The Swedish National Board of Housing, Building and Planning’s general recommendations on the analytical design of a building’s fire protection, BBRAD

BFS 2011:27 with amendments up to BFS 2013:12

1 Introduction

General recommendation
These are the general recommendations for
– Chapter 8, Article 9, and Chapter 10, Article 6 of the planning and building act (2010:900), PBA,
– Chapter 3, Article 8 of the planning and building ordinance (2011:338), PBO, and
– Section 5 of The Swedish National Board of Housing, Building and Planning’s Building Regulations (2011:6) – mandatory provisions and general recommendations, BBR.

The general recommendations regarding the application of the mandatory provisions in the abovementioned statutes indicate how someone can or should act in order to comply with the requirements of the mandatory provisions

The general recommendations may also contain particular information for the purpose of clarification or of an editorial nature.

The general recommendations are preceded by the words “General recommendation” and are printed using smaller, indented text.

1.1 Scope

General recommendation
The general recommendations in this statute can be applied to verify analytical design pursuant to BBR Section 5:112. Verification through analytical design includes the mandatory provisions that are not met through prescriptive design. The verification should give particular attention to the building’s fire protection in its overall perspective.

Applicable parts of this statute can be applied to verify the fire protection during alterations to buildings pursuant to BBR Section 5:8.

Applicable parts of this statute can be applied to verify a building’s load-bearing capacity in case of fire according to natural fire models or when deviating from the general recommendations in Section C, Chapter 1.1.2 in The Swedish National Board of Housing, Building and Planning’s mandatory provisions and general recommendations (2011:10) on the application of European construction standards (Eurocodes), EKS.

2 Design process

General recommendation
Analytical design should contain a description of the scope of the analysis, how it will be undertaken, and what is considered satisfactory fire safety.

Analytical design for fire protection of buildings should include the following stages:
– Identification of the need for verification.
– Verification of satisfactory fire safety.
– Verification check.

2.1 Identification of need for verification

General recommendation

When identifying the need for verification the deviation from prescriptive design should be clarified so that it is clear which parts of the building's fire protection that are affected. Table 1 can be used as a tool. Deviations from the general recommendations of BBR Section 5:2 should be considered in relation to relevant requirements of BBR Section 5:3-5:7.

Any deviations from the general recommendations for load-bearing capacity in case of fire in accordance with Section C, Chapter 1.1.2 in EKS should be identified.

Table 1 Matrix for identifying deviations from prescriptive design (PD)

Fire protection element		**Deviations from prescriptive design**							
		Deviation				**Addition**			
		1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
5:2	Fire resistance classes and other conditions								
5:3	Ability to escape in case of fire								
5:4	Protection against the outbreak of fire								
5:5	Protection against the development and spread of fire and smoke in buildings								
5:6	Protection against the spread of fire between buildings								
5:7	Possibility of rescue responses								
Section C, Ch. 1.1.2 in EKS	Load-bearing capacity in case of fire								

2.2 Verification

General recommendation

The verification should include a hazard identification in order to identify relevant scenarios that stress the building's fire protection. These scenarios should be chosen based on the level of risk for each scenario, i.e. the probability that the scenario occurs and consequence of the scenario.

The developer should demonstrate how the requirement in each mandatory provision is met based on the intended use. Particular attention should be given to how the requirement can be maintained during the building's economically reasonable working life.

If several simultaneous alternative solutions are implemented, an assessment of the robustness of the building's overall fire protection should be undertaken. Additional scenarios should therefore be considered, in addition to those presented in each section, in order to assess the robustness of the building's overall fire protection. The assessment can be a part of the sensitivity analysis.

2.2.1 Verification through qualitative assessment

General recommendation

Limited deviations refers to a minor effect on the fire safety and that the uncertainties with the chosen design are small. The starting point for qualitative assessment should be the hazard identification that the analytical design is based upon.

Verification through qualitative assessment can be based upon logical reasoning, statistics, proven solutions, testing, object specific tests, simple calculations, etc. Verification based on previous experiences should be checked with regards to changes in risks and conditions over time.

2.2.2 Verification through scenario analysis

General recommendation

Verification through scenario analysis should be based on one or multiple scenarios that test the building's fire protection. Scenario selection should be based on the hazard identification while allowing for varying conditions and stresses. Required fire scenarios should be identified and justified so that they represent a worst credible stress. All design scenarios should comply with the applicable acceptance criteria. Verification through scenario analysis can be based on the methods and acceptance criteria that are specified in sections 3-5.

