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of the
Nuclear Safety Standards Commission (KTA)

KTA 3905 (2020-12)

Load Attachment Points on Loads in Nuclear Power Plants

(Lastanschlagpunkte an Lasten in Kernkraftwerken)

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KTA SAFETY STANDARD

December 2020	Load Attachment Points on Loads in Nuclear Power Plants	KTA 3905

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PLEASE NOTE: Only the original German version of this safety standard represents the joint resolution of the 35-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in the Federal Gazette (Bundesanzeiger) of January 20th, 2021. Copies of the German versions of the KTA safety standards may be mail-ordered through the Wolters Kluwer Deutschland GmbH (info@wolterskluwer.de). Downloads of the English translations are available at the KTA website (http://www.kta-gs.de).

All questions regarding this English translation should please be directed to the KTA office:

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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, the 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 this 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, the Radiation Protection Act (StrlSchG) and the Radiological Protection Ordinance (StrlSchV) and further detailed in the Safety Requirements for Nuclear Power Plants (SiAnf) as well as in the Interpretations on the Safety Requirements for Nuclear Power Plants.

(2) Based on the Safety Requirements for Nuclear Power Plants (SiAnf) and the Interpretations on the Safety Requirements for Nuclear Power Plants, this Safety Standard specifies the requirements to be derived therefrom for load attachment points. Regarding the danger potential the general provisions and

a) additional requirements or

b) increased requirements

for load attachment points as well as

c) special requirements for load attachment points on core components

shall be taken into account.

(3) This Safety Standard deals with the design and analysis, materials, tests and inspections, operation and maintenance including documentation of load attachment points functioning as connecting element between load carrying device and load.

(4) Special requirements specific to a component are not dealt with here, but shall be taken into account where required.

(5) General requirements regarding quality assurance are specified in Safety Standard KTA 1401. Quality assurance requirements exceeding those of KTA 1401 are laid down in this Safety Standard for each individual case.

1 Scope

(1) This Safety Standard shall apply to load attachment points on loads which are handled in nuclear power plants during specified normal operation and must comply with the special provisions of section 4.

(2) This Safety Standard shall furthermore apply to load attachment points of the following core components:

a) fuel elements, control elements and in-core instrumentation lances for pressurized water reactors,

b) fuel elements, control rods and fuel assembly channels for boiling water reactors.

(3) Load attachment points on core component encapsulations are to be considered load attachment points on core components.

(4) This Safety Standard does not apply to:

a) load attachment points on reactor pressure vessel internals

   Note:
   Load attachment points on reactor pressure vessel internals are covered by KTA 3204.

b) load attachment points on containers for the storage, handling and internal transport of radioactive substances, which meet the requirements of KTA 3604.

2 Definitions

(1) Load attachment point (LAP)

The load attachment point is the connecting element between load carrying device and load and is either

a) an integral part of the load or

b) bolted on or

c) welded on or

d) anchored in the concrete in the case of structural concrete components

   Note:
   The delimitation between load attachment point and load is described in **Annex C** with reference to examples.

(2) Authorized inspectors

Authorized inspectors for the tests and inspections for the purpose of this Safety Standard are the following on the basis of nuclear, building or traffic legislation:

a) authorized inspectors consulted by the licensing or supervisory authority in accordance with § 20 of the Atomic Energy Act,

b) authorized inspectors from the institution competent under the building code of the respective State or the inspecting engineers put in charge by this institution,

c) authorized inspectors from the institution competent under the traffic legislation or the authorized inspector consulted by this agency.

3 General provisions

Load attachment points shall at least comply with the generally accepted engineering standards.

4 Special provisions

4.1 Classification

The classification of the load attachment points with respect to the additional or increased requirements shall be specified within the framework of the nuclear licensing and supervisory procedure. Examples for the classification and for the procedural steps of classification are given in **Annex D**.

4.2 Load attachment points with additional requirements

If, in the course of transportation of nuclear fuel, other radioactive substances, radioactive plant components or other loads, a failure of the load attachment point is expected to lead

a) to the immediate danger of a release of radioactivity with a subsequent radioactive exposure of persons in the plant subjected to an effective dose by inner exposure exceeding 1 mSv or to an external exposure exceeding 5 mSv

   or

b) to a loss of reactor coolant which cannot be isolated, or to a detrimental effect on, and going beyond the redundancy of, the safety equipment which is necessary to shut down the reactor at any time, to maintain the reactor in the shutdown condition or to remove residual heat, and no dangers as per section 4.3 need be expected,

then the additional requirements specified in this Safety Standard that exceed the requirements under section 3 shall apply to these load attachment points.

4.3 Load attachment points with increased requirements

If, in the course of transportation of nuclear fuel, other radioactive substances, radioactive components or other loads, a failure of the lifting equipment is expected to lead

a) to a criticality accident

   or

b) to the danger of a release of radioactivity where the maximum allowable discharge into the atmosphere may be exceeded as laid down in the license or the radioactive exposure of individual persons of the population in the nuclear power plant environment may exceed the limit values of the Radiological Protection Ordinance (StrlSchV)

then more stringent requirements specified in this Safety Standard that exceed the requirements under section 3 shall apply to these load attachment points.

4.4 Load attachment points on core components

Load attachment points on core components according to clause 1 (2) shall, in addition to the general provisions of section 3, meet the requirements of the pertinent sections of this Safety Standard.

5 Analytical and structural design

5.1 General

5.1.1 Load assumptions

(1) In the case of statically indeterminate systems where the calculated load distribution over all load attachment points is not ensured by the load carrying device, the maximum possible load, however, at least one half of the total load, shall be proved for each load attachment point.

(2) Where additional forces, e.g. as a result of breaking loose, static friction or tilting, cannot be precluded by design measures, these forces shall be taken into account.

(3) Ambient conditions such as pressure, temperature, fluid and radiation exposure shall be considered in the design.

(4) Component-specific requirements for the analytical and structural design, calculation, materials, tests and inspections, operation and maintenance shall be considered.

(5) For load attachment points used as support and attachment on the transportation means during transportation outside the nuclear power plant, the loadings resulting from transports inside and outside the nuclear power plant shall be considered in the fatigue analysis.

(6) For load attachment points no verification of adequate protection against external impacts is required.

5.1.2 Stress analysis

(1) The following analytical proofs shall basically be performed: stress analysis and fatigue analysis.

A fatigue analysis is not required

a) for structural steel components
   aa) which are designed according to DIN 15018-1 provided a number of stress cycles $N_\sigma = 2 \cdot 10^4$ will not be exceeded,
   ab) which are designed according to the standard series DIN EN 13001 provided a fatigue analysis may be omitted for the respective case of application in compliance with this standard series,
b) for other parts of load attachment points provided a number of 6,000 stress cycles will not be exceeded.

   Notes:

   (1) Structural steel components for the purposes of this Safety Standard are structural members made of welded or screwed together steel plates or rolled steel sections.

   (2) Other parts of load attachment points refer, inter alia, to parts where a stress evaluation on the basis of nominal stresses is not purposeful.

The number of stress cycles shall be determined in accordance with clause 5.1.3.

(2) Analytical proofs may be performed by calculation or experimentally or as a combination of calculation and experiments.

(3) The stress evaluation shall basically be based on nominal stresses. Where a stress evaluation on the basis of nominal stresses is not purposeful (e.g. in the case of volume-type parts with complex cross-sections and notches), the stress evaluation shall be made according to specific requirements for each individual case.

   Note:

   For bolted load attachment points of transport vessels for radioactive substances to be used within and outside nuclear power plants the requirements for the analytical proofs as well as the evaluation criteria for the stress analysis and the fatigue analysis are defined e.g. in the Guideline BAM-GGR 012.

(4) In the case of connections made with bolts to be reassembled upon disassembly, the following applies in addition to (1):

a) Where a fatigue analysis is to be carried out as per (1), the stress cycles resulting from disassembly and re-assembly operations shall be taken into account in the analysis.
b) Where no fatigue analysis is required as per subcl. (1) and a maximum of 10 disassembly and re-assembly operations is carried out, an fatigue analysis may be waived.
c) Where more than 10 disassembly and re-assembly operations are carried out, a fatigue analysis shall be carried out independently of the requirements of subcl. (1). In this case, both the stress cycles from operational loadings and from disassembly and re-assembly operations shall be taken into account.

5.1.3 Determination of the load collective

(1) As regards the fatigue analysis, the stresses in the part shall be calculated in due consideration of the load assumptions according to cl. 5.1.1 and be classified as to their magnitudes. With the related number of stress cycles the load collective shall be determined.

(2) In doing so, the number of stress cycles shall be calculated in accordance with the following equation

$$N_\sigma = U \cdot Z_{Sch} \cdot k_a \qquad (5.1\text{-}1)$$

using $k_a = 3$

$Z_{Sch} = 10$ for hoists with creep speed and for converter drives

$Z_{Sch} = 20$ for other drives

Where

k_a number of stress cycles as a result of a switching operation

N_σ number of (dynamic) stress cycles

U number of working cycles; a working cycle is the process between taking up and setting down of the load

Z_{sch} number of switching operations per working cycle (switching on to accelerate corresponds to one switching operation; switching over to braking, likewise).

(3) The cyclic history for the strength analysis shall be converted by the elementary Miner’s Rule (linear damage accumulation at continuous stress number diagram in a double logarithmic representation in accordance with sections B 1.2.1.3 and B 1.2.2.1 of KTA 3902) to a damage-equivalent single-step load collective. The stress amplitude belonging to N_σ shall be determined under consideration of the dynamic factor specified in the following sections for the individual parts. Where the stresses within a working cycle are unknown, the maximum stress amplitude after connection of the load shall be assumed as remaining constant over the entire working cycle.

(4) If the actual stresses within a working cycle are known from experimental investigations or from appropriate estima-

tion of the cyclic stressing history with suitable analytical models (e.g. taking account of the vibration energy consumed by the work loss being impressed on the system by the coupling impact), the fatigue analysis may be performed on this basis.

5.1.4 Structural design

5.1.4.1 Load attachment points according to section 4.2 or 4.3

(1) The following shall apply to structural steel components and weld seams:

a) the requirements of DIN 15018-1 and DIN 15018-2 when using the global safety factor concept,

b) the relevant stipulations of standard series DIN EN 13001 when using the partial safety factors concept.

(2) The requirements in accordance with VDI 2230 Sheet 1 apply to the construction of bolted connections.

(3) Only those load attachment points are permissible which are either an integral part of the load, are bolted on or welded on and, in the case of concrete parts, are anchored in the concrete.

(4) The load attachment point shall be designed such that it can only be positively attached to the lifting equipment. Safeguards shall be provided to prevent any inadvertent release of the load carrying device from the load attachment point.

(5) Load attachment points shall be constructed or marked such that they cannot be used in an inadmissible manner and the ergonomic requirements of KTA 3902, section 4.7, are satisfied in combination with the load carrying device.

