

Smoke and Heat Ventilation Systems

RWAtoday



Fundamentals

Planning aids

Regulations and
guidelines

Effective smoke control and natural ventilation combined.

ZVEI:

Specialist group
for electrically driven
smoke ventilation
and natural ventilation



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RWA today

Preface by Kurt Klingsohr Dipl.-Ing Chief Fire Officer (Retired)

For centuries, the destructive power of fire has forced man to take preventive measures. Solid roofing and fire walls were tried and developed to limit the spread of fire and associated material damage, and with improved modern materials is still basically applied today.

However, we now know that it is the smoke which accompanies fire, not the energetic effect of the fire itself, that endangers human life and health and that these legally protected rights must be our first concern in all fire protection efforts. When there is a fire in a building, at least in the largely solid structures built in our part of the world, people do not generally come to harm from fire – but they certainly do suffer from the smoke from the fire.

Fire fatalities are smoke fatalities. The products of combustion, often very hot and toxic, are blinding causing reduced visibility leading to panic reactions delaying not only public escape

but the rescue efforts of the fire authorities. At the same time smoke contributes substantially to property damage.

These dangers are best met by the evacuation of smoke from the buildings. A fire must be ventilated so that the smoke does not spread throughout the building – especially not into lobbies, corridors and staircases, which serve as escape routes. This publication examines the question of whether this aim should be achieved by natural openings or by power-operated facilities, and how these facilities are to be dimensioned, manufactured and maintained.

Recognizing the primary importance of „smoke ventilation“ as a complex within „preventative fire protection for buildings“ as an overall system, I commend the essential views presented in this publication as a step towards better smoke ventilation control and thereby better overall fire protection.

Preface by ZVEI The Specialist group for smoke and heat ventilation

„Preventive fire protection is one of the most important measures serving to protect human life and health, and necessary for the preservation of structural works.“

The rapid developments in building technology in most recent times have brought with them increased demands on fire protection systems. Since almost 90% of all fire victims are killed primarily by smoke poisoning, smoke and heat ventilation systems have become an indispensable part of fire protection strategies.

According to the law the planner is liable for ensuring that the smoke ventilation system is correct in technical terms and he is therefore responsible in the event of an emergency for human life.

The group member companies of the ZVEI, specializing in electrically driven smoke and heat ventilation systems, are available to inform and advise architects, consultants and building owners of the latest developments in products and control systems.

In addition, the aim of this publication is to highlight the modes of operation and advantages of electrically driven smoke and heat ventilation systems in a clear and comprehensive way.

This publication outlines the minimum requirements of electric smoke and heat ventilation systems for achieving guaranteed safety. The member firms are manufacturers of complete drive and control systems with decades of experience which is reflected in their products and services.





Fire formation

For combustion to occur, three things must be present:

A flammable substance + an ignition source of sufficient energy + oxygen.

During a fire, considerable quantities of combustion products like smoke gases, oxides, and thermal energy are produced. The most important function of a smoke and heat vent is to effectively evacuate these combustion products from the building.

Fire progress and the spread of smoke

The progress of a fire is for the most part determined by the composition of the burning material, the supply and concentration of oxygen, and the resultant combustion temperature.

Development of smoke gas quantities

Any type of combustion leads to development of smoke gases, which are toxic and poisonous. The enormous quantities of smoke gas that can develop within a very short time when materials burn can be seen clearly in the adjacent diagram. Building materials used for sound proofing or heat insulation in particular produce very high quantities of smoke gas when burnt. Without smoke and heat ventilation, rooms and buildings can be filled completely with smoke gases within just a few minutes. The combustion of just small quantities of foam rubber can fill a staircase completely within just a few minutes.

