and relief valve
- R134a refrigerant



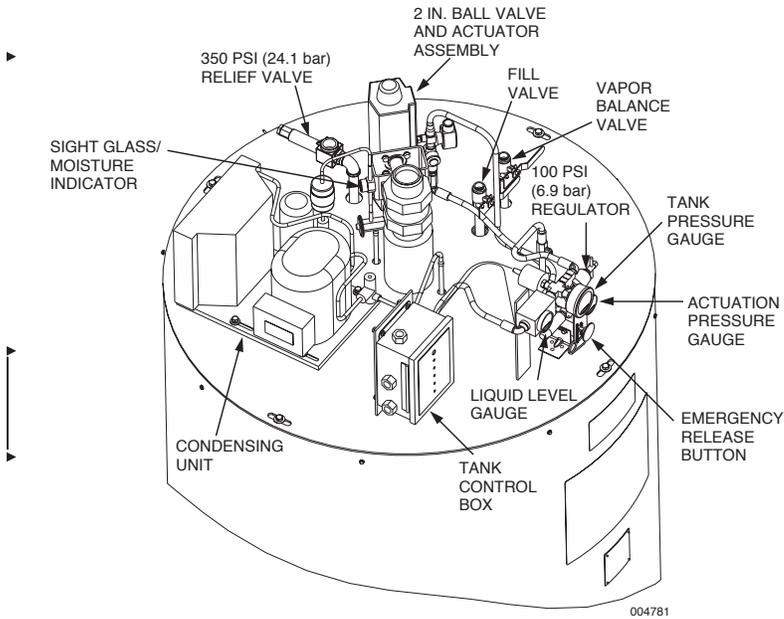
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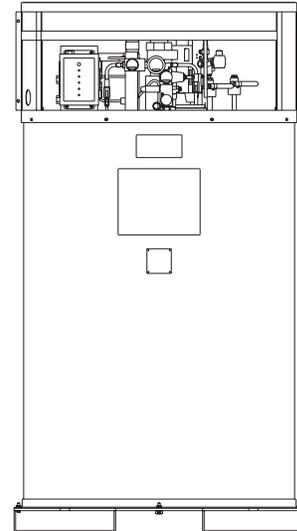
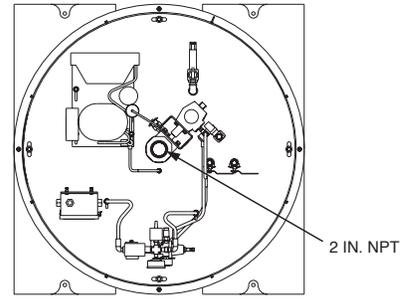
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Dimensions					
Tank Size	Part No.	A – Height	B – Base	C	D
1,000 lb (454 kg)	422986	86 in. (2184 mm)	39 1/8 in. (994 mm)	36 1/8 in. (918 mm)	22 5/8 in. (575 mm)
1,500 lb (680 kg)	422985	86 in. (2184 mm)	47 1/8 in. (1197 mm)	45 5/8 in. (1159 mm)	30 5/8 in. (778 mm)

**PRE-2001 SYSTEM – DRAWINGS ARE FOR REFERENCE ONLY**

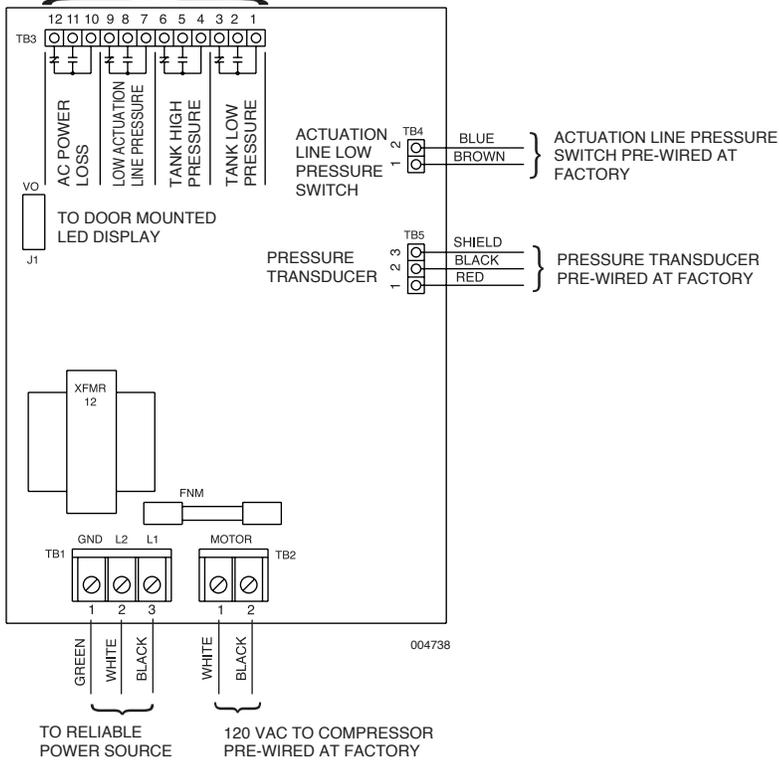


004781



002377

**CONTACTS FOR REMOTE SUPERVISION OF TANK CONDITION**



004738



A Tyco International Company

### Low Pressure Carbon Dioxide

### 3 3/4 - 46 Ton Storage Tanks

All storage units are provided with saddles.

Flanged discharge outlet is Class 300 ANSI class.

The pressure vessel is insulated with a minimum of 4 in. (102 mm) of urethane foam insulation. The insulation is covered with a white aluminum housing. All overlapping seams are sealed.

The pressure vessel is designed, built and tested to meet code requirements for ASME unfired pressure vessels, Section VIII Division I.

The storage tanks are listed for use with FM Approved systems.

The refrigeration system automatically maintains the carbon dioxide at approximately 0 °F (–18 °C) and a corresponding vapor pressure of 300 psi (20.7 bar). The compressor will start when tank pressure increases to 305 psi (21.0 bar), and stop when tank pressure is lowered to 295 psi (20.3 bar).

The semi-hermetic condensing unit consists of a compressor, cooling fan, condensing coils, and receiver tank. The refrigeration coil consists of the manifolded U-tube design to greatly increase the efficiency of the system.

The front panel of the tank contains two gauges, a pressure gauge and a liquid level gauge. These measure the liquid contents of the tank, in pounds, and the pressure inside the tank, in pounds-per-square-inch-gauge. Both of the gauges are non-electric and work whether the tank has power or not.

The tanks are provided with a series of vapor pressure relief valves that are designed to vent the vapor pressure should the tank be without electrical power to operate the refrigeration system for an extended period of time. The bleeder valve is set to open at a pressure of 330 psi (22.8 bar). When the tank pressure slowly rises, the bleeder valve will open and allow the carbon dioxide vapor to escape from the vessel. If the pressure continues to rise, the bleeder valve will continue to open allowing additional carbon dioxide to escape. If the pressure continues to rise, the main safety relief valve will open. The pressure vessel is protected from being subject to pressures greater than the maximum allowable working pressure by means of an ASME approved direct spring loaded or pilot operated safety relief valve, set to open at a pressure of 350 psi (24.1 bar). Relief valves are sized for inside installation, which are the more stringent requirements.

The 1 1/2 in. liquid fill and 1 in. vapor valves are full port 3 piece ball valves.

All storage units are provided with contacts to monitor:

- High pressure (above 315 psi (21.7 bar))
- Low pressure (decreases below 250 psi (17.2 bar))
- Power failure to compressor

All storage units can be provided with optional contacts to monitor:

- Low liquid level
- High liquid level

Refer to charts for standard sizes, dimensions and voltages.

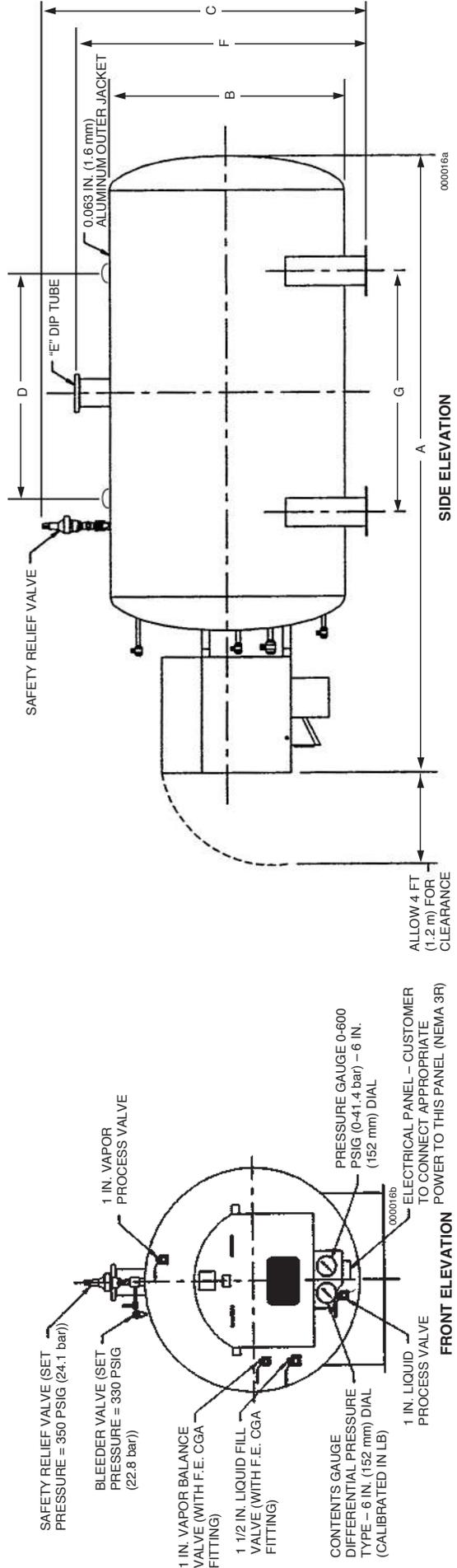
Other options available upon request: (not listed for use with FM Approved systems)

- Liquid level gauge contacts; single or double
- Additional dip tubes
- ▶ • Dual relief valves
- NEMA 4/4X control box enclosure
- ▶ • 200 VAC, 1-ph, 50 Hz (3 3/4 through 10 ton only)
- ▶ • 208/230 VAC, 1-ph, 60 Hz (3 3/4 through 10 ton and 14 ton only)
- 200/220 VAC, 3-ph, 50 Hz (all sizes)
- 208/230 VAC, 3-ph, 60 Hz (all sizes)
- ▶ • 460 VAC, 3-ph, 60 Hz (all sizes)
- ▶ • Alternate voltage (not listed for use with FM Approved systems)
- ▶ • Cold weather packages (not listed for use with FM Approved systems)

Dimensional Information Chart (E-Style Saddle Mounted Vessel)

Tank Capacity (Tons)	Part No.	A Length		B Width		C Height w/ Relief		D Lift Lugs		E Dip Tube		F Height w/ Valve		G Length - Saddle		Empty Weight		Standard Voltage (VAC)	HP
		ft-in.	m	ft-in.	m	ft-in.	m	ft-in.	m	ft-in.	m	ft-in.	m	ft-in.	m	lb	kg		
3.75	425950	11-10	3.6	5-10	1.8	8-6	2.6	2-8	0.8	4	102	7-6	2.3	3-0	0.97	7500	3402	460, 3-ph, 60 Hz	1
3.75*	440443	11-10	3.6	5-10	1.8	8-6	2.6	2-8	0.8	4	102	7-6	2.3	3-0	0.97	7500	3402	460, 3-ph, 60 Hz	1
6	441609	15-10	4.8	5-10	1.8	8-6	2.6	5	1.6	4	102	7-6	2.3	5-4	1.63	9000	4082	460, 3-ph, 60 Hz	1
6*	442562	15-10	4.8	5-10	1.8	8-6	2.6	5	1.6	4	102	7-6	2.3	5-4	1.63	9000	4082	460, 3-ph, 60 Hz	1
6	425899	15-10	4.8	5-10	1.8	8-6	2.6	5	1.6	6	152	7-6	2.3	5-4	1.63	9000	4082	460, 3-ph, 60 Hz	1
6*	440461	15-10	4.8	5-10	1.8	8-6	2.6	5	1.6	6	152	7-6	2.3	5-4	1.63	9000	4082	460, 3-ph, 60 Hz	1
8	425928	19-2	5.8	5-10	1.8	8-6	2.6	8-6	2.6	6	152	7-6	2.3	8-10	2.69	10200	4627	460, 3-ph, 60 Hz	2
8*	440419	19-2	5.8	5-10	1.8	8-6	2.6	8-6	2.6	6	152	7-6	2.3	8-10	2.69	10200	4627	460, 3-ph, 60 Hz	2
10	437372	23-4	7.1	5-10	1.8	8-6	2.6	12-3	3.7	8	203	7-6	2.3	12-5	3.78	11500	5216	460, 3-ph, 60 Hz	2
10*	440420	23-4	7.1	5-10	1.8	8-6	2.6	12-3	3.7	8	203	7-6	2.3	12-5	3.78	11500	5216	460, 3-ph, 60 Hz	2
12	437369	26-5	8.1	5-10	1.8	8-6	2.6	15-4	4.7	8	203	7-6	2.3	15-6	4.72	12650	5738	460, 3-ph, 60 Hz	3
12*	440421	26-5	8.1	6-7	2.0	8-6	2.6	15-4	4.7	8	203	7-6	2.3	15-6	4.72	12650	5738	460, 3-ph, 60 Hz	3
14	440307	20-7	6.3	7-4	2.2	10-3	3.1	7-4	2.2	8	203	9-1	2.8	7-4	2.24	14000	6350	220, 3-ph, 50 Hz	3
14*	440422	20-7	6.3	7-4	2.2	10-3	3.1	7-4	2.2	8	203	9-1	2.8	7-4	2.24	14000	6350	220, 3-ph, 50 Hz	3
14	441759	20-7	6.3	7-4	2.2	10-3	3.1	7-4	2.2	8	203	9-1	2.8	7-4	2.24	14000	6350	460, 3-ph, 60 Hz	2
14*	441760	20-7	6.3	7-4	2.2	10-3	3.1	7-4	2.2	8	203	9-1	2.8	7-4	2.24	14000	6350	460, 3-ph, 60 Hz	2
18	440308	25-1	7.6	7-4	2.2	10-3	3.1	10	3.0	8	203	9-1	2.8	10	3.05	16800	7621	460, 3-ph, 60 Hz	3
18*	440423	25-1	7.6	7-4	2.2	10-3	3.1	10	3.0	8	203	9-1	2.8	10	3.05	16800	7621	460, 3-ph, 60 Hz	3
22	440551	29-1	8.9	7-4	2.2	10-3	3.1	14	4.3	8	203	9-1	2.8	14	4.27	20500	9299	460, 3-ph, 60 Hz	3
22*	440309	29-1	8.9	7-4	2.2	10-3	3.1	14	4.3	8	203	9-1	2.8	14	4.27	20500	9299	460, 3-ph, 60 Hz	3
30	440554	37-1	11.3	7-4	2.2	10-3	3.1	22	6.7	8	203	9-1	2.8	22	6.7	26500	12020	460, 3-ph, 60 Hz	3
30*	440312	37-1	11.3	7-4	2.2	10-3	3.1	22	6.7	8	203	9-1	2.8	22	6.7	26500	12020	460, 3-ph, 60 Hz	3
38	440557	44-7	13.6	7-4	2.2	10-3	3.1	30	9.1	8	203	9-1	2.8	30	9.1	33000	14970	460, 3-ph, 60 Hz	4
38*	440560	44-7	13.6	7-4	2.2	10-3	3.1	30	9.1	8	203	9-1	2.8	30	9.1	33000	14970	460, 3-ph, 60 Hz	4
46	440377	53-1	16.2	7-4	2.2	10-3	3.1	38	11.6	8	203	9-1	2.8	38	11.6	37500	17010	460, 3-ph, 60 Hz	4
46*	440565	53-1	16.2	7-4	2.2	10-3	3.1	38	11.6	8	203	9-1	2.8	38	11.6	37500	17010	460, 3-ph, 60 Hz	4

\* Dual Refrigeration System Models



## Low Pressure Carbon Dioxide

## 2 In. Short Discharge Hose

- ▶ The 2 in. Discharge Hose may be added to a mini-bulk system where the storage unit attaches to the piping. It provides a
- ▶ flexible connection to allow for slight mis-alignment during installation or when a tank may be removed for refilling.

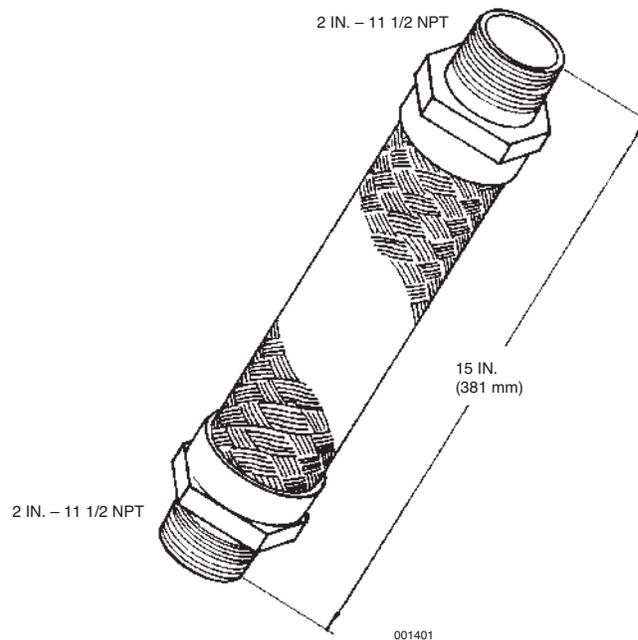
### 2 IN. DISCHARGE HOSE, SHORT (PART NO. 71863)

Inside Diameter – 2 in. (5.1 cm)

Operating Pressure – 500 psi (34.48 bar) Maximum

Burst pressure – 1800 psi (124.11 bar) Minimum

**Material:** Corrugated Stainless Steel Tube with Stainless Steel Braid and Ends

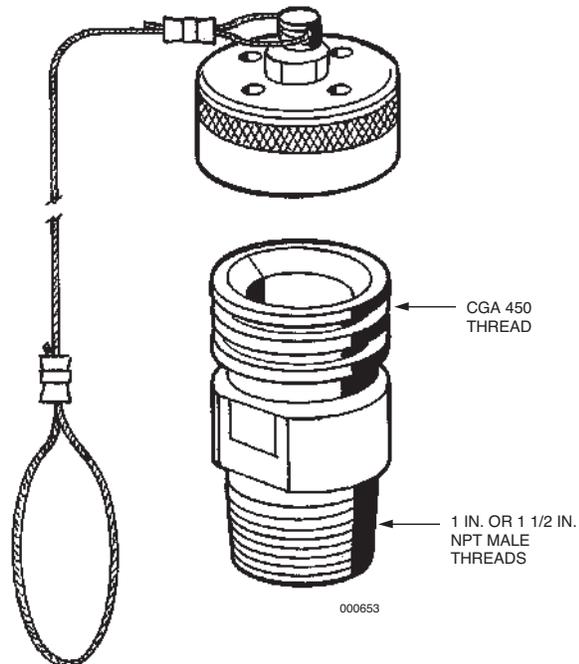




## Low Pressure Carbon Dioxide

## CGA 450 Fill Adaptor

- ▶ The CGA 450 Fill Adaptor, 1 in. Part No. 427735, and 1 1/2 in. Part No. 470078, provides a hose connection for filling the
- ▶ storage tank. The screw-on dust cover includes an attached and looped wire to keep the cap from being misplaced during the filling operation.





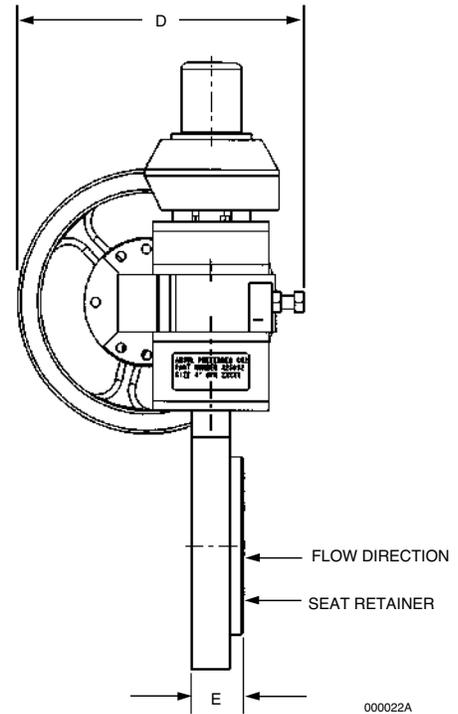
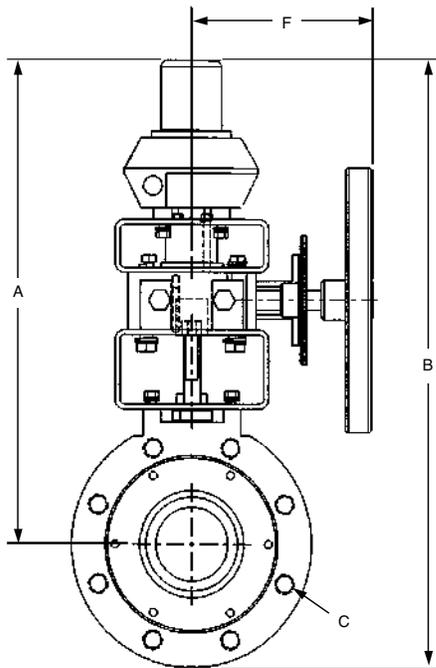


A Tyco International Company

## Low Pressure Carbon Dioxide

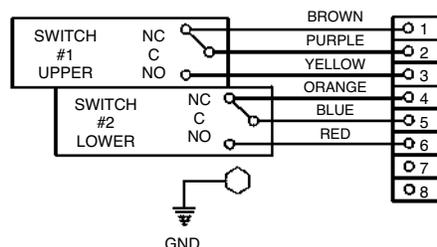
## 3 In. - 8 In. Tank Shut-Off Valve With Supervisory Switch

The tank shut-off valve is a manually operated valve located between the dip tube on the storage unit and the discharge header. The valve is used to isolate the storage unit from the system. The valve is equipped with a pad locking device to lock the valve in the open or closed position. The valve must be installed in the direction of the flow arrow. The valve body is carbon steel while the valve stem and disc are stainless steel. The valves carry a Class 300 ANSI rating. Each valve is equipped with two monitoring switches to provide constant supervision of fully open and fully closed positions of the valve at the control panel. In addition to the contacts the switch incorporates a high visibility position monitor which displays the position of the valve. The valve assembly is listed for use with FM Approved systems.



000022A

Dimensions									
Size	Part No.	A in. (mm)	B in. (mm)	C Qty. Threads	D in. (mm)	E in. (mm)	F in. (mm)	Weight lb (kg)	
3 in.	425045	17.75 (451)	21.0 (533)	8 3/4 - 10 NC	11.13 (283)	1.88 (48)	7 (178)	47 (21.3)	
4 in.	425052	18.50 (470)	22.75 (578)	8 3/4 - 10 NC	11.13 (283)	2.03 (52)	7 (178)	56 (25.4)	
6 in.	425057	22.50 (572)	26.88 (683)	12 3/4 - 10 NC	11.13 (283)	2.42 (62)	8 (203)	72 (32.7)	
8 in.	425062	23.25 (591)	30.88 (784)	12 7/8 - 9 NC	12.75 (324)	2.82 (72)	8 (203)	118 (53.5)	



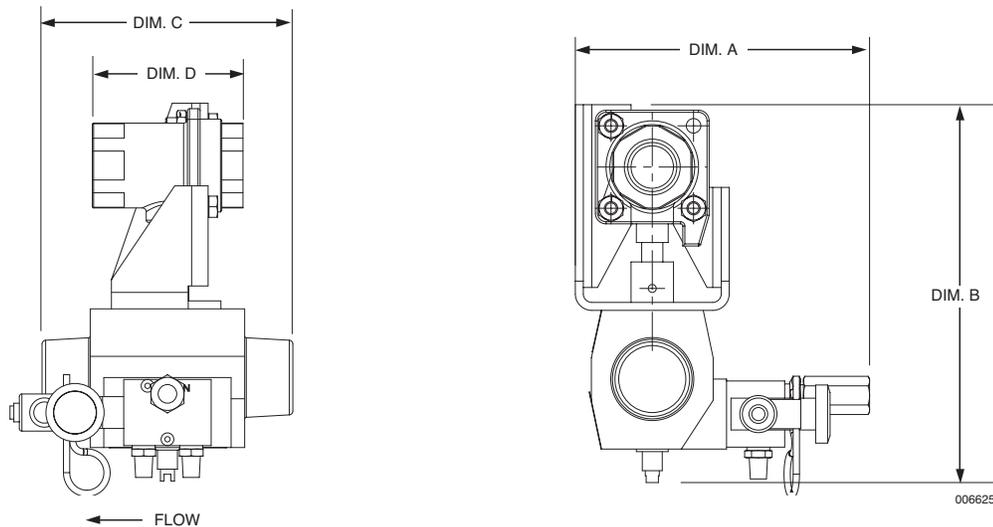
CONTACT CONFIGURATION



## 1/2 In. through 2 In. Selector Valve with Spring Return Actuator Assembly with Solenoid

### Low Pressure Carbon Dioxide

The selector valves are pneumatic operated valves of the ball valve type. The valve is equipped with a pneumatic actuator designed to function with CO<sub>2</sub> pressure. A spring return actuator will rotate counterclockwise when a sufficient supply of pressure is applied to the right hand air port or Port "A." Upon loss of pressure, this type of actuator will return to closed position. The valve body, shaft and ball are stainless steel. The pneumatic actuators are designed to operate at 110 psi (7.6 bar) with a maximum working pressure of 150 psi (10.3 bar) and a minimum working pressure of 80 psi (5.5 bar). The valve assembly is listed for use with FM Approved systems. Manual operation of the actuator is provided by a pneumatic override feature of the solenoid valve. To operate the override feature, remove the ring pin, push the knob in, and rotate the knob clockwise 90° to lock the valve open. To close the valve, rotate the knob counterclockwise 90°.



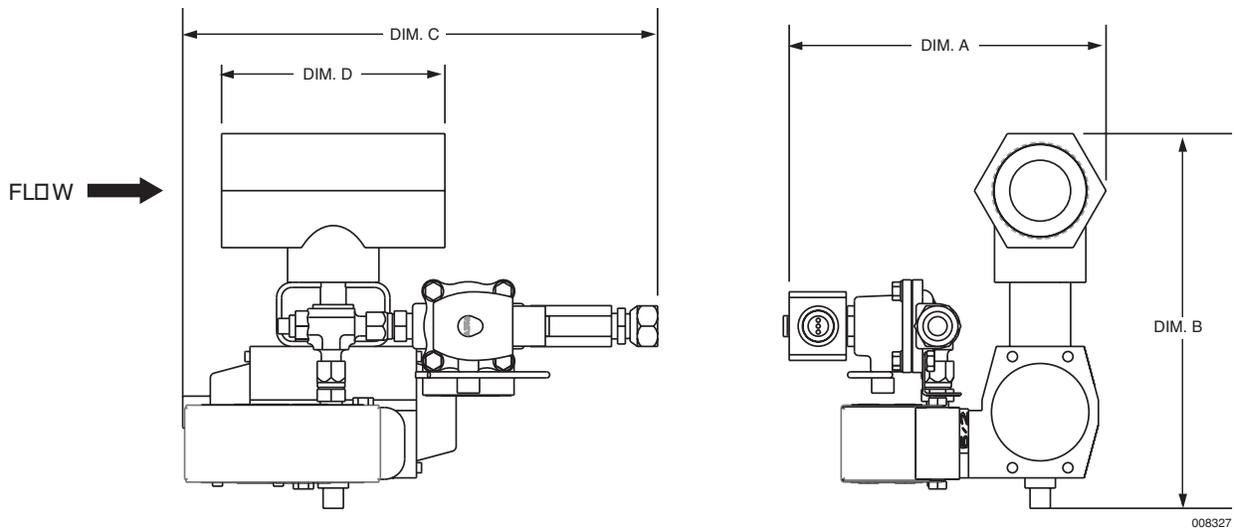
Dimensions											
Size	A		B		C		D		Weight		
in.	(cm)	Part No.	in.	(cm)	in.	(cm)	in.	(cm)	lb	(kg)	
1/2	(1.27)	425911	6.63	(16.84)	8.03	(20.40)	5.40	(13.72)	2.62	(6.65)	6.0 (15.24)
3/4	(1.90)	425912	6.63	(16.84)	8.56	(21.74)	5.91	(15.01)	3.00	(7.62)	7.0 (17.78)
1	(2.54)	425913	6.63	(16.84)	8.91	(22.63)	5.91	(15.01)	3.55	(9.02)	9.0 (22.86)
1 1/4	(3.18)	425914	3.87	(9.83)	10.90	(27.69)	8.03	(20.40)	4.00	(10.16)	19.0 (48.26)
1 1/2	(3.81)	425915	4.25	(10.80)	11.37	(28.89)	9.06	(23.01)	4.38	(11.13)	21.0 (53.34)
2	(5.08)	425916	4.86	(12.34)	11.96	(30.38)	10.67	(27.10)	5.50	(13.97)	22.0 (55.88)



## Low Pressure Carbon Dioxide

### 1/2 in. through 2 in. Selector Valve with Spring Return Actuator Assembly with Time Delay

The selector valves are pneumatically operated valves of the ball valve type. The valve is equipped with a pneumatic actuator designed to function with CO<sub>2</sub> pressure. A spring return actuator will rotate counterclockwise when a sufficient supply of pressure is applied to the right hand Port "A." Upon loss of pressure, this type of actuator will return to the closed position. The valve body, shaft, and ball are stainless steel. The pneumatic actuators are designed to operate at 110 psi (7.6 bar) with a maximum working pressure of 150 psi (10.3 bar) and a minimum working pressure of 80 psi (5.5 bar). The selector valves are equipped with a factory set, 30 second, pneumatic time delay assembly that is pre-piped and surface mounted on the actuator. For a complete description of the time delay assembly, see description for Part No. 436209. The assembly is listed for use with FM Approved systems. Manual operation of the timed selector valve assembly is provided by a manual operator on the solenoid valve. To operate the timed cycle, remove the ring pin, push in the knob, and rotate the knob clockwise 90° to lock the solenoid valve open. To close the valve, rotate the knob counterclockwise 90°.



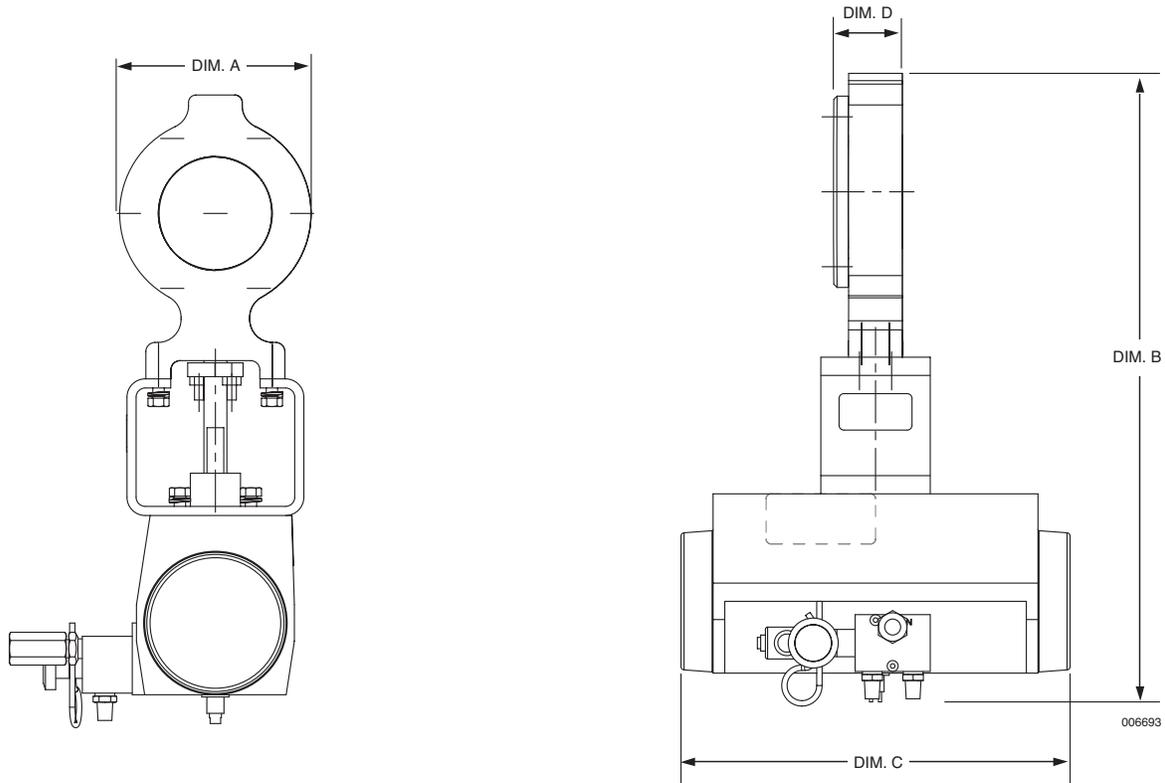
Dimensions												
Size			A		B		C		D		Weight	
in.	(cm)	Part No.	in.	(cm)	in.	(cm)	in.	(cm)	lb	(cm)	lb	(kg)
1/2	(1.27)	436255	7.7	(19.56)	6.9	(17.53)	11.6	(29.46)	2.62	(6.65)	10	(4.54)
3/4	(1.90)	436256	7.7	(19.56)	8.4	(21.34)	11.6	(29.46)	3.00	(7.62)	11	(4.99)
1	(2.54)	436257	7.7	(19.56)	9.9	(25.15)	11.6	(29.46)	3.55	(9.02)	13	(5.90)
1 1/4	(3.18)	436258	8.0	(20.32)	9.9	(25.15)	12.0	(30.48)	4.00	(10.16)	23	(10.43)
1 1/2	(3.81)	436259	8.3	(21.08)	11.1	(28.19)	12.5	(31.75)	4.38	(11.13)	25	(11.34)
2	(5.08)	436260	9.3	(23.62)	12.0	(30.48)	13.3	(33.78)	5.50	(13.97)	26	(11.79)



## Low Pressure Carbon Dioxide

### 3 In., 4 In., 6 In., and 8 In. Selector Valve With Spring Return Actuator Assembly with Solenoid

The selector valves are pneumatic operated valves of the butterfly valve type. The valve is equipped with a pneumatic actuator designed to function with CO<sub>2</sub> pressure. A spring return actuator will rotate counterclockwise when a sufficient supply of pressure is applied to the right hand air port or Port "A." Upon loss of pressure, this type of actuator will return to closed position. The valve body is carbon steel while the valve shaft and disk are stainless steel. The pneumatic actuators are designed to operate at 110 psi (7.6 bar) with a maximum working pressure of 150 psi (10.3 bar) and a minimum working pressure of 80 psi (5.5 bar). The valve assembly is listed for use with FM Approved systems. Manual operation of the actuator is provided by a pneumatic override feature of the solenoid valve. To operate the override feature, remove the ring pin, push the knob in, and rotate the knob clockwise 90° to lock the valve open. To close the valve, rotate the knob counterclockwise 90°.



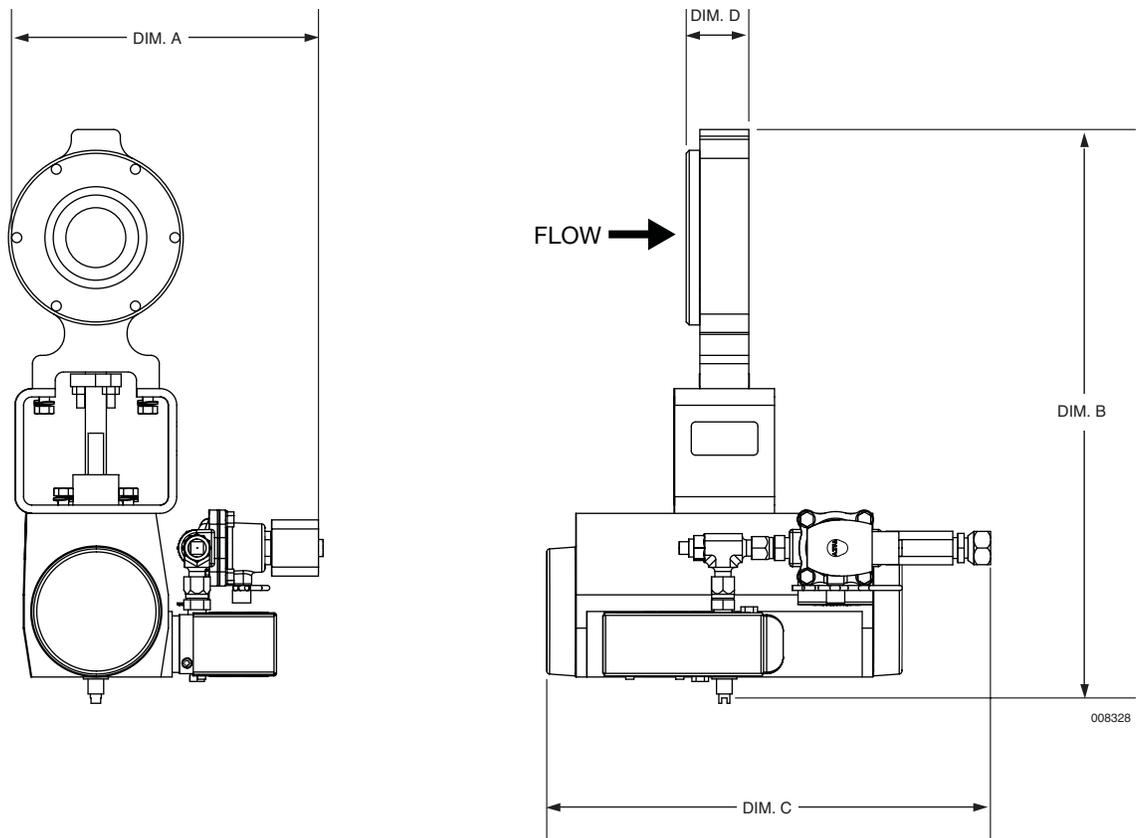
Dimensions											
Size – NPT	Part No.	A		B		C		D		Weight	
in. (cm)		in.	(cm)	in.	(cm)	in.	(cm)	lb	(cm)	lb	(kg)
3 (7.6)	425917	5.25	(13.3)	17.25	(43.8)	10.67	(27.10)	1.88	(4.78)	25	(11.3)
4 (10.2)	425918	6.75	(17.15)	20.74	(52.68)	12.00	(30.48)	2.03	(5.16)	35	(15.9)
6 (15.2)	425919	8.88	(22.55)	25.94	(65.89)	18.10	(45.97)	2.42	(6.15)	80	(36.3)
8 (20.3)	425920	10.94	(27.78)	31.68	(80.47)	21.85	(55.50)	2.82	(7.16)	150	(68.0)



## Low Pressure Carbon Dioxide

### 3 in., 4 in., 6 in., and 8 in. Selector Valve With Spring Return Actuator Assembly with Time Delay

The selector valves are pneumatically operated valves of the butterfly type. The valve is equipped with a pneumatic actuator designed to function with CO<sub>2</sub> pressure. A spring return actuator will rotate counterclockwise when a sufficient supply of pressure is applied to the right hand Port "A." Upon loss of pressure, this type of actuator will return to the closed position. The valve body is carbon steel while the valve shaft and disc are stainless steel. The pneumatic actuators are designed to operate at 110 psi (7.6 bar) with a maximum working pressure of 150 psi (10.3 bar) and a minimum working pressure of 80 psi (5.5 bar). The selector valves are equipped with a factory set, 30 second, pneumatic time delay assembly that is pre-piped and surface mounted on the actuator. For a complete description of the time delay assembly, see description for Part No. 436209. The assembly is listed for use with FM Approved systems. Manual operation of the timed selector valve assembly is provided by a manual operator on the solenoid valve. To operate the timed cycle, remove the ring pin, push in the knob, and rotate the knob clockwise 90° to lock the solenoid valve open. To close the valve, rotate the knob counterclockwise 90°.



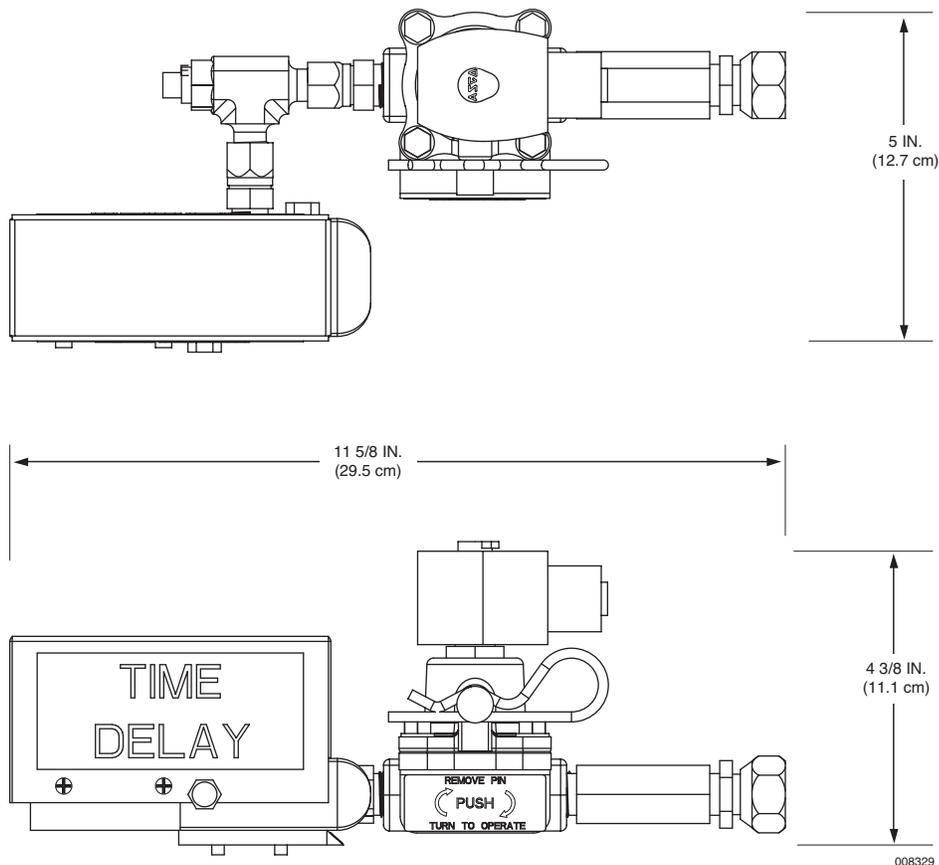
		Dimensions									
Size – NPT	Part No.	A		B		C		D		Weight	
in. (cm)		in.	(cm)	in.	(cm)	in.	(cm)	lb	(cm)	lb	(kg)
3 (7.6)	436298	9.5	(24.13)	17.3	(43.94)	13.4	(34.04)	1.88	(4.78)	29	(13.15)
4 (10.2)	436299	11.0	(27.94)	20.7	(52.58)	14.0	(35.56)	2.03	(5.16)	39	(17.69)
6 (15.2)	436300	13.2	(33.53)	25.9	(65.79)	18.1	(45.97)	2.42	(6.15)	84	(38.10)
8 (20.3)	436301	15.2	(38.61)	31.7	(80.52)	21.9	(55.63)	2.82	(7.16)	154	(69.85)



## Low Pressure Carbon Dioxide

## Time Delay

To meet the requirements of NFPA 12, a mechanical time delay is required for all carbon dioxide systems that protect “Normally Occupied” or “Occupiable” spaces protected with total flooding systems, or by local application systems where the discharge exposes personnel to concentrations of carbon dioxide in excess of 7.5 percent. These are areas where it is necessary to evacuate personnel prior to the discharge of a carbon dioxide system. The time delay uses a two-way solenoid valve and pressure from the control line to initiate the adjustable, factory set delay mechanism. Once the time delay is activated by pressure from the control line, an internal timing mechanism, delays discharge for 30 seconds. The time delay is installed on the selector valves for each independently controlled branch of the system. The time delay is listed for use with FM Approved systems and meets NFPA requirements for accuracy from 0-130 °F (-18-54.4 °C). The time delay is available with a factory setting of 30 seconds, but may be reset by a factory trained service technician for different delay times. This time delay is only approved for spring return selector valve and actuator assemblies that accept a Namur mount surface mounted control valve. The pneumatic timing cycle is initiated by a 24 VDC 2 way solenoid valve and automatically resets when control pressure is relieved. The time delay service assembly, Part No. 436209, includes a 40 micron in-line filter.

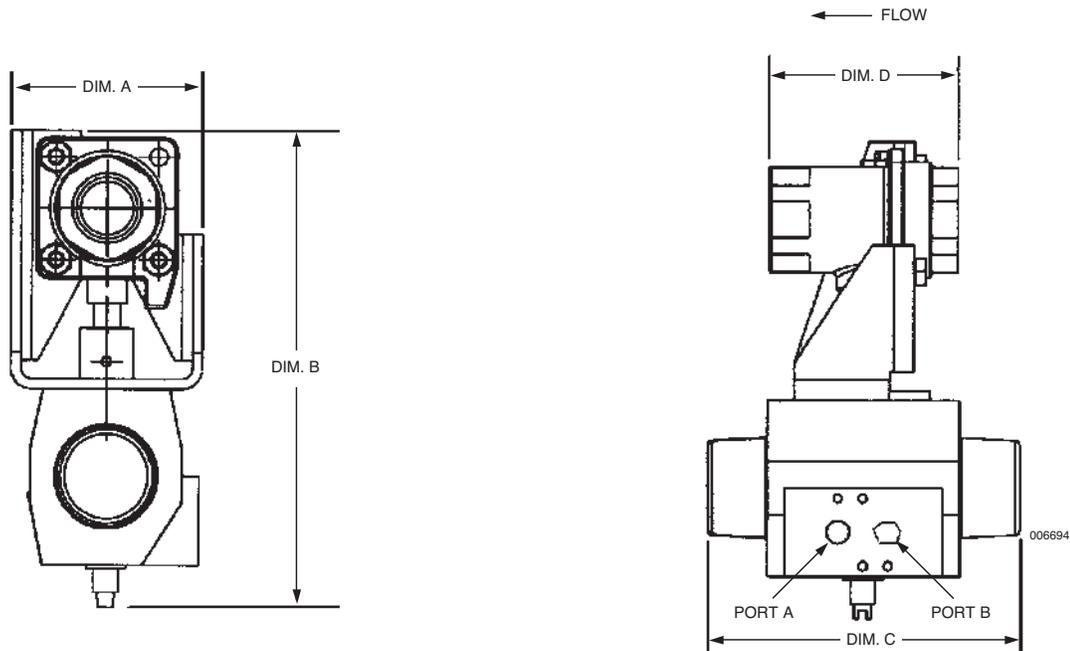




## Low Pressure Carbon Dioxide

## 1/2 In. – 2 In. Selector Valve With Spring Return Actuator Assembly

The selector valves are pneumatic operated valves of the ball valve type. The valve is equipped with a pneumatic actuator designed to function with CO<sub>2</sub> pressure. A spring return actuator will rotate counterclockwise when a sufficient supply of pressure is applied to Port “A.” Upon loss of pressure, this type of actuator will return to the closed position. The valve body, shaft and ball are stainless steel. The pneumatic actuators are designed to operate at 100 psi (6.9 bar) with a maximum working pressure of 150 psi (10.3 bar) and a minimum working pressure of 80 psi (5.5 bar). The valve assembly is listed for use with FM Approved systems. Manual operation of the actuator is provided by a pneumatic override feature of the solenoid valve. To operate the override feature, remove the ring pin, push the knob in, and rotate the knob clockwise 90° to lock the valve open. To close the valve, rotate the knob counterclockwise 90°.



**Note:** This valve shall be used in conjunction with an automatic timer cabinet. Electrical solenoid and manual override features are included with the automatic timer cabinet controls.

Dimensions										
Size		Part No.	A	B	C	D	Port A	Weight		
in.	(cm)		in.	(cm)	in.	(cm)	lb	(cm)	Threads	lb (kg)
1/2	(1.27)	425625	6.63 (16.84)	8.03 (20.40)	5.40 (13.72)	2.62 (6.65)		1/8 in. - NPT	6.0 (15.24)	
3/4	(1.90)	425626	6.63 (16.84)	8.56 (21.74)	5.91 (15.01)	3.00 (7.62)		1/4 in. - NPT	7.0 (17.78)	
1	(2.54)	425627	6.63 (16.84)	8.91 (22.63)	5.91 (15.01)	3.55 (9.02)		1/4 in. - NPT	9.0 (22.86)	
1 1/4	(3.18)	425628	3.87 (9.83)	10.90 (27.69)	8.03 (20.40)	4.00 (10.16)		1/4 in. - NPT	19.0 (48.26)	
1 1/2	(3.81)	425629	4.25 (10.80)	11.37 (28.89)	9.06 (23.01)	4.38 (11.13)		1/4 in. - NPT	21.0 (53.34)	
2	(5.08)	425630	4.86 (12.34)	11.96 (30.38)	10.67 (27.10)	5.50 (13.97)		1/4 in. - NPT	22.0 (55.88)	





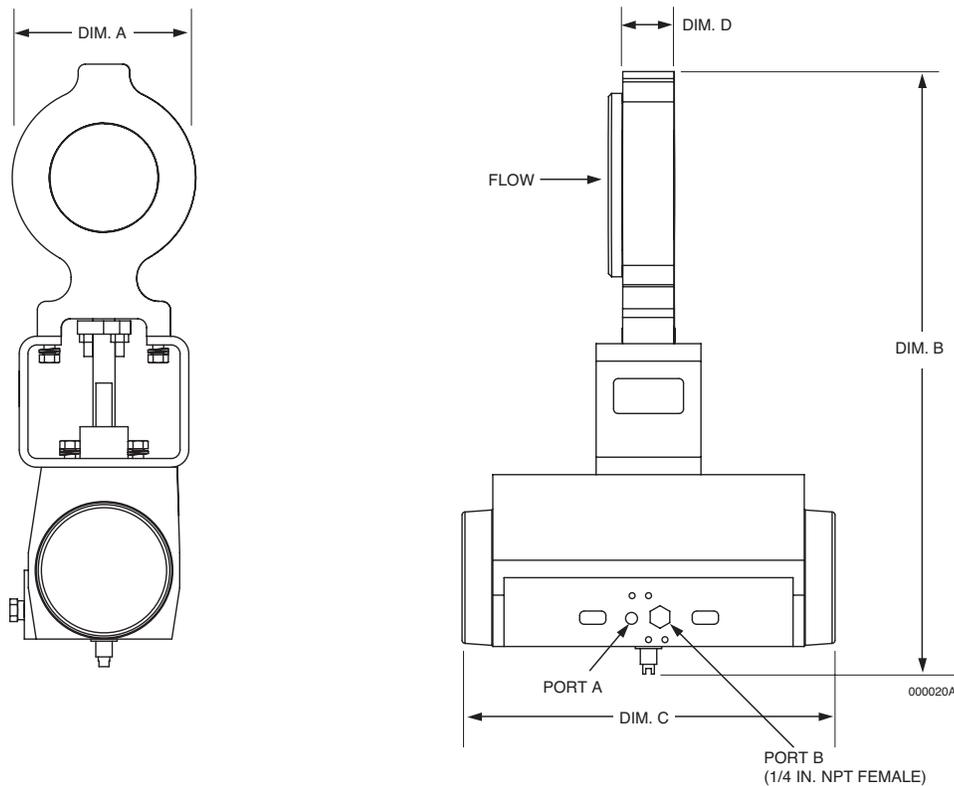
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# System Components

## 3 In., 4 In., 6 In. and 8 In. Selector Valve With Spring Return Actuator Assembly

### Low Pressure Carbon Dioxide

The selector valves are pneumatic operated valves of the butterfly valve type. The valve is equipped with a pneumatic actuator designed to function with CO<sub>2</sub> pressure. A spring return actuator will rotate counterclockwise when a sufficient supply of pressure is applied to Port "A." Upon loss of pressure, this type of actuator will return to the closed position. The valve body is carbon steel while the valve shaft and disk are stainless steel. The pneumatic actuators are designed to operate at 100 psi (6.9 bar) with a maximum working pressure of 150 psi (10.3 bar) and a minimum working pressure of 80 psi (5.5 bar). The valve assembly is listed for use with FM Approved systems.



**Note:** This valve shall be used in conjunction with an automatic timer cabinet. Electrical solenoid and manual override features are included with the automatic timer cabinet controls.

