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1.0 INTRODUCTION

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1.1 DESCRIPTION

This type of system consists of high pressure cylinders containing carbon dioxide (CO_2) agent under pressure, connected to fixed piping and nozzles or hoses. The systems are used for Total Flooding of a volume with carbon dioxide, such as a flammable liquid storage room, or for Local Application, such as on a Work Bench.

Since carbon dioxide is electrically non-conductive, it is frequently used for protection of electrical equipment. Being a gaseous fire extinguishing system makes CO_2 suitable for fires in electrical equipment, electronic equipment, and flammable liquids.

Where the hazard being protected is enclosed in a room, total flooding systems are provided. Where there is no enclosing room for the hazard, local application systems serve best. Since a total flooding system extinguishes fires by smothering within a fixed volume, the volume of the room being protected must be closed at the time of discharge. Any doors or dampers in the room must be self-closing or close automatically in the event of system operation.

1.2 GENERAL AND SAFETY HAZARDS

Carbon Dioxide is present in the atmosphere at an average concentration of about 0.03 percent by volume. It is also a normal end product of human and animal metabolism. Carbon Dioxide influences certain vital functions in a number of important ways, including control of respiration, dilation, and constriction of the vascular system – particularly the cerebrum – and the pH of body fluids. The concentration of carbon dioxide in the air governs the rate at which carbon dioxide is released from the lungs and thus affects the concentration of carbon dioxide in the blood and tissues. An increasing concentration in the air can, therefore, become dangerous due to a reduction in the rate of release of carbon dioxide from the lungs and decreased oxygen intake. Further details of carbon dioxide exposure can be obtained from DHHS (NIOSH) Publication No. 76-194. Personnel safety considerations are covered in Section 4.3. Table A provides information on acute health effects of high concentration of carbon dioxide.

Although carbon dioxide has been a commercial product for years – familiar in its solid form as “dry ice”, used as a refrigerant, or its gaseous form for carbonating beverages – this agent is not without hazards. Carbon dioxide extinguishes fires by creating an oxygen deficiency. For people in this atmosphere, this limitation of oxygen can be lethal. When carbon dioxide discharges, it creates a refrigerating effect, which can condense water vapor in the area, producing a fog, which reduces visibility. In addition, the rush of carbon dioxide through the nozzles creates a shrill noise, which can be frightening. The movement of carbon dioxide through the system under pressure while changing state from a liquid to a gas creates static electricity. For these reasons, pre-discharge alarms are usually required for evacuation of all occupants prior to carbon dioxide discharge.

Carbon dioxide is heavier than air and will settle into low spaces. Once actuated, all the carbon dioxide supply in the containers, which were activated, will be discharged. The system must be recharged after every use.

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Table A – Acute Health Effects of High Concentration of Carbon Dioxide (with Increasing Exposure Levels of Carbon Dioxide)

Concentration of Carbon Dioxide in Air (%)	Time	Effects
2	Several hours	Headache, dyspnea upon mild exertion
3	1 Hour	Dilation of cerebral blood vessels, increased pulmonary ventilation, and increased oxygen delivery to the tissues
4 -5	Within a few minutes	Mild headache, sweating, and and dyspnea at rest
6	1- 2 minutes <16 minutes Several hours	Hearing and visual disturbances Headache and dyspnea Tremors
7-10	Few minutes 1.5 minutes - 1 hour	Unconsciousness or near unconsciousness Headache, increased heart rate, shortness of breath, dizziness, sweating, rapid breathing
10-15	1+ minute	Dizziness, drowsiness, severe muscle twitching, and unconsciousness
17-30	<1 minute	Loss of controlled and purposeful activity, unconsciousness, convulsions, coma, and death

Source: EPA 430-R-00-002, "Carbon Dioxide as a Fire Suppressant: Examining the Risks," February 2000.

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1.3 SYSTEM COMPONENTS

A carbon dioxide high pressure total flooding system, the most common type, consists of fire detectors, manual releases, wiring, conduit, control panel, cylinder, solenoid or electrical control head, discharge control valve, discharge nozzles, extinguishing agent under pressure, and piping.

1.4 HIGH PRESSURE SYSTEMS

High pressure cylinders are designed to withstand the pressure created by the highest expected temperature within the room where they are located. The normal design is for a pressure of 58.6 Bar of 21^{o}C (850 psi at 70^{o}F). These cylinders must be treated with care when handled. If a cylinder or its valve leaks or breaks, the cylinder becomes a projectile, powered by high pressure gas, capable of demolishing masonry walls. Carbon dioxide high pressure cylinders contain carbon dioxide which is liquefied by pressure. If the temperature decreases to 0^{o}C (32^{o}F), the pressure drops to 34.7 Bar (504 psi). For this reason, the contents of the cylinder can be determined only by weighing the cylinders. The empty cylinder weight (tare weight) is stamped onto the cylinder body.

