

Australian Standard[®]

**Condensed aerosol fire extinguishing
systems—Requirements for system
design, installation and commissioning
and test methods for components**



This Australian Standard® was prepared by Committee FP-011, Special Hazard Fire Protection Systems. It was approved on behalf of the Council of Standards Australia on 8 June 2013.

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- Australian Industry Group
 - Australian Museum
 - Chamber of Commerce and Industry, Qld
 - CSIRO Manufacturing and Materials Technology
 - Engineers Australia
 - Fire Protection Association Australia
 - National Fire Industry Association
 - Security Providers Association of Australia
-

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**Condensed aerosol fire extinguishing
systems—Requirements for system
design, installation and commissioning
and test methods for components**

Originated as AS/NZS 4487:1997.
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PREFACE

This Standard was prepared by Standards Australia Committee FP-011, Special Hazard Fire Protection Systems, to supersede AS/NZS 4487:1997, *Pyrogen fire extinguishing systems*.

Pyrogen is a specific brand of condensed aerosol product and was the only commercially available condensed aerosol product available when the Standard was originally published in 1997. As a result, the original publication contained product specific information and requirements that are not relevant to other brands of condensed aerosol products. In recent years a number of different condensed aerosol products have been commercialized and there was a need to prepare a non-brand specific condensed aerosol standard which could be used for the design, installation and commissioning of all condensed aerosol systems. This revised Standard was published to meet this need and was developed using ISO 15779, *Condensed aerosol fire extinguishing systems—Requirements and test methods for components and system design, installation and maintenance—General requirements*, as the primary source document.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

This Standard incorporates a commentary on some of the clauses. The commentary directly follows the relevant clause shown in italics font-type and enclosed in a panel. The commentary is for information only and does not need to be followed for compliance with the Standard. Commentaries on clauses explain the purpose of a clause and give, in some cases background information.

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FOREWORD

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

The requirements of this 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 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 condensed aerosol.

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 extinguishing agents have for many years been recognized effective media 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 media are not suitable, or that in certain circumstances or situations there may be dangers in their use requiring special precautions.

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

Appendix E specifies the tests for determination of the extinguishing application density and system performance and they are designed in such a way to allow individual condensed aerosol manufacturers to use their system to carry out all of the extinguishing tests. The tests presented in Appendix E 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 m³.

STANDARDS AUSTRALIA

Australian Standard**Condensed aerosol fire extinguishing systems—Requirements for system design, installation and commissioning and test methods for components****1 SCOPE**

This Standard specifies requirements for the design, installation, testing, commissioning and safety requirements for condensed aerosol firefighting systems in buildings, plants or other structures. The characteristics of condensed aerosol extinguishing agents and types of fire for which they are a suitable extinguishing medium are also specified. Appendices D and E specify test methods for components and extinguishing application density and coverage.

This Standard covers total flooding systems utilizing electrically non-conducting condensed aerosol fire extinguishing agents for which there are sufficient data currently available to enable validation of performance characteristics by a listing organization.

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

2 NORMATIVE REFERENCES

The following are the normative documents referenced in this Standard.

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

AS

1603	Automatic fire detection and alarm systems
1603.11	Part 11: Visual warning devices
1670	Fire detection, warning, control and intercom systems (All parts)
1670.1	Part 1: System design, installation and commissioning—Fire
1851	Routine service of fire protection systems and equipment
4428	Fire detection, warning, control and intercom systems
4428.0	Part 0: Control and indicating equipment—General requirements and test methods
4428.1	Part 1: Control and indicating equipment—Fire
4428.3	Part 3: Control and indicating equipment—Fire brigade panel
4428.4	Part 4: Control and indicating equipment—Intercommunication systems for emergency purposes
4428.5	Part 5: Control and indicating equipment—Power supply units
4428.6	Part 6: Control and indicating equipment—Alarm signalling equipment
4428.7	Part 7: Control and indicating equipment—Air-handling fire mode control panel
4428.9	Part 9: Control and indicating equipment—Requirements for wire-free alarm zone circuits
4428.10	Part 10: Control and indicating equipment—Alarm investigation
7240	Fire detection and alarm systems
7240.2	Part 2: Control and indicating equipment (ISO 7240-2:2003, MOD)

AS/NZS

1850 Portable fire extinguishers—Classification, rating and performance testing

3013 Electrical installations—Classification of the fire and mechanical performance of wiring system elements

ISO

8201 Acoustics—Audible emergency evacuation signal

EN

60068 Environmental testing

60068-2-6 Part 2-6: Tests—Test Fc: Vibration (sinusoidal)

60068-2-30 Part 2-30: Tests—Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)

3 DEFINITIONS

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

3.1 Aerosol generator

Non-pressurized container which, when activated, generates a condensed aerosol extinguishing agent.

3.2 Aggressive environment

Environment including the following or as defined by the authority having jurisdiction:

- (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 temperature.
- (e) Vibrations and shocks.

3.3 Approved

Acceptable to the authority having jurisdiction.

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

3.4 Authority having jurisdiction

A minister of the Crown, a government department, or other public authority having power to issue regulations, orders or other instructions having the force of law in respect of any subject covered by an Australian Standard or, in cases where none of these apply, the owner or the owner's agent.

3.5 Automatic

Performing a function without the necessity of intentional human intervention.

3.6 Automatic/manual switch

Means of converting the system from automatic to manual actuation.

3.7 Competent person

A person who has acquired through training, qualification, experience, or a combination of these, the knowledge and skill enabling him/her to correctly perform the required task.

