

Approval Standard

For

Carbon Dioxide Extinguishing Systems

Class Number 5420

April 2007

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Foreword

Approvals are intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for Approval shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing and/or applications shall ensure a consistently uniform and reliable product or service. Approval Standards strive to be performance-oriented and to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and Listing depends on compliance with the Master Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on periodic follow-up audits of the manufacturing facility or service/application.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard describes requirements for fixed fire extinguishing systems which use carbon dioxide (CO₂) as the extinguishant.
- 1.1.2 FM Approvals criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facilities, audit of quality assurance procedures, and a follow-up program.

1.2 Scope

- 1.2.1 CO₂ systems are classed in two general categories according to hazard coverage design, total flooding or local application. Either type shall be designed for automatic and manual control to protect single or multiple hazard areas.
- 1.2.2 A basic CO₂ extinguishing system comprises one or more agent supply containers; discharge control valves arranged for automatic (or both automatic and manual) control; lock-out valves; piping; and discharge nozzles. Compatible FM Approved detectors and detection and release controls are required for automatic operation of these systems, but are not included in the scope of this standard.
- 1.2.3 This standard requires the examination of complete systems. Complete systems shall be submitted along with design, installation, operation, and maintenance instructions for Approval. However, the manufacturer may, at any time, submit additional separate component parts or auxiliary equipment for use on his system. Purchased devices such as thermostats, releases, and timers must also be submitted by the system manufacturer for evaluation as a part of his system, even though such devices may already be Approved and listed by FM Approvals. At minimum, a system shall consist of those component parts and auxiliary equipment considered necessary by FM Approvals for the system to operate satisfactorily. Incomplete systems shall not be Approved.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists has also been considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of CO₂ fire extinguishing systems (hereinafter referred to as "systems") for the purpose of obtaining Approval. Systems having characteristics not anticipated by this standard may be Approved if performance equal, or superior, to that required by this standard is demonstrated, or if the intent of the standard is met.

Alternatively, systems which meet all of the requirements identified in this standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

1.4 Basis for Approval

Approval is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

1.4.1 Examination and tests on production samples shall be performed to evaluate:

- The suitability of the product
- The performance of the product as specified by the manufacturer and required by FM Approvals; and as far as practical,
- The durability and reliability of the product.

1.4.2 An examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to produce the product which was examined and tested, and the marking procedures used to identify the product. These examinations are repeated as part of FM's Approved Product Follow-Up Program.

1.5 Basis for Continued Approval

Continued Approval is based upon:

- Production or availability of the product as currently Approved;
- The continued use of acceptable quality assurance procedures;
- Satisfactory field experience;
- Compliance with the terms stipulated in the Master Agreement;
- Satisfactory re-examination of production samples for continued conformity to requirements;
- Satisfactory Facilities and Procedures Audits (F&PAs) conducted as part of FM's Approved product follow-up program.

Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior authorization by FM Approvals.

1.6 Effective Date

The effective date of an Approval standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that standard. Products Approved under a previous edition shall comply with the new version by the effective date or forfeit Approval.

The effective date of this standard is **January 2, 2008** for full compliance with all requirements.

1.7 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with the Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing and Materials (ASTM) SI 10-2002, *"American National Standard for Use of the International System of Units (SI): The Modern Metric System."* Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are used in this standard.

2 FM APPROVALS

1.8 Applicable Documents

This standard is used in conjunction with the following standards, test methods, and practices as referenced in this standard:

