P/N 38-KFSARG-000
September 2004

Argonite®
Engineered Fire Suppression Systems

Design, Installation, and Maintenance Manual

FM APPROVED

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Kidde Fire Systems

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Argonite®

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Design, Installation, and Maintenance Manual

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FOREWORD

This manual is written for those who are designing, installing or providing maintenance to a Kidde Fire Systems Argonite® Engineered Fire Suppression System.

IMPORTANT

Kidde-Fenwal assumes no responsibility for the application of any systems other than those addressed in this manual. The technical data contained herein is limited strictly for information purposes only. Kidde-Fenwal believes this data to be accurate, but it is published and presented without any guarantee or warranty whatsoever. Kidde-Fenwal disclaims any liability for any use that may be made of the data and information contained herein by any and all other parties.

Kidde Argonite Fire Suppression Systems are to be designed, installed, inspected, maintained, tested and recharged by qualified, trained personnel in accordance with the following:

- Standard of the National Fire Protection Association No. 2001, titled *Clean Agent Fire Extinguishing Systems*.
- All instructions, limitations, etc. contained in this manual, P/N 38-KFSARG-000.
- All information contained on the system container nameplate(s).

Storage, handling, transportation, service, maintenance, recharge, and test of agent storage containers shall be performed only by qualified and trained personnel in accordance with the information in this manual and Compressed Gas Association pamphlets C-1, C-6 and P-1:

- C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*.
- C-6, *Standards for Visual Inspection of Compressed Gas Cylinders*.
- P-1, *Safe Handling of Compressed Gases In Containers*.

CGA pamphlets are published by the Compressed Gas Association, Crystal Square Two, 1725 Jefferson Davis Highway, Arlington, VA 22202-4102.

Any questions concerning the information presented in this manual should be addressed to:

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SAFETY SUMMARY

Argonite® fire suppression systems use pressurized equipment; therefore, personnel responsible for fire suppression systems must be aware of the dangers associated with the improper handling, installation or maintenance of this equipment.

Fire suppression system service personnel must be thoroughly trained in the proper handling, installation and service of Argonite equipment and follow the instructions used in this manual and in the Safety Bulletin and cylinder nameplate contained in this Appendix.

Kidde has provided warnings and cautions at appropriate locations throughout the text of this manual. These warnings and cautions are to be adhered to at all times. Failure to do so may result in serious injury to personnel.

In addition, Material Safety Data Sheets for Argonite is provided. Personnel must also be familiar with the information contained on these data sheets.

SAFETY BULLETIN 1, MARCH 2, 1987

SUBJECT: SAFE CYLINDER HANDLING PROCEDURES

⚠ WARNING

Pressurized (charged) cylinders are extremely hazardous and if not handled properly are capable of violent discharge. This may result in serious bodily injury, death and property damage.

Before handling Kidde system products, all personnel must be thoroughly trained in the safe handling of the containers as well as in the proper procedures for installation, removal, filling, and connection of other critical devices.

READ, UNDERSTAND and ALWAYS FOLLOW the operation and maintenance manuals, owners manuals, service manuals, etc., that are provided with the individual systems.

The following safety procedures must be observed at all times:

Moving Container. Containers must be properly secured in place. Containers must not be rolled, dragged or slid, nor allowed to be slid from tailgates of vehicles. A suitable hand truck, fork truck, roll platform or similar device must be used.

Rough Handling: Containers must not be dropped or permitted to strike violently against each other or other surfaces.

Storage: If storing upright, containers must be stored where they are not likely to be knocked over, or the containers must be secured.

For additional information on safe handling of compressed gas cylinders, see CGA Pamphlet PI titled "Safe Handling of Compressed Gases in Containers". CGA pamphlets may be purchased from The Compressed Gas Association, Crystal Square Two, 1725 Jefferson Davis Highway, Arlington, VA 22202.

SAFETY BULLETIN , MAY 1, 1993

SUBJECT: SAFE CYLINDER HANDLING PROCEDURES FOR PRESSURIZED CYLINDERS

Pressurized (charged) cylinders are extremely hazardous and if not handled properly are capable of violent discharge. This will result in serious bodily injury, death and property damage.

BEFORE handling Kidde system products, all personnel must be thoroughly trained in the safe handling of the containers as well as in the proper procedures for installation, removal, filling, and connection of other critical devices, such as flexible hoses, control heads, and safety caps.

READ, UNDERSTAND and ALWAYS FOLLOW the operation and maintenance manuals, owners manuals, service manuals, and other information that is provided with the individual systems.

THESE INSTRUCTIONS MUST BE FOLLOWED IN THE EXACT SEQUENCE AS WRITTEN TO PREVENT SERIOUS INJURY, DEATH OR PROPERTY DAMAGE.

PROTECTIVE CAP

a. Each cylinder is factory equipped with a protective cap installed on the cylinder. This device is a safety feature, and will provide controlled safe discharge when installed if the cylinder is actuated accidentally.

b. The protective cap must be installed on the cylinder AT ALL TIMES except when the cylinders are connected into the system piping or being filled.

INSTALLATION AND REMOVAL FROM SERVICE

Refer to Paragraphs 8-4 and 8-5 in this manual.

DEFINITIONS

⚠ WARNING

Indicates an imminently hazardous situation which, if not avoided, could result in death, serious bodily injury and/or property damage.

⚠ CAUTION

Indicates a potentiality hazardous situation which, if not avoided, could result in property or equipment damage.

ARGONITE MSDS SHEETS.

See Appendix A.

CHAPTER 1
GENERAL INFORMATION

1-1 GENERAL

This technical manual provides the necessary information for the design, installation and maintenance of a Kidde Fire Systems Argonite® Engineered Fire Suppression System. The content should enable the reader to understand the operation of an Argonite Engineered Fire System for industrial and offshore applications.

It has been assumed and intended in the preparation of the various sections of this manual that execution of its provisions is entrusted to people appropriately qualified in the specification, design, installation, operation and maintenance of Argonite systems and the associated equipment. In addition, this manual does not eliminate the need for system design by trained engineers/designers nor the use of competent engineering judgement.

This entire manual must be read and completely understood prior to the designing, installation or maintenance of a Kidde Fire Systems Argonite Engineered Fire Suppression System.

The manual does not cover detection and control systems, which are to be designed and installed in accordance with national codes and local requirements.

It is important that the fire protection of a building or plant be considered as a whole. Gaseous extinguishing systems form only a part, though an important part, of the available facilities. It should not be assumed that using a gaseous agent system necessarily removes the need to consider supplementary measures, such as automatic fire detection, the provision of fire extinguishers, other mobile appliances for first aid or emergency use, or to deal with special hazards.

For many years, gaseous extinguishants have been recognized as an effective medium for extinguishing ordinary Class A fires, flammable liquid Class B fires, and electrical Class C fires. However, in the planning of comprehensive hazard protection, it should not be forgotten that there may be hazards for which these agents are not suitable, or that in certain circumstances or situations there may be danger in their use requiring special precautions.

Care should always be taken to thoroughly evaluate and correct any factors that could result in unwanted discharges. It is essential that fire extinguishing equipment be carefully maintained to ensure instant readiness when required and that the owner be given detailed instruction regarding the operation of the systems installed in his building/plant.

1-1.1 Introduction

The interest in inert gas blends continues to increase due to the phase out of Halon systems in accordance with the Montreal Protocol and the growing interest in meeting the intent of the Kyoto Protocol.

The Kidde Fire Systems Argonite fire extinguishing system utilizes a 50/50 mixture of pure Nitrogen and Argon. Both gases are naturally occurring substances and present in the atmosphere, and as such, have no ozone depletion potential and no direct global warming risk.

There are no toxicological factors associated with the use of Argonite and Argonite will not decompose or produce any by-products when exposed to a flame from a fire condition. However, heat and by-products of the fire itself can still be substantial and could make the area untenable for human occupancy until the enclosure has been properly vented.

Argonite is stored in high-pressure cylinders at a nominal pressure of 2900 PSI (200 bar) at 70°F (21.1°C). Safety and exposure guidelines, including concentration levels, as established by NFPA 2001, *Standard for Clean Agent Fire Extinguishing Systems*, should be followed.

1-2 USE AND LIMITATIONS

Argonite fire extinguishing systems are primarily used as total flooding systems for protection of self-enclosed equipment or enclosed hazards to contain the extinguishant.

1-2.1 Use

Argonite systems operate safely in temperatures from -20°F to 130°F (-29°C to 54°C). Argonite will not cause "fogging" during a discharge, a condition caused by the supercooling of the water content in the air. The density of Argonite in air is similar to that of atmospheric air, which greatly improves the holding time after a release compared with other heavier/lighter agents.

Argonite is electrically nonconductive and therefore suitable for use to extinguish fires in electric and electronic equipment, such as that found at electronic data processing and telecommunication facilities. Argonite is also useful for extinguishing fires:

- Involving flammable and combustible liquids and gases
- In subfloors and other concealed spaces
- In tape file storage areas
- Involving delicate artifacts and high-value assets
- In places where other extinguishing media could be directly destructive.

Deep-seated fires in solid material require that the Argonite atmosphere be maintained for an extended period of time (holding time) to achieve total extinguishment.

Argonite does not leave any hazardous substances after a release. Since cleanup after a fire will only involve items damaged in the fire, downtime and secondary damage can therefore be kept to a minimum.

1-2.2 Use Limitations

Argonite should not be used to extinguish fires involving:

- Chemicals containing their own supply of oxygen and which are capable of rapid oxidation in the absence of air, such as cellulose nitrate, gunpowder, etc.
- Mixtures containing oxidizing materials, such as sodium chlorate or sodium nitrate.
- Chemicals capable of undergoing autothermal decomposition, such as some organic peroxides and hydrazine.
- Reactive metals, such as sodium, potassium, magnesium, titanium and zirconium.
- Reactive hydrides, or metal amides, some of which may react violently with gaseous extinguishants.

Note: This is not an inclusive list of use limitations. If any uncertainty arises as to whether Argonite is a suitable agent/system, contact Kidde Fire Systems.

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CHAPTER 2
FIRE EXTINGUISHMENT METHODS

2-1 INTRODUCTION

Argonite® systems extinguish fires by the following methods:

2-1.1 Total Flooding

Release of Argonite into an enclosure (total flooding) means that an inert atmosphere is created within the entire room volume.

2-1.2 Selector Valves/Distribution System

If more than one room or hazard in a building is to be protected, a common Argonite cylinder bank may be used. The capacity of the cylinder bank must be calculated for protection of the largest room/ hazard and/or adjoining rooms/hazards that may be involved in a fire simultaneously. In most cases, Argonite selector valve systems reduce the cost as compared to individual systems protecting the same hazards.

2-1.3 Modular System

In limited space areas where the authority having jurisdiction will allow for a modular system, cylinders located singly or in multiple units within the room may be used. The total quantity of stored agent, the number of nozzles etc., shall be that as required for a central bank system. Cylinders shall be connected either electrically or pneumatically, allowing for simultaneous discharge. Each individual unit shall be treated as a separate system.

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CHAPTER 3
DESIGN GUIDELINES

3-1 INTRODUCTION

Design guidelines for Argonite® systems are as established in NFPA 2001, *Standard for Clean Agent Fire Extinguishing Systems*. Argonite has been designated IG-55 in NFPA 2001 as a blend of two inert gases: Nitrogen and Argon (50% and 50%, respectively).

3-2 DESIGN STANDARDS

An Argonite system shall always be designed in accordance with the latest version of applicable design standards, taking into consideration requirements specified by local authorities having jurisdiction.

- NFPA 2001,
  Standard for Clean Agent Fire Extinguishing Systems

3-3 PERSONAL SAFETY

⚠ CAUTION **When extinguishing a fire using Argonite, the oxygen level in the protected room is reduced to a level that will not sustain combustion. This could create an imminent risk to personnel occupying the enclosure if the residual oxygen level becomes less than that which can support life. Products of combustion from the fire must also be considered a hazard.**

Suitable safeguards shall always be provided to ensure prompt evacuation from and prevent entry into a hazardous atmosphere, and include a safe means for prompt rescue of any trapped personnel. Safety items such as personnel training, warning signs, discharge alarms, self-contained breathing apparatus, evacuation plans and fire drills shall be considered and implemented as required.

⚠ CAUTION **Personnel should be acquainted with the fact that Argonite presents a noise hazard during discharge and may result in damage to hearing if personnel are present without protection during discharge.**

Consideration shall be given to the possibility of migration of Argonite to adjacent areas outside of the protected space (pressure relief vent openings, etc.).

Argonite systems may be designed for a residual oxygen level of 12% (sea level equivalent) if personnel can vacate the area within five minutes (exposure time of 5 minutes or less), but may be designed to have a residual oxygen level of 10% (sea level equivalent) if personnel can vacate the area within 3 minutes (exposure limited to 3 minutes or less).

⚠ WARNING **Argonite systems designed to reduce oxygen levels to below 12% should only be provided in normally unoccupied areas.**

Should the possibility exist for the oxygen level to drop below 10%, personnel must be evacuated prior to such oxygen depletion. A design concentration resulting in an oxygen level of less than 10% may only be used in normally unoccupied areas, and only if the personnel who could possibly be exposed can vacate the area within 30 seconds.

However, in all of situations it is necessary that personnel evacuate the hazard **prior** to system discharge. Hence the need to include both predischarge alarms and time delays into all system designs.

Argonite systems designed to concentrations below 42.5% (corresponding to an oxygen concentration of 12% or higher, sea level equivalent of oxygen) shall be permitted, given means are provided to limit exposure to no longer than 5 minutes.

Systems designed to concentrations between 42.5 and 52% (corresponding to between 12 and 10% oxygen, sea level equivalent of oxygen) shall be permitted, given means are provided to limit exposure to no longer than 3 minutes.

Systems designed to concentrations between 52 and 61.7% (corresponding to between 10 and 8% oxygen, sea level equivalent of oxygen) shall be permitted, given the following:

- The space is normally unoccupied.
- Where personnel could possibly be exposed, means are provided to limit the exposure to less than 30 seconds

Systems designed to concentrations above 61.7% (corresponding to 8% oxygen or below, sea level equivalent of oxygen), shall only be used in unoccupied areas where personnel are not exposed to such oxygen depletion.

⚠ WARNING Exposure beyond the stated limits may result in personal injury or death.

3-4 RELEASE TIME

- **Industrial**

  NFPA 2001 recommends 95% of the design quantity of Argonite be released within 60 seconds.

Other countries/authorities may have different requirements than those mentioned above, and therefore must be consulted.

3-5 TEMPERATURE CONSIDERATIONS

During a discharge of the agent only, the temperature within the protected enclosure will drop approximately 10°F to 20°F (5°C to 10°C). After the end of the discharge, the temperature will rise again within approximately 2 to 3 minutes.

3-6 ELECTRICAL CLEARANCE

All system components shall be located to maintain no less than minimum clearance from energized electrical parts. Should a design insulation level not be available and where nominal voltage is used for the design criteria, the highest minimum clearance listed for this group shall be used.

The following references shall be considered as the minimum electrical clearance requirements for the installation of clean agent systems:

- ANSI C2, *National Electrical Safety Code*
- NFPA 70, *National Electrical Code®*
- 29 CFR 1910, Subpart S
- NFPA 2001, *Standard for Clean Agent Fire Extinguishing Systems*

3-7 AUTOMATIC DETECTION AND CONTROL

Detection, actuation and control systems shall be installed, tested and maintained in accordance with the requirements of the Authority Having Jurisdiction (AHJ).

Automatic detection and actuation (release) is preferred. Selection of the detection devices shall be determined based on an evaluation of the flammables involved, the environment and the response time anticipated.

Means for manual release of the system shall be provided and located, installed and/or suitably protected so that they are not within the protected area and not subject to mechanical, chemical or other damage that would render them inoperative.

The control equipment shall supervise the actuating devices and the associated wiring and, as required, cause actuation.

Audible or visual alarms, or both, shall be used to indicate the operation of the system, hazards to personnel or failure of any supervised device. The device type—audible or visual–their number and location shall be such to comply with all local and/or national codes.

Audible and visual predischarge alarms shall be provided within the protected area to give positive warning of impending discharge. The operation shall be continued after discharge until positive action has been taken to acknowledge the alarm and proceed with appropriate action.

The time delay between the predischarge alarm and discharge shall be sufficient to allow personnel to evacuate prior to the discharge. Time delays shall be used only for personnel evacuation or to prepare the hazard area for discharge (closing of doors, vents, shut down of equipment, etc.).

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CHAPTER 4
SYSTEM DESCRIPTION

4-1 INTRODUCTION

An Argonite® system may involve parts as described below.

4-2 CENTRAL CYLINDER BANK

An Argonite system normally comprises a bank of cylinders consisting of a sufficient number of cylinders to provide the Argonite supply required. Where required, a reserve bank should consist of as many multiples of the primary supply as the authority having jurisdiction considers necessary. Main and reserve supplies may be permanently connected to the distribution piping and arranged for easy change over.

The cylinder bank shall not be located where it can be rendered inoperable or unreliable due to mechanical damage, exposure to chemicals or harsh weather conditions, or by any other foreseeable cause. Where exposure to such conditions is unavoidable, then a suitable enclosure or other protective measures shall be employed.

The cylinders in a bank must be securely supported and attached to a wall or a solid structure in a manner that allows for convenient individual inspecting/servicing. Each cylinder valve must be fitted with a pressure gauge. A supervisory pressure switch is provided for remote monitoring.

The cylinders in a bank are each connected to a discharge manifold or series of manifolds via flexible high-pressure hoses. The connection at the manifold includes an in-line check valve. Check valves are provided to prevent agent loss and to ensure personnel safety if the system is operated when any containers are removed for maintenance.

It is permissible to utilize multiple storage container sizes in the cylinder bank.

4-3 SELECTOR VALVE SYSTEM/DISTRIBUTION SYSTEM

Should the system be designed for protection of more than one hazard from a common cylinder bank, the manifold must be equipped with normally closed, pneumatically operated selector valves.

The pressure required to operate the pneumatic actuators on the selector valves is taken from the main distribution manifold, via a pressure regulator. The pressure regulator reduces the operating pressure to between 75 and 120 PSI (5 to 8 bar) to safely operate the selector valves, and shall include a relief device in case of overpressurization.

Each selector valve is equipped with its own actuator and solenoid valve assembly, which, when operated, will release Argonite into the appropriate hazard area.

A portion of the total number of Argonite cylinders may be used for a particular hazard. This is accomplished by utilizing a non-return (check) valve in the cylinder pilot line. The system designer shall specify the location of the valve.

A restrictor is used at the outlet of each selector valve to reduce the pressure going into the distribution piping.

Optional isolation (lockout) valves may be installed upstream of the selector valve. These valves must remain supervised open and may only be closed during system service or routine maintenance.

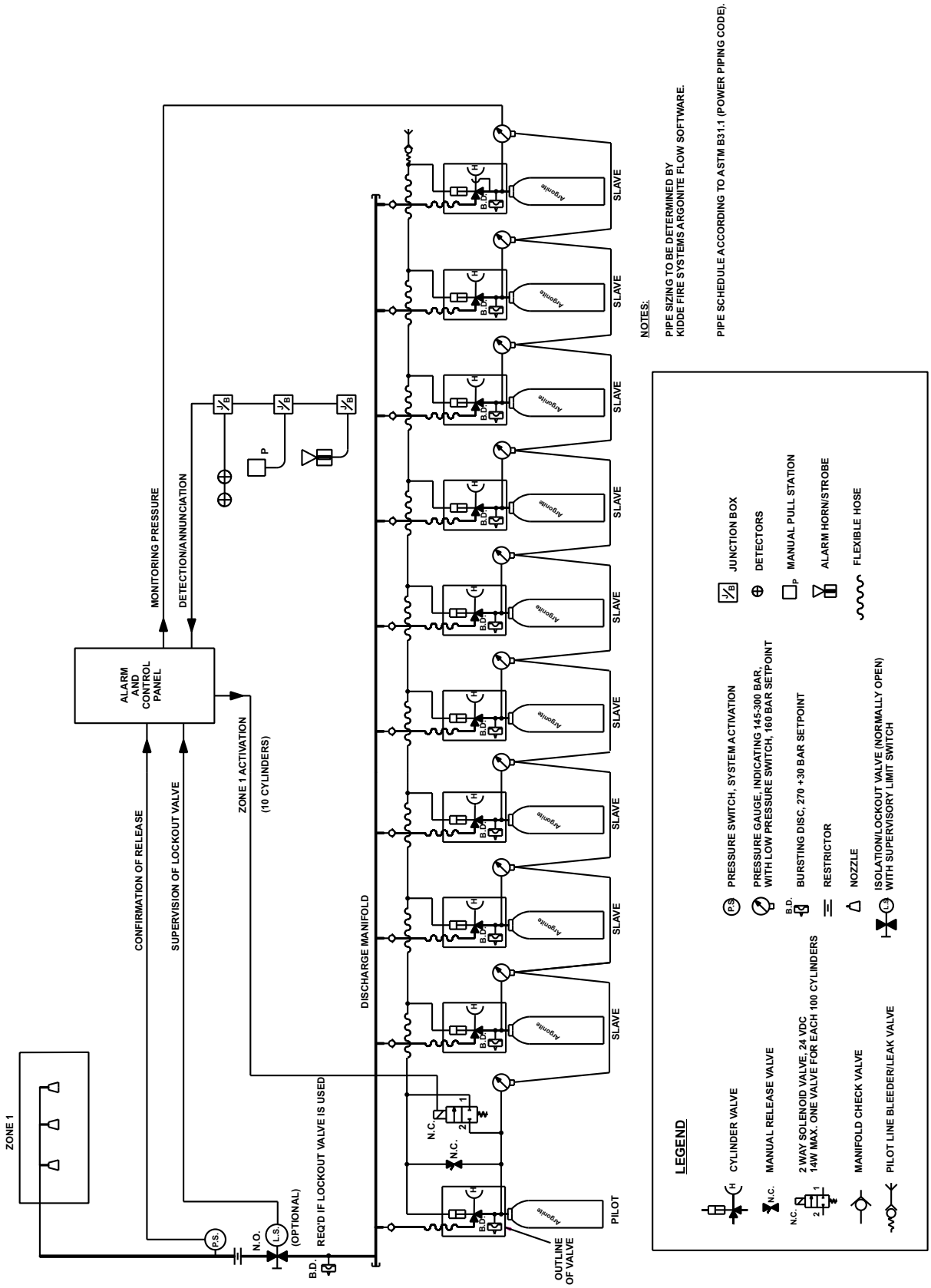

Figure 4-1. Piping and Instrumentation Diagram for Single Hazard Argonite System

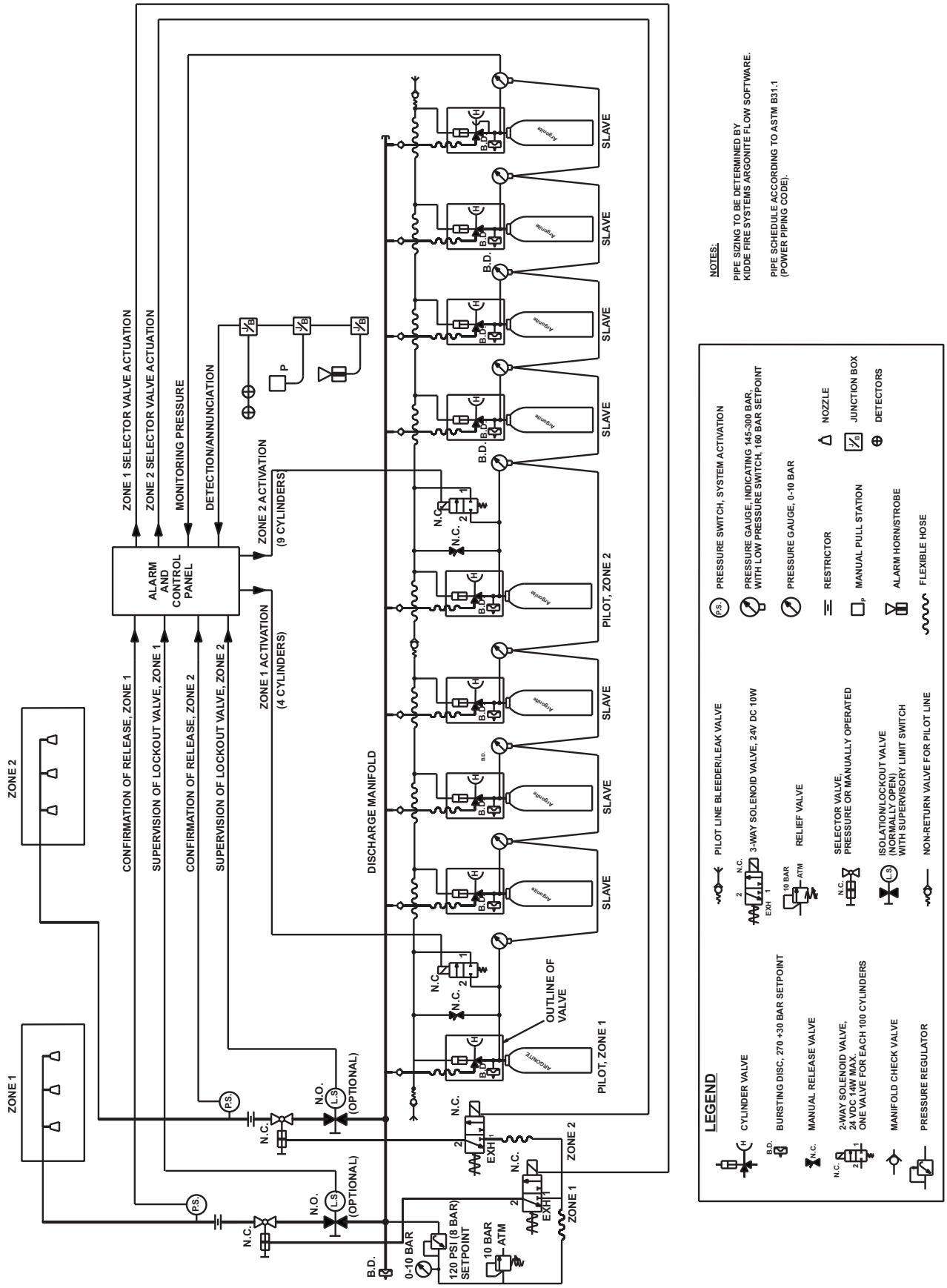

Figure 4-2. Piping and Instrumentation Diagram for Multi-Hazard Argonite System (Two Hazards Shown)

4-4 RESTRICTOR

The purpose of the restrictor is to reduce the pressure of the gas from the cylinder before it enters the piping system. The pressure is reduced from the storage pressure of 2900 PSI (200 bar).

Note: The Kidde Fire Systems Argonite flow calculation software is required to determine restrictor orifice sizes and pressure up and down stream of the restrictor.

4-5 RELEASE MODES

The system is capable of electric, pneumatic and manual actuation and can be released by one or more of the following methods.

4-5.1 Automatic Release

When a fire condition is detected and the control panel goes into an alarm state, the panel will annunciate a visual and/or audible alarm, activate the alarm relay and energize the high-pressure solenoid valve on the pilot cylinder. In a selector valve system, the low-pressure solenoid valve at the selector valve is also energized.

4-5.2 Manual Remote Release, Electrical

Remote release is accomplished by actuation of a switch at a manual release station (if required). Once the station has been actuated, the alarm and control panel will operate the system as described above.

