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Houses — Description of performance —

Part 4: Fire safety

Constructions d'habitation — Description des performances —

Partie 4: Sécurité au feu

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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.

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 15928-4 was prepared by Technical Committee ISO/TC 59, *Buildings and civil engineering works*, Subcommittee SC 15, *Performance criteria for single family attached and detached dwellings*.

ISO 15928 consists of the following parts, under the general title *Houses — Description of performance*:

— *Part 1: Structural safety*

— *Part 2: Structural serviceability*

— *Part 3: Structural durability*

— *Part 4: Fire safety*

Introduction

This part of ISO 15928 is one of a series under the general title: *Houses — Description of performance*. The objective of this series is to identify the methods used to describe the performance of houses. The ISO 15928 series is confined to buildings occupied for residential purposes that may be separated or linked horizontally, but not linked vertically and which have their own access and do not share any common space.

Each part of ISO 15928 relates to a separate attribute. The parts of ISO 15928 do not specify levels of performance and they are not intended to replace national standards or regulations, but to provide a standardized framework to enable the development of national standards and regulations in accordance with World Trade Organization (WTO) requirements. The parts of ISO 15928 do not provide design methods and/or design criteria.

Based on the framework provided by ISO 15928 (all parts), purchasers, regulators and standards writers in their respective countries can describe their requirements in standardized performance terms, as appropriate. Additionally, the manufacturers/providers can respond by describing the performance of their products in a similar manner. The purpose of this part of ISO 15928 is to provide a standardized system of describing performance that can be used to specify performance requirements and performance levels, or to rate houses in terms of fire safety.

NOTE The WTO *Agreement on technical barriers to trade*, Clause 2.8, states: "Whenever appropriate, members shall specify technical regulations based on product requirements in terms of performance rather than design or descriptive characteristics".

Houses — Description of performance —

Part 4: Fire safety

1 Scope

This part of ISO 15928 sets out a method for describing the fire safety performance of houses. It covers user needs, provides performance descriptions, and outlines evaluation processes. It includes the description of relevant parameters for early warning, fire suppression, fire containment, means of escape, control of structural behaviour and emission and spread of fire effluent.

This part of ISO 15928 is intended for use in the evaluation of the design and construction of houses, in the international trading of houses or their sub-systems, and in developing risk-management tools for the protection of houses. It does not specify a level of performance and it is not intended to provide a design method and/or criteria.

This part of ISO 15928 does not cover the performance of houses exposed to wild fire.

NOTE 1 Structural safety and other performance attributes of a house are covered in other parts of this ISO 15928 series.

NOTE 2 The emission of smoke and hot gases from contents in the house when ignited can impact the fire safety performance of a house, but the type or nature of such contents brought into the house is not the subject of the evaluation process.

NOTE 3 The term “wild fire” is used to mean the concept of wild land fire, bush fire and unplanned burning in vegetative fuels, etc.

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 6707-1, *Building and civil engineering — Vocabulary — Part 1: General terms*

ISO 8421 (all parts), *Fire protection — Vocabulary*

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6707-1, ISO 13943:2008, ISO 8421 (all parts) and the following apply.

3.1
fire
process of combustion characterized by the emission of heat and fire effluent and usually accompanied by smoke, flame, glowing or a combination thereof

NOTE Adapted from ISO 13943:2008, definition 4.96.

3.2
fire exposure
extent to which persons, animals or items are subjected to the conditions created by fire

[ISO 13943:2008, definition 4.108]

3.3
fire scenario
qualitative description of the course of a fire with respect to time, identifying key events that characterize the studied fire and differentiate it from other possible fires

NOTE It typically defines the ignition and fire growth processes, the fully developed fire stage, the fire decay stage, and the environment and systems that impact on the course of the fire.

[ISO 13943:2008, definition 4.129]

3.4
house
building occupied for residential purposes and designed as one unit (dwelling)

NOTE 1 The house can be a separate building, or linked horizontally with another house but not linked vertically.

NOTE 2 Where houses are linked, each has its own access and does not share any space in common with another.

NOTE 3 Where houses are linked, the wall between the houses is typically designed and constructed to limit the probability of fire spread between houses.