ASTM B 117 - 05, *Standard Practice for Operating Salt Spray (Fog) Apparatus*
Comité Européen des Assurances (CEA) 4007: 1997-08 (en), *Fire Protection Systems - Specifications for CO₂ Systems - Planning and Installation*
CEA 4009: 1997-07 (en), *Fire Protection Systems - Specifications for fire fighting systems using a gaseous extinguishant - Requirements and test methods for selector valves and their actuators*
CEA 4010: 2000-02 (en), *Fire Protection Systems - Specifications for CO₂ Fire Fighting Systems: Requirements and test methods for nozzles*
CEA 4001: 2003 - May (en), *Sprinkler Systems, Planning and Installation*
CEA 4012: 1997-07 (en), *Fire Protection Systems - Specifications for fire fighting systems using a gaseous extinguishant - Requirements and test methods for check and non-return devices*
CEA 4013: 1997-07 (en), *Fire Protection Systems - Specifications for fire fighting systems using a gaseous extinguishant - Requirements and test methods for hoses and container connection pipes*
CEA 4014: 1997-07 (en), *Fire Protection Systems - Specifications for fire fighting systems using a gaseous extinguishant - Requirements and test methods for container and valve assemblies*
Compressed Gas Association, Inc. (CGA) S - 1.1, *Pressure Relief Standards - Part 1 - Cylinders for Compressed Gases*, Edition 11
FM Approvals requirements for Class 3010, *Fire Alarm Control Equipment*
FM Approvals requirements for Class 3810, *Electrical and Electronic test, Measuring, and Process Control Equipment*
IEEE/ASTM SI 10-2002, *American National Standard for Use of the International System of Units (SI): The Modern Metric System*
International Standards Organization, (ISO) 6183, *Fire Protection Equipment - Carbon Dioxide Extinguishing Systems for Use on Premises - Design and Installation*
National Fire Protection Association (NFPA) 12 - 2005, *Standard on Carbon Dioxide Extinguishing Systems*
NFPA 72 - 2002, *National Fire Alarm Code*

1.9 Definitions

For purposes of this standard, the following terms shall apply:

Agent

The material delivered by a fire extinguishing system which contacts the burning material and acts to suppress or extinguish the fire. For the purposes of this standard, the agent is gaseous carbon dioxide or CO₂, which is stored under pressure as a liquid.

Agent Supply Container

The assembly holding the CO₂ supply for a fire extinguishing system, which includes the pressure vessel and various accessories necessary for management of the supply, such as valves, dip tubes, pressure gauges, and pressure relief devices. An agent supply container for a Low Pressure System is termed a Storage Container, while that for a High Pressure System is termed a cylinder.

Area of Coverage

The maximum area which can be protected by a CO₂ discharge nozzle, based upon the minimum effective extinguishing flow rate (*EFR*) for the hazard, the maximum flow rate which will not cause splashing of flammable liquids (*SFR*), and the distance from the nozzle to the burning surface in local application systems.

Automatic Control

A device or arrangement of devices for initiating system discharge, including a panel which monitors fire detectors and releases the agent when pre-established conditions have been met, without requiring human intervention.

Class A Fires

Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

Class B Fires

Fires in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.

Class C Fire

Fires in which the ignition source is energized electrical equipment.

Discharge Nozzle

A device that is used to distribute the extinguishing agent uniformly over or into a specific area, within a specific volume, or both.

Discharge Time

The time interval between when the extinguishing agent first becomes predominantly liquid at the nozzle and the time at which the discharge becomes predominately gaseous.

Engineered System

A CO₂ fire extinguishing system design in which friction loss of piping, nozzles, and other components, and an analysis of the piping configuration, are used in hydraulic calculations to predict flows at individual nozzles.

Fully Mechanical Manual Control

A manual discharge control which can function in the absence of electric power or other energy sources, except for stored agent pressure.

High Pressure System

A fire extinguishing system in which the agent is stored in cylinders which allow the temperature of the contents to vary with the ambient room temperature and in which the agent is stored at an initial pressure of 850 psi (58.6 bar) at 70 °F (21 °C) to maintain it in the liquid state.

Local Application System

A fire extinguishing system designed to protect a defined area or volume by the direct discharge of CO₂ onto burning materials.

Lock-Out Valve

A Supervised, lockable, manually operated valve, which can be used to isolate the CO₂ supply from the all or part of the system during maintenance and service.

Low Pressure System

A fire extinguishing system in which the agent is stored in refrigerated (and sometimes heated), insulated Storage Containers which automatically control its temperature at 0 °F (-18 °C), resulting in it being held in the liquid state at a nearly constant supply pressure of 300 psi (20.7 bar), independent of the ambient room temperature.

Main Shutoff Valve

A Supervised valve used in Low Pressure Systems, which is located at the Storage Container, and is intended to shut off the supply of CO₂ to the distribution system.

Manual Control

A device or arrangement of devices, for initiating fire extinguishing system discharge, which requires action by a human to release the agent.

Master Cylinder

See Pilot Cylinder.

