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DRY CHEMICAL SYSTEMS

SUPERSEDES HANDBOOK PAGES 24-14 TO 24-17

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1.0 SCOPE

This data sheet provides general information on dry chemical systems and general guidelines for their installation. Dry chemical systems should be specifically designed and installed in accordance with the appropriate manufacturer's guidelines as Approved[1] by Factory Mutual Research. Data Sheet 4-0, *Special Protection Systems,* also applies to dry chemical systems.

1.1 Changes

January 2000. This revision of the document has been reorganized to provide a consistent format.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Equipment and Processes

2.1.1 Installation - Layout and Design

2.1.1.1 Systems should be either:

1. *Engineered*, in which quantity and flow rate of dry chemical and pipe and nozzle sizes are calculated for the specific hazard.

2. *Preengineered (packaged)*, for which calculation of the quantity, flow rate, pipe sizes, or nozzle sizes is not needed. This type of system is suitable for hazards that are within the physical limitations recommended by the system manufacturer as Approved by the Factory Mutual Research.

2.1.1.2 *Location.* The dry chemical tanks and expellant gas assemblies should be located near the protected hazard, but not where they will be exposed by the hazard.

2.1.1.3 *Detection and Actuation.* Detection and actuation devices should be installed as outlined in Data Sheet 4-0, *Special Protection Systems.*

2.1.1.4 *Operating Devices.* Operating devices are used to release the expellant gas from its container for the pressurization of the dry chemical tank or to release the dry chemical if normally stored under pressure.

In fixed systems, expellant gas is released from its container by electrically, pneumatically, or mechanically dropping a weight that opens a cylinder valve or by mechanically releasing a spring that punctures the sealing disk of a gas cartridge. The dry chemical when stored under pressure is released by pneumatically or mechanically dropping a weight that opens the discharge valve.

Pressure trips may be used to release the weights of more than one unit for simultaneous discharge on hazards needing a greater capacity than is available for one unit. Pressure trips are operated by gas pressure taken from the low-pressure side of the expellant-gas regulator.

Hose-line systems are actuated at the cylinder by turning a hand wheel or by moving a lever.

2.1.1.5 *Storage Temperature Limits.* Dry chemical tanks and expellant-gas assemblies using nitrogen should be located where they will not be subject to temperatures above 120°F (49°C) or below -40°F (-40°C). Assemblies using carbon dioxide as an expellant gas should be located where they will not be subject to temperatures above 120°F (49°C) or below 32°F (0°C).

2.1.1.6 *Supply.* Reserve supplies of dry chemical should be stored in a clean, dry area in the original shipping containers with the lids tightly closed to prevent the entrance of moisture.

Before replenishing a system, the dry chemical should be checked carefully to determine that it is free-flowing and without lumps. The pressure or weight of the expellant gas container should be checked to ensure that it is above the minimum stipulated by the manufacturer. Proper operation of the system is dependent upon the physical characteristics of the dry chemical. It is essential to use only the dry chemical for which the system was designed.

Competitive brands of the same dry chemical agent may not be interchangeable. Also, different types of dry chemical agents may not be chemically compatible. In particular, mono-ammonium phosphate can react with bicarbonate-base agents producing pressures capable of rupturing the dry chemical container.

References to "Approved" in this data sheet means the product and services have satisfied the criteria for Factory Mutual Research Approval. Refer to the ***Approval Guide*** *for a complete listing of products and services that are Factory Mutual Research Approved.*

2.1.1.7 *Piping.* The distribution system should be constructed of standard-weight. (Schedule 40) galvanized-steel pipe and standard-weight galvanized-steel or malleable-iron fittings.

It is important that the piping system be balanced so that the pressure drop to any one nozzle will be about the same as to any other nozzle. Although dry chemical suspended in a gas may be homogeneous during flow, thereby simulating a liquid, certain natural forces such as momentum, centrifugal force, and sudden expansion of the gas may cause some separation of the two phases.

