F.R.A.M.E. 2008

Users' Manual

F.R.A.M.E.

Introduction.

"FRAME" means Fire Risk Assessment Method for Engineering. It is a method developed to make systematic fire risk evaluations for buildings, based on the combination of severity, probability and exposure of fire. "FRAME" is a development of the Swiss Gretener method, which was published in the 1970's.

I developed "FRAME" originally as a tool to help me as fire protection engineer to define a sufficient and cost effective fire safety concept for new or existing buildings. Unlike building codes that are mostly meant to assure a safe escape or rescue for the occupants, "FRAME" also aims at protecting the building, its content and the activities in it. This method can easily be used to evaluate fire risks in existing buildings, and to find out whether alternative designs have also comparable levels of risk.

The "FRAME" method measures the fire risk in buildings for the property and the content, for the occupants and for the activities in it. A systematic evaluation of all major influencing factors is given, and the final result is a set of values which express numerically, what otherwise has to be said by a long description of positive and negative aspects. The method is not suitable for open-air installations.

The "FRAME" method is conceived in such a way that the user verifies first the risk for the building and its content before verifying life safety and the protection of the activities, which is the easiest way to define an overall fire safety concept.

"FRAME" uses elementary fire models and follows the same approach as most risk evaluation tools. Starting from a limited number of fire scenarios, consideration is given to the probability of fire, to the severity of the consequences and to the level of exposure.

The method is aimed at the fire safety professional to help him in various aspects of his job:

- Designing the fire protection provisions for a particular building,
- Checking existing provisions to evaluate the level of risk before any attempt to design improvements.
- Making loss potential estimates : Experience has shown a relationship exists between the calculated Risk R and the amount of damage that can be expected after a serious fire event.
- Verifying trade-offs for building code requirements: A first calculation is made for the building according to the rules to define the required level of protection, and a second calculation with the proposed trade-off will identify if the same or a lower risk level is obtained.
- Controlling the quality of his own work: as the method requires a systematic review of most of the influencing factors of a fire risk, it obliges the engineer to think in a professional way and it helps him to reduce the influence of subjective appreciation.

The background of "FRAME" is explained in the " FRAME 2008 Technical Reference Guide". This Users' manual explains the use of the "FRAME" spreadsheet that has been developed in collaboration with Vinçotte Safety Engineers (www.vincotte.com).

The spreadsheet – template is prepared to allow the user to make two "FRAME" – calculations and the corresponding reports. The user can save his calculation as a regular xls file with an appropriate self-selected name.

This spreadsheet replaces the "FRAME" software program that was issued in 2000. Unfortunately, it is necessary to re-enter the data of a previous calculation in the spreadsheet, but the results will be the same.

Erik De Smet.

BASIC PRINCIPLES

There are five basic ideas for “FRAME”:

1. Adequate protection means equilibrium between threat, protection and exposure.
2. Severity, frequency and exposure expressed as result of influencing factors.
3. A severe fire only occurs when the combination of protection techniques fails.
4. Separate calculation for property, occupants, and activities.
5. One set of calculations per fire compartment.

The first basic idea of the “FRAME”-method is that there is equilibrium between threat, protection and exposure in an adequately protected building.

The equilibrium between the fire risk and the fire protection design that is proposed by using “FRAME” is situated at a level where the damage of a serious fire will be less than 10 % of the value of the concerned compartment. It is the same level of protection for which a fire insurance premium rate of approx. 1 ‰ of the insured value can be negotiated.

For life safety, the adequate level of protection is achieved when there are no deaths, except for the person who starts, or is in close proximity to, the fire. It corresponds with the socially accepted level of fire safety in most European countries of 5 victims per year per million population.

For business interruption, “FRAME” will give an evaluation of the overall sensitivity. The idea is that an adequate level of protection is such that the activities are only temporarily interrupted, and that life can be "back to normal" after the short period of time, necessary for clean up and (temporary) repairs.

The second basic idea is that severity, probability and exposure can be expressed in a formula with a number of influencing factors.

A first set of influencing factors will define numerical values for the worst cases, and these values will be named the potential risks P, reflecting the severity.

A second set of values will define numerical values that measure the level of exposure: A risk becomes less acceptable when the exposure is greater. The elements that define the level of exposure are the presence of ignition sources, the value of building and content, the means of escape provisions, and the economic importance of the activity. These elements will be used to calculate the acceptable risk levels, A.

The third set of influencing factors will define the protection level. The probability of a fire is the reverse value of the protection level D.

The level of fire protection can be expressed as a combination of values for the different protection technologies. These values will represent the following elements:

- -The universal extinguishing agent: water
- -The design of escape routes
- -The fire proofing of the construction
- -The methods of detection and warning
- -The manual fire fighting provisions
- -The automatic fire extinguishing systems
- -The public and private fire brigades
- -The physical separation of risks
- -The rescue and salvage arrangements

These elements define the quality and quantity of the fire protection available for a particular situation. The numerical value for the protection is the Protection Level.

Separate calculation for property, occupants, activities.

Three calculations will be made for each situation: The first for the building and its content (property), the second for the occupants, and the third for the business or activities that take place in the building.

These three calculations are necessary because the “worst cases” are different for the buildings, persons or activities, and there can be differences in the effectiveness of the protection in relation to each other.
- For the building and its content, total destruction is assumed to be the worst case.
- For the occupants, any starting fire is already a threat and is therefore "the worst case".
- For the activities, a fire that damages everything, even without complete destruction is considered to be the most harmful.

A separate calculation of the risk and the protection shall be made for each compartment. Within one building, several different scenarios can exist: For this reason, "FRAME" uses a single fire compartment as the basic unit for the calculations. For multi-storey buildings, each level has to be considered separately. For buildings with more than one fire compartment, each fire compartment shall be reviewed on its own.

DEFINITIONS AND BASIC FORMULAS.

1. Building and content:
The Fire Risk R is defined as the quotient of the Potential Risk P by the Acceptable Risk Level A and the Protection Level D

$$R = P / (A * D)$$

The Potential Risk P is defined as the product of the fire load factor q, the spread factor i, the area factor g, the level factor e, the venting factor v, and the access factor z.

$$P = q * i * g * e * v * z$$

The Acceptable Risk Level A is defined as the maximum value 1.6 minus the activation factor a, the evacuation time factor t, and the value factor c.

$$A = 1.6 - a - t - c$$

The Protection Level D is defined as the product of the water supply factor W, the normal protection factor N, the special protection factor S and the fire resistance factor F.

$$D = W * N * S * F$$

2. Occupants:
The Fire Risk R1 is defined as the quotient of the Potential Risk P1 by the Acceptable Risk Level A1 and the Protection Level D1

$$R1 = P1 / (A1 * D1)$$

The Potential Risk P1 is defined as the product of the fire load factor q, the spread factor i, the level factor e, the venting factor v, and the access factor z.

$$P1 = q * i * e * v * z$$

The Acceptable Risk Level A1 is defined as the maximum value 1.6 minus the activation factor a, the evacuation time factor t, and the environment factor r.

$$A1 = 1.6 - a - t - r$$

The Protection Level D1 is defined as the product of the normal protection factor N and the escape factor U.

$$D1 = N * U$$

<u>3. Activities:</u>
The Fire Risk R2 is defined as the quotient of the Potential Risk P2 by the Acceptable Risk Level A2 and the Protection Level D2

$$R2 = P2 / (A2 * D2)$$

The Potential Risk P2 is defined as the product of the spread factor i, the area factor g, the level factor e, the venting factor v, and the access factor z.

$$P2 = i * g * e * v * z$$

The Acceptable Risk Level A2 is defined as the maximum value 1.6 minus the activation factor a, the value factor c, the dependency factor d.

$$A2 = 1.6 - a - c - d$$

The Protection Level D2 is defined as the product of the water supply factor W, the normal protection factor N, the special protection factor S and the salvage factor Y.

$$D2 = W * N * S * Y$$

USING THE RESULTS

The aim of a “FRAME” calculation is to determine whether or not an appropriate balance between the potential hazard protection measures and probability of occurrence is achieved. For an adequately protected compartment, the values of the Risks are equal to or less than 1.

The main outcomes of determining the Risk using the method can be summarized as:

- The method provides an assessment of the extent to which the Risks for a building in use fall short of an ‘acceptable’ level.

- Where fire protection systems have been designed to comply with minimum legal requirements for life safety it can be anticipated that there may be ‘inadequate’ protection for the building, the contents and/or business continuity. Once the people are safe, the building can be "allowed" to burn.

- For this situation fire safety design improvements may be neither necessary nor attempted.

- After a first calculation, it appears that some improvements are still necessary: The fire protection engineer with some experience will "feel" the weak points as they show up during the calculation. Looking through the details will reveal the areas of possible improvement, and a new calculation can be made to get as a final result: a well-designed fire protection system.

THE PRACTICAL CALCULATION.

Before starting the practical calculation, collect all the necessary data. Remember that one calculation should be made per fire compartment, and that for each compartment you will need therefore a good description of its use and its construction, as well as information about the existing means of fire protection.

Once all information is gathered, the calculation can start of the influencing factors for the Potential Risks P, P_1, and P2. The second step is to calculate the Acceptable Risk Levels A, A_1, A_2, which will give us an indication of the most stringent protection requirements.

The next step is to calculate the values of W, N, S and F for the proposed fire protection system, and to check what the value is of R, the Fire Risk for the building and its content. Sometimes its will be necessary to recalculate this value if the chosen level of protection is inadequate. It is also possible to make a second calculation for a different protection concept in order to compare possible solutions.

