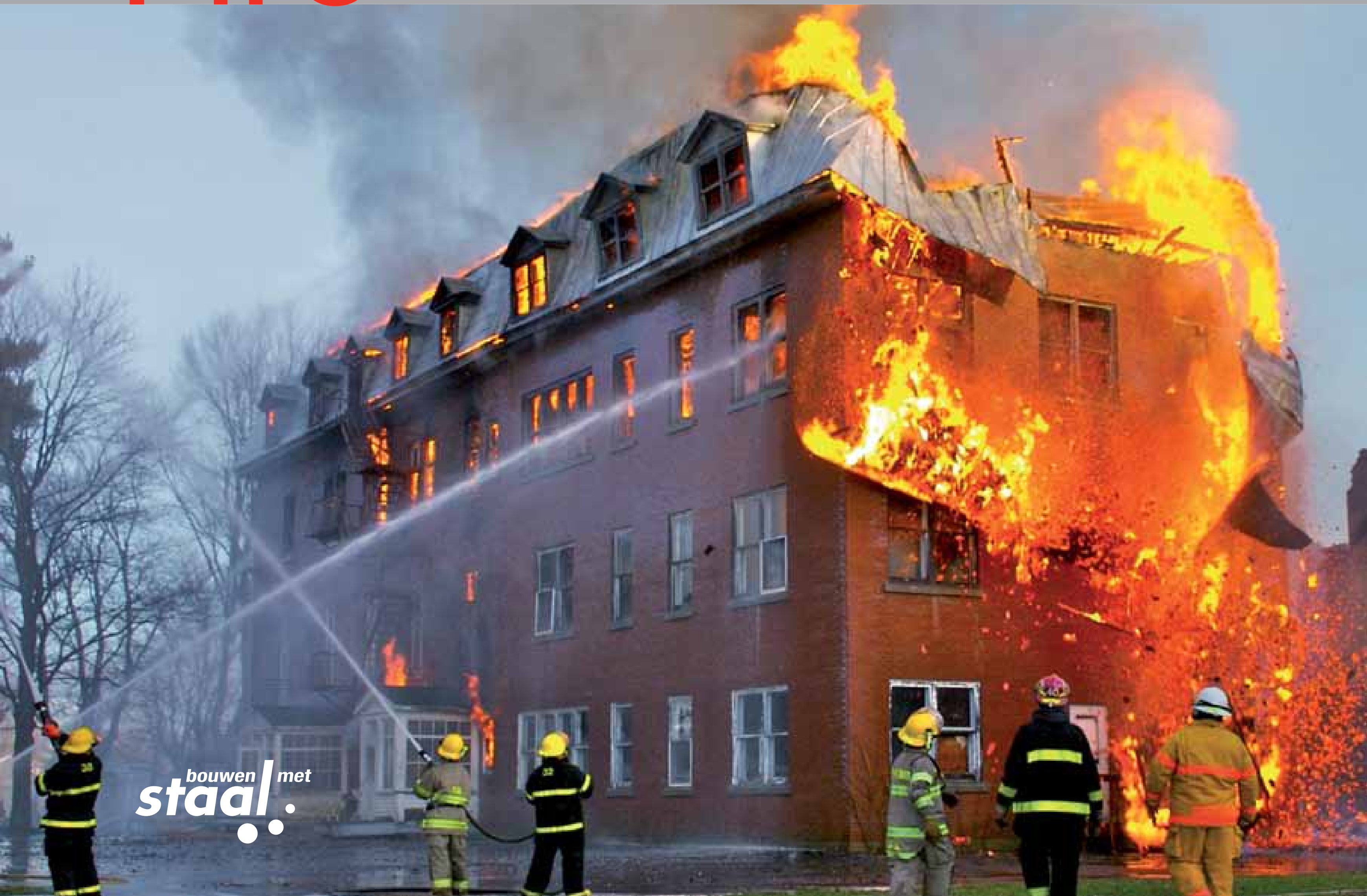
Annex for Switzerland

Steel Design 2

Fire



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Annex for Switzerland to *Fire* (Steel Design 2)

This annex has been prepared by Dr. Hetty Bigelow and Dr. Roland Bärtschi and is based on the English translation of *Fire*, published in 2021 by Bouwen met Staal. The original Dutch version was published in 2010 by Bouwen met Staal as *Brand*.
References are made to each NA symbol in *Fire* and the corresponding cl. in the Swiss standards.
Annexes to *Fire* (Steel Design 2) are also available for Belgium, Germany, Luxembourg and the Netherlands and can be downloaded free of charge from the website of SZS Stahlbau Zentrum Schweiz.