3.8 Condensed aerosol extinguishing agent

Extinguishing medium consisting of solid particles, generally in the order of magnitude of micrometres in diameter dispersed in gases which are generated and distributed by a combustion process of a solid aerosol-forming compound.

3.9 Coolant

Heat absorbing medium or process.

3.10 Design application density

Extinguishing application density of aerosol forming compound, including a safety factor, required for system design purposes. [Unit: g/m³]

3.11 Discharge time

Time from the generator activation until the end of its discharge.

3.12 Effective mass

Mass of aerosol forming compound required to achieve the design application density within the protected volume within the specified discharge time.

3.13 Electrical clearance

Unobstructed air distance between the aerosol generator components and unenclosed or uninsulated live electrical components not at earth potential.

3.14 Extinguishing application density

Minimum mass of aerosol forming compound 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. [Unit: g/m³]

3.15 Family of condensed aerosol generators

Range of generators designed with the same solid aerosol forming compound, the same kind of cooling device, discharge outlet, ignition device, layout and internal/external architecture (varying of mass of solid compound).

3.16 Hold time

Period of time during which a condensed aerosol is required to maintain at least the extinguishing application density throughout protected volume.

3.17 Hot work

Grinding, welding, thermal or oxygen cutting or heating and other related heat-producing or spark-producing operations.

3.18 Ignition device

Device which is able to ignite the solid aerosol-forming compound.

3.19 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.

3.20 Listing

Equipment, materials, or services included in a list published by an organization concerned with evaluation of products or services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.21 Listing organization

Internationally recognized fire protection system or components test and certification organization.

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

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 Lowest observed adverse effect level (LOAEL)

Lowest agent application density at which an adverse toxicological or physiological effect has been observed.

3.24 Manufacturer

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

3.25 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, Ref. [6] 1998).

3.26 No observed adverse effect level (NOAEL)

Highest agent application density at which no adverse toxicological or physiological effect has been observed.

3.27 Normally occupied area

Area intended for occupancy.

3.28 Normally unoccupied area

Area not normally occupied by people but which may be entered occasionally for brief periods.

3.29 Safety factor

Multiplier applied to the extinguishing application density to determine the aerosol design application density.

3.30 Solid aerosol-forming compound

Mixture of oxidant, combustible component and technical admixtures producing fire extinguishing aerosol upon ignition.

3.31 Supervised

Monitored for fault conditions.

3.32 System isolate switch

Manually operated switch, electrically supervised and secured from unauthorized use which prevents the automatic or manual electrical activation of the condensed aerosol generators by electrically opening the release circuit.

3.33 Thermal clearance

Air distance between a condensed aerosol generator and any structure or components sensitive to the temperature developed by the generator.

3.34 Total flooding system

System arranged to discharge condensed aerosol at the appropriate application density into an enclosed space.

3.35 Unoccupiable area

Area which cannot be occupied due to dimensional or other physical constraint.

NOTE: Examples of unoccupiable areas are shallow voids or cabinets.

3.36 User

Entity for whom the system is designed and installed.

4 USE AND LIMITATIONS

4.1 General

Condensed aerosol extinguishing agents are recognized as suitable for suppression of Class A, Class B and Class E fires as detailed in AS/NZS 1850.

The hazards, against which these systems offer protection, and any limitations on their use, shall be contained in the system 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 condensed aerosol.

Where aerosol generators are used in a potentially explosive application, the suitability of the generator for use in that application 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 authority having jurisdiction.

4.2 Aerosol agent description

4.2.1 Condensed aerosol

Condensed aerosol consists of micrometre-sized solid particles typically based on alkali metal salts dispersed in gases typically comprised of nitrogen, carbon dioxide and water vapour.

Condensed aerosol is not stored in a container. It is generated by a combustion process of a solid aerosol-forming compound contained in a non-pressurized canister, called an aerosol generator. Aerosol generators also contain an actuation device(s) designed to ignite the aerosol-forming compound and may have various 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 three dimensional media. Being a dispersion of fine solid particles in gas, the aerosol is not a clean agent. Following actuation of an aerosol generator there is a period of time during which the aerosol particles remains in suspension within the enclosure. If the protected enclosure is not ventilated, the aerosol particles will eventually settle down, forming a dust-like residue.

C4.2.2 *The end user should consider the potential adverse effects of condensed aerosol extinguishing agent discharge residue on sensitive equipment and other objects.*

4.2.3 Extinguishing mechanism

Condensed aerosol extinguishes fires primarily by a chemical action of removing reactive free radicals propagating the fire combustion reaction, which takes place on the surface of the solid aerosol particles, and therefore, the finer the particles, the more effective the extinguishing mechanism. Dilution of flammable gases and cooling are secondary extinguishing mechanisms.

4.3 Limitation of use

Condensed aerosols referred to in this Standard shall not be used on fires involving the following fuels unless relevant testing has been carried out to the satisfaction of the authority having jurisdiction:

- (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 auto-thermal 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 extinguishing agents.
- (e) Oxidizing agents such as nitric oxides and fluorine.
- (f) Pyrophoric materials such as white phosphorus or metallo-organic compounds.

NOTE: The above list may not be exhaustive.

4.4 Electrostatic discharge

Care shall be taken when discharging condensed aerosols in potentially explosive atmospheres. Aerosol generators shall be bonded and earthed.

4.5 Temperature limitations

All devices shall be designed for the conditions 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 $+75^{\circ}\text{C}$, or marked to indicate temperature limitations, or in accordance with manufacturers' specifications which shall be marked on the name-plate, or in the manufacturer's instruction manual.