4-5.3 Manual Emergency Release

In the unlikely event of total power failure and expiration of the emergency batteries, the system may be activated by pulling the pin and rotating the actuator handle. In a selector valve system, the manual override on the selector valve for the desired area must also be operated.

Note: The green handle on the top of the cylinder valve is **NOT** for manual operation and **should not be used for the operation of the system.**

4-6 CYLINDERS

Each cylinder is fitted with a pressure operated Argonite cylinder valve. The cylinders are available in 15.9, 66.7 or 80 Liter capacity and filled with Argonite at a pressure of 2900 PSI (200 bar) at 70°F (21.1°C). The cylinders are provided with a protective cap and green shoulder markings.

4-6.1 Cylinder Valves

Each valve is to be provided with a pneumatic operator to open the valve; one of the cylinder valves in the bank must be fitted with a manual/pneumatic actuator. A pressure gauge with supervisory pressure switch is provided for local and/or remote monitoring of cylinder pressure.

The pilot cylinder in a bank is provided with a pressure gauge/solenoid valve actuator unit allowing for electrical release. In event of release by the use of pressure through the manual/ pneumatic actuators on the slave cylinders, the pilot cylinder will provide pressure for their opening. The interconnection between pilot and slave cylinders is accomplished using high pressure flexible hoses.

After a discharge, the cylinder valve will automatically close when the pressure decreases to approximately 45 PSI (3 bar), maintaining a positive pressure as well as preventing moisture from entering the cylinder and thus ensuring corrosion protection of the interior of the cylinder.

4-6.2 Pressure Monitoring

Kidde Fire Systems offers means for remote and local pressure monitoring of the content within the cylinder.

The local monitoring is by the use of the pressure gauge on each cylinder.

The remote monitoring is by the use of a pressure gauge with supervisory pressure switch on each cylinder. The switch, which is normally under pressure, consists of one normally open contact that closes to annunciate loss of pressure at approximately 2200 PSI (150 bar).

4-7 SELECTOR VALVES

In systems where a common cylinder bank protects more than one hazard, selector valves are utilized. The selector valve is a pneumatically actuated ball valve, sized according to the system requirements.

In systems where remote indication of release into a specific area is required, a discharge pressure switch can be fitted downstream of the selector valve.

The solenoid valve energized by the fire alarm/control panel will provide pressure to the pneumatic actuator on the valve. The solenoid valve will close when de-energized, however the ball valve must be closed manually.

4-8 DISTRIBUTION PIPE NETWORK AND NOZZLES

The distribution pipe network is to be designed and the nozzles selected and positioned to allow an even distribution of the Argonite throughout the protected area. The piping and fittings should conform to NFPA 2001, Power Piping Code, and all local codes and standards.

4-9 FLOW CALCULATIONS

Flow calculations are to be based on the design drawings and should be verified prior to installation of the nozzles. Any significant changes should be evaluated, and if necessary, the flow calculation repeated and orifices in restrictor and nozzles replaced to ones suitable for the as-built situation.

All calculations to determine the size of restrictor orifice pipe dimensions and nozzle orifices must be carried out utilizing the approved Argonite software.

4-10 PRESSURE RELIEF VENTING

When released, fixed fire extinguishing systems employing compressed gases will create a considerable extra volume of gas within the room due to expansion. To compensate for the overpressure, suitable means of pressure relief venting must be employed. The free area of these openings/vents shall be appropriately sized to avoid structural damage.

Normal rooms will withstand an increase of pressure of approximately 5 millibars (2 in. H_2O). Pressure relief vents should be located at a high level on the wall or on the ceiling, clear of any direct nozzle discharge. At the end of the discharge the pressure relief vents shall close in order to maintain the extinguishing concentration for as long as possible.

The fire rating of all pressure vents should be equal to or greater than the rating of the structure.

4-11 SERVICE AND MAINTENANCE

The importance of maintenance cannot be overemphasized. Trained personnel shall regularly service an Argonite system. The service engineer shall be proficient in the installation and commissioning of Argonite systems as well as have detailed knowledge of the involved components.

At least annually, all systems shall be thoroughly inspected and tested for proper operation. The inspection should include a verification of the integrity of the protected volume and assurance that the protected volume has not increased or decreased. Changes in installed equipment occupying additional or less volume than at the design/installation stage will affect the resulting oxygen concentration after a discharge. A recalculation of the system may be required.

NFPA 2001 requires that if an Argonite cylinder shows a loss in pressure (adjusted for temperature) of more than 5% (2750 PSI at 70°F or 190 bar at 21.1°C) it shall be refilled or replaced. The cylinder pressure gauge reading shall be compared to a separate calibrated device at least annually.

Refer to Chapter 8 for further service and maintenance procedures.

CHAPTER 5
SYSTEM BASICS

5-1 INTRODUCTION

- The cylinders are installed in racks available in single, dual or quadruple row configuration.
- An Argonite® system may consist of one or more cylinders, connected through a common discharge manifold arrangement (cylinder bank).
- The cylinders in the bank are connected to a common release manifold arrangement via high pressure hoses and a check valve assembly, one for each cylinder. The check valves allow removal of one or more cylinders from the manifold.
- The cylinder valves are constructed to be capable of releasing of 80 Liters at 2900 PSI (200 bar) within 1 minute.
- The system can be released manually by removing a safety pin and turning the actuator handle. The manual release unit is mounted on the side of the pilot cylinder valve.

Note: The green handle on the top of the cylinder valve is **NOT** for manual operation and **should not be used for the operation of the system.**

- The cylinders are provided with a pressure gauge assembly and the pilot cylinder is also provided with a solenoid valve/manual release/gauge assembly.
- When energized, the solenoid valve will provide pressure for opening all of the cylinder valves.
- The pressure from the pilot cylinder is fed to pneumatic actuators on the slave cylinders.
- The manifold arrangement is further equipped with restrictor(s), which reduce the discharge piping pressure during the discharge.
- Selector valves may be used to divert Argonite to the required hazard.
- From the restrictor, Argonite is fed through a piping system to the nozzles, which distributes the gas in the room.
- An Argonite system is to be monitored and controlled by the building fire alarm and control panel or a local fire alarm and control panel (depending on local approval and/or requirements). Fire detectors for each hazard shall be selected based on the flammables involved, their burning rate and the accepted response time.
- The room should be evacuated before discharge in order to secure both the extinguishing effect as well as human safety (secure the hazard during and after the release). The control panel may be equipped with a time delay of 10 to 30 seconds (depending on requirements of authorities having jurisdiction). The warning alarm shall start sounding simultaneously with the start of the time delay period.

5-2 EXTINGUISHING EFFECT

Argonite is a 50/50 mixture of Nitrogen and Argon (N_2/Ar). When Argonite is discharged, an inert atmosphere is created in the protected hazard. Within a short time, the fire will be suffocated as the oxygen content will decrease from the normal 20.9% to 15 to 10% (depending on the flammables involved).

For most flammable liquids and solid materials, a 15% oxygen level is the lowest limit at which a fire can be sustained; however 30% safety factor requirements result in the 12.5 to 13% oxygen level. A 12% oxygen level is the lowest limit acceptable for personnel occupancy in the protected hazard/room.

Note: In order to achieve extinguishment of some materials, it is necessary to lower the oxygen level below 10%. These systems require special safety precautions.

CHAPTER 6
SYSTEM COMPONENTS

6-1 CYLINDERS

Argonite® gas is stored in high pressure cylinders having a filling pressure of 2900 PSI (200 bar) and a test pressure of 4830 PSI (333 bar).

The 66.7 and 80 Liter cylinders are spaced 12 in. (305 mm) apart and can be installed in single, double and quadruple row configurations. The 15.9 Liter cylinder, used for smaller protected spaces, is usually mounted separately.

Because Argonite is stored as a non-liquefied gas, dip tubes are not used, allowing the cylinders to be installed either vertically or horizontally, as required. All rack configurations are for vertical mounting only.

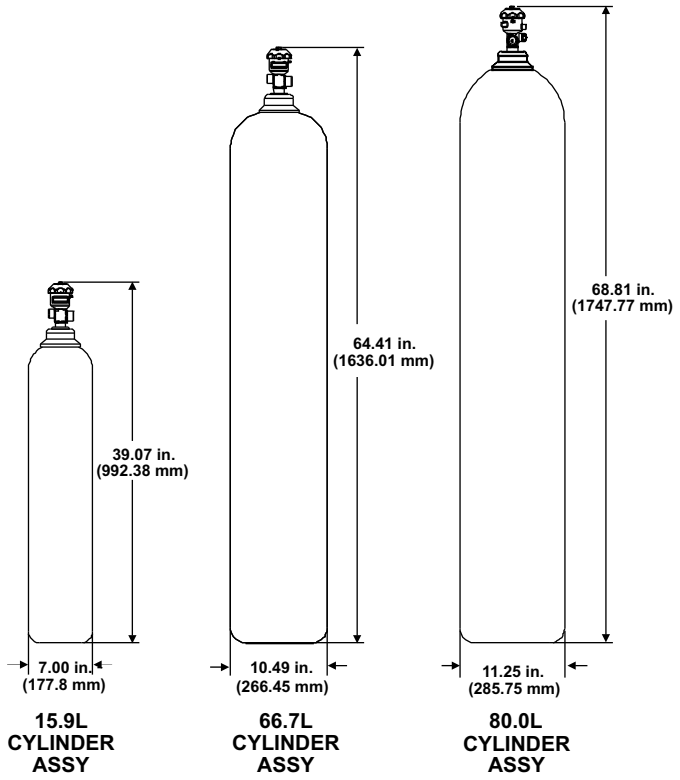

Figure 6-1. Cylinder Assemblies

Table 6-1. Cylinder Assembly Specifications

Part Number	Description	Filled Weight		Empty Weight	
		lb.	kg	lb.	kg
38-100159-001	15.9 Liter Cylinder Assembly (Filled Cylinder and Valve)	74	33.5	64	29.0
38-100667-001	66.7 Liter Cylinder Assembly (Filled Cylinder and Valve)	266	120.7	223	101.2
38-100800-001	80 Liter Cylinder Assembly (Filled Cylinder and Valve)	324	147.0	273	123.8

6-2 CYLINDER VALVE

Each cylinder is supplied with a pneumatic cylinder valve (discharge valve). The cylinder valve is equipped with a burst disc and must also be equipped with a completer kit that will include a pressure gauge with supervisory pressure switch, hose and connection fittings.

The completer kits allow the valves to be released either electrically, by means of a solenoid, or pneumatically, using the manual release. The valve discharge outlet is connected to the discharge manifold via a high pressure flexible hose and a check valve.

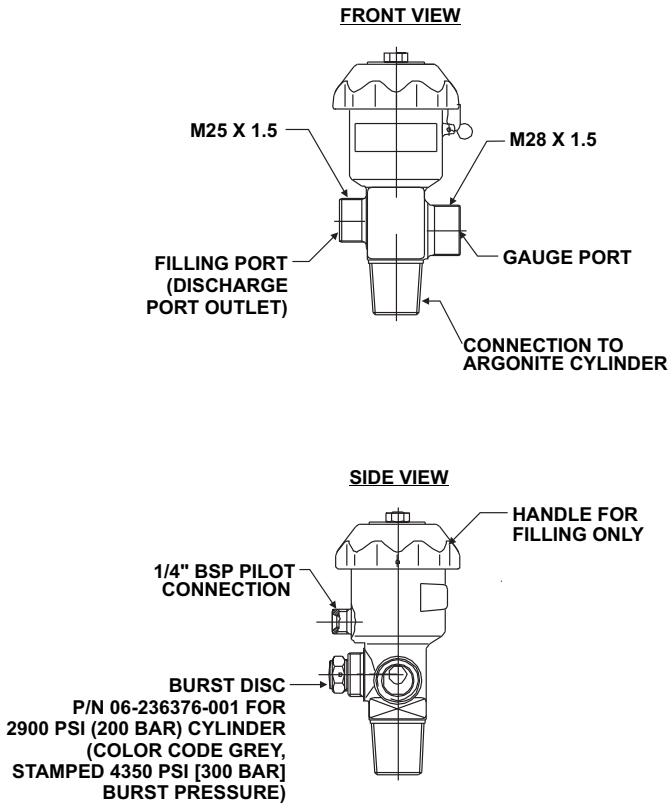

Figure 6-2. Argonite Cylinder Valve, P/N 06-220015-001

6-3 CYLINDER RELEASE

The pressure for activation is taken from the primary/pilot cylinder through the electrical actuator and via high pres-sure flexible hoses connected to the pneumatic actuator inlet on the pilot cylinder as well as to the actuator inlets on the neighboring slave cylinders. The actuation ports on the cylinders are interconnected by the use of high pressure flexible hoses. The arrangement allows all the cylinders in the cylinder bank to be opened almost simultaneously.

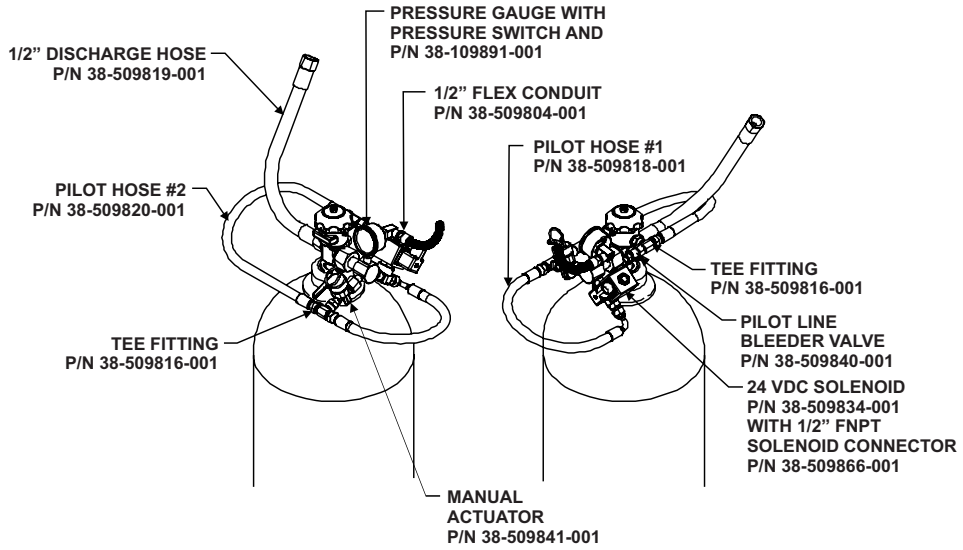

Figure 6-3. Primary Completer Kit

Table 6-2. Primary Completer Kit Information

Rating	Part Number	Description
NEMA 4	38-109802-001	Completer Kit includes: Manual Release Pressure Gauge with Supervisory Pressure Switch, Solenoid, Bleeder Valve, Hoses, Fittings and Emergency Operation Nameplate

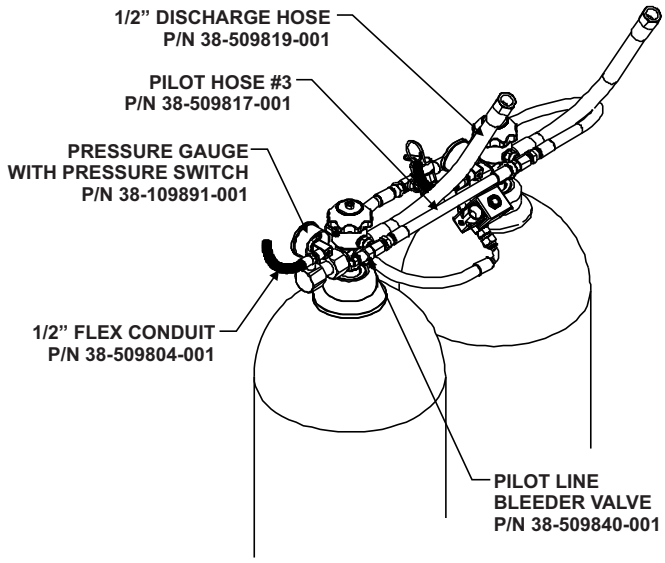

Figure 6-4. Standard Primary and Slave Completer Kit

Table 6-3. Slave Completer Kit Information

Rating	Part Number	Description
NEMA 4	38-109803-001	Completer Kit includes: Pressure Gauge with Supervisory Pressure Switch, Hoses and Fittings

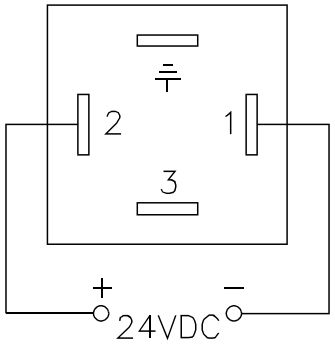

Figure 6-5. Solenoid Wiring Diagram

6-4 ELECTRICAL ACTIVATION

One solenoid valve (primary completer kit) can be used to actuate up to a maximum of 100 cylinders. When the number of system cylinders exceeds 100, two solenoid valves (two primary completer kits) must be used.

6-5 MANIFOLDS

Kidde Fire Systems does not supply manifolds or manifold components, except where noted. Manifold assemblies must be designed, as a minimum, in accordance with ASME B31.1, Power Piping code, NFPA 2001 and all state and local codes. The calculated thickness of the piping and the strength of fittings shall be based on the maximum internal working pressures anticipated.

For single cylinder systems, an Adapter (P/N 38-509828-001) is required to connect the discharge hose (BSP) directly to the Schedule 160 manifold pipe (NPT).

For multiple cylinder systems, a Check Valve (P/N 38-509833-001) is required to connect each discharge hose (BSP) to the manifold's welded thredolets (NPT).

Note: Check valves allow for the Argonite system to function properly if cylinders are disconnected from the manifold. Check valves will seal under normal working pressures, but may leak at pressures less than 700 PSIG (48 bar).

Test caps (P/N 38-509865-001) may be used to seal Check Valves, if required.

The examples below are provided for informational purposes only.

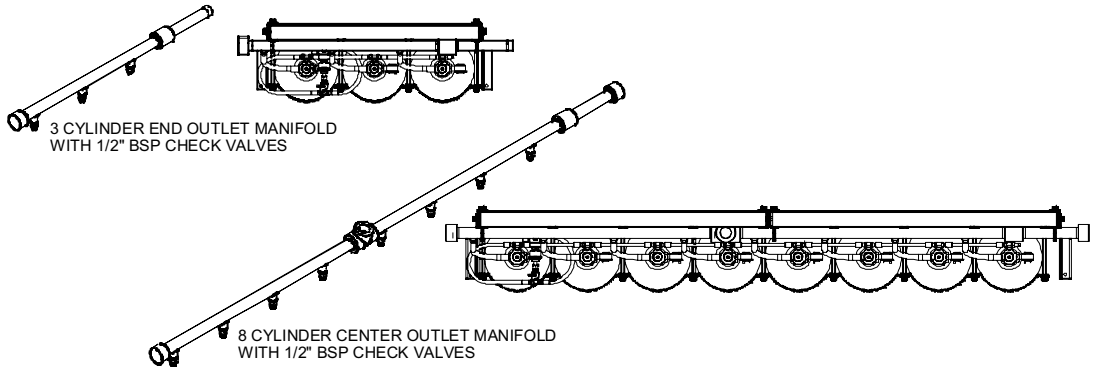

Figure 6-6. One Row Manifold Example

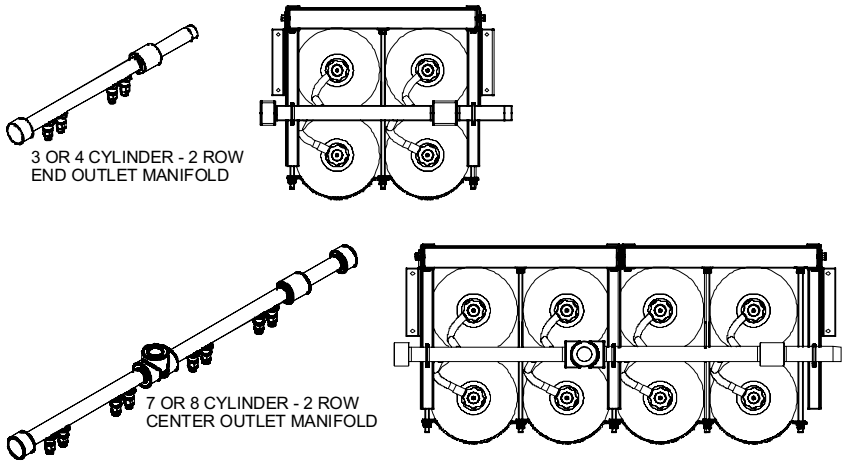

Figure 6-7. Two Row Manifold Example

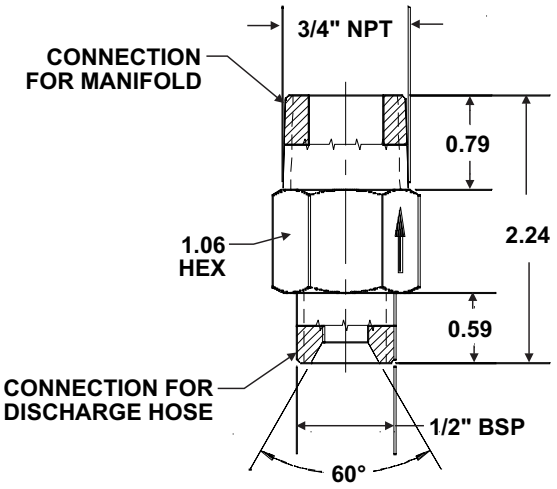

Figure 6-8. Check Valve, P/N 38-509833-001

6-6 SELECTOR VALVE SYSTEMS

Selector valves are used in multiple hazard systems where Argonite may be supplied to different hazards from the same cylinder bank. Refer to Figures 6-9, 6-10 and 4-2 for layouts of typical selector valve arrangement.

Systems that utilize differing numbers of cylinders for each hazard **MUST** use a pilot line non-return (check) valve (P/N 38-509832-001). This valve allows for a portion of the pilot line to be used for system activation, as needed. Separate pilot cylinders must be used for each hazard. For example, in Figure 4-2 when the Zone 1 pilot cylinder is activated, only 4 cylinders will discharge into the manifold. When the Zone 2 pilot cylinder is activated, all nine cylinders will discharge. The pilot line non-return valve (Figure 6-10) allows for the proper amount of Argonite to be discharged into each hazard.

Using the standard primary completer kit assembly(s), the cylinders to be released are discharged into the discharge manifold(s). At the end of the discharge manifold, customer supplied fittings and/or a selector manifold is used to contain the Argonite pressure until the proper selector valve is operated to release Argonite into the hazard area. The selector valves operate pneumatically or manually.

The pressure required to operate the selector valves is taken from the discharge manifold via a pressure regulator assembly (P/N 38-509803-001). One common regulator is used to reduce the operating pressure to 120 PSI (8.3 bar) for selector valve actuation.

Each selector valve is equipped with its own actuator and is supplied with a 24 Vdc 3-way solenoid. When actuated, the solenoid will route pressure to the actuator to open the selector valve. Once opened, the selector valve will remain open until manually closed.

Restrictors for each hazard area are to be installed downstream of their respective selector valves.

Note: All discharge piping upstream of the restrictors, including the selector valve manifold, must be Schedule 160 or stronger.

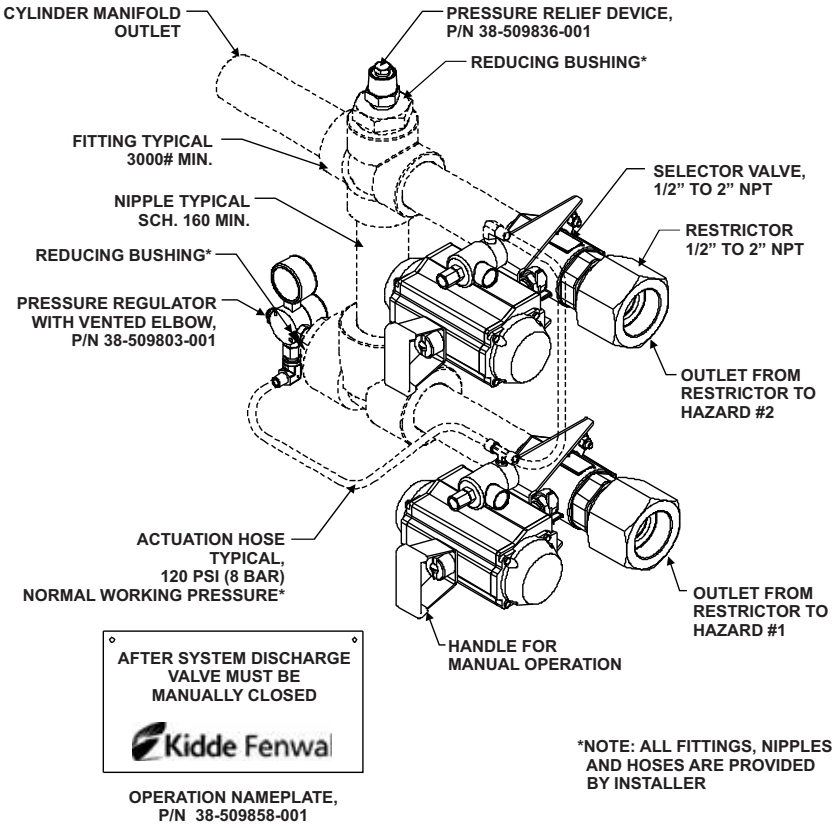

Figure 6-9. Typical Selector Valve System Arrangement

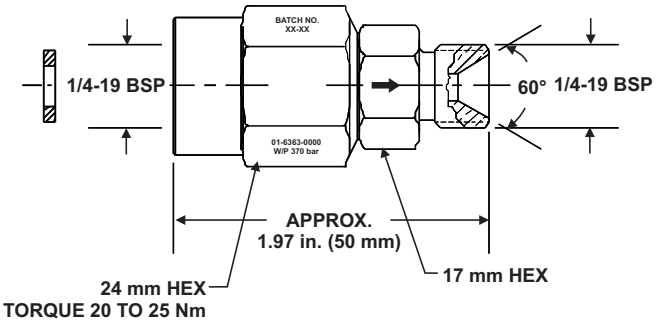

Figure 6-10. Non-Return (Check) Point for Pilot Lines, P/N 38-509832-001

The selector valve manifold or piping configuration is supplied by others (not Kidde Fire Systems) and must include a 3/4 in. relief valve (P/N 38-509836-001) and a 1/4 in. NPT fitting for connection of the pressure regulator. The relief valve and regulator are supplied as part of the Pressure Regulator Kit (P/N 38-509803-001).

6-6.1 Pressure Regulator Kit, P/N 38-509803-001

The preassembled pressure regulator kit consists of the Pressure Regulator (preset at 120 PSIG) with gauge and relief valve, the gauge adapters, the gauge adapter kits, a vented elbow and a 3/4 in. pressure relief valve. See Figure 6-11 and Table 6-4 for more information.