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Eurocodes in Switzerland

Switzerland is an EFTA but not an EC member despite its central geographical location in Europe. Still, Switzerland is obliged just as well as every other European country to retract any codes and standards contradictive to European regulations.

Switzerland has a long tradition of national codes, starting with the first code named "*Verordnung betreffend Berechnung und Prüfung der eisernen Brücken- und Dachkonstruktionen auf den schweizerischen Eisenbahnen*" in 1892. Since then, a comprehensive set of national codes has been elaborated, whereas the 2013 revision is the latest state of the national structural codes. In 2011, a comprehensive set of national codes on existing structures named SIA 269 has been published as a world's first.

Still, Switzerland has been very close to the elaboration of European codes and is very active in the European code committees from their first days. As a result, the Swiss national codes published by SIA, the Swiss Society of Engineers and Architects, are non-contradictive to Eurocode since 2003 when the first codes of the 260 series were published. The Swiss national codes are compact, well-condensed versions of the European codes, well-adapted to Swiss legal and practice boundary conditions.

Eurocodes are also used in countries where the degree of regulation must be much higher. This leads to very large documents which makes the vast extent of the Eurocode regulations a constant matter of discussion among the European countries.

In Switzerland, on the other hand, codes are not mandatory rules to be strictly obeyed but – at least from a legal perspective – more of a recommendation assumed to possibly reflect the state of the art. Therefore, Swiss standards do not need to cover every detail, but leave a lot of freedom and responsibility to the engineer. This allows for much shorter codes limited to a few principles, whereas one of the most important paragraphs is the "Exception Article" which basically says: "If you know better, do better". As such, Swiss codes are a non-contradictory, slim version of the Eurocodes.

In addition to the Swiss codes, Switzerland maintains national annexes to most European codes.

As far as fire safety is concerned, the regulations given by the association of cantonal fire insurances (*Vereinigung Kantonaler Feuerversicherungen VKF*) apply and the structural codes by SIA or CEN are used only in specific cases to prove sufficient bearing resistance in case of fire. The VKF regulations consist of the fire protection standard (*VKF-Brandschutznorm VKF-BSN*) and fire protection guidelines (*VKF-*

Brandschutzrichtlinien VKF-BSR). These two are complemented by fire safety comments (*VKF-Brandschutzerläuterungen VKF-BSE*), fire protection directories (*VKF-Brandschutzverzeichnisse VKF-BSVER*), fire safety data sheets (*VKF-Brandschutzmerkblätter VKF-BSM*), fire safety FAQ and documents regarding the state of art (*Stand der Technik Papiere STP*).

The first generation of nationwide VKF fire regulations was published in 2005, followed by the 2015 generation which has been revised in 2017. The next generation of VKF fire regulations is expected in 2026.
Today's fire regulations are based on a prescriptive approach, where predefined measures must be taken in order to meet the requirements **(VKF-BSN 1-15 article 10)**. Still, they allow for "engineering methods" (Ingenieurmethoden), be it that engineering methods are used for some particular structural members of a building **(VKF-BSN 1-15 article 11)** while everything else remains according to the prescriptive rules or that a whole project is designed for fire safety without any consideration of prescriptive rules **(VKF-BSN 1-15 article 12)**. In all cases the global safety level must at least meet the same standards as with prescriptive rules. The execution of any fire safety measures and of fire safety design calculations underly strict quality management requirements which are established by the fire safety authorities.
For steel structures, engineering methods give immense possibilities for the application of advanced fire design methods. Still, the formal requirements regarding engineering methods and ease of acceptance depend a lot on the specific authorities' prerequisites and may vary from canton to canton.

The present book "Fire" explains the fundamentals of steel design based on the Eurocodes. The Eurocodes allow for national regulations in some special cases and contain numerous "Nationally Determined Parameters" (NDPs), which must be defined in each country. The present annex thus is related to the Swiss national annexes and gives reference to the Swiss codes and regulations.

