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17

DRY CHEMICAL EXTINGUISHING SYSTEMS 1975

NATIONAL FIRE PROTECTION ASSOCIATION

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See Inside Back Cover for Official NFPA Definitions

Standard for

Dry Chemical Extinguishing Systems

NFPA No. 17 — 1975

1975 Edition of NFPA 17

The 1975 edition of this standard supersedes the 1973 edition and contains amendments recommended by the Committee on Dry Chemical Extinguishing Systems. The present edition was adopted by the National Fire Protection Association at the Fall Meeting in Pittsburgh, PA, November 17–20, 1975.

Changes other than editorial are denoted by a vertical line in the margin of the pages in which they appear.

Origin and Development of NFPA 17

The Dry Chemical Extinguishing Systems Committee was activated in 1952. At that time there was no dry chemical extinguishing system tested and listed by a nationally recognized testing laboratory, but by late 1954 a system was tested and listed by Underwriters' Laboratories, Inc. At its meeting in January 1955 the Committee prepared an outline of a standard on Dry Chemical Extinguishing Systems, and in the following year prepared the standard that was Tentatively Adopted by the National Fire Protection Association on June 7, 1956. Changes to the tentative standard led to approval of the first official NFPA Standard on Dry Chemical Extinguishing Systems in 1957. Further amendments were made in 1958, 1968, 1969, 1972 and 1973.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

Interpretation Procedure of the Committee on Dry Chemical Extinguishing Systems

Those desiring an interpretation shall supply the Chairman with five identical copies of a statement in which shall appear specific reference to a single problem, paragraph, or section. Such a statement shall be on the business stationery of the inquirer and shall be duly signed.

When applications involve actual field situations they shall so state and all parties involved shall be named.

The Interpretations Committee will reserve the prerogative to refuse consideration of any application that refers specifically to proprietary items of equipment or devices. Generally inquiries should be confined to interpretation of the literal text or the intent thereof.

Requests for interpretations should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

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Standard for

Dry Chemical Extinguishing Systems

NFPA 17 — 1975

NOTICE: An asterisk (*) preceding the number or letter designating a subdivision indicates explanatory material on that subdivision in Appendix A.

Chapter 1 Introduction

***1-1 Scope.** This standard includes minimum requirements for dry chemical fire extinguishing systems which discharge dry chemical from fixed nozzles and piping or from hose lines by means of expellant gas. It contains only the essentials and suggesions to make the standard workable in the hands of those skilled in this field. Portable dry chemical equipment is covered in the *Standard for the Installation, Maintenance and Use of Portable Fire Extinguishers* (NFPA 10–1974).

1-2 Purpose. This standard is prepared for use and guidance to those charged with the purchasing, designing, installing, testing, inspecting, approving, listing, operating or maintaining dry chemical fire extinguishing systems, in order that such equipment will function as intended throughout its life.

1-2.1 Only those skilled in this field are competent to design and install this equipment. It may be necessary for many of those charged with the purchasing, inspecting, testing, approving, operating, and maintaining this equipment to consult an experienced fire protection engineer, competent in this field, in order to effectively discharge their respective duties.

1-3 Definitions. For the purpose of clarification, the following general terms used with special technical meanings in this standard are defined.

Authority Having Jurisdiction is the organization, office, or individual responsible for "approving" equipment, an installation, or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA standards in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official,

electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances the property owner or his delegated agent assumes the role of the authority having jurisdiction; at government installations the commanding officer or a departmental official may be the authority having jurisdiction.

Calculation and Design refers to the process of computing, with the use of equations, graphs, or tables, the system characteristics such as flow rate, nozzle pressure, and pressure drop. This information is not required for listed pre-engineered systems.

Dry Chemical is a powder composed of very small particles usually of sodium bicarbonate, potassium bicarbonate, urea-based potassium bicarbonate, potassium chloride, or monoammonium phosphate with added particulate material supplemented by special treatment to provide resistance to packing, resistance to moisture absorption (caking) and the proper flow capabilities.

Engineered Systems are those requiring individual calculation and design to determine the flow rates, nozzle pressures, quantities of dry chemical, and the number and types of nozzles and their placement in a specific system.

Multipurpose Dry Chemical is usually monoammonium phosphate-based and is effective on fires in ordinary combustibles, such as wood or paper, as well as on fires in flammable liquids, etc.

Pre-Engineered Systems (sometimes known as "Package" Systems) are those having predetermined flow rates, nozzle pressures, and quantities of dry chemical. These systems have the specific pipe size, maximum and minimum pipe lengths, flexible hose specifications, number of fittings and number and types of nozzles prescribed by a nationally recognized testing laboratory. The hazards protected by these systems are specifically limited as to type and size by a nationally recognized testing laboratory based upon actual fire tests.

Chapter 2 General Information and Requirements

***2-1 Dry Chemical.** The type of dry chemical used in the system shall not be changed unless proved to be changeable by a nationally recognized testing laboratory, recommended by the manufacturer of the equipment, and approved by the authority having jurisdiction. Systems are designed on the basis of the flow and extinguishing characteristics of a specific make and type of dry chemical.

CAUTION: Types of dry chemical shall not be mixed. Mixtures of certain dry chemicals will generate dangerous pressures and will form lumps.

2-2 Use and Limitations.

***2-2.1 Use.** Types of hazards and equipment for which dry chemical extinguishing systems shall be considered satisfactory protection include the following:

(a) Flammable or combustible liquids and combustible gases.

CAUTION: Extinguishment of uncontrolled discharge of flammable liquids or combustible gases may result in a subsequent explosion hazard.

(b) Combustible solids having burning characteristics similar to naphthalene and pitch, which melt when involved in fire.

(c) Flammable liquids, combustible liquids, or combustible gases released from transfer or loading facilities.

(d) Electrical hazards such as transformers or oil circuit breakers.

(e) Textile operations subject to flash surface fires. Where bicarbonate base dry chemical is used, water shall be provided to extinguish possible smoldering or deep seated fire.

(f) Ordinary combustibles such as wood, paper, or cloth using multipurpose dry chemical when it can reach all surfaces involved in combustion.