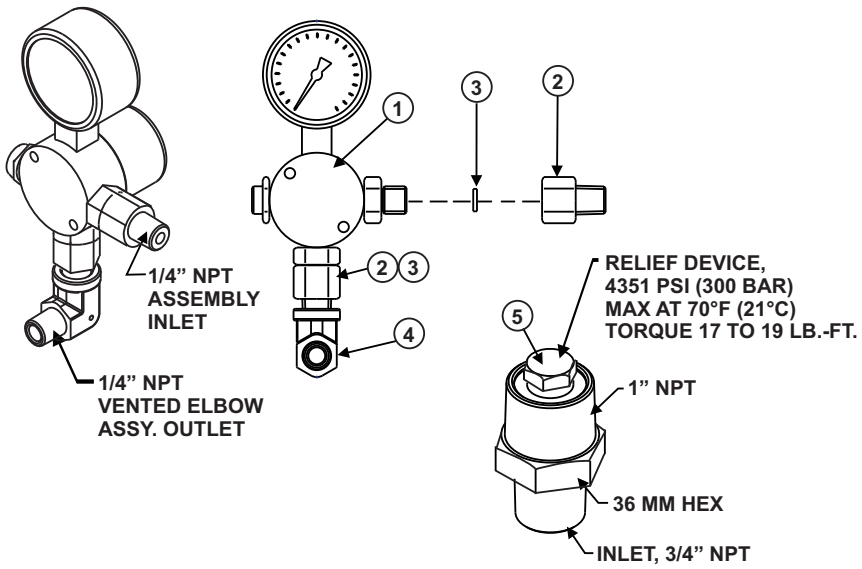

Figure 6-11. Selector Valve Pressure Regulator Kit, P/N 38-509803-001

Table 6-4. Pressure Regulator Kit

Item Number	Part Number	Description	Qty.
1	38-509830-001	Pressure Regulator preset at 120 PSI (8.3 bar) with gauge and relief valve	1
2	38-509825-001	Gauge Adapters (converts threads from BSP to NPT)	2
3	38-809826-001	Gauge Adapter Kits	2
4	38-509867-001	Vented Elbow, 1/4 in. NPT	1
5	38-509836-001	3/4 in. Pressure Relief Valve, 4350 PSI (300 bar)	1

6-6.2 Selector Valve Assemblies

Each selector valve assembly consists of the selector valve (in various sizes from 1/2" up to 2") with actuator and reset handle. It will also include the 24 Vdc 3-way actuation solenoid (weatherproof), and the nipple connector to assemble the unit.

The selector valves will operate pneumatically by actuating the solenoid, but because of the design of the unit, the valves must be closed manually after the discharge. An operation nameplate is also provided to be mounted near the associated selector valve assemblies.

All selector valves have a working pressure of 2900 PSI (200 bar).

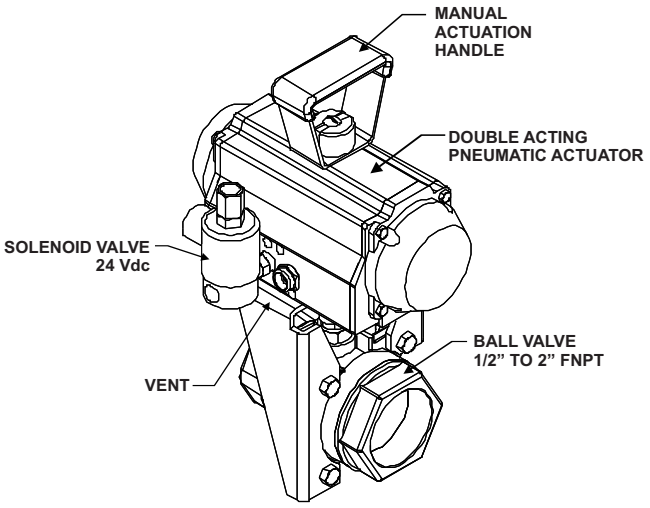

Figure 6-12. Selector Valve (Typical)

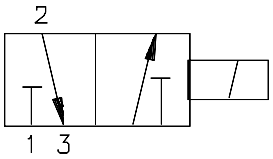

Figure 6-13. Selector Valve Solenoid Wiring Schematic

Table 6-5. Selector Valve Assemblies

With 24 Vdc 3-Way Solenoid (Weather-Proof)*	
Part Number	**Description**
38-609800-001	1/2 in. NPT (15 mm)
38-609800-002	3/4 in. NPT (20 mm)
38-609800-003	1 in. NPT (25 mm)
38-609800-004	1¼ in. NPT (32 mm)
38-609800-005	1½ in. NPT (40 mm)
38-609800-006	2 in. NPT (50 mm)
Note: * Assembly also includes Actuator, Reset Handle, Connector and Operation Nameplate.	

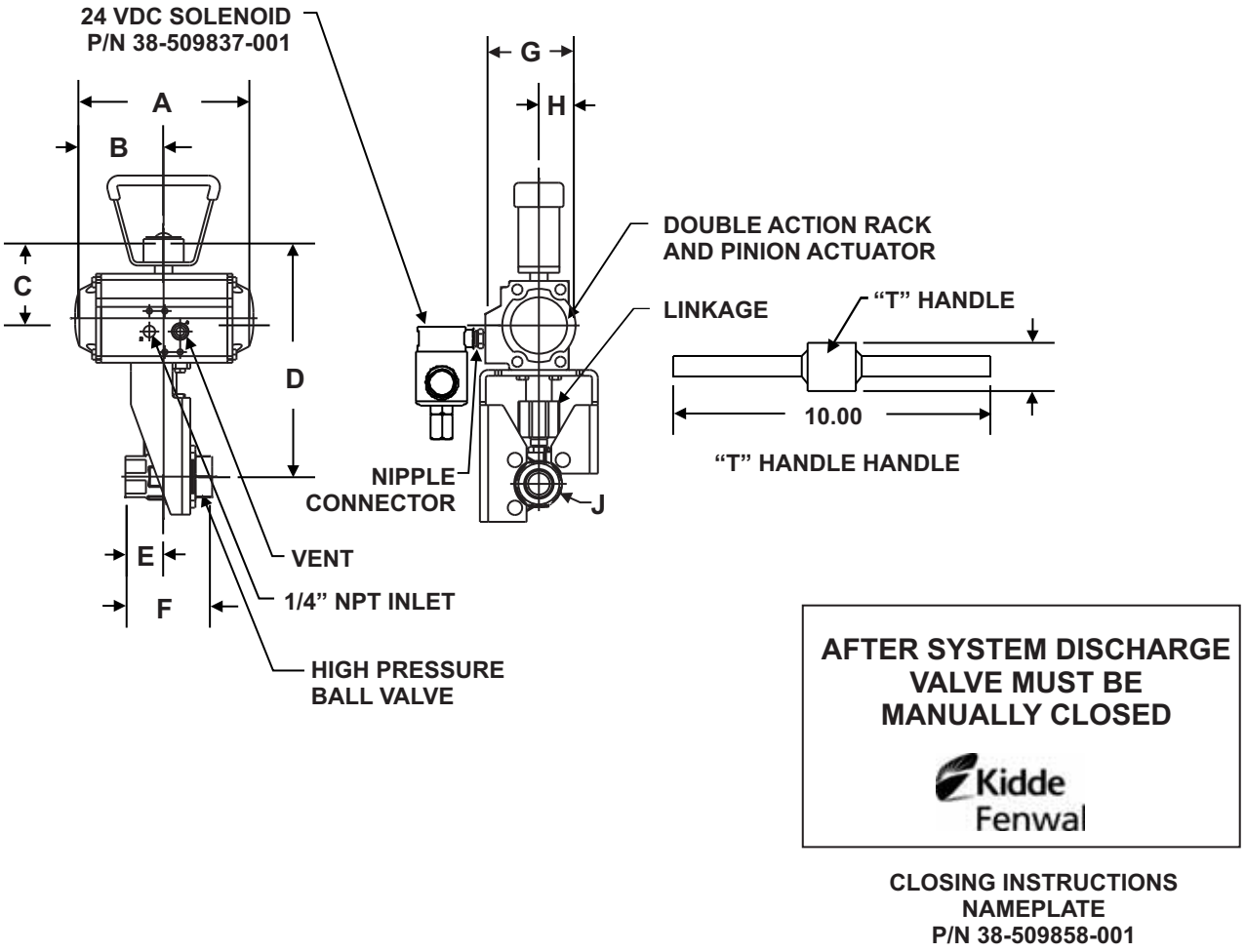

Figure 6-14. Detail, Selector Valve Assembly (Typical)

Table 6-6. Selector Valve Dimensions

Valve Size	Assembly Part Number	Dimensions									Nipple Connector
		A	B	C	D	E	F	G	H	J	
1/2 in.	38-509848-001	5.53	2.77	2.14	6.97	1.55	2.73	2.77	1.14	0.50	38-509813-001
3/4 in.	38-509848-002	6.24	3.12	2.46	7.29	1.92	3.50	3.27	1.42	0.88	38-509813-001
1 in.	38-509848-003	6.24	3.12	2.46	7.52	1.92	3.60	3.27	1.42	0.88	38-509813-001
1¼ in.	38-509848-004	8.24	4.14	2.80	8.65	2.10	3.93	3.72	1.67	1.00	38-509813-001
1½ in.	38-509848-005	9.74	4.87	3.05	9.35	2.47	4.55	4.18	1.95	1.25	38-509813-001
2 in.	38-509848-006	10.57	5.28	3.29	10.02	2.66	4.94	4.84	2.20	1.50	38-509814-001
Note: The Selector Valve Assembly part numbers listed only include the Valve, Actuator and Reset Handle.											

Table 6-7. Selector Valve Assembly Replacement Parts

Part Number	Description
38-509848-001	1/2" Valve, Actuator and Reset Handle Only
38-509848-002	3/4" Valve, Actuator and Reset Handle Only
38-509848-003	1" Valve, Actuator, and Reset Handle Only
38-509848-004	1¼" Valve, Actuator and Reset Handle Only
38-509848-005	1½" Valve, Actuator and Reset Handle Only
38-509848-006	2" Valve, Actuator and Reset Handle Only
38-509837-001	Solenoid, 24 Vdc, 3-Way, Weatherproof
38-509813-001	Nipple Connector 1/8" x 1/4" NPT (1/2" to 1½" Valves)
38-509814-001	Nipple Connector 1/4" x 1/4" NPT (2" Valves Only)
38-509858-001	Closing Instructions Nameplate

6.6.3 Isolation (Lockout) Valve Assemblies

Isolation (lockout) valves may be installed for maintenance/service reasons; for multi-hazard systems they are typically installed upstream of the selector valve as illustrated in Figure 4-2. For single hazard systems, the isolation valves shall be located upstream of the restrictor. These devices **MUST** be locked in the OPEN position whenever the Argonite System is in operational/standby condition. When the discharge piping is being serviced, these valves **MUST** be locked in the CLOSED position.

Isolation valve assemblies include a high visibility indicator and weatherproof limit switch. The limit switch shall initiate a "Trouble" signal at the control panel when the ball valve is in the closed position. All ball valves have a working pressure of 2900 PSI (200 bar). When using isolation valves, a pressure relief valve should also be installed wherever pressure could be trapped in closed sections of pipe.

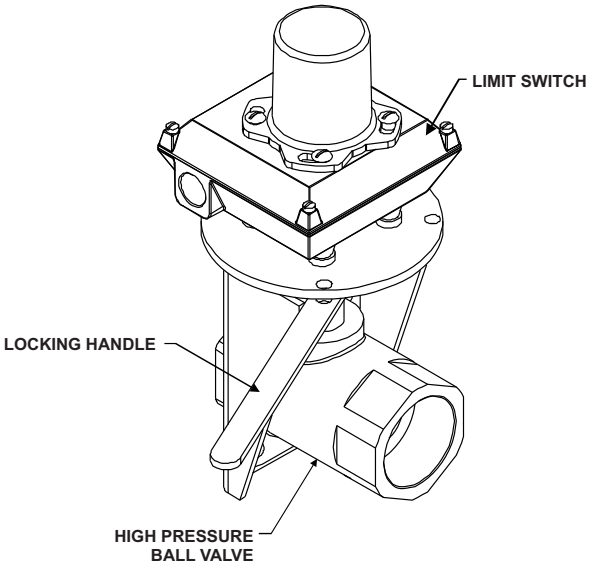

Figure 6-15. Isolation (Lockout) Valve, Typical

Table 6-8. Isolation (Lockout) Valve Assemblies

NEMA 4 and 4X with Limit Switch, 2-SPDT	
Part Number	**Size**
38-509835-001	1/2 in.
38-509835-002	3/4 in.
38-509835-003	1 in.
38-509835-004	1¼ in.
38-509835-005	1½ in.
38-509835-006	2 in.

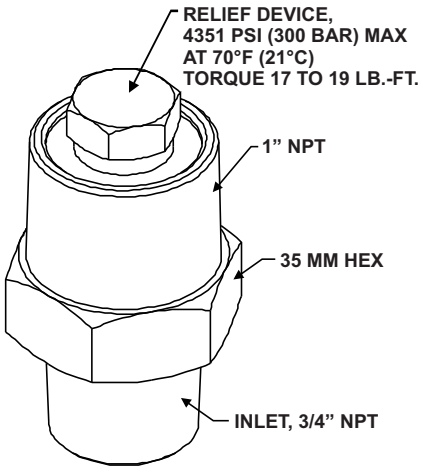

Figure 6-16. Pressure Relief Valve, P/N 38-509836-001

6-7 RESTRICTOR/ORIFICE

The high-pressure 2900 PSI (200 bar) Argonite is discharged into the distribution pipe network through a restrictor assembly. During agent flow, the restrictor reduces the initial manifold pressure before the agent enters the distribution piping. The size of the orifice is calculated based on the required discharge time and the required flow.

The restrictors are normally fitted onto the discharge manifolds; however, in certain cases—for example, single cylinder systems—the restrictor is installed directly at the beginning of the discharge piping. Discharge pipe/manifold pipe type restrictors are female NPT to female NPT, threaded.

The restrictor assures that the Argonite will be delivered to the distribution pipe network and discharge nozzles at the proper predetermined pressure. Restrictors are available in 1/2", 1", 1½" or 2" NPT. Larger 2½", 3" and 4" flange type orifice plate restrictors are also available.

6-7.1 Flow Restrictor

Size 1/2", 1" and 1½" restrictors are brass; 2" restrictor is stainless steel. See Figure 6-17 and Table 6-9 below.

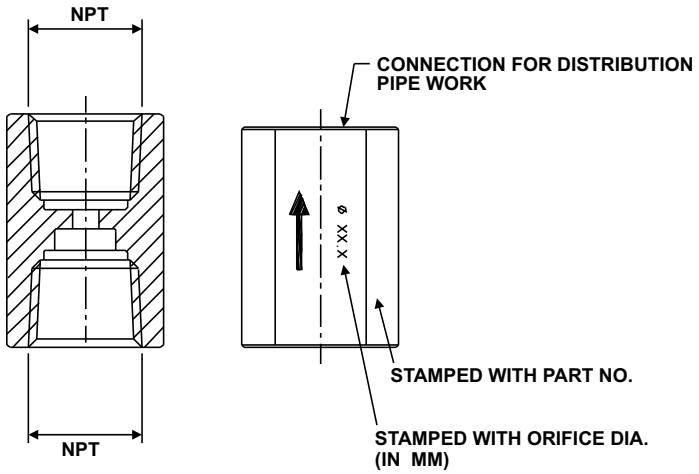

Figure 6-17. Threaded Restrictor

Table 6-9. Threaded Restrictor Details

Part Number	Description
38-050003-XXX	1/2" Brass Restrictor Code 3.5 to 7.5
38-100003-XXX	1" Brass Restrictor Code 5.0 to 13.0
38-150003-XXX	1½" Brass Restrictor Code 8.5 to 22.0
38-200003-XXX	2" St. Steel Restrictor Code 11.5 to 27.0
Note: When ordering, specify an 11-digit hyphenated part number, the restrictor part number plus the three-digit orifice code (e.g., 38-100003-070 to order a line restrictor, orifice code 7.0).	

6-7.2 Orifice Plate Restrictor Assemblies

For large systems with 2-1/2, 3, or 4 inch pipe, use a Class 1500# flange. Only the orifice plate will be provided by Kidde Fire Systems. The flange nuts must be torqued to at least the minimum required by the flange manufacturer. See Figure 6-18 and Table 6-10.

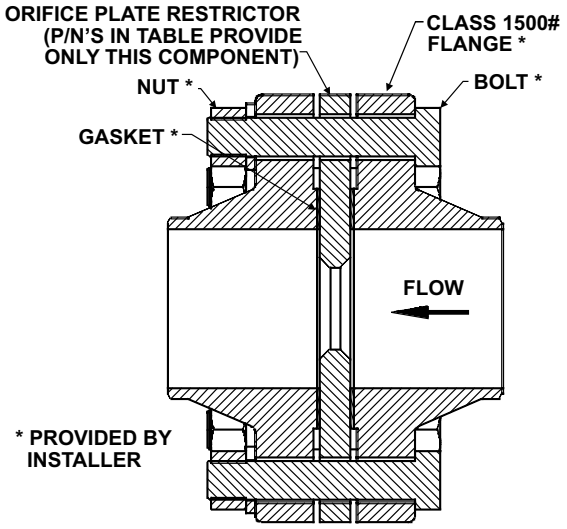

Figure 6-18. Flanged Restrictor Assembly

Table 6-10. Flange Restrictor Assembly Details

Part Number	Description
38-250001-XXX	2½ in. Orifice Plate Restrictor, Code 13.5 to 35.0
38-300001-XXX	3 in. Orifice Plate Restrictor, Code 18.0 to 43.0
38-400001-XXX	4 in. Orifice Plate Restrictor, Code 25.0 to 56.0
Note: When ordering, specify an 11-digit hypenated part number; the flanged orifice plate restrictor part number plus the three-digit orifice code (e.g., 38-300001-240 to order a 3 in. flanged orifice plate, orifice code 24.0).	

6-8 NOZZLES

Discharge nozzles are available in sizes from 1/2" to 1½". Each nozzle is available with a variety of orifices. The nozzles are to be installed in a position where the agent release will be most effective, allowing for unobstructed flow of the discharge stream. The nozzles shall be installed in a manner so that they will not potentially cause injury to personnel. When discharged from the nozzle, the agent should not directly impinge on areas where personnel might be found in the normal work area. The agent shall not impinge on any loose objects on shelves, cabinet tops, or similar surfaces where loose objects could be present and become missiles. Normally, the nozzles are located at ceiling level.

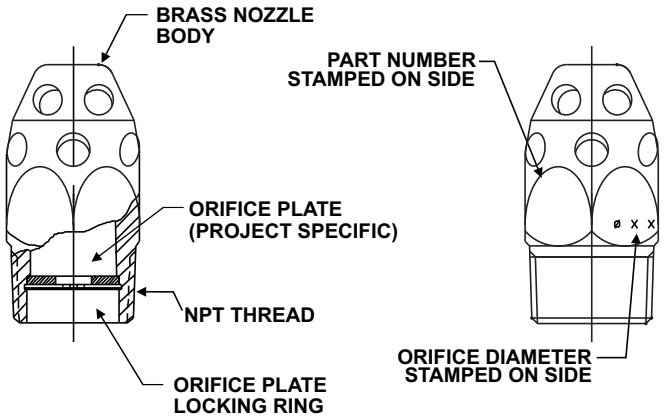

Figure 6-19. Discharge Nozzles

Table 6-11. Discharge Nozzle Description

Part Number	Description
38-300502-XXX	1/2 in. Nozzle (NPT) available in codes 3.0 to 10.0
38-300752-XXX	3/4 in. Nozzle (NPT) available in codes 4.0 to 13.5
38-301002-XXX	1 in. Nozzle (NPT) available in codes 5.0 to 17.0
38-301502-XXX	1½ in. Nozzle (NPT) available in codes 8.0 to 26.0
Note: When ordering, specify an 11-digit hyphenated part number–the nozzle assembly part number plus the three-digit orifice code (e.g., 38-301002-150 to order a 1 in. nozzle, orifice code 15.0).	

6-9 CYLINDER RACKS

6-9.1 Cylinder Mounting Bracket (P/N 38-109875-001)

Due to the relatively small size and light weight of the 15.9L cylinder assembly, the typical mounting bracket for this unit allows the cylinder to be wall mounted.

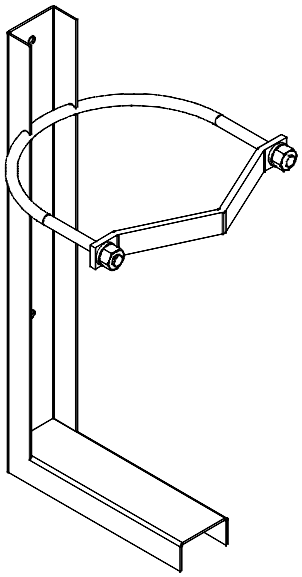

Figure 6-20. 15.9 L Cylinder Mounting Bracket

6-9.2 Wall Mount Bracket Kit for 66.7L and 80L Cylinders with Manifold Mounting Brackets

Each kit consists of unistrut steel mounting rails, threaded rods and straps, and hardware for 1 to 12 cylinders. Manifold mounting brackets are not included and must be ordered separately.

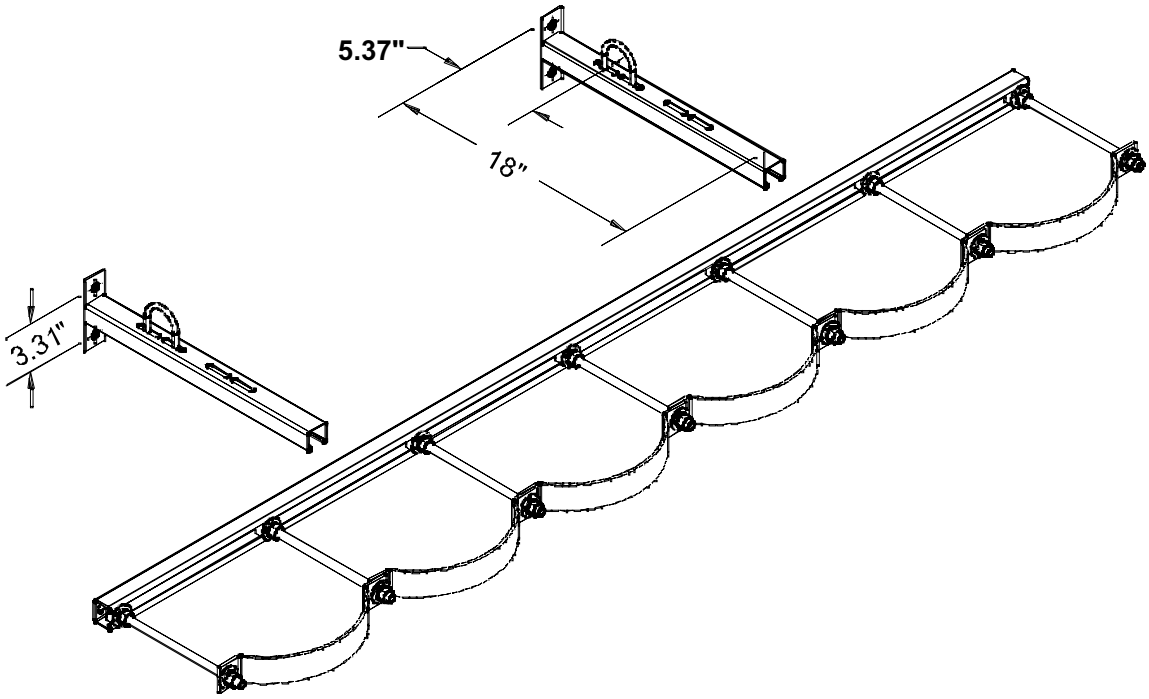

Figure 6-21. 66.7 and 80 L Cylinder Wall Mount Rack Kit and Wall Mount Brackets for Manifold

Table 6-12. Wall Mount 1-Row Rack Kit Ordering Information

Part Number	Number of Cylinders
38-109879-001	1
38-109880-001	2
38-109881-001	3
38-109882-001	4
38-109883-001	5
38-109884-001	6
38-109885-001	7
38-109886-001	8
38-109887-001	9
38-109888-001	10
38-109889-001	11
38-109890-001	12

Table 6-13. Wall Mount Brackets for Discharge Manifold Ordering Information

Part Number	Manifold Clamp Size	Manifold Note
38-503073-001	1 in.	A 1 in. manifold will typically flow from 2 to 6 cylinders.
38-503073-002	1½ in.	7 to 10 cylinder arrangements will most often require a 1½ in. manifold
38-503073-003	2 in.	When flowing 11 or 12 cylinders, a 2 in. manifold is usually required.
Note: A minimum of two (2) brackets is required. All brackets are 18 in. long, 3/8" to center line.		

6-9.3 Cylinder Rack Assemblies, Free Standing Racks

The cylinder racks are available in four basic styles:

- One row/one side
- One row/two sides
- Two rows/one side
- Two rows/two sides

The cylinder racks are shipped disassembled and must be field assembled. When assembled, the rack should be aligned so that the vertical upright sections are parallel. It is desirable and recommended to have the rack bolted to the floor and a wall or other vertical surface.

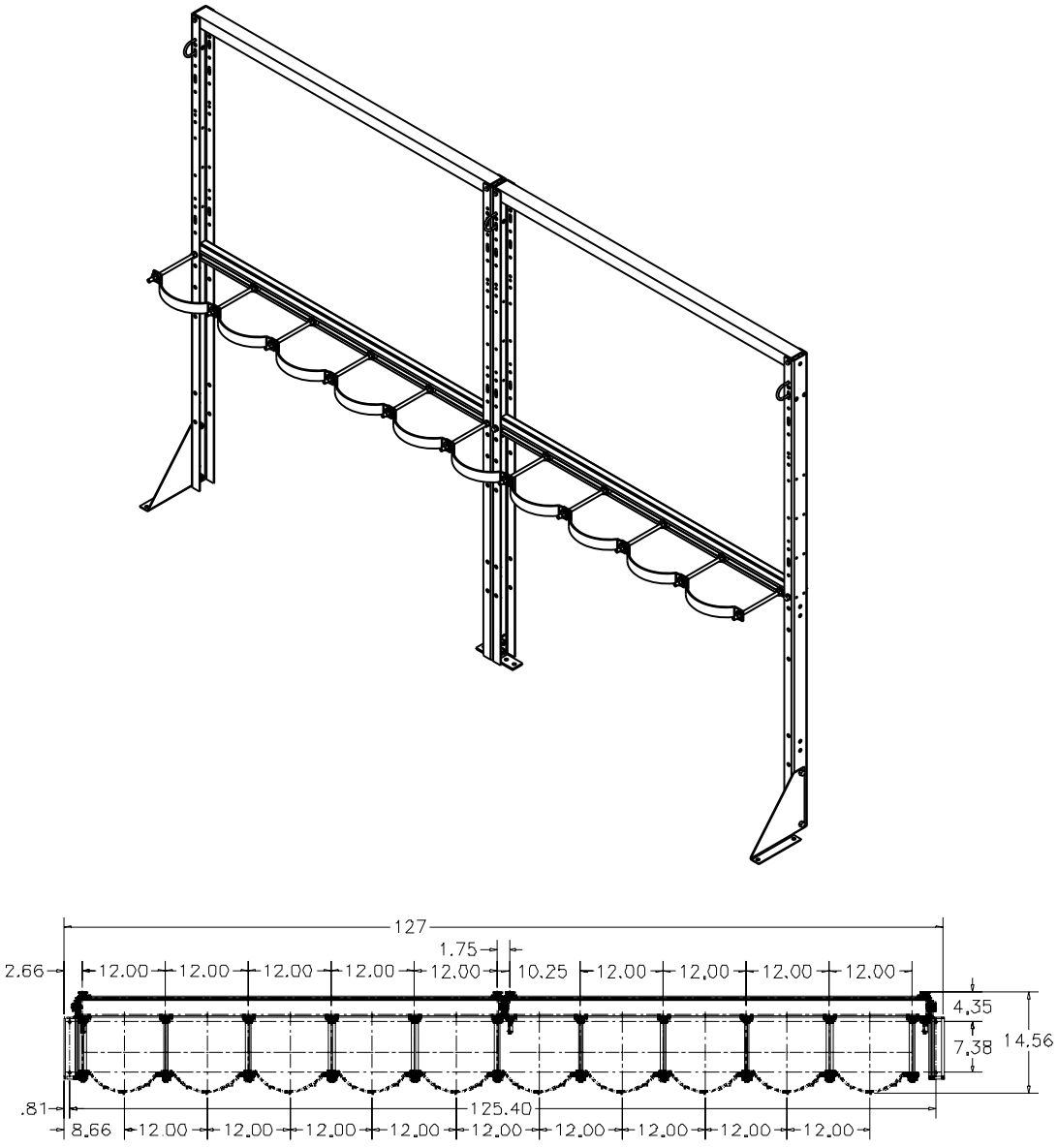

Figure 6-22. One Row/One Side Cylinder Rack (10 Cylinder Rack Assembly Shown)

Mount the discharge manifold to the rack uprights by means of the U-bolts supplied. Do not tighten the U-bolts until the cylinders and hosing have been connected. Some minor height adjustments may be required.

