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Introduction
This draft standard is based on European discussions in which the UK took an active part. Your comments on this draft are welcome and will assist in the preparation of the consequent British Standard. If no comments are received to the contrary, then the UK will approve this draft and implement it as a British Standard. Comment is particularly welcome on national, legislative or similar deviations that may be necessary.

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Date	Document

National Committee	Clause/ subclause	Paragraph/ Figure/ Table	Type of comment (General/ technical/editorial)	COMMENTS	Proposed change	OBSERVATIONS OF THE SECRETARIAT
	3.1	1st definition	Editorial	Definition is ambiguous and needs clarifying.	Amend to read '... so that the mains connector to which no connection ...'	
	6.4	§ 2	Technical	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	*Delete reference to UV photometer.*	

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 14972

August 2004

ICS

English version

Fixed firefighting systems - Watermist systems - Design and installation

Ortsfeste Brandbekämpfungsanlagen -
Feinsprühlöschanlagen - Planung und Einbau

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 191.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (prEN 14972:2004) has been prepared by Technical Committee CEN/TC 191 "Fixed firefighting systems", the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

Introduction

The main purpose of the standard is to provide adequate information to allow accurate selection of watermist technologies for suitable applications.

Although each watermist system is designed according to the manufacturer's guidelines, certain fundamental concepts common to all systems are covered in the standard, to enable quality checks of systems as far as design, installation and reliability are concerned.

1 Scope

This standard provides information for verifiable classification of watermist systems, according to their expected fire protection characteristics with reference to extinguishment, fire control or suppression.

It devises a series of specific test conditions to set out criteria capable of verifying performance claims of watermist systems, classify and determine the extent of their suitability for intended applications, whilst setting a minimum level of acceptable performance and/or safety.

As the fire test scenarios of this standard apply to a group of similar applications, by analogy the successful performance of watermist systems also applies to that group, as defined in annex A.

As individual watermist applications have varied requirements and duty, this European standard is intended to apply to both skidded stand alone and pumped systems. Aspects of watermist associated with explosion protection are beyond the scope of this standard. The standard is not intended to be used as a universal design manual of watermist, as different systems have different characteristics and hence follow different design criteria to satisfy their duty requirements. It is the approving authority's responsibility to assess and implement the design manual of specific watermist systems against the tests set out in this standard.

If the gas in the system is the major factor for extinguishing/suppression the relevant parts of EN 12094 are to be considered.

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.

EN 54-4, *Fire detection and fire alarm systems – Part 4: Power supply equipment.*

EN 12094-1, *Fixed fire fighting systems – Components for gas extinguishing systems – Part 1: Requirements and test methods for electrical automatic control and delay devices.*

EN 12259-1, *Fixed firefighting systems – Components for sprinkler and water spray systems – Part 1: Sprinklers.*

prEN 12259-6, *Fixed firefighting systems – Components for sprinkler and water spray systems – Part 6: Pipe couplings.*[1)]

prEN 12259-7, *Fixed firefighting systems – Components for sprinkler and water spray systems – Part 7: Pipe hangers.*[1)]

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1) under preparation

EN 12845, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance.*

EN 13501-1, *Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests.*

prEN 14816, *Fixed firefighting systems – Water spray systems – Design and installation.*

EN 60529:1991, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989 + A1:1999).*

EN 60079 (all parts), *Electrical apparatus for explosive gas atmospheres.*

EN ISO 14847, *Rotary positive displacement pumps – Technical requirements (ISO 14847:1999).*

IEC 61241 (all parts), *Electrical apparatus for use in the presence of combustible dust.*

ISO 565, *Test sieves – Metal wire cloth, perforated metal plate and electroformed sheet – Nominal sizes of openings.*

ISO 5660-1, *Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method).*

3 Terms and definitions

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

3.1
automatic nozzle
nozzle with an integrated release element

3.2
authority having jurisdiction
the organization, office, or individual responsible for approving equipment, and installation, or a procedure

3.3
certification of conformity
action by a third party, demonstrating that adequate confidence is provided that a duly identified product, process or service is in conformity with a specific standard or other normative document [EN 45020]

3.4
competent person
person with the necessary training and experience, with access to the relevant tool s , equipment and information, manuals and knowledge of any special procedures recommended by the manufacturer and/or holder of the approval of the watermist system, to be capable of carrying out the relevant maintenance procedures of this standard

3.5
deluge system
a watermist system using open nozzles attached to a piping system that is connected to a water supply through a valve that is opened by means of a detection system installed in the same area as the mist nozzles. When the valve opens, water flows into the piping system and discharges through all nozzles attached to the system.

NOTE 1 The system is controlled by a valve which is activated by a detection system and/or by manual means. When the valve is open and the system pressurised, water flows into the pipe work system and discharges simultaneously through all the nozzles. Systems may sometimes be sub-divided into zones.

NOTE 2 For water the word medium might be better as water and/or water with additive can be used.

3.6
discharge flow rate
the flow rate at which firefighting medium is applied, in litres per minute

3.7
dry pipe system
a watermist system using automatic nozzles attached to a piping system containing air, nitrogen, or inert gas under pressure, the release of which (as from an opening of an automatic nozzle) allows the water pressure to open a dry pipe valve. The water then flows into the piping system and out through any open nozzles

3.8
duration (system)
the total time for which the supply of fire fighting medium is designed to last, in minutes. For systems with intermittent discharge it is the sum of the times of discharge and the times without discharge

3.9
duration (discharge)
the time for which fire fighting medium is continuously applied, in minutes

3.10
extended service
third most frequent scheduled maintenance procedure

3.11
firefighting medium
substance which causes fire extinction, suppression or control

NOTE Media for use in watermist systems: demi water, potable and sweet industrial water, and water with additives are relevant.

The terminology includes the following:

a) water only, i.e. potable water, natural sea water, deionized water;

b) water with antifreeze;

c) water with fire extinguishing enhancing additive;

d) combination of the above with an inert gas or a blend of inert gases used primarily to atomize the water and/or to reduce oxygen concentration at the fire (see 3.26).

3.12
fire extinguishment
complete elimination of any flaming or smouldering fire

3.13
fire suppression
a sharp reduction in the heat release rate and prevention of re-growth of the fire

3.14
fire control
limitation of fire growth and prevention of structural damages (by cooling of the objects, adjacent gases and/or by pre-wetting adjacent combustibles)

3.15
fitness for purpose
ability of a product, process or service to serve a defined purpose under specific conditions [EN 45020]

3.16
inspection
most frequent scheduled maintenance procedure

3.17
installation (watermist)
part of a watermist system comprising a control valve set, the associated downstream pipes and nozzles

3.18
maintenance
the combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function [EN 50126]

3.19
preaction system
system, in which the control valve can be opened by an independent fire detection system in the protected area, allowing the fire fighting medium into the pipework within the protected area prior to the independent operation and subsequent operation of any automatic nozzle

3.20
watermist system
a watermist system is the entire means of a fire protection system connected to a water supply equipped with one or more nozzles capable of delivering watermist. Watermist systems may discharge plain watermist or a mixture of watermist and some other agent or agents like gases or additives

3.21
object protection system
a watermist system designed to discharge directly on an object or hazard to provide either extinguishment control or cooling as required

3.22
overhaul
least frequent scheduled maintenance procedure

3.23
qualified company
company registered by a national responsible body or accepted by the authorities having jurisdiction for design, installation and maintenance of fixed watermist systems and fully trained and authorized by the manufacturer

3.24
response time
the time measured from the moment fire is detected until extinguishing media is applied at full system pressure

3.25
single fluid system
a system which generates watermist by passage of water through the nozzle

3.26
twin fluid system
a system which generates watermist at the nozzle by mixing water with an atomizing gas fed from a separate pipe(s) from the water supply

3.27
system pressure

- low pressure: up to 12,5 bar;
- medium pressure: higher than 12,5 bar, but below 35 bar
- high pressure: 35 bar and higher

3.28
supplier
the party that is responsible for the product, process or service and is able to ensure that quality assurance is exercised. The definition may apply to manufacturers, distributors, importers, assemblers, service organisations, etc. [EN 45020]

3.29
user
person or persons responsible for/or having effective control over fire safety provisions adopted in or appropriate to the premises or building or risk where the watermist system is installed

3.30
volume protection system
a watermist system designed to protect a predefined volume

3.31
watermist
a water spray for which the $D_{v0,90}$ as measured in a plane 1 m from the nozzle, at its minimum design operating pressure less than 1 mm

3.32
watermist nozzle
special purpose device with one or more orifices which is designed to produce and discharge watermist

3.33
water supply, self-contained
a water supply designed exclusively for a single watermist system, with no connection to an external water source, typically comprising a set of bottles or a skid mounted pressure tank,pre-fabricated in the manufacturer's workshop

3.34
wet pipe system
a watermist system using automatic nozzles attached to a piping system containing water and connected to a water supply so that water discharges immediately from nozzles operated by the heat from a fire

3.35
preburn time
time from ignition of the fire source till the design pressure or design flow is available at the hydraulically most remote nozzle

3.36
rated working pressure
design pressure of system and system components

3.37
burst pressure
the pressure when a component will fail during testing under component test conditions

3.38
domestic occupancy
individual dwelling for occupation as a single family unit or constructed or adapted to be used wholly or principally for human habitation

3.39
residential occupancy
occupancy for multiple occupation, such as apartments, residential homes, houses of multiple occupancy (HMO), blocks of flats, boarding houses, aged persons homes, nursing homes, residential rehabilitation accommodation, and dormitories

4 Requirements

4.1 Protection criteria

4.1.1 General information

The aim of the present clause is to give a general guidance in order to choose the correct watermist system for each application. Nevertheless the selected watermist system shall be supported by test approvals and shall fulfil the other requirements described in the present standard. Systems that have proved their right performance can overrule the following considerations.

4.1.2 Limitations

4.1.2.1 Material which react with water

Watermist systems shall not be used for direct application to materials that react with water to produce violent reactions or significant amounts of hazardous products. This materials include:

a) Reactive metals, such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium and plutonium;

b) Metal alkoxides, such as sodium methoxide;

c) Metal amides, such as sodium amide;

d) Carbides, such as calcium carbide;

e) Halides, such as benzoyl chloride and aluminum chloride;

f) Hydrides, such as lithium aluminum hydride;

g) Oxyhalides, such as phosphorus oxybromide;

h) Silanes, such as trichloromethylsilane;

i) Sulfides, such as phosphorus pentasulfide;

j) Cyanates, such as methylisocyanate.

4.1.2.2 Liquefied gases

Watermist systems shall not be used for direct application to liquefied gases at cryogenic temperatures (such as liquefied natural gas), which boil violently when heated by water.

4.1.3 Identification of protection objectives on defined hazards

Identifying the fire protection objectives from the table below should be carried for each fire protection application. In multiple hazard cases it is necessary to identify the protection objectives for each hazard. Care shall be taken to prevent negative interaction between individual fire protection systems, see Table 1.

Table 1 — Protection objectives in fire protection

Fire protection	Objective	Requirements	Notes
Fire extinguishing	- fire extinguishing preventing the spread of the fire - binding the smoke gases	- fast response fire detectors and a short actuation time (≤ 3 min) - higher volume extinguishing intensities	minimum operating times according of the results from performance tests or against other technical standards
Fire control	- limiting and reducing the intensity of the fire at its seat and in relation to the surroundings - preventing the spread of the fire - binding the smoke gases - protecting people - protecting buildings - protecting technological equipment	- actuation of the system in the developing fire phase (≤ 5 min) - minimum operating time of the system is based on the time taken for the fire brigade to deploy	- Controlled burn-out of the section located in the fire - lower volume extinguishing intensities are necessary than for the "fire extinguishing" protection objectives - operating time according of the results from performance tests or against other technical standards
Fire suppression	see protection objectives fire control with the same or an lower heat flow	- actuation of the system in the developing fire phase (≤ 5 min) - minimum operating time of the system is based on the time taken for the fire brigade to deploy	see under fire control
Fire barrier	- complementing and supporting fire protection structures - preventing the spread of the fire into other fire sections and extinguishing sections - abatement of the smoke gases	- minimum operating time of the system corresponds to the fire resistance of the surrounding fire protection structures - coherent and optically dense aqueous film	no discharge of water onto the actual seat of the fire
Heat binding	- binding the quantity of heat released from a fire in the surroundings of the object to be protected - abatement of the smoke gases - preserving the safety of building structures and technological installations	- coherent and optically dense aqueous film - minimum operating time of the system is based on the time taken for the fire brigade to deploy or the specific requirements of the extinguishing system operator	system is arranged around the object to be protected

Once the protection objectives and the scope have been specified, the fire-specific factors of influence can be determined, taking account of the type of protection, i.e. object protection or volume protection.

4.1.4 Object protection

Systems designed to be installed in an object protection applications shall be tested for the associated hazard class selected and for the main protection objective/objectives of the applications concerned.

Systems designed to be installed in multiple hazard object protection areas, where protection for individual objects is foreseen, they shall be approved for all associated hazards present in the area.

If necessary additional systems/nozzles shall be installed to cover all hazards present in that area.

The system nozzle distribution shall provide sufficient object coverage as specified by the manufacturers design and installation manual.

4.1.5 Volume protection

Systems designed to be installed in a volume protection shall be tested for the hazard class selected and for the main fire protection objective/objectives.

Systems designed to be installed in a multiple hazard application shall be approved for all present hazards in the volume.

System nozzle distribution shall provide total volume protection, specified by the manufacturer's design and installation manual and shall consider relevant factors such as leakage via openings, ventilation rates, obstructions, etc..

NOTE The installation of an automatic door closing mechanism will improve the effectiveness of the system.

4.1.6 Other considerations:

4.1.6.1 Discharge delay

The fire fighting agent shall exit from all nozzles within 30 s after activation, whether the system is wet, dry, preaction or any other.

4.1.6.2 Selection of detection system

Detection shall be the responsibility of the watermist system supplier, who shall inform the end user of the most appropriate detection type to be installed to guarantee correct performance. The detection system shall be as specified in the manufacturers design and installation manual.

The detection system shall comply with clause 6.

4.1.6.3 Oxygen depletion

The system supplier shall demonstrate by calculations or discharge tests that the total amount of gaseous medium delivered into the protected enclosure in twin fluid systems and/or cylinder systems won't decrease oxygen concentration below a level dangerous to persons. In cases, where critical oxygen concentrations may prevail , early warning signals and appropriate system activation time delays shall be implemented in order to enable people to be evacuated from the area. The safety requirements effected by the gas concentration produced by the watermist system shall comply with national regulations.

NOTE This consideration applies to systems based on volume inerting.

4.2 Requirements on the qualified company

Watermist systems shall only be designed, installed and maintained by qualified companies.

5 Activation and Control

5.1 General

The detection and activation system can either be mechanical, hydraulic, pneumatic, sprinkler type or electrical. The pneumatic sprinkler activation systems should be in accordance with prEN 14816. The electrical activation should be in accordance with EN 12845.

Details of specific intermittent misting operations of systems and the associated modes of controls re-setting are not specified in this standard, but such systems can be applied in design, as long as the above agreed principles of system rationale are observed and followed.

Detection, actuation, alarm and control systems shall be installed, tested and maintained in accordance with appropriate national standards.

Failure of the control panel shall not be able to stop the ongoing watermist discharge or the ongoing discharge sequence.

5.2 Electrical activation and control

5.2.1 General

For the design, installation and maintenance of electrically activated systems, and also for component requirements in respect of these systems, see relevant parts of EN 54 and EN 12094.

Watermist systems shall be automatically activated, except where the authorities having jurisdiction allow only manual activation.