Maximum Working Pressure

The pressure in an Agent Supply Container, which has been filled to the maximum specified density at the appropriate working pressure at 70° F (21 °C) and subsequently warmed to the maximum installation temperature.

Minimum Working Pressure

The pressure in an Agent Supply Container, which has been filled to the minimum specified density at the appropriate working pressure at 70° F (21 °C) and subsequently cooled to the minimum installation temperature.

Nozzle Code

See Nozzle Size Number.

Nozzle Size Number

A convention used to equate the flow characteristics of nozzles having multiple orifices or complex configurations to those of a standard nozzle. It is the diameter, measured in multiples of 1/32 of an inch, of a simple, concentric, round orifice nozzle having the same flow rate for a given inlet pressure, with that equivalency determined by test, rather than through analysis of the nozzle's geometry.

Operable Pressure Range

The pressure range corresponding to the pressures in the Agent Supply Container at the specified minimum and maximum temperature for which the system is intended to be operable.

Operating Pressure

See working pressure.

Pilot Cylinder

One or more cylinders in a High Pressure System using multiple Agent Supply Containers which are directly actuated by the operating device and which supply pressure to actuate one or more Secondary or Slave Cylinders.

Pre-Engineered System

A fire extinguishing system design in which a predetermined range of piping and nozzle characteristics and configurations are used to predict individual nozzle flow rates.

Secondary Cylinder

One or more cylinders in a High Pressure System using multiple Agent Supply Containers which are operated by pressure supplied from a Pilot or Master Cylinder, rather than directly by an operating device.

Selector Valve

A valve, which is normally operated automatically, but which also has emergency Fully Mechanical Manual Control, and which restricts system discharge to one of multiple spaces or Zones protected by the same agent supply. Selector Valves are controlled by the detection and control system and are used to avoid discharging CO₂ into a space in which no fire has yet been detected, even though the overall system has been actuated to protect one or more other spaces.

Slave Cylinder

See Secondary Cylinder.

Specified

The value of a design parameter set by the manufacturer, which shall be at or less conservative than the limiting values of this standard.

Storage Container

An Agent Supply Container for a Low Pressure System, which includes an insulated pressure vessel jacket, liquid level indicator, and temperature maintenance equipment.

Supervised

A device, such as a valve, which is equipped with switches or is otherwise electrically monitored to allow its state to be displayed or to initiate and alarm via a control panel.

Total Flooding System

An extinguishing system designed to protect an enclosed hazard area by discharging Agent to reach and maintain an extinguishing concentration throughout the enclosed volume long enough to extinguish a fire. These systems are restricted to the use of specific nozzles within prescribed placement limits.

Working Pressure

The equilibrium pressure in a fully charged Agent Supply Container at 70 °F (21 °C).

Zone

A segment of the fire extinguishing system distribution piping, which is supplied through a Selector Valve, and which supplies Agent to one of the spaces protected by the system.

2. GENERAL INFORMATION

2.1 Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to:

Hydraulics Group Manager
FM Approvals
Hydraulics Laboratory
743A Reynolds Road
West Glocester, Rhode Island 02814 U.S.A.

The manufacturer shall provide the following preliminary information with any request for Approval consideration:

- A complete list of all models, types, sizes, and options for the products being submitted for Approval consideration;
- Assembly drawings, component drawings, materials list, anticipated marking format, nameplate format, brochures, sales literature, specification sheets, installation, operation and maintenance procedures;
- The number and location of manufacturing facilities;
- All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level; and
- All documents shall be provided with English translation.

2.2 Requirements for Samples for Examination

- 2.2.1 Following authorization of an Approval examination, the manufacturer shall submit samples for examination and testing based on a determination by FM Approvals following review of the preliminary information.
- 2.2.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.
- 2.2.3 The manufacturer shall submit samples representative of production. Any decision to use data generated utilizing prototypes is at the discretion of FM Approvals.
- 2.2.4 It is the manufacturer's responsibility to either provide or have available for witness testing at their facility any necessary test fixtures, such as those that may be required to evaluate the system.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of installation and use. The Approval test program requirements shall define the limits of the Approval investigation.

3.2 Physical or Structural Construction Features

3.2.1 Operating Range

All system components shall operate within the temperature ranges of Table 3.2. If the manufacturer specifies a lower minimum or higher maximum installation temperature, system and component evaluations will be based upon the resulting greater range.

