



# **Manuál pro projektování VRT ve stupni DÚR**

**High-Speed Lines Design Manual  
for the Planning Permit Level**

**1<sup>st</sup> June 2021**

**Confidential document**

**Full wording of the Annex A to Guideline SŽ PO-16/2020-GŘ  
For internal use of Správa železnic, state organization**



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## **Sources of images and schemes:**

Images and some schemes in this Manual were used with the approval of:

SNCF International	2 place aux Etoiles, 93 200 Saint Denis, France
SNCF Réseau	15/17 rue Jean-Philippe Rameau, 93 418 Saint Denis, France
SNCF Voyageurs	9 rue Jean-Philippe Rameau, 93 200 Saint Denis, France

## List of abbreviations

<b>AC</b>	Alternating Current
<b>AoE</b>	Automatic Train Operation over ETCS
<b>ASHS</b>	Autonomous Automatic Extinguishing System
<b>ATAF</b>	Automatic Track Ahead Free
<b>ATO</b>	Automatic Train Operation
<b>ATS</b>	Automatic Transfer Switch
<b>B+R</b>	system, space or area for safe bike storage at a public transportation terminal Bike and Ride
<b>BTS</b>	Base Transceiver Station
<b>CCS</b>	Control Command and Signalling
<b>CK MD</b>	Central Commission of the Czech Ministry of Transport
<b>CTD</b>	Telematics and Diagnostics Unit of Správa železnic, státní organizace (since April 1, 2020) Technical Command Centre of Správa železnic, State Organisation (TUDC; until March 31, 2020)
<b>ČD</b>	České dráhy, akciová společnost Czech Railways, joint stock company
<b>ČSN</b>	Czech Technical Standard
<b>ČSPH</b>	fuel filling station
<b>DC</b>	Direct Current
<b>DDTS</b>	Remote Diagnostics of Railway Systems and Equipment
<b>DOZ</b>	Signalling Equipment Remote Control
<b>DŘT</b>	Dispatching Control System
<b>DSP</b>	Building Permit Design
<b>DÚR</b>	Planning Permit Design (Zoning Permit Design)
<b>DWDM</b>	Dense Wavelength-Division Multiplexing
<b>ED</b>	Power Supply Dispatching
<b>EIA</b>	Environmental Impact Assessment
<b>EIRENE</b>	international standard for GSM-R European Integrated Railway Radio Enhanced Network
<b>EN</b>	European Norm
<b>ENE</b>	Energy supply/power supply
<b>EOV</b>	Electric Turnout Heating
<b>EPS</b>	Fire Alarm System
<b>ERA</b>	European Union Agency for Railways
<b>ERTMS</b>	European Rail Traffic Management System
<b>ERÚ</b>	Energy Regulatory Office
<b>ETCS</b>	European Train Control System
<b>EU</b>	European Union

<b>FRMCS</b>	Future Railway Mobile Communication System
<b>FS</b>	Full Supervision (ETCS mode)
<b>GPK</b>	Track Geometry
<b>GSM-R</b>	Global System for Mobile Communications – Railway
<b>GŘ</b>	Generální ředitelství Správy železnic, státní organizace Directorate General of Správa železnic, state organisation
<b>GVD</b>	Train Traffic Diagram
<b>HDPE</b>	High density polyethylene
<b>HS</b>	High-speed
<b>HSL</b>	High-speed line
<b>IEC</b>	International Electrotechnical Commission
<b>IED</b>	Intelligent Electronic Device
<b>INF</b>	Infrastructure
<b>IZS</b>	Integrated Rescue System
<b>K+R</b>	Place for stopping and dropping or taking on travellers by a public transportation terminal Kiss and Ride
<b>KDZ</b>	Expansion and Shrinking Device
<b>LGV</b>	Ligne à Grande Vitesse
<b>LOC&amp;PAS</b>	Locomotives and Passenger Rolling Stock
<b>MD ČR</b>	Ministry of Transport of the Czech Republic
<b>MPLS</b>	Multiprotocol Label Switching
<b>MN</b>	Small Voltage
<b>NN</b>	Low Voltage
<b>O21</b>	High-speed lines preparation department of Správa železnic (since 1 January 2021) High-speed lines preparation independent unit of Správa železnic (PVRT; until 31 December 2020)
<b>OS</b>	On-Sight (ETCS mode)
<b>P+R</b>	long-term parking for passenger cars by a public transportation terminal Park and Ride
<b>PHS</b>	Noise Protection Wall
<b>PJD</b>	Ballastless Track
<b>PK</b>	Road
<b>PNE</b>	Corporate Electric Power Standard
<b>PVRT</b>	High-speed lines preparation independent unit of Správa železnic (until 31 December 2020) High-speed lines preparation department of Správa železnic (O21; since 1 January 2021)
<b>RAMS</b>	Reliability, Availability, Maintainability, Safety
<b>RBC</b>	Radio Block Centre
<b>RV</b>	Reversing (ETCS mode)
<b>SFDI</b>	Státní fond dopravní infrastruktury State Transport Infrastructure Fund
<b>SH</b>	Shunting (ETCS mode)