(6) In the case of welded-on load attachment points the design shall ensure that either

a) the stress level in the weld seam does not exceed 80 % of the allowable stress (weld quality not to be proved)

or

b) non-destructive testing of the attachment weld volume is possible.

(7) Load-carrying weld seams shall satisfy the requirements of quality level B acc. to DIN EN ISO 5817 or DIN EN ISO 13919-1.

(8) When employing rope slings in accordance with DIN EN 13414-1 and DIN EN 13414-2 or chain slings in accordance with DIN EN 818-4 for load suspension devices and lifting accessories, only 50 % of the working load limit specified in these standards shall be used. This shall be taken into account in the structural design of load attachment points.

(9) The surfaces of load attachment points shall be such that they can be easily decontaminated.

5.1.4.2 Load attachment points according to section 4.4

(1) The load attachment point shall be designed such that it can only be positively attached to the lifting equipment. Safeguards shall be provided to prevent any inadvertent release of the load carrying device from the load attachment point.

(2) For weld seams the provisions of the drawings and related specifications apply.

(3) The requirements in accordance with VDI 2230 Sheet 1 apply to the construction of bolted connections.

5.2 Structural steel components

5.2.1 Design principles

(1) For the application of this Safety Standard, two verification methods are permitted for structural steel components:

a) method using a global safety factor (σ_{zul} concept) according to DIN 15018-1

and

b) method using partial safety factors according to the standard series DIN EN 13001.

(2) The simultaneous use of both methods within the entire verification process for a load attachment point is not allowed.

5.2.2 Additional requirements

5.2.2.1 Dynamic factor

(1) The dead weight of the load shall be multiplied by a dynamic factor of ψ = 1.35 for determination of the load assumptions.

(2) Where the maximum hoist speed $v_{h,max}$ is known, instead of the dynamic factor as per sub-clause (1) above the following values may be used

a) the dynamic factor[1] resulting from lifting class H3 according to DIN 15018-1 when using the global safety factor concept,

b) the dynamic factor

$$\Phi_2 = 1.3 + 0.396 \cdot v_{h,max} \quad (5.2\text{-}1)$$

for the verification according to DIN 13001-2 when using the partial safety factors concept.

For $v_{h,max}$ the maximum hoisting speed in m/s decisive for the specific load case shall be taken.

(3) Where a dynamic factor less than that of sub-clauses (1) or (2) is to be used, the maximum dynamic load factor occurring at the load attachment point during one working cycle shall be determined by means of calculation or experimentally in each individual case. As regards the determination of the dynamic factor this dynamic load factor shall be multiplied by a safety factor of 1.12.

5.2.2.2 Stress analysis

The stress analysis shall be carried out

a) as general stress analysis in accordance with DIN 15018-1 for the “main forces” load case H

or

b) in accordance with DIN EN 13001-3-1 in conjunction with DIN EN 13001-1 and DIN EN 13001-2 for load combination A (regular loads) using the specific resistance factor for material γ_{sm} as specified in section 5.2.2 of DIN EN 13001-3-1, however, a value of at least 1.0 shall be applied.

Based on the specifications as per b), the risk coefficient γ_n according to DIN EN 13001-2 may be taken as 1.0.

In the case of proof using the global safety factor concept, for structural steel components made of the austenitic steels 1.4541, 1.4306 and 1.4571 according to DIN EN 10088-2 or DIN EN 10088-3 the allowable stresses shall be taken from KTA 3902, Annex D.

5.2.2.3 Fatigue analysis

(1) For the fatigue analysis the following shall be used:

a) loading level group B 3 in accordance with DIN 15018-1

or

b) stress history class S3 according to DIN EN 13001-3-1 where a fatigue strength specific resistance factor γ_{mf} = 1.25 shall be used.

(2) The following shall apply to austenitic steels:

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[1] *In DIN 15018-1 the term “nominal load spectrum factor” is used instead of “dynamic factor”.*

a) In the case of proof using the global safety factor concept, the allowable stresses for the fatigue analysis shall be in accordance with KTA 3902 Annex D, section D1, when using austenitic steels 1.4541, 1.4306 and 1.4571 according to DIN EN 10088-2 or DIN EN 10088-3.

b) A design of structural steel components using austenitic steels within the partial safety factors concept is permitted only in those cases where the fatigue analysis may be waived according to section 6.3.3 of DIN EN 13001-3-1, in which case the number of stress cycles shall be determined according to section 5.1.3.

(3) Where the operating conditions are exactly known, e.g. the actually occurring loadings and stress cycles, the fatigue analysis for a single-step or multi-step load collective may be performed

a) in the case of proof using the global safety factor concept, on the basis of a stress-number diagram according to KTA 3902 Annex C for the steels S235 and S355, or on the basis of a stress-number diagram be performed according to KTA 3902 section D 2 for the austenitic steels 1.4541, 1.4306 and 1.4571,

b) in the case of proof using the partial safety factors concept, according to the requirements of DIN EN 13001-3-1 and to the stipulations in 5.2.1.1 and 5.2.1.2.

(4) The following safety shall be ensured:

a) in the case of proof using the global safety factor concept, a safety against the allowable maximum stress of

$\overline{\nu} = \sigma_D / \overline{\sigma} \geq 1.12$,

b) in the case of proof using the partial safety factors concept, a safety against the allowable stress range of

$$\nu = \frac{\Delta\sigma_{Rd}}{\Delta\sigma_{Sd}} \geq 1.12\,. \qquad (5.2\text{-}3)$$

with:

σ_D	endurance limit for normal stresses	N/mm^2
$\overline{\sigma}$	damage-equivalent tensile stress	N/mm^2
$\Delta\sigma_{Rd}$	limit design stress range (normal)	N/mm^2
$\Delta\sigma_{Sd}$	design stress range (normal)	N/mm^2

5.2.3 Increased requirements

5.2.3.1 Dynamic factor

(1) The dead weight of the load shall be multiplied by

a) a dynamic factor of ψ = 1.45 in case of redundant load attachment points

or

b) an increased dynamic factor of ψ = 1.8 in case of non-redundant load attachment points

for determination of the load assumptions.

Note:

The value ψ = 1.8 is obtained from the dynamic factor ψ = 1.45 multiplied with a safety factor 1.25 in the case of non-redundant load attachment points ($\psi = 1.45 \cdot 1.25 \approx 1.80$).

(2) Where the maximum hoist speed $v_{h,max}$ is known, instead of the dynamic factor as per sub-clause (1) above the following values may be used

a) the dynamic factor resulting from lifting class H4 according to DIN 15018-1 when using the global safety factor concept,

b) the dynamic factor

$$\Phi_2 = 1.4 + 0.528 \cdot v_{h,max} \qquad (5.2\text{-}4)$$

for the verification according to DIN 13001-2 when using the partial safety factors concept.

For $v_{h,max}$ the maximum hoisting speed in m/s decisive for the specific load case shall be taken.

In the case of non-redundant load attachment points 1.25 times the dynamic factor shall be used in the calculation.

(3) Where a dynamic factor less than that of sub-clauses (1) or (2) is to be used, the maximum dynamic load factor occurring at the load attachment point during one working cycle shall be determined by means of calculation or experimentally in each individual case. As regards the determination of the dynamic factor this dynamic load factor shall be multiplied

a) in case of redundant load attachment points by a safety factor of 1.25

and

b) in case of non-redundant load attachment points by a safety factor of 1.25 and an additional safety factor of 1.25.

(4) The loads resulting from shifting of the load due to failure of a part of the hoist in accordance with section B 2.1.1.2 of KTA 3902 shall be taken into account if more unfavourable stresses result than those determined with the dynamic factors specified above. For this load case

a) it is permissible to use 1.1 times the stresses of the “main and additional forces” load case (HZ) in accordance with DIN 15018-1 in the case of proof using the global safety factor concept,

b) the loads shall be assigned to load combination C according to section 4.2.4.10 of DIN EN 13001-2 in the case of proof using the partial safety factors concept.

5.2.3.2 Stress analysis

The stress analysis shall be carried out

a) as general stress analysis in accordance with DIN 15018-1 for the “main forces” load case H

or

b) in accordance with DIN EN 13001-3-1 in conjunction with DIN EN 13001-1 and DIN EN 13001-2 for load combination A (regular loads) using the specific resistance factor for material γ_{sm} as specified in section 5.2.2 of DIN EN 13001-3-1, however, a value of at least 1.0 shall be applied.

Based on the specifications as per b), the risk coefficient γ_n according to DIN EN 13001-2 may be taken as 1.0.

In the case of proof using the global safety factor concept, for structural steel components made of the austenitic steels 1.4541, 1.4306 and 1.4571 according to DIN EN 10088-2 or DIN EN 10088-3 the allowable stresses shall be taken from KTA 3902, Annex D, section D1.

5.2.3.3 Fatigue analysis

(1) For the fatigue analysis the following shall be used:

a) loading level group B 4 in accordance with DIN 15018-1

or

b) stress history class S4 according to DIN EN 13001-3-1 where a fatigue strength specific resistance factor γ_{mf} = 1.25 shall be used.

(2) The following shall apply to austenitic steels:

a) In the case of proof using the global safety factor concept, the allowable stresses for the fatigue analysis shall be in accordance with KTA 3902 Annex D, section D2, when using austenitic steels 1.4541, 1.4306 and 1.4571 according to DIN EN 10088-2 or DIN EN 10088-3.

b) A design of structural steel components using austenitic steels within the partial safety factors concept is permitted only in those cases where the fatigue analysis may be waived according to section 6.3.3 of DIN EN 13001-3-1, in which case the number of stress cycles shall be determined according to section 5.1.3.

(3) The requirements of sub-clauses 5.2.2.3 (3) and (4) shall be met in which case the following safety shall be ensured:

a) in the case of proof using the global safety factor concept, a safety against the allowable maximum stress of

$$\overline{\nu} = \sigma_D / \overline{\sigma} \geq 1.25 \qquad (5.2\text{-}5)$$

b) in the case of proof using the partial safety factors concept, a safety against the allowable stress range of

$$\nu = \frac{\Delta\sigma_{Rd}}{\Delta\sigma_{Sd}} \geq 1.25\,. \qquad (5.2\text{-}6)$$

with:

σ_D	endurance limit for normal stresses	N/mm^2
$\overline{\sigma}$	damage-equivalent tensile stress	N/mm^2
$\Delta\sigma_{Rd}$	limit design stress range (normal)	N/mm^2
$\Delta\sigma_{Sd}$	design stress range (normal)	N/mm^2

5.3 Trunnions, bolts, tie rods and similar parts

5.3.1 Additional requirements

5.3.1.1 Dynamic factor

(1) The dead weight of the load shall be multiplied by a dynamic factor of ψ = 1.35 for determination of the design loads.

(2) Where the maximum hoist speed is known, the dynamic factor resulting from lifting class H3 according to DIN 15018-1 may be used instead of the dynamic factor as per sub-clause (1) above.

