INTERNATIONAL STANDARD

ISO 21927-2

First edition
2006-11-15

Smoke and heat control systems —

Part 2:
Specification 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

Reference number
ISO 21927-2:2006(E)

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Published in Switzerland

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Foreword

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

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

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

ISO 21927-2 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*.

ISO 21927 consists of the following parts, under the general title *Smoke and heat control systems*:

— *Part 1: Specification for smoke barriers*

— *Part 2: Specification for natural smoke and heat exhaust ventilators*

— *Part 3: Specification for powered smoke and heat exhaust ventilators*

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 fire-fighting 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 smoke- and heat-exhaust ventilators 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 part of ISO 21927 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: Specification for natural smoke and heat exhaust ventilators

1 Scope

This part of ISO 21927 specifies requirements and gives test methods for natural smoke- and heat-exhaust ventilators that are intended to be installed in a roof and/or wall as a component of a natural smoke- and heat-exhaust system.

2 Normative references

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

ISO 6182-1, *Fire protection — Automatic sprinkler systems — Part 1: Requirements and test methods for sprinklers*

ISO 7240-7, *Fire detection and alarm systems — Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 and the following apply.

3.1
aerodynamic free area
product of the geometric area multiplied by the coefficient of discharge

3.2
ambient
properties of the surroundings

3.3
automatic activation
initiation of operation without direct human intervention

3.4
aspect ratio
ratio of length to width

3.5
automatic natural smoke- and heat-exhaust ventilator
smoke- and heat-exhaust ventilator that is designed to open automatically after the outbreak of fire if called upon to do so

NOTE Automatic natural smoke- and heat-exhaust ventilators can also be fitted with a manual control or release device.

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

NOTE 1 The coefficient takes into account any obstructions in the ventilator, such as controls, louvers and vanes, and the effect of external side winds.

NOTE 2 Also called aerodynamic efficiency.

3.7
dual-purpose ventilator
smoke- and heat-exhaust ventilator that has provision to allow its use for comfort (i.e. day-to-day) ventilation

3.8
exhaust ventilator
device for the movement of gases out of the construction works

3.9
fire-open position
configuration of the ventilator specified by its designer to be achieved and sustained while venting smoke and heat

3.10
gas container
vessel containing gas in a compressed form, the energy of which, when released, opens the ventilator

3.11
geometric area
A_v
area of the opening through a ventilator, measured in the plane defined by the surface of the construction works, where it contacts the structure of the ventilator

NOTE No reduction is made for controls, louvers or other obstructions.

3.12
initiation device
device that activates the operating mechanism of the component (e.g. of a damper or a ventilator) on receipt of information from a fire detection system or thermal device

3.13
manual operation
initiation of the operation of a smoke- and heat-exhaust ventilator by a human action (e.g. pressing a button, or pulling a handle)

NOTE A sequence of automatic actions in the operation of a smoke- and heat-exhaust ventilator started by the initial human action is regarded as manual operation for the purposes of this part of ISO 21927.

3.14
manually opened natural smoke- and heat-exhaust ventilator
natural smoke- and heat-exhaust ventilator that can be opened only by a manual control or release device

3.15
mass flux
total mass of gases crossing a specified boundary per unit time

3.16
natural ventilation
ventilation caused by buoyancy forces due to differences in density of the gases because of temperature differences

3.17
opening mechanism
mechanical device that operates the ventilator to the fire-open position

3.18
opening time
period between the information to open being received by the ventilators and achieving the fire-open position of the ventilator

3.19
projection area
cross-sectional area of the natural smoke- and heat-exhaust ventilator in its fire-open position above the plane of the roof, at a right angle to the side-wind flow

3.20
range of natural smoke- and heat-exhaust ventilators
ventilators of various sizes having the same method of construction and the identical number and type of opening devices

3.21
smoke- and heat-control system
arrangement of components installed in a construction works to limit the effects of smoke and heat from a fire

3.22
smoke- and heat-exhaust system
smoke and heat control system that exhausts smoke and heat from a fire in a construction works or part of a construction works

3.23
smoke- and heat-exhaust ventilation system
SHEVS
components jointly selected to exhaust smoke and heat in order to establish a buoyant layer of warm gases above cooler and cleaner air

3.24
smoke- and heat-exhaust ventilator
SHEV
device specially designed to move smoke and hot gases out of a construction works under conditions of fire

3.25
thermal device
temperature-sensitive device that responds to initiate a subsequent action

3.26
throat area
smallest cross-sectional area of the flow path through the ventilator

3.27
ventilator
device for enabling the movement of gases into or out of the construction works

3.28
wind-sensitive control system
control system designed to control two or more banks of ventilators on separate elevations so that only the ventilators not subject to positive wind pressures open in case of fire

3.29
wall
external building surface with an inclination of more than 60° relative to the horizontal

3.30
roof
external building surface with inclination of 60° or less relative to the horizontal

NOTE Shed roofs, independent of inclination angle, are considered to be part of roofs.

