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Smoke and heat control systems —

Part 2: Specifications for natural smoke and heat exhaust ventilators

Systèmes de contrôle de fumée et de chaleur —

Partie 2: Spécifications pour les dispositifs d'évacuation naturelle des fumées et de la chaleur

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 11, *Smoke and heat control systems and components*.

This second edition cancels and replaces the first edition (ISO 21927-2:2006), which has been technically revised. It also incorporates the Amendment ISO 21927-2:2006/Amd1:2010.

The main changes compared to the previous edition are as follows:

— the test apparatus has been amended;

— the whole document has been revised.

A list of all parts in the ISO 21927 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In a fire situation, smoke and heat exhaust ventilation systems create and maintain a smoke free layer above the floor by removing smoke. They also serve simultaneously to exhaust hot gases released by a fire in the developing stages. The use of such systems to create smoke-free areas beneath a buoyant layer has become widespread. Their value in assisting in the evacuation of people from buildings and other construction works, reducing fire damage and financial loss by preventing smoke damage, facilitating access for firefighting by improving visibility, reducing roof temperatures and retarding the lateral spread of fire is firmly established. For these benefits to be obtained, it is essential that natural smoke and heat exhaust ventilators (referred to in this document as NSHEV) operate fully and reliably whenever called upon to do so during their installed life. A smoke and heat exhaust ventilation system (referred to in this document as a SHEVS) is a system of safety equipment intended to perform a positive role in a fire emergency.

Smoke and heat control systems —

Part 2: Specifications for natural smoke and heat exhaust ventilators

1 Scope

This document applies to natural smoke and heat exhaust ventilators (NSHEV) operating as part of smoke and heat exhaust systems (SHEVS), placed on the market. This document specifies requirements and gives test methods for natural smoke and heat exhaust ventilators which are intended to be installed in smoke and heat control systems in buildings.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11925-2, *Reaction to fire tests — Ignitability of products subjected to direct impingement of flame — Part 2: Single-flame source test*

ISO 21927-9, *Smoke and heat control systems — Part 9: Specification for control equipment*

ISO 21927-10, *Smoke and heat control systems — Part 10: Specification for power output devices*

IEC 60584-1, *Thermocouples — Part 1: EMF specifications and tolerances*

EN 54-5, *Fire detection and fire alarm systems — Part 5: Heat detectors — Point detectors*

EN 54-7, *Fire detection and fire alarm systems — Part 7: Smoke detectors — Point detectors using scattered light, transmitted light or ionization*

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

EN 13823, *Reaction to fire tests for building products — Building products excluding floorings exposed to the thermal attack by a single burning item*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
aerodynamic free area
A_a
measure of smoke and heat exhaust area of the ventilator

Note 1 to entry: It is the geometric area multiplied by the coefficient of discharge.

3.2
ambient
relating to the properties of the surroundings

3.3
automatic initiation
activation of operation without direct human intervention

3.4
aspect ratio
ratio of length to width

3.5
comfort ventilation position
position of a NSHEV defined by the manufacturer for the purpose of comfort ventilation

3.6
coefficient of discharge
c_v
ratio of actual flow rate, measured under specified conditions, to the theoretical flow rate through the NSHEV, as defined in Annex B

Note 1 to entry: The coefficient takes into account any obstructions in the NSHEV such as controls, louvres and vanes and the effect of external side wind.

3.7
dual purpose NSHEV
NSHEV which has provision to allow its use for comfort (i.e. day to day) ventilation

3.8
fire open position
configuration of the NSHEV specified by its designer to be achieved and sustained while venting smoke and heat

3.9
gas container
vessel containing gas in a compressed form, the energy of which, when the gas is released from the vessel, will open the NSHEV

3.10
geometric area
A_v
area of the opening through a NSHEV, measured in the plane defined by the surface of the construction works, where it contacts the structure of the NSHEV

Note 1 to entry: No reduction is made for controls, louvres or other obstructions.

Note 2 to entry: Specific configurations are given in Figures B.1 and B.4.

