Safety Standards

of the

Nuclear Safety Standards Commission (KTA)

KTA 3205.2 (2018-10)

Component Support Structures with Non-Integral Connections;
Part 2: Component Support Structures with Non-Integral Connections for Pressure and Activity-Retaining Components in Systems Outside of the Primary Circuit

(Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen
Teil 2: Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen für druck- und aktivitätsführende Komponenten in Systemen außerhalb des Primärkreises)

The previous versions of this safety standard were issued in 1990-06 and 2015-11

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KTA SAFETY STANDARD

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Previous versions of the present safety standard: 1990-06 (BAnz No. 41a of February 28, 1991)
2015-11 (BAnz of January 8, 2016, Corrigendum of April 29, 2016)

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Comments by the Editor:

Taking into account the meaning and usage of auxiliary verbs in the German language, in this translation the following agreements are effective:

shall	indicates a mandatory requirement,
shall basically	is used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. It is a requirement of the KTA that these exceptions - other than those in the case of **shall normally** - are specified in the text of the safety standard,
shall normally	indicates a requirement to which exceptions are allowed. However, exceptions used shall be substantiated during the licensing procedure,
should	indicates a recommendation or an example of good practice,
may	indicates an acceptable or permissible method within the scope of the present safety standard.

Basic Principles

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the objective to specify safety-related requirements, compliance of which provides the necessary precautions in accordance with the state of the art in science and technology against damage arising from the construction and operation of the facility (Sec. 7, para. (2), subpara. (3) Atomic Energy Act - AtG) in order to achieve the fundamental safety functions specified in the Atomic Energy Act (AtG), in the Radiological Protection Ordinance (StrlSchV) and further detailed in the Safety Requirements for Nuclear Power Plants (SiAnf) as well as in the Interpretations of the Safety Requirements for Nuclear Power Plants (Interpretations of SiAnf).

(2) Certain requirements regarding passive systems are specified in the Safety Requirements for Nuclear Power Plants (SiAnf), namely in its Sec. 3.1, para. (1) and Sec. 6, para. (4). Within its scope the present safety standard, KTA 3205.2, details the measures to be met to fulfill those requirements. In this context, a number of standards from conventional technology, in particular DIN standards, were considered and are individually referenced.

(3) Component support structures have the safety-related function of transferring the loads from the supported component parts and components into the load-carrying parts of the power plant.

(4) This safety standard covers component support structures with non-integral connections for pressure and activity-retaining components outside of the primary circuit. Components with non-integral connections for primary circuit components (scope in accordance with KTA 3201) are dealt with in safety standard KTA 3205.1. Qualification tested standard supports are dealt with in KTA 3205.3. Component support structures with integral connections for components of systems outside of the primary circuit are dealt with particularly in KTA 3211.2 and KTA 3211.3.

1 Scope

(1) This safety standard applies to non-integral component support structures of Steel Construction Category S2 for pressure and activity retaining components outside of the primary circuit with design temperatures up to 350 °C in nuclear power plants with light-water reactors. The requirements apply out to and including the connections to the anchor plates or other structural components that are within the jurisdiction of construction supervision.

(2) The assignment of steel construction categories to component support structures is specified in **Table 1-1** based on the comparable safety-related significance of the components. Steel Construction Category S2 is basically assigned to all components dealt with under safety standard series KTA 3211. The exceptions are specified in **Table 1-1**.

(3) Standardized parts which are loaded or used in other ways than described in the qualification test appendices of KTA 3205.3 or that are not qualification tested standardized constructions or components require verifications specified in the present safety standard and – if necessary – their functionality shall be verified based on KTA 3205.3

(4) Structural steel components in Steel Construction Category S3 that need to be designed against earthquakes shall fulfill the requirements of **Table 1-1**.

(5) Pipe whip restraints are dealt with under KTA 3205.1, Appendix D.

(6) The design criteria, the verifications for the individual load case categories as well as the design situations are defined in **Table 1-2**.

2 Definitions

(1) The present safety standard relies on

a) the definition of non-integral support structure presented in KTA 3205.1,

b) the nomenclature presented in Appendix B,

c) the service limit levels as specified in KTA 3201.2 and KTA 3211.2

and the following definitions.

(2) Final document file

The final document file is that part of the accrued documents that is stored over the lifetime of the power plant or of the documented parts of the power plant.

(3) Authorized expert

An authorized expert is the expert person appointed in accordance with § 20 AtG by the proper licensing or supervisory authority for the performance of the tests specified in the present safety standard.

(4) Protective and special structures

Protective and special structures include, e.g., the steam generator pressure equalization port, storage facilities for new fuel elements, energy-absorbing structural elements.

(5) Equivalent yield stress

The equivalent yield stress, $R_{v0.2}$, is determined from the yield strength or from the yield strength and ultimate strength; it is a fictive yield strength.

(6) Interim document file

The interim document file is that part of the quality documentation that is stored at the manufacturing plant for the duration of component fabrication until delivery of the component and checking of the documents that will become part of the final file. The interim file comprises such documents that are important for the verification of the fabrication stages but not necessary for the description of the final condition of the power plant and its parts. These documents include, e.g.,

a) certificates of tests and inspections that will be repeated in the final condition of the power plant or its parts,

b) records concerning the quality assurance system.

3 Documents, Documentation, Design Approval, and Inspection

3.1 Documents and Documentation

(1) The documents to be created for the components of Steel Construction Category S2 and their documentation shall be as listed in **Table 3-1**.

(2) **Table 3-1** shall also be applied to components in Steel Construction Category S3 that require a seismic design of seismic Class I or Class IIa as specified in KTA 2201.1, Sec. 4.1.1.

3.2 Design data sheets

The design data sheets shall present information regarding the following points:

a) type of component support structure, steel construction category, seismic classification, execution class for welds (in accordance with DIN EN 1090),

b) plant facility, plant component,

c) compartment number,

d) level elevation,

e) system designation, e.g., designation of the pipelines in accordance with the Identification System for Power Plants (KKS),

f) material or material group,

g) characteristic values of possible actions (without partial safety factors) or loads including the load direction, load superposition and load classification,

h) components to be supported,

i) design temperature, operating and design-basis accident temperatures of the component support structures,

k) marks of approval, and

l) if necessary, the required movement capabilities (degrees of freedom) and the deformation limits.

3.3 Design Review and Inspection

(1) The documents specified under Serial Nos. 1 through 6 in **Table 3-1** for the component support structures in accordance with **Table 1-1** shall be submitted for design review prior to beginning fabrication. The handling of the documents under Section 3.1 specifically for pipe supports is listed in **Table 3-2**.

(2) Where pipe supports are constructed from catalogue parts, these parts shall be subjected to a design review or shall be subjected to a qualification test as specified in KTA 3205.3.

(3) The design review or the on-site tests and inspections regarding proper and professional design and construction shall be performed by the authorized expert (cf. Section 7.8.3).

(4) Regarding the steel platforms of Steel Construction Category S3 under Ser. No. 1 of **Table 1-1** or the anchoring devices under Ser. No. 4 of **Table 1-1** that are subject to construction supervision, the proper building authority shall specify the inspection requirements. The specifications of loads and actions of the components on the steel platforms shall be checked by the authorized expert.

4 Analysis

4.1 General Requirements

4.1.1 Choosing the verification procedure

(1) Within the scope of the present safety standard two verification procedures are allowable:

a) verification procedure using partial safety factors in accordance with the Eurocode (DIN EN 1990, DIN EN 1991 and DIN EN 1993) - Load and Resistance Factor Design (LRFD),

b) certification procedure using a global safety factor (σ_{zul}-concept - Allowable Strength Design (ASD)).

The application of these procedures is detailed in the following subsections.

(2) Component support structures for newly to be constructed systems shall be calculated by applying the verification procedure using partial safety factors in accordance with Eurocodes (DIN EN 1990, DIN EN 1991 and DIN EN 1993). New component support structures for existing systems, the latter of which were calculated by applying the procedure using a global safety factor (σ_{zul}-concept), either one of the procedures (paragraph (1), item a) or item b)) may, coequally, be applied.

(3) Component support structures fabricated from ferritic steels which, in addition to simple column-buckling, require additional certifications of stability (lateral torsional buckling or buckling in case of plate and shell structures), shall be verified by the verification procedure using partial safety factors.

(4) Component support structures fabricated from austenitic materials that require proofs of stability shall be verified applying the certification procedure using partial safety factors.

(5) A simultaneous application of both procedures within the overall verification procedure for a component support structure is basically not tolerable. The exception is if the dimensioning of component parts occurs in accordance with a different body of technical standards, provided, the respective component parts are not monolithically connected to the overall support structure and neither the transfer of the stress resultants within the overall support structure nor the overall stability are affected.

(6) Within the framework of design, the loads or actions shall be allocated (cf. **Table 1-2** and the exemplary allocation in **Table 4-1)** to the

a) design situations related to civil engineering (permanent, variable, accidental) or

b) load case categories (H, HZ, HS1, HS2/HS3).

Note:

The allocation to the design categories A1. A2 and A3 in accordance with DIN 25449 are shown in **Table 4-1**.

4.1.2 Extent of the certification process

(1) The certification process shall deliver information on

a) actions and combinations of actions, design values for the resistances and certification of the limit conditions, or

b) loads and load combinations, allowable stresses and stress analyses.

(2) A fatigue analysis shall be performed on mounting supports for highly dynamic loads (e.g., vibration dampers). In case of predominantly static loadings, the cyclic strength analysis or fatigue analysis may be waived. Predominantly static loads exist if the component support structures are not affected by highly dynamic loads (caused by, e.g., pressure pulses, external vibration excitation, turbulences).

Note:

Fatigue analyses are detailed, e.g., in DIN EN 1993-1-9.

4.1.3 Basics of the certification process

(1) The analytical certifications shall basically be performed based on the beam bending theory and the rod and bar statics. Numeric methods (e.g., finite element method) may also be applied.

(2) Utilization of the plastic behavior is allowable. In these cases, the reaction on the supported component shall be taken into consideration. Additional details are specified in Sections 4.2 and 4.3.

(3) Dynamic loads may be accounted for by static equivalent loads. Additional details are specified in Sections 4.2 and 4.3.

(4) The analytical certifications may be replaced or supplemented by experimental certifications.

(5) The yield strength, R_{eH} , and the 0.2 % proof stress, $R_{p0.2}$, may be considered as being equivalent unless otherwise specified in **Table 4-4** and **Table 4-5**.

(6) In the case of T-joints of hollow sections the failure mechanisms of DIN EN 1993-1-8 shall be taken into account.

(7) The slenderness ratio of component parts subjected to compressive loadings may not be larger than 150.

4.1.4 Friction forces

(1) Friction forces shall be verified only for the combinations of actions 0, 1 and 2 listed in **Table 4-2** or for the load cases H and HZ listed in **Table 4-3**. The friction coefficient, μ, to be applied– without a more detailed certification – for ferritic steels is:

a) $\mu = 0.45$ for steel on steel, unmachined, without lubricant, with coating, or

b) $\mu = 0.30$ for steel on steel, machined (e.g., brushed), no coating.

(2) Smaller friction coefficients are allowable, provided, suitable measures (e.g., provision of sliding plates) are taken. Certificates of these friction coefficients shall be provided.

(3) The friction coefficient, μ, for the certification of positional stability of a construction – without a more detailed verification – shall be $\mu = 0.15$. Other friction coefficients are allowable, provided, they are verified.

(4) For slip-resistant bolted connections the minimum friction coefficients to be used shall be in accordance with technical standards (e.g., DIN EN 1993-1-8, Sec. 3.9). Stainless steel bolts may not be used for slip-resistant connections unless verified by experiment in the individual case.

4.1.5 Temperature influence

(1) In the case of steels S235 (St 37) and S355 (St 52) the yield strength and tensile strength for temperatures higher than 80 °C shall be reduced by the temperature dependent reduction factor, k, shown in **Figure 4-1**. In the case of other materials for which the yield strength at elevated temperatures is not available, the reduction factor to be used shall be that for S355 (cf. Section 6).

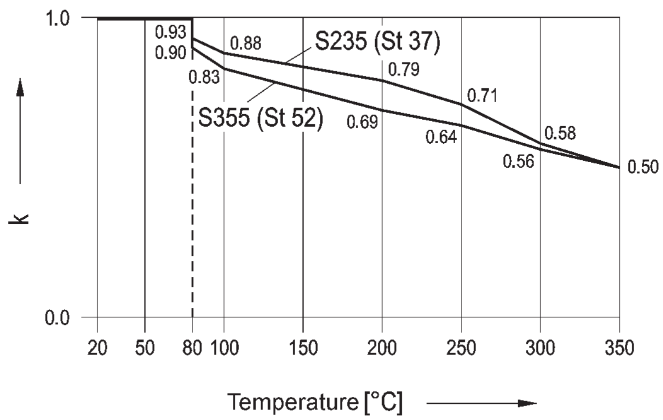


Figure 4-1: Temperature dependent reduction factor, k, for determining both the yield strength at elevated temperatures and the tensile strength

The following equations shall be applied:

$$R_{eHT} = k \cdot R_{eH} \tag{4-1}$$

$$R_{p0.2T} = k \cdot R_{p0.2} \tag{4-2}$$

$$f_{yT} = k \cdot f_y \tag{4-3}$$

$$f_{uT} = k \cdot f_u \tag{4-4}$$

Nomenclature:

f_{yT}	nominal value of yield strength at temperature, T
f_y	nominal value of yield strength at room temperature, RT
f_{uT}	nominal value of tensile strength at temperature, T
f_u	nominal value of tensile strength at room temperature, RT
R_{eHT}	yield strength at temperature, T
R_{eH}	yield strength at room temperature, RT
$R_{p0.2T}$	0.2 % proof stress at temperature, T
$R_{p0.2}$	0.2 % proof stress at room temperature, RT

(2) The temperature dependence of the elastic modulus, of the shear modulus and of the coefficient of thermal expansion does not need to be considered.

