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Condensed aerosol fire extinguishing systems — Requirements and test methods for components and system design, installation and maintenance — General requirements

Systèmes d'extinction d'incendie utilisant des aérosols — Exigences et méthodes d'essai pour la conception des composants et des systèmes, l'installation et l'entretien — Exigences générales

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15779 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 8, *Gaseous media and firefighting systems using gas*.

Introduction

Firefighting systems covered in this International Standard are designed to provide a supply of condensed aerosol extinguishing medium for the extinction of fire.

Several different methods of supplying condensed aerosol extinguishant to, and applying it at, the required point of discharge for fire extinction have been developed in recent years, and there is a need for dissemination of information on established systems and methods. This International Standard has been prepared to meet this need.

The requirements of this International Standard are made in the light of the best technical data known to the working group at the time of writing but, since a wide field is covered, it has been impracticable to consider every possible factor or circumstance that might affect implementation of the recommendations.

It has been assumed in the preparation of this International Standard that the execution of its provisions is entrusted to people appropriately qualified and experienced in the specification, design, installation, testing, approval, inspection, operation and maintenance of systems and equipment, for whose guidance it has been prepared, and who can be expected to exercise a duty of care to avoid unnecessary release of extinguishant.

It is important that the fire protection of a building or plant be considered as a whole. Condensed aerosol extinguishing systems form only a part, though an important part, of the available facilities, but it should not be assumed that their adoption necessarily removes the need to consider supplementary measures, such as the provision of portable fire extinguishers or other mobile appliances for first aid or emergency use, or to deal with special hazards.

Condensed aerosol extinguishants have for many years been a recognized effective medium for the extinction of flammable liquid fires and fires in the presence of electrical and ordinary Class A hazards, but it should not be forgotten, in the planning of comprehensive schemes, that there may be hazards for which these mediums are not suitable, or that in certain circumstances or situations there may be dangers in their use requiring special precautions.

Advice on these matters can be obtained from the appropriate manufacturer of the extinguishant and/or the extinguishing system. Information may also be sought from the appropriate fire authority, the health and safety authorities and insurers. In addition, reference should be made as necessary to other national standards and statutory regulations of the particular country.

It is essential that firefighting equipment be carefully maintained to ensure instant readiness when required.

Routine maintenance is liable to be overlooked or given insufficient attention by the owner of the system. It is, however, neglected at peril to the lives of occupants of the premises and at the risk of crippling financial loss. The importance of maintenance cannot be too highly emphasized. Installation and maintenance should only be carried out by qualified personnel.

Inspection should include an evaluation that the extinguishing system continues to provide adequate protection for the risk (protected zones as well as state of the art can change over time).

Annex D deals with the tests for determination of the extinguishing application density and system performance and they are designed in such a way to allow individual installers to use his or her system and carry out all of the extinguishing tests. The tests presented in Annex D have been established to evaluate application densities suitable for the protection of Class A fires with wood crib fire tests and plastic fuel hazards such as may be encountered in information technology, telecommunications and process control facilities, as well as Class B fires with heptane pan and heptane can test fires in an enclosure of 100 m^3.

Condensed aerosol fire extinguishing systems — Requirements and test methods for components and system design, installation and maintenance — General requirements

1 Scope

This International Standard specifies requirements and test methods for components and gives recommendations for the design, installation, testing, maintenance and safety of condensed aerosol firefighting systems in buildings, plants or other structures, and the characteristics of the extinguishants and types of fire for which they are a suitable extinguishing medium. It covers total flooding systems primarily related to buildings, plant and other specific applications, utilizing electrically non-conducting condensed aerosol fire extinguishants for which there are sufficient data currently available to enable validation of performance characteristics by an appropriate independent authority.

Local applications of condensed aerosol extinguishing systems are not covered by this International Standard. Any local applications require a pre-engineered and pre-designed system which has been tested and approved for a specific application by a relevant authority.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3941, *Classification of fires*

EN 60068-2-6, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

EN 60068-2-30, *Environmental testing — Part 2-30: Tests — Test Db and guidance: Damp heat, cyclic (12h + 12h cycle)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
aerosol extinguishing agent
condensed aerosol
extinguishing medium consisting of finely divided solid particles, generally in the order of magnitude of microns in diameter suspended in gas generated and distributed by a combustion process of a solid aerosol-forming compound

3.2
aerosol generator
non-pressurized container which, when activated, generates a condensed aerosol extinguishing agent

NOTE The pressurized container system includes the mounting bracket(s).