Fire safety

Annex CH

1

p. 1-6 **VKF-BSN 1-15 art. 32 sec.2 & VKF-BSR 15-15 tab. 1-3**

The requirements for the fire resistance of the structure can be reduced or even eliminated by using a sprinkler system when using the “standard concept” of the Swiss fire safety guideline BSR.

p. 1-9 **VKF-BSN 1-15 art. 10 & 11**

Standard concepts include passive as well as technical installation measures. If the proposed fire safety concept differs from the standard concepts, the applicant will have to prove its equivalence. The fire protection authorities decide upon the equivalence.

p. 1-10 **VKF-BSR 15-15 cl. 3.3.3 + Annex**

Detailing requirements are given in cl. 3.3.3 and its annex.

p. 1-12 **EN 1994, cl. 4.3.5.3 + Annex H**

Potfire not only enables calculations according to the EN 1994-1-2 main document but also offers a more advanced method according to the French National Annex. According to the “Exception Article” in SIA codes this method can also be used in Switzerland.
Furthermore, Steel**work** C1/12 [13] contains tables for fire assessment of composite structures according to SIA 264 and EN 1994 requirements.

p. 1-13 (no NA symbol in *Fire*) **VKF-BSR 13-15 cl. 3.2.5**

Intumescent coating can only be considered R30 or R60 in Switzerland.

p. 1-14

In Switzerland applicators of intumescent coating must be VKF certified, and further quality management regulations apply. The use of intumescent coatings requires pre-clarification with fire protection authorities and is very limited in some cantons.

p. 1-16 (a) **VKF-BSR 20-15 & VKF-BSN 1-15 art. 10 & 11**

The Swiss fire safety regulations define the necessity of fire detection systems. If the proposed fire safety concept differs from the standard concepts, the applicant will have to prove its equivalence. The fire protection authorities decide upon the equivalence.

p. 1-16 (b)

No additional requirements in Switzerland.

p. 1-17 (a) **VKF-BSR 18-15 cl. 5 & VKF-BSR 19-15 cl. 5**

Sprinkler systems require periodic inspection. Inspection intervals depend on building type, seize and usage as well as the extinguishing system.

p. 1-17 (b) **VKF-BSR 19-15 cl. 5**

Planning of sprinkling systems requires pre-clarification with fire protection authorities.

p. 1-18 (a) **VKF-BSR 15-15 tab. 1-3**

Sprinkler systems are part of the “standard solutions” and can reduce the required resistance up to 30 minutes. If the proposed fire safety concept differs from the standard concepts, the applicant will have to prove its equivalence. The fire protection authorities decide upon the equivalence.

p. 1-18 (b)

No additional requirements in Switzerland.

p. 1-19 **SIA 260**

SIA 260 allows for nominal temperature-time curves (standard temperature-time curve, external fire cure and hydrocarbon curve) as well as parametric temperature-time curves (natural fires). SIA 260/1 contains the respective references. The use of non-standard temperature-time curves requires pre-clarification with fire protection authorities.

p. 1-20 (a) **VKF-BSN 1-15 art. 8**

Constructions and facilities must be created, operated, and maintain in a way which ensures:

a safety of people and animals
b prevention of fires and explosions as well as spread of flames, heat and smoke
c limitation of spread of fire to adjacent constructions and facilities
d preservation of structural resistance for a specific period
e guaranteeing effective firefighting and safety of emergency forces

p. 1-20 (b) **VKF-BSR 14-15 cl. 4 & VKF-BSR 15-15 tab. 1-3 & VKF-BSR 16-15**

In Switzerland the required fire resistance of vertical escape routes is 30, 60, 90 or 120 minutes, depending on building height and occupancy (VKF-BSR 15-15). Moreover, VKF-BSR 14-15 requires in some cases fire behavior group of building materials without fire contribution (RF1) and/or restricts the amount of combustible materials for vertical and horizontal escape routes. Furthermore VKF-BSR 16/15 restricts the total lengths of horizontal escape routes to 35 m in general. For some circumstances the total length of an escape route can be extended to 50 m. Please note that in the VKF-BSR the term “horizontal escape routes” refers to two different concepts: corridors and escape routes where the corridor is only a part of the route.

p. 1-20 (c) **VKF-BSR 15-15 tab. 1-3**

In Switzerland the required fire resistance of the main load-bearing structure depends on building height and occupancy. For structures in accordance with the “standard concept” the required fire resistances lie between 30 and 120 minutes. Equivalence of concepts differing from the standard concept must be proven. The fire protection authorities decide upon the equivalence.