NOTE 4 Adapted from ISO 15928-2:2005, definition 3.1 and modified to align the definition with concepts of house, housing and dwelling defined in ISO 6701-1 and to include Notes to address whether one house is linked to another.

3.5
parameters
group of variables used to quantitatively describe performance

3.6
performance
behaviour of houses related to users' needs

[ISO 15928-2:2005, definition 3.1]

3.7
performance description
statement that identifies agents which affect performance in a qualitative manner, and establishes how these agents affect the state of the house

3.8
user
person that a house is designed to accommodate

3.9
user needs
design objectives
general statement of requirements for a house that are regarded as being satisfactory by the user

4 Fire safety performance

4.1 User needs

The fire safety performance of a house, which may affect the safety of the occupants of the house and may also lead to property damage to the house or an adjacent property, shall be such that the risk of the following does not exceed a level acceptable to the user:

a) fire ignition,

b) fire growth,

c) fire spread,

d) inadequate early warning,

e) inadequate means of escape,

f) inadequate time to escape, and

g) damage to the house or any adjacent property.

NOTE 1 Risk of economic loss caused by fire damage to the subject house is often addressed through insurance coverage purchased by the house owner.

NOTE 2 Local regulations typically do not include fire safety requirements intended to limit property damage for the subject house.

NOTE 3 The availability and capability of local emergency response services (i.e. municipal fire fighting) can often have an impact on the amount of loss (life and property) in a fire. Whether the impact of such services and the fire safety performance of the house is taken into consideration depends on the user of this part of ISO 15928 and what level of risk they consider acceptable.

4.2 Performance description

The performance description is an expression of the ability of the house, with an appropriate degree of reliability, to withstand fire and provide protection to occupants and adjacent properties when subject to any accidental fire in terms of the probability of:

a) ignition occurring, either from internal or external causes,

b) a fully developed fire occurring,

c) the occupants having adequate time to safely escape, and

d) the fire spreading and damaging nearby properties.

NOTE 1 Performance related to fire safety of occupants can also be assessed in terms of expected risk to life relative to the number of deaths and injuries.

NOTE 2 In this part of ISO 15928, the durability of materials is not considered to have a bearing on the fire safety performance of the house.

4.3 Principles for describing fire safety performance

The fire safety performance can be described by the fire exposure, the resistance of the structure under the effect of those fire conditions, and in terms of a combination of some or all of the following:

a) actions relevant to both a smouldering fire scenario and a flaming fire scenario,

b) early warning,

c) fire suppression,

d) containment of fire spread,

e) control of emission and spread of fire effluents,

f) adequate means of escape,

g) control of structural behaviour, and

h) the nature of the occupants of the house.

NOTE Behavioural scenarios can be used to consider the different behavioural aspects of the occupants, including evacuation behaviour, movement behaviour, pre-movement behaviour, recognition behaviour and response behaviour.

5 Parameters for the description of performance

The fire safety performance of a house shall, as a minimum, be described by a combination of parameters provided on each of the relevant building elements or building characteristics described in 4.3.

5.1 Parameters for the description of fire actions

The parameters for describing fire actions are:

a) the nature of the fire (e.g. smouldering and flaming fires),

b) the characteristics of the occupants (e.g.number,age, ability, mobility).

5.2 Parameters for describing early warning

The parameters for describing the early warning performance of the house are:

a) number of devices,

b) location of devices,

c) type of devices, and

d) interconnectivity between devices within a house, within a building and with the emergency services.

NOTE See the relevant International Standards for guidance on warning devices, listed in A.5.2.

5.3 Parameters for describing fire suppression

The parameters for describing the performance of fixed fire suppression equipment are the presence versus absence, automatic versus manual type of suppression agent, coverage and density of agent distribution. Similar parameters apply to portable fire suppression equipment such as manual fire extinguishers.

NOTE Fire suppression efforts by responding emergency fire service personnel can impact fire safety. The use of the standard determines whether manual suppression by fire fighters is taken into consideration in evaluating the fire safety performance of the house.

Where taken into consideration, the parameters for describing performance are the type of fire department (volunteer/career), proximity of the fire station and availablity of local water supplies.