Once the adequate protection for the building is defined, check if this concept is also adequate for the protection of the occupants. Therefore, first calculate the values of U and of R_1. Eventually, define additional protection, which can change the calculation for the occupants as well as for the building.

The fire protection concept that protects adequately the building and the people in it may still have some weak points as far as the activities are concerned. You will calculate the values of Y and of R2 to check this. Additional requirements to protect the activities will influence only slightly the protection level of the building and the occupants.

Spreadsheet build-up.

The spreadsheet is distributed as an executable Excel-file, made with DoneEx XCell compiler. This means that the user should have Microsoft Excel 2000 or higher installed on his PC. Clicking on the FRAME2008-ENG.exe icon starts Microsoft Excel and loads the FRAME spreadsheet.

The spreadsheet has the following pages:

Info FRAME : cover page with general information, acknowledgments, disclaimer and warnings.

Info P : information and reference sheet for the factors and sub factors used in the Potential Risk calculation. To be used for user defined values. This sheet can also be printed as instructional pages.

Info A : information and reference sheet for the factors and sub factors used in the Acceptable Risk calculation. To be used for user defined values. This sheet can also be printed as instructional pages.

Info D : information and reference sheet for the factors and sub factors used in the Protection Level Risk calculation. To be used for user defined values. This sheet can also be printed as instructional pages.

FRAME2008 : summary sheet with the results of 3 calculations and the recommended protection based on the orientation value Ro. The calculations are identified as “reference , variant 1 and variant 2”.

This sheet has also “printing buttons” for a full report with the 3 calculations, a separate report of each calculation, and a print of the INFO pages, which can be used as a printed manual.
P -REF : calculation sheet for the Potential Risk of the reference case. The results are automatically reported in the FRAME 2008 sheet.

A- REF: calculation sheet for the Acceptable Risk of the reference case. The results are automatically reported in the FRAME 2008 sheet.

D- REF : calculation sheet for the Protection Level of the reference case. The results are automatically reported in the FRAME 2008 sheet.

P – V1 Potential Risk : calculation sheet for the first part of variant 1.
A – V1 Acceptable Risk: calculation sheet for the second part of variant 1.
D – V1 Protection Level: calculation sheet for the third part of variant 1.

P – V2 Potential Risk : calculation sheet for the first part of variant 2.
A – V2 Acceptable Risk: calculation sheet for the second part of variant 2.
D – V2 Protection Level: calculation sheet for the third part of variant 2.

Saving and retrieving your calculation.

Standard saving procedure

When using File/save your executable file will be modified with the latest data you have used, and when you open the executable file again, all your latest selections will appear on the spreadsheet. IT IS RECOMMENDED **NOT TO USE** THIS FEATURE : When closing the Excel sheet , answer NO to “save changes ?” option and you will keep your FRAME executable in its original form.

Saving with File/save (as).

Saving a file with File/save (as) **newname.exe** saves your calculation sheet with the latest data you have used as a new executable file. It means that when you open this executable file again, all your latest selections will appear on the spreadsheet. **IT IS RECOMMENDED TO USE THIS FEATURE** if you want to keep the original FRAMExxx.exe as it was supplied.

Saving the data only.

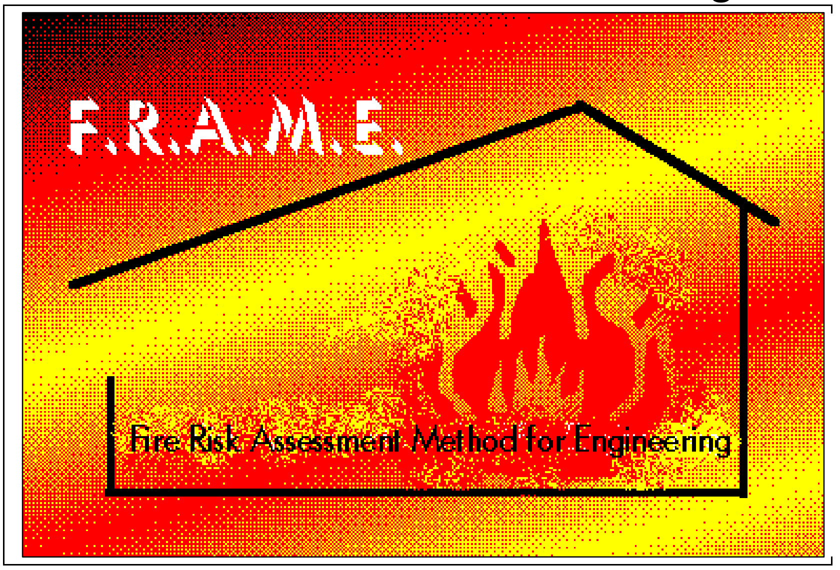
On the top of your spreadsheet, you will find an additional reference DoneEx. In Excel 2007 this application is found under “Plug -In”. There you will find the FRAME 2008 application and “Export Data” . Use this feature to save the data of your FRAME calculation under an appropriate name and dedicated directory.

When you want to reuse this calculation, the DoneEx/FRAME2008/Import Data feature will load the data back in your FRAME spreadsheet. The data must have been saved in the same language version of FRAME, otherwise you will receive a warning and the data are not correctly recognized. You will find on the sheets the data were not translated in the original language, but the corresponding values were not taken over.

.

The “Info FRAME” page.

FRAME : Fire Risk Assessment Method for engineering



This spreadsheet contains all the information and operations for a fire risk assessment according to the "FRAME"-method. The calculation basis is a single fire compartment; each building shall thus be divided in compartments. For each type of compartment, a separate calculation is required, usually for the one that has evidently the highest risk potential.

At the start, default values or the data of a previous saved calculation are used. One may need a pocket calculator to define some data before entering them in spreadsheet.

Some cells and the info pages contain additional information about the meaning of the factor or the requested data.

Yellow fields indicate input fields. This can be a direct users' input or a selection list linked to the info pages.
Green fields allow for inputs that can override other data.

DISCLAIMER:
Everybody uses this program and the FRAME method on his own and only responsibility. In no event will the author be providing any warranty either expressed or implied to the user. The user assumes the entire responsibility for the application of the method, its appropriateness, reliability and correctness of the data used, and for the conclusions derived from its application.

This program is only suitable for use by a person skilled in fire protection as complementary to and in support of his professional judgement formed through learning and experience.

FRAME: Fire Risk Assessment Method for Engineering. Version 2008.01

This spreadsheet has been developed in collaboration with VINCOTTE BELGIUM.

The “FRAME 2008” page.

The summary.

This page presents the identification data and the summary of the results of the “FRAME” calculations. Three variants can be presented together.

Subject of this analysis:

Building identification name of the building

Location

Address

City – Country

identification of the compartment and the occupancies / activities present.

identification of the compartment

Author of this calculation

Date of this analysis	date(s) of the analysis

Description of the Fire safety concept of the reference status

The reference situation is usually the actual status.

Description of the Fire safety concept of Variant 1.

Variant 1 is usually the proposed improvements

Description of the Fire safety concept of Variant 2.

Variant 2 can be used for an alternative proposition

This page allows the user to identify his calculation(s). Remember that a “FRAME” is always made for a single compartment, which has to be properly identified.

Risk for:		Reference	Variant 1	Variant 2
Property	**R**	**0.57**	**0.34**	**0.34**
Occupants	**R1**	**0.90**	**0.48**	**0.48**
Activities	**R2**	**0.40**	**0.25**	**0.25**

Potential risk	**P**	**0.80**	**0.80**	**0.80**
	P1	**1.71**	**1.71**	**1.71**
	P2	**0.61**	**0.61**	**0.61**

Go to INFO | Go to input | Go to input | Go to input

Acceptable risk	**A**	**1.04**	**1.10**	**1.10**
	A1	**1.18**	**1.23**	**1.23**
	A2	**0.96**	**0.96**	**0.96**

Go to INFO | Go to input | Go to input | Go to input

Protection Level	**D**	**1.35**	**2.12**	**2.12**
	D1	**1.61**	**2.90**	**2.90**
	D2	**1.60**	**2.60**	**2.60**
	Fo	**1.30**		

Go to INFO | Go to input | Go to input | Go to input

The spreadsheet is set up to present three variants.

The reference situation. This can be the as-is situation to make an assessment of an existing situation before improvement, or it can also be a code-compliant concept for which an alternative equivalent design is sought, or any other starting case.

Variants 1 and 2 can be used for a proposed improvement or alternative design, and the description shall indicate what changes are made.

The values of the property, occupants and activities risk are coloured :

Green values indicate acceptable risk levels
Blue values indicate risk levels that may need improvement
Red values give unacceptable risk levels
A red bar indicates that abnormal values are obtained, e.g. negative values

These data appear on the report printout of the FRAME 2008 page.

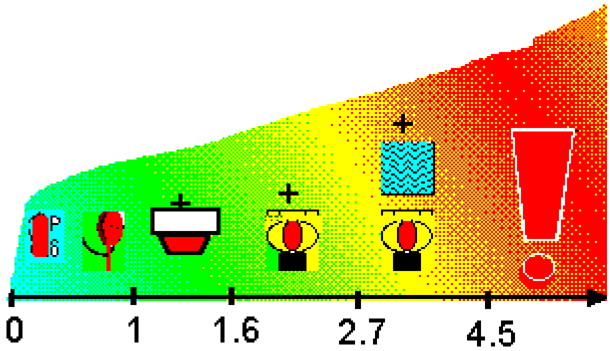
Calculation of the Orientation Value Ro, the initial risk.