3.11
initiation device
device which activates the operating mechanism of the NSHEV on receipt of information from a fire detection system or thermal device

3.12
opening mechanism
mechanical device which operates the NSHEV to the fire open position

3.13
projection area
cross-sectional area of the movable part (e.g. flap, window) of the NSHEV:

a) above the plane of the roof, at a right angle to the side wind flow;

b) on the wall at a right angle to the side of the wall

3.14
range
NSHEV of various sizes having the same method of construction and the same type of opening mechanism

3.15
natural smoke and heat exhaust ventilator
NSHEV
product specially designed to move smoke and hot gases out of a construction works naturally under conditions of fire

Note 1 to entry: In the context of this document, smoke and hot gas movement means any motion of smoke and hot gas within and out of a construction work under the influence of thermal buoyancy, e.g. exhausting and extracting smoke and hot gas, directing and guiding smoke and hot gas.

Note 2 to entry: A typical NSHEV consists of a fixed frame or upstand and of one or more flaps to be opened in case of fire by an opening mechanism initiated by a smoke or heat sensitive initiation device.

3.16
thermal device
temperature-sensitive device which responds to initiate a subsequent action

3.17
throat area
smallest cross-sectional area of the flow path through the NSHEV

Note 1 to entry: See Figure G.6.

3.18
ventilator
device for enabling the movement of gases into or out of the construction works

3.19
wind deflector
any part of the NSHEV guiding the wind over the open NSHEV

3.20
wind-sensitive control system
control system designed to control two or more banks of NSHEV on separate elevations so that only the NSHEV not subject to positive wind pressures opens in case of fire

3.21
wall
external building surface with an inclination of more than 60° relative to the horizontal

3.22
roof
external building surface with an inclination of 60° or less relative to the horizontal shed roofs, and which continuous roof-lights, independent of the inclination angle

4 Symbols and abbreviated terms

For the purposes of this document, mathematical and physical quantities are represented by symbols, and expressed in units as follows.

Symbol	Definition	Unit
A_a	aerodynamic free area, expressed in square metres	m^2
A_{ex}	area of the exit plane of NSHEV, expressed in square metres	m^2
A_n	nozzle exit area (for open jet facilities); test section entrance area (for closed test section facilities), expressed in square metres	m^2
A_{pr}	projection area of the NSHEV for the side wind flow, expressed in square metres	m^2
A_{sc}	horizontal cross section area of the settling chamber, expressed in square metres	m^2
A_{throat}	smallest geometric cross section area through which the air flows	m^2
A_v	geometric area of the NSHEV, expressed in square metres	m^2
B	width of the open hole of the settling chamber, expressed in metres	m
b	width of the geometric opening of a NSHEV, expressed in metres	m
B_n	width of nozzle exit area in open jet facilities, width of the test section in closed test section facilities, expressed in metres	m
B_v	maximum width of the NSHEV in the fire open position, expressed in metres above the upper surface of the settling chamber	m
C_v	coefficient of discharge, dimensionless	—
C_{v0}	coefficient of discharge without side wind influence, dimensionless	—
C_{vw}	coefficient of discharge with side wind influence, dimensionless	—
d_h	hydraulic diameter of the settling chamber [$d_h = (4 \cdot A_{sc}) / P$], expressed in metres	m
$d_{h,g}$	hydraulic diameter of the geometric NSHEV area, expressed in metres	m
H_n	height of nozzle exit area in open jet facilities, height of the test section in closed test section facilities, expressed in metres	m
H_v	maximum height of the NSHEV in the fire open position above the upper surface of the settling chamber, expressed in metres	m
h_p	profile height of a wall-mounted NSHEV, expressed in metres	m
h_{us}	height of the NSHEV upstand, expressed in metres	m
h_{uwd}	height of the upper edge of wind deflectors above the roof surface, expressed in metres	m
L	length of the open hole of the settling chamber, expressed in metres	m
l	length of the geometric opening of a NSHEV, expressed in metres	m
$I_{u,\,hUS}$	turbulence intensity in flow direction at height h_{US}	—
m	ratio of geometric areas (= A_{ex} / A_v), dimensionless	—
$\dot{m}_{ing}$	mass flow rate entering the settling chamber, expressed in kilograms per second	kg/s
NSHEV	natural smoke and heat exhaust ventilator	—
P	perimeter length of the cross section of the settling chamber, expressed in metres	m
p_{amb}	ambient pressure, expressed in Pascals	Pa
p_d	wind stagnation pressure, expressed in Pascals	Pa
p_{int}	internal static pressure, expressed in Pascals	Pa
$p_{int,\,v0}$	internal static pressure without side wind, expressed in Pascals	Pa
$p_{int,\,vw}$	internal static pressure with side wind, expressed in Pascals	Pa