5.4 Parameters for describing containment of fire spread

The parameters for describing the containment of fire spread are:

a) the resistance to fire spread in terms of the amount of time required for the fire spread from one room to another, from one storey to another, or from one house to another, and

b) the combustibility characteristics of the materials (i.e. ignitability, flame spread, heat release).

5.5 Parameters for describing control of emission and spread of fire effluents

The parameters for describing control of emission and spread of fire effluent are:

a) the nature and concentration of combustion gases,

b) smoke obscuration.

NOTE 1 The emission of fire effluents from the burning contents in a house fire also has an impact on fire safety.

NOTE 2 The impact of the structural elements and finishes on potential spread of hot fire gases and toxic smoke is discussed in 5.4.

5.6 Parameters for describing adequate means of escape

The parameters for describing the adequacy of the means of escape are:

a) the number and location of accessible openings, including those available when normal routes are not available,

b) the maximum travel distance to the nearest accessible opening,

NOTE The occupants and their expected movement behaviour are also critical when considering the minimum "performance" levels for means of escape.

5.7 Parameters for describing control of structural behaviour

The parameters for control of structural behaviour are described by a combination of control of the collapse mode under fire conditions and the fire resistance of the load bearing system and components.

The parameter for describing the performance relating to the fire resistance of load bearing systems and other structural components is the amount of time the load bearing system and components can maintain their stability during a fire.

NOTE 1 The amount of time an element continues to demonstrate fire resistance is usually measured in minutes (e.g. 15 min, 30 min, 45 min, and 60 min).

NOTE 2 Structural collapse in a fire can be a factor affecting availability of escape routes and both damage to the subject house as well as damage to a neighbouring house(s)/building(s).

6 Evaluation

6.1 General

Evaluation may be carried out by:

a) analysis,

b) testing,

c) service experience, or

d) a combination of the above.

In evaluating any design, the design should present enough detailed information to allow its evaluation in terms of meeting the fire-safety objectives when assessed against the design fire scenarios. The level of safety can be ensured by comparing the proposed design to acceptable or tolerable levels of risk. Guidance on the key elements needed for fire safety analysis of the different steps and their linkages in an evaluation process has been developed [67], [68].

6.2 Analysis

Whether the fire safety performance criteria have been satisfied can be determined by an analysis of the trial design. Analysis involves consideration of ignition sources and consideration of the fuel load and fuel types along with interaction between the fire and different forms of suppression, and their expected effectiveness. Analysis is also needed of the generation of fire effluents, based on types of materials exposed to the fire and their fire properties. Analytical methods can be used to determine fire effects on individual structural members relative to general stability in a fire. Analysis methods can also be used to evaluate the occupants of a house and their condition which affects their ability to escape. Such an analysis considers, among others, the location, type and activity of the occupants, their susceptibility to fire effluents, and ability to move through available escape routes [55], [61].

6.3 Testing

Testing of structural elements shall incorporate a realistic representation of materials, loading conditions, boundary conditions and construction practices. Testing for evaluating structural fire resistance shall be full-scale unless all scale effects can be appropriately estimated. Testing of finished materials (both interior and exterior) shall include materials representative of end-use applications.

6.4 Service experience

Service experience shall comprise a sufficient number of representative fire loss examples in residential occupancies, exposed to similar or more severe design fires and fire scenarios, together with adequate documentation.

6.5 Combination

A combination of analysis, testing and service experience may be used for evaluation. Simplified analytical procedures using a combination of results of fire testing and fire loss experience may be used.

Annex A
(informative)

Commentary

A.1 General

This annex includes background information on this part of ISO 15928, guidance on its use and suggestions on good practice.

Details on references and documents referred to in any Note in this part of ISO 15928 or in this Annex are provided in the Bibliography.

A.2 Comments on Scope (Clause 1)

The purpose of this part of ISO 15928 is to standardize the method of describing the fire safety performance for housing, i.e. to standardize the parameters by which the fire safety aspects of house performance are expressed or defined. This part of ISO 15928 does not specify a level of performance and it is not intended to provide design method and/or criteria.

This International Standard is part of the ISO 15928 series of standards which are designed to facilitate the communication between the specifier (purchaser/user) and the provider (seller). Structural safety, serviceability and durability attributes are covered in other parts of ISO 15928.