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

4.6 Compatibility with other extinguishing agents

Systems employing the simultaneous discharge of aerosols and other extinguishing agents to protect the same enclosed space shall not be permitted unless approved.

5 SAFETY

5.1 General

Any hazard to personnel created by the actuation and discharge of the condensed aerosol extinguishing system should be considered in the design of the system with reference to the hazards associated with the particular condensed aerosol system. When selecting a condensed aerosol system, careful consideration should be given to applicable occupational health and safety data.

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

NOTE: For additional information see Appendix C.

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

Unnecessary exposure to a condensed aerosol shall be avoided.

Following the discharge 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.

Following a 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.

5.2 Toxicity

No condensed aerosol shall be used that is carcinogenic, mutagenic or teratogenic at the design application density expected during use.

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.

The NOAEL, LOAEL or, if NOAEL and LOAEL are not known, the maximum allowable exposure to a design application density 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

NOTE: Refer to Appendix C for toxicity assessment techniques.

5.3 Reduced visibility

All condensed aerosols reduce visibility, some more than others.

NOTE: Appendix C contains guidance in assessing visibility levels for condensed aerosols.

5.4 Turbulence

Turbulence caused by discharge from the condensed aerosol generator may be enough to dislodge unsecured objects directly in its path.

5.5 Removal of discharged generators

Immediately after discharge the condensed aerosol generators will be hot. Protective gloves shall be worn when removing discharged condensed aerosol generators.

5.6 Hot work

An open flame or prolonged exposure to high temperatures may cause activation of the condensed aerosol generators. Appropriate precautions shall be taken.

5.7 Safety precautions

5.7.1 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 shall be readily available.

5.7.2 Specific requirements

The following general safety aspects shall apply for areas protected by the aerosol systems and which are capable of being occupied:

- (a) Time delay devices:
 - (i) A pre-discharge alarm shall be incorporated with a time delay sufficient to allow evacuation of personnel prior to discharge.
 - (ii) Time delay devices shall be used only for evacuation of personnel or to prepare the hazard area for discharge.
- (b) Automatic/manual switch, to allow the system to be placed in manual mode when the protected enclosure is occupied.
- (c) System isolate switch to prevent discharge of the system during maintenance activities. The actuation of this switch shall provide an indication of system isolation.
- (d) Exit routes, which shall be kept clear at all times, and emergency lighting and adequate direction signs to minimize travel distances for areas which may be occupied.
- (e) Outward-swinging self-closing doors which can be opened from the inside, including when locked from the outside.
- (f) Continuous visual and audible alarms at entrances and designated exits inside the protected area and continuous visual alarm outside the protected area which operate until the protected area has been made safe.
- (g) Appropriate warning and instruction signs.
- (h) Where required, pre-discharge alarms within such areas that are distinctive from all other alarm signals that will operate immediately upon detection of the fire.
- (i) Means for prompt natural or forced-draft ventilation of such areas after any discharge of condensed aerosol.

NOTE: Care should be taken to completely dissipate hazardous atmospheres and not just move them to other locations.

- (j) Instructions and drills for all personnel within or in the vicinity of protected areas, including maintenance or construction personnel who may be brought into the area, to ensure they take proper action when the system operates. Personnel shall not re-enter the enclosure until it has been verified as being safe to do so.

5.7.3 Thermal hazards

Condensed aerosol generators shall not be installed at less than the minimum thermal clearance as specified in the listing of the product. See Clause 7.5.2 for details of specific thermal distance installation limitations.

5.8 Electrical hazards

Where exposed electrical conductors are present, electrical clearances no smaller than those specified by electrical safety regulations.

5.9 Electrical earthing

Systems within electrical substations or switch rooms shall be bonded and earthed, where required to prevent the metalwork from becoming electrically charged.

6 CONDENSED AEROSOL GENERATORS

6.1 Testing and listing

Condensed aerosol generators shall be tested and listed by a listing organization (see Clauses 3.20 and 3.21).

The test methods used to evaluate the performance of condensed aerosol generators shall be as detailed in Appendices D and E or, where acceptable to the listing organization, to the test methods detailed in equivalent, internationally recognized test protocols. For example, UL 2775.

Appendix D specifies test methods for the endurance and function testing of condensed aerosol generators whilst Appendix E specifies test methods for determination of extinguishing application densities and area coverage.

6.2 Design application densities

6.2.1 General

This Clause (6.2) sets out the requirements for the condensed aerosol application densities.

6.2.2 Class B fires

The minimum Class B design application density for each condensed aerosol shall be a demonstrated minimum extinguishing application density for each Class B fuel multiplied by a safety factor of 1.3. The minimum extinguishing application density used shall be that demonstrated by the minimum extinguishing application density fire test (Appendix E, Paragraph E6.2, heptane pan test).

Procedures using heptane in the fire extinguishment/area coverage fire test procedure are detailed in Paragraphs E6.1 and E6.2. For hazards involving multiple fuels, the value for the fuel requiring the greatest design application density shall be used.

6.2.3 Class A fires

The minimum extinguishing application density for Class A surface fires shall be determined by test using the fire test procedure described in Appendix E, Paragraphs E6.1 (Wood crib test), E6.3 (Polymeric sheet fire tests) and E6.4 (Class A compatible wood crib test). The minimum design application density for Class A surface fires shall be the highest extinguishing concentration density determined from the results of four test scenarios times a safety factor of 1.3.