6-9.3.1 ONE ROW/ONE SIDE CYLINDER RACKS

Table 6-14. Rack Information

Part Number	Rack Size
38-109809-001	2 Cylinders
38-109810-001	3 Cylinders
38-109811-001	4 Cylinders
38-109812-001	5 Cylinders
38-109813-001	6 Cylinders
38-109814-001	7 Cylinders
38-109815-001	8 Cylinders
38-109816-001	9 Cylinders
38-109817-001	10 Cylinders
38-109818-001	11 Cylinders
38-109819-001	12 Cylinders

Table 6-15. Cylinder Rack Kits, One Row/One Side

Item Number	Description	2 Cylinder P/N 38-109809-001		3 Cylinder P/N 38-109810-001		4 Cylinder P/N 38-109811-001		5 Cylinder P/N 38-109812-001		6 Cylinder P/N 38-109813-001		7 Cylinder P/N 38-109814-001	
		Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number
1	Header	1	38-503075-001	1	38-503075-002	1	38-503075-003	1	38-503075-004	1	38-503075-005	1	38-503075-002
2	3/8 in. - 16 in. x 1 in. HHDCS	2	38-503076-001	2	38-503076-001	2	38-503076-001	2	38-503076-001	2	38-503076-001	4	38-503076-001
3	3/8 in. Lockwasher	2	38-503077-001	2	38-503077-001	2	38-503077-001	2	38-503077-001	2	38-503077-001	4	38-503077-001
4	3/8 in. - 16 HEX Nut	2	38-503078-001	2	38-503078-001	2	38-503078-001	2	38-503078-001	2	38-503078-001	4	38-503078-001
5	U-Bolt	2	38-503079-003	2	38-503079-003	2	38-503079-003	2	38-503079-003	2	38-503079-003	3	38-503079-002
6	U-Bolt Lockwasher	4	38-503080-001	4	38-503080-001	4	38-503080-001	4	38-503080-001	4	38-503080-001	6	38-503080-002
7	Upright	2	38-503081-001	2	38-503081-001	2	38-503081-001	2	38-503081-001	2	38-503081-001	4	38-503081-001
8	Rail	1	38-503074-001	1	38-503074-002	1	38-503074-003	1	38-503074-004	1	38-503074-005	1	38-503074-003
9	1/2 in. -13 Channel Nut	5	38-503082-001	6	38-503082-001	7	38-503082-001	8	38-503082-001	9	38-503082-001	15	38-503082-001
10	1/2 in. Lockwasher	12	38-503083-001	14	38-503083-001	16	38-503083-001	18	38-503083-001	20	38-503083-001	30	38-503083-001
11	Stud (Threaded Rod)	3	38-503084-001	4	38-503084-001	5	38-503084-001	6	38-503084-001	7	38-503084-001	9	38-503084-001
12	1/2 in. Flat Washer	4	38-503085-001	6	38-503085-001	8	38-503085-001	10	38-503085-001	12	38-503085-001	14	38-503085-001
13	1/2 in. - 13 HEX Nut	10	38-503086-001	12	38-503086-001	14	38-503086-001	16	38-503086-001	18	38-503086-001	26	38-503086-001
14	Cylinder Strap	2	38-503087-001	3	38-503087-001	4	38-503087-001	5	38-503087-001	6	38-503087-001	7	38-503087-001
15	Brace, Left Side	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001
16	Brace, Right Side	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	6	38-503090-001	6	38-503090-001	6	38-503090-001	6	38-503090-001	6	38-503090-001	13	38-503090-001
18	1/2 in. -13 x 1½ in. HHDCS	–	–	–	–	–	–	–	–	–	–	2	38-503091-001
19	Rail Support	–	–	–	–	–	–	–	–	–	–	2	38-503092-001
20	Rail	–	–	–	–	–	–	–	–	–	–	1	38-503074-002
21	Header	–	–	–	–	–	–	–	–	–	–	1	38-503075-003

Item Number	Description	8 Cylinder P/N 38-109815-001		9 Cylinder P/N 38-109816-001		10 Cylinder P/N 38-109817-001		11 Cylinder P/N 38-109818-001		12 Cylinder P/N 38-109819-001	
		Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number
1	Header	2	38-503075-003	1	38-503075-003	2	38-503075-004	1	38-503075-004	2	38-503075-005
2	3/8 in. - 16 in. x 1 in. HHDCS	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001
3	3/8 in. Lockwasher	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001
4	3/8 in. - 16 HEX Nut	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001
5	U-Bolt	3	38-503079-002	3	38-503079-002	3	38-503079-002	3	38-503079-001	3	38-503079-001
6	U-Bolt Lockwasher	6	38-503080-002	6	38-503080-002	6	38-503080-002	6	38-503080-002	6	38-503080-002
7	Upright	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001
8	Rail	2	38-503074-003	1	38-503074-003	2	38-503074-004	1	38-503074-004	2	38-503074-005
9	1/2 in. -13 Channel Nut	15	38-503082-001	16	38-503082-001	17	38-503082-001	18	38-503082-001	19	38-503082-001
10	1/2 in. Lockwasher	32	38-503083-001	34	38-503083-001	36	38-503083-001	38	38-503083-001	40	38-503083-001
11	Stud (Threaded Rod)	9	38-503084-001	10	38-503084-001	11	38-503084-001	12	38-503084-001	13	38-503084-001
12	1/2 in. Flat Washer	16	38-503085-001	18	38-503085-001	20	38-503085-001	22	38-503085-001	24	38-503085-001
13	1/2 in. - 13 HEX Nut	28	38-503086-001	30	38-503086-001	32	38-503086-001	34	38-503086-001	36	38-503086-001
14	Cylinder Strap	8	38-503087-001	9	38-503087-001	10	38-503087-001	11	38-503087-001	12	38-503087-001
15	Brace, Left Side	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001
16	Brace, Right Side	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	12	38-503090-001	12	38-503090-001	12	38-503090-001	12	38-503090-001	12	38-503090-001
18	1/2 in. -13 x 1½ in. HHDCS	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001
19	Rail Support	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001
20	Rail	–	–	1	38-503074-004	–	–	1	38-503074-005	–	–
21	Header	–	–	1	38-503075-004	–	–	1	38-503075-005	–	–

6-9.3.2 ONE ROW/TWO SIDES CYLINDER RACKS

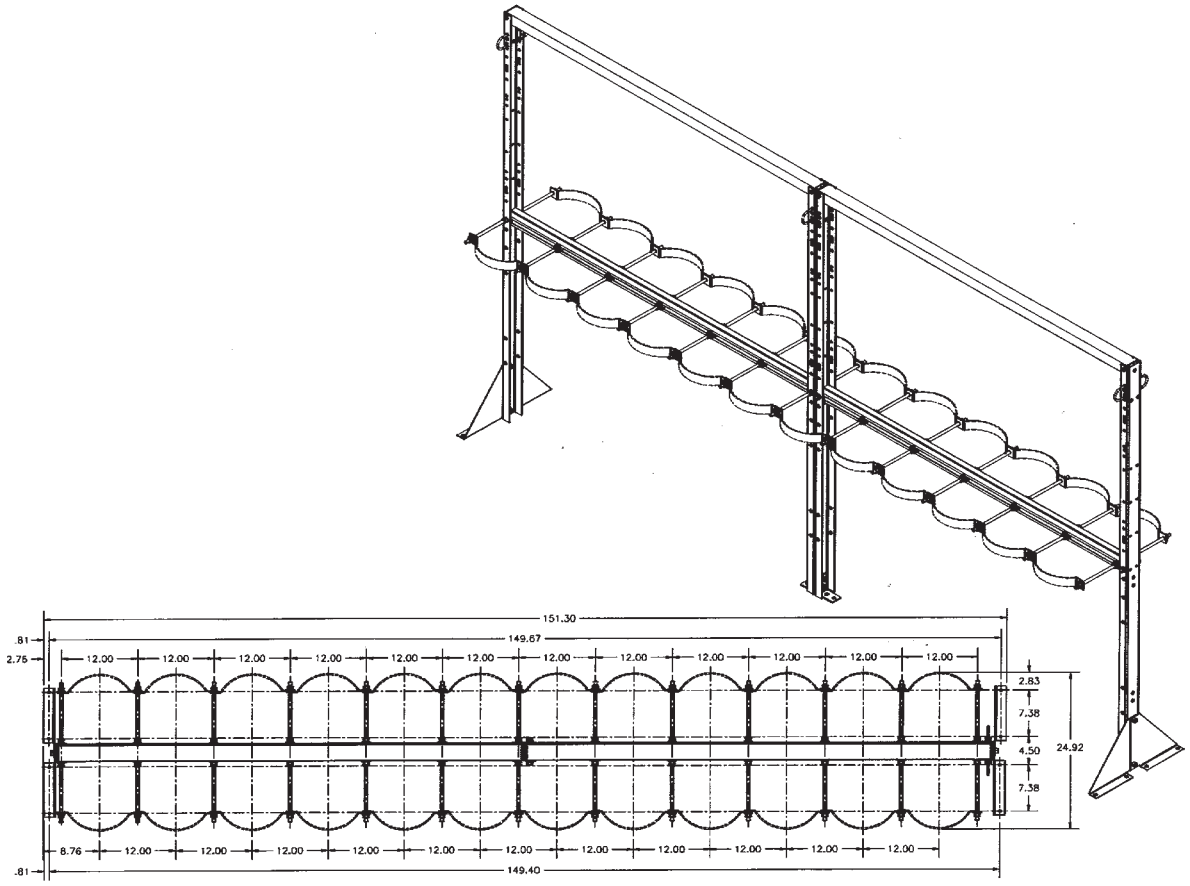

Figure 6-23. One Row/Two Sides Cylinder Rack (24 Cylinder Rack Assembly Shown)

Table 6-16. Rack Information

Part Number	Rack Size
38-109820-001	3 or 4 Cylinders
38-109821-001	5 or 6 Cylinders
38-109822-001	7 or 8 Cylinders
38-109823-001	9 or 10 Cylinders
38-109824-001	11 or 12 Cylinders
38-109825-001	13 or 14 Cylinders
38-109826-001	15 or 16 Cylinders
38-109827-001	17 or 18 Cylinders
38-109828-001	19 or 20 Cylinders
38-109829-001	21 or 22 Cylinders
38-109830-001	23 or 24 Cylinders

Table 6-17. Cylinder Rack Kits, One Row/Two Sides

Item Number	Description	3 or 4 Cylinders P/N 38-109820-001		5 or 6 Cylinders P/N 38-109821-001		7 or 8 Cylinders P/N 38-109822-001		9 or 10 Cylinders P/N 38-109823-001		11 or 12 Cylinders P/N 38-109824-001		13 or 14 Cylinders P/N 38-109825-001	
		Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number
1	Header	1	38-503075-001	1	38-503075-002	1	38-503075-003	1	38-503075-004	1	38-503075-005	1	38-503075-002
2	3/8 in. - 16 in. x 1 in. HHDCS	2	38-503076-001	2	38-503076-001	2	38-503076-001	2	38-503076-001	2	38-503076-001	4	38-503076-001
3	3/8 in. Lockwasher	2	38-503077-001	2	38-503077-001	2	38-503077-001	2	38-503077-001	2	38-503077-001	4	38-503077-001
4	3/8 in. - 16 HEX Nut	2	38-503078-001	2	38-503078-001	2	38-503078-001	2	38-503078-001	2	38-503078-001	4	38-503078-001
5	U-Bolt	4	38-503079-003	2	38-503079-003	2	38-503079-003	2	38-503079-003	2	38-503079-003	3	38-503079-002
6	U-Bolt Lockwasher	4	38-503080-001	4	38-503080-001	4	38-503080-001	4	38-503080-001	4	38-503080-001	6	38-503080-002
7	Upright	2	38-503081-001	2	38-503081-001	2	38-503081-001	2	38-503081-001	2	38-503081-001	4	38-503081-001
8	Rail	1	38-503074-001	1	38-503074-002	1	38-503074-003	1	38-503074-004	1	38-503074-005	1	38-503074-003
9	1/2 in. -13 Channel Nut	5	38-503082-001	6	38-503082-001	7	38-503082-001	8	38-503082-001	9	38-503082-001	15	38-503082-001
10	1/2 in. Lockwasher	12	38-503083-001	14	38-503083-001	16	38-503083-001	18	38-503083-001	20	38-503083-001	30	38-503083-001
11	Stud (Threaded Rod)	3	38-503084-001	4	38-503084-001	5	38-503084-001	6	38-503084-001	7	38-503084-001	9	38-503084-001
12	1/2 in. Flat Washer	4	38-503085-001	6	38-503085-001	8	38-503085-001	10	38-503085-001	12	38-503085-001	14	38-503085-001
13	1/2 in. - 13 HEX Nut	10	38-503086-001	12	38-503086-001	14	38-503086-001	16	38-503086-001	18	38-503086-001	26	38-503086-001
14	Cylinder Strap	2	38-503087-001	3	38-503087-001	4	38-503087-001	5	38-503087-001	6	38-503087-001	7	38-503087-001
15	Brace, Left Side	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001
16	Brace, Right Side	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	6	38-503090-001	6	38-503090-001	6	38-503090-001	6	38-503090-001	6	38-503090-001	13	38-503090-001
18	1/2 in. -13 x 1½ in. HHDCS	–	–	–	–	–	–	–	–	–	–	2	38-503091-001
19	Rail Support	–	–	–	–	–	–	–	–	–	–	2	38-503092-001
20	Rail	–	–	–	–	–	–	–	–	–	–	1	38-503074-002
21	Header	–	–	–	–	–	–	–	–	–	–	1	38-503075-003

Item Number	Description	15 or 16 Cylinders P/N 38-109826-001		17 or 18 Cylinders P/N 38-109827-001		19 or 20 Cylinders P/N 38-109828-001		21 or 22 Cylinders P/N 38-109829-001		23 or 24 Cylinders P/N 38-109830-001	
		Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number
1	Header	2	38-503075-003	1	38-503075-003	2	38-503075-004	1	38-503075-004	2	38-503075-005
2	3/8 in. - 16 in. x 1 in. HHDCS	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001
3	3/8 in. Lockwasher	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001
4	3/8 in. - 16 HEX Nut	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001
5	U-Bolt	6	38-503079-002	6	38-503079-002	6	38-503079-002	6	38-503079-001	6	38-503079-001
6	U-Bolt Lockwasher	12	38-503080-002	12	38-503080-002	12	38-503080-002	12	38-503080-001	12	38-503080-001
7	Upright	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001
8	Rail	2	38-503074-003	1	38-503074-003	2	38-503074-004	1	38-503074-004	2	38-503074-005
9	1/2 in. -13 Channel Nut	22	38-503082-001	24	38-503082-001	26	38-503082-001	28	38-503082-001	30	38-503082-001
10	1/2 in. Lockwasher	50	38-503083-001	52	38-503083-001	56	38-503083-001	62	38-503083-001	64	38-503083-001
11	Stud (Threaded Rod)	9	38-503084-001	20	38-503084-001	22	38-503084-001	24	38-503084-001	26	38-503084-001
12	1/2 in. Flat Washer	34	38-503085-001	36	38-503085-001	40	38-503085-001	46	38-503085-001	48	38-503085-001
13	1/2 in. - 13 HEX Nut	44	38-503086-001	48	38-503086-001	52	38-503086-001	56	38-503086-001	60	38-503086-001
14	Cylinder Strap	16	38-503087-001	18	38-503087-001	20	38-503087-001	22	38-503087-001	24	38-503087-001
15	Brace, Left Side	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001
16	Brace, Right Side	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	12	38-503090-001	12	38-503090-001	12	38-503090-001	12	38-503090-001	12	38-503090-001
18	1/2 in. -13 x 1½ in. HHDCS	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001
19	Rail Support	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001
20	Rail	–	–	1	38-503074-004	–	–	1	38-503074-005	–	–
21	Header	–	–	1	38-503075-004	–	–	1	38-503075-005	–	–

6-9.3.3 TWO ROWS/ONE SIDE CYLINDER RACKS

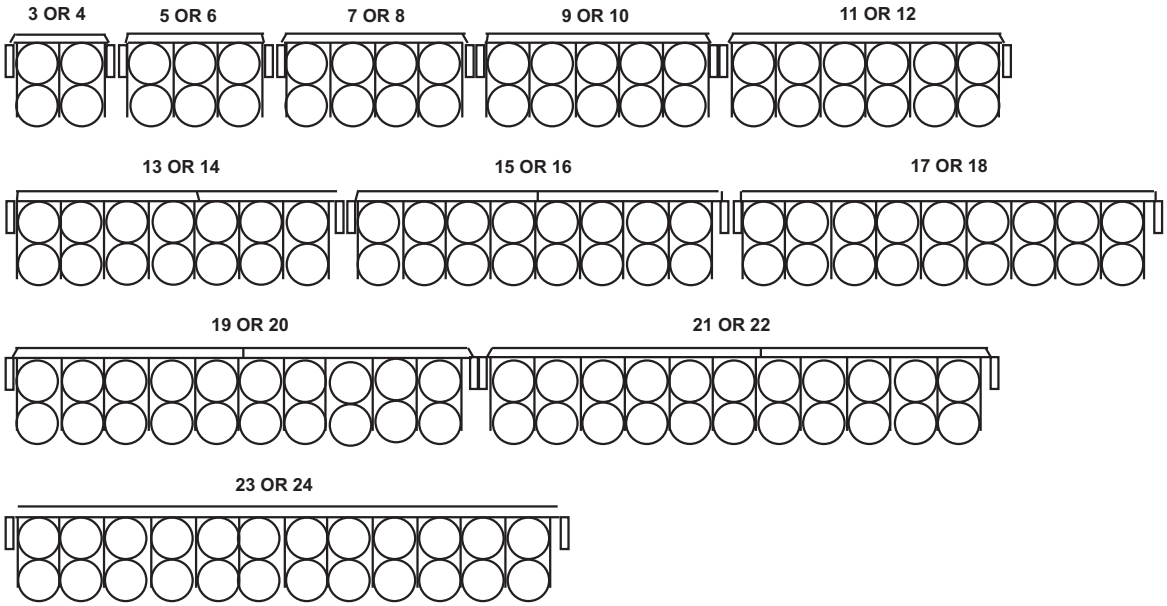

Figure 6-24. Two Rows/One Side Cylinder Racks

Table 6-18. Rack Information

Part Number	Rack Size (Number of Cylinders)
38-109831-001	3 or 4
38-109832-001	5 or 6
38-109833-001	7 or 8
38-109834-001	9 or 10
38-109835-001	11 or 12
38-109836-001	13 or 14
38-109837-001	15 or 16
38-109838-001	17 or 18
38-109839-001	19 or 20
38-109840-001	21 or 22
38-109841-001	23 or 24

Table 6-19. Cylinder Rack Kits, Two Rows/One Side

Item Number	Description	3 or 4 Cylinders P/N 38-109831-001		5 or 6 Cylinders P/N 38-109832-001		7 or 8 Cylinders P/N 38-109833-001		9 or 10 Cylinders P/N 38-109834-001		11 or 12 Cylinders P/N 38-109835-001	
		Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number
1	Header	1	38-503075-001	1	38-503075-002	1	38-503075-003	1	38-503075-004	1	38-503075-005
2	3/8 in. - 16 in. x 1 in. HHDCS	2	38-503076-001	2	38-503076-001	2	38-503076-001	2	38-503076-001	2	38-503076-001
3	3/8 in. Lockwasher	2	38-503077-001	2	38-503077-001	2	38-503077-001	2	38-503077-001	2	38-503077-001
4	3/8 in. - 16 HEX Nut	2	38-503078-001	2	38-503078-001	2	38-503078-001	2	38-503078-001	2	38-503078-001
5	U-Bolt	2	38-503079-003	2	38-503079-002	2	38-503079-002	2	38-503079-002	2	38-503079-001
6	U-Bolt Lockwasher	2	38-503080-001	4	38-503080-002	4	38-503080-002	4	38-503080-002	4	38-503080-002
7	Upright	2	38-503081-001	2	38-503081-001	2	38-503081-001	2	38-503081-001	2	38-503081-001
8	Rail	1	38-503074-001	1	38-503074-002	1	38-503074-003	1	38-503074-004	1	38-503074-005
9	1/2 in. -13 Channel Nut	5	38-503082-001	6	38-503082-001	7	38-503082-001	8	38-503082-001	9	38-503082-001
10	1/2 in. Lockwasher	17	38-503083-001	19	38-503083-001	21	38-503083-001	23	38-503083-001	25	38-503083-001
11	Stud (Threaded Rod)	3	38-503084-002	4	38-503084-002	5	38-503084-002	6	38-503084-002	7	38-503084-002
12	1/2 in. Flat Washer	5	38-503085-001	7	38-503085-001	9	38-503085-001	11	38-503085-001	13	38-503085-001
13	1/2 in. - 13 HEX Nut	15	38-503086-001	17	38-503086-001	19	38-503086-001	21	38-503086-001	23	38-503086-001
14	Cylinder Strap	2	38-503087-001	3	38-503087-001	4	38-503087-001	5	38-503087-001	6	38-503087-001
15	Brace, Left Side	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001
16	Brace, Right Side	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	10	38-503090-001	10	38-503090-001	10	38-503090-001	10	38-503090-001	10	38-503090-001
18	Manifold Mounting Bracket	2	38-503093-001	2	38-503093-001	2	38-503093-001	2	38-503093-001	2	38-503093-001
19	Stud (Short Rod)	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001

Item Number	Description	13 or 14 Cylinders P/N 38-109836-001		15 or 16 Cylinders P/N 38-109837-001		17 or 18 Cylinders P/N 38-109838-001		19 or 20 Cylinders P/N 38-109839-001		21 or 22 Cylinders P/N 38-109840-001		23 or 24 Cylinders P/N 38-109841-001	
		Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number
1	Header	1	38-503075-002	2	38-503075-003	1	38-503075-003	2	38-503075-004	1	38-503075-004	2	38-503075-005
2	3/8 in. - 16 in. x 1 in. HHDCS	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001
3	3/8 in. Lockwasher	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001
4	3/8 in. - 16 HEX Nut	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001
5	U-Bolt	3	38-503079-001	3	38-503079-001	3	38-503079-001	3	38-503079-001	3	38-503079-001	3	38-503079-001
6	U-Bolt Lockwasher	6	38-503080-002	6	38-503080-002	6	38-503080-002	6	38-503080-002	6	38-503080-002	6	38-503080-002
7	Upright	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001
8	Rail	1	38-503074-003	2	38-503074-003	1	38-503074-003	2	38-503074-004	1	38-503074-004	2	38-503074-005
9	1/2 in. -13 Channel Nut	14	38-503082-001	15	38-503082-001	16	38-503082-001	17	38-503082-001	18	38-503082-001	19	38-503082-001
10	1/2 in. Lockwasher	37	38-503083-001	39	38-503083-001	41	38-503083-001	43	38-503083-001	45	38-503083-001	47	38-503083-001
11	Stud (Threaded Rod)	8	38-503084-002	9	38-503084-002	10	38-503084-002	11	38-503084-002	12	38-503084-002	13	38-503084-002
12	1/2 in. Flat Washer	15	38-503085-001	17	38-503085-001	19	38-503085-001	21	38-503085-001	23	38-503085-001	25	38-503085-001
13	1/2 in. - 13 HEX Nut	31	38-503086-001	33	38-503086-001	35	38-503086-001	37	38-503086-001	39	38-503086-001	41	38-503086-001
14	Cylinder Strap	7	38-503087-001	8	38-503087-001	9	38-503087-001	10	38-503087-001	11	38-503087-001	12	38-503087-001
15	Brace, Left Side	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001	1	38-503088-001
16	Brace, Right Side	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001	1	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	18	38-503090-001	18	38-503090-001	18	38-503090-001	18	38-503090-001	18	38-503090-001	18	38-503090-001
18	Manifold Mounting Bracket	3	38-503093-001	3	38-503093-001	3	38-503093-001	3	38-503093-001	3	38-503093-001	3	38-503093-001
19	Stud (Short Rod)	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001
20	1/2 in. -13 x 1½ in. HHDCS	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001
21	Rail Support	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001
22	Rail	1	38-503074-002	–	–	1	38-503074-004	–	–	1	38-503074-005	–	–
23	Header	1	38-503075-003	–	–	1	38-503075-004	–	–	1	38-503075-005	–	–