The intent is to provide a standardized system that is to be used to realize performance description.

The objectives of this part of ISO 15928 are as follows:

a) to facilitate international trade in housing systems and housing products, and to exchange housing information and knowledge by eliminating technical barriers;

b) to facilitate innovation in housing by providing a systematic framework for evaluation and acceptance;

c) to establish user needs related to fire safety in specific technical engineering terms in order to facilitate communication among all stakeholders.

This part of ISO 15928 may also be useful in increasing consumer product awareness and in developing quality systems for houses.

A.3 Comments on Normative references (Clause 2)

Only references relevant to fire safety and quoted in the text are listed here. Other useful references are listed in the Bibliography.

A.4 Comments on Fire safety performance (Clause 4)

A.4.1 Comments on User needs (4.1)

In identifying and considering user needs, users are taken to be the owners and the occupiers of the house. The user needs for fire safety are thought of in terms of the safety of the people living in the house. Those inside the house may be injured by the fire or the structural collapse during the fire. Adjacent properties are also protected to a certain extent by reducing the risk of external fire spread. The acceptable level of performance may vary from user to user and may depend on user expectation, especially as it relates to economic loss from damage to the house.

The user needs in the event of a fire are to limit the probability of:

— ignition either from internal or external causes,

— a fire becoming fully developed once ignition is initiated,

— injuries to occupants of the house,

— damage to the house, and

— fire spread to and/or damage of nearby properties.

NOTE Users of this part of ISO 15928 can include regulators, specifiers, or emergency services personnel.

A.4.2 Comments on Performance description (4.2)

The main objectives of fire safety performance are to ensure that the available safe escape time for occupants is adequate and that damage to the house and the risk of fire spread to adjacent properties is limited. The available safe escape time in a fire should exceed the required safe escape time and is a function of various time-related factors such as detection time, evacuation time, time to incapacitation, time to structural collapse etc. These, in turn, depend on the performance of the house as a whole and/or of its parts, e.g. built-in or inherent fire resistance, alarm system, active suppression, etc., as well as the movement behaviour and movement time of the occupants.

Some of these time-related factors and building performance characteristics may be assessed or measured; others, that cannot be assessed or measured, can be described based on empirical knowledge. The risk of fire spread and collapse can be controlled by selection of materials with appropriate fire characteristics, as needed, relevant to the required and available safe escape time.

Thus, a “high level” performance description of fire safety would be the available safe escape time and the risk of fire spread and collapse. The corresponding verification method could be established by using fire engineering principles. Alternatively, a “lower level” performance description whose verification methods are readily available can be established by describing the performance attributes as proposed in this part of ISO 15928.

NOTE 1 When the user has taken into consideration the impact of local fire fighting emergency response, the fire safety performance will be impacted by the fire brigade response time and fire fighting capabilities, including available water supplies and access to the house.

NOTE 2 In the context of this part of ISO 15928, fire fighters are not considered to be users of the building and no performance indicators have been specified for their safety.

A.4.3 Comments on Principles for describing fire safety performance (4.3)

The fire performance attributes are of two types:

a) attributes for limiting the likelihood of a fully developed fire, and

b) attributes for the safety of the occupants and neighbouring properties.

NOTE 1 Fire properties of the construction materials as well as the contents of the house can affect both of the above.

NOTE 2 The contents of a house are not the object of concern of this part of ISO 15928.

It is difficult to directly quantify the type and size of a fire that might occur and the subsequent effect it may have on the level of structural safety and the time to escape. However, it is possible in some cases to consider the effect of specific design fires and expected response of the structure and any active fire protection systems for each fire scenario. Analytical procedures can also be used to assess the effects that the changes in the fire and the different responses have on the level of risk to the occupants.

It is also difficult to evaluate the occupant characteristics and the subsequent effect their capability of self-preservation and evacuation may have on the assessed level of fire safety. The susceptibility to fire effluent and ability to perceive danger, respond and move to a safe location, affect the required time to escape. However, it

is possible in some cases to develop rough estimates of egress time, although such estimates should be used with caution [72].

A.5 Comments on Parameters for the description of performance (Clause 5)

There are multiple factors to be considered for describing the performance of the house in a fire. Those expected to have the greatest impact on the level of fire safety are described in the following subclauses.