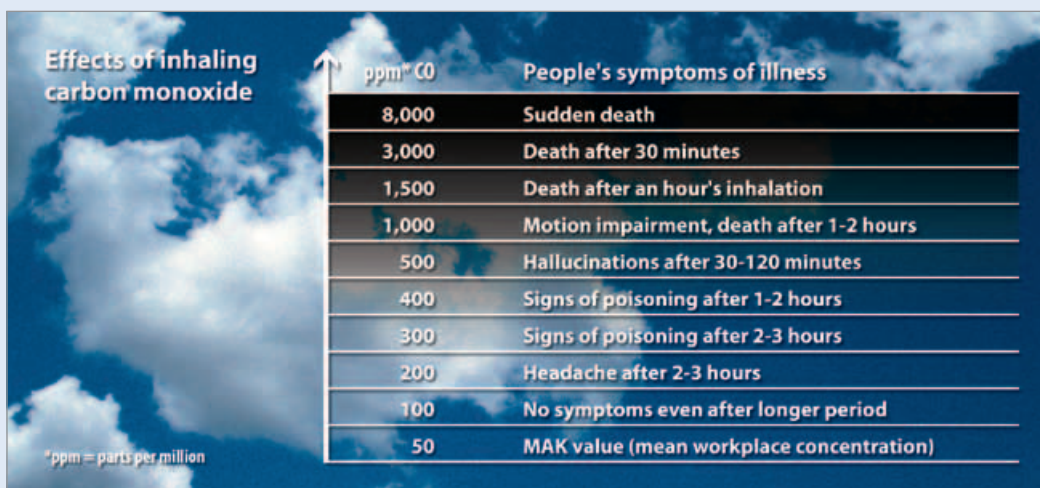
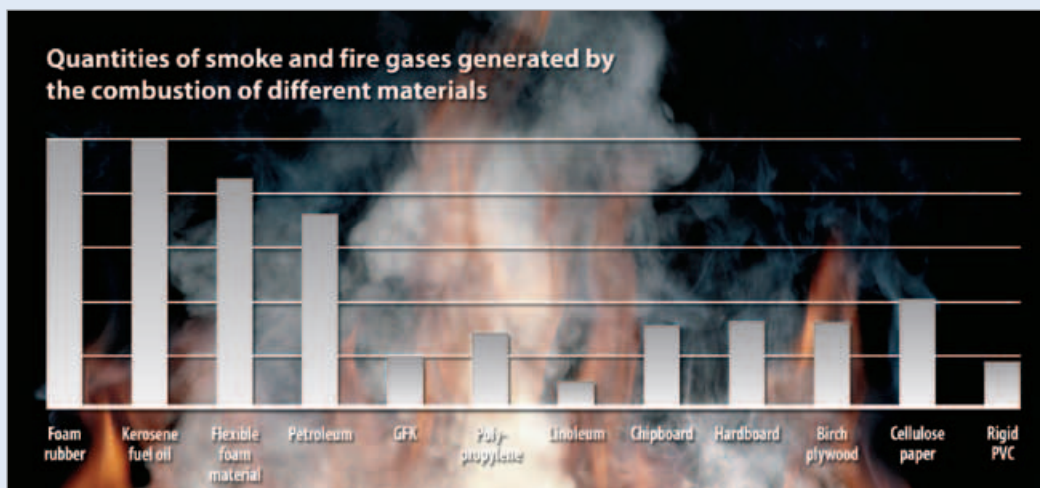
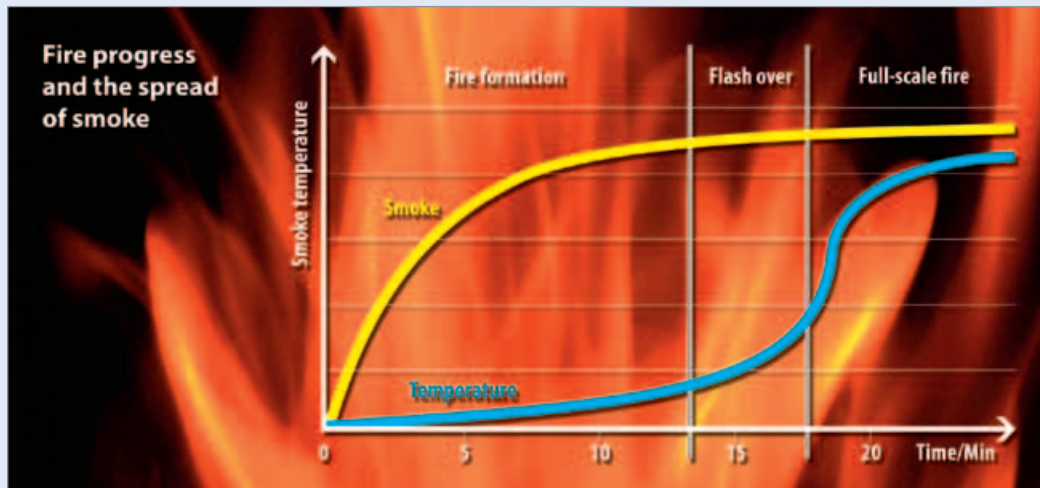
Danger from smoke gases and possible effects

Fire fatalities are smoke fatalities. Smoke from fire is comprised of a mixture of complete and incomplete combustion products. Depending on the nature of the source of the fire, the smoke will contain a mixture of solid particles and soot particles. There are two main causes of death from smoke from fires:

1. Smoke from fires contain lethal toxic constituents.
Depending on type and concentration, these can cause death within a very quick space of time.
2. Smoke from fires contains „corrosive constituents“.
Inhaling these substances cause burning to the lungs and respiratory tract.

In most cases it is the combined effect of both causes which leads to the poisoning and the considerable internal injuries of fire victims. Permanent injuries or the death of the fire victim are often the result (see the diagram on the right).

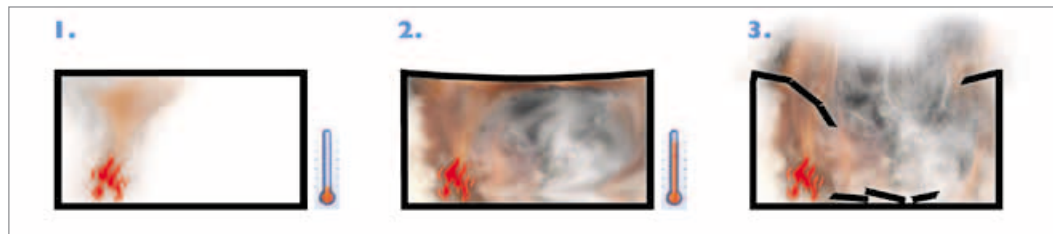
Death from fire as a result of direct contact with the fire is a seldom occurrence. However, for those attempting to escape and for the rescue services the likelihood increases if an uncontrolled „full-scale fire“ develops because of the lack of a smoke and heat ventilation system.





Spread of smoke in buildings without smoke and heat ventilation systems

Large quantities of smoke gas rise from the fire on the basis of thermal lift and fill the room or the building with smoke. The layer of smoke gas makes both active and passive rescuing impossible. It is even possible for the building structure to collapse under the effect of the heat load on the building generated by the smoke gases.



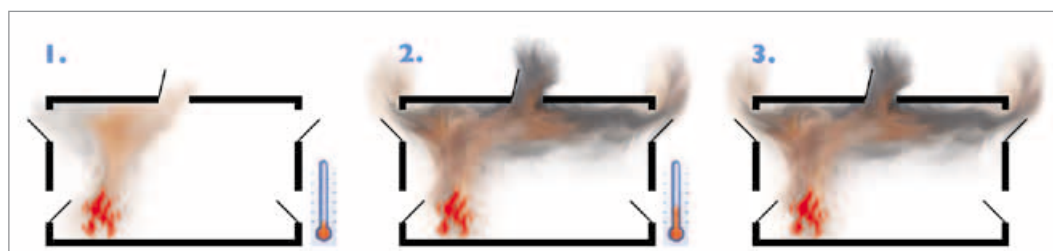
Protection of building structures by smoke and heat ventilation systems

The purpose of smoke and heat ventilation systems is defined in DIN 18232 as follows:

„The purpose of smoke and heat ventilation systems is to release smoke and heat in the case of a fire, helping to reduce the fire load on building components.“

The risk of burning buildings collapsing is another risk factor. Protection of the building structure therefore achieves several aims. It enables people who are attempting to escape to be able to do so unaided; rescue personnel have more time to evacuate the building; neighboring building components or buildings could be affected; under certain circumstances the fire may spread. In all cases, smoke and heat ventilation systems contribute to the protection of building structures. Their purpose is to delay a „flash over“ for as long as possible.

