Engineering Specifications

Low Pressure CO_2 Fire Suppression System

tyco Fire Protection Products

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LOW PRESSURE CARBON DIOXIDE
FIRE SUPPRESSION SYSTEM SPECIFICATION GUIDE
2015-FEB-12

Tyco Fire Protection Products
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Note: Items shown in brackets are either instructions to the writer or options to be added or deleted on specific requirements.

This section provides for the design and provision of a fire suppression system using low pressure carbon dioxide and includes all components required for a complete system. This section includes performance and descriptive type specifications. Edit to avoid conflicting requirements.

PART 1 – GENERAL

1.01 THIS GUIDE INCLUDES THE FOLLOWING:

A. Fire detection and control system
B. Actuation system operation
C. Storage units and distribution system
D. Pipe and fittings
E. Hose reels

1.02 RELATED SECTIONS:

A. Section [ ] – interlocks
B. Section [ ] – painting
C. Section [ ] – other fire protection systems
D. Section [ ] – electrical
E. Section [ ] – building fire alarm and detection systems
F. Section [ ] – general requirements and materials

1.03 REFERENCES:

Referenced standards are listed within the text of this section. Select the specific standards required for project conditions:

A. ANSI/ASME B16.3 – Malleable iron threaded fittings class 300
B. ANSI/ASME B16.9 – Factory made wrought steel butt welding fittings
C. ANSI/ASME B31.1 – Power piping
D. ANSI/ASME B31.1 – Pressure vessels
E. ANSI/ASME Section 8 – Welding and brazing qualifications
F. ANSI/WAS D1.1 – Standard Welding Code
G. ANSI/NFPA 12 – Carbon Dioxide Extinguishing Systems
H. ANSI/NFPA 70 – National Electric Code
I. NFPA 72 – National Fire Alarm Code
J. ASTM-A53 – Pipe, steel, black and hot dipped zinc coated, welded and seamless
K. ASTM-A106 – Seamless carbon steel pipe for high temperature service
L. FM – Factory Mutual Engineering
M. NEMA – Enclosures for control panels
N. IRI – Industrial Risk Insurers
O. UL – Underwriters Laboratory

1.04 DESIGN REQUIREMENTS:

A. This section covers a fire protection system of the [local application] [and] [total flooding] type with low pressure CO_2. [This section covers a [purging] [inerting] system utilizing low pressure CO_2 to suppress or prevent fire.]

B. System to be fixed installation where equipment is designed and installed to provide fire suppression capability for hazards described below. [A complete description of the hazards to be protected must be given along with references to appropriate drawings.] (If hazards are interposing or in close proximity (within 25 ft (7.6 m)) to one another, provision for simultaneous discharge shall be considered.)

C. Total flooding: [Identify fuel, enclosure volume, CO_2 design concentration, abnormal temperatures. Provide dimensions and location of all unclosable openings of the enclosure. If an extended discharge is required, provide a specific duration.]

D. Local Application: [Description of hazard, including dimensions and extent of coverage needed as well as any special conditions must be given. State if the fuel is heated oils/flammable.]

E. Hose reels: [Provide the number of reels required. Provide reel locations within the site.]

F. Design, fabrication and installation of system and its components shall be in compliance with requirements and recommendations of ANSI/NFPA-12.

1.05 PERFORMANCE REQUIREMENTS:

A. Activation:

1. Electric: An alarm condition from any detector, or operation of a manual release station (electric) shall start the predischarge sequence. At this time the control panel shall begin the predischarge timer(s), start all audible and visable alarm devices, shutdown exhaust air handling fans, close all dampers, release door holders, shutdown fuel and power to process equipment, and actuate the building fire alarm system. The predischarge period shall be of sufficient duration for personnel to evacuate the area. The alarm devices shall continue to operate until the control panel is reset.

2. Pneumatic: An pneumatic time delay and pneumatic sirens are required for all total flood hazards that are normally occupied or occupiable. Futher, a pneumatic time delay and pneumatic sirens are required for local application systems which serve normally occupied or occupiable enclosures where the discharge will expose personnel to hazardous concentrations of CO_2. The pneumatic siren(s) shall sound during the evacuation and discharge period. Total flooding CO_2 systems are not permitted to be installed in normally-occupied areas.