p. 1-21 **SIA 260 & VKF-BSN 1-15 art. 11**

SIA 260 allows for nominal temperature-time curves (standard temperature-time curve, external fire cure and hydrocarbon curve) as well as parametric temperature-time curves (natural fires). SIA 260/1 contains the respective references.
If the proposed fire safety concept differs from the standard concepts, the applicant will have to prove its equivalence. The fire protection authorities decide upon the equivalence.

p. 1-22 (a) **VKF-BSR 15-15 tab. 1-3**

No requirements to the fire resistance of bearing structures of single-story buildings.

p. 1-21 (b) **VKF-BSN 1-15 art. 11**

In Switzerland all concepts differing from the standard concepts have to be approved by the fire protection authorities.

p. 1-24 **VKF-BSR 15-15 cl. 4 & VKF-BSR 27-15 cl. 7.4**

The required fire resistance of components can be proven by means of the standard fire approach or by means of natural fire approach.
Simplified and general approaches according to Eurocode require approval by a qualified engineer.

p. 1-25 **SIA 260, cl 4.4.3.5**

The recommended values of γ_G = 1.0 and γ_Q = 1.0 are adopted.

p. 1-26 **SIA 260, cl 4.4.3.5**

In Switzerland values ψ_2 have to be used in the accidental load combination.

p. 1-30 **Literature**

Additional literature specific for Switzerland.

13. Stahlbau Zentrum Schweiz: Steel**work** C1/12, ISBN 978-3-85761-300-5, 2012.

Annex CH 2

Calculation of the fire resistance

p. 2-4 **SIA 260, cl 4.4.3.**

SIA 260 specifies ψ_2 = 0.3 and ψ_0 = 0.7 for imposed (variable) loads on office floors. The partial load factors for load bearing structures (type 2) are $\boldsymbol{\gamma_G}$ **= 1.35** and γ_Q = 1.5. Equations (2.3) and (2.4) have to be slightly modified.

p. 2-17 **SIA 263 cl. 4.1.3 & cl. 4.8.1.2**

As SIA 263 defines γ_{M0} = 1.05 and $\gamma_{M,fi}$ = 1.0, the simplified equations presented in this section have to be slightly modified.

p. 2-18 **VKF-BSR 27-15 cl. 7.4**

Simplified and general approaches according to Eurocode require approval by a qualified engineer.

p. 2-20 **SIA 260 cl. 4.4.3 + Annex A**

In Switzerland values ψ_2 have to be used in the accidental load (fire) combination. SIA 260 defines ψ_2 = 0 for wind loads on buildings, thus representing that fire and wind will not occur at the same time.

p. 2-23 **SIA 260 cl. 4.4.3 + Annex A**

The recommended value ψ_2 = 0.8 is accepted.

p. 2-25 **SIA 260 cl. 4.4.3 + Annex A**

The recommended value ψ_2 = 0.3 is accepted.

p. 2-26 (no NA symbol in *Fire*) **SIA 263 cl.4.5.1 & cl.4.8**

The SIA 263 approach differs slightly from the one according to the Eurocodes. However, contents of equations (2.17) to (2.19) in *Fire* are just labeled differently.

$\bar{\lambda}_k$	(cl. 4.5.1.4)	=	$\bar{\lambda}_y$	(2.17)
λ_k	(cl. 4.5.1.4)	=	λ_y	(2.18)
λ_E	(cl. 4.5.1.4)	=	λ_1	(2.19)

The SIA 263 approach continues as follows:

$\bar{\lambda}_{K,\Theta} = 1.2 \cdot \bar{\lambda}_k$ (cl. 4.8.5.5)
$\alpha_k = 0.49$ (cl. 4.8.5.5. specifies buckling curve c according to cl. 4.5.1.4)

$$\Phi_k = 0.5\left[1 + \alpha_k(\bar{\lambda}_{K,\Theta} - 0.2) + \bar{\lambda}_{K,\Theta}^{\ 2}\right]$$
$$\chi_{fi} = \frac{1}{\Phi_k + \sqrt{\Phi_k^{\ 2} - \bar{\lambda}_{K,\Theta}^{\ 2}}}$$
$$N_{K,fi,\Theta,Rd} = \frac{\chi_{fi}}{1.2} \cdot k_{y,\Theta} \cdot N_{pl}$$

$k_{y,\Theta} = f_{y,\Theta}/f_y$ The reduction factor $k_{y,\Theta}$ can be read off figure 14 in SIA 263. It is in accordance with the Eurocode approach given in *Fire* and depends on the steel temperature θ_a.