Symbol	Definition	Unit
T	temperature, expressed in degrees C	°C
U_v	length of the boundary of the geometric area of a NSHEV, expressed in metres	m
V_∞	side wind velocity, expressed in metres per second	m/s
V_l	local air speed, expressed in metres per second	m/s
$V_{m,\,sc}$	mean velocity of the settling chamber, expressed in metres per second	m/s
V_n	mean nozzle velocity, expressed in metres per second	m/s
V_{sc}	local velocities in plane above settling chamber, see Figure B.6, expressed in metres per second	m/s
α	opening angle of the NSHEV, expressed in degrees and referenced to the closed flap position	—
β	angle of attack, expressed in degrees	—
β_{crit}	incidence angle at which the smallest value of C_{vw} obtained with side wind, occurs, expressed in degrees	—
δ	relative wall thickness (= h_{US} / d_h), dimensionless	—
δ_p	relative profile thickness (= h_p / d_h) of a wall-mounted NSHEV, dimensionless	—
μ	contraction coefficient (= A_a / A_{ex}), dimensionless	—
θ	angle of installation of NSHEV on a roof or in a wall, expressed in degrees	—
Δp	pressure difference, expressed in Pascals	Pa
Δp_{v0}	reference pressure difference between the static pressure in the settling chamber and the ambient pressure without side wind, expressed in Pascals	Pa
Δp_{vw}	reference pressure difference between the static pressure in the settling chamber and the ambient pressure with side wind, expressed in Pascals	Pa
Δp_{int}	pressure difference between the static pressure in the settling chamber and the ambient pressure, expressed in Pascals	Pa
ΔT	temperature difference, expressed in Kelvins	K
ρ_{air}	density of air, expressed in kilograms per cubic metre	kg/m^3

5 Requirements

5.1 Nominal activation conditions/sensitivity

5.1.1 Initiation device

5.1.1.1 General

To ensure the natural smoke and heat exhaust ventilator (NSHEV) opens in the event of a fire, it shall be fitted with one or more of the following automatic initiation devices:

a) a thermal initiation device;

b) an initiation device activated by an electrical signal from a remote source, e.g. a smoke and heat detector system, the interruption of electrical power supply;

c) a pneumatic initiation device, e.g. a pneumatic signal or a loss of compressed air;

d) an initiation device able to respond to other types of release signals.

In addition, remote initiation can take place by means of a manually operated initiation device.

e) A pneumatic non fail safe NSHEV, which does not open automatically on loss of power, shall have at least a thermal device and one power source in accordance with ISO 21927-10, which is mounted

directly in the NSHEV, unless the required control panel monitors the lines to the NSHEV and indicates a failure.

In some specific design cases where it is suitable to initiate the NSHEV manually only, the NSHEV may be installed without an automatic initiation device.

5.1.1.2 Automatic initiation or release device

Any automatic initiation or release device shall be within the NSHEV and shall be exposed to the hot gas entering the closed NSHEV.

There are two exceptions to this requirement, where an automatic thermal initiation or release device shall not be fitted to the NSHEV.

a) If the NSHEV is to be installed as a wall-mounted NSHEV. Adverse wind conditions may cause a NSHEV which has been opened by the automatic initiation device to inlet and not remove heat and smoke.

b) In specific design cases where it is suitable that the NSHEV shall only be manually initiated. The response behaviour of thermal automatic initiation devices shall be in accordance with ISO 21927-9. Smoke detectors shall comply with the requirements of EN 54-7 and heat detectors with EN 54-5.