The system shall be arranged so that there is no possibility of an alarm being produced in an adjacent extinguishing zone by the fire fighting medium.

5.2.2 Application of EN 54

The relevant part of EN 54 series shall be applied to the detection part of watermist systems, with the following additions:

a) The cable inlets and the detector bases shall at least comply to protection type IP 54 according to specifications of EN 60529. If the system can be automatically released via the detection system without the need of manual reset after the first release of the system they shall at least comply to protection type IP 65 according to specifications of EN 60529.

NOTE To achieve rapid fire extinguishing, the activation of the watermist system should be activated by one alarm signal only. If , on the other hand, the system is activated after the reception of two alarm signals, generated by automatic fire detectors, the reception of the first signal should be indicated visibly and audibly. On the reception of the first signal, outputs (eg for plant shut down) may be activated.

b) When the water discharge of the system depends on detector signal after the first release, no flame detectors or smoke detectors shall be used, unless the type of detector has proven its reliability in the resence of watermist.

c) Heat detectors shall have maximum response temperatures up to 120 °C. If higher temperature is present in the coverage area of the watermist system, the activation temperature shall be at least 30 °C above the maximum temperature to be expected during standard operation.

d) If monitoring is required, all the following active elements of watermist systems shall have their functions supervised for open line and/or short circuit and shall have its status signalled:

   1) The signal from the (separate) detection system to activate the watermist control system.

2) The output circuit from the watermist control system to the electrical activating device for the water discharge.

3) The system "discharged" device, i.e. pressure device or flow device.

4) A maintenance isolate switch, if installed. It shall electrically isolate the electrical activating device.

5) The expellent gas pressure-switch, if installed, to monitor the operational status of the system.

6) A level-switch (in case of a water storage container) to monitor the operational status of the system.

7) The "double-action" manual release device to activate the watermist control system.

NOTE Indicators for elements 4, 5 and 6 may be combined in one "system-status-indicator".

e) If networked ringmains (loops) are used, several actuators shall be connected within a maximum of 8 sections in one loop. Between adjacent section actuators short circuit isolators shall be installed.

f) If a system operates intermittently, a post-spraying period of at least 10 s shall be incorporated after the end of alarm.

NOTE 1 For intermittent system, UV detectors (ultra-violet detectors) should not be utilised for monitoring the extinguishing result, since the ultra-violet range of the light to be detected is falsified in the wavelength range from 170 nm to 290 nm.

NOTE 2 For intermittent system, IR detectors (infrared detectors) may be used, which detect light wavelengths of 1 µm to10 µm and flickering flame frequencies of < 10 Hz, can detect the flame unambiguously through a watermist jet.

5.2.3 Power supply

The electric power supply shall be independent of the supply for the hazard area and shall comply with EN 54-4.

5.2.4 Manual activation

Watermist systems activation by fire detection shall be equipped with a manual triggering device.

Watermist systems with automatic nozzles need not a manual activation.

The manual triggering device should be located near the exit, outside the protected rooms and should be installed at normal operating height, at highly visible locations.

In addition to any means of automatic operation, the system shall be provided with an emergency triggering device for providing direct mechanical actuation of the system.

NOTE 1 National standards may require the release to operate after the pre-discharge alarms and time delay.

NOTE 2 National standards may require a manual triggering device incorporating a double action or other safety device to restrict accidental operation.

5.2.5 Alarm indications

Alarms or indicators or both shall be used to indicate the operation of the system or failure of any supervised device. The type (audible, visual), number, and location of the devices shall be such that their purpose is satisfactorily accomplished.

The activation of a watermist system should activate an acoustic alarm and an optical alarm.

5.3 Non-electrical activation

Where pneumatic, hydraulic or mechanic control equipment is used, the lines shall be protected against crimping and other possible damage. Where installations could be exposed to adverse conditions that could affect the integrity of the installation (electrical cable, pipework, key parts, etc), appropriate precautions shall be taken to counteract such occurrence.

6 Installation design

6.1 General

6.1.1 Design parameters

The installation and design shall comply with the parameters (e.g. nozzle type and spacing, operating pressures) as used in successful fire tests specified in the annexes of this European Standard.

6.1.2 Manufacturer's specifications

The manufacturer shall describe and/or specify the procedure up to the erection of the system.

The system shall be designed in accordance with the selected nozzle type and the fire hazard.

The nozzle performance characteristics shall be documented accordingly, and minimum and/or maximum values shall be specified for the nozzle arrangement in the coverage area of the extinguishing system.

6.1.3 Extinguishing systems

Fire extinguishing systems shall meet the following fundamental system requirements:

a) nozzle(s) shall be positioned in accordance with the manufacturer's manual in order to distribute the extinguishing media to all areas where fire either occur or spread;

b) after the system duration time the system shall be able to prevent fire re-ignition;

c) systems shall be capable of fire extinguishment, for the relevant application, in accordance with the annexes of this European Standard.

6.1.4 Control/Suppression systems

These systems shall meet the following fundamental system requirements:

a) nozzle(s) shall be positioned in accordance with the manufacturer's manual;

b) the discharge duration time shall be long enough to allow manual intervention to take over fire fighting efforts;

c) systems shall be capable of fire suppression/control, for the relevant application, in accordance with the annexes of this European Standard.

6.2 Pipes and fittings

The piping shall be installed in accordance with the manufacturer's design and installation manual with the same safety level as described in EN 12845 and shall be protected against corrosion. Pipes shall be installed in such a way that the pipes are not exposed to damage, for example by fire, by passing vehicles, by frost, by seismic movement (see EN 12845).

Piping materials shall be of stainless steel or of at least equivalent quality in respect to corrosion. Alternative solutions (materials and/or system measurements) shall be possible if the same level of safety in respect to clogging due to corrosion can be proven.

Special consideration shall be given to systems installed in corrosive environments.

Special consideration shall be given to possible thermal expansion problems which may occur due to very long straight pipe runs.

6.3 Pipe supports

Pipe supports shall be designed and spaced according to the manufacturer's design an installation manual and with same safety as described in EN 12845.

6.4 Hydraulic and pneumatic circuits

The installation shall be in accordance with 7.2.

A pressure relief valve shall be installed, set at a pressure, that does not exceed 1,5 times the normal operating pressure in the circuit.

6.5 Non-return valves

Non return valves are to be installed in accordance with the manufacturer's design and installation manual, if more than one section is fed by a common supply. Non return valves shall also be installed to prevent backflow e.g. into the town mains or as a separation between pumps/water sources.

6.6 Drainage

All system piping and fittings shall be installed in such a way that the entire system can be drained.

6.7 Pressure gauges/monitoring

If monitoring is required, all monitoring equipment shall be installed according to the manufacturer's design and installation manual.

NOTE This drawing is intended only to show the arrangement of the pressure gauges and not all necessary equipment.

6.8 Electrical Design

6.8.1 General

Detection, control and activation systems shall be able to function either automatically or manually. In the case of automatic activation, provision for manual triggering shall be provided. Detection, control and activation systems shall be installed, commissioned and maintained in compliance with the relevant national standards. The electric installation of automatic extinguishing systems shall comply with the latest relevant standards for high voltage/low voltage. Special attention shall be paid to the safe earthing of the piping network.

6.8.2 Electrical Equipment

All electrical equipment used in the automatically actuated extinguishing system shall comply with the relevant national regulations.

Special attention shall be paid to the use of equipment in hazardous classified areas and the appropriate ingress protection grade.

NOTE See EN 60079 and IEC 61241.

6.8.3 Fire detection system

Fire detection systems shall comply with the requirements of the relevant parts of EN 54 and the national codes as far as selection of type and positioning of detectors is concerned.

To reduce the probability of false activation, it is recommended to design the system on basis of a 2-detector confirmation. In case of 2-detector confirmation the fire alarm signal shall be given within the protected area. After a "confirming" alarm from a second detector the system release shall start on basis of the "programmed" sequence of, for example, time delay on activation device, shut down protected processes, shut down of ventilation, etc. The number of detectors compared to standard rules for spacing of detectors to achieve a quick responding extinguishing system shall be doubled.

For optical type detectors (infrared or ultraviolet type flame detectors) special attention shall be paid to the positioning of the detectors and the environmental influences.

Due to the fact of a possibility of "blinding" an optical detector, a minimum of two detectors shall be installed.

Further operational conditions shall be considered as time delays, voting and sensitivity control.

6.8.4 Control and indicating equipment

The following minimum requirements shall be implemented:

a) power supply including batteries in accordance with 6.8.5;

b) supervision of circuits of active elements in accordance with 5.2.2 d);

c) systems "actively discharged" shall be indicated by a red visual indicator, to be generated from a device fitted downstream the system main valve.

Such a device may be "pressure"-type switch, or a "flow"-type switch:

— A switch, to electrically isolate the circuitry of the system discharge device, shall be provided to allow for proper testing and maintenance. The status of this switch shall be clearly indicated on the control panel.

— Alarming functions to be included in accordance with 6.8.7.

6.8.5 Power supplies for detection and control

The emergency power supply shall be capable to keep the system in operation for at least 24 h from first loss of power. The electrical supply shall be exclusively for the detection and control system.

The electrical supply isolating switch for the detection and control system shall be clearly marked as follows:

DO NOT SWITCH OFF AUTOMATIC FIRE FIGHTING SYSTEM

The connection shall be made on the supply side of the main electrical distribution board.

6.8.6 Power supplies for operation

This requirement is valid for pumps and other directly AC powered equipment without battery backup. On automatically activated watermist systems the power from the public network shall be connected on the supply side of the main switch (or as close as allowed by national standards). The electrical supply for the automatic watermist system shall not be connected to any other type of electric equipment. The group isolate switch for the automatic extinguishing system shall be clearly marked as follows:

DO NOT SWITCH OFF AUTOMATIC FIRE FIGHTING SYSTEM

6.8.7 Alarming

Alarms shall be in accordance with the requirements of the authority having jurisdiction. Audible alarms and where appropriate visible warning signs shall be provided:

a) Fire alarm signal upon the first alarm from one of the installed detectors. The signal may be by means of visible indication and/or an alert tone. The alarm for each installation shall be connected to a permanently manned location.

NOTE In case of high noise levels it is advisable to install a "visual attention maker" by means of for example flashing light instead of the alert sounder.

b) Evacuate alarms where it is required to leave the protected area before or at system discharge. Visual devices shall illuminate text as: "do not enter" or "leave the area", "automatic extinguishing" and evacuation sounder alarms will be activated and will continue until the risk area will be declared safe by qualified staff. Alarm tones and signs to be in accordance with local requirements.

c) System Operational Status, any conditions that may effect either automatic operation, or the effectiveness of the system installed shall cause a visual indication on the system control and indicating device. Such conditions shall include but not be limited to the following;

   — operation of the maintenance override function

   — failure in the fire detection system;

   — fault in the activation circuit;

   — failure in capacity of the firefighting media, i.e. low water level, low pressure expellent gas, fire pumps;

   — status "manual" in case of a device being installed for selection of either automatic, or manual operation;

   — failure in power supply.

Fault indications shall be connected to a permanently manned location.

6.9 Nozzle spacing

Nozzles shall be spaced and installed in accordance with the manufacturer's manual, mainly based on test results, taking into account at least the following parameters:

a) type of hazard;

b) nozzle positioning, minimum and maximum spacing between nozzles;

c) distance from walls and other obstructions, installation of nozzles to compensate for obstructions, installation around openings;

d) distance to the risk, etc.;

e) height below ceilings and height and design of the ceiling.

6.10 Air velocity, openings and ventilation

Air velocity, openings and ventilation shall be taken into account, in accordance with the manufacturer's instructions, based on test results.

Wherever possible, the ventilation system shall be shut down before the system operates. In those cases where this is not possible or desirable, the air velocity and/or total leakage area shall be within the limits specified by the manufacturer on the basis of tests.

6.11 Hydraulic and pneumatic Calculations

6.11.1 Pressure loss

Only appropriate and validated calculation procedures shall be applied..

6.11.2 Water hammer

The effects of possible water hammers shall be considered.

6.12 Automatic shut-down

6.12.1 Fuel and other combustibles used in the protected area

During a fire incident provision shall be made to stop any supply of combustible substances as part of the shut-down emergency procedures (product and raw materials feed), with the exception of the minimum supply for emergency running systems. This point shall also be taken into consideration when specifying the operating period.

6.12.2 Power supply to equipment in the protected area

Normally, power supplies to the equipment in the affected area shall be switched off upon activation of the system or detection of a fire. Minimum supplies for emergency running systems are an exception. This interlock is application-dependant (e.g. motor test beds, gas turbines)

6.13 Enclosure requirements

Fire resistance, pressure relief openings, obstructions shall be in accordance with the manufacturer's design manual.

6.14 Documentation

6.14.1 General

Documentation shall be complete to allow for risk identification, as for system effectiveness.

The documentation shall include at least:

a) full project information, including system identification, type and application as well as hazard limits;

b) system design parameters and hydraulic calculations (water or other medium);

c) commissioning and acceptance requirements;

d) detailed constructional and operational information of the object to be protected;

e) nozzle location and identification;

f) full functional system description (to include operating sequence, time delays, abort functions, maintenance switches and all other relevant items);

g) full package schematic diagrams, including all point to point connections within the entire system;

h) plan and sectional view of the protected area showing the lay-out of:

   1) zone divisions, size and locations;

   2) all piping, nozzles and all hangers and supports;

   3) all devices of the alarm and control system;

   4) all controlled devices, such as dampers, shutters, valves etc.;

   5) all warning and instruction signs;

i) isometric view of the complete system showing full detail of all system pipes and equipment.

6.14.2 System calculations

Hydraulic and pneumatic calculations shall be carried out using either the methods as given in 6.11 or in accordance with (authorized) instructions of the manufacturer. All calculations shall be provided, including a summary of calculations, and shall be referenced to a drawing showing the locations of reference nodes in the system.

6.14.3 Desin approval

All documentation shall be submitted to the appropriate authority for approval, preferably before the commencement of work.

When field conditions necessitate any material change from approved documentation, the change shall be submitted for approval.

6.14.4 Maintenance

A full maintenance schedule including a user's program of inspection and service schedule shall be provided upon acceptance testing.

7 Components

7.1 Nozzles

NOTE There are two types of nozzles: open and automatic.

7.1.1 General

NOTE See annex D.

Common aspects are:

They shall be made of corrosion resistant metal, and shall not be prone to be damaged by mechanical impact.

They shall be permanently marked to identify the manufacturer, model no, year of manufacturing, the approval mark(s), and/or component identification.

7.1.2 Open nozzles

Open nozzles shall be equipped with a blow off cap or other protective device, if the environment is prone to allow clogging of the exit port(s) by foreign material. These devices shall provide an unobstructed opening upon system operation and shall be arranged in such a way as to prevent injure of personnel.

7.1.3 Automatic nozzles

Automatic nozzles shall be equipped with a heat sensitive device designed to react at a pre-determined nominal release temperature.

Automatic nozzles shall be equipped with opening devices which are colour coded in accordance with EN 12259-1 to indicate their temperature rating.

Automatic nozzles shall be equipped with a blow off cap or other protective device, if the environment is prone to allow clogging of the exit port(s) by foreign material. These devices shall provide an unobstructed opening upon system operation and shall be arranged in such a way as to prevent injure of personnel.

7.2 Piping and fittings

7.2.1 General

The burst pressure of pipes, fittings, hoses, etc. shall be at least four times the rated working pressure.

7.2.2 Piping

Piping and fittings used in watermist systems shall be the suitable metal or synthetic material, to provide adequate protection against corrosion and sludge development.

The chosen material shall be suitable to withstand the anticipated temperatures.