Verification through scenario analysis should include a sensitivity analysis to identify variables with significant effect on the level of safety. Such variables should be chosen conservatively. Variables that can be included in a sensitivity analysis include heat release rate, flame temperature, occupant walking speed, and occupant distribution amongst exits. The variables specified in the general recommendations in sections 3-5 are normally not required to be assessed in terms of sensitivity.

The result of the sensitivity analysis should be included in an assessment to determine if the proposed fire safety design is satisfactory.

2.2.3 Verification through quantitative risk analysis

General recommendation

Verification through quantitative risk analysis should be based on distributions of applicable variables. The distributions of these variables should reflect the conditions that can be expected during the building's economically reasonable working life.

Verification through quantitative risk analysis should include a sensitivity analysis to identify variables with significant effect on the level of safety. Such variables should be chosen conservatively. An uncertainty analysis may be included in the sensitivity analysis to study such variables in detail.

The result of the sensitivity analysis should be considered when assessing satisfactory fire safety of the chosen design. Variables that can be included in a sensitivity analysis include heat release rate, the reliability of technical systems, occupant walking speed, and occupant distribution amongst exits.

The results of a quantitative risk analysis can for example be presented as individual risk or societal risk.

2.3 Satisfactory fire safety

2.3.1 General

General recommendation

The fire protection can be verified through a comparison with the safety level given using prescriptive design for a reference building. Alternatively, the fire protection design can be verified using the acceptance criteria that are specified in these general recommendations.

The reference building should be an equivalent building meeting prescriptive design requirements, e.g. in terms of building class, occupancy class, fire load, number of levels, and number of occupants allowed in the building.

For a qualitative assessment, a comparison with a reference building according to prescriptive design should constitute the level of satisfactory fire safety. A scenario analysis should consider the acceptance criteria specified in these general recommendations when assessing a satisfactory level of fire safety.

A quantitative risk analysis should consider either a reference building according to prescriptive design or the acceptance criteria specified in these general recommendations when assessing a satisfactory level of fire safety.

2.3.2 Building class Br0

General recommendation
The building design shall be verified against the performance requirements specified in BBR. The fire protection should be evaluated in an overall assessment based on the risk profile of the building.

For buildings with building class Br0, the general recommendations in BBR Section 5 can only be used as a reference to a limited extent. Limited extent refers to, for example, fire protection related only to separate rooms, fire compartments or components. At a minimum the fire protection design should be equivalent to the corresponding building class, for example building class Br1 for buildings with three or more storeys, or building class Br2 for buildings with a single story and places of assembly in occupancy class 2B or 2C.

The acceptance criteria specified in these general recommendations can be used to determine a satisfactory level of fire safety.

The following aspects should be given special consideration
– if external fire-fighting responses are not possible,
– if internal rescue responses can be complicated,
– if the anticipated consequence is great,
– if the evacuation process can be associated with significant difficulties.

3 Ability to escape in case of fire

3.1 Analysis method

General recommendation
Assessing the ability to escape in case of fire should be based upon a comparison of the evacuation time and the time when untenable conditions occur. The evacuation time should include awareness time, pre-movement time, and travel time. Appropriate occupant behaviour should be included when choosing the conditions of the analysis, based on the actual occupancy and the scenarios in the hazard identification. The risk assessment can therefore be used to identify so called evacuation scenarios.

The hazard identification is expected to include that fires may occur in various locations in a space, although not necessarily at the same time. . The analysis should also consider different potential conditions for the evacuation, e.g. a high number of occupants with impaired mobility or orientation capacity, or children.

The analysis should include effects of the design fire impacting the evacuation process. As an example, the evacuation process should be affected by the failure of technical systems in required fire scenario 3, and that the design fire location can cause varying occupant distributions amongst the exits.

Analysis of evacuation from buildings should show that the available safe egress time is longer than the evacuation time for all applicable scenarios.

Expected occupant behaviour should be considered for the actual occupancy.

The walking distance to the nearest escape route should not exceed 80 m.

3.2 Evacuation process

3.2.1 Occupant load

General recommendation
The verification of the ability to escape in case of fire should be based on the maximum number of people likely to be in the premises. Table 5:333 in BBR can be used to estimate the maximum number of people in a building if it is not known. Buildings intended to be used for multiple purposes should, in addition to the main occupancy, also consider other relevant occupancies when determining the occupant load.