(3) In case structural measures (e.g., expansion bushings, slotted holes) are provided that create sufficient expansion possibilities, then no restraint loadings within the component support structure need to be analytically certified. Likewise, no restraint loadings within the component support structure need to be considered, provided, it is verified that the fictive free thermal expansion of the respective component part does not exceed a value of 1 mm.

(4) Forces due to a restrained thermal expansion of the component support structure shall be considered in connection with the building structure interaction loads.

(5) The range of thermal stress shall be verified based on 1.0 times ΔT as the secondary stress from a twofold yield strength as specified in safety standard KTA 3211.2. A superposition with loadings from external loads is not required.

(6) For bolts at temperatures higher than 80 °C, the allowable stress limits shall be determined from the engineering product standard or the materials standard. In the case of bolts of Property Classes 4.6, 5.6, 8.8, 10.9 the temperature dependent reduction factors, k, for steel S235 (St 37) shown in **Figure 4-1** may be applied.

Note:

The temperature distribution in the pipe enclosing component parts is dealt with in, e.g., in KTA 3205.3, Sec. 4.2.

4.1.6 Load transfer through direct contact

Compressive forces perpendicular to the contact joint may be considered to be transferred completely through the contact, provided, the following requirements are met:

a) The surfaces of the abutting contact joints shall be flat and parallel to each other.

b) Local instabilities due to fabrication imperfections can be excluded.

c) Lateral shifting of the component parts at the abutting contact joint can be excluded.

d) The relative position of the joined abutting components shall be secured; friction forces may not be considered when verifying that the relative position of abutting component parts is secured.

e) A possible gap may not be larger than 0.5 mm.

4.2 Certification Procedure Using Partial Safety Factors

(1) The following certificates shall be provided – as far as individually applicable – for all combinations of actions that are simultaneously effective:

a) certificate of the ultimate limit state,

b) certificate of stability (column buckling, lateral torsional buckling, buckling),

c) certificate of positional stability (lateral tilting, sliding, lifting off),

d) certificate of the serviceability limit state. The data – as far as applicable – shall be specified in the design data sheet. All specifications shall be function oriented.

(2) When determining limit values of the resistance in accordance with DIN EN 1993, the material property values listed in **Table 4-4** shall be used for the yield strength, f_y , and the tensile strength, f_u.

4.2.1 Types of actions

Note:

The terms *actions* (permanent, variable, accidental), *action types, combinations of actions,* design *situations, partial safety factor, ultimate limit state* and *serviceability limit state* are applied as defined in accordance with DIN EN 1990 and DIN EN 1993.

All actions that are effective individually or in combination with other actions shall be specified. Partial actions may be neglected, provided, they are comparatively minimal. Typical actions include:

a) Permanent actions, G, (permanent standard loads): Deadweight of the support structure and weight of the components with filling and insulation (if applicable) – such as, e.g., pipelines – as far as they are not contained in the component loads A through D as specified in KTA 3201.2.

b) Variable actions, Q, (temporary standard loads): B1 – Longer lasting loads effective during operating hours, e.g., stacking or construction loads, B2 – Short temporary loads effective outside of operating hours or only for a short time during operating hours, e.g., stacking loads, test or traffic loads, component loads A, B or P.

c) Accidental actions, A, (special loads): E.g., component loads C and D; external events such as earthquakes; internal events such as pipe rupture loads, jet impingement forces; pressures and temperatures from design basis accidents.

4.2.2 Certification of limit states

4.2.2.1 Ultimate limit state

The combinations of actions for certifying the ultimate limit state shall be as listed in **Table 4-2** unless deviating values are specified in the design data sheet.

4.2.2.2 Serviceability limit state

The project- and system-oriented combinations of actions for certifying the serviceability limit state shall be as specified in the design data sheet.

4.2.2.3 Static equilibrium

The positional stability (lateral tilting, sliding, lifting off) shall be verified in addition to the two limit states.

4.2.3 Resistance

The characteristic resistance parameters shall be determined on the basis of the partial safety factors, γ_M, in accordance with DIN EN 1993-1 and the associated national annexes, e.g.,

a) γ_{M0} for the resistance of cross-sections,

b) γ_{M1} for the resistance in case of loss of stability,

c) γ_{M2} for the resistance of cross-sections in case of fracture due to tensile loading.

4.2.4 Certificates

4.2.4.1 General requirements

(1) The certifications required for the limit states of steel components or steel component parts shall be according to DIN EN 1993-1-1, DIN EN 1993-1-3 through DIN EN 1993-1-10 and DIN EN 1993-1-12. In the case of stainless-steel component parts, the requirements in accordance with DIN EN 1993-1-4 and additionally the general building supervisory approval Z 30.3-6 shall be considered. The deviations specified in the present safety standard with respect to the technical standards cited above shall be observed.

(2) Force transfers into sections shall be designed in accordance with DIN EN 1993-1-8.

3) The plastic analysis of the support structure in accordance with DIN EN 1993-1-1, Sec. 5.4.3, is only allowable for a cross-section of Class 1 and for the materials listed under Ser. Nos. 1 and 2 of **Table 4-4** and then only for the combinations of actions 4 through 7 of **Table 4-2**. The procedure and application of other materials shall be specified in agreement with the authorized expert. This method may not be applied to the dynamic analysis based on static equivalent loads.

(4) The stress evaluation of plate and shell structures shall be performed according to DIN EN 1993-1-5, DIN EN 1993-1-6 and DIN EN 1993-1-7.

4.2.4.2 Design value for the support capacity of qualification tested component parts

(1) Equation (4-5) shall be used for calculating the design value for the load capacity of component parts that were qualification tested as specified in KTA 3205.3 and that have a load ratio H : HZ : HS equal to 1 : 1.15 : 1.5.

$$F_{Rd} = 1.5\ F_{(\text{Load Case H})} \qquad (4\text{-}5)$$

(2) Equation (4-6) shall be used for component parts that were qualification tested as specified in safety standard KTA 3205.3 and that have a load ratio H : HZ : HS equal to 1 : 1.5 : 1.7.

$$F_{Rd} = 1.7\ F_{(\text{Load Case H})} \qquad (4\text{-}6)$$

4.2.4.3 Certification of serviceability

(1) The limit states of deformations shall be determined and evaluated in accordance with DIN EN 1993-1-1, Sec. 7, if required with regard to fulfilling the function.

(2) In case a plastic analysis of the support structure is performed, the limit states of deformation shall always be determined and certified.

4.3 Procedures Using Allowable Stresses

(1) The following certifications shall be provided – as far as individually applicable – for all load cases and load case combinations with simultaneously effective loadings:

a) general stress analysis (certification of strength),

b) certification of stability,

c) certification of positional stability (lateral tilting, sliding, lifting off),

d) certification of the deformation limits. The data – as far as necessary – shall be as specified in the design data sheet. All specifications shall be function oriented.

(2) The stresses (including reference stresses) shall be determined in accordance with KTA 3205.1, Appendix E.

(3) In the case of Load Case HS2/HS3, the advantage of plastic behavior may be utilized. The procedure shall be specified in agreement with the authorized expert. The deformations shall be verified and evaluated.

(4) Dynamic loads may be dealt with by static equivalent loads. In this case no advantage of the global plastic behavior (e.g., plastic hinge) may be utilized. The consideration of a local plastic behavior shall be agreed upon by the authorized expert.

4.3.1 Loads and load cases

All loadings shall be specified that will be effective individually or in combination with other loadings. Partial loads may be neglected, provided, they are comparatively small. Typical loadings to be considered include:

a) Permanent standard loads: Dead-weight of the support structure and weight of the components with filling and insulation (if applicable, e.g., pipelines) as far as they are not included in the component loads A through D as specified in KTA 3211.2.

b) Temporary standard loads: B1 – Longer lasting loads during operation, e.g., stacking or construction loads, B2 – Short temporary loads effective outside of operating hours or effective only for a brief time during operation, e.g., stacking, test or traffic loads.

c) Component loads A through D: Loads emanating from the supported component as far as they are not already accounted for as permanent standard loads under item a).

d) Accidental loads (Special loads): These are, e.g., external events such as earthquakes, or internal events such as pipe rupture loads, jet impingement forces; pressure and temperature from design basis accidents.

4.3.2 Categorization of loadings

(1) The load combinations shall be specified in the design data sheet in a project- and system-oriented way.

(2) The load combinations shall be allocated to the load case categories (service limit levels) as shown in **Table 4-3** unless deviations from this requirement are specified in the design data sheet.

4.3.3 Allowable stresses

(1) The values for the equivalent yield stress, $R_{v0.2}$, shall be specified depending on the material used as listed in **Table 4-5**. In the case of load cases H, HZ and HS, the allowable stresses relative to the equivalent yield stress are those listed in **Table 4-6**, **Table 4-7**, **Table 4-9**, and **Table 4-10**.

(2) If the construction is verified as a plate and shell structure, e.g., by the general shell theory, the allowable stresses may be calculated as specified in KTA 3205.1.

4.3.4 Bolts as fasteners

(1) The values to be used for the allowable stresses of bolts in Property Classes 4.6, 5.6, 8.8 and 10.9 at temperatures lower than 80 °C shall be as listed in **Table 4-8**.

(2) In the case of other bolts than in Property Classes 4.6, 5.6, 8.8 and 10.9, the allowable stresses shall basically be calculated as shown in **Table 4-10**. Alternatively, the allowable stresses may be calculated as specified in KTA 3205.1.

(3) The allowable shear force of the bolt shall be determined by multiplying the allowable shear stress of the bolt with the cross-section of the shear area as listed in **Table 4-11**. The allowable traction force of the bolt shall be determined by multiplying the allowable normal stress of the bolt with the stress cross-section as listed in **Table 4-11**.

(4) In the case of shear bearing bolted connections without (SL) and with (SLP) fit bolts the individual verifications of simultaneously effective shear and tensile loadings shall be performed mutually independent of each other. In this case, the allowable values for the individual loadings may be fully utilized without the need of verifying a reference stress.

(5) Bolts of Property Classes 8.8 and 10.9 may be specified as regularly pre-loaded bolts (pre-loaded slip-resistant bolted connection). The allowable tensile force and the allowable shear force may not exceed the values listed in **Table 4-12** and **Table 4-13**.

(6) In the case of a simultaneous loading of an outer (external) load parallel and perpendicular to the direction of the bolt axis, the allowable transferrable lateral force in slip-resistant bolted connections without (GV) and with (GVP) fit bolts shall be reduced as follows

$$\mathrm{zul.\,Q_{GV,Z}} = \left(0.2 + 0.8 \cdot \frac{\mathrm{zul.Z} - \mathrm{Z}}{\mathrm{zul.Z}}\right) \cdot \mathrm{zul.\,Q_{GV}} \tag{4-7}$$

$$\mathrm{zul.\,Q_{GVP,Z}} = 0.5 \cdot \mathrm{zul.\,Q_{SLP}} + \left(0.2 + 0.8 \cdot \frac{\mathrm{zul.Z} - \mathrm{Z}}{\mathrm{zul.Z}}\right) \cdot \mathrm{zul.\,Q_{GV}} \tag{4-8}$$

Nomenclature:

Z : available traction force of the bolt

zul.Z : maximum allowable traction force of the bolt as listed in **Table 4-12** and **Table 4-13**

zul.Q : maximum allowable lateral force as listed in **Table 4-12** and **Table 4-13**

4.3.5 Load introduction without stiffeners

(1) In the case of rolled sections with an H-shaped cross-section, forces may be introduced without requiring stiffeners, provided,

a) the cyclic strength certification is not the determining factor, and

b) the girder (beam) cross-section is secured against twisting and lateral movements, and

c) the certification is provided that a load introduction without stiffeners is feasible from the viewpoint of statics.

(2) The effective length shall be calculated assuming a 1 : 2.5 incline of the load distribution. Hereby, both the chord of the girder (beam) as well as the curved areas may be considered. The calculation of the effective lengths for the individual cases under items a), b) and c) is shown in **Figure 4-2**.

Note:

Figures 4.2a, 4.2b and 4.2c do not show all forces that lead to an equilibrium state.