6.2.4 Higher Hazard Class A fires (e.g. electrical switch rooms, telecommunication and electronic risks)

It is recognized that the wood crib and polymeric sheet Class A fire tests may not adequately indicate extinguishing concentrations suitable for the protection of certain plastic fuel hazards (e.g. electrical and electronic type hazards involving grouped power or data cables such as computer and control room under-floor voids, telecommunication facilities, etc.). An extinguishing concentration not less than that determined in accordance with Clause 6.2.3, or not less than 95% of that determined from the heptane fire test described in Appendix E, Paragraph E6.2, whichever is the greater, should be used under certain conditions. These conditions include:

- (a) Cable bundles greater than 100 mm in diameter.
- (b) Cable trays with a fill density greater than 20% of the tray cross-section.
- (c) Horizontal or vertical stacks of cable trays (closer than 250 mm).

- (d) Equipment energized during the extinguishment period where the collective power consumption exceeds 5 kW.

NOTE: Where electrical equipment shut down is delayed, higher concentrations, longer hold times, or other fire protection systems can be considered.

6.3 Aerosol generator performance requirements

6.3.1 General

This Clause (6.3) sets out the requirements for the performance of aerosol generators.

6.3.2 Distribution coverage—Condensed aerosol generators

The maximum area coverage and the maximum and minimum protected area height limitations for each condensed aerosol generator size shall be determined by the fire extinguishment/area coverage fire test procedure as described in Appendix E, Paragraphs E5.1 and E5.2.

6.3.3 Discharge time

Discharge times for each size condensed aerosol generator shall be specified by the manufacturer.

Aerosol generators and released aerosols shall not cause fire or explosion during actuation and discharge. The minimum thermal clearances from the condensed aerosol generator's discharge outlet(s) for 75°C, 200°C and 400°C shall be specified in the product listing. Refer to Clause 7.5.2 for requirements on minimum thermal clearances. Parameters of the aerosol discharge shall be verified by the test procedure as described in Appendix E.

6.3.4 Ambient temperature and humidity operation range

Aerosol generators shall be operable for the total service life period within temperature and humidity range specified by the manufacturer and listed by a listing organization.

The temperature operation range shall be verified by the accelerated aging test procedure as described in Appendix D, Paragraph D8. The humidity operation range shall be verified by the temperature and humidity operation range tests as described in Appendix D, Paragraph D7.

6.3.5 Service life

The service life of aerosol generators for typical applications shall be specified by the manufacturer and listed by a listing organization.

The specified service life shall be verified by the accelerated aging test procedure as described in Appendix D, Paragraph D8.

6.3.6 Vibration and shock resistance

The aerosol generator and its mounting bracket shall withstand the vibration and shock resistance tests as described in Appendix D, Paragraph D11.

6.3.7 Corrosion

The aerosol generator and its mounting bracket shall withstand the corrosion test as described in Appendix D, Paragraph D9.

6.3.8 Impact

The packaged condensed aerosol generator shall not be a disposal hazard after the impact (drop test) as described in Appendix D, Paragraph D13.

6.3.9 Actuation element

The technical characteristics and actuation processes shall be specified by the manufacturer for all types of actuation devices incorporated in the aerosol generator.

6.3.10 *Exposure to fire*

Aerosol generators intended for installation inside the protected enclosure shall be tested for reliability of operation and effectiveness of the discharge under the heat exposure conditions by the test procedure as described in Appendix D, Paragraph D17.

6.4 **Marking**

Manufacturers shall put a permanent name-plate or other permanent marking specifying the following on each aerosol generator:

- (a) Condensed aerosol trade name.
- (b) Manufacturer.
- (c) Date of manufacture.
- (d) Serial number.
- (e) Mass of aerosol forming compound.

Each aerosol generator shall be indelibly marked indicating the installation date, and the expiration date. Installation life (from installation to expiration date) for condensed aerosol generators depends on the specific application and the installation environment (based on expected conditions of operation, e.g. temperature and humidity).

7 SPECIFICATIONS, PLANS AND APPROVALS

7.1 **Specifications**

Specifications for condensed aerosol fire extinguishing systems shall be prepared under the supervision of a person fully experienced in the design of condensed aerosol systems and, where appropriate, with the advice of the authority having jurisdiction. The specification shall include all pertinent items necessary for the proper design of the system such as the designation of the authority having jurisdiction, variances from this Standard to be permitted by the authority having jurisdiction, design criteria, system sequence of operations, the type and extent of the acceptance testing to be performed after installation of the system, owner training requirements and working documents as defined in Appendix B, Paragraph B2. The specification shall also include mounting parts for the generator.

Layout and system proposal documents shall be submitted for approval to the authority having jurisdiction before installation or modification begins. The type of documentation required shall be as specified in Appendix B.

7.2 **Enclosure**

7.2.1 *Venting and structural strength*

The protected enclosure shall have sufficient structural strength and integrity to contain the condensed aerosol discharge. Venting shall be provided to prevent excessive over or under-pressurization of the enclosure. The type and location of pressure relief vents shall ensure maximum possible containment of the agent during and after its discharge.

The designer/installer shall provide reliable calculations for venting requirements for each system if applicable.

A calculation method or formula to estimate a minimum vent area shall be provided by the system manufacturer.

C7.2.1 *When an aerosol is discharged into a closed volume, an overpressure may be developed due to the amount of gas generated and the effect of increased temperature on the atmosphere.*

Following the discharge the combined volume of aerosol and air will become greater than the initial room volume. The final result will increase the pressure or will exhaust the excess volume through vent openings. The air temperature is increased during the discharge but will return to normal levels as heat is adsorbed by solid surfaces in the room.