(g) Kitchen hoods, ducts and associated range-top hazards such as deep fat fryers. [*See also 4-4.1 and A-2-1(3).*] For other specific details, see *Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapor from Commercial Cooking Equipment* (NFPA 96–1973).

(h) Some plastics depending upon the type of material and their configuration of hazard. For more specific information, consult the manufacturer of the equipment.

2-2.2 Limitations. Types of materials for which dry chemical extinguishing systems shall not be considered satisfactory protection include the following:

(a) Chemicals containing their own oxygen supply such as cellulose nitrate.

(b) Combustible metals such as sodium, potassium, magnesium, titanium, and zirconium. Dry powder systems listed by a nationally recognized testing laboratory for combustible metal fires may be used.

(c) Deep-seated or burrowing fires in ordinary combustibles where the multipurpose dry chemical cannot reach the point of combustion.

2-2.2.1 Before dry chemical extinguishing equipment is considered for use to protect electronic equipment or delicate electrical relays, the effect of residual deposits of dry chemical on the performance of this equipment shall be evaluated.

2-2.2.2 Multipurpose dry chemical shall not be considered satisfactory for use on machinery such as carding equipment in textile operations and delicate electrical equipment because, upon exposure to temperatures in excess of 250°F or relative humidity in excess of 50%, deposits will be formed which may be difficult to remove.

***2-2.2.3** Dry chemical, when discharged, will drift from the immediate discharge area and settle on surrounding surfaces. Prompt cleanup will minimize possible staining or corrosion of certain materials which may take place in the presence of moisture.

2-3 Systems Protecting One or More Hazards.

2-3.1 Where, in the opinion of the authority having jurisdiction, two or more hazards may be simultaneously involved in fire by reason of their proximity, the hazards shall be protected by individual systems installed to operate simultaneously, or by a single system designed to protect all hazards that may be simultaneously involved.

2-3.2 Where hand hose lines may be used on a hazard that is also protected by a fixed system, separate dry chemical supplies shall be provided.

2-3.3 A single dry chemical supply shall be used for both a hand hose line system and a fixed nozzle system only if the hazards protected by the two systems are separated so that the hand hose lines cannot be used on the hazard protected by the fixed nozzle system, and the probability of fire occurring simultaneously in both hazards is slight.

***2-4 Personnel Safety.**

2-4.1 Safety Requirements. In total flooding systems where there is a possibility that personnel may be exposed to a dry chemical discharge, suitable safeguards shall be provided to ensure prompt evacuation of such locations, and also to provide means for prompt rescue of any trapped personnel. Such safety items as personnel training, warning signs, discharge alarms, predischarge alarms, and respiratory protection shall be considered. In local application systems where the dry chemical is likely to discharge upon personnel, such as in loading racks, discharge alarms and special personnel training shall be provided.

CAUTION: Hazards to Personnel. The discharge of large amounts of dry chemical may create hazards to personnel such as reduced visibility and temporary breathing difficulty.

2-4.2 When stored-pressure or cartridge operated dry chemical cylinders are not attached to piping, the discharge outlet shall be provided with a protective diffusing safety cap to protect personnel from recoil and high flow discharge in case of accidental actuation. Such protective caps shall also be used on empty cylinders to protect threads. These caps shall be provided by the manufacturer of the equipment.

2-4.3 All system components shall be so located as to maintain minimum clearances from live parts as shown in the following table.

As used in this standard, "clearance" is the air distance between dry chemical equipment, including piping and nozzles, and unenclosed or uninsulated live electrical components at other than ground potential.

The clearances given are for altitudes of 3,300 ft. or less. At altitudes in excess of 3,300 ft., the clearance shall be increased at the rate of 1 percent for each 330 ft. increase in altitude above 3,300 ft.

The clearances are based upon minimum general practices related to design Basic Insulation Level (BIL) values. To coordinate the required clearance with the electrical design, the design BIL of the equipment being protected shall be used as a basis, although this is not material at nominal line voltages of 161 kv or less.

Up to electrical system voltages of 161 kv the design BIL kv and corresponding minimum clearances, phase to ground, have been established through long usage.

At voltages higher than 161 kv, uniformity in the relationship between design BIL kv and the various electrical system voltages has not been established in practice and is dependent upon several variables so that the required clearances to ground shall be based upon the design BIL used rather than on the nominal line or ground voltage.

Possible design variations in the clearance required at higher voltages are evident in the Table, where a range of voltages is indicated opposite the various BIL test values in the high voltage portion of the Table. However, the clearance between uninsulated energized parts of the electrical system equipment and any portion of the dry chemical system shall not be less than the minimum clearance provided elesewhere for electrical system insulations on any individual component.

Table 2-4.3
Clearance from Dry Chemical Equipment To Live Uninsulated Electrical Components

Nominal Line Voltage kv	Nominal Voltage to Ground kv	Design BIL kv	Minimum Clearance inches
15	9	110	6
23	13	150	8
34.5	20	200	12
46	27	250	15
69	40	350	23
115	66	550	37
138	80	650	44
161	93	750	52
196–230	114–132	900	63
		1050	76
287–380	166–220	1175	87
		1300	98
		1550	120
500	290	1675	131
		1800	142
500–700	290–400	1925	153
		2100	168
		2300	184

NOTE: 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.

2-5 Specifications, Plans and Approvals.

2-5.1 Specifications. Specifications for dry chemical fire extinguishing systems shall be drawn up with care under supervision of a competent person, and with the advice of the authority having jurisdiction. To ensure a satisfactory system, the following items shall be in the specifications.

2-5.1.1 The specifications shall designate the authority having jurisdiction and indicate whether plans are required.

2-5.1.2 The specifications shall state that the installation shall conform to this standard and meet the approval of the authority having jurisdiction.

2-5.1.3 The specifications shall include the specific tests that may be required, if any, to meet the approval of the authority having jurisdiction, and indicate how the cost of testing is to be borne.

2-5.1.4 These specifications shall indicate the hazard to be protected and shall include such information as physical dimensions, combustibles, air handling equipment, heat sources, etc.

2-5.2 Plans. Where plans are required, the responsibility for their preparation shall be entrusted only to competent persons.

2-5.2.1 These plans shall be drawn to an indicated scale or be suitably dimensioned, and shall be made so that they can be easily reproduced.