For example, if several nozzles were installed consecutively at right angles to a straight run of pipe, the momentum of the dry chemical would carry most of it past the first nozzles. These nozzles would, therefore, discharge more gas and less dry chemical than those farther on. To eliminate this, all branch piping should be balanced by the use of tees, the dry chemical entering the side port and leaving through the two end ports. The selector-valve manifold is designed so that after operation of the system, no dry chemical will remain packed *against* any of the unopen valves (Fig. 1).

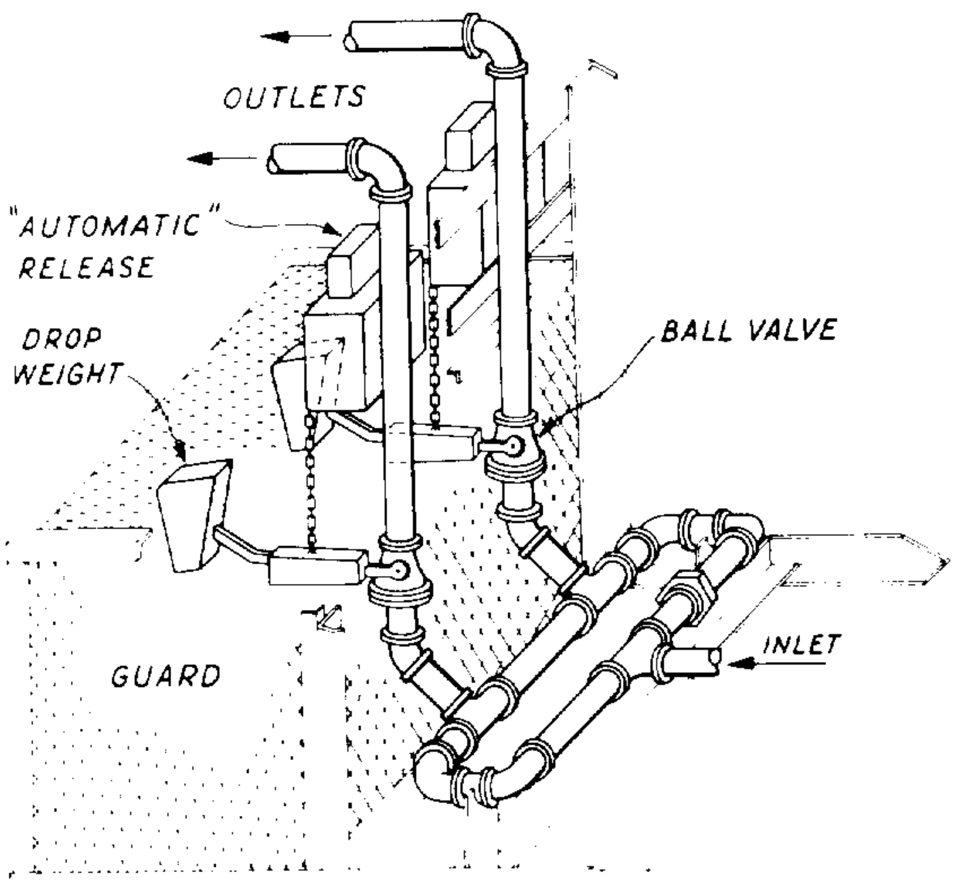

Fig. 1. Two-outlet selector valve manifold.

Changes in direction and division of flow should be made in accordance with the recommendations of the system manufacturer as Approved by Factory Mutual Research.

2.1.1.8 *Nozzles.* Nozzles are of various designs and discharge patterns. Nozzles for distributing the dry chemical should be of a type Approved for the particular application.

2.1.1.9 *Pipe and Nozzle Sizes.* The pipe and nozzle sizes are dependent upon the outlet pressure of the dry chemical unit, nozzle pressure, and flow rate. These items are interrelated and should be balanced to provide a correct system. Certain limitations of flow rate and pressure drop are known for various numbers and sizes of nozzles, and pipe sizes should be adjusted accordingly. Sizes should be determined in accordance with the appropriate manufacturer's guidelines as Approved by Factory Mutual Research.