Operation of detectors initiates an alarm condition in the control panel. The control panel sound pre-discharge alarms, operate the building fire alarm system, and do other routines, but must operate the carbon dioxide cylinder solenoid or electrical control head. The solenoid or control head, which sits on top the discharge control valve, upon operation provides a gas escape route through the valve to the atmosphere. The escape of gas creates an imbalance of pressure in the discharge control valve. This causes the carbon dioxide gas in the cylinder to raise a piston in the valve, which uncovers the discharge port to release the gas through the discharge hose, manifold, distribution piping and final discharge at the nozzle to the atmosphere.

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2.0 DESIGN

2.1 Total Flooding System

C02 total flooding systems are based on creating an extinguishing concentration of C02 within an enclosed space containing the combustible materials, the quantity of C02 is determined by applying an appropriate factor to the volume being protected.

The efficiency of a total flooding system depends upon maintaining the concentration for as long as possible, so before total flooding can be considered as a method of extinguishing, the protected space must be reasonably well enclosed.

A fixed supply of C02 is permanently connected to fixed piping and discharge nozzles are arranged to discharge C02 into the protected space.

2.1.1 Examples of Hazards

Rooms, vaults, enclosed machines, ovens dust collectors, floor and ceiling voids and fume extraction ducts.

2.1.2 Types of Fires

Fires that can be extinguished by total flooding methods shall be divided into the following two categories:

(a) Surface fires involving flammable liquids and gases, and solids.
Surface fires are subject to prompt extinguishment when carbon dioxide is quickly introduced into the enclosure in a quantity to overcome leakage and provide an extinguishing concentration for the particular materials involved.

(b) Deep seated fires involving solids subject to smoldering.
For deep seated fires, the required extinguishing concentration shall be maintained for a period of time to allow the smoldering to be extinguished and the material to cool to point at which re-ignition will not occur when the inert atmosphere is dissipated.

2.1.3 Where C02 is NOT Effective

(a) Materials that contain their own oxygen supply and liberate oxygen when burning, e.g. cellulose nitrate.

(b) Reactive metals e.g. sodium potassium, magnesium, titanium, zirconium, uranium and plutonium.

(c) Metal hydrides.

While C02 may not extinguish these fires, it will not react dangerously or increase the burning rate. C02 will protect adjacent, combustibles and will also extinguish fires of other materials in which the reactive metals are often stored.

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Example:

(a) Sodium stored or used under kerosene.
(b) Cellulose nitrate in a solvent.
(c) Magnesium chips covered with heavy oil.

2.2 C02 Requirement for Surface Fires

2.2.1 Volume Factor

The volume factor used to determine the basic quantity of carbon to protect an enclosure containing a material requiring a design concentration of 34% shall be in accordance with table 1.

The volume to be used is the gross volume of the enclosure but you are permitted to deduct permanent, impermeable elements of the building structure i.e. beams, stanchions, solid stairways and foundations.

Table 1 – Flooding Factors

Volume of Space M3	Volume Factor Kg C02/m3	Calculated Minimum Kg
Up to 3.96	1.15	-
3.97 – 14.15	1.07	4.5
14.16 – 45.28	1.01	15.1
45.29 – 127.35	0.90	45.4
127.36 – 1415.0	0.80	113.5
Over 1415.0	0.77	1135.0

Volume Factors above, must ONLY be used for SURFACE FIRES

Example: Room: 6m x 9m x 3m = 162m3
162m3 x 0.80 kg/m3 = 129.6kg

2.2.2 Flammable Materials

The design concentration shall be determined by adding the factor (20 percent) to the minimum effective concentration. In no case shall a concentration less than 34 percent be used. Table 2 shall be used to determine the minimum carbon dioxide concentration for the liquids and gases shown in the table.

For material not given in table 2, the minimum theoretical carbon dioxide concentration shall be obtained from some recognized source or determined be test.

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2.3 Interconnected Volumes

In two or more interconnected volumes where free flow of C02 can occur, the C02 quantity shall be the sum of the quantities calculated for each volume, using its respective volume factor from Table 1. If one volume requires greater than normal concentration, the higher concentration shall be used for all interconnected volumes.