The evacuation assessment should consider that some of the occupants may have impaired mobility or orientation capacity. Public buildings should be designed based on the assumption that one percent of the occupants might be people with impaired mobility or orientation capacity.

3.2.2 Awareness time

General recommendation
The awareness time for people that see a fire should not be less than 30 s. If the building is provided with an evacuation alarm, the awareness time for people not able to see the fire can be taken as the time when the evacuation alarm is activated.

If delayed activation of the evacuation alarm is used, it is expected that appropriately trained personnel are available in the building. The time for delayed activation of the evacuation alarm should be included in the awareness time unless otherwise demonstrated.

3.2.3 Pre-movement time

General recommendation

Table 2 Proposed pre-movement times for some occupancies

Occupancy	Person sees the fire	Pre-movement time
Public, school, office, shopping centre, shop	Yes	1 minute
Shopping centre, no alarm	No	4 minutes
Shopping centre, bells or sirens	No	3,5 minutes
Shopping centre, simple spoken announcement	No	2 minutes
Shopping centre, informative spoken announcement	No	1 minute
Minor premises with standard alarm in the premises, small cinema, shop, church	No	1 minute
Hospital[1], personnel available, bells or sirens	No	2 minutes
Hospital[1], personnel available, alarm and text message	No	1 minute
Night club, personnel[2]	No	1–1,5 minutes
Night club, customers[2]	No	3–5 minutes

1 Refers to hospital wards that are easily surveyable (simple corridor).
2 Depends on the type of alarm and the internal safety organisation.

Table 2 uses the terms simple spoken announcement and an informative spoken announcement. For example, a simple spoken announcement refers to "A technical fault has occurred in the building. Please exit the building." An informative spoken announcement should inform people in the building of the event and what actions they are expected to take.

3.2.4 Travel time

General recommendation
An assessment of the ability to escape in case of fire should contain an estimation of occupant distribution within the building and amongst the exits.

Occupant walking speeds, for varying conditions, can be chosen from Tables 3 or 4. People with impaired mobility or orientation capacity can be assumed to travel with the speeds and flows specified in Tables 3 and 4 multiplied by 2/3.

Table 3 ***Walking speed and flow capacity for people moving independently of other people***

Connection	**Walking speed**	**Minimum width** [1]	**Flow capacity**
Horizontal	1,5 m/s	0,9 m	
Ascending stair	0,6 m/s	0,9 m	
Descending stair [2]	0,75 m/s	0,9 m	
Door	-	0,8 m	[3]

[1] Escape routes serving more than 150 occupants should have a minimum clear width of 1,20 m.
[2] The flow should be calculated using the effective width of the stair, i.e. the total stair width reduced by 0,3 m. The specified value refers to stairs with an incline in the range 26°–32°.
[3] The flow for doors that occupants are familiar with can be taken as 1,1 p/sm. For other situations 0,75 p/sm should be applied.

Table 4 ***Walking speed and flow capacity for high occupant load factors and people moving in groups. High occupant load factors refer to no more than 2 occupants per m²***

Connection	**Walking speed**	**Minimum width** [1]	**Flow capacity**
Horizontal	0,6 m/s	0,9 m	1,2 p/sm
Ascending stair	0,5 m/s	0,9 m	
Descending stair [2]	0,5 m/s	0,9 m	1 p/sm
Door	-	0,8 m	[3]

1 Escape routes serving more than 150 occupants should have a minimum clear width of 1,20 m.
2 The flow should be calculated using the effective with of the stair, i.e. the total stair width reduced by 0,3 m. The specified flow refers to stairs with an incline of 26°–32°.
3 The flow for doors that occupants are familiar with can be taken as 1,1 p/sm. For other situations 0,75 p/sm should be applied.

Travel time (s) from a space can be calculated with the following equation

$$t_{trav} = \frac{l}{v} + \frac{n}{b \cdot f}$$

where l is the longest walking distance (m), v is the applicable walking speed (m/s), n is the number of people passing through a door, b is the door width (m), and f is the flow capacity through the door.

Short queuing times should be sought where there is a risk for high occupant load factors, which can be relevant for occupancy classes 2B and 2C. The queuing time should be limited to no more than eight minutes. Factors that affect the risk of personal injuries should be considered when assessing the maximum allowable queuing time.