<b>SIF</b>	Schema des installations ferroviaires
<b>SNCF</b>	Société Nationale des Chemins de fer Français
<b>SpS</b>	Sectioning Point
<b>SR</b>	Staff Responsible (ETCS mode)
<b>SŽDC</b>	Správa železniční dopravní cesty, státní organizace (until 31 December 2019) Správa železnic, státní organizace (since 1 January 2020)
<b>SZZ</b>	Station Signalling System
<b>TEN-T</b>	Trans-European Transport Network pursuant to Regulation of the European Parliament and Council Regulation (EU) No. 1315/2013 on Union guidelines for the development of trans-European transport network
<b>TGV</b>	Train à Grande Vitesse
<b>TK</b>	Top of the Rail Head
<b>TNS</b>	Power Supply Substation
<b>TNŽ</b>	Technical Norm for Railways
<b>TS</b>	Transformer Station
<b>TSI</b>	Technical Specifications for Interoperability
<b>TCI</b>	Technical Command Centre of Správa železnic (until 31 March 2020) Telematics and Diagnostics Unit of Správa železnic (CTD; since 1 April 2020)
<b>TV</b>	Catenary
<b>TZZ</b>	Track Safety System
<b>UIC</b>	International Union of Railways Union Internationale des Chemins de fer
<b>UN</b>	Unfitted (ETCS mode)
<b>UPS</b>	Uninterruptible Power Supply/Source
<b>ÚP</b>	City-level Zoning Plan
<b>ÚTS</b>	Due Diligence Study
<b>VPVRK</b>	Free Space of High-Speed Track
<b>VR</b>	High-speed (HS)
<b>VRT</b>	High-speed Line (HSL)
<b>VN</b>	High Voltage
<b>VVN</b>	Extra High Voltage
<b>ZPDP</b>	Train Detection Systems
<b>ŽST</b>	Railway Station
<b>ZÚR</b>	Regional Zoning Plan
<b>ZVN</b>	Extremely High Voltage
<b>ZZEE</b>	Power Back-Up Unit

# 1 Introduction

Based on **Regulation (EU) No. 1315/2013 of the European Parliament and of the Council on Union guidelines for the development of the trans-European transport network**, the Czech Republic committed to support the development of railway infrastructure by building new rail lines in the main directions of the TEN-T trans-European network corridors.

In 2017 **the Czech government issued decree No. 389 on the fast connections development scheme in the Czech Republic** for the construction of new high-speed rail lines, modernisation of significant existing lines, procurement of corresponding rolling stock and creation of a new operating concept, particularly for long-distance passenger railway transport.

SŽ, as the railway infrastructure manager, was authorised – based on the documents mentioned above – with the construction of new high-speed rail lines. One of the steps in this task is to adopt the regulations and standards for the design, construction and operation of railways with speeds over 200 km/h. This adaptation is however a long process, so this document shall bridge the transition period, defining the technical and operating requirements for high-speed rail lines in the Fast railway connections system and allowing continuous preparations of different projects on the level of Due Diligence, Feasibility Study and the Planning Permit.

**This Manual for the design of high-speed rail lines for the planning permit level (hereafter only the "Manual") is the result of cooperation between SŽ and SNCF International** that started in April 2019 based on the Services Agreements (and an amendment thereto) signed by the top management of these two organisations. As part of this cooperation, SŽ made work trips, organised numerous workshops, held continuous consultations and accessed documents of this most experienced high-speed infrastructure manager in Europe, to obtain high-speed railways know-how. Their concept (the TGV connections and LGV lines) is very close to that of the Fast connections and/or high-speed network in the Czech Republic.