6-9.3.4 TWO ROWS/TWO SIDES CYLINDER RACKS

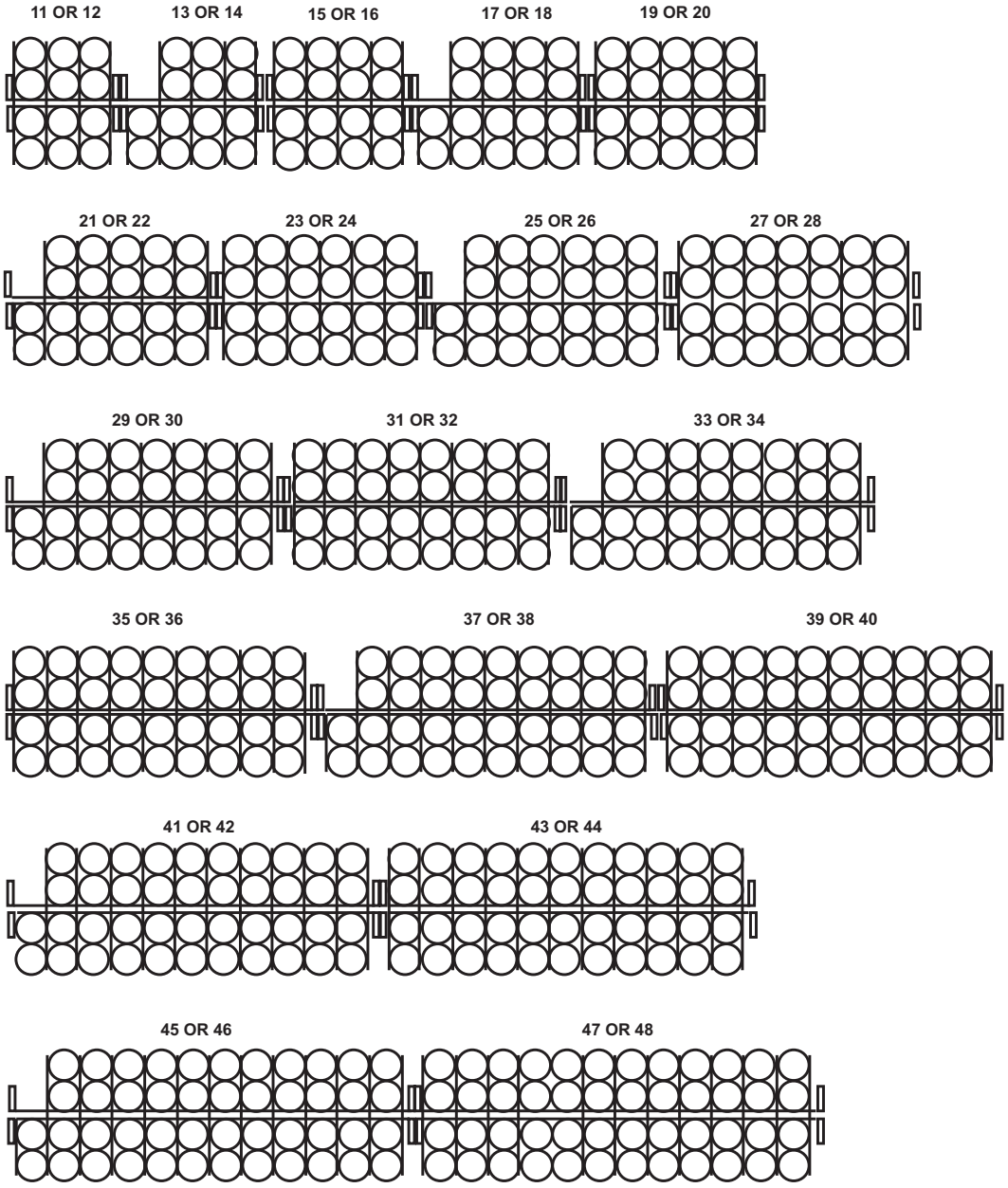

Figure 6-25. Two Rows/Two Sides Cylinder Rack

Table 6-20. Two Rows/Two Sides Cylinder Rack Information

Part Number	Rack Size
38-109842-001	11 or 12 Cylinders
38-109843-001	13 or 14 Cylinders
38-109844-001	15 or 16 Cylinders
38-109845-001	17 or 18 Cylinders
38-109846-001	19 or 20 Cylinders
38-109847-001	21 or 22 Cylinders
38-109848-001	23 or 24 Cylinders
38-109849-001	25 or 26 Cylinders
38-109850-001	27 or 28 Cylinders
38-109851-001	29 or 30 Cylinders
38-109852-001	31 or 32 Cylinders
38-109853-001	33 or 34 Cylinders
38-109854-001	35 or 36 Cylinders
38-109855-001	37 or 38 Cylinders
38-109856-001	39 or 40 Cylinders
38-109857-001	41 or 42 Cylinders
38-109858-001	43 or 44 Cylinders
38-109859-001	45 or 46 Cylinders
38-109860-001	47 or 48 Cylinders

Table 6-21. Cylinder Rack Kits, Two Rows/Two Sides

Item Number	Description	11 or 12 Cylinders P/N 38-109842-001		13 or 14 Cylinders P/N 38-109843-001		15 or 16 Cylinders P/N 38-109844-001		17 or 18 Cylinders P/N 38-109845-001		19 or 20 Cylinders P/N 38-109846-001		21 or 22 Cylinders P/N 38-109847-001	
		Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number
1	Header	1	38-503075-002	1	38-503075-003	1	38-503075-003	1	38-503075-004	1	38-503075-004	1	38-503075-005
2	3/8 in. - 16 in. x 1 in. HHDCS	2	38-503076-001	2	38-503076-001	2	38-503076-001	2	38-503076-001	2	38-503076-001	2	38-503076-001
3	3/8 in. Lockwasher	2	38-503077-001	2	38-503077-001	2	38-503077-001	2	38-503077-001	2	38-503077-001	2	38-503077-001
4	3/8 in. - 16 HEX Nut	2	38-503078-001	2	38-503078-001	2	38-503078-001	2	38-503078-001	2	38-503078-001	2	38-503078-001
5	U-Bolt	4	38-503079-001	4	38-503079-001	4	38-503079-001	4	38-503079-001	4	38-503079-001	4	38-503079-001
6	U-Bolt Lockwasher	8	38-503080-002	8	38-503080-002	8	38-503080-002	8	38-503080-002	8	38-503080-002	8	38-503080-002
7	Upright	2	38-503081-001	2	38-503081-001	2	38-503081-001	2	38-503081-001	2	38-503081-001	2	38-503081-001
8	Rail	1	38-503074-002	1	38-503074-003	1	38-503074-003	1	38-503074-004	1	38-503074-004	1	38-503074-005
9	1/2 in. -13 Channel Nut	8	38-503082-001	10	38-503082-001	10	38-503082-001	12	38-503082-001	12	38-503082-001	14	38-503082-001
10	1/2 in. Lockwasher	12	38-503083-001	33	38-503083-001	33	38-503083-001	36	38-503083-001	37	38-503083-001	40	38-503083-001
11	Stud (Threaded Rod)	8	38-503084-002	10	38-503084-002	10	38-503084-002	11	38-503084-002	12	38-503084-002	13	38-503084-002
12	1/2 in. Flat Washer	13	38-503085-001	15	38-503085-001	17	38-503085-001	20	38-503085-001	21	38-503085-001	24	38-503085-001
13	1/2 in. - 13 HEX Nut	29	38-503086-001	33	38-503086-001	33	38-503086-001	36	38-503086-001	37	38-503086-001	39	38-503086-001
14	Cylinder Strap	6	38-503087-001	7	38-503087-001	8	38-503087-001	9	38-503087-001	10	38-503087-001	11	38-503087-001
15	Brace, Left Side	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001
16	Brace, Right Side	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	12	38-503090-001	12	38-503090-001	12	38-503090-001	12	38-503090-001	12	38-503090-001	12	38-503090-001
18	Manifold Mounting Bracket	4	38-503093-001	4	38-503093-001	4	38-503093-001	4	38-503093-001	4	38-503093-001	4	38-503093-001
19	Stud (Short Rod)	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001
Item Number	**Description**	**23 or 24 Cylinders P/N 38-109848-001**		**25 or 26 Cylinders P/N 38-109849-001**		**27 or 28 Cylinders P/N 38-109850-001**		**29 or 30 Cylinders P/N 38-109851-001**		**31 or 32 Cylinders P/N 38-109852-001**		**33 or 34 Cylinders P/N 38-109853-001**	
		Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number
1	Header	1	38-503075-005	1	38-503075-003	1	38-503075-003	2	38-503075-003	2	38-503075-003	1	38-503075-004
2	3/8 in. - 16 in. x 1 in. HHDCS	2	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001
3	3/8 in. Lockwasher	2	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001
4	3/8 in. - 16 HEX Nut	2	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001
5	U-Bolt	4	38-503079-001	6	38-503079-001	6	38-503079-001	6	38-503079-001	6	38-503079-001	6	38-503079-001
6	U-Bolt Lockwasher	8	38-503080-002	12	38-503080-002	12	38-503080-002	12	38-503080-002	12	38-503080-002	12	38-503080-002
7	Upright	2	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001
8	Rail	2	38-503074-005	1	38-503074-003	1	38-503074-003	2	38-503074-003	2	38-503074-003	1	38-503074-004
9	1/2 in. -13 Channel Nut	14	38-503082-001	20	38-503082-001	20	38-503082-001	22	38-503082-001	22	38-503082-001	24	38-503082-001
10	1/2 in. Lockwasher	39	38-503083-001	51	38-503083-001	57	38-503083-001	60	38-503083-001	59	38-503083-001	63	38-503083-001
11	Stud (Threaded Rod)	14	38-503084-002	15	38-503084-002	16	38-503084-002	17	38-503084-002	18	38-503084-002	19	38-503084-002
12	1/2 in. Flat Washer	22	38-503085-001	28	38-503085-001	29	38-503085-001	32	38-503085-001	33	38-503085-001	35	38-503085-001
13	1/2 in. - 13 HEX Nut	39	38-503086-001	51	38-503086-001	53	38-503086-001	55	38-503086-001	57	38-503086-001	58	38-503086-001
14	Cylinder Strap	12	38-503087-001	13	38-503087-001	14	38-503087-001	15	38-503087-001	16	38-503087-001	17	38-503087-001
15	Brace, Left Side	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001
16	Brace, Right Side	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	12	38-503090-001	16	38-503090-001	22	38-503090-001	23	38-503090-001	22	38-503090-001	23	38-503090-001
18	Manifold Mounting Bracket	4	38-503093-001	6	38-503093-001	6	38-503093-001	6	38-503093-001	6	38-503093-001	6	38-503093-001
19	1/2 in. -13 x 1½" HHDCS	–	–	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001
20	Rail Support	–	–	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001
21	Rail	–	–	1	38-503074-002	1	38-503074-002	–	–	–	–	1	38-503074-003
22	Header	–	–	1	38-503075-002	1	38-503075-002	–	–	–	–	1	38-503075-003
23	Stud	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001

Table 6-21. Cylinder Rack Kits, Two Rows/Two Sides (cont.)

Item Number	Description	35 or 36 Cylinders P/N 38-109854-001		37 or 38 Cylinders P/N 38-109855-001		39 or 40 Cylinders P/N 38-109856-001		41 or 42 Cylinders P/N 38-109857-001		43 or 44 Cylinders P/N 38-109858-001	
		Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number	Qty.	Part Number
1	Header	1	38-503075-004	2	38-503075-004	2	38-503075-004	1	38-503075-005	1	38-503075-005
2	3/8 in. - 16 in. x 1 in. HHDCS	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001	4	38-503076-001
3	3/8 in. Lockwasher	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001	4	38-503077-001
4	3/8 in. - 16 HEX Nut	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001	4	38-503078-001
5	U-Bolt	6	38-503079-001	6	38-503079-001	6	38-503079-001	6	38-503079-001	6	38-503079-001
6	U-Bolt Lockwasher	12	38-503080-002	12	38-503080-002	12	38-503080-002	12	38-503080-002	12	38-503080-002
7	Upright	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001	4	38-503081-001
8	Rail	1	38-503074-004	2	38-503074-004	2	38-503074-004	2	38-503074-005	1	38-503074-005
9	1/2 in. -13 Channel Nut	24	38-503082-001	26	38-503082-001	26	38-503082-001	28	38-503082-001	28	38-503082-001
10	1/2 in. Lockwasher	64	38-503083-001	67	38-503083-001	68	38-503083-001	71	38-503083-001	72	38-503083-001
11	Stud (Threaded Rod)	20	38-503084-002	21	38-503084-002	22	38-503084-002	23	38-503084-002	24	38-503084-002
12	1/2 in. Flat Washer	36	38-503085-001	39	38-503085-001	40	38-503085-001	43	38-503085-001	44	38-503085-001
13	1/2 in. - 13 HEX Nut	60	38-503086-001	62	38-503086-001	64	38-503086-001	68	38-503086-001	68	38-503086-001
14	Cylinder Strap	18	38-503087-001	19	38-503087-001	20	38-503087-001	21	38-503087-001	22	38-503087-001
15	Brace, Left Side	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001	2	38-503088-001
16	Brace, Right Side	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001	2	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	22	38-503090-001	23	38-503090-001	22	38-503090-001	23	38-503090-001	22	38-503090-001
18	Manifold Mounting Bracket	6	38-503093-001	6	38-503093-001	6	38-503093-001	6	38-503093-001	6	38-503093-001
19	1/2 in. -13 x 1½" HHDCS	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001	2	38-503091-001
20	Rail Support	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001	2	38-503092-001
21	Rail	1	38-503074-003	–	–	–	–	1	38-503074-004	1	38-503074-004
22	Header	1	38-503075-003	–	–	–	–	1	38-503075-004	1	38-503075-004
23	Stud	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001	1	38-503084-001

Item Number	Description	45 or 46 Cylinders P/N 38-109859-001		47 or 48 Cylinders P/N 38-109860-001	
		Qty.	Part Number	Qty.	Part Number
1	Header	2	38-503075-005	2	38-503075-005
2	3/8 in. - 16 in. x 1 in. HHDCS	4	38-503076-001	4	38-503076-001
3	3/8 in. Lockwasher	4	38-503077-001	4	38-503077-001
4	3/8 in. - 16 HEX Nut	4	38-503078-001	4	38-503078-001
5	U-Bolt	6	38-503079-001	6	38-503079-001
6	U-Bolt Lockwasher	12	38-503080-002	12	38-503080-002
7	Upright	4	38-503081-001	4	38-503081-001
8	Rail	2	38-503074-005	2	38-503074-005
9	1/2 in. -13 Channel Nut	30	38-503082-001	30	38-503082-001
10	1/2 in. Lockwasher	75	38-503083-001	76	38-503083-001
11	Stud (Threaded Rod)	25	38-503084-002	26	38-503084-002
12	1/2 in. Flat Washer	47	38-503085-001	48	38-503085-001
13	1/2 in. - 13 HEX Nut	70	38-503086-001	72	38-503086-001
14	Cylinder Strap	23	38-503087-001	24	38-503087-001
15	Brace, Left Side	2	38-503088-001	2	38-503088-001
16	Brace, Right Side	2	38-503089-001	2	38-503089-001
17	1/2 in. -13 x 1 in. HHDCS	23	38-503090-001	22	38-503090-001
18	Manifold Mounting Bracket	6	38-503093-001	6	38-503093-001
19	1/2 in. -13 x 1½" HHDCS	2	38-503091-001	2	38-503091-001
20	Rail Support	2	38-503092-001	2	38-503092-001
21	Rail	–	–	–	–
22	Header	–	–	–	–
23	Stud	1	38-503084-001	1	38-503084-001

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CHAPTER 7
SYSTEM DESIGN

7-1 INTRODUCTION

The purpose of this chapter is to provide the minimum design requirements for Argonite® fire extinguishing systems based upon sound engineering principles, current international standards, test data and field experiences.

General requirements and design criteria are based on NFPA 2001.

Nothing within this chapter intends to restrict new technologies or findings, providing that the level of safety prescribed is not reduced. This chapter does not cover general requirements and design criteria for fire detection and control systems. Reference should be made to local requirements.

7-2 GENERAL

Kidde Fire Systems' Argonite fire extinguishing systems utilize a pure inert gaseous extinguishing agent of 50% Nitrogen and 50% Argon when discharged into an enclosed hazard. (See MSDS in Appendix A.)

Argonite Fire Extinguishing Systems are usually applied as total flooding systems.

Individual system designs may vary considerably, depending on the nature of the hazard and the flammable material involved.

7-3 PHYSICAL PROPERTIES OF ARGONITE

Table 7-1. Properties of Argonite

Property	Units	Value
Molecular Weight	N/A	33.95
Boiling Point at 760 mm Hg	°C	-190.1
Freezing Point	°C	-199.7
Critical Temperature	°C	-134.7
Critical Pressure	kPa	4,150
Specific Heat, Vapor at Constant Pressure (1 atm) and 25°C	kJ/kg°C	0.782
Chemical Formula	N2 (Nitrogen) Ar (Argon)	50% 50%

7-3.1 Specification for Argonite AR/N_2 50%/50% by Volume, Atmospheric

Tolerance of mixture in air: Ar 48% to 50%
N_2 50% to 52 %

7-3.2 Purity of AR and N_2

Argon: Ar ≥ 99.99%:

$O_2 \leq 10$ ppm

$H_2O \leq 10$ ppm

Nitrogen: $N_2 \geq 99.7\%$

$O_2 \leq 10$ ppm

$H_2O \leq 10$ ppm

Note: Only principal contaminants are shown. Other measurements may include: CO; NO; NO_2, CO_2, etc., most at < 20 ppm.

7-4 EVALUATION OF HAZARD/RISK

The design and installation of an Argonite fire extinguishing system requires a thorough evaluation of the hazard to be protected. The hazard to be protected shall be inspected for relevant information and detailed drawings studied. The following should be considered:

- Integrity of the enclosure.
- Unclosable ventilation and exhaust openings, as their location could jeopardize the agent holding time and require additional agent to be discharged over time (extended discharge).
- Volume of unclosable air ducts, intake and exhaust.
- Volume of recirculating air-handling equipment.
- Automatic shutdown of forced ventilation upon fire detection. Spring operated fire damper(s) may be taken into consideration when calculating the required pressure relief vent opening.
- A general estimate of the flammables involved. The fuel demanding the highest extinguishing concentration shall govern.
- Quantity of flammables expected to be in the enclosure.
- Automatic shutdown of liquid supply systems at fire detection.
- Location of the most probable place for a fire to start.
- Location and volume of open fuel reservoirs. Nozzles should be positioned to avoid a direct discharge onto the fuel surface, which could cause the fuel to splash and spread the fire.
- Evaluation of the worst possible fire scenario
- Possibility of a liquid spill spreading into adjoining hazards?
- Hot surfaces that might cause reignition after the holding time.
- Shutdown of electrical equipment prior to agent release.
- Suspended ceiling and/or elevated floor spaces— volume, discharge nozzles.
- Provision for closing doors and windows upon fire detection.
- Adequate pressure relief venting to accommodate the resulting pressure increase caused by a discharge.

- Planned escape routes.
- Fire detectors, selected based on the type of fire anticipated (response time).
- Audible/visual alarms required.

⚠ CAUTION **Under certain conditions, it can be dangerous to extinguish a gas jet fire. Provision must be made to be cut off the gas supply before agent discharge begins.**

As a general guideline, an extended discharge is not required in a normal, relatively tight enclosure, i.e., EDP rooms with automatic ventilation systems that shut down upon fire detection. However, if the enclosure is too tight, the increased pressure inside the enclosure during/after a discharge will be relatively high.

In order to avoid structural damage due to excessive pressure, pressure relief vents should be provided. The optimal solution would be to have spring operated vents/fire dampers, which will be forced open when the pressure builds up at the beginning/during the discharge and close automatically after the discharge when the pressure dissipates. Enclosure integrity procedures are provided in NFPA 2001, Appendix C.

7-5 EVALUATION OF CYLINDER STORAGE SPACE

The following items must be considered when evaluating the cylinder storage spaces:

- A standard Argonite system will operate within a temperature range of -20°F to 130°F (-29°C to 54°C).
- If closed pipe sections are involved, safety reliefs are required for all closed sections of pipe.
- Pressure relief venting.
- Cylinder storage room equipped with proper exhaust ventilation.
- Cylinder storage space.
- Allowance for proper access to cylinders during installation and service/maintenance.
- Floor capable of carrying the load.
- Wall/structure strong enough for mounting wall brackets supports.
- Storage room should not be used for other purposes that could result in fire exposure to cylinders.

7-6 INERTING

Inerting concentrations shall be used where conditions for subsequent reflash or explosion could exist. These conditions exist when:

- The quantity of fuel expected to be in the enclosure is sufficient to develop a concentration equal to or greater than one-half of the lower flammable limit throughout the enclosure, and
- The volatility of the fuel before the fire is sufficient to reach the lower flammable limit in air (maximum ambient temperature or fuel temperature exceeds the closed cup flash point temperature), or
- The system cannot respond quickly enough to detect and extinguish the fire before the volatility of the fuel is increased to a dangerous level because of the fire.

The minimum design concentration used to inert atmospheres involving flammable liquids and gasses shall be the normal design value plus an added 10% safety factor.

7-7 EXTINGUISHING VALUES

- Class A: 31.6%
- Class B: 30.1% - n-Heptane

7-7.1 Class A and Class C

Flammables require a safety factor of 20%. Design concentration 37.9% (Oxygen Concentration = 12.97%).

7-7.2 Class B

Flammable liquids require a safety factor of 30% above the extinguishing concentration or 30% above the cup burner value established for the fuel. Design concentration 39.1% for n-Heptane (Oxygen Concentration = 12.72%).

7-7.3 Equation Formula for Specific Requirements

- $X = 2.303 * (V_S/s) * Log_{10}(100/(100-C) = V_S/s * Ln (100/(100-C))$

  Where:

  X = Volume of agent required per m^3 of protected volume to produce the indicated concentration at temperature specified.

  V_S = Specific volume of Argonite at 70°F (21.1°C) = 0.71086 m^3/kg at 1013 mbar.

  C = Design concentration of Argonite in the protected area

  s = Specific volume of superheated Argonite vapor. Can be approximated by the formula:s = 0.6598 + 0.00242t

  t = Temperature in the Hazard (C).

  For further details regarding specific vapor volumes at various temperatures, refer to NFPA 2001, Appendix A.

- $M_x = X/s$

  Where:

  M_x = The mass of Argonite/volume of protected area [See Tables 7-3 and 7-4 for M_x (kg/m^3 and $kg/ft.^3$) values at various temperature and design concentration conditions.]

7-8 DESIGN CONCENTRATIONS

7-8.1 NFPA Design Concentrations

- **Class A**: The minimum design concentration for a Class A surface fire hazard shall be the extinguishing concentration times a safety factor of 1.2.
- **Class B**: The minimum design concentration for a Class B fuel hazard or an only manually actuated system shall be the extinguishing concentration times a safety factor of 1.3.
- **Class C**: The minimum design concentration for Class C hazards shall be at least that for a Class A surface fire.

7-8.2 ISO Design Concentrations

The minimum design concentration for all hazards shall be the extinguishing concentration of the flammable times a safety factor of 1.3.

7-9 DESIGN FACTORS

In addition to the concentration requirement, additional Argonite may be required due to special conditions that would affect the extinguishing efficiency, such as unclosable openings and their effect on distribution and maintaining concentration; reignition from heated surfaces; enclosure geometry; and obstructions and their effect on distribution.

7-9.1 Effects of Altitude

At elevations above sea level, Argonite expands to a greater specific vapor. A system designed for sea level will develop a greater concentration level at an elevation above sea level. To correct for the effects of a higher elevation, the quantity of agent used should be reduced. The correction factors are listed in Table 7-2.

Table 7-2. Elevation Correction Factors

Altitude		Enclosure Pressure		Correction Factor
ft.	km	PSIA	cm Hg	
-3000	-0.92	16.25	84.00	1.11
-2000	-0.61	15.71	81.20	1.07
-1000	-0.30	15.23	78.70	1.04
0	0	14.71	76.00	1.00
1000	0.30	14.18	73.30	0.96
2000	0.61	13.64	70.50	0.93
3000	0.92	13.12	67.80	0.89
4000	1.22	12.58	65.00	0.86
5000	1.52	12.04	62.20	0.82
6000	1.83	11.53	59.60	0.78
7000	2.13	11.03	57.00	0.75
8000	2.44	10.64	55.00	0.72
9000	2.74	10.22	52.80	0.69
10000	3.05	9.77	50.50	0.66

Note: Multiply the correction factor by the seal level design quantity of Argonite to obtain the correct quantity for a given altitude.

Table 7-3. Total Flooding Quantities, Volume Requirements for ENVIRO-55 (Metric, Mx [kg/m^3])

Temperature (°C)	Typical Design Concentration (% by Volume) From NFPA 2001						
	34	38	40	42	46	50	54
-30	0.8566	0.9856	1.0532	1.1231	1.2703	1.4290	1.6009
-25	0.8224	0.9461	1.0110	1.0781	1.2196	1.3719	1.5369
-20	0.7899	0.9093	0.9711	1.0352	1.1710	1.3182	1.4768
-15	0.7602	0.8741	0.9338	0.9960	1.1259	1.2670	1.4193
-10	0.7316	0.8417	0.8986	0.9582	1.0840	1.2193	1.5369
-5	0.7041	0.8106	0.8653	0.9233	1.0437	1.1750	1.3155
0	0.6791	0.7806	0.8339	0.8897	1.0064	1.1322	1.2686
5	0.6549	0.7532	0.8041	0.8574	0.9705	1.0910	1.2235
10	0.6317	0.7267	0.7759	0.8276	0.9358	1.0528	1.1800
15	0.6092	0.7012	0.7492	0.7989	0.9038	1.0173	1.1394
20	0.5889	0.6779	0.7238	0.7725	0.8742	0.9830	1.1002
25	0.5694	0.6554	0.6997	0.7471	0.8443	0.9498	1.0637
30	0.5504	0.6337	0.6768	0.7225	0.8167	0.9191	1.0297
35	0.5334	0.6127	0.6550	0.6987	0.7900	0.8894	0.9969
40	0.5156	0.5936	0.6342	0.6769	0.7655	0.8607	0.9651
45	0.4997	0.5752	0.6144	0.6559	0.7418	0.8342	0.9344
50	0.4843	0.5573	0.5955	0.6355	0.7188	0.8084	0.9058
55	0.700	0.5405	0.5776	0.6159	0.6967	0.7837	0.8780

Table 7-4. Total Flooding Quantities, Volume Requirements for ENVIRO-55 (US Standard, Mx [kg/ft.^{3}])

Temperature (°F)	Typical Design Concentration (% by Volume) From NFPA 2001						
	34	38	40	42	46	50	54
-20	0.02404	0.02765	0.02955	0.03151	0.03565	0.04010	0.04492
-10	0.02295	0.02642	0.02827	0.03013	0.03407	0.03829	0.04294
0	0.02199	0.02529	0.02706	0.02883	0.03259	0.03668	0.04109
10	0.02107	0.02422	0.02586	0.02759	0.03123	0.03513	0.03936
20	0.02019	0.02323	0.02479	0.02648	0.02991	0.03365	0.03770
30	0.01935	0.02228	0.02379	0.02538	0.02874	0.03232	0.03620
40	0.01858	0.02141	0.02284	0.02437	0.02758	0.03104	0.03476
50	0.01789	0.02058	0.02195	0.02343	0.02650	0.02981	0.03341
60	0.01722	0.01978	0.02111	0.02254	0.02550	0.02867	0.03212
70	0.01657	0.01904	0.02032	0.02171	0.02454	0.02761	0.03096
80	0.01595	0.01834	0.01957	0.02092	0.02366	0.02659	0.02979
90	0.01536	0.01770	0.01887	0.02015	0.02280	0.02564	0.02872
100	0.01482	0.01704	0.01821	0.01946	0.02198	0.02473	0.02771
110	0.01430	0.01645	0.01756	0.01874	0.02122	0.02385	0.02674
120	0.01383	0.01591	0.01696	0.01813	0.02049	0.02304	0.02585
130	0.01335	0.01536	0.01641	0.01750	0.01980	0.02227	0.02495

7-10 DESIGN CONSIDERATIONS

7-10.1 Electrical Clearance

All system components shall be located so as to maintain minimum clearances from live parts, as shown in Table 7-5. As used in this manual, "clearance" shall be the air distance between equipment, including piping and nozzles, and unenclosed or uninsulated live electrical components at other than ground potential.

The clearances in Table 7-5 are for altitudes of 3,300 feet (1,000 m) or less. At altitudes in excess of 3,300 feet (1,000 m) the clearance shall be increased at the rate of 1 percent for each 330 ft. (100 m) increase in altitude above 3,300 feet (1,000 m).

Where the design BIL is not available and where nominal voltage is used for the design criteria, the highest minimum clearance listed for this group shall be used.