2.1.1.10 *Total Flooding Systems.* In areas protected by total flooding systems, openings should be automatically closed no later than the start of the discharge. All ventilating equipment, conveyors, ignitable liquid pumps, and mixers should be interlocked with the dry chemical system and arranged to shut down automatically upon discharge of the system. Since the extinguishing action is transient, total flooding systems should be used only where no reignition is anticipated.

The discharge of dry chemical into a closed space may expel small amounts of flammable vapors and gases, and their safe venting to atmosphere without spreading to adjacent fire hazards or work areas should be considered. The quantity and flow rate of dry chemical necessary should be determined from the appropriate manufacturer's guidelines as Approved by Factory Mutual Research.

2.1.1.11 *Local Application Systems.* Local-application systems should be designed so that, in addition to the primary hazard, they will cover any adjacent combustibles to which or from which the fire may spread.

All ventilating fans, conveyors, ignitable liquid pumps, and mixers should be interlocked to shut down automatically upon discharge of the system. The quantity and flow rate of dry chemical necessary should be determined from the appropriate manufacturer's guidelines as Approved by Factory Mutual Research.

2.1.1.12 *Hose Line Systems.* Hose line systems should be selected on the basis of their approval listings to protect the hazard area, and they should not be used in lieu of recommended fixed-nozzle systems. Hose line systems are suitable for use on all hazards extinguishable by dry chemical if accessible and within the scope of manual fire fighting.

Extinguishment with hose lines depends greatly on the ability and skill of the operator. Personnel should be thoroughly trained in the proper operation of the system and in fire-fighting techniques. Hose-line stations should be located where they will be accessible during a fire and within reach of the protected hazards. Actuating controls should be located at the hose-line station. Hose should be connected and stored on a hose reel, rack, or in a hose house, ready for immediate use.

Sufficient quantity of dry chemical should be provided to permit a hose line to discharge for at least 30 sec. Where simultaneous use of two or more hose lines is possible, a sufficient quantity of dry chemical should be provided to supply the maximum number of nozzles likely to be used at any one time, for at least 30 sec at the appropriate flow rate.

2.1.2 Acceptance Tests

After installation of a dry chemical system is complete, a turnover test should be made in accordance with the guidelines of Data Sheet 4-0, *Special Protection Systems.*

The initial test of a new installation should ensure that all expellant-gas containers are actuated. If possible, the dry chemical and expellant gas should be discharged through the piping and nozzles. If a discharge of dry chemical is undesirable, expellant gas should be discharged through the system and observations made to ensure that all nozzles are discharging.

2.1.3 Maintenance

2.1.3.1 Dry chemical systems should be maintained as outlined in Data Sheet 4-0, *Special Protection Systems.*

2.1.3.2 In addition, at least semiannually, all expellant gas containers should be checked by pressure or weight to determine that the proper amount of expellant gas is available. The minimum acceptable limitation of expellant gas varies with the design of the equipment and is indicated on the system nameplate. In stored-pressure systems, the pressure gauge should be checked to determine that the pressure is in the operable range.

2.1.3.3 At least annually, the dry chemical in gas-cartridge or cylinder-operated systems should be checked to make sure it is free-flowing and without lumps.

2.1.3.4 All dry chemical containers less than 150 pounds nominal capacity (based on sodium bicarbonate agent), auxiliary pressure containers, valve assemblies, hoses and fittings, check valves, directional valves, manifolds, and hose nozzles should be hydrostatically tested at an interval not to exceed 12 years. The dry chemical removed from the container prior to testing should be discarded. During such testing, other protective measures should be taken to minimize the probability of a fire and any potential damage unless a connected reserve is provided. All equipment should be thoroughly dried prior to recharging.