3. Mechanical: Each master/selector valve shall be provided with an emergency manual override operator.

B. Interface system with building fire alarm, plant annunciation system. [Describe in detail which alarm and/or trouble signals that are to be monitored.]

C. Tank Supervisory Alarms:

1. System control power failure, refrigeration motor power failure, and refrigeration alarm power failure shall produce a "trouble" alarm and shall be annunciated at the system control panel.

- and/or -

2. A refrigeration "high-low" pressure signal shall be activated by a pressure-operated switch at the storage tank.

1.06 SAFETY REQUIREMENTS:

A. An pneumatic time delay and pneumatic sirens are required for all total flood hazards that are normally occupied or occupiable. Futher, a pneumatic time delay and pneumatic sirens are required for local application systems which serve normally occupied or occupiable enclosures where the discharge will expose personnel to hazardous concentrations of CO_2. The pneumatic siren(s) shall sound during the evacuation and discharge period. Total flooding CO_2 systems are not permitted to be installed in normally-occupied areas.

B. Each hazard [zone] shall have an isolation valve to mechanically lock-out to flow of CO_2 to the hazard discharge nozzles. The isolation valve shall be fitted with a status switch reporting the position to the system control panel.

C. Each hazard [zone] that serves an area where personnel can be exposed to the residual discharge shall be served by an odorizer to scent the discharged CO_2.

D. Each Master/Selector Valve shall be accompanied by an electrical maintenance switch. This will provide a means to electrical isolation the master/selector valve solenoid for maintenance or personnel access to confined spaces.

E. Warning signs, as depicted in the NFPA 12 standard, shall be posted where appropriate for the location. These signs shall have pictoral graphics as required. The text shall be in a language appropriate to site personnel.

F. Pressure switches downstream of all master/selector valves shall report that CO_2 has discharged to that section of the system.

1.07 SUBMITTALS:

A. Submit shop drawings under provision of section [ ].

B. Submit shop drawings indicating detailed layout of system, locating each component. Include control diagrams, wiring diagrams, and written sequence of operation.

C. Submit product data under provisions of section [ ].

D. Submit product data for each piece of equipment comprising the system including storage unit, control valves, control panels, nozzles, manual releases, detectors, alarm bells or horns, and annunciators.

E. For local application and total flood hazards, submit design calculation derived from computer programs developed specifically for low pressure CO_2 flow calculations. Analysis shall include calculation to verify system terminal pressures, nozzle flow rate, orifice code number, piping pressure loses, component flow data, and pipe sizes considering actual and equivalent lengths of pipe and elevation changes.

F. Submit [shop drawings] [product data] and [calculations] to [Authority Having Jurisdiction (AHJ)], [Fire Marshall], [Owner's fire insurance underwriter] for approval. Submit proof of approval to [ ].

G. Submit test reports indicating successful completion of test to [ ].

H. Submit manufacturer's installation instruction under provisions of section [ ].

1.08 OPERATION AND MAINTENANCE DATA:

A. Submit operation and maintenance manuals under provision of section [ ].

B. Include electrical schematic of circuits, written description of system design, drawings illustrating control logic and equipment location, and technical bulletins describing equipment.

C. Provide list of recommended spare parts at completion of project.

1.09 REGULATORY REQUIREMENTS:

A. Conform to applicable ANSI/NFPA-12 for system.

B. Conform to ANSI/NFPA-70 for electrical wiring and wiring devices.

C. Equipment and devices to be FM Approved.

1.10 MAINTENANCE SERVICE TO INCLUDE AS PART OF INITIAL INSTALLATION:

A. Inspect system [six months] [twelve months] after system has been tested and placed into service.

B. At each inspection, determine agent contents and pressure, and that system is in proper working order. Include complete checkout of control, detection, and alarm system. Refer to manufacturer's operation and maintenance manual.

C. Submit documents, certifying satisfactory system conditions. Include manufacturer's certificate of acceptance of qualification of inspector.

1.11 WARRANTY:

Provide 1-year warranty to include coverage for system component failures and provide for replacement for any carbon dioxide lost as a result of equipment failure. This warranty shall be valid for 1 year from the date of the system acceptable, but not more than 18 months after date of shipment of equipment from the manufacturer’s site.