Other piping materials than listed above may be used if proven to be suitable by applicable tests. The piping and fittings should be suitable for the applied pressure system, and this has to be proven by a hydrostatic test at 150 % of the rated working pressure.

Where applicable, pipe joints shall comply with prEN 12259-6. Components for higher operating pressures than referred to in prEN 12259-6, shall provide the same safety level. If no applicable European Standards are available, the manufacturer shall prove that the components comply with following basic requirements:

— minimum bursting strength;

— vibration;

— water hammer;

— corrosion;

— heat resistance.

7.2.3 Pipe supports

Pipe supports for low pressure systems shall be in accordance with prEN 12259-7. Otherwise the manufacturer shall prove that the following basic requirements are complied with:

— load

— vibration

— heat resistance

Pipe supports shall be suitable for the environmental conditions, for the expected temperature, including the stresses induced in the pipe work by temperature variations, and be able to withstand the anticipated dynamic and static forces.

7.2.4 Flexible hoses

The length of the hose shall be limited to the minimum necessary taking into account the installation guidelines and restrictions of the hose manufacturer.

Flexible hoses intended for use in watermist systems used to protect occupancies containing flammable liquids are to be made of fire-resistant materials and reinforced with wire braid or other suitable material.

Flexible hoses shall fulfil the relevant requirements of pipes and fittings. This excludes the temperature requirements, if the flexible hose is installed in the water supply.

7.3 Control valves

Where installed in systems operating below 12,5 bar, the wet pipe and the preaction/deluge alarm control valves shall comply with the relevant part of EN 12259.

Sequential alarm control valve for any pressure system and control valves for systems operating above 12,5 bar shall be suitable for the pressures, temperatures and environment imposed on them. They shall be in accordance with the acceptance criteria of the essential features of the tests as listed in the relevant part of EN 12259.The valve shall be made of corrosion resistant material, or having corrosion resistant finishing. The valve shall have a clear mark to indicate the correct way of installation.

For control valves with actuator mechanism, such as pneumatic type, hydraulic type, or electrical type, the specifications of the actuator shall match the valve operation criteria.

7.4 Pressure regulating valve

Pressure regulating valves shall be capable of providing a stable regulated output at the rated flow capacity and design setting, over the full range of input pressures that will be experienced over the course of the discharge period. Pressure set, point-adjusting mechanisms on the pressure regulating valve shall be tamper resistant, and a permanent marking shall indicate the adjustment. A means to indicate evidence of tampering shall be provided. The pressure regulating valve's set point shall be set by the manufacturer. Permanent markings shall indicate the inlet and outlet connections of the pressure regulating valve.

7.5 Shut-off valves

Shut-off valves shall meet the requirements of EN 12845 and the relevant parts of EN 12259 for systems up to 12,5 bar operating pressure.

If shut-off valves are installed for systems operating above 12,5 bar, the shut-off valve shall be suitable for the applicable pressure class, and they shall be in accordance with the acceptance criteria of the essential features of the tests as listed in EN 12845.

Valves, which are not required to be in compliance with the standards mentioned above, shall include a "open–shut" indicator, which can not be tampered with.

7.6 Check valves

Check valves shall be suitable for the applicable pressure class.

7.7 Safety valves

Pressure relief valves are to be designed to withstand a pressure equal to 1,5 times the maximum working pressure of the system.

7.8 Strainers.

Strainers shall be made of corrosion resistant materials. For pressure bearing parts and for the sieve, metallic materials shall be used. The flow direction shall be given on the body of system strainers.

System strainers shall be installed in each water supply connection. It shall be possible to take out the sieve and the dirt particles of system strainers without having to remove the strainer housing.

All parts shall be constructed in such a way that wrong mounting will be obvious. The rated working pressure shall be equal to the system operating pressure, with a minimum of 12,5 bar. Strainers shall be designed in such a way that spheres with a diameter of more than 0,8 times of the minimum nozzle waterway dimension cannot pass the strainer.

Nozzles with waterways that cannot be passed by a 4 mm sphere shall be equipped with upstream strainers. These strainers shall be designed to prevent any particles carried in the discharge pipework from clogging the discharge orifices. The total area of openings from the nozzle strainer shall be enough to allow the clogging test in accordance with annex C to be successfully fulfilled.

The free flow through the range pipe shall not be obstructed by the strainers of nozzles installed directly into a pipe fitting, i.e. no part of the strainer shall protrude into that pipe.

If the nozzle strainer is projecting from the nozzle inlet into the pipe fitting, the design shall be such, that a sphere with a diameter of 3 mm can pass the waterways between the inner surface of the pipe fitting and the outer surface of the strainer.

The pressure loss of the strainer shall be taken into account during hydraulic calculation.

7.9 Water supply components.

The components of low pressure systems shall be in accordance with EN 12259. The components of systems with higher pressure shall fulfil the same safety level as given in EN 12259.

Pressure vessels, vessels with external expelling gas, and pumps shall be:

a) the suitable metal alloy or composite material to provide adequate protection against corrosion and sludge development,

b) shall be conform to withstand the design pressure in accordance with the European Pressure Equipment Directive,

c) shall be compatible with the specific watermist system as proven by the performance standard outlined in the test procedures in the annex, or by a functional acceptance test.

7.10 Detection and activation

The components of the system shall comply with the relevant parts of EN 54 and/or EN 12094-1.

8 Water supply, including additives

8.1 General

The water supply can be based on either potable or sea water. If sea water is used, provisions shall be made to allow a thorough flushing of the system piping with fresh water after a functioning. If sea water is used for a closed head system, provision shall be made to precharge the system with fresh water.

The water supply can be from a connection with the public water distribution system taking into account the requirements and restrictions from the Water Distribution Authorities.

The water supply can be from an automatic starting fire pump. The fire pump installation should be in accordance with EN 12845.

The water supply can be also from a pressurized container. The installation of the pressurized container should be in accordance with EN 12845.

8.2 Water quality

Water used in watermist systems should be the equivalent of a potable supply with respect to particulate impurities and dissolved gases.

The water shall be free from fibrous or other matter in suspension liable to cause accumulations in the system piping. Salt or brackish water shall not be retained in installation pipework.

8.3 Additives

8.3.1 General

A watermist system shall be considered a system with additives when components other than those normally present in fresh water are added to the water in significant percentages as specified by the manufacturer. Systems using sea water as emergency supply shall not be considered as systems with additives.

Additives can be used in watermist systems for various reasons including the followings:

— preventing freezing in containers and system piping (wet systems);

— preventing water/container deterioration;

— preventing corrosion;

— enhancing fire suppression capabilities.

8.3.2 Identification

Watermist using additives shall be clearly identified by means of container labels, if applicable, and by including Material Safety Data Sheet of the additive in the system manual. The effects of the additive shall be explained in the system manual.

8.3.3 Safety requirements

Watermist systems using additives shall not be used in occupied areas unless they have been evaluated to be safe for human exposure at the maximum concentration of the additive that can be reached upon system discharge. Evaluation shall include skin irritation, eye irritation and acute toxicity on human beings.

8.3.4 Listing in the manufacturer's manual

All systems using additives, whichever the reason, shall be tested and listed in the manufacturer's manual with the specific type of additive used in the specific concentration; whereas a method of mixing the additive with water is used, the system of mixing shall also be part of the listing.

The listing shall be based on test results.

8.3.5 Additives enhancing fire suppression capabilities

Systems using additives to enhance fire suppression capability shall have a supply of additive sufficient to cover at least the same duration as manufacturer has used in the test, which gives the design criteria in each case.

8.4 Duration

8.4.1 General

Table 2 shows the minimum discharge duration.

Table 2 — Minimum discharge duration

Systems	Duration	Fire tests in accordance with
Extinguishing systems	Spaces, where fires can be fought manually within 5 min: Discharge duration at least twice the extinguishment time in the relevant fire tests, minimum 5 min, unless otherwise specified in the relevant test procedure. *Other spaces:* Discharge duration to prevent re-ignition, at least twice the duration required for before mentioned spaces, minimum 10 min, unless otherwise specified in the relevant test procedure	Annex B
Suppression and control systems	Minimum capacity for the duration 30 min/60 min depending on the risk.	to be completed

NOTE Intermittent systems shall repeat the discharge sequence throughout the required discharge duration.

Water supplies shall be capable of furnishing automatically at least the requisite pressure/flow conditions of the system. The water supply shall be used only for the fire protection system. Each water supply shall have sufficient capacity for the case specified below:

8.4.2 Self-contained systems

Self-contained accumulator systems in unmonitored spaces and/or spaces with delayed access shall automatically generate a second full discharge within the required minimum given above.

8.5 Continuity

8.5.1 General

All practical steps shall be taken to ensure the continuity and reliability of water supplies. A water supply shall not be affected by possible frost conditions or drought or flooding or any other conditions that could reduce the flow or effective capacity or render the supply inoperative, including tampering.

NOTE Water supplies should preferably be under the control of the user, or else the reliability and right of use should be guaranteed by the designated organisation having control.

8.5.2 Frost protection

The stored water and the feed pipe and the control valve set shall be maintained at a minimum temperature of 4 °C. If this is not possible , measures have to be taken to ensure that the frost has no adverse effects on the system reliability, e.g. via acceptable additives.

8.5.3 Housing of equipment for water supplies

Water supply equipment, such as pumps, pressure tanks and gravity tanks, shall not be housed in buildings or sections of premises in which there are hazardous processes or explosion hazards. The water supplies, stop valves and control valves shall be installed such that they are safely accessible even in a fire situation. All components of the water supplies and control valve sets shall be installed such that they are secured against tampering and are adequately protected against freezing. Local application water supplies shall be installed outside hazardous areas.

8.6 Maximum and minimum water pressure

The maximum and minimum pressure of the water supply shall be within the approved limits of pressure for the nozzles specified by the manufacturer in consideration of the static pressure difference and the pipe hydraulic pressure loss.

8.7 Test devices

8.7.1 Self-contained systems

Self-contained systems shall be equipped with means to test the bottle valves unless the system can be tested via full discharge tests.

They shall be equipped with a means to permanently check the pressure or weight of pressurized bottles. They shall be equipped with means to check the water content.

8.7.2 Pump and town main supplied systems

Watermist installations shall be permanently provided with devices for measuring pressure and flow. At least one suitable flow and pressure measuring arrangement shall be permanently installed and shall be capable of checking each water supply. The testing apparatus shall be of adequate capacity and shall be installed in accordance with the supplier's instructions. Each supply to the installation shall be tested independently with all other supplies isolated.

NOTE See 6.7 for a typical layout.

8.8 Type of water supply

The choice of the water supply depends on the necessary reliability of the system. The choice of the kind of water supply depends on the protection criteria and risk which is protected. For special hazards, or a high degree of protection e.g. personal safety a water supply with higher reliability is required.

The intention of the following table is to give some guideline for the necessary water supply. The choice of the water supply should be based on the risk analysis of the area to be protected, see Table 3.

Table 3 — *Guidance on the minimum choice of water supply*

Type of water supply		Application		
		Life safety	Property Protection	
			Critical risk	High risk
Direct connection to water networks (including town mains)	Single feed	-	-	X
	Double feed	X(M)	X	X
Pressurised gas/water tank or cylinder system		X(M)(S)	X(M)(S)	X
Gravity tank		X(M)	X	X
1 pump and 1 tank		-	-	X(M)
Multiple pumps and 1 tank		-	-	X(M)
1 pump and 1 reserve pump and 1 or 2 tanks		X(M)	X(M)	X
Multiple pumps and 1 reserve pump and 1 or 2 tanks		X(M)	X(M)	X
2 pumps and 2 tanks, each with an actuation circuit		X(M)	X(M)	X
Multiple pumps and 2 tanks, each with multiple activation circuits		X(M)	X(M)	X

NOTE 1 M indicating mandatory monitoring with alarm (electrical pump: power available (all phases), pump on demand, pump running, start failure; diesel pump (additionally: battery and engine data); water networks (sufficient pressure); gravity tank: water level. The alarm shall be transmitted to a permanently manned station.

NOTE 2 S indicating redundant means for the electrical actuation and for the mechanical actuation (moving parts) shall be provided. This may be done by doubling the pilot battery

NOTE 3 The determination of the critical and high risk shall be determined by the owner or by the designated authorities. This standard does not address domestic occupancies or similar small occupancies as life safety occupancies.

NOTE 4 X means that the requirement is mandatory.

8.9 Pressurization systems

8.9.1 General

Pumps used in watermist systems are usually of centrifugal or positive displacement type. Centrifugal pumps are used in low pressure and medium pressure systems, whereas positive displacement pumps are used in medium and high pressure systems.

8.9.2 Centrifugal pumps

Centrifugal pumpsets shall be designed and installed in accordance with the requirements of EN 12845.

8.9.3 Positive displacement pumps

NOTE 1 Positive displacement pumps are piston pumps and, hence, the flow and pressure characteristics are quite different than those of a centrifugal pump. In contrast to the centrifugal pump, the flow rate of a positive displacement pump does not depend on system back pressure but is proportional only to pump speed.

NOTE 2 Certain system features, such as the electrical power supply connections, location and sizing of circuit breakers, and supervision, are similar to conventional fire pump installations. The pump itself should meet the requirements of technical standards, e.g. EN ISO 14847.

Pumps shall be fitted with pressure relief valves and flow by-pass arrangements in order to avoid damage to the pump and system.

8.9.4 Cylinders and storage tanks

High pressure containers or cylinders shall be constructed, tested, and marked in accordance with recognised, International Standards for seamless steel cylinders. Charged cylinders shall be tested for tightness before shipment in accordance with an approved procedure.

Where manifolded, cylinders shall be mounted and supported in a rack provided for this purpose, including facilities for convenient, individual servicing or weighing of contents. When any cylinder is removed for maintenance, means shall be provided to prevent leakage from the manifold if the system is operated.

Storage temperatures shall be maintained within the range specified by the manufacturer. External heating or cooling shall be an approved method to keep the temperature of the storage container within desired ranges.

Containers shall be secured with supports to prevent container movement and possible physical damage.

When the storage container(s) is placed in the hazard area being protected, provisions should be made to ensure that the system operation is not adversely affected by its location.

The relevant regulations of the Pressure Equipment Directive and its related standards shall be applied. For low pressure storage tanks the relevant clauses of EN 12845 shall be applied.

Pressure tanks and cylinders shall be internally protected against corrosion.

8.9.5 Pump systems

NOTE Pump systems are divided normally in the following parts:

- Pumps
- Drivers
- Tank
- Main town connection
- Jockey
- Controller.

8.9.5.1 Pumps

Pumps supplying watermist systems shall be automatically controlled. Pumps supplying watermist systems shall be of sufficient capacity (flow and pressure) to meet the requirements for the system supply.

Pumps capable to over pressurising the system shall be provided with approved means of pressure relief to prevent excessive increase in pressure. Overpressure shall not exceed the working pressure of any component that may be in contact with water. *Pressure relief valve shall be able to circulate the total amount* of flow giving by the pumps at system component maximum working pressure..

Water flow driving through the pressure relief valve shall never be directed back to the pump suction line in order to prevent heating of the water. Flow may be directed back to the tank or to the drainage line of the system.

Pumps shall be equipped with a test fitting or hose outlet on the discharge side of the pump in order to test flow rate and the developed pressure.

All valves of the pump system that may alter correct functioning of the system shall give signal of its position (closed/opened) or at least shall be of locked position.

Pump inlet shall be provide with vacuum/pressure pressure gauge and pump outlet shall be provided with a pressure gauge.

Non return valve rated for the system pressure shall be installed in the pump outlet port.

8.9.5.2 Drivers

Drivers shall be designed in order to supply the maximum power requirement of the pump.

Dual-drive pump units shall not be used.