3.3 Required fire scenarios

General recommendation

The scenarios may be required to be repeated for various fire locations in complex buildings where the worst credible fire location cannot be predicted. Examples of when this may be relevant are buildings and spaces with varying ceiling heights, buildings with multiple open and connected levels, and underground buildings with few openings to the outside. A hazard identification can provide support for this work.

3.3.1 Required fire scenario 1

General recommendation

Fire scenario 1 is characterized by a severe fire progression with rapid growth rate and a high heat release rate, a worst credible scenario. All technical fire protection systems can be assumed to perform as intended by the design and the effects of these can be credited.

The fire progression should be modelled in accordance with the following conditions and specifications:

– Fire progress (growth rate, maximum heat release rate and production of species) are chosen pursuant to Tables 5 and 6.

– Automatic fire suppression systems can affect the design fire in accordance with the section regarding *Effects of automatic fire suppression systems*.

3.3.2 Required fire scenario 2

General recommendation

If the building is not provided with a total coverage automatic fire and evacuation alarm, the analysis should include fire scenario 2.

Fire scenario 2 is characterized by a fire in a normally unoccupied space adjacent to a space with a large number of people. All technical fire protection systems can be assumed to perform as intended by the design and the effects of these can be credited.

The fire progression should be modelled in accordance with the following conditions and specifications:

– Fire progress (growth rate, maximum heat release rate and production of species) are chosen pursuant to Tables 5 and 6.

– Automatic fire suppression systems can affect the design fire in accordance with the section regarding *Effects of automatic fire suppression systems*.

3.3.3 Required fire scenario 3

General recommendation

Fire scenario 3 is characterized by a fire progression that can be seen as a less severe stress on the building's fire protection, occurring simultaneously as each technical fire protection system is rendered ineffective. The following technical fire protection systems should be rendered ineffective one by one in required fire scenario 3:

– Automatic fire and evacuation alarms.
– Automatic fire suppression systems.
– Automatic smoke ventilation or any other system limiting the spread of fire and smoke.
– Lifts used for evacuation.
– Consequential failures should be considered if the event can disable multiple systems, e.g. power failures or signal errors.

The fire progression should be modelled in accordance with the following conditions and specifications:

– Fire progress (growth rate, maximum heat release rate and production of species) are chosen in accordance with Tables 5 and 6.

– Automatic fire suppression systems can affect the design fire in accordance with the section regarding *Effects of automatic fire suppression systems*, except for when the fire suppression system itself is rendered ineffective.

3.3.4 Fire progress

General recommendation

The heat release rate (kW) should be calculated in accordance with the equation below and can, within the room of fire origin, be limited by the ventilation conditions.

Heat release rate = αt^2

α – growth rate, kW/s^2

t - time, s

Design values in the fire scenarios should not be less than those specified in Table 5 for the early stages of the fire progression.

Table 5 Design fire growth rate, heat release rate, and heat of combustion for the early stages of the fire progression

Occupancy	Growth rate, kW/s^2	Heat release rate, MW	Heat of combustion, MJ/kg
Offices and schools	0,012	5,0	16
Dwellings, hotels and healthcare facilities	0,047	5,0	20
Places of assembly	0,047	10,0	20
All occupancies for required fire scenario 3	According to row 1–3	2,0	20

Design values for the fire scenarios should not be less than those specified in Table 6 for the early stages of the fire progression. These characteristics are applicable if well ventilated combustion can be expected.

Table 6 Design values for the production of soot and species for the early stages of the fire progression

Occupancy	Soot production	CO-production	CO_2-production
Fire scenarios 1 and 2	0,10 g/g	0,10 g/g	2,5 g/g
Fire scenario 3	0,06 g/g	0,06 g/g	2,5 g/g

The values in Table 6 for required fire scenario 3 can also be used for required fire scenarios 1 and 2 if an automatic water sprinkler system is not provided within the space.

If the combustion takes place under ventilation-controlled conditions, this should be considered when selecting the values for production of soot, CO and CO_2.

3.3.5 Effects of automatic fire suppression systems

General recommendation

The effects of an automatic fire suppression system can be applied as stated below. Other types of fire suppression systems that are not mentioned below should be assessed specifically.