Table 3.2.1 Required Operation Temperature Range

Highest Allowable Minimum Operating Temperature	Lowest Allowable Maximum Operating Temperature
°F (°C)	°F (°C)
32 (0)	120 (49)

3.2.2 Materials

3.2.2.1 All components shall be made of corrosion resistant materials suitable for their intended use.

3.2.2.2 Gaskets and O-Rings

Gaskets and o-rings used in the system shall be compatible with the CO₂ extinguishing agent. Compatibility shall be determined by successful performance in the one-year and maximum and minimum storage temperature leakage tests of Sections 4.1 and 4.2 and review of third-party data demonstrating successful performance at maximum and minimum installation

temperatures while exposed to the agent. For standard elastomers, the material manufacturer's certificates of compliance verifying the compatibility of the specific elastomer compound with the carbon dioxide for the temperature and pressure range of usage shall be acceptable. Where such certifications are not available, tests of the elastomer shall be conducted. At minimum, tensile strength, ultimate elongation, and hardness of samples shall not be changed by more than 40 percent from new condition by a 45 day exposure to the agent at the maximum storage temperature and pressure.

3.2.3 Control

3.2.3.1 For normal operation, a system shall be automatically controlled and operable from a manual control, easily accessible to the hazard. If the normal manual means of actuation utilizes electric power, the source of that power shall be completely independent of any electric power source used for automatic operation. Alternatively, a power source used for both normal manual and automatic operation shall be provided with an independent back-up, such as a battery. Whether normally operated automatically or manually, all systems shall also be provided with an alternate means of fully mechanical manual emergency control. Fully mechanical manual emergency controls shall not require an electric power source but may make use of CO₂ pressure to operate the release. These emergency controls shall be located at or near the device being controlled.

3.2.3.2 Control panels shall comply with NFPA Standard 72 and FM Approvals requirements for Classes 3010 and 3810 as a releasing control. Control panels need not be submitted as a part of a system. However, system design shall be such that the system is operable by a minimum of one FM Approved detection and release panel.

3.2.4 Strength

All unprotected component parts which contain the flow of CO₂ shall have minimum bursting pressures as shown in Table 3.2.4. Components protected by a pressure relief device shall have minimum bursting pressures equal to or greater than twice the pressure relief setting. The discrepancy between the agent supply container requirement and that for other continuously pressurized components is due to the well-established pressure vessel design and manufacturing protocols which are used. Agent supply containers are typically cylindrical in form. Cylinders are simple forms which lend themselves well to calculation of applied stresses, whereas components such as valves typically exhibit more complex geometries and states of stress. Further, cylinders are typically manufactured with third party oversight or by manufacturers qualified by third parties. Therefore, the test results for cylinders are judged to be more representative of the range of production than are those for many other components. Low pressure agent supply containers need not be subjected to burst pressure tests if designed to a recognized standard and burst pressure design calculations are submitted per that standard.

Table 3.2.4. *Required Minimum Bursting Pressures*

<i>Component Service</i>	<i>High Pressure Systems</i>		<i>Low Pressure Systems</i>	
	<i>psi</i>	<i>(bar)</i>	<i>psi</i>	<i>(bar)</i>
Subject to agent storage pressure	6000	(413.8)	1800	(124.1)
Subject to agent discharge pressure	5000	(344.8)	1800	(124.1)
Agent supply containers	5000	(344.8)	875	(60.3)

3.2.5 Pressure Vessels

3.2.5.1 Agent supply containers shall conform to the appropriate regulations for the installation location. In the U.S.A., U.S. Department of Transportation (DOT), Title 49, Code of Federal Regulations, Parts 171 through 180 are appropriate for high pressure system cylinders, which are shipped pressurized. The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VII is used for low pressure system storage containers, which are filled after installation. In a multiple cylinder system, all cylinders supplying the same

manifold shall be of the same size and design for interchangeability of position. The following documents shall be submitted for each diameter of each storage container pressure vessel design to demonstrate compliance with the relevant design standard:

- a. Calculation of wall thicknesses per the method specified in the standard, with appropriate supporting references, as necessary.
- b. Certificate of chemical analysis of materials.
- c. Certificate of physical properties of materials.