5.1.2 Opening mechanism

5.1.2.1 General

The NSHEV shall be provided with an opening mechanism with energy within the NSHEV, e.g. gas containers, spring systems, electrical power supply, and/or with an external energy source. For the external links, the manufacturer of the NSHEV shall specify the operating requirements for the initiation device and the opening mechanism, e.g. voltage, energy.

5.1.2.2 Integral gas containers

Any gas container forming an integral part of the NSHEV shall be equipped with a pressure release device to prevent an explosion if the container overheats. The energy supply shall comply with ISO 21927-10.

5.1.3 Inputs and outputs

If the NSHEV is intended to operate with an external energy source, it shall be equipped with inputs and/or outputs to allow connection of the NSHEV to the control panel and power supplies in accordance with ISO 21927-10.

5.2 Response delay (response time)

5.2.1 Reliability

The NSHEV shall when tested in accordance with Annex C open, i.e. reach its fire open position, within 60 s after actuation.

5.2.2 Opening under (snow/wind) load

Roof mounted NSHEV shall open, reach its fire open position not more than 60 s after actuation and remain in position without an external energy supply (until reset), when tested under the snow load appropriate to its classification and under the specified side wind in accordance with Annex D.

After testing the NSHEV in accordance with Annex F it shall open into the fire open position within 60 s after actuation.

5.2.3 Low ambient temperature

When tested in accordance with Annex E the NSHEV shall open into to the fire open position within 60 s after actuation.

5.2.4 Opening under heat

The NSHEV shall when tested in accordance with Annex G open, i.e. reach its fire open position within 60 s under exposure to heat and to remain in the fire open position with not more than 10 % reduction of the throat area.

5.3 Operational reliability

The NSHEV shall when tested in accordance with Annex C open, i.e. reach its fire open position, within 60 s after actuation without damage and remain in its fire open position without an external energy supply (until reset).

5.4 Effectiveness of smoke/hot gas extraction (aerodynamic free area)

The aerodynamic free area, A_a, of the NSHEV shall be determined in accordance with Annex B.

Roof mounted NSHEV shall be tested without and with side wind. Wall-mounted NSHEV may be tested without side wind only.

In order to prevent air from flowing through the NSHEV into the fire room the aerodynamic free area, A_a, shall be larger than 0 m^2.

Wind deflectors subjected to atmospheric wind when the NSHEV is in the closed position and forming an integral part of the NSHEV to ensure the determined aerodynamic free area, A_a, shall be tested in accordance with 5.6.4.

Devices having influence on the aerodynamic performance are integral parts of the NSHEV and shall be installed in accordance with the manufacturer's instructions and shall be tested in accordance with Annex B, whether they are fixed to the NSHEV itself or to the surrounding construction.

When using the simple assessment procedure to determine the aerodynamic free area, see B.1. The side length shall not exceed 2,5 m and the aspect ratio of the geometric area shall not exceed 5:1.

Large area NSHEV may lead to plug holing, i.e. exhaust flows where smoke from the smoke layer and room air are mixed and removed and therefore the removal of smoke is decreased.

5.5 Performance parameters under fire conditions

5.5.1 Resistance to heat

The NSHEV shall open within 60 s under exposure to heat and remain in the fire open position without an external energy supply with not more than 10 % reduction of the throat area when tested in accordance with Annex G.

If the NSHEV shall be installed in a building, it shall have a minimum class $B_{300}30$.

For NSHEV larger than the largest NSHEV tested in accordance with Annex G, an assessment of the heat exposure effect shall be made by the testing station to ensure that the performance is not negatively affected.

NOTE At present, maximum dimensions of the test apparatus for the heat exposure test are in the range of 4 m.

5.5.2 Mechanical stability

The reduction of the throat area shall not be more than 10 % reduction when tested in accordance with Annex G.

No part or component of the NSHEV shall fall from the NSHEV during the first 6 min of the test.