4 Symbols

Symbol	Definition	Unit
A	any number used in the classifications	
A_a	aerodynamic free area, expressed in square meters	(m^2)
A_n	nozzle exit area (for open jet facilities), expressed in square meters	(m^2)
A_{pr}	projection area of the ventilator for the side-wind flow, expressed in square meters	(m^2)
A_{sc}	horizontal cross-section area of the settling chamber, expressed in square meters	(m^2)
A_v	geometric area of the ventilator, expressed in square meters	(m^2)
B	width of the open hole of the settling chamber, expressed in meters	(m)
B_n	width of nozzle exit area in open jet facilities, expressed in meters	(m)
B_v	maximum width of the ventilator in the fire-open position, expressed in meters 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	–
H_n	height of nozzle exit area in open jet facilities, expressed in meters	(m)
H_v	maximum height of the ventilator in the fire-open position above the upper surface of the settling chamber, expressed in meters	(m)
L	length of the open hole of the settling chamber, expressed in meters	(m)
$\dot{m}_{ing}$	mass flow rate entering the settling chamber, expressed in kilograms per second	(kg/s)
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)

T	temperature, expressed in degrees Celsius	(°C)
ΔT	temperature difference, expressed in Kelvin	(K)
V_{∞}	side-wind velocity, expressed in meters per second	(m/s)
$V_{\mathrm{m,\,sc}}$	mean velocity of the settling chamber, expressed in meters per second	(m/s)
V_{n}	mean nozzle velocity, expressed in meters per second	(m/s)
V_{sc}	local velocities in plane above settling chamber, see Figure B.6, expressed in meters per second	(m/s)
W_{s}	snow load, expressed in pascals	(Pa)
W_{w}	wind load, expressed in pascals	(Pa)
W_{wd}	design wind load, expressed in pascals	(Pa)
α	opening angle of the ventilator, expressed in degrees	°
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	°
θ	angle of installation of ventilators on a roof, 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)
ρ_{air}	density of air, expressed in kilograms per cubic meter	(kg/m^3)

5 Design requirements

5.1 Initiation device

5.1.1 General

To ensure that the natural smoke and heat ventilator opens in the event of a fire, it shall be fitted with an automatic initiation device.

Each ventilator shall be fitted with one or more of the following automatic initiation devices:

a) thermal initiation device;

b) initiation device activated by an electrical signal from a remote source, e.g. a smoke and heat detector system, the interruption of electrical supply or a manually actuated “fire override” switch;

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

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

The response behaviour of thermal automatic initiation devices shall comply with the requirements of ISO 6182-1. Smoke detectors shall comply with the requirements of ISO 7240-7. In addition, a manually operated initiation device may be fitted.

A pneumatic non-fail-safe SHEV, which does not open automatically on loss of power, shall have at least a thermal device and one power source that is mounted directly in the SHEV, unless the required control panel monitors the lines to the SHEV and indicates a failure.

In some specific design cases where it is suitable that the ventilator shall be only manually initiated, the ventilator may be installed without an automatic initiation device.

5.1.2 Thermal initiation device

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

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

a) if the ventilators are installed as wall-mounted ventilators;

NOTE Adverse wind conditions can cause a ventilator, which has been opened by the automatic initiation device, to let in air and not remove heat and smoke.

b) in specific design cases where it is suitable that the ventilators are only manually initiated.

5.2 Opening mechanism

5.2.1 General

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

5.2.2 Integral gas containers

Any gas container forming an integral part of the ventilator shall be equipped with a pressure-release device to prevent an explosion if the container overheats.

5.3 Opening of the ventilator

For on-site testing purposes, there are two types of ventilators:

a) type A, which are able to be opened into their fire-open position;

b) type B, which are able to be opened into their fire-open position and closed remotely.

5.4 Size of the geometric area

The size and form of the geometric area shall be such that it complies with the limitation set by the test apparatus available for the heat exposure test.

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

NOTE As of the publication date of this part of ISO 21927, maximum dimensions of the test apparatus for the heat exposure test are in the range of 3 m.

For ventilators larger than the largest ventilator 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.

5.5 Inputs and outputs (connections)

The SHEV shall be equipped with inputs and/or output that allow its connection with the control panel and power supplies.

6 General testing procedures

For type approval testing, tests shall be carried out in the sequence specified in Clause A.1.

For each test, a test report shall be prepared in accordance with Clause A.2.

Some of the tests mentioned may be omitted when type testing a new product belonging to a product range that has been tested if only detail changes have been made.

The use of additional functions to smoke ventilation (e.g. daily ventilation) and/or add-ons to the SHEVs are permitted if they do not negatively alter the performance of the SHEV.

7 Aerodynamic free area of the ventilator

The aerodynamic free area of the ventilator shall be determined in accordance with Annex B.

For roof-mounted ventilators, the aerodynamic free area is written $A_{a\ Roof}$.

For wall-mounted ventilators, the aerodynamic free area is written $A_{a\ Wall}$.

8 Performance requirements and classification

8.1 Reliability

8.1.1 Reliability classification

The ventilator shall be classified as one of the following:

a) Re A;

b) Re 50;

c) Re 1 000.

The designation A, 50 and 1 000 represents the number of openings into the fire-open position and closing under no applied load in accordance with Annex C.