Please note that the Eurocode approach is also valid in Switzerland.

p. 2-29 **SIA 260 cl. 4.4.3 + Annex A**

The recommended value $\psi_2 = 0.3$ is accepted.

p. 2-30 (no NA symbol in *Fire*) **SIA 263 cl.4.5.1 & cl.4.8**

As the SIA approach differs slightly from the Eurocode approach given in *Fire*, the values given in the example are not exactly the same. The SIA approach leads to the following differences:

$$\alpha_k = 0.49$$
$$\bar{\lambda}_{K,\Theta} = 1.2 \cdot \bar{\lambda}_k = 1.2 \cdot 0.47 = 0.56$$
$$\Phi_k = 0.5\left[1 + \alpha_k(\bar{\lambda}_{K,\Theta} - 0.2) + \bar{\lambda}_{K,\Theta}^{\ 2}\right] = 0.5\,[1 + 0.49(0.56 - 0.2) + 0.56^2] = 0.75$$
$$\chi_{fi} = \frac{1}{\Phi_k + \sqrt{\Phi_k^{\ 2} - \bar{\lambda}_{K,\Theta}^{\ 2}}} = \frac{1}{0.75 + \sqrt{0.75^2 - 0.56^2}} = 0.81$$

No iterations required to find $k_{y,\Theta}$.

$$N_{Ed} = N_{K,fi,\Theta,Rd} = \frac{\chi_{fi}}{1.2} \cdot k_{y,\Theta} \cdot N_{pl}$$
$$\Leftrightarrow k_{y,\Theta} = \frac{1.2}{\chi_{fi}} \cdot \frac{N_{Ed}}{N_{pl}} = \frac{1.2}{0.81} \cdot 0.39 = 0.581$$

This corresponds to a slightly smaller critical temperature of $\theta_{a,cr}$ = 564°C.

Please note that the Eurocode approach is also valid in Switzerland.

p. 2-31 (no NA symbol in *Fire*) **SIA 263 cl.4.5.2 & cl.4.8 & Annex B**

The SIA 263 approach differs slightly from the one according to the Eurocodes:
Lateral torsional buckling must be checked if

$\bar{\lambda}_{D,\Theta} = 1.2 \cdot \bar{\lambda}_D \geq 0.4$ (cl. 4.8.5.8)

$\bar{\lambda}_D = \sqrt{\frac{W f_y}{M_{cr}}}$ (cl.4.5.2.3), $\bar{\lambda}_D$ in SIA 263 is the same as $\bar{\lambda}_{LT}$ in EN 1993-1-1.

$\alpha_D = 0.21$ (rolled section) or $\alpha_D = 0.49$ (welded section)

$$\Phi_D = 0.5 \left[1 + \alpha_D\left(\bar{\lambda}_{D,\Theta} - 0.4\right) + \bar{\lambda}_{D,\Theta}{}^2\right]$$

$$\chi_{fi} = \frac{1}{\Phi_D + \sqrt{\Phi_D{}^2 - \bar{\lambda}_{D,\Theta}{}^2}}$$

$$M_{D,fi,\Theta,Rd} = \frac{\chi_{fi}}{1.2} \cdot k_{y,\Theta} \cdot W \cdot f_y$$

Please note that the Eurocode approach is also valid in Switzerland.

p. 2-32 **SIA 260 cl. 4.4.3 + Annex A**

The recommended value $\psi_2 = 0.3$ is accepted.

p. 2-32 (no NA symbol in *Fire*) **SIA 263 cl.4.5.2 & cl.4.8 & Annex B**

As the SIA approach differs slightly from the Eurocode approach given in *Fire*, the values given in the example are not exactly the same. The SIA approach leads to the following differences:

$\bar{\lambda}_{D,\Theta} = 1.2 \cdot \bar{\lambda}_D = 1.2 \cdot 0.8 = 0.96$

$\alpha_D = 0.21$

$$\Phi_D = 0.5 \left[1 + \alpha_D\left(\bar{\lambda}_{D,\Theta} - 0.4\right) + \bar{\lambda}_{D,\Theta}{}^2\right] = 0.5\,[1 + 0.21\,(0.96 - 0.2) + 0.96^2] = 1.020$$

$$\chi_{fi} = \frac{1}{\Phi_D + \sqrt{\Phi_D{}^2 - \bar{\lambda}_{D,\Theta}{}^2}} = \frac{1}{1.02 + \sqrt{1.02^2 - 0.96^2}} = 0.734$$

No iterations required to find $k_{y,\Theta}$.

$$M_{Ed} = M_{D,fi,\Theta,Rd} = \frac{\chi_{fi}}{1.2} \cdot k_{y,\Theta} \cdot M_{pl}$$

$$\Leftrightarrow k_{y,\Theta} = \frac{1.2}{\chi_{fi}} \cdot \frac{M_{Ed}}{M_{pl}} = \frac{1.2}{0.734} \cdot 0.39 = 0.633$$

This corresponds to a slightly higher critical temperature of $\theta_{a,cr}$ = 547°C.
Please note that the Eurocode approach is also valid in Switzerland.

p. 2-35

Steel**work** C1/12 [11] contains tables with maximum vertical loads and bending moments of common IFBA, IFBB and SFB beams under standard fire load. The values were calculated with finite element models and cover R60 and R90 for S35 and C25/30.

p. 2-40 **SIA 260 cl. 4.4.3 + Annex A**

The recommended value $\psi_2 = 0.3$ is accepted.

p. 2-44 **SIA 260 cl. 4.4.3 + Annex A**

The recommended value $\psi_2 = 0.3$ is accepted.

p. 2-46 **Literature**

Additional literature specific for Switzerland.

11. Stahlbau Zentrum Schweiz: Steelwork C1/12, ISBN 978-3-85761-300-5, 2012.

Fire safety engineering

p. 3-8 **VKF-BSN 1-15 art. 11**

In Switzerland all concepts differing from the standard concepts have to be approved by the fire protection authorities.

p. 3-9 **VKF-BSR 15-15 tab. 1-3**

The standard concept defines the required fire resistances (in minutes) of car parks depending on building height. Different requirements are made for structural elements, fire compartment ceilings and walls as well as horizontal and vertical escape routes.
Equivalence of concepts differing from the standard concept must be proven. The fire protection authorities decide upon the equivalence.

p. 3-10 (a) **SIA 260 & VKF-BSN 1-15 art. 11**

SIA 260 allows for nominal temperature-time curves (standard temperature-time curve, external fire cure and hydrocarbon curve) as well as parametric temperature-time curves (natural fires). SIA 260/1 contains the respective references. The use of non-standard temperature-time curves requires pre-clarification with fire protection authorities.
If the proposed fire safety concept differs from the standard concepts, the applicant will have to prove its equivalence. The fire protection authorities decide upon the equivalence.

p. 3-10 (b) **VKF-BSN 1-15 art. 11**

In Switzerland all concepts differing from the standard concepts have to be approved by the fire protection authorities.

p. 3-12 (a) **VKF-BSN 1-15 art. 11**

In Switzerland all concepts differing from the standard concepts have to be approved by the fire protection authorities.

p. 3-12 (b) **VKF-BSN 1-15 art. 11**

In Switzerland all concepts differing from the standard concepts have to be approved by the fire protection authorities.

p. 3-14 **VKF-BSN 1-15 art. 11**

In Switzerland all concepts differing from the standard concepts have to be approved by the fire protection authorities.

p. 3-17 **VKF-BSN 1-15 art. 11**

In Switzerland all concepts differing from the standard concepts have to be approved by the fire protection authorities.

Annex CH 4

Design tables

p. 4-7 **SIA 260, cl 4.4.3.**

The partial load factors for load bearing structures (type 2) are γ_G **= 1.35** and γ_Q = 1.5. In Switzerland values ψ_2 have to be used in the accidental load combination.

p. 4-8 **SIA 260, cl 4.4.3.**

See remarks to p. 4-7.

p. 4-20 (no NA symbol in *Fire*) **SIA 263 cl.4.5.1 & cl.4.8**

The SIA 263 approach regarding the calculation of the relative slenderness differs slightly from the one according to the Eurocodes. However, the Eurocode approach is also valid in Switzerland.