2.3.1 Special Conditions

Additional quantities of carbon dioxide shall be provided to compensate for any special condition that can adversely affect the extinguishing efficiency.

2.4 Openings That Cannot Be Closed

Any openings that cannot be closed at the time of extinguishment shall be compensated for by the additional of a quantity of carbon dioxide equal to the anticipated loss at the design concentration during a 1 minute period or arranged to close automatically before or simultaneously with the start of the C02 discharge. This can be done by self-closing door devices, fire curtains or steel shutters.

2.4.1 Limitations of Openings That Cannot Be Closed

The maximum area permitted is the smaller result of the following calculations:

(a) An area in square metres which is numerically equivalent to 10% of the volume in cubic metres.

(b) 10% of the total area of all sides, top and bottom in square metres.

When these openings exceed this limitation, the system should be designed by a local application method.

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Table 2 - Minimum Carbon Dioxide Concentration for Extinguishment

Material	Theoretical Minimum CO2 Concentration (%)	Minimum Design CO2 Concentration (%)
Acetylene	55	66
Acetone	27*	34
Aviation gas grades 115/145	30	36
Benzol, benzene	31	37
Butadiene	34	41
Butane	28	34
Butane-I	31	37
Carbon disulfide	60	72
Carbon monoxide	53	64
Coal or natural gas	31*	37
Cyclopropane	31	37
Diethyl ether	33	40
Dimethyl ether	33	40
Dowtherm	38*	46
Ethane	33	40
Ethyl alcohol	36	43
Ethyl ether	38*	46
Ethylene	41	49
Ethylene dichloride	21	34
Ethylene oxide	44	53
Gasoline	28	34
Hexane	29	35
Higher paraffin Hydrocarbons Cn H2m + 2m – 5	28	34
Hydrogen	62	75
Hydrogen sulfide	30	36
Isobutane	30*	36
Isobutylene	26	34
Isobutyl formate	26	34
JP-4	30	36
Kerosene	28	34
Methane	25	34
Methyl acetate	29	35
Methyl alcohol	33	40
Methyl butane-I	30	36
Methyl ethyl ketone	33	40
Methyl formate	32	39
Pentane	29	35
Propane	30	36
Propylene	30	36
Quench, lube oils	28	34

Note: The theoretical minimum extinguishing concentration in air for the materials in the table were obtained from a compilation of Bureau of Mines, Bulletins 503 and 627, *Limits of Flammability of Gases and Vapors.*

- Calculated from accepted residual oxygen values.

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Table 3 – Flooding Factors for Specific Hazards

Design Concentration (%)	m^3 / kg CO_2	kg CO_2 / m^3	Specific Hazards
50	0.62	1.60	Dry electrical hazards in general (spaces less than 56.6m³)
50	0.75	1.33	Dry electrical hazards in general (spaces greater than 56.6m³)
65	0.50	2.00	Record (bulk paper) storage, ducts, Covered trenches
75	0.38	2.66	Fur storage vaults, dust collectors

2.5 Carbon Dioxide Requirements for Deep Seated Fires

Basic Quantity

After the design concentration is reached, the concentration shall be maintained for a substantial period of time, but not less than 20 minutes. Any possible leakage shall be given special consideration because no allowance is included in the basic flooding factors.

The design concentration listed in table 2 shall be achieved for the hazards listed. Flooding factors for others deep-seated fires shall be justified to the satisfaction of the authority having jurisdiction before use.

Multiply the volume to be protected (cubic metres) by the flooding factor given in table 3 or 4.

Example: Paper documents storage room: Design Concentration: 65%
6m x 6m x 3m high = $108m^3$
$108m^3$ x $2kg/m^3$ C02 = 216kg

2.5.1 Openings

Total flooding systems protecting solid materials cannot tolerate the degree of openings permitted for surface fire protections.

The design concentration must be maintainable over a long period, so low level openings are not practicable. Small openings at or near the ceiling are ideal because:

(a) Compensation for losses involves only reasonable quantities of additional C02.
(b) They allow the escape of hot gases
(c) They prevent pressure increases that can stress the enclosure structure.

Any openings that cannot be closed shall be compensated for by the addition of C02 equal in volume to the expected loss during the extinguishing and holding time.

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2.5.2 Forced Ventilation

When forced air ventilation systems are used, they shall, if possible, be shutdown before, or simultaneously, with the start of the C02 discharge. If this cannot be done, additional C02 must be applied.
If there is a short run down time but the quantity of air removed is significant, additional C02 must be applied, the additional C02 must be discharged within the time specified for the required design concentration.
For calculation purposes the volume of air removed in one minute will be replaced with C02 at the design concentration being used.