This Manual was then written by SŽ experts who adopted the proven French solutions to the conditions of the Czech railways and the local legal environment.

SNCF International and any other part of the SNCF group are not responsible for any further use, implementation or development based on the Manual.

**The Manual in its complete version is the Annex A of the Správa železnic Director General's guidance No. SŽ PO-16/2020-GŘ** dated 27 April 2020. On the basis of this instruction, the Manual is, inter alia, being further corrected and updated on the basis of the knowledge acquired during the process of preparing the preliminary design documentation for individual HSL sections, under the responsibility of O21 and in cooperation with the SNCF holding companies. Individual comprehensive versions of the Manual are always marked with the date of publication.

The aim of this Manual is to introduce the comprehensive requirements of the investor (i.e. SŽ) to planning permit design contractors for HSL sections in the Czech Republic. These requirements involve the design, scope and principles of different solutions to HS systems and sub-systems based on proven French solutions (reference system) arising from more than 40 years of experience of SNCF with and shall be applied in the Czech environment. This Manual shall therefore allow civil engineers and designers prepare the planning permit design in accordance with the requirements of act No. 183/2006 Coll. on zoning and the building code (the Building Act), as amended, its implementing decrees and other regulations that are binding on the national and European level (particularly TSI) and give them the chance of designing a system that will be optimised in terms of design, economical execution, operating

costs and maintenance options and that will be environmentally friendly and negotiable with the state administration, self-governments and the public.

**The concept and scope of this Manual correspond with the requirements of Appendix No. 3 "Planning permit design scope and contents" to decree. No. 499/2006 Coll. on civil design documentation, as amended.**

Given the importance and the European reach of the project, this document is also available in the English language with the title High-Speed Railways Design Manual for the Planning Permit Level and can be used by foreign designers expected to participate in public tenders for the contractor for the planning permit design.

## **1.1 Sources and inputs for this Manual**

This Manual was prepared by the High-speed lines preparation independent unit (PVRT) respectively by High-speed lines preparation department since 1 January 2021 (O21) of the Track Modernisation Division of SŽ Directorate General, which is the author of this regulation, and is based on these inputs:

- **Cooperation between Správa železnic (SŽ) and SNCF** from April 2019 based on the Services Agreements (including the appendix thereto) made between SŽ and SNCF International, the primary aim of which was to create this Manual based on excursions, lectures, expert workshops (see below), inputs and consultations with experts from SNCF that has been developing, preparing, designing, operating, maintaining and servicing its own high-speed railways system for more than 40 years.  
All rights granted by companies of the SNCF holding under this cooperation are expressly intended for use by Správa železnic for the preparation, implementation and promotion of high-speed rail lines in the Czech Republic.
- **Référentiel Infrastructure – Référentiel Technique pour la réalisation des LGV** (and related regulations), which is an internal technical manual in the exclusive ownership of SNCF containing the basic concept, requirements and civil and technical solutions of the French HS system.
- **Requirements and remarks of SŽ expert units** – mostly of the strategy department, different track operability division units of the directorate general and technical railways maintenance.
- **Technical Operations Studies – Technical HS solutions** prepared by companies SUDOP PRAHA a.s., ACRI and Metroprojekt a.s. between 2015 and 2017 and approved by the Central Commission of the Ministry of Transport in October 2017.
- Questions from designers, discussions, consultations, discussions, etc.

### **1.1.1 Expert workshops of SŽ and SNCF**

Below you can find the time line and a brief outline of expert workshops that took place between May 2019 and January 2020 mostly in Prague. The inputs for and outputs of these events are available (mostly in the French language) at the Manual's Gestor (O21).