PART 2 – PRODUCTS

2.01 MANUFACTURERS:

In this article, list the manufacturers acceptable for this project:

A. Tyco Fire Protection Products
One Stanton Street
Marinette, Wisconsin 54143 USA
(714) 735-7411

2.02 PIPE AND PIPING SPECIFICATIONS:

A. The following specifications set forth minimum standards for installation. If the requirements of local codes or the Authority Having Jurisdiction (AHJ) are more stringent, these more stringent requirements shall govern the installation:

1. Type of pipe: Piping shall be black or galvanized ASTM grade A53 seamless or electric welded grade A or B or A106 grade A, B, or C.

2. Installation shall be performed in a workmanlike manner according to the highest standards of modern practice.

3. All pipe and fittings shall be new and of recent manufacture.

4. All pipe shall be reamed after cutting so that all burrs and sharp edges are removed.

5. All pipe must be thoroughly cleaned before installation. A wire flue brush should be pulled through the length several times followed by clean cloth rags treated for the purpose. All foreign matter and oil must be removed by this process.

6. All pipe and fittings installed out of doors or in corrosive areas must be galvanized or treated with a proper protective coating.

7. Pipe Dope: All screwed pipe shall be coated with Teflon tape or an approved pipe joint compound. When tape or pipe joint compound is used, coating of the threads must start at least two threads back from the pipe end.

8. Welding:

a. All welding must be performed by a certified welder.

b. All welded pipe 3/4 in. and smaller shall be welded using a gas welding or other approved method.

c. All welds shall be pounded to loosen scale and weld beads and then cleaned of the same.

d. **No backing rings, chill rings are permitted**.

9. Welded Pipe Reductions: Reductions in welded pipe shall be by one of the following devices:

a. Butt weld concentric reducers

b. Swaged nipples

c. Weld o-lets

d. Where socket weld fittings are permitted, see below. A socket weld reducing coupling can be used only for a one-size reduction. All other reductions in socket weld pipe shall be made using the above permitted methods.

When methods b, c, or d are used, it is imperative that these fittings be installed in strict accordance with the manufacturer's installation instructions. In each case they must be installed so as to permit full flow. All entrance holes from the main pipe run to the fitting must be of proper size and free of sharp edges, ridges, or burrs.

10. Threaded Pipe Reductions: Reduction in screwed pipe shall be by means of screwed concentric reducing fittings or swaged nipples. Flush bushings shall not be used. Hex bushings, 3000 lb forged steel may be used for reduction in one pipe size only.

11. Flanges and Unions:

a. No unions over 2 in. size are permitted.

b. All flanges must be 300 lb ANSI class forged steel.

c. All weld neck flanges used with Schedule 80 pipe must have extra heavy pipe wall bore Schedule 80. All weld neck flanges used with Schedule 40 pipe must have standard weight pipe wall bore Schedule 40.

d. Where flanged pipe connections are used, they shall be gasketed with 1/16 in. (0.6 mm) thick compressed type gasket materials.

e. High grade steel bolts grade 8 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 8 or better.

f. All connectors, that is, bolts and nuts shall be torqued to the required number or foot pounds as recommended in the standard piping handbooks. Required torque valves for installation of flanged pressure-operated valves shall be as recommended by ANSUL CO_2 Systems.

12. Pipe Take-Offs: All pipe take offs shall be from the side or bottom of the header. Where a take off involves a reduction of several pipe sizes, a bottom take off should be provided.

B. Tank Header: The tank header is under continuous pressure and therefore it shall be constructed of Schedule 80 black steel pipe with extra heavy welding fittings and ANSI 300 lb class flanges.

1. The tank header can be fabricated using one of the following procedures or by a combination of these procedures:

a. By the use of extra heavy butt welding fittings

b. By the use of extra heavy weld o-lets or thread-o-lets or equivalent

2. All welds must allow full flow. No miter weld fittings shall be used. Backing rings or chill rings shall not be used.

C. Actuation Line:

1. All piping shall be either 1/2 in. threaded steel pipe or stainless steel tubing.

2. When pipe is used, the following applies:

   a. The pipe shall be a minimum of Schedule 40 and where it is installed outdoors or other corrosive environments, galvanized pipe shall be used. (Industrial Risk Insurers requires all piping to be Schedule 40 galvanized or Schedule 80 black.)

   b. All threaded pipe connections shall be treated with a suitable pipe sealant (e.g., Swak by Cajun Part No. MS PTS-50: Rector seal or equivalent is acceptable). The use of Teflon tape on actuation line piping is not allowed.

   c. All pipe fittings shall be 300 lb malleable or ductile iron. A 300 lb steel union shall be installed near the termination of all piping. The use of 150 lb fittings is not allowed.