The total burden on economies as a result of fire and related damage is considerable, forever driving corporate expenditure on personnel and property insurance upwards.





Protective aims of smoke and heat ventilation

Because building fires cannot be prevented, the smoke and heat ventilation is of central importance for preventive fire protection.

The protective aims are:		
 ● Protection of human lives	 ● Environmental protection/ Animal protection	 ● Preservation of material assets
The protective aims are achieved by:		
● To keep escape routes free of smoke ● Active rescue ● Passive rescue ● Location of the fire	● Reduction of environmental damage ● Minimization of fire extinction damage ● Minimization of extinguishing agents	● Protection of building structures ● Support of fire-fighting efforts ● Ventilation of the fire ● Minimization of thermal stress



Principle and objectives of natural smoke ventilation

The combustion process associated with fires generates primarily smoke, heat and hot conflagration gases. These combustion products rise upwards in rooms on the basis of the principle of thermal lift to form a layer of smoke and conflagration gases below the ceiling. This layer of smoke gas increases in density the longer the fire continues and fills the room within just a short space of time. With the help of electric motor actuator drive units the smoke and heat ventilation openings in the top part of the room and, if applicable, the supply air openings, are opened automatically in just moments.

These openings therefore make it possible to directly evacuate the rising combustion products such as smoke, heat and conflagration gases out of the building while the fire is still in the early stages of development. The required supply air openings in the bottom area enable the mass flow to be compensated and also reinforce the thermal lift effect.

The point in time that the smoke and heat ventilation system is opened has a major influence on the optimum effectiveness of the „natural smoke ventilation“ system. It is now accepted that automatic smoke detectors should be used, in order that the ventilators open at the first sign of smoke. Every system should as a rule be fitted with manual tripping equipment.

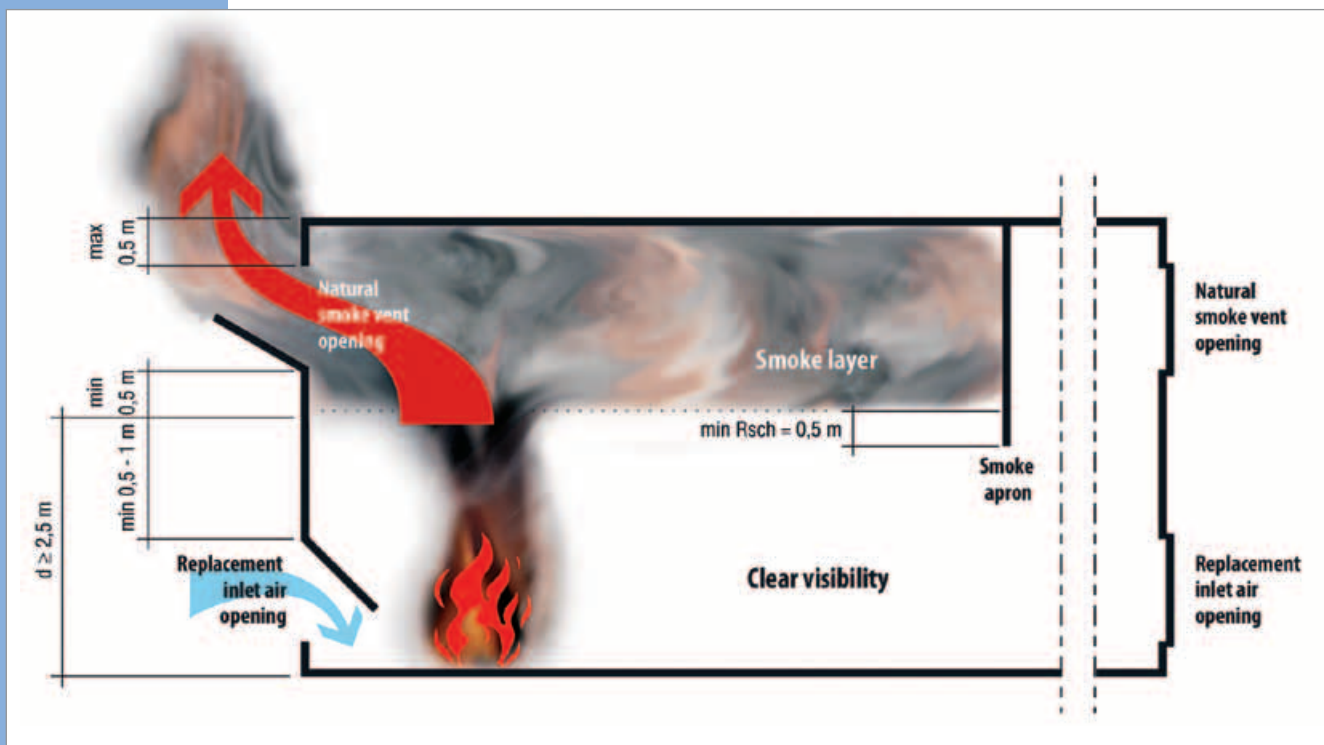
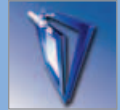


Diagram: Section through a building with a smoke and heat ventilation system. Equilibrium between inflowing air and outflowing gases





Smoke vent, electric motor operated

The electric motor driven system for smoke and heat ventilation consists essentially of the components illustrated in the schematic (see below). The control system is divided into two parts. Heat and Smoke release in the case of fire and daily natural ventilation. Operation in the event of a fire is triggered by automatic alarms, manual alarms or an external alarm generator. When triggered, the smoke and heat ventilation openings open.