3.3
aggressive environment
environment including the following or as defined by the appropriate authority:

a) exterior situations exposed to the sun, ultraviolet radiation, wind, rain, or salt spray;

b) corrosive atmospheres;

c) abnormally dusty or moisture-laden atmospheres;

d) extreme temperatures;

e) vibrations and shocks

3.4
approved
acceptable to a relevant authority

NOTE In determining the acceptability of installations or procedures, equipment or materials, the authority may base acceptance on compliance with the appropriate standards.

3.5
authority
organization, office, or individual responsible for approving equipment, installations or procedures

3.6
automatic
performing a function without the necessity of intentional human intervention

3.7
automatic/manual switch
means of converting the system from automatic to manual actuation

3.8
electrical clearance
unobstructed air distance between the aerosol generator components and unenclosed or uninsulated live electrical components not at ground potential

3.9
thermal clearance
air distance between a condensed aerosol generator and any structure or components sensitive to the temperature developed by the generator

3.10
competent person
designated person, suitably trained, qualified by knowledge and practical experience and with the necessary instructions, to enable the required tests and examinations to be carried out

3.11
coolant
heat-absorbing medium or process

3.12
design application density
extinguishing application density of extinguishant, including a safety factor, required for system design purposes

NOTE 1 The design application density may also be referred to as the design factor.

NOTE 2 Measured in g/m^3.

3.13
discharge time
time from the generator activation until the end of its discharge/extinguishing application density

NOTE Measured in g/m^3.

3.14
extinguishant
condensed aerosol extinguishing agent

3.15
extinguishing application density
effective minimum mass of discharged extinguishant per unit of enclosure volume required to extinguish fire involving a specific fuel under defined experimental conditions, using a specific aerosol generator type and size, excluding any safety factor

NOTE Measured in g/m^3.

3.16
family of condensed aerosol generators
range of generators designed with the same solid compound, the same kind of cooling device, discharge outlet, ignition device, layout and internal/external architecture (varying of mass of solid compound)

3.17
effective mass
mass of discharged extinguishant required to achieve the design application density within the protected volume within the specified discharge time

3.18
hold time
period of time during which an extinguishant is required to maintain at least the extinguishing application density to maintain even distribution throughout protected volume

3.19
hot work
grinding, welding, thermal or oxygen cutting or heating and other related heat-producing or spark-producing operations

3.20
ignition device
device which is able to ignite the solid aerosol-forming compound

3.21
inspection
visual examination to give reasonable assurance that the extinguishing system is fully charged and operable and has not been activated or tampered with, and that there is no obvious physical damage or condition to prevent operation

3.22
location drawing
layout diagram of protected volume clearly indicating the as-installed location of all aerosol generators, controls, maintenance isolate switch (lock-off devices), and associated components of the systems

3.23
lock-off device
lockable manual shut-off device that prevents the electrical actuation of aerosol generators

NOTE 1 The lock-off device may be in the form of a lockable system isolate switch.

NOTE 2 The actuation of this device provides an indication of system isolation.

NOTE 3 The intent is to prevent the discharge of agent into the hazard area when the lock-off device is activated.

3.24
lowest observed adverse effect level
LOAEL
lowest agent factor at which an adverse toxicological or physiological effect has been observed

3.25
listed
systems or components that are included in a list published by a listing authority organization

3.26
listing organization
internationally recognized fire protection system or components test and certification organization

NOTE Examples of these organizations are: Factory Mutual (FM); Underwriters Laboratories (UL/ULC); Loss Prevention Certification Board (LPCB); VdS Schadenverhütung; All-Russia Scientific Research Institute for Fire Protection (VNIIPO).

3.27
maintenance
thorough check to give maximum assurance that the extinguishing system will operate as intended

NOTE Maintenance includes a thorough examination and any necessary repair or replacement of system components.

3.28
manual
requiring intentional intervention to accomplish a function

3.29
manufacturer
entity that is responsible for the design, manufacturing, packaging and quality assurance of a device before it is placed on the market

3.30
mass median aerodynamic diameter
MMAD
particle size and distribution of any aerosol statistically, based on the weight and size of the particle, along with the geometric standard deviation

NOTE Fifty percent of the particles by weight will be smaller than the median diameter and fifty percent of the particles will be larger (US EPA Health Effects Test Guidelines OPPTS 870.1300 Acute Inhalation Toxicity, August 1998).