An extra feature at the bottom of the Risk Assessment page, is the calculation of the initial risk Ro for the reference case. This is an intermediate value to help the fire protection designer find a recommended alternative to variant 1, based on the value of Ro.

The recommendation is automatically generated from the comparison between the calculated value of Ro and the orientation table below. This part of the calculation is not included in the printed report.

Orientation Value Ro, Initial Risk	**2.59**
Proposed Fire protection concept, based on Ro of "Reference" case :	**Install sprinklers**

Ro limit	Up to	
0	1	Use manual fire protection
1	1.6	Add automatic fire detection
1.6	2.7	Install sprinklers
2.7	4.5	Sprinklers with improved water supplies
4.5	Too hazardous: reduce risk	



The “Info P” page.

This page gives information on the sub factors used in the Potential Risk calculations. The info page shows the selection lists which can be used as entry data on the next calculation page. Some cells have a pop-up comment added which gives extra information how to define that particular item. (The pop-up comment is shown below in 8 pt characters).

The Potential risks P, P1, P2 are calculated with the fire load factor q, the spread factor i, the area factor g, the level factor e, the venting factor v, and the access factor z.

Fire load factor q.

INFO for sub factors of Potential Risks

Fire load factor q

The fire load factor q is calculated with the fire load density of building elements and contents. It indicates how much heat can be produced per unit area (m²). In theory, one must make a list of all available combustible materials with their specific heat value, make a calculation of the total possible heat release and divide this by the area of the compartment. In practice, the next tables give reasonable estimates of the values of Q_i and Q_m (in MJ/m²) so that an exact calculation is not always necessary.

Sub factor immobile fire load density Qi.

Immobile fire load density Qi	
The ‘immobile’ fire load Qi comes from all combustible elements used for the construction such as the structure: beams, columns, girders, walls and partitions, windows, carpeting and decoration materials. In practice, building types can be classified in five groups with broadly the same fire loads. The following table gives the most relevant values.	
A. Totally Incombustible (e.g. concrete / steel only)	0
B. Incombustible construction, with max. 10% allowance for combustible construction elements as windows, roof covering, etc.	100
C1. Wooden structure finished with incombustible materials.	300
C2. Masonry construction with wooden floors and girders	300
D. Incombustible structure, combustible finishing.	1000
E. Totally combustible construction	1500

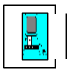
This list pops-up at the P-page.

For compartments of mixed construction, it is recommended to use the highest estimate of Q_i for the whole compartment.

Sub factor mobile fire load density Qm.

The table with values of Q_m gives an estimate of the mobile fire load density, based on several surveys found in the technical literature, as well as by calculation based on the required sprinkler water densities. The column “range” gives an overview of the data found. The user can correct the average value of the table on the P-calculation sheet or enter a user-defined value based on his observations, so that a more fitting value is used.

It is not necessary to have a sprinkler system to use this table: When the design criteria of an adequate sprinkler system are known , the table gives a fair guess of the corresponding fire load density.



Mobile (moveable) fire load density Qm		Range
In theory, one must calculate with the total heat release of all materials of the content divided by the total floor area. In practice, the next table gives reasonable estimates.		
User defined		
a. Low fire hazard (LH or light hazard) occupancies	200	
a1. Offices	400	80 - 550
a2. Dwellings	500	330 - 780
a3. Schools	200	215 - 340
a4. Hospitals	250	100 - 330
a5. Hotels	250	310 - 330
b. Ordinary fire hazard with low fire load (OH1 / NFPA: OH Gp1)	600	
c. Ordinary fire hazard with medium fire load (OH2 / NFPA OH Gp2)	1500	
d. Ordinary fire hazard with high fire load (OH3 / NFPA OH Gp2+)	2000	
e. Ordinary fire hazard with very high fire load (OH4)	2500	
f. High hazard class HH1	2500	
g. High hazard class HH2 (NFPA EH Gp1)	3000	
h. High hazard class HH3 (NFPA EH Gp2)	3750	
i. Rack storage For storage hazards, the fire load density is calculated with the total spray density needed for sprinklers. The fire load equals 300 MJ/m² per 1 l/min/m² sprinkler design density (or 0.1 gpm/sq.ft = 1250 MJ/m². For in-rack protection, add 3750 MJ/m² for each row of in rack sprinklers to the fire load density derived from the roof sprinklers density.	6750	
j. Large drop sprinklers protected storage	7500	
k. ESFR protected storage 7m high	12000	
l. ESFR protected storage 5.5 bar	15000	

Fire spread factor i.

The fire spread factor i indicates how easy a fire can spread through a building. It is calculated from the average dimension of the content m, the flame propagation class M, and the destruction temperature T.

Factor T is the temperature rise necessary to start the destruction of the content (or the building). In this formula, T is expressed in centigrade (°C), m in meter and M has no dimension. For the factors M and T, a weighted average can be entered. There is a 100 % check added: the total % will be in RED as long as it differs from 100 % (see below for factor M).

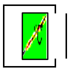
Sub factor m, the average dimension.

Factor m is the average dimension of the content and reflects the ratio between the total volume of the content and the total surface. To calculate m it is required to estimate the size (length, width, height or thickness) of typical objects in the content and to calculate an average dimension. Take n typical dimensions, expressed in meter, and the n-th root of the product will be calculated as the average dimension of the content.

Average dimension of content : m	
Fire spreads essentially on the surface of burning objects. The more surface available, the easier a fire will spread, as can be seen on small twigs in a campfire. The average dimension of the content reflects the ratio between the total volume (in m³) of the content and the total surface (in m²). Enter maximum 10 typical dimensions (in meter) here:	
To calculate m, estimate n typical sizes (length, width, height or thickness) of typical objects. The calculated average dimension of the content is the n-th root of the product of these sizes. The average dimension of the content m can vary between 0.001 m (40 thou) to 2 m (80 inch).	
dimension 1	1
dimension 2	0.3
dimension 3	0.5
dimension 4	
dimension 5	
dimension 6	
dimension 7	
dimension 8	
dimension 9	
dimension 10	
Total number of dimensions entered	3
Calculated average dimension	0.53

Sub factor T, temperature rise.

T is the temperature necessary to start ignition or damage of the content. The following scale gives an indication of the relevant values in °C.



Temperature rise T		
Define the temperature necessary to start ignition or damage of the content. The following scale gives an indication of the relevant values in °C. Equivalent values in °F are in brackets.		
USER DEFINED INPUT	0	TOTAL:
WEIGHTED AVERAGE of the following classes: Any intermediate value is also acceptable. E.g. in a warehouse were packed and unpacked metal spare parts are stored, T= 250°C can be used. Be sure that the total of all classes is 100 %	234	100.00% This field becomes orange if not = 100%
a. Inflammable liquids (21°C - 70°F)	20	20.00%
b. Plastics, electronics, human beings (100°C - 212°F) Human beings only need to be considered as “ content” when they will remain for an extended time in the compartment during the fire growing phase.	100	0.00%
c. Textile, wood, paper, food (200°C - 400°F)	200	0.00%
d. Average content of residential buildings (250°C - 482°F)	250	60.00%
e. Machinery, household appliances (300°C - 572°F)	300	0.00%
f. Metal objects (400°C - 752°F)	400	20.00%
g. Non combustible (construction) materials (500°C - 932°F)	500	0.00%

Sub factor reaction to fire class M.

For the purpose of evaluation the speed of fire spread, 6 flame propagation or “reaction to fire” classes, called M are used. It is important to notice that these classes apply for the surfaces. A closed metal container with gasoline can be classified as M = 0, and a TV-set in a polystyrene box will be classified M = 4 or even M = 5. For mixed contents, such as in warehouses, a weighed average class e.g. M = 2.5 can also be used in the formula.

The table uses as reference classes the classifications that can be found in EN 13501-1 (reaction to fire) and EN 12845 (sprinklers – packaging material categories)

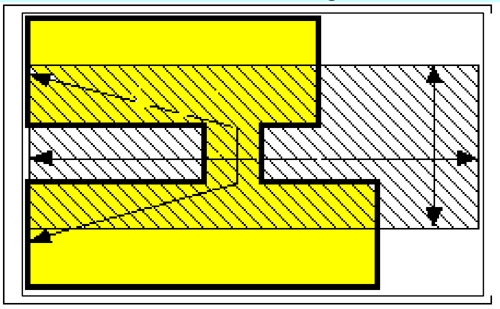
Reaction to fire class M		TOTAL:
WEIGHTED AVERAGE of the following classes. A weighted average is also acceptable. E.g. where unpacked and expanded plastic protected metal spare parts are stored, a combination of A1 and F can be used. Be sure that the total is 100 %	2.5	90.00% This field becomes orange if not = 100%
A1 per EN13501-1 or Incombustible	0	40.00%
A2 per EN13501-1or Nearly incombustible	0.5	0.00%
B per EN13501 or EN12845 Cat. I : Difficult to ignite (self extinguishing)	1	0.00%
C per EN13501-1 : Slow burning materials	2	0.00%
D per EN13501 or EN12845 Cat. II: Combustible surfaces	3	0.00%
E per EN13501-1 or EN12845 Cat. III Flammable surfaces	4	0.00%
F. EN12845 Cat. IV : Highly flammable surfaces	5	50.00%

The area factor g.

The area factor g indicates the horizontal influence of the fire. The factor g is calculated with the values of l, the theoretical length of the compartment, and of b, the equivalent width, expressed in meter. In order to define L and b it is very useful to have a scale drawing of the compartment, especially when it is a building of an irregular shape.