- Study trip (13<sup>th</sup> to 24<sup>th</sup> May 2019; France)
  - Making the widest possible circle of stakeholders in SŽ familiar with how to operate HSLs in everyday practice (lectures, excursions).
- The Czech railway and legal environment (4<sup>th</sup> June 2019; France)
  - Making SNCF experts familiar with the Czech economic, railway and legal environment, with the current state of works on the preparation of the different HS routes and with the required detail level of this Manual.
- Bridges (25<sup>th</sup> June 2019; Prague)
- Alignment (26<sup>th</sup> and 27<sup>th</sup> June 2019; Prague)
- Railway sub-structure (11<sup>th</sup> July 2019; Prague)
- HSLs and the surroundings – SIF railway systems scheme (17<sup>th</sup> July 2019; Prague)
- Tunnels (18<sup>th</sup> July 2019; Prague)
- Railway superstructure (30<sup>th</sup> and 31<sup>st</sup> July 2019; Prague)
- Catenary and power supply (23<sup>rd</sup> Aug. 2019; Prague)
- Maintenance (27<sup>th</sup> to 29<sup>th</sup> Aug. 2019; France)



- A workshop in France focused on the provision of operability and maintenance technology, held directly in SNCF maintenance sites and on sites where major work is under way on HSLs (done always during a regular night closure).
- A link between the design of a new rail line designed for 100 years and its effective maintenance is considered to be the core issue in France.
- Communication systems (3<sup>rd</sup> Sep. 2019; Prague)
- Safety systems (4<sup>th</sup> Sep. 2019; Prague)
- HSLs preparation and construction management + interoperability (5<sup>th</sup> Sep. 2019; Prague)
- HSLs and surroundings – noise, environment, roads, etc. (10<sup>th</sup> Sep. 2019; Prague)
- Project management of HSLs projects in SNCF (16th Jan. 2020; Prague)
- Public consultations in France (17th Jan. 2020; Prague)
- PR of the HSL projects at national and regional level (6th Nov. 2020; MS Teams)
- Concept of HSL stations (25<sup>th</sup> Nov. 2020; MS Teams)
- RAMS assessment and HSL interoperability (17<sup>th</sup> Feb. 2021; MS Teams)
- Traffic Management Concept (19<sup>th</sup> Mar. and 6th Apr. 2021; MS Teams)

## 1.2 Requirements for high-speed railways

### 1.2.1 General requirements

Certain restrictions to the HSLs system are laid down in related regulations (national or international), which brings corresponding design and sizing of certain civil structures that are dependent on them.

Other restrictions arising from the experience with the design, construction and operation of HSLs however often lead to more specific requirements regarding civil and technical solutions that are not defined in any regulations yet. Such specific requirements for the design of high-speed rail lines are described in more detail in this Manual and are mostly based on the experience of SNCF experts and their units SNCF Réseau and SNCF Voyageurs (SNCF Mobilités until 31<sup>st</sup> December 2019).

These initial requirements include:

- contact between train wheels and rails must be preserved under all circumstances;
- the route shall be designed as a comfortable route due to static and dynamic load on the structure and for high convenience of passengers;
- operation on the HSL must meet the highest reliability, quality and safety requirements and distances between trains must be correctly defined, so that required precision of the timetable can be reached.

### 1.2.2 Operating requirements

**The HSL must meet very strict Reliability, Availability, Maintainability and Safety (RAMS) requirements.**

RAMS analysis within the framework of the preliminary design processing means activities in the scope of Stage 1 and Stage 2 according to **ČSN EN 50126-1 ed. 2** supplemented by preliminary risk analysis (part of Stage 3) and general RAMS specification. The use of the standard solutions of the Manual guarantees the fulfilment of the service life, maintainability and operational use of the sub-elements of the infrastructure, but not of the HSL section as a whole.

Combination of the high travel speeds, the stopping distance of the train and the vertical curvature of the track do not give the driver the possibility to stop the train within the visibility range. On top of this, the train speed must be independent of weather (fog, snowfall, etc.). For these reasons, the signal system used on the conventional network cannot be used and rail lines and trains operated at speeds over 160 km/h must be equipped with the **ETCS Level 2 safety system** (according to the TSI requirements).

The driver cannot generally stop his/her train if an obstacle, reaching into the driving profile (falling rock or boulder, land slide, random object, vehicle, etc.), appears or if there is a defect on the railway superstructure (rail misalignment, rail fracture, etc.). These restrictions commit the designer to take all known risks that may affect the operating safety into account and take all necessary measures against such risks. These measures primarily involve the use of the ETCS Level 2 safety system, use of wind speed and snow sensors, or retaining systems against the fall of a vehicle onto the track. Given the nature of operation on HSLs, train stopping or a major speed reduction are only possible in very exceptional situations. These cases seriously compromise reliability in the HSL timetable.