3. Whenever tubing is used, the following applies:

   a. All steel tubing shall be 1/2 in. X 0.035 in. (0.9 mm) wall and shall be painted to provide corrosion protection. All tubing installed outdoors or in corrosive atmosphere shall be stainless steel 1/2 in. X 0.035 (0.9 mm).

   b. All tubing fittings shall be of the same material as the tubing and shall be of the compression type. All tubing to pipe fittings shall be treated with a pipe sealant as described in 2-b. above.

   c. All tubing shall be properly supported.

4. A filter supplied by CO_2 equipment supplier shall be installed at the actuation line termination into each valve (as shown on design drawings).

5. Whenever a hose reel bleeder valve is used, a 1/4 in. pressure regulator may be installed directly on top of the sub-header piping upstream of the selector valve or bleeder. The location of these regulators shall be as shown on the system design drawings.

6. The actuation line shall be provided with an approved pressure regulator to maintain 100 psi (6.9 bar) pressure on the actuation line.

7. The actuation line shall be provided with an approved two level supervisory switch to provide notification at the control panel when pressure in the actuation line drops to 90 psi (6.2 bar) and 80 psi (5.5 bar) respectively.

D. Master Valve Piping:

1. All piping downstream of master valve between master valve and selector valves or between valve and hose reels shall be either (A) Schedule 40 black steel pipe welded with welded fittings, or (B) Schedule 40 steel pipe with listed grooved type couplings and fittings.

2. When method (A) is used, the following can be used:

   a. Standard weight socket weld fittings are acceptable with exception that no 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.

3. When method (B) is used, the following applies:

a. Where grooved couplings and fittings are used, they shall be listed/approved for use with low pressure carbon dioxide fire suppression systems.

b. Pipe preparation must be in strict accordance with the manufacturer's recommended procedure. Installation must be exactly as per the manufacturing specifications in all aspects.

c. Grooved couplings shall be installed so as to allow contraction of the pipe (pipe ends butted together).

d. Grooved couplings must be approved in advance by the system designer with approval obtained prior to start of design.

E. Discharge Piping: Piping downstream of selector valves, that is, piping which is open to atmosphere, shall be Schedule 40. Screwed pipe joints are always permitted and in most installations, approved grooved pipe connections may be used. Grooved fittings must be approved for use with carbon dioxide. Approval of fittings must be sought prior to the start of installation.

1. Screwed Joints: Threaded pipe fittings shall be class 300 lb malleable iron or ductile iron for pipe through 3 in. 1000 lb ductile iron forged steel shall be used in all larger sizes.

2. Grooved Joints:

a. Where grooved couplings and fittings are used, they shall be listed/approved for use with low pressure carbon dioxide fire suppression 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).

F. Pressure Relief Piping and Fittings: Piping to pressure reliefs shall be as specified above for discharge piping. All takeoffs for pressure relief piping shall be from the top of the discharge piping.

G. Dirt Trap: A dirt trap consisting of a tee with capped nipple shall be installed at the end of each run. The nipple shall be at least 2 in. (51 mm) long. A longer nipple up to approximately 18 in. (457 mm) is preferred where space permits.

Note: Dirt traps for Schedule 40 welded headers are to be formed by welding a Schedule 80 nipple to the end of the line. The Schedule 80 nipple is threaded at the open end for connection of a screwed pipe cap.

H. Underground Piping: Underground piping is to be avoided. If unavoidable, a piping configuration layout for underground piping should be submitted for approval to system designer prior to the start of system design. The following general requirements shall apply to underground piping:

1. Trench depth for underground piping shall be a minimum of 3 ft (0.9 m) or below frost line whichever is deeper.

2. Underground pipe shall be Schedule 80 black steel with welded joints as specified for the type of run involved.

3. A protective, insulate covering will be required of all underground pipe. Approval of system designer is required.

4. Underground piping shall be welded when possible. The only exception would be in a hazardous location where welding is not permitted. In this case, flanged connections shall be used. All underground pipe joints shall be tested for leaks at 300 psi (20.7 bar) before the insulate and protective coating is applied.