2-5.2.2 These plans shall contain sufficient detail to enable the authority having jurisdiction to evaluate the hazard or hazards, and to evaluate the effectiveness of the system. The details on the hazards shall include materials involved, the location and arrangement, and the exposure to the hazard.

2-5.2.3 The details on the system shall include sufficient information and calculations on the amount of dry chemical; the size, length and arrangement of connected piping, or piping and hose; description and location of nozzles so that the adequacy of the system can be determined. Flow rates of nozzles used shall be provided for engineered systems. Information shall be submitted pertaining to the location and function of detection devices, operating devices, auxiliary equipment and electrical circuitry, if used. Sufficient information shall be indicated to identify properly the apparatus and devices used.

2-5.3 Approval of Plans. Where plans are required, they shall be submitted to the authority having jurisdiction for approval before work starts.

2-5.3.1 Where field conditions necessitate any substantial change from the approved plan, the corrected as-installed plans shall be submitted to the authority having jurisdiction for approval.

2-5.4 Approval of Installations. The completed system shall be tested by qualified personnel as required by the authority having jurisdiction. These tests shall be adequate to determine that the system has been properly installed and will function as intended. Only listed equipment and devices shall be used in these systems.

2-5.4.1 The installer shall certify to the authority having jurisdiction that the installation has been made in accordance with the approved plans and the listing of a nationally recognized testing laboratory.

2-5.4.2 Approval tests shall include a discharge of expellant gas through the piping and nozzles. Observations for serious gas leakage and for continuity of piping with free unobstructed flow shall be made. Observations shall be made of the flow of expellant gas through all nozzles. Piping shall not be hydrostatically tested. Where pressure testing is required, it shall be by means of a dry gas. The labeling of devices with proper designations and instructions shall be checked.

2-5.4.3 After any tests, care shall be taken to see that all piping and nozzles have been blown clean, using compressed air or nitrogen if necessary. Care also shall be taken to see that the system is properly charged and placed in the normal "set" condition.

2-6 Operation and Control of Systems. See:

(a) Standard for Central Station Signaling Systems (NFPA 71–1974)

(b) Standard for Local Protective Signaling Systems (NFPA 72A–1974)

(c) Standard for Auxiliary Protective Signaling Systems (NFPA 72B–1974)

(d) Standard for Remote Station Protective Signaling Systems (NFPA 72C–1974)

(e) Standard for Proprietary Protective Signaling Systems (NFPA 72D–1974)

(f) Standard for Automatic Fire Detectors (NFPA 72E–1974)

as applicable to detection, alarm and control functions for dry chemical extinguishing systems.

2-6.1 Methods of Actuation. Systems shall be classified as automatic or manual in accordance with the following methods of actuation:

(a) Automatic Operation. Operation that does not require any human action.

(b) Normal Manual Operation. Operation of a system requiring human action where the device used to cause the operation is located near the hazard so as to be easily accessible at all times (*see 2-6.3.4*). Operation of one control shall be all that is required to bring about the full operation of the system.

(c) Emergency Manual Operation. Operation of the system by human means where the device used to cause operation is fully mechanical in nature and is located on the device being controlled or on its mounting assembly. "Fully mechanical" may incorporate use of the system pressure to complete operation of the device.

2-6.2 Detection of Fires. Fires or conditions likely to produce fire shall be detected by visual (human senses) or by automatic means.

2-6.2.1 Reliance on visual detection shall be permitted only with permission of the authority having jurisdiction where fires or conditions likely to produce fires can be readily detected by such means.

2-6.2.2 Automatic detection shall be by a listed or approved device that is capable of detecting and indicating heat, flame, smoke, combustible vapors, or an abnormal condition in the hazard, such as process trouble, that is likely to produce fire.

2-6.2.3 An adequate and reliable source of energy shall be used in detection systems.

2-6.3 Operating Devices. Operating devices shall mean expellant gas releasing mechanisms, dry chemical discharge controls, and shutdown equipment.

2-6.3.1 Operation shall be by listed mechanical, electrical, or pneumatic means. An adequate and reliable source of energy shall be used.

2-6.3.2 All operating devices shall be designed for the service they will encounter, and shall not be readily rendered inoperative or susceptible to accidental operation. Devices shall be normally designed to function properly from −40 F to +150 F, or marked to indicate temperature limitations.

2-6.3.3 All devices shall be designed, located, installed, or protected so that they are not subject to mechanical, environmental or other conditions that would render them inoperative.

2-6.3.4 The normal manual control for actuation shall be located so as to be conveniently and easily accessible at all times including the time of the fire. The control shall cause the complete system to operate.

2-6.3.5 All valves controlling the release and distribution of dry chemical shall be provided with an emergency manual control.

Exception No. 1: This does not apply to slave cylinders.

Exception No. 2: It is possible for the normal manual control to qualify as emergency manual control if provisions of 2-6 are satisfied.

2-6.3.6 Manual controls shall not require a pull of more than 40 lb. (force) nor a movement of more than 14 in. to secure operation.

2-6.3.7 Means shall be provided for checking the amount of expellant gas to assure that it is sufficient for the proper operation of the system.

2-6.3.8 All shutdown devices shall be considered integral parts of the system and shall function with the system operation. If the expellant gas is used to pneumatically operate these devices, then the gas must be taken prior to its entry into the dry chemical tank.

2-6.3.9 All remote manual operating devices shall be identified as to the hazard that they protect.

2-6.4 Supervision. Where supervision of any or all of the following is provided, it shall be arranged to give indication of failure: the automatic detection system, the electrical actuation circuit, the electrical power supply.

2-6.5 Alarms and Indicators. Alarms and/or indicators are used to indicate the operation of the system, hazard to personnel, or failure of any supervised device or equipment. The devices may be audible or visual. The type, number, and location of the devices shall be such that their purpose is satisfactorily accomplished. The extent and type of alarm and/or indicator equipment shall be approved.

2-6.5.1 An alarm or indicator shall be provided to show that the system has operated, that personnel response may be needed, and that the system is in need of recharge.

2-6.5.2 Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication of any failure and shall be distinctive from alarms indicating operation or hazardous conditions.