Dimensions								
Size – NPT	Part No.	A	B	C	D	Weight		
in. (cm)		in. (cm)	in. (cm)	in. (cm)	lb (cm)	lb	kg	
3 (7.6)	425662	5.25 (13.3)	17.25 (43.8)	10.67 (27.10)	1.88 (4.78)	25	(11.3)	
4 (10.2)	425663	6.75 (17.15)	20.74 (52.68)	12.00 (30.48)	2.03 (5.16)	35	(15.9)	
6 (15.2)	425664	8.88 (22.55)	25.94 (65.89)	18.10 (45.97)	2.42 (6.15)	80	(36.3)	
8 (20.3)	425665	10.94 (27.78)	31.68 (80.47)	21.85 (55.50)	2.82 (7.16)	150	(68.0)	





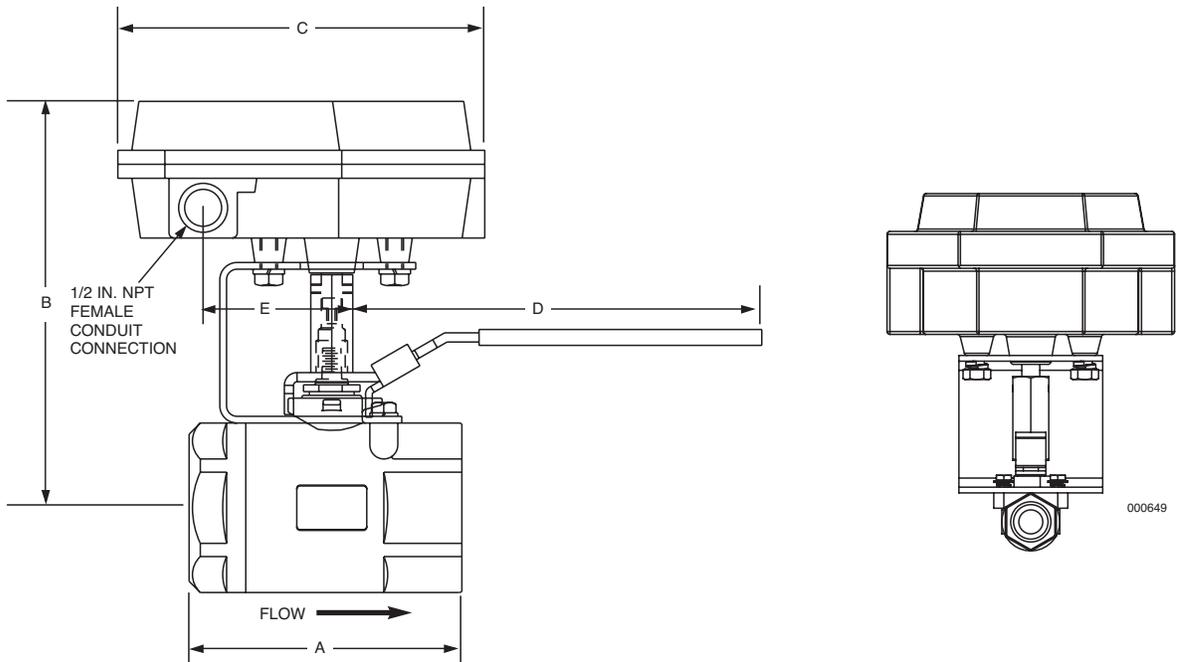
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# System Components

## Low Pressure Carbon Dioxide

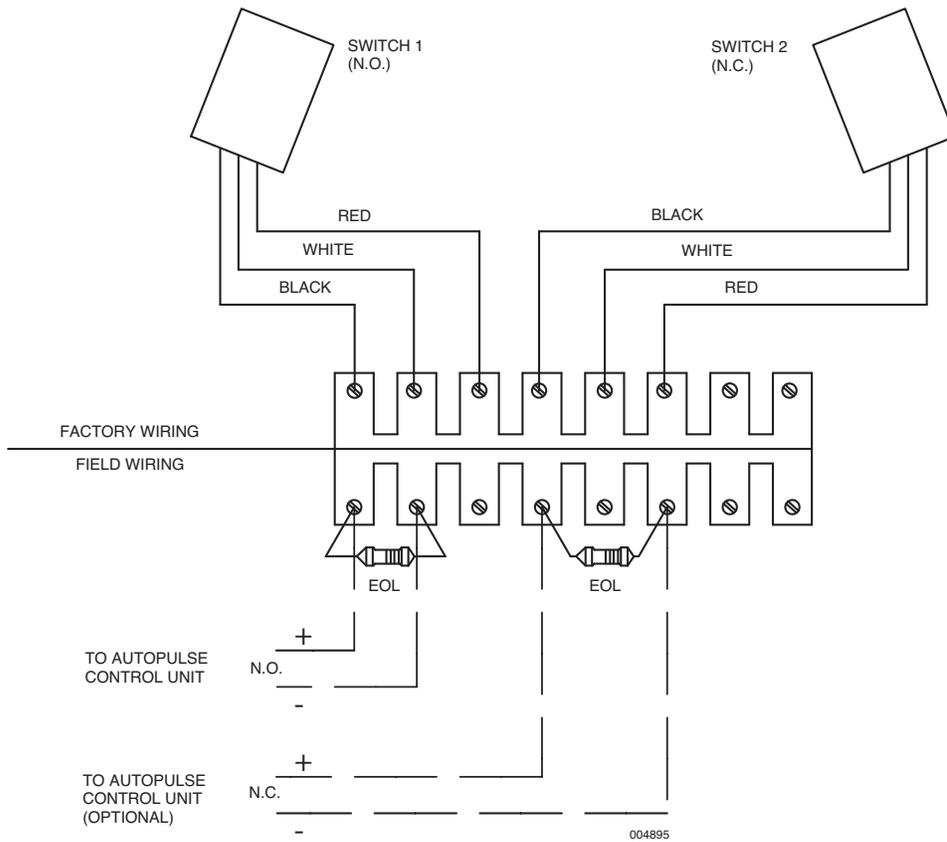
## 1/2 In. - 2 In. Lock-Out Valve With Supervisory Switch

The lock handle stop valve is a manually operated valve used in various locations of the piping system. The valve is used to inhibit the discharge of CO<sub>2</sub> into an entire system or specific area of a system. The valve is equipped with a slide locking device to padlock the valve in the closed position. Each valve is equipped with a monitoring switch to provide constant supervision of the valve at the control panel with contacts for the fully open and fully closed positions. Install warning sign, Part No. 428974, in an easily visible location near valve. The valves are listed for use with FM Approved systems.



		Dimensions											
Size	Part No.	A		B		C		D		E		Weight	
		in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	lb	(kg)
1/2 in.	428153	2.36	(60)	7.07	(179)	6.56	(167)	4.19	(106)	2.3	(58)	6	(2.7)
3/4 in.	428154	2.80	(71)	7.25	(184)	6.56	(167)	5.75	(146)	2.3	(58)	7	(3.2)
1 in.	428155	3.23	(82)	7.41	(188)	6.56	(167)	5.75	(146)	2.3	(58)	7	(3.2)
1 1/4 in.	428156	3.62	(92)	7.55	(192)	6.56	(167)	7.63	(194)	2.3	(58)	8	(3.6)
1 1/2 in.	428157	4.06	(103)	7.75	(197)	6.56	(167)	7.63	(194)	2.3	(58)	9	(4.1)
2 in.	428158	4.65	(118)	8.02	(204)	6.56	(167)	7.63	(194)	2.3	(58)	11	(5.0)

Depth: 6 in. (152 mm)



## CARBON DIOXIDE SYSTEM LOCK-OUT VALVE

VALVE MUST BE CLOSED AND LOCKED PRIOR TO ENTRY OF PROTECTED SPACE

NOTIFY PROPER PERSONNEL PRIOR TO CLOSING VALVE (TROUBLE ALARM WILL SOUND)

ALTERNATE FIRE PROTECTION MUST BE PROVIDED WHILE THIS VALVE IS CLOSED

VALVE MUST BE RESET AFTER EXIT FROM PROTECTED SPACE TO RETURN PROTECTION AND ALARM SYSTEMS TO STAND-BY STATUS



**CARBON DIOXIDE DOES NOT SUPPORT LIFE. FAILURE TO LOCK-OUT THE CARBON DIOXIDE SYSTEM BY CLOSING AND LOCKING THIS VALVE BEFORE ENTRY INTO THE PROTECTED SPACE MAY CAUSE INJURY OR DEATH IF THE SYSTEM ACTUATES.**

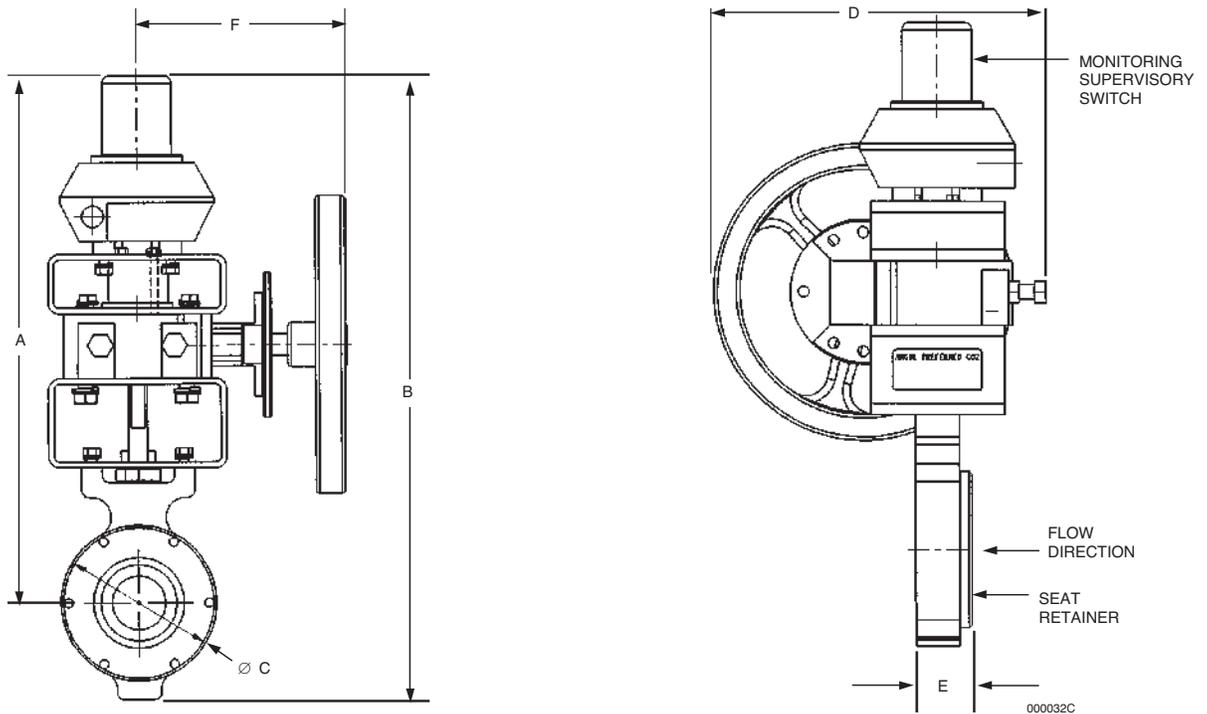
TYCO FIRE PROTECTION PRODUCTS, MARINETTE, WI 54143-2542

LABEL NO. 428974

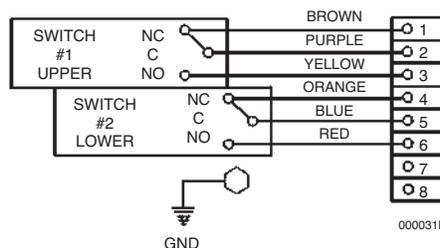
## Low Pressure Carbon Dioxide

## 3 In. – 8 In. Lock-Out Valve With Supervisory Switch

The lock-out valve (blocking valve) is a manually operated valve used in various locations of the piping system. The valve is used to inhibit the discharge of CO<sub>2</sub> into an entire system or specific area of a system. The valve is equipped with a pad locking device to lock the valve in the open or closed position. The valve must be installed in the direction of the flow arrow. The valve body is carbon steel while the valve stem and disc are stainless steel. The valves carry a Class 300 ANSI rating. Each valve is equipped with two monitoring switches to provide constant supervision of fully open and fully closed positions of the valve at the control panel. In addition to the contacts, the switch incorporates a high visibility position monitor which displays the position of the valve. The valves are listed for use with FM Approved systems.



Dimensions									
Size	Part No.	A in. (mm)	B in. (mm)	C in. (mm)	D in. (mm)	E in. (mm)	F in. (mm)	Weight lb (kg)	
3 in.	425113	17.75 (451)	21.0 (533)	5.25 (133)	11.13 (283)	1.88 (48)	7 (178)	47 (21.3)	
4 in.	425116	18.50 (470)	22.75 (578)	6.75 (172)	11.13 (283)	2.03 (52)	7 (178)	56 (25.4)	
6 in.	425121	22.50 (572)	26.88 (683)	8.88 (225)	11.13 (283)	2.42 (62)	8 (203)	72 (32.7)	
8 in.	425124	23.25 (591)	30.88 (784)	11.0 (279)	12.75 (324)	2.82 (72)	8 (203)	118 (53.5)	



CONTACT CONFIGURATION



## Low Pressure Carbon Dioxide

## Automatic Timer Cabinet

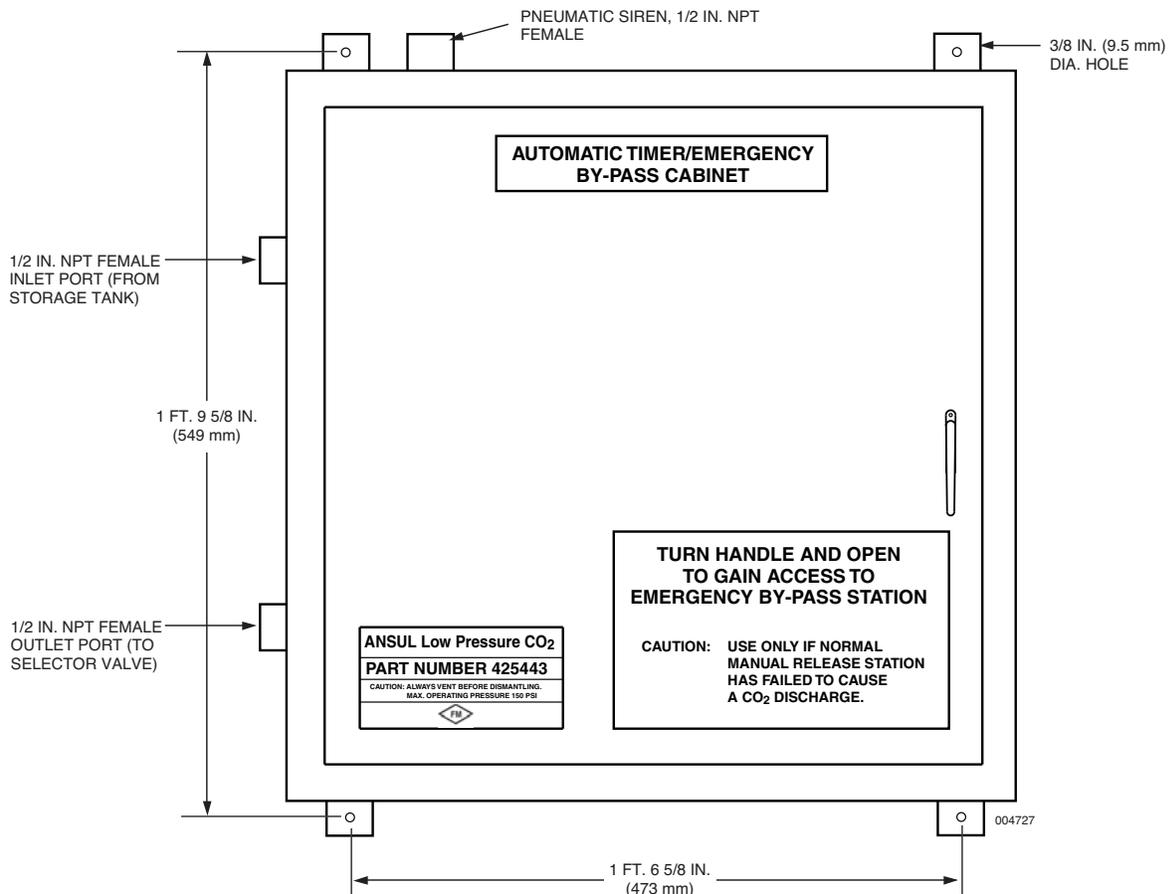
The ANSUL Automatic Timer Cabinet, Part No. 425443 is a pneumatically operated assembly. Three 1/2 in. NPT connections on the NEMA-4 cabinet provide connections for the necessary external piping.

The low pressure storage unit must provide 100-110 psi (689.5-758.5 kPa) of CO<sub>2</sub> vapor pressure through a regulator for operation of the timer cabinet. When the solenoid or Emergency Manual Operator are actuated the CO<sub>2</sub> vapor pressure will accomplish the following:

- A. Delays discharge for an adjustable time period.
- B. Immediately alerts personnel of the pending CO<sub>2</sub> discharge without time delays. A port, which provides pressure to a remotely located pneumatic siren, Part No. 437616, will warn personnel.
- C. Provides pneumatic pressure to open the master and selector valves to begin the discharge and then, after an adjustable discharge time, vents the pneumatic pressure which will cause the valves to close.
- D. Monitors the piping between the automatic timer cabinet and the master/selector valve and notifies the control panel in the event of a damaged line.
- E. Monitors the actuation line from the storage tank.

The delay timer provides 3 seconds to 100 seconds of pre-discharge time. The discharge duration timer causes the master/selector valves to remain open for 18 seconds to 10 minutes of CO<sub>2</sub> discharge into the hazard area. An optional discharge duration timer provides 3 minutes to 100 minutes of CO<sub>2</sub> discharge time.

One automatic timer cabinet should be provided for each protection zone and should be located at or near the valve being controlled. The emergency manual push-button located inside the door of the cabinet should only be used in the event of failure of the automatic or normal manual actuation devices.





## Low Pressure Carbon Dioxide

## Pressure-Operated Siren

▶ The pressure-operated siren (Part No. 437616) is used to warn personnel of a system discharge. The siren is operated with the nitrogen pressure from the pilot cylinder. The siren will operate at the start of the system actuation and will continue through most of the discharge time. The minimum decibel level of the siren at 10 ft (3.1 m) is 90 dB. A pipe hanger or bracket must be installed within one foot of the siren. The siren is listed for use with FM Approved systems.

### Material

Body: Brass  
 Grill: Steel  
 Screen: Stainless Steel

### Specifications

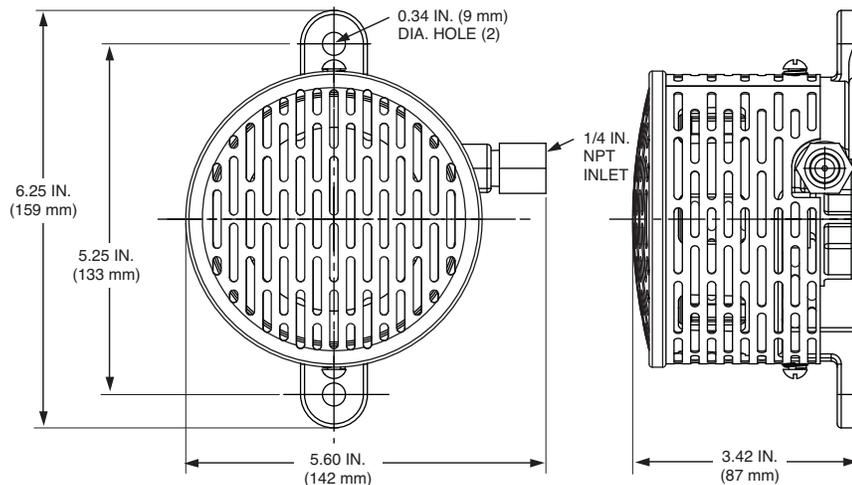
Flow Rate: 13.6 lb/minute (6.1 kg/minute)

#### Maximum Pipe Length:

- 240 ft (73.2 m) of 3/4 in. Schedule 40 pipe
- 430 ft (131.1 m) of 1/2 in. Schedule 40 pipe
- 675 ft (205.7 m) of 3/8 in. Schedule 40 pipe

Maximum Elbows: 30

Maximum Sirens: 5



**FIGURE 2-65**

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## Low Pressure Carbon Dioxide

## Pressure-Operated Air Horn

An air horn is used to provide an alarm either during the pre-discharge period or during a discharge of carbon dioxide. NFPA 12 requires a pneumatic audible alarm to warn personnel prior to a system discharge. When installed in conjunction with a time delay, the pneumatic air horn, Part No. 471672, meets these requirements. The air horn, when activated, will operate prior to the start of a system discharge and continue throughout the CO<sub>2</sub> discharge. The minimum decibel level of the siren at 10 ft (3 m) is 115 dB.

Vapor from the storage tank is regulated at 100 psi (6.9 bar) and is supplied to the air horn through the actuation line. The piping may be run directly from the actuation line, from the valve activating the time delay, or from the air horn port on the automatic timer cabinet. It is recommended that the horn be surface-mounted in a protected space. The ANSUL air horn is listed for use with FM Approved systems.

**Material:** Body – Brass

**Finish:** Red polyester urethane powder paint

**Sound Level:** 115 dB minimum at 10 ft (3 m) when installed in accordance with the following design requirements:

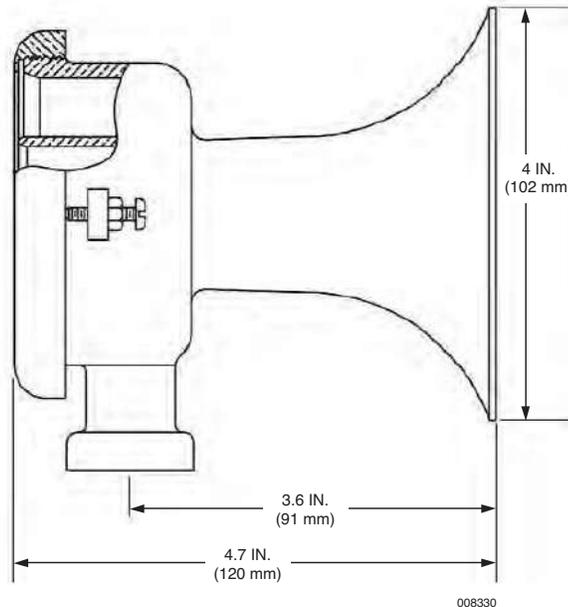
Required Pipe: 1/4 in. Schedule 40

Maximum Flow Rate: 1.35 lb/minute (0.62 kg/minute)

Maximum Sirens: 6

Maximum Pipe Length: 200 ft (61 m) minus 1 ft (0.3 m) for every elbow used

Design of the system must include the agent used through the siren if the siren is not located in the hazard area.

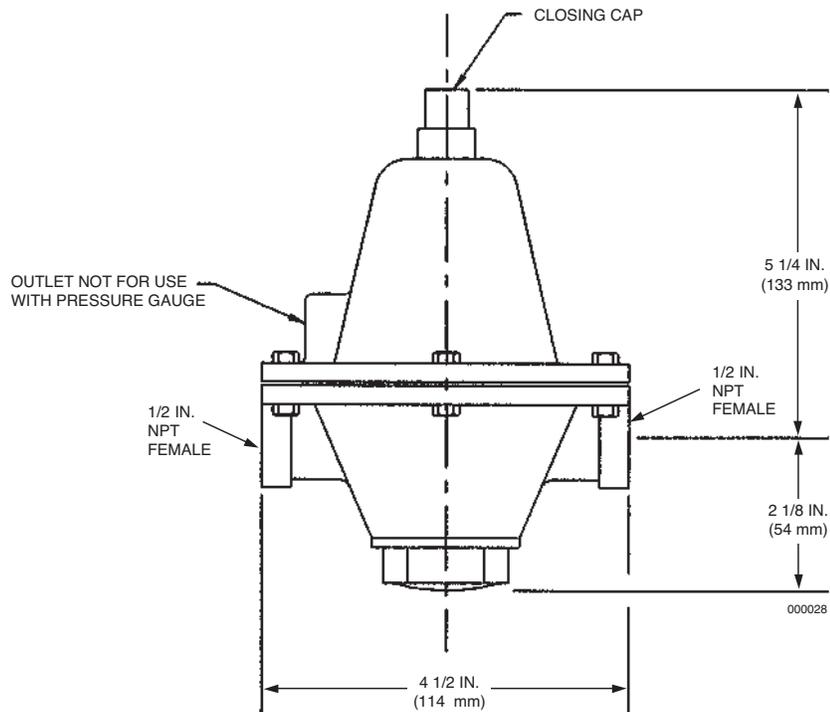




## Low Pressure Carbon Dioxide

## 1/2 In. Pressure Regulator 100 psi

The pressure regulator is a fully automatic pressure regulating valve. The regulator is installed in the pneumatic actuation line of bulk systems to maintain 100 psi (6.9 bar) operating pressure for the pneumatically actuated system valves. The regulator should be installed in the vapor process supply line at the storage unit. The regulator is constructed of brass. The regulator is listed for use with FM Approved systems and is NYC approved. Part No. 425259.





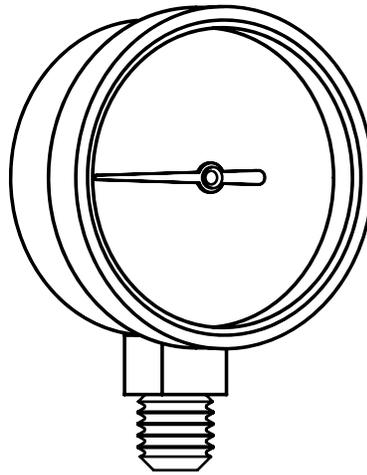


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## Low Pressure Carbon Dioxide

## 200 psi Pressure Gauge

The 200 psi (13.8 bar) Pressure Gauge (Part No. 425261) provides easy monitoring of the actuation line of a bulk system. The 1/4 in. NPT male connection is located on the bottom of the gauge. The gauge is set in 10 psi increments from 0 psi to 200 psi (0 – 13.8 bar). The gauge is listed for use with FM Approved systems.



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**Low Pressure Carbon Dioxide**

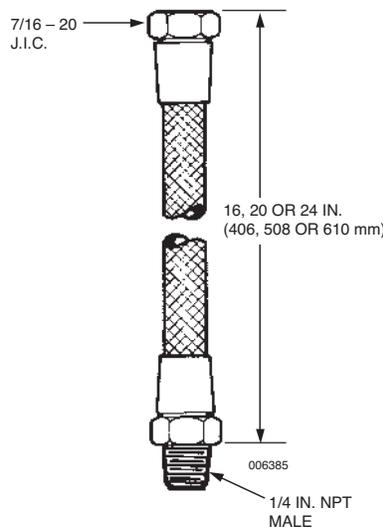
**Pneumatic Hoses and Fittings**

**Stainless Braid-Covered Actuation Hose**

These 3/16 in. ID hoses are constructed from Teflon tubing with a stainless steel wire braid cover. There is a 7/16-20 female swivel on one end and a 1/4 in. NPTM on the other end. The minimum bending radius for the actuation hoses is 27/32 in. (21 mm). The hoses are listed for use with FM Approved systems.

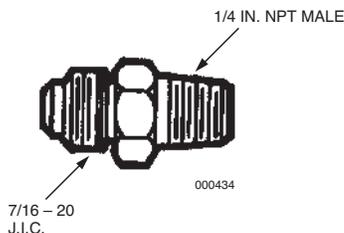
They may be used anywhere in the system where flow is not a concern. Typically, they are used to connect pressure switches and master/selector valve actuation lines.

Part No.	Description
73596	12 in. (305 mm)
73597	16 in. (406 mm)
73598	20 in. (508 mm)
415142	32 in. (813 mm)
430815	42 in. (1067 mm)



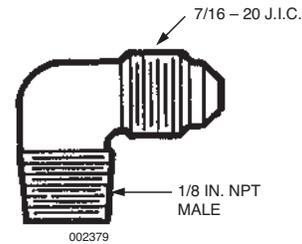
**Male Connector (1/4 in.)**

The brass connector, Part No. 32338, is used to adapt from pipe to the stainless braid-covered hose in a pneumatically-actuated system.



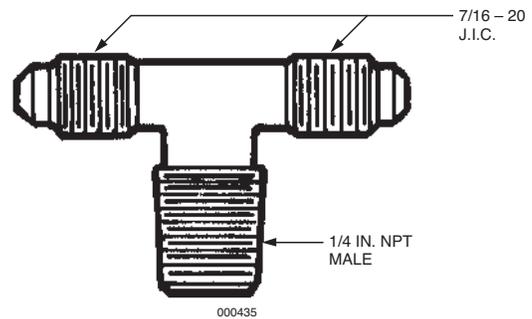
**Male Elbow (1/8 in.)**

The brass elbow, Part No. 32334, is a 90° adaptor from 1/8 in. pipe threads to the stainless braid-covered threads.



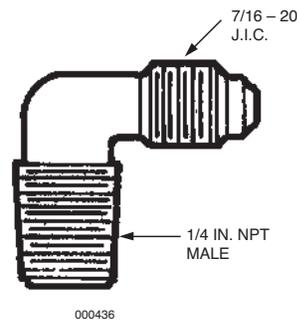
**Male Branch Tee (1/4 in.)**

The brass tee, Part No. 31811, is used to adapt from pipe threads to the stainless braid-covered threads.



**Male Elbow (1/4 in.)**

The brass elbow, Part No. 31810, is a 90° adaptor from 1/4 in. pipe threads to the stainless braid-covered threads.





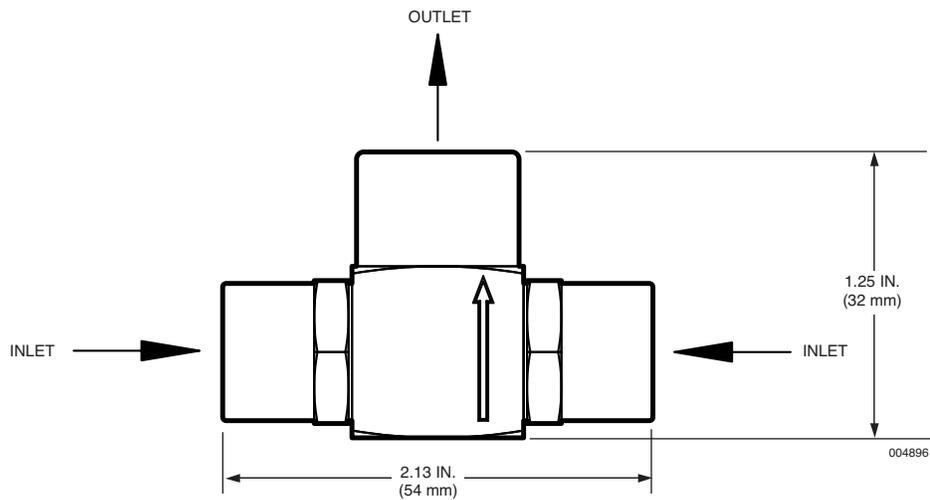
## Low Pressure Carbon Dioxide

## 1/4 In. Shuttle Valve

The 1/4 in. Shuttle Valve, Part No. 427266, is a mechanical device which allows the inlet pressure from either of two supply sources to flow to a common outlet. When pressurized, the center ball travels within the center chamber. This permits flow out of a common outlet port, while blocking the opposing inlet port.

The shuttle valve is often used to integrate multiple actuation (pilot) lines for a common storage source. Other applications include pressure supply transfer to pressure trips and pressure switches.

- ▶ The shuttle valve has a brass body and is suitable for 1/4 in. NPT connections on all 3 ports. The shuttle valve is listed for use
- ▶ with FM Approved systems.

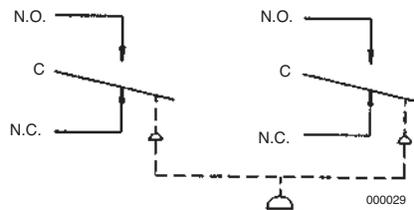
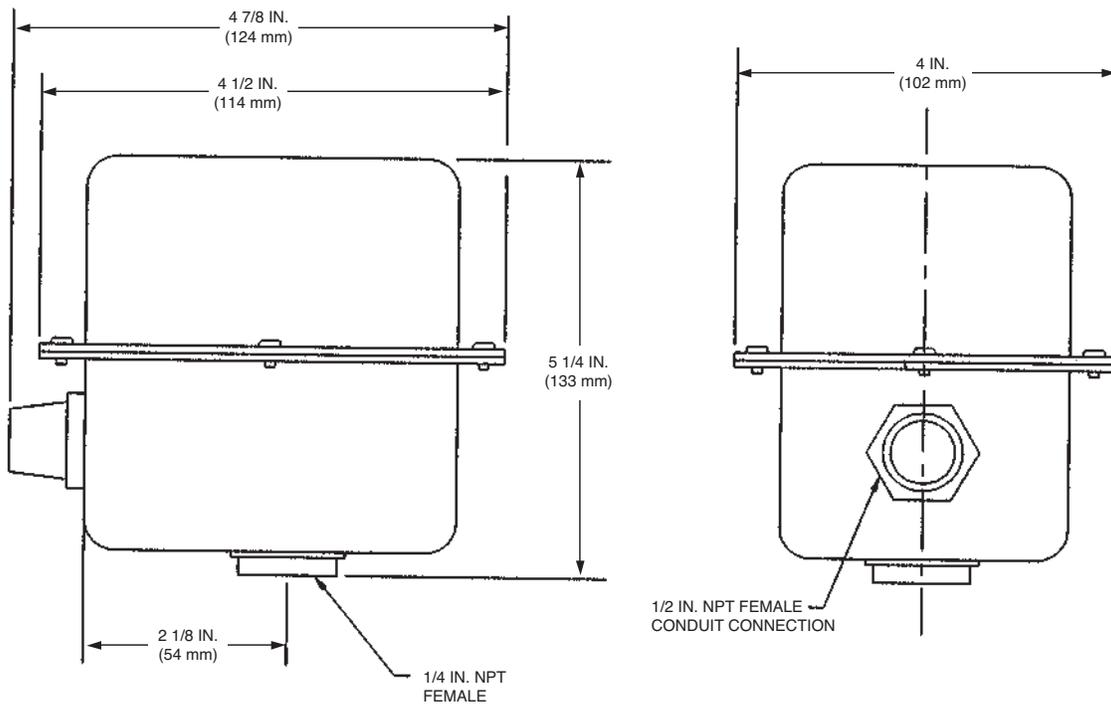




**Low Pressure Carbon Dioxide**

**Actuation Line Supervisory Pressure Switch**

The actuation line supervisory pressure switch is a two level, self-restoring pressure switch which shall be installed in the pneumatic actuation piping of bulk systems at the most remote point in the system. The first set of contacts will close on loss of pneumatic pressure below 80 psi (5.5 bar). If the pressure continues to drop to 70 psi (4.8 bar), a second set of contacts will close and cause a second indication at the annunciation panel. The pressure switch is listed for use with FM Approved systems and is NYC Approved. Part No. 425125.





## Low Pressure Carbon Dioxide

## Supervisory Non-Latching Pressure Switch

The supervisory non-latching pressure switch is a self-restoring pressure switch which shall be installed in the pneumatic actuation piping of bulk systems at the most remote point in the system. The contacts will close on loss of pneumatic pressure below 80 psi (5.5 bar).

- ▶ The non-latching pressure switch, Part No. 425733, may be used on discharge lines. This device is not listed for use with FM Approved systems. The switch utilizes a piston sensor to detect a pressure change. The response, at a predetermined set point of 80 psi (5.5 bar), actuates a SPDT snap-acting switch, converting a pressure signal into an electrical signal. The control setpoint may be varied by turning the internal slotted adjustment screw bushing. To attach the pressure switch to a conduit connection, hold the electrical connection steady with a wrench on the flats hex, then attach the conduit.

**Caution:** Use wrench on Hex at the end being loosened or tightened. For installation into piping use the Hex adjacent to the 1/4 in. NPT thread. For connection of conduit fittings use the Hex adjacent to the 1/2 in. NPT. Using the opposing Hex will cause damage to the pressure switch.

### Adjustments:

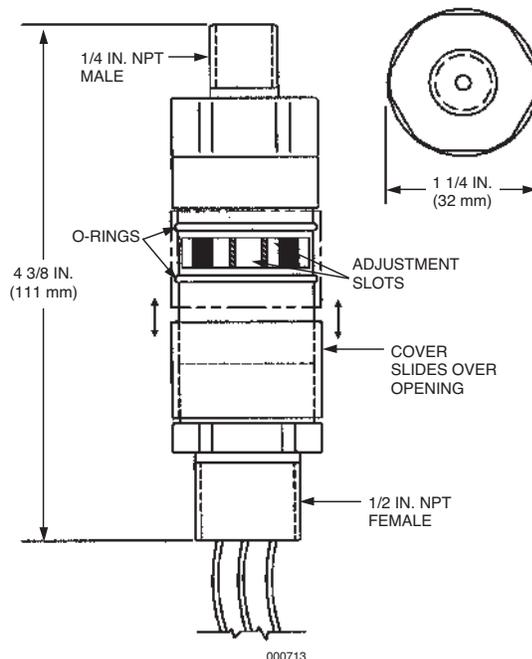
1. Connect the pressure switch to a pressure source.
2. With power disconnected, slide the cover towards the electrical terminations while twisting it to overcome friction.
3. Connect power or an ohm meter to the leads.
4. Insert a screwdriver into the adjustment slot and turn the internal adjustment nut left (clockwise) to increase the setting or right (counterclockwise) to decrease the setting.
  - A. For setting on rise of pressure, apply the desired pressure and turn the internal adjustment nut left until the switch transfers (circuit across the N.O. and the COM terminals closes).
  - B. For setting on fall of pressure, apply pressure equal to the normal system operating pressure. Reduce the source pressure to the setpoint value. Turn the internal adjustment nut right until the switch transfers (circuit across the N.C. and the COM closes).
5. After completing the adjustments, slide the cover closed over the adjustment compartment. Recheck the set point.

### Terminations (18 in. (457 mm) leads, 18 AWG):

- N.O. Blue
- N.C. Black
- COM Violet

Operating Range: 10 to 150 psi (0.69 to 10.3 bar)

Valve preset @ 80 psi (5.5 bar) pressure drop





## Low Pressure Carbon Dioxide

## Pressure Switch – 3PDT

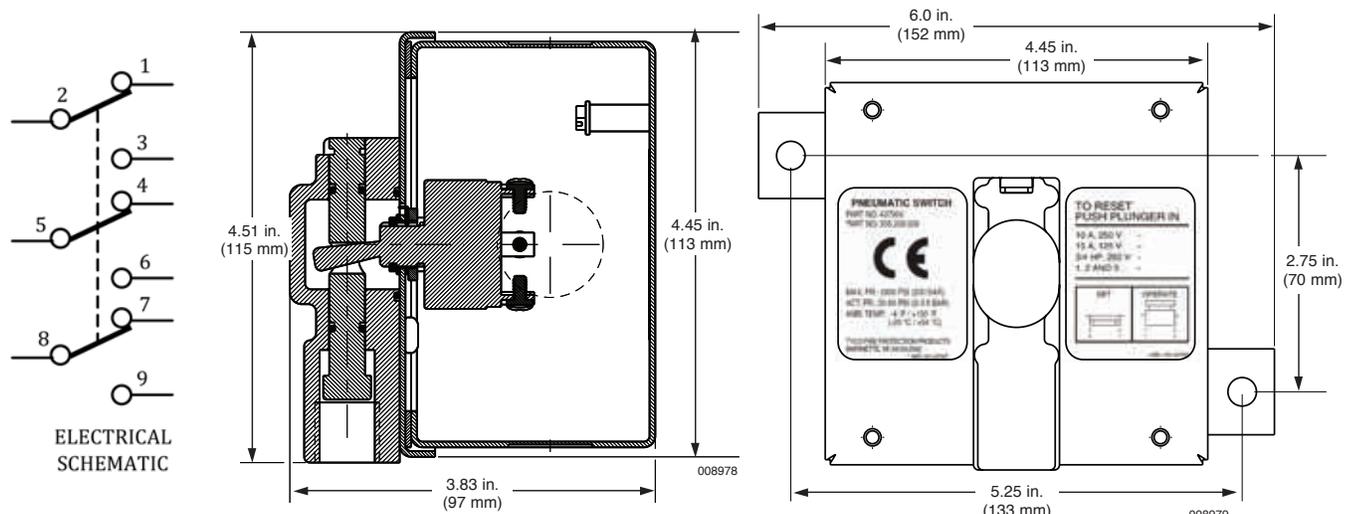
### Description

The pressure switch is operated by carbon dioxide pressure when the system is discharged. The pressure switch can be used to open or close electrical circuits to shut down equipment (single or 3-phase) or turn on lights or alarms. The housing is constructed of 16 ga. steel, painted red, and is rated IP65 for dust and water ingress. The 3/8 in. NPT brass pressure inlet is used to connect the pressure switch to the suppression system.

Minimum operating pressure is 50 psi (3.5 bar).

Shipping Assembly Part No.	Description
437900	Pressure switch – 3PDT

Component	Material	Thread Size/Type	Electrical Rating	Approvals
Pressure Switch 3PDT	Switch: Nickel-plated Brass Housing/Cover: C.R. 16 ga. steel Plunger: Stainless Steel Pressure Port: C37700 Brass	Conduit Inlets: 3/4 in. and 1/2 in. Pressure Inlet: 3/8 in. NPT Female	10A, 250 VAC 15 A, 125 VAC  3/4 HP, 250 VAC 1-, 2-, and 3-phase	Listed for use with FM Approved systems







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## Low Pressure Carbon Dioxide

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## Low Pressure Carbon Dioxide

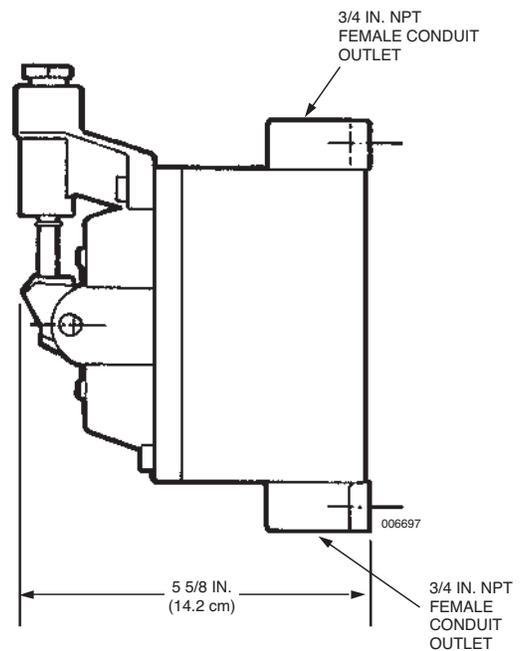
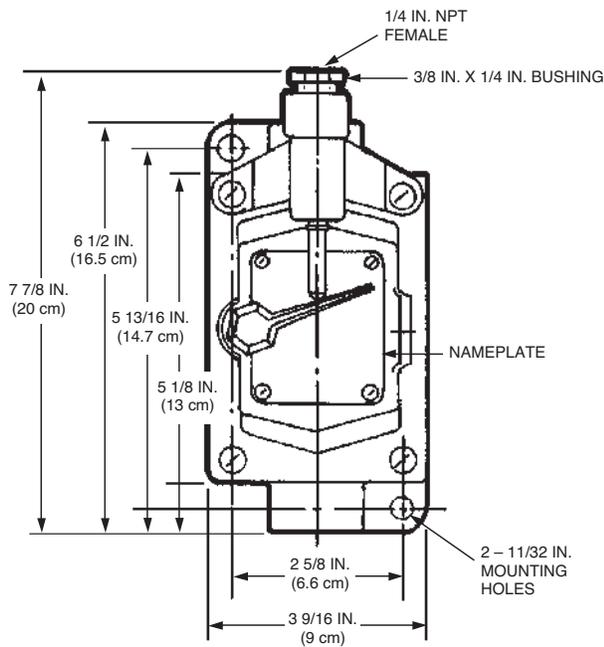
## Pressure Switch – DPDT

The pressure switch is operated by carbon dioxide pressure when the system is discharged. The pressure switch can be used to open or close electrical circuits to either shut down equipment or turn on lights or alarms. The double pole, double throw (DPDT) pressure switch is constructed with a sealed enclosure. A 1/4 in. NPT pressure inlet is used to connect the 1/4 in. pipe from the carbon dioxide system. The pressure switch latches when activated and requires manual resetting.

Shipping Assembly Part No.	Description
43241	Pressure switch – DPDT

Trip pressure approx. 50 psi (3.5 bar)

Component	Material	Thread Size/Type	Electrical Rating	Approvals
Pressure Switch DPDT	Housing: Malleable Iron	Conduit Inlet: 3/4 in. NPT Female Pressure Inlet: 1/4 in. NPT Female	10A 125 VAC 5A 250 VAC	Listed for use with FM Approved systems





## Low Pressure Carbon Dioxide

## Pressure Relief Valves

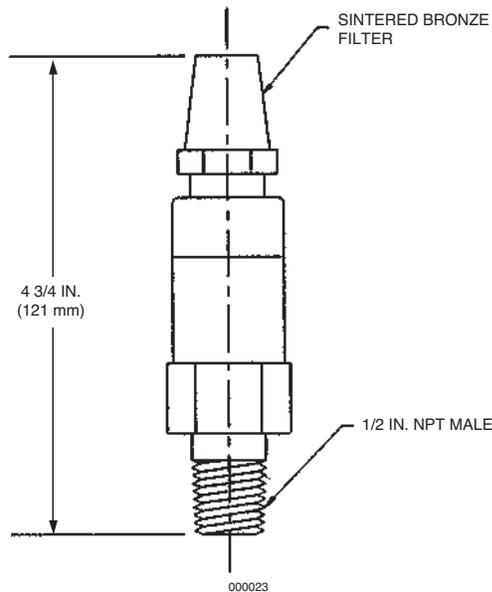
There are two (2) styles of pressure relief valves that may be provided with the system. A 150 psi (10.3 bar) pressure relief valve shall be installed in the actuation line at any point between the regulator and the supervisory pressure switch if applicable. In addition, a 450 psi (31.0 bar) pressure relief valve shall be installed within the system piping network, where trapped CO<sub>2</sub> pressure could exist. The pressure relief valves are equipped with a filter to prevent blockage of the relief port.

▶ The relief valves are listed for use with FM Approved systems.

If any reliefs are in an enclosed area where there is a potential for CO<sub>2</sub> buildup, they must be vented to a safe area (i.e. outdoors). Remove the filter, attach a threaded pipe and relocate the filter to the end of the pipe run.

**⚠ CAUTION**

Clogging of this filter will adversely affect the performance of the relief valve.



Part No.	Description
425251	150 psi (10.3 bar) Pressure Relief Valve
▶ 425252	350 psi (24.1 bar) Pressure Relief Valve
425253	450 psi (31.0 bar) Pressure Relief Valve



## Low Pressure Carbon Dioxide

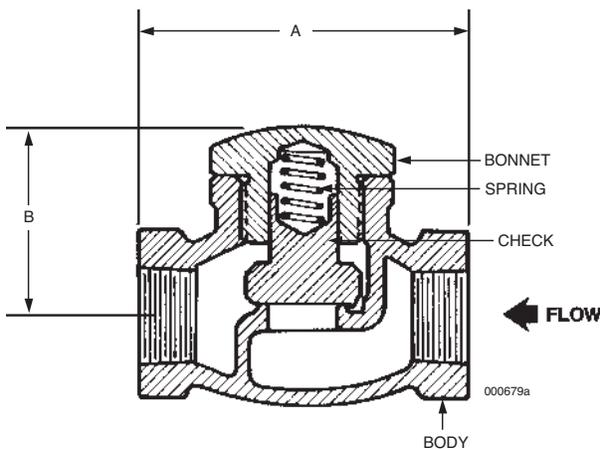
## 1/2 In. – 3 In. Check Valves

Check valves are available in sizes from 1/2 in. through 3 in. Three body styles are available: threaded, weld neck flange, and threaded flange. The weld neck flange style valves are supplied with two (2) Class 600 ANSI weld neck, flat faced, forged steel flanges, complete with bolts, nuts and gaskets. Check valves can be used in multi-tank mini-bulk systems to protect against loss of agent during a discharge if a tank is temporarily removed from the manifold for servicing. They are also used in bypass lines of master valves.

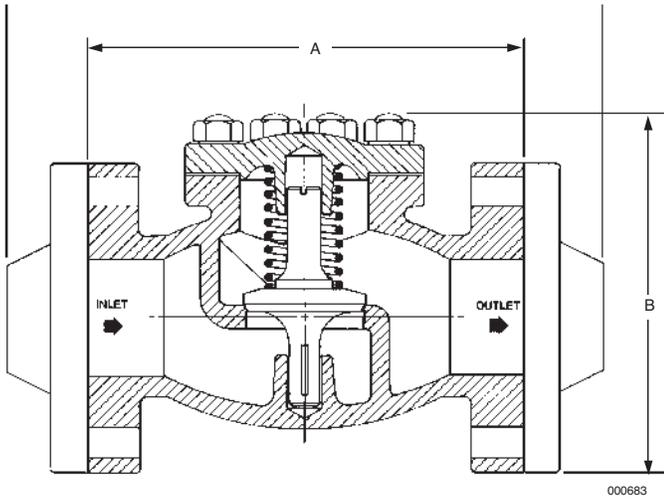
Threaded check valve bodies are constructed of bronze and contain female NPT threads.

Weld neck flange and the 3 in. threaded flange check valve have a bronze body with a steel flange. The check valves are listed for use with FM Approved systems.

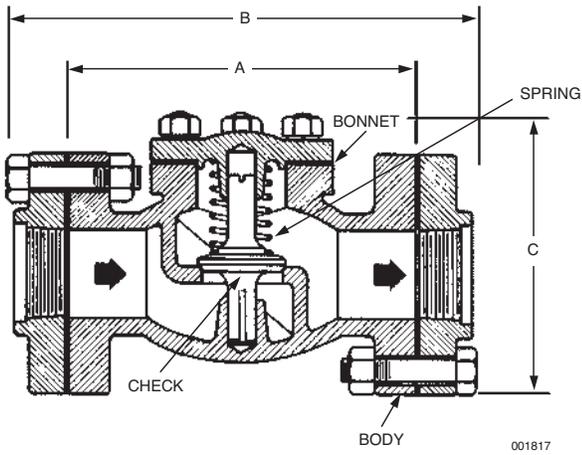
Part No.	Description
40860	1/2 in. check valve – threaded
40852	3/4 in. check valve – threaded
41470	1 in. check valve – threaded
41549	1 1/4 in. check valve – threaded
41463	1 1/2 in. check valve – threaded
40649	2 in. check valve – threaded
40656	2 1/2 in. check valve – threaded
40794	2 in. check valve – weld neck flange
46095	2 1/2 in. check valve – weld neck flange
40672	3 in. check valve – weld neck flange
40665	3 in. check valve – threaded flange



Check Valve - Threaded				
Valve Size	Dimension A		Dimension B	
	in.	(cm)	in.	(cm)
1/2 in.	3	(7.6)	2 5/8	(6.6)
3/4 in.	3 5/8	(9.2)	3 1/8	(7.9)
1 in.	4 1/8	(10.4)	3 3/4	(9.5)
1 1/4 in.	5	(12.7)	4 1/2	(11.4)
1 1/2 in.	5 1/2	(13.9)	5 1/8	(13)
2 in.	6 1/2	(16.5)	5 3/4	(14.6)
2 1/2 in.	8	(20.3)	6 3/4	(17.1)



Check Valve - Flanged				
Valve Size	Dimension A		Dimension B	
	in.	(cm)	in.	(cm)
2 in.	10 1/4	(26)	7 1/2	(19)
2 1/2 in.	10 3/4	(27.3)	8 11/16	(22.1)
3 in.	11 1/2	(29.2)	9 1/2	(24.1)



Check Valve - Threaded Flange						
Valve Size	Dimension A		Dimension B		Dimension C	
	in.	(cm)	in.	(cm)	in.	(cm)
3 in.	11 1/2	(29.2)	15	(38.1)	9 1/2	(24.1)



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## Low Pressure Carbon Dioxide

## Odorizer and Nameplate

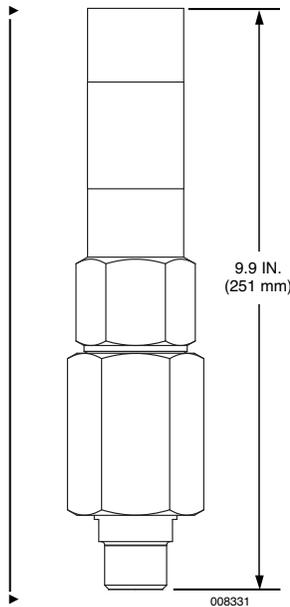
The odorizer, Part No. 42278, is used to inject a small amount of wintergreen scent into the carbon dioxide while flowing through the piping network. When carbon dioxide discharges into the hazard area, it will carry a scent of wintergreen with it. This wintergreen scent is a warning to personnel entering the hazard area that the area contains a concentration of carbon dioxide and precautions must be taken: either leave the area immediately or secure proper breathing apparatus. The internal ampoule containing the oil of wintergreen in the odorizer must be replaced after each system discharge. Unit must be installed in an upright position as the last component in the piping system before the nozzle.

### Shipping Assembly

<u>Part No.</u>	<u>Description</u>
42278	Odorizer
42284	Replacement ampoule
42280	Nameplate
▶ 428271	Replacement Burst Disc Assembly

**Material:** Steel

▶ **Thread Size/Type:** 3/4 in. NPT Male



# ODORIZING UNIT

**Part No. 42278**

**INSTALL UNIT UPRIGHT**

AFTER USE, REMOVE ASSEMBLY AND UNSCREW RUPTURED BURST DISC. REMOVE CAP AND CLEAN OUT BROKEN AMPOULE. USING REPLACEMENT KIT PART NO. 42284 REPLACE AMPOULE AND BURST DISC. SCREW CAP DOWN TIGHT AND REINSTALL ASSEMBLY.

TYCO FS&BP  
MARINETTE, WI 54143-2542  
715-735-7411

LABEL NO. 42280-05

002378



**Low Pressure Carbon Dioxide****Pressure Trip**

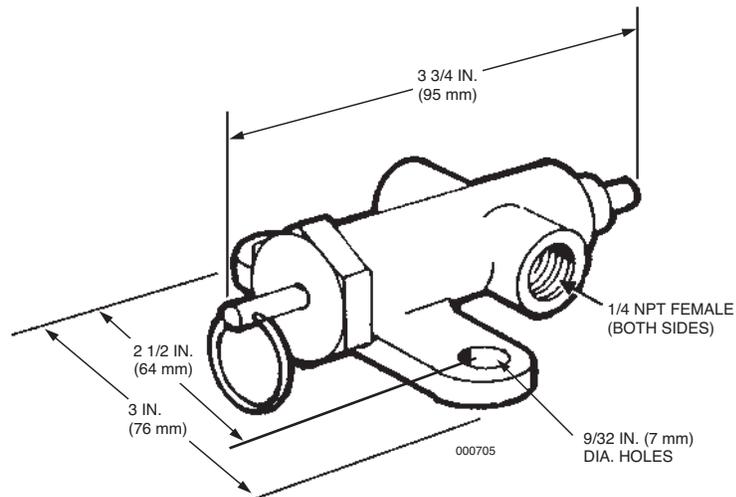
The function of the pressure trip, Part No. 5156, is to set off a counterweight or spring-loaded mechanical device which closes doors, windows, or dampers upon actuation of the system.

The pressure trip is connected to the discharge line of a carbon dioxide system. By either pneumatic or manual actuation, the pressure trip can release spring or weighted devices to close doors, windows, open fuel dump valves, close fire dampers or close fuel supply valves. The pressure trip is constructed of brass with two 1/4 in. NPT fittings for connection to discharge lines. The link on the pressure trip is released either pneumatically, by agent discharge pressure; or manually, by use of the pull ring. The link then releases the device which performs the auxiliary functions. The pressure trip is listed for use with FM Approved systems.