The formula for g considers the size and the shape of the compartment. When a building is only accessible from its narrow side (see below), the values of l and b are reversed to reflect the increased difficulty for the fire brigade to control a fire in such a building.

Area factor g

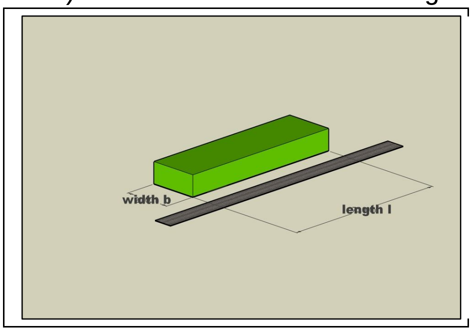


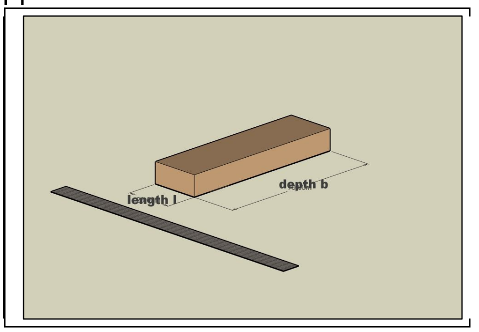
Step 1: Define the longest distance between the centres of two sides of the compartments' perimeter. This is the theoretical length l.

Step 2: Define the total surface area of the compartment : Atot

Step 3: Divide this area by the theoretical length to obtain the equivalent width b.

Step 4: Check if the building is accessible at its long side (left view): If NOT (right view): use the " Narrow building" approach.





Building access for the fire brigade	
Building accessible at its long side	long
Building only accessible at its narrow side	narrow

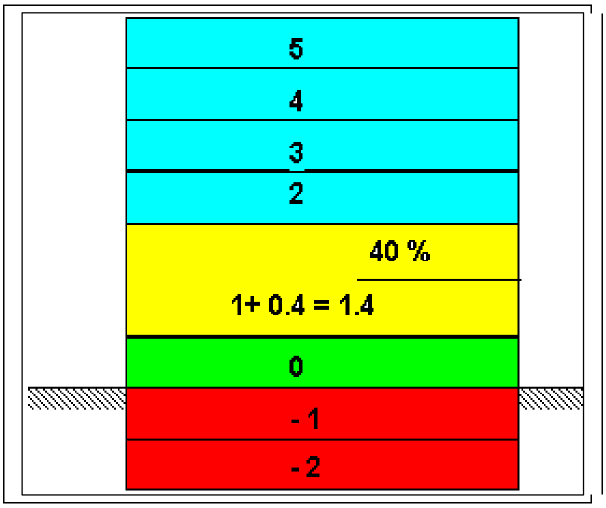
The level factor e:

Level factor e

Level number E, galleries, mezzanines, etc.

Number all the levels in the following way: E =0 for the main access level. All upper levels are then E = 1,2,3, etc. All underground levels are then E= -1, -2, -3, etc.

For galleries between levels, add the additional floor space as the decimal part of the level number. When a first floor has a gallery of 40 % additional floor space, enter the level number as 1.4.

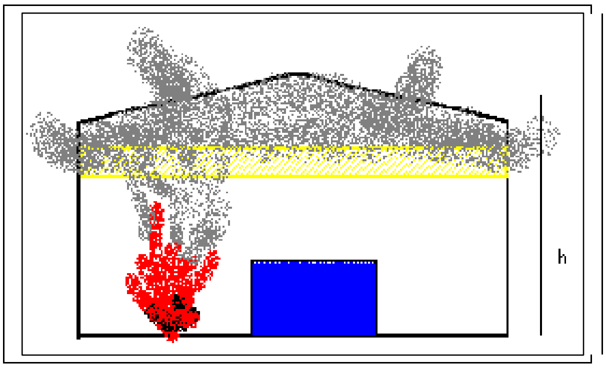


The venting factor v:

Venting factor v

The venting factor v is calculated with the values of Qm, k and h.

The mobile fire load is the most relevant measure for the potential heat release inside the building.



STEP 1: Define the height h, between the floor and the ceiling of the storey. For a sloping roof or ceiling, it is the average height that is used. The maximum value for h = 15 m. For higher ceilings, “FRAME” uses 15 m

STEP 2: Measure the total area of single glazed windows, glass and plastic skylights in the ceiling (roof) and upper third of the walls opening to the outside. Enter this area in m².

When looking at the walls, one can broadly say that the openings in the lower third of the wall will allow fresh air to come in, the middle third will be a neutral zone, and the openings of the upper third will let the smoke out. Double-glazed windows, armoured glass and similar "strong" materials should not be considered as they take some time to break under the effects of the fire.

STEP 3 : Measure the aerodynamic area of natural smoke vents in m²

STEP 4: Define the capacity for the mechanical exhaust systems for smoke extraction in Nm³/hour

OR define the ratio smoke exhaust openings / floor area

When the exact venting capacity is not known, a fair guess of that capacity can be made, according to the quantity of light material present in the roof construction. E.g., when a roof is made up of solid and transparent (plastic) sheet in a ratio of 1 transparent sheet for 19 solid sheets, the light elements represent 5 % of the roof. Take 1/3 of this to estimate the venting ratio at 1.5 % or k = 0.015. Do not guess values higher than 0.02 (2 % venting area).

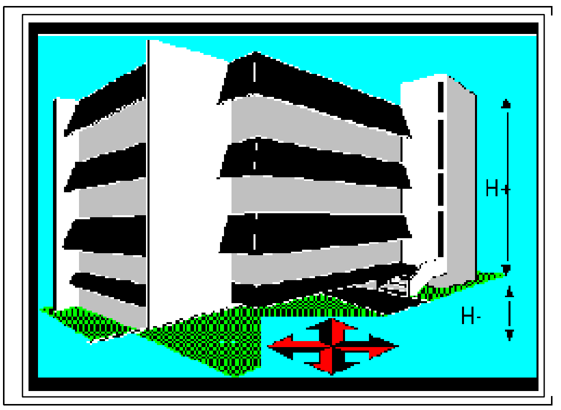
The access factor z:

Access factor z

The access factor z indicates how difficult it is for outside help to get into the fire area and is calculated with b, H+ or H- and Z.

To define Z, the number of access directions, draw an imaginary map of the building with the north at the main entrance of the building, and check also the south, east and west for free access for the fire brigade. The number of accessible directions is Z (1 to 4).

Z
1
2
3
4



To define H^+ or H^- : Look at the fire brigades' way towards the fire up or down. When they have to go upward, call H^+ the vertical distance from the access level to the floor level of the compartment. When they have to go downward, call H^- the distance from access level to the basement floor. The value of H is expressed in m

The P-REF page.

On this page, all data for the calculation of the Potential Risk for the reference case can be entered and the corresponding factors are calculated.

Potential risk calculation

DATA	Symbol	Unit				Results	Comments
Fire load factor q.							
Immobile (building) fire load density:	**Qi**	MJ/m²	C1. Wooden structure finished with incombustible materials. This cell shows the Qi-list of the Info on P page	300	0	**300**	
Mobile (moveable) fire load density	**Qm**	MJ/m²	i. Rack storage This cell shows the Qm-list of the Info on P page	6750		**6750**	
			The calculated value of q is =	**q**	=	**2.02**	
Fire spread factor i.							
Temperature rise	**T**		WEIGHTED AVERAGE of the following classes This cell shows the T-list of the Info on P page	234	200	**234**	
Average dimension of content	**m**	*Define m: average dimension of content (see info P or enter value in column F)*		1.00	0	**1.00**	
Reaction to fire class of surfaces	**M**		WEIGHTED AVERAGE of the following classes. This cell shows the M-list of the Info on P page	2.5		**2.5**	
			The calculated value of i is :	**i**	=	**1.02**	
Area factor g							
Theoretical length	**l**	m	Define the longest distance between the centres of two sides of the compartments' perimeter. This is the theoretical length l.		80	**80**	
Total compartment area	Atot	m²	Define the total surface area of the compartment		2000	**2000**	
Equivalent width	**b**	m	Divide this area by the theoretical length to obtain the equivalent width b.			**25**	
Frontage			Building accessible at its long side	long			
			The calculated value of g is :	**g**	=	**1.05**	
Venting factor v							
Mobile (moveable) fire load density	**Qm**	MJ/m²	The mobile fire load Qm, which is already entered, is used here.			**6750**	
STEP 1 : Floor to ceiling height	**h**	m	*The maximum value for h = 15 m. For higher ceilings, use 15 m*		4	**4**	
Smoke venting ratio	**k**		*Define the smoke-venting ratio k as follows:*				

	STEP 2	m^2	Total area of single glazed windows, glass and plastic skylights in the ceiling (roof) and upper third op the walls giving to the outside.		10	3
	STEP 3	m^2	Measure the aerodynamic area of static smoke vents in m^2		10	10
		Nm^3/h	Nominal flow of mechanical (smoke) ventilation systems			0
		m^2	Total area of compartment	2000		0.01
			The smoke venting ratio k (calculated with these values) or estimated	k =	3%	**0.03**
			The calculated value of v is:	**v**	=	**0.98**
Level factor e						
Level	**E**		*Mezzanines and platforms : add decimal value to level number*		0	**0**
			The calculated value of e is:	**e**	=	**1.00**
Access factor z						
The number of access directions	**Z**		The number of accessible directions is Z (1 to 4).		4	**4**
Height difference	**H**	m	Height difference in meter (positive or negative)		-3	
	b		already entered for factor g			25
			Access factor z	**z**	=	**1.05**
Potential Risks						

			Potential risk values for :		
Fire load factor q.	**q**	**2.02**	property (building and content)	**P**	**2.20**
Fire spread factor i.	**i**	**1.02**	occupants (people)	**P1**	**2.10**
Area factor g	**g**	**1.05**	activities	**P2**	**1.09**
Level factor e	**e**	**1.00**			
Venting factor v	**v**	**0.98**			
Access factor z	**z**	**1.05**			

Clicking on the yellow cells shows the lists of suggested values from the Info on P page, of which one can be selected , or the measured value has to be entered. In the green cells, the suggested value can be corrected. When weighed averages are used, they shall be defined first on the info Page.