2-7 Dry Chemical Supply.

2-7.1 Quantity. The amount of dry chemical in the system shall be at least sufficient for the largest single hazard protected, or for the group of hazards which are to be protected simultaneously.

2-7.2 Quality. The dry chemical used in the system shall be supplied by the manufacturer of the equipment. The characteristics of the system are dependent upon the composition of the dry chemical and the type of expellant gas, as well as upon other factors, and, therefore, it is imperative to use the dry chemical provided by the manufacturer of the system and the type of expellant gas specified by the manufacturer of the system.

2-7.2.1 Where carbon dioxide or nitrogen is used as the expellant gas, it shall be of good commercial grade, free of water and other contaminants that might cause container corrosion.

2-7.2.1.1 Carbon doxide used as an expellant gas shall meet the following specifications:

(a) The vapor phase shall not be less than 99.5 percent carbon dioxide.

(b) The water content of the liquid phase shall not be more than 0.01 percent by weight (−30 F dew point).

(c) Oil content shall not be more than 10 ppm by weight.

2-7.2.1.2 In general, carbon dioxide obtained by converting dry ice to liquid shall not be satisfactory unless it is properly processed to remove excess water and oil.

***2-7.3 Reserve Supply.** Where a dry chemical system protects multiple hazards by means of selector valves, sufficient dry chemical and expellant gas shall be kept on hand for one complete recharge of the system. For single hazard systems, a similar supply shall be kept on hand if the importance of the hazard is such that it cannot be shut down until recharges can be procured.

2-7.4 Storage. Storage of charging supplies of dry chemical shall be in a constantly dry area, and the dry chemical shall be contained in metal drums or other containers which will prevent the

entrance of moisture even in small quantities. Prior to charging the dry chemical chamber, the dry chemical shall be carefully checked to determine that it is in free-flowing powdery condition, and the pressure or weight of the expellant gas shall be checked as stipulated by the manufacturer to determine that it is above the required minimum.

2-7.4.1 The dry chemical tank and expellant gas assemblies shall be located near the hazard or hazards protected, but not where they will be exposed to a fire or explosion in these hazards.

2-7.4.2 The dry chemical tank and expellant gas assemblies shall be located so as not to be subjected to severe weather conditions, or to mechanical, chemical, or other damage. When excessive climatic or mechanical exposures are expected, suitable enclosures or guards shall be provided.

2-7.4.3 The dry chemical tank and expellant gas assemblies utilizing nitrogen shall be located where the ambient temperature is normally between −40 F and 120 F. Assemblies utilizing carbon dioxide shall be located where the ambient temperature is normally between 32 F and 120 F. Exposure extremes of short duration can be tolerated. Otherwise, methods shall be provided for maintaining the temperatures within the ambient ranges given.

NOTE: Systems for use at higher or lower temperatures can be specially designed.

2-7.4.4 The dry chemical tank and expellant gas assemblies shall be located where they will be easy to inspect, maintain and service.

2-8 Distribution System.

***2-8.1 Pipe and Fittings.** Threaded pipe and fittings shall be galvanized malleable iron, galvanized steel, stainless steel, copper, or brass. Black steel pipe with welded joints or malleable iron threaded fittings may be used when the atmosphere is relatively noncorrosive. Special corrosion resistant materials shall be used for corrosive atmospheres. Steel pipe shall not be less than Schedule 40 and brass and copper pipe shall be not less than the approximate Schedule 40 wall thickness (regular pipe) for pipe sizes of 6 in. or less.

2-8.1.1 Cast iron pipe and fittings shall not be used.

2-8.1.2 Tubing shall not be used for dry chemical distribution.

2-8.1.3 Flexible piping (hose) shall be used only in accordance with the listings of a nationally recognized testing laboratory as they are stated for specific dry chemical fire extinguishing systems. (*See A-2-8.1.*)

2-8.1.4 Piping for systems to be installed for protection of cryogenic liquid spill fires shall be protected from submergence in the liquid, localized liquid impingement, and the simultaneous exposure to cryogenic liquid and flame temperatures. Where the dry chemical supply lines are installed underground within the potential spill area, the individual branch lines shall be brought up through insulated sleeves. The insulated sleeves shall be extended above the maximum anticipated cryogenic liquid accumulation depth. Any sub-branching abovegrade shall also be protected against localized impingement by the cryogenic liquid.

***2-8.2 Arrangement and Installation of Pipe and Fittings.** Piping shall be installed in accordance with good commercial practices.

2-8.2.1 All piping shall be laid out to produce the desired dry chemical flow rate at the nozzles, and care shall be taken to avoid possible restrictions due to foreign matter and faulty fabrication and/or improper installation.

2-8.2.2 The piping system shall be securely supported and shall not be subject to mechanical, chemical, or other damage. Where explosions are possible, the piping system shall be hung from supports that are least likely to be displaced.

2-8.2.3 Pipe shall be reamed and cleaned before assembly, and after assembly the entire piping system shall be blown out with dry gas before nozzles or discharge devices are installed. The use of pipe-thread compound or tape shall not be used.

2-8.3 Valves. All valves shall be listed for the intended use, particularly in regard to flow capacity and operation. Selector valves shall be of the quick-opening type, allowing essential free passage of the dry chemical without restriction.

2-8.3.1 Valves shall not be easily subject to mechanical, chemical, or other damage.

2-8.4 Discharge Nozzles. Discharge nozzles shall be listed for the use intended, in accordance with subsequent chapters.

2-8.4.1 Discharge nozzles shall be of adequate strength for use with the expected working pressures.

2-8.4.2 Discharge nozzles shall be of brass, stainless steel, or other corrosion-resistant materials, or be protected inside and out against corrosion. They shall be made of noncombustible materials, and shall withstand the expected fire exposure without deformation.

2-8.4.3 All nozzles shall be designed and subsequently located, installed or protected so that they are not subject to mechanical, environmental or other conditions that would render them inoperative.

2-8.4.4 Discharge nozzles shall be so connected and supported that they may not be readily put out of alignment. Where nozzles are connected directly to flexible hoses, they shall be provided with mounting brackets or fixtures to assure that they can be aligned properly and that the alignment will be maintained.