**Note:** Operating pressure must be a minimum of 75 psi (5.2 bar)

Maximum load is 70 lb (31.8 kg).

**Material:** Brass





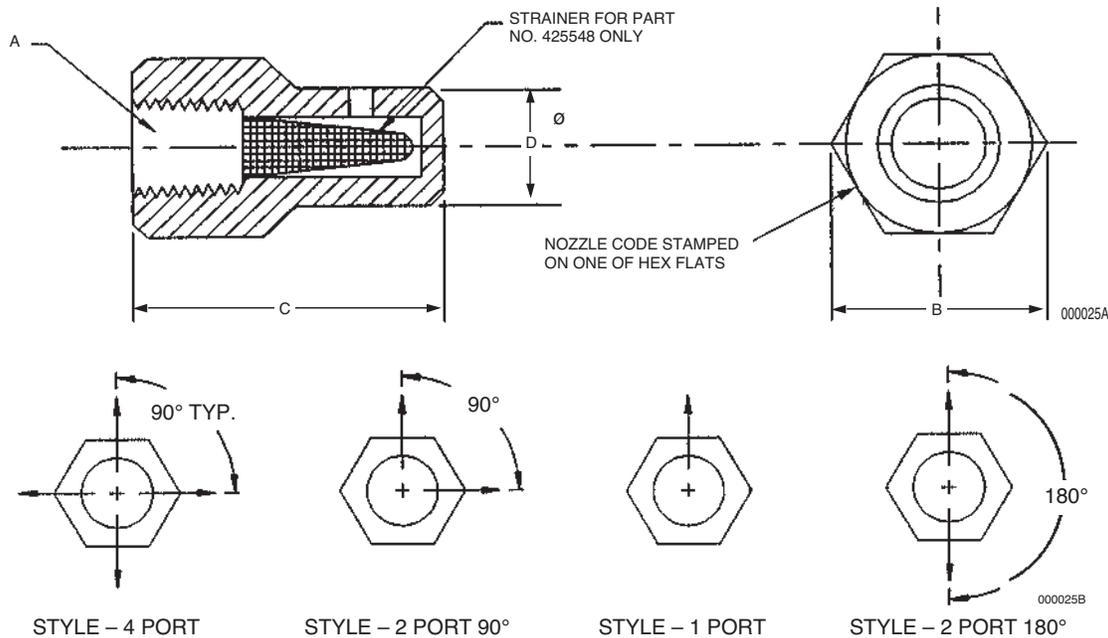
## Low Pressure Carbon Dioxide

## Radial Nozzle

Radial nozzles are limited to use on total flooding applications. The nozzles are constructed of brass and are factory drilled in 1/2 code increments. Strainers will be provided for the lower orifice code 1/2 in. nozzles. The nozzles are listed for use with FM Approved systems.

When ordering, designate code number, number of ports (4, 2 or 1) and port orientation for the 2-port nozzle (90° or 180°).

Dimensions									
Size	Part No.	A		B		C		D	
		in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
1/2 in.	425288	1/2	(13)	1 1/8	(29)	2 5/32	(55)	1	(25)
3/4 in.	425289	3/4	(19)	1 3/8	(35)	2 15/32	(63)	1 1/4	(32)
1 in.	425290	1	(25)	1 5/8	(41)	2 7/8	(73)	1 1/2	(38)
1 1/4 in.	425291	1 1/4	(32)	2	(51)	3 19/32	(91)	1 7/8	(48)
1 1/2 in.	425292	1 1/2	(38)	2 1/4	(57)	3 7/8	(98)	2 1/8	(54)
2 in.	425293	2	(51)	3	(76)	4 11/16	(119)	2 7/8	(73)



**Radial Flow Orifice Arrangement (End View)**  
Arrows Indicate Port Direction

Code Range				
Size	Part Number	4 Port	2 Port	1 Port
1/2 in.	425548*	4.0-6.0	3.0-4.5	2.5-3.0
1/2 in.	425288	6.5-13.0	5.0-13.0	4.5-13.0
3/4 in.	425289	6.5-22.0	6.5-22.0	6.5-22.5
1 in.	425290	7.5-28.5	7.5-29.0	8.0-27.0
1 1/4 in.	425291	11.5-39.5	11.5-38.0	11.5-39.5
1 1/2 in.	425292	14.0-45.0	14.0-45.5	14.0-38.0
2 in.	425293	17.5-54.5	17.5-51.5	17.5-37.0
*With Strainer				



## Low Pressure Carbon Dioxide

## Discharge Nozzle – Regular Type

### Description

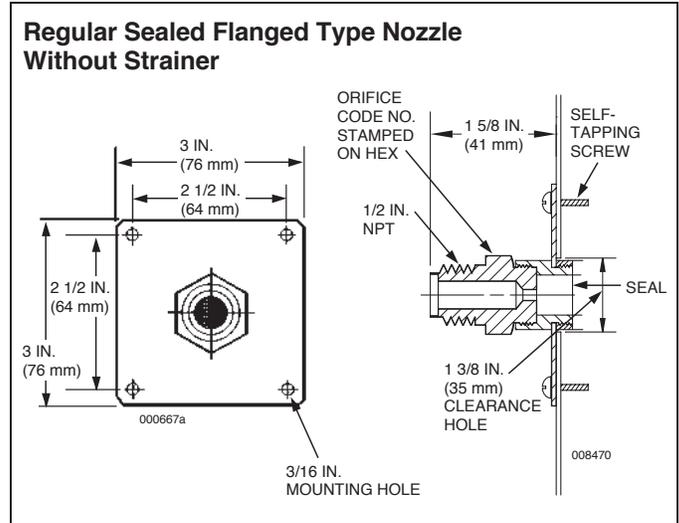
The regular type nozzle is used for total flooding applications only. The nozzle has a sealing disc retaining ring and a frangible seal to prevent foreign matter from entering and plugging the nozzle orifice. The discharge rate of the regular nozzle depends on nozzle pressure and orifice size. The regular type nozzle provides orifice sizes of 3 through 12.

The nozzle is available with 1/2 in. NPT threads.

The nozzle is supplied in natural brass with a plated steel flange. The nozzle is listed for use with FM Approved systems.

Shipping Assembly Part No. Brass	Description	Orifice Code
426117	Regular sealed with flange nozzle	3 – 12
45699	Spare Seal Kit (10 disks and 2 washers)	

**Note:** When ordering, specify orifice code required: Example – Part No. 426117 – 9.5.





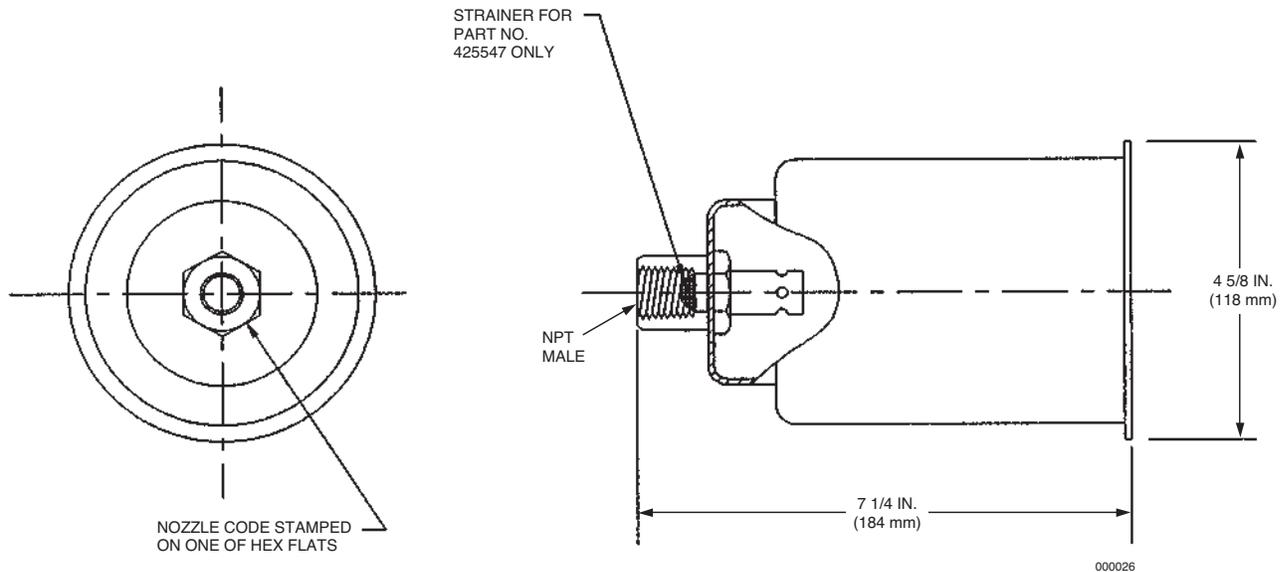
## Low Pressure Carbon Dioxide

## 4 In. Short Range (SR) Nozzle

SR nozzles can be used in total flooding or local application systems. SR nozzles may be used in total flood systems where a “cushioned” discharge is required. Selection of the SR nozzles should be within the flow-rate of 20 to 150 lb/min. (9.1 to 68.0 kg/min.) when used on total flood systems. When SR nozzles are used for local application, the area of coverage and height above the hazard determines the flow rates which are shown on the nozzle chart in the nozzle section of the design manual. For local application rate-by-volume method, the flow rates shall be between 10 to 130 lb/minute (4.5 to 59 kg/minute).

There are two (2) sizes of SR nozzles: 1/2 in. NPT and 3/4 in. NPT. The nozzle has a brass discharge tip and a steel shell with a red enamel finish. Nozzles are factory drilled in 1/2 code increments. Strainers are only provided for those nozzles with an orifice diameter less than 1/8 in. (Code 6.5). The nozzles are listed for use with FM Approved systems.

Size	Part Number		Code Range
	Brass	Stainless Steel (not FM Approved)	
1/2 in.	425547	433058	4.5-6.0
1/2 in.	425274	433058	6.5-17.0
3/4 in.	425275	433057	6.5-22.0







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## Low Pressure Carbon Dioxide

## Discharge Nozzle – Type “D”

The type “D” nozzle is used primarily for local application (rate-by-volume) and is also listed and approved for use as a total flooding nozzle. The nozzle shell is drawn carbon or stainless steel and the insert is brass or stainless steel. The “D” type nozzle is available in orifice sizes ranging from 1 through 7. The discharge rate of the nozzle depends on the orifice size and nozzle pressure. The area covered in local application is dependent upon the discharge rate and the height of the nozzle above the surface being protected. Height range: 15 to 91 1/2 in. (38 to 232 cm). Discharge rate: 11 to 48.5 lb per minute (5 to 22 kg per minute). See carbon dioxide design manual for FM Approved flow rates. The carbon steel nozzle is painted red with chrome.

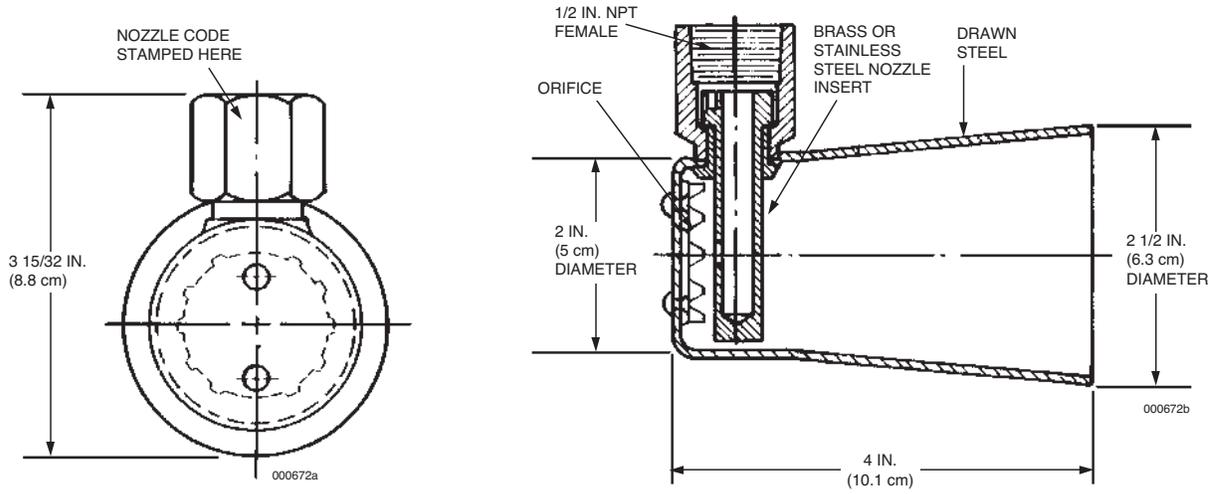
Component	Material	Thread Size/Type	Orifice Size	Approvals
▶ Type “D” nozzle	Shell: Steel Insert: Brass Strainer: Monel	1/2 in. NPT Female	1 through 7	Listed for use with FM Approved systems

Shipping Assembly		Description	Orifice Code
Part No. Standard	Stainless Steel* (not listed for use with FM Approved systems)		
426100	428103	Type “D” nozzle with strainer	1 – 3
426101	428104	Type “D” nozzle	3.5 – 7
426301		Type “D” nozzle, Chrome Plated	3.5 – 7

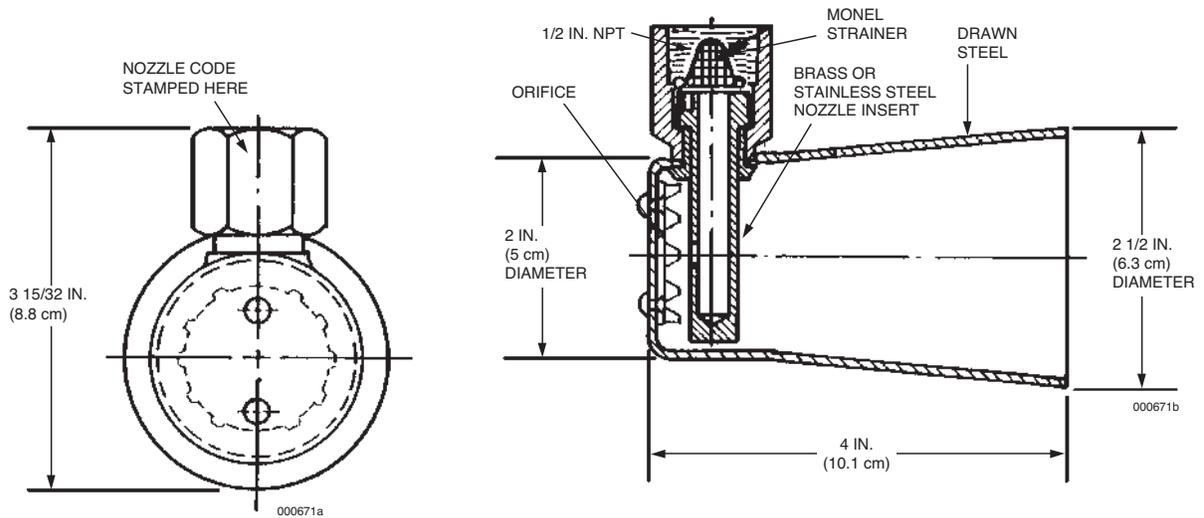
**Note:** When ordering, specify orifice code required: Example – Part No. 426100 – 2.5.

\* Completely stainless steel – except strainer.

## Carbon Dioxide Type "D" Discharge Nozzle



## Carbon Dioxide Type "D" Discharge Nozzle with Strainer



## Low Pressure Carbon Dioxide

## Discharge Nozzle – Type “D” (Corrosion Resistant)

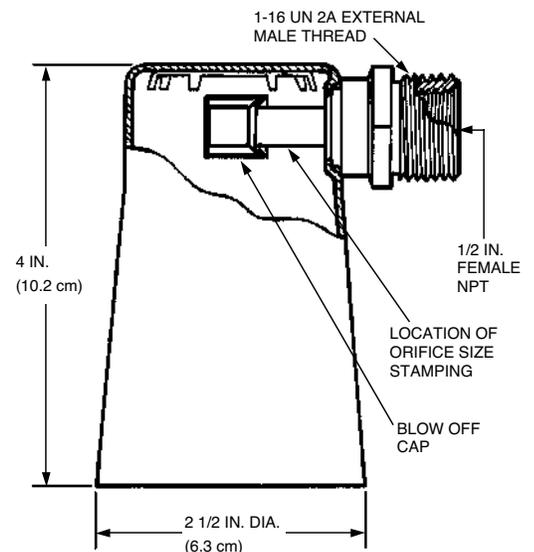
The corrosion resistant (CR) type “D” nozzle is used primarily for local application wet bench protection but is also approved for use as a total flooding nozzle. The nozzle shell is drawn sheet steel and the insert is stainless steel. The entire nozzle is coated with a corrosion resistant material which is not effected by the acid type environment of a typical wet bench hazard. The CR “D” type nozzle is available in orifice sizes ranging from 1 through 7. Nozzle shipping assembly includes a blow off cap. Cap should be installed using special tool, Part No. 426206.

Also available is a plastic nozzle tube adaptor which can be threaded on the external nozzle threads and plastic tubing can be attached to this to cover the discharge piping within the corrosive environment.

The discharge rate of the nozzle depends on the orifice size and nozzle pressure. The area covered in local application is dependent upon the discharge rate and the height of the nozzle above the surface being protected. Height range: 24 to 33 in. (61 to 84 cm). Discharge rate: 16.4 to 21.8 lb per minute (7.4 to 9.9 kg per minute). See carbon dioxide design manual for FM Approved flow rates

Component	Material	Thread Size/Type	Orifice Size	Approvals
Type “D” nozzle	Shell: Steel Insert: Stainless Steel Strainer: Monel Assembly coated with acid resistant material (Halar® ECTFE)	1/2 in. NPT Female	1 through 7	Listed for use with FM Approved systems*
Blow Off Cap	Teflon® (TFE)			

Shipping Assembly Part No.	Description	Orifice Code
422647	Type “D” nozzle with strainer	1
422648	Type “D” nozzle with strainer	1+
422649	Type “D” nozzle with strainer	2
422650	Type “D” nozzle with strainer	2+
422651	Type “D” nozzle with strainer	3
422652	Type “D” nozzle	3+
422653	Type “D” nozzle	4
422654	Type “D” nozzle	4+
422655	Type “D” nozzle	5
422656	Type “D” nozzle	5+
422657	Type “D” nozzle	6
422658	Type “D” nozzle	6+
422659	Type “D” nozzle	7
422888	Pipe Seal Adaptor	
422890	Spare Blow Off Cap (1)	



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► **Note:** For non-typical wet bench environments, contact the Technical Services Department.

\*FM APPROVAL limited to non-corrosive environments.



## Low Pressure Carbon Dioxide

## Hose Reel Stations

The carbon dioxide hose reel can be used in areas that normally do not require fixed pipe systems, or as a back up to a fixed pipe system. When used as a back up, provisions must be made to have self-contained breathing apparatus available for anyone entering the hazard area immediately after the fixed system discharge. A dedicated master valve located at the storage tank is needed to serve one or more hosereels. Wherever liquid CO<sub>2</sub> may be trapped between components, a 450 psi (31 bar) pressure relief device shall be installed in the piping between the components.

Pushing the start button opens the hosereel master valve and floods the hose reel header up to the playpipe valve. Personnel control the discharge of carbon dioxide with the manual valve on the playpipe. The initial discharge of CO<sub>2</sub> will be in vapor form that will change to liquid once the pipe and hose become chilled. To reduce the time of the vapor discharge a bleeder valve can vent the carbon dioxide vapor for a predetermined interval. The effective projection range is approximately 20-30 ft (6.1-9.1 m) depending on the nozzle orifice and pressure. Pushing the stop button causes the master valve to close.

When ordering a hose reel, include nozzle code #18 with part number.

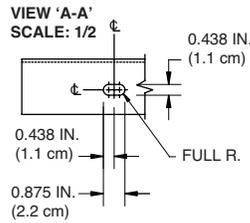
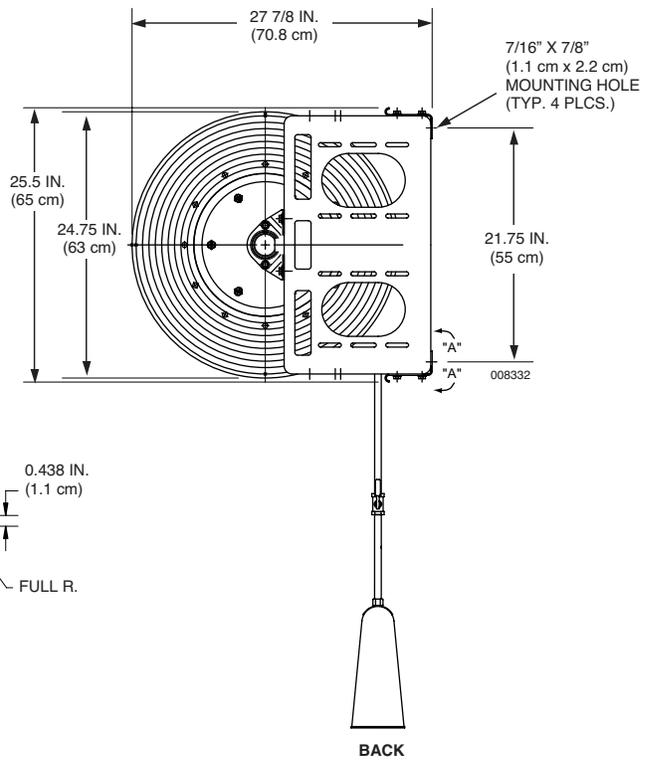
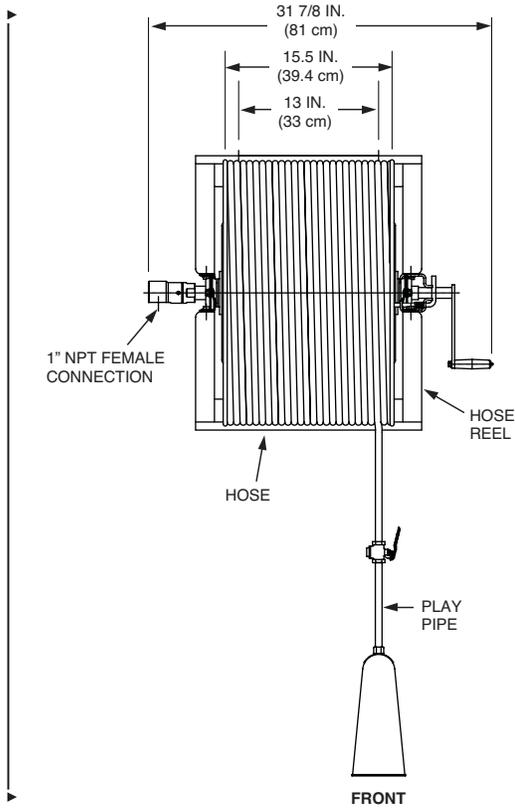
- ▶ The hose reel stations are listed for use with FM Approved systems.

Part No.	Description
▶ 425301	Hose Reel Assembly, 1 in. x 100 ft (30.5 m) hose
▶ 425304	Hose Reel Assembly, 1 in. x 150 ft (45.7 m) hose

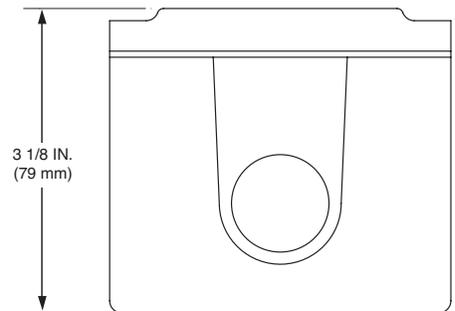
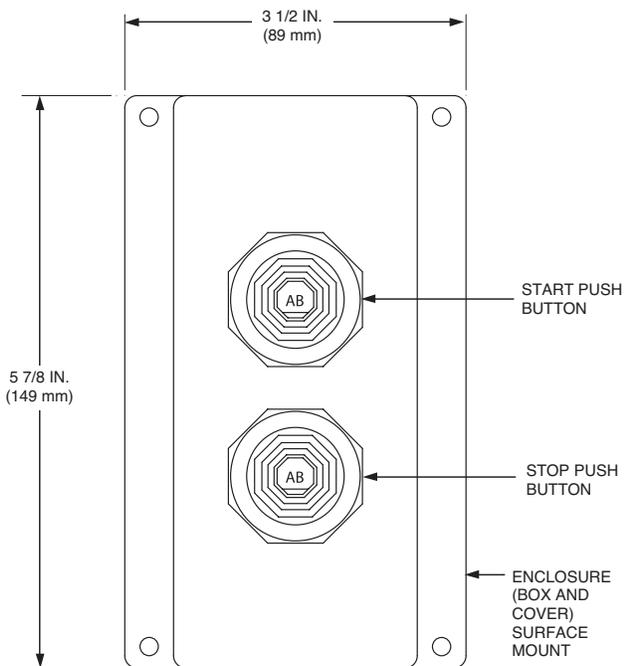
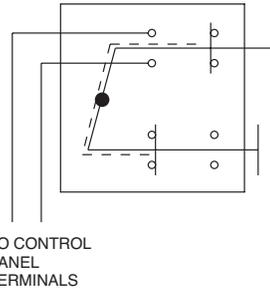
The hose reel assembly is shipped with the following components:

Part No.	Description
▶ 436197	Hose Reel
425313	Operation Hose Reel Sign
425423	Warning Sign
▶ 425253	1/2 in. NPT 450 psi (31 bar) Relief Valve Assembly
425177	Playpipe
425266	Start/Stop Station
▶ 425463	1 in. x 100 ft (30.5 m) Hose
OR	
▶ 425178	1 in. x 150 ft (45.7 m) Hose





**ON/OFF STATION WIRING DIAGRAM**



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## Low Pressure Carbon Dioxide

## Electric Manual Release Stations

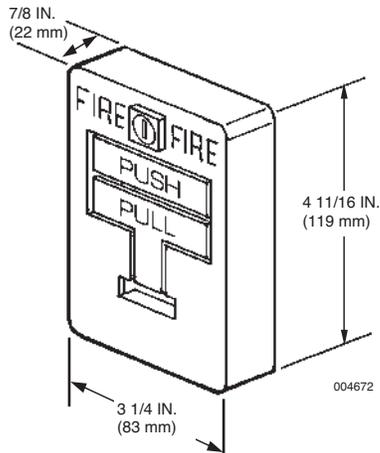
The release station on a carbon dioxide system is used to provide release of the system or master/selector valve from a manually operated remote station.

The T-handle release station is operated by pushing in the top bar and pulling the handle on the front of the station as far down as it will go; at which point the handle locks into place and is easily visible from up to 50 ft (15.2 m). Opening the station with the key, placing the handle in the normal upright position and re-locking the station resets the pull station.

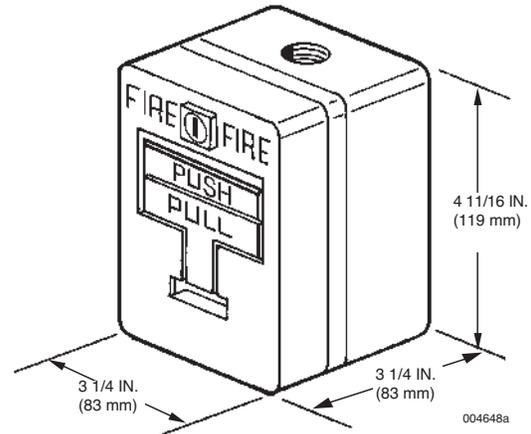
The electric manual release station is FM Approved.

Part No.	Description
428655	Electric Manual Release Station, SPST
428656	Electric Manual Release Station, DPST
428659	Weatherproof Backbox
428661	Break Rod
418336	Key

STANDARD PULL STATION



WEATHERPROOF PULL STATION





## Low Pressure Carbon Dioxide

## Warning Signs and Plates

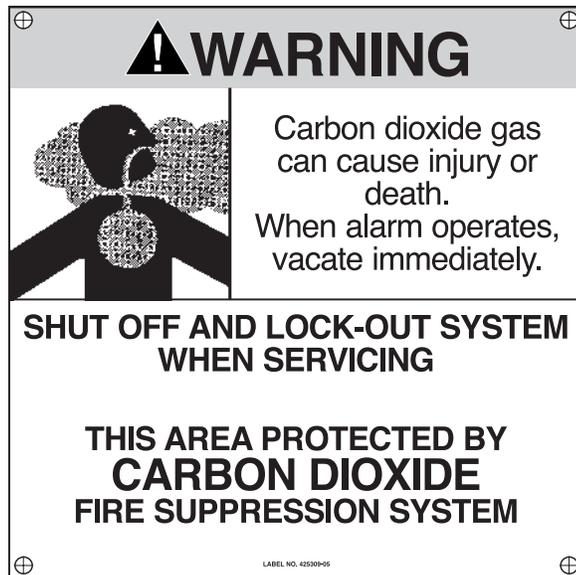
The following warning plates are required either inside or outside the hazard area to warn personnel that the space is protected by a carbon dioxide system and no one should enter after a discharge without being properly protected. The warning plates are furnished with four mounting holes for ease of installation.

**Mounting Hole Size:** 7/32 in. (0.56 cm)

**Approvals:** UL (EX-2968), listed for use with FM Approved systems

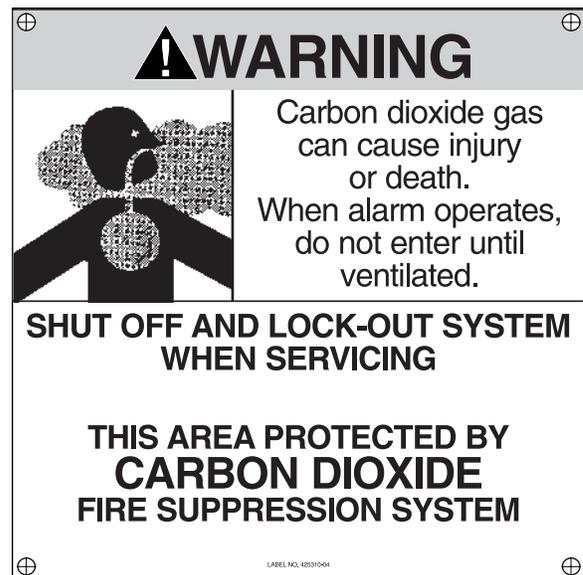
**Material:** Aluminum

**Part No. 425309 Sign In Every Protected Area**



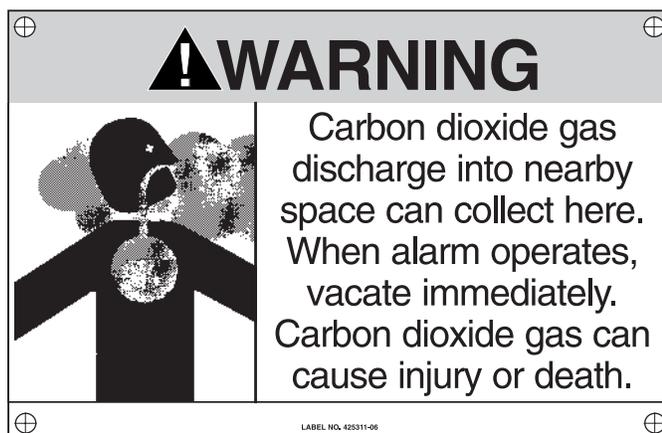
10 in. (25 cm) x 10 in. (25 cm)

**Part No. 425310 Sign at Every Entrance to Protected Space**



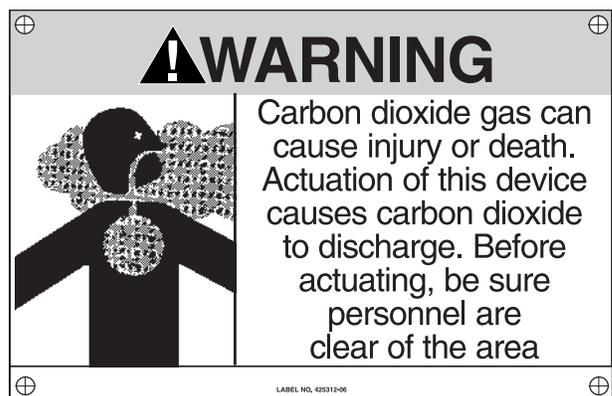
10 in. (25 cm) x 10 in. (25 cm)

**Part No. 425311 Sign In Every Nearby Space Where CO<sub>2</sub> Can Accumulate to Hazardous Levels**



10 in. (25 cm) x 10 in. (25 cm)

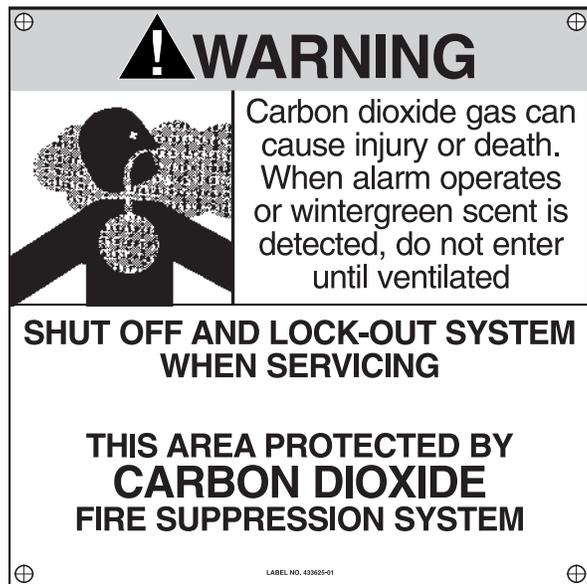
**Part No. 425312 Sign at Each Manual Actuation Station**



10 in. (25 cm) x 6.5 in. (16.5 cm)

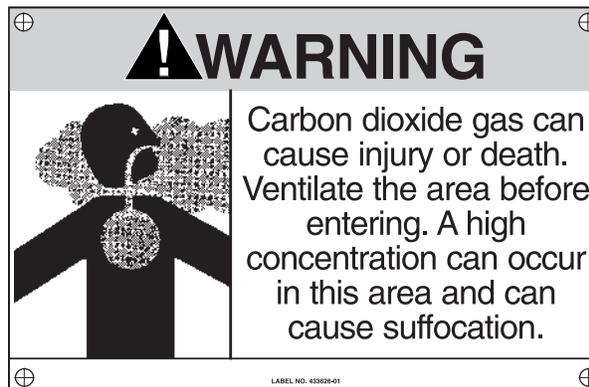
Two warning plates are available for mounting inside or outside the hazard area to warn personnel CO<sub>2</sub> is being released when the alarm is sounding. The warning plates are furnished with four mounting holes for ease of installation. The plate is constructed of BAKELITE engraving stock with a red finish.

**Part No. 433625 Sign at Every Entrance to Protected Space for Systems Provided with Wintergreen Odorizer**



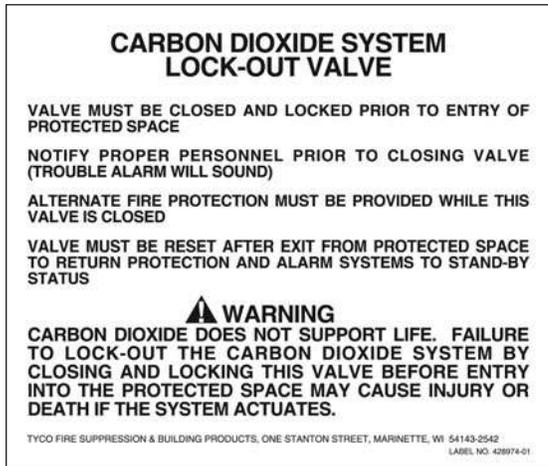
10 in. (25 cm) x 10 in. (25 cm)

**Part No. 433626 Sign Outside Each Entrance to Carbon Dioxide Storage Room**



10 in. (25 cm) x 6.5 in. (16.5 cm)

**Part No. 428974 Lock-Out Valve Nameplate**



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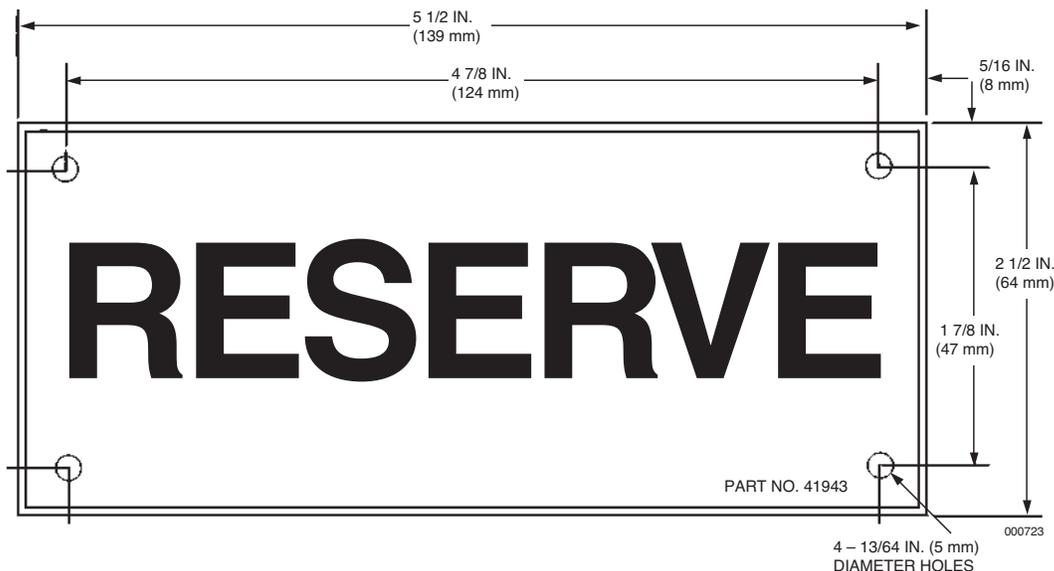
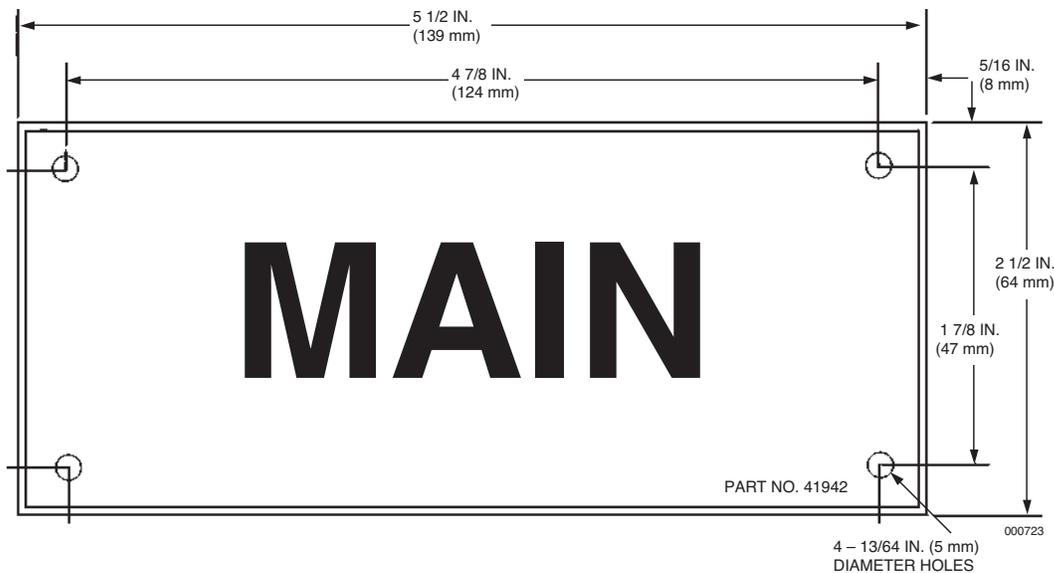
5.4 in. (13.7 cm) x 4.5 in. (11.4 cm)

## Low Pressure Carbon Dioxide

## Nameplates – Main or Reserve

The nameplates are furnished with four mounting holes for ease of installation. The “MAIN” nameplate is available for labeling components and/or remote pull stations to distinguish them from reserve system components. The “RESERVE” nameplate is available for labeling components and/or remote pull stations to distinguish them from main system components.

Shipping Assembly Part No.	Description
41942	Nameplate – MAIN
41943	Nameplate – RESERVE





## Low Pressure Carbon Dioxide

### 3-1 GENERAL

- ▶ A. This section is provided as a guide for designing low pressure CO<sub>2</sub> fire extinguishing systems. The two major types of systems covered in this section are total flooding and local application. Analysis of the hazard will determine which method is best for the application.
- ▶ 1. Areas with permanent walls or enclosures are generally total flooding applications. The structure shall be able to contain the gas, which allows the CO<sub>2</sub> concentration to build. The spaces for total flooding will have limited openings. CO<sub>2</sub> fills the confined space and smothers the fire.
- ▶ 2. Surfaces, objects and structures, which do not have a solid barrier to contain the CO<sub>2</sub> are protected with local application. CO<sub>2</sub> blankets the hazardous outer surfaces at a high flow rate for a specific duration. The application of CO<sub>2</sub> extinguishes the surface fire and cools the structures and surrounding atmosphere to reduce the possibility of reflash.
- ▶ B. Pneumatic alarms consume carbon dioxide from the storage supply. A designer must account for the quantity of agent consumed by the pneumatic alarms when designing a system.
  - 1. In the case of total flooding systems the CO<sub>2</sub> consumed by the pneumatic alarms can be used to meet the agent requirement for the protected space if the alarms are within the hazard enclosure. If the alarms are located outside the enclosure the quantity of carbon dioxide required to operate the pneumatic alarms must be added to the quantity required to protect the hazard when calculating the agent quantity required for the supply.
  - 2. For design of local application systems, the flow rate of carbon dioxide required to supply the pneumatic alarms must be added to the system flow rate to determine the total, required system flow rate.

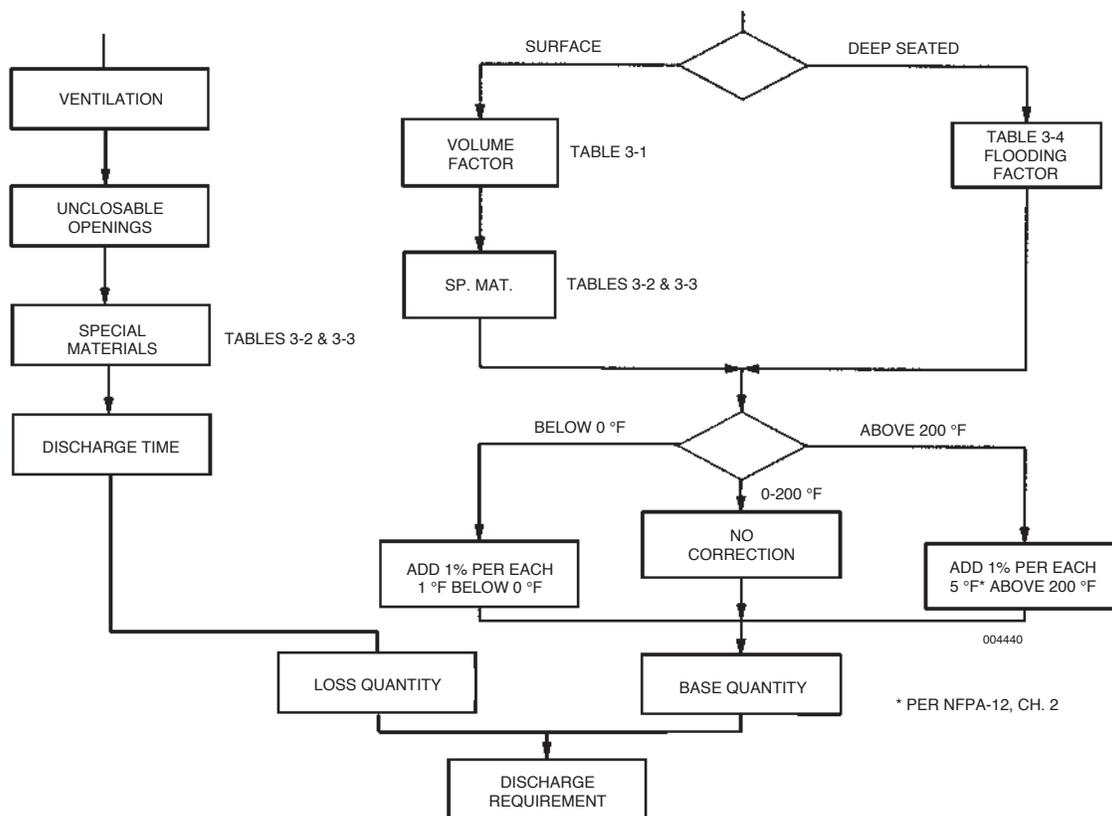
### 3-2 TOTAL FLOOD SYSTEM DESIGN

- A. A total flooding system consists of a fixed supply of carbon dioxide connected to a piping network with fixed nozzles that discharge into an enclosed space. This type of system may be used whenever an enclosure exists around the hazard. The enclosure must be adequate to contain and hold the discharge of agent to achieve the required carbon dioxide concentration. Figure 3-1 illustrates a total flood design process.
- B. Fires which can be extinguished by total flooding methods may be divided into two categories:
  - 1. Surface fires involving flammable liquids, gases and solids.
  - 2. Deep seated fires involving solids subject to smoldering.
- C. A full discharge test is required by NFPA 12 to ensure that design concentrations are met as required for total flooding hazards.
- D. Surface fires are the most common hazard and are usually subject to prompt extinguishment when carbon dioxide is quickly introduced into the enclosure in sufficient quantity. No hold time is stated in the current NFPA 12.
- E. For deep-seated fires, the required extinguishing concentration shall be maintained for a sufficient period of time to allow the smoldering to be extinguished and the material to cool to a point that prevents re-ignition. The current edition of NFPA 12 requires a 20 minute hold time.

**SECTION 3 – SYSTEM DESIGN**

**3-2 TOTAL FLOOD SYSTEM DESIGN (Continued)**

**SYSTEM DESIGN PROCESS – TOTAL FLOODING**



**Caution:** This design criteria is for hazard enclosure temperature only. Equipment listed for the low pressure CO<sub>2</sub> system has an operable range of 0 to 110 °F (–18 to 43 °C) for Mini-Bulk and 0 to 120 °F (–18 to 49 °C) for Bulk.

**Figure 3-1**  
Total Flood Design Process

**3-2.1 Quantity Calculations For Surface Fires**

- A. Chapter 2 of NFPA 12 gives the guidelines for determining the quantity of carbon dioxide for surface fires. The design requirement is to be discharged within 60 seconds.
- B. The design concentration of carbon dioxide shall not be less than 34%.
- C. Gross cubic volume of the enclosed space should be used to determine the quantity required. In figuring the net cubic volume, the volume of only permanent, unremovable, impermeable structures may be subtracted from the gross volume.

Volume of Space ft <sup>3</sup>	Incl.	Volume Factor lb CO <sub>2</sub> /ft <sup>3</sup>	Calculated Quantity – Not Less Than
Up to	140 (3.96 cu m)	0.072 (1.15 kg/m <sup>3</sup> )	—
141 (3.97 cu m)	500 (14.15 cu m)	0.067 (1.07 kg/m <sup>3</sup> )	10 lb (4.5 kg)
501 (14.16 cu m)	1,600 (45.28 cu m)	0.063 (1.01 kg/m <sup>3</sup> )	35 lb (15.1 kg)
1,601 (45.29 cu m)	4,500 (127.35 cu m)	0.056 (0.90 kg/m <sup>3</sup> )	100 lb (45.4 kg)
4,501 (127.36 cu m)	50,000 (1415.0 cu m)	0.050 (0.80 kg/m <sup>3</sup> )	250 lb (113.5 kg)
Over	50,000 (1415.0 cu m)	0.046 (0.74 kg/m <sup>3</sup> )	2,500 lb (1135.0 kg)

**Table 3-1**  
Flooding Factors For 34% Concentration (NFPA 12)

**3-2 TOTAL FLOOD SYSTEM DESIGN (Continued)****3-2.1 Quantity Calculations For Surface Fires (Continued)**

C. Table 3-2 lists the minimum design concentrations required for extinguishment of some common liquids and gases.

<b>Material</b>	<b>Minimum Design CO<sub>2</sub> Concentration (%)</b>
Acetylene	66
Acetone	34
Aviation Gas Grades 115/145	36
Benzol, Benzene	37
Butadiene	41
Butane	34
Butane 1	37
Carbon Disulfide	72
Carbon Monoxide	64
Coal or Natural Gas	37
Cyclopropane	37
Diethyl Ether	40
Dimethyl Ether	40
Dowtherm	46
Ethane	40
Ethyl Alcohol	43
Ethyl Ether	46
Ethylene	49
Ethylene Dichloride	34
Ethylene Oxide	53
Gasoline	34
Hexane	35
Higher Paraffin Hydrocarbons	34
Hydrogen	75
Hydrogen Sulfide	36
Isobutane	36
Isobutylene	34
Isobutyl Formate	34
JP - 4	36
Kerosene	34
Methane	34
Methyl Acetate	35
Methyl Alcohol	40
Methyl Butane 1	36
Methyl Ethyl Ketone	40
Methyl Formate	39
Pentane	35
Propane	36
Propylene	36
Quench, Lube Oils	34

**Note:** The theoretical minimum extinguishing concentrations in air for the above materials were obtained from a compilations of Bureau of Mines Limits of Flammability of Gases and Vapors (Bulletins 503 and 627).

**Table 3-2**  
Minimum Carbon Dioxide Concentrations For Extinguishment (From NFPA 12)

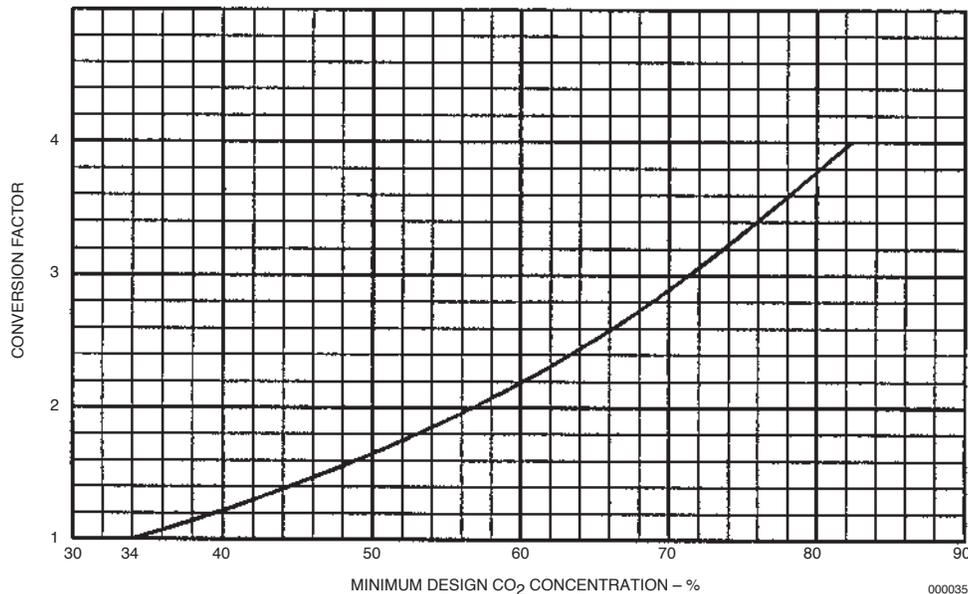
**3-2 TOTAL FLOOD SYSTEM DESIGN (Continued)**

**3-2.1 Quantity Calculations For Surface Fires (Continued)**

D. Connected volumes that are open to one another are considered one continuous hazard. The highest concentration flooding factor for any subsection of the volume shall be used to determine the design concentration for the entire space.

**3-2.2 Material Conversion Factor**

For materials requiring a design concentration over 34%, the basic quantity of carbon dioxide calculated from the volume factor given in table 3-1 shall be increased by multiplying this quantity by the appropriate conversion factor given in Table 3-3.



**Table 3-3**  
Material Conversion Factors  
(NFPA 12)

**3-2.3 Special Conditions**

- A. Additional quantities of carbon dioxide shall be provided to compensate for any special condition that may adversely affect the extinguishing efficiency. If the quantity for loss exceeds the computed discharge requirement, local application should be considered.
- B. Any openings that cannot be closed at the time of extinguishment shall be compensated for by the addition of a quantity of carbon dioxide equal to the anticipated loss at the design concentration during the discharge period. This amount of carbon dioxide shall be applied through the regular distribution system. See Chapter 2 of NFPA 12.
- C. For ventilating systems that cannot be shut down, additional carbon dioxide shall be added to the space through the regular distribution system in an amount computed by multiplying the volume moved during the liquid discharge period by the appropriate flooding factor.
- D. For applications where the normal temperature of the enclosure is above 200 °F (93 °C), a 1% increase in the calculated total quantity of carbon dioxide shall be provided for each additional 5 °F above 200 °F (93 °C).
- E. For applications where the normal temperature of the enclosure is below 0 °F (-18 °C), a 1% increase in the calculated total quantity of carbon dioxide shall be provided for each 1 °F below 0 °F (-18 °C).

**3-2 TOTAL FLOOD SYSTEM DESIGN (Continued)****3-2.4 Quantity Calculations For Deep Seated Fires**

The quantity of carbon dioxide for a deep-seated type fire is based on a fairly tight enclosure. After the design concentration is reached, an extinguishing concentration shall be maintained for a substantial period of time, but not less than 20 minutes. Any possible leakage shall be given special consideration since no allowance is included in the basic flooding factors. A separate extended discharge system may be employed to account for leakage during the hold time.

**3-2.5 Combustible Materials**

- A. Deep-seated fires have a denser mass as compared to surface fires. Therefore, higher concentrations of CO<sub>2</sub> are required to extinguish deep-seated fires effectively.
- B. For deep seated fires, the design concentration shall be achieved within 7 minutes as specified in Paragraph 2 of the NFPA 12. In addition to the basic quantity, any leakage or temperature factors must be added.
- C. The discharge rate shall develop a concentration of 30% that must be achieved within 2 minutes. To develop the 30% concentration, a flooding factor of 0.043 pounds of CO<sub>2</sub> per cubic foot (0.69 kg of CO<sub>2</sub> per cubic meter) should be used.
- D. The design concentrations listed in Table 3-4 shall be achieved for the hazards listed. Generally, the flooding factors have been found to provide proper design concentrations for the rooms and enclosures listed.