Regular and accurate connections on HSLs are extremely important for passengers. Any delay in HS operation has an immediate impact on connecting means of transport, on the turning of trains and causes major delays of connecting trains, with serious consequences particularly during the morning and afternoon peaks. This also translates into financial compensation claims from passengers and train operators.

Small operating reserves in travel times of trains, particularly during peaks, do not allow almost any operation disruptions. When calculating the travel time, penalties for trains slowing down on very short sections (due to maintenance) must be added. The speeds in such sections still remain relatively high (230 km/h, 160 km/h or 100 km/h).

**Table 1. Some typical basic RAMS parameters for HSL (informative)<sup>1</sup>**

Service parameter	Parameter description	Monitored parameter value
Regularity	The regularity parameter is based on delays of regular train services running on the whole or part of the HSL and related to undesirable events for which the infrastructure manager and the infrastructure operator are responsible.	1 minute per thousand train-kilometres
Availability and integrity	The parameter (un)availability of HSL in the event of an adverse event depends on the length of time for which normal services cannot be provided until the consequences of the event are sufficiently mitigated by bringing the equipment back to normal or operational status. This time is defined as the 'recovery time' after the event.	average 120 minutes
Reliability	The reliability indicator 'F1' corresponds to the number of adverse events with major disruption attributable to the infrastructure manager and operator. Major Disruptive Adverse Events are events that result in a cumulative time loss of more than 200 minutes for one or more trains.	3 adverse events with major traffic disruption per year
	The reliability indicator 'F2' corresponds to the number of adverse events of all kinds per 100 km of single-track line which have operational consequences or impacts on the regularity of operation and for which the infrastructure manager and the infrastructure manager are responsible.	15 events per 100 km of single track per year
Comfort	The comfort level is assessed on the basis of the quality of the Track geometry in the longitudinal direction. The indicators representing the quality of the Track geometry in the longitudinal direction are:	
	Parameter 'NL' corresponding to the instantaneous value of the level deviation on the 200 m track of the worst	0,62

<sup>1</sup> Under the terms of the concession contract (public-private partnership) for the operation of the LGV Sud Europe Atlantique concluded between SNCF Réseau, the contracting entity, and LISEA SAS, the concessionaire and operator. The values are subsequently reported in the annual LGV SEA track declaration.

monitored section, as defined in IN 1896 (Maintenance of Gauge and Track geometry for HSL).	
The parameter "NL status" corresponds to the percentage of 200 m sections with NL values higher than 0.90 in relation to the total length of the monitored lines.	10 %

Availability and reliability of the reference speed on HSLs is the essential prerequisite for ensuring regular connections. Given the high attractiveness of HS trains and with work restrictions in the immediate vicinity of the tracks, maintenance work on HSLs are performed at night during a night closure. Minor day closures (closing of a part of the track) are intended for the most urgent repairs and inspections only. All this leads to measures addressing the possibility of staff movement in the HSL area, the frequency and the location of differently sized approaches to the tracks and defining the amount, and thus the noise, of the night maintenance required.

Regular connections on HSLs must be ensured under all circumstances, mostly in terms of the climate and weather (frost, very wet or very dry periods, rain, snowfall, wind, etc.), Restrictions (lower speed, detour) may be adopted only in very short periods of time if an exceptional phenomenon arises (very strong wind, heavy snowfall, earthquake, etc.).

### 1.2.3 Quality of civil works

All civil structures must be made in high quality to ensure safe operations, regular connections and high convenience for passengers on HSLs. As track maintenance and repairs can only be done at night during the night break, any long-term intervention into the HS track is very challenging and costly. Therefore, the following principles must be followed:

- technical solutions enabling diagnostics, inspection and maintenance work without the need for operation restrictions on the HSL;
- **reliability and durability of all civil structures during their whole service life of 100 years**, i.e. the structures must be in operation for this period of time without any expected changes to safety coefficients and without any interventions except for routine maintenance (rails replacement, slope maintenance, drainage maintenance, coatings on metal structures, possible replacement of bridge bearings, etc.).