2.1.3.5 When annual inspection of the dry chemical containers or system components reveals conditions such as but not limited to corrosion or pitting in excess of manufacturer's limits, structural damage, fire damage, repairs by soldering, welding or brazing, the affected part(s) shall be replaced or hydrostatically tested in accordance with the recommendations of the manufacturer and/or the original certifying agency.

2.1.3.6 Immediately after use, all hand-hose lines should be blown clear of dry chemical to prevent the possibility of plugging upon subsequent operation.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 General

Satisfactory performance of a dry chemical extinguishing system can best be assured by following the loss prevention recommendations within this document.

4.0 REFERENCES

4.1 FM

Data Sheet 4-0, *Special Protection Systems.*

4.2 NFPA Standards

NFPA 17, *Dry Chemical Extinguishing Systems,* 1998.

APPENDIX A GLOSSARY OF TERMS

Gas cartridge or cylinder: a container of expellant gas, when released by automatic or manual means, pressurizes a container of dry chemical. The dry chemical is carried through the piping by the expellant gas.

Stored pressure: a container of dry chemical that is constantly under nitrogen pressure.

APPENDIX B DOCUMENT REVISION HISTORY

This document does not have any revision history.

APPENDIX C SUPPLEMENTARY INFORMATION

C.1 Properties of Dry Chemical

Dry chemical used in Approved systems is mostly sodium bicarbonate, very finely ground, to which has been added other ingredients to keep it free-flowing and to resist the caking effect of moisture. Other dry chemical agents used in Approved dry chemical extinguishing systems include potassium bicarbonate, potassium chloride, and monoammonium phosphate (i.e., multipurpose type).

The dangers of dry chemical in fire-extinguishing concentrations to exposed personnel are temporary breathing difficulty and reduced visibility. In areas using total flooding systems, suitable means should be provided to permit evacuation of personnel. In areas using local application systems where the dry chemical is not confined, there is little hazard.

There have been many theories as to how dry chemical extinguishes fire, all of which probably have some basis in fact. The more generally accepted theory is that dry chemical has an inhibiting effect on the combustion chain reaction. Other theories contend that 1) dry chemical provides a physical blanketing, 2) oxygen in the air is diluted by carbon dioxide and water vapor produced by the fine solid particles, or 3) heat is reflected by the dry chemical particles.

C.2 Types of Dry Chemical Systems

There are two basic types of dry chemical systems:

1. *Gas cartridge or cylinder.* A container of expellant gas, when released by automatic or manual means, pressurizes a container of dry chemical. The dry chemical is carried through the piping by the expellant gas.

2. *Stored pressure.* A container of dry chemical that is constantly under nitrogen pressure.

Typical systems are shown in Figures 2 to 4. Systems are further classified by arrangement and method of application, and may be total flooding, local-application, or hose-line.

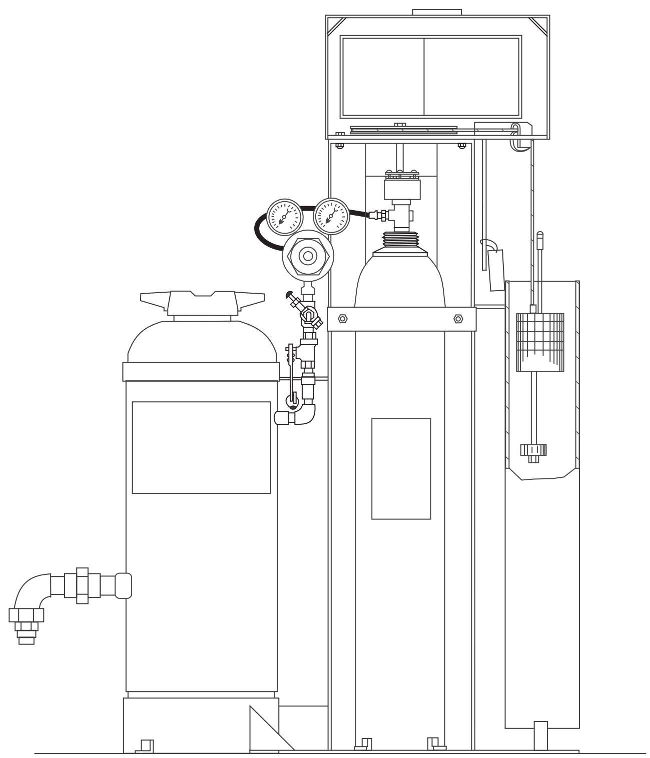

Fig. 2. Dry chemical and expellant-gas storage cylinders with piping connection.