The “Info A” page.

This page gives information on the sub factors used in the Acceptable Risk calculations. The info page shows the selection lists which can be used as entry data on the next calculation page. Some cells have a pop-up comment added which gives extra information how to define that particular item.

The activation factor a.

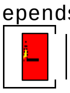
There are so many possible ignition sources that the only way to define the activation factor is to go through a review of possible fire sources, classified in the categories: main activities, heating systems, electrical installations, secondary activities and areas classified for explosion hazards.

Main activities:

MAIN ACTIVITIES	
A1. Non industrial occupancies: offices, residential, assembly, educational	0
A2. Industry of non-combustible products (EN Sprinkler class OH1)	0
B. Most industries, large stores, retail shops (EN Sprinkler classes OH2 and OH3)	0.2
C. Industry of combustible products such as paper, wood, petrochemicals (OH4 / HH1-HH4)	0.4
D. Warehouses and similar storage (Sprinkler class S)	0

Heating systems:

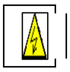
Defects on heating systems are well-known fire causes. The probability of a fire originated in the heating system depends on the type of heat transfer, the location of the heat generator and the type of fuel used.



Process and room heating systems (1)	
E1. No heating available: no risk	0
E2. Heat transfer through water, steam, or solids	0
E3. Heat transfer through pulsed air or through oil.	0.05
Process and room heating systems (2)	
F0. Not applicable	0
F1. Heat generator in a fireproof separated room	0
F2. Heat generator in the compartment under consideration.	0.1
Process and room heating systems (3)	
G0. Not applicable	0
G1. Energy source: electricity, coal, fuel oil.	0
G2. Energy source: gas	0.1
G3. Energy source: wood or waste materials	0.15

Electrical installations:

Defects of electrical installations are well-known fire causes. The probability of a fire of electrical origin depends on the way the installation is installed and maintained. Regular checking of code compliance offers a good guarantee for a safe installation.



Electrical Installations.	
I1. In compliance with the rules and regularly checked	0
I2. In compliance with the rules without regular checks	0.1
I3. Not according the rules	0.2

Explosion risks:

The presence or occasional escape of flammable vapours, gases or dusts is an additional source of fire.

Explosion risks (1)	
Z. Not applicable	0
Z0. Permanent explosion risk ATEX zone 0	0.3
Z1. Explosion risk under normal conditions ATEX zone 1, NEC: Class I Div.1	0.2
Z2. Occasional explosion risk ATEX Zone 2 NEC: CLASS I DIV.2 area	0.1
Explosion risks. (2)	
K0. Not applicable	0
K1. Dust explosion hazard ATEX zones 20/21/22 NEC : Class II area	0.2
K2. Production of combustible dusts without extraction	0.1

Painting, spraying or coating with flammable products; use of solvents and flammable glues, etc.	
NONE	0
N1. In a separated, well ventilated room	0.05
N2. In a separated space without additional ventilation	0.1
N3. Without separation	0.2

Secondary activities:

Secondary activities are only taken into account when they create an additional number of fire sources, compared with the main activities. Welding e.g. will not be aggravating in a metalwork shop but must be taken into account in a carpentry shop.

The evacuation time factor t

Evacuation time factor t

The evacuation time factor is calculated with the number of persons present in the compartment, their mobility, the dimensions of the building and the characteristics of the exit ways.

The total length of the evacuation path is calculated with the values of b, l, H+ or H-, which were already given.

INFO about X

Define X, the number of persons that can be present in the compartment. X is total number of persons that will have to evacuate the compartment.

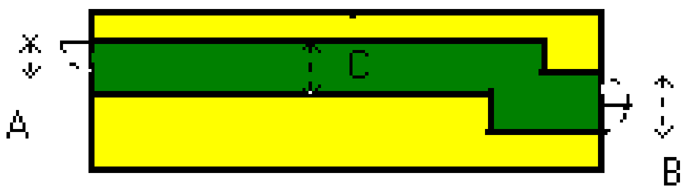
If this number is unknown, use the next table with occupant load factors based on NFPA 101. Be careful: local code requirements may use different occupant load factors.

User defined total number of persons in the compartment	
01. Waiting spaces	3
02. Places of assembly, concentrated use (halls, churches, dancing)	1.5
03. Places of assembly, normal use (conference rooms, restaurants, cafés)	0.6
04. Classrooms in schools, no fixed seating	0.5
05. Day nurseries	0.3
06. Schools: laboratories, shops and vocational rooms	0.2
07. Medical institutions	0.1
08. Jails, detention houses	0.1
09. Residential buildings (houses, hotels, guest houses)	0.05

10. Sales area on street access floor, below street access floor	0.3
11. Sales area on floors above access floor	0.2
12. Offices	0.1
13. Factories	0.03
14. Storage and warehouses	0.003
15. LOCAL CODE DEFINED OCCUPANT LOAD FACTOR	0.2

INFO about x

Define x, by counting all the exit units of the compartment according to legal and practical rules.
x is the number of exit units. The minimal width for an exit is 0.6 m (or 2 ft) unless law or practical conditions specify it otherwise. E.g. in a hospital, it is clear that the minimal width is that of the beds which are used in the hospital.
Consider some 20 cm (8 in) of lost width, i.e. a 80 cm (32 in) wide door has an effective width of 60 cm (24 in). A 2 m wide (80 in) corridor has an effective width of 1.80 m (72 in).
To define the value of x, look for each exit at the narrowest passage on the path, measure the width in cm or inches, deduct 20 cm or 8 in and divide the result by 60 cm or 24 in. This will give the number of exit units per exit path. The sum of all the quotients gives the total number of exit units of the compartment.



In the example, the width of door A is relevant for exit path A, but for B it is the width C of the corridor.
Remark: large gates, sliding doors (except where specifically designed for emergency exit) and roller shutters shall not be considered as exit units!

INFO about p

Persons that can move independently and are accustomed to the building features will be able to evacuate rapidly. People who need help or have to find their way to the exits will need more time.
Factor p corrects the evacuation time for the lack of mobility of the occupants and for other unfavourable circumstances..
Possibility D permits the calculation of a p factor for a mixed group

			%
A. Mobile and independent persons (adults, workers)	1		10.00 %
B. Mobile persons needing guidance (pupils, visitors)	2		20.00 %
C. Persons with limited mobility (patients, elderly, inmates) Such as patients or elderly, handicapped or sleeping persons (in hotels)...	8		70.00 %
D. Calculated value for mixed group	6.1	check:	100.00%

INFO about K - Available and distinct exit paths

The number of AVAILABLE and DISTINCT exit paths is calculated in the following way:

First, enter the number of exits that end in the open air, basically external doors and exterior stairways , but no ladders.

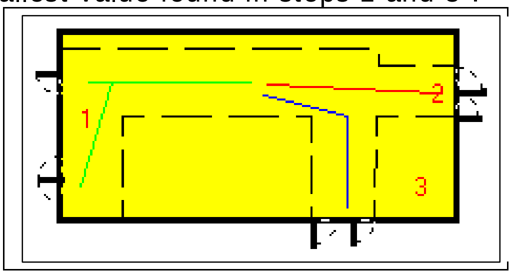
The second step is to define the maximum capacity of all the exits together. This is done (automatically) by multiplying the number of exit units by 120.

The maximum capacity of an exit unit having a useful width of 60 cm (e.g. a door of 80 cm) is 120 persons per minute. If more people try to use this exit, they will be queuing to pass, which slows down the exit movement.

The third step is to divide this capacity by the number of occupants that are present. This quotient is the theoretical number of "distinct" exit paths. The real number of distinct exit paths shall be not more than 4 (implying a 90° angle between them).

When all the exit units are needed to satisfy the evacuation requirements for the occupants , they shall be considered as a SINGLE useful exit path.

The number of the AVAILABLE and DISTINCT exit paths "K" is then the smallest value found in steps 1 and 3 .



	value of K
Less than 1:	Not allowed
more than 1 and less than 2:	1
more than 2 and less than 3:	2
more than 3 and less than 4:	3
more than 4:	4

The content factor c.

Factor c defines the value of the contents of the compartment. It is calculated from is monetary value and replacement possibilities.

relative value of the content c1

Choose the value of c1 according to the possibility to replace the contents:

a. the contents can be easily replaced	0
b. the contents can difficulty be replaced	0.1
c. the contents are unique.	0.2

The property value V .
'Property' means as well the compartment itself as the goods in it, as its occupants.