(3) Where a dynamic factor less than that of sub-clauses (1) or (2) is to be used, the maximum dynamic load factor occurring at the load attachment point during one working cycle shall be determined by way of calculation or experimentally in each individual case. As regards the determination of the dynamic factor this dynamic load factor shall be multiplied by a safety factor of 1.12.

5.3.1.2 Stress analysis

(1) The following safety factors shall be proved for the parts

$$\nu_\sigma = \frac{R_{eH} \text{ or } R_{p0.2}}{\sigma} \geq 1.5 \qquad (5.3\text{-}1)$$

$$\nu_\tau = \frac{\tau_{s_t}}{\tau} \geq 1.5 \qquad (5.3\text{-}2)$$

$$\nu_{\sigma_v} = \frac{R_{eH} \text{ or } R_{p0.2}}{\sigma_v} \geq 1.5 \qquad (5.3\text{-}3)$$

$$\sigma_v = \sqrt{\sigma^2 + 3 \cdot \tau^2} \qquad (5.3\text{-}4)$$

where

σ	normal stress from the maximum load occurring
σ_V	stress intensity
R_{eH} or $R_{p0.2}$	yield point or proof stress
τ	shear stress
τ_{s_t}	yield point for torsional stress $< R_{eH} / \sqrt{3}$ or $R_{p0.2} / \sqrt{3}$

(2) The weld seams shall be dimensioned in accordance with DIN 15018-1 for the “main forces” load case (H).

5.3.1.3 Fatigue analysis

(1) In the case of $N_\sigma < N_D$ the safety for the finite-life fatigue range shall be proved as follows:

$$\nu_\sigma = \frac{\overline{\sigma}_D}{\sigma} \geq 2.0 \qquad (5.3\text{-}5)$$

$$\nu_\tau = \frac{\overline{\tau}_D}{\tau} \geq 2.0 \qquad (5.3\text{-}6)$$

and

$$\left(\frac{\sigma}{\overline{\sigma}_D}\right)^2 + \left(\frac{\tau}{\overline{\tau}_D}\right)^2 \leq \left(\frac{1.0}{2.0}\right)^2 \qquad (5.3\text{-}7)$$

(2) The safety for the endurance strength range $N_\sigma \geq N_D$ shall be proved as follows:

$$\nu_\sigma = \frac{\sigma_D}{\sigma} \geq 2.0 \qquad (5.3\text{-}8)$$

$$\nu_\tau = \frac{\tau_D}{\tau} \geq 2.0 \qquad (5.3\text{-}9)$$

and

$$\left(\frac{\sigma}{\sigma_D}\right)^2 + \left(\frac{\tau}{\tau_D}\right)^2 \leq \left(\frac{1.0}{2.0}\right)^2 \qquad (5.3\text{-}10)$$

where

$\sigma_D = f(\sigma_n, K_n)$	endurance strength for normal stresses
σ_n	endurance strength of the material test specimen for normal stresses at a 50 % survival probability
K_n	product of endurance strength reduction factor, roughness factor and shape factor for normal stresses
N_D	$5 \cdot 10^6$ stress cycles
N_σ	number of actual stress cycles
R_m	tensile strength
$\overline{\sigma}_D$	finite-life fatigue strength for normal stresses
$\tau_D = f\left(\tau_t, \tau_{K_t}\right)$	endurance strength for torsional stresses
τ_t	endurance strength of the material test specimen for torsional stresses at a 50 % survival probability
$\overline{\tau}_D$	finite-life fatigue strength for shear stresses
τ_{K_t}	product of fatigue strength reduction factor, roughness factor and shape factor for torsional stresses

(3) The stress-number diagrams shall be determined using the requirements for shafts, axles and similar parts laid down in clause B 1.2.2.1 of KTA 3902.

(4) Material characteristics, fatigue strength reduction factor, roughness factor, stress concentration factor and shape factor shall be taken from the relevant literature, e.g. [1] to [7] (see **Annex E**).

(5) If materials not dealt with in the literature in **Annex E** are used, the above-mentioned characteristic values shall be verified and guaranteed in each individual case.

(6) The requirements of DIN 15018-1 loading level group B 3 shall apply for dimensioning the weld seams.

5.3.2 Increased requirements

5.3.2.1 Dynamic factor

(1) The dead weight of the load shall be multiplied by

a) a dynamic factor of ψ = 1.45 in case of redundant load attachment points

or

b) an increased dynamic factor of ψ = 1.8 in case of non-redundant load attachment points.

for determination of the load assumptions.

Note:

The value ψ = 1.8 is obtained from the dynamic factor ψ = 1.45 multiplied with a safety factor 1.25 in the case of non-redundant load attachment points ($\psi = 1.45 \cdot 1.25 \approx 1.80$).

(2) Where the maximum hoist speed is known, the dynamic factor resulting from lifting class H4 according to DIN 15018-1 may be used instead of the dynamic factor as per sub-clause (1) above. In the case of non-redundant load attachment points 1.25 times the dynamic factor shall be used in the calculation.

(3) Where a dynamic factor less than that of sub-clauses (1) or (2) is to be used, the maximum dynamic load factor occurring at the load attachment point during one working cycle shall be determined by way of calculation or experimentally in each individual case. As regards the determination of the dynamic factor this dynamic load factor shall be multiplied

a) in case of redundant load attachment points by a safety factor of 1.25

and

b) in case of non-redundant load attachment points by a safety factor of 1.25 and an additional safety factor of 1.25.

(4) The loads resulting from shifting of the load due to failure of a part of the hoist in accordance with section B 2.1.1.2 of KTA 3902 shall be taken into account if more unfavourable stresses result than those determined with dynamic factors specified above. A stress analysis shall be performed for this load case, where a safety factor equal to or greater than 1.25 against the yield point shall be taken into account. For weld seams it is permissible to use 1.1 times the stresses of the “main and additional forces” load case (HZ) in accordance with DIN 15018-1.

5.3.2.2 Stress analysis

(1) The safety factors in accordance with section 5.3.1.2 shall be proved for the parts.

(2) Weld seams shall be dimensioned in accordance with DIN 15018-1 for the “main forces” load case (H).

5.3.2.3 Fatigue analysis

(1) In the case of $N_\sigma < N_D$ the safety for the finite-life fatigue range shall be proved as follows:

$$\nu_\sigma = \frac{\overline{\sigma}_D}{\sigma} \geq 2.5 \quad (5.3\text{-}11)$$

$$\nu_\tau = \frac{\overline{\tau}_D}{\tau} \geq 2.5 \quad (5.3\text{-}12)$$

and

$$\left(\frac{\sigma}{\overline{\sigma}_D}\right)^2 + \left(\frac{\tau}{\overline{\tau}_D}\right)^2 \leq \left(\frac{1.0}{2.5}\right)^2 \quad (5.3\text{-}13)$$

(2) The safety for the endurance strength range $N_\sigma \geq N_D$ shall be proved as follows:

$$\nu_\sigma = \frac{\sigma_D}{\sigma} \geq 2.5 \quad (5.3\text{-}14)$$

$$\nu_\tau = \frac{\tau_D}{\tau} \geq 2.5 \quad (5.3\text{-}15)$$

and

$$\left(\frac{\sigma}{\sigma_D}\right)^2 + \left(\frac{\tau}{\tau_D}\right)^2 \leq \left(\frac{1.0}{2.5}\right)^2 \quad (5.3\text{-}16)$$

(3) The stress-number diagrams shall be determined using the requirements for shafts, axles and similar parts laid down in clause B 1.2.2.1 of KTA 3902.

(4) Material characteristics, fatigue strength reduction factor, roughness factor, stress concentration factor and shape factor shall be taken from relevant literature, e.g. [1] to [7] (see **Annex E**).

(5) If materials not dealt with in the literature in **Annex E** are used, the above-mentioned characteristic values shall be verified and guaranteed in each individual case.

(6) The requirements of DIN 15018-1 loading level group B 4 shall apply for dimensioning the weld seams.

5.4 Bolted connections

5.4.1 Additional requirements

5.4.1.1 Dynamic factor

(1) The dead weight of the load shall be multiplied by a dynamic factor of ψ = 1.35 for determination of the load assumptions.

(2) Where the maximum hoist speed is known, the dynamic factor resulting from lifting class H3 according to DIN 15018-1 may be used instead of the dynamic factor as per sub-clause (1) above.

(3) Where a dynamic factor less than that of sub-clauses (1) or (2) is to be used, the maximum dynamic load factor occurring at the load attachment point during one working cycle shall be determined by way of calculation or experimentally in each individual case. As regards the determination of the dynamic factor this dynamic load factor shall be multiplied by a safety factor of 1.12.

5.4.1.2 Stress analysis

(1) VDI 2230 Sheet 1 shall be used for dimensioning bolted connections. The following requirements shall be met:

a) the usage factor of the yield stress during tightening shall be limited to 0.7,

b) the usage factor of the yield stress due to additional forces from operating conditions shall be limited to 0.1.

(2) If bolted connections according to DIN EN ISO 898-1 and DIN EN ISO 898-2 or DIN EN ISO 3506-1 and DIN EN ISO 3506-2 subject to additional tensile loading are used, then the determined bolt load shall be increased by a factor of 1.12. These requirements are not imposed, if bolts in accordance with Materials Test Sheet WPB 14 according to **Annex A** are used.

5.4.1.3 Fatigue analysis

(1) The fatigue analysis shall be performed in accordance with VDI 2230 Sheet 1. A safety factor of at least 2.0 shall be ensured against the endurance strength or the finite-life fatigue strength.

(2) In case of a multi-step load collective (e.g. due to assembly and disassembly activities), the loading history covered by the stress analysis acc. to (1) shall be modelled as damage-equivalent single-step stress collective. The damage-equivalent stress pertinent to the number of stress cycles N_D shall be determined as follows in the analysis of finally quenched and tempered bolts:

$$\overline{\sigma} = \sigma_1 \cdot \left[\frac{\sum\limits_i N_i \cdot \left(\frac{\sigma_i}{\sigma_1}\right)^c}{N_D}\right]^{\frac{1}{c}} \quad (5.4\text{-}1)$$

where the following is to be used:

$N_D = 2 \cdot 10^6$

$c = 3$

with:

σ_1 actual stress amplitude of 1st step of load collective step (maximum stress)

σ_i actual stress amplitude of the respective step of load collective

N_i actual number of stress cycles of the respective step of load collective

The following shall be verified:

$$\nu = \frac{\sigma_{ASV}}{\bar{\sigma}} \geq 2.0 \qquad (5.4\text{-}2)$$

with:

σ_{ASV} stress amplitude of endurance limit of finally quenched and tempered bolts according to VDI 2230 Sheet 1

Note:

Where in the analysis of final-rolled bolts, the stress amplitude of the endurance limit is determined in a suitable manner in due consideration of its dependence on the mean stress, the damaging-equivalent stress may be determined analogously by using σ_{ASG} (stress amplitude of endurance limit of final-rolled bolts in accordance with VDI 2230 Sheet 1) in lieu of σ_{ASV} and c=6.