Total flooding systems discharge dry chemical into enclosed spaces through fixed nozzles connected by piping to a supply (Fig. 5).

Local-application systems discharge dry chemical directly on the hazard, without any enclosure, through fixed nozzles connected by piping to a supply (Fig. 6).

Hose-line systems discharge dry chemical through manually operated nozzles connected by hose or by piping and hose to a fixed supply (Fig. 4). Hose-line systems are used to supplement fixed-protection systems or portable fire extinguishers.

C.3 Uses and Limitations

Dry chemical systems are generally considered to be supplementary protection to automatic sprinklers.

Dry chemical systems are used primarily for extinguishing fires in ignitable liquids. They are suitable for fires in hot oils and asphalt since they will not cause serious boilovers.

Bicarbonate-base dry chemical can be particularly effective for extinguishing fire in deep fat fryers caused by overheating. The saponification reaction between the dry chemical and fat or grease prevents reignition. Multipurpose dry chemical will not saponify the fat or grease and can prevent the saponification reaction between the fat or grease and any bicarbonate-base dry chemical subsequently used.

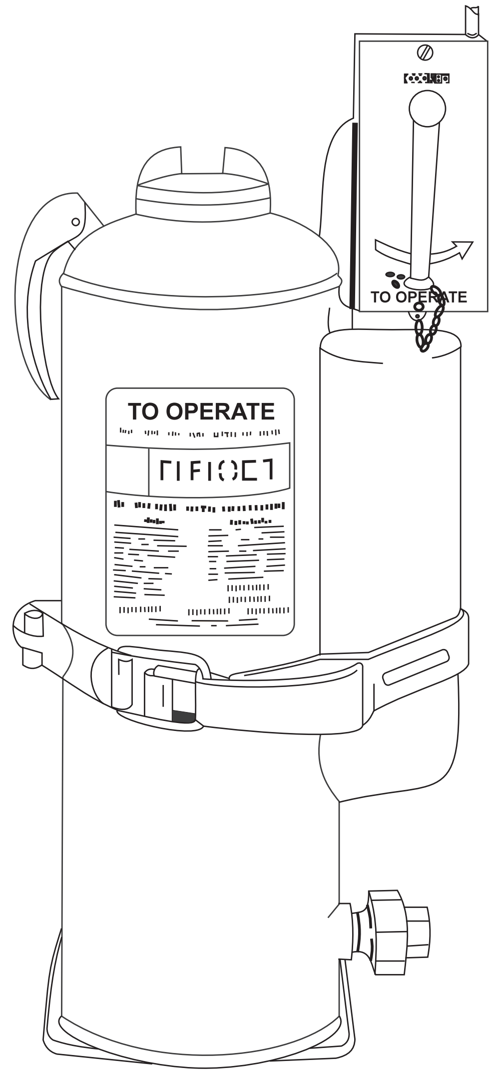

Fig. 3. Dry chemical cylinder with expellant-gas cartridge attached to side.

Multipurpose dry chemical is also effective on ordinary combustible such as wood, paper, or cloth when it can reach all surfaces involved in combustion. Bicarbonate-base dry chemical is also effective for textile surface fires, although water should be provided to extinguish possible smoldering or deep-seated fires.

Dry chemical systems are not suitable for fires in materials such as cellulose nitrate that contain their own oxygen supply. They are not recommended for fires involving delicate electrical equipment such as telephone switch boards, computers, and certain other electronic equipment because the dry chemical will insulate the fine and delicate contacts, necessitating complete cleaning.