Example: Assume the room has $30m^3$ of air removed by the ventilation system in one minutes.

$30m^3$ x $2kg/m^3$ = 60kg + 216kg (original) = 276 kg

Services such as heating, fuel supplies, paint spraying, conveyors etc. must also be shutdown before or simultaneously, with the C02 discharge.

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Table 4 – Flooding Factors applicable for Deep Seated Fires Only.

Hazard	Design Concentration (%)	Flooding Factors (kg/m³)
Electrical equipment Enclosed rotating equipment Dry electrical wiring Electrical insulating materials	50	1.35
Computer Installations Central processing areas and Equipment	53	1.50
Data processing Tape controlled machinery	68	2.25
Stores Record stores and archives off Paper documents	65	2.00
Fur storage vaults Dust collectors	75	2.70
General Cocoa Leather Silk Wool	63	1.78
Coffee Cork Cotton Peanuts Rubber Soybean	75	2.70

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2.6 Distribution System

General

The distribution system for applying carbon dioxide to enclosed hazards shall be designed with due consideration for the material involved and the nature of the enclosure, because these items can require various discharge times and rates of application.

2.6.1 Rates of Application

Where advancement of flame is potentially rapid, as in surface fires, the C02 discharge must be comparably fast to minimise damage. For surface fires the design concentration shall be achieve within 1 minute.

Where the spread of fire is potentially slow, such as deep seated fires in solid materials, more emphasis is placed on maintaining a fire suppression concentration for a lengthy period of time to allow time for cooling. The design concentration shall be achieved within 7 minutes, but the rate shall be not less than that required to develop a concentration of 30% in 2 minutes.

Where the spread of fire may be faster than normal for the type of fire expected, or where high values, or vital machinery or equipment are involved, rate higher than the stated minimums may be used.

Where a hazard contains materials that will produce both the surface and deep seated fires, the rate of application should be at least the minimum required for surface fires.

2.6.2 Nozzle Distribution

Horns should space approximately 6m apart.

For rooms up to 5m high, install horns at a height of 2.5m and angle of 45^o . Average throws approximately 4m.

For rooms between 5 and 10m high, install at 1/3 height up from floor.

For rooms with high stacking or rooms over 10m high, it may be necessary to install at 1/3 and 2/3 levels.

2.6.3 Pipe Selection

For the selection of the various grades of pipe and fittings in order to meet the duties imposed by operating pressures and temperatures, please refer to Section 3.2 Distribution Piping and Fittings.

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2.6.4 Pipe Size Estimates

Hydraulic pipe size calculations are accurately determined by using the SRI Fire Protection C02 Computer Calculation Program. However, for estimating for a quotation, only a reasonably accurate result is needed and this can be achieved by using the table below,

Table 5 - Pipe Size Estimates	
Flow Rate (kg/min)	Estimates Pipe Size Nominal bore (mm)
Up to 123	20
123 to 177	25
178 to 363	32
364 to 545	40
546 to 1045	50
1045 to 1363	65

2.6.5 Storage Cylinders Location

It is important to get a commitment from the prospective client about the location of storage containers because this will affect the installation of pipe, detection lines and cabling, and remote pull controls.

Storage containers should be located as near as possible to the hazard they protect, but should not be exposed to the fire in a manner that is likely to impair performance. They should not be exposed to weather conditions or put in a location where they can be subjected to chemical or other damage. Suitable guards or enclosures should be provided when necessary.

The general ambient storage temperatures should not exceed the following:

(a) For total flooding systems:
Not greater than 46°C or less than –18°C

(b) For local application systems:
Not greater than 46°C or less than 0°C

NOTE: The minimum storage temperature for local application is higher than that allowed for total flooding systems because the discharge area limit tests were carried out at a minimum temperature of 0°C and to operate at lower temperatures would cause the figures in Table 5 to be incorrectly applied.

2.6.6 Distribution Valves

When the multiple hazards are located reasonable close together they can be protected with a single bank of containers with the C02 being directed to the hazard on fire by opening the appropriate distribution valve on a distribution valve manifold.

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When using this method it is important to consider the list below:

(a) The amount of C02 is sufficient for the largest hazard.

(b) There is only one supply of agent so it must not be possible for fire to spread from one zone to another.

(c) Any number of zones can be protected by a single bank of containers but Insurers' rules generally limit the number to 5 zones.

(d) A reserve supply of C02 should be considered.

2.6.7 Alarms

System condition indicators should be provided as appropriate to the surroundings.