7.2.2 Loss of condensed aerosol to adjacent areas

To prevent loss of condensed aerosol through openings to adjacent areas, openings shall be permanently sealed or equipped with automatic closures.

NOTE: Where adequate retention of the condensed aerosol is not practicable, consideration should be given to extending protection to include the adjacent enclosures.

7.2.3 Forced-air ventilating systems

Forced-air ventilating systems shall be shut down or closed automatically where their continued operation would adversely affect the performance of the fire-extinguishing system or result in propagation of the fire.

Other services within the protected enclosure (e.g. fuel and power supplies, heating appliances, paint spraying) that are likely to impair the performance of the extinguishing system shall be shut down prior to, or simultaneously with, the discharge of the condensed aerosol.

7.3 Total flooding quantity

7.3.1 General

The total mass of aerosol forming compound in the system shall be at least sufficient for the largest single hazard or group of hazards that are to be protected simultaneously.

The mass of aerosol forming compound required to achieve the design application density shall be calculated from the following equation:

$$M = C \times V \quad \dots 7.1$$

where

M = the total flooding quantity, in g

C = design application density, in g/m³

V = protected volume, in m³ (may include adjacent connected areas)

The design application density is to be specified by the manufacturer in the design manual.

In addition to these calculated total flooding quantities, additional quantities of condensed aerosol may be required to compensate for any special conditions that would adversely affect the extinguishing efficiency or, if required, by the physical characteristics of the condensed aerosol.

7.3.2 Safety factor

The safety factor of 1.3 relates to the increase of 30% from the extinguishing application density to the design application density. Circumstances which may not be adequately covered by this factor of 1.3 may need allowance for additional condensed aerosol or other means if the leakage area/volume ratio exceeds that detailed in the listed design manual. Some examples include but are not limited to the following:

- (a) Where leakage occurs from a non-tight enclosure.

- (b) Where leakage occurs due to doors being opened during or immediately after discharge. This should be covered by operational protocols for individual risks.
- (c) Where excessive leakage occurs from an enclosure.
- (d) Where metal surfaces, heated by the fire, may act as an ignition source if not adequately cooled during condensed aerosol discharge and hold time.

7.4 Design application density adjustment

7.4.1 *Effects of altitude*

Altitude, has no effect on condensed aerosol design application density calculations, but it affects the condensed aerosols spatial distribution. Where ambient pressures vary by more than 11% (equivalent to approximately 1000 m of elevation change) from standard sea level pressure (101 300 Pa absolute), the design calculations of the condensed aerosol shall be adjusted in accordance with the manufacturers specifications.

7.4.2 *Effects of temperature*

Temperature, as with altitude, has no effect on condensed aerosol design application density calculations, but it affects the condensed aerosols spatial distribution.

At elevated temperatures, aerosol expands to a greater specific volume. A system designed for standard conditions will therefore develop, at the same design application density, a higher distribution at elevated temperatures. Reduction in quantity of condensed aerosol is, however, not recommended, as it may result in lower extinguishing performance.

At lower temperatures, aerosol may expand to a lesser specific volume. This may result in lower coverage compared to that achieved under standard temperature conditions. The likelihood of this should be low due to a high velocity and the elevated temperature of aerosol being released.

At temperatures below zero, the quantity indicated at room temperature shall be increased to compensate for a lower coverage. The design application density determined at room temperature shall be multiplied by a correction factor determined by the manufacturer and included in the design manual.

7.5 Size and quantity of aerosol generators

7.5.1 *Maximum or minimum protected height limitations*

The selected generator sizes shall comply with the maximum distance and area coverage and maximum or minimum protected height limitations as specified for each generator. The maximum and minimum height and coverage distance for each size of aerosol generators shall be determined by area coverage fire tests as described in Appendix E.

7.5.2 *Minimum thermal clearance*

The selected generator sizes and their locations shall be appropriate for the protected area in terms of the minimum thermal clearance from the discharge outlets. If the protected area is congested or contains temperature-sensitive equipment, it would be appropriate to select several smaller generators that require less minimum clearance although one large generator may be adequate in terms of achieving the required design quantity.

The following general criteria apply:

- (a) For locations where personnel may be situated, the minimum thermal clearance shall refer to a temperature not exceeding 75°C.
- (b) For locations where combustible materials or equipment may be situated, the minimum thermal clearance shall refer to a temperature not exceeding 200°C.
- (c) For locations where non-combustible equipment may be situated, the minimum thermal clearance shall refer to a temperature not exceeding 400°C.

7.5.3 *Several smaller generators versus few large generators*

In some applications such as cable ducts and trenches, several smaller generators of the same family evenly spread along the protected enclosure would provide better distribution and faster achievement of the minimum design density throughout the area although one large generator may fulfil the agent quantity requirement.

7.5.4 *Mounting locations*

Certain protected enclosures may have very specific permissible mounting locations. This may influence the quantity and size of the generators selected.

7.5.5 *Quantity of aerosol generators*

7.5.5.1 *General*

The number of aerosol generators needed to protect a room may be increased in order not to exceed maximum coverage distance.

7.5.5.2 *Same generator size*

The same generator size of aerosol generations is calculated as follows:

$$n = \left\lceil \frac{M}{M_g} \right\rceil \quad \dots 7.2$$

where

n = the rounded-up number of aerosol generators of one size

M = total design quantity, in grams

M_g = mass of aerosol forming compound in one generator, in grams

7.5.5.3 *Different generator size*

If different sizes of aerosol generators should be selected, the total mass of aerosol forming compound shall be not less than the design quantity.