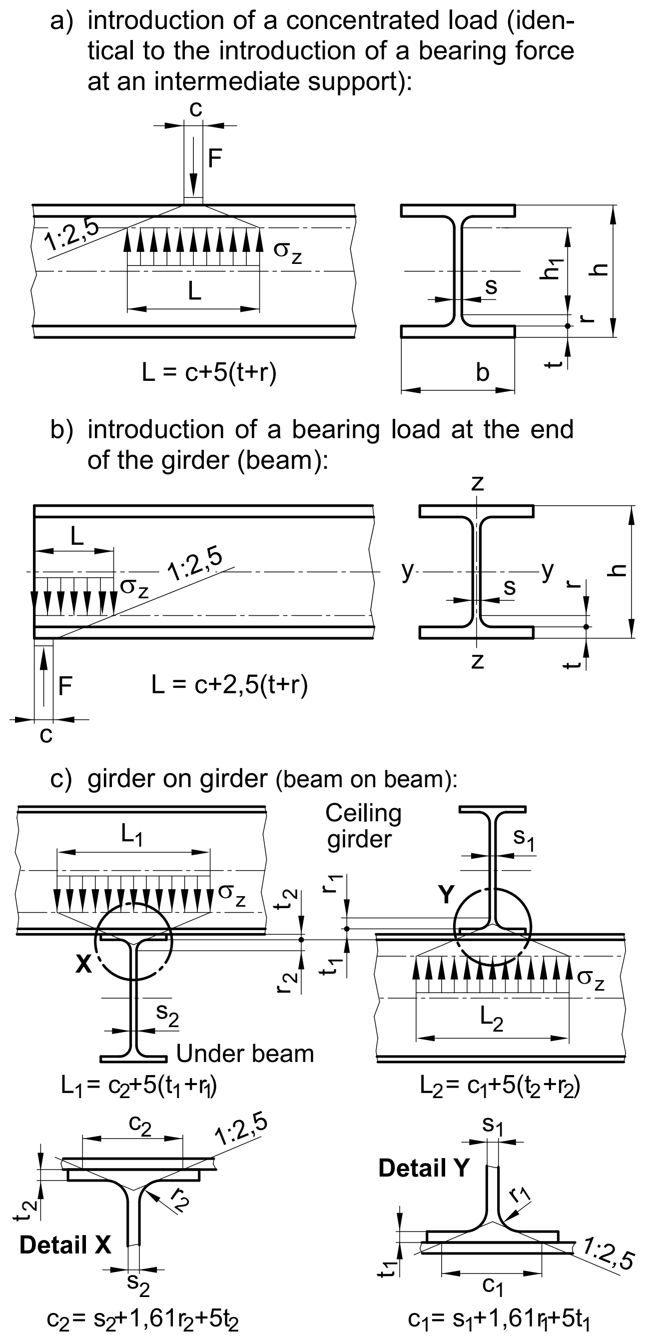


Figure 4-2: Load introduction without stiffeners in case of rolled sections with an H-type cross-section

(3) The stresses shall meet the following requirements:

a) in case σ_x and σ_z have different algebraic signs and

$$|\sigma_x| > 0.5 \cdot \sigma_{zul} \qquad (4\text{-}9)$$

then

$$\sigma_z = \frac{F}{s \cdot L\ (1.25 - 0.5|\sigma_x|/\sigma_{zul})} \leq \sigma_{zul} \qquad (4\text{-}10)$$

b) in all other cases

$$\sigma_z = \frac{F}{s \cdot L} \leq \sigma_{zul} \qquad (4\text{-}11)$$

Nomenclature:

σ_x : normal stress in the decisive cross-section of the girder (beam) as shown in **Figure 4-2**

s : web thickness of the girder (beam)

L : effective length as shown in **Figure 4-2**

(4) In case of a slenderness ratio of the web (ratio of web height to web thickness) that is larger than 60, the safety against buckling shall be verified for the web.

4.3.6 Certification of stability

(1) Simple certifications of stability (column buckling) for compression struts of ferritic steels shall be performed as specified in Appendix A.

(2) The positional stability shall be verified as specified in KTA 3205.1, Sec. 4.3.3.8 and KTA 3205.1, Appendix E, Sec. E 5.

5 Design

5.1 General Requirements

(1) Steel structures shall be designed and constructed observing the acknowledged technical standards (in particular the DIN EN 1090 and DIN EN 1993) and such that the design is ensured to be

a) functional,

b) load conform,

c) appropriate to the material,

d) suited for manufacturing (i.e., fabrication and testing), and

e) maintenance friendly

and that interactions between these requirements are taken into account.

(2) For the component support structures in Steel Construction Category S2 dealt with in the present safety standard, the execution class to be applied shall be EXC2 in accordance with standards series DIN EN 1090. In the case of highly dynamically loaded component support structures in Steel Construction Category S2 (cf. Section 4.1.2, para. (2)) the execution class to be applied shall be EXC3 in accordance with standards series DIN EN 1090 unless deviations from this requirement are specified in the design data sheet.

5.2 Requirements

(1) Expansions due to elevated temperatures shall be observed. If necessary, measures allowing for these expansions shall be provided.

(2) The design (bearing conditions, function of mounting supports, mutual interaction) shall be such that the assumptions applied in the design analysis of the pipelines are met.

(3) The building structure tolerances and anchoring location tolerances shall be observed.

(4) A sufficient accessibility of the components (including pipelines) shall be ensured.

(5) The requirements regarding the ability to be decontaminated shall be observed.

(6) The movement of the components due to thermal expansion shall be considered.

(7) Structural tolerances shall be specified in accordance with DIN ISO 2768-1 and DIN ISO 2768-2 and for welded constructions in accordance with DIN EN ISO 13920. The tolerance category shall be chosen with special regard to the individual application. In exceptional cases, adjustment tolerances that are well-founded by design reserves may individually be specified.

(8) The design shall consider the possibility for higher-load support conditions due to plastic deformations. Stability-critical designs that could lead to a sudden failure of the component part shall be avoided (e.g., by lateral-tilt protection or other stiffeners).

(9) In particular, the load transfer locations and the load bearing locations shall be secured against local instabilities (e.g., by verifications as specified under Section 4.3.5 or by stiffeners).

(10) The support structures of pipelines shall be arranged taking the testability (including inservice inspections) of the welds into consideration.

(11) The minimum dimensions for load-bearing parts shall basically be as follows:

a) wall thickness 4 mm,

b) bolts M 12.

Exceptions are allowable in well-founded cases.

(12) The weld seams shall be arranged such that both the accessibility of the weld and the minimization of residual stress within the weld are considered. Over-head weldings and unfavorably angular weld seams shall be avoided as far as possible.

(13) The seams shall be welded such that they are in accordance with DIN EN 1090-2 and DIN EN 1993-1-8. Discontinued fillet welds are not tolerable.

(14) In the case of weld seams, the weld quality of which must be certified, their testability shall be ensured.

(15) Plug weldings are allowable, provided they conform with the specifications of DIN EN 1993-1-8.

(16) Welds welded from both sides shall be preferred to single-side welds (connections of open sections or metal plates to anchor plates, end plates and others).

(17) To avoid a chipping off the concrete due to high thermal input a sufficiently large edge distance shall be observed when welding sections to the anchoring elements, unless a low thermal input is assured by only applying minimally thick weld layers.

(18) Mechanical connection elements under a predominantly non-static loading shall always be secured. The choice of the securing measure shall consider the level of the dynamic loading. Securing by welds is only allowable in the case of steels and bolt materials that are suited for welding.

(19) At least two bolts shall be used for bolted bar connections.

(20) Slotted holes are allowed; a sufficiently large edge distance shall be observed.

(21) In the case of inclined loading surfaces (e.g., U-sections) the bolt heads or the nuts shall be provided with incline-equalizing (e.g., wedge-shaped) washers.

(22) The data required for tightening preloaded bolts (e.g., necked-down bolts) shall be noted in the construction drawings (e.g., minimum required and maximum allowable torque or rotation angle as well as lubricant).

(23) Shear areas within the threaded regions of bolts are allowable, provided, they are certified in accordance with DIN EN 1993-1-8.

(24) The thread engagement of the threaded parts shall normally be 0.8 · d taking the material pairing into account. Here, d represents the outer thread diameter of the threaded part. Shorter thread engagement are allowable in well-founded cases.

Note:

Additional requirements are specified in DIN EN 1992-1-8/NA and VDI 2230 Sheet 1.

(25) In the case of hollow sections, the requirements in accordance with DIN EN 1993-1-8 shall be observed.

(26) In the case of tensile loading of welded components in their through-thickness direction the requirements in accordance with DIN EN 1993-1-10 shall be observed (cf. Section 6).

(27) In the case of sliding supports sufficient clearances shall be provided. No unallowed tilting shall be possible.

(28) Sliding supports shall be designed and constructed such that unallowed movements are impossible.

(29) Special friction certifications are required in the case of sliding supports with paired austenitic materials.

(30) Paired austenitic materials are allowed in the case of guide bearings for pipelines, provided, the surface pressure is low and sufficient play (2 to 3 mm) is available.

(31) Support structures with non-metallic components including lubricants shall normally not lose their functional capability up to a radiation dose of 10^5 J/kg over their specified lifetime.

6 Materials and Product Forms

(1) The allowable materials and corresponding test certificates regarding material tests in accordance with DIN 10204 are listed in **Table 6-1**. Other materials may only be used upon agreement with the authorized expert.

(2) Only such materials may be used for welded constructions for which the weldability has been verified.

Note:

This requirement is met for the steels S235 and S355 in their normalized or quenched and tempered rolled condition in accordance with DIN EN 10025-2 (purchase order for Delivery Condition +N).

(3) For ferritic plates subject to tensile loading in the through-thickness direction the requirements in accordance with DIN EN 1993-1-10 and DIN EN 10164 for determining the weld quality class (Z-class) shall be met. At least the requirements listed in **Table 6-2** shall be met. The connecting weld area shall be tested for laminar imperfections; no laminar imperfections are not tolerable.

(4) The weld filler materials and consumables shall be qualification tested in accordance with VdTÜV Guideline 1153 and shall be attuned to the respective welding procedure.

(5) Ferritic bolts and nuts in accordance with DIN EN ISO 898-1 and DIN EN ISO 898-2 are allowable, provided, the bolts are in Property Classes 4.6, 5.6, 8.8 or 10.9 and the nuts are in 4, 5, 8 or 10. Furthermore, austenitic bolts and nuts in accordance with DIN EN ISO 3506-1 and DIN EN ISO 3506-2 are allowable, provided, they are in Steel Types A2 through A5 and Property Classes 50, 70 and 80.

(6) It shall basically be considered to be sufficient as certification when the strength category or the material is stamped on the bolts and nuts in accordance with DIN EN ISO 898-1, DIN EN ISO 898-2, DIN EN ISO 3506-1 and DIN EN ISO 3506-2.

(7) In the case of ferritic bolts in Property Class 10.9 and austenitic bolts an Inspection Certificate 3.1 in accordance with DIN 10204 is additionally required.

(8) Structural elements not required to maintain the equilibrium of forces, e.g., stiffeners outside the points of main load application, may be certified, simply, by a Declaration of Compliance with the Order 2.1 in accordance with DIN 10204.

(9) Completely documented components (e.g., stored material) may be used, provided, no safety related concerns exist.

7 Manufacturing

7.1 General Requirements

(1) The manufacturer of component support structures shall ensure and monitor the proper performance of all necessary work with due consideration of the requirements of the present safety standard.

(2) The manufacturer shall have proper facilities and qualified personnel at his disposal such that the product forms can be properly fabricated, tested and transported Facilities and personnel of other organizations that are certified to meet these requirements may also be employed.

(3) The manufacturer shall ensure that their products have the required quality. The manufacturer shall employ an effective quality management system (e.g., certified in accordance with DIN EN ISO 9001). The manufacturer shall employ responsible and expert supervisory personnel for all fabrication, test and inspection steps within their range of activity.

(4) The manufacturer shall be certified as having at his disposal a plant-internal fabrication control in accordance with DIN EN 1090-1, Appendix B.

7.2 Manufacturer Qualification

The manufacturer shall be certified as being qualified to perform weldings. The requirements in accordance with DIN EN 1090-2, Appendix A, shall be met regarding the execution class EXC3.

7.3 Personnel Requirements

7.3.1 Welding supervision

(1) The responsible welding supervisory personnel shall be employees of the manufacturing plant. Their duty shall be to ensure that the technical standards are fulfilled.

(2) If in a manufacturing plant more than one person is assigned to be welding supervisor the areas of responsibility of the individual persons shall be clearly specified with regard to each other.

(3) The welding supervisor with superordinate responsibility in accordance with DIN EN ISO 14731 shall have the qualification of a welding engineer.

(4) Welding technicians and welding experts – trained and tested in accordance with DIN EN ISO 14731 – as well as further personnel that due to their experience are suited for certain limited applications (e.g. welding apprentices) may be deployed in support of the responsible welding supervisor (e.g., as delegates or deputies). These personnel shall normally be employees of the manufacturing plant.

7.3.2 Welders

The welding of constructions may only be performed by welders with a valid test certificate in accordance with DIN EN ISO 9606-1.

7.3.3 Operators of fully mechanized welding equipment

(1) The operators of fully mechanized welding equipment shall be qualified in accordance with DIN EN ISO 14732 certifying that they possess sufficient knowledge in operating the equipment. This certification shall be rendered by suitable weld test coupons or by means of welding procedure qualification tests or production weld tests.

(2) The manufacturer shall issue an informal certificate showing when and by which weld test coupons or by which welding procedure qualification tests or production weld tests the operating personnel has obtained their qualification.

7.3.4 Test personnel

The test personnel shall meet the requirements in accordance with DIN EN 1090-2.

7.4 Principles for Performing Welding Tasks

7.4.1 General requirements

(1) In addition to the requirements of this section, the requirements in accordance with DIN EN 1090-2 shall also be observed.

(2) The welding process may not be started before the following prerequisites are fulfilled:

a) All tests and inspections of the product forms and component parts including tests and inspections of the weld seam area and the weld seam flanks, if so required, shall have been successfully completed and certified.

b) All documents necessary for the welding (e.g., work instruction of the manufacturer, welding schedules, possibly heat treatment plans or final inspection plans and technical drawings) shall have been provided in vicinity of the workplace.

7.4.2 Performing of welding tasks

7.4.2.1 General requirements

(1) Welding procedures shall be qualified by fulfilling the requirements in accordance with DIN EN 1090-2, Tables 12 and 13. In case of qualifying the welding procedures in accordance with DIN EN 1090-2, Table 12, only welding procedure qualification tests in accordance with DIN EN ISO 15614-1 or preproduction weld tests in accordance with DIN EN ISO 15613 may be used.

(2) The weld filler materials and consumables to be used shall have been approved for the base material.

(3) The storing of weld filler materials and consumables shall meet the requirements of the manufacturer of these materials. The weld filler materials and consumables shall be stored in a dry storage facility.