A.5.1 Comments on Parameters for the description of fire actions (5.1)

A.5.1.1 Nature of the fire

The factors chosen to describe the nature of the fire can involve a variety of factors that play a significant role in the fire's development. These include: form of ignition, type of fuel ignited, location of the fire, effects of compartment geometry, initial status of doors and windows, ventilation (whether natural or mechanical), type of construction and lining materials. Guides have been developed to provide specific details and guidance on how to establish design fire scenarios [71], [74], [75], [76].

A.5.1.2 Characteristics of the occupants

The occupant characteristics also involve a variety of factors that play a significant role in their behaviour and safety in a fire. The analysis and prediction of human behaviour during a fire requires a system view of the people, environment and the fire. Occupant characteristics can be divided into two categories, physical capabilities and cognitive capabilities. Guides have been developed to provide specific details and guidance on critical aspects to be considered in predicting human behaviour in a fire [77].

A.5.2 Comments on Parameters for describing early warning (5.2)

The factors to be considered when describing the performance relating to early warning are:

a) time lag between the start of a fire and its detection and the activation of an alarm,

b) reliability of the detection and alarm system (e.g. percentage of failures in its functioning), and

c) effectiveness of the alarm system in alerting the occupants.

The following ISO documents provide further guidance on parameters describing the performance of fire detection and alarm device/systems: References [31] [32], [33], [34], [35], [36], [37], [38].

A.5.3 Comments on Parameters for describing fire suppression (5.3)

The factors to be considered when describing the performance of a fire suppression feature are the following.

a) Fixed fire suppression, including sprinkler systems and chemical extinguishing systems:

   1) time lag between the start of a fire and the beginning of functioning of the suppression system,

   2) area that can be covered by the system,

   3) duration of its functioning,

   4) reliability of its functioning (e.g. percentage of failures in its functioning), and

   5) effectiveness of the system in controlling or extinguishing the fire.

NOTE 1 The reliability of sprinkler systems is often affected in part or in whole by human error (i.e. closed control valves). Some devices are designed to make human error failures less likely.

b) Manual fire suppression(including portable fire extinguishers):

   1) ease and simplicity of operation,

2) size of fire that can be controlled or extinguished by the unit,

3) duration of its functioning,

4) reliability of its functioning (e.g. percentage of failures in its functioning), and

5) effectiveness of the agent in controlling or extinguishing the fire.

NOTE 2 The user of this part of ISO 15928 determines whether manual fire suppression by fire fighters is also taken into consideration in evaluating the fire safety performance of the house.

Where the impact of fire fighter intervention on suppression of the fire is evaluated, the factors to be considered include (site) accessibility for fire brigade vehicles, response time, number of persons as first responders, size and water flow capacity of fire mains and other fire fighting equipment, and accessibility for fire fighters to various parts of the house.

The following ISO documents provide further guidance on the parameters for describing the performance of fire suppression systems/devices: References [14], [22], [23], [24], [25], [26], [27], [28], [29], [30].

A.5.4 Comments on Parameters for describing containment of fire spread (5.4)

One of the factors for describing interior fire containment is the resistance of internal walls and floors to fire spread in terms of the amount of time during which the walls or floors retard the propagation of fire from one room to another or from one storey to another. Openings in the interior walls and floors to allow for free movement of people and goods increase the probability of fire spread within the house.

In some circumstances, fire compartments may be incorporated within a single house to limit probability of fire spread. Where houses are linked together, the wall separating houses is typically designed to provide a higher level of fire resistance than that usually prescribed for the structural elements of the house. The fire resistance of floors and walls can be determined through testing.

NOTE 1 The fire resistance of the structure also relates to structural stability in a fire and can impact the availability of escape routes (see A.5.6 and A.5.7).

NOTE 2 Except for the walls that separate houses that are linked together, local regulations typically do not prescribe a minimum fire resistance for structural elements in houses.

Window openings that are vertically adjacent to one another, storey to storey, can also allow fire spread, regardless of the type of cladding, due to extension of the flame into open windows or flame radiation through the windows igniting combustible materials, e.g. curtains.