The height of the protected enclosure shall not exceed the maximum height limitation listed for the smallest generator size selected, unless uniformity of the aerosol distribution for the greater height has been proved by a discharge test.

7.5.6 *Multiple generator systems*

In case of the need of more than one aerosol generator to protect a volume, generators of the same family shall be used.

7.6 **Duration of protection**

It is important that an effective condensed aerosol concentration not only be achieved, but be maintained for a sufficient period of time to allow effective emergency action. This is equally important in all classes of fires since a persistent ignition source (e.g. an arc, heat source, oxyacetylene torch, or deep-seated fire) can lead to resurgence of the initial event once the condensed aerosol has dissipated.

Due to the specific characteristics of the extinction process of condensed aerosols that primarily produce particulates, no method is known to evaluate the hold time in real installations, other than real discharge which is not practical. For this reason, a specific test is required for each aerosol formulation to determine the maximum leakage area to volume ratio that provides for the minimum hold time declared by the manufacturer. The approach for determining hold time is detailed in Appendix E, Paragraph E7.

The leakage area for a specific room may be determined as the ELA value obtained with the door fan test described in Annex E of AS ISO 14520.1:2009. The details of the test to determine the area/volume ratio are given in Appendix E, Paragraph E7.

To ensure the protection is adequate in terms of hold time, the following comparison shall be fulfilled:

$$\frac{ELA}{V_{room}} \leq \text{leakage area to volume ratio (Paragraph E7)}$$

The hold time shall be not less than 10 min, unless otherwise specified by the authority having jurisdiction.

7.7 Detection, actuation and control systems

7.7.1 General

Systems may be configured for—

- (a) automatic detection with automatic and manual actuation;
- (b) automatic detection with manual actuation; or
- (c) manual actuation only.

Detection, actuation and control systems shall be independent from any general building fire detection and alarm system.

NOTE: A signal may be sent to the building emergency warning system when the condensed aerosol system is actuated.

Detection shall be by any method or device approved and shall be capable of early detection and indication of heat, flame, smoke, combustible vapours, or any abnormal condition in the hazard that is likely to produce fire.

7.7.2 Electrical detection

Electrical detection, actuation and control systems shall be in accordance with this Clause 7.7 and Appendix A.

Except where the potential exists for a very rapidly developing fire, detection should be configured for dual detector automatic actuation of the condensed aerosol system.

NOTE: Because an aerosol extinguishing agent is a smoke-like medium in itself, release of the aerosol may cause unwanted activation of smoke detectors in adjacent areas.

7.7.3 Operating devices

7.7.3.1 Automatic operation

Automatic systems shall be controlled by automatic fire detection and actuation systems suitable for the system and hazard, and shall also be provided with a means of manual operation.

Automatic systems shall perform all functions necessary for the successful operation of the system, including time delay and ancillary functions (e.g. equipment shutdown, damper closure and fuel shut-off). All ancillary equipment shall incorporate manual reset facilities.

7.7.3.2 Manual operation

For other than stand alone (not requiring an external source of power) systems provision shall be made for manual operation of the condensed aerosol system by means of a control situated outside the protected space or inside adjacent to the main exit from the space.

Unless otherwise specified, manual operation shall initiate the normal discharge sequence (e.g. pre-discharge delay, visual and audible warning devices) of the condensed aerosol system.

The manual operation device shall incorporate a double action or other safety device to restrict accidental operation.

7.7.3.3 *Local control (LC) and local control station (LCS)*

Where electrical control systems are used, provision shall be made for manual operation of the condensed aerosol system by means of a local control station (LCS), situated outside the protected space or inside adjacent to the main exit from the space

The LCS may be incorporated within the control and indicating equipment when the c.i.e. is located either within or adjacent to the protected area. Access to the LCS facilities shall not require the opening of any equipment door, and operation of the LCS controls shall not require the use of any key.

7.7.3.4 *Visual warning devices*

Except for systems protecting unoccupiable areas, other than underfloor areas, visual fire alarm warning devices shall be provided as follows:

- (a) Incorporating the words 'FIRE ALARM' and readily visible to the occupants of the protected area.
- (b) Incorporating the words 'DO NOT ENTER' and located above each access door of the spaces likely to be occasionally entered. They shall be readily visible to persons having access to the protected area.
- (c) Incorporating the words 'EVACUATE AREA' and readily visible to the occupants of the protected area.
- (d) Incorporating the words 'EXTINGUISHING SYSTEM INOPERATIVE' and located at the principal entry. It shall be readily visible to persons having access to the protected area.

The letter sizes, colours, and operation of the visual warning devices shall be in accordance with Paragraph A6.5.

7.7.3.5 *Aural alarms*

Aural alarms shall be provided within the protected area to give positive warning of detection of the presence of fire and impending discharge. The sequence of operation and tone of the aural alarm shall be in accordance with Paragraph A6.

7.7.3.6 *System isolate switch*

The discharge of electrically operated aerosol generators in total flooding applications in areas where people may be present shall be capable of being prevented by means of a system isolating switch.

NOTE: The intent of the isolate switch is to allow the system to be electrically isolated prior to personnel entering the protected space or adjacent areas which could be rendered hazardous by the discharge of condensed aerosol.

The system isolate switch shall be situated outside the protected area or inside adjacent to the main exit from the area and protected from an accidental operation.

While the system isolate switch is active and the discharge of the system is inhibited, the fire detection and alarm systems shall continue to function and the system shall return to its operation control when the device is reactivated.