I. Pipe Sleeves: All piping through building walls, partitions, floors slabs, roof slabs and the like, shall be sleeved:

1. Sleeves shall be Schedule 40 pipe at least two sizes larger that the pipe being sleeved. 1 in. pipe is the minimum size to be used as a sleeve.

2. Sleeves shall be packed with an approved sealing material so as to be dust tight.

3. Sleeves through floor slabs must extend at least 2 in. (51 mm) above the floor. A greater extension may be used if required by local building codes.

4. Sleeves extending through roof slabs must extend above the roof and be flashed in accordance with local building codes.

J. Expansion Joints:

1. Contraction of steel piping during discharge is based on 1 in. (25 mm) of contraction per 100 ft (30.5 m) of steel pipe.

2. 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 "U" type bends or, in cases where space is limited, an approved manufactured expansion joint.

3. In piping which utilizes grooved type couplings, these couplings shall be installed to permit contraction of the piping.

4. In straight runs using welded or screwed joints, an expansion joint must be installed within approximately 100 ft (30.5 m) of continuous run and each approximate 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.

5. 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.

K. Inspection for Mechanical Integrity:

1. All pipe and fittings that are under constant tank pressure ball shall be bubble tight. Bubble tests shall be made using leak-tec, or approved equal, under full tank pressure.

2. Concealed pipe joints such as those in walls, ceilings, trenches and the like shall be tested at 300 psi (20.7 bar) before the joint is concealed.

3. Pipelines not under constant pressure shall not exhibit any visible or audible leak, but bubble tightness is generally not required.

4. Under no conditions shall water be used to test piping or other CO_2 equipment. Either dry nitrogen or CO_2 shall be used for testing.

L. Painting:

Specify owner's painting requirements.

M. Pipe Hangers and Supports: All pipe hangers and supports shall conform to the provisions outlined in ANSI B31.1, latest edition, except as modified and supplemented by this specification. All pipe must be solidly anchored to structural members where longitudinal or lateral movement is possible:

1. Rigid hangers are required wherever a change in direction or change in elevation in the piping system occurs. On long straight runs as minimum, every other hanger shall be rigid. All hangers shall be fabricated of steel and installed in a workmanlike manner.

2. 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.

3. Hangers and pipe shall be designed to prevent stress from being induced into piping during the temperature change caused by a system discharge.

4. All piping supports shall be fabricated and installed so that they will not be disengaged by the movement of supported pipe.

5. Pipe shall not be hung using one pipeline as a support for another.

6. Piping supports shall be arranged so that no excessive bending stresses are induced into the piping from concentrated loads between supports.

7. The maximum spacing between pipe supports for screwed or welded piping is given in **Table 1** on Page 11. The maximum spacing between pipe supports for systems utilizing the grooved coupling method for system discharge piping is given in **Table 2** on Page 11.

Table 1: Maximum Spacing Between Supports For Screwed or Welding Pipe

Nominal Pipe Size		Maximum Span	
in.	(mm)	ft	(m)
1/4	(6)	5	(1.5)
1/2	(13)	5	(1.5)
3/4	(19)	6	(1.8)
1	(25)	7	(2.1)
1 1/4	(32)	8	(2.4)
1 1/2	(38)	9	(2.7)
2	(51)	10	(3.0)
2 1/2	(64)	11	(3.4)
3	(76)	12	(3.7)
4	(102)	14	(4.3)
5	(127)	16	(4.9)
6	(152)	17	(5.2)
8	(203)	19	(5.8)

Table 2: Maximum Spacing Between Supports For Pipe With Grooved Joints

Nominal Pipe Size		Maximum Span	
in.	(mm)	ft	(m)
3/4	(19)	7	(2.1)
1	(25)	7	(2.1)
1 1/4	(32)	7	(2.1)
2	(51)	7	(2.1)
3	(76)	10	(3.0)
4	(102)	10	(3.0)
5	(127)	12	(3.7)
6	(152)	12	(3.7)
8	(203)	12	(3.7)

2.03 CARBON DIOXIDE SYSTEM COMPONENT REQUIREMENTS:

The components of the carbon dioxide systems shall be provided in accordance with the following requirements:

A. Storage Unit:

1. The storage unit capacity shall be _____ ton (_____ kg) minimum and has been sized for [single] [double] shot protection.