Table 7-5. Minimum Electrical Clearance

Nominal System Voltage (kV)	Maximum System Voltage (kV)	Design BIL(2) (kV)	Minimum Clearance	
			in.	mm
13.8	14.5	110	7	178
23.0	24.3	150	10	254
34.5	36.5	200	13	330
46.0	48.3	250	17	432
69.0	72.5	350	25	635
115.0	121.0	550	42	1067
138.0	145.0	650	50	1270
161.0	169.0	750	58	1473
230.0	242.0	900	76	1930
		1050	84	2134
345.0	362.0	1050	84	2134
		1300	104	2642
500.0	550.0	1500	124	3150
		1800	144	3658
765.0	800.0	2050	167	4242

Note:
1. For voltages up to 161 kV, the clearances are taken from NFPA 70, National Electrical Code. For voltages 230 kV and above, the clearances are taken from Table 124 of ANSI C2, National Electrical Safety Code.
2. BIL values are expressed as kilovolts (kV), the number being the crest value of the full wave impulse test that the electrical equipment is designed to withstand. For BIL values that are not listed in this table, clearances may be found by interpolation.

7-10.2 Leakage

Not only is it important that the Argonite design concentration be achieved within the prescribed discharge time, but also that the extinguishing concentration is maintained for the specified period of time to allow effective emergency action by trained personnel. This is equally important in all classes of fires (A, B, C) since a persistent ignition source (e.g., an arc, heat source, oxyacetylene torch or deep-seated fire) can lead to a resurgence of the fire once the Argonite has dissipated.

It is necessary to insure that the agent leakage does not occur during discharge and that the required concentration levels can be maintained for the entire holding period. Guidelines as established by NFPA 2001 should be followed.

7-10.3 Temperature Considerations

During discharge the temperature within the protected enclosure will drop approximately 10°F to 20°F (5°C to 10°C). The temperature will rise again after approximately 2 to 3 minutes.

7-10.4 Flow Calculation

The Kidde Fire Systems flow calculation program must be used to design an Argonite system. Refer to the Argonite Flow Calculation Software Manual, P/N 38-KFSARG-100, for details on the flow calculation program used by Kidde Fire Systems. It is based on the input of:

- Cylinder storage pressure at 70°F (21.1°C).
- Hazard enclosure temperature (start of pipe).
- Hazard enclosure volume(s), raised floor, room and suspended ceiling as applicable.
- Specific Argonite Quantity (kg).
- Argonite design concentration.
- Cylinder size (15.9 L, 66.7 L or 80 L).
- Number of cylinders.
- Discharge time required (normally 60 seconds).
- Minimum and maximum temperatures of the hazard.
- Number of nozzles selected per hazard.
- Piping data, estimated pipe dimensions and pipe schedule.
- Maximum pressure the enclosure/building structure can withstand.

The program shall calculate and determine/verify:

- Orifice diameter for the restrictor(s).
- Pipe sizes and required pipe schedule.
- Maximum pressure in distribution pipe network.
- Orifice diameter for each individual discharge nozzle.
- Estimated size of pressure relief vent opening.
- Final Argonite concentration for each protected hazard.
- Actual discharge time (95% of design concentration).

7-10.5 Calculation of Room Volume

The volume to be used in calculating the required amount of Argonite shall be the gross enclosure volume less the volume of any internal building structures, such as columns. The volume shall include ventilation ducts and other related volumes.

7-10.6 Quantity of Agent Calculation

The fire extinguishing or inerting concentrations shall be used in determining the Argonite design concentration for a particular flammable. For combinations of flammables, the extinguishing or inerting value for the flammable requiring the greatest concentration shall be used.

The ambient temperature of the enclosure is necessary to determine the proper amount of Argonite to be delivered to the hazard.

If a common bank of cylinders is used for several hazards/systems, these shall be calculated individually as if they were single systems. The number of cylinders required for the cylinder bank will be based on the hazard with the largest demand, or the largest demand required for protecting hazards that may be on fire simultaneously. The quantity of extinguishant to be stored must, as a minimum, be adequate to protect the largest hazard, and possibly other hazards if the risk exists of several fires occurring simultaneously.

It is the project engineer's responsibility that the design concentration is chosen based on the following:

It is the project engineer's responsibility that the design concentration is chosen based on the following:

- Integrity of the room, unclosable openings, unstoppable extraction ventilating, etc.
- Combustible flammables involved.
- Quantity of flammables permitted in the enclosure.
- Design concentration equal to or higher than required by the most demanding flammable.
- Ventilation conditions.
- Elevation/altitude.
- Escape possibilities.
- Personal safety in general.

7-10.7 Cylinder Content

At a filling pressure of 2900 PSI (200 bar) at 70°F (21.1°C), standard cylinders contain the following:

Table 7-6. Cylinder Content

Cylinder Volume (L)	Nominal Filling 2900 PSI (200 bar)	Gas Used During Release	Gas Remaining After Release
15.9	4.4 kg	4.3 kg	0.1 kg
66.7	18.4 kg	18.2 kg	0.2 kg
80.0	22.1 kg	21.8 kg	0.3 kg

7-10.8 Cylinder/Volume Ratio, Class A and Class C Fires

Based on the cylinder size and pressure, each cylinder can protect the following volume at 70°F (21.1°C):

Table 7-7. Cylinder/Volume Ratio, Class A and Class C Fires

Cylinder Volume (L)	Nominal Protected Volume 2900 PSI (200 bar)			
	ISO (30% Safety Factor)		NFPA (20% Safety Factor)	
	$ft.^3$	m^3	$ft.^3$	m^3
15.9	205.80	5.83	228.80	6.48
66.7	863.60	24.45	959.50	27.17
80.0	1035.30	29.32	1150.60	32.58

Values are based on the following equation: $V_{enc} = M_{gas} / M_x$

For M_{Gas} see Table 7-6. For M_x, see Paragraph 7-7.3.

7-10.9 Cylinder/Volume Ratio, Class B Fires (n-Heptane)

Based on the cylinder size and pressure, each cylinder can protect the following volume at 70°F (21.1°C):

Table 7-8. Cylinder/Volume Ratio, Class B Fires (n-Heptane)

Cylinder Volume (L)	Nominal Protected Volume 2900 PSI (200 bar)			
	ISO (30% Safety Factor)		NFPA (20% Safety Factor)	
	$ft.^3$	m^3	$ft.^3$	m^3
15.9	219.70	6.22	219.70	6.22
66.7	921.80	26.10	921.80	26.10
80.0	1105.00	31.29	1105.00	31.29

Values are based on the following equation: $V_{enc} = M_{Gas} / M_x$

For M_{Gas} see Table 7-6. For M_x, see Paragraph 7-7.3.

7-11 CYLINDER BANK INSTALLATION

7-11.1 Location

The cylinders and accompanying hardware shall be placed and installed according to the relevant cylinder bank assembly layout.

Note: As each 2900 PSI (200 bar), 80 L cylinder has a weight of approximately 300 lb. (136 kg), it is important to insure that the floor can bear the resulting load.

7-12 CYLINDER VALVE

This valve type has internal pneumatic actuation built in and is to be pneumatically operated. The valve handle is to be used only for filling purposes. For non-VdS approved systems it is recommended that all cylinder banks are equipped with a minimum of one manual/pneumatic actuator.

For normal system actuation, a solenoid valve actuator is used. The number of cylinders controlled by any single solenoid valve should not exceed 100. The solenoid valve(s) are to be energized for the entire discharge period—approximately 2 minutes.

7-13 NOZZLES

7-13.1 Selecting Number of Nozzles

The nozzles are designed for 360° coverage. The maximum coverage of a single nozzle is 1,254 ft.^{2} (116.5 m^2).

The 360 nozzle cannot be mounted in a corner or against a wall. The maximum nozzle discharge radius is 25 ft. (7.6 m), with the longest side not to exceed 35 ft., 5 in. (10.8 m). These nozzles should be centered in the area of protection when multiple nozzles are discharged into the same hazard.

The height of the room shall range between 1 ft. (0.3 m) and 16 ft. (4.88 m) from floor to ceiling. The nozzle should be placed as close or near to the containers as possible to minimize system piping. The ceiling tiles in the hazard area must be clipped to hold them in place during a discharge and prevent damage.

At the maximum height of 16 ft. (4.88 m) the distance that such a nozzle can cover is reduced to 18.8 ft. (5.7 m).

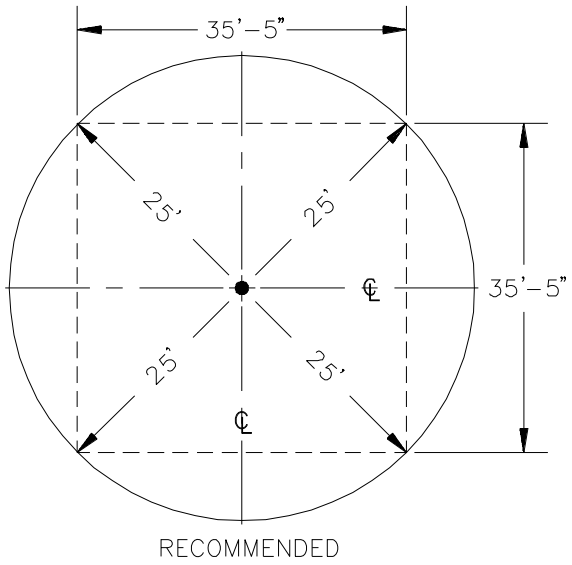

Figure 7-1. 360° Nozzle Determination

Note: The maximum enclosure height that may be flooded by a single tier of nozzles is 16 ft. (4.88 m). For enclosures with ceiling heights above 16 ft. (4.88 m), nozzles shall be placed at multiple levels/elevations to a maximum height per elevation of 16 ft. (4.88 m).

The number of nozzles, their size and location in the distribution piping network shall be such that the desired design concentration will be established within the specified discharge time in all parts of the protected enclosure, and such that the discharge will not unduly splash flammable liquids or create dust clouds that could extend the fire, create an explosion, harm any personnel occupying the enclosure or otherwise adversely affect the contents or integrity of the enclosure.

Kidde Fire Systems supplies nozzles ranging in size from 1/2" to 1½", with orifices from 3 mm to 26 mm. The quantity of Argonite per nozzle will vary based on pressure and orifice size.

In an Argonite system, pipe diameters, nozzle sizes, nozzle orifices and restrictor sizes shall always be verified by a flow calculation.

When determining the number of nozzles to be used in a system, the shape of the enclosure (area and volume) as well as the shape of any protected voids (raised floor, suspended ceiling) must be taken into account. Other important considerations include: installed equipment in the enclosure/void (chimney effect); pressure in the pipe (pipe wall thickness); obstructions that may affect the distribution of the discharged Argonite; and architectural considerations, i.e., a warehouse may allow for the use of a 1½" nozzle whereas an office environment may require a number of smaller nozzles.

In hazards with suspended ceilings, room nozzles shall be installed in such a way that the jets from the nozzles do not damage the ceiling tiles excessively during discharge. For lightweight ceiling tiles, it is recommended that the tiles be securely anchored around each discharge nozzle. In addition, consideration shall also be given to having nozzles installed above the ceiling (simultaneous discharge) in order to equalize the pressure during discharge, thus reducing the risk of unnecessarily damaging ceiling tiles.

7-13.2 Underfloor Nozzles

The maximum area of coverage for a single nozzle in an underfloor is 35' 5" x 35' 5" (10.8 m x 10.8 m), or 1,254 ft.^{2} (116.5 m^2), with the same limitations on height and positioning noted in the preceding para-graphs. The **MINIMUM** height of an underfloor that may be protected is 12 in. (30.5 cm). The coverage possible in an underfloor is dependent upon the density of cables, runways, and other equipment that might be present in the underfloor space. The maximum figures should be used only for underfloors that will be relatively open. This requires some judgment on the part of the designer, but in general, if the horizontal line of sight is more than 70% obstructed in an underfloor, these maximum figures should be reduced by 50%.

In protected hazards with underfloors that are unprotected and not gas tight, consideration shall be given to having nozzles installed below the floor (simultaneous discharge) in order to equalize the pressure and achieve the extinguishing concentration below the floor.

7-13.3 Nozzle Location

The nozzle(s) may be positioned flush with the ceiling or within 7.5 in. (191 mm) of the ceiling with the design radius covering the required area.

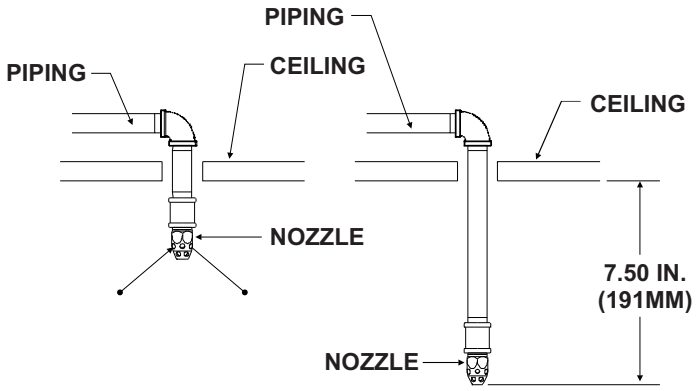

Figure 7-2. Nozzle Location

Table 7-9. Estimating Pipe Sizes

Pipe Size	Flow (kg/Minute)							
	Schedule 40		Schedule 80		Schedule 160		Schdule XXS	
	min.	max.	min.	max.	min.	max.	min.	max.
1/2 in. (15 mm)	1.30	26.90	0.80	15.30	0.20	3.70	N/A	N/A
3/4 in. (20 mm)	3.00	60.10	2.30	46.10	1.30	25.60	N/A	N/A
1 in. (25 mm)	5.10	101.60	4.20	84.00	2.90	58.50	1.20	23.30
1¼ in. (32 mm)	8.60	172.30	7.50	149.30	6.20	124.00	3.60	72.80
1½ in. (40 mm)	11.40	228.80	10.10	201.00	8.10	162.70	5.60	111.70
2 in. (50 mm)	18.00	360.90	16.10	321.10	12.50	249.70	10.10	201.80
2½ in. (65 mm)	25.10	501.10	22.40	447.40	19.00	379.70	13.60	272.20
3 in. (80 mm)	37.90	757.30	34.00	679.40	28.10	561.80	22.00	439.30
4 in. (100 mm)	65.10	1302.10	58.70	1173.40	47.30	946.70	39.90	798.10
5 in. (125 mm)	104.90	2097.60	94.70	189370	75.10	1501.70	66.30	1326.90
6 in. (150 mm)	157.50	3149.20	140.30	2805.80	111.40	2227.90	98.30	1965.40
8 in. (200 mm)	298.20	5964.20	267.50	5349.90	205.50	4108.90	209.80	4196.10

7-14 DISTRIBUTION PIPING

The piping system shall conform to the requirements of NFPA 2001. In addition, the system shall be securely supported with allowances made for agent thrust forces and thermal expansion/contraction, and should not be subjected to mechanical, chemical, vibration, corrosion or other damages.

Where explosions are likely, the piping shall be attached to supports that are least likely to be displaced.

Although Argonite piping systems are not under continuous pressure, provisions should be made to insure that the type of piping installed can withstand the maximum stress at maximum storage temperatures.

If black pipe is used, insure that no rust flakes or particles remain inside the pipe as this would ruin ceiling tiles and/or create a spray of rust/dust, which, in the event of protecting an enclosure containing delicate equipment such as computers, would unnecessarily damage the equipment.

⚠ CAUTION **Consideration should be given to the fact that the pipe network is "open" under normal conditions and that humidity entering the pipe may result in corrosion. The rust flakes will loosen from the inside of the pipe during a release and may block orifices in the restrictor or in the nozzles, thus jeopardizing the agent release/distribution. It is recommended that "dirt" traps be used at the last nozzle in the line and at bends.**

7-14.1 Selection of Piping Material

When selecting pipes fitted by the use of threaded fittings, compression fittings or welded fittings, care must be taken to insure a smooth internal installation. In addition, the pipe selected must be of a noncombustible material with physical and chemical characteristics such that its integrity during discharge can be predicted with reliability.

⚠ CAUTION **It is important that the pipe selected have minimal internal corrosion, which can clog up discharge nozzles. Special corrosion-resistant materials or coatings shall be required in severely corrosive atmospheres. The selected piping schedule shall always be in accordance with the requirement of the authorities having jurisdiction.**

Also important is that the interior of the pipe be free of burrs that may be present after cutting and threading.

A variety of pressure rated piping can be used: carbon steel, stainless steel 304 or stainless steel 316. Wall thickness of the selected pipe shall be calculated in accordance with ASME B31.1, Power Piping Code.

The internal pressure used for this calculation/selection shall be the system's maximum peak pressure calculated at the maximum operating temperature. In piping sections where a valve arrangement introduces a section of closed piping, such sections shall be equipped with a pressure relief device. Closed pipe sections are to be given attention equal to that given the discharge manifold.

7-14.2 Estimating Pipe Sizes

The values listed in Table 7-9 are approximate flow rates for estimating pipe sizes.

⚠ WARNING **The Kidde Fire Systems' Argonite Flow Calc program must be used to verify exact pipe sizes, nozzle orifices and restrictor sizes for all system designs and installations. See Argonite Flow Calc Manual, P/N 38-KFSARG-100. Failure to use the Argonite Flow Calculation Software could result in system malfunction, thereby causing property damage, personal injury and/or death.**

7-15 PIPE HANGERS AND SUPPORTS

- All supports and parts thereof shall conform to the requirements for pres-sure piping ASME B31.1, latest issue, and NFPA 2001.
- Conventional hanger design which is generally accepted as good practice, using standard stock or production units as manufactured by recognized reputable manufacturers, shall be utilized whenever possible but within the limits as set forth hereafter.
- All piping must be solidly anchored to walls, ceiling structure, or columns by angle iron brackets, support struts, or equivalent brackets where longitudinal or lateral sway may occur. Particular attention must be paid to the bracing of all piping changes in direction, nozzle piping, and storage unit header piping.
- All piping must be securely anchored to rigid support. Pipe supports and parts shall be steel and adequate to support the pipe in a sub-cold condition, and to allow for free and ample movement for contraction except where anchored, thereby preventing excessive stress. Pipe shall be supported and anchored as the piping system requires.
- Cast iron supports, half clamps, conduit clamps, malleable iron ring-type hangers, single beam clamps, or "C" clamps ***SHALL NOT BE USED*** to support piping. Beam clamps that grab both sides of the beam flange are acceptable, in addition to drilling of or welding to the beams (if authorized by owner).

- All parts of the supporting equipment must be fabricated and installed so that they will not be disengaged or distorted by movement of the supported pipe. **A pipe line is not to be supported from another pipe line**.
- All pipe supports shall be installed to avoid interference with other piping, hangers, electrical conduit, and supports or building structure and equipment.
- Supports shall be sufficiently close together to avoid excessive bending stresses from concentrated loads between supports. Spacing between supports is shown in Table 7-10.
- Where rod type hangers are permitted for intermediate support between rigid supports, they shall be a steel clevis hanger of the proper size for the sup-ported pipe and with solid bar-type hanger rod. See Table 7-11 on the following page for rod sizes. Hanger rods shall not be subjected to stresses due to bending.

Note: "C" clamps are not acceptable to support rod hangers.

Generally it is acceptable to alternate hangers on rods. Where an intermediate hanger is used between two rigid supports, the distance between hangers shall be reduced to approximately 75 percent of the distances shown in Table 7-10.

Table 7-10. Maximum Spacing Between Pipe Supports for Screwed, Welded or Grooved Pipe

Nominal Pipe Size		Maximum Span	
in.	mm	ft.	m
1/4	8	5	1.5
1/2	15	5	1.5
3/4	20	6	1.8
1	25	7	2.1
1¼	32	8	2.4
1½	40	9	2.7
2	50	10	3.0
2½	65	11	3.4
3	80	12	3.7
4	100	14	4.3
5	125	16	4.9
6	150	17	5.2
8	200	19	5.8

Table 7-11. Rod Size As Determined by Pipe Size for Fire Protection

Pipe Size		Rod Size	
in.	**mm**	**in.**	**mm**
≤ 1	≤ 25	3/8	9.6
1½ to 3	40 to 80	1/2	12.7
4 and 5	100 and 125	5/8	15.8
6	150	3/4	19.0
8	200	7/8	22.2

7-16 CLEANING OF PIPE NETWORK

Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, utilizing a suitable nonflammable cleaner. The pipe network shall be free of particulate matter and oil residue before installation of nozzles or discharge devices.

7-17 PRESSURE TESTING OF PIPE NETWORK

⚠ CAUTION **Never include actuation valves (cylinder or selector) as part of the piping network pressure test. As outlined in Paragraph 6-5, always disconnect the cylinder outlet hose from the manifold check valve and cap all check valves (using cap P/N 38-509865-001) prior to pressure testing of the piping network. For single cylinder systems, ensure the piping is plugged and the outlet hose detached before pressure testing.**

Pneumatic pressure testing creates a potential risk of injury to personnel in the area as a result of airborne projectiles if rupture of the piping system occurs. Prior to the pneumatic pressure test being conducted, the protected area shall be evacuated and appropriate safeguards shall be provided for test personnel.

- **NFPA 2001**

  The piping shall be pneumatically tested in a closed circuit for a period of 10 minutes at 40 PSIG (276 kPa) per NFPA 2001. At the end of 10 minutes, the pressure drop shall not exceed 20 percent of the test pressure. Exception: It shall be permissible to omit the pressure test if the total piping contains no more than one change in direction fitting between the storage container and the discharge nozzle, and if all piping is physically checked for tightness.

- **ISO 14520-1**

  Pneumatically tested at 45 PSI (3 bar) for a period of 10 minutes using Air/Argonite or N_2. Pressure drop not to exceed 20% of the test pressure at end of test.

Note: A test report/statement of completion must be issued.

7-17.1 Discharge Test

Per NFPA 2001, a discharge test is not generally recommended. Typically, a puff test or short duration flow test is used to confirm that all piping and nozzles in the system are clear of obstructions.

7-18 PRESSURE RELIEF VENTING

Fixed fire extinguishing systems, employing inert gases, extinguish fires by reducing the level of oxygen to below a level where combustion of the present flammables cannot be sustained. The required amount of gas discharged into a room or enclosure will result in a positive pressure that displaces the atmospheric air from the room. Suitable means of pressure relief venting must be provided in order to avoid structural damage.

The building element rating, the minimum rated construction element, shall govern as the basis for calculating the required opening.

⚠ WARNING **Overpressure will affect the opening of doors into the room, i.e., if the door should open inwards, it will be almost impossible to open the door while the room is still pressurized. Doors that open outwards from the still pressurized room will create a potential risk for the person who tries to open the door, as the door plate may open with a tremendous force as soon as the door lock is freed.**

No enclosure is 100% tight. A certain amount of leakage to adjacent areas is to be anticipated during and following an Argonite discharge. Consideration shall be given to concentration, products of combustion and the relative size of adjacent spaces. Additional consideration shall be given to exhaust/vent paths when opening or venting the enclosure after a discharge.

If defined, normal leakage can be taken into consideration when calculating/designing the relief vent opening.

Kidde Fire Systems does not take responsibility for verifying whether weak point(s) in an enclosure construction—windows, vent channels (Spiro Tubes sectioned by dampers, etc.), door frames, door plates at locks, ceilings, etc.—are capable of withstanding the pressure buildup. In addition, Kidde Fire Systems does not have the expertise to supply or install enclosure/building relief vents.

7-19 PRESSURE RELIEF DEVICE VENTING

Closed piping sections shall be equipped with a pressure relief device to relieve the pressure in the event of heat exposure in excess of the system limitations, i.e., above 120°F (50°C).

Preferably, the relief should be vented to the atmosphere.

Note: For storage rooms having a relatively small volume compared with the volume of stored gas, consideration shall always be given to the risk of external heat exposure, the ventilating conditions in the room, etc.

7-20 SAFETY PRECAUTIONS, OCCUPIED SPACES

In areas that potentially could be occupied, the following must be provided.

- Time delay devices:
  - For applications where a discharge delay does not significantly increase the threat from fire to life or property, extinguishing systems shall incorporate a predischarge alarm with a time delay sufficient to allow personnel evacuation prior to discharge.
  - Time delay devices shall only be used for personnel evacuation or to prepare the hazard area for discharge.
- Automatic/Manual switch and lockout devices where required.

Note: Although lockout devices are not always required, they are essential in some situations, particularly for some specific maintenance functions.

- Exit routes that shall be kept clear at all times, emergency lighting and adequate directional signs to minimize travel distances. Outward-swinging, self-closing doors that can be opened from the inside, including when locked from the outside.
- Continuous visual and audible alarms at entrances and designated exits inside the protected area as well as continuous visual alarms outside the protected area that operate until the protected area has been made safe. Where required, predischarge alarms that are distinctive from other alarm signals and that will operate immediately upon initiation of the time delay cycle upon detection of a fire.
- Appropriate warning and instruction signs.
- Means for prompt natural or forced-draft ventilation of protected spaces after any discharge of extinguishant. Forced-draft ventilation will often be necessary. Care shall be taken to completely dissipate the hazardous atmosphere and not just move it to other locations, as Argonite and decomposition products are heavier than air.
- Provide instruction and conduct drills for all personnel within or near protected areas, including maintenance or construction personnel who may be brought into the area, to ensure their correct response upon system operation.
- In addition to the above, the following are recommended:
  - Self-contained breathing apparatus should be available and personnel trained in its use.
  - Personnel should not enter the enclosure until it has been verified as being safe.

7-21 SIGNS AND LABELING

7-21.1 Storage Room

All doors to the system storage room shall be marked with a sign with the following text in the local language:

Argonite Cylinder Storage Room: ***Before entering, ensure Oxygen content is above 18%.***

7-21.2 Argonite Cylinders

Each cylinder is labeled with an Argonite label. The purpose of the label is to provide filling information, transport/safety information, inspection information and general precautions to be taken during reinstallation of the cylinder.

7-21.3 Warning Alarms and Signs

Audible and visual alarm devices within, as well as outside the enclosure, shall be provided with warning signs.

Figure 7-3. Exit Warning Sign, P/N 38-509859-001

Figure 7-4. Entrance Warning Sign, P/N 38-509860-001

7-21.4 Pressure Relief Vents (If Used)

Relief vent openings shall be provided with a warning sign to caution personnel of possible pressure discharge and hazardous atmosphere.

7-22 ALARM AND DETECTION

This manual does not cover detection and control systems. However, it shall be noted that in systems requiring more than 100 cylinders released simultaneously, additional solenoid valve(s)—one per every 100 cylinders—shall be energized simultaneously; and that in the case of selector valve systems, a solenoid valve for the selector valve shall also be energized.

When selecting a detection and control system, evaluate the ambient environmental conditions to determine the appropriate device and sensitivity in order to prevent false discharges while still providing the necessary earliest actuation. In high airflow environments, air-sampling detection devices should be considered.

⚠ WARNING **Detectors installed at the maximum spacing as listed or approved for fire alarm use can result in excessive delay in agent release, especially where more than one detection device is required to be in alarm before automatic actuation results (cross zone system). Where there is a risk of a flammable atmosphere forming, the spacing and location of flammable vapor detectors requires careful consideration to avoid excessive delay in agent release.**

Hazards associated with fast growing fires would include, but are not limited to, flammable liquid storage or transfer and aerosol filling areas.

CHAPTER 8
SERVICE AND MAINTENANCE

8-1 INTRODUCTION

It is essential that the Argonite® system be carefully maintained to ensure readiness when required. Routine maintenance is liable to be overlooked or given insufficient attention by the owner of the system. However, its neglect can imperil the lives of the occupants of the premises and result in a crippling financial loss.