8.9.5.3 Tanks

Water tanks shall be supervised for the following conditions:

a) water level;

b) water temperature (for tanks located in unheated areas).

Tanks shall be provided with a drain valve and an overflow outlet.

A valve shall be placed at the outlet of the tank, between tank and pumps, for maintenance purposes.

Tanks shall be provided with some venting to atmosphere to avoid over/under pressure.

NOTE It is not applied to pressurised tanks.

This venting shall include a screen to avoid particles.

Tank shall include a name plate with volume and liquid contained.

8.9.5.4 Connections to water networks

Connection to water networks shall be provided with a strainer.

The connection to the water network shall have a capacity to provide the maximum system demand at the minimum pressure required. For design purposes, only up to 85 % of the residual pressure shall be assumed at the required flow rate.

Local or national regulations for the direct connections to public water networks shall be applied.

8.9.5.5 Jockey pumps

Jockey pumps shall be able to supply the system with a pressure high enough to open an activated automatic nozzle.

A jockey pump shall be dimensioned in such way that it cannot supply enough water to the smallest and/or most remote nozzle at jockey pump pressure. In case of bulb breakage the jockey pump flow shall not be able to supply the flow that the smallest nozzle installed needs. in order to get the main pump(s) started unless the pressure developed by the jockey pump is equal to the nozzle operating pressure.

A test valve shall be provided for test purposes at the jockey pump outlet. Some protection devices, e.g. non-return valve shall be installed between the jockey pump and the pipe system to avoid breakage of the jockey pump due to the main pump operation controller.

Pumps shall start automatically upon system actuation. Manual activation system shall be provided.

8.9.5.6 Monitoring.

Monitoring shall include the following:

a) Electric pumpsets with

   1) Pump running

   2) Loss of power

   3) Phase reversal

   4) Controller not in automatic position

   5) Running meter (hours of operation per pump)

b) Diesel-driven pumps with

   1) Pump running

   2) Power failure

   3) Controller not in automatic position

   4) Low oil pressure

   5) High water temperature

   6) Failure to start/overcrank

   7) Over speed

   8) Fuel level (set at 75 % capacity).

9 Acceptance tests and maintenance

9.1 Acceptance test

9.1.1 Scope

This section sets out the minimum requirements for the acceptance of the watermist firefighting system.

9.1.2 Criteria for acceptance

The completed system shall be commissioned in accordance with at least the following not limited to:

— Validation that the pipework are cleaned and free of swarf and debris.

— Check of completed system against approved documentation, with the physical verification of protected risk system design, site conditions and risk limitations.

— *Perform a full functional check of the system subsequent verification of all required output, operational* and alarming functions. In case of automatic detectors in accordance with EN 54 there shall be a check by activating every individual detector.

The performance of the completed watermist system shall be proven by the following:

— All pipework/hoses shall be hydraulically/pneumatically tested to 1,5 times the rated working pressure for 2 h. Loss verification may be done by pressure gauge or visibly on the system.

During pneumatic pressure testing appropriate safety rules shall be followed in order to avoid any risk to people around the test area.

— Watermist system test shall be carried out either by

  — a full discharge test, with recording of system and supply pressure, performance observation, or by

  — a validation of pressure and flow of the water supply and free passage to all watermist nozzles by utilising alternative ways, provided this is allowed by the authority having jurisdiction.

On completion of the acceptance procedure, a certificate of compliance shall be submitted by the installer/supplier.

9.1.3 Third party acceptance of watermist systems

The completed system(s) shall be reviewed and tested by competent personnel to meet the acceptance of the authority having jurisdiction. These competent personnel shall confirm that listed equipment and devices have been used in the system where required by this Standard. To determine that the system has been properly installed and functions as specified, the installer shall:

— notify the authority having jurisdiction and the owner's representative of the time and date testing is to be performed; and

— perform all the required acceptance tests.

9.1.4 Commissioning certificate

The installer of the system shall provide the user with the commissioning certificate containing the following (see also 6.14.1):

— results of the hydrostatic testing;

— that the necessary flushing and cleaning operations have been conducted so that pipe work are free of swarf and debris that could cause the nozzles to block;

— results of the functional tests.

9.1.5 Inspection, maintenance and training

9.1.5.1 Inspection

At least annually, or more frequently as required by the authority, all systems shall be thoroughly inspected and tested for proper operation by competent independent personnel.

The inspection report with recommendations shall be filed with the owner.

9.2 Maintenance

9.2.1 General

The maintenance shall be in accordance with the manual of the manufacturer. At least the system shall be maintained in accordance with the manufacturer's instructions by a company authorised by the manufacturer.

9.2.2 User's program of inspection

The installer shall provide the user with an inspection program for the system and components in accordance with the manufacturer's manual. The Program shall include instruction on the action to be taken in respect of faults.

NOTE The user's inspection program is intended to detect faults at an early stage to allow rectification before the system may have to operate. A suitable program for the weekly routine includes the following:

— visual check of the hazard

— visual check of the control panel

— water and gas pressure gauges

— water levels in open storage tanks

— correct position of all main stop valves

— automatic pump starting

— alarm transmission connection

— trace heating and localized heating systems.

The manufacturer's manual shall include the above mentioned points as a minimum.

9.2.3 Training

All persons who may be expected to inspect, test, maintain, or operate fire extinguishing systems shall be trained and kept adequately trained in the functions they are expected to perform. Personnel working in an enclosure protected by watermist shall receive training in the operation and use of the system, and regarding safety issues.

Annex A
(normative)

Test procedures

A.1 General procedures

The diagrams in Figures A.1 and A.2 show the general procedure to figure out the important test and design parameters.

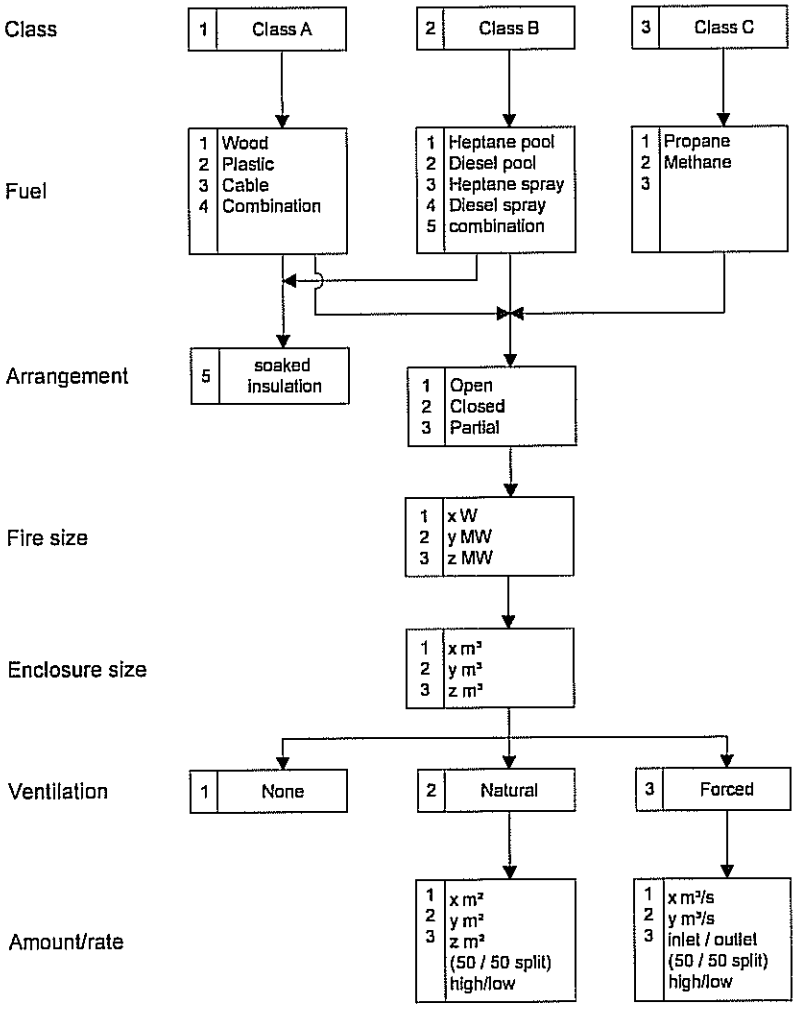


Figure A.1 — Test parameters

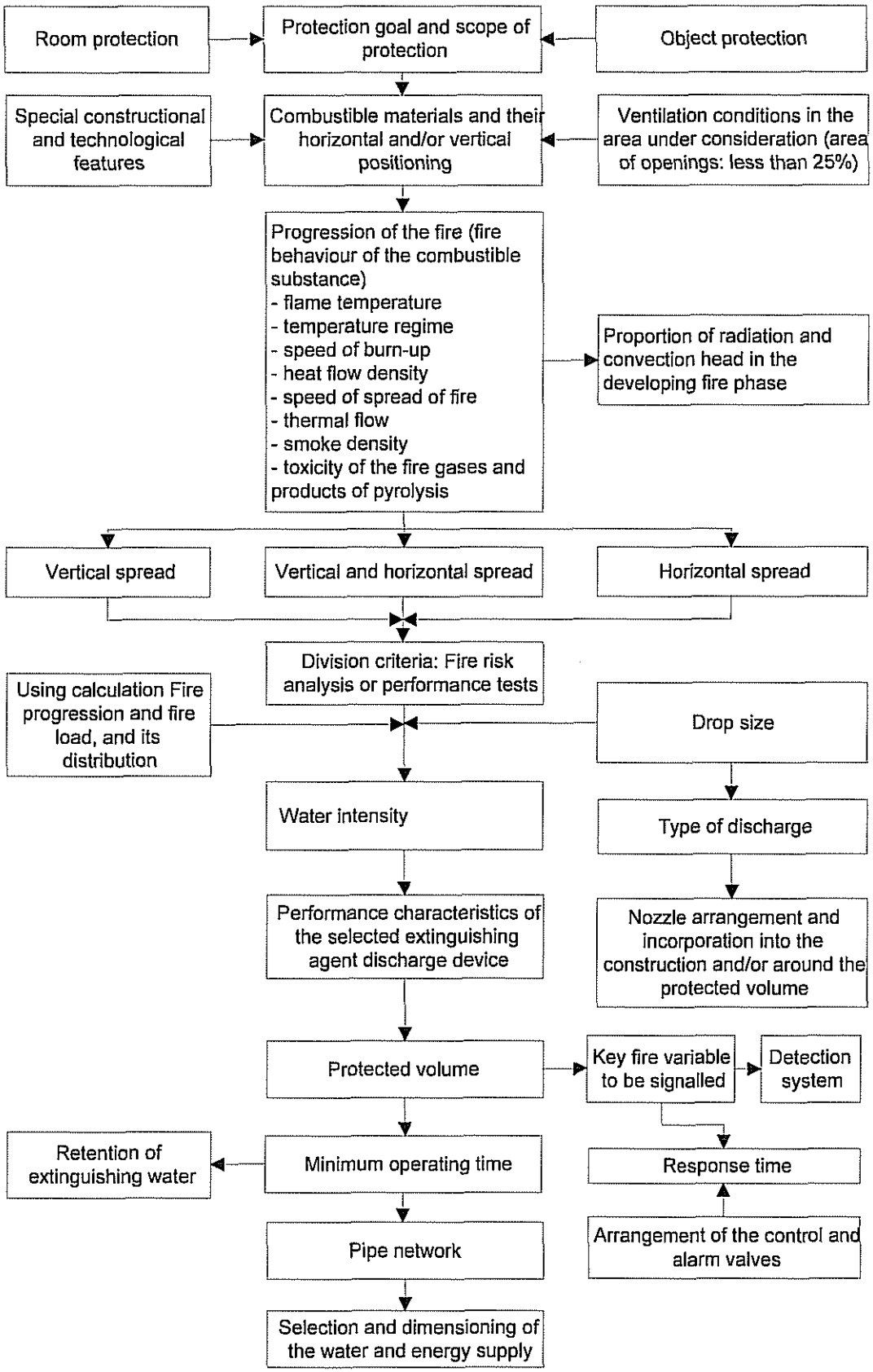


Figure A.2 — Design parameters

A.2 Content of a test report

The test report shall include at least the following:

a) Title of the test

a) Purpose

b) Test configuration

c) Class

d) Fuel

e) Type amount, configuration,

f) Arrangement

   1) Open – direct impingement of spray possible

   2) Obscured – no direct impingement possible

   3) Partial – partial obscuration i.e. mesh walkways etc.

g) Fire size

h) Enclosure

i) Ventilation

   1) Natural

   2) Vent area

   3) 50/50 split high/low

   4) x m^2

   5) Ventilation rate

   6) Forced

   7) 50/50 split high/low

   8) y m^3/s

   9) Ventilation amount

j) Carrying out the test

   — pre-burn, initiation, duration etc.

k) Description of test apparatus

l) Description of measuring equipment

m) Pass/fail criteria

1) Extinguishment, suppression, or control

2) Speed of operation

3) Time to achieve extinguishment, suppression, or control

4) Duration of suppression or control

5) Amount of water used (flow rate and total quantity)

6) Degree of enclosure cooling achieved

7) Degree of item cooling achieved

8) Extent of damage

9) Prevention of re-ignition

n) Test report

1) Name and address of test laboratory

2) Layout of nozzles and pipework

3) Type of nozzles

4) Control devices

5) Flows and pressures

6) Conclusions?

o) Extrapolation, e.g.:

1) Type of hazard

2) Minimum and maximum spacing between nozzles

3) Distance from walls and other obstructions

4) Distance to the risk

5) Height below ceilings

6) Air velocity.

A.3 Test procedure for flammable liquids (control and suppression systems)

A.3.1 General

This test procedure is intended for evaluating the fire performance of watermist fire protection systems intended for the protection of industrial flammable liquid hazards. Examples of such hazards include stationary combustion engines (reciprocating of gas turbine engines); processes involving flammable liquids at atmospheric pressure, such as dipping, electrostatic coating and cleaning processes; processes handling flammable liquids above atmospheric pressure, such as hydraulic fluid systems and cutting oil systems. Typical fire scenarios in these hazards include pool and spray fires of flammable liquids.

This test procedure is not applicable to storage (e.g. palletized or in rack) of flammable liquids. This procedure is only applicable to minimum test volumes of 100 m^3.

The fire performance of volume protection systems shall not depend on the relative positioning of the watermist nozzles and the fire hazard.

The installation criteria of the object protection systems shall always include the distance from the nozzles to the fire hazard.

The performance of the object protection system may be enhanced by a limited test volume encapsulating the test set-up. This shall be reflected as similar enclosure requirements applying to the installations.

The criteria of the fire test are extinguishment but the systems are classified as control/suppression systems because of the installation variables (test procedures for extinguishing systems are under development).

A.3.2 *Test procedure for volume protection compartment systems (control and suppression systems)*

A.3.2.1 Scope

This test method is applicable for water-based firefighting systems. The test method is intended for watermist nozzles mounted on the ceiling or along the perimeters of the enclosure. Watermist nozzles shall be installed to protect the entire hazard volume.

In actual installations, the nozzle configuration shall reflect the one used in the tests. Zoned activation is permitted. The installation specification provided by the manufacturer shall include at least:

— minimum system pressure

— maximum system pressure

— maximum nozzle spacing

— minimum nozzle spacing

— maximum enclosure height

— maximum enclosure volume

— maximum size of ventilation opening

— minimum closed-cup flashpoint of flammable liquids in the protected space

— maximum degree of obstruction between the fires and the watermist nozzles

— the need for additional local application systems for areas of high hazard inside the enclosure

— allowable openings and their locations

— nozzle locations and positioning

— detection and activation time

— use of additives

— obstacles.