Monoammonium phosphate and potassium chloride are slightly acidic, and in the presence of moisture can corrode metals such as steel, cast iron, and aluminum. Sodium bicarbonate and potassium bicarbonate are slightly basic, and in the presence of moisture can corrode metals such as aluminum, aluminum brass, aluminum bronze, and titanium. Corrosion can be minimized by prompt cleanup. Most dry chemical agents can be cleaned up by wiping, vacuuming, or washing the exposed materials or surfaces. Mono-ammonium phosphate will require some scraping and washing if exposed surfaces were hot when the agent was applied. Dry chemical is not effective on metal fires, but special dry compounds or dry powders are available which will extinguish fires in such metals as sodium, potassium, magnesium, aluminum, and titanium. Dry chemical

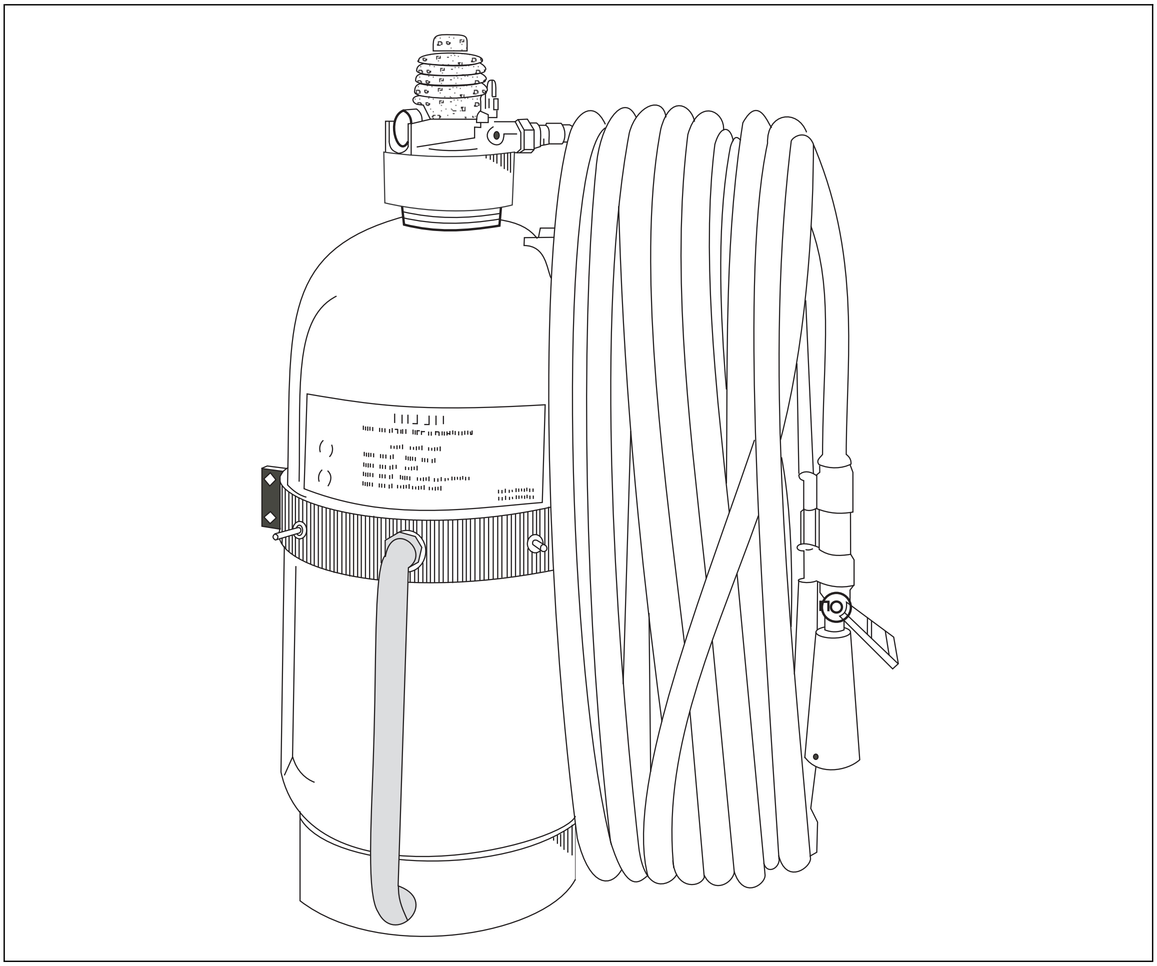

Fig. 4. Stored-pressure dry chemical cylinder with hose line.

systems are not recommended for extinguishing fires in escaping gases because of the danger of an explosion from reignition of gas that would continue to escape after the flame is extinguished.

APPENDIX D NFPA STANDARD

This data sheet does not conflict with NFPA 17, *Dry Chemical Extinguishing Systems*.