Design Concentration %	lbs. CO <sub>2</sub> /ft <sup>3</sup>	kg CO <sub>2</sub> /m <sup>3</sup>	Specific Hazard
50	0.100	1.60	Dry electrical hazards in general. (Spaces 0-2000 ft <sup>3</sup> (0-56.6 m <sup>3</sup> ))
50	0.083 (200 lb minimum)	1.33 (91 kg minimum)	Dry electrical hazards in general. (Spaces greater than 2000 ft <sup>3</sup> (56.6 m <sup>3</sup> ))
65	0.125	2.00	Record (bulk paper) storage, ducts and covered trenches.
75	0.166	2.66	Fur storage vaults, dust collectors.

**Table 3-4**  
Flooding Factors For Deep-Seated Hazards  
(NFPA 12)

**3-2.6 Special Conditions**

- A. Refer to Section 3-2.3 for special conditions which may apply to deep-seated applications also.

## SECTION 3 – SYSTEM DESIGN

2-1-10 Page 3-6

REV. 1

### 3-2 TOTAL FLOOD SYSTEM DESIGN (Continued)

#### 3-2.7 Flow Rate Calculations

- A. Carbon dioxide leaves the storage tank as a liquid at 0 °F (–18 °C). As the liquid flows through the discharge piping, the liquid CO<sub>2</sub> vaporizes as it cools the discharge line. This is termed the initial vapor phase. The CO<sub>2</sub> vapor is vented through the nozzles. As the discharge line is chilled, the agent is able to maintain the liquid state. This phenomenon results in reduced density of the agent during the initial vapor phase.
- B. Since the flow rate for the vapor phase is considerably less than the flow rate for the liquid phase, flow rates will differ.
- C. To determine the exact pipe sizes, a customized hydraulic calculation program is used, which accounts for special factors that are not considered in the estimating guides. These special factors include: ambient pipe temperatures, additional valves, numerous fittings, and authorities guidelines.
- D. A basic rule when estimating the flow rate for total flood systems is to apply the initial vapor factor to the calculated requirement for the first minute. See Table 3-5 for Vapor Factors.
- E. The factors below should be increased to compensate for the heavier wall thickness of Sch. 80 pipe and ambient pipe temperatures.

Linear Length of Pipe Run	Initial Vapor Factor
10 ft – 50 ft (3.1 m – 15.2 m)	1.1
51 ft – 100 ft (15.6 m – 30.5 m)	1.2
101 ft – 150 ft (30.8 m – 45.7 m)	1.3
151 ft – 250 ft (46.0 m – 76.2 m)	1.4
251 ft – 500 ft (76.5 m – 152.4 m)	1.5

**Table 3-5**  
Vapor Factors For Initial Vapor Phase  
(Use to Estimate Flow Rates)

#### 3-2.8 Nozzle Placement Guide For Total Flooding

- ▶ A. All ANSUL Low Pressure CO<sub>2</sub> nozzles may be used for total flooding. Nozzle selection is determined by these considerations:
  - 1. Configuration of the hazard as to the area or space the nozzle will protect.
  - 2. The nozzle flow rate shall coincide with the selected nozzle pipe size connection availability.
  - 3. Environment or mounting orientation of the nozzle.
- B. Radial nozzles usually create a high velocity discharge for thorough mixing of CO<sub>2</sub> within the protected space. These nozzles are normally used for total flooding rooms and larger enclosures.
  - 1. Radial nozzles need not be mounted directly at the ceiling. Where obstructions exist, the nozzle should be mounted below the obstructions. In no case should the nozzles be installed less than 3 ft (0.9 m) above the highest hazard elevation.
  - 2. Pipe connections of 1/2 in. to 2 in. are available to match the required flow rate.
  - 3. Nozzles shall be spaced to insure a uniform discharge concentration is built within the protected space. The spacing for 2 in. radial nozzles shall not exceed a 40 ft (12.2 m) square for a 4 port; 40 ft x 20 ft (12.2 x 6.1 m) for a 2 port; and 20 ft (6.1 m) square for a 1 port nozzle.
  - 4. Generally acceptable flow rates for radial nozzles range between 10 lb/minute to 500 lb/minute (4.5 kg/minute to 226.8 kg/minute).

### 3-2 TOTAL FLOOD SYSTEM DESIGN (Continued)

#### 3-2.8 Nozzle Placement Guide For Total Flooding (Continued)

- C. Regular Type nozzles are used in covered trenches, small enclosures, dirty environments, and in flooding ductwork. The frangible seal prevents dirt, debris, and solvent from accumulating in the discharge lines.
  - 1. The Regular Type nozzle is available with a 1/2 in. male NPT connection. It can supply flow rates of 10 to 100 lb/minute (4.5 to 45.4 kg/min).
  - 2. Nominal spacing for Regular Type nozzles shall not exceed 20 ft (6.1 m).
  - 3. A mounting kit is included for direct placement into metal enclosure housings or flat ducts.
- D. SR nozzles are used when a “cushioned discharge” is needed for a total flooding space.
  - 1. SR nozzles are available with 1/2 in. and 3/4 in. female NPT connections. This limits flow rates to a maximum of 130 lb/minute (58.9 kg/min) and a code 14.0 orifice.
  - 2. For total flooding, SR nozzles are suitable for smaller enclosures, such as under floors. Additionally, these nozzles may be aimed at a hazardous object within the room to localize the discharge. Nozzle distance shall be approximately equivalent to those listed in the Rate-by-Area chart on Page 3-10.
- E. Orifice tab unions are installed in the discharge line to regulate the discharge flow rate into the protected space. These nozzles are generally used in conjunction with inerting systems. The nozzles are available in 1/2 in. through 2 in. NPT connection sizes. Stainless steel nozzles are also available. Other special applications for this nozzle can occur where the nozzle is not to be located within the protected space.
  - 1. Inability of single nozzle to deliver the required flow rate to flood the maximum area.
  - 2. Consideration of obstructions within the hazard that require additional nozzles to cover the space on both sides of the obstruction.
  - 3. The hazard contains delicate or fragile materials that might be damaged by a highly turbulent discharge.
- F. “D” nozzles are used where corrosion resistance and/or a cushioned discharge is needed for total flood space.
  - 1. The “D” nozzle is available with a 1/2 in. female NPT connection. It can supply flow rates of 11-48.5 lb per minute.
  - 2. Nominal spacing for “D” nozzles shall not exceed 20 ft (6.1 m).

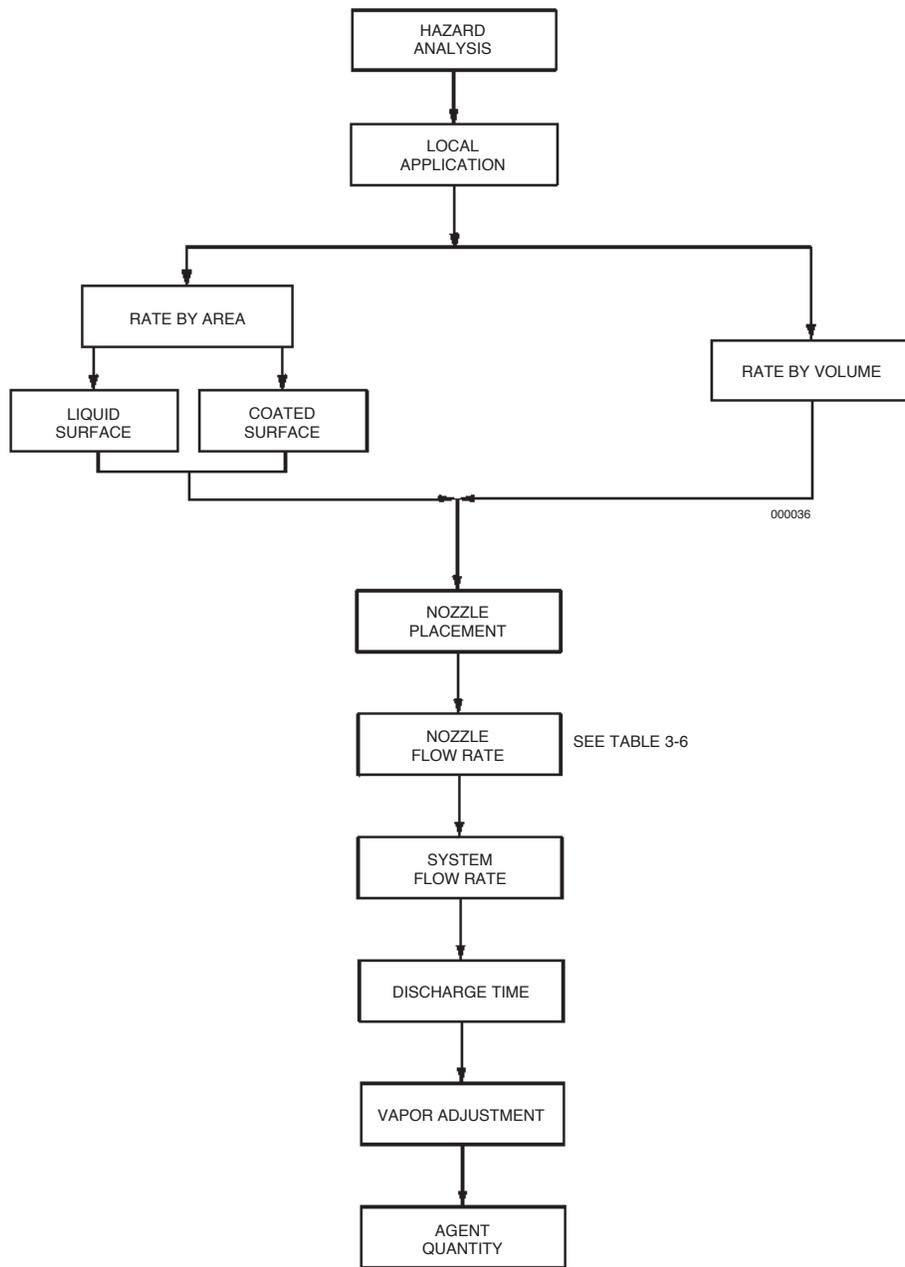
### 3-3 LOCAL APPLICATION SYSTEM DESIGN

#### 3-3.1 General

- A. A local application system consists of a fixed supply of carbon dioxide permanently connected to a system of fixed piping with nozzles arranged so as to discharge liquid CO<sub>2</sub> directly onto the hazard.
- B. Local application systems are used for the suppression of surface fires in flammable liquids, gases and shallow solids where the hazard is not enclosed or where the enclosure does not conform to the requirements for total flooding. Examples of hazards that may be protected by local application systems include dip tanks, quench tanks, spray booths, machining operations, and printing presses. Figure 3-2 illustrates a local application design process.
- C. A discharge test must be conducted to verify complete coverage of the hazard for the required discharge time based on nozzle placement.
- D. Only the liquid discharge is effective for local application.
- E. Refer to Table 3-8 for a pipe size estimating guide.

LOCAL APPLICATION SYSTEM DESIGN (Continued)

3-3.1 General (Continued)



**Figure 3-2**  
Local Application Design Process

3-3.2 Duration of Discharge

A. The minimum effective discharge time for computing the quantity of agent shall be 30 seconds of liquid discharge at the nozzles. Where there is a possibility that metal or other material may become heated above the ignition temperature of the fuel, the effective (liquid) discharge time shall be increased to permit adequate cooling of the material. Fuels with a boiling point higher than their ignition temperature, such as paraffin wax or cooking oil, require a minimum discharge time of 3 minutes.

### 3-3 LOCAL APPLICATION SYSTEM DESIGN (Continued)

#### 3-3.3 Storage Quantity

##### A. For Mini-Bulk

1. The quantity required in storage is based on liquid CO<sub>2</sub> delivered during the discharge period. The liquid CO<sub>2</sub> quantity is increased by 40% to compensate for vaporized CO<sub>2</sub> in the storage vessel(s) and in the pipe. An example of a system for 1000 lb/min flow rate with a 30 second discharge is as follows:  
(1000 lb/min x 1/2 minute liquid) x 1.4 = 700 lb

##### B. For Bulk

1. Contact Technical Services for variables.

#### 3-3.4 Types Of Surface Fires

- A. Within the scope of this manual, two types of surfaces must be considered: liquid surfaces and wetted/coated surfaces. The liquid surface is flammable liquid more than 1/4 in. (6.4 mm) in depth. Coated surfaces are defined as a film or a pool of liquid less than 1/4 in. in depth.
- B. NFPA 12 Chapter 3, the Industrial Risk Insurers Interpretive Guide, and FM Global Property Loss Prevention Data Sheets should be referenced when determining the suitability of a hazard for the local application method of protection.

#### 3-3.5 Methods Of Application

There are two accepted methods of calculating the quantity of CO<sub>2</sub> required for local application systems:

- A. The RATE-BY-AREA METHOD is used where the fire hazards are flat surfaces or low level objects associated with horizontal surfaces.
- B. The RATE-BY-VOLUME METHOD of system design is used where the fire hazard consists of three dimensional irregularly shaped objects that cannot be easily reduced to equivalent surface areas.

3-3 LOCAL APPLICATION SYSTEM DESIGN (Continued)

3-3.5 Rate-By-Area Method

A. The SR nozzle is the only nozzle approved for local application rate-by-area protection. The nozzle spacing and flow rate are selected from Table 3-6 and are based on the distance from the end of the nozzle to the protected surface. Nozzle quantity is determined by dividing the length and the width of the hazard by the side of square and then multiplying the two numbers together. The system flow rate is calculated by adding the flow rates for all nozzles together.

Coated Surface Side Of Square ft (m)	SR Nozzle		Liquid Surface Side Of Square ft (m)
	Height ft-in. (m)	Rate lb/min (kg/min)	
3.24 (0.98)	1-0 (0.31)	31.0 (14.1)	2.74 (0.84)
3.35 (1.02)	1-3 (0.38)	33.5 (15.2)	2.83 (0.86)
3.45 (1.05)	1-6 (0.46)	36.0 (16.3)	2.92 (0.89)
3.55 (1.08)	1-9 (0.53)	38.5 (17.5)	3.00 (0.91)
3.65 (1.11)	2-0 (0.61)	41.0 (18.6)	3.08 (0.94)
3.74 (1.14)	2-3 (0.69)	43.0 (19.5)	3.16 (0.96)
3.85 (1.17)	2-6 (0.76)	45.5 (20.6)	3.26 (0.99)
3.94 (1.20)	2-9 (0.84)	48.0 (21.8)	3.33 (1.02)
4.03 (1.23)	3-0 (0.91)	50.5 (22.9)	3.40 (1.04)
4.12 (1.26)	3-3 (0.99)	53.0 (24.0)	3.48 (1.06)
4.20 (1.28)	3-6 (1.07)	55.2 (25.0)	3.55 (1.08)
4.28 (1.31)	3-9 (1.14)	58.0 (26.3)	3.62 (1.10)
4.36 (1.33)	4-0 (1.22)	60.0 (27.2)	3.69 (1.13)
4.44 (1.35)	4-3 (1.29)	62.5 (28.4)	3.75 (1.14)
4.52 (1.38)	4-6 (1.37)	65.0 (29.5)	3.82 (1.16)
4.60 (1.40)	4-9 (1.45)	67.5 (30.6)	3.89 (1.19)
4.69 (1.43)	5-0 (1.52)	70.0 (31.8)	3.96 (1.21)
4.76 (1.45)	5-3 (1.60)	72.5 (32.9)	4.02 (1.23)
4.85 (1.48)	5-6 (1.68)	75.0 (34.0)	4.10 (1.25)
4.91 (1.50)	5-9 (1.75)	77.2 (35.0)	4.15 (1.27)
4.99 (1.52)	6-0 (1.83)	79.5 (36.1)	4.22 (1.29)
5.05 (1.54)	6-3 (1.91)	82.0 (37.2)	4.27 (1.30)
5.13 (1.56)	6-6 (1.98)	84.5 (38.3)	4.34 (1.32)
5.18 (1.58)	6-9 (2.06)	87.0 (39.5)	4.38 (1.34)
5.26 (1.60)	7-0 (2.13)	89.5 (40.6)	4.45 (1.36)
5.32 (1.62)	7-3 (2.21)	92.0 (41.7)	4.49 (1.37)
5.40 (1.65)	7-6 (2.29)	94.2 (42.7)	4.56 (1.39)
5.45 (1.66)	7-9 (2.36)	97.0 (43.9)	4.60 (1.40)
5.52 (1.68)	8-0 (2.44)	99.5 (45.1)	4.67 (1.42)

Note: Nozzle is only FM Approved between 1 ft-0 in. (0.9 m) and 8 ft-0 in. (2.4 m) at the listed flow rates.

Table 3-6  
SR Nozzle Coverage

- B. When SR nozzles are installed perpendicular to the hazard, they are centered over the area protected. The height used in determining the necessary flow rate and area coverage shall be the distance from the aiming point on the protected surface to the end of the nozzle measured along the axis of the nozzle.
- C. Nozzles may also be installed at angles between 45° and 90° from the plane of the hazard surface as defined in Table 3-7. When installed at an angle, nozzles shall be aimed at a point measured from the near side of the area protected by the nozzle. The location is calculated by multiplying the fractional aiming factor in Table 3-7 by the width of the area protected by the nozzle. Refer to Figure 3-3 for guidelines on nozzle orientation.

**3-3 LOCAL APPLICATION SYSTEM DESIGN (Continued)**

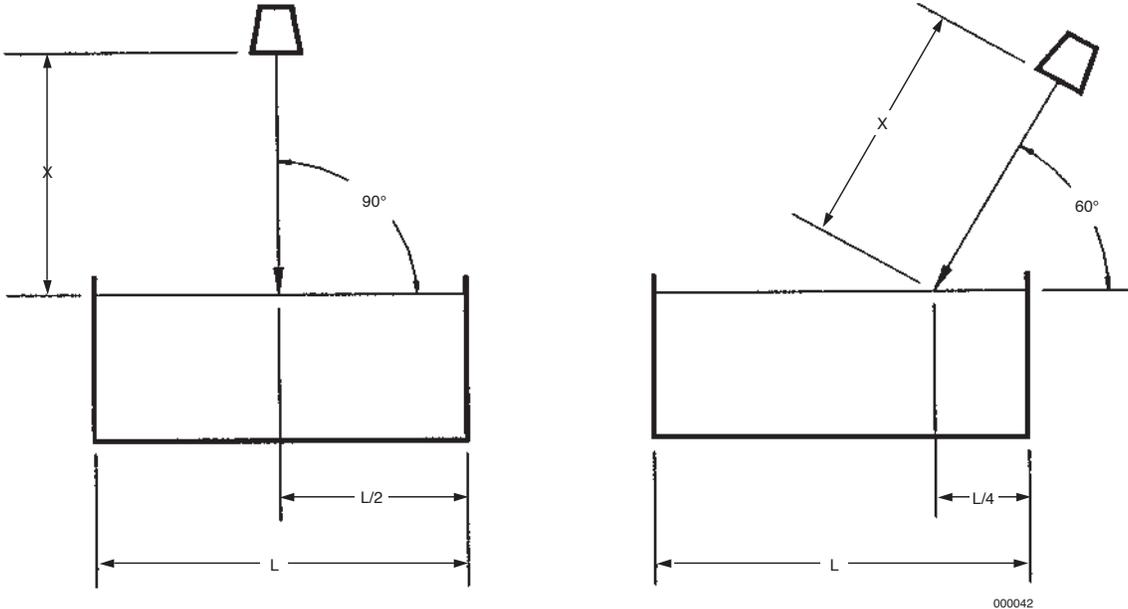
**3-3.5 Rate-By-Area Method (Continued)**

- D. If there is a physical limitation on the height of the nozzle above the protected surface, this height limitation may determine the number of nozzles that must be used. If there are no restrictions on nozzle height, the minimum number of nozzles may be determined by the allowable distance and side of square covered.
- E. When coated stock or parts extend more than two feet above a protected surface, the rate by volume method should be considered.
- F. To insure proper system performance, consideration should be given to elimination of the affects of air currents, winds and forced drafts.

Discharge Angle (1)	Aiming Factor (2)
45 – 60	1/4
60 - 75	1/4-3/8
75 - 90	3/8-1/2
90 (Perpendicular)	1/2 (Center)

**Note:** (1) Degrees from plane of hazard surface.  
 (2) Fractional amount of nozzle coverage side-of-square.

Example:



**Note:** Distance “X” and the flow rate are the same in both examples, only the aiming point for the nozzle changes.

**Table 3-7**  
 Aiming Factors For Angular Placement of Nozzles, Based on 6 in. (152 mm) Freeboard

**3-3 LOCAL APPLICATION SYSTEM DESIGN (Continued)**

**3-3.6 Rate-By-Volume Method**

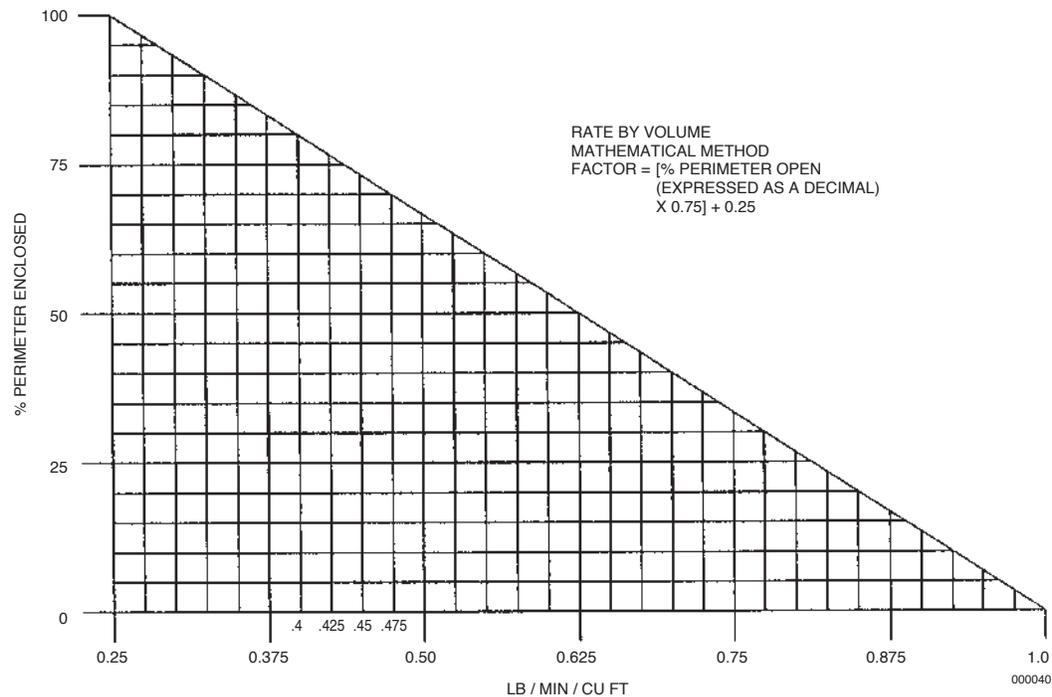
- A. If a hazard is three dimensional in nature and cannot be easily reduced to equivalent surface areas, rate-by-area protection is not recommended. For such three dimensional solid hazards, a rate-by-volume approach should be used when designing a local application system.
- B. The discharge rate shall be based on the volume of an assumed enclosure entirely surrounding the hazard.
- C. The assumed enclosure shall be based on an actual closed floor unless special provisions are made to take care of bottom conditions.
- D. The assumed walls and ceiling of this enclosure shall be at least 2 ft (0.6 m) from the main hazard unless actual walls are involved and shall enclose all areas of possible leakage, splashing or spillage.
- E. No deductions shall be made for solid objects within this volume.
- F. A minimum dimension of 4 ft (1.2 m) shall be used in calculating the volume of the assumed enclosure.
- G. The basic system discharge rate is calculated using one lb/min/ft<sup>3</sup> of assumed volume. The factor may be revised for partial enclosures; refer to Section 3-3.7.
- H. A sufficient number of nozzles shall be used to adequately cover the entire hazard volume on the basis of the system discharge rate as determined by the assumed volume. The nozzle spacing and flow rate for “D” nozzles are selected from Table 3-8 and are based on the distance from the end of the nozzle to the protected surface. SR nozzles are also available for rate by volume – see Table 3-6 for SR nozzle spacing and flow rate.
- I. Nozzles shall be located and directed so as to retain the discharged carbon dioxide about the hazard by suitable cooperation between nozzles and objects in the hazard volume.
- J. Barriers shall be located so as to eliminate any possible effects of air currents or forced drafts.

Height ft-in.	(m)	Rate lb/min	(kg/min)	Height ft-in.	(m)	Rate lb/min	(kg/min)
1-3	(0.38)	11.0	(4.9)	4-9	(1.45)	29.0	(13.1)
1-6	(0.46)	12.8	(5.8)	5-0	(1.52)	30.7	(13.9)
1-9	(0.53)	14.6	(6.6)	5-3	(1.60)	32.4	(14.7)
2-0	(0.61)	16.4	(7.4)	5-6	(1.68)	34.1	(15.4)
2-3	(0.69)	18.2	(8.2)	5-9	(1.75)	35.8	(16.2)
2-6	(0.76)	20.0	(9.0)	6-0	(1.83)	37.5	(17.0)
2-9	(0.84)	21.8	(9.8)	6-3	(1.91)	39.2	(17.7)
3-0	(0.91)	23.6	(10.7)	6-6	(1.98)	40.9	(18.5)
3-3	(0.99)	25.4	(11.5)	6-9	(2.06)	42.6	(19.3)
3-6	(1.07)	26.0	(11.8)	7-0	(2.13)	44.3	(20.1)
3-9	(1.14)	26.6	(12.0)	7-3	(2.21)	46.0	(20.8)
4-0	(1.22)	27.2	(12.3)	7-6	(2.29)	47.7	(21.6)
4-3	(1.29)	27.8	(12.6)	7-7.5	(2.32)	48.5	(22.0)
4-6	(1.37)	28.4	(12.8)				

**Table 3-8**  
“D” Nozzle Coverage

**3-3 LOCAL APPLICATION SYSTEM DESIGN (Continued)****3-3.7 Rate-By-Volume Partial Enclosure**

- A. If the assumed enclosure has a closed floor and is partly defined by permanent continuous walls extending at least 2 ft (0.61 m) above the hazard (where the walls are not normally part of the hazard) the discharge rate may be proportionately reduced to not less than 0.25 lb/min/ft<sup>3</sup> (NFPA 12).
- B. Refer to Figure 3-3 to determine the allowable flow rate reduction for a hazard with a partial enclosure.

**Figure 3-3**

Partial Enclosure Flow Rate Reduction Per NFPA 12

**3-4 HOSE REEL SYSTEM DESIGN****3-4.1 General**

Hose reel systems can be used to supplement fixed nozzle carbon dioxide systems where the hazards cannot be adequately protected by a fixed nozzle system. Examples of this may be hazards involving numerous small spot fires on a continuous basis that can be extinguished with relatively small amounts of CO<sub>2</sub>, large hazards with limited fuel at remote locations, hazards where the fuel can be spilled outside the protected space, complex three dimensional hazards, etc. Hose reel systems can also be used to supplement hand portable extinguishers for larger hazards where a fixed nozzle system is not required.

**3-4.2 Location**

- A. The hose reel stations must be installed in easily accessible locations that are readily visible from all angles and must have enough room around them to allow the user to easily remove the hose in an emergency. They should not be located inside the hazard area or in an area that would expose the operator to a fire in the hazard area they protect.
- B. The length of hose on the station must allow the operator to reach all areas of the space protected by the hose reel.
- C. If multiple hose reels are incorporated all hazard areas must be capable of being protected by at least one of the hose reel stations. Overlapping protection from more than one hose reel is preferred for complex hazards.

**3-4.3 Flow Rate and Range**

The Playpipe provides a circular discharge pattern with a range of 20 to 30 feet (6.1 to 9.1 m). The flow rate from the Playpipe will be approximately 200 to 300 lb/min (90.1 to 136 kg/min) and will depend on the length and diameter of the pipe supplying the hose reel.

**3-4 HOSE REEL SYSTEM DESIGN (Continued)**

**3-4.4 Agent Quantity and Duration of Discharge**

Agent quantity in the storage tank should include as a minimum enough carbon dioxide for simultaneous discharge of the maximum quantity of hose reels to be used for a minimum of one-minute discharge duration. Multiple discharges should be considered if appropriate when considering storage capacity and pipe size requirements.

**3-4.5 General Arrangement**

- A. A typical hose reel system includes a Master Valve located at the CO<sub>2</sub> storage tank that is operated by a control panel. An On/Off switch is included with the hose reel to control the Master Valve flow. When the On Switch is used the control panel energizes the Master Valve solenoid. This opens the Master Valve charging the supply lines to all hose reels served by the network. The operator can then remove the Playpipe assembly from the bracket and proceed to the appropriate location. CO<sub>2</sub> will not discharge until the operator depresses the Playpipe valve lever. Once the operator releases the lever, CO<sub>2</sub> flow ceases. This ensures that CO<sub>2</sub> discharge is under complete control of the operator at all times.
- B. The On/Off switch should be located as close as possible to the hose reel it controls.
- C. A check valve must be installed parallel with the Master Valve to allow flow from the piping back into the storage tank to permit trapped CO<sub>2</sub> in the supply line to be reclaimed into the storage tank.
- D. Also included with the hose reel is a 450 psi relief valve. Carbon dioxide will become trapped between the Master Valve and the Playpipe whenever the Playpipe Valve is closed. The 450 psi relief valve should be installed in the piping at the highest point immediately adjacent to the hose reel to prevent over-pressurization.
- E. A Bleeder Valve arrangement can be included in piping networks when the hose reel(s) are located a long distance from the storage tank. The Bleeder Valve arrangement includes a Selector Valve, a nozzle, a 1/4 in. NPT – 100 psi regulator, a 200 psi pressure gauge, a 1/4 in. filter, and a 150 psi Relief Valve. The function of the Bleeder Valve arrangement is to increase the flow rate through the supply pipe during the vapor phase of the discharge. This vents the vapor as quickly as possible to reduce the time it takes to get liquid discharge at the Playpipe. The time that the Selector Valve remains open must be preset in the control panel and should be determined by a discharge test and set to the time required to reach liquid discharge at the Bleeder nozzle.
- F. When multiple hose reels are attached to a single supply line a vapor trap should be included at each hose reel take off. The vapor trap prevents liquid from being deviated to “non-demand” branch lines. Failure to install vapor traps shown on the design drawings will be detrimental to the hose reel performance and will diminish the operator’s ability to control a fire. Refer to the Installation section for further information regarding vapor traps.

**3-4.6 Training**

Manual fire fighting with a Playpipe requires special techniques. Personnel that could be expected to use the hose reel system must be trained in its use and safety precautions. Discharge training is strongly encouraged to allow the operators to experience the thrust from the Playpipe and to allow them to become familiar with the discharge pattern.

**3-5 ESTIMATING PIPE SIZE**

Once flow rates for the system requirement are established, those flow rates dictate the pipe sizes. Refer to Table 3-9 to find estimated pipe sizing. This chart applies to average lengths up to 300 ft.

CO <sub>2</sub> Flow Rate Per Minute		Pipe		CO <sub>2</sub> Flow Rate Per Minute		Pipe	
lb	(kg)	Schedule	Size	lb	(kg)	Schedule	Size
40	(18.1)	40	1/2 in.	1,500	(680.4)	40	2 1/2 in.
80	(36.3)	40	3/4 in.	1,300	(589.7)	80	2 1/2 in.
175	(79.4)	40	1 in.	2,500	(1134)	40	3 in.
125	(56.7)	80	1 in.	2,200	(998)	80	3 in.
400	(181.4)	40	1 1/4 in.	5,500	(2495)	40	4 in.
300	(136.1)	80	1 1/4 in.	4,500	(2041)	80	4 in.
500	(226.8)	40	1 1/2 in.	10,000	(4536)	40	6 in.
400	(181.4)	80	2 in.	8,000	(3629)	80	6 in.
900	(408.2)	40	2 in.	24,000	(10,886)	40	8 in.
800	(362.9)	80	2 in.				

**Note:** This chart is an estimating guide only.

**Table 3-9**  
Pipe Size Estimating Guide

**3-6 EXAMPLES OF HAZARD PROTECTION****Example No. 1**

Hazard Classification: Paint Storage Room  
 Dimensions: 20 ft x 20 ft x 10 ft H (6.1 m x 6.1 m x 3 m H)  
 Volume Of Mix Room: 20 ft x 20 ft x 10 ft = 4,000 cu ft (113.3 cu m)  
 Special Conditions: None (no un-enclosable openings, ventilation, hazard temperature or abnormal pipe temperature)  
 Type Of Hazard: Surface type fire  
 Length Of Pipe Run: 400 ft (121.9 m) (Actual) Linear  
 Discharge Required: 34% Concentration within 1 minute: 4,000 cu ft x 0.056 lb CO<sub>2</sub> /cu ft = 224 lb/min  
 Storage Required: CO<sub>2</sub> plus loss allowance of 10%: 224 lb x 1.1 = 246 lb/min  
 Estimated Design Flow Rate: 246 lb/min x 1.5 (Vapor Factor) = 369 lb/min (167.4 kg/min)

**Example No. 2**

Hazard Classification: Acetylene storage room  
 Dimensions: 15 ft W x 15 ft L x 12 ft H  
 Volume Of Mix Room: 15 ft x 15 ft x 12 ft = 2,700 cu ft (76.5 cu m)  
 Special Conditions: Design concentration of 66% required per table 3-1  
 Type Of Hazard: Surface type fire  
 Length Of Pipe Run: 100 ft (30.5 m) (Actual) Linear  
 Discharge Required: 66% concentration within 1 minute: 2,700 cu ft x 0.056 lb CO<sub>2</sub> /cu ft x 2.6 material conversion factor from table 3-3 = 393 lb  
 Storage Required: CO<sub>2</sub> plus loss allowance of 10% = 393 lb x 1.1 = 432 lb CO<sub>2</sub> required  
 Estimated Design Flow Rate: 432 lb/min x 1.2 (Vapor Factor) = 518 lb/min (234.9 kg/min)

## SECTION 3 – SYSTEM DESIGN

9-1-03 Page 3-16

### 3-6 EXAMPLES OF HAZARD PROTECTION (Continued)

#### Example No. 3

Hazard Classification: Record Storage Room

Dimensions: 30 ft W x 50 ft L x 20 ft H

Volume Of Warehouse: 30 ft x 50 ft x 20 ft = 30,000 cu ft (849.5 cu m)

Special Conditions: Deep seated hazard with no extreme temperatures, excessive leakage, un-enclosable openings, hazard temperature or piping environmental temperature

Length Of Pipe Run: 200 ft (Actual) Linear

Deep Seated Fire: 65% concentration within 7 minutes: 30,000 x 0.125 lb CO<sub>2</sub> /cu ft = 3750 lb plus loss allowance of 10% (3750 lb x 1.1 = 4125 lb)

Total CO<sub>2</sub> Required: 4125 lb

As described earlier in this manual, a 30% concentration within 2 minutes is required:  
30,000 x 0.043 lb CO<sub>2</sub> /cu ft = 1290 lb

To estimate the flow rate, multiply amount of CO<sub>2</sub> required in 1 minute by appropriate vapor factor:

1290 lb / 2 minutes = 645 lb in 1 minute 645 x 1.4 (Vapor Factor) = 903 lb/min

Estimated Design

Flow Rate: 903 lb/min (409.6 kg/min)

#### Example No. 4

Hazard Classification: Computer Room Sub-Floor

Dimensions: 100 ft W x 50 ft L x 1 ft H

Volume Of Space: 100 ft x 50 ft x 1 ft = 5,000 cu ft (141.6 cu m)

Special Conditions: FM Global Property Loss Prevention Data Sheets require NO excessive openings, ventilation to be shut-down and dampered. Non-combustible construction, cables only, hazard temperatures and piping environment at ambient.

Type Of Hazard: Dry electrical fire.

Length Of Pipe Run: 100 ft (Actual) Linear

Dry Electrical Fire: 50% concentration within 7 minutes: 5,000 x 0.083 lb CO<sub>2</sub> /cu ft = 415 lb plus loss allowance of 10% (415 lb x 1.1 = 456 lb)

Total CO<sub>2</sub> Required: 456 lb

**Note:** Factory Mutual (FM) requires that 30% concentration is achieved within one minute.

5,000 cu ft x 0.043 lb CO<sub>2</sub> /cu ft = 215 lb/min

Estimated Design

Flow Rate: 215 x 1.2 (Vapor Factor) = 258 lb/min (117 kg/min)

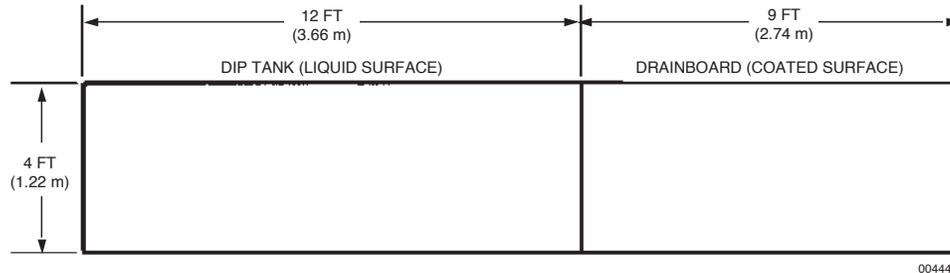
### 3-6 EXAMPLES OF HAZARD PROTECTION (Continued)

#### 3-6.1 Rate-By-Area Method

The following examples will illustrate the use of table 3-6.

**Example No. 1:** No nozzle placement restrictions.

Hazard: 4 ft x 12 ft (1.22 m x 3.66 m) dip tank and 4 ft x 9 ft (1.22 m x 2.74 m) drainboard. Parts are within 2 ft (0.61 m) of the protected surface.



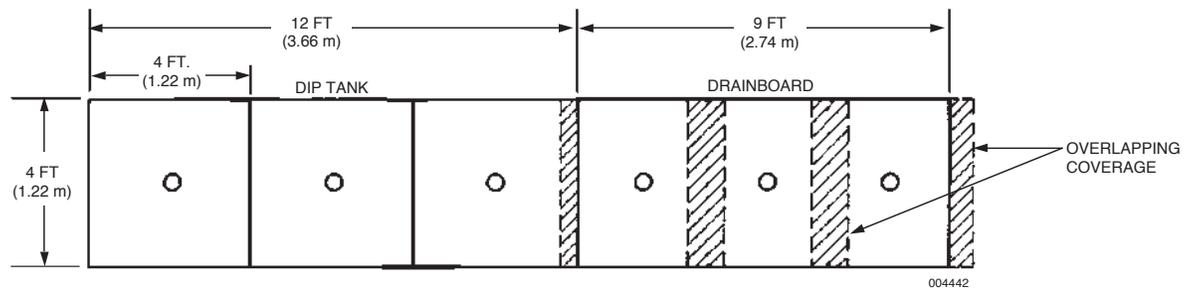
Step 1. Divide hazard area into squares using width of hazard as one side of square.

Dividing the dip tank into squares yields three (3) areas of 4 ft x 4 ft (1.22 x 1.22 m). Using the maximum width of coverage of 4 ft, determine the nozzle height above the surface from the nozzle chart.

Step 2. At 4 ft (1.22 m) width the liquid surface nozzle height is 5 ft 3 in. (1.6 m) from the surface. The drainboard is a coated surface and the nozzles will be located 3 ft (0.91 m) above the surface.

Step 3. Determine rate of discharge based on nozzle height. At 5 ft 3 in. (1.6 m) height a nozzle has a flow rate of 72.5 lb/min (32.8 kg/min) At 3 ft (0.91 m), the rate would have to be 50.5 lb/min (based on table 3-6).

Step 4. Locate Nozzles – One per Square Area of Coverage, directly overhead.



Step 5. System Discharge Rate is: Single Nozzle Rate x Number of Nozzles  
 $72.5 \text{ lb/min} \times 3 = 217.5 \text{ lb/min}$  ( $32.8 \text{ kg/min} \times 3 = 98.7 \text{ kg/min}$ )  
 $50.5 \text{ lb/min} \times 3 = 151.5 \text{ lb/min}$  ( $22.9 \text{ kg/min} \times 3 = 68.7 \text{ kg/min}$ )

Total System Flow Rate =  $217.5 \text{ lb/min} + 151.5 \text{ lb/min} = 369 \text{ lb/min}$   
 $(98.7 \text{ kg/min} + 68.7 \text{ kg/min} = 167.4 \text{ kg/min})$

Step 6. Assuming an ordinary flammable liquid, calculate the total quantity of CO<sub>2</sub> required:

$369 \text{ lb/min} \times 1/2 \text{ minute} = 185 \text{ lb of LIQUID CO}_2$ .  
 $(167.4 \text{ kg/min} \times 1/2 \text{ minute} = 83.9 \text{ kg of LIQUID CO}_2)$

However, since the initial discharge will be vapor, additional CO<sub>2</sub> must be added. Using the factors in Table 3-5, the base quantity must be corrected to attain the actual quantity required from the storage unit. Assume that 125 ft (38.1 m) of actual pipe will run from storage to the hazard.

Basic Quantity x 1.3 = Actual quantity required from storage unit.

$185 \text{ lb} \times 1.3 \text{ (Vapor Factor)} = 240 \text{ lb CO}_2 \text{ required}$   
 $(83.9 \text{ kg} \times 1.3 \text{ (Vapor Factor)} = 108.9 \text{ kg CO}_2 \text{ required})$

3-6 EXAMPLES OF HAZARD PROTECTION (Continued)

3-6.1 Rate-By-Area Method (Continued)

**Example No. 2:** Consider the same dip tank and drainboard with a restricted nozzle height. The nozzles over the dip tank **MUST** be located 4 ft (1.22 m) above the surface because of obstructions. Nozzles over the drainboard must be located closer than 2 ft (0.61 m) from the drainboard surface.

Step 1. From Table 3-6, determine the maximum width of coverage for an SR Nozzle at 4 ft (1.22 m) above a liquid surface.

Width of liquid surface coverage at 4 ft (1.22 m) height for an SR nozzle is 3 ft 8 in. (1.12 m) with a 60 lb/min nozzle rate (based on table 3-6).

Step 2. Based on the maximum allowable width of 3 ft 8 in. (1.12 m), we will need to use two rows of four (4) SR nozzles to protect the 4 ft x 12 ft (1.22 m x 3.66 m) dip tank.

Step 3. Based on a 2 ft (0.61 m) nozzle height above the drainboard and a maximum allowable width of 3 ft 7.8 in. (1.11 m), two rows of three (3) SR nozzles should be used.

Step 4. Determine system flow rate.

8 - SR nozzles at 60 lb/min (27.2 kg/min)

6 - SR nozzles at 41 lb/min (18.6 kg/min)

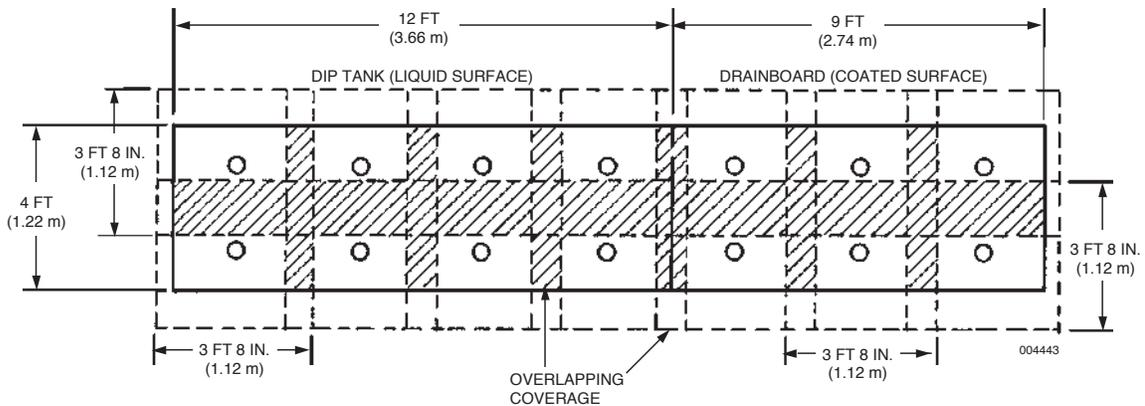
$(8 \times 60 \text{ lb/min}) + (6 \times 41 \text{ lb/min}) = 726 \text{ lb/min} (329.3 \text{ kg/min})$

Step 5. Liquid Discharge  $726 \text{ lb/min} \times 1/2 \text{ min} = 363 \text{ lb} (164.7 \text{ kg/min})$

Step 6. Multiply basic liquid quantity by vapor factor from Table 3-5. For example:

Assume 125 ft (38.1 m) of pipe from the storage unit to the hazard. The vapor factor is 1.3.

$1.3 \times 363 \text{ lb} = 472 \text{ lb} (214.1 \text{ kg})$  of liquid must discharge from the storage unit.



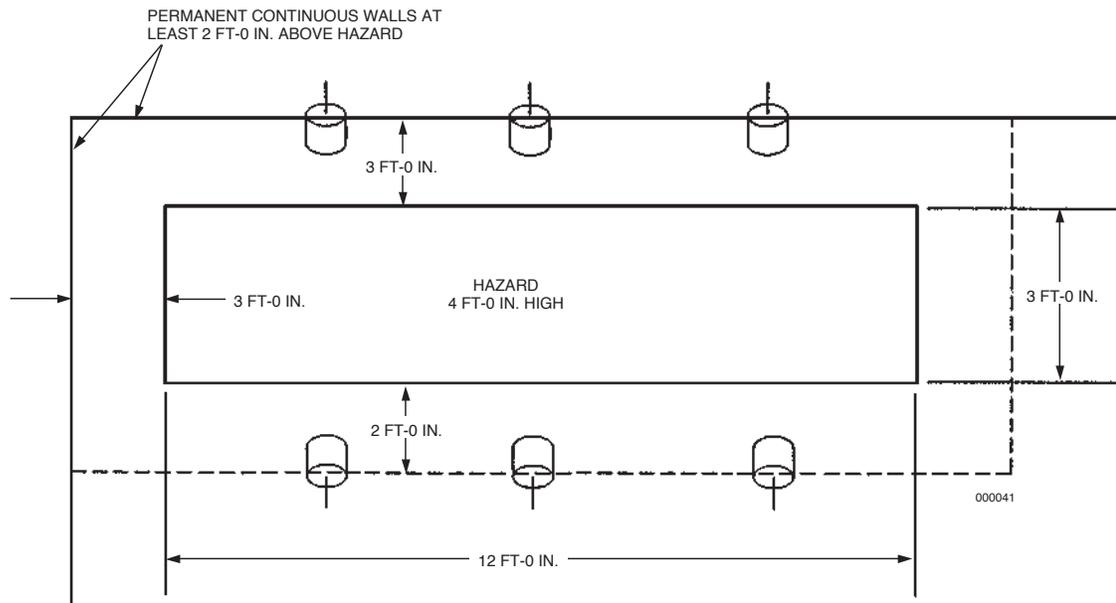


3-6 EXAMPLES OF HAZARD PROTECTION (Continued)

3-6.2 Rate-By-Volume (Continued)

**Example No. 2:** Rate-By-Volume (Partial Enclosure)

Consider the same hazard as shown in Example No. 1, located in a corner. The walls form a partial enclosure on two sides of the hazard. Distance from the machine to the walls is three feet.



The assumed volume is calculated as follows:

$$(12 \text{ ft} + 2 \text{ ft} + 3 \text{ ft}) \times (3 \text{ ft} + 2 \text{ ft} + 3 \text{ ft}) \times (4 \text{ ft} + 2 \text{ ft}) = 816 \text{ cu ft (23.1 cu m)}$$

Referring to Figure 3-3 based on 50% of the perimeter enclosed, a factor of 0.625 lb/min/cu ft is used.

The total amount of carbon dioxide required to protect the above hazard is: 816 cu ft x 0.625 lb/min/cu ft = 510 lb/min (231 kg/min)

Therefore, the same hazard requires only 510 lb/min (231 kg/min) flow rate when the hazard has a percentage of the perimeter permanently enclosed versus 672 lb/min (304.8 kg/min) when the hazard has no enclosure.

This same hazard, with a partial enclosure will only require (6) nozzles versus (8) nozzles for a hazard without any walls, when located at the same height above the hazard.

## Low Pressure Carbon Dioxide

### WARNING

The storage tanks covered in this manual contain carbon dioxide at pressures up to 350 psi (24 bar). Sudden release of this pressure may cause personal injury. The accidental discharge of a carbon dioxide system in an occupied area could cause injury or death due to asphyxiation.

For safety, only knowledgeable, qualified, service technicians, trained specifically for this equipment, should perform installation, service, or maintenance on the storage tanks. All precautions must be taken to avoid accidental actuation or discharge. Personnel in the protected hazard area should be evacuated before servicing the system.

#### 4-1 GENERAL

- ▶ **4-1.1** Installation of ANSUL Low Pressure CO<sub>2</sub> Systems should only be performed by qualified installers in accordance with guidelines set forth in the current edition of NFPA Standard 12 and all local codes and regulations.
- 4-1.2** The key to a professional installation is in the method that the components are installed. All common practices for piping and wiring must be observed.
  1. The installation should be neat and clean. All components must be installed level and plumb. Wall penetrations should be sealed and painted to match the surrounding wall if appropriate.
  2. Pipe joints must be tight and sealed with joint compound or teflon tape.
  3. Pipe and conduit should be installed straight, level, and plumb.
  4. Wiring that is not inside conduit should be straight, level, and plumb. It should be bundled and tied together with appropriate ties.
- 4-1.3** All materials must be new and shall be of the highest grade, free from defects and imperfections.
- 4-1.4** As a minimum, installation must comply with all of the following codes and standards:
  - NFPA 12
  - NFPA 70
  - NFPA 72
  - Local codes and standards
  - Customers' special requirements
- 4-1.5** All installations are to be performed in accordance with the parameters of this manual and all appropriate codes and standards from the local, state, and federal Authority Having Jurisdiction.
- 4-1.6** For successful system performance, the carbon dioxide system components must be located within their FM Approved temperature ranges. The ambient temperature ranges for the Bulk systems are 0 °F to 120 °F (–18 °C to 49 °C) and the ambient temperature ranges for the Mini-Bulk systems are 0 °F to 110 °F (–18 °C to 43 °C). All AUTOPULSE Control Systems are designed for indoor applications and for temperature ranges between 32 °F to 120 °F (0 °C to 49 °C).

## SECTION 4 – INSTALLATION

2-1-10 Page 4-2

REV. 1

### 4-2 TYPICAL PROJECT SCHEDULE

**4-2.1** Typical project schedule – following acceptance of purchase order:

- Review customer specifications
- Field survey of hazard, if applicable
- Obtain hazard/building drawings (include plan, elevation, and detail drawings)
- Submittal of design drawings and supporting documentation for approval
- Secure drawing approvals
- Release all equipment except nozzles
- ▶ Arrange a pre-installation meeting with Technical Services
  - Review drawings, manuals and specifications with the installation contractors
- Pour tank foundation, if required
- Procure installation materials
- Confirm power connections and disconnect switches are ready for the storage unit, control panel and any other components required for the project.
- Arrange for a crane to move the tank from the transport truck and place it on the pad
- Proceed with installation of pipe, wiring, and system devices
- ▶ Notify Technical Services of any changes to the routing or locations for drawing and calculation revisions
- Release discharge nozzles for drilling upon completion of final system calculations
- ▶ Arrange for commissioning and testing by Technical Services after entire installation is complete
- Coordinate the date with all interested parties to conduct the acceptance test (i.e. end user, insurers, fire marshal, engineering firm, etc.)
- Arrange filling of the storage tank during checkout of the system
- Check-out the control panel terminations and operational functions
- Test all components of the system
- Review operation and maintenance procedures with facility personnel
- Review system operation and safety procedures with facility personnel
- Conduct the discharge test (**Note:** NFPA 12 mandates discharge/concentration testing for approval of systems)
- Recharge the storage unit
- Hand over system, including reports and operation and maintenance manuals, to the client

### 4-3 REVIEW ALL DOCUMENTS PERTAINING TO INSTALLATION

**4-3.1** Before beginning an installation, the following documents shall be reviewed thoroughly:

- Customer specifications
- Codes and standards
- The installation instructions
- System Design Drawings
- Instructions included with components
- Component Data Sheets
- ▶ ANSUL Low Pressure CO<sub>2</sub> Manual

#### 4-4 INSPECT AND TEST ALL EQUIPMENT

- ▶ **4-4.1** The ANSUL tanks and all components are delivered to the carrier in new condition. When you receive our product, you should expect it to be in the same condition. For your own protection, take time to visually inspect each shipment in the presence of the carrier's agent before you accept delivery. Pay special attention to the components, refrigeration unit, piping and connections on the tank. If any damage is observed, make an appropriate notation on the freight bill. Then, ask the driver to sign the notation before you receive the equipment. You should decline to accept containers that show damage that may affect serviceability.
- 4-4.2** Prior to job site installation, all loose components should be tested at the installer's shop. This testing can prevent installation delays and allows time for warranty claims, substitution, or replacement.
  - A. Bench testing of all components can save valuable time and prevent delays encountered on the job site upon discovery of incorrect non-functioning components. It also allows the installer time to become familiar with the equipment to be installed.
  - B. Bench testing of components prior to installation will also allow time for replacement of incorrect or damaged components without affecting the project deadline.

#### 4-5 INSTALLING COMPONENTS

##### 4-5.1 Storage Tank

###### A. Location

1. The storage unit shall not be located in an area where it will be subjected to temperatures outside its FM Approved range. Mini-Bulk storage tanks are approved for a temperature range of 0 °F to 110 °F (–18 °C to 43 °C). Bulk storage tanks are rated for a temperature range of 0 °F to 120 °F (–18 °C to 49 °C).
2. The Mini-Bulk storage unit's control box is not rated for exposure to outdoor atmospheres. If a tank is to be located outdoors, it shall be protected by a shelter or enclosure.
3. Dusty, oily locations shall be avoided. The collection of such material on the refrigeration condenser may reduce its efficiency. A dry, well-ventilated location is preferable.
4. The storage unit shall not be located in an area where it might be subject to damage by moving or falling objects. A break in the insulation shell could allow water to enter the insulation and cause deterioration or loss of insulation efficiency.
5. A storage unit shall be located as near as possible to the hazard or hazards they protect, but they shall not be located where they will be exposed to a fire or explosion in these hazards. The storage tanks are not rated for hazardous or explosive environments. Components located in hazardous areas require a special rating.
6. A storage unit shall not be located so as to be subject to severe weather conditions or be subject to mechanical, chemical, or other damage. When excessive climactic or mechanical exposures are expected, suitable guards or enclosures shall be provided.
7. Carbon dioxide storage units are generally filled from large cargo tank trailers, up to 20 tons capacity. Therefore, the location selected should be within 20 ft (6.1 m) of driveways capable of supporting these delivery units or the fill lines must be extended. Proper ball valves and relief valves are to be installed on extended fill lines.