5.4.2 Increased requirements

5.4.2.1 Dynamic factor

(1) The dead weight of the load shall be multiplied by

a) a dynamic factor of ψ = 1.45 in case of redundant load attachment points

b) an increased dynamic factor of ψ = 1.8 in case of non-redundant load attachment points

for determination of the design loads.

Note:

The value ψ = 1.8 is obtained from the dynamic factor ψ = 1.45 multiplied with a safety factor 1.25 in the case of non-redundant load attachment points ($\psi = 1.45 \cdot 1.25 \approx 1.80$).

(2) Where the maximum hoist speed is known, the dynamic factor resulting from lifting class H4 according to DIN 15018-1 may be used instead of the dynamic factor as per sub-clause (1) above. In the case of non-redundant load attachment points 1.25 times the dynamic factor shall be used in the calculation.

(3) Where a dynamic factor less than that of sub-clauses (1) or (2) is to be used, the maximum dynamic load factor occurring at the load attachment point during one working cycle shall be determined by way of calculation or experimentally in each individual case. As regards the determination of the dynamic factor this dynamic load factor shall be multiplied

a) in case of redundant load attachment points by a safety factor of 1.25

and

b) in case of non-redundant load attachment points by a safety factor of 1.25 and an additional safety factor of 1.25.

(4) The loads resulting from shifting of the load due to failure of a part of the hoist in accordance with section B 2.1.1.2 of KTA 3902 shall be taken into account if more unfavourable stresses result than those determined with dynamic factors specified above. The degree of utilization of the yield stress limit due to additional bolt loads shall be limited to 0.3 for this load case.

5.4.2.2 Stress analysis

(1) VDI 2230 Sheet 1 together with the conditions specified in clause 5.4.1.2 shall apply to the dimensioning of bolted connections.

(2) If bolted connections in accordance with DIN EN ISO 898-1 and DIN EN ISO 898-2 or DIN EN ISO 3506-1 and DIN EN ISO 3506-2 subject to additional tensile loading are used, then the required number of bolts shall be doubled or the determined bolt load shall be increased by a factor of 1.5. These requirements are not imposed, if bolts in accordance with Materials Test Sheet WPB 14 according to **Annex A** are used.

5.4.2.3 Fatigue analysis

(1) The fatigue analysis shall be performed in accordance with VDI 2230 Sheet 1. A safety factor of at least 2.5 shall be ensured against the endurance strength or the finite-life fatigue strength.

(2) In the case of a multi-step load collective the analysis as per (1) shall be performed in accordance with clause 5.4.1.3. The following shall be verified:

$$\nu = \frac{\sigma_{ASV}}{\bar{\sigma}} \geq 2.5 \qquad (5.4\text{-}3)$$

5.5 Application of loads into structural concrete components

5.5.1 Additional requirements

5.5.1.1 Dynamic factor

(1) The dead weight of the load shall be multiplied by a dynamic factor of ψ = 1.35.

(2) Where the maximum hoist speed is known, the dynamic factor resulting from lifting class H3 according to DIN 15018-1 may be used instead of the dynamic factor as per sub-clause (1) above.

(3) Where a dynamic factor less than that of sub-clauses (1) or (2) is to be used, the maximum dynamic load factor occurring at the load attachment point during one working cycle shall be determined by way of calculation or experimentally in each individual case. As regards the determination of the dynamic factor this dynamic load factor shall be multiplied by a safety factor of 1.12.

5.5.1.2 Application of load

(1) The proof of load application into a structural concrete component shall be performed in accordance with the requirements specified in DIN EN 1992-1-1 in connection with DIN EN 1992-1-1/NA. The loads shall be assumed to be characteristic actions and shall be proved for permanent and temporary design situations.

(2) DIN EN 1991-1-1 in connection with DIN EN 1991-1-1/NA and DIN EN 1990 in connection with DIN EN 1990/NA shall apply to the determination of load assumptions. In addition to the requirements of these standards, the dynamic factor as per clause 5.5.1.1 shall be considered.

(3) Construction products or types of construction for which proof of load application is not rendered on the basis of technical building regulations, may be used upon approval by the authorizes inspector according to § 20 Atomic Energy Act if their suitability has been proved as follows:

a) by means of an approval under building regulation or

b) by means of a European technical approval or

c) by other suitable proofs (approval on a case-by-case-basis).

(4) The additional load on the structural concrete component resulting from the load test specified in no. 3 d) of **Table 9-1** shall individually be taken into account corresponding to the application of the load. In this case, the combination of loads applied shall be assigned to requirement category A2 according to DIN 25449.

5.5.2 Increased requirements

5.5.2.1 Dynamic factor

(1) The dead weight of the load shall be multiplied by

a) a dynamic factor of $\psi = 1.45$ in case of redundant load attachment points

or

b) an increased dynamic factor of $\psi = 1.8$ in case of non-redundant load attachment points.

Note:

The value $\psi = 1.8$ is obtained from the dynamic factor $\psi = 1.45$ multiplied with a safety factor 1.25 in the case of non-redundant load attachment points ($\psi = 1.45 \cdot 1.25 \approx 1.80$).

(2) Where the maximum hoist speed is known, the dynamic factor resulting from lifting class H4 according to DIN 15018-1 may be used instead of the dynamic factor as per sub-clause (1) above. In the case of non-redundant load attachment points 1.25 times the dynamic factor shall be used in the calculation.

(3) Where a dynamic factor less than that of sub-clauses (1) or (2) is to be used, the maximum dynamic load factor occurring at the load attachment point during one working cycle shall be determined by way of calculation or experimentally in each individual case. As regards the determination of the dynamic factor this dynamic load factor shall be multiplied

a) in case of redundant load attachment points by a safety factor of 1.25

and

b) in case of non-redundant load attachment points by a safety factor of 1.25 and an additional safety factor of 1.25.

(4) The loads resulting from shifting of the load due to failure of a part of the hoist in accordance with section B 2.1.1.2 of KTA 3902 shall be taken into account if more unfavourable stresses result than those determined with the dynamic factors specified above.

5.5.2.2 Application of load

The requirements of clause 5.5.1.2 shall be met in which case the dynamic factor as per clause 5.5.2.1 shall be considered.

5.6 Ropes and chains

Ropes and chains are not permitted as load attachment points.

5.7 Core components

5.7.1 General

For the determination of the load assumptions the dead weight of the load shall be multiplied by a load intensification factor $f_Ü = 2.0$. The load intensification factor comprises the dynamic factor and additional forces from frictional contacts.

Note:

As regards the proof for the specific load case “load shifting” see clause 5.7.5.

5.7.2 Stress analysis

(1) For the load attachment points of core components only primary stresses are considered. The following allowable stress intensities shall be complied with:

a) allowable primary membrane stress intensity

$$P_{m,zul} = 0.66 \cdot R_{p0.2T} \quad (5.7\text{-}1)$$

b) allowable primary membrane plus bending stress intensity

$$P_{m+b,zul} = 1.0 \cdot R_{p0.2T} \quad (5.7\text{-}2)$$

with

$R_{p0.2T}$: proof stress at handling temperature

Note:

Primary stresses are stresses necessary to satisfy the laws of equilibrium of external forces and moments.

Membrane stresses are defined as the average stress value of the individual stress component over the cross-section under consideration.

Bending stresses are defined as variable linear stresses proportional to their distance from the neutral axis.

(2) The stress intensities shall be derived from the individual stress components in accordance with the theory of von-Mises.

(3) The allowable primary stress intensities for weld seams are derived from the allowable primary stress intensity of the base material multiplied by the weld seam factors v and v_2 for the type of loading and weld quality. The weld seam factors v shall be taken from **Table 5-1**.

For the weld seam factors v_2 to consider the weld quality the following values shall be used:

$v_2 = 1.0$ for proved weld quality (5.7-3)

$v_2 = 0.5$ without proof of weld quality (5.7-4)

Type of seam	Type of loading	Weld seam factor v
Butt weld	Tension	1.0
	Compression	1.0
	Bending	1.0
	Shear	0.8
Fillet weld	Any loading	0.8

Table 5-1: Weld seam factors v to consider the respective type of loading

(4) VDI 2230 Sheet 1 shall be used for dimensioning bolted connections. The following requirements shall be met:

a) the degree of utilization of the yield stress limit when tightening shall be limited to 0.7,

b) the degree of utilization of the yield stress limit as a result of operational additional bolt forces shall be limited to 0.1.

5.7.3 Experimental analysis

(1) For load attachment points of core components the limits of primary membrane plus bending stress intensity need not be complied with if, by testing on a series-produced part or prototype component, it can be proved that

a) $L_{max} \leq L_G$ (5.7-5)

and

b) $L_{max} \leq 0.44 \cdot L_U$ (5.7-6)

where

L_{max} = $f_Ü$ · dead weight (design load)

$f_Ü$ = 2.0 (load intensification factor)

L_G service load (deformations are limited such that detaching or attachment of the load carrying device is still possible)

L_U rupture load or maximum test load

(2) For all experimental analyses the differences between the conditions on the test parts and the most unfavourable combination of the parts used (e.g. dimensional tolerances, minimum of specified strength values) shall be taken into account. The load introduction during the test shall reflect the true conditions on the part. The consideration of these requirements shall ensure that the loads determined during

the test reflect conservatively the load carrying capacity of the true structure at specified loads.

5.7.4 Fatigue analysis

For load attachment points on core components the number of stress cycles N_σ is less than $2 \cdot 10^4$. Therefore, no fatigue analysis need be made.

5.7.5 Analytical proof for the special load case “load shifting”

(1) The loads resulting from shifting of the load due to failure of a part of the hoist in accordance with section B 2.1.1.2 of KTA 3902 shall be taken into account if more unfavourable stresses result than those determined with the load intensification factor as per clause 5.7.1.

(2) For this load case it shall be proved that the hold function of the load attachment point is maintained.

Where the dead weight of the load is multiplied with a load intensification factor $f_Ü = 4.0$ for use in this analytical proof, this will be considered a load assumption to cover this special load case. Alternatively, the proof may be based on a smaller load intensification factor as far as this factor has been proved for the lifting equipment to be operated.

(3) The proof as per (2) is considered to have been rendered if the criteria as per a) or b) have been satisfied and the deformations are limited in accordance with the requirement under c).

a) A stress analysis as per 5.7.2 shall be performed in which case the following allowable stress intensities shall be adhered to:

   aa) allowable primary membrane stress intensity

   $$P_{m,zul} = 0.7 \cdot R_{mT} \qquad (5.7\text{-}7)$$

   ab) allowable primary membrane plus primary bending stress intensity

   $$P_{m+b,zul} = 1.0 \cdot R_{mT} \qquad (5.7\text{-}8)$$

   with R_{mT} : tensile stress at handling temperature

b) An experimental analysis as per clause 5.7.3 shall be performed to prove that

   $$L_{max} \le 0.8 \cdot L_U \qquad (5.7\text{-}9)$$

   where

   L_{max} : $f_Ü \cdot$ dead weight (design load)

   $f_Ü$: load intensification factor due to load shifting

   L_U : rupture load or maximum load applied in the test

c) the deformations shall be limited such that the hold function of the load attachment point is maintained.