Note: Safety should be a prime concern during installation, service, maintenance, testing, handling and recharging of Argonite Systems and agent containers. All personnel who could be expected to inspect, test, maintain, or operate fire extinguishing systems shall be thoroughly trained and kept thoroughly trained in the functions they are expected to perform.

Personnel working in an enclosure protected by a clean agent shall receive training regarding agent safety issues.

The importance of maintenance cannot be too highly emphasized. As a minimum, the following should be required for maintaining the system.

8-1.1 Cylinder Pressure

Although the pressure of all cylinders is checked at the commissioning stage, the pressures should be checked again approximately two (2) weeks after installation or after cylinder refilling following a system discharge.

8-1.2 Pressure Gauges

Visually check that all cylinder pressure gauges are reading the correct pressure as stated on the cylinder label (located on the cylinder body). If the cylinder gauge indicates a pressure less than 2750 PSI (190 bar) at 70°F (21.1°C), the cylinder must be recharged.

Preventive Maintenance; at least semiannually.

8-1.3 Cylinder Valves

Check that the cylinder valve(s) are in the closed and sealed position.

8-2 PREVENTIVE MAINTENANCE, TEST AND SERVICE ANNUALLY

8-2.1 Hoses

Examine all hoses for signs of damage or wear. Replace if suspect. Additionally, all hoses must be hydrostatically tested every 5 years.

8-2.2 Selector Valve (if used)

If used, the selector valve should be manually activated and the operation of the optional selector valve limit switch observed (if used). Signal to be initiated on control panel. Replace the microswitch if found to be defective.

8-2.3 Distribution Pipe Network and Nozzles

All pipework and nozzles should be visually inspected for any signs of damage, deterioration or obstruction.

Nozzles should be checked for any signs of blockage and cleaned if appropriate. Any paint or lacquer shall be removed.

8-2.4 Protected Room

At least every twelve months, the protected room shall be thoroughly inspected to determine if changes to the volume, penetrations or leakages have occurred that could adversely affect the extinguishing performance of the system.

Where the integrity inspection indicates that changes in the conditions could result in an inability to maintain the extinguishing concentration, they shall be corrected or the system redesigned to provide the original degree of protection.

8-2.5 Pressure Testing of Argonite Cylinders

All cylinders must be removed, pressure tested and recertified as required by the authorities having jurisdiction.

8-3 ARGONITE CYLINDER ASSEMBLY

Visually check the following:

- The Argonite Cylinder is installed and secured in its mounting bracket.
- The discharge hose is connected to the check valve on the manifold and to the discharge port on the cylinder valve.
- The pneumatic actuator is fitted on the connection port on the Argonite cylinder valve.
- The pressure gauge or pressure gauge solenoid valve unit is fitted on the port of the Argonite cylinder valve.
- The actuator hose from the pressure gauge solenoid valve unit is fitted on the free port of the tee piece.

Refer to the following figures for system details. Figures 6-15 and 6-16 can also be referenced.

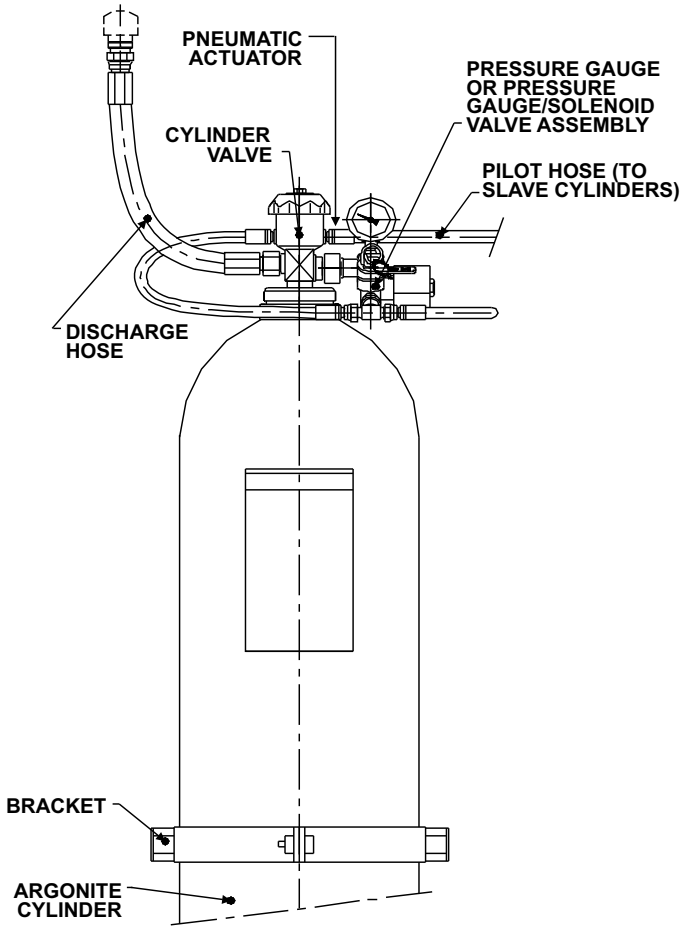

Figure 8-1. Argonite Cylinder Valve Assembly

8-4 PRESSURE GAUGE UNITS

8-4.1 Pressure Gauge with Supervisory Pressure Switch Assembly for Slave Cylinders

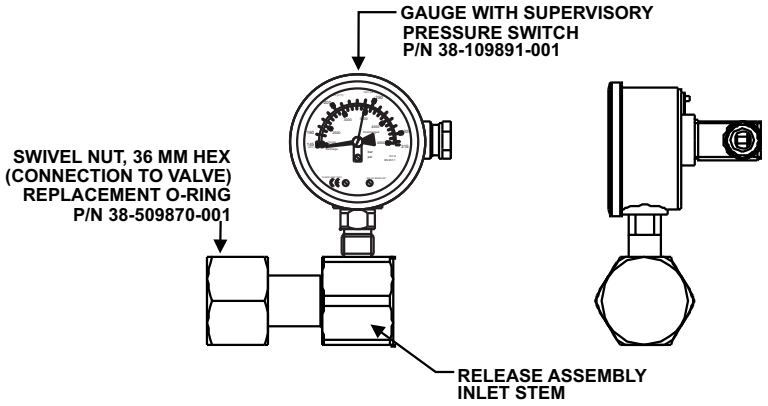

Figure 8-2. Pressure Gauge with Supervisory Pressure Switch

8-4.2 Solenoid Valve, Gauge and Supervisory Pressure Switch Assembly for Pilot Cylinder(s)

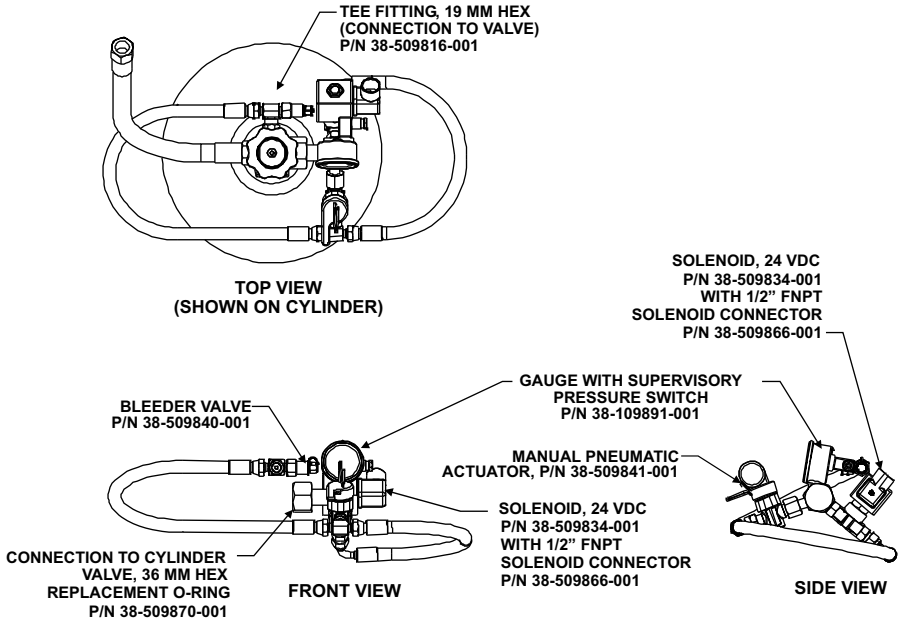

Figure 8-3. Solenoid Valve Assembly with Gauge and Supervisory Pressure Switch

8-4.3 Installation and Removal

The solenoid valve assemblies for 2900 PSI (200 bar) systems are dismantled and installed on the cylinder in the following way:

8-4.3.1 DISASSEMBLY

1. Dismantle all interconnecting pilot hoses.
2. Carefully loosen the 36 mm hex nut, used to attach the gauge assembly to the cylinder, to relieve pressure. (A loud, high-pitched sound will be heard during the venting. This is caused when the O-ring seal reaches the conical rim in the connection and releases the trapped pressure.)
3. When the pressure indicated on the pressure gauge has fallen to "0" unthread the gauge assembly from the cylinder valve.

8-4.3.2 ASSEMBLY

Note: Verify that all cylinders are properly restrained and that the discharge hose for each cylinder is connected to both the cylinder valve and system piping prior to reassembly.

1. Ensure the O-ring in the swivel nut is in place and greased.
2. Fit the complete unit on the cylinder valve, adjust gauge so that it is positioned vertically and tighten the swivel nut by hand until pressure is indicated on the gauge.
3. Secure swivel nut by the use of a 36 mm wrench. Apply torque 34 to 37 lb.-ft. (46 to 50 Nm).

Note: Do not turn unit after the swivel nut has been tightened.

4. Check all connections for leaks using a spray leak detection liquid. There should be no visible leaks.

Note: The pressure gauge unit and the pressure gauge and solenoid valve assemblies are to be installed on the cylinders as indicated on the assembly drawing.

5. Do not connect the hose from the solenoid valve to the actuation port until after the unit has been pressurized and there is no leakage through the free hose end.
6. Attach the interconnecting pilot hoses between the cylinders. Use a fixed spanner wrench. Apply torque 15 to 18 lb.-ft. (20 to 25 N-m).

8-5 AFTER SYSTEM RELEASE

After a discharge, return the system to operating mode as soon as possible. Ensure that the Argonite cylinder pressure gauge(s) on the refilled cylinder valve(s) reads 2900 PSI (200 bar) at 70°F (21.1°C).

8-5.1 Cylinder Replacement

⚠ WARNING **Safety is a prime concern! Never assume that a cylinder is empty; treat all cylinders as if they are fully charged. The Kidde Fire Systems cylinder valve is capable of producing high discharge thrusts out of the valve outlet if not handled properly. Remember that pressurized cylinders are extremely hazardous. Always fit the cylinder valve with a protective cap before removing the cylinder(s) from the rack and/or moving the cylinder(s). Failure to do so can result in serious bodily injury and possibly death, as well as property damage.**

When an Argonite cylinder has been operated or the remaining pressure is less than 2750 PSI (190 bar), it should be refilled immediately to the normal operating pressure at 70°F (21.1°C).

Before removing the cylinder from its bracket assembly, the following steps should be followed:

1. Disable the solenoid release circuit on the control panel.
2. Remove the coil from the high pressure solenoid valve unit, remove nut/screw and pull out the coil.
3. Disconnect the pilot hose (19 mm hex) from the cylinder valve connection.
4. Carefully loosen the 36 mm swivel nut on the gauge unit to relieve pressure out the vent hole.
5. When the pressure indicated on the pressure gauge has fallen to zero (0), disconnect the gauge unit from the cylinder valve.
6. Disconnect the pilot hoses and discharge hoses from the cylinder valve outlets.
7. Fit the protective cap on the cylinder.
8. Remove the cylinder bracket.
9. Roll the cylinder out from the wall bracket, free of the manifold.
10. Place the cylinder on the cylinder carrier and tighten the holding strap.
11. Move the cylinder to a truck and secure.
12. Repeat steps 1 to 13 until all cylinders have been placed on the truck.
13. When all cylinders are out of the room and secured on the truck, drive to nearest refilling station or contact Kidde Fire Systems.

⚠ CAUTION **An Argonite cylinder can weigh more than 300 lb. Always take precautions to prevent personnel injuries. All dismantled parts are to be treated with great care in order to avoid damage. Cylinders should never be dragged, rolled or allowed to strike any object.**

8-5.2 Re-Installation

Follow Steps 1 to 13 above in reverse order.

⚠ WARNING **Discharge hoses must be connected into the system piping before being attached to the cylinder valve outlet to prevent injury in the event of discharge.**

8-6 TESTING

8-6.1 Solenoid Valve, High Pressure

The operation of the solenoid valve unit on the Argonite cylinder shall be verified as follows:

1. Mechanically disconnect the pressure gauge solenoid valve unit from the Argonite cylinder valve.
2. Connect a pressure supply to the inlet of the unit.
3. Energize the solenoid valve (24 Vdc 13 w).
4. Confirm operation.
5. Reinstall the pressure gauge solenoid valve unit. (Remember to install a new O-ring). Before connecting the hose to the pneumatic actuator, ensure that there is no leakage from the hose end.

8-6.2 Pneumatically Operated Selector Valves

Check the operation of the pneumatically operated selector valves as follows:

1. Disconnect the instrument tubing from the pneumatic actuator on the selector valve.
2. Apply a pressure of 85 to 125 PSI (6 to 8 bar) to the inlet port of the actuator.
3. Supply 24 Vdc to the actuator solenoid; the valve should open.
4. Remove the 24 Vdc power; the valve should close.
5. Remove the pressure from the actuator.
6. Close the valve using the handle on top of the valve. (The valve will not close automatically.)
7. The handle can also be used to open the valve during emergency conditions.

8-6.3 Pressure Regulator, Selector Valve Systems

Check the operation of the pressure regulator. If no full discharge test is performed, the operation/adjustment of the pressure regulator can be performed as follows:

1. Remove the regulator and install it in a test bench consisting of a pressure source of 2900 PSI (200 bar), a calibrated pressure gauge 0 to 4000 PSI (0 to 300 bar) upstream, and a calibrated pressure gauge 0 to 300 PSI (0 to 20 bar) down-stream of the reducing valve.
2. Correct operation of the regulator will be indicated on the downstream pressure gauge, which should read approximately 85 to 125 PSI (6 to 8 bar). The relief valve will open if the regulator outlet pressure exceeds 145 PSI (10 bar).
3. If pressure is out of range, remove the cover and adjust by turning the internal screw clockwise to increase the pressure and counterclockwise to decrease the pressure until the required settings are achieved.

No further dismantling of the regulator shall be done. Should the regulator be faulty, return to Kidde Fire Systems for factory repair or replacement.

8-7 TROUBLESHOOTING

8-7.1 Low Pressure in Cylinder

Should low pressure be indicated, the cause may be due to one of the following conditions:

- The cylinder valve handwheel is slightly open, partially releasing the contents.

  Action:
  Check that the valve is seating correctly (fully clockwise) and that the seal on handwheel is intact.

- The cylinder pressure is dependent on ambient temperature, thus a lower ambient temperature will cause a drop in pressure.

  Action:
  Check/confirm the ambient temperature of the cylinders.

8-7.2 Leaking Pressure Gauge Unit

- Check the connection swivel nut, the gauge connection and the plug using leak detection liquid.

  Action:
  If leakage is detected at the swivel connection, dismantle and replace the O-ring (P/N 38-509870-001).

- Leakage detected at gauge connection and plug.

  Action:
  Contact Kidde Fire Systems' Field Service Department, or authorized distributor, immediately.

8-7.3 Leaking Pressure Gauge/Solenoid Valve Unit

- Check the connection swivel nut, the gauge connection and the solenoid valve connection using leak detection liquid.

  Action:
  If leakage is detected at the swivel connection, dismantle and replace the O-ring (P/N 38-509870-001).

- Leakage is detected at the gauge connection and/or solenoid valve.

  Action:
  Contact Kidde Fire Systems' Field Service Department, or authorized distributor, immediately.

CHAPTER 9
FILLING INSTRUCTIONS

9-1 INTRODUCTION

These procedures are included to allow the owner to inform the selected filling station about general guidelines for filling Argonite® cylinders equipped with a Kidde Fire Systems high-pressure cylinder valve(s).

The intent is to have the highest guarantee of correct filling wherever in the world an Argonite cylinder is filled. The filling procedures may be adjusted according to the normal routines for the chosen filling station, provided the station complies with all stipulated requirements for pressures and contents.

9-2 RESPONSIBILITIES

It is the responsibility of the owner or service contract holder to issue these procedures to the relevant filling stations. It is the responsibility of the filling station to fill cylinders according to these procedures—to attach filling labels, prepare filling list(s), issue letter of conformity, etc.

9-3 SPECIFICATION FOR ARGONITE AR/N_2 50%/50% BY VOLUME, ATMOSPHERIC

- Tolerance of mixture in air:
  - Ar 48% to 50%
  - N_2 50% to 52%

9-3.1 Purity of Gases

- Argon:
  - Ar $\geq$ 99.99%
  - $O_2 \leq$ 10 ppm
  - $H_2O \leq$ 10 ppm
- Nitrogen:
  - $N_2 \geq$ 99.7%
  - $O_2 \leq$ 10 ppm
  - $H_2O \leq$ 10 ppm

9-4 GENERAL FILLING

The filling process may use pressure or weight as the means of controlling the quantity of the two gases administered. The quantity and pressure must be in accordance with the specific requirements.

9-4.1 Filling, Pressure Controlled

The Kidde Fire Systems Argonite systems utilize cylinder storage pressures of 2900 PSI (200 bar) at 70°F (21.1°C). See the Pressure/Temperature chart for Argon, Nitrogen and combined Argonite in Paragraph 9-4.2.1.

The filling may be initiated using either of the two gases.

9-4.1.1 FILLING: 2900 PSI (200 BAR) NOMINAL

1. Fill Nitrogen to 1450 to 1500 PSI (100 to 104 bar) pressure.
2. Top off with Argon until the specified filling pressure of 2900 PSI (200 bar) is reached.
3. Alternatively, fill Argon to 1320 to 1375 PSI (91 to 95 bar) pressure.
4. Top off with Nitrogen until the specified filling pressure of 2900 PSI (200 bar) is reached.

The final pressure and temperature shall be checked according to a minimum pressure of 2900 PSI (200 bar) at 70°F (21.1°C).

9-4.2 Filling, Weight Controlled at 70°F (21.1°C)

Nitrogen and Argon shall be administered according to the table below in order to achieve the required cylinder pressure. It must be noted that the net volume of the cylinder shall be used for calculating the required quantity of the individual gases.

The final filling pressures(s) shall be verified. See the Pressure/Temperature chart for Argon, Nitrogen and combined Argonite in Paragraph 9-4.2.1.

If topping off is required, this is to be done using Nitrogen.

9-4.2.1 PRESSURE/TEMPERATURE/WEIGHT RELATIONSHIP

Table 9-1. Gas Pressure/Temperature/Weight Chart

Nominal Pressure	Temperature	Nitrogen kg/L	Argon kg/L	Argonite kg/L
2900 PSI (200 bar)	70°F (21.1°C)	0.114 to 0.119	0.156 to 0.163	0.272 to 0.274

9-4.3 Refilling After Discharge

After discharge, the cylinders will remain pressurized to approximately 45 PSI (3 bar) and thus contain dry Argonite from the previous filling.

The cylinder is to be repressurized according to local requirements. The surface treatment and coating shall be intact. If damaged, the topcoat shall be repaired according to the paint specification using compatible paint in the same color (RAL code).

Cylinders shall be restamped as required by local requirements and the service label on the cylinder shall be filled out.

9-5 ARGONITE VALVE

The Kidde Fire Systems Argonite cylinder valve is a pneumatically operated, quick opening valve. The valve is designed and suitable for use in fire extinguishing systems having a storage pressure up to 2900 PSI (200 bar). The valve is held shut by the pressure within the cylinder.

The valve may be opened/closed manually by turning the handwheel clockwise/counter-clockwise. However, when valve is under pressure, the force required to turn the handwheel demands that a special tool be used. The opening/closing feature of the valve is only intended to allow a function check of the valve prior to filling. It is recommended that the valve be operated pneumatically when it is under pressure.

9-6 FILLING

Filling is performed through the valve discharge port outlet (see Figure 9-1).

Prior to starting the filling process, check the valve operation by opening/closing the valve. Connect the valve-filling inlet to the Argonite filling systems.

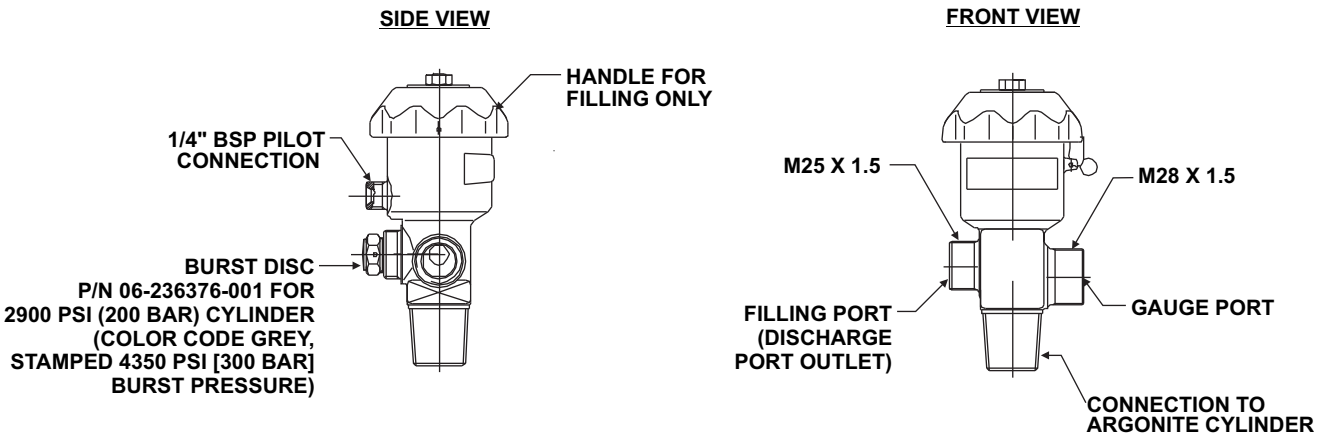

Figure 9-1. Argonite Cylinder Valve

Table 9-2. Filling

Part Number	Description
38-509801-001	Filling Adapter, Valve Discharge Port to 1/4" NPT
38-509802-001	Filling Adapter, Valve Discharge Port to CGA-580
38-509871-001	Spare O-Ring

9-6.1 Filling Through Discharge Port/Valve Outlet

- The valve outlet thread is male, M25 x 1.5
- The orifice area is: 0.0491 $in.^2$ (31.67 mm^2)
- Tools:
  - Filling Adapter:
  - Filling valve with connection to filling adapter with a venting valve to be used (pressure in supply line to be vented prior to disconnecting the filling adapter from the filling inlet).
  - Handle for opening/closing the valve.

Torque required to manually open/close the valve during the filling process:

Table 9-3. Required Torque for Filling

Pressure	Torque to Open		Torque to Close	
	N-m	in.-lb.	N-m	in.-lb.
0	2.5	22.1	1.5	13.3
2900 PSI (200 bar)	6.0	53.1	5.0	44.3

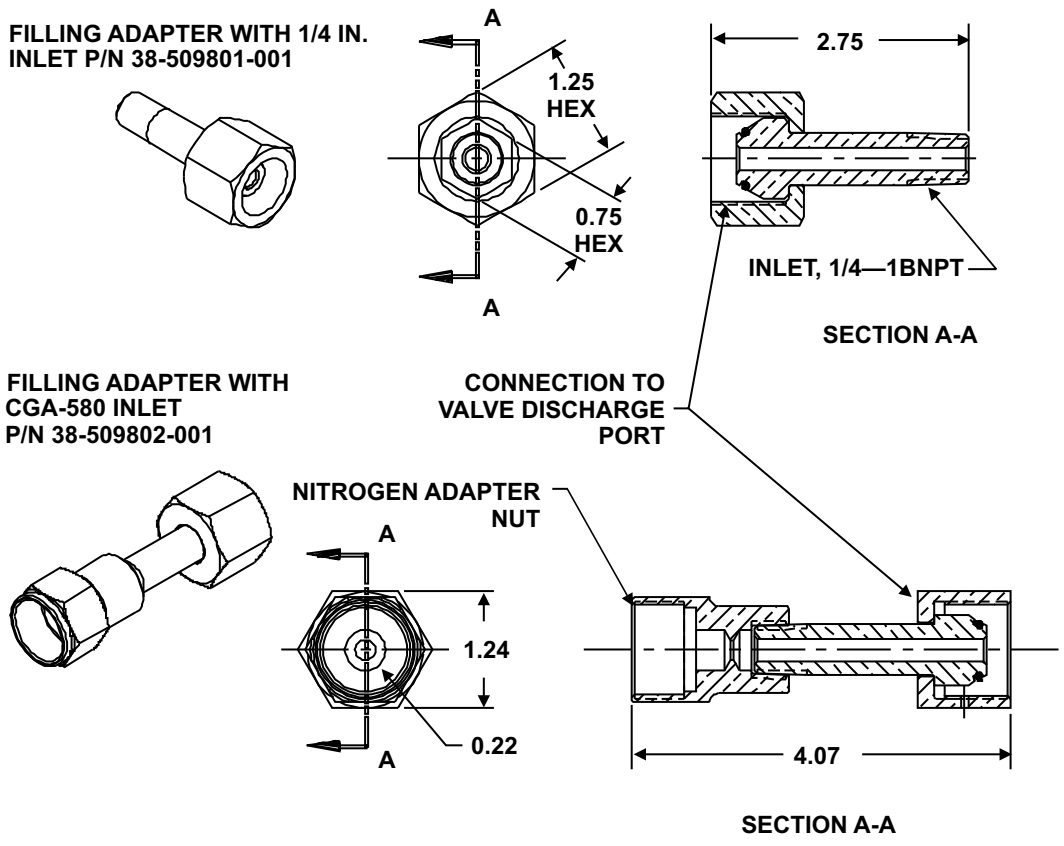

Figure 9-2. Filling Adapters

9-6.2 Filling Check List

Table 9-4. Filling Check List

Step	Description	Checked	Comments
1	List the cylinder number on the filling list.		
2	Check the valve function by using the handwheel to open and close the valve.		
3	For filling through the valve discharge outlet, the valve shall be fully open during filling. Open the valve by turning the handwheel counterclockwise until resistance is met.		
4	Fill the selected first gas (Argon or Nitrogen) to the required pressure. Check the individual pressure against those referenced in Paragraph 9-4.1 filling by pressure, or against the table in Paragraph 9-4.2.1 if filling by weight.		
5	Fill the second gas (Argon or Nitrogen) to the required pressure. If filling by weight, check weight against Table 9-1.		
6	When filling is completed and both gases filled, check the Argonite pressure. Close the valve by turning the handle clockwise until firm resistance is met.		
7	Leak test all connection points; no leaks are to be accepted.		
8	Seal off valve. Use hole in the handwheel and eye on valve body.		
9	Fit the cylinder with the protective transport cap.		
10	Attach the label, completed as required.		
11	Secure the cylinder in the transport cage, or on pallets.		
12	Ship to Receiver/Site as agreed.		