3.2.5.2 High pressure system cylinders shall be selected to contain no more than a 68 percent liquid filling volume, unless a higher percent fill is allowed by the authority having jurisdiction in the location of intended installation. Low pressure system storage containers shall be selected to contain no more than 95 percent liquid filling volume, unless a lower fill density is required by the authority having jurisdiction.

3.2.6 Discharge Valves

The pressure loss versus flow through discharge valves shall be measured to allow accurate calculations for system design. Discharge valves shall use different sizes or connection designs for all ports to minimize the likelihood of improper connection at installation. Valves not designed for mounting directly on an agent supply container may use inlet and outlet connections of the same size and design, but shall be marked to indicate correct direction of flow. For pressure operated valves, the manufacturer shall provide data for the minimum available force or torque for each actuator and the maximum required operating force or torque for the corresponding valve. Proper operation of the most adverse combinations shall be verified by test.

3.2.7 Siphon Tubes

High pressure cylinder valve assemblies shall include a siphon tube to discharge liquid CO₂ from the cylinder. The discharge end of the siphon tube shall be mechanically fastened and sealed to remain in place during all conditions of use and to prevent gas discharge until the liquid level drops below the opening on the free end of the siphon tube. The free end of the siphon tube shall be configured to prevent restriction of flow by contact with the cylinder wall. Flow rate measurements for high pressure cylinder valves shall be performed with siphon tubes in place and installed in the normal design proximity to the cylinder wall if the minimum clearance between the end of the tube and the wall is less than 0.25 of the tube's inside diameter. Siphon tubes in low pressure storage containers shall also meet the 0.25 tube inside diameter clearance requirement. In both cases, compliance with this requirement shall be demonstrated by drawings showing the calculated assembly clearance, based upon worst case dimensional tolerance stack-ups. Alternatively, the manufacturer's assembly process may contain some controlled procedure for verifying the minimum required clearance.

3.2.8 Pressure Relief Devices

Calculations shall be submitted to verify that the pressure relief device is designed and sized to comply with the uninsulated cylinder flow capacity requirements as specified in either the Compressed Gas Association Pamphlet S-1.1, or equivalent acceptable to the authority having jurisdiction. Supply container pressure relief devices shall operate between 2400 psi and 3000 psi (165.5 bar and 206.9 bar) on high pressure systems and at 350 psi (24.1 bar) on low pressure systems, unless the authority having jurisdiction requires a lower setting. Low pressure system piping that may contain CO₂ liquid trapped between closed valves after a discharge shall be provided with a pressure relief device set at 450 psi (31.0 bar).

3.2.9 Discharge Heads and Connectors

If a high pressure system discharge head must be removed from the valve assembly during weighing or recharging operations, the assembly shall contain a check valve. When a discharge connector must be removed, an anti-recoil device shall be installed on the valve's discharge connection and a plug or cap shall be provided to seal the disconnected end of the loop. Appropriate warnings shall be displayed on these devices to caution the user with regard to the high pressure discharge hazard and the proper procedure for mitigating this hazard.

3.2.10 Manifolds and Piping

Manifolds of proprietary designs used in place of standard pipe and fittings shall have minimum internal diameters greater than or equal to that of their corresponding pipe sizes. In multiple container installations where the discharge of a pilot cylinder(s) actuates secondary cylinders, the manifold piping shall be arranged so that any one pilot cylinder will actuate the entire battery, regardless of the total number of pilot cylinders in the system. All cylinders in a battery shall be of the same size and design.

3.2.11 Cylinder Supports

Equipment which supports multiple cylinder installations shall be designed to facilitate removing individual cylinders for inspection and servicing.

3.2.12 Protective Covering

All valves and control devices with exterior movable parts that are vulnerable to obstruction or physical damage shall be protected by paneled enclosures or cages. Operating, levers, handles, or buttons requiring manual access for operation shall be exempt from this requirement to the extent necessary to allow for their unimpeded operation. Conduit shall be used for cables, wires, or tubes outside the enclosures.