(a) A total flooding systems should have indicators located outside the entrance doors to show:

C02 Discharged – red lamp
System in Normal – green lamp

These indications may not always be necessary for local application system.

(b) Additional alarms may be needed to be transmitted to remote locations including a Central Station, and other system conditions may be required such as:

Fire – red flashing lamp
System Operated – red steady lamp
Supply Healthy – green lamp

Warning labels are required to be located alongside manual release points, and located on all entrance doors.

Operating and Maintenance manuals should always be provided.

Audible alarms should be provided as appropriate to the type of system and protected area.

2.6.8 Detection

Automatic detection systems used with C02 extinguishing systems should comply with appropriate codes of practice - eg. (NFPA 72 – National Fire Alarm Code)

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3.0 INSTALLATION

3.1 GENERAL

This Chapter provides installation instructions covering the main components. Before installing, refer to the bill of material on the System Layout Drawing to ensure all required system components are available.

All SRI C02 System equipment must be installed to facilitate proper inspection, testing, manual operation, recharging and any other required maintenance as may be necessary. Equipment must not be subject to severe weather conditions or mechanical, chemical or other damage which could render the equipment inoperative. Equipment must be installed in accordance with NFPA 12 and the Authority Having Jurisdiction.

3.2 DISTRIBUTION PIPING AND FITTINGS

3.2.1 Piping – General

Refer to the system drawings for location and layout of the Agent Distribution Piping System. Examine the configuration to ensure the piping and nozzles do not interfere with objects in the hazard area. Also, confirm that the discharge pattern from the nozzles will not be obstructed by objects in the hazard area. Should conflicts occur, make changes before proceeding with installation.

3.2.2 Pipe

I) All the pipe work sizes shown in the schematic of the installation have been determined using a computer programme. It is IMPORTANT that these sizes are used to ensure the correct flow of C02 within the stated discharge time.

ii) The pipe and fittings materials must conform to the requirements of as shown in the following tables.

Table 6 - Open Ended Pipe work

Up to & incl. 40mm	API 5L	B	Schedule 40
	ASTM A106-77	A or B	
Over 40mm up to & incl. 50mm	ASTM A106-77	A or B	Schedule 80
	API 5L	B	

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iii) The pipe works MUST BE FIRMLY SUPPORTED because, in the event of a fire, the discharge will impose a force on the pipe work. If the piping became dislodged, considerable damage could be caused and the extinguishing system may not function correctly. Allowance must be made for expansion and contraction of the pipe work. See Table 10 for the minimum recommended pipe support spacing.

Table 7 – Hanger Spacing

Pipe size (mm)	15	20	25	32	40	50	80	100	150
Max Spacing (m)	1.5	1.8	2.1	2.4	2.7	3.4	3.7	4.3	5.2

iv) Electrical Clearances

Where exposed electrical conductors are present, clearance no smaller than those given in Table 7 shall be provided where practicable, between the electrical conductors and all parts of the C02 System that may be approached during maintenance, where these clearance distances cannot be achieved, warning notices shall be provided and a safe system of maintenance work shall be adopted.

Minimum clearance from any point on or about the permanent equipment where a man may be required to stand (measured from position of the feet).

Table 8 - Safety Clearance of Pipe work

To the nearest unscreened live conductor in air (section clearance) Metres	2.59	2.59	2.74	2.74	2.89	3.05	3.20	3.35	3.50	3.81	4.27	4.57
To the nearest part not at earth potential of an insulator supporting a live conductor (ground clearance) Metres	2.44											
Max rated Voltage (XY)	11	15	22	33	44	66	88	110	132	165	220	275

The terms insulator includes all forms of insulating supports, such as pedestal and suspension insulators, bushings, cable sealing ends and the insulating supports of certain types of circuit breakers etc.

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Table 9 – Equivalent Length of Treaded Pipe Fitting

Pipie Size (mm)	90º Elbow (m)	45º Elbow (m)	Long Bend & Thru Tee (m)	Side Tee (m)	Union (m)
10	0.18	0.4	0.24	0.82	0.09
15	0.24	0.52	0.3	1.04	0.12
20	0.3	0.67	0.42	1.37	0.15
25	0.4	0.85	0.55	1..74	0.18
32	0.52	1.13	0.7	2.29	0.24
40	0.61	1.31	0.82	2.65	0.27
50	0.79	1.67	1.06	3.41	0.37
65	0.95	2.01	1.25	4.08	0.43
80	1.16	2.5	1.55	5.06	0.55
100	1.52	3.26	2.01	6.64	0.73
125	1.92	4.08	2.56	8.35	0.91
150	2.32	4.94	3.08	10	1.07