2-8.4.5 Discharge nozzles shall be clearly marked for identification of type and size.

2-8.4.6 Where external clogging by foreign materials is likely, the listed discharge nozzle assemblies shall include protective caps.

2-8.5 Pipe Size and Nozzle Determination. Pipe sizes and nozzles shall be selected on the basis of calculations to deliver the required dry chemical flow rate at each nozzle or, for pre-engineered systems, in accordance with limitations set by a nationally recognized testing laboratory.

2-8.5.1 Equations, or graphs derived therefrom, shall be used to determine the pressure drop in the pipe line in engineered systems. This design information shall be based on tests performed by the manufacturer and confirmed by a nationally recognized testing laboratory. It is not required in pre-engineered systems.

2-9 Electrical Wiring and Equipment.

2-9.1 Installation. Electrical wiring and equipment shall be installed in accordance with the *National Electrical Code*, NFPA 70–1975, or the requirements of the local authority having jurisdiction.

2-10 Inspection, Maintenance, and Instruction.

***2-10.1 Inspection and Tests.** At least annually, all dry chemical systems including alarms, shutdowns, and other associated

equipment shall be thoroughly inspected and checked for proper operation by competent personnel. (*See 2-6 and 2-10.1.9.*)

2-10.1.1 The purpose of this inspection and testing shall be not only to ensure that the system is in full operating condition, but also to indicate the probable continuance of that condition until the next inspection. Attention at this inspection shall be given to any extension of the hazard protected by the system. A suitable gas discharge test shall be made when this inspection indicates it to be advisable. (*See 2-10.1.*)

2-10.1.2 The inspector's report, with recommendations, if any, shall be filed with the owner or with whomever is designated by the owner.

2-10.1.3 Between the regular service contract inspection or tests, the system shall be inspected visually or otherwise by competent personnel, following an approved schedule.

2-10.1.4 At least semiannually, all expellant gas containers shall be checked by pressure or weight against the required minimums.

2-10.1.5 At least semiannually, all stored pressure dry chemical containers shall be checked by pressure and weight against the required minimums.

2-10.1.6 Except for stored pressure systems, at least annually the dry chemical in the system storage container shall be sampled from the top center and also near the wall to determine the existence of lumps harder than will be friable when dropped from a height of 4 inches.

2-10.1.7. The following parts of dry chemical systems with dry chemical chambers of less than 150 pounds nominal capacity (based on sodium bicarbonate agent) shall be hydrostatically tested at an interval not to exceed twelve years: dry chemical chambers, auxiliary pressure containers, valve assemblies, hoses and fittings (not including field piping), check valves, directional valves, manifolds, and hose nozzles. The procedures shall be those approved by a nationally recognized laboratory for each type of equipment.

(a) The dry chemical removed from the chamber prior to testing shall be discarded.

(b) Care shall be exercised to make certain that all equipment tested is thoroughly dried prior to recharging.

(c) To protect the hazard during this operation, if there is no automatic connected reserve, alternate protection acceptable to the authority having jurisdiction shall be provided.

2-10.1.8. When annual inspection of any dry chemical chambers or system components reveals conditions such as but not limited to corrosion or pitting in excess of manufacturer's limits, structural damage or 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 or the original certifying agency or both. The hydrostatic testing of dry chemical chambers shall follow the applicable procedures outlined in 2-10.1.7.

2-10.1.9 Fixed temperature sensing elements of the fusible alloy type shall be replaced at least annually or more frequently if necessary to assure proper operation of the system.

2-10.2 Maintenance. These systems shall be maintained in full operating condition at all times. Use, impairment, and restoration of this protection shall be reported promptly to the owner and the authority having jurisdiction.

2-10.2.1 Any troubles or impairments shall be corrected at once by competent personnel.

2-10.3 Instruction. All persons who may be expected to inspect, test, maintain, or operate dry chemical fire extinguishing systems shall be thoroughly trained and kept thoroughly trained in the functions that they are expected to perform.

2-10.3.1 Training programs shall be established that are approved.

Chapter 3 Total Flooding Systems

3-1 General Information.

3-1.1 Definition. A total flooding system means a supply of dry chemical permanently connected to fixed piping, with fixed nozzles arranged to discharge dry chemical into an enclosed space or enclosure about the hazard.

3-1.2 Uses. This type of system shall be used only where there is a permanent enclosure about the hazard that is adequate to enable the required concentration to be built up. The total area of unclosable openings shall not exceed 15 percent of the total area of the sides, top, and bottom of the enclosure.

3-1.2.1 Consideration shall be given to the elimination of probable sources of reignition because the extinguishing action of a dry chemical flooding system is transient.

3-1.2.2 Deep-seated fires involving solids subject to smoldering shall be protected by multipurpose dry chemical systems where the dry chemical can reach all surfaces involved in combustion. Bicarbonate-base dry chemicals shall not be used for protection against this type of fire.

3-1.3 General Requirements. Total flooding systems shall be designed, installed, tested, and maintained in accordance with the applicable rules in Chapter 2 and with the additional rules set forth in this chapter.

3-2 Hazard Specifications.

3-2.1 Enclosure. In the design of total flooding systems the characteristics of the enclosure shall be considered as follows:

3-2.1.1 The total area of unclosable openings for which no compensation is provided shall not exceed 1 percent of the total area of the sides, top, and bottom of the enclosure. Unclosable openings having an area in excess of 1 percent and not exceeding 5 percent shall be compensated for by the provision of additional dry

chemical. Unclosable openings having an area in excess of 5 percent of the total enclosure area and not exceeding 15 percent shall be screened by local application of additional dry chemical. (*See 3-3.4.1.*)

3-2.2 Leakage and Ventilation. The leakage of dry chemical from the protected space shall be minimized since the effectiveness of the flooding system depends upon obtaining an extinguishing concentration of dry chemical.

3-2.2.1 Where possible, openings such as doorways, windows, etc., shall be arranged to close before, or simultaneously with, the start of the dry chemical discharge, or 3-3.4.1 shall be followed.

3-2.2.2 Where forced air ventilating systems are involved, they shall either be shut down and/or closed before, or simultaneously with, the start of the dry chemical discharge, or 3-3.4.2 shall be followed.