(4) Alkaline-coated rod electrodes shall be processed in accordance with the requirements of their manufacturer.

7.4.2.2 Preheating

(1) The requirements specified in **Table 6-2** and those in accordance with DIN EN 1011-2 shall be observed when specifying the preheat temperature.

(2) The preheating procedure shall be monitored as specified in accordance with DIN EN ISO 13916.

7.4.2.3 Welding in cold-formed zones

The requirements for welding in cold-formed regions shall be applied as specified in accordance with DIN EN 1993-1-8.

7.4.2.4 Acceptance criteria for weld seams

The acceptance criteria for irregularities of weld seam shall be applied as specified in accordance with DIN EN 1090-2, Sec. 7.6.

7.5 Heat Treatment

Where a post-weld heat treatment dependent on material, wall thickness or design is required, it shall be performed in accordance with the pertinent material specification sheets or technical rules.

Note:

Quality requirements regarding the heat treatment are detailed in DIN EN ISO 17663.

7.6 Marking

(1) The constructions shall be unambiguously, correctly and indelibly marked including the following information:

a) system designation (e.g., in accordance with the Identification System for Power Plants – KKS), and

b) manufacturer.

(2) DIN EN 1090-2, Sec. 5.2 Table 1 shall be observed before separating parts from product forms. In the case of an Inspection Certificate 3.1 in accordance with DIN EN 10204, the identification marking shall be transferred to the individual parts.

(3) The marking shall be transferred ensuring that the material certificates can be allocated to the parts. The authorization for transferring the identification markings shall be specified within the framework of the plant-internal fabrication control system.

7.7 Corrosion Protection and Cleanliness

(1) The requirements in accordance with DIN EN 1090-2, Sec. 10 shall be applied. In certain cases, additional measures may be required.

(2) The component parts and their surfaces shall normally be such as to allow their decontamination.

(3) Corrosion-effecting contaminations (e.g. chloride-containing or ferritic) shall be avoided on surfaces of stainless steels during fabrication, transport, storage and assembly.

7.8 Final Inspection

7.8.1 General requirements

(1) The extent of inspections and tests as well as the participation of the authorized expert and the purchaser in such tests and inspections shall be specified in the final inspection plan.

(2) The final inspections shall be certified in the course of manufacturing; summary certifications are allowed.

7.8.2 Inspections and tests by the manufacturer

7.8.2.1 Final inspection prior to and during fabrication

The following procedures shall be specified in the fabrication documents:

a) checking the materials certificates, the stamping and identification marking of parts,

b) checking the dimensions and checking for transport damages,

c) receiving inspection of the product forms (component parts) in the manufacturing plant and at the construction site,

d) supervising welding tasks (weld seam preparation, consumables, preheating if required, welding process), and

e) checking the heat treatment.

7.8.2.2 Final inspection after fabrication

The following inspections and tests shall be performed by the manufacturer:

a) Inspection of the welds

aa) Visual inspection of 100 % of the welds.

ab) The extent of non-destructive testing of the weld seams in the load path specified under Section 4.2 shall be as specified in accordance with DIN EN 1090-2 depending on the execution class specified under Section 5.1, para. (2).

ac) The extent of non-destructive testing of weld seams for which, as listed under **Table 4-7,** , Section 4.3, the weld quality must be verified, shall be as listed in **Table 7-1**.

c) Dimensional check and fabrication inspection in the manufacturing plant or in the final-assembled condition.

d) Acceptance test and functional test at the construction site in the final-assembled condition, e.g., testing for conformance with the design documents, assignment of materials, identification marking; checking the adjustment tolerances (cf. Section 5.2 (7)).

7.8.3 Tests and inspections by the authorized expert

(1) The tests and inspections specified under Section 7.8.2 shall additionally be subject to random checks by the authorized expert. Certifications of the manufacturer prerequisites specified under Section 7.1 shall be presented to the authorized expert.

(2) If no design-reviewed drawings including strength calculations are available, the authorized inspector shall perform in-plant inspections during assembly regarding the proper and professional construction as well as for conformance with the licensing requirements (license conditions) for the power plant. For pipe supports the requirements of **Table 3-2** shall be applied.

8 Inservice Inspections

(1) Component support structures that must be moveable for their proper functioning shall be subjected to visual examinations within the framework of recurrent walk-through inspections. With regard to the specification of the extent of testing, footnote 5 of **Table 1-1** shall be observed.

Note:

Detailed requirements regarding inservice inspections are specified in KTA 3211.4.

(2) If spring hangers, shock absorbers and vibration dampers are fabricated according to the requirements of the present safety standard, they shall be subjected to inservice inspections as specified in KTA 3205.3, Sec. 11.

<table>
<tr><th rowspan="3">Ser. No.</th><th colspan="2" rowspan="2">Requirements for non-integral component support structures are specified in:</th><th>KTA 3205.1</th><th>KTA 3205.2</th><th>Technical standards other than KTA [1)]</th></tr>
<tr><th colspan="3">KTA 3205.3</th></tr>
<tr><th colspan="2">Steel structure types:</th><th>Components as specified in KTA 3201</th><th>Components as specified in KTA 3211</th><th>Other components</th></tr>
<tr><td>1</td><td colspan="2">Steel platforms with supporting function</td><td>S1</td><td colspan="2">S3 [2)]</td></tr>
<tr><td>2a</td><td rowspan="2">Pipeline and valve supports, pump supports [3)]</td><td>> DN 100</td><td>S1</td><td>S2 [5)]</td><td>S3 [2), 5)]</td></tr>
<tr><td>2b</td><td>≤ DN 100</td><td>S2 [4), 5)]</td><td colspan="2">S3 [2), 5)]</td></tr>
<tr><td>3a</td><td rowspan="2">Pressure vessel supports</td><td>Weight force ≥ 50 kN or pressure-times-liter value ≥ 1000 [bar · l]</td><td>S1</td><td>S2</td><td>S3 [2)]</td></tr>
<tr><td>3b</td><td>Weight force < 50 kN or pressure-times-liter value < 1000 [bar · l]</td><td>S1</td><td colspan="2">S3 [2)]</td></tr>
<tr><td>4</td><td colspan="2">Protective and special constructions (without Ser. No. 5) including the storage facility for new fuel assemblies</td><td colspan="2">S2</td><td>S3 [2)]</td></tr>
<tr><td>5</td><td colspan="2">Pipe-whip restraints</td><td colspan="2">Requirements as specified in Appendix D of KTA 3205.1,</td><td>–</td></tr>
<tr><td colspan="6">1) In accordance with corresponding technical standards.
2) Support structures to be designed against earthquakes shall additionally meet the requirements of Section 3.1, Section 3.3, para.(2) and Section 7.8.3, para. (2).
3) The determining nominal diameter (DN) for a pump is that of its discharge nozzle.
4) Falls within the scope of the KTA 3205.1; however, the verification procedure shall be as specified in the present safety standard.
5) Irrespective of the categorization, inservice inspections regarding functionality shall be performed over the entire range out to the nearest anchor point.</td></tr>
</table>

Table 1-1: Steel construction categories for the component support structures

<table>
<tr><th>Load case categories (service limit levels as specified in the present safety standard)</th><th>Design situations in accordance with DIN EN 1990 and DIN EN 1993</th><th>Design criteria</th></tr>
<tr><td>H
(main loads)
HZ
(main and additional loads)</td><td>Permanent and variable</td><td>Complete serviceability is available, cyclic loading possible, always re-usable.</td></tr>
<tr><td>HS1
(main and special loads)</td><td>Unusual (seldom)</td><td>Complete serviceability is assumed.
After occurrence of this kind of load case, the respective component support structure may have to be inspected. The inspection criteria shall be specified on a case-by-case basis.</td></tr>
<tr><td>HS2
(main and special loads)</td><td rowspan="2">Accidental</td><td>Stability and required functionality are sustained (limited deformations, e.g., bearing clearance).
It shall be checked on a cases-by-case basis whether the respective component support structure must be repaired or exchanged after the occurrence of this kind of load case.</td></tr>
<tr><td>HS3
(main and special loads)</td><td>Sustained stability. Large plastic deformations are tolerable.
It shall be checked on a cases-by-case basis whether further use of the respective component support structure is possible after the occurrence of this kind of load case.</td></tr>
</table>

Table 1-2: Load case categories and associated design criteria

Ser. No.	Documents for design, Manufacture and Documentation	Type of Documentation
1	Design data sheet (see Section 3)	E
2	Bill of material [1)]	E
3	Design drawings	E
4	Analysis (including data regarding the building structure interaction loads or the actions influencing the connection with the building)	E
5	Final inspection plan [1)]	Z [4)]
6	Welding procedure sheet [5)] (if required, heat treatment plan)	E [4)]
7	Data on settings (for movable supporting elements)	E [4)]
8	Material certificate [2)]	Z [6)]
9	Non-destructive testing records (US, D) [2)]	Z
10	Non-conformance report	E [3)]
11	Collective test certification [1)]	E

E = final file
Z = interim file
US = ultrasonic testing
R = Radiography

1) May be integrated in the design drawing
2) May be covered by the collective test certification
3) If covered by the documents of the final document file, then only for the interim document file
4) If not integrated in the design drawing
5) Superordinate, e.g., welding groove related welding procedure sheets are allowed
6) For protective and special constructions: E (final file)

Table 3-1: Documents regarding design, manufacture and documentation for Steel Construction Category S2

Pipe Support	Time of Submission, and Handling	Extent of Documents
Constructions not made from catalogue production parts	a) Required prior to assembly, e.g., prior to connecting with anchor plate b) Comparison of desired and actual values and, if required, inspection prior to fuel-loading	Extent of documents as listed in **Table 3-1**, Ser. Nos. 1 through 11
Constructions made from catalogue production parts (non-typified and statically indeterminate)	a) Required prior to assembly b) Comparison of desired and actual values and, if required, inspection prior to fuel-loading	Instead of **Table 3-1**, Ser. Nos. 1 through 11: Assembly drawing and load comparison verification as well as setup and adjustment plan
Simple constructions made from catalogue parts	a) Required prior to assembly	

Table 3-2: Handling of documents listed in **Table 3-1** for pipe supports

Designation / Source	Allocation				
Service limit levels of pant engineering / KTA 3201.2 and KTA 3211.2	A	B	P	C	D
Load case categories / KTA 3205.1 and KTA 3205.2	H	HZ	HZ	HS1	HS2/HS3
Design situations / DIN EN 1990 and DIN EN 1993	permanent and variable			accidental	
Design categories / DIN 25444	A1			A2	A3

Table 4-1: Exemplary allocation of various design categories (unless otherwise allocated as specified in the design data sheet)

Ser. No.			Combinations of actions:	0	1	2	3	4	5	6	7
	Design categories in accordance with DIN 25449:			A1			A2	A3			
1	Permanent actions	Permanent standard loads (e.g., dead weight)		1.35	1.35	1.35	1.35	1.0	1.0	1.0	1,0
2	Temporary actions	Temporary standard loads	B1		1.5	1.5	1.5 [3]	1.0 [3]	1.0 [3]	1,0 [3]	1,0 [4]
3			B2		1.5	1.5					
4		Component loads P [1]		1.35							
5		Component loads A [1]			1.5 [10]						
6		Component loads B [1] [6]				1.5 [12]					
7	Accidental actions [2]	Component loads C [1] [6]					1.17				
8		Component loads D[1]						1.0		1.0	1,0 [4]
9		Temperatures during design basis accidents									1,0
10		Pipe rupture loads, jet impingement forces [5] [9]							1.0		
11		Additional loads from external events [7] from the component support structure itself [8]								1.0	
12	Safety factors, ψ , for load combinations [11]			1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0

1) The component loads A through D and P correspond to loads allocated to the service limit levels A through D and P as specified in KTA 3211.2.

2) The design data sheet shall include a detailed list of the accidental actions as they are allocated to the associated steel construction.

3) Only if a simultaneous occurrence of accidental actions must be assumed (e.g., according to probability considerations in the individual case).

4) Only if a simultaneous occurrence with design basis accident temperatures must be assumed (e.g., according to probability considerations in the individual case).

5) The temperature specific yield strength shall be assumed for the jet impinged area.

6) Including loads from restrained thermal expansion and boundary displacements.

7) Design basis earthquake and burst-pressure wave, airplane crash, blast-pressure wave.

8) Regarding the loading of the component support structure itself caused by its oscillation behavior during an external event, the superposition of unidirectional loading parameters from various excitation directions is specified in KTA 2201.1, Sec. 4.3.1.

9) Pipe rupture loads and jet impingement forces do not need to be assumed to occur simultaneously.

10) A reduced safety factor of 1.35 may be assumed to account for the ratio of water content to component load.

11) Safety factors for load combinations smaller than 1.0 are allowable in well-founded cases.

12) If more accurate information on the actions is available, a value of 1.35 is allowable in well-founded cases.

Table 4-2: Partial safety factors, γ_F, for actions

Ser. No.	Loads			0	1	2	3	4	5	6	7
				Load Combinations (Superposition of the loads)							
				Load case categories (service limit levels)							
				HZ	**H**	**HZ**	**HS1**	**HS2/HS3** [10]			
	Design categories in accordance with DIN 25449:			**A1**			**A2**	**A3**			
1	Standard loads	Permanent standard loads		X	X	X	X	X	X	X	X
2		Temporary standard loads	B1		X	X	X [3]	X [3]	X [3]	X [3]	X [4]
3			B2		X	X					
4		Component loads P [1]		X							
5		Component loads A [1]			X						
6		Component loads B [1) 6]				X					
7	Accidental actions [2]	Component loads C [1) 6]					X				
8		Component loads D [1]						X		X	X [4]
9		Temperatures during design basis accidents									X
10		Pipe rupture loads, jet impingement forces [5) 9]							X		
11		Additional loads from external events [7] from the component support structure itself [8]								X	

1) The component loads A through D and P correspond to loads allocated to the service limit levels A through D and P as specified in KTA 3211.2.