Table 10 – Equivalent Length of Welded Pipe Fitting

Pipe Size (mm)	90º Elbow (m)	45º Elbow (m)	Long Bend & Thru Tee (m)	Side Tee (m)	Union (m)
10	0.06	0.21	0.15	0.49	0.09
15	0.09	0.24	0.21	0.64	0.12
20	0.12	0.33	0.27	0.85	0.15
25	0.15	0.43	0.33	1.07	0.18
32	0.21	0.55	0.46	1.4	0.24
40	0.24	0.64	0.52	1.65	0.27
50	0.3	0.85	0.67	2.1	0.37
65	0.36	1	0.82	2.5	0.43
80	1.16	1.25	1	3.1	0.55
100	0.61	1.65	1.34	4.08	0.73
125	0.76	2.04	1.67	5.12	0.91
150	0.91	2.47	2.01	6.16	1.07

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3.2.3 Pipe Joining

The method of joining all pipes must be in accordance with the latest requirements listed in NFPA 12. Acceptable fittings include screwed, flanges, welded, brazed, flared and compression. Each fitting must be 300 lb. Class. Ordinary cast iron fittings are not acceptable.

3.2.4 Cleaning

All pipe lengths must be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oil before assembly.

3.2.5 Threads

It is recommended that only Teflon tape be used and must be only applied to male pipe threads. Threads on all pipe and fittings must be tapered threads conforming to ANSI Specification B-20.1.

3.2.6 Installation

All piping must be installed in accordance with good engineering practice. The piping system shall be securely supported by hangers or piping bracket with allowance for expansion and contraction. Refer to ANSI B-31.1 for bracing requirements.

Class 150 and cast iron fittings must not be used. Fittings used must be a minimum 300 lb. Class conforming to ASTM A-197 and have a minimum working pressure of 42 bar (620 PSI). Pressure temperature ratings of the fitting manufacturer must not be exceeded. Teflon tape must be applied on male threads only for screwed fittings. See NFPA 12 for further details. All threaded joints must be in accordance with ANSI B-20.1.

3.3 DISCHARGE NOZZLE

After the system piping has been blown free of debris, install the discharge nozzles in strict accordance with the system drawings. Orientate the nozzles as shown on drawings. Make certain that the correct nozzle type(s), and orifice size(s) are installed in the proper location(s).

3.4 PILOT (LOOP) HOSE (PRESSURE ACTUATION LINES)

Flexible Pilot (Loop) Hose must be ¼”

3.5 FLEXIBLE DISCHARGE HOSE C/W CHECK VALVE

WARNING: ALWAYS CONNECT FLEXIBLE DISCHARGE HOSE INTO SYSTEM PIPING BEFORE CONNECTING TO SRI CYLINDER

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The discharge hose is a heavy duty flexible hose which connects the valve discharge outlet to the manifold. There is a check valve attached to the discharge hose which connects to the manifold.

NOTES: **The discharge hose must have a smooth bend radius in flexible loop.**

3.6 C02 CYLINDER

The cylinders should be located as close to the protected hazard area as possible. The assemblies shall be located in a readily accessible location to allow for manual actuation and ease of inspection, service and maintenance.

The cylinders shall be located in an environment protected from the weather and where the ambient temperature does not exceed 54°C (130°F) nor fall below 0°C (32°F). External heating or cooling may be required to maintain this temperature range. Cylinders must be located and mounted where they will not be subject to accidental damage or movement. Suitable protection to prevent accidental cylinder damage or movement must be installed when necessary to prevent accidental discharge, bodily injury or property damage.

Position cylinders in designated location and secure in place with cylinder bracket and attaching hardware. Orientate cylinders to that valve outlet is angled towards discharge piping.

Connect flexible discharge hose to cylinder outlet port. Repeat for each cylinder in system.

Connect Copper tubing or pilot hose between the pilot cylinder or the Master Cylinder and the first slave cylinder, pneumatic actuation port. Repeat for the other slave cylinders.

Each cylinder bracket must be securely anchored to structural supports to absorb the force generated by cylinder discharge.

3.7 LEVER OPERATED CONTROL HEAD

The lever to be installed on every cylinder on the valve.

Ensure safety seal wire intact before testing and commissioning. This is to prevent any accidental discharge by pulling the lever.

3.8 PILOT CYLINDER AND MOUNTING BRACKET

Locate pilot cylinder mounting bracket in area where cylinder will be protected from inclement weather by a suitable total or partial enclosure, preferably adjacent to cylinders.