Secondary power supply via battery backup and automatic monitoring of all safety functions are also standard. The smoke and heat ventilation function has overriding priority over the natural ventilation function. The natural ventilation function is controlled via ventilation switches, temperature sensors and wind and rain sensors, and it is also possible to link the systems to central building service management systems and/or external fire alarm systems.

The smoke and heat ventilation openings can be divided into smoke and heat ventilation and natural ventilation groups depending on specific requirements. Benefits of electrically driven complete systems include:

- Reliable manual operation
- Fast, efficient automatic operation via smoke and fire detection systems
- Constant system status monitoring
- Fault and alarm indication at the building service management system (optional).
- Natural ventilation at the same time without any additional components
- Smoke and heat ventilation actuators which can be harmoniously integrated in the architecture of the building





Electro-mechanical drive units

The most important component of a system is the electromechanical drive unit, (actuator) used to open and close the smoke ventilation opening. Any actuator used to operate a smoke and heat ventilation opening must meet the following requirements:

- Can be used in smoke and heat ventilation systems
- Can be used on a daily basis for natural ventilation
- Modern in design

Actuators produced by manufacturers belonging to the ZVEI are developed and produced for smoke and heat ventilation applications. Decades of experience backed up by product testing and certification ensure that the products are proven suitable for smoke and heat ventilation. They provide a high degree of structural stability and operational reliability. High production test criteria ensure that they are suitable for daily ventilation purposes. Modern actuator designs provide the perfect blend of performance and aesthetics continually demanded by architects and planners.

Technical requirements include:

- Lifting forces suitable for the weight of the sash and for snow and wind load requirements
- Lifting distance suitable for the required opening area
- Automatic limit stops
- Structural stability up to 300°C / 30 minutes
- Service life of at least 11,000 cycles



Electrical control

The technical specification for the electrical control system and power supply device for the smoke and heat ventilation system must comply with approved technical practice. In terms of structure the control center can be either modular or compact. Practical experience has shown that a compact design is most appropriate for smaller smoke and heat ventilation systems with just one or two actuators, e.g. for stairwells, whereas larger smoke and heat ventilation systems tend to be largely of modular design. The extent to which control centers are divided internally into natural ventilation sections and smoke and heat ventilation sections depends on the specific case. The two main functions of the control center, namely smoke and heat ventilation in the event of a fire and daily natural ventilation must be faultlessly separated, i.e. the smoke and heat ventilation function must have overriding priority. A further requirement is that the alarm lines for automatic alarms and for manual control devices must be monitored. Likewise, the actuator cables also have to be monitored. In order to ensure operational reliability in the event of a power failure, a secondary power supply for at least 72 hours operation must be maintained. Visual indicators for system status are also advisable.

Requirements of electrical control systems and power supply devices:

- Two independent power supplies (mains + battery)
- Each power supply must be capable of operating all drive units at the same time
- Integrated secondary power supply to be maintained for at least 72 hours operation
- Smoke ventilation always has overriding priority (the natural ventilation function is switched off)
- All safety-related functions must be monitored



Manual control devices for smoke and heat ventilation systems



The electric manual control device provides for manual operation of the smoke and heat vent system. It also indicates the operating condition of the system. Rules for the design of such devices are provided in EN 12101 Part 9. This directive does not preclude flush mounting into the building structure. In this case, a frame must be used to recess the alarm switch into the wall. At least one manual control device should be installed at a prominent location in the entrance area to the smoke section. The prescribed mounting height is for the center of the alarm switch to be mounted 1400 mm (± 120 mm) above the floor. The color of the manual alarm switch should generally be orange (as per RAL 2011).

Automatic alarms



Smoke detector

The most common detector is the light-scatter detector, commonly called an optical detector. This smoke detector is characterized by its wide range of application, operational reliability and fast smoke recognition. Tested detectors (as per DIN EN 54, part 7) provide a maximum amount of safety.

Thermal detector

There are two different variants: the thermo-maximal detector, which responds to a particular temperature and the thermo-differential detector, which measures the quantity of temperature rise per time unit and issues an alarm at a particular value.



Fire alarm systems and sprinkler facilities

Volt free auxiliary contacts of fire alarm systems can be used to automatically operate the smoke and heat ventilation system. When an automatic fire extinction facility (for example sprinkler) is operated in conjunction with a smoke and heat vent, the smoke vent system can be opened independently even before the triggering of the sprinkler system. Recent scientific findings and field trials have shown that sprinkler release time is not or insignificantly influenced by already opened smoke and heat vent systems. A heat and smoke exhaust system should operate quickly and independently of any sprinkler system.

Daily ventilation

The critical benefit to the user of an electric motor driven smoke and heat ventilation system is the day-to-day ventilation facility. This enables the user to regulate the room climate on an infinitely adjustable and natural basis. Thanks to the wide range of combination options available for modern smoke and heat ventilation systems, it is possible to meet practically every wish in respect of room climate.

Natural ventilation – Manual



Manual ventilation can be operated on an infinitely adjustable basis with a ventilation switch or, if prioritization of users is required, by a key-operated switch. A range of different operator control options are available.





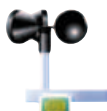
Natural ventilation – Automatic



For automatic ventilation, smoke and heat ventilation systems can be connected to air conditioning systems, louver control systems, fully automated controllers and even simple thermostat-regulated control systems.



Possible and commonly used control and regulation options include:



Time: timer

Temperature: thermostat

Relative humidity: hygrometer

Wind and rain: wind velocity indicator and rain detector

External connections



All connections to non system-specific components are termed external connections. A connection to external facilities is often used to integrate a fire alarm system or a central building management system (BMS). The fire alarm system can in this case serve either as an external alarm trigger or as a display and alarm indicator. The BMS is commonly used for the daily ventilation application and as a fault indication display. The building control system can also be used for positioning the window actuators and thereby for regulating the climate of the building.