Another factor for describing interior fire containment is the resistance of the finishes or exposed surfaces of internal walls, ceilings and floors to fire and fire spread in terms of the propensity for the materials to ignite and propagate flame and release heat. The time to ignition, rate of flame spread and total heat released can be determined by testing and depends upon the fire test procedure, which should relate to the prescribed design fire and fire scenario for interior fires.

NOTE 3 Except for the walls and ceilings, local regulations typically do not prescribe limits on the combustibility of floor surfaces in houses.

The factor for describing exterior fire containment is the resistance of external walls and roofs to fire spread in terms of the amount of time during which the external walls (including windows) or roof of a house resist the propagation of fire from another house or from one storey to another within the same house. Similar to interior finishes, this can be evaluated based on the resistance of the exposed surfaces of external walls and roof to fire and fire spread in terms of the propensity for the materials to ignite and propagate flame. The time to ignition and rate of flame spread can be determined by testing and depend upon the fire test procedure, which should relate to the prescribed design fire and fire scenario for external fires.

This parameter can be evaluated based on the thermal flux caused by convective and radiative heat transfer from a neighbouring house that is on fire and the ability of the exterior finishes on the external walls and roofs

not to ignite, as well as resistance to ignition propagation caused by flying embers or burning brands. Windows in exterior walls can allow fire to spread from building to building via this heat transfer mechanism.

NOTE 4 The user of this part of ISO 15928 determines whether fire suppression by fire fighters is also taken into consideration in evaluating the fire safety performance of the house.

Where the impact of fire fighter intervention on the spread of fire (internal or external) is evaluated, the factors to be considered include (site) accessibility for fire brigade vehicles, response time, number of persons as first responders, size and water flow capacity of fire mains and other fire fighting equipment, and accessibility for fire fighters to various parts of the house.

NOTE 5 A specific time factor based on expected fire brigade response and arrival at the house is often used in evaluating potential for building-to-building fire spread.

The following ISO documents provide further guidance and specific test procedures: References [1], [9], [10], [13], [15], [16], [17], [18], [19], [20], [21], [39], [40], [44], [45], [46], [48], [49], [56], [63].

A.5.5 Comments on Parameters for describing control of emission and spread of fire effluents (5.5)

The factor for describing performance of the materials used in a house relative to the products of combustion produced in a fire include mass or volumetric smoke production rates, and species production rates, both of which are influenced by the ratio of air to fuel in the combustion zone. The effects of smoke and other combustion products are often evaluated relative to their effect on tenability and time available for escape, based on end points such as incapacitation and lethality, using concentration-time profiles.

Factors for describing performance of the house relative to reduced visibility due to obscuration by smoke include specific optical density of smoke and opacity of smoke.

Further guidance on the measurement of smoke and combustion products from burning materials and their impact on safety is available from the references in the Bibliography.

NOTE 1 The fire effluent produced from burning materials and its propagation (spread) throughout the house can be affected by whether the “design fire” is prescribed as one involving flaming combustion or smouldering combustion.

NOTE 2 Emission and propagation of smoke and toxic gases can have a direct effect on the time available for escape and usability (tenability) of escape routes as well as the movement behaviour of the occupant (see 5.6).

The following ISO documents provide further guidance on determining and evaluating emission of smoke and toxic gases from building materials: References [20], [51], [53], [55], [60], [61], [64], [65], [66], [67], [70].

A.5.6 Comments on Parameters for describing adequate means of escape (5.6)

The factors for describing performance of adequate means of escape are:

a) the time period during which a means of escape remains useable,

b) the exit capacity (number of people the exit can accommodate), and

c) the number of means of escape, including those available when normal routes are not useable.

NOTE 1 The fire resistance of the structure and structural stability in a fire impacts the availability of escape routes (see A.5.7).

The adequacy (safety) of the means of escape in a fire is also related to the different behavioural aspects of the occupants, including evacuation behaviour, movement behaviour, pre-movement behaviour, recognition behaviour and response behaviour. It is possible in some cases to develop rough estimates of egress time, but such estimates should be used with great care [69].

Additional guidance on the significant fire research work undertaken in the area of human behaviour in fires can be found in specific references [75], [76].