3-3 Dry Chemical Requirements and Distribution.

***3-3.1 General.** The following factors shall be considered in the total flooding of enclosed spaces with dry chemical:

(a) Minimum quantity of dry chemical required.

(b) Minimum rate of flow of dry chemical.

(c) Spacing limitations of the nozzles.

Exception: In the case of pre-engineered systems, the rate of flow need not be considered since it is governed by the piping and nozzle limitations verified by a nationally recognized testing laboratory.

3-3.1.1 The quantity of dry chemical and the flow rate shall be sufficient to create a fire extinguishing concentration in all parts of the enclosure.

3-3.1.2 The nozzles shall be placed so as to provide not less than the minimum design concentration of dry chemical in all parts of the enclosure. For fires in ordinary combustibles where multipurpose dry chemical shall be used for protection, additional dry chemical applied by local application may be required in order to protect adequately all exposed surfaces.

3-3.1.3 The nozzles shall be located so that the discharge will not be obstructed.

3-3.2 Volume Allowances. In calculating the net volume to be protected, allowance shall be permitted for permanently located structures, etc., that materially reduce the volume.

3-3.3 Rate of Application. In engineered systems the minimum design rate of application shall be based on the quantity of dry chemical and the maximum time to obtain the design concentration.

Exception: In pre-engineered systems, these factors are established for specific volume and other conditions given in the listing of such systems by nationally recognized testing laboratories. (See Appendix, A-3-3.1.)

3-3.3.1 In engineered systems, the rate of application shall be such that the design concentration in all parts of the enclosure shall be obtained within 30 seconds.

3-3.4 Compensation for Special Conditions. Additional quantities of dry chemical, and additional nozzles, if necessary, shall be provided to compensate for any special condition that may adversely affect the extinguishing effectiveness of the system.

3-3.4.1 Unclosable openings having areas in excess of 1 percent of the total area of the sides, top, and bottom of the enclosure, and not exceeding 5 percent, shall be compensated for by the use of supplemental dry chemical in the proportions of not less than 0.5 lb. per sq. ft. of unenclosed opening, applied through the regular distribution system. When the unclosable openings have areas exceeding 5 percent of the total of the sides, top, and bottom of the enclosure, and not exceeding 15 percent, compensation shall be furnished by additional dry chemical in the proportion of not less than 1 lb. per sq. ft. of unclosed opening, applied simultaneously by location application over the openings. A system that is listed by a nationally recognized testing laboratory for or including protection of unclosable openings may be used in lieu of the above.

3-3.4.2 For ventilating systems that will not be shut down, supplementary dry chemical shall be added to the protected volume through the regular distribution system. The supplementary dry chemical shall be added at the point or points of air inlet and shall be in proportion to the volume of air removal during the period of dry chemical discharge, calculating as if it were additional volume to be protected.

Exception: Pre-engineered systems listed for restaurant hood and duct protection are suitable for use with or without shutdown of the ventilation system or closure of dampers.

Chapter 4 Local Application Systems

4-1 General Information.

4-1.1 Definition. A local application system means a supply of dry chemical permanently connected to a system of fixed piping with nozzles arranged to discharge directly onto the fire.

***4-1.2 Uses.** Local application systems shall be used for the extinguishment of fires in flammable or combustible liquids, gases, and shallow solids such as paint deposits, where the hazard is not enclosed or where the enclosure does not conform to the requirements for total flooding. Application of dry chemical shall be from nozzles mounted on the tank side or overhead.

4-1.3 General Requirements. Local application systems shall be designed, installed, tested, and maintained in accordance with the applicable requirements in Chapter 2 and with the additional requirements set forth in this chapter.

4-2 Hazard Specifications.

4-2.1 Extent of Hazard. The hazard shall be so isolated from other hazards or combustibles that fire will not spread outside the protected area. The entire hazard shall be protected. The hazard shall include all areas that are or may become coated by combustible or flammable liquids or shallow solid coatings, such as areas subject to spillage, leakage, dripping, splashing, or condensation, and all associated materials or equipment such as freshly coated stock, drainboards, hoods, ducts, etc., that might extend fire outside or lead fire into the protected area.

Exception: Protection of the entire hazard may require the combined use of local application and total flooding systems such as in a restaurant kitchen where the deep-fat fryers can be protected by a local application system and the space above the grease filters in the hood can be protected by a combination local application-total flooding system.

4-2.2 Location. The design of the system shall consider the location of the hazard which may be indoors, partly sheltered or completely outdoors so as to provide a discharge that will not be affected by winds or other stray air currents.

4-3 Dry Chemical Requirements and Distribution.

4-3.1 General. The following factors shall be considered in the design of local application systems:

(a) Minimum quantity of dry chemical.

(b) Minimum flow rate.

(c) Nozzle distribution patterns.

(d) Nozzle placement limitations with respect to flammable liquid surfaces.

(e) Possible obstruction to nozzle distribution pattern.

Exception: In the case of the pre-engineered systems, the rate of flow need not be considered since it is governed by the pipe and nozzle limitations verified by a nationally recognized testing laboratory (see A-3.3.1).

4-3.2 Draft Conditions. The quantity of dry chemical, the dry chemical flow rate, and the number of nozzles shall be sufficient to extinguish fires under the most severe wind or the most severe draft conditions expected in the hazard area.

4-3.2.1 The maximum allowable draft condition shall be that specified by a nationally recognized testing laboratory.

4-3.3 Nozzle Placement. The nozzles shall be placed so as to provide an extinguishing concentration of dry chemical over the entire hazard during discharge.

4-3.3.1 The nozzles shall be placed about (tankside) and/or above (overhead) the flammable liquid surface within the limits of the listing in order to prevent splashing during discharge.

4-3.4 Coated Surfaces. Although it is recognized that fires on coated surfaces are less severe than fires in deep layer flammable liquids, such areas shall be treated as if they were deep layer flammable liquid areas because no distinction has been made in this standard.

4-3.5 Duration of Discharge. The minimum effective discharge time shall be determined by the required minimum quantity of dry chemical and the minimum application rate.

Exception: In the case of pre-engineered systems, these factors need not be considered since they are governed by the piping and nozzle limitations gathered by a nationally recognized testing laboratory.