The dependency factor d:

The activity in the compartment will be hampered or interrupted by a fire. The added value / turnover ratio is a good reference for the sensitivity for business interruption.

dependency factor d	
The activity in the compartment will be hampered or interrupted by a fire. The added value is a good reference for the sensitivity for business interruption. The added value is the sum of the costs of personnel, financial costs, investments, and the company results. The turnover is the total yearly monetary value of all the revenues coming from the economic activity of the unit, which is considered. The dependency factor d is the ratio of added value by turnover. The higher this ratio, the more sensitive is the activity. As a guideline the values for d can be estimated as follows:	
a. High technology industry (e.g. aircraft) : 0.7 to 0.9	0.8
b. Precision industry (e.g. electronics) : 0.45 to 0.7	0.6
c. Manufacturing industry : 0.25 to 0.45	0.35
d. Commercial companies, warehouses: 0.05 to 0.15	0.1
e. Administrative services: 0.8	0.8
f. Average for most businesses	0.3
g. USER DEFINED INPUT	0

The Acceptable Risk page.

On this page, all data for the calculation of the Acceptable Risk for Variant 1 can be entered and the corresponding factors are calculated.

name of the building	identification of the compartment

Acceptable risk calculation

DATA	Symbol	Unit				Results	Comments
Activation factor			DEFINE all relevant situations				
Main activities	*a1*		A2. Industry of non-combustible products (EN Sprinkler class OH1)	0		**0**	
Process and room	*a2*		E2. Heat transfer through water, steam, or solids	0		**0**	
heating systems	*a3*		F2. Heat generator in the compartment itself.	0.1		**0.1**	
	a4		G2. Energy source: gas	0.1		**0.1**	
Electrical Installations.	*a5*		I1. In compliance with the rules and regularly checked	0		**0**	
Explosion risks.	*a6*		Z. Not applicable	0		**0**	
Dust hazard	*a7*		K0. Not applicable	0		**0**	
Secondary activities	*a8*		Secondary welding operations	no		**0**	
	a9		Additional woodworking or use of plastics	no		**0**	
Painting, spraying, glues,	*a10*		NONE	0		**0**	
Others	*a11*		Special hazards (e.g. non-controllable smokers)	no		**0**	
			Total value of activation factor a:	**a**	=	**0.2**	
Evacuation time factor							
	b	m	*value entered at: potential risk factor g*			**40**	
	l	m	*value entered at: potential risk factor g*			**50**	
Number of occupants	**X**	persons/m²	User defined total number of persons in the compartment	m	**100**	**100**	
Total of exit units	**x**	exit units	x is the number of exit units. The minimal width for an exit is 0.6 m (or 2 ft) unless law or practical conditions specify it otherwise.	2	50	**2**	
DISTINCT exit paths	**K**	number	Calculated number of distinct exit paths:.	2.4	gives:	**2**	
Mobility factor	**p**		A. Mobile and independent persons (adults, workers)	1		**1**	
			People with limited perception of the risk	no		**0**	
			There is a clear evacuation plan:	yes		**0**	
			There is a danger for panic	no		**0**	

Equivalent length of vertical travelling path			*based on H+ or H- value entered at potential risk factor z*		0	0
			Evacuation time factor	**t**	=	**0.08**
Content factor						
Relative value	**c1**		b. the content can difficulty be replaced	0.1		**0.1**
Absolute value of content			Actual value in million of CURRENCY (e.g. EUR, GBP, USD, SWF...)	13.0	million	EUR
Building cost index			National building cost index at the time of the risk assessment	654		
Correction for inflation			National building cost index in 2000	503	in 2000:	**10.00**
Exchange rate		EUR	1 CURRENCY = x.yz EURO	1.00	in EURO	
Reference value			Value in EURO , at given exchange rate and corrected for inflation			**10.00**
Content value factor	**c2**					**0.04**
			Content factor	**c**	=	**0.14**
Environment factor						
	Qi		*value entered at potential risk factor q*			**100**
	M		*value entered at potential risk factor i*			**1**
			Environment factor	**r**	=	**0.30**
Dependency factor						
Added value /turnover ratio	**d**		f. Average for most businesses	0.3	0	0.3
			Dependency factor	**d**	=	**0.3**
Acceptable Risks						

			Acceptable risk values for :		
Activation factor	**a**	**0.20**	property (building and content) = 1.6 - a - t - c	**A**	**1.19**
Evacuation time factor	**t**	**0.08**	occupants (people) = 1.6 - a - t - r	**A1**	**1.02**
Content factor	**c**	**0.14**	activities = 1.6 - a - c - d	**A2**	**0.96**
Environment factor	**r**	**0.30**	**WARNING :If the value of A or A1 or A2 is lower than 0.2 or even negative,**		
Dependency factor	**d**	**0.30**	**an unacceptable risk situation exists ! CHANGE first a, t, c, r or d**		

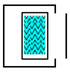
The info D page.

The water supply factor W

Factor w is defined as the sum of (unfavourable) factors wi for which the values can be found in the next table.

WATER SUPPLY FACTOR W

Water is the most common extinguishing means. Factor W defines the minimum standard (including town mains) required for the water supply and considers the type of water storage, the hydrant network, the available flow and pressure.



Water storage type	
1. Water storage for general use, automatically filled	0
2. Water storage for general use, manually filled	4
3. No water storage available (within 300 m)	10

Required Quantity of Water for Fire Extinguishment

The required quantity in m³ is equal to the total fire load in MJ/m² divided by 4. A smaller quantity will can reduce the efficiency of fire fighting operations.

0%	4
70%	3
80%	2
90%	1
100%	0

Distribution network

An adequate distribution piping system is required, its size depending on the total water capacity required. The distribution system shall be capable of supplying the required quantity of fire extinguishment water to the fire scene in 2 hours without considerable pressure losses

The following table gives the flow capacity of piping systems, based on a maximum water velocity of 2 m/sec, which guarantees low friction losses over larger distances. Network (looped) systems are adequate for twice these flows.

None or < DIA80	0
DIA 80 (3")	34.3
DIA100 (4")	59.2
DIA150 (6")	134.3
DIA200 (8")	232.3
DIA250 (10")	366.8
DIA300 (12")	526.1
DIA350 (14")	676.9

Distribution network supply capacity	
ADEQUATE	0
LIMITED	2
NONE	6

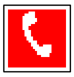
Hydrant hose connections:

An adequate number of fire hydrants is required. One 2.5" (70) hose connection is necessary per 50 m of building perimeter of the building. One 3" connection equals two 2.5"(70); one 4"(100) connection equals three 2.5" (70).

The normal protection factor N.

Normal protection means the chain: discovery - alarm - manual intervention:

Discovery and warning



A correct normal chain of warning consist of means of discovery, a guaranteed warning system to the fire service and an audible signal to the occupants to evacuate the building if required.
“means of discovery” of a fire : e.g. continuous human presence in the building and/or a watchman service.

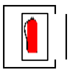
A “warning system” to signal the existence of a fire to the fire service: this can be a telephone network with a “fire call” number, or a manual push button system linked to the guard post who will call the fire service, or linked to an automatic call system for the fire service, or any other organised way to contact the fire service.

Sometimes the warning remains local, e.g. when the guard has no instructions or means to call the fire service. This will be penalised.

There must be an audible alarm signal to the occupants to evacuate the compartment. In noisy environments a visual signal may also be required.

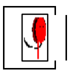
First intervention means.

The usual means for a first intervention are hand extinguishers, hose reels and inside hose stations. The type and number of the equipment must be adapted to the risk. Each country has its own rules.
Local standards should be used to define the number and type of hand held and mobile extinguishers. Hose reels and hose stations should be located in such a way that any part of the building can be reached by at least one hose jet. Hose reels are adequate for buildings with a low fire load and untrained users Hose stations are preferred where the fire load is high and where the people are trained.



Portable and Mobile extinguishers

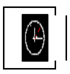
1. Extinguishers adequate (type and quantity)	0
2. Extinguishers absent or of inadequate numbers or types	2



Hose reels and/or hose stations

1. Adequate number and location	0
2. Inadequate numbers or location	2
3. None	4

Fire brigade arrival time



The time between the notification of the fire and the first intervention of the fire brigade is the period where the fire can develop while those in the building fight the fire.

1. First fire brigade arrival in less than 10 min	0
2. Arrival after 10 to 15 min	2
3. Arrival after 15 to 30 min	5
4. More than 30 minutes delay	10

Occupants' training

The training in the use of the manual means received by the occupants, is of great importance during that first period.

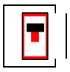
1. All occupants know how to use extinguishers, hose stations	0
2. Only a limited number of persons trained	2
3. No extinguisher training given	4

The special protection factor S

SPECIAL PROTECTION FACTOR S

Under special protection the following are considered: automatic fire detection, improved water supplies, automatic fire protection systems, well equipped fire brigades.

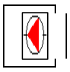
Automatic detection



Automatic detection systems speed up the discovery of a fire and the fire brigade intervention. They can only be considered if there is a guaranteed connection to the fire brigade, which will immediately react to the signal. Sprinkler systems connected to a fire alarm by flow switches can be considered as slow thermal detection systems. Smoke and flame detectors will be considered as fast detectors. Electronic supervision of the system and individual identification of a small fire zone (e.g. per detector) will give extra bonuses.

None	0
1. Automatic detection by sprinklers + flow or pressure switch	4
2. by thermal (heat) detectors	5
3. by smoke or flame detectors	8
4. by smoke alarm units	2

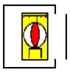
Improved water supplies



The water supplies are of prime importance for fire fighting. Rivers, lakes and any other water storage that can guarantee 4 or more times the quantity of water needed are considered as inexhaustible. The water has to be conveyed to the fire scene by a flow/pressure source with a reliable energy source : a water tower, pump, elevated reservoir..

Single flow/pressure source	0
Highly reliable : One water storage with a double flow/pressure source	5
Duplicated highly reliable: two storages, each with a flow/pressure source	12

Automatic protection for the compartment.