Smoke ventilation versus smoke removal

The term smoke ventilation refers to the process of smoke ventilation in the event of a fire (hot smoke ventilation). A stable, low-smoke layer is created close to the floor, which makes it possible to use escape and rescue routes in safety. It is a mandatory requirement in Germany that a natural smoke and heat ventilation device in accordance with EN 12101 – Part 2 must be installed wherever natural “smoke ventilation” is required under building regulations.

The purpose of smoke removal is cold smoke ventilation, which is for removing any smoke remaining in the building after a fire. The device used here is a building product without any safety relevance and which is listed in Building Rules List C.

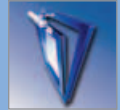
Natural smoke and heat ventilation devices

Natural smoke and heat ventilation devices are designed to ventilate smoke and hot gases from buildings in the event of fire. According to EN 12101 Part 2, these building products are comprised of the following components:

- Drive unit with brackets (3)
- Matching hardware system, if applicable
- Window profile (1)
- Infill (2)
- Window hardware



Smoke vent,
electric motor
operated



EN DIN 12101 Part 2 - Legal background

Harmonized European standard EN 12101 Part 2 sets out the requirements of the natural smoke and heat ventilation device as a building product and provides rules on the testing, classification and the CE mark of conformity for such products. The purpose of the CE mark of conformity is to facilitate the import and export of goods within the EU. By applying the CE mark of conformity to a product, the manufacturer confirms that the product conforms with all valid European directives applicable to it.



The standard stipulates the following requirements for the testing and classification of natural smoke and heat ventilation devices:

- Determination of the aerodynamic opening area
- Testing of reliability
- Function tests under load
- Function testing at a low ambient temperature
- Structural stability testing under wind load
- Testing of the impact of heat

Certification in accordance with EN 12101 Part 2

Conformity procedures as required by EN 12101-2 are described in Appendix ZA.

Product	Use	System for certification of conformity
Natural smoke and heat ventilation devices	Fire protection	1

Appendix ZA to this standard stipulates that the following are mandatory requirements:

- Initial type testing (ITT)
- In-company quality controls
- Initial inspection and continuous external monitoring by a certified organization



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Building regulations: Standard building regulations, building regulations of the federal states and special building regulations

Regulations on fire protection for buildings are provided in building regulations. Since building regulations fall under the legislation of the federal states in Germany, each state has its own building regulations, and the same applies to special building regulations. The latter cover all requirements pertaining to special types of buildings. The respective building regulations contain information on the dimensioning of smoke removal and smoke ventilation systems. An overview of the contents of these regulations is provided below:

MBO standard building regulations:

The standard building regulations (Musterbauordnung [MBO]) form the basis for the state building regulations and have been jointly drawn up by the federal states. They set out the objectives for fire protection, since buildings must as a general rule comply with general statutory requirements.

Standard building regulations (Musterbauordnung [MBO]), Section 3 (1) (as issued in November 2002)

„Structures shall be arranged, constructed, altered and maintained in such a way as to ensure that no risk is posed to public safety and order, and in particular life, health and the natural basis of existence.“

Standard building regulations (Musterbauordnung [MBO]), Section 14 (as issued in November 2002)

„Physical structures shall be arranged, constructed, altered and maintained in a manner conducive to preventing the outbreak and spread of fires and smoke (spread of fire), and, in the event of fire, to facilitating the rescue of people and animals and effective firefighting.“

The general provisions of the standard building regulations (MBO) are incorporated in the building regulations of the federal states in more or less the same wording and given further detail in the legal text of the respective building regulations and associated supplementary regulations for special buildings. The special building regulations in each of the states are also based on standard regulations, and regulations under public and private law also apply.

The following tables can therefore provide no more than an overview and it is always necessary in addition to take account of the regulations in the federal state in which the built structure is to be erected.

Standard building regulations (Musterbauordnung [MBO]), Section 35 (8) (as issued in November 2002)

„Provisions must be made for all required stairwells to be capable of ventilation. They must have windows with a clear area of at least 0.50 m² which are capable of being opened and which lead directly into the open in every floor above ground level. In the case of inner stairwells required in buildings and stairwells required in buildings with a height (as defined by Section 2 (3) 3) of more than 13 m, each stairwell must be fitted with a smoke outlet at its head with a clear area of at least 1 m²; it must be capable of being opened from the ground floor and from the upper-most landing.“

Standard building regulations (Musterbauordnung [MBO]), Section 37 (4) (as issued in November 2002)

„Every basement level without windows must be provided with at least one opening leading into the open in order to enable smoke to be evacuated. Shared light shafts for superposed basement levels are not permitted.“




Standard building regulations (Musterbauordnung [MBO]), Section 39 (3) (as issued in November 2002)

„Lift shafts must be capable of being ventilated and must be provided with smoke outlets of a size equivalent to at least 2.5 percent of the ground area of the lift shaft, but no less than 0.10 m². The smoke outlets must be fitted in positions where the wind cannot have a negative influence on the escaping smoke.“

Standard building regulations (Musterbauordnung [MBO]), Section 51 (as issued in November 2002)

„Special requirements may be made“ in particular cases in relation to special buildings in order to safeguard the general requirements contained in Section 3 (1). (...) 11. ventilation and smoke removal (...)”

The table on pages 16-17 provides an overview of the requirements of the building regulations of each of the federal states in relation to smoke ventilation in stairwells.

Important: Extracts from the latest versions. The regulations are subject to constant amendments and these must therefore always be taken into account as well.

Requirements of the standard special building regulations (Muster-Sonderbauverordnungen [SBVO])

The following special buildings are subject to special building regulations and other regulations.

- Multistorey buildings
- Hotels and lodgings
- Shopping centers
- Assembly rooms
- Schools
- Hospitals
- Industrial buildings

Important: Extracts from the latest versions are shown below. The regulations are subject to constant amendments and these must always be taken into account.