2. The storage tank shall be built to ASME standards, and bear the ASME label.

3. The storage tank is to have a baked white aluminum housing to protect the insulation and should be riveted and sealed at all joints to prevent water damage to the insulation.

4. The storage tank shall be supported by two saddles of heavy steel construction welded and cross braced to the vessel for adequate support.

5. The storage vessel shall be provided with two top lifting lugs.

6. Tank pressure gauge shall be 6 in. (152 mm) dial type with a rated accuracy of 1/2 of 1%.

7. The tank liquid level gauge shall read contents in thousand of pounds of liquid CO_2 at 0 °F (-18 °C). The gauge divisions shall be in two hundred pound increments.

8. (Optional) The liquid level gauge shall be equipped with [one set] [two sets] of electrical contacts which may be used to annunciate a low liquid level in the storage unit.

9. The storage unit shall be equipped with two independent alarm pressure switches for annunciation of high or low tank pressure. These switches shall operate at 315 psi (21.7 bar) and 250 psi (17.2 bar) respectively.

10. The storage unit shall be equipped with the required ASME safety relief. This relief shall be set at 350 psi (24.1 bar).

11. A high pressure bleeder valve set at 330 psi (22.6 bar) shall be included with the storage unit assembly.

12. The refrigeration system shall operate on a power supply of [specify voltage]. A disconnect switch shall be provided by the purchaser for the power service.

B. Valves: All valves shall meet the requirements set forth in the current edition of the NFPA Standard 12, and shall be FM Approved for carbon dioxide extinguishing systems.

1. Tank Shut-Off Valves:

   a. A manually-operated tank shut-off valve shall be provided. Valves are sized 4 in. through 8 in. and shall be equipped with a geared hand wheel operator and carry a 300 lb rating. The flanges mounted on either side of the valve must have inside diameter chamfered 1/4 in. (6 mm) deep 45° angle for the valve clearance.

   b. The tank shut-off valve shall be equipped with a DPDT limit switch to permit remote annunciation if the valve is other than fully opened. The contacts shall be provided on the tank shut-off valve to indicate a fully closed position.

2. Master/Selector Valves:

   a. Valves in sizes 1/2 in. up to and including 2 in. shall be ball type approved for low pressure carbon dioxide service. Valves in sizes 3 in. and larger shall be high-performance butterfly style suitable for low pressure carbon dioxide service.

   b. The master valve and selector valve shall not fail open. The master or selector valve shall not open automatically in the event of any electric or pneumatic failure.

   c. Master and selector valves shall be provided with an integral, adjustable pneumatic time delay.

   d. Master/selector valves shall be provided with spring return pneumatic actuators. An override device shall be mounted on the valve actuator or within the Automatic Time Delay Cabinet for emergency manual operation.

3. Isolation Valves:

   a. Valves in sizes 1/2 in. up to and including 2 in. shall be ball type approved for low pressure carbon dioxide service. Valves in sizes 3 in. and larger shall be high performance butterfly style suitable for low pressure carbon dioxide service.

   b. The isolation valve shall be fitted with an electrical status switch.

   c. The isolation valve shall have device to accommodate a lock.

C. Actuation Line Supervision:

1. Actuation line serving all master/selector valves shall be supervised.

2. Actuation line to be provided with a supervisory pressure switch to provide annunciation at 80 psi (5.5 bar).

3. Actuation line to be provided with a pressure regulator to maintain 100 psi (6.9 bar) on the line.

D. Nozzles:

1. Nozzles shall be supplied in quantities sufficient to properly cover the areas being protected in accordance with NFPA-12.

2. Nozzles shall be permanently marked as to type and orifice.

E. Electrical:

1. The electric service to the storage tank shall be provided with a fused disconnect and sized per the electrical requirements of the tank compressor.

2. CO_2 System Control Panel and electrical devices shall be designed to operate on 24VDC service.

3. All field electrical devices shall be supervised for electrical integrity.

4. All master/selector valve solenoid circuits shall incorporate a maintenance lock-out switch to disable the solenoid during maintanence.