Consider at this point only automatic protection systems that cover the entire compartment. Partial systems for critical items are taken into account with factor Y.

None	0
1. Sprinklers with one (public) water supply	11
2. Sprinklers with one independent water supply	14
3. Sprinklers with two independent water supplies	20

Sprinkler systems can only be considered as automatic protection when they are adequate for the occupancy and have at least one adequate water supply.

Responding fire station

1. Full time station 24h/24 7d/7	8
2. Professional crewed station (day time crewed, night time retained)	6
3. Retained station (part time professionals)	4
4. Volunteer crewed station	2

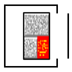
Industrial private fire brigade

None	0
1. Part time industrial fire brigade (working hours)	6
2. Full time industrial fire brigade 24h/24	14

Temporary private fire brigades are only fully staffed during working hours. Permanent private fire brigades are staffed "around the clock". This type of private fire brigades is normally only organised at large industrial sites.

The fire resistance factor F

FIRE RESISTANCE FACTOR F



The fire resistance factor F is defined by the fire resistance of the building elements, but with a correction for the value of the special protection S. Such correction is necessary as the presence of active fire protection systems reduces somewhat the benefit of passive protection.

The average fire resistance is calculated with the fire resistance in minutes of the structure, the outside walls, the roof or ceiling, and the inner walls. In most countries, the fire rating of construction elements will be expressed in minutes as defined by tests based on the ISO R 834 time/temperature curve.

For structural building elements the main criterion is stability, although other requirements such as thermal insulation, smoke- and flame tightness and other features are also in use for certification.

“FRAME” considers stability only for load bearing elements such as columns, beams, floors and roofs.
For partitions (subcompartmentation) flame tightness and insulation are required.

The following limitations also apply
1. To avoid unrealistic high values, do not use fire ratings higher than 120 minutes.
2. Do not use higher values for outside walls, roof or ceiling and inner walls than for the structure.
3. For mixed construction elements, use the rating of the weakest part.
4. Windows in outside walls can be neglected if they cover less than 5 % of the wall area.
5. The rating of roofs and ceilings is mainly defined by the underside.
6. For buildings with sprinklers designed to protect the structure or the roof, the duration of the water supply can be taken as the fire rating, but not for more than 60 minutes.
7. Consider only interior walls which subdivide the compartment in fire areas, none of them should be more than 25 % of the compartment, and no area should be larger than 1000 m²

The escape factor U and the salvage factor Y:

ESCAPE FACTOR U

The escape factor U takes into account all elements of the special protection that decrease the evacuation time or reduce the development of the fire. Additional compartmentation and protection of the exit paths are also evaluated.

Automatic detection systems speed up the discovery of a fire and the evacuation. The same values apply as for factor S, the special protection. Compartmentation and exit path protection will reduce smoke and heat spread. Shortening the exit paths and good signage will allow the occupants to move faster into a safe area.

Automatic fire detection systems

Compartment wide fire detection systems, which are already entered for the special protection factor S are automatically taken into account for the calculation of the escape factor U.
Partial fire detection in critical areas, e.g. in escape routes or increased hazard rooms can be considered here. A small bonus is given , when less than 300 persons have to be evacuated.

Subcompartments

None	0
1. EI30 Subcompartments (fire areas of max.1000 m^2)	2
2. EI60 Subcompartments (fire areas of max.1000 m^2)	4

Type of stairways for evacuation

No stairs used for exit	0
1. Open inside stairs	0
2. Single enclosed inside stair	1
3. More than one enclosed inside stair	2
4. At least one enclosed and smoke protected inside stair	3
5. More than one enclosed and smoke protected inside stair	4
6. Inside stair(s) and 1 outside stair	6
7. Inside stair(s) and more than 1 outside stair	8
8. Inside stair and outside toboggan or ladders for 1st / 2nd floor	2

Horizontal exits

No horizontal exits	0
1. Horizontal exit to adjacent compartment min. 50% of required capacity	2
2. Horizontal exit(s) to adjacent compartment(s) 100% of required capacity	8

Sprinkler protection

None	0
1. Sprinklers only in areas with increased fire risk	5
2. Whole compartment protected by sprinklers	10

SALVAGE FACTOR Y

The salvage factor Y evaluates those physical provisions that protect sensitive parts of the activity against the impact of a fire, and organisational measures to assure a swift restart of the activities if necessary on an other location.

F.R.A.M.E.

The Protection Level page:

name of the building			**identification of the compartment**				
Calculation of the Protection Level D							
DATA	Symbol	Unit				Results	
							Comments
WATER SUPPLY Factor							
Water storage type	*w1*		1. Water storage for general use, automatically filled	0		**0**	
Water storage capacity		m^3	Estimated capacity of water storage available for fire fighting	160	m^3		
		m^3	Required Capacity for fire extinguishment	175	m^3		
	w2		Available capacity as % of required	91%	1	**1**	
Distribution network							
Nominal diameter of main water piping		mm	DIA100 (4")	flow capacity	59.2		
Looped network ?			no	total m^3/h	59.2		
	w3		Distribution network supply capacity	LIMITED		**2**	
Hydrant hose connections		m	Building perimeter (= 2 * (b+l))	180	m		
		#	Number of available 2.5" (70) connections	4			
		#	Number of available 3" (80) connections	0			
		#	Number of available 4" (110) connections	0			
			Equivalent number of 2.5" (70) connections	4			
	w4		Average distance between connection on the building perimeter	45		**0**	
Static pressure		m H2O	*Floor level height H+ or H- + ceiling height*	4			
			Required network static pressure	3.9	bar		
	w5	bar	Available static pressure in the distribution network	5	bar	**0**	
				w	=	**3**	
			WATER SUPPLY Factor	**W**	=	**0.86**	
Normal protection Factor							
Discovery	*n1*		There is a watch service or continuous human presence	yes		**0**	
Warning			There is also a manually operated alert system	yes		**0**	
Call to fire brigade			There is (also) a guaranteed warning to the fire brigade	yes		**0**	
Occupants alarm			There is also an alarm to the occupants	yes		**0**	
Extinguishers	*n2*		1. Extinguishers adequate (type and quantity)	0		**0**	
Fire hose stations	*n3*		1. Adequate number and location	0		**0**	
Fire brigade arrival	*n4*		2. Arrival after 10 to 15 min	2		**2**	
Occupants' training	*n5*		2. Only a limited number of persons trained	2		**2**	

				n	=	4	
			Normal protection Factor	N	=	0.81	
Special protection factor							
Automatic fire detection	*s1*		Guaranteed transmission of the detection signal to the fire brigade directly / through control room	yes			
			None	0		0	
			Electronic supervised system - fault monitoring	no		0	
			Individual identification of small fire zones (detector, room)	no		0	
Improved water supply	*s2*		Inexhaustible water supplies (4 times adequate)	no		0	
	s3		Reserved for fire fighting only	no		0	
Control of water supply	*s4*		Under control of building user (independent)	no		0	
Energy supply	*s5*		Single energy supply	0		0	
Sprinkler protection	*s6*		None	0		0	
Other	*s7*		Other automatic extinguishing systems (CO2, foam, inert gas)	no		0	
Public fire brigade	*s8*		1. Large professional public fire brigade 24h/24	8		8	
Private fire brigade	*s9*		None	0		0	
				s	=	8	
			Special protection factor	S	=	1.48	
Fire resistance factor							
Structural /compartments	**fs**	min.	Average fire resistance (REI) of the structural and separating elements:	30	min.	30	
Outside walls	**ff**	min.	Average fire resistance of the outside walls (E = flame tightness)	30	min.	30	
Ceiling or roof	**fd**	min.	Average fire resistance of the ceiling or the roof (RE)	30	min.	30	
Interior walls	**fw**	min.	Average fire resistance of interior walls (EI)	0	min.	0	
			Calculated weighed average for fire resistance	f	=	26.25	
			Initial structural fire resistance (stability)	Fo	=	1.30	
			Fire resistance factor	F	=	1.24	
Escape protection factor							
Automatic fire detection	*u1*		*Some data are already entered at factor S*				
			None	0	see at S	0	
			Electronic supervised system - fault monitoring	no	see at S	0	
			Individual identification of small fire zones (detector, room)	no	see at S	0	
			Partial detection system, only in areas critical for people safety	no		0	
			No more than 300 persons to be warned simultaneously	yes		2	
			Evacuation alarm with spoken messages by voice communication system	no		0	
Subcompartments	*u2*		None	0		0	
Exit path protection	*u3*		No stairs used for exit	0		0	

Horizontal exits			No horizontal exits	0		**0**	
Signage and illumination			Exit paths completely marked and illuminated	yes		**4**	
Sprinklers?	*u4*		None	0		**0**	
Other automatic system	*u5*		Other automatic extinguishing systems (CO2, foam, inert gas)	no	see at S	**0**	
Smoke vents actuation	*u6*		Smoke venting actuated by automatic detection	no		**0**	
Public fire brigade	*u7*		1. Large professional public fire brigade 24h/24	8	see at S	**8**	
Private fire brigade	*u8*		None	0	see at S	**0**	
				u	=	**14**	
			Escape protection factor	**U**	=	**1.98**	
Salvage factor							
Compartmentation	**yi**		None	0		**0**	
PHYSICAL PROTECTION							
Detection	**yi**		Partial detection system, only in areas critical for business continuity	no		**0**	
Sprinkler			Local sprinkler protection for critical equipment	no		**0**	
Other systems	**yi**		Other LOCAL automatic extinguishing systems (CO2, foam, inert gas)	no		**0**	
ORGANISATION							
FINANCIAL	**yi**		Safeguarded financial and economical data	yes		**2**	
EQUIPMENT	**yi**		Easy access to spare parts and replacements	yes		**4**	
REPAIRS	**yi**		Repairs possible with minimal help	yes		**2**	
RELOCATION			Immediate transfer of activities possible	no		**0**	
COOPERATION	**yi**		Written agreements for relocation exist	no		**0**	
PRODUCTION CENTRES	**yi**		Production capacity available at more than one location	no		**0**	
				y	=	**8**	
			Salvage factor	**Y**	=	**1.48**	
Protection levels D							
			Protection levels for:				
WATER SUPPLY Factor	**W**	**0.86**	Property	**D**	**1.28**		
Normal protection Factor	**N**	**0.81**	Occupants	**D1**	**1.61**		
Special protection factor	**S**	**1.48**	Activities	**D2**	**1.52**		
Fire resistance factor	**F**	**1.24**					
Escape protection factor	**U**	**1.98**					
Salvage factor	**Y**	**1.48**					

The P- V1, A- V1, D- V1, P- V2, A- V2 and D- V2 pages.