The operation of the system isolate switch shall activate an indicator at the fire panel.

7.7.4 *Warning notices*

Warning notices shall have black lettering on a yellow background with a letter size equal to or greater than that detailed in Figures 1, 2 and 3. Notices shall be provided at the following locations:

- (a) At all entrances to the protected enclosure (see Figures 1 and 3).
- (b) At each emergency manual release point (see Figure 2).

- (c) At each system isolate switch (see Figure 3).

NOTE: The notice in Figure 3 is complementary to the notice in Figure 1 and should be located next to it.

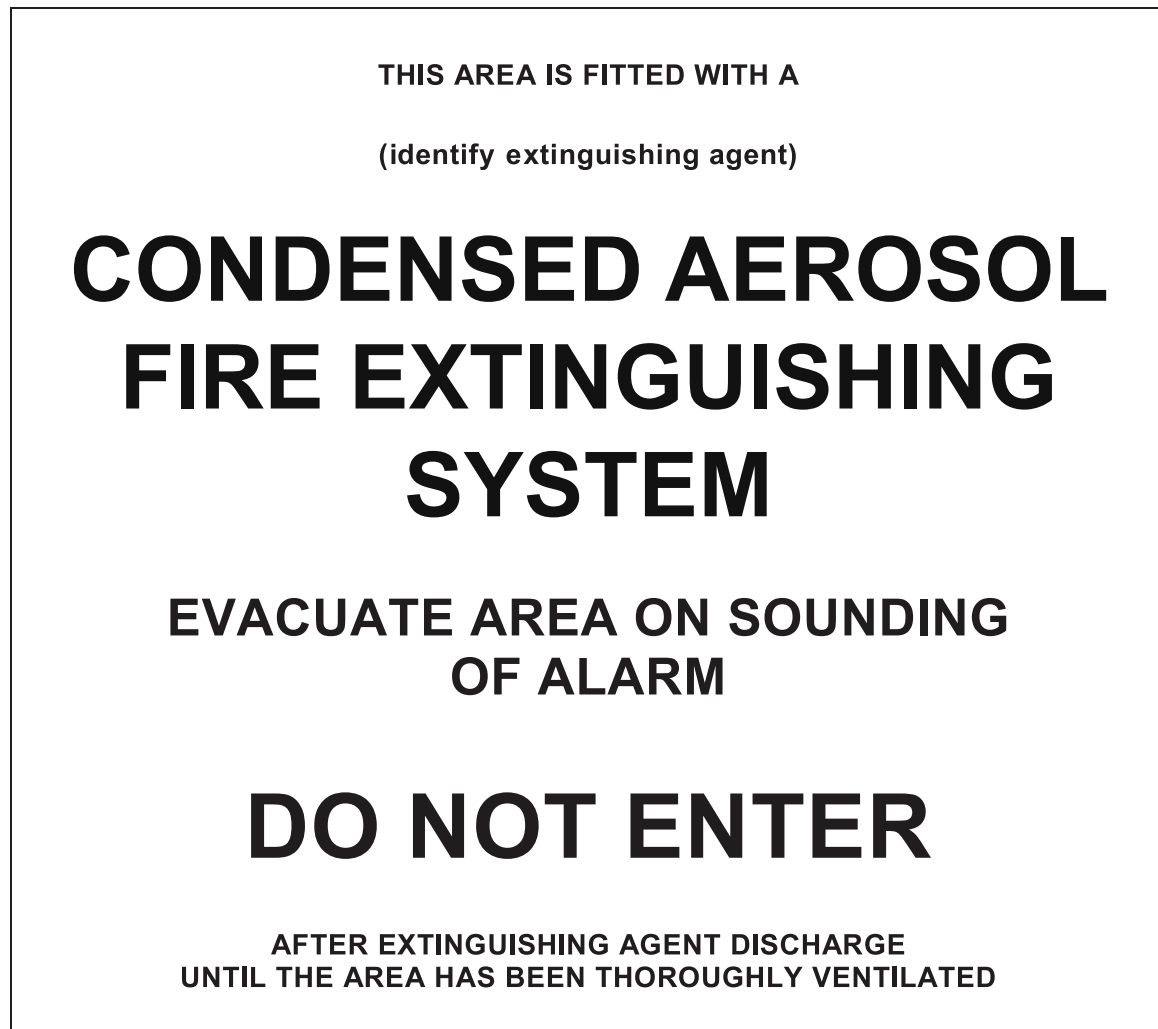


FIGURE 1 TYPICAL INSTRUCTION NOTICE TO BE DISPLAYED AT EACH ENTRY TO THE PROTECTED AREA OR ENCLOSURE

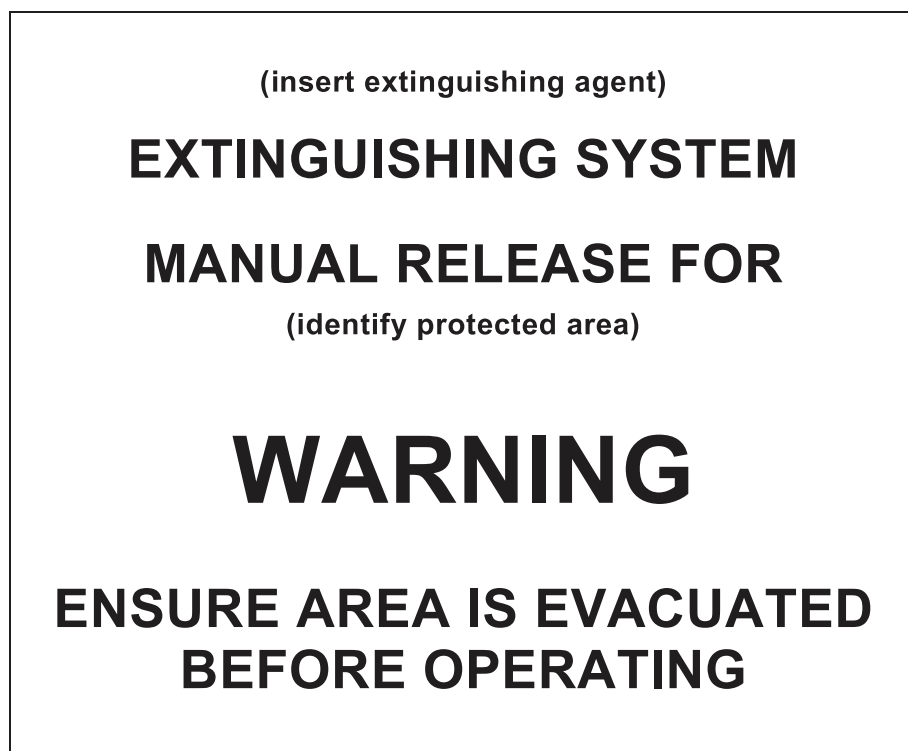


FIGURE 2 TYPICAL INSTRUCTION NOTICE TO BE DISPLAYED AT THE MANUAL RELEASE

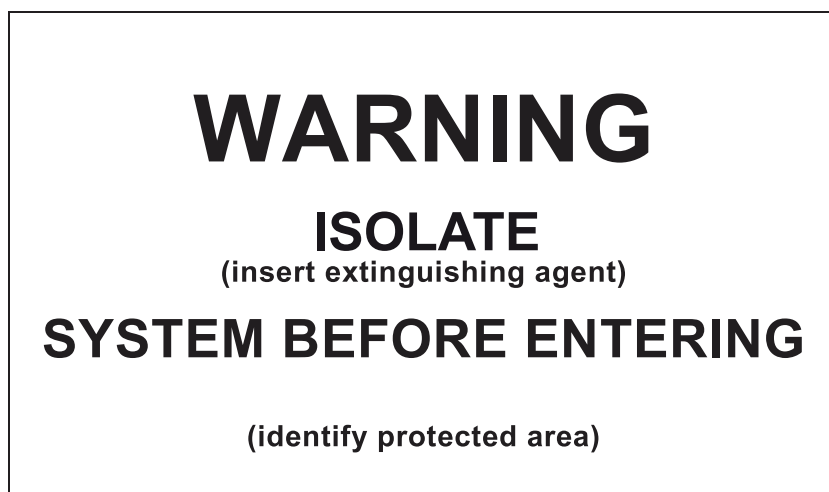


FIGURE 3 SYSTEM ISOLATE WARNING SYSTEM NOTICE

8 COMMISSIONING AND ACCEPTANCE

8.1 General

This Clause sets out the minimum requirements for the commissioning and acceptance of the aerosol extinguishing system.

8.2 Tests

8.2.1 General

The completed system shall be reviewed and tested by a competent person to meet the approval of the authority having jurisdiction. Only equipment and devices designed to national standards shall be used in the systems. To determine that the system has been properly installed and will function as specified, the tests specified in Clauses 8.2.2 to 8.2.9 shall be performed.

WARNING: A SYSTEM ISOLATE SWITCH SHALL BE OPERATED PRIOR TO ENTERING THE PROTECTED ENCLOSURE.

8.2.2 Enclosure check

Determine that the protected enclosure is in general conformance with the plans. The actual enclosure volume and dimensions shall be checked against the protected volume calculations specified in the system design. Fan rundown and damper closure time shall be taken into consideration.

All total flooding systems shall have the enclosure checked to locate and then effectively seal any significant air leaks that could result in a failure of the enclosure to hold the specified condensed aerosol extinguishing application density for the specified holding period.