2) The design data sheet shall include a detailed list of the accidental actions as they are allocated to the associated steel constructions.

3) Only if a simultaneous occurrence of accidental actions must be assumed (e.g., according to probability considerations in the individual case).

4) Only if a simultaneous occurrence with design basis accident temperatures must be assumed (e.g., according to probability considerations in the individual case).

5) The temperature specific yield strength shall be assumed for the jet impinged area.

6) Including loads from restrained thermal expansion and boundary displacements.

7) Design basis earthquake and burst-pressure wave, airplane crash, blast-pressure wave.

8) Regarding the loading of the component support structure itself caused by its oscillation behavior during an external event, the superposition of unidirectional loading parameters from various excitation directions is specified in KTA 2201.1, Sec. 4.3.1.

9) Pipe rupture loads and jet impingements forces do not need to be assumed as occurring simultaneously.

10) The load case categories HS2 and HS3 shall be allocated in the design data sheet in accordance with the individual protective goal of the component support structure. (cf. **Table 1-2**).

Table 4-3: Load cases and load case categories

Ser. No.	Usage	Material	Formula symbols in accordance with DIN EN 1993-1	
			f_y (Nominal Value of Yield Strength) corresponds to $R_{v0,2}$	f_u (Nominal Value of Tensile Strength)
1	Component parts and weld seams	Structural steels: S235 (St 37), S355 (St 52), as well as: P235TR1 (St 37.0), P235GH (St 35.8), P355NH (St 52.0)	R_{eHT}	R_{mT}
2		Creep resistant and fine-grained steels: P255NH (W StE 255), P275NH (W StE 285), P315NH (W St E315), P355NH (W StE 355), P265GH (HII), 15 MnNi 6 3, 16 Mo 3 (15 Mo 3)	R_{eHT}	R_{mT}
3		42 CrMo 4	$\min \left\{R_{eHT};\ \frac{2}{3}\ R_m\right\}$	R_{mT}
4		Ferritic steels, with the exception of Ser. Nos. 1, 2 and 3	$\min \left\{R_{eHT};\ \frac{2}{3}\ R_{mT}\right\}$ 1)	R_{mT}
5		Stainless steels	$R_{p0.1T}$ or alternatively 2) $1.2 \cdot R_{p0.2T}$	R_{mT}
6a	Bolts	Property Classes 4.6, 5.6, 8.8 und 10.9	–	R_{mT}
6b		Ferritic steels, with the exception of Ser. No. 6a	R_{eHT}	R_{mT}
6c		Austenitic bolts	$R_{p0.2T}$	R_{mT}

1) In case the ratio $R_{eH} / R_m \geq 0.7$, $R_{v0.2} = \min \{R_{eHT}\ ;\ 1.5/2.4\ R_m\}$. If the yield strength is less pronounced, the values for the 0.2 % proof stress shall be applied.
2) If no values for $R_{p1,0T}$ are available.

Table 4-4: Material property values for the material-dependent analysis in accordance with DIN EN 1993

Ser. No.	Usage	Material	Equivalent Yield Stress, $R_{v0.2}$, for Steel Construction Category S2
1	Component parts and weld seams	Structural steels: S235 (St 37), S355 (St 52), as well as: P235TR1 (St 37.0), P235GH (St 35.8), P355NH (St 52.0)	R_{eHT}
2		Creep resistant and fine-grained steels: P255NH (W StE 255), P275NH (W StE 285), P315NH (W St E315), P355NH (W StE 355), P265GH (HII), 15 MnNi 6 3, 16 Mo 3 (15 Mo 3)	R_{eHT}
3		42 CrMo 4	$\min \left\{R_{eHT};\ \frac{2}{3}\ R_m\right\}$
4		Ferritic steels, with the exception of Ser. Nos. 1, 2 and 3	$\min \left\{R_{eHT};\ \frac{2}{3}\ R_{mT}\right\}$ 1)
5		Stainless steels	$R_{p0.1T}$ or alternatively 2) $1.2 \cdot R_{p0.2T}$
6a	Bolts	Property Classes 4.6, 5.6, 8.8 und 10.9	Allowable stresses, cf. **Table 4-8**
6b		Ferritic steels, with the exception of Ser. No. 6a	R_{eHT}
6c		Austenitic bolts	$R_{p0.2T}$

1) In case the ratio $R_{eH} / R_m \geq 0.7$, $R_{v0.2} = \min \{R_{eHT}\ ;\ 1.5/2.4\ R_m\}$. If the yield strength is less pronounced, the values for the 0.2 % proof stress shall be applied.

2) If no values for $R_{p1,0T}$ are available.

Table 4-5: Material-dependent equivalent yield stress, $R_{v0.2}$

<table>
<tr><th rowspan="2">Ser. No.</th><th rowspan="2" colspan="3">Kind of Stress</th><th colspan="4">Allowable Stresses (in relation to $R_{v0.2}$)</th></tr>
<tr><th>H</th><th>HZ</th><th>HS1</th><th>HS2/ HS3</th></tr>
<tr><td>1</td><td colspan="3">Compression, bending compression (verification of stability)</td><td>0.58</td><td>0.66</td><td>0.75</td><td>0.8</td></tr>
<tr><td>2</td><td colspan="3">Compression, bending compression (stress analysis), tension and bending</td><td>0.66 [1)]</td><td>0.75 [1)]</td><td>0.85</td><td>1.0</td></tr>
<tr><td>3</td><td colspan="3">Shear stress</td><td>0.38</td><td>0.43</td><td>0.50</td><td>0.58</td></tr>
<tr><td>4</td><td colspan="3">Reference stress</td><td>0.66 [2)]</td><td>0.75 [2)]</td><td>0.85 [2)]</td><td>1.0</td></tr>
<tr><td>5</td><td rowspan="5">Allowable bearing pressure [4)] for a material thickness ≥ 3 mm and these bolt connections</td><td>SL</td><td>Rough bolts (DIN 7990), high-strength bolts
(DIN EN 14399-4) or countersunk head bolts (DIN 7969)
Bore hole tolerance 0.3 mm < Δd ≤ 2 mm without pre-loading [3)]</td><td>1.17</td><td>1.33</td><td>1.50</td><td>1.75</td></tr>
<tr><td>6</td><td>SL</td><td>High-strength bolts (DIN EN 14399-4)
Bore hole tolerance 0.3 mm < Δd ≤ 2 mm
irregular pre-loading: ≥ 0.5 · F_V</td><td>1.58</td><td>1.80</td><td>2.10</td><td>2.4</td></tr>
<tr><td>7</td><td>SLP</td><td>Fit bolts (DIN 7968)
Bore hole tolerance Δd ≤ 0.3 mm – without pre-loading</td><td>1.33</td><td>1.50</td><td>1.75</td><td>2.0</td></tr>
<tr><td>8</td><td>SLP</td><td>High-strength fit bolts - Bore hole tolerance Δd ≤ 0.3 mm
irregular pre-loading: ≥ 0.5 · F_V</td><td>1.75</td><td>1.96</td><td>2.25</td><td>2.6</td></tr>
<tr><td>9</td><td>GV, GVP</td><td>High-strength bolts [5)] - Bore hole tolerance 0.3 mm < Δd ≤ 2 mm
High-strength fit bolts - Bore hole tolerance Δd ≤ 0.3 mm
pre-load: 1.0 · F_V</td><td>2.00</td><td>2.25</td><td>2.50</td><td>3.0</td></tr>
</table>

SL : shear bearing bolted connection
GV : slip-resistant bolted connection
SLP : shear bearing bolted connection with fit bolts
GVP : slip-resistant bolted connection with fit bolts
F_V : pre-load force as specified in **Tables 4-12** and **4-13** for bolt sizes 8.8 and 10.9 respectively; values of F_V for other bolt sizes are specified in VDI 2230 Sheet 1

1) In case of corner stresses due to two-axial bending (local stress amplification), 10 % higher values are allowed (see KTA 3205.1, Appendix E, Sec. E 2.6).

2) In case of a local stress limitation, 10 % higher values are allowed.

3) In case of slotted holes, the values to be applied are 100 % lengthwise and 70 % crosswise.

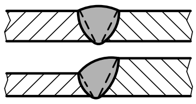
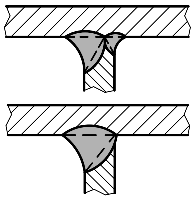
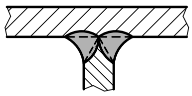
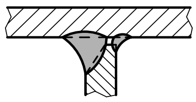
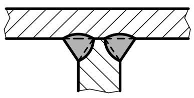
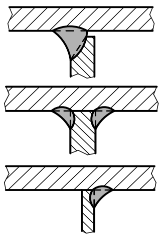
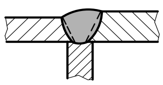
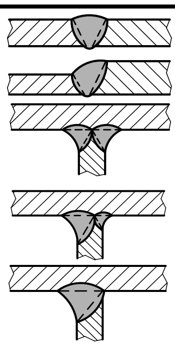
4) Edge distance: 2.0 d ≤ e ≤ min {3d; 6t} in direction of force
1.5 d ≤ e ≤ min {3d; 6t} transverse to direction of force

Hole spacing: 3 d ≤ e ≤ min {6d; 12t}

with the edge distance (e), the hole diameter (d), and the smallest sheet thickness (t).

5) See Section 4.1.4, paragraph 4.

Table 4-6: Allowable stresses (in relation to the equivalent yield stress, $R_{v0.2}$, listed in **Table 4-5**) for component parts

Ser. No.	Kind of Weld Seam			Kind of Stress	Weld Quality	S235 (St37) and P265GH (H II) [S355 (St52) and other steels]			
						H	HZ	HS1	HS2/HS3
1	Full-penetration welds	Butt welds		Compression, bending compression	All weld qualities	0.66 [0.66]	0.75 [0.75]	0.85 [0.85]	1.00 [1.00]
		Single bevel groove weld (Half-V welds)		Tension, bending tension, design stress intensity	Certified weld quality 1)	0.66 [0.66]	0.75 [0.75]	0.85 [0.85]	1.00 [1.00]
		Double-bevel butt welds (Double-Half-V welds)			Weld quality not certified	0.56 [0.47]	0.63 [0.53]	0.70 [0.60]	0.84 [0.71]
2	Not fully penetrating welds	Half-Y welds		Compression, bending compression	All weld qualities	0.66 [0.66]	0.75 [0.75]	0.85 [0.85]	1.00 [1.00]
		Double-Half-Y welds		Tension, bending tension, design stress intensity	Verified weld quality 1)	0.66 [0.66]	0.75 [0.75]	0.85 [0.85]	1.00 [1.00]
					Weld quality not verified	0.56 [0.47]	0.63 [0.53]	0.70 [0.60]	0,84 [0,71]
3	Fillet welds			All kinds of loadings	All weld qualities	0,56 [0,47]	0.63 [0.53]	0.70 [0.60]	0.84 [0.71]
4	Three-sheet welds			Compression, bending compression	All weld qualities	0,66 [0,66]	0.75 [0.75]	0.85 [0.85]	1.00 [1.00]
				Tension, bending tension, design stress intensity	Verified weld quality 1)	0,66 [0,66]	0.75 [0.75]	0.85 [0.85]	1.00 [1.00]
					Weld quality not verified	0,56 [0,47]	0.63 [0.53]	0.70 [0.60]	0.84 [0.71]
5	All welds			Shear force in seam direction	All weld qualities	0,56 [0,47]	0.63 [0.53]	0.70 [0.60]	0.84 [0.71]

1) Cf. Section 7.8.2.2

Note: Stresses listed under Ser. Nos. 1 through 4 are all directed perpendicular to the direction of the weld seam.

Table 4-7: Allowable stresses (in relation to the equivalent yield stress, $R_{v0.,2}$, as listed in **Table 4-5**) for weld seams in service limit levels of the load cases H, HZ, HS1 and HS2/HS3 for the steels S235 (St 37), S355 (St 52) and other steels

Ser. No.	Property Class	Kind of Stress		Load Case H	HZ	HS1	HS2/HS3
				N/mm²	N/mm²	N/mm²	N/mm²
1	4.6	SL	Shear	112	126	146	168
2			Tension	110	125	143	165
3		SLP	Shear	128	147	166	192
4			Tension	110	125	143	165
5	5.6	SL	Shear	160	184	208	240
6			Tension	150	170	195	225
7		SLP	Shear	160	184	208	240
8			Tension	150	170	195	225
9	8.8	SL	Shear	168	189	218	254
10			Tension	252	287	328	379
11		SLP	Shear	196	224	255	298
12			Tension	252	287	328	379
13	10.9	SL	Shear	240	270	312	360
14			Tension	360	410	468	540
15		SLP	Shear	280	320	364	426
16			Tension	360	410	468	540

Note:
The allowable bearing pressure is obtained from the smaller Rv0.2 value of the bolt and base material as listed in Table 4-6.