3.2.13 Actuation Devices or Control Heads

The device which opens a high pressure cylinder discharge valve shall either be an autonomous control head attached to the valve, or an internal component of either the discharge head or the valve assembly itself. One action shall actuate all the cylinders in a battery. This shall be accomplished automatically by the connection of pilot to secondary cylinders, or by a mechanical system acting simultaneously on all cylinder valves. In the former arrangement, CO₂ pressure from a pilot cylinder moves a piston in the secondary cylinder control head, valve assembly, or discharge head to unseat the valve disk and open the valve. Such pistons shall have sufficient area such that, when acted upon by the minimum pilot pressure, sufficient force is generated to overcome the force generated by the maximum system pressure acting over the valve disk sealing area. Compliance shall be demonstrated by test or the submission of appropriately annotated drawings displaying the area ratio calculation. Control heads on pilot cylinders shall be designed for single or simultaneous multiple unit operation. They shall be actuated automatically by a fire detection device, or by a fully manual emergency release device (Section 3.2.3.1). Handles or levers on these and any other manual controls shall not require a force to operate exceeding 40 lb (178 N), nor travel of more than 14 in. (36 cm), nor rotation of more than 270 degrees. Valves controlled by gear operators shall not require more than 10 turns to open. Torque required to operate any device shall not exceed 40 lbf•ft (54 N•m).

3.2.14 Auxiliary Manual Controls

Auxiliary manual controls shall be provided for systems using automatic control heads or mechanical release devices which do not incorporate a fully mechanical manual control. These auxiliary controls shall be used for remote, manual operation or in emergencies due to failure of the automatic control. Auxiliary controls which are not located within the protective enclosures provided for other components shall be protected by a sturdy, break-open type box. Control devices that require cables shall demonstrate smooth, responsive motion with the most complex or lengthy specified arrangement.

3.2.15 Selector and Lockout Valves

Selector valves shall be provided for systems protecting multiple hazards. Lockout valves shall be provided to safeguard personnel from accidental discharge during servicing of the system. The rate of flow through selector and lockout valves shall be measured to allow accurate calculations for system design. Requirements for selector and lockout valve controls are the same as those for discharge valves. Therefore, the same design may be used for both types of valve on low pressure systems. The actuation of one selector valve shall not open other selector valves in the system. These valves shall be designed with a provision for remote supervision of valve position (fully open or fully closed). Supervisory devices shall be compatible with FM Approved control equipment. Only low pressure tank shutoff and lockout valves require supervision. Selector valves are exempt from this requirement, but may be supervised if required by the system controls.

3.2.16 Nozzles

Discharge nozzles shall be evaluated for the intended use, including flow characteristics and area of coverage. Nozzles or outlets shall be made of metallic, corrosion resistant materials that will not deform or otherwise be damaged by fire exposure. Nozzles shall not have orifices less than 0.040 in. (1 mm) in diameter. Nozzle flow paths shall be of decreasing area configurations. Orifice plates shall not be used in nozzles, unless the manufacturer can demonstrate by test that any solid CO₂ produced under any flow condition will not plug downstream nozzle flow paths or otherwise interfere with normal discharge. Nozzles shall be permanently marked to identify manufacturer, type, and nozzle size number.

3.2.17 Nozzle Screens

Outlets less than 1/8 in. (3.17 mm) diameter shall be protected from plugging due to foreign materials in the system by a screen. If the screen is placed in the passageway supplying the nozzle, it shall be formed into a cone or hemisphere with its outside surface facing the upstream direction. Nozzle screens shall provide a free area not less than five times the total nozzle orifice area and shall be fabricated of a mesh having openings between 0.020 in. and 0.030 in. (0.5 mm and 0.8 mm) in their least dimension.

3.2.18 Nozzle Covers

Caps or frangible seals shall be provided on nozzles for installations in which the nozzles are subject to clogging from external materials. Such caps or seals shall have a maximum releasing pressure of 44 psi (3 bar) as installed, and shall in no way obstruct flow from the outlet, after release.

3.2.19 Carbon Dioxide

Carbon dioxide gas for use as an extinguishing agent shall meet the requirements of Table 3.2.19. Certificates of conformity shall be presented for all CO₂ used in testing for an Approval examination. Unlike most other gaseous extinguishing agents, CO₂ is a pure substance and is commonly available. Accordingly, low pressure systems are usually refilled on site and high pressure supply containers are usually refilled in a commercial facility which refills other industrial gas cylinders. While FM Approvals does not require factory filling of CO₂ cylinders, the recharge gas must also meet the following requirements.