Should pressure relief vents be required for the application, determine that the effective total vent area is in conformance with the design calculations. Ensure that the type and location of the vents are in accordance with the design recommendations so as to provide maximum possible containment of the aerosol during and after its discharge.

8.2.3 Review of design calculations

The type of enclosure occupancy (normally occupied, normally unoccupied) shall be checked against that indicated in the system designer calculations.

The actual enclosure volumes shall be checked against those indicated in the system designer calculations.

The fire hazards (classes of fires) shall be checked against those indicated in the system designer documentation. The selected design application density shall be appropriate for the hazard. In case of multiple fire hazards the greatest design application shall be used.

An adequate quantity of condensed aerosol forming compound to produce the manufacturers required design application density shall be provided. Total flooding quantity shall be appropriate for the actual protected volume.

Operation temperature range, humidity and other expected ambient conditions shall be checked for compliance with those specified by the manufacturer.

8.2.4 Review of the mechanical components of condensed aerosol generators

The following reviews apply:

- (a) The number and size(s) of the aerosol generators shall be checked for conformance to the design calculations. The number shall be adequate to produce the specified total flooding quantity. The generator size(s) shall be appropriate in relation to maximum height and area coverage limitations.
- (b) Check orientation of the generators to ensure optimum condensed aerosol dispersal and containment is achieved.
- (c) The aerosol generators shall be installed in such a manner that they will not potentially cause injury to personnel. Condensed aerosol shall not directly impinge on areas where personnel may be found in the normal work area, or on any loose objects on shelves, cabinet tops, or similar surfaces where loose objects could be present and become missiles.