If the heat release rate is no more than 5,0 MW on activation of an automatic water sprinkler system or residential sprinklers, the heat release rate can be reduced as follows:

– After sprinkler activation the heat release rate is kept constant for 1 minute.

– Thereafter the heat release rate is reduced to 1/3 of the heat release rate at the time of sprinkler activation. This reduction takes place during the subsequent minute.

– The heat release rate is then kept constant at that level.

If the heat release rate exceeds 5,0 MW on sprinkler activation, the heat release rate should be kept constant after sprinkler activation.

Gas extinguishing systems designed pursuant to applicable standards can be assumed to reduce the heat release rate completely shortly after the extinguishing concentration has been reached.

3.4 Tenable conditions

General recommendation
Table 7 demonstrates acceptable levels of tenable conditions in case of fire for verification of safe evacuation. Criteria 1 or 2 as well as 3-5 should be met to demonstrate acceptable levels. This means that evacuation through smoke can be accepted in some cases. Visibility should be calculated to exit signs, walls or equivalent features.

Table 7 Tenability condition levels for analysis of safe evacuation

Criteria	Level
1. Smoke layer above floor level	minimum 1,6 + (ceiling height (m) x 0,1)
2. Visibility, 2,0 m above floor level	10,0 m in spaces > 100 m^2
	5,0 m in spaces ≤ 100 m^2. This criteria can also be applied where queuing occurs in the early stages at the location where the queue is formed.
3. Thermal radiation/radiant heat dosage	maximum 2,5 kW/m^2, or a brief dosage of maximum 10 kW/m^2 combined with maximum 60 kJ/m^2 in addition to the energy from a thermal radiation of 1 kW/m^2
4. Temperature	maximum 80 °C
5. Toxicity, 2,0 m above floor level	Carbon monoxide concentration (CO) < 2 000 ppm Carbon dioxide concentration (CO_2) < 5 % Oxygen concentration (O_2) > 15 %

(BFS 2012:13).

3.5 Special situations

3.5.1 Evacuation lift

General recommendation
If an evacuation lift is installed in the building, the ability to escape and the lift design should be verified through analytical design.

Evacuation lifts should be regarded as a complement to the stairs used for evacuation. To replace a stair with evacuation via lifts the analysis should include factors such as prolonged evacuation time and evacuation capacity.

Exit signs should be designed for the intended use of the evacuation lifts.

The following issues and factors should particularly be analysed:

– the building evacuation strategy and evacuation time (alternative escape routes and any zoned evacuation),
– control systems, measures related to maintenance and that the system function is maintained during the building's economically reasonable working life,
– how the lift function is ensured during the time required for evacuation,
– requirements for accessibility,
– redundancy of systems vital for the lift function (such as power supply and incoming signals),
– protection against fire and smoke for people evacuating while waiting for the lift, in the lift and on the route from the lift to a place in the open,
– protection of the lift machinery against fire,
– impact from any water intrusion to the lift shaft,
– the risk of smoke- and thermal effects on sensitive components,

– possible effects of cold air temperature on sensitive components,
– control sequences at detection,
– means of communication (such as alarm buttons and emergency telephones),
– waiting times for people evacuating,
– possible behaviour of people evacuating or other people in the building that may lead to delayed evacuation or unnecessary risk-taking,
– possibility to activate and control the lift function and how activation and control is handled.

4 Protection against the development and spread of fire and smoke in buildings

4.1 Verification of separation capability between fire compartments

4.1.1 Analysis method

General recommendation
In the analysis of separation capability for structural elements, the maximum temperature and the maximum level of thermal radiation on the side not exposed to fire (the opposite side) should not be higher than acceptable levels for all applicable scenarios

4.1.2 Required fire scenarios

General recommendation
Required fire scenarios should be identified and justified so that they represent a worst credible stress of the building's fire protection. The size of fire compartments, its openings, penetrations and similar should be taken into consideration.

4.1.2.1 Design fire characteristics

General recommendation
Separation capability for fire compartment separating structural elements can be verified by natural fire models pursuant to SS-EN 1991-1-2, Annex A. The design should be for a fully developed fire unless otherwise demonstrated, also see Section C, chapter 1.1.2 in EKS. The design fire load should be determined in accordance with The Swedish National Board of Housing, Building and Planning's general recommendations on fire load, BBRBE.