***4-3.5.1** In the case of engineered systems, the minimum discharge time shall be increased to compensate for any hazard condition that would require a longer discharge period to assure complete extinguishment.

Exception: Hot saponifiable fats do not require an extended discharge period when sodium bicarbonate-base dry chemical is the extinguishing agent.

4-4 Special Considerations.

4-4.1 Where systems protect hazards which are normally heated, such as deep fat fryers, char broilers, upright broilers, griddles and ranges in kitchens, or wax tanks, the power or fuel supply to heaters shall be shut off automatically upon actuation of the extinguishing systems.

Chapter 5 Hand Hose Line Systems

5-1 General Information.

5-1.1 Definition. Hand hose line systems means a hose and nozzle assembly connected, by fixed piping or directly, to a supply of dry chemical. A separate dry chemical supply may be provided for hand hose line use, or dry chemical may be piped from a central storage unit which may be supplying several hose lines or fixed manually or automatically operated systems (*see 2-3.2 and 2-3.3*).

5-1.2 Uses. Hand hose line systems shall be acceptable to supplement fixed nozzle fire protection systems or to supplement portable fire extinguishers for the protection of specific hazards for which dry chemical is a suitable extinguishing agent. These systems shall not be used as a substitute for dry chemical fire extinguishing systems equipped with fixed nozzles except where the hazard cannot be adequately or economically provided with fixed nozzle protection. The decision as to whether hose lines are applicable to the particular hazard shall rest with the authority having jurisdiction.

5-1.3 General Requirements. Hand hose line systems shall be installed and maintained in accordance with the applicable provisions of Chapters 2, 3, and 4, except as outlined below.

5-2 Hazard Specifications.

5-2.1 Hand hose line systems shall be considered suitable for combatting fires in all hazards covered under Chapter 2 except those which are inaccessible and beyond the scope of manual fire fighting.

5-3 Location and Spacing.

5-3.1 Location. Hand hose line stations shall be placed so that they are easily accessible and have hose lines long enough to reach the most distant hazard that they are expected to protect. In general they shall be located so that they are not exposed to the hazard.

5-3.2 Spacing. If multiple hose stations are used, they shall be spaced so that any area within the hazard may be covered by one or more hose lines.

5-3.3 Actuation. Manual actuation shall be possible at each hose line station.

5-4 Dry Chemical Requirements.

***5-4.1 Rate and Duration of Discharge.** The rate and duration of discharge, and consequently the amount of dry chemical, shall be determined by the type and potential size of the hazard. A hand hose line shall have a sufficient quantity of dry chemical to permit its effective use for a minimum of 30 seconds. The minimum flow rate shall also be sufficient to prevent surging and interrupted discharge. These values for minimum flow rate shall be confirmed by a nationally recognized testing laboratory.

5-4.2 Provision for Use by Inexperienced Personnel. The possibility of these hose lines being used by inexperienced personnel shall be considered and adequate provision made so that there will be a sufficient supply of dry chemical to enable them to effect extinguishment of fires in the hazards that they are likely to encounter.

5-4.3 Simultaneous Use of Hose Lines. Where simultaneous use of two or more hose lines is possible, a sufficient quantity of dry chemical shall be available to supply the maximum number of nozzles that are likely to be used at any one time for at least 30 seconds and at the appropriate flow rates.

5-5 Equipment Specifications.

5-5.1 Hose. Hose lines on systems shall incorporate hose listed for this use. Normally, identifying marking on the hose will indicate the acceptability of the hose for this purpose.

5-5.2 Nozzle Assemblies. Nozzles shall be so designed that they can be handled by one man and shall incorporate a quick-opening shutoff arrangement to control the flow of dry chemical.

5-5.3 Hose Line Storage. The hose shall be coiled on a hose reel or rack so that it will be ready for immediate use without the necessity of coupling and may be uncoiled with a minimum of delay. If installed outdoors, it shall be protected against the weather.

***5-5.4 Operation of Hose Lines.**

5-5.4.1 The pressurizing valve shall remain in the open position during the entire fire fighting operation.

5-5.4.2 The hose lines shall be cleared of dry chemical immediately after use.

5-6 Training.

5-6.1 All personnel who are likely to use this equipment shall be kept properly trained in its operation and in the fire fighting techniques applicable to this equipment.

Appendix A

A-1-1 Scope. The dry chemical systems described in this standard are designed to discharge dry chemical from fixed nozzles and piping, or from hose lines by means of an expellant gas. The intent of the standard is to present the design considerations applicable to these systems.

Because the flow of dry chemical (solid particles suspended in a gaseous medium) does not follow general hydraulic theories, most of the flow principles have been determined experimentally. The dry chemicals produced by various manufacturers are usually not identical in all characteristics and each manufacturer designs equipment for use with a specific dry chemical. Therefore, system design principles applicable to the products of one manufacturer are not applicable to the products of another manufacturer. As a result, it is not practical to include system design details as a part of this standard.

It is now generally accepted that the flame extinguishing properties of dry chemicals are due to the interaction of the particles to stop the chain reaction that takes place in flame combustion. Dry chemicals vary in their flame extinguishing effectiveness. Multipurpose dry chemical owes its effectiveness in extinguishing fires in ordinary combustibles such as wood and paper to the formation of a glow-retarding coating over the combustible material. For additional information on dry chemicals and their extinguishing characteristics, see Appendix A-2-1.

A-2-1 Agent Characteristics: A dry chemical extinguishing agent is a finely divided powdered material that has been specially treated to be water repellent and capable of being fluidized and free-flowing so that it may be discharged through hose lines and piping when under expellent gas pressure. Dry chemicals currently in use may be described briefly as follows:

1. Sodium Bicarbonate ($NaHCO_3$) Based Dry Chemical

This agent consists primarily of sodium bicarbonate and is suitable for use on all types of flammable liquid and gas fires (Class B) and also for fires involving energized electrical equipment (Class C).

Its effect on fires in common cooking oils and fats is particularly good, as in combination with these materials the sodium bicarbonate based agent reacts to form a type of soap (saponification), which floats on the liquid surface such as in deep fat fryers and effectively prevents reignition of the grease.