Table 4-8: Allowable stresses in relation to the load cases for bolts of Property Classes 4.6, 5.6, 8.8 and 10.9 at temperatures lower than or equal to 80 °C

Kind of Stress	Material	H	HZ	HS1	HS2 / HS3
		Allowable Stresses in N/mm²			
Compression, bending compression, bending tension, bending	S235	160	180	210	235
	S355	240	270	310	355
Hertzian contact pressure	S235	650	800	890	960
	S355	850	1050	1190	1295
Bearing pressure for hinge pins (multi-shear bolt connection)	S235	210	240	275	320
	S355	320	360	415	480
Kind of Stress	**Material**	**Allowable Stresses / $R_{v0.2}$**			
Compression, bending compression, bending tension, bending	all others	0.67	0.75	0.85	1.00
Hertzian contact pressure	all others	2.40	3.00	3.30	3.60
Bearing pressure for hinge pins(multishear bolt connection)	all others	0.90	1.00	1.15	1.33

Table 4-9: Allowable stresses for bearing parts and hinged joints (in relation to the equivalent yield stress, $R_{v0.2}$, listed in Table 4-5)

Kind of Stress	Load Case			
	H	HZ	HS1	HS2 / HS3
For bolts with $R_{eH} \leq 450$ N/mm^2				
Tension Shear	0.47 $R_{v0.2}$	0.52 $R_{v0.2}$	0.61 $R_{v0.2}$	0.69 $R_{v0.2}$
For bolts with $R_{eH} > 450$ N/mm^2				
Tension	0.40 $R_{v0.2}$	0.45 $R_{v0.2}$	0.52 $R_{v0.2}$	0.59 $R_{v0.2}$
Shear	0.26 $R_{v0.2}$	0.30 $R_{v0.2}$	0.34 $R_{v0.2}$	0.40 $R_{v0.2}$

Table 4-10: Allowable stress for bolts and threaded parts not covered by Table 4-8 (in relation to the equivalent yield stress, $R_{v0.,2}$, listed in Table 4-5)

Bolt Size	Shear Area in mm^2		Stress Cross-Section in mm^2
	Rough bolts (SL-connection)	Fit bolts (SLP-connection)	
M 12	113	133	84.3
M 16	201	227	157
M 20	314	346	245
M 22	380	415	303
M 24	452	491	353
M 27	573	616	459
M 30	707	755	561
M 36	1018	1075	817

Table 4-11: Parameters for the cross-sections of bolts

Bolt Size	Pre-load force, F_v, in kN	Allowable Lateral Force in kN						Allowable Tensile Force in kN		
		Pre-loaded slip-resistant bolted connection (GV)			Pre-loaded slip-resistant bolted connection with fit bolts (GVP)			GV and GVP		
		H	HZ/HS1	HS2/HS3	H	HZ/HS1	HS2/HS3	H	HZ/HS1	HS2/HS3
M 12	50	20	22.5	25	38.5	43.5	56	35	40	44
M 16	100	40	45.5	50	72	82	96	70	80	88
M 20	160	64	72.5	80	112.5	128	146	112	128	141
M 22	190	76	86.5	95	134	153	174	133	152	167
M 24	220	88	100	110	156.5	178.5	207	154	176	194
M 27	290	116	132	145	202	230.5	258	203	232	255
M 30	350	140	159	175	245.5	280	318	245	280	308
M 36	510	204	232	255	354.5	404	451	357	408	449

Table 4-12: Allowable forces per bolt and friction surface in case of pre-loaded bolt connections with bolts of Property Class 10.9

Bolt Size	Pre-load force, F_v, in kN	Allowable Lateral Force in kN						Allowable Tensile Force in kN		
		Pre-loaded slip-resistant bolted connection (GV)			Pre-loaded slip-resistant bolted connection with fit bolts (GVP)			GV and GVP		
		H	HZ/HS1	HS2/HS3	H	HZ/HS1	HS2/HS3	H	HZ/HS1	HS2/HS3
M 12	35	14	15.8	17.5	27	30.5	39.2	24.5	28	30.8
M 16	70	28	31.9	35	50.4	57.4	67.2	49	56	61.6
M 20	110	44.8	50.8	56	78.8	89.6	102	78.4	89.6	98.7
M 22	130	53.2	60.6	66.5	93.8	107	122	93.1	106	117
M 24	150	61.6	70	77	110	125	145	108	123	136
M 27	200	81.2	92.4	102	141	161	181	142	162	179
M 30	245	98	111	123	172	196	223	172	196	216
M 36	355	143	162	179	248	283	316	250	286	314

Table 4-13: Allowable forces per bolt and friction surface in case of pre-loaded bolted connections with bolts of Property Class 8.8

Application	Materials [1]	Product Form	Requirements	Kind of Certification in accordance with DIN EN 10204
(1) Steel platforms (2) Pipe supports (3) Component support structures (4) Protective and special constructions (with the exception of pipe whip restraints [4]) (5) Storage facility for new fuel assemblies	S235JR (RSt37-2) [1.0038] S235J0 (RSt37-2) [1.0114] S235J2 (St37-3) [1.0117]	Sections Plates [2] Rods	DIN EN 10025-2	2.2 [5]
	S355J2 (St52-3) [1.0577]	Sections Plates [2] Rods	DIN EN 10025-2	3.1
	S235JRH (RSt37-2) [1.0039] S235J2 (St37-3) [1.0116] S355J2H (St52-3) [1.0576]	Hollow sections Pipes	DIN EN 10250 DIN EN 10210-1	
	P265GH (HII) [1.0425] 16 Mo 3 (15 Mo 3) [1.5415]	Plates [2]	DIN EN 10028-2	
	15 MnNi 63 [1.6210]	Plates [2]	VdTÜV-WB 427/1	
	16Mo3 (15Mo3) [1.5415] P250GH (C22.8) [1.0460]	Rods Forgings	DIN EN 10273 DIN EN 10222-2	
	P255NH (WStE255) [1.0462] P275NH (WStE285) [1.0487] P315NH (WStE315) [1.0506] P355NH (WStE355) [1.0565]	Plates Rods	DIN EN 10028-3	
	P235TR1 (St37.0) [1.0254] P235GH (St35.8) [1.0345] P355NH (St52.0) [1.0565]	Seamless pipes	DIN EN 10216-1 DIN EN 10216-2 DIN EN 10216-3	
	X5 CrNi 18-10 [1.4301] X6 CrNiTi 18-10 [1.4541] X6 CrNiNb 18-10 [1.4550] X6 CrNiMoTi 17-12-2 [1.4571]	Seamless pipes Welded pipes	DIN EN 10216-5 DIN EN 10217-7 DIN EN 10296-2	
	X5 CrNi 18-10 [1.4301] X6 CrNiTi 18-10 [1.4541] X6 CrNiNb 18-10 [1.4550] X6 CrNiMoTi 17-12-2 [1.4571] X12 Cr 13 (X10 Cr 13) [1.4006]	Plates Rods Forgings	DIN EN 10028-7 DIN EN 10088-3 DIN EN 10222-5 DIN EN 10272	
	C45E (Ck45) [1.1191] C35E (Ck35) [1.1181]	Rods Forgings	DIN EN 10083 DIN EN 10269	
	42 CrMo 4 (42 CrMo 4) [1.7225] 21 CrMoV 5-7 (21 CrMoV 5-7) [1.7709] 25 CrMo 4 (24 CrMo 5) [1.7218]	Rods	DIN EN 10083-3 DIN EN 10269	
(6) Anchor plates	S235JR (RSt37-2) [1.0038] S235J0 (RSt37-2) [1.0114] S235J2 (St37-3) [1.0116] S355J2 (St52-3) [1.0577]	Plates [2]	DIN EN 10025-2	
Also, regarding (5)	X12 Cr 13 (X10 Cr 13) [1.4006] X20 Cr 13 (X20 Cr 13) [1.4021]	Rods Sections [3] Forgings	DIN EN 10088-3	

1) If materials are available in various heat treatment conditions, the heat treatment condition shall be specified in the purchase order.

2) For ferritic steel plates with t > 20 mm that are stressed in the through-thickness direction, the weld quality class (Z-class) listed in **Table 6-2** shall be verified by an Inspection Certificate 3.1 (DIN EN 10204)

3) Z-class shall also be verified for sections

4) Pipe whip restraints are dealt with in Appendix D of KTA 3205.1.

5) Execution class EXC3 requires an Inspection Certificate 3.1.

Table 6-1: Requirements for materials and the certification of material tests

	S235 (St 37), P265GH (HII)			S355 (St 52) and other ferritic steels		
	Sheet thickness, t, in mm					
	≤ 20	20 < t ≤ 40	> 40	≤ 20	20 < t ≤ 40	> 40
Without preheating	—	Z15 1)	Z25 1)	—	Z25 1)	Z25 1)
With preheating about 120 °C ± 20 K	—	—	Z25	—	Z15	Z25
1) The welding of S355J2+N and other ferritic steels with t > 25 mm requires a preheating to 120 °C.						

Table 6-2: Required Z-class for ferritic steel plates stressed in the through-thickness direction

Kind of Tests and Inspections	**Materials**	
	S235 (St37) S355 (St52) P265GH (HII) [1.0425] 16 Mo 3 (15 Mo 3) [1.5415] P235GH (St35.8) [1.0345] X5 CrNi 18-10 [1.4301] X6 CrNiNb 18-10 [1.4550] X6 CrNiTi 18-10 [1.4541] X6 CrNiMoTi 17 12 2 [1.4571]	Other Materials
Ultrasonic or radiographic inspection	10 %	25 %
Surface inspection	random testing	random testing

Table 7-1: Extent of non-destructive testing of weld seams by the manufacturer

Appendix A

Omega Procedure

Contents

A 1 Column Buckling of Compression Bars; Single-Piece Compression Bars with a Uniform Cross-Section

(1) Bars with a low rotational resistance (e.g., I-profiles) shall be examined for rotational bending buckling and rotational buckling. In this case it is not the procedure described in the following is not applicable.

(2) Single-piece compression bars shall comply with equation (A-1).

$$\omega \cdot \frac{F}{A} \leq \sigma_{zulT} \qquad \text{(A-1)}$$

Nomenclature:

F : absolute value of the largest compression force occurring in the bar

A : non-weakened cross-section of the bar

σ_{zulT} : allowable temperature dependent compressive stress for the load case and type of structural steel

ω : buckling coefficient as listed in **Tables A-1** through **A-2**, dependent on type of structural steel and slenderness ratio, λ,

λ : the largest slenderness ratio of the compression bar given by equation (A-2):

$$\lambda = \max\left\{\frac{K_y \cdot L}{i_y};\ \frac{K_z \cdot L}{i_z}\right\} \qquad \text{(A-2)}$$

K_y, K_z : Euler buckling factors of the individual case (usually between 0.5 and 2)

L : length of compression bar

i_y, i_z : radius of gyration of the corresponding section axis

(3) No bucking examination is required for compression bars with a slenderness ratio, λ, complying with equation (A-3). In this case the buckling coefficient, ω, shall be set equal to 1.

$$\lambda \leq 20 \qquad \text{(A-3)}$$

(4) **Tables A-3** and **A-4** shall be applied to single-piece compression bars made from round pipes.

λ	0	1	2	3	4	5	6	7	8	9
20	1.04	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.08
30	1.08	1.09	1.09	1.10	1.10	1.11	1.11	1.12	1.13	1.13
40	1.14	1.14	1.15	1.16	1.16	1.17	1.18	1.19	1.19	1.20
50	1.21	1.22	1.23	1.23	1.24	1.25	1.26	1.27	1.28	1.29
60	1.30	1.31	1.32	1.33	1.34	1.35	1.36	1.37	1.39	1.40
70	1.41	1.42	1.44	1.45	1.46	1.48	1.49	1.50	1.52	1.53
80	1.55	1.56	1.58	1.59	1.61	1.62	1.64	1.66	1.68	1.69
90	1.71	1.73	1.74	1.76	1.78	1.80	1.82	1.84	1.86	1.88
100	1.90	1.92	1.94	1.96	1.98	2.00	2.02	2.05	2.07	2.09
110	2.11	2.14	2.16	2.18	2.21	2.23	2.27	2.31	2.35	2.39
120	2.43	2.47	2.51	2.55	2.60	2.64	2.68	2.72	2.77	2.81
130	2.85	2.90	2.94	2.99	3.03	3.08	3.12	3.17	3.22	3.26
140	3.31	3.36	3.41	3.45	3.50	3.55	3.60	3.65	3.70	3.75
150	3.80	Limitation $\lambda \leq 150$								
An interpolation of intermediate values is not required.										

Table A-1: Buckling coefficients, ω , for S235 (St37)

λ	0	1	2	3	4	5	6	7	8	9
20	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10	1.11
30	1.11	1.12	1.12	1.13	1.14	1.15	1.15	1.16	1.17	1.18
40	1.19	1.19	1.20	1.21	1.22	1.23	1.24	1.25	1.26	1.27
50	1.28	1.30	1.31	1.32	1.33	1.35	1.36	1.37	1.39	1.40
60	1.41	1.43	1.44	1.46	1.48	1.49	1.51	1.53	1.54	1.56
70	1.58	1.60	1.62	1.64	1.66	1.68	1.70	1.72	1.74	1.77
80	1.79	1.81	1.83	1.86	1.88	1.91	1.93	1.95	1.98	2.01
90	2.05	2.10	2.14	2.19	2.24	2.29	2.33	2.38	2.43	2.48
100	2.53	2.58	2.64	2.69	2.74	2.79	2.85	2.90	2.95	3.01
110	3.06	3.12	3.18	3.23	3.29	3.35	3.41	3.47	3.53	3.59
120	3.65	3.71	3.77	3.83	3.89	3.96	4.02	4.09	4.15	4.22
130	4.28	4.35	4.41	4.48	4.55	4.62	4.69	4.75	4.82	4.89
140	4.96	5.04	5.11	5.18	5.25	5.33	5.40	5.47	5.55	5.62
150	5.70	Limitation $\lambda \leq 150$								
An interpolation of intermediate values is not required.										