For separating structures that according to prescriptive design is designed in fire resistance class EI 60 or higher, the separation capability should be decided for full fire progression, including the decay phase. For lower fire resistance classes, part of full fire progression is applicable for the time that the class number indicates, excluding the decay phase. For structural elements that according to prescriptive design is designed in class EI 90 or higher, the design fire load should be increased by 50 %. *(BFS 2013:12).*

4.1.2.2 Effects of automatic fire suppression systems

General recommendation
The effects of automatic fire suppression systems pursuant to BBR 5:252 can be taken into account by reducing the design fire load to 60 % of its original value.

4.1.3 Acceptance criteria

General recommendation
When designing separating structures using natural fire models, the temperature on the side of the structural element not exposed to fire should not be higher than 200 °C as an average or 240 °C at any point.

Integrity (E) of separating structure should be designed in the same manner as corresponding fire resistance class pursuant to BBR. The assessment of integrity should give particular consideration that structural elements can be deformed or damaged in case of fire.

Fire resistance class EI can be exchanged for class E if the safety for people evacuating is high and the probability of fire spread does not increase. The requirement is satisfied if doors, walls and similar are arranged so that the distance to people evacuating or to combustible material is long enough so that the thermal radiation does not exceed 2,5 kW/m^2. Higher thermal radiation levels can be acceptable if the time aspects for evacuation and ignition are taken into consideration.

4.2 Fire protection in ventilation systems

4.2.1 Analysis method

General recommendation
Analytical design of the fire protection in a building's ventilation system can be implemented with the following methods:

– Flow control in case of fire, where fans or fans in combination with other safety solutions are used to limit the amount of smoke that spread to other fire compartments in the building.

– Pressure relief of the fire room activated at an early stage by e.g. an automatic fire alarm. Activation should ensure that the fire room is depressurized so that the risk of fire and smoke spread to other fire compartments is limited.

– Pressure relief of ventilation ducts activated in an early stage by e.g. an automatic fire alarm. Activation should ensure that ventilation ducts are depressurized so that the risk of fire and smoke spread to other fire compartments is limited. Pressure relief of ventilation ducts should not be implemented for spaces in protection level 1.

Design using the methods above require verification by calculations or testing. Consideration should be given to applicable pressure drops and buoyancy in vertical ducts due to smoke with high temperature.

4.2.2 Required fire scenarios

General recommendation
Required fire scenarios should be identified and justified so that they represent a worst credible stress of the building's fire protection at different times during a fire progression. Required fire scenarios should include various configurations of open and closed windows in the building envelope and any interactions between air flows through different parts of the ventilation system, e.g. cooker hoods.

4.2.2.1 Design fire characteristics

General recommendation
The fire growth, the geometry and the ventilation conditions of the fire room should be taken into consideration when determining the fire progression and the fire flow.

– The fire growth rate should correspond to 0,047 kW/s2 in the early stages of the fire progression unless otherwise demonstrated.

– The fire flow can be limited by a maximum pressure increase that can be assumed to be 1500 Pa unless otherwise demonstrated.

– In the early stages of fire progression, the design smoke temperature can be assumed to be a maximum of 350°C.

– The smoke temperature in the later stages of fire progression, i.e. when flashover has occurred, can be decided by natural fire models pursuant to SS-EN 1991-1-2, Annex A or equivalent. The design fire load should be determined in accordance with The Swedish National Board of Housing, Building and Planning's general recommendations on fire load, BBRBE.
(BFS 2013:12).

4.2.2.2 Effects of automatic fire suppression systems

General recommendation
If the fire compartment is equipped with an automatic sprinkler system or residential sprinklers, the smoke temperature can be assumed to be limited to the smoke temperature on sprinkler activation.

4.2.3 Other conditions

General recommendation
Fans should be designed to deliver required flow at the applicable pressure differences and smoke temperatures. Leakage through constructions, installations within the building and the building envelope should be taken into consideration.

Pressure differences created by the ventilation system that may affect the possibility to open doors during evacuation should be taken into consideration. This can also apply to individual rooms within a fire compartment. Rules for doors are given in BBR Section 5:335.

4.2.4 Acceptance criteria for smoke spread in ventilation systems

General recommendation
Fire compartments containing escape routes or sleeping people, e.g. Vk3, Vk4, Vk5B and Vk5C, should be assigned to protection level 1. Other fire compartments can be assigned to protection level 2.