5.8 Analytical proof using the finite element method

5.8.1 General

(1) Besides the analytical proofs described in sections 5.2 to 5.4 and 5.7 it is also permitted to perform strength analyses on the basis of the finite element method (FEM).

(2) When using the finite element method, the requirements in Annex C, section C3 of KTA 3201.2 shall be met.

(3) Analytical proofs using finite element calculations are permitted both for proofs based on DIN 15018-1 and for proofs based on DIN EN 13001-3-1.

(4) The requirements of section 5.8.2 apply to the stress analysis using the finite element method in the case of proofs based on DIN 15018-1 and the requirements of section 5.8.3 in the case of proofs using the partial safety factors concept according to DIN EN 13001-3-1.

Note:
As regards the procedure to be followed for parts where a stress evaluation based on nominal stresses is not purposeful, refer to sub-clause 5.1.2 (3).

(5) Deviating from the stipulations in clause 5.8.2 a suitable stress limitation procedure for bolted connections shall be fixed, e.g. in accordance with VDI 2230, Sheet 1, Guideline BAM-GGR 012.

(6) The requirements of section 5.7 apply to the stress limitation for load attachment points on core components.

5.8.2 Stress analysis using the global safety factor concept in proofs according to DIN 15018-1

5.8.2.1 Stress analysis

(1) Stresses shall be classified in dependence of the cause of stress and its effect on the mechanical behaviour of the part as per section 7.7.2 of KTA 3201.2 into stress categories, i.e. primary stresses, secondary stresses and peak stresses.

(2) Remote from discontinuities only primary stresses shall be considered.

(3) Primary stresses (P) are stresses which satisfy the laws of equilibrium of external forces and moments (loads). Here, membrane stresses (P_m) are defined as the average value of the respective stress component over the section governing the load-bearing behaviour, in the case of plate or shell type structures the average value of the respective stress component distributed across the thickness. Primary bending stresses (P_b) are defined as stresses that can be altered linearly across the considered section and proportionally to the distance from the neutral axis, in the case of plate or shell type structures as the portion of the stresses distributed across the thickness that can be altered linearly.

(4) The stress intensity shall be derived from the linearised individual stress components.

(5) The location of linearization outside the area of influence of geometric discontinuities shall be selected such that

a) only primary stress components are covered,

b) the maximum sum of primary stress components is covered.

(6) The requirements of (5) a) und (5) b) are deemed to have generally been met if

a) linearisation is effected at a distance $\sqrt{R \cdot s}$ to the geometric discontinuity in the case of shell-like parts (e.g. skirts, pipes) where R and s are defined as follows:

   R : mean smallest radius of shell

   s : smallest wall thickness

b) linearisation is effected at a distance of half the section diameter in the case of round steel sections, at a distance of half the smallest dimension of cross-section in the case of rectangular steel sections, sheets and plates,

c) linearisation is effected at a distance $\sqrt{R \cdot s}$ to the geometric discontinuity in the case of other shapes where R and s are defined as follows:

   R : half the smallest dimension of rolled section, half the smallest leg width of angle section, radius of bore.

   s : smallest wall thickness

Linearisation may also be effected at other distances, but a suitable analytical proof as regards compliance with the requirements of (5) a) and (5) b) shall be performed.

(7) The following shall apply to the stress intensity derived from the linearized stress components:

a) Remote from the discontinuity the equivalent stress intensity due to the load combinations to be proofed according to DIN 15018-1 shall not exceed the allowable stresses specified in DIN 15018-1.

b) At the discontinuity the equivalent stress intensity may exceed the allowable stresses specified in DIN 15018-1 provided both the equilibrium of stresses due to local stress redistributions and the allowable stresses are complied with and the equivalent stress intensity does not exceed the following value:

ba) for load case H $\sigma_V \leq 0.8 \cdot R_{p0.2}$

bb) for load case HZ $\sigma_V \leq 0.9 \cdot R_{p0.2}$

bc) for load case HS $\sigma_V \leq R_{p0.2}$

with $R_{p0.2}$: yield strength

Here, plausibility checks are allowed to demonstrate possible stress redistributions.

c) The stress limitation for σ_V at the discontinuity need not be satisfied if it can be proved by means of a limit analysis that the allowable lower limit load as per section 7.7.4 of KTA 3201.2 are not exceeded in which case, for the purpose of calculating the lower bound collapse load, the following yield stress values shall be taken

ca) in load case H: $\sigma_F = 1.0 \cdot R_{p0.2}$

cb) in load case HZ: $\sigma_F = 1.10 \cdot R_{p0.2}$

cc) in load case HS: $\sigma_F = 1.20 \cdot R_{p0.2}$

and the specified load shall not exceed 67 % of the lower bound collapse load in accordance with section 7.7.4.1 of KTA 3201.2.

(8) For the evaluation as per (7) the stress intensity to be taken shall be the maximum of

a) the equivalent stress intensity according to the von Mises theory and

b) the largest principal stress.

(9) For the allowable stresses of weld seams DIN 15018-1 shall apply.

5.8.2.2 Fatigue analysis

(1) The fatigue analysis shall be performed in accordance with sections 5.1 to 5.3 using the safety factors specified there.

(2) The fatigue analysis when using the finite element method differs from the procedures under sections 5.1 to 5.3 only with respect to the determination of the nominal stress. Here, the stress intensity determined during the stress analysis shall be evaluated on the basis of linearized individual stress components.

(3) The fatigue strength reduction factor may also be determined on the basis of a FEM analysis alternatively to the requirements of section 5.3. In this case, the fatigue strength reduction factor is calculated to be conservative and is formed by the quotient of maximum stress intensity (non-linerarized) and the stress intensity derived from primary membrane and bending stresses as per subclause (1).

5.8.3 Stress analysis using the partial safety factors concept according to DIN EN 13001-3-1

5.8.3.1 Stress analysis

(1) Stresses shall be determined using the loads, load combinations and partial safety factors according to Table 12a of DIN EN 13001-2 and the requirements specified in sections 5.2 to 5.4 and 5.7.

(2) The stresses so determined shall be classified in dependence of the cause of stress and its effect on the mechanical behaviour of the part as per KTA 3201.2, section 7.7.2 into stress categories, i.e. primary stresses, secondary stresses and peak stresses.

(3) Remote from discontinuities only primary stresses shall be considered (cf. clause 5.8.2.1 (3)).

(4) The equivalent stress intensity shall be derived from the linearised individual stress components.

(5) The location of linearisation outside the area of influence of geometric discontinuities shall be selected such that

a) only primary stress components are covered,

b) the maximum sum of primary stress components is covered.

(6) The requirements of (5) a) und (5) b) are deemed to have generally been met if

a) linearisation is effected at a distance $\sqrt{R \cdot s}$ to the geometric discontinuity in the case of shell-like parts (e.g. skirts, pipes) where R and s are defined as follows:

R : mean smallest radius of shell

s : smallest wall thickness

b) linearisation is effected at a distance of half the section diameter in the case of round steel sections, at a distance of half the smallest dimension of cross-section in the case of rectangular steel sections, sheets and plates,

c) linearisation is effected at a distance $\sqrt{R \cdot s}$ to the geometric discontinuity in the case of other shapes where R and s are defined as follows:

R : half the smallest dimension of rolled section, half the smallest leg width of angle section, radius of bore.

s : smallest wall thickness

Linearisation may also be effected at other distances, but a suitable analytical proof as regards compliance with the requirements of (5) a) and (5) b) shall be performed.

(7) The following shall apply to the equivalent stress intensity derived from the linearised stress components:

a) Remote from the discontinuity the equivalent stress intensity due to the load combinations in consideration of partial safety factors shall not exceed the limit design stress f_{Rd} according to section 5.2 of DIN EN 13001-3-1.

b) At the discontinuity the equivalent stress intensity due to the load combinations in consideration of partial safety factors may exceed the limit design stress f_{Rd} provided both the equilibrium of stresses due to local stress redistributions and the limit design stress are complied with and the equivalent stress intensity does not exceed the following value:

$\sigma_{V} \leq 1.2 \cdot f_{Rd}$

with f_{Rd} : limit design stress

Here, plausibility checks are allowed to demonstrate possible stress redistributions.

c) The stress limitation for σ_V at the discontinuity need not be satisfied if it can be proved by means of a limit analysis that the allowable lower limit load as per KTA 3201.2, section 7.7.4 (maximum absorbable load when using an ideal-elastic/ideal-plastic material behaviour) complies with the equilibrium conditions and that the limit design stress f_{Rd} is not exceeded.

(8) For the evaluation as per (7) the equivalent stress intensity to be taken shall be the maximum of

a) the equivalent stress intensity according to the von Mises theory and

b) the largest principal stress.

(9) For the limit design stresses in welded connections section 5.2.5 of DIN EN 13001-3-1 shall apply.

5.8.3.2 Fatigue analysis

(1) The allowable stresses to be used in the fatigue analysis shall be determined to meet the requirements of DIN EN 13001-3-1.

(2) The fatigue analysis when using the finite element method differs from the procedures under sections 5.2 to 5.4 and 5.7 only with respect to the determination of the nominal stress. Here, the stress intensity determined during the stress analysis shall be evaluated on the basis of the linearised individual stress components.

(3) The fatigue strength reduction factor may also be determined on the basis of a FEM analysis alternatively to the requirements of section 5.3. In this case, the fatigue strength reduction factor is the quotient of maximum equivalent stress intensity (non-linerarised) and the equivalent stress intensity derived from primary membrane and bending stresses as per subclause (1).

6 Materials

6.1 Manufacture

The materials used for load attachment points according to sections 4.2 to 4.4 shall be manufactured to meet the basic requirements specified in section 3 of KTA 1401.

Note:
The qualification of the materials manufacturer is deemed to have been proved e.g. if
a) the manufacturer is approved according to VdTÜV technical leaflet MB WERK 1253/1,
b) the product is a regulated construction product or a non-regulated construction product which bears the specimen mark of conformity (Ü mark of conformity).

6.2 Selection of Materials

6.2.1 General

(1) The selection of materials shall be based, in addition to the strength characteristics (yield point, tensile strength) governing the dimensioning, also on the toughness characteristics (resistance to brittle fracture) and, if necessary, on the suitability for welding, the loading capacity in thickness direction and where required the corrosion resistance.