A.3.2.2 The test set-up

The test enclosure shall be made of non-combustible materials. The floor area, the ceiling height and the maximum size of the ventilation opening of the enclosure shall be specified by the manufacturer. These shall be considered as maximum values for installations, unless a validated method for extrapolating test data can be provided.

A square-shaped steel plate, with a nominal thickness of 5 mm, measuring X m × X m (minimum 1 m × 1 m, maximum to be specified by the manufacturer), shall be positioned at 1,5 m height above floor level. If the manufacturer does not specify additional ceiling nozzles to be installed below obstructions, a second test with the steel plate at 1,0 m below the nozzles shall be conducted. The value of X shall be specified by the manufacturer. In addition, the manufacturer may specify permissible obstructions (such as beams, columns or HVAC ducts) and their relative positioning to the nozzles, which shall be used in the fire tests.

A single fuel type shall be used for the tests. The fuel shall be chosen by the manufacturer. The hazards protected may involve fuels with a similar or higher closed-cup flash point than used in the fire test.

The method of activation shall be specified by the manufacturer and shall be verified by the authorities. The mode of operation shall be specified by the manufacturer and shall be used in the tests.

A.3.2.3 The test method

A.3.2.3.1 Fire test 1 – small pool fire

a) Test fire

A square-shaped 0,5 m^2 pool fire located on the floor, centrally under the steel plates; the plates shall be positioned either under one or between four nozzles, choosing the location of smaller water discharge density at the fire location.

b) Fuel

Diesel oil or heptane

c) Preburn time

— Fire test 1a: 20 s

— Fire test 1b: 120 s

d) Criteria

1) The fire shall be extinguished within 15 min from system activation

2) There shall be no reignition within 30 min from system activation

3) The average gas temperature shall remain below 100 °C after 3 min from system activation. The average temperature is the average of two gas temperature measurements performed at 3 m horizontal distance from the pool centre, one at 2 m above the floor and the other 1 m below the ceiling.

A.3.2.3.2 Fire test 2 – small spray fire

a) Test fire

A horizontal spray positioned 1,0 m above the floor under the steel plate. The distance along the spray axis from the table edge to the fuel spray nozzle shall be 1/3 times X; the distance perpendicular to the spray axis from the table edge to the fuel spray nozzle shall be ½ times X (where X is the side length of the table). The

fuel spray shall have a nominal fuel pressure of 8,5 bar, and the spray nozzle shall be of the wide spray angle (80), full cone type. The fuel flow rate shall be (0,03 ± 0,005) kg/s.

b) Fuel: diesel oil or heptane

c) Preburn time: 20 s

d) *Criteria:*

1) The fire shall be extinguished within 15 min from system activation

2) There shall be no re-ignition within 30 min from system activation

3) The average gas temperature shall remain below 100 °C after 3 min from system activation. The average temperature is the average of two gas temperature measurements performed at 3 m horizontal distance from the pool centre, one at 2 m above the floor and the other 1 m below the ceiling.

A.3.2.3.3 Fire test 3 – effect of fire location

The most difficult of fire tests 1a, 1b and 2 shall be repeated by changing the location of the obstructed fire to either under one nozzle or to between four nozzles.

A.3.2.3.4 Fire test 4 – large pool fire

a) Test fire:

— for enclosure volume < 250 m^3: a square-shaped 2 m^2 shielded pool fire located on the floor, centrally under the steel plate; during the preburn, the enclosure shall be ventilated through a vertical rectangular door of measures 1 m × 2 m (width × height); in the beginning of system discharge, the specified ventilation condition has to be arranged

— volume ≥ 250 m^3: a square-shaped 4 m^2 shielded pool fire located centrally under the steel plate; during the preburn, the enclosure shall be ventilated through a vertical rectangular door of measures 2 m × 2 m (width × height); in the beginning of system discharge, the specified ventilation condition has to be arranged.

The location of the pool shall correspond to the most difficult location encountered in fire tests 1 to 3.

b) Fuel: diesel oil or heptane

c) preburn time

— Fire test 4a: 20 s

— Fire test 4b: 120 s

d) Criteria:

1) The fire shall be extinguished within 15 min from system activation

2) There shall be no re-ignition within 30 min from system activation

3) The average gas temperature shall remain below 100 °C after 3 min from system activation. The average temperature is the average of two gas temperature measurements performed at 3 m horizontal distance from the pool centre, one at 2 m above the floor and the other 1 m below the ceiling.

The fire performance of the system is deemed adequate if all criteria are met in all tests. Additional local application systems for areas of high hazard are required if the extinguishment time of one or more fires is longer than 15 min but less than 30 min, and all other criteria are met.

Additional criteria (for all fire tests) may be applied if required by the installation. Examples of such criteria are:

— maximum surface temperatures or maximum heating/cooling rates of chosen constructions,

— maximum gas temperatures at chosen locations,

— maximum allowed concentrations of toxic gases,

— minimum allowed concentration of oxygen,

— maximum pressure difference between the inside and the outside of the enclosure

A.4 Fire test procedure for cable tunnels

A.4.1 Scope

This test procedure is only applicable to mainly horizontal (max. 10°) cable tunnels.

NOTE Horizontal cable tunnels relates to the orientation of the tunnel, not of the cable orientation.

This test procedure does not include testing of the function of the cable.

The test procedure is applicable to systems only, where the manufacturer's design manual considers the following principles:

Along the length of a cable gallery of more than 60 m sectioning will be reasonable.

If the sections are separated by a constructed fire-barrier of REI 90 (according to EN 13501-1) the water supply and water storage has to be designed for a simultaneous release of one section only.

If the sectioning is done virtually (no existing fire barrier between the sections) the water supply and water storage has to be designed for a simultaneous release of up to two sections. In case of virtual sectioning particular attention shall be given to the choice of the detection system with specific consideration of the maximal possible wind speed inside the cable gallery.

An appropriate test or an approved calculation method taking into account the type of the detection system shall be mandatory in order to prove that the spatial resolution of the detection system relative to the section length is satisfying.

The detection system is not part of the scope of the system.

A.4.2 Purpose

This test procedure describes the requirements and test methods for the application of water mist systems in cable galleries.

A.4.3 Test configuration

A.4.3.1 Fuel

The fire load shall consist of different sized cables. The minimum fire load shall be given by

For bigger fire loads the distribution – percentage of different sizes shall be kept. Cables with bigger diameters shall be preferably positioned in the lower cable trays.

Table A.1 — Cable arrangement describing the minimal fire load

Tray number	Outer diameter mm	Number of cables	Total fire load of isolating material per m [a]	Total metal weight per m [a]	Length [a] m
1 (top)	≤ 12	40			
2	12 to 14	40			
3	14 to 20	40			
4	14 to 20	30			
5	20 to 30	30			
6	20 to 30	15			
7	30 to 40	10			
8 (bottom)	> 40	5			
a To be determined by applicant.					

Arrangements of more cable trays each above the other are up to the applicant.

A.4.3.2 Arrangement

Nozzle or nozzle-head and piping arrangement is up to the applicant as long as the following restrictions are fulfilled:

a) A minimum of 8 cable trays above each other shall be used. The maximum number of cable trays above each other protected per nozzle supply line shall be given in the manufacturers manual.

b) If only a single line of nozzles is to protect cable trays on both sides of the enclosure, if it sufficient to provide loaded cable trays only on one side of the enclosure during testing. On the other side plastic (e.g. PE, PP) cable insulation material shall be provided on otherwise empty trays to prove that the fire does not spread from the source side to the target side.

Tests shall be done both with the minimum and maximum nozzle to tray distances and maximum nozzle spacing.

Nozzles or nozzle-heads and supply lines have to respect an obstacle-free walk way running parallel to the cable trays

The gas burner shall be placed in the middle between two adjacent nozzles (heads).

A.4.3.3 Enclosure

An enclosure is required. The enclosure shall be of non combustible material (class A1 in accordance with EN 13501-1).

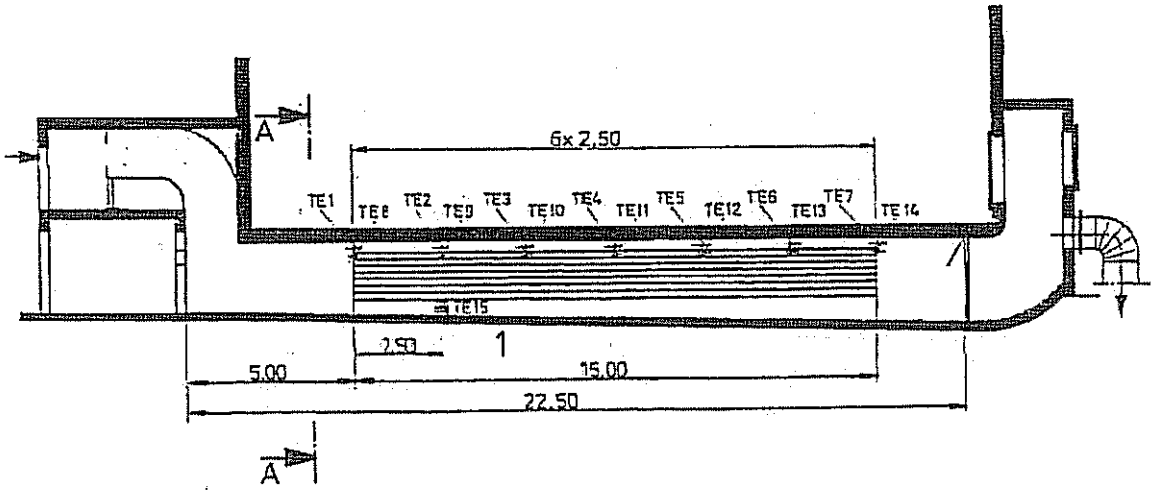
The minimum size of the enclosure shall be as follows:

— Height: Minimum 200 mm above the top tray, but at least 2,75 m.

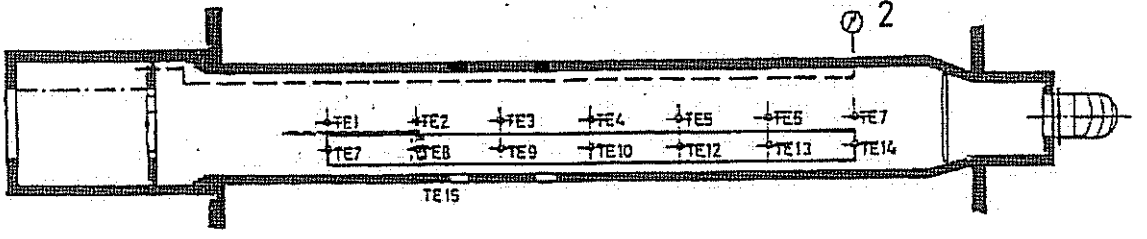
— Length: given by the minimum length of cable trays required to be able to detect at least 0,5 m of unaffected cables at both ends plus 2 m at the side of air entrance and one meter at the side of air outlet. All machinery needed to establish the ventilation shall be placed outside of the above described minimum length.

— Width: Minimum 1 600 mm.

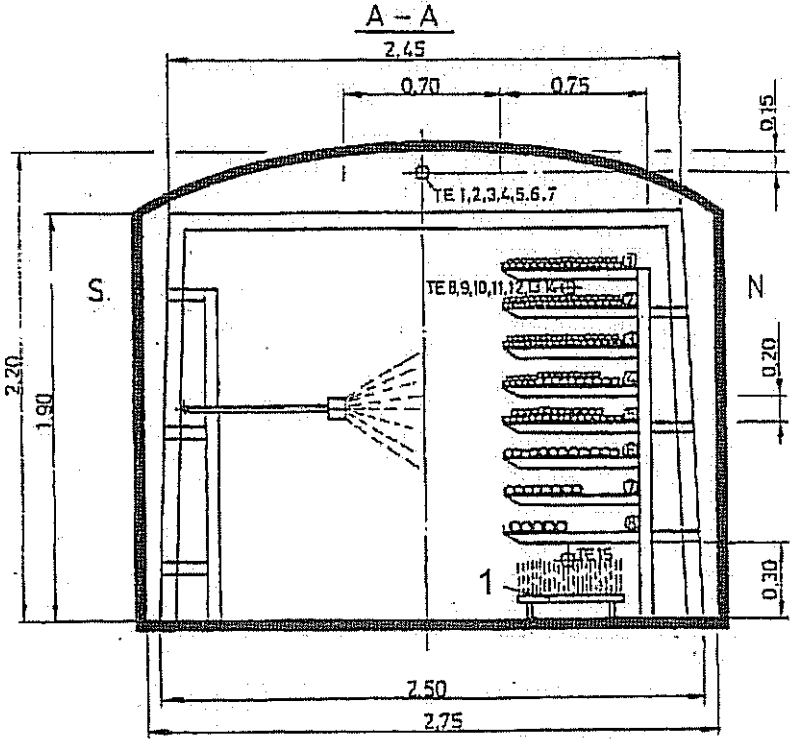
Examples are given in Figure A.3.



a) Side view



b) top view



c) front view

Key TE thermocouple 1 Gas burner 2 Pressure device

Figure A.3 — Example for minimum dimensions of the fire test room with the arrangement of cable trays and watermist nozzles

A.4.3.4 Ventilation

All tests shall be carried out under a forced ventilation of at least 1 m/s longitudinal ventilation.

The ventilation shall be adjusted to the chosen value before the fire tests start and shall be kept constant during the performance of the fire test.

Performing the tests under higher wind velocities is up to the applicant.

Testing under forced ventilation does not mean that the ventilation system does not have to be shut off in the real installation. This requirement as specified in 6.10 is still valid.

A.4.3.5 Carrying out the test

A.4.3.5.1 General

The pre-burn time shall be 5 min. During these 5 min a 250 kW gas burner shall be placed on the floor underneath the cable trays and shall be constantly burning. After these 5 min the gas burner shall be turned off.

A.4.3.5.2 Carrying out the test with an automatic fire alarm system

The release of the water mist system shall take place 5 min after ignition

A.4.3.5.3 Carrying out the test without any fire alarm system (manual releases system)

After the 15 min pre-burn time the water mist system shall be released.

A reference test of the worst configuration shall be conducted.

A.4.4 Description of test apparatus

The cable trays shall be of non combustible material (class A1 according to EN 13501-1).

Position of the tray nearest bottom shall be at least 300 mm above floor.

The cable trays shall have a width of at least 600 mm. The use of cable trays with a greater width is up to the applicant.

The vertical distance between two cable trays of one set shall be at least 200 mm.

Horizontal distance between the set of cable trays and the side wall of the enclosure shall be 200 mm.

The test can be carried out either with one set of cable trays on one side of the enclosure or with two sets of cable trays on both sides of the enclosure.

NOTE Specifications for cable trays are under preparation.

A.4.5 Description of measuring equipment

Velocity of wind due to ventilation shall be measured in the middle of the virtual volume of the free space of the walk-way.

A thermocouple shall be placed within the plume of the initiating gas burner and the measured temperature shall be recorded all the test.

Thermocouples shall be placed every 2 m along the cable trays in three lines. For wind velocities up to 2 m/s one line shall be placed in a 100 mm distance underneath the ceiling, one line shall be placed on the top of the set of cables in the second tray from the top. For wind velocities higher than 2 m/s an additional line shall be placed on the top of the set of cables in the fourth tray from the top.

Thermocouples type K (0,5 mm) shall be used. Maximum sampling time shall be 2 s.

NOTE These values are under discussion and will be specified after the CEN enquiry.

The water pressure in the supply line shall be measured and recorded during all the test at a place in the line which is distanced from the supplying apparatus at least as far as the hydraulically most unfavorable nozzle.