3.31
monitoring
supervision of the operating integrity of an electrical, mechanical, pneumatic or hydraulic control feature of a system

3.32
no observed adverse effect level
NOAEL
highest agent factor at which no adverse toxicological or physiological effect has been observed

3.33
normally occupied area
area that is occupied by persons, under normal circumstances

3.34
particulate concentration
concentration of the solid fraction of the aerosol in the protected space after system discharge at the design application density

NOTE 1 Measured in g/m^3.

NOTE 2 This information is necessary to assess the potential health effects of accidental exposure to the agent in occupied spaces, and the potential degree of visibility obscuration.

3.35
release
physical discharge or emission of aerosol as a consequence of the aerosol generator's actuation

3.36
safety factor
multiplier of the extinguishing application density to determine the aerosol design application density

3.37
solid aerosol-forming compound
mixture of oxidant, combustible component and technical admixtures producing fire extinguishing aerosol upon ignition

3.38
supplier
entity that is responsible for the product and is able to ensure that its quality is ensured

3.39
system isolate switch
manually operated switch located at each entrance to the protected area, electrically supervised and secured from unauthorized use which prevents the automatic or manual electrical activation of the condensed aerosol generators by electrically opening the released circuit

3.40
total flooding system
firefighting system arranged to discharge extinguishant into an enclosed space to achieve the appropriate design application density factor

3.41
unoccupiable area
area which cannot be occupied due to dimensional or other physical constraint requiring intentional intervention to accomplish a function

NOTE Examples of unoccupiable areas are shallow voids or cabinets.

3.42
user
entity whom the system is designed for, and who is responsible for operation and to ensure the consistency of performance as described by the supplier and to follow the legal regulations

4 Use and limitations

4.1 General

This International Standard sets out requirements for the design, installation, service and maintenance of aerosol systems used as fire extinguishing media for total flooding applications. This International Standard also covers performance requirements and methods of testing for aerosol generators or storage containers and associated components. The design, installation, service and maintenance of aerosol fire-extinguishing systems shall be performed by those competent in fire extinguishing system technology.

4.2 Aerosol agent description

4.2.1 Condensed aerosol

Condensed aerosol consists of finely divided solid particles typically based on alkali metal salts and gases typically comprised of nitrogen, carbon dioxide and water vapour.

Condensed aerosol is not stored in a container. It is self-generated by a combustion process of a solid aerosol-forming compound contained in a non-pressurized canister, an aerosol generator. Aerosol generators also contain an actuation device(s) designed to ignite the aerosol-forming compound and may have various cooling arrangements to cool the aerosol prior to its release into a protected area.

The aerosol generating combustion process provides sufficient energy for a rapid discharge and efficient distribution of the aerosol. No propelling gas is required for the aerosol delivery. An aerosol generator has one or more discharge outlets and is normally placed inside the protected risk area. No piping is required.

4.2.2 Physical characteristics

Aerosols are electrically non-conductive gas-like media, which are suspended in the air in the protected volume.

Being a suspension of fine solid particles in a gaseous medium, the aerosol is not a clean agent. Following actuation of an aerosol generator there is a period of time during which the aerosol remains suspended within the enclosure; if the enclosure is not ventilated, the aerosol suspension will eventually settle down, forming a dust-like residue, normally in a very small quantity.

4.2.3 Extinguishing mechanism

Aerosols extinguish fires by:

a) chemical interference by removing the reactive free radicals;

b) physically cooling the seat of the fire; or

c) reducing the concentration of oxygen by introducing inert gas.

Generally, an aerosol generator will primarily use two of the three mechanisms.

For aerosol generators that produce particulates, the chemical and cooling mechanisms take place mainly on the surface of the solid aerosol particles, and therefore, the finer the particles, the more effective the extinguishing mechanism.

For aerosol generators that produce inert gas and water vapour, these inert gases displace air, reducing the amount of oxygen available for combustion. The combustion is then cooled to the point of extinguishment as heat is transferred to the water.

4.3 Application

Aerosol extinguishants are recognized as suitable for suppression of Class A and Class B fires.