(2) In the case of bolted connections a suitable combination of materials shall be used. The following shall apply to corrosion protection coatings of ferritic bolts and nuts:

a) In the case of electroplated corrosion protection coatings only bolts and nuts coated by electroplating shall be used together. In the case of corrosion protection coatings by hot dip galvanizing only complete bolting assemblies (bolts, nuts and washers) of one manufacturer shall be used.
b) Hot dip galvanized bolts of property classes 8.8 and 10.9 as well as the associated nuts and washers shall be used only if they were galvanized in the manufacturer's own factory or on the manufacturer's responsibility in an external factory.
c) Electro-galvanized bolts and nuts may only be used if
   ca) the electroplating is performed in accordance with DIN EN ISO 4042 and
   cb) the risk of hydrogen embrittlement resulting from the manufacturing process is minimized by using the prevention measures according to Tables 3 and 4 of DIN EN ISO 4042, independent of the product standard.
d) Other metallic corrosion protection coatings may be used if
   da) the compatibility with the steel is ensured and
   db) hydrogen embrittlement is avoided and
   dc) an adequate behaviour during tightening has been proved.

(3) Hot dip galvanizing of fasteners shall meet the requirements of DIN EN ISO 10648 and of the guideline “Manufacture of hot dip galvanized bolts” [1].

(4) The filler metals and consumables shall have been approved according to VdTÜV technical leaflet MB SCHW 1153.

6.2.2 Materials in accordance with Annex A

(1) Materials tests required for the usually employed materials are specified in the form of materials test sheets in **Annex A** for the dimensional range as specified in the stated quality standards.

(2) The requirements of sub-clause 6.2.1 (2) shall also apply to bolts listed under material test sheet WPB 14.

(3) Inspection certificates 3.2 according to DIN EN 10204 shall be confirmed or be established by the respective authorized inspector as per clause 2 (2) or by the technical inspecting agency tasked by him.

6.2.3 Other materials

(1) Other materials and dimensional limits than those specified in the materials test sheets under **Annex A** are only permitted if corresponding materials test sheets have been compiled and have been subjected to design approval.

(2) Where materials are used for which no allowable stresses are specified in the generally valid engineering standards, the allowable stresses for the stress analysis and the fatigue analysis shall be derived by theoretical analysis or from realistic experiments.

6.3 Testing of materials

(1) The tests specified in the materials test sheets under **Annex A** shall be conducted and certified in accordance with their classification.

(2) The test results shall meet the specified requirements.

6.4 Materials identification marking

(1) The materials identification marking of the product forms shall be maintained during processing.

(2) The transfer of identification marks on product forms for further processing shall be carried out by the manufacturer's employee authorized to transfer identification marks by stamping in the case of inspection certificate 3.1 according to DIN EN 10204 and by the authorized inspector in the case of inspection certificate 3.2 according to DIN EN 10204.

(3) Where during further processing of product forms no material identification mark can be applied for operational or fabrication-dependent reasons, production-accompanying measures shall be taken to ensure that unambiguous identification and traceability is possible.

7 Design approval

7.1 Required documents

(1) The documents specified below shall be submitted in clear and checkable form for design approval by the authorized inspector.

Note:
In the case of parts to be proved under building legislation, the design approval in accordance with this Safety Standard is conducted as a structural static verification.
In the case of components subject to approval under traffic legislation, the design approval in accordance with this Safety Standard is carried out within the framework of type testing under traffic legislation.

(2) A cover sheet shall list the individual design approval documents in addition to the exact designations of the part,

sub-unit or component to be subjected to design approval. It shall also contain a table on the state of the latest revisions and a list of all KTA Safety Standards and specifications applicable to design, manufacture and testing as well as testing, inspection and work instructions, if necessary.

7.1.1 Load attachment points according to section 4.2 or 4.3

7.1.1.1 Design data sheet

The design data sheet shall contain the following data:

a) classification of the load attachment point and - if certification for welding according to DIN EN 1090-2 is applied - execution class of weld seams specified according to DIN EN 1090-2,

b) dead weight of the load and specifications regarding the centre of gravity, point of load introduction and direction of forces as well as temperatures, fluids and radiological exposure which may impair the material characteristics,

c) loads resulting from shifting of the load due to failure of a part of the hoist in accordance with section B 2.1.1.2 of KTA 3902 in the case of increased requirements.

d) in case of bolts which, after disassembly, have to be reassembled again by design:
Indication of the number of disassembly and re-assembly operations and on intended tests and examinations prior to re-using them (e.g. visual inspection, check of load-bearing bolts and related nut threads by ring and plug gauges).

7.1.1.2 General arrangement drawings, detailed drawings and parts lists with material data

The general arrangement drawings, detailed drawings and parts lists with material data shall contain the following data:

a) position and arrangement of the load attachment points,

b) description of the delimitation between load attachment point and load,

c) dimensions for strength calculation,

d) correlation of the individual parts to the materials test sheets,

e) type of fasteners, specifications in the case of preloaded bolted connections.

7.1.1.3 Strength calculations

The strength calculations shall contain the following data:

a) stress, strength and safety analyses for all parts in the load path up to and including the connection of the load attachment point to the load,

b) Indication of model structure and quotation of program description, insofar as the calculations are made using data processing systems,

c) stress-strain measurement program if this is planned to supplement the calculations.

7.1.1.4 Materials test sheets

For materials not listed in **Annex A** materials test sheets with the following data shall be established:

a) identification number of the materials test sheet,

b) product form,

c) material designation,

d) test requirements for the material with indication of the extent of testing and the certification in accordance with DIN EN 10204,

e) identification marking of the material.

7.1.1.5 Welding procedure specification

The welding procedure specification shall contain the following data:

a) weld geometry and assignment of welds,

b) base metals, weld filler metals and consumables,

c) welding procedure and welding certification,

d) heat treatment,

e) welder's qualification/qualification of operating personnel of fully mechanized and automatic welding units,

f) quality level,

g) welding data.

N o t e :
As regards design approval documents required for welding production tests see section 8.1.

7.1.1.6 Test instructions for non-destructive testing

(1) Test instructions shall be established for non-destructive testing, where required in section 8 or in **Annex B**.

(2) These instructions may be established for identical test objects in standardized form.

(3) The test instructions shall contain detailed information on:

a) assignment to the individual test objects,

b) time of testing as far as it influences the extent and performance of the test in accordance with the test and inspection sequence plan,

c) test requirements, test methods and test facilities/equipment to be used, type of sensitivity adjustment for ultrasonic testing,

d) if required, additional explanations regarding the performance of the test (e.g. drawing to scale),

e) reference system and counting direction for a description of indications assigned to a test object,

f) information for recording and evaluating of indications,

g) intended substitute measures to be taken if the applicability of the requirements of **Annex B** is restricted.

7.1.1.7 Test and inspection sequence plan for final inspection

(1) The test and inspection sequence plan shall contain the following data:

a) requirements and extent of the tests and inspections in accordance with section 8,

b) test and inspection sequence as well as type of tests and inspections and certificates,

c) person performing the test or inspection (manufacturer, authorized inspector).

(2) As regards the sequence of performance of tests and inspections, the test and inspection sequence plan for final inspection shall be subdivided into test and inspections to be performed prior to, during and upon finalization of production.

(3) Where required due to the complexity of tests and inspections, the test and inspections listed under **Table 8-1** shall be subdivided into individual test and inspection steps in the test and inspection sequence plan for final inspection.

7.1.1.8 Test and inspection sequence plan for acceptance testing

The test and inspection sequence plan for acceptance testing shall contain the following data:

a) requirements and extent of the tests and inspections in accordance with section 9,

b) test and inspection sequence.

7.1.1.9 Test and inspection sequence plan for in-service inspections

The test and inspection sequence plan shall contain the following data:

a) requirements and extent of the tests and inspections in accordance with section 10,

b) intervals between tests and inspections.

7.1.2 Load attachment points according to section 4.4

7.1.2.1 Drawings, parts lists and specifications

The general arrangement drawings, detailed drawings, parts lists and specifications shall contain the following data:

a) dimensions for strength calculation of load attachment points,

b) material data to make assignment of individual parts to the materials test sheets possible,

c) type of fasteners, specifications in the case of preloaded bolted connections.

7.1.2.2 Strength calculations

The strength calculations shall contain the following data:

a) position and arrangement of the load attachment points,

b) description of the delimitation between load attachment point and load,

c) dead weight of the load and indication of the point of load application and direction of forces as well as temperatures, fluids and radiological exposure which may impair the material characteristics,

d) stress, strength and safety analyses for the load attachment point,

e) indication of model structure and quotation of program description, insofar as the calculations are made using data processing systems,

f) description of the test program and test results in the case of experimental analysis.

7.1.2.3 Materials test sheets

For materials not listed in **Annex A** materials test sheets with the following data shall be established:

a) identification number of the materials test sheet,

b) product form,

c) material designation,

d) test requirements for the material with indication of the extent of testing and the certification in accordance with DIN EN 10204,

e) identification marking of the material.

7.1.2.4 Welding procedure documentation

Where a welding procedure is applied during fabrication of the load attachment point, a document shall be established to specify the applied welding procedure qualification requirements. These requirements comprise the establishment of welding procedure specifications, the performance of welding procedure qualifications and the required qualification of welders or welding operators and weld setters.

Note:
As regards design approval documents required for welding production tests see section 8.1.

7.1.2.5 Test and inspection documents

The tests and inspections to be performed by the manufacturer shall be fixed.

7.2 Procedure

(1) The documents submitted in accordance with section 7.1.1 or 7.1.2 shall be checked for:

a) completeness,

b) correspondence of the data with the specified values and requirements,

c) compliance with the licensing provisions and requests of the supervisory authority.

(2) The documents submitted in accordance with sections 7.1.1.1 and 7.1.1.2 shall, additionally, be checked for:

a) accessibility of the load attachment points for maintenance and repair work and for in-service tests and inspections,

b) correspondence of the data regarding materials in the parts lists and in the associated materials test sheets.

(3) The documents submitted in accordance with sections 7.1.1.3 and 7.1.2.2 shall, additionally, be checked for:

a) correctness and completeness of the load assumptions,

b) correctness and completeness of the calculations,

c) observance of the allowable stresses or allowable loadings and of the safety factors.

(4) The materials test sheets compiled in accordance with sections 7.1.1.4 and 7.1.2.3 shall be checked for correctness with regard to the extent of testing and type of certification.

(5) The welding procedure specification submitted in accordance with sections 7.1.1.5 and 7.1.2.4 shall be checked with regard to the suitability of the intended welding procedure as well as to the correctness and completeness of the data.

7.3 Certification of design approval

(1) The authorized inspector shall establish a certificate on the performance of the design approval and the results obtained.

(2) In the event of a positive result, the design approval is regarded as concluded upon submission of this certificate.