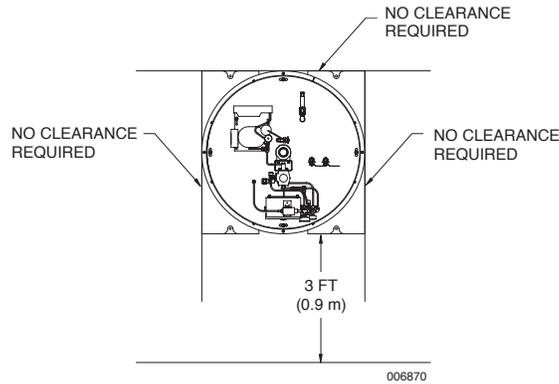
**SECTION 4 – INSTALLATION**

**4-5 INSTALLING COMPONENTS (Continued)**

**4-5.1 Storage Tank (Continued)**

**B. Access Clearance**

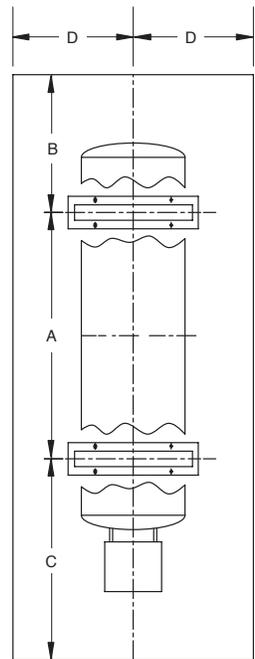
1. Sufficient clearance shall be provided at the front and rear of the bulk storage unit and the front and top of the Mini-Bulk tank. Permit easy access to the manway, the refrigeration system, manifold piping, valves, etc. Allow at least 4 ft (1.23 m) of clearance to service the refrigeration unit. Do not obstruct or restrict the flow of air to the refrigeration unit.
2. Mini-Bulk tanks require access to the top and front of the storage unit, as the refrigeration system and all controls are located on top of the unit. Refer to Figure 4-1 for the required clearances around the Mini-Bulk storage tanks.



**Figure 4-1**  
Mini-Bulk Storage Tank Clearances

3. Bulk storage units require access on both ends (one end for the refrigeration system and the other end for the manway). Spacing on the side of the unit should be adjusted according to the manifold and piping arrangement. Refer to Figure 4-2 for the required clearances around the Bulk storage tanks.

Tank Size - Tons	A		B		C		D	
	ft-in.	(m)	ft-in.	(m)	ft-in.	(m)	Ft.-in.	(m)
3 3/4	3-0	(0.91)	5-6	(1.6)	11-6	(3.4)	6-0	(1.8)
6	5-4	(1.6)	6-6	(1.9)	11-6	(3.4)	6-0	(1.8)
8	8-10	(2.7)	6-6	(1.9)	11-6	(3.4)	6-0	(1.8)
10	12-5	(3.8)	6-6	(1.9)	11-6	(3.4)	6-0	(1.8)
12	15-6	(4.7)	6-6	(1.9)	11-6	(3.4)	6-0	(1.8)
14	7-4	(2.2)	7-6	(2.3)	11-9	(3.6)	6-9	(2.1)
18	10-0	(3.1)	8-3	(2.5)	13-3	(4.0)	6-9	(2.1)
22	14-0	(4.3)	8-3	(2.5)	13-3	(4.0)	6-9	(2.1)
30	22-0	(6.7)	8-3	(2.5)	13-3	(4.0)	6-9	(2.1)
38	30-0	(9.1)	8-3	(2.5)	13-3	(4.0)	6-9	(2.1)
46	38-0	(11.6)	8-3	(2.5)	13-3	(4.0)	6-9	(2.1)



**Figure 4-2**  
Bulk Storage Tank Clearances

**4-5 INSTALLING COMPONENTS (Continued)****4-5.1 Storage Tank (Continued)****C. Foundation**

1. The foundation shall be designed by a civil engineer following all federal, state, and local codes and in consideration of but not limited to the following:
  - The installation of a carbon dioxide storage unit in or on a building, platform, or any existing surface should only be made after it has been determined that the surface can support the system.
  - If the storage unit is to be installed on concrete foundations, structural steel supports on concrete foundations or piers, the foundations shall extend below the frost line.
  - A concrete slab without footing may be used if acceptable to local codes or other Authority Having Jurisdiction. When so installed, flexibility should be provided in piping and electrical conduit.
2. Support loading information – Bulk
  - a. Maximum weight table with loading column (lb/in<sup>2</sup>) for base plates

Nominal Tank Size Tons	Weight				Full Loading Per Saddle	
	Empty lb	(kg)	Full lb	(kg)	lb/in	(kg/cm <sup>2</sup> )
1000 lb	1400	(635)	2400	(1100)	1.93	(0.14)
1500 lb	2000	(910)	3500	(1590)	2.33	(0.16)
3.75	7500	(3402)	15000	(6804)	6.9	(0.48)
6	9000	(4082)	21000	(9525)	9.7	(0.68)
8	10200	(4627)	26200	(11885)	12.1	(0.85)
10	11500	(5216)	31500	(14288)	14.6	(1.03)
12	12650	(5738)	36650	(16624)	17.0	(1.20)
14	14000	(6350)	42000	(19050)	16.2	(1.12)
18	16800	(7621)	52800	(23950)	20.4	(1.43)
22	20500	(9299)	64500	(29257)	24.9	(1.75)
30	26500	(12020)	86500	(39236)	33.4	(2.35)
38	33000	(14970)	109000	(49442)	42.1	(2.96)
46	37500	(15876)	129500	(58740)	50.0	(3.52)

**TABLE 4-1 – STORAGE TANK LOAD REQUIREMENTS**  
**MINIMUM REQUIREMENTS**  
 Concrete – 3000 psi Rated

**SECTION 4 – INSTALLATION**

8-27-13 Page 4-6

REV. 2

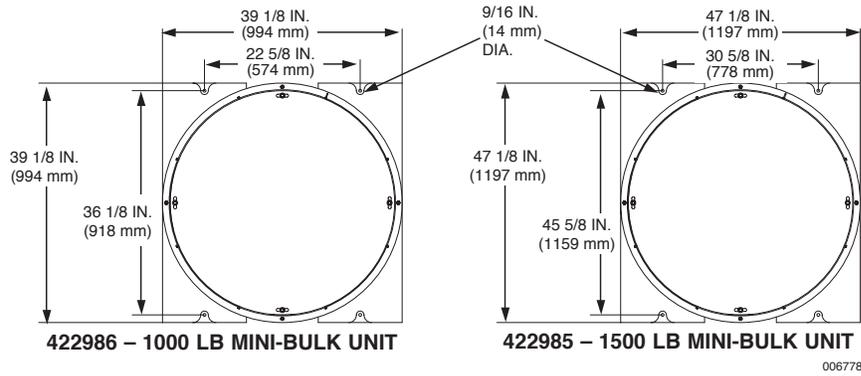
**4-5 INSTALLING COMPONENTS (Continued)**

**4-5.1 Storage Tank (Continued)**

C. Foundation (Continued)

3. Bolt pattern and hole diameter

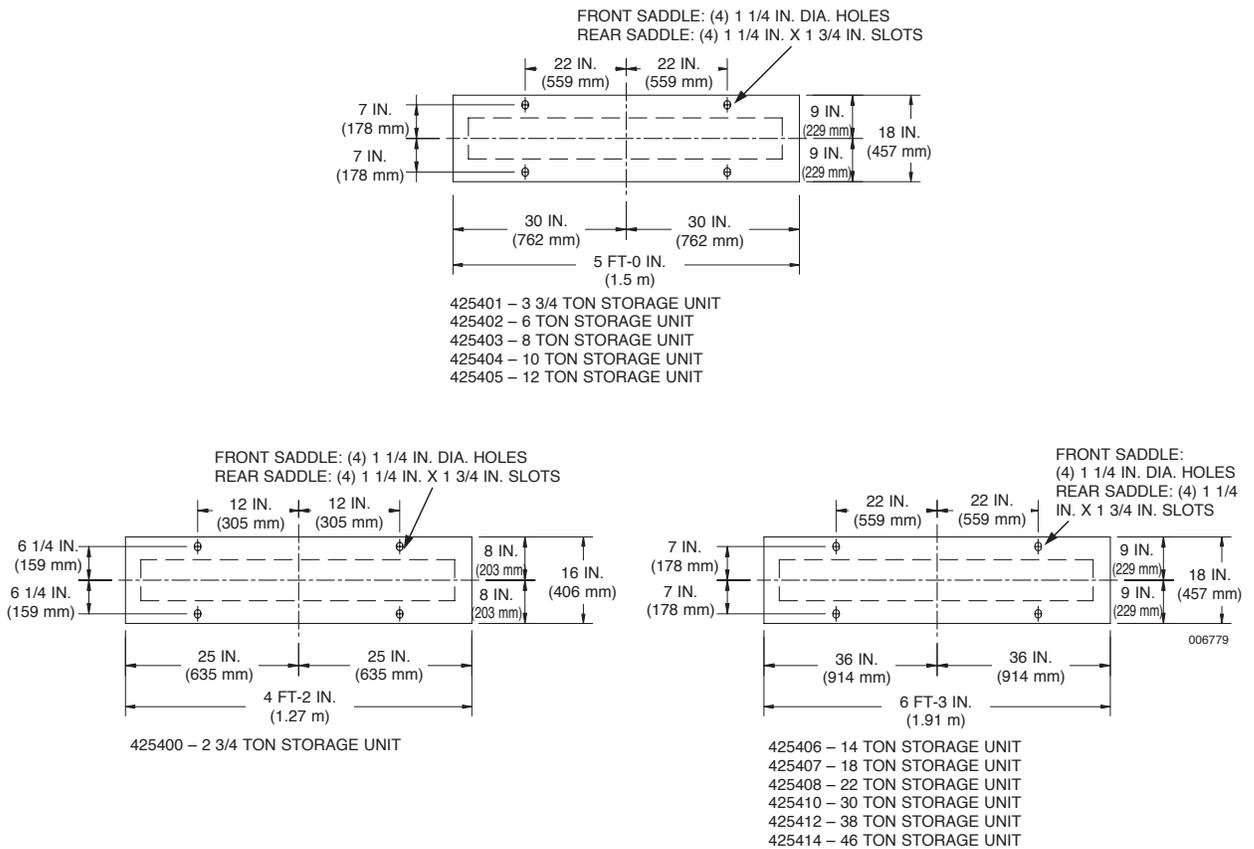
a. Mini-Bulk – refer to Figure 4-3.



**Figure 4-3**

Mini-Bulk Mounting Details

b. Bulk saddle dimensions – refer to Figure 4-4



**Figure 4-4**

Base Plate Details

## 4-5 INSTALLING COMPONENTS (Continued)

## 4-5.1 Storage Tank (Continued)

## D. Anchor Bolts

1. Once the storage tank is in its final location, it must be bolted to the foundation.
2. Anchor and bolt size/grade are to be established by the Civil Engineer as part of the foundation design.

## E. Handling

 **CAUTION**

Storage units are shipped with a slight pressure charge in the tank. This pressure should be relieved prior to installing tank shut off valve.

1. Bulk storage tanks are not designed to be lifted when they are full or partially filled. Damage to the ASME inner vessel may occur if the tank is lifted while it contains agent.
2. All valves (except instrumentation valves) should be closed and the dip tube on a Bulk storage unit should have a tank shut-off valve or blind flange affixed. All ports and openings should remain closed until system connections are made.
3. A Bulk storage tank should be unloaded by a crane using cables and spreader bars, unless it can be rolled on dollies or pipe rollers. Lifting lugs are located on top of the vessel.
  - a. When moving a Bulk storage tank, always be careful to prevent crushing the aluminum skin. Damage to the aluminum skin and insulation can affect the integrity of the container's insulation causing an increased load on the refrigeration system.
4. While moving a Mini-Bulk container, treat the load carefully. The base of a Mini-Bulk storage tank is designed with slots to allow movement with a forklift. This is the preferred method of moving a Mini-Bulk storage tank. The attachment points provided on the tanks will also allow you to use a hand truck or a hoist to handle these loads properly. Do not attempt to move these tanks by any other means. When moving the tanks, the following precautions should be observed:
  - Never lay the tank on its side. Always ship, operate and store the unit in a vertical or upright position.
  - When loading or unloading the tank from a truck, use a hand truck, lift gate, crane or parallel loading dock. Never attempt to manually lift the unit.
  - To move the tank over rough surfaces or to lift the tank, attach an appropriate sling (see Figure 4-5 and a portable lifting device that will handle the weight of the container.

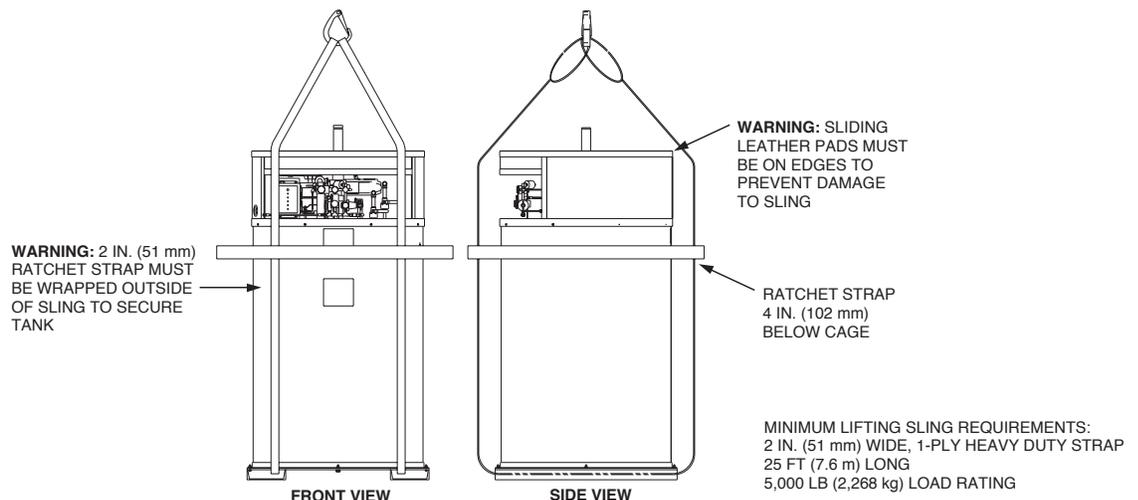


Figure 4-5

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5. When the storage unit is in position, it shall be inspected for rigging damage. Damage to the outer shell and insulation can affect the integrity of the container's insulation system causing an increased load on the refrigeration system.

**SECTION 4 – INSTALLATION**

**4-5 INSTALLING COMPONENTS (Continued)**

**4-5.1 Storage Tank (Continued)**

F. Unpacking information

1. Once it has been established that the storage tank has been delivered intact and it has been unloaded and placed in position, remove all wrappings and packaging. **Do not remove insulation and wrapping from the CO<sub>2</sub> and coolant lines.**
2. Some storage tanks are shipped with shipping pads under the compressor or other refrigeration components. These pads must be removed before operation of the refrigeration system.
3. When all wrapping, packaging, and shipping pads have been removed, carefully inspect the entire storage tank to ensure that the unit is in good physical condition and ready for operation.
4. Inspect for loose fasteners, pipe, fittings, electrical connections etc. and tighten as necessary.
5. Check all fittings, valves, and flange bolts for tightness

G. Power requirements

1. Refer to Table 4-2 for recommended wire sizes, circuit ratings and fuse sizes to supply the AC power to the storage tank.

Tank Capacity – Tons	Voltage	Horsepower	Phase	Amps	Fuse	Wire (See Note)
0.5 (Mini-Bulk 1000 lb)	120	0.25	1	10	15	#14
0.75 (Mini-Bulk 1500 lb)	120	0.25	1	10	15	#14
3.75	208/230	1	1	8.7	15	#14
	208/230	1	3	8.1	15	#14
	460	1	3	4.4	15	#14
6	208/230	1	1	8.7	15	#14
	208/230	1	3	8.1	15	#14
	460	1	3	4.3	15	#14
8	208/230	2	1	17.1	30	#10
	230	2	3	9.8	15	#14
	460	2	3	5.7	15	#14
10	208/230	2	1	17.1	30	#10
	230	2	3	9.8	15	#14
	460	2	3	5.7	15	#14
12	230	3	3	21.8	35	#10
	460	3	3	11.1	20	#12
14	208/230	2	1	17.1	30	#10
	230	2	3	9.8	15	#14
	460	2	3	5.7	15	#14
	200/220	3	3	21.8	35	#10
18	230	3	3	21.8	35	#10
	460	3	3	11.1	20	#12
22	230	3	3	21.8	35	#10
	460	3	3	11.1	20	#12
30	230	3	3	21.8	35	#10
	460	3	3	11.1	20	#12

- Notes:**
- Use 194 °F (90 °C) rated cable only
  - Limit of three insulated conductors per raceway
  - Conductors sized using Table 310.15(B)(16) in NFPA 70, 2014 (NEC)
  - Conductors are de-rated for 120 °F operation per Table 310.15(B)(2)(a) and account for maximum allowable fuse size per 240.4(D)(1) through 240.4(D)(7) in NFPA 70, 2014 (NEC)
  - Consult Factory for information regarding tank sizes larger than 30 tons

**Table 4-2**  
Storage Tank Electrical Requirements

4-5 INSTALLING COMPONENTS (Continued)

4-5.1 Storage Tank (Continued)

G. Power requirements (Continued)

2. Careful consideration shall be given in each case to the dependability of the electrical supply and wiring system. This shall include the possible effect of fire that may threaten the service to the storage unit.
3. Electrical service shall be installed in accordance with NFPA 70 (National Electric Code) and all state and local codes.
4. Electrical disconnects must be provided for each supply to major components such as the storage tank and control panel. The power sources are to be dedicated for each component.

H. Storage tank control box wiring

1. Refer to Figure 4-6 for a wiring diagram of a standard Mini-Bulk storage tank control box.

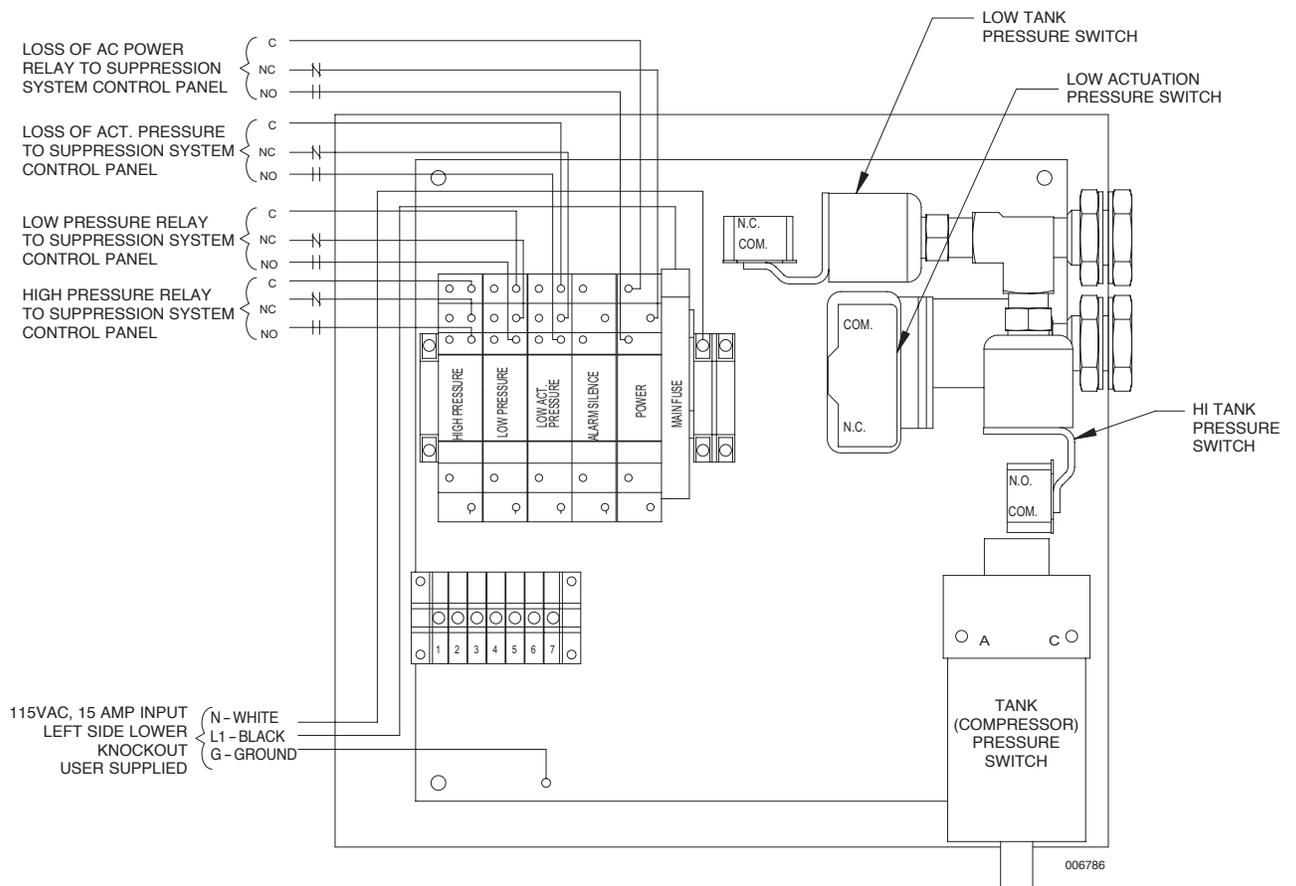


Figure 4-6  
 Mini-Bulk Wiring Diagram

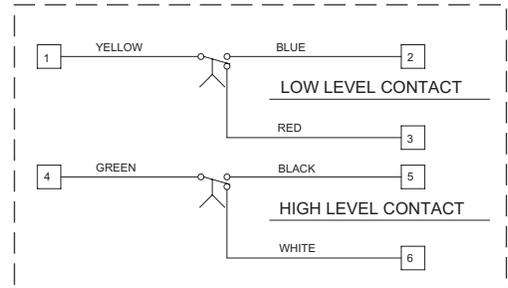
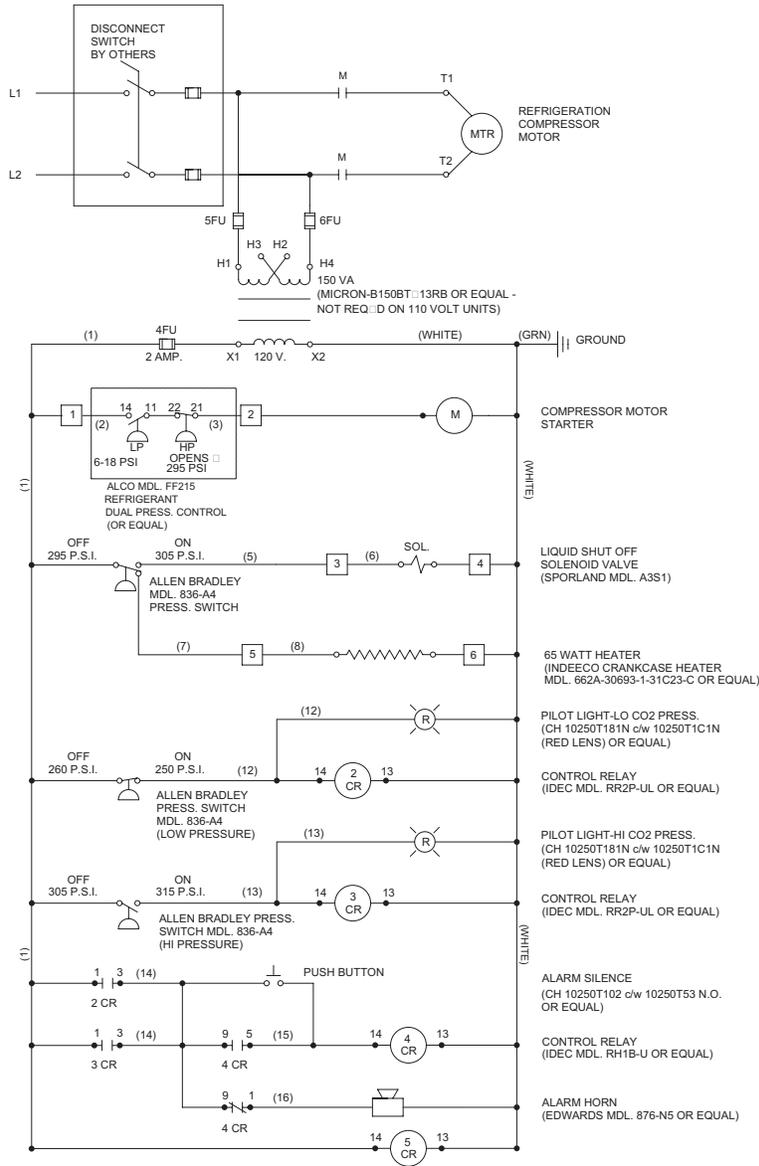
**SECTION 4 – INSTALLATION**

**4-5 INSTALLING COMPONENTS (Continued)**

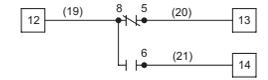
**4-5.1 Storage Tank (Continued)**

H. Storage tank control box wiring (Continued)

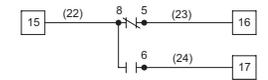
2. Refer to Figures 4-7 and 4-8 for wiring diagrams of a standard Bulk storage tank control box.



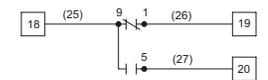
OPTIONAL WIRING



CR2 LOW PRESSURE AUXILIARY ALARM CONTACT



CR3 HIGH PRESSURE AUXILIARY ALARM CONTACT



CR5 AC POWER LOSS RELAY CONTACTS

**Figure 4-7**

Bulk Tank Control Box Wiring Schematic – Single Phase

4-5 INSTALLING COMPONENTS (Continued)

4-5.1 Storage Tank (Continued)

H. Storage tank control box wiring (Continued)

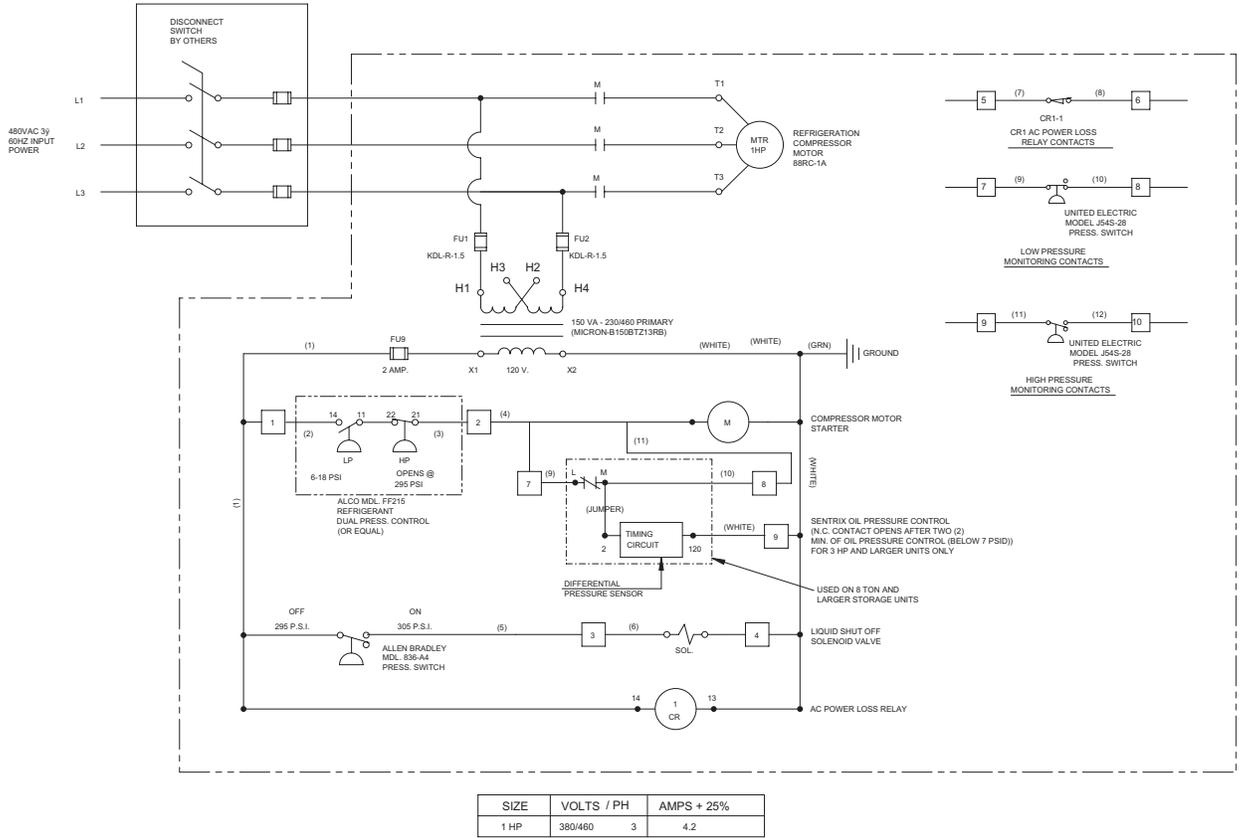


Figure 4-8a

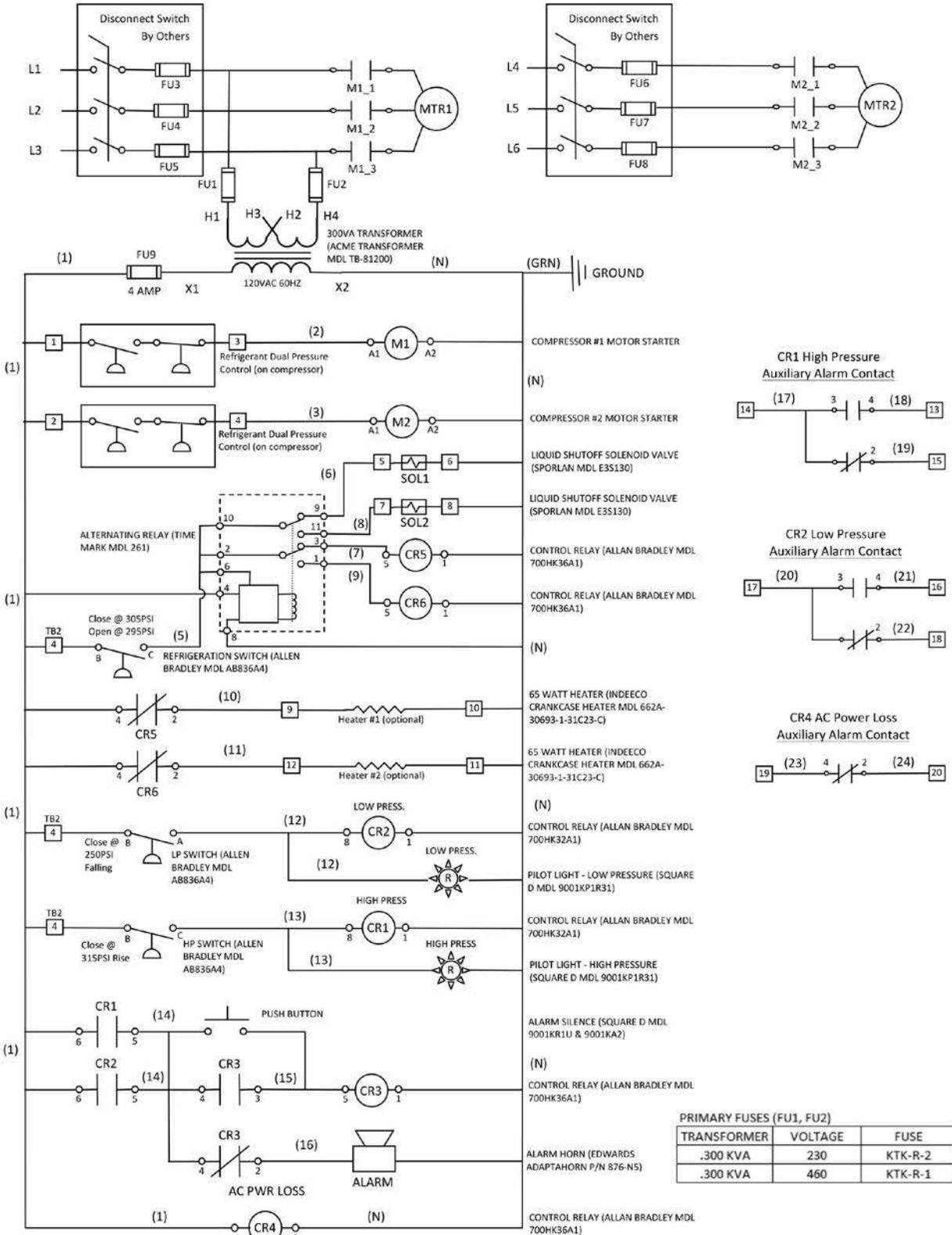
Bulk Tank Control Box Wiring Schematic – Three Phase

**SECTION 4 – INSTALLATION**

**4-5 INSTALLING COMPONENTS (Continued)**

**4-5.1 Storage Tank (Continued)**

H. Storage tank control box wiring (Continued)



PRIMARY FUSES (FU1, FU2)		
TRANSFORMER	VOLTAGE	FUSE
.300 KVA	230	KTK-R-2
.300 KVA	460	KTK-R-1

**Figure 4-8b**  
Dual Refrigeration

#### 4-5 INSTALLING COMPONENTS (Continued)

##### 4-5.1 Storage Tank (Continued)

###### I. Relief valve installation

1. On some of the larger Bulk storage tanks, the relief valve is shipped separately, and is not installed on the storage tank prior to shipment.
2. Install the relief valve onto the storage tank carefully, using joint compound and standard piping practices. A leaking connection can only be repaired by emptying the storage tank, so care must be taken to ensure a clean tight installation initially. Leak test the joint with soap solution on initial vapor pressurization of storage unit.

##### 4-5.2 Relief Valves

If the storage unit is located in a small, enclosed location, the outlet from the safety relief valves must be piped to the outside or a point where discharge of carbon dioxide vapor will not result in a high concentration of carbon dioxide. Such piping must be provided with drain holes at low points and must not be equipped with valves or other means of restricting or stopping the flow of gas. The size of the discharge line should be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device below that required. All relief valves and bladder valves are calculated with 50 ft (15.2 m) of discharge piping and a maximum of four elbows. The piping must match the outlet thread size of the relief valve; **do not decrease the pipe diameter**. If more than 50 ft (15.2 m) of pipe or more elbows are required, consult Technical Services for guidance.

4-5 INSTALLING COMPONENTS (Continued)

4-5.3 Piping

A. General

1. All pipe shall be new.
2. All materials shall be of the highest grade, free from defects and imperfections.
3. Piping shall be of noncombustible material having physical and chemical characteristics such that its deterioration under stress can be predicted with reliability. Special corrosion resistant materials or coatings may be required in severely corrosive atmospheres. Examples of materials for piping and the standards covering these materials are:
  - a. Ferrous Piping: Black or galvanized steel pipe shall be either ASTM A-53 seamless or electric welded, Grade A or B, or ASTM A-106, Grade A, B, or C. Furnace butt weld ASTM-53 may be used. ASTM A-120 and ordinary cast-iron pipe shall not be used. Pipe after master/selector valve shall be minimum of Schedule 40. Manifolds shall be Schedule 80.
  - b. This standard does not preclude the use of other materials such as stainless steel TP304 or TP316 for threaded connections, or TP304, TP316, TP304L, or T3316L for welded connections, or other piping.

 <b>WARNING</b>
Class 150 and cast-iron fittings shall not be used. ASTM A-120 and ordinary cast-iron pipe shall not be used.

4. All pipe and fittings installed outdoors or in corrosive areas should be galvanized or coated with a proper rust inhibitor.
5. Flexible piping, tubing, or hoses (including connections), where used, shall be of approved materials and pressure ratings. It shall be inspected regularly.

B. Layout

1. All pipe branching for the CO<sub>2</sub> distribution system shall be from the side or bottom of the header or sub-header. Where branching involves a reduction of several pipe sizes, a bottom take-off is preferred.

 <b>CAUTION</b>
Branching from top of pipe in the CO <sub>2</sub> distribution system may cause a vapor discharge resulting in system failure.

2. Pipe branching for control components shall be from the top of the header or sub-header. Control components are items such as Relief Valves, Pressure Switches, Pressure Trips, solenoids, regulators, etc. that do not require liquid CO<sub>2</sub> and are not used to discharge agent in or onto the protected space.

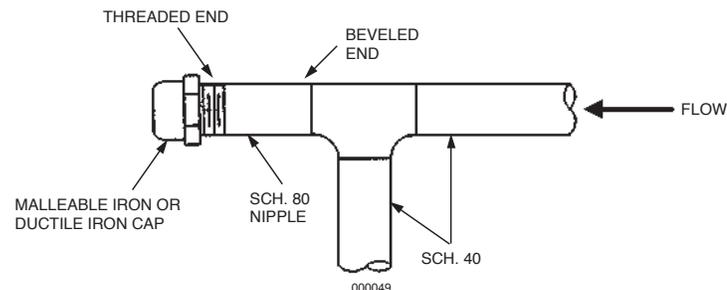
C. Dirt Trap

1. Dirt traps are used throughout the system to trap contaminants within the piping to prevent those contaminants from obstructing components like nozzles, alarm components, control components, etc. A dirt trap consists of a tee with a short nipple and cap on the through side of the tee. Inertia carries any contaminants into the dirt trap instead of making the turn to continue down the piping network.
2. Dirt traps are to be installed:
  - Beyond the last branch connection of each main header.
  - Beyond the last branch connection of each subheader.
  - Beyond the last branch connection of each nozzle piping arrangement.

**4-5 INSTALLING COMPONENTS (Continued)****4-5.3 Piping (Continued)**

- The dirt trap shall be at least 2 in. (51 mm) long, terminating in a malleable iron or ductile iron threaded cap. A longer nipple up to approximately 18 in. (457 mm) is preferred where space permits.

The nipples for dirt traps in headers involving Sch. 40 pipe with welded joints shall be Sch. 80, threaded one end to receive threaded cap as shown in Figure 4-9.



**Figure 4-9**

**D. Cleaning**

- All pipes must be reamed after cutting so that all burrs and sharp edges are removed.
- All pipes must be blown clean and swabbed thoroughly with solvent inside to remove foreign matter and oil before installation. Some effective solvents are trichlorethylene or perchlorethylene.

**E. Joint Compound**

- All screwed pipe threads must be coated with Teflon tape or an approved pipe joint compound. The joint compound is to be applied to the male threads only. Coating of the threads must start at least two threads back from the pipe end.

**F. Welded Pipe Sections**

- A certified welder must perform all welding.
  - Manifold welding and testing should be performed according to the requirements of the latest edition of ASME B31.3, Power Piping Code with a maximum allowable working pressure of 350 psi (24.1 bar). or as dictated by the Authority Having Jurisdiction.
  - Discharge pipe welding should be welded using procedures established by local codes, the Authority Having Jurisdiction and the installer.
- All welded pipe 3/4 in. and smaller must be welded using gas welding or other approved method.
- All welds must be clean from scale, flux and weld beads.
- No backing rings (chill rings) are permitted.

**4-5.4 Fittings****A. General**

- Welded joints, screwed or flanged fittings (malleable iron or ductile iron) may be used. Mechanical grooved couplings and fittings may be used if they are specifically listed for carbon dioxide service.
- Flush bushings shall not be used. When hex bushings are used, more than one pipe size reduction or a 3000 lb (6615 kg) forged steel bushing shall be provided to maintain adequate strength.
- Suitable flared, compression-type or brazed fittings shall be used with copper or brass tubing.
- Where brazed joints are used, the brazing alloy shall have a melting point of 1000 °F (538 °C) or higher.
- All fittings shall be new.
- All materials shall be of the highest grade, free from defects and imperfections.

## SECTION 4 – INSTALLATION

2-1-10 Page 4-14

REV. 1

### 4-5 INSTALLING COMPONENTS (Continued)

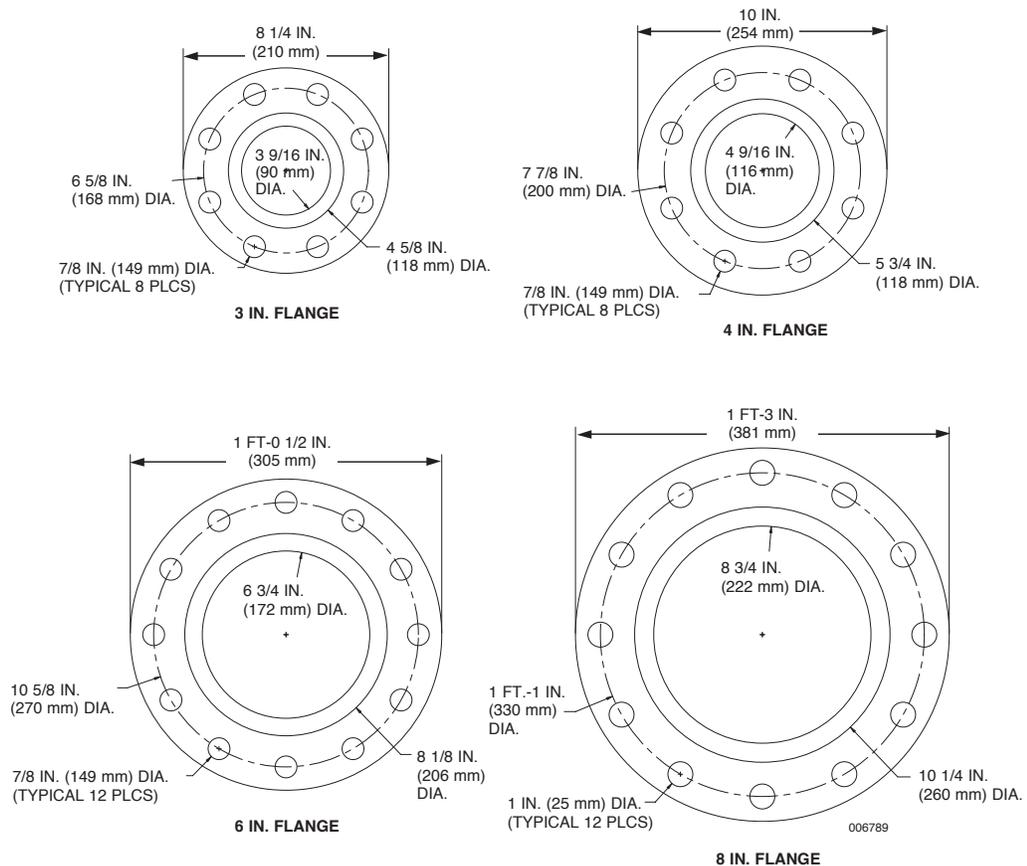
#### 4-5.4 Fittings (Continued)

##### B. Threaded Fittings

1. Fittings shall be class 300 malleable or ductile iron fittings through 3 in. and 1000 lb (454 kg) ductile iron or forged steel fittings in all larger sizes.
2. All reductions in screwed pipe shall be by means of concentric reducers or swaged nipples.
3. Hex bushings, although permitted by NFPA 12, are not recommended.

##### C. Flanged Fittings

1. All flanges must be 300 lb ANSI Class forged steel.
2. All weld neck flanges used with Sch. 80 pipe must have extra heavy pipe wall (Bore Sch. 80). All weld neck flanges used with Sch. 40 pipe must have standard weight pipe wall (Bore Sch. 40).
3. Where flanged pipe connections are used, they shall be gasketed with 1/8 in. thick "garloc," Blue-Gard style 3200 compressed non-asbestos gasket or approved equal.
4. High-grade steel bolts Grade 5 or better as per ASTM A-193 or studs with graded nuts shall be used on all flanged connections. All nuts shall have full engagement on the bolt or stud. (Use Grade 5 per ASTM A-194 or better.)
5. All connectors, such as, bolts and nuts, shall be torqued to the required number of foot-pounds as recommended in the standard piping handbooks. Required torque values for installation of flanged pressure operated valves shall be as recommended by the gasket manufacturer. Refer to the Bolt and Torque Specifications in the appendix for more information.
6. Refer to Figure 4-10 for flange bolt patterns to match ANSUL Low Pressure CO<sub>2</sub> Valves.



**Figure 4-10**  
Flange Pattern Details

**4-5 INSTALLING COMPONENTS (Continued)****4-5.4 Fittings (Continued)****D. Grooved Fittings**

1. Grooved fittings can be used on the distribution piping downstream of the discharge valve. The pipe shall be grooved in accordance with the manufacturer's installation instructions. Grooved fittings shall be specifically listed by a third party testing agency for carbon dioxide service. Bolts and nuts must meet the manufacturer's specifications.

**4-5.5 Bulk Storage Tank Manifold**

- A. Piping from the storage tank shut-off valve to the next normally closed valve(s) is to be considered part of the storage tank manifold.
- B. The storage tank manifold is constantly charged with carbon dioxide. A leak in this section will cause a loss of storage tank capacity and therefore care must be taken to ensure that this section is carefully constructed without leaks of any kind.
- C. The storage tank manifold shall be constructed of Schedule 80 black steel pipe as outlined in paragraph 5.3 with ANSI 300 lb Class flanges.
- D. The storage tank manifold can be fabricated using one of the following procedures or by a combination of these procedures:
  1. By the use of extra heavy butt-welding fittings.
  2. By the use of extra heavy Weld-o-lets or Thread-o-lets. Thread-o-lets shall only be used for those devices, which are only available with threaded connections.
- E. When procedure 2 is used, it is imperative that these fittings be installed in full compliance with the manufacturer's installation instructions. All welds must allow full flow. No mitered weld fittings shall be used. Backing rings (chill rings) shall not be used.
- F. The ends of the header pipe should be blanked off with butt-welding caps or blind flanges.
- G. A 450-psi (31 bar) pressure relief valve shall be installed in the header.
- H. For storage units placed in a warm environment, insulating the manifold will minimize heat entry into the tank.

**4-5.6 Liquid Auxiliary Process Line – Bulk Tanks Only**

- A. Piping between the tank Shut-off Valve and Master/Selector Valve must be Schedule 80 threaded.
- B. A 450 psi relief valve must be installed between the Shut-off Valve and Master/Selector Valve.
- C. For storage units placed in a warm environment, insulate the piping up to the Master/Selector Valve.

**4-5.7 Master/Discharge Valve to Selector Valve or Hose Reel Piping**

The piping between the first normally closed valve (Master or Discharge Valve) and the last normally closed valve (Selector Valve or Hose Reel Playpipe) in a piping system may be subjected to intermittent pressurized conditions, and therefore must be of greater strength than a section that is open to the atmosphere.

- A. A Master Valve must be provided with a by-pass that includes a check valve to allow carbon dioxide trapped between the Master and Selector Valves to bleed back into the storage tank. The check valve must allow flow of carbon dioxide from the selector valve back into the storage tank. It is very important that the flow direction be correct to prevent CO<sub>2</sub> in the storage tank from getting into the piping between the Master and the Selector Valve where it could vaporize and create dangerously high pressures.

**CAUTION**

Ensure the check valve direction of flow is correct.

## SECTION 4 – INSTALLATION

9-1-03 Page 4-16

### 4-5 INSTALLING COMPONENTS (Continued)

#### 4-5.7 Master/Discharge Valve to Selector Valve or Hose Reel Piping (Continued)

- B. All piping downstream of a Master/Discharge Valve (between Master/Discharge Valve and Selector/Shut-Off Valves or between Master Valves) shall be either:
1. Schedule 40 black steel pipe only with welded fittings.
    - a. Standard weight socket weld fittings, with the exception that no reducing bushings are to be used and a socket weld-reducing coupling can be used only for a one size reduction. All other reductions shall be made using a butt-welding concentric reducer.
    - b. Standard weight butt-welding fittings. BACKING RINGS (CHILL RINGS) SHALL NOT BE USED.
    - c. 1000 lb forged steel screwed fittings, back-welded.
  2. Schedule 40 black steel pipe with listed grooved type fittings.
    - a. Where grooved couplings and fittings are used, the fittings and gaskets shall be listed/approved for liquid service with low-pressure carbon dioxide fire suppression systems at a normal pressure of 300 psi (20.7 bar), and a normal temperature of 0 °F (17.7 °C).
    - b. Pipe preparation and installation must be in strict accordance with the manufacturer's recommended procedure.
    - c. Grooved fittings shall be installed so as to allow contraction of the pipe (ends butted together).
    - d. The use of grooved fittings must be approved in advance by the Authority Having Jurisdiction with approval obtained prior to start of design.
  3. Schedule 80 black steel pipe with threaded fittings.
    - a. Threaded pipe fittings shall be Class 300 malleable iron or ductile iron for pipe through 3 in., Class 1000 lb ductile iron or forged steel fittings shall be used in all larger sizes.

#### 4-5.8 Downstream Piping

- A. Piping downstream of selector valves and master valves, that is, piping which is open to atmosphere, must be schedule 40 minimum. Welded and screwed pipe joints are always permitted and in most installations approved grooved pipe connections may be used. Approval from the Authority Having Jurisdiction must be sought prior to the start of design for the project.
- B. Fittings in discharge piping shall be either:
1. Threaded Pipe Fittings: Threaded pipe fittings shall be Class 300 lb malleable iron or ductile iron for pipe through 3 in., Class 1000 lb ductile iron or forged steel shall be used in all larger sizes.
  2. Grooved Fittings:
    - a. Grooved couplings and fittings shall be listed/approved for use with low-pressure carbon dioxide fire systems.
    - b. Pipe preparation must be in strict accordance with the manufacturer's recommended procedure. Installation must be exactly as per the manufacturer's specification in all respects.
    - c. Grooved couplings shall be installed so as to allow contraction of the pipe (pipe ends butted together).
  3. Weld Fittings:
    - a. Only with Schedule 40 black steel pipe.
    - b. Standard weight socket weld fittings, with the exception that no reducing bushings are to be used and a socket weld-reducing coupling can be used only for a one size reduction. All other reductions shall be made using a butt-welding concentric reducer.
    - c. Standard weight butt-welding fittings. BACKING RINGS (CHILL RINGS) SHALL NOT BE USED.
    - d. 1000 lb forged steel screwed fittings, back-welded.

#### 4-5 INSTALLING COMPONENTS (Continued)

##### 4-5.9 Actuation Line Piping

###### A. Common requirements

1. All threaded actuation line pipe connections shall be treated with a suitable pipe sealant. The use of Teflon tape is not allowed.
2. All pipe fittings shall be Class 300 malleable or ductile iron. A Class 300 brass to steel union shall be installed near the storage unit terminations of all pneumatic actuation lines. Class 150 fittings are not permitted.
3. Copper tubing shall not be used.
4. If stainless steel tubing is used, the following applies:
  - a. All stainless steel tubing shall be a minimum of 0.035 wall thickness.
  - b. All tubing must be reamed after cutting.
  - c. Tube fittings shall be of the same material as the tubing and shall be of the compression type. Tube to pipe fitting shall be treated with a pipe sealant as described above. All fittings must have a minimum pressure rating of 1800 psi (124 bar).
  - d. All tubing shall be properly supported.
5. A 150-psi (10.3 bar) pressure relief valve, Part No. 425251, shall be installed at the end of the actuation line.
- ▶ 6. In bulk systems, and mini-bulk systems using remote actuation, a supervisory pressure switch, Part No. 425125, shall be installed to monitor integrity of the actuation network after the main/reserve isolation check valves.
  - a. Normally this would be installed at the end of the actuation line.
  - b. In systems employing multiple actuation lines, a supervisory pressure switch should be installed at the end of each line.
  - c. On Mini-Bulk systems that employ main/reserve isolation check valves, a supervisory pressure switch shall be installed after the check valves.

**Caution:** Leakage of actuation lines will cause a reduction of storage tank CO<sub>2</sub> contents.

7. Use caution when tightening fittings to prevent damage such as cracking and stripping threads.

**Note:** Aluminum in-line filters are especially susceptible to cracking caused by overtightening.

## SECTION 4 – INSTALLATION

2-1-10 Page 4-18

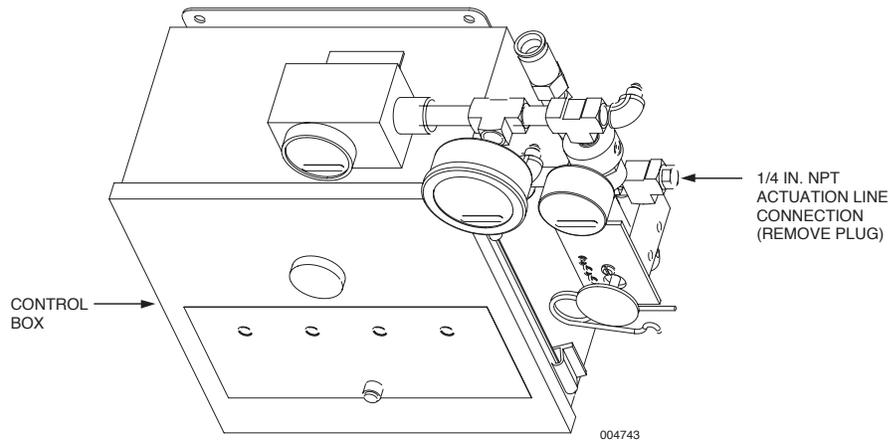
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### 4-5 INSTALLING COMPONENTS (Continued)

#### 4-5.9 Actuation Line Piping (Continued)

##### B. Mini-Bulk system requirements

1. Remove the plug from the regulated pressure port to connect additional actuation piping. See Figure 4-11.



**Figure 4-11**

2. All actuation piping shall be 1/4 in. through 1/2 in. threaded Schedule 40 black pipe, 1/4 in. through 1/2 in. stainless steel tubing, or ANSUL Stainless Steel Braid Covered Actuation Hose and fittings.
3. If the system employs Main and Reserve storage tanks, check valves (1/4 in.) or a shuttle valve shall isolate the actuation pipe for the main bank from the reserve bank actuation pipe.

##### C. Bulk system requirements

1. All piping shall be 1/2 in. threaded Schedule 40 black pipe, 1/2 in. stainless steel tubing, or ANSUL Stainless Steel Braid Covered Actuation Hose and fittings.
2. A pressure regulator (Part No. 425259) and pressure gauge (Part No. 425261) must be installed in the actuation line to maintain 100 psi (6.9 bar).