For fire compartments in protection level 1, acceptable limit of smoke spread should be 1 % of the receiving fire compartment volume.

For fire compartments in protection level 2, acceptable limit of smoke spread should be 5 % of the receiving fire compartment volume.

4.3 Special situations

4.3.1 Pressurisation of spaces

General recommendation
Pressurization can be used to provide protection against fire and smoke spread to spaces. SS-EN 12101-6 can be applied for verification of stair pressurization. As an alternative, the corresponding method can be used to verify that pressurization of protected lobbies or other spaces provides sufficient protection.

5 Protection against the spread of fire between buildings

5.1 Analysis method

General recommendation
Limitation of the risk of fire spread between buildings can e.g. be achieved if

- buildings are constructed at a sufficient distance from each other
- unprotected structural elements are limited in size,
- the ability to spread fire is limited for exposed surfaces, or
- the extent of fire is limited by fire resistant installations such as automatic fire suppression systems.

In the analysis of the spread of fire between buildings, the maximum thermal radiation levels on the exposed building should not be higher than acceptable levels for all applicable scenarios.

5.2 Required fire scenarios

General recommendation
Required fire scenarios should be identified and justified so that they represent a worst credible stress of the building's fire protection. The size of fire compartments, openings and placement of adjacent buildings should be taken into consideration.

Emitted thermal radiation should be calculated for full fire progression in the fire compartment that pose the highest risk for the spread of fire to adjacent building

5.2.1 Design fire characteristics

General recommendation
The design level of emitted thermal radiation from window areas can be based on a simplified model with constant thermal radiation from the window areas pursuant to Table 8. The table is valid provided that the façade material is designed in at least class A2-s1,d0 and is not expected to emit any radiation.

Table 8 ***Thermal radiation levels for protection against the spread of fire between buildings***

Occupancy	Thermal radiation level, kW/m^2
Dwellings, offices, places of assembly, open parking garages	84
Stores, industries, warehouses	168

SS-EN 1991-1-2 Annex B can be applied to determine fire progression and properties of flames that burst out from windows. The design fire load should be determined in accordance with The Swedish National Board of Housing, Building and Planning's general recommendations on fire load, BBRBE.

When deciding emitted thermal radiation, consideration should be given to whether the façade can be expected to remain intact during the design fire progression. Surfaces that should be included in the assessment are e.g. combustible façades, windows and other surfaces that can be expected to emit thermal radiation. *(BFS 2013:12).*

5.2.2 Effects of automatic fire suppression systems

General recommendation
If the fire compartment is equipped with an automatic sprinkler system or residential sprinklers the following reduction of the fire effects can be made

– emitted thermal radiation pursuant to Table 8 can be reduced by 50 % or
– the design fire load can be reduced to 60 % of its original value when applying SS-EN 1991-1-2.

5.3 Acceptance criteria

General recommendation
Buildings should be designed so that the thermal radiation level towards adjacent building is below 15 kW/m^2 for at least 30 minutes. Alternative levels of thermal radiation can be decided based on the façade surface design and materials.

6 Documentation

6.1 Documentation

General recommendation
A description of buildings that are fully or partially designed using analytical design should be reported in its entirety as a part of the fire protection documentation.

The documentation should at least contain the following parts
- deviations from prescriptive design,
- conducted hazard identification,
- design conditions and assumptions that the verification is based on,
- plans for operation and maintenance,
- description and justification of used methods and models,
- documentation of performed calculations to the extent that the calculation process can be followed,
- deviations from the general recommendations in this statute and motives for these and
- conclusions based on the analytical verification.

6.2 Verification check

General recommendation
The inspection plan pursuant to Chapter 10, Article 6-8 of the planning and building act (2010:900), PBA should contain the following check points:
- That all deviations from prescriptive design are verified.
- That design checks are carried out.
- That the design conditions are correct.

If calculations are used as a bases for scenario analysis or quantitative risk analysis, the calculation accuracy should be confirmed by design check. Design check refers to control of design conditions, building documents and calculations. This control should be undertaken by a person not previously engaged in the project.

These general recommendations[1] are effective from 1 January 2012.

These general recommendations[2] are effective from 3 December 2012.

These general recommendations[3] are effective from 1 July 2013.

[1] BFS 2011:27.
[2] BFS 2012:13.
[3] BFS 2013:12.