Overview of the standard special building regulations (SBVO)

Special building regulations	Date of issue	Structure
Standard Hotel and Lodgings Building Regulations	Dec 2000	No regulations on smoke removal / smoke ventilation or natural ventilation
Standard Building Guidelines for Schools	Jul 1998	Smoke ventilation
Standard Shopping Center Regulations	Sep 1995	Smoke ventilation and natural ventilation
Standard Assembly Room Building Regulations	Jun 2006	Smoke ventilation/removal and natural ventilation
Standard Hospital Building Regulations	Dec 1976	Smoke ventilation and natural ventilation
Standard Building Guidelines for Industrial Buildings	Mar 2000	Smoke ventilation/removal and natural ventilation
Standard Building Guidelines for Multistorey Buildings	Apr 2008	Smoke removal



Requirements of the standard building regulations (MBO) and the building regulations of the federal states (without „safety stairwells“) Dated: 15.11.2009

Federal state	Source	Dated	Smoke vent when?	
	MBO (Standard Building Regulations) Smoke ventilation: Section 35 (8) 3 Ventilation: Section 35 (8) 1 and 2	November 2002, in the version dated October 2008	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Baden-Württemberg	Smoke ventilation: Section 11 (5) of the implementing regulations (AVO) to supplement Sec. 28 of the federal state building regulations (LBO) Ventilation: Section 11 (2) 1 of the implementing regulations (AVO) to supplement Sec. 28 of the federal state building regulations (LBO)	08. Aug 95 in the version of the regulation dated 25. Apr 07; the amending law (ÄndG), adopted by the parliament of the Land on 04. Nov 09, is not taken into account for lack of implementing regulations (AVO)	In the case of stairwells required in buildings containing more than five storeys and in the case of inner stairwells required in buildings, by means of a smoke outlet.	
Bavaria 2008	LBO (Federal State Building Regulations) Smoke ventilation: Article 33 (8) 3 Ventilation: Article 33 (8) 1 and 2	In the version of publication dated 14. Aug 07, last amended by law dated 27. Jul 2009 (valid from 1. Aug 2009)	Stairwells	
Berlin	LBO (Federal State Building Regulations) Smoke ventilation: Section 35 (8) 3 Ventilation: Section 35 (8) 1 and 2	29. Sep 2005 in the version dated 07. Jun 2007	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Brandenburg	LBO (Federal State Building Regulations) Smoke ventilation: Section 31 (10) 2 and 3, and (11) Ventilation: Section 31 (10) 1, and (11)	17. Sep 2008	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m, excluding residential buildings with no more than 2 residential units.	
Bremen	LBO (Federal State Building Regulations) Smoke ventilation: Section 35 (8) 3 Ventilation: Section 35 (8) 1 and 2	Revised version of the LBO adopted by the parliament of the Land on 01. Oct 2009	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Hamburg	LBO (Federal State Building Regulations) Smoke ventilation: Section 33 (8) 3 Ventilation: Section 33 (8) 1 and 2	14. Dec 2005 in the version dated 17. Feb 2009	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Hesse	LBO (Federal State Building Regulations) Smoke ventilation: Section 31 (6) 3 Ventilation: Section 31 (6) 1 and 2	18. Jun 2002 in the version dated 06. Sep 2007	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Mecklenburg West Pomerania	LBO (Federal State Building Regulations) Smoke ventilation: Section 35 (8) 3 Ventilation: Section 35 (8) 1 and 2	18. Apr 2006	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Lower Saxony	LBO (Federal State Building Regulations) Smoke ventilation: Section 34 a Ventilation: § 34	13. Jul 1995, revised issue dated 10. Feb 2003, last amended 14. Nov 2006	No regulations	
North Rhine Westphalia	LBO (Federal State Building Regulations) Smoke ventilation: Section 37 (12) Ventilation: Section 37 (11) 1 and 2	01. Mar 2000 in the version of the law dated 28. Oct 2008	In the case of buildings containing more than 5 storeys above ground level and for inner stairwells required in buildings	
Rhineland-Palatinate	LBO (Federal State Building Regulations) Smoke ventilation: Section 34 (11) Ventilation: Section 34 (10)	24. Nov 1998 in the version dated 04. Jul 2007	In the case of buildings containing more than 5 storeys above ground level and for stairwells required in buildings where not adjacent to an external wall	
Saarland	LBO (Federal State Building Regulations) Smoke ventilation: Section 35 (5) 3 Ventilation: Section 35 (5) 1 and 2	18. Feb 2004 in the version dated 21. Nov 2007	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Saxony	LBO (Federal State Building Regulations) Smoke ventilation: Section 35 (8) 3 and 4 Ventilation: Section 35 (8) 1 and 2	28. May 2004 in the version dated 30. Jul 2008	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Saxony-Anhalt	LBO (Federal State Building Regulations) Smoke ventilation: Section 34 (8) 3 Ventilation: Section 34 (8) 1 and 2	20. Dec 2005	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Schleswig-Holstein	LBO (Federal State Building Regulations) Smoke ventilation: Section 36 (8) 3 Ventilation: Section 36 (8) 1 and 2	22. Jan 2009	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	
Thuringia	LBO (Federal State Building Regulations) Smoke ventilation: Section 33 (8) 3 Ventilation: Section 33 (8) 1 and 2	16. Mar 2004 in the version dated 05. Feb 2008	In the case of inner stairwells required in buildings and stairwells required in buildings with a height of more than 13 m	