Devices having influence on the aerodynamic performance are integral parts of the NSHEV and shall be installed in accordance with the manufacturer's instructions and shall be tested in accordance with Annex G whether they are fixed to the NSHEV itself or to the surrounding construction.

5.5.3 Reaction to fire

The reaction to fire shall be classified in accordance with A.5 and tested in accordance with Annex H.

5.6 Performance under environmental conditions

5.6.1 Opening under load

To simulate the side wind influence, the roof-mounted NSHEV shall be subjected, in the most unfavourable wind direction, to a side wind of 10 m/s velocity when tested in accordance with Annex D.

Roof mounted NSHEV shall open, reach its fire open position within not more than 60 s after actuation and remain in position without an external energy supply (until reset), when tested under the snow load appropriate to its classification and under the specified side wind in accordance with Annex D.

For NSHEV fitted with wind deflectors, the deflectors shall not be fitted in such a way to encourage snow or ice to collect to the detriment of the operation of the NSHEV.

5.6.2 Low ambient temperature

When tested in accordance with Annex E, the NSHEV shall open into to the fire open position within 60 s after actuation. No such test is necessary for NSHEV classified T(05), see A.6.

Tests shall be conducted with simulated snow load with the classification in accordance with A.6.

5.6.3 Stability under wind load

The NSHEV shall not open at the opening side(s) more than 50 mm (measured at the location of the actuator) under the wind load appropriate to its classification, see A.6. It shall also not suffer permanent deformation when tested in accordance with Annex F and, following this test, shall open into the fire open position within 60 s after actuation.

5.6.4 Resistance to wind-induced vibration

If wind deflectors form an integral part of the NSHEV, their natural frequency of vibration shall be higher than 10 Hz with a logarithmic decrement of damping greater than 0,1 when tested in accordance with F.5.2.

5.6.5 Resistance to heat

The NSHEV shall open within 60 s under exposure to heat and remain in the fire open position with not more than 10 % reduction of the throat area when tested in accordance with Annex G.

If the NSHEV shall be installed in a building it shall have a minimum class B_{300}30.

5.7 Durability

5.7.1 Response delay (response time)

The durability of NSHEV considering response delay is fulfilled if the fire open position is reached within 60 s after being tested at least 49 times in accordance with Annex C.

5.7.2 Operational reliability

The durability of NSHEV considering operational reliability is fulfilled if the fire open position is reached after being tested at least 49 times in accordance with Annex C.

5.7.3 Performance parameters under fire conditions

The NSHEV is regarded to be durable if, after the test in accordance with Annex G, the throat area is not reduced by more than 10 % and all parts relevant for the aerodynamic performance of the NSHEV, e.g. filling, wind deflectors and flaps and all structural parts, remain in place.

6 Testing, assessment and sampling methods

Test of NSHEV shall be carried out in accordance with Annexes B, C, D, E, F, G and H.

For each test, a test report shall be prepared.

The methods for testing, assessing and sampling for the essential requirements of Clause 5 are:

— For the "nominal activation condition/sensitivity", the presence of the initiation device according to 5.1.1, the "opening mechanism" according to 5.1.2 and "inputs and outputs" according to 5.1.3 shall be checked as present.

— The "response delay (response time)" shall be less than ≤60 s. It shall be tested for reliability according to Annex C, for opening under (snow/wind) load according to Annex D and F, for low ambient temperature according to Annex E and for opening under heat according to Annex G and assessed in accordance with Annex A. The sampling methods are given in Annexes C, D, E, F, and G.

— The operational reliability shall be tested in accordance with Annex C and assessed in accordance with Annex A. The sampling method is given in Annex C.

Table 1

Reliability classes	Number of openings into the fire open position
Re 50	50
Re 500	500
Re 1000	1 000
Re A	A

— The effectiveness of smoke/heat gas extraction — aerodynamic free area shall be tested and assessed in accordance with Annex B. The aerodynamic free area, A_a, shall be larger than 0 m^2. The sampling method is given in Annex B.

— The performance parameters under fire conditions, resistance to heat and mechanical stability shall be tested and assessed in accordance with Annex G with A as:

$B_{300}30$,

$B_{600}30$,

B_A30.