The water flow rate shall be measured and recorded during all the test at a place between the supplying apparatus and the first nozzle.

A.4.6 Pass/fail criteria

After 5 min from start of the water spray the 5 s temperature average of all temperatures measured shall be below 100 °C.

After a duration of water spray of 15 min the system shall be turned off. After turning off the system no visible flames and no smoldering fires are allowed. No re-ignition is allowed. The surveillance time for the check of re-ignition shall be at least 15 min. At least 0,5 m of cables at both ends shall be unaffected by the fire.

The water shall be 30 min/60 min depending on the risk, see 8.4.1.

A.4.7 System design and applications covered

Test results are valid for applications which show

— a smaller number of trays,

— less fire loads and plastic insulation material,

— smaller wind velocities,

— smaller heights of enclosure,

— smaller width of enclosure,

— bigger water rates than used in the test,

— higher pressures at the nozzle(head) with the lowest pressure than used in the test,

— cable trays smaller in width,

— vertical distance between two cable adjacent trays greater

as tested.

If the test was performed with one set of cable trays each above the other an extrapolation for two sets of cable trays on both sides of an enclosure is not allowed but has to be considered as two independent single configurations.

Obstacles of non combustible material (e.g. switch gears) on the opposite side of the set of cable trays and not exceeding a maximum depth of 300 mm are covered by the test procedure without further testing provided

those do not encumber the water spray. A mandatory statement that this does not include any protection of the equipment inside the obstacle or to the obstacle itself shall be given to the customer.

A.5 Fire test procedure for office occupancies of Ordinary Hazard Group 1

A.5.1 Introduction

A.5.1.1 Scope

This test method is intended for evaluating the fire performance of water mist systems equivalent to the fire performance of a sprinkler system for office and school occupancies belonging to Ordinary Hazard Group 1, as defined in EN 12845.

The test procedure is applicable to ceiling mounted automatic nozzles to be used in unlimited volumes with a minimum hydraulic demand area of 72 m^2 and a minimum duration in accordance with EN 12845. The test procedure is applicable for horizontal, solid, flat ceilings with heights of 2 m and above, up to the maximum ceiling height tested.

A.5.1.2 General approach

The purpose of the test procedure is to ensure, as a minimum requirement, equivalent level of fire protection for the water mist fire protection systems as compared to traditional sprinkler systems. To this end, fire tests shall be conducted using both a traditional sprinkler system and the tested water mist system.

A relatively realistic office fuel package is employed in the test. As the fuel package is rather complex, the reference testing with a prescribed sprinkler system serves also to indicate the baseline performance at each different test facility and set-up. Thus, when setting up a test series, it is sufficient to replicate the office fuel package as closely as practically possible. However, within one test series, all fuel packages shall be identical (make, type).

A.5.2 Office fuel package

A.5.2.1 General

The office fuel package shall consist of typical office workstations with associated fuel loading. The complex geometry of the fuel package implies both horizontal and vertical spray shielding and substantial potential for fire growth beyond the initial sprinkler operation.

The fuel package consists of the following elements:

— two table plates,

— a padded wooden-frame chair,

— a wooden drawer under one table,

— files, books, a monitor and a keyboard on the table,

— plywood walls surrounding the tables,

— a gas burner and a wood crib for ignition.

The typical masses of the individual components shall be as listed in Table A.2.

NOTE The tolerance of all dimensions is 5 %.

Table A.2 — Office fire load

Combustible material	Item	typical mass kg
Wood	Table plates	56
	Wall panel	30
	Drawer	15
	Chair (frame)	6
Paper	Filed paper	90
	Books	5
	Newspaper	1
Polyether foam	Chair (padding)	1
	Simulated files	1
Electronics	Monitor and keyboard	16

A photograph of a typical fuel package is shown in Figure A.4. Below, each element is described in more detail.

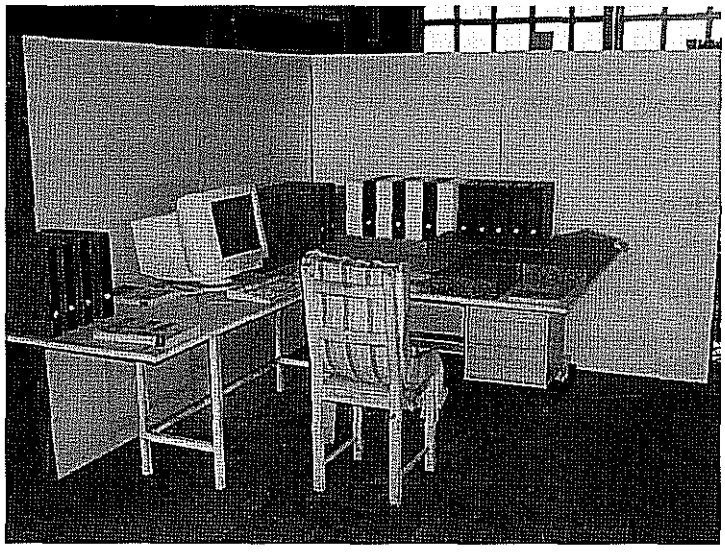


Figure A.4 — An overview of the office fuel package

A.5.2.2 Tables

The tables shall be constructed of two plain uncoated 22 mm thick chipboard plates, one measuring (304 x 76 x 76) cm, the other (152 x 108 x 76) cm, as given in Figure A.5. Also shown in Figure A.5 are the stands to which the table tops shall attached by screws, and the position of the wooden drawer, which also serves to support the table tops.

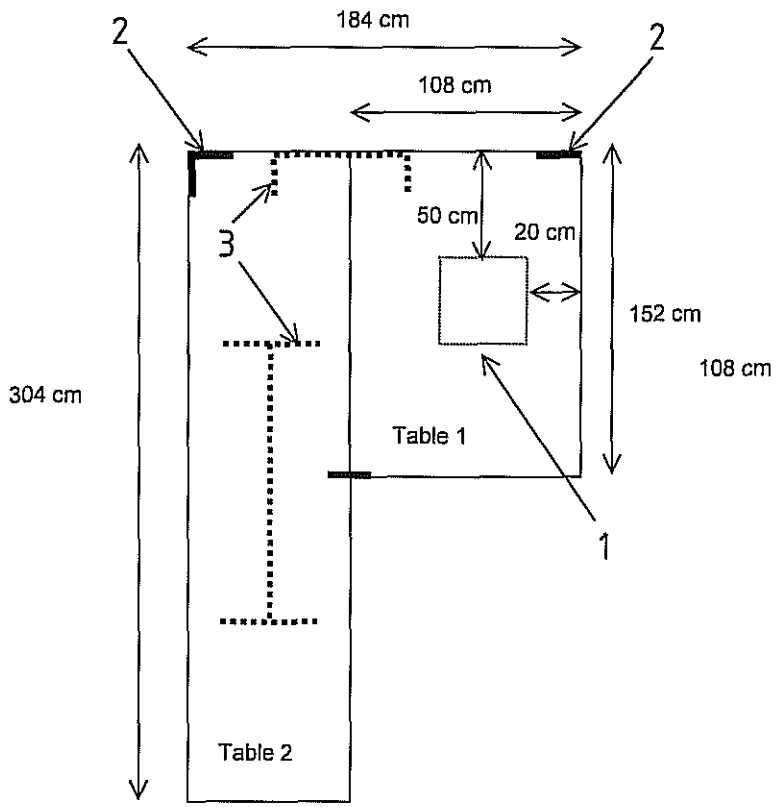


Figure A.5 — A schematic presentation of the table construction

A.5.2.3 Padded chair

The padded wooden chair shall be constructed of a plain wooden chair by attaching to it a (40 x 100) cm piece of cotton-covered polyether foam mattress with screws and washers. The front edge of the chair shall be positioned flush with the edge of table 1, and there shall be a 20 cm gap between the chair and table 2.

The polyether foam and the cotton cover shall as follows:

The mattresses should be made of non-fire retardant polyether and they should have a density of approximately 33 kg/m^3. The cotton fabric should not be fire retardant treated and it should have an area weight of 140 g/m^2 to 180 g/m^2. When tested in accordance with ISO 5660-1, the polyether foam should give results as given in Table A.3. The frame of the bunk beds should be of steel nominally 2 mm thick.

Table A.3 — Cone calorimeter test for foam in accordance with ISO 5660-1

Test conditions	Irradiance: 35 kW/m^2	
	Horizontal Position	
	Sample thickness: 50 mm	
	No frame retainer should be used	
Test results	Time to ignition:	2 s to 6 s
	3 min average Heat release rate HRR, q_{180}:	(270 ± 50) kW/m^2
	Effective heat of combustion:	(28 ± 3) MJ/kg
	Total heat release:	(50 ± 12) MJ/m^2

A.5.2.4 *Wooden drawer*

The drawer shall be made of 20 mm thick veneered chipboard, and have the approximate measures of (40 x 42 x 58) cm and an approximate weight of 14,6 kg. Steel supports shall be mounted to the bottom of the drawer to give the required elevation. The drawers shall be attached centrally 20 cm from the end of the large table by four screws through the top of the table plate.

A.5.2.5 Items on the table

The combustible material on the table shall consist of paper packed in cardboard files, books, simulated plastic files, a computer monitor and a keyboard. The items shall be arranged on the table as shown in Figure A.6. The simulated plastic files shall be of size 30 x 30 x 10 cm, cut out of the polyether foam of the fire test mattresses. A newspaper weighing approximately 900 g shall be placed above the ignition source.

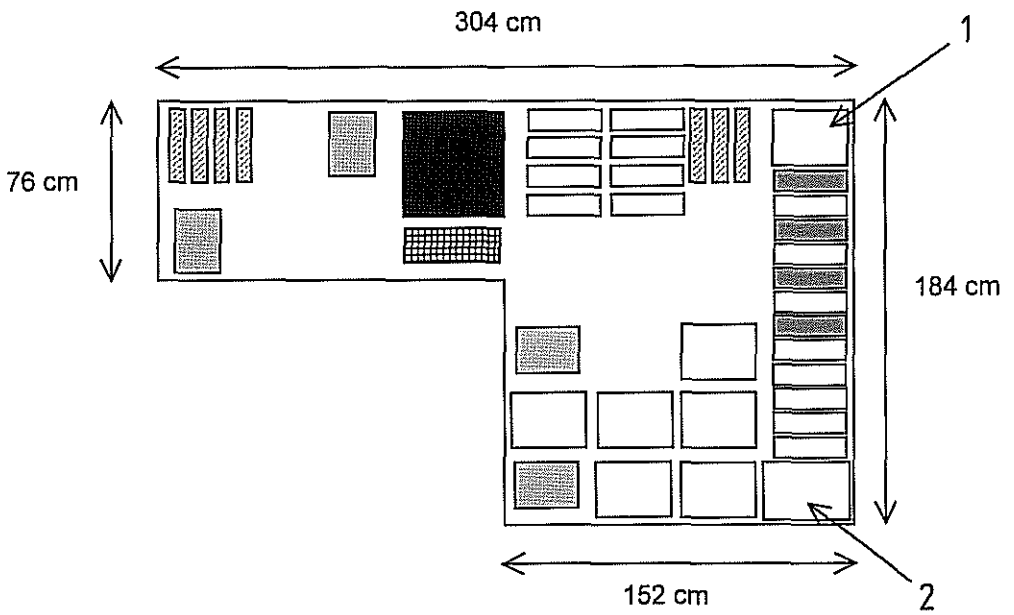


Figure A.6 — Layout of the combustible items on the table

A.5.2.6 Walls

The plywood walls shall stand on the floor and be made of 4 mm thick uncoated plywood panels measuring (125 x 180) cm. Each wall shall extend 250 cm from the corner, and a 10 cm air gap shall be left between the table plate and the wall. The plywood panels shall be attached to solid non-combustible plates, measuring (125 x 180) cm.

A.5.2.7 Conditioning of the fuel load

The fuel package elements should have a normal humidity content prior to the test , as obtained by storage indoor at (20 ± 5) °C for two weeks.

A.5.2.8 The ignition source

The ignition shall be accomplished by a gas burner and a wood crib. The heat release rate of the burner shall be 30 kW. The wood crib shall be made of 16 wood (spruce or fir) sticks measuring (38 x 38 x 250) mm and arranged in four layers of alternating orientation inside a square steel pan of (30 x 30 x 10) cm. 250 ml of heptane shall be poured into the pan to ensure the ignition of the crib. The pan and crib shall be placed on the floor between the drawer and the wall, with the pan edge flush with the drawer edge. A photograph of the ignition arrangement is shown in Figure A.7.

The fire shall be ignited by applying a flame over the gas burner and switching on the gas flow. The burner shall be operated for 300 s, independent of a sprinkler or watermist nozzle activation.

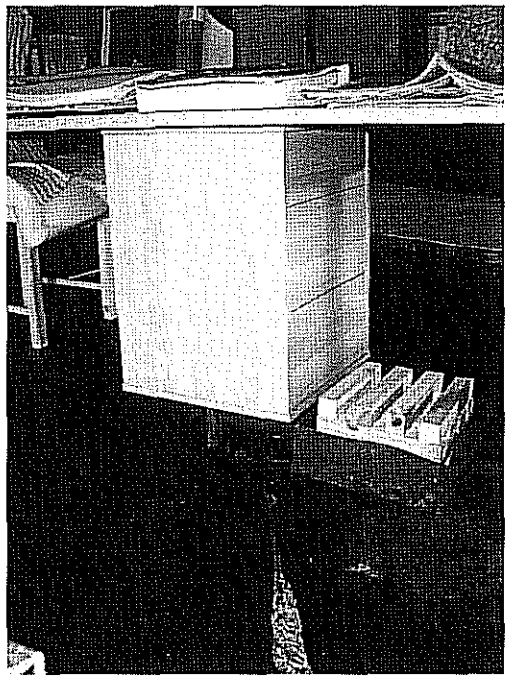


Figure A.7 — The positioning of the gas burner and the wood crib with respect to the drawer

A.5.3 Reference sprinkler system

The sprinkler system used in the reference tests shall be characterised as follows:

— Classification: Ordinary Hazard 1

— Water flux: 5 l/min/m^2

— Protected area per sprinkler: 12 m^2

— Sprinkler arrangement: square grid (3,5 m spacing)

— Sprinkler:

  — Type: pendent spray sprinkler in accordance with EN 12259-1, surface mounted on the ceiling with a flat escutcheon.

  — *Thermal sensitivity: Special response as specified in EN 12845.*

  — Nominal *K* factor: 80

  — Temperature rating: 68 °C.

These values represent the minimum values specified in EN 12845. Should that standard be modified, the specifications listed above shall be modified accordingly.

The water supply shall be capable of supplying a flow rate of at least 300 l/min at an operating pressure of 0,563 bar.

A.5.3.1 Test procedure

A.5.3.1.1 General

The tests with the water mist system shall be conducted at maximum ceiling height, maximum spacing and minimum discharge condition. The system shall be installed in accordance with the manufacturer's installation manual, reflecting the maximum allowed time delay of water pressure build up of the system. An evaluation test of the worst case watermist configuration *shall be conducted* .

A.5.3.1.2 Reference sprinkler tests

The sprinkler system shall be pressurised to be capable of supplying 0,56 bar immediately after operation of the first sprinkler. Upon activation of the first sprinkler, the flowing water pressure shall be maintained at a *system operating pressure of 0,56 bar.*

The water flow shall be shut-off 30 min after the activation of the first sprinkler. Any remaining fire shall be manually extinguished and the fire damages shall be recorded.