## 1.3 Objectives

This Manual shall optimise and technical and financial solution in all relevant areas. It defines the requirements for the design of HS civil structures, reflects the restrictions of the HSLs system for every type of civil structure and brings details about:

- the criteria to be fulfilled;
- the sizing principles meeting the above-mentioned general and operation requirements;
- typical and/or recommended solutions;
- exceptional solutions;
- forbidden solutions;
- special requirements connected with civil design and construction of HSLs.

## 1.4 Area of application

**The requirements of this Manual apply on the territory of the Czech Republic for HSLs designated only for passenger trains<sup>2</sup> with maximum loading 22.5 tonnes per axle (for speeds  $200 < V \leq 230$  km/h) and 18.0 tonnes per axle (for speeds  $V > 230$  km/h).**

All vehicles operated on the HSLs must be meet the TSI requirements.

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<sup>2</sup> Alternatively, fast freight transport by modified or specially designed high-speed train sets.

Design speeds of less than and including 200 km/h (e.g. connecting rail lines) are speeds for conventional lines designed according to current applicable ČSN standards and SŽ regulations taking into account the concept of future operation and maintenance of such line (joint fencing with HSL, joint maintenance with HSL, etc.).

**Chapter 18 Specifics of HSLs with mixed operation** is a supplement to the standard design of HSLs intended exclusively for passenger trains (or freight transport by modified high-speed train sets) contained in other chapters of the Manual and describes separately the specific elements of HSL design for mixed passenger and freight transport.<sup>3</sup>

## **1.5 Exemptions from recommended values and solutions**

The application of values that are exceptionally allowed in the Manual and the application of exemptions from the solutions described herein must be approved by the investor, i.e. SŽ and the author of this regulation, the High-speed lines preparation independent unit (PVRT) respectively High-speed lines preparation department (O21) since 1 January 2021 of the Track Modernisation Division of SŽ General Direction in cooperation with the respective departments of the track operability division of the General Direction and/or operations control division of the Directorate General.

In order to grant an exemption, the Manual's Gestor may require the applicant to submit a test, analysis, calculation or other study demonstrating the economic efficiency and compatibility and/or impacts of the proposed exceptional solution on the network-wide VRT concept in the Czech Republic. Local custom, established practice, or the unusual nature of the solutions contained in the Manual are not sufficient grounds for granting an exemption.

However, the principle is to limit their use to the lowest possible level, due to the limitation of the number of modifications and deviations of the adopted operational and validated reference system.

## **1.6 Design values**

The proposed values stated in this document comply with the EU interoperability directive and TSI. Specific values, which may be more stringent than those given in the TSI, are contained in the individual chapters of the Manual.

The intervals and values stated below are used in this Manual depending on the importance of the different parameters (particularly in chapter 2 Alignment). Different areas, intervals and levels can be merged or not used on a case-to-case basis. If no limit value is used for a parameter, then a value identical with the maximum or minimum value is intended.

### **1.6.1 Recommended values**

These values represent a value range which the designer must comply with unless local or other restrictions prevent the designer from this. The application of recommended values guarantees a comfortable ride and adequate costs of track maintenance.

#### **1.6.1.1 Limit value**

This value defines the range of recommended design values from the top or from the bottom. If limit values are exceeded, the high travel convenience for passengers is compromised and line maintenance costs rise. Therefore, this value should not be exceeded.

### **1.6.2 Exceptional values**

These values represent a value range that is very rare and must be limited only to specific, limited places where the relevant solution does not allow such values.

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<sup>3</sup> Based on SNCF Réseau's specifications for HSLs of the category "LGV Mixte".

#### **1.6.2.1 Maximum and minimum value**

This value defines from the top of from the bottom the range of exceptional design values, lying outside the range of recommended values. This value must not be exceeded.

#### **1.6.2.2 Application of exceptional values and solutions**

The application of exceptional values that may compromise travel convenience or maintenance conditions must be justified with serious reasons (not systematic issues). As a result, the following general restriction applies: an exceptional value regarding the horizontal or vertical proposal is permitted every 20 km provided these exceptional proposals do not overlap and the distance between such places where these values were used is at least 300 m.

The use of exceptional values and solutions is governed by **chapter 1.5 Exemptions from recommended values and solutions**. The possibility of keeping the solution open for changes in the more detailed design phases, particularly on the Building Permit Design level, is an essential pre-condition of the use of exceptional values and solutions.