F. Control Panel:

1. Provide an AUTOPULSE control panel located as shown on the drawings to electrically activate the carbon dioxide system. The control panel shall be modular and serve as many zones as required.

2. The control panel shall be FM Approved for fire alarm and releasing service.

3. The control panel shall provide visual indication on the panel face for the following:

   a. Each initiating circuit alarm and circuit trouble.

   b. Each carbon dioxide release circuit alarm and circuit trouble.

   c. Primary power source failure for each zone.

4. Carbon dioxide shall discharge upon single detector [cross zone] [counting zone detector] actuation or a manual release station.

5. Alarm, trouble, and AC power failure output contacts for each zone shall actuate the local alarm and common building fire alarm system.

6. Provide SPDT dry contacts for the following output signals to the building fire alarm panel:

   a. General alarm condition, discharge notification.

   b. General trouble condition, operational problem notification.

   c. Loss of primary power source to the control panel.

   d. Discharge disabled mechanically or electrically.

   e. Storage unit refrigeration unit power failure.

   f. Storage tank "high-low" pressure trouble.

7. The control panel shall have battery backup to support the entire system for 24 hours and then perform an alarm sequence for 10 minutes in the event of a primary power failure. A charger shall be provided to recover the batteries in 48 hours from a fully discharged condition. Standby batteries shall be of the sealed, lead acid, or lead calcium type.

8. The control panel shall be UL Listed, FM Approved, and comply with the requirements as set forth in NFPA 72.

G. Alarm Devices:

1. Electrically-actuated fire alarm horns and strobe lights shall be furnished and installed. Each fire alarm horn strobe shall be actuated and receive operating power from the control panel. Terminals for this purpose shall be provided in the system control cabinet. Each device shall be approved or listed.

2. The contractor shall furnish and install adequate fire alarm horns and strobes to notify plant personnel located in the protected areas. Additionally, horn/strobes shall be provided outside the entrance(s) to the protected area. The output for the audible and visible devices shall be adequate for the conditions encountered.

H. Thermal Detectors: Compact, stainless steel cover, hermetically sealed assembly, rate-of-rise compensating type at temperature seating of _____ °F (_____ °C).

I. _____ Detectors: Specify another type of detection system required.

J. Vaporizer (Optional):

1. Vaporizer shall be of the electric "direct to process" type designed to vaporize liquid CO_2 and superheat CO_2 vapor by means of electrically heated aluminum platens.

2. Vaporizer capacity shall be _____ lb (_____ kg) per hour minimum. Capacity shall be adequate to handle CO_2 vapor flow under maximum use conditions.

3. Operation of vaporizer shall be such that each platen is independently controlled so that if any one platen fails, it will not affect operation of the others.

4. Each unit shall be equipped with an individual platen contractor, individual platen overheat thermostats, electronic gas discharge temperature controller, and electronic low discharge gas temperature shutdown capability.

5. Unit shall be designed for outdoor use in normal weather conditions.

K. Hand Hose Lines:

1. Hose reels: Manual fire fighting shall be provided by means of _____ hose reels with 100 ft (30.5 m) of 1 in. hose, control valve, projection nozzle, and manual on/off station. The hose reels shall be located [describe]. Each station shall be provided with an on/off station and so arranged that when the switch is activated, the pressure-operated control valve in the hose reel header will open. This shall place the hose under carbon dioxide pressure up to the control valve. The play pipe control valve shall enable the operator to control the flow of carbon dioxide discharge. Activation of the off button switch shall cause the main control valve to close.

Note: A bleeder system for the hose reels should be included if the designer determines this will expedite the flow of liquid CO_2 to the hose reels.

2.04 TESTING AND ACCEPTANCE:

Upon completion of installation, the system shall be thoroughly tested for correct operation and function. Test shall include actual operation of all mechanical and electrical equipment and careful inspection of all piping and nozzles. Carbon dioxide shall be discharged into all hazards during the test period. A full CO_2 discharge and concentration test shall be made for typical or similar total flooding hazards, using a carbon dioxide meter to determine the concentration. For hazards involving local application, carbon dioxide discharge tests shall be made to verify operation and nozzle performance.

2.05 MAINTENANCE:

Contractor shall make available an inspection service contract to ensure that services are always available to keep the protection system in full operation.