A.5.3.1.3 Watermist system tests

The tested system shall either be:

a) Pressurised to its minimum operating pressure specified by the manufacturer. Upon activation of the first nozzle, the flowing water pressure shall be maintained at the minimum system operating pressure for systems using a constant operating pressure. For systems with non constant operating pressure the pressure characteristics used in the test shall resemble the conditions of a real installation when supplying the required 72 m^2 and shall resemble the last 30 min of the operating time of the system.

b) Pressurised to the minimum stand-by pressure specified by the manufacturer. Upon activation of the first nozzle, the flowing water pressure shall be gradually increased to the minimum system operating pressure, specified by the manufacturer. The delay time until the minimum system operating pressure is reached shall correspond to the delay time expected in an actual installation.

The water flow shall be shut-off 30 min after the activation of the first nozzle. Any remaining fire shall be manually extinguished and the fire damages shall be recorded.

A.5.3.1.4 Test arrangement

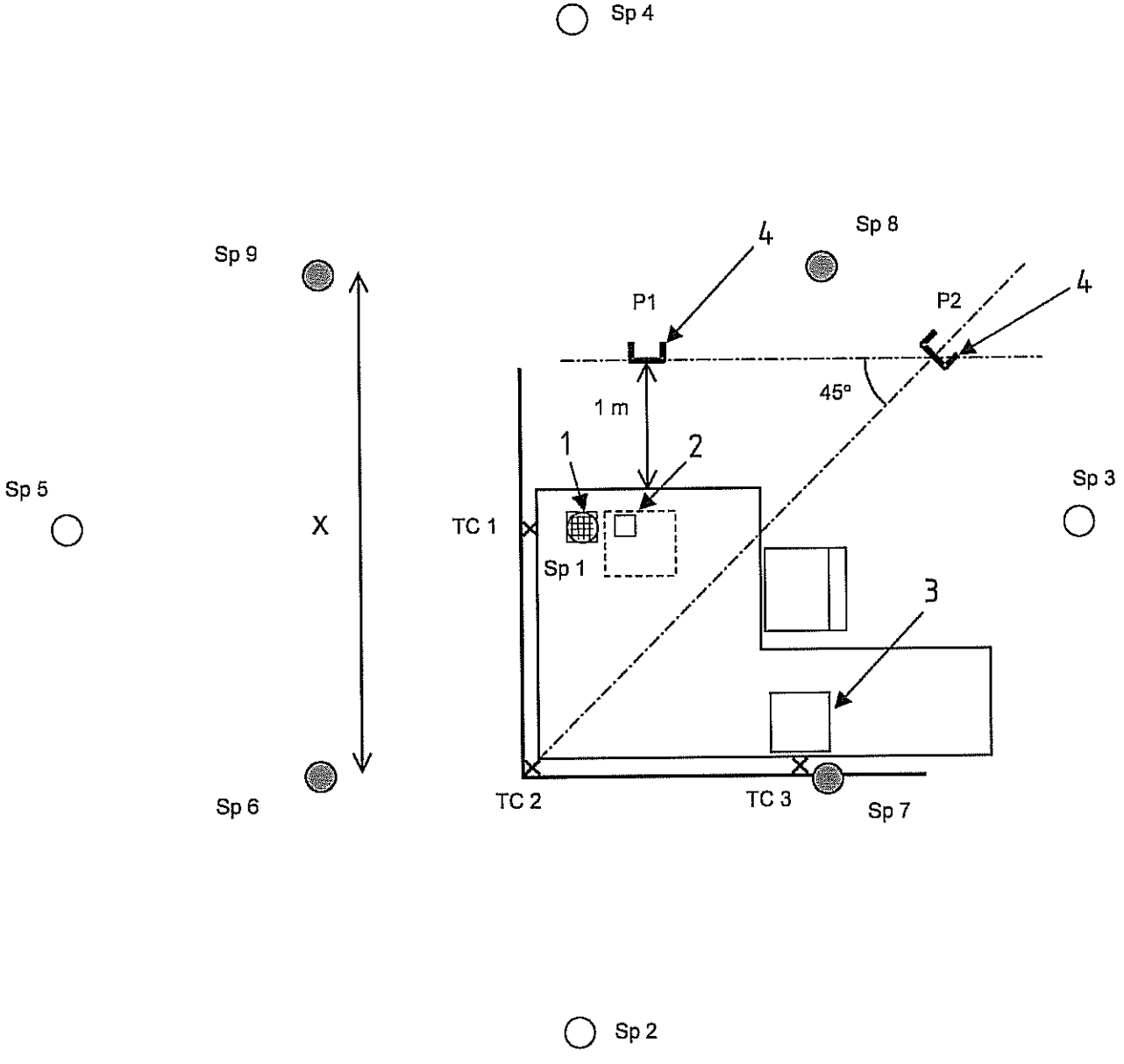
The test programme (see 4.3) shall involve tests with ignitions under one nozzle and between four nozzles. The nozzle grids shall be installed with respect to the fire load as shown in Figure A.8. Nine nozzle locations shall be used, which are denoted as Sp 1 to Sp 9. The location of Sp 1 is fixed and it is directly above the wood crib. The other locations depend on the spacing X, but their symmetry shall be in accordance with Figure A.8.

Minimum test facility requirements, if the system is to be used in rooms with unlimited size: Ceiling area 80 m², minimum 1 m from ceiling rim to test facility wall, sufficient ventilation or space.

If these conditions are not met, the watermist system shall only be installed in rooms with a maximum size equal to the limits of the facility, they are tested in.

For fire tests with ignition under one nozzle, sprinklers shall be installed in locations Sp 1 to Sp 5. For fire tests with ignition between four nozzles, sprinklers shall be installed in locations Sp 6 to SP 9.

The sprinklers shall be installed with their yoke arms parallel to the chair backrest.



Key

1	crib	3	monitor
2	burner	4	plate thermocouple locations
TC	Thermocouple locations	Sp 1 to Sp 5	Ignition under 1 nozzle
		Sp 6 to Sp 9	Ignition between 4 nozzles

Figure A.8 — The arrangement of the nozzle grids, the fire load and the ceiling thermocouples

A.5.3.1.5 Fire tests

The four fire tests as given in Table A.4 shall be conducted.

Table A.4 — Fire tests

Test ID	Ignition	Suppression system
REF-1	under 1	Reference sprinkler system
REF-2	between 4	Reference sprinkler system
WM-1	under 1	Tested water mist system
WM-2	between 4	Tested water mist system

A.5.3.1.6 Instrumentation

The following quantities shall be measured during the tests:

— Gas temperature 75 mm below the ceiling surface at three locations (above ignition, above corner and above the monitor) with 0,5 mm bare K-type thermocouples (see Figure A.4). Each thermocouple shall be installed at the ceiling directly above the gap between the table plate and the wall panel. There shall be no direct impingement on the thermocouple by the nozzles.

— Water pressure at the ceiling level

The tests shall be recorded on video. The damages to the wall panels and the items on the table shall be photographed after each test, and they shall appear as part of the test report.

A.5.3.2 Evaluation of test results

The performance of the tested water mist system shall be evaluated against the performance of the reference sprinkler system. The evaluation shall reflect the overall performance of both systems.

Due to the complexity of the fuel package, the damages to the office fuel package shall be evaluated quantitatively. The evaluation shall consider at least the following items:

— the extent (by area) of consumed material and charring in the wall panels (50 %),

— the number of combustible items on the table which have suffered fire damages (at least charring) (50 %).

The percentages given in the brackets describe the extent to which the criterion goes into the pass fail evaluation.

The total damages of the tests REF-1 and REF-2 shall be compared to the total damages of tests WM-1 and WM-2. The damages of each individual WM test shall be less than the damage in the worst of the REF tests. Critical judgement shall be exercised when evaluating the damages.

The temperature curves measured during the test shall be averaged over 30 s (maximum time between measurements 1 s), and the peak temperatures shall be determined from the averaged curves.

The average ceiling gas temperature shall be determined as the average over the three peak temperatures.

The average ceiling gas temperatures of each individual WM test shall be less than the average ceiling gas temperature in the worst of the REF tests.

Annex B
(informative)

Drop size distribution determining procedure

B.1 Symbols and definitions

B.1.1 Mean diameters

$$\overline{D}_{pq}^{(p-q)} = \frac{\sum_{i-1}^{n} D_i^p}{\sum_{i-1}^{n} D_i^q}$$

where

n	number of drops in sample
D_i	diameter of the i^{th} drop
q, p	integers 1, 2, 3or 4 p > q
$\sum_i$	summation of D_i^p or D_i^q representing all drops in the sample

More common representative diameters are:

$\overline{D}_{10}$	linear mean diameter
$\overline{D}_{20}$	surface area mean diameter
$\overline{D}_{30}$	*volume mean diameter*
$\overline{D}_{32}$	volume/surface mean diameter (Sauter Mean Diameter SMD).

Surface area mean diameter: is the diameter of a drop whose area, if multiplied by the number of drops, equals the total area of the sample.

Volume mean diameter: is the diameter of a drop whose volume, if multiplied by the number of drops, equals the total volume of the sample.

Sauter Mean Diameter (SMD): is the diameter of a drop whose ratio of volume to surface area, is the same as that of the entire sample.

B.1.2 Representative diameters

D_{vf}	*drop diameter such that the fraction, f,* of total liquid volume is in drops of smaller diameter
D_{kub}	upper - boundary diameter of drops in the k^{th} size class
D_{klb}	lower - boundary diameter of drops in the k^{th} size class

B.2 Test data

Present annex gives guidance to calculate appropriate sample size, size class widths, characteristics drop sizes and dispersion measure of drop size distribution i . Drop size distribution measurements shall be carried for each watermist nozzle, at least, at locations illustrated at Figure B.1 measured at a plane 1 m from nozzle.

The accuracy of and correction procedures for measurements of drops using particular equipment are not part of this practice.

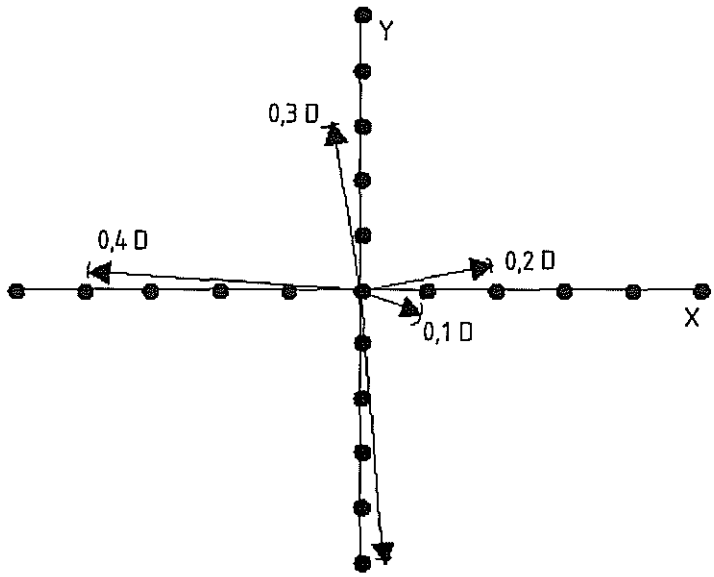


Figure B.1 — Droplet size measurements locations

B.3 Data processing

To better understand following points in accordance with Table B.1. The following calculations shall be made at every location. Mean values shall be obtained from data of all locations to obtain a representative values of a spray.

Report the largest and smallest drops of the entire sample, the number of drops in each size class, and the class boundaries.

The ratio of the volume of the largest drop to the total volume of the liquid in the sample shall be less than the tolerable fractional error in the desired representation (usually less than 1 %). All of the drops the sample at the large-drop end of the distribution should be measured.

$$\frac{D^3 \max}{n \text{ x } \overline{D}_{30}^3} \text{x } 100 < 1{,}0$$

example:

$$\frac{6532^3}{6109 \text{ x } 1832{,}4^3} \text{ x } 100 = 0{,}74 < 1{,}0$$

99 % of the volume of liquid represented by data should be in size classes such that no size class has boundaries with a ratio greater than 1,5. For the majority of size classes, this ratio should not exceed 1,25. The criteria may be relaxed for measurements where the degree of accuracy is unattainable:

— $(D_{kub}-D_{klb})/(D_{kub}+D_{klb})$ multiplied by the liquid volume in the k^{th} class and divided by the total volume of liquid in the sample shall be less than 0,05 for every class.

— CalculateD_{32} D_{30}, D_{20}, D_{10}.

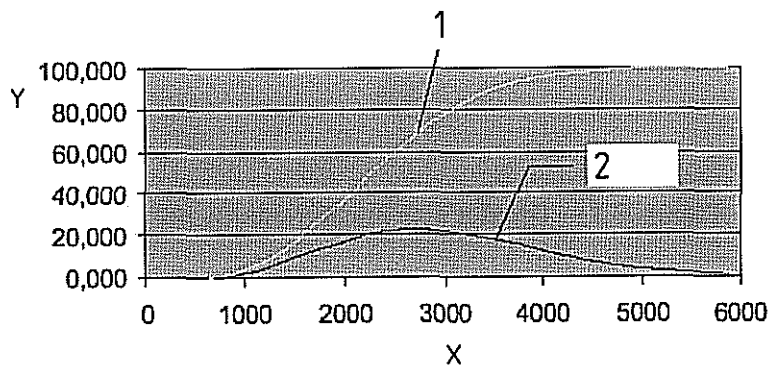
— Calculate volume percentage in each class:

$$\text{Volume\%}_K = \frac{\sum_{i-1}^{N_K} D_i^3}{\sum_{i-1}^{N} D_i^3} \text{x } 100$$

where

N_K Number of drops in class K

— Calculate cumulative volume percentage:



Key

1 Cumulative volume, in percent 2 Volume, in percent

Figure B.2 — Calculation of the volume percentage

— Calculate $D_{v0,1}$,$D_{v0,5}$,$D_{v0,9}$ from graph or by curve fitting distribution to a mathematical function.

— Calculate relative Span which gives notion on distribution dispersion:

$$SPAN = \frac{D_{v0,9} - D_{v0,1}}{D_{v0,5}}.$$

Table B.1 — Sample data calculation

Diameter µm		Class Width	Ratio	Drops	Sum of D_i^r in each size class			Vol. % in Class	Cum % by Vol.
					D_i	D_i^2	D_i^3		
288,0	360,0	72,0	1,25	65	2,1060E+04	6,8515E+06	2,2381E+09	0,006	0,006
360,0	450,0	90,0	1,25	119	4,8195E+04	1,9599E+07	8,0028E+09	0,021	0,027
450,0	562,5	112,5	1,25	232	1,1745E+05	5,9704E+07	3,0473E+10	0,081	0,108
562,5	703,0	140,5	1,25	410	2,5943E+05	1,6483E+08	1,0515E+11	0,280	0,388
703,0	878,0	175,0	1,25	629	4,9722E+05	3,9466E+08	3,1452E+11	0,837	1,225
878,0	1097,0	219,0	1,25	849	8,3839E+05	8,3130E+08	8,2761E+11	2,202	3,427
1097,0	1371,0	274,0	1,25	990	1,2217E+06	1,5137E+09	1,8832E+12	5,010	8,437
1371,0	1713,0	342,0	1,25	981	1,5127E+06	2,3421E+09	3,6411E+12	9,687	18,124
1713,0	2141,0	428,0	1,25	825	1,5898E+06	3,0761E+09	5,9762E+12	15,900	34,024
2141,0	2676,0	535,0	1,25	579	1,3945E+06	3,3725E+09	8,1892E+12	21,788	55,812
2676,0	3345,0	669,0	1,25	297	8,9412E+05	2,7028E+09	8,2035E+12	21,826	77,637
3345,0	4181,0	836,0	1,25	111	4,1769E+05	1,5782E+09	5,9876E+12	15,930	93,567
4181,0	5226,0	1045,0	1,25	21	9,8774E+04	4,6649E+08	2,2121E+12	5,885	99,453
5226,0	6532,0	1306,0	1,25	1	5,8790E+03	3,4705E+07	2,0570E+11	0,547	100,000
—	—	—	—	6109	8,9169E+06	1,6564E+10	3,7587E+13	—	—

Typical calculation results:

D_{10} = 1459,63	$D_{v0,1}$ = 1550,82	SPAN = 0,79
D_{20} = 1646,62	$D_{v0,5}$ = 2587,33	
D_{30} = 1832,40	$D_{v0,9}$ = 3585,22	
D_{32} = 2269,22		

Annex C
(informative)

Testing of nozzles

C.1 Tests for open and closed nozzles

Table C.1 gives the tests for open and closed nozzles.