8 Final inspection

8.1 General

(1) Prior to the beginning of production, the observance of the following requirements regarding manufacture shall be proved:

a) confirmation of the manufacturer's ability to meet the quality assurance requirements according to KTA 1401,

b) attestation of welding qualification

   ba) basically by attestation of qualification according to DIN 18800-7, class E, with extension to the requirements of DIN 15018-2 (the attestation of qualification shall be provided on the basis of welding procedure qualifications according to DIN EN ISO 15614-1),

   or

   bb) the manufacturer shall be certified for execution class EXC 4 according to DIN EN 1090-2,

c) qualification test certificate of welders/operating personnel of fully mechanized and automatic welding units,

d) certification of supervisory personnel and NDT personnel according to the provisions in section B 2.1,

e) suitability of production, measuring and test facilities,

f) validity of marking-transfer certificate,

g) calibration of welding equipment and heat treatment facilities,

h) suitability of the devices for measuring the tightening parameters of bolted connections.

(2) Where materials and welding procedures are used which are not part of the welder's qualification in accordance with clause (1) b), welding procedure qualifications according to DIN EN ISO 15614-1 shall be submitted. If no principal rules for the performance of welding procedure qualifications are available for welded joints between certain materials, production tests shall be performed according to design-approved documents within the scope of final inspection.

(3) Deviations from the design-approved documents are only permitted by agreement with the authorized inspector.

8.2 Load attachment points according to section 4.2 or 4.3

8.2.1 General

Within the final inspection the correspondence of the design approval documents with the construction of the load attachment point shall be checked.

8.2.2 Documents

The following documents shall be available:

a) test and inspection sequence plan for the final inspection in accordance with 7.1.1.7,
b) detailed drawings and parts lists with data on materials,
c) materials documentation,
d) certificate concerning the transfer of markings on product forms in accordance with section 6.4,
e) welding procedure specifications in accordance with 7.1.1.5,
f) certificates on the suitability for welding in accordance with 8.1,
g) test instructions.

8.2.3 Extent of tests and inspections

The extent of tests and inspections prior to the beginning of production is specified in section 8.1, the extent of final inspection on the components shall be taken from **Table 8-1**. The non-destructive tests and inspections shall be conducted in accordance with **Annex B**. The manufacturer shall perform 100 % of the tests and inspections. The tests and inspections to be performed by the authorized inspector are specified for the individual test and inspection steps in **Table 8-1**.

8.2.4 Certification of final inspection

(1) The authorized inspector shall establish a certificate on the performance of the final inspection and the results obtained.

(2) In the event of a positive result, the final inspection is regarded as concluded upon submission of this certificate.

8.3 Load attachment points according to section 4.4

8.3.1 General

Within the final inspection the correspondence of the design approval documents with the construction of the load attachment point shall be checked.

8.3.2 Documents

The following documents shall be available:

a) drawings, parts lists and specifications,
b) test and inspection documents in accordance with 7.1.2.5,
c) materials documentation in accordance with materials test sheets,
d) welding procedure qualifications according to 7.1.2.4.

8.3.3 Extent of tests and inspections

The type and extent of the tests and inspections to be performed by the manufacturer shall be taken from the related specification. The extent of tests and inspections by the authorized inspector are specified in **Table 8-1**.

8.3.4 Certification of final inspection

(1) The type of certificate of the tests and inspections to be performed by the manufacturer shall be laid down in the specification.

(2) The authorized inspector shall establish a certificate on the performance of the final inspection and the results obtained.

(3) In the event of a positive result, the final inspection is regarded as concluded upon submission of this certificate.

9 Acceptance test

9.1 Load attachment points according to section 4.2 or 4.3

9.1.1 General

Before the load attachment point is put into service an acceptance test shall be conducted by the authorized inspector to prove that the load attachment point in its ready-for-operation condition meets the requirements with regard to load-carrying capacity and functional capability.

9.1.2 Documents

The following documents shall be available for the acceptance test:

a) test and inspection sequence plan for the acceptance test in accordance with 7.1.1.8,
b) documentation of the tests and inspections in accordance with sections 7 and 8 with the associated test certificates.

9.1.3 Extent of tests and inspections

(1) The extent the tests and inspections shall be taken from **Table 9-1**.

(2) Tests already conducted and documented within the framework of the final inspection may be dispensed with in the acceptance test.

9.1.4 Certification of acceptance test

(1) The authorized inspector shall establish a certificate on the performance of the acceptance test and the results obtained.

(2) In the event of a positive result, the acceptance test is regarded as concluded upon submission of this certificate.

9.2 Load attachment points according to section 4.4

For load attachment points on core components an acceptance test is not required.

10 In-service inspections

10.1 Load attachment points according to section 4.2 or 4.3

10.1.1 General

(1) Unless otherwise specified, the in-service inspections shall be conducted by the licensee in test intervals as specified in 10.1.3. The inspection dates shall be agreed upon in good time between the licensee and the authorized inspector.

(2) If the in-service inspections lead to the detection of defects on load attachment points, a new inspection to an extent related to the size of the repaired defects is required after repair. The period for repair of the defects shall be agreed upon with the authorized inspector.

10.1.2 Documents

In addition to the test and inspection sequence plan for in-service tests and inspections the following documents shall be available:

a) test instructions according to KTA 1202,

b) certificate of the last in-service inspection; the acceptance test certificate shall be submitted for the first in-service inspection,

c) records on all maintenance and repair work carried out,

d) records on the number of transports and handling operations carried out since the last in-service inspection in the case of load attachment points on loads transported inside and outside the nuclear power plant.

   Note:

   A transport means the entire cycle consisting of to-and-fro conveyance to or from the site of the nuclear power plant.

e) in case of preloaded bolted connections:

   records on disassembly and re-assembly and on the inspections performed prior to re-using such bolts.

10.1.3 Inspection intervals

(1) The inspection intervals are specified in **Table 10-1**. If other inspection intervals are specified for the component assigned to the load attachment point in KTA Safety Standards (e.g. KTA 3201.4), intervals deviating from **Table 10-1** may be specified in the test and inspection sequence plan.

Note:

The necessity of co-ordinating the inspection intervals laid down for the components is derived from operational boundary conditions, e.g. accessibility, radiation protection.

As the test and inspection plan is subject to design approval, the involvement of the authorized inspector is ensured.

(2) If load attachment points on loads are not used beyond the date of the next regular in-service inspection specified in **Table 10-1**, it is permitted to conduct the next in-service inspection, at the latest, prior to the next use of these load attachment points.

10.1.4 Performance of tests and inspections

(1) The extent of the tests and inspections shall be taken from **Table 10-1**.

(2) The following requirements apply to visual testing for condition monitoring:

a) Visual testing shall be performed according to DIN EN 13018, preferably as direct visual testing.

b) The examinations shall be performed as local visual testing.

c) The test personnel shall meet the requirements of DIN EN 13018 and shall have been qualified and certified according to DIN EN ISO 9712.

d) Deviations from the specified conditions shall be documented as conspicuous indications and be evaluated.

e) Crack-like conspicuous indications are not permitted. Where conspicuous indications cannot be clearly identified they shall be subjected to a surface inspection according to **Annex B**.

(3) Non-destructive tests and inspections shall be performed in accordance with **Annex B**.

(4) If non-destructive tests and inspections are not possible because of local conditions (accessibility), regulations shall be specified jointly with the authorized inspector in each individual case.

(5) The in-service tests and inspections shall be performed in the presence of the authorized inspector.

10.1.5 Certification of in-service tests and inspections

Upon completion, in-service tests and inspections shall be certified by the authorized inspector.

10.2 Load attachment points according to section 4.4

For load attachment points on core components no in-service tests and inspections are required.

11 Operation and maintenance

11.1 Load attachment points according to section 4.2 or 4.3

(1) The operating instructions shall be observed when using the load attachment points.

(2) The licensee shall take care to ensure that the tests and inspections specified in the testing manual (in accordance with KTA 1202) are conducted properly and in time.

(3) The load attachment points shall be checked for obvious defects before each use. If defects impairing safety are detected, the load attachment points shall not be used before the defect has been repaired.

(4) Maintenance work shall be carried out such that safety is not impaired. Load attachment points not properly repaired shall not be used.

(5) Records containing at least the following data shall be prepared on all maintenance work carried out:

a) unambiguous designation of the load attachment point,

b) type of maintenance work,

c) designation of the associated documents.

(6) The records of maintenance work shall be included in the documentation and submitted to the authorized inspector during the in-service tests and inspections in accordance with section 10.

(7) The records on disassembly and re-assembly work done on preloaded bolted connections and on the tests and inspections performed prior to re-using such bolts, shall be added to the documentation and be submitted to the authorized inspector during the in-service inspections according to section 10.

(8) The design approval as per section 7 may be omitted for new components to be installed, if the components are exclusively fabricated according to design approval documents established for first-time manufacture and new editions of standards used in the design approval documents don't give reason to doubt the validity of the design approval documents. The materials testing shall be conducted in accordance with section 6, the final inspection in accordance with section 8 and the acceptance test in accordance with section 9.

In the case of replacement of bolts in the load path of the load attachment point (LAP) by new ones, a new load test in accordance with **Table 9-1** may be omitted, provided less than 50 % of the bolts at the LAP are replaced.

11.2 Load attachment points according to section 4.4

(1) The operating instructions shall be observed when using the load attachment points.

(2) Repair shall be carried out in accordance with a qualified procedure and be documented accordingly.

12 Documentation

12.1 General

The documentation shall make it possible to trace back all manufacturing processes and test/inspection procedures, in-service tests and inspections as well as maintenance measures to be supervised acc. to sections 6 to 11, respectively.

12.2 Compilation of documents

(1) The documents shall be compiled in due consideration of requirements in KTA 1404.

(2) The compiled documents shall contain the design approved documents as well as all proofs, records and attestations certifying the actual condition and the tests and inspections performed.

12.3 Performance of documentation

(1) Documentation of manufacturing documents shall accompany the manufacturing process. The manufacturer shall ensure that the documentation, including that of subcontractors, is complete.

(2) The licensee is responsible for continuing the documentation with regard to maintenance measures and in-service inspections, unless provided otherwise in individual cases.