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Locate pilot cylinder mounting bracket in area where cylinder will be protected from inclement weather by a suitable total or partial enclosure, preferably adjacent to cylinders.

Install pilot cylinder in position onto mounting bracket, tighten sufficiently to hold cylinder in place while allowing cylinder enough free space to be manually rotated.

Manually rotate cylinder until cylinder valve discharge outlet is in desired position.

CAUTION: ***Pilot cylinder must be positioned so that actuation device, when installed, is readily accessible and cannot be obstructed during manual operation.***

Securely tighten mounting bracket clamps and hardware.

3.9 PRESSURE SWITCH

WARNING: ***Warn text to prevent personnel injury, de-energise all electrical components prior to pressure switch installation.***

Pressure switches must be connected to the piping in an upright position as shown on the technical drawings. The standard switches have pressure inlets to connect to the system piping. The electrical connections are either conduit knockouts for the standard pressure switch.

3.10 MANUAL PULL STATION

Locate the remote pull boxes as shown on the technical drawings.

Connect pull boxes to the pilot cylinder or master cylinder using 3/8 inch schedule 40 pipe or approved conduit. Do not run more than one cable in each pipe run.

Install a corner pulley at each change in pipe direction. Do not bend the pipe.

Beginning at the pull boxes, remove the covers of the first corner pulley. Feed the cable through the pulley into the 3/8 inch pipe. Connect one end of the cable to the cable fastener and cable into handle. Route the other end to the pilot cylinder or master cylinder, taking up as much slack as possible. Attach the end of the cable to the lever of the valve at appropriate angle to ensure the lever can be pull down without difficulty.

Reattach the corner pulley covers.

3.11 POST INSTALLATION CHECK-OUT

After the C02 system installation has been completed, perform the following inspection and tests.

Verify that cylinders are installed in accordance with installation drawings.

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Verify that cylinder brackets and U-Bolts are properly installed and all fittings are secured.

The piping distribution system must be inspected for compliance with the system drawings, NFPA 12 and design limitations within this manual.

Check that discharge piping and actuation piping are securely hung. Ensure all fittings are tight and securely fastened to prevent gas leakage and hazardous movement during discharge. Means of pipe size reduction and installation position of tees must be checked for conformance to the design requirements.

The piping distribution system must be cleaned, blown free of foreign material and inspected internally to prevent the possibility of any oil or particulate matter that may soil the hazard area or affect the agent distribution due to a reduction in the effective nozzle orifice area.

The system piping should be pressure tested in accordance with the requirements of NFPA 12 and the Authority Having Jurisdiction.

Verify nozzles are installed in the correct location as indicated on installation drawings. Discharge nozzle must be oriented such that optimum gas dispersal can be achieved. Check nozzle orifices for obstructions.

The discharge nozzles, piping and mounting brackets must be installed such that they will not cause potential injury to personnel. Gas must not be discharged at head height or below, where personnel in the normal work area would be injured by the gas discharge. Gas just not directly impinges on any loose objects or shelves, cabinet tops or similar surfaces where loose objects could be propelled upon agent discharge.

Manual pull stations must be properly installed, readily accessible, and accurately identified. All manual stations used to activate SRI C02 systems should be properly identified as to their purpose. Particular care should be taken where manual pull stations for more than one system are in close proximity and could be confused or the wrong system actuated. In this case, manual stations should be clearly identified as to which hazard area they affect.

All acceptance testing shall be in accordance with NFPA 12 current edition.

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4.0 COMMISSIONING

This section described the commissioning procedure.

Before commencement of commissioning tests visually check the following:-

1. Check that the installation conforms to the engineering drawings. Any deviations from drawings must be reported.

2. All work, e.g. electrical wiring, carried out by other contractors has been completed satisfactorily.

3. Check the protected area for confinement of the extinguishing agent, i.e. that no passage is allowed to other spaces through floor or ceiling voids, ductwork, holes in partitions or vents, unless allowance has been made.

4. Check that all manual controls are accessible and correctly identified.

5. Check that the discharge nozzles are unobstructed and are adequately secured. Check that the nozzles comply with sizes shown on the drawings.

6. Check that the C02 cylinder and valve manifolds are correctly sized, and that check valves and Directional valves are installed for correct directional flow.

7. Check the manifold to cylinder installation for undue strain on connecting loops because incorrect installation can cause service problems.

8. Check the cylinders are installed in an accessible location, that the area is clean, dry and ventilated and meets the safe temperature requirements.