## 4-5 INSTALLING COMPONENTS (Continued)

## 4-5.10 Remote Fill Line Piping

## A. Mini-Bulk system requirements

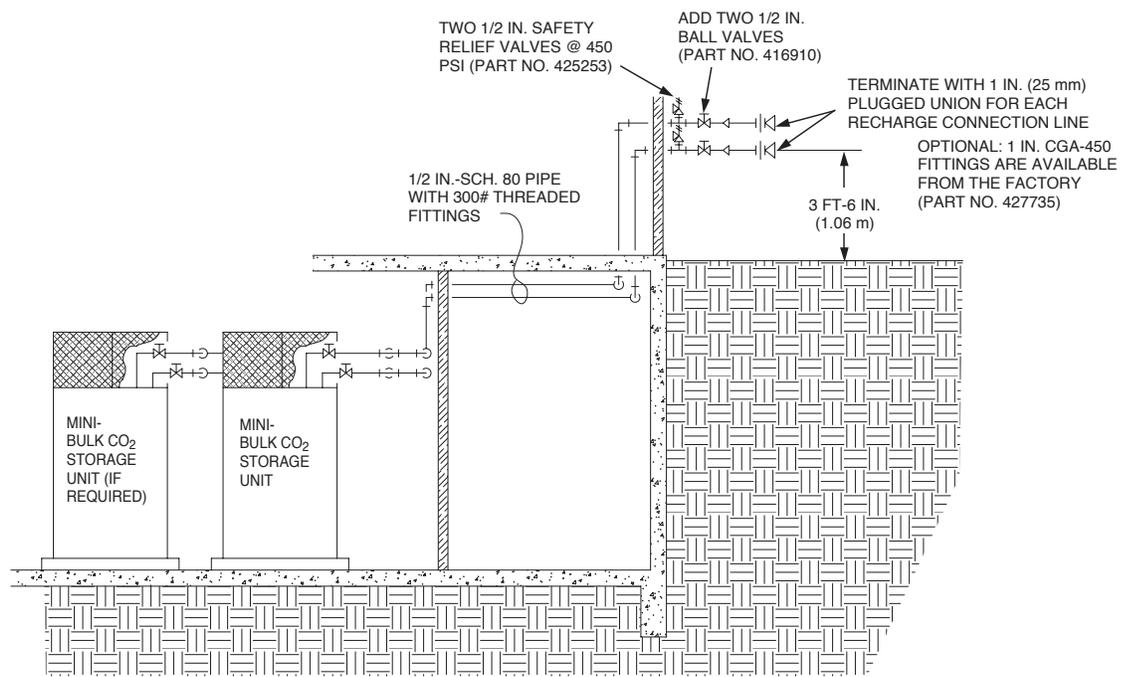
1. Storage tanks may require both a fill line and a vapor return line extension. The lines shall be Schedule 40 welded pipe or Schedule 80 threaded. The vapor line and fill line shall be 1/2 in. If these lines exceed 50 ft (15.2 m) in length, contact Technical Services for recommendations. A 450-psi (31.0 bar) safety relief valve (Part No. 425253) is required to relieve pressure of the trapped gas in each of these extended lines. The relief valves should always be installed in the top of the pipe and at the highest point of the pipe run to ensure only carbon dioxide vapor is vented.
  - a. If vented into enclosed space, the volume must be sufficient to prevent accumulation of CO<sub>2</sub> in concentrations high enough to affect safety of personnel. Refer to NFPA 12 Carbon Dioxide Extinguishing Systems, 1-10.2.3.
  - b. In outdoor locations, the relief valve outlet should point downward to prevent moisture from collecting in the relief valve outlet.

**Note:** The ball valves provided with the tank are not to be removed and installed at the end of the fill lines.

2. 1/2 in. ball valves must be installed at the remote fill connections outside the building.

**Note:** The ball valves provided with the tank are not to be removed and installed at the end of the fill lines.

3. Refer to Figure 4-12 for further guidance in the layout of the remote fill lines.



**Figure 4-12**  
Mini-Bulk Storage – Remote Fill

## SECTION 4 – INSTALLATION

2-5-15 Page 4-20

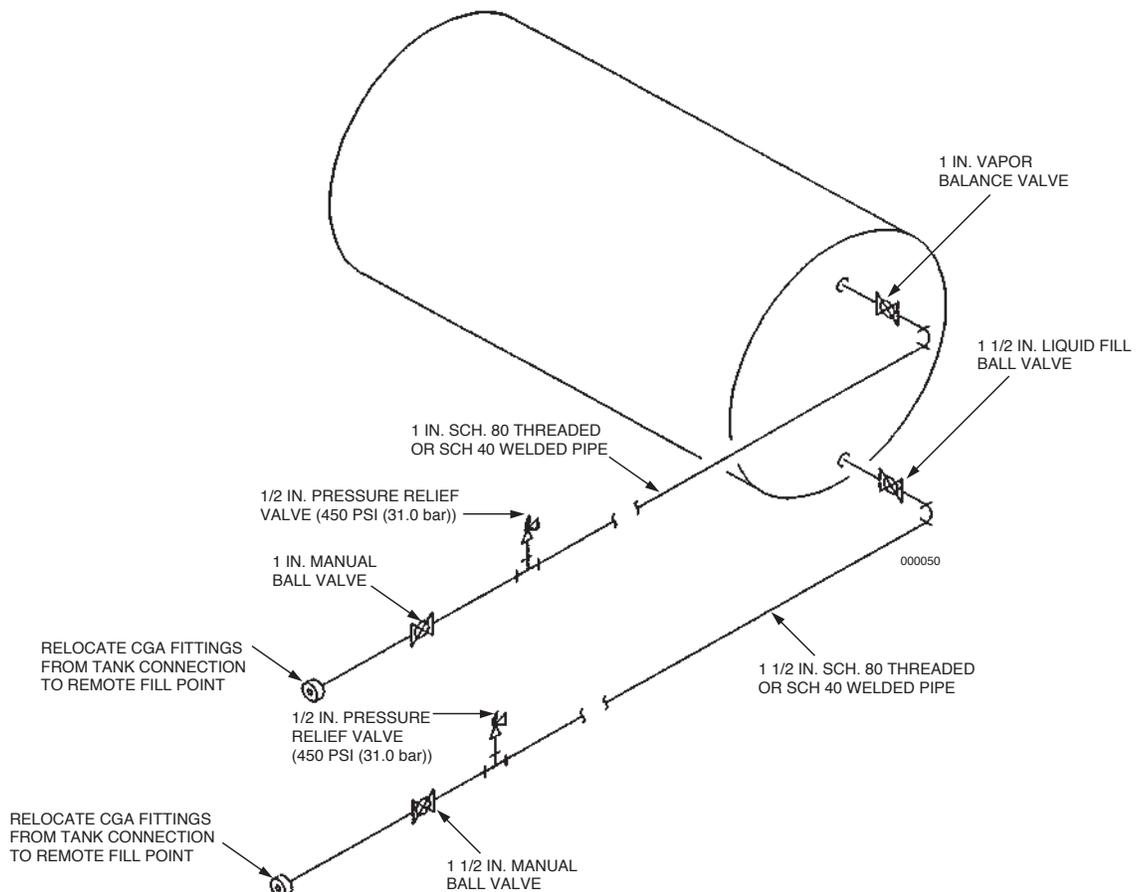
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### 4-5 INSTALLING COMPONENTS (Continued)

#### 4-5.10 Remote Fill Line Piping (Continued)

##### B. Bulk system requirements

1. Fill and Equalizing lines (Figure 4-13) should be terminated with the appropriate size ball valve and the CGA connection fittings. These termination points must be a minimum of 8 in. (203 mm) apart, centerline-to-centerline, 3 ft 6 in. (107 cm) above grade or floor and securely anchored. Since the CGA fittings are furnished on the storage unit fill and equalizing lines, they can be removed and used at the termination points of the extended fill and equalizing lines. Three hundred pound malleable iron, galvanized unions can then be substituted at the storage unit. A 450 psi (31.0 bar) safety relief valve (Part No. 425253) is required to relieve pressure of the trapped gas in each of these extended lines. The relief valves should always be installed in the top of the pipe and at the highest point of the pipe run to ensure only carbon dioxide vapor is vented.
    - a. If vented into enclosed space, the volume must be sufficient to prevent accumulation of CO<sub>2</sub> in concentrations high enough to affect safety of personnel. Refer to NFPA 12 Carbon Dioxide Extinguishing Systems, 1-10.2.3.
    - b. In outdoor locations, the relief valve outlet should point downward to prevent moisture from collecting in the relief valve outlet.
- Note:** The ball valves provided with the tank are not to be removed and installed at the end of the fill lines.
2. The pipe size for fill and equalizing lines must be as identified on the drawings and must be:
    - a. Schedule 80 black steel pipe with class 300 malleable iron or ductile iron, fittings.
    - b. Schedule 40 black steel pipe with welded joints. Fittings to be butt-welding, Tube-Turns or equal, or class 1000 minimum socket weld fittings.



**Figure 4-13**  
Fill Line Extension

## 4-5 INSTALLING COMPONENTS (Continued)

### 4-5.11 Relief Valve Discharge Piping

- A. When a storage unit is located in a building, all relief valve vent lines should be piped to the outside (refer to 4-5.2). The pipe size of this vent line shall be as called for on the drawings and shall be Schedule 40. Fittings shall be class 300 malleable iron or ductile iron. A class 300 malleable iron union shall be used to connect the extended vent line to the storage unit. If the pipe is extended 50 ft (15.2 m) or less, match the relief valve outlet connection size. For lengths more than 50 ft (15.2 m), Technical Services MUST BE CONSULTED FOR PIPE LIMITATIONS.
- B. Relief valve discharge piping must be provided with 1/8 in. drain holes at low points and must not be equipped with valves or other means of restricting or stopping the flow of gas.
  - 1. Weather/animal-preventive fittings shall be supplied by the end user and attached to the termination point of the extended vent line to prevent rain, snow, animals, etc. from entering the piping.

### 4-5.12 Underground Piping

- A. Underground piping is to be avoided. If unavoidable, a routing for underground piping will be submitted for approval to the system designer prior to the start of design.
- B. All underground piping shall be schedule 80 black steel pipe with butt-welded joints. Fittings to be either extra heavy steel butt-welding fittings or socket-weld fittings, Class 1000 minimum. NO CHILL RINGS ARE PERMITTED. In hazardous locations where welding is not permitted, flanged connections are to be used. Welding of flanges can be accomplished in a non-hazardous area.
- C. Pipe joints to be tested for leaks at 300 psi (20.7 bar) before corrosion prevention coating is applied.
- D. All underground piping is to be treated and wrapped with a suitable material to provide an absolute seal so as to prevent ground moisture from coming in contact with the pipe. Pre-wrapped schedule 80 pipe is acceptable if joints are properly treated.
- E. Trench depth for underground piping to be a minimum of 3 ft (0.9 m) but in no case less than lowest frost depth. Piping run in the ground but beneath a building floor slab need not be as deep unless the building is unheated and the ground is subject to freezing.
- F. Include expansion joints if pipe lengths dictate (see Section 4-5.13).

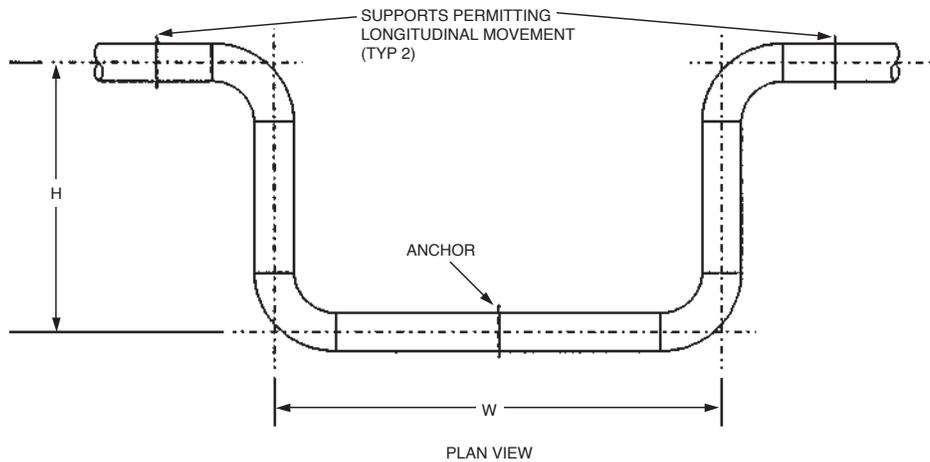
### 4-5.13 Expansion Loops

- A. Steel piping expands and contracts with changes in its temperature as experienced during the discharge of a system. These changes must be accounted for in long piping runs to prevent damage to the system caused by lengthening or shortening of the piping.
- B. The contraction of steel piping during discharge is based on 1 in. (25 mm) of contraction per 100 ft (30.5 m) of steel pipe.
- C. Allowance must be made for this contraction by using either a joint which permits movement, a piping system which contains natural swing joints, fabricated circular type of “U” type bends or, in cases where space is limited, an approved manufactured expansion joint. See Figure 4-14.

**SECTION 4 – INSTALLATION**

**4-5 INSTALLING COMPONENTS (Continued)**

**4-5.13 Expansion Loops (Continued)**



**Note:** Rigid hangers should be installed at all three (3) points noted above. However, the tension on the “U” bolts supporting the pipe to the hanger must be adjusted to allow longitudinal movement on either side of the loop.

Pipe Size	Dimension H		Dimension W	
	ft	(m)	ft	(m)
1/2 in.	1	(0.31)	5.5	(1.67)
1/2 in.	2	(0.61)	1.5	(0.46)
1/2 in.	3	(0.91)	0.5	(0.15)
3/4 in.	1	(0.31)	8.5	(2.59)
3/4 in.	2	(0.61)	3	(0.91)
3/4 in.	3	(0.91)	1	(0.31)
3/4 in.	4	(1.22)	0.5	(0.15)
1 in.	1	(0.31)	10	(3.05)
1 in.	2	(0.61)	3.5	(1.07)
1 in.	3	(0.91)	1	(0.31)
1 in.	4	(1.22)	0.5	(0.15)
1 1/4 in.	1	(0.31)	12	(3.66)
1 1/4 in.	2	(0.61)	5	(1.52)
1 1/4 in.	3	(0.91)	1	(0.31)
1 1/4 in.	4	(1.22)	0.5	(0.15)
1 1/2 in.	1	(0.31)	13.5	(4.12)
1 1/2 in.	2	(0.61)	6	(1.83)
1 1/2 in.	3	(0.91)	2	(0.61)
1 1/2 in.	4	(1.22)	0.5	(0.15)
2 in.	1	(0.31)	15.5	(4.77)
2 in.	2	(0.61)	7.5	(2.29)
2 in.	3	(0.91)	2.5	(0.76)
2 in.	4	(1.22)	0.5	(0.15)

Pipe Size	Dimension H		Dimension W	
	ft	(m)	ft	(m)
2 1/2 in.	1	(0.31)	18	(5.48)
2 1/2 in.	2	(0.61)	9	(2.74)
2 1/2 in.	3	(0.91)	4	(1.22)
2 1/2 in.	4	(1.22)	1	(0.31)
3 in.	1	(0.31)	20	(6.09)
3 in.	2	(0.61)	10	(3.05)
3 in.	3	(0.91)	5	(1.52)
3 in.	4	(1.22)	1	(0.31)
3 in.	5	(1.52)	0.5	(0.15)
4 in.	1	(0.31)	21.5	(6.55)
4 in.	2	(0.61)	11.5	(3.51)
4 in.	3	(0.91)	5	(1.52)
4 in.	4	(1.22)	2	(0.61)
4 in.	5	(1.52)	0.75	(0.23)
6 in.	2	(0.61)	14	(4.27)
6 in.	3	(0.91)	7.5	(2.29)
6 in.	4	(1.22)	2.5	(0.76)
6 in.	5	(1.52)	1	(0.31)
8 in.	2	(0.61)	14	(4.27)
8 in.	3	(0.91)	9.5	(2.89)
8 in.	4	(1.22)	3.5	(1.07)
8 in.	5	(1.52)	1.5	(0.46)

**Figure 4-14**  
Estimating Guide For Expansion Loops

**4-5 INSTALLING COMPONENTS (Continued)****4-5.13 Expansion Loops (Continued)**

- D. In piping which utilizes grooved type couplings, these couplings shall be installed to permit contraction of the piping.
- E. In straight runs using welded or screwed joints, an expansion joint must be installed within 100 ft (30.5 m) of continuous run from the storage unit and each 100 ft (30.5 m) of run thereafter. For runs using grooved pipe, a representative of the manufacturer should be contacted to determine the location and number of expansion joints in long runs.
- F. Pipe anchors shall be capable of withstanding any contraction thrusts that may be imposed by the piping while permitting movement intended in the design of the piping system to relieve stress. This will require rigid anchoring of certain points in the piping system while leaving other points of the pipe free to move longitudinally so as to relieve stress.

**4-5.14 Vapor Traps**

- A. Vapor traps must be installed in the system where shown on the system drawings when required by the design. These traps are used in systems with master valves that supply selector valves or hose reels. A vapor trap provides a means of limiting liquid flow to only the selector valve or hose reel called upon for discharge. The vapor trap will ensure that the initial vapor time will be minimized to the shortest possible period. See Figure 4-15.
- B. Vapor traps must be located at all possible splits in the discharge flow. These splits are identified at the branch point when gas flow could be diverted to multiple hazards or hose reels. This will be noted on the system drawings.

4-5 INSTALLING COMPONENTS (Continued)

4-5.14 Vapor Traps (Continued)

- C. A vapor trap is comprised of a short rise in pipe elevation at the branch splits in the direction of the flow. The vapor trap often forms a U trap. The elevation changed must be a minimum of 2 pipe diameters to provide an effective trap. Refer to the detail below for a variety of acceptable trap arrangements.
- D. A vapor trap can serve additionally as an expansion loop. When the loop serves dual purposes, the minimum requirement of both arrangement guidelines must be met.

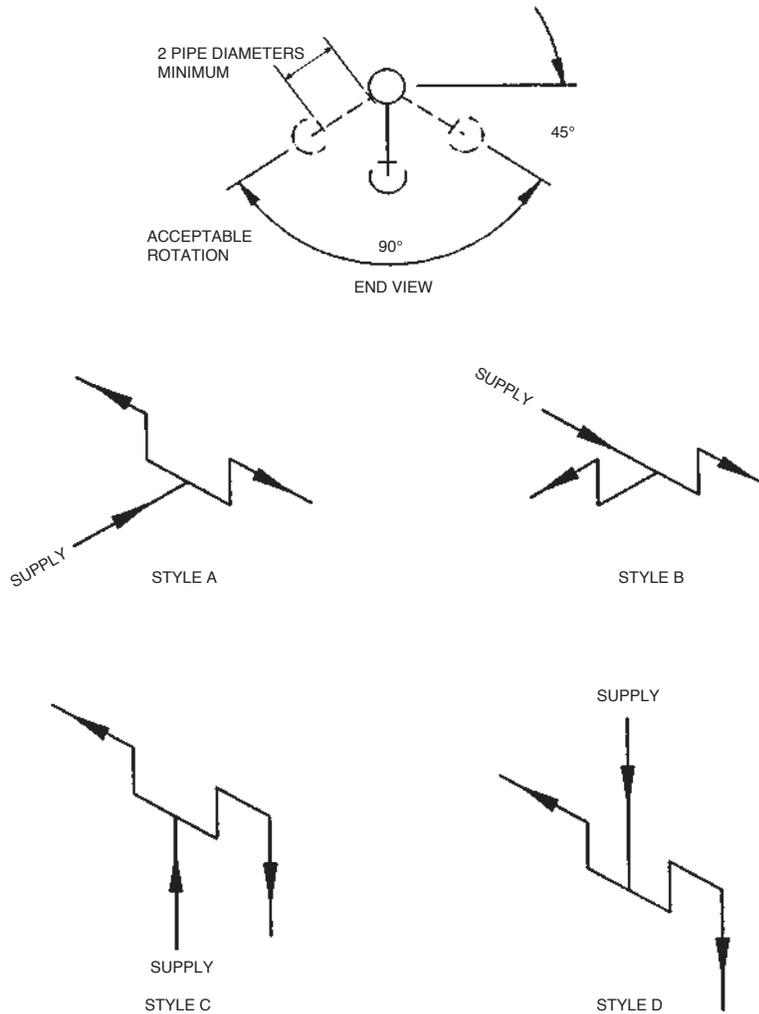


Figure 4-15  
Typical Vapor Traps

4-5.15 Pipe Hangers & Supports

- A. All pipe hangers and supports shall conform to the provisions outlined in ANSI B31.1, latest edition. All pipe must be solidly anchored to structural members where longitudinal or lateral movement is possible with due allowance for agent thrust forces, thermal expansion and contraction and shall not be subject to mechanical damage. Hangers are classified as rigid or intermediate.
- B. Rigid hangers are required wherever a change in direction or change in elevation in the piping system occurs. On long straight runs as a minimum, every other hanger shall be rigid.
- C. Where rod type hangers are acceptable for intermediate supports between rigid hangers, they must be the steel clevis hanger type of the proper pipe size with a solid bar type hanger rod. These hangers shall be used only where hanger rods are not subject to stresses due to bending. See Table 4-3.
- D. All hangers shall be steel and installed in a workmanlike manner.

**4-5 INSTALLING COMPONENTS (Continued)****4-5.15 Pipe Hangers & Supports (Continued)**

- E. All piping shall be attached to rigid hangers by means of U-bolts locked with double nuts. The pipe shall be free to move longitudinally within the U-bolt except where the piping design requires it to be anchored.
- F. Hangers and pipe shall be designed to prevent stresses from being induced into the piping during the temperature change caused by a system discharge.
- G. All piping supports shall be fabricated and installed so that the movement of the supported pipe will not disengage them.
- H. Pipe shall not be hung using one pipeline as a support for another.
- I. Piping supports shall be arranged so that no excessive bending stresses are induced into the piping from concentrated loads between supports.
- J. The maximum spacing between pipe supports for screwed or welded piping is given in Table 4-4. Maximum spacing between pipe supports is given in Table 4-5 for systems utilizing the grooved coupling method for system discharge piping.
- K. Cast iron supports, conduit clips, C-clamps, malleable iron ring type hangers, etc. are not acceptable for fabrication or installation of pipe supports.

Pipe Size		Rod Size	
in.	(mm)	in.	(mm)
1 in. and smaller	(25 mm and smaller)	3/8	(10 mm)
1 1/4 in. to 3 in.	(30 mm to 75 mm)	1/2	(15 mm)
4 in. and 5 in.	(100 mm to 130 mm)	5/8	(17 mm)
6 in.	(150 mm)	3/4	(20 mm)
8 in.	(200 mm)	7/8	(23 mm)

**TABLE 4-3**

Rod Size As Determined By Pipe Size

Nominal Pipe Size		Maximum Span	
in.	(mm)	ft	(m)
1/2	(15)	5	(1.5)
3/4	(20)	6	(1.8)
1	(25)	7	(2.1)
1 1/4	(30)	8	(2.4)
1 1/2	(40)	9	(2.7)
2	(50)	10	(3.0)
2 1/2	(65)	11	(3.4)
3	(75)	12	(3.7)
4	(100)	14	(4.3)
5	(130)	16	(4.9)
6	(150)	17	(5.2)
8	(200)	19	(5.8)

**TABLE 4-4**Maximum Spacing Between Supports  
For Screwed Or Welded Pipe

Nominal Pipe Size		Maximum Span	
in.	(mm)	ft	(m)
1/2	(15)	5	(1.5)
3/4	(20)	7	(2.1)
1	(25)	7	(2.1)
1 1/4	(30)	7	(2.1)
1 1/2	(40)	7	(2.1)
2	(50)	7	(2.1)
2 1/2	(65)	8	(2.4)
3	(75)	10	(3.0)
4	(100)	10	(3.0)
5	(130)	12	(3.7)
6	(150)	12	(3.7)
8	(200)	12	(3.7)

**TABLE 4-5**Maximum Spacing Between Supports  
For Pipe With Grooved Joints

## SECTION 4 – INSTALLATION

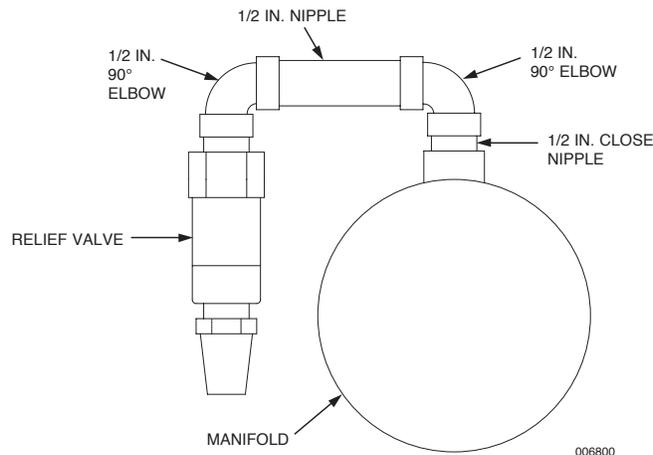
2-5-15 Page 4-26

REV. 1

### 4-5 INSTALLING COMPONENTS (Continued)

#### 4-5.16 Relief Valves for Manifolds and Closed Sections of Pipe

- A. A pressure relief valve must be installed in any section of pipe that can trap liquid. Examples are sections of pipe between valves, hose reel pipe sections, actuation lines, remote fill lines, etc.
- B. Piping to pressure relief valves shall be as specified for that section of piping. All branch connections for pressure relief valve piping shall be from the top of the discharge piping.
- C. Relief valves should always be installed in the top of the pipe and at the highest point of the pipe run to ensure only carbon dioxide vapor is vented.
- D. If the relief valve is installed outdoors, the outlet must be pointed downward to prevent moisture from collecting inside the relief valve. This is commonly accomplished by the use of a “goose-neck,” a section of pipe with two elbows so the pipe turns horizontally and then downward. Refer to Figure 4-16.



**Figure 4-16**  
Outdoor Relief Valve Piping Detail

- E. The 150 psi (10.3 bar) relief valves are used in actuation line applications where the pressure will not exceed 100 psi (6.9 bar).
- F. The 450 psi (31 bar) relief valves are used for discharge piping applications.
- G. Relief valves located indoors may be required to be vented outdoors. (Refer to 4-5.2.)

#### 4-5.17 Tank Shut-Off Valve

##### A. Mini-Bulk Storage Tanks

- ▶ Mini-Bulk storage tanks employ a 2 in. threaded lock-out valve as a tank shut-off valve. Refer to Section 4-5.19 for connection information.

##### B. Bulk Storage Tanks

**Caution:** Do not force the valve in either extreme direction when operating with the hand wheel. Operating the valve hard against the stops may cause mis-alignment between the disc and the seat, resulting in possible leakage.

**4-5 INSTALLING COMPONENTS (Continued)****4-5.17 Tank Shut-Off Valve (Continued)****B. Bulk Storage Tanks (Continued)**

1. The tank shut-off valve is designed to be mounted between Class 300 ANSI flanges (not included with valve). When the valve is open, the disc will extend into the pipe on both sides of the valve, further on the body side than the seat retainer side of the valve. Piping must be large enough to allow the disc to clear the pipe. The valve is operated by turning the hand wheel counterclockwise to open, clockwise to close. The minimum pipe inside diameter (ID) allowable and standard pipe IDs are listed in Tables 4-6 and 4-7.
  - a. The valve must be installed in the direction of flow indicated on the label.
  - b. When the disc is in the closed position, carefully center the valve between the flanges. The tapped holes match ANSI pipe flanges and assist in positive alignment.
  - c. Refer to Section 4-5.4. for flange, bolt, gasket, and torque requirements when installing the valve.
2. Two position switches are included on each tank shut-off valve to allow supervision of the valve by the control panel.
  - a. One switch provides an indication when the valve is completely opened.
  - b. The other switch provides an indication when the valve is completely closed.
3. Refer to the tank shut-off valve component sheets for wiring diagrams and conduit connection information for both types of valves. The switches should be tested after installation to verify that the cam settings are correct. A multimeter can be attached to each switch to verify the switch operation while operating the tank shut-off valve.
  - a. Valves are supplied preset and should not require adjustment.
  - b. Adjust the cams, if necessary, to operate the switches only at the fully open and fully closed positions. Cams are adjusted by pushing in on the cam and rotating it as necessary.

Minimum ID of Pipe For Disk Clearance	
Valve Size	Class 300
3	2.867
4	3.745
6	5.710
8	7.600

**TABLE 4-6**

Nominal Inside Diameter Of Pipe		
Valve Size	Sch. 40	Sch. 80
3	3.068	2.900
4	4.026	3.826
6	6.065	5.761
8	7.981	7.625

**TABLE 4-7****Notes:** Tables 4-6 and 4-7:

1. Minimum ID of pipe with recommended clearances (per API 609) have been calculated by adding the minimum ID with zero clearance to a minimum recommended diametric clearance for each pipe size.
2. These tables assume that the pipe is on the body side of the valve and that the pipe is perfectly centered. The seat retainer side of the valve will always have more clearance than the body side.
3. A minimum of 1/8 in. (3.1 mm) thick gasket is used between the pipe flange and valve body face.
4. When using a pipe whose ID is smaller than the recommended minimum inside diameter of pipe with adequate clearance, a chamfer of 45 degrees should be provided on the end of the pipe so that it clears the disc.

## SECTION 4 – INSTALLATION

2-1-10 Page 4-28

REV. 1

### 4-5 INSTALLING COMPONENTS (Continued)

#### 4-5.18 Master/Selector Valves

##### A. General

- ▶ 1. The Master/Selector Valves include a two-way solenoid valve for actuation and also include a pneumatically operated manual override feature. The override consists of a button valve, which is locked in place with a ring pin.
- 2. Operation of the override consists of removing the ring pin, pushing the button in, and twisting it 90° to lock the override in the open position. Failure to twist the button will allow the override to release, closing the valve.
- 3. Since the emergency mechanical operator is located on the valve actuator, the master/selector valves should always be located in an easily accessible location.
- ▶ 4. Master/Selector Valves without a solenoid valve are used when an Automatic Timer Cabinet is included in the system. These Master/Selector Valves do not include a solenoid valve or manual override because these features are provided by the Automatic Timer Cabinet
- ▶ a. Master/Selector Valves without a solenoid valve can be located in a location that is not readily accessible in an emergency.
- ▶ 5. All Master/Selector Valves can be installed in any orientation. If the valve is installed outdoors, it shall be protected from the environment and maintained within the FM Approved temperature range. The vent filter on the solenoid valve/pneumatic actuator must point downward to prevent moisture from entering it, which could lead to water inside the actuator body, hindering valve operation.

##### B. Threaded Valves

- 1. The master/selector valves in sizes 1/2 in. through 2 in. are threaded ball valves that include a pneumatic actuator and may include a solenoid valve.
- 2. The valve must always be installed with the direction of the flow as indicated on the valve.
- 3. When installing a threaded ball valve, the threads on the mating pipe must be free from grit, dirt, or burrs. Care must be taken to ensure that any pipe sealants used are not so excessively applied to the pipe threads that the valve cavity becomes obstructed.
- 4. A 300 lb malleable iron union installed downstream of the valve assembly will aid in the installation or replacement of the valve.

##### C. Flanged Valves

- 1. Master/selector valves in sizes 3 in. through 8 in. are butterfly valves that include a pneumatic actuator and may include a solenoid valve.
- 2. The flanged valves are designed to mount between Class 300 ANSI flanges.
- 3. When a butterfly valve is open, the disc will extend into the pipe on both sides of the valve, further on the body side than the seat retainer side. The piping must be large enough to allow the disc to clear the ID of the pipe on both sides. The minimum pipe ID allowable and standard pipe IDs are listed in Tables 4-6 and 4-7.
- 4. The valve must always be installed with the direction of flow as indicated on the label.
- 5. When installing a valve ensure that the disc is in the closed position and carefully center the valve between the flanges.
- 6. Valve sizes 3 in. through 8 in. require matching Class 300 ANSI flanges for mounting. These flanges are not included with the valve.
- 7. Refer to Section 4-5.4 for flange, bolt, gasket, and torque requirements when installing the valve.

##### D. Master/Selector Valves with a solenoid valve include a filter at the actuation line pressure connection

- ▶ 1. The filter provides a 3/8 in. NPT female inlet connection from the actuation line on the time delay valve and a 1/4 in. NPT female inlet connection from the actuation line on the valves without a time delay. Fittings threaded to the filter should not be overtightened to prevent cracking of the filter.
- ▶ 2. The filter is included to prevent dirt and debris from getting into the solenoid valve, where it could prevent proper operation of the valve.
- ▶ 3. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.

## 4-5 INSTALLING COMPONENTS (Continued)

### 4-5.18 Master/Selector Valves (Continued)

#### E. Wiring information

- ▶ 1. The Master/Selector Valve solenoid includes two power leads and a ground lead.
  - a. The solenoid is not a polarized device, therefore either lead can be connected to the positive and negative terminals from the control panel.
  - b. The leads are approximately 72 in. (1.8 m) long.
- ▶ 2. The solenoid valve is a 24 VDC device that draws 0.48 Amps.
- 3. The solenoid includes a 1/2 in. NPT female conduit connection.

### 4-5.19 Lock-Out Valve

#### A. General

1. A Lock-Out Valve is a ball or butterfly valve installed in the piping between the storage tank and the nozzles. It is intended to prevent an accidental discharge of carbon dioxide when personnel are present in or around the protected space. Lock-Out Valves are required under NFPA 12 Chapter 1. This can apply to both total flood and local application systems. It is the responsibility of the designer of the system, not the installer, to make this determination.
2. Lock-Out Valves should be installed in a readily accessible area near the entrance to the protected space so that the system can be easily locked-out when necessary. Lock-Out Valves that are in difficult to access locations may not be used as intended.
3. A 450 psi (31 bar) safety relief valve (Part No. 425253) must be added to any closed pipe section associated with these valves.

#### B. Threaded Valves

1. The lock-out valve sizes 1/2 in. – 2 in. are threaded ball valves. The valve must be installed in the direction of the flow indicated on the label.
  - a. When installing the threaded ball valves, be sure the threads on the mating pipe are free from grit, dirt, or burrs. Care must be taken to ensure that any pipe sealants used are not so excessively applied to the pipe threads that the valve cavity becomes obstructed.
  - b. Provide 300 lb Malleable Iron union downstream of valve to aid in installation and replacement of the valve.
2. Ball Valve type Lock-Out Valves use the valve handle to indicate the position of the valve.
  - a. When the handle is in line with the piping, it indicates that the valve is open.
  - b. When the handle is across the piping, it indicates that the valve is closed.

#### C. Flanged Valves

1. The Lock-Out Valve sizes 3 in. – 8 in. are designed to be mounted between Class 300 ANSI flanges (not included with valve). When the valve is open, the disc will extend into the pipe on both sides of the valve, further on the body side than the seat retainer side of the valve. Piping must be large enough to allow the disc to clear the pipe. The valve is operated by turning the hand wheel counter clockwise to open, clockwise to close. The minimum pipe ID allowable and standard pipe IDs are listed in Tables 4-6 and 4-7.
  - a. The valve must be installed in the direction of flow indicated on the label.
  - b. With the disc in the closed position, carefully center valve between flanges.
  - c. Refer to Section 4-5.4. for flange, bolt, gasket, and torque requirements when installing the valve.
2. Butterfly type Lock-Out Valves include an indicator that identifies the position of the valve.

#### D. Two position switches are included on each lock-out valve to allow supervision of the valve by the control panel.

1. One switch provides an indication when the valve is completely opened.
2. The other switch provides an indication when the valve is completely closed.

## SECTION 4 – INSTALLATION

9-1-03 Page 4-30

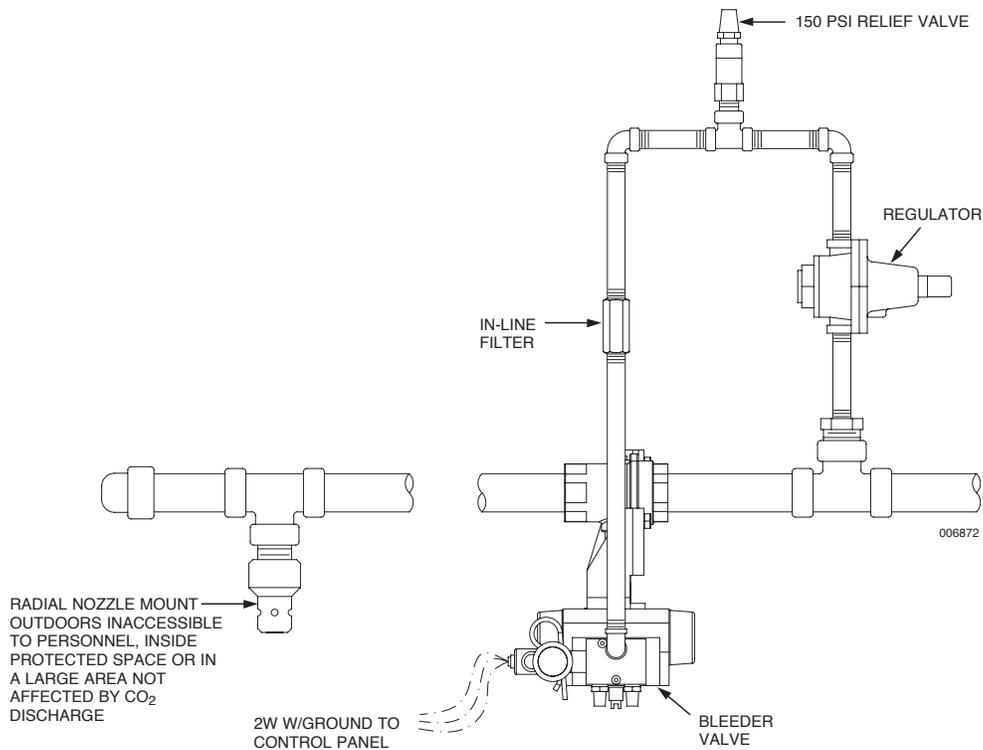
### 4-5 INSTALLING COMPONENTS (Continued)

#### 4-5.19 Lock-Out Valve (Continued)

- E. Refer to the Lock-Out Valve component sheets for wiring diagrams and conduit connection information for both types of valves.
1. The switches should be tested after installation to verify that the cam settings are correct. A multimeter can be attached to each switch to verify the switch operation while operating the Lock-Out Valve.
    - a. Valves are supplied preset and should not require adjustment.
    - b. Adjust the cams, if necessary, to operate the switches only at the fully open and fully closed positions. Cams are adjusted by pushing in on the cam and rotating it as necessary. Adjustment should be such that an indication is received within a few turns of the wheel. However, take care that cam does not roll off switch when valve is fully closed and open.

#### 4-5.20 Bleeder Valves

- A. A Bleeder Valve arrangement may be added to long pipe runs with low flow rates to reduce the vapor discharged from a fixed nozzle or a hose reel nozzle at the beginning of a discharge.
- B. The Bleeder Valve is opened at the beginning of a discharge to increase the flow of CO<sub>2</sub> through the piping, which decreases the amount of time required to obtain liquid at the nozzles. It also vents a large amount of the vapor generated during the initial part of the discharge.
- C. A Bleeder Valve Arrangement consists of a Selector Valve, a Discharge Nozzle, a Relief Valve, and an Actuation Regulator (see Figure 4-17). A Discharge Nozzle, sized to the necessary flow rate, is located outdoors, inside the protected space, or into a large area that will not be affected by the amount of CO<sub>2</sub> discharged from the Bleeder Valve. Consult the Installation drawings for the nozzle location. The nozzle must be placed in a location that prevents discharge of carbon dioxide in a manner that could endanger personnel.



**Figure 4-17**  
CO<sub>2</sub> Vapor Bleeder Valve Arrangement

## 4-5 INSTALLING COMPONENTS (Continued)

### 4-5.20 Bleeder Valves (Continued)

- D. Due to the distance between most Bleeder Valves and the storage tanks, it would be impractical to run an actuation line to the Bleeder Valve. Actuation pressure is obtained from the discharge supply line by attaching a small (1/4 in.) pipe to the top of the supply line just before the Bleeder Valve. A 1/4 in. Regulator is connected to the pipe, and the discharge from the Regulator is connected to the Bleeder Valve solenoid valve. The tap for the actuation pressure must be from the top of the supply pipe to feed vapor to the Regulator.
- E. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- F. The open time for a Bleeder Valve must be established by a discharge test of the system to determine the length of time required to achieve liquid flow at the system nozzle. Once this time has been established, the control panel timer must be set accordingly.

### 4-5.21 Discharge Pressure Switch

- A. A Discharge Pressure Switch is a pneumatically operated, electric switch installed in the discharge piping network. It can be used to electrically activate or deactivate process and/or environmental control components if not done by the system control panel. A Discharge Pressure Switch is also installed in a system to provide a signal to the control panel to activate alarms in the event that the system is activated manually.
- B. A Discharge Pressure Switch can be installed anywhere in the piping network, but is usually installed immediately after a Selector Valve.
- C. The Discharge Pressure Switch is provided with a 1/4 in. NPT female inlet connection on the front cover of the switch.
  - 1. The switch can be connected to the discharge piping with steel pipe and fittings to match those in the discharge piping at that point. Stainless steel hoses and brass flare fittings are also available to make the installation easier. See component sheets in Section 2.
  - 2. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- D. Conduit connections are made to the top and/or the bottom of the pressure switch mounting box through 1/2 in. NPT female conduit connections (Switch Part No. 43241) or to the top through 1/2 in. and side through 3/4 in. conduit knockout inlets in the pressure switch mounting box (Switch Part No. 437900).
  - 1. Various types of Discharge Pressure Switches are available. Refer to the Pressure Switch Component Sheet in Section 2, Installation Drawings, and Installation Instructions included with the device for specific information regarding mounting and wiring.
- E. The Discharge Pressure Switch should be mounted on a solid wall with appropriate fasteners as close to its pressure source as possible.

### 4-5.22 Odorizer

- A. An Odorizer is an optional component added to a system that will emit a wintergreen scent when carbon dioxide has been discharged from a system. It includes a housing pressurized by carbon dioxide from the system, a burst disc, and a glass ampoule filled with oil of wintergreen.
- B. Connection to the discharge piping system is through a 3/4 in. NPT male thread on the Odorizer.
  - 1. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- C. The Odorizer must be installed as the last component (except the discharge nozzles) in the piping network.
  - 1. Oil of wintergreen liquid can be corrosive and can also damage seals and gaskets.
  - 2. The Odorizer must be installed so that the oil of wintergreen cannot migrate back to the storage tank, where damage to the internal pressure vessel could occur.
- D. The Odorizer must be installed upright, with the threaded connection to the discharge piping at the bottom.
- E. If oil of wintergreen is not to be discharged for testing, the Odorizer must be removed.
  - 1. The owner may wish to discharge the oil of wintergreen to train personnel what to expect after a discharge.
  - 2. If the Odorizer is removed, replace with a pipe plug before a discharge test to prevent leakage of carbon dioxide. Be sure to reinstall the Odorizer or replace the ampoule and burst disc after all testing has been completed. Care must be observed when replacing a spent ampoule due to broken glass.

## SECTION 4 – INSTALLATION

2-1-10 Page 4-32

REV. 1

### 4-5 INSTALLING COMPONENTS (Continued)

#### 4-5.23 Discharge Nozzles

- A. Discharge nozzles are available in different types and sizes and may be connected to the piping with either male or female connections. Refer to the appropriate component sheet and the system drawings for proper installation.
- ▶ B. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13 to prevent nozzle blockage, which could detrimentally affect system performance.
- C. Each nozzle has the orifice code stamped on it during manufacture. The nozzle codes must be matched to the system drawings to ensure proper flow rate from each nozzle according to the system design.
- D. In most local application systems, nozzles require aiming to perform properly. Refer to the system drawings or other instructions provided with the system design for the correct distance from the hazard and proper aiming procedures and/or points.

#### 4-5.24 Actuation Line Components

##### A. Mini-Bulk Systems

Actuation components are pre-piped into the Mini-Bulk system and therefore installation of these components is not required on the job site.

##### B. Bulk Systems

###### 1. Regulator

- a. The Actuation Line Regulator is used to reduce the normal storage tank vapor pressure of 300 psi (20.7 bar) to 100 psi (6.9 bar), which is the nominal operating pressure for the Master/Selector Valves. It is always installed as the first device in the Actuation Line after the storage tank vapor actuation ball valve.
- ▶ b. The regulator is supplied with 1/2 in. NPT female inlet and outlet connections.
- c. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- d. Although the regulator is pre-set, it should be tested and may require adjustment after installation.
- e. To properly adjust the regulator:
  - 1) After all components are connected to the pilot line, apply pressure.
  - 2) Check the regulator pressure setting on the gauge just downstream of the regulator.
  - 3) If necessary, remove the cap on the top of the regulator with a wrench.
  - 4) Adjust the stem with a wrench until the actuation line pressure is 100 psi +/- 5 psi (6.9 bar +/- 0.3 bar).
  - 5) If the pressure must be reduced, the pressure in the actuation line must be lowered before it can be accurately set. To accomplish this, close the 3-way Vapor Process Valve at the storage tank. The valve will vent the actuation line pressure when it is closed. Then reopen the valve to pressurize the actuation line at the lower pressure.
  - 6) Tighten the lock nut on the stem.
  - 7) Replace and tighten the cap.

###### 2. 200 psi (13.8 bar) Pressure Gauge

- a. The 200 psi (13.8 bar) Pressure Gauge is used to set and monitor the Actuation Line Pressure downstream of the regulator.
- ▶ b. The 200 psi (13.8 bar) Pressure Gauge is supplied with a 1/4 in. NPT male connection.
- c. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- d. The 200 psi (13.8 bar) Pressure Gauge should be installed into a tee immediately after the regulator. A reducing tee or a standard tee with a reducing bushing can be used to accomplish the pipe size reduction.

###### 3. 150 psi (10.3 bar) Relief Valve

- a. A 150 psi (10.3 bar) Relief valve must be installed in the Actuation Line to prevent over-pressurization of the piping. The relief valve can be installed anywhere in the Actuation Line downstream of the regulator.

## 4-5 INSTALLING COMPONENTS (CONTINUED)

### 4-5.24 Actuation Line Components (Continued)

- b. The 150 psi (10.3 bar) Relief Valve is provided with a 1/2 in. NPT male connection.
- c. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- d. If the Relief Valve is installed outdoors it must be installed with the outlet pointed downward to prevent accumulation of water in the outlet, which could prevent proper operation of the valve.

#### 4. Actuation Line Supervisory Pressure Switch

**Caution:** Use wrench on Supervisory Pressure Switch Hex at the end being loosened or tightened. For installation into piping, use the Hex adjacent to the 1/4 in. NPT thread. For connection of conduit fittings, use the Hex adjacent to the 1/2in. NPT. Using the opposing Hex will cause damage to the pressure switch.

- a. A Supervisory Pressure Switch must be included in the Actuation Line to monitor the pressure. Without proper Actuation Line pressure, the system will not function because pressure is required to operate the Master/Selector valves. The switch is preset to operate at 80 psi (5.5 bar).
- b. The Actuation Line Supervisory Pressure Switch must be located at the most remote point of the Actuation Line to detect a pressure loss in the event that the pipe is broken or crimped. It senses a loss of pressure in the Actuation Line and notifies the control panel to sound a supervisory signal.
- c. The storage tanks are provided with a three-way valve to shut-off the Actuation Line pressure at the storage tank. When this valve is closed, it vents the pressure in the Actuation Line so that the Actuation Line Supervisory Pressure Switch activates.
- d. The Actuation Line Supervisory pressure switch is provided with a 1/4 in. NPT male or female connection. Refer to 4-5.16.
- e. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- f. If multiple Actuation Lines are included in a system, each line must include a separate Actuation Line Supervisory Pressure Switch.

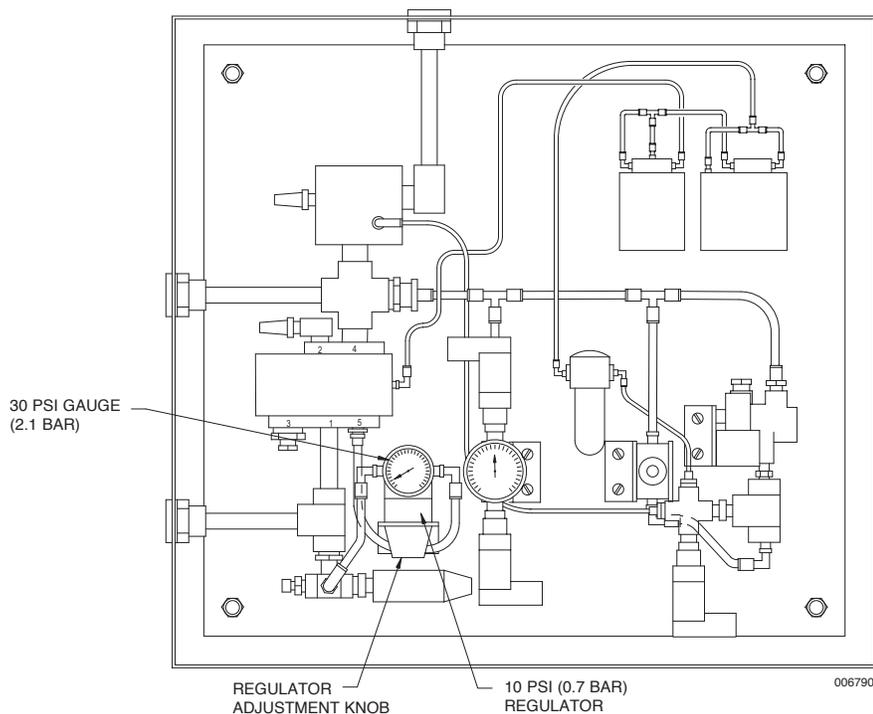
### 4-5.25 Automatic Timer Cabinet

- A. The Automatic Timer Cabinet may be added to a system to provide a pneumatic time delay to prevent a manual discharge of a system without a time delay period.
- B. The Automatic Timer Cabinet should be located on a wall near the Selector Valve that it activates.
- C. The cabinet should be fastened to the wall with 3/8 in. bolts and the appropriate fasteners for the wall construction.
- D. A 1/2 in. NPT female inlet connection from the pilot line is provided on the Automatic Timer Cabinet.
  - 1. An inlet filter is supplied separately (inside the Automatic Timer Cabinet). It must be installed between the Actuation Line and the inlet to the Automatic Timer Cabinet.
  - 2. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- E. The Automatic Timer Cabinet is provided with a 1/2 in. NPT female outlet for a piping connection to a Selector Valve.
- F. The Automatic Timer Cabinet is also provided with a 1/2 in. NPT female outlet connection for a Pressure Operated Siren. The siren operates during the delay period to warn personnel of pending discharge. If a siren will not be installed, the outlet must be plugged with a 1/2 in. pipe plug.
- G. The manually adjustable timers for time delay and discharge duration must be set according to the requirements of the specific system. Turning the adjustment knob on the front of each timer until the pointer is set to the correct time sets the timers.
- H. Spring return type Master/Selector valves are used with Automatic Timer Cabinets since the solenoid valve required is installed in the cabinet.
- I. An Actuation Line Supervisory Pressure Switch and terminals are installed in the cabinet. This eliminates the need for a switch in the actuation line piping.
- J. An activation pressure switch and terminals are provided in the cabinet. This eliminates the need for a discharge pressure switch to be installed in the discharge piping. A gauge is also provided.

4-5 INSTALLING COMPONENTS (Continued)

4-5.25 Automatic Timer Cabinet (Continued)

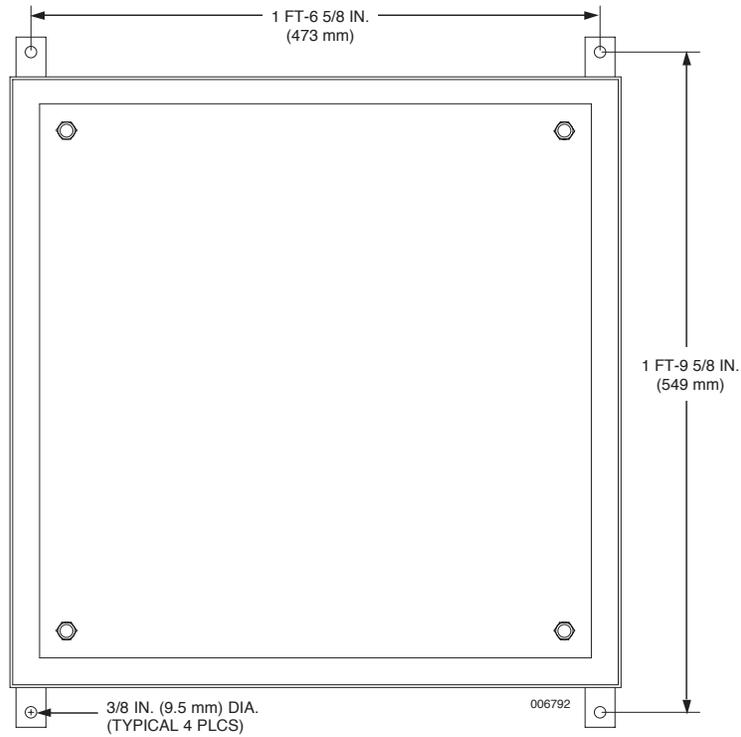
- K. A pressure switch and terminals are installed in the cabinet that monitors the actuation line piping from the cabinet to the Master Selector Valve. A 10 psi (0.7 bar) charge of CO<sub>2</sub> vapor is maintained in the piping to monitor its integrity.
- L. After installation of the Automatic Timer Cabinet and pressurization of the Actuation Line the installer must check the supervisory pressure and adjust it if necessary.
  - 1. A gauge is provided in the face of the Automatic Timer Cabinet to provide an indication of the supervisory pressure. The pressure should be at 10 psi +/- 1 psi (0.7 +/- 0.07 bar). If the pressure is outside of this range, remove the cover plate of the Automatic Timer Cabinet and adjust the supervisory pressure with the regulator adjustment knob in the lower left corner of the interior of the cabinet (see Figure 4-18). Then reinstall the faceplate.