These pages give in the first columns the values obtained for the reference case and the possibility to modify the data. The modified data are only used for Variants 1 and 2 when the YES option is chosen in the "Change ?" column. The modified values are automatically used in the variants' calculation.

name of the building				identification of the compartment					
Potential risk calculation									
DATA	Symbol	Unit	P- REF	CHANGING DATA			CHANGED VALUES	Change ?	variant
Fire load factor q.									
Immobile (building) fire load density:	**Qi**	MJ/m²	**100**	B. Incombustible construction, with max. 10% allowance for combustible construction elements as windows, roof covering, etc.	100	0	**100**	no	**100**
Mobile (moveable) fire load density	**Qm**	MJ/m²	**600**	b. Ordinary fire hazard with low fire load (OH1 / NFPA: OH Gp1)	600		**600**	no	**600**
			1.35	**The calculated value of q is =**	**q**	=	**1.35**		**1.35**

Acceptable risk calculation									
DATA	Symbol	Unit	A - REF	CHANGING DATA			CHANGED VALUES	change ?	Variant
Activation factor				DEFINE all relevant situations					
Main activities	**ai**		**0**	A1. Non industrial occupancies: offices, residential, assembly, educational	0		**0**	no	**0**
Process and room	**ai**		**0**	E2. Heat transfer through water, steam, or solids	0		**0**	no	**0**

name of the building				identification of the compartment					
Calculation of the Protection Level D									
DATA	Symbol	Unit	D - REF	CHANGING DATA			CHANGED	Change?	Variant
WATER SUPPLY Factor									
Water storage type	*w1*		**0**	1. Water storage for general use, automatically filled	0		**0**	no	**0**
Water storage capacity		m³	**160**	Estimated capacity of water storage available for fire fighting	160	m³			

Special compartment types.

Atrium compartments.

Using FRAME for risk evaluation for atriums and compartments with more than one floor requires some explanation to obtain a correct result. One must always take care to use the most relevant value for the formulas.

Basically, additional floor area for mezzanines and partial levels will be considered in the level factor e, as a percentage of the ground floor area, but other factors are also modified in an atrium.

Fire load factor q.
The immobile fire load Qi has to include all combustible construction elements: if the mezzanines are built on a wooden structure, this has to be included in Qi.

For the mobile fire load Qm, one must check if the goods on the mezzanine are protected from fire spread from the level below, e.g. by a concrete floor.

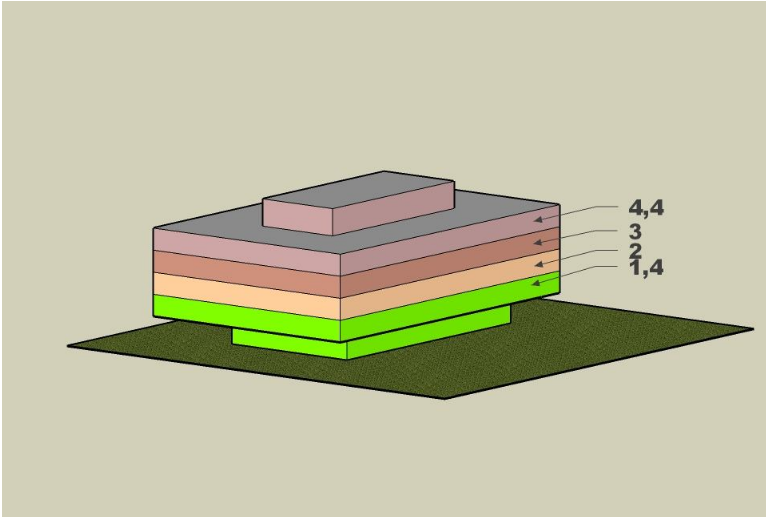
Basically the fire load on every level can be seen as separate, and the highest value will be used in the formula. But when the fire load is located on a grating floor, in which case fire spread is likely , it is better to add the fire load of the floors to calculate Qm, but in that case the area of the grating floor does not count anymore for the level factor e.

Area factor g
To evaluate the compartmentation, the basis is that a complete level of a building is compartment. When in a building, e.g. an apartment building, subcompartmentation exists between the individual flats, on the same floor and using the same access and evacuation paths, it is necessary to consider the whole floor as a single compartment, otherwise unrealistic low values will be found for factors g and t. The subcompartmentation is taken into account in the factors F and U

However, in the case that a floor is subdivided in two or more compartments, so that evacuation is possible to an adjacent compartment as "safe area" , each part of the floor can considered as a separate compartment.

Level factor e.
To obtain the correct value for the level factor e, it is necessary to consider the largest floor as "access floor" When e.g. a compartment is composed of a small ground floor and a passage to a larger floor above, the "access level" for the risk evaluation will be the larger upper floor.

The area of the mezzanine is added as a decimal part of the floor area and added to the floor number E, which is increased. The rule is: before the decimal point : the floor number , and after the decimal point : the percentage additional floor area of the mezzanines, if necessary more than 100 % .

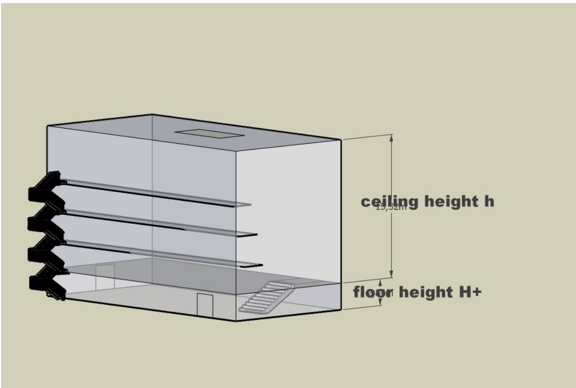


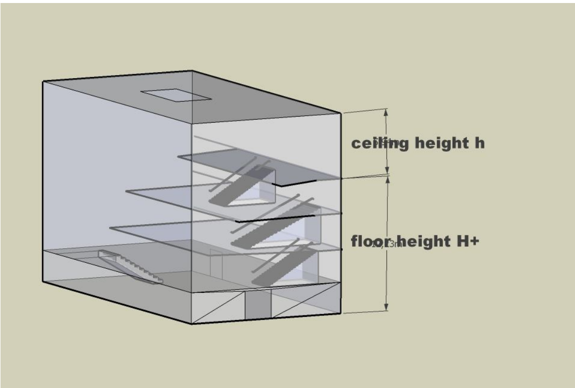
In the special case where the access is located at ground level (number 0) with a connection to a basement below (90 %)and a mezzanine above (90%) the final level number will be ground floor number 0 (access) + 0.9 (basement) + 0.9 (mezzanine) = 1.8 (which gives e = 1.34).

Ventilation factor v.

The ventilation factor of a single level compartment is calculated with the average height between floor and ceiling, as typical for the available space where smoke can accumulate. However, in an atrium or duplex type compartment, the ceiling height is the distance between the ceiling and the highest floor which has to be evacuated by an path inside the compartment.

Only when there is a direct exit for the mezzanines , the whole height of the atrium can be seen as the ceiling height. Remember that the software accepts only 15 m as maximum for the ceiling height. Higher values have to be topped off at 15 m.





Mezzanine with direct exit | Mezzanine with internal exit

Access factor z.

The same reasoning is valid for the access factor:
It is the highest mezzanine which the fire brigade has to access from inside the compartment that has to be used as "floor level " for the atrium. On the example at the left the highest balcony is not considered, as access from outside the compartment is possible. On the right, the highest balcony is the floor level for the atrium. In this way, the factors e, z, and v will take into account the higher risk in the situation at the right.

Lofts and duplexes.

A special case which requires some care in the risk evaluation are the upper levels of buildings with loft and a duplex floor which lays behind the facade.

For the compartimentation the basis is always the whole floor level which is to been seen as a single compartment, and subcompartmentation is treated as a protection (in factors F and U) the duplex floor will be the decimal part of the floor number (as explained previously).

In the sketch below, the fire brigade can reach the buildings from several sides, but in the left building the upper level (floor 4.5) can only be reached by one way (inside the building), as the fire brigades' aerial ladder cannot reach it. In the formula for factor z, Z=1 will be selected, which reflects the higher risk. For the right building, the fire brigade can reach the flat roof and from there the loft, so there is more than one access possibility. In a number of cases, factor z will not change, which means that the risk increase by the hampered access is negligible.