The hazards, against which these systems offer protection, and any limitations on their use, shall be contained in the system supplier's design manual.

Total flooding fire-extinguishing systems are used primarily for protection against hazards that are in enclosures or equipment that, in itself, includes an enclosure to contain the extinguishant. The following are examples of such hazards, but the list is not exhaustive:

a) electrical and electronic hazards;

b) telecommunications facilities;

c) flammable and combustible liquids and gases.

Where aerosol generators are used in a potentially explosive application, the suitability of the generator to the atmosphere for the determined life shall be assessed. Thus, aerosol generators shall be constructed such that they do not cause fire or explosion when actuated. Aerosol generators may be used in hazardous areas subject to the manufacturer obtaining the specific listings and approvals for such areas from the appropriate authorities having jurisdiction.

CAUTION — Aerosol extinguishing systems are intended for the types of fire for which they are a suitable extinguishing medium. The end user should consider the potential adverse effects of aerosol extinguishing agent discharge residue on sensitive equipment and other objects.

4.4 Limitation of use

The extinguishants referred to in this International Standard shall not be used on fires involving the following fuels unless relevant testing has been carried out to the satisfaction of the authority:

a) chemicals containing their own supply of oxygen, such as cellulose nitrate;

b) mixtures containing oxidizing materials, such as sodium chlorate or sodium nitrate;

c) chemicals capable of undergoing autothermal decomposition, such as some organic peroxides;

d) reactive metals (such as sodium, potassium, magnesium, titanium and zirconium), reactive hydrides, or metal amides, some of which may react violently with some aerosol extinguishants;

e) oxidizing agents such as nitric oxides and fluorine;

f) pyrophoric materials such as white phosphorous or metallo-organic compounds.

The above list may not be exhaustive.

4.5 Electrostatic discharge

Care shall be taken when discharging extinguishant into potentially explosive atmospheres. Electrostatic charging of aerosol generators or other conductors not bonded to earth may occur during the discharge of extinguishant. These conductors may discharge to other objects with sufficient energy to initiate an explosion. Where the system is used for inerting, generators shall be adequately bonded and earthed.

4.6 Potentially explosive atmosphere

Under certain conditions, the potential for explosive atmospheres may exist. Areas where such potential may exist are classified as hazardous. Condensed aerosols may be used in hazardous areas subject to the manufacturer obtaining the specific listings and approvals for such areas from the appropriate authorities.

4.7 Temperature limitations

All devices shall be designed for the service they will encounter and shall not readily be rendered inoperative or susceptible to accidental operation.

Devices shall normally be designed to function properly from –20 °C to +75 °C, or marked to indicate temperature limitations, or in accordance with manufacturers' specifications which shall be marked on the name-plate, or (where there is no name-plate) in the manufacturer's instruction manual.

For condensed aerosols, special care shall be taken to determine the maximum ambient temperature at which the aerosol generator can be installed, without risk of actuation by temperature itself.

Condensed aerosol generators shall not be employed at less than the minimum thermal clearance distances specified in the manufacturer's instruction manual.

4.8 Compatibility with other extinguishants

Mixing of extinguishants in the same container shall be permitted only if the system is approved for use with such a mixture. Systems employing the simultaneous discharge of aerosols and other extinguishants to protect the same enclosed space shall not be permitted.

4.9 Environmental

When selecting an extinguishing system or agent to protect a hazard area, the effects of the agent on the environment shall be considered.

5 Safety

5.1 General

Any hazard to personnel created by the actuation and discharge of the condensed aerosol extinguishing system shall be considered in the design of the system with reference to the hazards associated with particular aerosol

extinguishants. When selecting an aerosol extinguishant, careful consideration should be given to independent occupational health and safety data.

Potential hazards of aerosol extinguishing systems include noise, reduced visibility, high or low temperature, turbulence, potential toxicity, and skin or eye irritation to persons in the protected space and other areas where the aerosol may migrate. For additional information see Annex B.

Determination for use of an agent in spaces that are normally occupied, normally unoccupied, or unoccupiable shall be based on an evaluation of the adverse effects(s) caused due to accidental exposure to the agent. Potential adverse health effects shall be assessed for the particulate concentration, the size of the particulates (i.e. the mass median aerodynamic diameter), and the concentration of gases expected after actuation of the aerosol extinguishing system at the concentration design density.