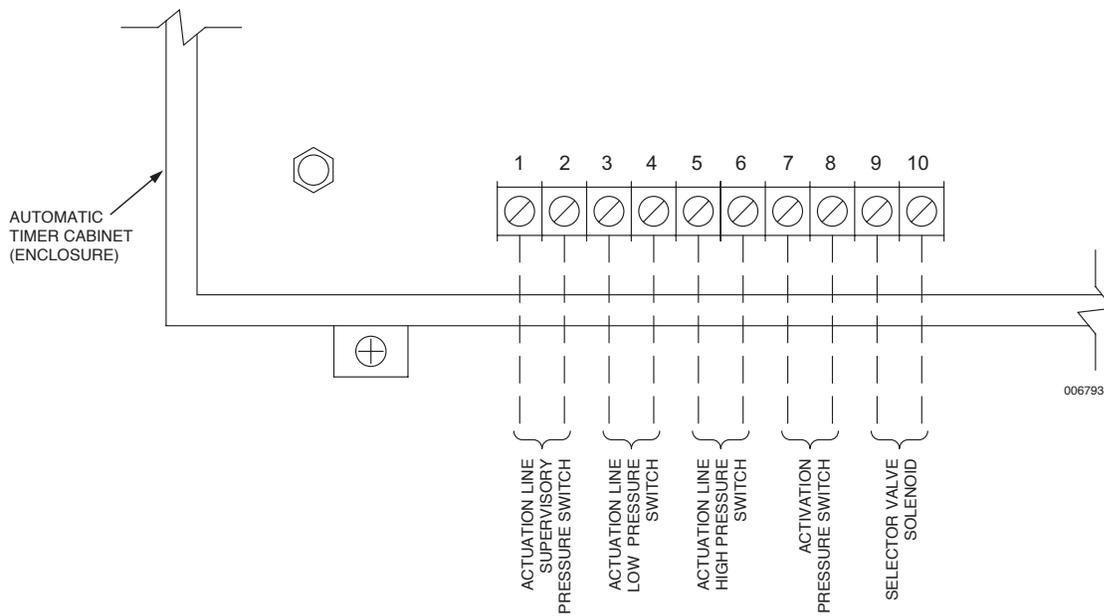
**Figure 4-18**  
Automatic Timer Cabinet

4-5 INSTALLING COMPONENTS (Continued)

4-5.25 Automatic Timer Cabinet (Continued)



**Figure 4-19**  
 Automatic Timer Cabinet Mounting Detail



**Figure 4-20**  
 Automatic Timer Cabinet Wiring Diagram

## SECTION 4 – INSTALLATION

2-1-10 Page 4-36

REV. 1

### 4-5 INSTALLING COMPONENTS (Continued)

#### 4-5.26 Pneumatic Audible Alarms

- A. The pneumatic alarm devices are designed to be operated by the carbon dioxide supply. The pneumatic air horn can only be operated with CO<sub>2</sub> vapor at a maximum pressure of 150 psi (10.3 bar). It must only be supplied from the actuation line, either directly or through a time delay device. The pneumatic siren can be operated by either liquid CO<sub>2</sub> supplied by the discharge line, or vapor CO<sub>2</sub> supplied either directly from the actuation line or through a time delay device.

 **CAUTION**

Operation of the pneumatic air horn with liquid CO<sub>2</sub> may cause malfunction of the alarm and possibly permanent damage.

- B. For systems using time delay equipped selector valve assemblies a pneumatic audible alarm must be connected after the solenoid valve activating the time delay using the port provided. For systems using the automatic timer cabinet a pneumatic audible alarm must be connected to the siren port on the timer cabinet.
- C. The use of a pneumatic audible alarm in conjunction with an automatic timer cabinet or time delay equipped selector valve assembly is intended to give personnel a warning of discharge or pending discharge during the pre-discharge time delay period.
- D. The pneumatic siren is provided with 1/4 in. NPT female connection. The pneumatic air horn is provided with 3/8 in. NPT female connection.
- E. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- F. The pneumatic audible alarms may be installed in any orientation.
- G. It is important to understand that the pneumatic audible alarms exhaust carbon dioxide into the space where they are located.
1. Personnel who may be in the area must be made aware of this situation and must evacuate immediately upon operation of the audible alarm.
  2. The carbon dioxide that will be discharged from the audible alarm must be accounted for in the design of the system.
- H. The pneumatic audible alarm must be installed in a location that cannot endanger the personnel by the carbon dioxide discharge or by the sound emitted.
- I. Warning signs (Part No. 425309) should be placed in areas visible to personnel, at the entrance to the hazard and near the alarm device.

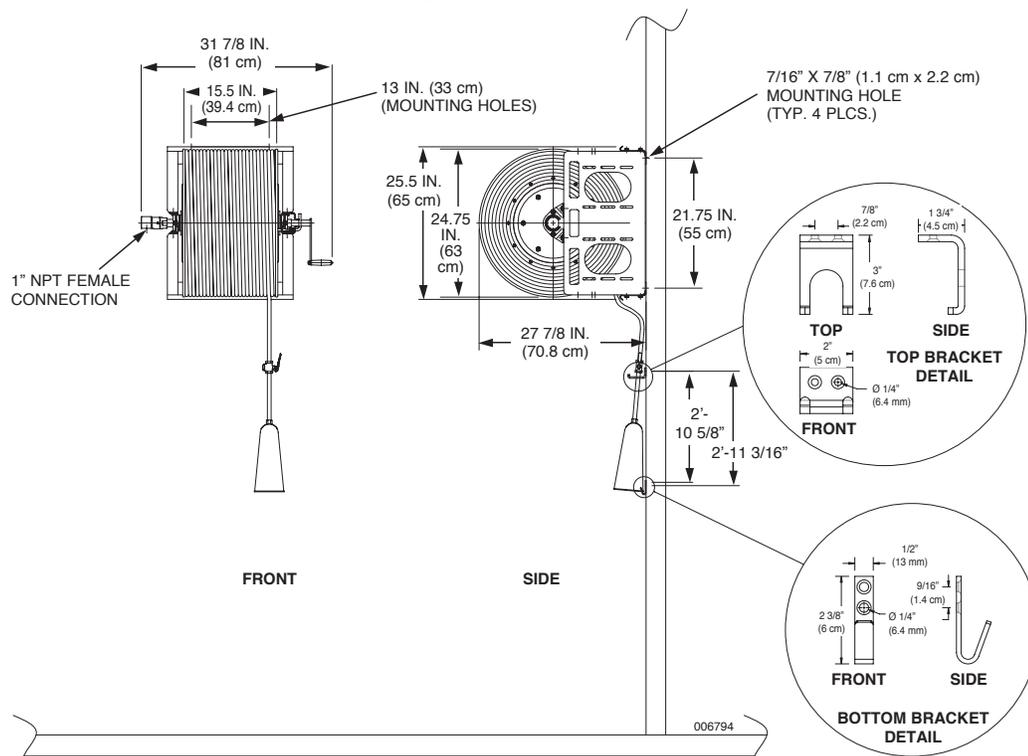
#### 4-5.27 Solenoid Valve

- A. Occasionally Actuation Line Pressure must be controlled by a solenoid valve to provide proper operation of a system. A Solenoid Valve is available for this purpose.
- B. The solenoid valve inlet is a 1/4 in. NPT female connection.
- C. The solenoid valve outlet is a 1/8 in. NPT male connection that can be changed to 1/4 in. NPT female connection by removal of an adapter.
- D. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- E. The solenoid valve can be installed in any orientation.
- F. The solenoid valve is a non-polarized device with two electrical leads, which must be connected to the control panel as required by the instructions for the control panel. It is provided with a 1/2 in. female conduit connection.

## 4-5 INSTALLING COMPONENTS (Continued)

## 4-5.28 Hose Reels

- A. Hose Reels are available for the ANSUL Low Pressure CO<sub>2</sub> systems to allow manual attack of a fire in areas where hazards are numerous and/or too difficult to protect with fixed nozzles.
- B. A Hose Reel Assembly consists of:
1. A metal hose reel frame
  2. A 1 in. hose either 100 ft or 150 ft (30.5 m or 47.7 m) long.
  3. A Playpipe nozzle
  4. An On/Off Switch to control the Selector Valve at the Storage Tank
  5. A 450 psi (31 bar) Relief Valve
- C. The hose reel is provided with a 1 in. NPT female inlet connection.
- D. The hose reel should be mounted approximately 48 in. (1.23 m) above floor level. Other heights may be used as required.
- E. Refer to Figure 4-21 for information regarding the mounting bolt pattern of the hose reel.



**Figure 4-21**  
Hose Reel Mounting Detail

- F. The hose reel should be mounted with 3/8 in. bolts and the appropriate fasteners for the wall to which it is mounted.
- G. Mounting brackets for the Playpipe nozzle are available to secure it to the wall or other appropriate surface.
1. The Playpipe brackets should be located directly below the Hose Reel. Refer to Figure 4-21 for mounting details for the brackets.
- H. The On/Off Switch should be mounted to the wall immediately adjacent to the Hose Reel Assembly.
1. The On/Off Switch is provided with a surface mount back box for wall mounting.
  2. The Switch should be mounted approximately 48 in. (1.23 m) above the floor.
  3. The Switch is a push button type on/off switch, with two electrical connection points to provide a contact closure type switch for use in the control of a Selector Valve to be located at the storage tank. Refer to the project installation drawings for wiring details.

## SECTION 4 – INSTALLATION

2-1-10 Page 4-38

REV. 1

### 4-5 INSTALLING COMPONENTS (Continued)

#### 4-5.28 Hose Reels (Continued)

- I. After use and system reset, the Playpipe nozzle should be opened to vent all CO<sub>2</sub> trapped in the hose.
- J. To reduce the time it takes for liquid CO<sub>2</sub> to reach the nozzle a bleeder valve may be installed in the piping to the hose reel.

#### 4-5.29 Detection and Control Components

- A. Detection and Control systems vary greatly from one low pressure system to the next. These components are covered under a different venue. Consult the appropriate Component Sheets and Installation Manuals for the equipment in question. Refer to AUTOPULSE Detection and Control Manuals.
- B. Installation drawings will also provide valuable information regarding this equipment.

#### 4-5.30 Manual Release Station

- A. A Manual Release Station provides an electrical signal to activate the appropriate Master/Selector Valves and other components to discharge a system.
- B. Manual Release Stations should be located in easily accessible locations around the protected space or equipment to allow fast manual actuation in the event of a fire. Suggested locations are at exit doors and the path of egress.
- C. The Manual Release Station must be mounted between 42 in. and 54 in. (1.06 m and 1.37 m) above floor level.
- D. Various types of Manual Release Stations are available. Refer to the Data Sheet, Installation Drawings, and Installation Instructions included with the device for specific information regarding mounting and wiring.
- E. Most manual release stations must be manually reset before the system control panel is reset. Reset keys or tools are provided with the station.

#### 4-5.31 1/4 in. Shuttle Valve

- A. The Shuttle Valve is used to connect two pressure sources to a single outlet. The internal shuttle prevents pressure from one source from transferring to the other source by plugging the inlet from the other source. An example may be the use of a single Discharge Pressure Switch with pressure sources from an initial and an extended discharge system. If the Discharge Pressure Switch is connected to both sources without a Shuttle Valve, the extended system will continue to discharge some of its agent through the initial system piping.
- B. The Shuttle Valve is arranged in a tee shape with the (2) 1/4 in. NPT female inlets opposing each other and the 1/4 in. NPT female outlet on the “bull” side of the tee.
- C. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13 to prevent it from impeding movement of the internal shuttle.
- D. Stainless steel hoses are available for connecting to piping (see Pneumatic Hoses and Fittings in Section 2).

#### 4-5.32 Warning Signs

- A. Warning Signs are provided to inform personnel of proper operation of the system, identification of spaces, and to warn personnel of the dangers associated with protection of a hazard with carbon dioxide.
- B. Warning Signs, as indicated on the Installation drawings, should be mounted in easily recognizable locations near doorways, alarm devices, and actuation devices as appropriate for the Warning Sign in question.
- C. Warning Signs are provided with an adhesive backing for easy installation
- D. Warning Signs also include 5/32 in. diameter holes to allow installation with No. 6 screws or other bolts.

#### 4-5.33 Pressure Trip

- A. A Pressure Trip can be installed anywhere in the discharge piping system. It is used to release a weight at the beginning of a discharge. The weight may be used to close dampers, doors, windows, etc.
- B. Each Pressure Trip is provided with (2) 1/4 in. NPT female connections on opposite sides of the body. The connections can be used as either inlets or outlets.

**4-5 INSTALLING COMPONENTS (Continued)****4-5.33 Pressure Trip (Continued)**

- C. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- D. Plug one of the connections if the Pressure Trip in question is the last or only device on the branch pipe from the discharge piping.
- E. Two lugs are provided on the body of the Pressure Trip for mounting to a solid surface such as a wall or a duct.
  - 1. Refer to the Data Sheet for information regarding location of the lugs and mounting bolt information.
  - 2. Use fasteners appropriate to the surface the Pressure Trip is mounted on to securely attach it.
- F. The Pressure Trip must be located directly above the weight it is to release.
- G. The maximum load rating for the weight to be released is 70 lb (31.8 kg).
- H. Orientation of the Pressure Trip is flexible as long as the weight can be released properly.

**4-5.34 Check Valves**

- A. Check Valves are used in a low-pressure system to provide a bypass of the Master Valve to allow flow of carbon dioxide trapped between a Master Valve and Selector Valves back into the storage tank. They may also be provided for other uses such as to allow a nozzle, pressure switch, pressure trip, etc., to be supplied by more than one system and to manifold Mini-Bulk units when they need to be removed for filling.
- B. Check Valves can be installed in any orientation providing proper flow direction through valve.
- C. Check Valves allow flow in one direction only; it is critical to system performance that the flow direction is carefully checked during installation. An arrow on the body of the valve indicates direction of flow and must be correct when installing the valve.
- D. 1/2 in. through 2 in. Check Valves are provide with NPT female connections.
  - 1. Use joint compound sparingly as indicated in paragraph 4-5.3E on page 4-13.
- E. 3 in. Check Valves are provided with flanged connections.
  - 1. Refer to Section 4-5.4 for flange, bolt, gasket, and torque requirements when installing the valve.

**4-6 CHECK-OUT AND START-UP OF REFRIGERATION SYSTEM****CAUTION**

Initial fill of the storage unit shall be performed by a qualified carbon dioxide equipment specialist.

**4-6.1 Mini-Bulk Systems**

- A. Ensure that the following storage unit conditions are as specified (refer to the appropriate System Design Drawings for detailed information):
  - ▶ 1. Mounting and anchoring.
  - ▶ 2. Tank lock-out valve mounted and in the closed position
  - ▶ 3. Power supply voltage.
  - ▶ 4. Field wiring terminations.
  - ▶ 5. Confirm the proper electrical service connection at the control box and ground the unit base. Leave the customer provided electrical disconnect switch(es) in the OFF position at this time.
  - ▶ 6. Check the moisture indicator for a dry system indication. Moisture indicator is located above the expansion valve in the refrigeration system. A white cap covers the moisture indicator. Remove cap to view indicator and replace when finished. The indicator should be green (yellow indicates wet).
  - ▶ 7. Connections to cargo tank (see 4-5.10).

## SECTION 4 – INSTALLATION

2-1-10 Page 4-40

REV. 1

### 4-6 CHECK-OUT AND START-UP OF REFRIGERATION SYSTEM (Continued)

#### 4-6.2 Bulk Systems

- A. Ensure that the following storage unit conditions are as specified: Refer to the appropriate System Design Drawings for detailed information.
1. Compressor horsepower/voltage.
  2. Mounting and anchoring.
  3. Tank shut-off valve mounted and in closed position.
  4. Electrical feed voltage and over-current protection.
  5. Field wiring terminations at tank control box.
  6. Electrical supply has a disconnect means.
  7. Power supply disconnect switches for the refrigeration unit are in the OFF position.
  8. Electrical grounding.
  9. Check the refrigerant moisture indicator for a dry system indication. A white cap covers indicator. Remove cap to view indicator and replace when finished. The indicator should be green (yellow indicates wet).
- B. Start-up of refrigeration unit (see Figure 4-22):
1. Loosen shipping bolts on compressor unit (remove shipping clips and pads, if used).
  2. Momentarily energize motor starter and check for correct rotation of condenser fan as shown by arrow on condensing unit.
  3. Open service valve at liquid reservoir, pressurizing refrigeration system.
  4. Close service valve.
  5. Check refrigeration lines and valves for leaks with a solution suitable for detecting R404A refrigerant leaks in pressurized piping or electronic leak detection equipment. If leaks are present, contact Technical Services and do not fill tank.
  6. Open all refrigeration service valves.
  7. Turn power on to tank control box. Low-pressure light and horn should operate.
  8. Jumper refrigeration pressure switch in tank control box to open refrigeration solenoid valve and ensure that unit operates with rise in suction pressure. If unit does not operate or short cycles, contact Technical Services.
  9. When refrigeration line at suction inlet of compressor develops frost, remove jumper. Unit should shut off.
  10. If refrigeration unit operates in a short cycle manner after power is applied, contact Technical Services. If a refrigeration contractor is available to troubleshoot the unit, do so upon approval by Technical Services.

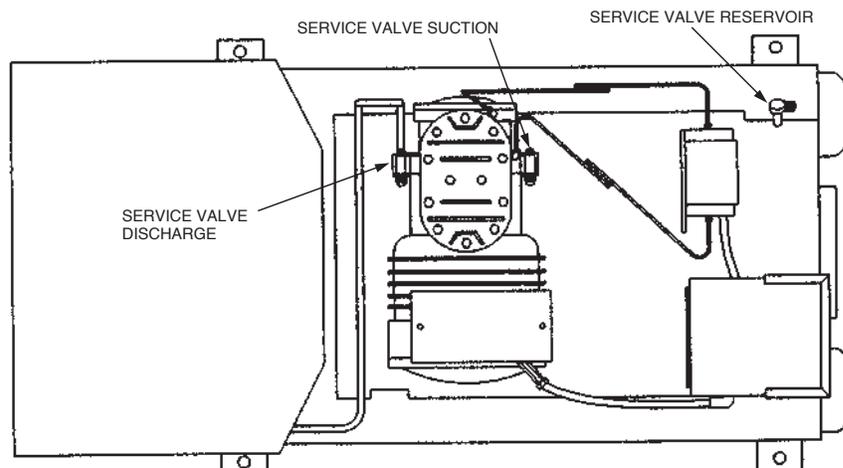


Figure 4-22

Compressor Service Valve Location

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## 4-7 INITIAL FILLING OF STORAGE TANK

### 4-7.1 Safety Issues

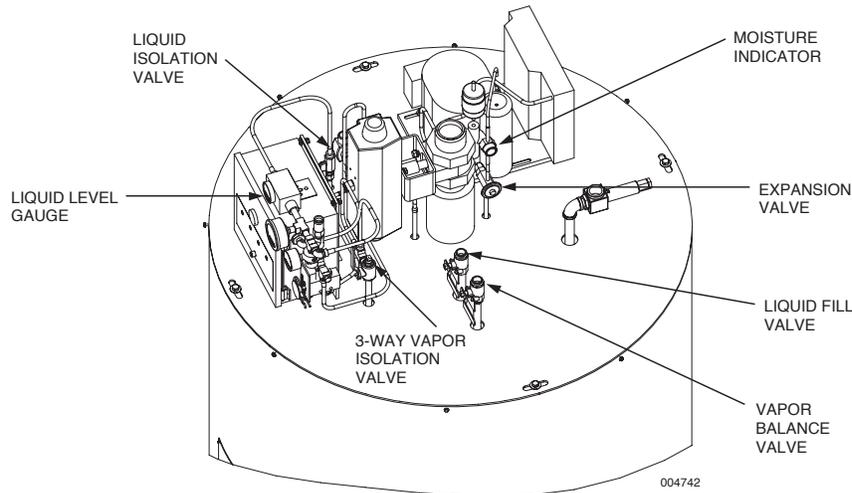
When filling a low pressure carbon dioxide storage tank, a malfunction could potentially cause a leak of carbon dioxide that could collect within a space. All personnel involved in the filling process shall be trained and familiar with the inherent safety risks associated with carbon dioxide including, but not limited to, the following:

- The introduction of carbon dioxide into a confined space creates serious hazards to personnel. Gaseous carbon dioxide is an asphyxiant. Concentrations of 10% or more can produce unconsciousness or death. Lower concentrations may cause headache, sweating, rapid breathing, increased heart rate, shortness of breath, dizziness, mental depression, visual disturbance and shaking. The seriousness of the latter manifestations is dependent upon the concentration of carbon dioxide and the length of time the individual is exposed. Visibility is also greatly reduced during a normal discharge of carbon dioxide, which can hinder evacuation. Contact with skin by compressed CO<sub>2</sub> or dry ice can cause frostbite-type burning.
- Carbon dioxide is an odorless gas and should be treated as a dangerous material with poor warning properties. It is heavier than air and high concentrations can persist in open pits, tanks, or low depressions in terrain. Consideration shall be given to the possibility of carbon dioxide drifting and settling into areas outside of the protected space.
- Before entering an area where carbon dioxide has been or may be present, the area shall be ventilated to clear the gas. Proper monitoring equipment, such as an oxygen level monitor, shall be used to verify the area is safe. Self-contained breathing apparatus may be needed and only personnel trained in its use shall be allowed to use it.
- If the storage tank is a Bulk unit, ensure that the Tank Shut-Off Valve and all other tank valves, except instrument line valves, are closed.
- ▶ • If the storage tank is a Mini-Bulk unit, ensure that the lock-out valve is closed.
- ▶ • Before beginning the Purging and/or Fill procedures, carefully inspect the remote fill lines if applicable.

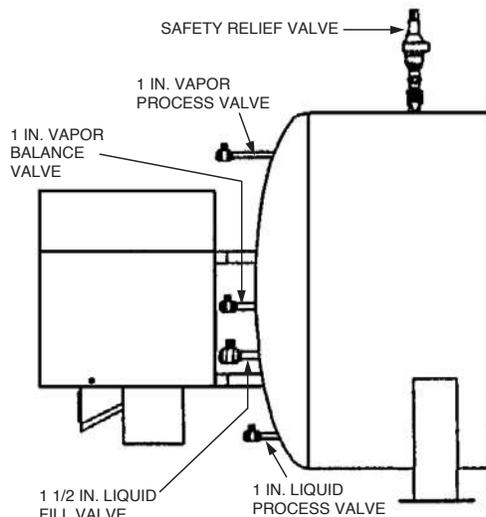
4-7 INITIAL FILLING OF STORAGE TANK (Continued)

4-7.2 Purging

- A. Purging applies to new storage tanks, or storage tanks that have lost all pressure and may have had air enter the internal vessel. It must be performed to remove any moisture from the inside of the vessel to prevent internal corrosion of the pressure vessel or ice build up that could prevent proper operation of the system.
- B. Before shipment, moisture was removed from the storage unit and it was pressurized with carbon dioxide vapor. However, no warranty is expressed or implied that the vapor contents, when shipped, were free of air or other non-condensable material. Therefore, it is strongly suggested that the storage unit be purged before filling. Your CO<sub>2</sub> supplier should follow their standard procedure for purging a new system. If your supplier has no set procedure, purge the storage unit as follows:
  1. Blow the unit pressure down to 0 psi through vapor balance valve.
  2. Pressurize to 10 psi (0.7 bar) with CO<sub>2</sub> vapor, allow to stand 2 minutes.
  3. Blow down to 2 psi (0.1 bar) through vapor balance valve.
  4. Repeat steps B and C at least five times.
- C. Refer to Figure 4-23 for valve identification of fill valves.



MINI-BULK – TOP VIEW



BULK – SIDE VIEW

Figure 4-23

#### 4-7 INITIAL FILLING OF STORAGE TANK (Continued)

##### 4-7.3 Filling Mini-Bulk Storage Tanks

- A. Pressurize the storage tank with carbon dioxide vapor to 100 psi (6.9 bar) and check for leaks using a solution suitable for detecting leaks in pressurized piping.
- B. Allow the cargo tank pressure and the Mini-Bulk unit pressure to equalize, making sure that the Mini-Bulk unit pressure is a minimum of 200 psi (13.8 bar).
- C. Check the liquid isolation valve (it should be completely open).
- D. Check the vapor isolation valve (it should be completely open).
- E. Check the liquid level gauge calibration (it should be near zero).
- F. Refer to steps 9-14 under TYPICAL TWO HOSE FILLING PROCEDURE (4-7.5) and pump approximately 50% of the full carbon dioxide charge of liquid carbon dioxide into the Mini-Bulk unit. Stop the pump.  
**Caution:** The Mini-Bulk unit pressure must be a minimum of 200 psi (13.8 bar) to ensure that the pressure vessel temperature and pressure are within the safe range for liquid filling. Maintain the minimum pressure during the filling process by throttling the vapor balance valve.
- G. Close the Mini-Bulk unit liquid fill and vapor balance valves. Close the blow down valve on the cargo tank vapor line.
- H. Check all of the liquid and vapor piping and valves for leaks.
- I. Allow the Mini-Bulk unit pressure to build above 305 psi (21.0 bar).
- J. Confirm compressor service valves are open. Move the refrigeration disconnect switch to the ON position. The refrigeration unit should start.
- K. Check the refrigerant level at the refrigeration system moisture indicator. If the refrigerant level is low (indicated by bubbles in the moisture indicator window), consult Technical Services or a reputable refrigeration contractor such as a LINC approved contractor.
- L. Open Mini-Bulk unit liquid fill and vapor balance valves.
- M. Refer to steps 13 to 27 under TYPICAL TWO HOSE FILLING PROCEDURE (4-7.5) and complete the filling procedure.
- N. During the first few days of operation, monitor the storage unit pressure at regular intervals. The pressure should remain between 290 to 305 psi (20 to 21 bar).

## SECTION 4 – INSTALLATION

2-1-10 Page 4-44

REV. 1

### 4-7 INITIAL FILLING OF STORAGE TANK (Continued)

#### 4-7.4 Filling Bulk Storage Tanks

- A. Pressurize the storage tank with carbon dioxide vapor to 100 psi (6.9 bar) and check for leaks using a solution suitable for detecting leaks in pressurized piping.
- B. Refer to Figure 4-24 for valve identification of the Instrument Valves.

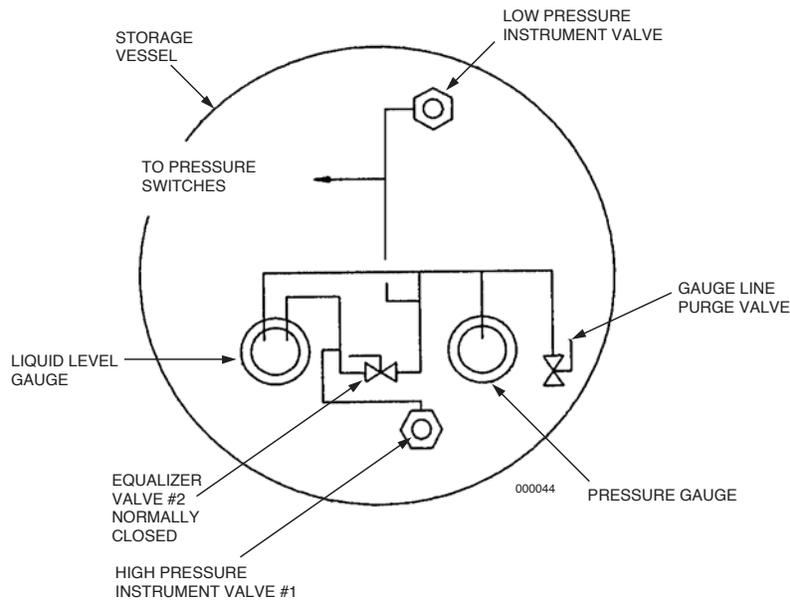


Figure 4-24

- C. Verify that the Instrument Vapor Supply Valve is open.
- D. Momentarily purge the Instrument Tubing of air with the Gauge Line Purge Valve.
- E. Verify that the gauge pressure on the storage unit matches the CO<sub>2</sub> supply pressure.
- F. Verify that the Instrument Equalizer Valve is closed.
- G. Check for leaks using a solution suitable for detecting leaks in pressurized piping.  
**Note:** Measurement of temperatures and pressures in the refrigeration system should only be performed by a qualified Commercial/Industrial Refrigeration System technician.
- H. Check the pressure on the suction side of the compressor for a possible carbon dioxide leak in the evaporator coil.
  1. Connect a refrigeration gauge manifold to the suction side of the compressor at the service fitting.
  2. If a pressure of 300 psi (20.69 bar) is found, contact Technical Services for direction.
- I. Verify that all of the refrigerant service valves are open. See Figure 4-22 for locations.
- J. Refer to steps 9-14 under TYPICAL TWO HOSE FILLING PROCEDURE (4-7.5) and pump approximately 1000 lb (453.6 kg) of carbon dioxide into the bulk unit. Stop the pump. **Caution:** The bulk unit pressure must be a minimum of 200 psi (13.8 bar) to ensure that the pressure vessel temperature and pressure are within the safe range for liquid filling. Maintain the minimum pressure during the filling process by throttling the vapor balance valve.
- K. Check all of the liquid and vapor piping and valves for leaks.
- L. Verify that the refrigeration disconnect switch is on.
- M. Build the storage unit pressure to 308 psi (21.24 bar). (Refrigeration unit should start.)

## 4-7 INITIAL FILLING OF STORAGE TANK (Continued)

### 4-7.4 Filling Bulk Storage Tanks (Continued)

- N. Monitor the refrigeration system suction and discharge pressures for 15 minutes.
1. The suction pressure should settle between 15 and 22 psi (1.03 to 1.52 bar) at an ambient temperature of 60 °F (15.5 °C) or above. However, it is not uncommon for the suction pressure to fluctuate slightly as the thermostatic expansion valve throttles.
  2. The refrigerant level is factory set by the superheat method. Superheat should not exceed 15 °F (–9.4 °C); however, 9 °F to 12 °F (–12.7 to –11.1 °C) superheat is preferred. The evaporator coil temperature should be –20 °F (–28.8 °C) and suction line temperature should be approximately –8 °F (–22.2 °C).
- O. Refer to steps 13 to 27 under TYPICAL TWO HOSE FILLING PROCEDURE (4-7.5) and complete the filling procedure.
- P. Continue to monitor the suction and discharge pressures during the on cycle. After the refrigeration system has operated for approximately two hours turn the refrigeration system off and check the oil level in the compressor.
- Q. Allow the refrigeration system to cycle (lower the unit pressure to 295 psi (20.34 bar). At or about 295 psi (20.34 bar), an electrical signal will close the liquid line solenoid valve. The refrigeration unit will continue to run until all of the refrigerant in the system is pumped into the refrigerant reservoir. Once this cycle is completed, the refrigeration dual pressure control (set at 6 psi (0.414 bar) off and 20 psi (1.4 bar) on) will shut the system off. The system will continue to cycle on and off if the pressure goes higher than 20 psi (1.4 bar). This cycle is commonly referred to as a “repeat pump down cycle” or short cycling. If the unit continues to short cycle after cycling off, contact Technical Services.
- R. The liquid level gauge and pressure gauge should be checked daily for proper levels after filling. The pressure should remain between 290 to 305 psi (20 to 21 bar). The liquid level gauge should not change.

### 4-7.5 Typical Two Hose Filling Procedure

The following is a typical two hose procedure for filling a carbon dioxide storage unit from a carbon dioxide cargo tank (transport trailer) as adapted from the CGA (Compressed Gas Association) publication CGA G-6.4-1992: Safe Transfer of Low Pressure Liquefied Carbon Dioxide in Cargo Tanks, Tank Cars and Portable Containers.

1. Park the cargo tank so that unloading can be performed safely. Place chocks under the cargo tank wheels.
2. Pressure may exist between the liquid and/or vapor shut-off valves and the dust caps. Relieve the pressure on cargo tank piping by opening the blow down valves. After purging, close the blow down valves.
3. Remove the dust caps from all liquid and vapor connections and inspect the connections for cleanliness. Clean as necessary.
4. Ensure that the instrument isolation valves on the storage unit are open.
5. Connect the vapor hose to the cargo tank vapor discharge line and to the storage unit vapor balance valve. Attach hose safety restraints.
6. Connect the liquid hose to the cargo tank liquid line and to the storage unit liquid fill valve. Attach hose safety restraints.
7. Pressurize the vapor line by opening the cargo tank vapor discharge valve. Purge the line by opening the cargo tank vapor blow down valve. After purging, close vapor blow down valve.
8. Equalize the pressure between the storage unit and the cargo tank by opening the storage unit vapor balance valve.
9. Open the vapor by-pass valve on the cargo tank and pressurize the liquid discharge line.
10. Purge the liquid line by opening the cargo tank liquid blow down valve. After purging, close the liquid blow down valve.
11. Open the storage unit liquid fill valve.
12. Open the cargo tank liquid discharge valve and close the vapor by-pass valve.
13. Crack open the blow down valve on the cargo tank vapor line.

**4-7 INITIAL FILLING OF STORAGE TANK (Continued)**

**4-7.5 Typical Two Hose Filling Procedure (Continued)**

14. Be sure the liquid loading pump is cooled down and flooded before starting it. (**Caution:** The storage unit pressure must be a minimum of 200 psi (13.9 bar) to ensure that the pressure vessel temperature and pressure are within the safe range for liquid filling. Maintain the minimum pressure during the filling process by throttling the vapor balance valve.) Start the pump.
15. When liquid begins to exit the blow down valve on the cargo tank vapor line, stop the pump immediately to prevent overfilling. **Note:** Extended fill lines will require longer verification times.
16. Close the storage unit liquid fill and vapor balance valves. Note: If the valves won't close use a heat gun to warm the valves.
17. Close the cargo tank liquid discharge valve.
18. Open the cargo tank vapor by-pass valve.
19. Open both cargo tank blow down valves to purge liquid carbon dioxide from pipe and hoses.
20. Close the cargo tank vapor valve.
21. Close the cargo tank vapor by-pass valve.
22. When the liquid and vapor hoses are at atmospheric pressure, disconnect the hoses.
23. Detach the safety restraints, replace all dust plugs and/or caps, and store the hoses in the cargo tank hose tubes. Close the blow down valves.
24. Close and latch the cargo tank doors.
25. Remove the wheel chocks from the cargo tank wheels.
26. Place visual inspection seals on the storage tank, or remote liquid fill and vapor balance valves.
27. Inform the appropriate personnel that the storage unit has been filled, and that the system will be deemed operational when the storage tank pressure has reached a minimum of 280 psi (19.3 bar).

**4-7.6 Fill Level**

- A. The level of the liquid carbon dioxide in the storage unit must be kept below the evaporator coils. After the tank is filled, the vapor balance valve should be opened slightly to observe the discharge of carbon dioxide (see Figure 4-23). If the discharge is clear to slightly foggy, the unit is properly filled. If the discharge is dense and containing particles of dry ice, the liquid level in the tank is too high indicating an overfill condition. Another sign of tank overfill is ice buildup on the vapor balance valve. If the unit has been overfilled, open the vapor balance valve until the discharge becomes clear or only slightly foggy. Then close the vapor balance valve.

**4-7.7 Test the Operation of the High and Low Pressure Alarms**

- A. The High and Low Pressure Switches are normally activated whenever tank pressure rises above 315 psi (21.7 bar) or drops below 250 psi (17.2 bar). The pressure switches should be tested to verify that each switch is in good working order and will notify the control panel properly. To test the pressure switches:
- B. Bulk Systems (Refer to Figure 4-23)
  1. Low Pressure Switch
    - a. Close the Low Pressure Instrument Valve.
    - b. Slightly open the Gauge Line Purge Valve. The alarm should sound at approximately 250 psi (17.2 bar), indicating that the low pressure switch is operating properly. Also, the red low pressure lamp on the tank control box will illuminate and the low pressure relay contacts will close and cause a supervisory alarm at the system control panel.
    - c. Open the Low Pressure Instrument Valve. All alarms should clear.

## 4-7 INITIAL FILLING OF STORAGE TANK (Continued)

### 4-7.7 Test the Operation of the High and Low Pressure Alarms (Continued)

2. High Pressure Switch
  - a. Close the Low Pressure Instrument Valve.
  - b. Open the Equalizer Valve.
  - c. Open the Gauge Line Purge Valve until liquid CO<sub>2</sub> escapes. A white stream of liquid will indicate this. Close the Purge Valve.
  - d. Close the high pressure instrument valve.
  - e. Observe the Pressure Gauge carefully as it rises. At approximately 315 psi (21.7 bar) the alarm should sound indicating that the High Pressure Switch is operating properly. Also, the red high pressure lamp on the tank control box will illuminate and the high pressure relay contacts will close and cause a supervisory alarm at the system control panel. Also, when the gauge reaches approximately 305 psi (21 bar) the refrigeration switch should close and the unit will run.
  - f. Open the Gauge Line Purge Valve and completely blow down instrument tubing. Close the Purge Valve.
  - g. Open the Low Pressure Instrument Valve.
  - h. Open the High Pressure Instrument Valve.
  - i. Close the Equalizer Valve. Both gauges should return to Normal and all Alarms will clear.
- C. Mini-Bulk Systems (Refer to Figure 4-23)
  1. Low Pressure Switch
    - a. Partially close the Vapor Isolation Valve until the Pressure Gauge indicates a slow pressure drop.
    - b. The alarm should sound at approximately 250 psi (17.2 bar), indicating that the low pressure switch is operating properly.
    - c. Open the Vapor Isolation Valve. The alarm panel should reset.
  2. High Pressure Switch
    - a. The High Pressure Switch on a Mini-Bulk system can be tested by disabling the refrigeration system and allowing pressure in the storage tank to increase to 315 psi (21.7 bar).
    - b. An alternate method of testing the High Pressure Switch is to attach a portable high pressure source with a reliable regulator, such as a nitrogen cylinder, to the vent port of the Vapor Isolation Valve. Once the pressure source is attached and the line to the Vapor Isolation Valve is pressurized to 300 psi (20.7 bar), close the Vapor Isolation Valve and increase the pressure from the portable source slowly until the alarm buzzer activates at approximately 315 psi (21.7 bar). Then close the portable pressure source, bleed the pressure back to 300 psi (20.7 bar), open the Vapor Isolation Valve, and remove the portable pressure source.

### 4-7.8 Leak Testing

#### A. Refrigeration System

1. Evidence of refrigerant loss is usually associated with the refrigeration system “short cycling,” continuous operation of the refrigeration unit or high storage unit pressure even though refrigeration system has been operating for a long period of time.
2. Refrigerant leaks can best be detected by an electronic leak detector or leak detection solution.
3. Whenever checking for refrigerant leaks, be sure to test all connections in the refrigerant lines. Start at the compressor and follow through the entire system.

## SECTION 4 – INSTALLATION

9-1-03 Page 4-48

### 4-7 INITIAL FILLING OF STORAGE TANK (Continued)

#### 4-7.8 Leak Testing (Continued)

##### B. Carbon Dioxide Piping

1. Larger carbon dioxide leaks should be easily detected by the appearance of a white gas or by frost or ice on the piping. It may be necessary to test pipe connections and valves with a bubble solution to locate small leaks.
2. Start with the storage tank valves including the Tank Shut-Off Valve, the Relief Valve, the 330 psi Bleeder Valve, and all valves connected to the storage tank and the instrument lines
3. Next check all of the Actuation line as appropriate to the type of storage tank and system. Include the Regulator, the Gauge, the Master/Selector Valve actuators, the Actuation Line Supervisory Pressure Switch, and the Actuation Line Pressure Switch as appropriate.
4. Check the piping between the Tank Shut-Off Valve and the Master Valves and/or Selector valves as appropriate.
5. Check packing on all tank and system valves.

### 4-8 INSPECTION OF THE INSTALLATION

**4-8.1** Prior to testing of a system, the entire installation should be inspected and tested to ensure that it was installed properly and that all components perform properly. A small amount of time spent inspecting and testing the installation can pay huge benefits in the customer's confidence during the acceptance testing when they see that the system performs as it was designed without problems.

**4-8.2** The first step in this process is a detailed visual inspection of all components. The inspection should:

- A. Verify that all components are in place.
- B. Verify that all components are installed according to the instructions provided previously in this section.
- C. Ensure that all components are mounted securely.
- D. Verify that all piping is securely supported and anchored.
- E. Verify that all pipe and fittings are tight.
- F. Verify that all conduit and fittings are installed properly and anchored.
- G. Verify that all electrical components are wired correctly.
- H. Verify that proper power sources have been provided.
- I. Verify a neat, clean installation.
- J. Verify that all interlocks and monitoring connections have been completed.
- K. Verify that the piping meets all requirements of all applicable codes and standards.
- L. Confirm that all wiring meets all requirements of all applicable codes and standards.
- M. Verify that all warning signs are in place.
- N. Verify that proper detection and alarm devices are installed correctly.
- O. Verify that all manually operated components are readily accessible.
- P. Verify that all nozzles are installed and correctly aimed, and proper codes are in place per drawings and calculations.
- Q. If the system is a total flood system, ensure that the enclosure is adequate to contain the carbon dioxide for the time required.
- R. Confirm all as-built conditions are okay and drawings have been marked to reflect as-built conditions.

**4-8.3** A typical checklist is included in the appendix to assist in the installation inspection. The checklist can be used as is or modified to meet the requirements of a specific system.

## 4-9 PRELIMINARY TEST OF SYSTEM

**4-9.1** When the installation and inspection are completed, it is important to test all components of the system to ensure that they perform properly prior to the commissioning testing of the system.

▶ **4-9.2** The Tank Shut-Off Valve on Bulk systems or the Lock-Out Valve on Mini-Bulk storage tanks should be closed to prevent discharge of carbon dioxide during the following tests. Verify that the control panel receives a supervisory signal indicating the valve has been closed.

▶ **4-9.3** Actuation Line Components

A. If the actuation line on a Bulk system has not yet been pressurized, open the Vapor Process Valve for the Actuation Line.

B. Verify the Regulator setting by checking the pressure on the 200 psi (13.8 bar) gauge. Nominal pressure for Mini-Bulk tanks is 110 psi (7.6 bar) and for Bulk tanks is 100 psi (6.9 bar).

1. If the storage tank is a Mini-Bulk unit and the pressure is less than 90 psi (6.2 bar) or over 130 psi (9.0 bar) replace the regulator.

2. If the storage tank is a Bulk unit and the pressure is less than 90 psi (6.2 bar) or over 110 psi (7.6 bar), adjust the Regulator setting. Refer to paragraph 4-5.24B for the proper procedure.

C. Supervisory Pressure Switch Test

1. Close the Vapor Process, or Vapor Isolation Valve, and verify that the Actuation Line Supervisory Pressure Switch provides a supervisory signal to the Detection and Control system.

2. Reopen the Vapor Process, or Vapor Isolation Valve, to maintain Actuation Line pressure for the remaining tests, and to ensure the supervisory signal clears.

D. Test Master and Selector Valves

1. Test each Master and Selector Valve for operation.

a. Operate the Manual Override for the valve by removing the ring pin, pushing, and twisting the knob while observing the shaft protruding from the pneumatic actuator to ensure that it turns 90°. Finish by turning the knob, replacing the ring pin, and checking to ensure that the shaft rotated back to its original position.

b. Initiate proper alarms at the control panel to operate the solenoid on the valve while observing the shaft to ensure it turns 90°. Confirm both discharge delay and valve soak times. Verify that the valve returns to the closed position upon completion of soak time.

▶ **4-9.4** Manifold Test

A. Visually verify that all Master and Selector Valves attached to the manifold are closed and all outlet components are connected properly and closed as appropriate.

B. Pressurize the manifold by slowly opening the Tank-Shut Off Valve. Listen for a continuing flow of carbon dioxide that would indicate a discharge of carbon dioxide from the manifold. If flow continues for an extended period of time, close the Tank Shut-Off Valve and investigate for a leak from the manifold, which may be identifiable by frosting of the pipe.

C. Once the manifold is pressurized, leak test all connections using a soap solution or other appropriate means.

D. Close the Tank Shut-Off Valve after completion of the manifold tests to prevent an unexpected discharge of carbon dioxide while completing the remaining tests.

▶ **4-9.5** Discharge Pressure Switches

A. The only true method of testing the Discharge Pressure Switches is to apply pressure to the inlet. Unfortunately, this requires a discharge of carbon dioxide. At this point, the best method for testing the switches is to manually operate the switch to verify proper shutdown, start-up, or alarm notification of equipment attached to the switch. Final operational testing of the switches will be performed during the discharge test conducted as part of the commission testing of the system.

## SECTION 4 – INSTALLATION

2-5-15 Page 4-50

REV. 2

### 4-9 PRELIMINARY TEST OF SYSTEM (Continued)

#### ▶ 4-9.6 Pressure Trips

- A. Like the Pressure Switches, the Pressure Trips cannot be tested without a discharge of the system. To manually test each Pressure Trip, pull the ring attached to the shaft opposite the end with the weight to release the weight. Verify that the device operated by the weight performs properly. Then reset the weight. Final operational testing of the trips will be performed during the discharge test conducted as part of the commission testing of the system.

#### ▶ 4-9.7 Lock-Out Valves

- A. Operate each Lock-Out Valve in the system to verify that the control panel receives a supervisory signal that the valve is closed.

#### ▶ 4-9.8 Time Delay

##### A. Automatic Timer Cabinet

1. Test each Automatic Timer Cabinet for operation.
  - i. Operate the Manual Override by removing the ring pin and pushing the knob while observing the shaft protruding from the pneumatic actuator on the Selector Valve to ensure that it turns 90° after the appropriate time delay. Finish by pulling the knob out and replacing the ring pin. Verify that the valve closes after the appropriate discharge time by checking to ensure that the shaft rotated back to its original position.
  - ii. Apply power to initiate proper alarms at the control panel to operate the Automatic Timer Cabinet while observing the shaft on the Selector Valve to ensure it turns 90° after the appropriate time delay. Verify that the Selector Valve closes after the appropriate discharge time is completed. Remove the power.
2. During the tests listed above, verify that the control panel receives an alarm signal from the discharge pressure switch in the Automatic Timer Cabinet.
3. Close the Vapor Process, or Vapor Isolation Valve and verify that the Actuation Line Low Pressure Supervisory Switch and the Pneumatic Actuation Line Supervisory Switch provide a supervisory signal to the Detection and Control system.
4. Reopen the Vapor Process, or Vapor Isolation Valve to maintain Actuation Line pressure for the remaining tests.

##### B. Time Delay Test and Adjustment Procedure

For ease of adjustment and to ensure safety, the time delay may be adjusted and checked using a 100 psi (6.9 bar) dry compressed carbon dioxide vapor source connected at the 1/2 in. female NPT swivel adapter on the inlet side of the solenoid valve where the actuation line would normally be connected. The time delay equipped selector valve assemblies may be tested either prior to installation or after installation using the following procedure.

1. With the time delay cover removed, adjust time delay to desired setting as indicated on the dial. If the desired setting is 30 seconds leave the dial in the factory set position. **Note:** The numbers on the dial are to aid in the initial adjustment and do not represent the actual delay time. The actual delay time must be verified using the procedure below. **Note:** 30 second time delays are to be adjusted to 33 seconds. 60 second time delays are to be adjusted to 66 seconds. This keeps the time delay performing within tolerances while being operated in extreme conditions. As a general rule add 10% to your desired time.
2. Connect the 100 psi (6.9 bar) carbon dioxide vapor supply to the actuation line connection.
3. Remove the hairpin cotter pin from the manual operator on the solenoid valve.
4. To start the timing cycle, simultaneously start the stop watch, push in the manual operator on the solenoid valve and rotate the manual operator 180 degrees in the clockwise direction.
5. Observe the shaft connecting the actuator to the discharge valve. When the shaft rotates. The timing cycle is complete. Rotate the manual operator on the solenoid valve counterclockwise and release.
6. Observe the time recorded on the stopwatch. If the time is less than the desired setting, rotate the adjustment knob clockwise slightly and retest. If the time is greater than the desired setting, rotate the adjustment knob counterclockwise slightly and retest.

▶ **4-9.8 Time Delay (Continued)**

B. Time Delay Test and Adjustment Procedure (Continued)

7. Repeat steps 4, 5, & 6 until the desired setting is achieved.
8. Re-install the hairpin cotter pin.
9. Install the time delay cover.

▶ **4-9.9 Pneumatic Audible Alarms**

- A. Any pneumatic audible alarms attached to an Automatic Timer Cabinet will activate when the Automatic Timer Cabinet is tested. Verify operation at that time.

 **WARNING**

Carbon dioxide from a pneumatic audible alarm inside an enclosed space may cause a build-up of gas that will not support life. **Verify that the space is evacuated prior to the test.**

- B. Any pneumatic audible alarms attached to a time delay equipped selector valve assembly will activate when the time delay equipped selector valve assembly is tested. Verify operation at that time.

 **WARNING**

Carbon dioxide from a pneumatic audible alarm inside an enclosed space may cause a build-up of gas that will not support life. **Verify that the space is evacuated prior to the test.**

- C. Pressure Operated Sirens not attached to an Automatic Timer Cabinet must be tested during the discharge test conducted as part of the commissioning testing of the system.

▶ **4-9.10 Solenoid Valve**

- A. If a Solenoid Valve is included in the system for control of a pneumatic component, activate the solenoid valve from the control panel and verify that the pneumatic component controlled by the solenoid performs properly.

## SECTION 4 – INSTALLATION

2-5-15 Page 4-52

REV. 2

### 4-9 PRELIMINARY TEST OF SYSTEM (Continued)

#### ▶ 4-9.11 Hose Reel System

- A. Verify that the Auxiliary Liquid Process Valve is closed at the Bulk Storage tank if the hose reel system is supplied from this source.
- B. Operate the On button of the Hose Reel On/Off Station and verify that the Master/Selector or Selector Valve supplying the Hose Reels opens. If a bleeder valve is included, verify that it also opens.
- C. Operate the Off button of the Hose Reel On/Off Station to verify that the valve closes properly, if the control panel is programmed to perform in this manner.
- D. Test the operation of the Hose Reel for free movement by removing some of the hose, then rewind the hose.
- E. Test for free movement of the Playpipe Nozzle operating handle.
- F. Open Auxiliary Liquid Process Valve upon completion of testing.
- G. The time that the Bleeder Valve remains open must be preset in the control panel and should be determined by a discharge test and set to the time required to reach liquid discharge at the Playpipe.

**Note:** Bleeder valve time duration to be tested and set when supply valve can be opened.

#### ▶ 4-9.12 Detection and Control Panel

- A. Follow the instructions provided with the control panel to verify its performance.
- B. Input Devices: Operate each input device and verify that the appropriate output from the control panel performs properly.
- C. Supervisory Devices: Activate each supervisory signal input to verify that the appropriate supervisory signal is generated at the control panel.
- D. Releasing Devices: During testing of the input devices, verify that each releasing device performs properly, including the appropriate time delay and discharge timing for each of the Selector Valves.
- E. System Trouble: Check system trouble signals by inducing open circuits, short circuits, disconnected batteries, ground faults, etc.
- F. Auxiliary functions: Verify all auxiliary function relays and contacts operate as designed.
- G. Battery operation: Operate alarms, supervisory and trouble signals with the control panel on battery power. Confirm that batteries charge and trouble clears when system power is restored.

#### ▶ 4-9.13 Inspect the Hazard

- A. Carefully inspect the hazard to ensure that it meets the requirements of the system design. Refer to the drawings and documentation provided with the system design for information.
- B. Total Flooding Systems Check
  1. Check integrity of the protected area before the discharge test. It is critical that the CO<sub>2</sub> design concentration be maintained for a predetermined period of time to ensure the complete and permanent extinguishment of the fire.
  2. Therefore, as part of testing, it is important that the protected areas be tightly sealed. Sealing each area should cover the following items:
    - a. All doors leading from the protected areas should have drop seals on the bottoms, weather stripping around the jambs, latching mechanisms, and door-closer hardware. In addition, double doors should have a weather-strip to prevent leakage between doors and a coordinator to ensure proper sequence of closure. In general, doors should be treated as though they are being weatherproofed for outside use and with the least amount of light possible passing around all sides. Doors that, for any reason, cannot be kept normally closed should be equipped with door holders designed to release on alarm.
    - b. All duct work leading from or into a protected area must be permanently sealed off, airtight, with metal plates caulked and screwed in place. Ductwork left in service from the building air handling unit must have positive close type dampers installed with neoprene seals. Dampers must be spring loaded or motor operated to provide 100% air shut-off. The building air handling units should be shut down during a test if possible to prevent the spread of CO<sub>2</sub> into other areas of the building as well as being shut down during system operation.

#### 4-9 PRELIMINARY TEST OF SYSTEM (Continued)

##### ▶ 4-9.13 Inspect the Hazard (Continued)

- c. Self-contained air handling units within the protected area may be left in service. However, the air handling unit could be the source of a fire, so systems not manned 24 hours a day should be shut down automatically by the detection and control system.
- d. Protected areas should be enclosed with wall partitions that extend slab-to-slab. Where this is not possible, any drop ceiling tiles should be clipped. If the ceiling rests on top of the walls, all tiles should be clipped and a caulk bead applied around the entire perimeter where tile touches the wall. In either case, all tiles should be clipped in place within 4 ft (1.23 m) of any discharge nozzle.
- e. Any holes, cracks, or penetrations leading into or out of the protected area must be sealed. This includes pipe chases and wire troughs. All walls should be caulked around the inside perimeter of the room where the walls rest on the floor slab and where the walls intersect with the ceiling slab above.
- f. If a raised floor continues out of the protected area into adjoining rooms, bulkheads must be installed under the floor directly under above-floor border partitions. These bulkheads must be caulked top and bottom. If the adjoining rooms share the same underfloor air handlers, the bulkheads must have dampers installed as is required for ductwork. See Step b.
- g. All floor drains should have traps, and the traps should be designed to have water in them at all times.
- h. Porous block walls must be sealed slab-to-slab to prevent gas from passing through the block. Two or three coats of paint are normally required.
- i. Once the gas is discharged, in most jurisdictions, it must remain in the room as long as designed. The length of time that the gas will remain is directly proportional to the “airtightness” of the room.

#### 4-10 COMMISSION TESTING

##### 4-10.1 Commission Testing

Commission testing of a system is performed in the presence of the Authority Having Jurisdiction, the customer’s representatives, and any other parties identified by either. It is meant to demonstrate that the system is installed properly and will perform according to the specifications and applicable codes and standards.