**(LBO) regarding smoke ventilation and natural ventilation of „required stairwells“**

Smoke vent where?	Smoke vent size?	Operation points where?	Ventilation
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell; windows may be designed for use as smoke outlets if they are situated at a sufficiently high position.	Clear area of at least 1 m ²	Must be capable of being opened from the ground floor. Smoke outlets may be required to be capable of being operated from other positions. Exceptions may be permitted.	Required stairwells must be located adjacent to an external wall and in each floor of the stairwell above ground level must have windows which are capable of being opened.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing	Required stairwells: Every floor above ground level must have windows measuring at least 0.6 m x 0.9 m (width x height) which are capable of being opened, have a spandrel of no more than 1.20 m in height, and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 5 % of the building area, but no less than 1 m ²	Ground floor and upper-most landing.	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing. Clause 4: In the case of stairwells with a building area of over 40 m ² , special precautions must be taken to provide support for rescuing of persons.	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing.	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing.	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
No regulations	No regulations	No regulations	Stairwells must be capable of being ventilated. Stairwells adjacent to an external wall must have windows, with the exception of residential buildings with no more than two residential units.
At the head of the stairwell	Clear area of at least 5 % of the building area, but no less than 1 m ²	Ground floor and upper-most landing. Exceptions (from all requirements) may be permitted.	Required stairwells located adjacent to an external wall must have windows measuring at least 0.5 m ² on each floor, and these must be capable of being opened.
At the head of the stairwell	Clear area of at least 5 % of the building area, but not less than 1 m ²	Ground floor and upper-most landing. Other operating points may be required. Exceptions from all requirements may be permitted.	Required stairwells must be capable of being ventilated. In the case of stairwells adjacent to the external wall in category 3 + 4 buildings, every floor above ground level must have windows measuring at least 0.6 m x 0.9 m (width x height) which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing.	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.
At the head of the stairwell	Clear area of at least 1 m ²	Ground floor and upper-most landing	Required stairwells: Every floor above ground level must have windows with a clear area of at least 0.5 m ² which are capable of being opened and which lead directly into the open.

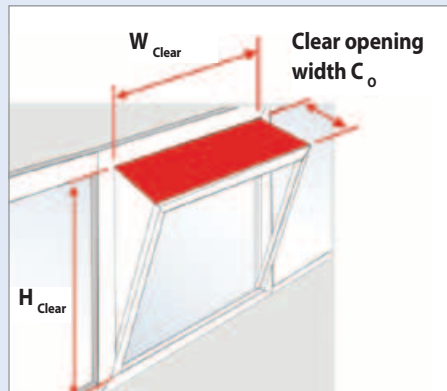




Aerodynamic and geometric ventilation area

In dependency on the basis for the planning work, a distinction is made between the aerodynamic and the geometric opening area. It is important to establish at the outset in the planning phase which method is to be used for determining the smoke and heat ventilation areas for further design work. Requirements in respect of smoke removal systems (e.g. in stairwells) are generally based on a geometric opening area. The requirement for an aerodynamic opening area, on the other hand, presupposes the use of a smoke ventilation system and hence a natural smoke and heat ventilation device.

The German standard building regulations and associated state building regulations generally require a geometric ventilation area for the removal of smoke from stairwells, elevator shafts and basements in buildings. This value can be determined in advance on the basis of the following diagram. The available geometric opening area is determined by taking direct measurements on the available smoke and heat ventilation opening.

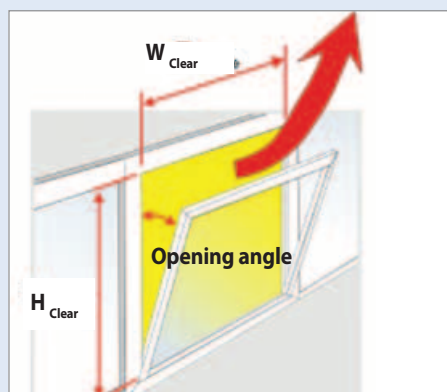


$$A \text{ (geometric area)} = C_o \cdot W_{\text{Clear}}$$

Where the opening angle is greater than 60°, the calculated value “A” should be used for the maximum clear opening area of the window.

The maximum area can only be smaller than or equal to $W_{\text{Clear}} \cdot H_{\text{Clear}}$.

For the smoke vents which are required especially for special types of building it is necessary for the aerodynamic opening area to be calculated. This requires the experimental determination of a flow rate coefficient, as stipulated in EN 12101 Part 2, which allows the aerodynamic opening area to be calculated as follows:



$$A_a \text{ (aerodynamic area)} = W_{\text{Clear}} \cdot H_{\text{Clear}} \cdot C_{v0}$$

C_{v0} = Experimentally verified flow rate coefficient in dependency on the opening angle.

Fixtures installed in the opening on the wall which is a statutory requirement under building regulations will have an influence on the flow rate and this change must be accounted for by a coefficient.

Supporting regulations:

- EMC and low voltage directive for the electric drive unit used
- Machinery directives and German trade association guidelines BGR232.
See also the ZVEI publication “RWAupdate 3” for power-operated windows
- Standard cable system directive (Musterleitungsanlagenrichtlinie [MLAR]) for the maintenance of electric cable function

**Natural smoke ventilation opening devices**

All conventional window leaf types can be controlled using the opening devices that have been time-tested in use for many years. The following electric motor systems dominate this field:

- Direct openers with rack, spindle or chain drive units
- Scissor drive systems

Depending on the size and weight of the leaf and its installation position, additional mechanical interlocks are used in combination with these systems so that the leafs can be adequately secured against driving rain and wind loads.

Supporting regulations

- Powered windows, see German trade association guidelines BGR 232 and ZVEI publication “RWAupdate 3”
- Maintenance of electric cable function, see the standard cable system directive (MLAR), which has now come into force in all the federal states in Germany.





Which cables are required?

Cable sizes and number of cores

At the heart of every smoke and heat ventilation system is the electrical control unit. This is where all the actuation commands come together. The cables required for connecting up the components will vary depending on the components which are connected. The cables to the manual control devices (smoke and heat ventilation switches) and the automatic alarms (e.g. smoke detectors) are generally multi-core cables with core diameters of 0.8 mm. The permissible length varies according to the system and it is therefore always essential to seek clarification with the manufacturer. Very long cables generally require screening. The connections to the ventilation components (ventilation switches, wind/rain sensors or control from an existing building management control system in the building) are also generally run with multi-core cables with core diameters of 0.8 mm. Here too it is always essential to seek clarification with the manufacturer of the system.