In any proposed use of condensed aerosol where there is a possibility that people may enter the protected enclosure or be close to the protected risk, suitable safeguards such as personnel training, warning signs, pre-discharge alarms and system isolate switches shall be provided. Means of ventilation after fire should be readily available.

Unnecessary exposure to a condensed aerosol shall be avoided.

Following the use of a condensed aerosol, personnel should not enter the protected area until it has been thoroughly ventilated. Venting of the post-fire atmosphere should be to an open-air area, where possible, to prevent the inadvertent exposure of personnel to any combustion products of the fire and aerosol-generating reaction. In case of fire involving unknown products it is imperative to check the concentration of carbon monoxide and other potentially toxic gases before entering the premises.

Following a system discharge, the aerosol that has settled should be removed in accordance with the manufacturer's recommendations. Protective clothing including gloves and goggles should be worn. A respirator or mask may be required.

Adherence to this International Standard does not remove the user's statutory responsibility to comply with the appropriate safety regulations.

In order to assess the potential human health effects manufacturers should conduct the toxicity testing for use. This requires direct toxicity assessment on the aerosol after discharge of the system at the maximum design factor.

5.2 Toxicity

5.2.1 General

No fire suppression extinguishant shall be used which is carcinogenic, mutagenic or teratogenic at the design concentration density expected during use.

5.2.2 Condensed aerosols

Condensed aerosol extinguishing systems for normally occupied areas are permitted where the aerosol particulate concentration does not exceed the adverse effect level as determined by a scientifically accepted technique (see Annex B). Any gases produced as a result of the aerosol-forming reaction shall not exceed the appropriate excursion limit for the critical toxic effect.

When activated, condensed aerosol generators may produce toxic levels of gases such as carbon monoxide, nitrogen oxides and ammonia, which are typical by-products of the aerosol generating reaction. Actual concentrations of these by-products depend on the chemical compositions of the solid aerosol-forming compound and coolant, engineering design of the aerosol generators and conditions of the enclosure under protection. Maximum allowable exposure to a design factor of the aerosol under conditions of a sealed enclosure shall be provided for each agent by its manufacturer. Any possible adverse effects on humans that may be experienced at the indicated allowable exposures should be described. The information shall be supported by the appropriate test results on chemical composition of the aerosol and its short-term "acute" adverse effects. The results shall be endorsed by an independent testing laboratory having an appropriate authority.

5.3 Reduced visibility

5.3.1 General

All aerosol extinguishing agents reduce visibility, some more than others. Annex B contains guidance in assessing visibility levels for aerosol extinguishing agents.

5.3.2 Safety precautions

Safety precautions such as personnel training, goggles, audio devices, floor mounted directional lighting, evacuation plans and exit drills shall be included in the operational plan for the occupancy.

5.4 Turbulence

Turbulence caused by high-velocity discharge from the condensed aerosol generator may be enough to dislodge substantial objects directly in its path, such as ceiling tiles and light fittings. Therefore, tiles and light fittings should be properly secured. Aerosol discharge may also cause enough general turbulence to move unsecured paper and light objects.

5.5 Thermal hazards

5.5.1 Minimum thermal clearance

Condensed aerosol generators shall not be employed at less than the minimum thermal clearance as specified in the listing of the product.

For locations where personnel may be situated, the minimum thermal clearance shall refer to the temperature not exceeding 75 °C.

For locations where combustible materials or equipment may be situated, the minimum thermal clearance shall refer to the temperature not exceeding 200 °C.

For locations where non-combustible materials or equipment may be situated, the minimum thermal clearance shall refer to the temperature not exceeding 400 °C.

5.5.2 Removal of discharged generators

Protective gloves shall be worn when removing discharged condensed aerosol generators immediately after discharge.

5.5.3 Hot work

As open flame or prolonged exposure to temperatures exceeding 400°C may cause activation of the condensed aerosol generators, they shall be removed from a protected area prior to any hot work being carried out within their vicinity.

5.5.4 Casing temperatures for condensed aerosol generators

The manufacturer shall indicate the maximum temperature of the condensed aerosol generator casing during system discharge.

5.6 Safety precautions

5.6.1 General

In any proposed use of aerosol where people may enter the protected enclosure or be close to the protected risk, suitable safeguards such as personnel training, warning signs, pre-discharge alarms and system isolate switches shall be provided. Means of ventilation after fire should be readily available.