Sodium bicarbonate base dry chemical is not generally recommended for the extinguishment of fires in ordinary combustibles (Class A), although it may have a transitory effect in extinguishing surface flaming of such materials.

2. Dry Chemicals Based on the Salts of Potassium

Commercially available agents are essentially potassium bicarbonate ($KHCO_3$), potassium chloride (KCL), and urea based potassium bicarbonate ($KC_2N_2H_3O_3$). All three agents are suitable for use on all types of flammable liquid and gas fires (Class B) and also for fires involving energized electrical equipment (Class C).

It is generally recognized that salts of potassium are more effective in terms of chemical extinguishment mechanisms than sodium salts in extinguishing Class B type fires except those in deep fat fryers and other cooking equipment.

Dry chemicals based on the salts of potassium are not generally recommended for the extinguishment of fires in ordinary combustibles (Class A), although they may have a transitory effect in extinguishing surface flaming of such materials.

3. Multipurpose Dry Chemicals

This agent has as its base monoammonium phosphate ($NH_4H_2PO_4$) and is similar in its effect on Class B and Class C fires to the other dry chemicals. However, it does not possess a saponification characteristic and should therefore not be used on deep-fat fryers. Unlike the other dry chemicals it does have a considerable extinguishing effect on Class A materials. The agent, when heated, decomposes to form a molten residue which will adhere to heated surfaces. On combustible solid surfaces (Class A) this characteristic excludes the oxygen necessary for propagation of the fire.

4. Foam-Compatible Dry Chemicals

The above types of dry chemical may be compatible with the mechanical foams. Foam compatible dry chemicals are "listed" by nationally recognized fire testing laboratories. Foam-liquid concentrates "listed" by these same laboratories are tested to insure that they will meet these compatibility features. It is thus important that when foams are used to supplement dry chemicals, only "listed" compatible dry chemical-foam concentrates be used.

Extinguishing Mechanisms: The detailed mechanisms by which dry chemical agents extinguish fires have not been completely determined. However, it is generally accepted that the Primary

Extinguishing Mechanisms include interruption of the chain reaction sequence by chemical reactions, reduction of liquid fuel evaporation rates by reduction in flame radiation at the liquid surface, and inerting effects due to reduction of oxygen concentration within the active fire zone. Secondary Extinguishing Mechanisms may include heat absorption effects (particularly at high dry chemical concentrations), additional cooling effects due to the formation of water vapor by the pyrolysis processes, additional inerting effects due to the formation of carbon dioxide by the pyrolysis of the dry chemical, and fire retardant effect due to surface coatings.

The effectiveness of the chemical reaction mechanisms differs with the currently used dry chemical agents and is believed to be the primary reason for the differences in overall effectiveness of the different agents at critical extinguishing flow rates. The physical mechanisms, such as reduction of the flame feedback radiation and reduction of oxygen concentrations, are significantly influenced by dry chemical concentrations in the flame zone as well as the dry chemical agent physical properties. The more important extinguishing mechanisms are discussed in more detail in the following paragraphs.

The flame chain reaction sequence is a detailed set of chemical reactions in an oxidative combustion process. The rates at which the various reactions occur determine the extent of pyrolysis. The reactions are best illustrated in terms of a simple hydrocarbon such as methane, CH_4, where the probable reactions are as follows[1]:

$$2CH_4 + 2O_2 \rightarrow 2CH_3 + OH + 3O + H \quad \text{Chain Initiation}$$

$$\left.\begin{array}{l} CH_3 + O_2 \rightarrow H_2CO + OH \\ 2O_2 + 2H \rightarrow 2OH + 2O \\ CH_4 + OH \rightarrow CH_3 + H_2O \\ H_2CO + O \rightarrow HCO + OH \\ HCO \rightarrow H + CO \\ CO + OH \rightarrow CO_2 + H \\ 4OH \rightarrow 2H_2O + O \end{array}\right\} \text{Chain Propagation}$$

$$\left.\begin{array}{l} CO + O \rightarrow CO_2 \\ CO + 2OH \rightarrow CO_2 + H_2O \end{array}\right\} \text{Chain Termination}$$

Bibliography

[1]Westenburg, A. A. and Fristrom, R. M., J. Phys., Chem. *65* 591 (1961)

The basic scheme involves initiation of the chain reaction, in this case, the generation of CH_3, OH, O and H radicals. These radicals react with fuel materials and oxygen resulting in the generation of species which in turn react to produce more radicals. In this way, the chain reaction propagates itself. Normal termination of the chain reaction occurs when the radicals necessary to propagate the chain reaction are destroyed through recombination or by chemical reaction.

It is widely accepted that two basic mechanisms are involved in the chemical extinguishing action of a dry chemical and that their contribution to the overall extinguishing effectiveness differs with each type of dry chemical agent. However, both mechanisms are based upon the ability of the agent to cause termination in the chain reaction of the fuel oxidizer combination.

One chemical mechanism involves the increase in the extinguishing effectiveness that is observed with decreasing median particle size. This is most generally discussed in terms of the total surface area of all the particles, or specific surface area, rather than median particle size. In general, the higher the specific surface area, the more effective the agent within the constraints imposed by hardware considerations. The argument advanced is that decreasing the median particle size (increasing the specific surface area) affords more active surface for radicals generated in the flame to recombine on, thus accelerating the termination of the chain reaction occurring within the flame. The other chemical mechanism involves the formation of chemical species capable of reacting with chain propagating radicals.[2] It is believed that finely divided salts containing Na or K, because of a high surface area, exhibit good heat transfer characteristics resulting in vaporization of the highly reactive metal, or metal hydroxide, which can efficiently scavenge H or OH radicals in the chain reaction propagation in the flame, resulting in chain termination. In general, the chemical extinguishing reactions become more energetically favorable as the atomic weight of the metal ion increases within the Metals of Group IA of the Periodic Table.

The level of effectiveness of agents based upon monoammonium phosphate, $NH_4H_2PO_4$, which has been found to be slightly less than that of agents based on potassium salts, cannot readily be explained by the foregoing theories. The reaction of this material with flame radicals is energetically less probable. It is more likely

Bibliography

[2]Friedman, R. and Levy, J. B., Combustion and Flame, 7 195 (1963)