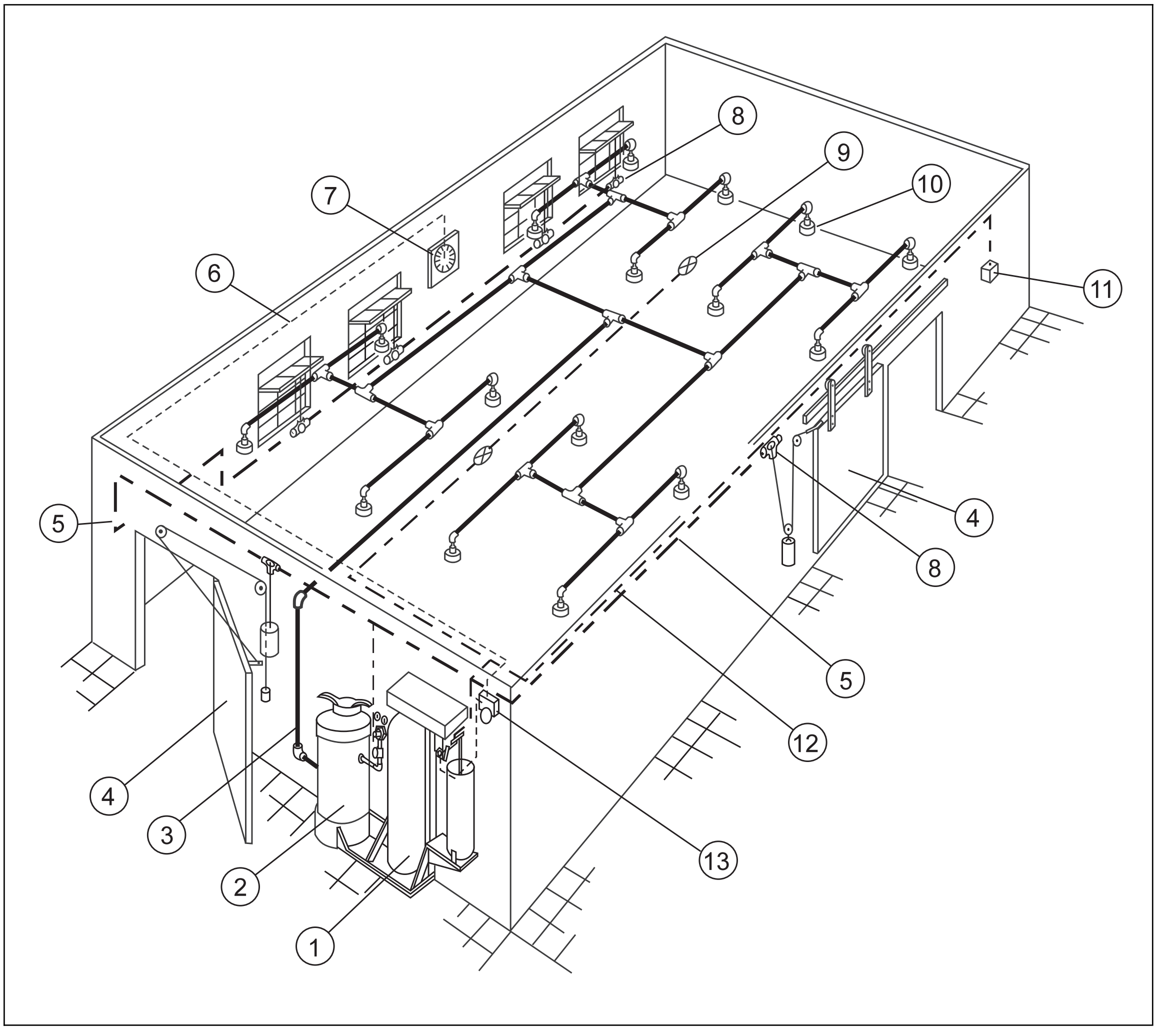

Fig. 5. Total flooding dry chemical system.

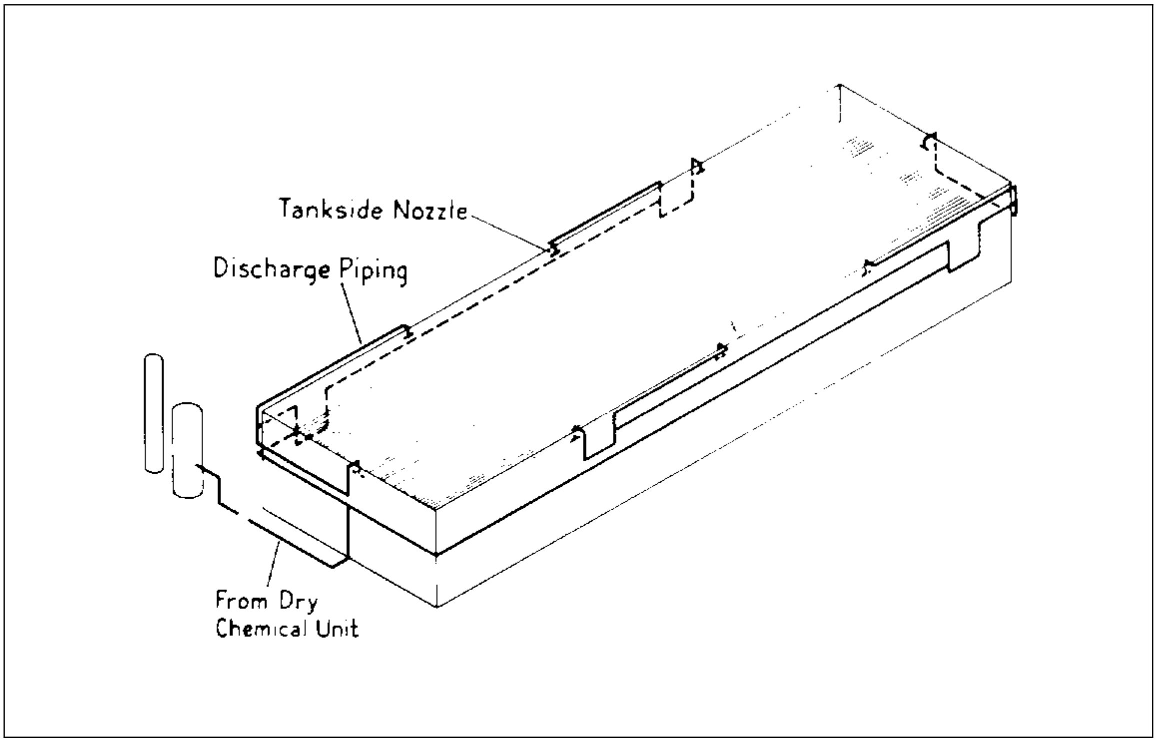

Fig. 6. Local-application system. Typical arrangement of piping and nozzles at dip tank.