Table 3.2.19. Carbon Dioxide Requirements

<i>Characteristic</i>	<i>Allowable Limit</i>
Vapor phase purity	99.5 percent, minimum
Liquid phase water content	0.01 percent maximum, by weight
Oil content	10 ppm maximum, by weight

3.2.20 Auxiliary Equipment

Auxiliary equipment includes those devices required in a system to protect against a specific hazard. The need for these devices shall be determined by FM Approvals according to the nature of the hazard. The devices listed below may be required for the system to earn Approval for specific applications. Other devices not included below may also be required.

3.2.20.1 Pressure Operated Release

A pressure operated release shall be provided on all doors and windows in a hazard area which is to be sealed off in the event of fire. The release shall operate at a maximum pressure of 50 psi (3.5 bar) from a piston or plunger driven by CO₂ from the extinguishing system. The release shall not permit the escape of excessive gas from the system. It shall automatically reset and may have a control for manual operation.

3.2.20.2 Pressure Operated Switches

Pressure operated switches may be used to shut down fans, conveyors, or other electrical equipment near the hazard area, and activate alarm and indicator circuits. These switches shall operate at a maximum CO₂ pressure of 50 psi (3.5 bar) and not release excessive gas from the system. They may have a means for alternate, manual control and shall be designed for manual resetting only.

3.2.20.3 Time Delays

A delay device shall be installed on systems to minimize the likelihood of accidental exposure of personnel to CO₂ discharge. This device may either delay the operation of the system, or delay the discharge of CO₂ after the system has been actuated. In the first arrangement, the actual discharge shall be manually controlled. A manual override shall be provided in the second arrangement to allow immediate discharge.

3.2.20.4 Alarms

Alarms and/or indicators shall be provided to show that the system is operating, warn personnel of the forthcoming discharge of CO₂ or of its presence in unventilated areas, and signal the failure of any supervised equipment. Indicators which show that the system has been used and must be serviced shall operate upon actuation of the system and require manual resetting. Nozzles used on pressure operated alarms must meet the requirements in Section 3.2.16.

3.2.20.5 Check Valves

Check valves shall be provided on systems that utilize standby agent supplies, or separate the flow of CO₂ to initial and delayed discharge lines. These valves may exhibit minor leakage in the reverse flow direction. They shall open at a maximum pressure of 0.1 times the system pressure at maximum storage temperature.

3.2.20.6 Safety Valves

Manifold relief valves shall be used on systems equipped with selector valves to vent closed sections of pipe, when necessary. These safety valves shall operate at pressures of 2400 to 3000 psi (165.5 and 206.9 bar) on high pressure systems and at 450 psi (31.0 bar) on low pressure systems and be arranged so that their discharge of CO₂ is not likely to injure personnel.

3.2.20.7 Venting Valves

Devices shall be provided to prevent the premature operation of cylinder or selector valves by residual pressures that may leak into enclosed manifolds, control heads or discharge heads. They shall have closing pressures of 25 to 100 psi (1.7 to 6.9 bar). If these vents are incorporated in control heads, they shall be closed when the control is in operation and open when the control is inoperative.

3.2.20.8 Changeover Devices

Changeover devices such as valve or switch assemblies shall be provided on automatic systems having both primary and manifold or secondary batteries of supply containers. This will direct the command of the automatic fire detection device to the proper batteries. The changeover device shall be enclosed in a mounting box and shall indicate which batteries are subject to operation.

3.2.21 Low Pressure Agent Supply Container Configuration Requirements

3.2.21.1 Low pressure supply containers shall be equipped with a liquid level gauge, a pressure gauge, a high-low pressure alarm, and a vapor connection for actuation of auxiliary devices.

3.2.21.2 The pressure gauge shall be selected to indicate normal tank pressure in the middle third of its range.

3.2.21.3 The high-low pressure alarm shall be set to low alarm at no lower than 250 psi (17.2 bar). The high pressure alarm shall be set no higher than 90 percent of the pressure vessel's maximum allowable working pressure (MAWP).

3.2.21.4 A refrigeration system shall be provided with adequate capacity to maintain 300 psi (20.7 bar) agent supply pressure at the maximum allowable ambient temperature of 120 °F (49 °C).

3.2.21.5 A heating system shall be provided for agent supply containers installed where ambient temperatures may go below -10 °F (-23 °C), at which temperature the CO₂ pressure could fall below 250 psi (17.2 bar).