NOTE 2 The user of this part of ISO 15928 determines whether evacuation of occupants by fire fighters is also taken into consideration in evaluating the fire safety performance of the house.

Where the impact of fire fighter intervention on the evacuation of occupants is evaluated, the factors to be considered are site accessibility for fire brigade vehicles, response time, number of persons as first responders, type of fire fighting equipment, and accessibility for fire fighters to various parts of the house.

The following ISO documents provide further guidance on determining and evaluating adequate means of escape: References [55], [62], [68], [70].

A.5.7 Comments on Parameters for describing control of structural behaviour (5.7)

The factors for describing performance of the structural behaviour relative to fire resistance include fire stability, fire integrity and thermal insulation. All of these performance factors are measured according to “time of occurrence” and can be determined through calculation and/or fire testing. Thermo-physical and mechanical properties of structural materials at elevated temperatures can also be determined based on testing.

NOTE The fire stability of the structure impacts the fire spread and availability of escape routes (see A.5.4 and A.5.6).

The following ISO documents provide further guidance on determining fire resistance and structural properties at elevated temperatures using calculations or testing: References [1], [2], [3], [4], [5], [6], [7], [8], [11], [12], [43], [54], [59], [69].

A.6 Comments on Evaluation (Clause 6)

A.6.1 Comments on General (6.1)

The specifier should indicate the method required for evaluation, usually a combination of analysis and testing. Fire safety design can be established using a deterministic and/or a probabilistic approach. In most cases, deterministic design is easier, faster and less expensive. In any case, predicting the growth and severity of a fire and the behaviour of the structure and the occupants of the house exposed to the fire is complex. Refer to the International Standards and other referenced documents listed in the Bibliography for guidance.

Bibliography

[1] ISO 834-1:1999, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

[2] ISO/TR 834-3:1994, *Fire-resistance tests — Elements of building construction — Part 3: Commentary on test method and test data application*

[3] ISO 834-4:2000, *Fire-resistance tests — Elements of building construction — Part 4: Specific requirements for loadbearing vertical separating elements*

[4] ISO 834-5:2000, *Fire-resistance tests — Elements of building construction — Part 5: Specific requirements for loadbearing horizontal separating elements*

[5] ISO 834-6:2000, *Fire-resistance tests — Elements of building construction — Part 6: Specific requirements for beams*

[6] ISO 834-7:2000, *Fire-resistance tests — Elements of building construction — Part 7: Specific requirements for columns*

[7] ISO 834-8:2002, *Fire-resistance tests — Elements of building construction — Part 8: Specific requirements for non-loadbearing vertical separating elements*

[8] ISO 834-9:2003, *Fire-resistance tests — Elements of building construction — Part 9: Specific requirements for non-loadbearing ceiling elements*

[9] ISO 1182:2010, *Reaction to fire tests for products — Non-combustibility test*

[10] ISO 1716:2010, *Reaction to fire tests for products — Determination of the gross heat of combustion (calorific value)*

[11] ISO 3008:2007, *Fire resistance tests — Door and shutter assemblies*

[12] ISO 3009:2003, *Fire-resistance tests — Elements of building construction — Glazed elements*

[13] ISO/TR 3814:1989, *Tests for measuring "reaction-to-fire" of building materials — Their development and application*

[14] ISO 3941:2007, *Classification of fires*

[15] ISO 5657:1997, *Reaction to fire tests — Ignitability of building products using a radiant heat source*

[16] ISO/TS 5658-1:2006, *Reaction to fire tests — Spread of flame — Part 1: Guidance on flame spread*

[17] ISO 5658-2:2006, *Reaction to fire tests — Spread of flame — Part 2: Lateral spread on building and transport products in vertical configuration*

[18] ISO 5658-4:2001, *Reaction to fire tests — Spread of flame — Part 4: Intermediate-scale test of vertical spread of flame with vertically oriented specimen*

[19] ISO 5660-1:2002, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method)*

[20] ISO 5660-2:2002, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 2: Smoke production rate (dynamic measurement)*

[21] ISO/TR 5660-3:2003, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 3: Guidance on measurement*

[22] ISO 6182-1:2004, *Fire protection — Automatic sprinkler systems — Part 1: Requirements and test methods for sprinklers*