Table C.1 — Nozzle tests

Test	Open Nozzles	Closed Nozzles
1) Operating temperatures	—	X ± (0,035 X + 0,62) °C where X = Normal release temperature
2) Water flow	K= Q/√P where P = Pressure , in bar, Q= litres per minute	K= Q/√P where P = Pressure , in bar, Q= litres per minute
3) Water distribution	Water distribution of nozzles shall comply with distribution of nozzles from fire tests.	Water distribution of nozzles shall comply with distribution of nozzles from fire tests.
4) Water droplet size and velocity	Water droplet size and velocity shall comply with nozzles used in fire tests ± 10%	Water droplet size and velocity shall comply with nozzles used in fire tests ± 10%
5) Functional tests	Tests conducted at 75 %, 100 %, 125 % of the recommended minimum operating pressure, with nozzles in installation positions advised by the manufacturer for the nozzle type. Protection cap released within 5 s of nozzle operation	Tests conducted at 75 %, 100 %, 125 % of the recommended minimum operating pressure, with nozzles in installation positions advised by the manufacturer for the nozzle type. Operation within 5 s after response of release element. No lodgement of release parts after 10 s. Protection cap released within 5 s of nozzle operation.
6) Strength of nozzle body	—	The nozzle should not show permanent elongation of more than 0,2% between load bearing points after being subjected to twice the average service-load.
7) Strength of release element	—	The lower tolerance limit of bulb strength (0,99 confidence for 99% of samples) > Twice the upper tolerance limit of the bulb / nozzle assembly load including the highest calculated water pressure on nozzle.(0,99 confidence for 99% of samples)

Table C.1 (*continued*)

8) Leak resistance	—	No sign of leakage rupture operation or release any parts, when tested at twice the rated working pressure, minimum 30 bar.
9) Heat exposure	—	No damage to release element when tested at (20 ± 5) °C below nominal release temperature in water bath (< 93 °C), or oil (> 93 °C). Bath temperature increase < 20 °C/min. Temperature should then be increased with 1 °C/min until air-bubble disappear. Test to be conducted four times with four nozzles. No damage to glass bulb may occur.
10) Thermal shock	—	24 nozzles heated to (10 ± 2) °C below normal release temperature. After 5 min nozzles are moved into a (10 ± 1) °C water bath. Hereafter the nozzles should be functional tested in accordance with function test (5)
11) Stress Corrosion	5 x fully assembled, and not coated nozzles and nozzle parts are exposed to the following tests: Stress corrosion: Brass (Ammonia test) Stress corrosion: Brass (mercury test) Stress corrosion Stainless steel (Boiling magnesium chloride solution) 5 x fully assembled nozzles After tests the nozzles are exposed to the maximum water pressure recommended for the nozzles in 30 min. No damages may occur.	5 x fully assembled, and not coated nozzles and nozzle parts are exposed to the following tests: Stress corrosion: Brass (Ammonia test) Stress corrosion: Brass (mercury test) Stress corrosion Stainless steel (Boiling magnesium chloride solution) 5 x fully assembled nozzles After tests the nozzles are exposed to the maximum water pressure recommended for the nozzles in 30 min. No damages may occur.
12) Salt spray corrosion	Nozzles for non corrosive environments 10 nozzles are exposed to a salts-spray with 20 % mass sodium chloride, 35 °C for a period of 10 days. Hereafter the nozzles are tested to comply with the acceptance requirements of test 2, 3, 4, 5, 6. Nozzles for corrosive environments 10 nozzles are exposed to a salt-spray with 20 % mass sodium chloride, 35 °C for a period of 30 days. Hereafter the nozzles are tested to comply with the acceptance requirements of test 2, 3, 4, 5, 6.	Nozzles for non corrosive environments 10 nozzles are exposed to a salt-spray with 20 % mass sodium chloride, 35 °C for a period of 10 days. Hereafter the nozzles are tested to comply with the acceptance requirements of test 2, 3, 4, 5, 6. Nozzles for corrosive environments 10 nozzles are exposed to a salts-pray with 20 % mass sodium chloride, 35 °C for a period of 30 days. Hereafter the nozzles are tested to comply with the acceptance requirements of test 2, 3, 4, 5, 6.

Table C.1 (*continued*)

13) Moist air exposure	10 nozzles are exposed to (98 ± 2) % humidity, (95 ± 4) °C for 90 days. After the exposure the nozzles should comply with the acceptance requirements of test 2, 3, 4, 5, 6.	10 nozzles are exposed to (98 ± 2) % humidity, (95 ± 4) °C for 90 days. After the exposure the nozzles should comply with the acceptance requirements of test 2, 3, 4, 5, 6, 8.
14) Water hammer	—	Nozzles should not leak when subjected to pressure surges from 4 bar to four times the rated pressure for operating pressures (max. 200 bar) up to 100 bar and two times the rated pressure for pressures greater than 100 bar. They should show no signs of mechanical damages, when tested in accordance with? and should operate within the limitations of test (5) at the minimum design pressure.
15) Dynamic heating (RTI, C)	—	The time response index and the RTI-value should be measured in accordance with EN 12259-1 to be characterised within the corresponding fast response, special response, and standard response requirements.
16) Resistance to heat	One nozzle body should be heated in an oven at 800 °C for a period of 15 min with the nozzle in its normal installed position. Hereafter the nozzle is quickly immersed in a 15 °C water bath. The water bath should not heat more than 5 °C from the hot nozzle. The nozzle should not show: Visual breakage or deformation. Change in flow constant K of more than 5 %, and no changes exceeding 10 % in discharge characteristics of water droplets and droplet velocity at lowest operating pressure. Nozzle should visually not show more than 5 % variance in spray angle.	One open nozzle body should be heated in an oven at 800 °C for a period of 15 min with the nozzle in its normal installed position. Hereafter the nozzle is quickly immersed in a 15 °C water bath. The water bath should not heat more than 5 °C from the hot nozzle. The nozzle should not show: Visual breakage or deformation. Change in flow constant K of more than 5 %, and no changes exceeding 10 % in discharge characteristics of water droplets and droplet velocity at lowest operating pressure. Nozzle should visually not show more than 5 % variance in spray angle.
17) Resistance to vibration	Five nozzles are vibration tested in accordance with EN 12259-1. After the test the nozzles should show no visible deterioration and should meet the requirements of tests 2, 3, 4, 5.	Five nozzles are vibration tested in accordance with EN 12259-1. After the test the nozzles should show no visible deterioration and should meet the requirements of tests 2, 3, 4, 5, 8.
18) Impact Test	Five nozzles are tested. A nozzle is placed on the nozzle inlet on a concrete base. A ball of steel, with the mass similar to the nozzles, is aimed to hit the nozzle with a free fall from 1 m above the nozzle. After the test the nozzles should show no visual damages. The nozzles should comply with test 5.	Five nozzles are tested. A nozzle is placed on the nozzle inlet on a concrete base. A ball of steel, with the mass similar to the nozzles, is aimed to hit the nozzle with a free fall from 1 m above the nozzle. After the test the nozzles should show no visual damages. The nozzles should comply with test 5 and test 8.

Table C.1 (*continued*)

19) Lateral discharge test	—	Two nozzles are installed in accordance with the installation guidelines of the manufacture. A piece of paper is fitted around the heat sensitive element of the one nozzle, and the heat sensitive element is removed from the other sensitive element. It is checked that watermist from the open nozzle do not wet the paper at any water pressure, and any position of the nozzles within the manufactures guidelines.
20) Thirty-day leakage test	—	Five nozzles should be installed on water (water with agent) filled test line maintained under a constant pressure of twice the rated working pressure for 30 days at an ambient temperature of (20 ± 5) °C During the 30 days the nozzles may show no leaks. Hereafter the nozzles are functional tested in accordance with test 5.
21) Vacuum test	—	Three nozzles are submitted to a vacuum of 460 mm Hg applied to the nozzle inlet for one minute at a temperature of (20 ± 5) °C. Following this test each sample is leakage tested in accordance with test (8).
22) Clogging test	see C.2	see C.2

C.2 Clogging test

C.2.1 The water flow rate of an open watermist nozzle with its strainer or filter should be measured at its rated working pressure. The nozzle and strainer or filter should then be installed in test apparatus described in figure 3 and subjected to 30 min of continuous flow at rated working pressure using contaminated water which has been prepared in accordance with C.2.3.

C.2.2 Immediately following the 30 min of continuous flow with the contaminated water, the flow rate of the nozzle and strainer or filter should be measured at rated working pressure. No removal, cleaning or flushing of the nozzle, filter or strainer is permitted during the test.

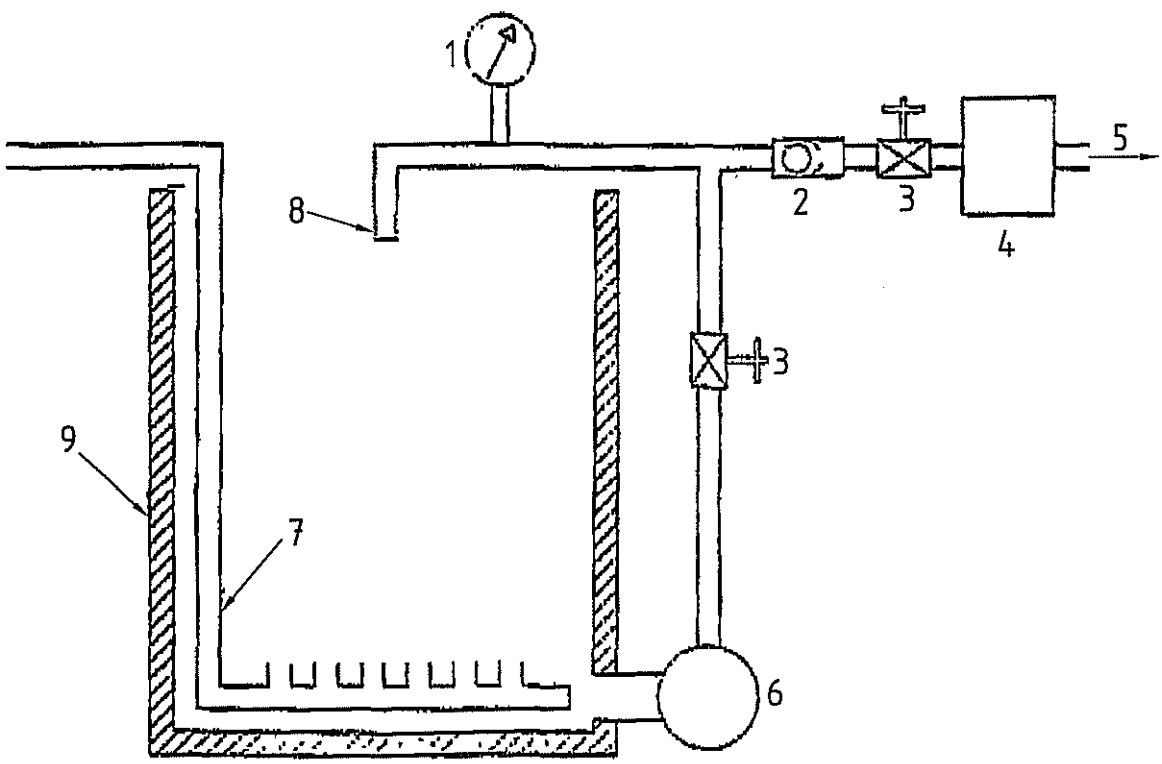
C.2.3 The water used during the 30 min of continuous flow at rated working pressure specified in C.2.1 should consist of 60 l of tap water into which has been mixed 1,58 kg of contaminants which sieve as described in Table C.2. The solution should be continuously agitated during the test.

Table C.2 — Contaminant for contaminated water cycling test

Sieve designation[a]	Nominal sieve opening mm	Contaminant (± 5 %)[b] g		
		Pipe scale	Top soil	Sand
No. 25	0,706	—	456	200
No. 50	0,297	82	82	327
No. 100	0,150	84	6	89
No. 200	0,074	81	—	21
No. 325	0,043	153	—	3
	Total	400	544	640

a Sieve designations correspond with those specified in the standard for wire-cloth sieves for testing purposes, sieve sizes 25 mesh, 50 mesh, 100 mesh, 200 mesh and 325 mesh, see ISO 565.

b The amount of contaminant may be reduced by 50 % for nozzles limited to use with copper or stainless steel piping and by 90 % for nozzles having a rated pressure of 50 bar or higher and limited to use with stainless steel piping.



Key

1 Pressure gauge
2 Check valve
3 Flow control valve
4 Flow meter
5 Fresh water supply
6 Pump
7 Air line for agitating contaminated water
8 Nozzle port
9 Container

Figure C.1 — Clogging test apparatus

Annex D
(informative)

Function tests

D.1 Preliminary function tests

— Where a system is connected to a remote central alarm station, notify the station that the fire system test is to be conducted and that an emergency response by the fire department or alarm station personnel is not required. Notify all concerned personnel at the end-user's facility that a test is to be conducted and instruct them as to the sequence of operation.

— Check each resettable detector for proper response.

— Check that polarity has been observed on alt polarised alarm devices and auxiliary relays.

— Check that alt end-of-line devices have been installed, where required, across alt circuits.

— Check all supervised circuits for correct fault response.

D.2 System function operational test

— Operate detection initiating circuit(s). All alarm functions shall occur according to the design specification.

— Operate the necessary circuits to initiate a second alarm circuit if present. Verify all second alarm functions occur according to design specifications.

— Operate manual release device. Verify that manual release functions occur according to design specifications.

— Where appropriate, operate hold switch. Verify that functions occur according to design specifications.

— Confirm that visual and audible supervisory signals are received at the control panel.

— Function-check alt resettable valves and activators, unless testing the valve wilt release extinguishant.

— Where fitted, check pneumatic equipment for integrity to ensure proper operation.

— Remote monitoring operations (if applicable).

— Disconnect primary power supplies, operate one of each type of input device while on Standby power. Verify that an alarm signal is received at remote panel after device is operated.

— Reconnect primary power supply.

— Operate each type of alarm condition, and verify receipt of fault condition at the remote station.

— Control panel primary power source.

— Verify that the control panel is connected to a dedicated unsweetened circuit and labelled properly. This panel shall be readily accessible, yet restricted to unauthorised personnel.

— Test a primary power failure in accordance with the manufacturer's specification, with the system fully operated on standby power.

— Completion functional test:

When all functional tests are complete return the system to its fully operational design condition, notify the central alarm station and alt concerned personnel at the end- user's facility that the fire system test is complete and that the system has been returned to full service condition by following the procedures specified in the manufacturers' specifications.

— Completion certificate and documentation:

The installer shall provide to the user a completion certificate, a complete set of instructions, calculations and drawings showing the system as installed, and a statement that the system complies with alt the appropriate requirements of this standard, and giving details of any departure frown appropriate recommendations. The certificate shall give the design concentrations and if carried out, the report of the door fan test.

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