A transport label must always be on the transported cylinder(s). See Paragraph 9-9 for a description of the labels and stock numbers.

9-7 ARGONITE FILLING TABLES, PRESSURE/TEMPERATURE RELATIONSHIP

9-7.1 Filling Argonite, By Pressure

Based on an ideal gas equation, corrected for Argonite compression factors at 70°F (21.1°C). The graph is only valid after the temperature is equalized between the Argonite gas and the cylinder.

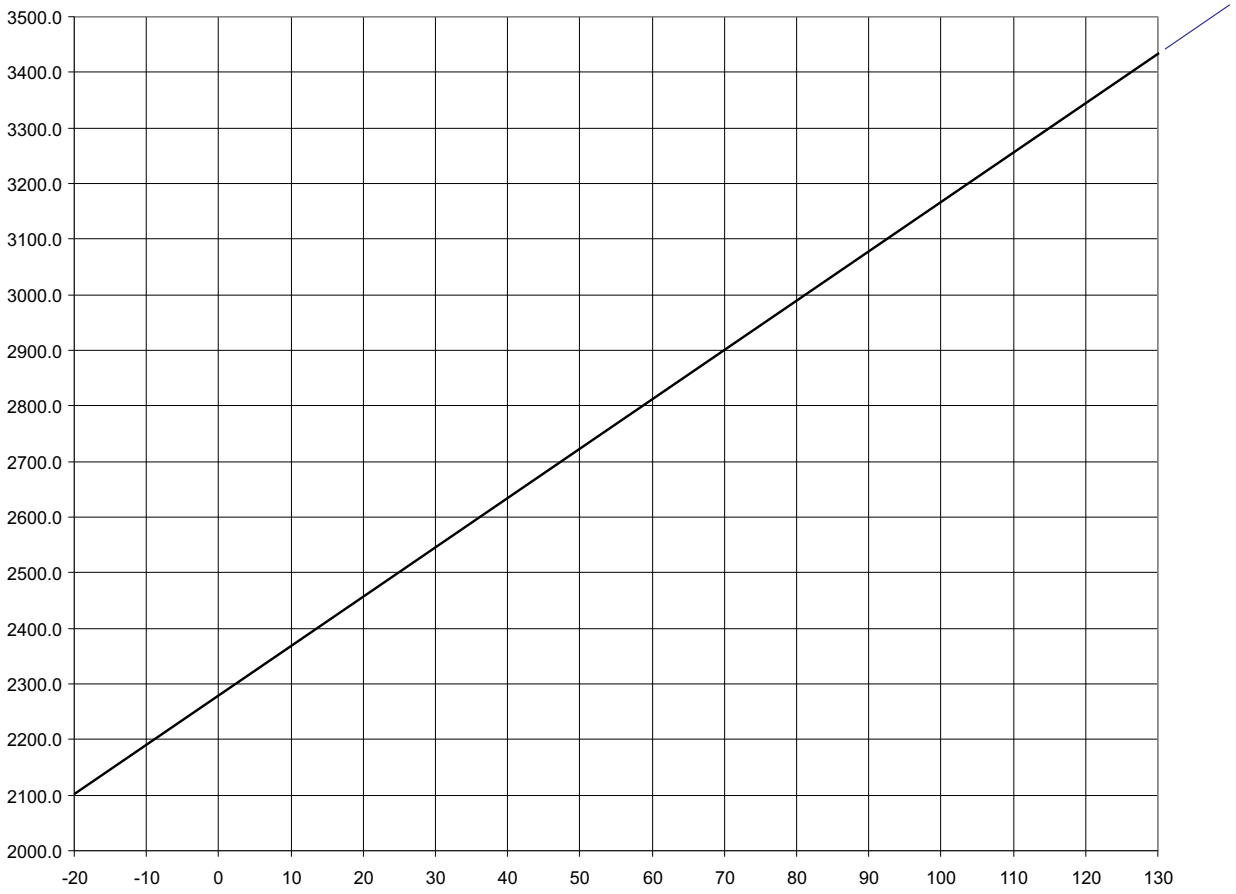

Figure 9-3. Filling Argonite, By Pressure

9-7.2 Filling Argonite, Nitrogen First

Based on ideal gas equation factors for Nitrogen.

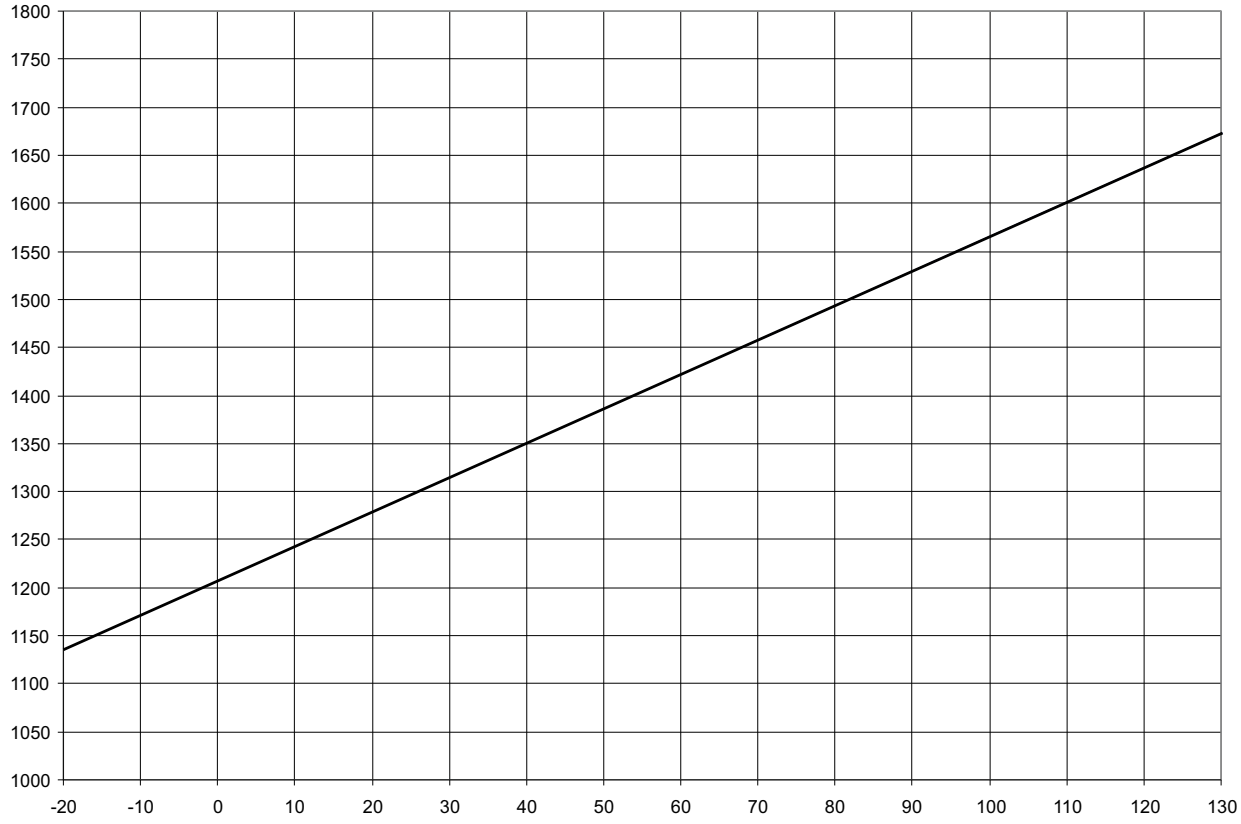

Figure 9-4. Filling Argonite, Nitrogen First

9-7.3 Filling Argonite, Argon First

Based on ideal gas equation factors for Argon.

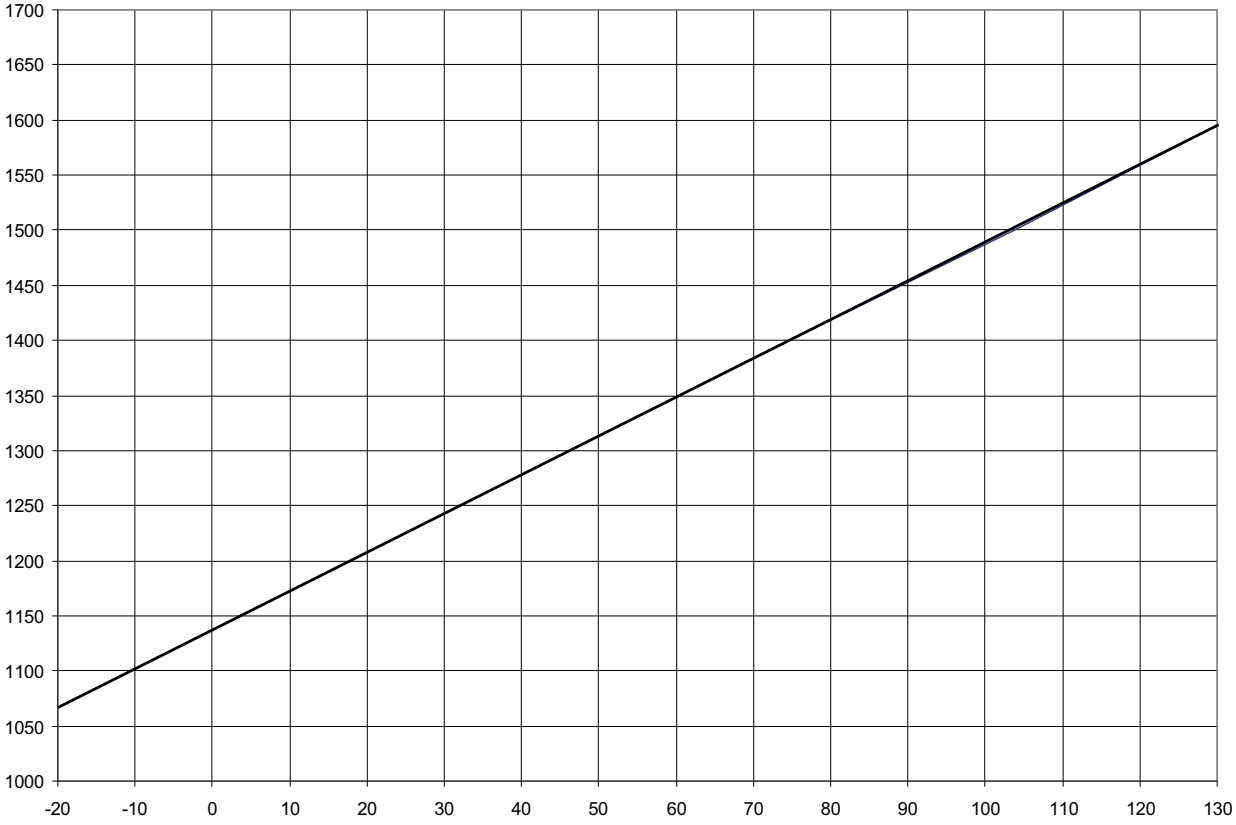

Figure 9-5. Filling Argonite, Argon First

9-8 FILLING LIST

The filling station is to complete the filling list and issue copy to the purchaser as well as include a copy with the shipment.

Table 9-5. Filling List

Filling List Number:		**Order Number:**		
Client:				
Cylinder Number	**Cylinder Size (15.9 L, 66.7 L or 80 L)**	**Argonite Pressure**	**Fill Date**	**Filler's Signature**

9-9 LETTER OF CONFORMITY

If required, the filling station shall issue a letter of conformity covering the filled cylinders, as follows:

This is to certify that to the best of our knowledge, the filling of the cylinders referenced in Filling List No. xxxxx, Order No. xxxxxx, Client xxxxxx, have been filled with xxxx% Argon and xxxx% Nitrogen in accordance with the requirements provided in these filling instructions.

9-10 CYLINDER TRANSPORT LABELS

Table 9-6. Argonite Cylinder Filling Labels

Part Number	Cylinder
38-641800-001*	80 L
38-641667-001*	66.7 L
38-641159-001*	15.9 L
***Note:** All cylinder lables are for 2900 PSI (200 bar), and are DOT (Department of Transportation) and TC (Transport Canada) Versions	

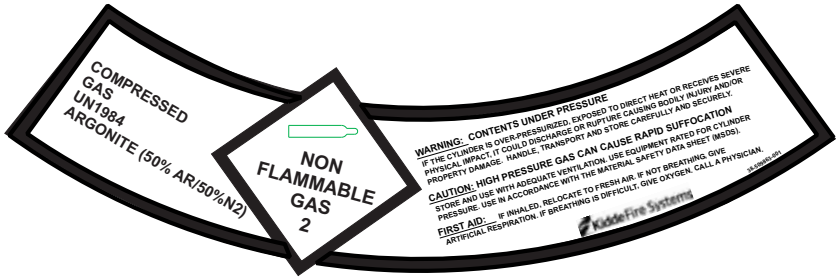

Figure 9-6. Argonite Compressed Gas Label, P/N 38-509863-001

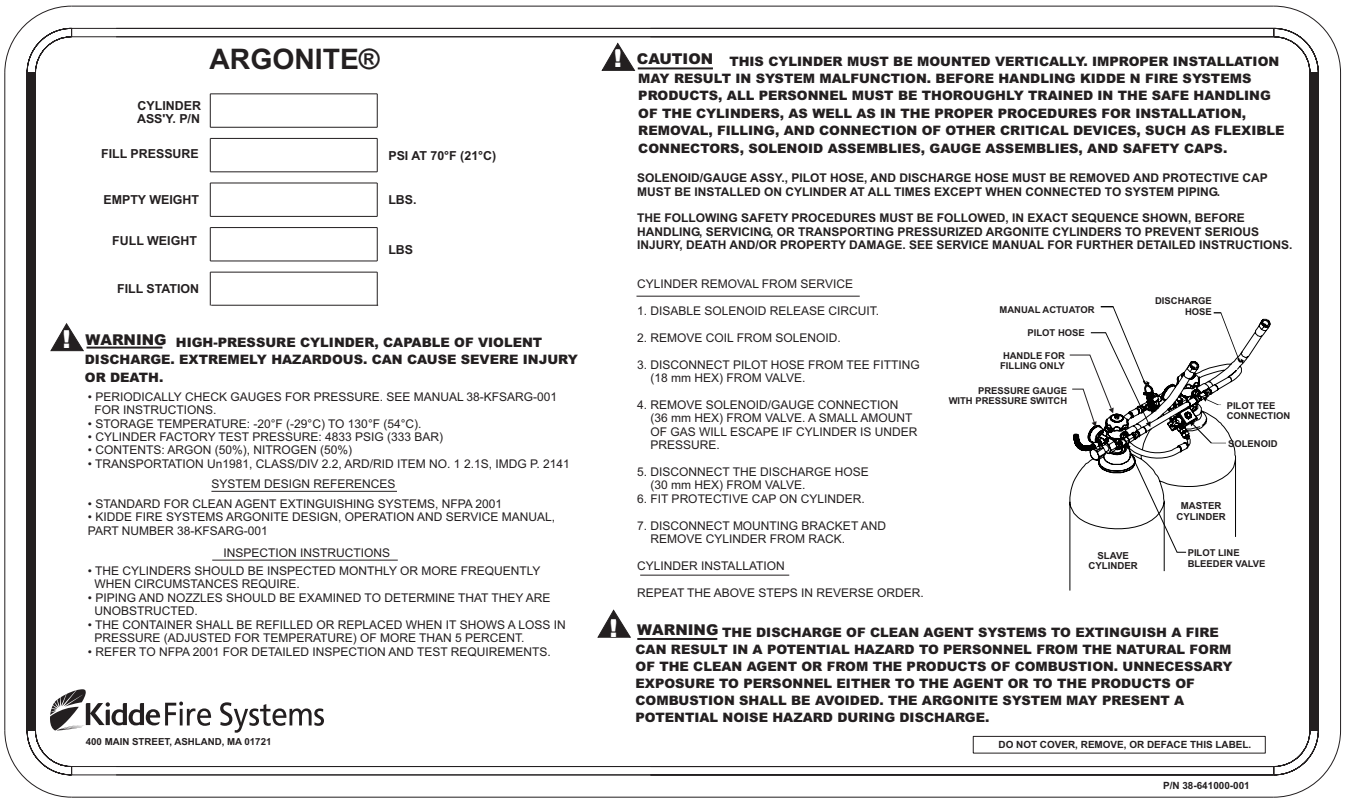

Figure 9-7. Cylinder Filling Label, P/N 38-641000-001 (80 L Cylinder Shown)

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APPENDIX A
ARGONITE® SAFETY DATA

A-1 IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND COMPANY

- MSDS No.: Argonite®
- Product Name: Argonite
- Chemical Formula: N_2 / Ar
- Company Identification: Local filling station
- Emergency Phone Numbers: Local filling station

A-1.1 COMPOSITION/INFORMATION ON INGREDIENTS

- Substance/Preparation:
  - Preparation
- Components/Impurities:
  - Contains no components or impurities which will influence the classification of the product
- CAS No.
  - N/A
- EEC No.
  - N/A
- Argonite Specifications:
  - Mixture of 50% to 52% N_2 and 48% to 50% Ar.
  - H_2O < 10ppm O_2 < 10ppm in base components.

A-2 HAZARDS IDENTIFICATION

- Hazards Identification:
  - In high concentrations may cause asphyxiation.
  - Compressed gas.

A-3 FIRST AID MEASURES

- Inhalation:
  - May cause asphyxiation at high concentrations. Symptoms may include loss of mobility/ consciousness. Victim may not be aware of asphyxiation.
  - Wearing self-contained breathing apparatus, remove victim to an uncontaminated area. Keep victim warm and at rest. Seek medical assistance. Apply artificial respiration if breathing has stopped.
- Skin/eye contact:
  - Compressed gas directed at the skin can enter the body through small wounds or can even penetrate the skin, causing serious or fatal injuries. Seek medical advice immediately.
- Ingestion:
  - Ingestion is not considered a potential route of exposure.

A-4 FIRE FIGHTING MEASURES

- Specific Hazards:
  - Exposure to fire may cause containers to rupture/explode. Call the Fire Department
  - Non flammable.
- Hazardous combustion products:
  - None.
- Suitable extinguishing media:
  - All known extinguishants can be used.
- Specific methods:
  - If possible, stop flow of product.
  - Move container away or cool with water from a protected position.
- Special protective equipment for fire fighters:
  - In confined spaces use self-contained breathing apparatus.

A-5 ACCIDENTAL RELEASE MEASURES

- Personal precautions
  - Evacuate area.
  - Use self-contained breathing apparatus when entering area unless atmosphere is proved safe.
  - Ensure adequate air ventilation.
- Environmental precautions:
  - Provided it is safe to do so, try to stop release.
  - Prevent entry to sewers, basements, and workpits or any place where accumulation can be dangerous.
- Clean up methods:
  - Ventilate area.

A-6 HANDLING AND STORAGE

- Handling and Storage:
  - Backflow of any contaminating substance into container must be prevented.
  - Use only equipment that is specified as suitable for this product, its supply pressure and temperature. Contact your supplier if in doubt.
  - Compressed gas cylinders are heavy and contain considerable stored energy. Use suitable equipment and handle with appropriate caution. Refer to suppliers.
  - Keep containers below 122°F (50°C) in a well-ventilated place.

A-7 EXPOSURE CONTROLS/PERSONAL PROTECTION

- Exposure Limit Value, ELV
  - No ELV specified, but atmosphere must have a minimum 18% free oxygen
- Personal Protection
  - Ensure adequate air ventilation.

A-8 PHYSICAL AND CHEMICAL PROPERTIES

- Molecular weight: 33.95
- Melting point: -327.46°F (-199.7°C)
- Boiling point: -310.18°F (-190.1°C)
- Critical temperature: -210.46°F (-134.7°C)
- Relative density gas: Heavier than air
- Relative density liquid: N/A

- Vapor pressure 68°F (20°C): N/A
- Solubility in water: Negligible
- Appearance/color: Colorless gas
- Odor: No odor warning properties
- Auto ignition temperature: Not applicable
- Flammability range: Non flammable
- Other data: Vapor is heavier than air. May accumulate in confined spaces, particularly at or below ground level.

A-9 STABILITY AND REACTIVITY

- Stability and Reactivity
  - Stable under normal conditions.

A-10 TOXICOLOGICAL INFORMATION

- General
  - No toxicological effects from this product.
- LC50/ ih (ppm)
  - No acute toxicity

A-11 ECOLOGICAL INFORMATION

- General
  - No ecological damage is caused by this product.
  - Nitrogen and Argon are natural components of air. Nitrogen constituting approximately 78% and Argon approximately 0.9% of the earth's atmosphere.

A-12 DISPOSAL CONSIDERATIONS

- General
  - To atmosphere in well ventilated area. Consider noise and pressure hazards. Do not discharge into any place where its accumulation could be dangerous.
  - Contact your Kidde Fire Systems' supplier if guidance is required.

A-13 TRANSPORT INFORMATION

- UN No.: 1981
- Class/Div. 2.2
- Emergency Action Code: None specified
- ADR/RID ITEM No. 1 2.1a
- IMDG page 2141
- IMO EMS 2 - 04
- ADR/RID Hazard No. Not specified
- Labelling ADR Non flammable non-toxic gas.
- Other transport information
  - Avoid transport on vehicles where the load space is not separated from the driver's compartment.
  - Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in an emergency.
  - Before transporting product containers ensure:
    - Cylinder valve is closed and not leaking
    - Valve outlet cap or plug (where provided) is correctly fitted
    - Adequate ventilation
    - Compliance with applicable regulations.

A-14 REGULATORY INFORMATION

- Number in annex 1 of Dir. 67/548
  - Not included in Annex 1.
- EC Classification
  - Not classified as a dangerous substance.
- EC Labelling (Symbols, R and S phrases)

  - Symbols:

    Compressed gas.

  - Risk Phrases:

    Asphyxiate in high concentrations.

  - Safety Phrases:

    Do not breathe the gas. Keep containers in a well-ventilated place.

A-15 OTHER INFORMATION

The hazard of asphyxiation is often overlooked and must be stressed during operator training.

Before using this product in any new process or experiment, a thorough material compatibility and safety study should be carried out.

Details in this document are believed to be correct at present. While great care has been taken in the preparation of this information, no liability for injury, damage or non-compliance with any legislation or directive arising from its use can be accepted.

This sheet does not constitute or substitute for the user's own assessment of workplace risk as required by other health and safety legislation.

APPENIDX B
ARGONITE® SURFACE FIRE REQUIREMENTS

Table B-1. Concentration of Argonite® Required

Project:						**Date:**	
Hazard:						**Engineer:**	
Type of Combustible:							
Volume							
_____	L	x	_____	H	=	_____	cu. ft./m
_____	L	x	_____	H	=	_____	cu. ft./m
_____	L	x	_____	H	=	_____	cu. ft./m
_____	L	x	_____	H	=	_____	cu. ft./m
				Total	=	_____	cu.ft./m
Argonite Required (Refer to Tables B-3 and B-4)							
_____	Vol.	x	_____ (concentration factor)		=	_____	kg
_____	kg	x	_____		=	_____	kg
				Total Kilograms Required	=	_____	
Storage Required							
_____	kg required	/	_____	kg/cyl	=	_____	cylinders
_____			Cylinders Main	and		_____	Cylinders Reserve

Table B-2. Argonite Cylinder Assembly Information

Description	Part Number	Usable Capacity (kg)
80 L Cylinder Assembly 2900 PSI (200 bar) DOT and TC Versions	38-100800-001	21.83
66.7 L Cylinder Assembly 2900 PSI (200 bar) DOT and TC Versions	38-100667-001	18.21
15.9 L Cylinder Assembly 2900 PSI (200 bar) DOT and TC Versions	38-100159-001	4.34
Note: All Cylinder Assemblies include a filled cylinder and valve.		

Table B-3. Total Flooding Quantities, Volume Requirements of Argonite
(Metric, kg/m3)

Temperature (°C)	Design Concentration (% by Volume)						
	34	**38**	**40**	**42**	**46**	**50**	**54**
-30	0.8566	0.9856	1.0532	1.1231	1.2703	1.4290	1.6009
-25	0.8224	0.9461	1.0110	1.0781	1.2196	1.3719	1.5369
-20	0.7899	0.9093	0.9711	1.0352	1.1710	1.3182	1.4768
-15	0.7602	0.8741	0.9338	0.9960	1.1259	1.2670	1.4193
-10	0.7316	0.8417	0.8986	0.9582	1.0840	1.2193	1.3656
-5	0.7041	0.8106	0.8653	0.9233	1.0437	1.1750	1.3155
0	0.6791	0.7806	0.8339	0.8897	1.0064	1.1322	1.2686
5	0.6549	0.7532	0.8041	0.8574	0.9705	1.0910	1.2235
10	0.6317	0.7267	0.7759	0.8276	0.9358	1.0528	1.1800
15	0.6092	0.7012	0.7492	0.7989	0.9038	1.0173	1.1394
20	0.5889	0.6779	0.7238	0.7725	0.8742	0.9830	1.1002
25	0.5694	0.6554	0.6997	0.7471	0.8443	0.9498	1.0637
30	0.5504	0.6337	0.6768	0.7225	0.8167	0.9191	1.0297
35	0.5334	0.6127	0.6550	0.6987	0.7900	0.8894	0.9969
40	0.5156	0.5936	0.6342	0.6769	0.7655	0.8607	0.9651
45	0.4997	0.5752	0.6144	0.6559	0.7418	0.8342	0.9344
50	0.4843	0.5573	0.5955	0.6355	0.7188	0.8084	0.9058
55	0.4700	0.5405	0.5776	0.6159	0.6967	0.7837	0.8780
Concentration Required: _____%							

Table B-3. Total Flooding Quantities, Volume Requirements of Argonite
(US Standard, kg/ft.3)

Temperature (°C)	Design Concentration (% by Volume)						
	34	**38**	**40**	**42**	**46**	**50**	**54**
-20	0.02404	0.02765	0.02955	0.03151	0.03565	0.04010	0.04492
-10	0.02295	0.02642	0.02827	0.03013	0.03407	0.03829	0.04294
0	0.02199	0.02529	0.02706	0.02883	0.03259	0.03668	0.04109
10	0.02107	0.02422	0.02586	0.02759	0.03123	0.03513	0.03936
20	0.02019	0.02323	0.02479	0.02648	0.02991	0.03365	0.03770
30	0.01935	0.02228	0.02379	0.02538	0.02874	0.03232	0.03620
40	0.01858	0.02141	0.02284	0.02437	0.02758	0.03104	0.03476
50	0.01789	0.02058	0.02195	0.02343	0.02650	0.02981	0.03341
60	0.01722	0.01978	0.02111	0.02254	0.02550	0.02867	0.03212
70	0.01657	0.01904	0.02032	0.02171	0.02454	0.02761	0.03096
80	0.01595	0.01834	0.01957	0.02092	0.02366	0.02659	0.02979
90	0.01536	0.01770	0.01887	0.02015	0.02280	0.02564	0.02872
100	0.01482	0.01704	0.01821	0.01946	0.02198	0.02473	0.02771
110	0.01430	0.01645	0.01756	0.01874	0.02122	0.02385	0.02674
120	0.01383	0.01591	0.01696	0.01813	0.02049	0.02304	0.02585
130	0.10335	0.01536	0.01641	0.01750	0.01980	0.02227	0.02495
Concentration Required: _____%							

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Kidde Fire Systems
400 Main Street
Ashland, MA 01721
Ph: (508) 881-2000
Fax: (508) 881-8920
http://www.kiddefiresystems.com

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