Table A-2: Buckling coefficients, ω , for S355 (St52)

λ	0	1	2	3	4	5	6	7	8	9
20	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.02	1.02	1.02
30	1.03	1.03	1.04	1.04	1.04	1.05	1.05	1.05	1.06	1.06
40	1.07	1.07	1.08	1.08	1.09	1.09	1.10	1.10	1.11	1.11
50	1.12	1.13	1.13	1.14	1.15	1.15	1.16	1.17	1.17	1.18
60	1.19	1.20	1.20	1.21	1.22	1.23	1.24	1.25	1.26	1.27
70	1.28	1.29	1.30	1.31	1.32	1.33	1.34	1.35	1.36	1.37
80	1.39	1.40	1.41	1.42	1.44	1.46	1.47	1.48	1.50	1.51
90	1.53	1.54	1.56	1.58	1.59	1.61	1.63	1.64	1.66	1.68
100	1.70	1.73	1.76	1.79	1.83	1.87	1.90	1.94	1.97	2.01
110	2.05	2.08	2.12	2.16	2.20	2.23	continued like **Table A-1**			
An interpolation of intermediate values is not required.										

Table A-3: Buckling coefficients, ω , for S235 (St37) in the case of single-piece compression bars made from round pipes

λ	0	1	2	3	4	5	6	7	8	9
20	1.02	1.02	1.02	1.03	1.03	1.03	1.04	1.04	1.05	1.05
30	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.10	1.10
40	1.11	1.11	1.12	1.13	1.13	1.14	1.15	1.16	1.16	1.17
50	1.18	1.19	1.20	1.21	1.22	1.23	1.24	1.25	1.26	1.27
60	1.28	1.30	1.31	1.32	1.33	1.35	1.36	1.38	1.39	1.41
70	1.42	1.44	1.46	1.47	1.49	1.51	1.53	1.55	1.57	1.59
80	1.62	1.66	1.71	1.75	1.79	1.83	1.88	1.92	1.97	2.01
90	2.05	continued like **Table A-2**								
An interpolation of intermediate values is not required.										

Table A-4: Buckling coefficients, ω , for S355 (St52) in the case of single-piece compression bars made from round pipes

A 2 Straight, Regularly Eccentrically Compressed Bars; Loadings from Compression and Bending

(1) The following requirements shall be observed whenever the compression force, F, of the bar acts on a lever arm, a, or where, additionally to the compression force, a regularly F-dependent or F-independent bending torque, M, is applied.

(2) Firstly, a stress analysis regarding compression and bending as specified under Section 4.3 shall be performed verifying that the largest stresses occurring in the bar do not exceed the value σ_{zul} .

$$\sigma_{b,d} = \frac{M}{W_d} \leq \sigma_{zulT} \quad \text{(A-4)}$$

$$\sigma_{b,z} = \frac{M}{W_z} \leq \sigma_{zulT} \quad \text{(A-5)}$$

Nomenclature:

$\sigma_{b,d}$: maximum compressive stress

$\sigma_{b,z}$: maximum tensile stress

W_d : moment of resistance of the non-weakened bar cross-section at the compressive bending edge

W_z : moment of resistance of the non-weakened bar cross-section at the tensile bending edge

(3) Secondly, a buckling analysis as specified in the following paragraphs (4) and (5) shall be performed for a buckling in the presumed major moment plane.

(4) If the force application point is located on one of the two main axes of the cross-section – i.e., the moment, M, engages one of the main cross-section axes – and the center of gravity of the bar cross-section is either equally distant from the tensile bending edge and the compressive bending edge (e_z equals e_d , cf. **Figure A-1**) or is closer to the tensile bending edge (e_z smaller than e_d , cf. **Figure A-2**), equation (A-6) shall be fulfilled.

$$\omega \cdot \frac{F}{A} + 0.9 \cdot \frac{M}{W_d} \leq \sigma_{zulT} \quad \text{(A-6)}$$

Where the center of gravity of the bar cross-section is located closer to the compressive bending edge than to the tensile bending edge (e_z larger than e_d , cf. **Figure A-3**), equations (A-7) and (A-8) shall be fulfilled.

$$\omega \cdot \frac{F}{A} + 0.9 \cdot \frac{M}{W_d} \leq \sigma_{zulT} \quad \text{(A-7)}$$

$$\omega \cdot \frac{F}{A} + \frac{300+2\cdot\lambda}{1000} \cdot \frac{M}{W_d} \leq \sigma_{zulT} \quad \text{(A-8)}$$

(5) In the case of compression bars with a large slenderness ratio λ and a small lever arm a the application of equations (A-6) through (A-8) in which absolute values of assumed stresses are summed up will result in larger cross-section dimensions than with the general stress analysis required under Section A 2, paragraph (2); these larger values shall then be applied to the design.

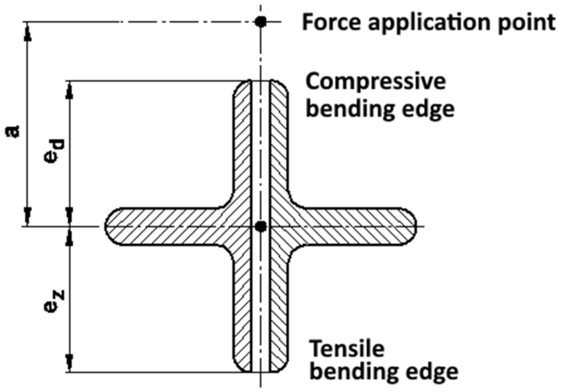


Figure A-1: Bar cross-section with $e_z = e_d$

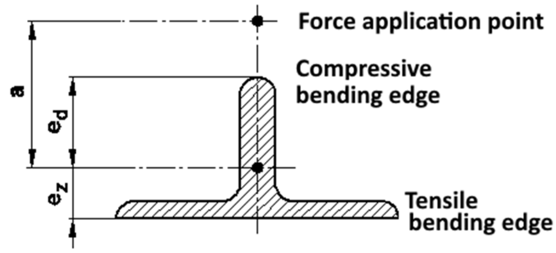


Figure A-2: Bar cross-section with $e_z < e_d$

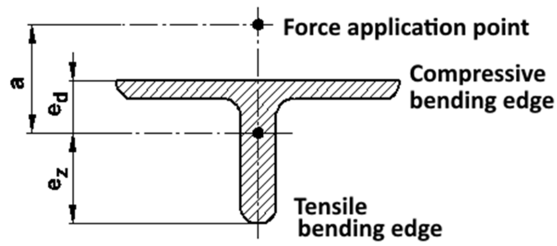


Figure A-3: Bar cross-section with $e_z > e_d$

Appendix B

Symbols and Nomenclature

F_{Rd}	:	Design value for the load capacity
f_u	:	Nominal value of tensile strength at room temperature (RT)
f_{uT}	:	Nominal value of tensile strength at temperature (T)
F_V	:	pre-load force
f_y	:	nominal value of yield strength at room temperature (RT)
f_{yT}	:	nominal value of yield strength at temperature (T)
GV	:	slip-resistant connection
GVP	:	slip-resistant connection with fit bolts
K_y, K_z	:	Euler buckling factors
L	:	effective length
R_{eH}	:	yield strength at room temperature (RT)
R_{eHT}	:	yield strength at temperature (T)
R_m	:	tensile strength at room temperature (RT)
R_{mT}	:	tensile strength at temperature (T)
$R_{p0,2}$	:	0.2 % proof stress at room temperature (RT)
$R_{p0,2T}$	:	0.2 % proof stress at temperature (T)
$R_{p1,0T}$	:	0.1 % proof stress at temperature (T)
$R_{v0,2}$:		equivalent yiel stress
s	:	web thickness of the girder (beam)
SL	:	shear bearing stress
SLP	:	shear bearing stress with fit bolts
Z	:	actual traction force of the bolt
zul. Q	:	maximum allowable lateral force
zul. Z	:	maximum allowable traction force of the bolt
zul. $Q_{GV,Z}$	:	allowable transferrable shear force of slip resistant connections
zul. $Q_{GVP,Z}$	:	allowable transferrable shear force of slip resistant connections with fit bolts
γ_F	:	partial safety factor for the actions
γ_{M0}	:	partial safety factor for the resistance of cross-sections
γ_{M1}	:	partial safety factor for the resistance in case of loss of stability
γ_{M2}	:	partial safety factor for the resistance of cross-sections in case of fracture due to tensile loading
ΔT	:	temperature increase
σ_x	:	normal stress in the determining cross-section of the girder
μ	:	friction coefficient
ψ	:	safety factor for load combinations

Appendix C

Regulations Referred to in the Present Safety Standard

(Regulations referred to in the present safety standard are valid only in the versions cited below. Regulations which are referred to within these regulations are valid only in the version that was valid when the latter regulations were established or issued.)

AtG		Act on the peaceful utilization of atomic energy and the protection against its hazards (Atomic Energy Act – AtG) of December 23, 1959, revised version of July 15, 1985 (BGBl. I, p. 1565), most recently changed by Article 1 of the Act of July 10, 2018 (BGBl. I, p. 1122, 1124)
StrlSchV		Ordinance on the protection from damage by ionizing radiation (Radiological Protection Ordinance – StrlSchV) of July 20, 2001 (BGBl. I, p. 1714; 2002 I, p. 1459), most recently changed as called for in Article 10 by Article 6 of the Act of. January 27, 2017 (BGBl. I, p. 114, 1222)
SiAnf	(2015-03)	Safety requirements for nuclear power plants of November 22, 2012, revised version of March 3, 2015 (BAnz AT of March 30, 2015 B2)
Interpretations	(2015-03)	Interpretations of the safety requirements for nuclear power plants of November 22, 2012, revised version of March 3, 2015 (BAnz AT of March 30, 2015 B3)
KTA 2201.1	(2011-11)	Design of Nuclear Power Plants against Seismic Events; Part 1: Principles
KTA 3201.2	(2017-11)	Components of the reactor coolant pressure boundary of light water reactors; Part 2: Design and analysis
KTA 3205.1	(2018-10)	Component support structures with non-integral connections; Part 1: Component support structures with non-integral connections for components of the primary circuit of light water reactors
KTA 3205.3	(E2018-10)	Component support structures with non-integral connections; Part 3: Series-production standard supports
KTA 3211.2	(2013-11)	Pressure and activity retaining components of systems outside the primary circuit; Part 2: Design and analysis
KTA 3211.3	(2017-11)	Pressure and activity retaining components of systems outside the primary circuit; Part 3: Manufacture
KTA 3211.4	(2017-11)	Pressure and activity retaining components of systems outside the primary circuit; Part 4: Inservice inspections and operational monitoring
DIN 267-13	(2007-05)	Fasteners - Technical specifications - Part 13: Parts for bolted connections with specific mechanical properties for use at temperatures ranging from -200 °C to +700 °C
DIN 7968	(2017-08)	Hexagon fit bolts with hexagon nut for steel structures
DIN 7969	(2017-08)	Slotted countersunk head bolts with hexagon nut for steel structures
DIN 7990	(2017-08)	Hexagon head bolts with hexagon nut for steel structures
DIN 25449	(2016-04)	Reinforced and prestressed concrete components in nuclear facilities - Safety concept, actions, design and construction
DIN EN 1011-2	(2001-05)	Welding - Recommendation for welding of metallic materials - Part 2: Arc welding of ferritic steels; German version EN 1011-2:2001
DIN EN 1090-1	(2012-02)	Execution of steel structures and aluminium structures - Part 1: Assessment and verification of constancy of performance of steel components and aluminium components for structural use; German version EN 1090-1:2009+A1:2011
DIN EN 1090-2	(2011-10)	Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures; German version EN 1090-2:2008+A1:2011
DIN EN 1090-3	(2008-09)	Execution of steel structures and aluminium structures - Part 3: Technical requirements for aluminium structures; German version EN 1090-3:2008
DIN EN 1990	(2010-12)	Eurocode: Basis of structural design; German version EN 1990:2002 + A1:2005 + A1:2005/AC:2010 in connection with

DIN EN 1990/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode: Basis of structural design
DIN EN 1990/NA/A1	(2012-08)	National Annex - Nationally determined parameters - Eurocode: Basis of structural design; Amendment A1
DIN EN 1991-1-1	(2010-12)	Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings; German version EN 1991-1-1:2002 + AC:2009 in connection with
DIN EN 1991-1-1/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings
DIN EN 1991-1-1/NA/A1	(2015-05)	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings; Amendment A1
DIN EN 1991-1-2	(2010-12)	Eurocode 1: Actions on structures - Part 1-2: General actions - Actions on structures exposed to fire; German version EN 1991-1-2:2002 + AC:2009 in connection with
DIN EN 1991-1-2/NA	(2015-09)	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-2: General actions - Actions on structures exposed to fire
DIN EN 1991-1-2 Corrigendum 1	(2013-08)	Eurocode 1 - Actions on structures - Part 1-2: General actions - Actions on structures exposed to fire; German version EN 1991-1-2:2002, Corrigendum to DIN EN 1991-1-2:2010-12; German version EN 1991-1-2:2002/AC:2012
DIN EN 1991-1-3	(2010-12)	Eurocode 1: Actions on structures - Part 1-3: General actions - Snow loads; German version EN 1991-1-3:2003 + AC:2009 in connection with
DIN EN 1991-1-3/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-3: General actions - Snow loads
DIN EN 1991-1-3/A1	(2015-12)	Eurocode 1 - Actions on structures - Part 1-3: General actions - Snow loads; German version EN 1991-1-3:2003/A1:2015
DIN EN 1991-1-4	(2010-12)	Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions; German version EN 1991-1-4:2005 + A1:2010 + AC:2010 in connection with
DIN EN 1991-1-4/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions
DIN EN 1991-1-5	(2010-12)	Eurocode 1: Actions on structures - Part 1-5: General actions - Thermal actions; German version EN 1991-1-5:2003 + AC:2009 in connection with
DIN EN 1991-1-5/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-5: General actions - Thermal actions
DIN EN 1991-1-6	(2010-12)	Eurocode 1: Actions on structures - Part 1-6: General actions, Actions during execution; German version EN 1991-1-6:2005 + AC:2008 in connection with
DIN EN 1991-1-6/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-6: General actions, Actions during execution
DIN EN 1991-1-6 Corrigendum 1	(2013-08)	Eurocode 1: Actions on structures - Part 1-6: General actions, Actions during execution; German version EN 1991-1-6:2005, Corrigendum to DIN EN 1991-1-6:2010-12; German version EN 1991-1-6:2005/AC:2012
DIN EN 1991-1-7	(2010-12)	Eurocode 1: Actions on structures - Part 1-7: General actions - Accidental actions; German version EN 1991-1-7:2006 + AC:2010
DIN EN 1991-1-7/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-7: General actions - Accidental actions
DIN EN 1991-1-7/A1	(2014-08)	Eurocode 1 - Actions on structures - Part 1-7: General actions - Accidental actions; German version EN 1991-1-7:2006/A1:2014
DIN EN 1993-1-1	(2010-12)	Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings; German version EN 1993-1-1:2005 + AC:2009 in connection with
DIN EN 1993-1-1/NA	(2015-08)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings

DIN EN 1993-1-1/A1	(2014-07)	Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings; German version EN 1993-1-1:2005/A1:2014
DIN EN 1993-1-3	(2010-12)	Eurocode 3: Design of steel structures - Part 1-3: General rules - Supplementary rules for cold-formed members and sheeting; German version EN 1993-1-3:2006 + AC:2009 in connection with
DIN EN 1993-1-3/NA	(2017-05)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-3: General rules - Supplementary rules for cold-formed members and sheeting
DIN EN 1993-1-4	(2015-10)	Eurocode 3: Design of steel structures - Part 1-4: General rules - Supplementary rules for stainless steels; German version EN 1993-1-4:2006 + A1:2015 in connection with
DIN EN 1993-1-4/NA	(2017-01)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-4: General rules - Supplementary rules for stainless steels
DIN EN 1993-1-5	(2017-07)	Eurocode 3 - Design of steel structures - Part 1-5: Plated structural elements; German version EN 1993-1-5:2006 + AC:2009 + A1:2017 in connection with
DIN EN 1993-1-5/NA	(2016-04)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-5: Plated structural elements
DIN EN 1993-1-6	(2017-07)	Eurocode 3 - Design of steel structures - Part 1-6: Strength and Stability of Shell Structures; German version EN 1993-1-6:2007 + AC:2009 + A1:2017 in connection with
DIN EN 1993-1-6/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-6: Strength and stability of shell structures
DIN EN 1993-1-7	(2010-12)	Eurocode 3: Design of steel structures - Part 1-7: Plated structures subject to out of plane loading; German version EN 1993-1-7:2007 + AC:2009 in connection with
DIN EN 1993-1-7/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel Structures - Part 1-7: Plated structures subject to out of plane loading
DIN EN 1993-1-8	(2010-12)	Eurocode 3: Design of steel structures - Part 1-8: Design of joints; German version EN 1993-1-8:2005 + AC:2009 in connection with
DIN EN 1993-1-8/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-8: Design of joints
DIN EN 1993-1-9	(2010-12)	Eurocode 3: Design of steel structures - Part 1-9: Fatigue; German version EN 1993-1-9:2005 + AC:2009 in connection with
DIN EN 1993-1-9/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-9: Fatigue
DIN EN 1993-1-10	(2010-12)	Eurocode 3: Design of steel structures - Part 1-10: Material toughness and through-thickness properties; German version EN 1993-1-10:2005 + AC:2009 in connection with
DIN EN 1993-1-10/NA	(2016-04)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-10: Material toughness and through-thickness properties
DIN EN 10025-1	(2005-02)	Hot rolled products of structural steels - Part 1: General technical delivery conditions; German version EN 10025-1:2004
DIN EN 10025-2	(2005-04)	Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels; German version EN 10025-2:2004
DIN EN 10025-3	(2005-02)	Hot rolled products of structural steels - Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels; German version EN 10025-3:2004
DIN EN 10025-4	(2005-04)	Hot rolled products of structural steels - Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels; German version EN 10025-4:2004
DIN EN 10025-5	(2005-02)	Hot rolled products of structural steels - Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance; German version EN 10025-5:2004
DIN EN 10025-6	(2009-08)	Hot rolled products of structural steels - Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition; German version EN 10025-6:2004+A1:2009

DIN EN 10028-2	(2009-09)	Flat products made of steels for pressure purposes - Part 2: Non-alloy and alloy steels with specified elevated temperature properties; German version EN 10028-2:2009
DIN EN 10028-3	(2009-09)	Flat products made of steels for pressure purposes - Part 3: Weldable fine grain steels, normalized; German version EN 10028-3:2009
DIN EN 10028-7	(2016-07)	Flat products made of steels for pressure purposes - Part 7: Stainless steels; German version EN 10028-7:2016
DIN EN 10083-1	(2006-10)	Quenched and tempered steels - Part 1: General technical delivery conditions; German version EN 10083-1:2006
DIN EN 10083-2	(2006-10)	Quenched and tempered steels - Part 2: General technical delivery conditions for unalloyed steels; German version EN 10083-2:2006
DIN EN 10083-3	(2007-01)	Quenched and tempered steels - Part 3: General technical delivery conditions for alloyed steels; German version EN 10083-1:2006
DIN EN 10083-3 Corrigendum 1	(2009-01)	Quenched and tempered steels - Part 3: Technical delivery conditions for alloyed steels; German version EN 10083-3:2006, Corrigendum for DIN EN 10083-3:2007-01; German version EN 10083-3:2006/AC:2008
DIN EN 10088-1	(2014-12)	Stainless steels - Part 1: List of stainless steels; German version EN 10088-1:2014
DIN EN 10088-2	(2014-12)	Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes; German version EN 10088-2:2014
DIN EN 10088-3	(2014-12)	Stainless steels - Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes; German version EN 10088-3:2014
DIN EN 10088-4	(2010-01)	Stainless steels - Part 4: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes; German version EN 10088-4:2009
DIN EN 10088-5	(2009-07)	Stainless steels - Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes; German version EN 10088-5:2009
DIN EN 10164	(2005-03)	Steel products with improved deformation properties perpendicular to the surface of the product - Technical delivery conditions; German version EN 10164:2004
DIN EN 10204	(2005-01)	Metallic products - Types of inspection documents; German version EN 10204:2004
DIN EN 10210-1	(2006-07)	Hot finished structural steel hollow sections - Part 1: General; German version EN 10210-1:2006
DIN EN 10210-2	(2006-07)	Hot finished steel structural hollow sections - Part 2: Tolerances, dimensions and sectional properties; German version EN 10210-2:2006
DIN EN 10216-1	(2014-03)	Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 1: Non-alloy steel tubes with specified room temperature properties; German version EN 10216-1:2013
DIN EN 10216-2	(2014-03)	Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties; German version EN 10216-2:2013
DIN EN 10216-3	(2014-03)	Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 3: Alloy fine grain steel tubes; German version EN 10216-3:2013
DIN EN 10216-5	(2014-03)	Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 5: Stainless steel tubes; German version EN 10216-5:2013
DIN EN 10216-5 Corrigendum 1	(2015-01)	Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 5: Stainless steel tubes; German version EN 10216-5:2013, Corrigendum to DIN EN 10216-5:2014-03
DIN EN 10217-7	(2015-01)	Welded steel tubes for pressure purposes - Technical delivery conditions - Part 7: Stainless steel tubes; German version EN 10217-7:2014
DIN EN 10222-2	(2017-06)	Steel forgings for pressure purposes - Part 2: Ferritic and martensitic steels with specified elevated temperatures properties; German version EN 10222-2:2017
DIN EN 10222-5	(2017-06)	Schmiedestücke aus Stahl für Druckbehälter - Teil 5: Martensitische, austenitische und austenitisch-ferritische nichtrostende Stähle; Deutsche Fassung EN 10222-5: 2017
DIN EN 10250-1	(1999-12)	Open die steel forgings for general engineering purposes - Part 1: General requirements; German version EN 10250-1:1999

DIN EN 10250-2	(1999-12)	Open die steel forgings for general engineering purposes - Part 2: Non-alloy quality and special steels; German version EN 10250-2:1999
DIN EN 10250-3	(1999-12)	Open die steel forgings for general engineering purposes - Part 3: Alloy special steels; German version EN 10250-3:1999
DIN EN 10250-4	(2000-02)	Open die steel forgings for general engineering purposes - Part 4: Stainless steels; German version EN 10250-4:1999
DIN EN 10250-4 Corrigendum 1	(2008-12)	Open die steel forgings for general engineering purposes - Part 4: Stainless steels; German version EN 10250-4:1999, Corrigendum to DIN EN 10250-4:2000-02
DIN EN 10269	(2014-02)	Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties; German version EN 10269:2013
DIN EN 10272	(2016-10)	Stainless steel bars for pressure purposes; German version EN 10272:2016
DIN EN 10273	(2016-10)	Hot rolled weldable steel bars for pressure purposes with specified elevated temperature properties; German version EN 10273:2016
DIN EN 10296-2	(2006-02)	Welded circular steel tubes for mechanical and general engineering purposes - Technical delivery conditions - Part 2: Stainless steel; German version EN 10296-2:2005
DIN EN 10296-2 Corrigendum 1	(2007-06)	Welded circular steel tubes for mechanical and general engineering purposes - Technical delivery conditions - Part 2: Stainless steel; German version EN 10296-2:2005, Corrigenda to DIN EN 10296-2:2006-02; German version EN 10296-2:2005/AC:2007
DIN EN 14399-4	(2015-04)	High-strength structural bolting assemblies for preloading - Part 4: System HV - Hexagon bolt and nut assemblies; German version EN 14399-4:2015
DIN EN ISO 898-1	(2013-05)	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread (ISO 898-1:2013); German version EN ISO 898-1:2013
DIN EN ISO 898-2	(2012-08)	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes - Coarse thread and fine pitch thread (ISO 898-2:2012); German version EN ISO 898-2:2012
DIN EN ISO 1461	(2009-10)	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (ISO 1461:2009); German version EN ISO 1461:2009
DIN EN ISO 3506-1	(2010-04)	Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs with specified property classes - Coarse pitch thread and fine pitch thread (ISO/DIS 3506-1:2009); German version EN ISO 3506-1:2009
DIN EN ISO 3506-2	(2010-04)	Mechanical properties of corrosion-resistant stainless steel fasteners - Part 2: Nuts with specified property classes - Coarse pitch thread and fine pitch thread (ISO/DIS 3506-2:2009); German version EN ISO 3506-2:2009
DIN EN ISO 5817	(2014-06)	Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817:2014); German version EN ISO 5817:2014
DIN EN ISO 9001	(2015-11)	Quality management systems - Requirements (ISO 9001:2015); German and English version EN ISO 9001:2015
DIN EN ISO 9606-1	(2013-12)	Qualification testing of welders - Fusion welding - Part 1: Steels (ISO 9606-1:2012 including Cor 1:2012); German version EN ISO 9606-1:2013
DIN EN ISO 13916	(1996-11)	Welding - Measurement of preheating temperature, interpass temperature and preheat maintenance temperature (ISO 13916:1996); German version EN ISO 13916:1996
DIN EN ISO 13920	(1996-11)	Welding - General tolerances for welded constructions - Dimensions for lengths and angles; shape and position (ISO 13920:1996); German version EN ISO 13920:1996
DIN EN ISO 14731	(2006-12)	Welding coordination - Tasks and responsibilities (ISO 14731:2019); German version EN ISO 14731:2006
DIN EN ISO 14732	(2013-12)	Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732:2013); German version EN ISO 14732:2013
DIN EN ISO 15613	(2004-09)	Specification and qualification of welding procedures for metallic materials - Qualification based on pre-production welding test (ISO 15613:2004); German version EN ISO 15613:2004

DIN EN ISO 15614-1	(2012-06)	Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1: 2004 + Amd 1:2008 + Amd 2:2012); German version EN ISO 15614-1:2004 + A1:2008 + A2:2012
DIN EN ISO 17663	(2009-10)	Welding - Quality requirements for heat treatment in connection with welding and allied processes (ISO 17663:2009); German version EN ISO 17663:2009
DIN ISO 2768-1	(1991-06)	General tolerances; tolerances for linear and angular dimensions without individual tolerance indications; identical with ISO 2768-1:1989
DIN ISO 2768-2	(1991-04)	General tolerances; geometrical tolerances for features without individual tolerances indications; identical with ISO 2768-2:1989
VDI 2230 Blatt 1	(2015-11)	Systematic calculation of highly stressed bolted joints - Joints with one cylindrical bolt
VdTÜV MB SCHW 1153	(2012-10)	Guideline for the qualification testing of weld filler materials and consumables
VdTÜV-WB 427/1	(2001-03)	Fine-grained steel 15MnNi6-3 – Material No. 1.6210
Type Approval Z-30.3-6	(2017-05)	General Type Approval Z-30.3-6 of May 12, 2017 “Products, components and connecting elements made from stainless steel” of the “Deutsches Institut für Bautechnik (DIBT)” valid until May 1, 2022

Appendix D (informative)

Amendments Regarding Previous Version 2015-11

The Appendix C, Regulations Referred to in the Present Safety Standard, was updated.

The references to KTA 3205.1 were updated.