##### 4-10.2 Safety and Rescue Issues

- A. A normal part of commission testing is a discharge test of the system(s) to verify that proper flow rates, discharge times, and proper concentration levels are achieved and maintained as designed. It is very important to understand and explain the safety issues relating to carbon dioxide prior to the test. All personnel associated with the test must be briefed on these issues prior to the start of any discharge test.
- B. During the review and inspection of the system it shall be locked-out and if the system is a Bulk system the Tank Shut-Off Valve shall be closed.
- C. Hazards to Personnel:

The introduction of carbon dioxide into a confined space creates serious hazards to personnel. Gaseous carbon dioxide is an asphyxiant. Concentrations of 10% or more can produce unconsciousness or death. Lower concentrations may cause headache, sweating, rapid breathing, increased heart rate, shortness of breath, dizziness, mental depression, visual disturbance and shaking. The seriousness of the latter manifestations is dependent upon the concentration of carbon dioxide and the length of time the individual is exposed. Visibility is also greatly reduced during a normal discharge of carbon dioxide, which can hinder evacuation. Contact with skin by compressed CO<sub>2</sub> or dry ice can cause frostbite type burning.

Carbon dioxide is an odorless gas and should be treated as a dangerous material with poor warning properties. It is denser than air and high concentrations can persist in open pits, tanks, or low depressions in terrain. Consideration must be given to the possibility of carbon dioxide drifting and settling into areas like these outside of the protected space.

Before entering an area where carbon dioxide has been, or may be present, the area must be ventilated to clear the gas. Proper monitoring equipment, such as an oxygen level monitor, must be used to verify the area is safe. Self-contained breathing apparatus may be needed and only personnel trained in its use shall be allowed to use it.

## SECTION 4 – INSTALLATION

■ 2-1-10 Page 4-54

REV. 1

### 4-10 COMMISSION TESTING (Continued)

#### 4-10.2 Safety and Rescue Issues (Continued)

D. Warning:

Areas protected by carbon dioxide must have proper warning safeguards for personnel in place. Pre-discharge audible and visual alarms must be located in and around the hazard for personnel warning. Along with these, a discharge time delay of sufficient duration to allow for evacuation under “worst” case conditions is to be provided. Dry runs must be made to determine the minimum evacuation time needed. Appropriate warning signs shall be affixed outside protected areas and areas where CO<sub>2</sub> may accumulate. Personnel training shall be provided. Personnel must know about system presence, how it operates, and actions to take when alarms occur.

E. Rescue:

Do not attempt to remove individuals trapped in an area where carbon dioxide is present without proper rescue equipment or you may also become overcome. Rescue should only be performed by personnel equipped with self-contained breathing apparatus. If the exposed person is unconscious, obtain assistance from qualified medical personnel and put into effect the established emergency procedures.

F. Inhalation First Aid:

If a person has inhaled large amounts of carbon dioxide and is exhibiting adverse affects, move the exposed individual to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get professional medical attention immediately.

G. External Exposure First Aid:

Skin contact with dry ice, vapor, or liquid carbon dioxide may result in frostbite, causing skin lesions or more serious injury from deep-freezing of the tissues. Stop exposure immediately. If frostbite has occurred, obtain professional medical attention immediately. Do not rub the area. Do not apply heat that is warmer than 107 °F (42 °C). Eye contact should be considered as a corneal burn. Frostbite of the eye structure may also occur. Exposure is to be stopped and professional medical attention obtained immediately.

#### 4-10.3 Notification of proper personnel

- A. Prior to initiation of commissioning testing, ensure that all appropriate personnel and outside monitoring agencies have been notified. Commission testing involves activating alarms. If the proper notifications have not been made, emergency personnel will respond causing embarrassment at the least and potentially fines associated with false alarms. If shut down, or start-up of facility equipment is associated with a discharge, the facility personnel need to be advised and a decision must be made as to whether this equipment will be tested or by-passed.

#### 4-10.4 Pre-test briefing

- A. Prior to the beginning of the acceptance testing of the system, all personnel involved should be assembled and the entire test procedure reviewed. Include agenda, safety issues, responsibilities, and any other issues related to the specific installation.

#### 4-10.5 Inspection of system

- A. A complete inspection of the entire installation, with all representatives, should be completed prior to beginning of the commission testing.
- B. Refer to section 4-8 for guidance.

#### 4-10.6 Component testing

- A. Conduct the tests outlined in section 4-9 with representatives to verify proper performance of all components.

**4-10 COMMISSION TESTING (Continued)**

**4-10.7 Discharge test each hazard**

- A. Conduct a discharge test of each individual system to verify proper performance. Refer to the Discharge/ Concentration Test Procedure (F-200174) for detailed instructions.

**4-10.8 Review tests**

- A. After all testing has been performed, assemble all personnel associated with the test and review the results. Address all issues and create action plans for correction of any deficiencies.

**4-10.9 Refill tank**

- A. After completion of all testing, arrange to have the tank completely filled.

**4-10.10 Turn the system over to the customer**

- A. Conduct a meeting with the customer's representatives where any remaining issues are resolved and documentation, keys, access codes, etc. are transferred to the customer.



# Low Pressure Carbon Dioxide

**⚠ WARNING**

The storage tanks covered in this manual contain carbon dioxide at pressures up to 350 psi (24 bar). Sudden release of this pressure may cause personal injury. The accidental discharge of a carbon dioxide system in an occupied area could cause injury or death due to asphyxiation.

For safety, only knowledgeable, qualified, service technicians, trained specifically for this equipment, should perform installation, service, or maintenance on the storage tanks. All precautions must be taken to avoid accidental actuation or discharge. Personnel in the protected hazard area should be evacuated before servicing the system. Refer to safety guidelines in Section 4.

## 5-1 GENERAL

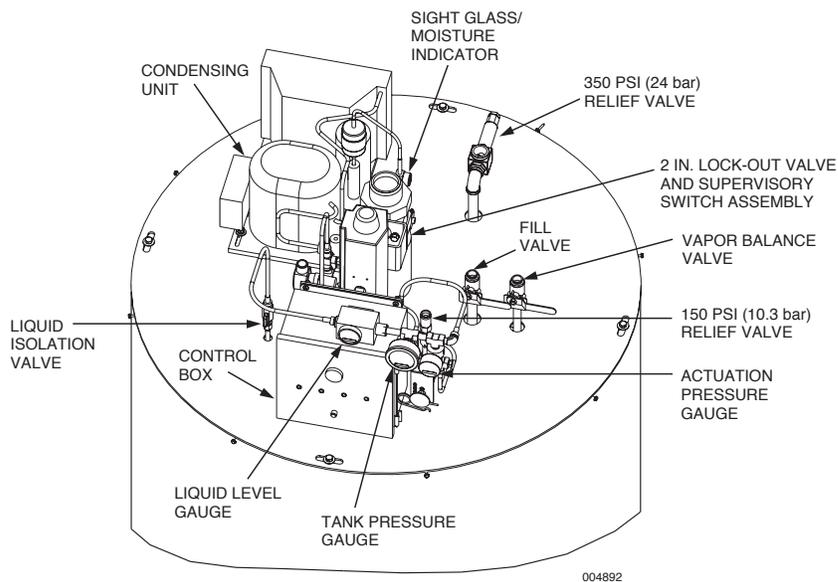
- A. Operation and service procedures in this section are provided as a guide for identifying and correcting systems faults. The use of these procedures by competent personnel will reduce system down time and minimize unnecessary costs. Troubleshooting tables are provided for identifying and isolating system/component faults.
- B. The CO<sub>2</sub> system shall be maintained in full operating condition at all times. Use, impairment and restoration of this protection shall be promptly reported to the Authority Having Jurisdiction.

### 5-1.1 Inspection And Testing

All carbon dioxide systems shall be thoroughly inspected and tested at least annually according to NFPA 12 Standard for Carbon Dioxide Systems Chapter 1 for proper operation by competent personnel.

### 5-1.2 Storage Tank General Management

Figures 5-1 and 5-2 illustrate basic Mini-Bulk and Bulk storage tank configurations with basic components labeled for clarification of the following procedures.



**Figure 5-1**  
Mini-Bulk Tank

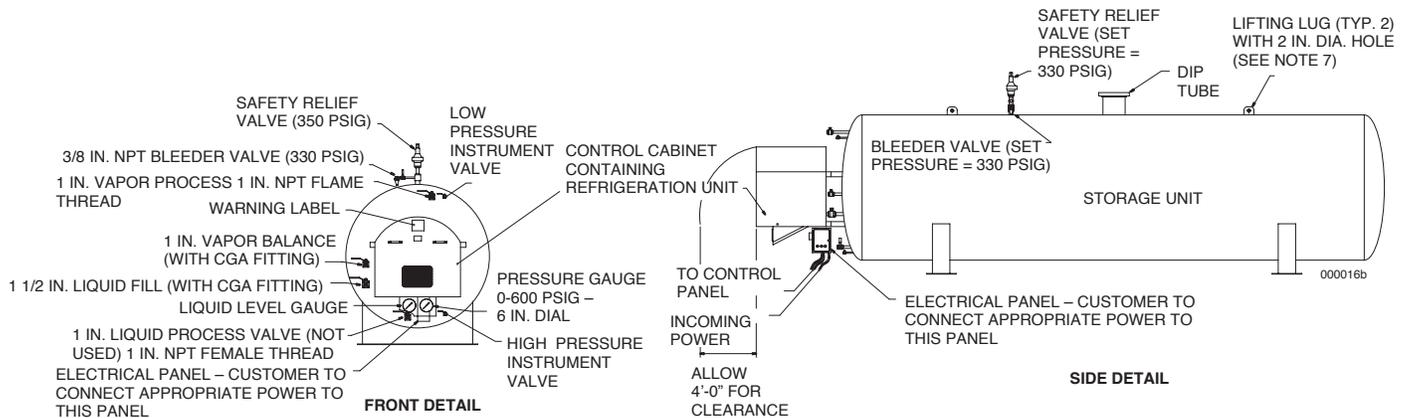
## SECTION 5 – OPERATION AND SERVICE

2-1-10 Page 5-2

REV. 1

### 5-1 GENERAL (Continued)

#### 5-1.2 Storage Tank General Management (Continued)



**Figure 5-2**  
Bulk Storage Connection Detail

### 5-2 CONTROL ACTUATION OPERATION

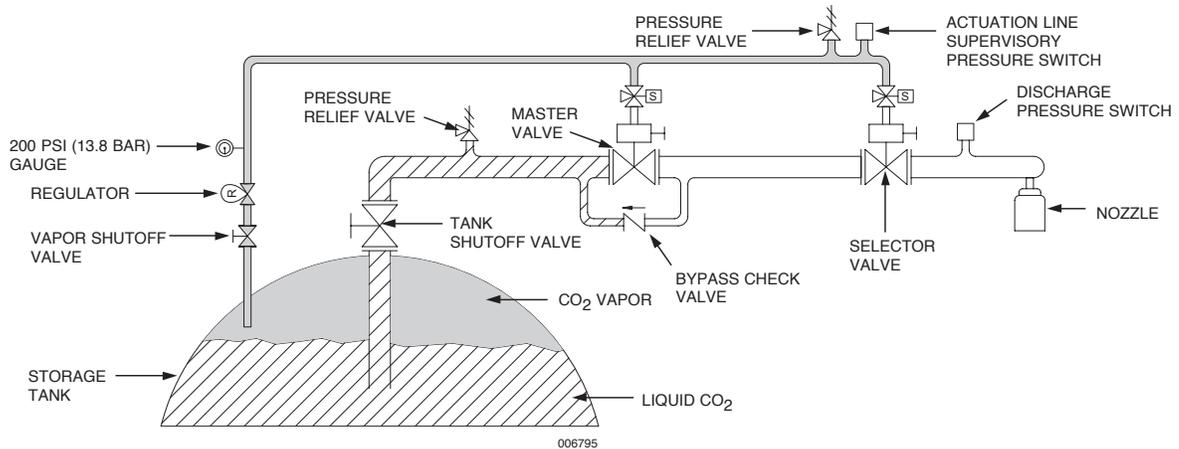
- ▶ A. The ANSUL Low Pressure CO<sub>2</sub> Systems pneumatic actuation system differs from other system configurations, designed in previous years. Our design is updated to minimize the dependence on vapor (pilot) pressure. If system electrical power is lost, the control panel is equipped with sufficient battery back-up power to maintain standby power plus enough alarm/release power for the longest actuation sequence. In addition, a system emergency mechanical override feature is incorporated in the control arrangement as required by NFPA 12. The override feature is manual/pneumatic. It does not rely on electrical power.

## 5-2 CONTROL ACTUATION OPERATION (Continued)

B. There are three basic operating conditions for all CO<sub>2</sub> fire protection systems. These conditions include standby, actuation and system reset which will functionally restore the system to standby. Each of these conditions are described as follows:

### 1. Standby

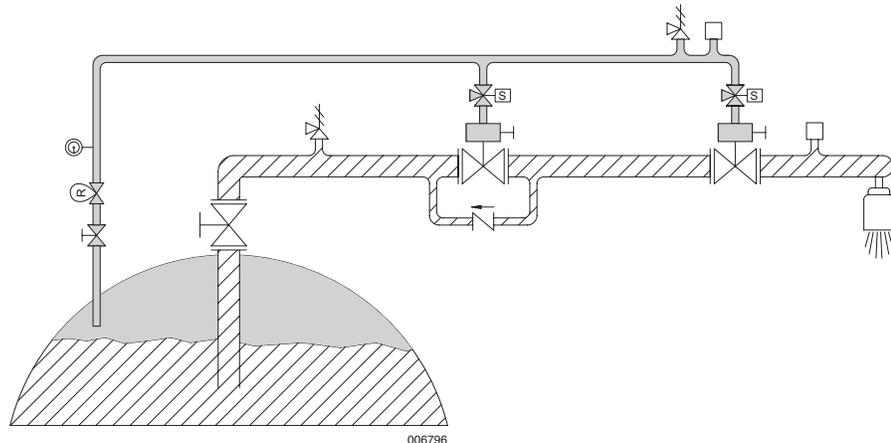
When the system is in standby mode, the control panel awaits a signal from the detection network or one of the manual stations about the hazard area. The Master Discharge, Master-Selector and Selector Valves, which limit gas flow, are normally in a closed position. Each discharge valve is factory fitted with a 24 vdc solenoid valve, an in-line filter and connectors for pneumatic-electric operation via a signal from the control panel. Figure 5-3 illustrates that CO<sub>2</sub> vapor pressure is reduced from 300 psi to 100/110 psi (20.7 bar to 6.9/7.6 bar) throughout the pilot pressure network. A supervisory pressure switch monitors the network, signaling the control panel if actuation pressure is decreased due to leak or a break in the pipe. The discharge line is charged with CO<sub>2</sub> from the diptube up to the Master Discharge, and/or Master-Selector Valve(s) on the storage unit manifold. In standby, all electric-pneumatic discharge valves remain closed and their corresponding solenoid valves are normally de-energized and in a closed position also.



**Figure 5-3**  
Standby Condition

### 2. Actuation

a. When the system is activated by the detectors or a manual release station, actuation is initiated. Normal system actuation should **always** depend primarily upon the electrical devices to actuate the system to ensure proper system operation and the safety of the facility personnel. The control panel energizes the appropriate discharge solenoid valve(s). Vapor pressure flows through the solenoid to the pneumatic operator atop the discharge valve, as shown in Figure 5-4. The discharge valve opens allowing liquid CO<sub>2</sub> to flow through the pipe to the discharge nozzles. The discharge will continue until the solenoid release duration setting has expired, then power is removed from the solenoid coil, actuation vapor is vented, and the discharge valve closes. (See Figure 5-5.)



**Figure 5-4**  
Actuation Condition

**5-2 CONTROL ACTUATION OPERATION (Continued)**

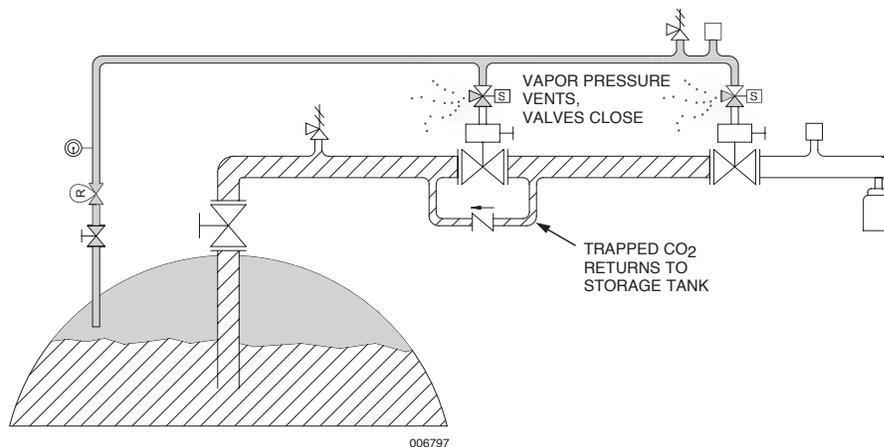
- b. In rare situations when both primary and standby power are lost, the emergency manual operation uses a manual push button to open the discharge valve actuator. If selector valves are installed, they must also be manually opened at the selector valve. If automatic timer cabinets are included in the system, activate the emergency button in the cabinet (open door, pull pin, and strike button). When the override feature is utilized, the CO<sub>2</sub> discharge will continue until the discharge valve(s) and push button(s) are manually reset or the storage tank contents are exhausted.

**CAUTION**

Failure to return the manual release button to the normal position will result in failure to recharge the tank.

**3. System Reset**

Following the normal (electrically initiated) discharge period, the discharge valve(s) will close automatically, resetting the CO<sub>2</sub> system. After the solenoid (release) circuit has timed out, power is removed from the solenoid coil. Figure 5-5 shows that when the solenoid valve closes, flow is blocked from the discharge actuation port. Actuation pressure trapped between the solenoid and the discharge valve actuation port is discharged out the solenoid vent port. This allows the discharge valves to close. Liquid CO<sub>2</sub> trapped between the Master Valve and the Selector Valve will be reclaimed to the storage unit via the check valve bypass around the Master Valve. Vapor pressure from the storage unit maintains actuation pressure to reactivate the system if a second discharge is required. The system control panel, pressure switches and other devices require additional reset procedures to bring the system to normal standby condition.



**Figure 5-5**  
System Reset

**5-3 SCHEDULED MAINTENANCE**

Table 5-1 is provided as a guide to assist in designing a specific maintenance program. These items should be incorporated into the complete maintenance program. Maintenance shall be performed only by competent personnel trained by the manufacturer.

**A. NFPA Requirements**

1. Inspection – Every 30 days, operational condition
2. Hose Test – Every 5 years in accordance with NFPA 12, Section 1-10.2
3. Entire System – Every year checked and tested for proper operation
4. Electrical System – Refer to NFPA 72

**CAUTION**

When annual maintenance is performed, any personnel working in the general protected area should be notified and proper safety precautions taken.

**Table 5-1**  
Recommended Test And Maintenance Procedure

Check	Weekly	Monthly	Annually	What to Check
Complete System			X	All components of the system should be thoroughly inspected and tested for proper operation to insure the system is in full operating condition.
Liquid Level	X			Visually inspect liquid level gauge. Also inspect after each operation. If container shows more than 10% loss, it shall be refilled.
Tank Pressure	X			Visually inspect pressure gauge to see that pressure in tank is within normal range of 295-305 psi (20.3-21 bar).
Power to refrigeration unit	X			Check to see that all disconnect switches are closed and that main power is energized.
Vapor and fill lines	X			Check that liquid fill line and vapor equalizing valves are closed.
Carbon dioxide leakage		X		Check manifold discharge and actuation lines for carbon dioxide leakage around all valve packing glands, fittings and through seats of relief valves.
Exterior condition of storage tank	X			Check for deterioration or separation of covering. Replace deteriorated covering or insulation as required. (Consult factory for guidance.)
Refrigeration system		X		1. Check all refrigerant line connections for leakage. 2. Check condensing unit coils and motor for heavy dust and dirt deposits. Clean as necessary.
Refrigeration system			X	Have refrigeration system serviced by certified commercial/ industrial refrigeration technician.
Safety relief valves (tank and system)		X		Check for visible signs of leakage, tampering or blockage of sintered bronze filter.
High & low tank pressure supervision			X	Check operation of pressure switch. Refer to Sec. 4-7.7 on installation procedures.
Nozzles		X		Visually inspect all nozzles for blockage, damage and proper alignment.
Tank shut-off valve (Bulk systems only)	X (1)		X (2)	1. Valve position. 2. Operate valve to fully closed position and verify supervisory, signal at control panel, then re-open valve. Check for leakage.
Master/Selector Valves	X			Verify that ring pin on manual actuators is in place.

**SECTION 5 – OPERATION AND SERVICE**

**5-3 SCHEDULED MAINTENANCE (Continued)**

**Table 5-1 (Continued)**  
Recommended Test And Maintenance Procedure

Check	Weekly	Monthly	Annually	What to Check
Master/Selector Valves <b>(Bulk systems only)</b>			X	With tank shut-off valve closed energize the solenoid and observe operation of valve. Reset system and operate mechanical operator on valve. Return operator to neutral position. Check for any leaks.
Solenoid valve sintered bronze filter	X			Check to make sure inlet filter is not plugged or bronze outlet filter clogged.
Actuation line supervisory pressure switch			X	Close the actuation line supply valve and slowly bleed pressure out of line. Verify that the control panel receives a supervisory signal at approximately 80 psi (5.5 bar).
Actuation line	X			Check to make sure 100 psi (6.89 bar) is being maintained in actuation line.

**Note:** The above recommended inspection schedule is considered as a minimum requirement. Authorities Having Jurisdiction or insurance companies may require a more stringent inspection schedule. More frequent inspection may be required for process operations that create dirty/damaging environments.

**5-4 MINI-BULK SYSTEM SERVICE – STORAGE UNIT**

- ▶ All carbon dioxide systems shall be thoroughly inspected and tested for proper operation by personnel trained by the manufacturer. Contact Technical Services for consultation before any work is performed.

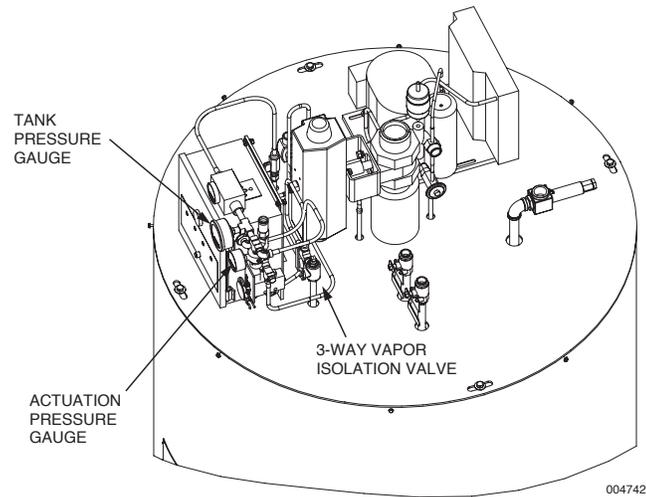
A. Check For Leaks:

1. **Carbon Dioxide:** Carbon dioxide leaks should be easily detected by the appearance of a white gas or by frost or ice on piping. It may be necessary to test pipe connections and valves with a bubble solution to locate small leaks.
2. **Refrigerant:** Loss of cooling efficiency is associated with continuous operation of the cooling unit or high storage unit pressure although cooling system is operating.

B. Check Operation of Low Actuation Pressure Alarm:

The low actuation pressure switch is activated whenever pressure in the actuation line drops below 80 psi (5.5 bar). The pressure switch should be tested to verify that the switch is in good working order and will activate the control panel and properly operate the compressor. To test the pressure switch:

1. While monitoring the actuation pressure gauge, quickly turn handle on the 3-way vapor isolation valve (see Figure 5-6) to the horizontal position to vent actuation pressure.
2. As the pressure bleeds off, an alarm should activate at approximately 80 psi (5.5 bar). Initial response will be the low pressure tank alarm with audible and visual indication.
3. Continue to observe gauge and indicators. A visual signal will confirm the low actuation line pressure switch has activated.
- ▶ 4. If no alarms actuate (audible or visual), contact Technical Services.
5. Return valve handle to the vertical position.
6. Alarms will automatically reset.
7. Record results of test.

**5-4 MINI-BULK SYSTEM SERVICE – STORAGE UNIT (Continued)****Figure 5-6****5-5 BULK SYSTEM STORAGE UNIT****5-5.1 General**

- A. Once the storage unit is properly installed and checked out for proper operation, it requires very little attention. Check the pressure and liquid level gauges at the beginning and end of each work day. If the pressure is not within the normal pressure range, it should be reported at once. If the liquid level is at or below the re-order quantity, the proper authority should be notified.
- B. These systems shall be maintained in full operating condition at all times. Use, impairment, and restoration of this protection shall be reported per facility standard operating procedures.
- C.
  1. Preventive Maintenance  
By competent field service personnel where complete maintenance on the refrigeration system is required. See Table 5-1.
  2. Minor Maintenance  
By facility maintenance personnel familiar with the pressure vessel or refrigeration unit. See Table 5-2.
  3. Major Maintenance  
By competent field service personnel familiar with the storage unit, and equipped with the proper tools and test equipment for servicing the pressure vessel and/or refrigeration unit. See Table 5-3.

**SECTION 5 – OPERATION AND SERVICE**

**5-5 BULK SYSTEM STORAGE UNIT (Continued)**

**5-5.1 General (Continued)**

**Table 5-2**  
Minor Maintenance; Minor Trouble Shooting

<b>COMPLAINT</b>	<b>POSSIBLE CAUSE</b>	<b>REMEDY</b>
Unit pressure high, refrigeration system not running.	<ol style="list-style-type: none"> <li>1. Blown fuse.</li> <li>2. Electric power off.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace fuse.</li> <li>2. Check power source.</li> </ol>
Refrigeration system does not start, hums but trips on overload protector.	<ol style="list-style-type: none"> <li>1. Low voltage.</li> <li>2. Blown fuse.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check power source.</li> <li>2. Replace fuse.</li> </ol>
Unit pressure high, refrigeration system running.	<ol style="list-style-type: none"> <li>1. Air passage across condenser coil restricted.</li> <li>2. Condenser coils dirty.</li> <li>3. Condenser fan blade slipping on shaft.</li> <li>4. Tank overfilled.</li> </ol>	<ol style="list-style-type: none"> <li>1. Remove obstruction.</li> <li>2. Clean.</li> <li>3. Tighten bolt.</li> <li>4. Reduce liquid level in tank. Bleed off excess liquid through vapor balance valve. Bleed-off should exhibit vapor only. Liquid through the vapor balance valve is evidence of overfill.</li> </ol>
Refrigeration system operates long or continuously.	<ol style="list-style-type: none"> <li>1. Condenser coils dirty.</li> <li>2. Air passage across condenser coil restricted.</li> <li>3. High ambient temperature.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean.</li> <li>2. Remove obstruction.</li> <li>3. Shelter tank and refrigeration system from direct sunlight.</li> </ol>
Refrigeration system noisy.	<ol style="list-style-type: none"> <li>1. Loose parts or mountings.</li> <li>2. Tubing rattle</li> </ol>	<ol style="list-style-type: none"> <li>1. Locate and tighten.</li> <li>2. Re-form tubing to be free of contact.</li> </ol>
Pressure relief valve venting when unit pressure is not high.	<ol style="list-style-type: none"> <li>1. Defective valve.</li> </ol>	<ol style="list-style-type: none"> <li>1. Empty tank and replace valve with new safety valve. Refill tank and check for leaks.</li> </ol>
Liquid level gauge shows 0. Unit known to contain liquid.	<ol style="list-style-type: none"> <li>1. Equalizer valve open.</li> <li>2. Liquid supply to instruments valve closed.</li> <li>3. Liquid supply frozen/ restricted.</li> <li>4. Out of calibration.</li> <li>5. Defective gauge.</li> </ol>	<ol style="list-style-type: none"> <li>1. Close equalizer valve.</li> <li>2. Open valve.</li> <li>3. Thaw and purge liquid supply to instrument line.</li> <li>4. Calibrate gauge.</li> <li>5. Replace gauge.</li> </ol>
Liquid level gauge shows over-full.	<ol style="list-style-type: none"> <li>1. Tank overfilled.</li> <li>2. Vapor supply to instruments valve closed.</li> <li>3. Gauge out of calibration.</li> <li>4. Leak in instrument piping.</li> <li>5. Defective gauge.</li> </ol>	<ol style="list-style-type: none"> <li>1. Bleed off excess liquid through vapor balance valve. Bleed-off should exhibit vapor only. Liquid through the vapor balance valve is evidence of overfill.</li> <li>2. Open valve.</li> <li>3. Calibrate gauge.</li> <li>4. Repair leak.</li> <li>5. Replace gauge.</li> </ol>
Liquid level gauge shows below zero.	<ol style="list-style-type: none"> <li>1. Liquid supply to instruments valve closed.</li> <li>2. Gauge out of calibration.</li> <li>3. Liquid supply to instruments valve frozen or otherwise restricted.</li> <li>4. Defective gauge.</li> </ol>	<ol style="list-style-type: none"> <li>1. Open valve.</li> <li>2. Calibrate gauge.</li> <li>3. Thaw and purge liquid supply line.</li> <li>4. Replace gauge.</li> </ol>
Liquid level gauge reading erratic.	<ol style="list-style-type: none"> <li>1. Equalizer valve not completely closed.</li> <li>2. Instrument bleed-off valve not completely closed.</li> <li>3. Leak in instrument piping.</li> <li>4. Liquid supply to instruments partially frozen or restricted.</li> <li>5. Defective gauge.</li> </ol>	<ol style="list-style-type: none"> <li>1. Close equalizer valve.</li> <li>2. Close bleed-off valve.</li> <li>3. Repair leak.</li> <li>4. Thaw and purge liquid supply.</li> <li>5. Replace gauge.</li> </ol>

**5-5 BULK SYSTEM STORAGE UNIT (Continued)****5-5.1 General (Continued)****Table 5-3**  
Maintenance

The following trouble shooting table is intended for in-plant maintenance, provided the person chosen for this work is a qualified refrigeration service technician and has studied the material contained in this manual. In the event of malfunction not covered in either troubleshooting chart or failure of remedy to correct the trouble, a certified commercial/industrial rated ► refrigeration system technician or an ANSUL Low Pressure CO<sub>2</sub> Systems service technician should be called for further instructions.

## TROUBLESHOOTING

COMPLAINT	POSSIBLE CAUSE	REMEDY
Unit pressure too high, refrigeration not running.	<ol style="list-style-type: none"> <li>1. Blown fuse.</li> <li>2. Electric power off.</li> <li>3. Controls out of adjustment.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace fuse.</li> <li>2. Check power source.</li> <li>3. Adjust controls.</li> </ol>
Unit pressure too high, refrigeration system is running.	<ol style="list-style-type: none"> <li>1. Insufficient air across condenser coils.</li> <li>2. Condenser coils dirty.</li> <li>3. Low on refrigerant.</li> <li>4. Super heat too high or too low.</li> <li>5. Bad compressor valves.</li> <li>6. Internal mechanical trouble in compressor.</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine reason and correct.</li> <li>2. Clean coils.</li> <li>3. Find and stop leak, add refrigerant.</li> <li>4. Replace expansion valve, never adjust.</li> <li>5. Replace valves.</li> <li>6. Replace compressor.</li> </ol>
Refrigeration system does not start, hums but trips on overload protector.	<ol style="list-style-type: none"> <li>1. Low voltage to unit.</li> <li>2. Compressor motor has a winding open or shorted.</li> <li>3. Internal mechanical trouble in compressor.</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine reason and correct.</li> <li>2. Replace compressor.</li> <li>3. Replace compressor.</li> </ol>
Refrigeration system starts, but short cycles on overload protector.	<ol style="list-style-type: none"> <li>1. Low or unbalanced voltage to unit.</li> <li>2. Excessive discharge pressure.</li> <li>3. Suction pressure too high.</li> <li>4. Compressor too hot.</li> <li>5. Overload protector defective.</li> </ol>	<ol style="list-style-type: none"> <li>1. Determine reason and correct.</li> <li>2. Check ventilation. Check fan for proper operation. Check for contaminated refrigerant.</li> <li>3. Bad solenoid valve. Replace.</li> <li>4. Check refrigerant charge, repair leak, add refrigerant.</li> <li>5. Check current, replace overload protector.</li> </ol>
Refrigeration system runs okay but short cycles on CO <sub>2</sub> pressure switch.	<ol style="list-style-type: none"> <li>1. Differential set too close.</li> <li>2. Defective switch.</li> </ol>	<ol style="list-style-type: none"> <li>1. Widen differential to 10 psi (0.7 bar).</li> <li>2. Replace switch.</li> </ol>
Refrigeration system short cycles on dual refrigerant pressure control. <ol style="list-style-type: none"> <li>1. High side.</li> <li>2. Low side.</li> </ol>	<ol style="list-style-type: none"> <li>1a. Insufficient air across condenser coils.</li> <li>1b. System overcharged.</li> <li>1c. Air in system.</li> <li>1d. Carbon dioxide leak in evaporator coil.</li> <li>2a. System under charged.</li> <li>2b. Liquid line crimped.</li> <li>2c. Restriction in expansion valve.</li> </ol>	<ol style="list-style-type: none"> <li>1a. Determine reason and correct.</li> <li>1b. Reduce charge.</li> <li>1c. Purge and replace refrigerant.</li> <li>1d. Contact Technical Services.</li> <li>2a. Fix leak, add refrigerant.</li> <li>2b. Replace crimped section.</li> <li>2c. Clean expansion valve. Replace if necessary.</li> </ol>
Refrigeration system operates long or continuously.	<ol style="list-style-type: none"> <li>1. Low on refrigerant.</li> <li>2. CO<sub>2</sub> pressure control differential too wide.</li> <li>3. CO<sub>2</sub> control contacts stuck closed.</li> <li>4. Condenser coils dirty.</li> <li>5. Insufficient air across condenser coils.</li> <li>6. High ambient temperature.</li> </ol>	<ol style="list-style-type: none"> <li>1. Fix leak, add refrigerant.</li> <li>2. Adjust differential to 10 psi (.7 bar).</li> <li>3. Replace control.</li> <li>4. Clean coils.</li> <li>5. Determine reason and correct.</li> <li>6. Shelter refrigeration system from direct sunlight.</li> </ol>
Refrigeration system operating, but compressor is frosted.	<ol style="list-style-type: none"> <li>1. Expansion valve passing excess refrigerant.</li> <li>2. Expansion valve stuck open.</li> <li>3. Overcharge of refrigerant.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace expansion valve, never adjust.</li> <li>2. Clean valve of foreign particles. Replace if necessary.</li> <li>3. Reduce charge.</li> </ol>

## SECTION 5 – OPERATION AND SERVICE

2-1-10 Page 5-10

REV. 1

### 5-5 BULK SYSTEM STORAGE UNIT (Continued)

#### 5-5.2 Preventive Maintenance

Annually, the refrigeration system should be serviced by a certified commercial/industrial refrigeration technician.

#### 5-5.3 Refilling Storage Unit

Refilling the storage unit is basically the same as the initial filling procedure, except operating power to the refrigeration unit is not disconnected and the purging procedure is not required. Refer to Section 4-7 in the installation section for filling procedure.

Prior to filling, check the pressure and temperature of the carbon dioxide which is to be transferred into the storage unit. The temperature should be approximately 0 °F (-17.8 °C). If the temperature is too high or too low, it could adversely affect the pressure in the storage unit. If the pressure of the carbon dioxide is higher than 330 psi (22.8 bar), it may increase the storage unit pressure and cause the safety valve to open and discharge carbon dioxide.

### 5-6 BULK SYSTEM TANK SHUT-OFF VALVE ASSEMBLY

#### 5-6.1 Operation

- A. The tank shut-off valve is operated by the manual gear actuator. Rotation of the handwheel rotates the valve open or closed and operates the supervisory switches.
- B. Seepage at the valve stem during and after a CO<sub>2</sub> discharge is common. Immediate contraction, due to the liquid CO<sub>2</sub>, at the valve stem has a greater effect on the stem than the packing seal. This seepage will subside as the temperature equalizes.

#### 5-6.2 Service

- A. During its life, the only service that may be required should be periodic stem seal adjustment. If leakage at the stem is noted, simply tighten the valve stem gland nut until leakage subsides. See Table 5-4 for torque values. It is impractical to predict frequency of stem adjustment as it is influenced by such factors as frequency of cycling. **IMPORTANT:** As is the case with any valve, it is important that stem leaks do not go unattended. Lack of maintenance of stem leakage could cause a premature need to replace stem seals.

**Caution:** Do not overtighten gland nuts, as this may cause increased operating torque and improper valve operation or closure.

- B. If the leakage cannot be stopped by this action, the system seals require replacement. Consult Technical Services.

Size – in.	ft-lb	(Nm)
3 in.	35	(3.9)
4 in.	35	(3.9)
6 in.	35	(3.9)
8 in.	40	(4.5)

**Table 5-4**  
Gland Nut Torque

**5-6 BULK SYSTEM TANK SHUT-OFF VALVE ASSEMBLY (Continued)****5-6.3 Replacement**

A. Depressurize the storage tank and system by opening the liquid fill valve to empty the tank.

**Warning:** Never open the Vapor Balance Valve to empty a low pressure CO<sub>2</sub> storage tank. A large block of dry ice will form and cause internal damage to the pressure vessel.

B. Open the vapor balance valve on tank. This will vent any residual pressure build-up within the tank.

C. Close the tank shut-off valve.

**Caution:** Remove dirt and debris from the valve area. Foreign objects may fall into the opening during valve removal resulting in seal damage when system is pressurized.

D. Clean valve/flange area of all dirt and debris.

E. Remove valve assembly:

1. Loosen flange bolts in a sequential order.
2. Attach lifting device to assembly, if needed.
3. Remove flange bolts and remove assembly.

F. Care should be taken not to scratch the valve disc or seats.

▶ G. Valve assemblies requiring further disassembly or part replacement should be returned to the manufacturer for repair.

H. Install valve assembly:

1. Ensure valve and flange area is clean. Remove any dirt or debris from adjoining pipe.
2. Care should be taken not to scratch the valve disc or seats.
3. Position valve assembly between its mating flanges with new gaskets in place.
4. Secure with bolts. Tighten bolts in sequential order in 20% (40 ft lb (54 Nm)) increments until final torque is reached.

**5-6.4 Manual Gear Actuator**

**Warning:** Under no circumstances should the actuator be removed from the valve body while the valve assembly is mounted in the system. The eccentric design of the valve may allow line pressure to open the valve. Also, valve seat and disc will be mis-aligned.

**Caution:** Do not adjust stop nuts on actuator. The valve seat and disc may become mis-aligned

▶ The manual gear actuator is mounted on the valve body by the factory. Consult Technical Services for removal or disassembly of the actuator.

## SECTION 5 – OPERATION AND SERVICE

2-1-10 Page 5-12

REV. 1

### 5-7 DISCHARGE/SELECTOR VALVE ASSEMBLY

#### 5-7.1 Operation

- A. The discharge/selector valves utilize carbon dioxide vapor pressure to operate the pneumatic actuators on the valves. A solenoid valve located on the valve controls the pressure to the actuators. Upon activation of the solenoid valve, pressure is permitted to enter the pneumatic actuator to open the valve. The valve remains open for a pre-determined time period at which point the solenoid is de-energized, redirecting or exhausting the pneumatic pressure causing the valve to close. The carbon dioxide pressure in the pneumatic actuation line is regulated and supervised to operate at 90-100/110 psi (6.2-6.9/7.8 bar). A supervisory pressure switch is installed in the actuation line to provide a signal at the control panel when the pneumatic pressure drops below 80 psi (5.5 bar). In the event of failure of the pressure regulator, a 150 psi (10.3 bar) pressure relief valve is installed to prevent excessive pressure in the pneumatic actuators.
- B. Seepage at the valve stem during and after a CO<sub>2</sub> discharge is not uncommon. Immediate contraction, due to the liquid CO<sub>2</sub>, at the valve stem has a greater effect to the stem than the packing seal. This seepage will subside as the temperature equalizes.

#### 5-7.2 Service

##### 5-7.2.1 Ball Valves And Butterfly Valves

During its life, the only service that may be required should be periodic stem seal adjustment. If leakage at the stem is noted, simply tighten the valve stem gland nut until leakage subsides. It is impractical to predict frequency of stem adjustment as it is influenced by such factors as frequency of cycling. IMPORTANT: As is the case with any valve, it is important that stem leaks do not go unattended. Lack of maintenance of stem leakage could cause a premature need to replace stem seals.

**Caution:** Do not disconnect actuator from butterfly valve. Removal of the actuator from the valve will result in mis-alignment of the valve disc. Disc to seal leakage will occur.

#### 5-7.3 Replacement

##### 5-7.3.1 Ball Valves And Butterfly Valves

**Caution:** Remove dirt and debris from the valve area. Foreign objects may fall into the opening during valve removal resulting in seal damage when system is pressurized.

Do not disconnect actuator from butterfly valve. Removal of the actuator from the valve will result in misalignment of the valve disc. Disc to seal leakage will occur.

- A. Close tank shutoff valve/master shutoff valve.
- B. Clean valve/flange area of all dirt and debris.
- C. Relieve actuation line and discharge piping pressure.
- D. Remove valve assembly.
- E. The valve assembly should be returned to the manufacturer for repairs or replacement.
- F. The valve assembly should not be repaired or disassembled in the field.

**Note:** For additional requirements with time delay equipped selector valve assemblies, see section 5-7.9.

#### 5-7.4 Pneumatic Actuators

##### 5-7.4.1 Operation

The actuators provide the means of converting lineal to rotary motion through a rack and pinion or Scotch Yoke design. The operating medium is filtered carbon dioxide vapor.

##### 5-7.4.2 Service

**Caution:** Do not disconnect actuator from butterfly valve. Removal of the actuator from the valve will result in mis-alignment of the valve disc. Disc to seal leakage will occur.

The actuators are permanently lubricated. Additional lubrication is not required.

The valve assembly should be returned to the manufacturer for repair or replacement.

## 5-7 DISCHARGE/SELECTOR VALVE ASSEMBLY (Continued)

### 5-7.5 Maintenance

**Warning:** Turn off electrical power and line pressure to valve before making repairs. It is not necessary to remove valve from pipe line for repairs.

**Caution:** Clogging of the exhaust filter could adversely affect the performance of the solenoid valve.

Inspect the exhaust filter/muffler on the solenoid valve to ensure proper operation in atmospheres that could result in clogging.

### 5-7.6 Troubleshooting



Close tank shutoff or discharge valve before proceeding.

**Warning:** System should be disabled before working on solenoid.

- A. Faulty Control Circuit: Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open-circuited or grounded coil, broken lead wires or splice connections.
- B. Burned-Out Coil: Check for open-circuited coil. Replace solenoid valve assembly if necessary.
- C. Low Voltage: Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.
- D. Incorrect Pressure: Check valve pressure. Pressure to valve must be within the range specified on nameplate.
- E. Excessive Leakage (Improper Opening and Closing of Ports): Remove solenoid valve assembly from system and replace with a new solenoid valve assembly (see 5-7.7.1).
- F. Slow exhaust operation: Check to make sure exhaust filter is not plugged or clogged. If so, clean or replace.

### 5-7.7 Solenoid Valve

#### 5-7.7.1 Replacement

**Caution:** Remove dirt and debris from the solenoid valve area. Foreign objects may fall into the opening during valve removal resulting in a possible malfunction.

- A. Close tank shutoff or discharge valve before proceeding.
- B. Clean valve/actuator area of all dirt and debris.
- C. Relieve actuation line pressure to the valve.
- D. Disconnect actuation line and wiring.
- E. Remove valve from actuator.
- F. Ensure the valve port of the actuator is clear of dirt and debris.
- G. Install new solenoid valve.
- H. Connect actuation line and wiring.
- I. Test solenoid valve for proper operation.

### 5-7.8 In-Line Filter

#### 5-7.8.1 Operation

Positioned before each solenoid valve, the in-line filter prevents dirt and debris from entering the solenoid valve.

#### 5-7.8.2 Service

The filter cartridge should be checked periodically. Replace the filter if clogging is evident.

## SECTION 5 – OPERATION AND SERVICE

2-1-10 Page 5-14

REV. 1

### 5-7 DISCHARGE/SELECTOR VALVE ASSEMBLY (Continued)

#### 5-7.9 Time Delay Assembly

##### 5-7.9.1 Time Delay Installation Instructions

For service or retrofit applications, the time delay comes as a pre-piped service assembly. The time delay comes with 1/2 in. Female NPT swivel connector for easy installation. Partial disassembly of the pre-piped assembly is required in order to install the assembly. **Note: The time delay assembly is equipped with a bleeder plug which allows the system to reset after a discharge is complete. To install pneumatic sirens or air horns, remove the bleeder plug and connect the siren piping where the bleeder plug was installed.**

1. Close actuation line shut-off valve.
2. Vent actuation line in a well ventilated area.
3. Close master tank shut off valve or zone shut off valve to prevent the accidental discharge of CO<sub>2</sub>.
4. Turn off power to detection and control system.
5. Disconnect actuation line from existing valve actuator assembly.
6. Remove electrical connection from existing solenoid valve.
7. Remove two Allen head screws holding solenoid valve to actuator.
8. Carefully clean mounting surface of actuator where time delay valve will be mounted. Be sure not to allow dirt to go into the ports on the actuator.
9. To install new time delay, remove red cover from time delay assembly, which is held in place by two Phillips head screws. **Do not adjust the timer setting.**
10. Remove two 0.15 in. (4 mm) Allen head screws holding the timer & pilot block assembly to the surface mount valve. Do not lose o-ring gasket. Note its orientation (the open loop aligns with the small pilot hole).
11. Install surface mount valve with adapter plate. Make sure the o-rings are in place between the actuator and the adapter plate, and the gasket is in place between the adapter plate and the valve. Tighten the two Allen head screws securely.
12. Re-install the timer & pilot block assembly to the valve using the 0.15 in. (4 mm) Allen head screws and tighten securely.
13. Although the time delay is factory preset to 30 seconds, slight variations in timing may occur due to the different sizes of actuators. Or, some installations may require delay settings other than the 30 second factory preset in order to allow personnel adequate time to evacuate the protected space or to meet the requirements of the Authority Having Jurisdiction (AHJ). Because of this, it is necessary to check the time delay function once it is installed in the application. Follow the test and adjustment procedure and then complete the installation as follows.
14. Re-install the red cover with the two Phillips head screws. Tighten securely.
15. Connect the actuation line to the 1/2" Female NPT swivel adapter on the solenoid valve.
16. Check all fitting connections on the time delay assembly to ensure they are tight. **Do not over tighten.**
17. Wire the solenoid according to section 4-5.18E on page 4-29 of this manual.
18. Open actuation line shut off valve. Inspect for leaks.
19. Open master tank shut off valve or zone shut off valve.

### 5-8 LOCK-OUT VALVE ASSEMBLY

#### 5-8.1 Operation

- A. The 1/2 in. – 2 in. lockout valve is operated by a locking lever handle. Rotation of the lever rotates the ball valve open or closed and activates the supervisory switches.
- B. The 3 in. – 8 in. lockout valve is operated by a manual gear actuator. Rotation of the handwheel rotates the valve open or closed and activates the supervisory switches.
- C. Seepage at the valve stem during and after a CO<sub>2</sub> discharge is not uncommon. Immediate contraction, due to the liquid CO<sub>2</sub>, at the valve stem has a greater effect to the stem than the packing seal. This seepage will subside as the temperature equalizes.

## 5-8 LOCK-OUT VALVE ASSEMBLY (Continued)

### 5-8.2 Service

#### 5-8.2.1 Ball Valves And Butterfly Valves

During its life, the only service that may be required should be periodic stem seal adjustment. If leakage at the stem is noted, simply tighten the valve stem gland nut until leakage subsides. It is impractical to predict frequency of stem adjustment as it is influenced by such factors as frequency of cycling. **IMPORTANT:** As is the case with any valve, it is important that stem leaks do not go unattended. Lack of maintenance of stem leakage could cause a premature need to replace stem seals.

**Caution:** Do not disconnect actuator from butterfly valve. Removal of the actuator from the valve will result in mis-alignment of the valve disc. Disc to seal leakage will occur.

### 5-8.3 Replacement

#### 5-8.3.1 Ball Valves And Butterfly Valves

**Caution:** Remove dirt and debris from the valve area. Foreign objects may fall into the opening during valve removal resulting in seal damage when system is pressurized.

Do not disconnect operator from butterfly valve. Removal of the operator from the valve will result in mis-alignment of the valve disc. Disc to seal leakage will occur.

- A. Clean valve/flange area of all dirt and debris.
- B. Relieve discharge piping pressure.
- C. Remove valve assembly.
- D. The valve assembly should be returned to the manufacturer for repairs or replacement.
- E. The valve assembly should not be repaired or disassembled in the field.

### 5-8.4 Manual Gear Actuator

**Warning:** Under no circumstances should the actuator be removed from the valve body while the valve assembly is mounted in the system. The eccentric design of the valve may allow line pressure to open the valve. Also, valve seat and disc will be mis-aligned.

**Caution:** Do not adjust stop nuts on actuator. The valve seat and disc may become mis-aligned

The manual gear actuator is mounted on the valve body by the factory. Consult Technical Services for removal or disassembly of the actuator.

#### 5-8.4.1 Service

Periodic servicing on the worm gear actuators is normally not necessary, but for those customers having such programs, the following procedures would certainly not be detrimental.

- A. Remove indicator plate.
- B. Remove actuator lid, being careful not to get foreign material into unit.
- C. Add number 2-EP grease to gear case around sector, worm and bearings, as necessary.
- D. Be certain mating surfaces between lid and housing are clean.
- E. Apply a thick film of grease or gasket sealer to housing.
- F. Apply a thick film of 2-EP grease around sector gear (drive sleeve) bearing where the lid bore fits.
- G. Carefully install actuator lid, (being careful not to get foreign material into unit).
- H. Replace lid bolts and tighten.
- I. Grease top of sector hub where indicator plate mounts.
- J. Put indicator in place and tighten bolts.

## SECTION 5 – OPERATION AND SERVICE

■ 2-1-10 Page 5-16

REV. 1

### 5-9 ACTUATION LINE SUPERVISORY PRESSURE SWITCH

#### 5-9.1 Operation

When pressure is applied, the switch transfers. Wire connection for supervision is to the normally closed contacts which are held open under normal actuation line pressure. When pressure drops below 80 psi (5.5 bar), the switch closes, providing a supervisory signal to the control panel.

#### 5-9.2 Maintenance

**Warning:** Before removal or inspection of switch, remove actuation line pressure.

If damaged, the switch must be replaced.

**Caution:** Use wrench on Supervisory Pressure Switch Hex at the end being loosened or tightened. For installation into piping use the Hex adjacent to the 1/4 in. NPT thread. For connection of conduit fittings use the Hex adjacent to the 1/2 in. NPT. Using the opposing Hex will cause damage to the pressure switch.

### 5-10 BULK SYSTEM PRESSURE REGULATOR

#### 5-10.1 Operation

The regulator is supplied by 300 psi (20.7 bar) of main tank pressure and maintains 100 psi (6.9 bar) of output pressure.

#### 5-10.2 Service

Adjustment of pressure output is the only service required.

#### 5-10.3 Adjustment

(Refer to Paragraph 4-5.24B in installation section.)

- A. Remove cap over the adjusting screw.
- B. Loosen lock-nut.
- C. Turn the adjusting screw to change pressure.
  - Clockwise to increase pressure.
  - Counterclockwise to decrease pressure.
- D. Tighten locknut.
- E. Install cap over the adjusting screw.

### 5-11 MINI-BULK SYSTEM PRESSURE REGULATOR

#### 5-11.1 Operation

The regulator is supplied by 300 psi (20.7 bar) of main tank pressure and maintains 110 psi (7.8 bar) of output pressure.

#### 5-11.2 Service

Regulator is not adjustable. Replace if outside normal operating parameters.

### 5-12 PRESSURE RELIEF VALVE

**Caution:** Clogging of the muffler/filter could adversely affect the performance of the relief valve. Clean and inspect on a regular basis.

#### 5-12.1 Operation

Pressure relief valves of the 150 psi (10.3 bar) and 450 psi (31 bar) type are utilized to relieve an over-pressure condition. The valves are equipped with a muffler/filter to prevent debris from entering the exhaust port.

#### 5-12.2 Service

The muffler/filter should be checked periodically for cleanliness. Replace the filter if clogging is evident.

## 5-13 DISCHARGE NOZZLES

### 5-13.1 Operation

The discharge nozzles throttle the carbon dioxide discharge at a pre-determined rate as determined by the flow calculations.

### 5-13.2 Service

The nozzles should be checked periodically for damage, blockage, or misalignment. The nozzle codes shall be verified according to system design drawings as part of normal maintenance procedure.

## 5-14 HOSE REEL

### 5-14.1 Operation

A. Operation of the hose reel is manual but charging of the hose line is automatically controlled by the start/stop station. If use of the hose reel is required, remove the playpipe and nozzle from the storage position by lifting straight up and push the start button, which automatically charges the line to the shut-off valve. While approaching the fire, push the handle of the shut-off valve to the open position and aim the discharge at the base of the fire. This will provide a full liquid carbon dioxide discharge at the time the fire is reached. In the case of burning liquids aiming the discharge directly into the fire may cause splashing and spread the burning liquid.

**Warning:** When the valve is opened, there is a recoil from the carbon dioxide being discharged. The operator must brace themselves before opening the valve.

B. Continue discharging into the fire several seconds after the flames have been extinguished. This provides additional cooling of the material in the fire area which is necessary to prevent re-ignition. After the discharge, stand-by to keep play pipe ready for use in the event of a reflash.

C. After the fire has been extinguished, rewind the hose on the reel and replace the playpipe assembly. Push the stop button and reset control panel if required to automatically close the hose reel master valve. Discharge the trapped carbon dioxide from the hose reel after the valve has been closed by operating the lever until all pressure is expelled. The hose reel is again ready for use.

### 5-14.2 Maintenance

A. Hose reels require little or no maintenance other than routine semi-annual inspection, lubrication to prevent corrosion and allow free movement, and cleaning of dirt and obstructions.

B. For re-ordering parts, refer to the engineering drawings supplied with your installation for model, description, size and stock number.

## 5-15 ODORIZER

### 5-15.1 Replacement

A. Remove odorizer assembly from piping.

B. Remove ruptured burst disc assembly and odorizer cap.

C. Remove broken ampoule from odorizer and clean all parts. Care must be observed when removing a spent ampoule due to broken glass.

D. Using Part No. 42284, carefully install new burst disc and ampoule.

E. Thread cap on odorizer and re-install onto piping. Ensure all parts are wrench tightened to prevent CO<sub>2</sub> from leaking during discharge.

**SECTION 5 – OPERATION AND SERVICE**

9-1-03 Page 5-18

**NOTES:**