Special attention must be paid to the connecting cables between the electrical control unit (central smoke and heat ventilation control unit) and the actuator drive units. These cables must be sized on the basis of the specific scheme because they carry the power required for opening the smoke and heat ventilation sash. In most circumstances a 3 core cable will be sufficient, but the cross-sectional area must be calculated with reference to overall power consumption and cable length. Incorrect, undersized cables can cause problems with the drive units and even lead to the eventual failure of the complete smoke and heat ventilation system. Only if the installed electrical cables are capable of delivering sufficient power to the motor, and thereby ensuring that the permissible voltage drop is not exceeded, is it possible to be sure that the system will offer fail-safe operation in the event of a fire. The cross-sectional areas must be determined by the responsible planner of the system with reference to the rating information provided by the manufacturer.

Maintenance of cable function

The type of cable used and the associated type of installation required is covered by the standard cable system directive (Musterleitungsanlagenrichtlinie [MLAR]), which applies in all of the federal states. The standard cable system directive is based on the state of the art of technology in the year 2002. As in the directive issued in 1998, this directive distinguishes for the first time between natural smoke and heat ventilation systems and power-operated smoke and heat ventilation systems (fire gas ventilation systems). Whereas earlier versions specified classification E90 in accordance with DIN 4102 Part 12 as a cross the board standard requirement for cable function maintenance, the 1998 version specified for the first time that classification E30 would be sufficient for function maintenance for natural smoke ventilations systems. It is a requirement of DIN 4102 Part 12 that these cables must be tested and approved. The cables must be installed in accordance with the specifications of the cable manufacturer and secured with appropriate fastening materials.

Exceptions in accordance with the standard cable system directive (MLAR) 2002:

A maintenance of function facility for smoke and heat ventilation is not required if the entire cable run is monitored by an early fire detection element with a SMOKE parameter (smoke detector) which sets off the automatic alarm for opening the smoke and heat ventilation system when tripped. In practical terms this means rooms with a smoke and heat ventilation system cable running through them have to be monitored by smoke detector unless the cable is of E30 design.



Flush-mounted installation

As a general rule it is advisable to install cables for smoke and heat ventilation systems on a flush-mounted basis, especially in new buildings. It should be noted, however, that flush-mounted installation is not a permitted form of installation for achieving maintenance of function as set out in DIN 4102 Part 12. For flush-mounted cables to comply with maintenance of function requirements they have to likewise be of E30 classification design or the room has to be protected by smoke detectors.

In all cases it is therefore advisable to consult the applicable authorities on the type of cable installation to be used. Regardless of whether or not the standard cable system directive (MLAR) has been introduced as a technical construction standard in the federal state concerned, reference should be made to the technical solutions and state of the art in technology set out in the standard cable system directive (MLAR 2002). It is always advisable to select the method of cable installation which is the best in technical terms and also the cheapest, not least in the interests of the building owner. In addition, monitoring by automatic smoke detectors also ensures that the smoke and heat ventilation system is always activated at the earliest opportunity.

Cables between junction boxes and electric motor drive units

The cable circuit for the smoke and heat ventilation system ends at the junction box or similar connection point for the drive unit.

The flexible, heat-resistant connecting cable from the drive unit forms part of the electro-mechanical system component and does not form part of the electrical installation.

Summary

Not only must all the required components for a smoke and heat ventilation system be selected with great care, the electrical connections between the components to form a system also require careful planning and equally careful installation. Both specialist technical knowledge and familiarity with the relevant statutory regulations are indispensable.

The member firms of the ZVEI specialist group for electrically driven smoke and heat ventilation systems and ZVEI installer firms are always ready to be of assistance as your competent partners.

You will find your specialist ZVEI firm at:

www.ZVEI.org/sicherheitssysteme or www.ZVEI-errichter.de





Design, installation and function testing

All member companies of the „Specialist group for smoke and heat ventilation systems“ and certified ZVEI installer firms provide competent system planning and design services. Competent planning and design always covers all the costs and materials required for the system, along with details about cable installation and information about how the system operates.

Smoke and heat ventilations systems must always be installed and tested either by the manufacturer or by an authorized and qualified specialist firm in order to ensure that all system-relevant functions are fulfilled without a hitch.

In addition, the building regulations in most of the federal states require that the commissioning of and acceptance inspections for smoke and heat ventilation systems have to be undertaken by certified expert consultants.

Finally, compliance with applicable directives and guidelines is also required (EN, DIN, VDE).

Servicing and maintenance

Statutory regulations require that smoke and heat ventilation systems are serviced and inspected at regular intervals to ensure that they are in proper working order. This work may only be carried out by authorized, qualified personnel. For further information, please refer to the publication “RWAupdate 1”.



Aims and responsibility of the members of the ZVEI specialist group for smoke and heat exhaust ventilation systems

The Members of ZVEI specialist manufacturers group see it as duty and responsibility in a modern and productive society, to fulfill the following aims to the best of their ability:

- to save lives
- to ensure the protection of health and living space
- protection of the environment and animals
- to achieve protection against property damage

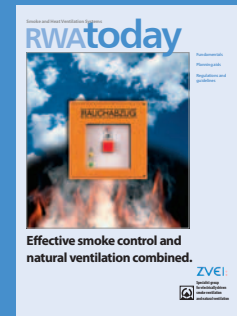
All member companies are certified to DIN ISO 9000 ff quality standards.

Natural smoke ventilation with electrically actuated drives - a concept of the future

By combining modern electronics with high-performance drive units and alarm technology, electrically driven smoke and heat ventilation systems respond and actuate quickly and reliably. The aim of saving lives is fulfilled by quick-response tripping via automatic smoke detectors. Short response times and quick actuation of smoke and heat ventilation openings are essential for saving lives.



More publications are available
from your specialist ZVEI firm or
direct from the ZVEI.



All publications are also available in German.

ZVEI:



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and natural ventilation

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