9. Check that all system controls, such as valves, lock off, pull boxes, manually or electrically operated devices, and are accessible to operating personnel. If located outdoors ensure that they conform to the required standards and that adequate shelter has been provided.

10. Check that pipes and fittings are sized in accordance with the drawings and are adequately secured. All piping must be rigidly secured to the nozzle to prevent damage from recoil.

11. Check that all warning labels and notices give correct information for system operation and that they are suitably located.

12. Check weigh of cylinders to ensure net content is in accordance with the requirements.

13. Check all discharge hose are screw and secure tight at both ends.

14. Check all copper tubing for pneumatic actuation is secure and screw tight at both ends.

15. Check that manual lever on the valve is available and is in standby position.

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16. Discharge test should be recommended when there is any question about the adequacy of the system.

WARNING: ***Do not proceed with any functional tests until every precaution has been taken to prevent accidental discharge, ensure that all personnel in protected areas know that you are there and of the work you are doing.***

Instruction for Re-commissioning the system after discharge

1. Refit the cylinder transport caps. Remove the empty C02 cylinders.

2. Replace with fully charged cylinder and secure.

3. Send back empty cylinder to SRI for refilling.

4. If distribution valves are fitted check that they are shut.

5. Check nozzles' orifices for debris, clean if necessary.

6. Re-set all system ancillaries, including pressure switches, pressure trips, dampers, curtains, door or window shutters, ventilators, remote lock-off services and pull boxes.

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5.0 OPERATION

5.1 GENERAL

Pressurized C02 gas is retained in the cylinder by a discharge valve. When the discharge valve is actuated by a solenoid or electric control head, the C02 gas discharges through the valve outlet and is directed through the distribution piping to the nozzles. The nozzles provide the proper flow rate and distribution of C02 gas.

5.2 OPERATING PROCEDURES

5.2.1 Automatic Operation

When a system is operated automatically via the 2 zone detection and control system, personnel must evacuate the hazard area promptly upon hearing the alarm. Make sure no one enters the hazard area. Call the fire brigade immediately.

5.2.2 Manual Pull Station or Remote Manual Operation

Operate as follows:-

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

NOTE: These instructions must be posted on display in the protected area.

5.2.3 Local Manual Operation

Operate as follows:-

CAUTION: This manual control is not part of the normal system actuation and should only be used in a last resort, emergency condition.

1. Proceed to the appropriate Master cylinder(s) or pilot cylinder (if used) for the hazard.
2. Operate the lever by pull it downward.
3. Leave the hazard area quickly.
4. Allow no one to enter the hazard area. Call the fire brigade immediately.

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5.3 POST FIRE OPERATION

WARNING: ***Do not enter a hazard area with an open flame or lighted cigarette. The possible presence of flammable vapours may cause re-ignition or explosion.***

WARNING: ***Ensure fire is completely extinguished before ventilating area. Before permitting anyone to enter the hazard area, ventilate area thoroughly or use self-contained breathing apparatus.***

5.4 CYLINDER RECHARGE

5.4.1 Recharge all C02 and pilot cylinders immediately after use.

5.4.2 Return all cylinders to SRI for refilling.

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6.0 MAINTENANCE

This part of the manual describes procedures which enable a proficient Service Engineer to undertake the regular inspection and testing of a C02 safely in accordance with the recommendation of NFPA 12.

Before going to site the Service Engineer should obtain the relevant details and drawings of the systems to be serviced and refer to report of previous service visits and of fault call-outs since the last service.

The Engineer's signature on the Service Report and on the record card after carrying out the work, is confirmation that the system, on that day is in complete operational order. It is an advantage to have a witness to this fact, and he should therefore encourage the Customer's representative to accompany him while he does the work.

The first action to take, when arriving at site, is to report to the customer's representative and to ask if there any specific instructions with which to comply.

Ask if any particular problems have arisen since the last service visit.

Ask if any fires have occurred and how the system performed.

Similarly, record any false or accidental operation and get reason.

If it is necessary to take some action which may cause inconvenience to the Customer, ask his permission first.

Notify all concerned that the fire protection system being maintained and may be inoperative.

Work systematically and in a clean, tidy and professional manner.

Consider the possibility of genuine fire alarm occurring while you are working on the system and make appropriate arrangements.

Prepare a service report. Submit a copy to the client, one to the Service Manager and retain a copy.

Service visits should be on a six-monthly (minimum) basis.

Typical maintenance records are provided in this manual.

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TECHNICAL DATA
AND
DRAWINGS

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