Test / Inspection	Tests and inspections by authorized inspector		
	Additional requirements acc. to section 4.2	Increased requirements acc. to section 4.3	Core components acc. to section 4.4
a) Receiving inspection of identification marks and stampings, if any, on the product forms	—	—	—
b) Material identification marks of parts for compliance with parts list according to section 6.4	X	X	X
c) Ultrasonic testing for laminar imperfections in weld-junction areas on parts under tensile stress in thickness direction	25 %	25 %	—
d) Check for compliance of the position, arrangement, dimensions and assembly with design approval documents	X	X	X
e) Check of threads on bolts and nuts in the load path with additional tensile load using thread ring gauge and thread plug gauge according to DIN ISO 965-2	—	X	
f) Observation of welding data	25 %	25 %	X
g) Visual testing of weld seams	25 %	25 %	X
h) Non-destructive testing of load-bearing weld seams [1]: - Surface inspection	25 %	25 %	X
- Ultrasonic or radiographic testing: For butt welds between ferritic steels with wall thicknesses equal to or smaller than 15 mm radiography shall preferably be used; if the wall thickness is equal to or greater than 8 mm alternatively ultrasonic testing; for wall thicknesses greater than 15 mm and equal to or smaller than 40 mm ultrasonic testing shall preferably be used, alternatively radiography. For wall thicknesses exceeding 40 mm ultrasonic testing shall be used. For all wall thicknesses of austenitic butt welds radiography shall be used. For attachment weld seams the test procedure shall be laid down in a test instruction. In the case of austenitic attachment weld seams radiographic testing shall be preferred.	25 % [2]	100 % [2]	—
i) Examination of repair welds in acc. with a design-approved repair welding procedure specification or a qualified welding procedure	X	X	X
j) Surface inspection within the area of machined surfaces in finished condition	25 %	100 %	
k) Observance of the design requirements and bolting torque of preloaded bolted connections for compliance with the design approval documents	10 %	10 %	X
l) Where ultrasonic testing is to be carried out as in-service inspection in lieu of a surface inspection, a baseline ultrasonic test shall additionally be carried out on trunnions, bolts, tie-rods and similar parts in their finished condition. The type and extent of this baseline test shall be fixed in a test instruction.		X	

X Partial inspection by authorized inspector, i.e. inspection to enable the inspector to confirm that the objectives of the respective inspection stage have been attained.

— No inspection by the inspector.

% Percentage share of inspection by the authorized inspector.

[1] Where the stress level in the weld seam does not exceed 30 % of the allowable stress, no non-destructive testing is required.

[2] Where the weld quality has to be verified.

Table 8-1: Extent of final inspection

No.	Test object	Tests and inspections	Performance
1	Bolted-on LAP	a) Identification marking	
		b) Visual inspection	
		c) Correct assembly	
		d) Load test	1.25 times the load to be absorbed by the LAP. If the load is applied statically, the test load shall be 1.5 times the load to be absorbed
		e) Functional test with the load suspension device or lifting accessory	
		f) Check of the bolting torque subsequent to the load test	in compliance with the provisions specified in the design approval documents
		g) In the case of load attachment points according to section 4.3: surface inspection (alternatively ultrasonic testing [1]) on all zones in the load path (e.g. weld seams, trunnions, bolts, tie-rods and similar parts) subsequent to the load test	in accordance with **Annex B**
2	Welded-on LAP and LAP as integral part of the load	a) Identification marking	
		b) Visual inspection	
		c) Correct position and arrangement	
		d) Load test	1.25 times the load to be absorbed by the LAP. If the load is applied statically, the test load shall be 1.5 times the load to be absorbed
		e) Functional test with the load suspension device or lifting accessory	
		f) In the case of load attachment points according to section 4.3: surface inspection (alternatively ultrasonic testing [1]) on all zones in the load path (e.g. weld seams, trunnions, bolts, tie-rods and similar parts) subsequent to the load test	in accordance with **Annex B**
3	LAP anchored in the concrete structural part	a) Identification marking	
		b) Visual inspection	
		c) Correct position and arrangement	
		d) Load test [2]	1.25 times the load to be absorbed by the LAP. If the load is applied statically, the test load shall be 1.5 times the load to be absorbed
		e) Functional test with the load suspension device or lifting accessory	
		f) Check on the concrete surface in the load introduction areas for inadmissible crack formation	
		g) In the case of load attachment points according to section 4.3: surface inspection (alternatively ultrasonic testing [1]) on all zones in the load path which remain accessible after concreting (e.g. weld seams, trunnions, bolts, tie-rods and similar parts) subsequent to the load test	in accordance with **Annex B**

[1] See Table 8-1 l).
[2] Taking clause 5.5.1.2 (4) into account.

Table 9-1: Extent of acceptance testing

No.	Test object	Tests and inspections	Intervals between inspections			
			LAP of loads used only inside the nuclear power plant		LAP of loads used inside and outside the nuclear power plant and also subject to traffic legislation	
			section 4.2	section 4.3	section 4.2	section 4.3
1	Bolted-on LAP	a) Condition, deformations, wear, corrosion	1 year	1 year	15 transports, at the latest after 3 years [4]	15 transports, at the latest after 3 years [4]
		b) Smooth engagement of movable parts				
		c) Bolting torque of bolted connections for compliance with the design approval documents				
		d) Check for adherence to specified in the design approval documents allowable number da) of disassembly and re-assembly operations on preloaded bolted connections				
		db) of transports and handlings carried out	—	—		
		e) Check of threads on bolts and nuts in the load path with additional tensile load using thread ring gauge and thread plug gauge according to DIN ISO 965-2 (random)	—	—	—	15 transports, at the latest after 3 years [4]
		f) Surface inspection (alternatively ultrasonic testing [1]) on all zones in the load path (e.g. weld seams, trunnions, bolts, tie-rods and similar parts)	—	3 years [2]	—	15 transports, at the latest after 3 years [4]
		g) Condition, deformations (e.g. by means of check as per serial no. 1 e), wear, corrosion after dismantling the LAP	—	3 years [3]	—	60 transports, at the latest after 6 years
		h) Load test in the assembled condition (see **Table 9-1** No. 1d)	—	—	—	60 transports, at the latest after 6 years
		i) Surface inspection (alternatively ultrasonic testing [1]) on all zones in the load path (e.g. weld seams, trunnions, bolts, tie-rods and similar parts) subsequent to the load test				
2	Welded-on LAP and LAP as integral part of the load	a) Condition, deformations, wear, corrosion	1 year	1 year	15 transports, at the latest after 3 years [4]	15 transports, at the latest after 3 years [4]
		b) Smooth engagement of movable parts				
		c) Surface inspection (alternatively ultrasonic testing [1]) on all zones in the load path (e.g. weld seams, trunnions, bolts, tie-rods and similar parts)	—	3 years [2]	—	15 transports, at the latest after 3 years [4]
		d) Check for adherence to specified in the design approval documents allowable number of transports and handlings carried out	—	—	15 transports, at the latest after 3 years [4]	15 transports, at the latest after 3 years [4]
3	LAP anchored in the concrete structural part	a) Condition, deformations, wear, corrosion	1 year	1 year	15 transports, at the latest after 3 years	15 transports, at the latest after 3 years
		b) Inadmissible crack formation on the concrete surface in the load introduction area				
		c) Smooth engagement of movable parts				
		d) Surface inspection (alternatively ultrasonic testing [1]) on all zones in the load path which remain accessible after concreting (e.g. weld seams, trunnions, bolts, tie-rods and similar parts)	—	3 years [2]	—	15 transports, at the latest after 3 years

1) See Table 8-1 l).

2) 6 years where it is proved in each individual case that for these parts utilization reserves

$$\frac{D}{S} = \frac{\text{theoretical period of utilization}}{\text{consumed portion of theoretical period of utilization}} > 1.5$$

are available for the intended service life. See Annex 1 of the Accident Prevention Regulation DGUV 55 for the determination of D and S. When determining D and S the same load shall always be used as reference load. This does not apply to parts made of austenitic materials where the risk of stress corrosion cracking may occur.

3) 6 years for connections that will not be disassembled for operational reasons.

4) As an alternative to the tests and inspections to be carried out after 3 years at the latest, for LAP on brand new transport and storage containers (TLB) in the case of bolted-on LAP only the tests and inspections 1 a), 1 b) and 1 d) and in the case of welded-on LAPs only the tests and inspections 2 a), 2 b) and 2 d) may be carried out in the installed condition and without dismantling other components. A TLB shall be considered as brand new if it is not older than 6 years, has not been loaded or cold-tested and has been verifiably preserved in accordance with the applicable provisions and stored temporarily within a building either by the manufacturer or by the user. Evidence of compliance with these requirements shall be submitted during the in-service tests and inspections.

Table 10-1: Extent and test intervals of in-service inspections

Annex A

Materials test sheets (WPB)

WPB	Load attachment points
1	Hot rolled plates and sheets, strips, wide flats and steel sections of structural carbon steel according to DIN EN 10025-2
2	Hot rolled bars made of structural carbon steels according to DIN EN 10025-2
3	Forged bars and open-die forgings made of general structural steels according to DIN EN 10250-2
4	Welded tubes made of carbon steels according to DIN EN 10217-1
5	Seamless tubes made of carbon steels according to DIN EN 10216-1
6	Seamless or welded hot finished hollow sections of structural carbon steels according to DIN EN 10210-1
7	Bars and forgings made of quenched and tempered steels according to DIN EN ISO 683-1, DIN EN ISO 683-2 or SEW 550
8	Plates, sheets and strips made of austenitic steels according to DIN EN 10088-2 and of ferritic-austenitic steels according to DIN EN 10028-7
9	Bars and forgings made of austenitic steels according to DIN EN 10088-3 or DIN EN 10250-4 and of ferritic-austenitic steels according to DIN EN 10222-5 or DIN EN 10272
10	Seamless tubes made of austenitic steels according to DIN EN 10216-5
Note: Materials test sheet WPB 11 was deleted.	
12	Bolts and nuts ≤ M 39 according to DIN EN ISO 898-1, DIN EN ISO 898-2 and DIN EN ISO 3269
13	Bolts and nuts made of austenitic steels according to DIN EN ISO 3506-1, DIN EN ISO 3506-2 and DIN EN ISO 3269
14	Bolts and studs, thread rolled, head bolts with forged-on head, and subsequently heat-treated
15	Welded tubes made of austenitic steels according to DIN EN 10217-7
16	Bars and forgings made of stainless martensitic steels according to DIN EN 10088-3 or DIN EN 10250-4
17	Plates, sheets and strips made of zirconium alloys
18	Forged bars and open-die forgings made of weldable fine grain structural steel according to DIN EN 10222-4

Materials test sheet 1: Hot rolled plates and sheets, strips, wide flats and steel sections of structural carbon steel according to DIN EN 10025-2

MATERIALS TEST SHEET		**WPB 1**
Load attachment points		
Product form: Hot rolled plates and sheets, strips, wide flats and steel sections		
Materials: S235J0 (1.0114), S235J2 (1.0117), S235JR (1.0038), S355J2 (1.0577), S355K2 (1.0596)		
Requirements: DIN EN 10025-1, DIN EN 10025-2 [1)], DIN EN 10164		
Tests and inspections	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Chemical composition: Ladle analysis	3.1	3.1
2. Attestation of heat treatment condition or of as-delivered condition	3.1	3.1
3. Tensile test at room temperature: 3.1 One specimen per melt and test unit	3.1	3.2
3.2 Three tensile specimens in thickness direction for product thicknesses > 20 mm and tensile stress in thickness direction: Test unit according to DIN EN 10164 [2)] Quality class Z 25 according to DIN EN 10164	3.1	3.2
4. Notched bar impact test at test temperature according to DIN EN 10025-2: One set of impact test specimen per tensile test specimen as per no. 3.1 as far as the nominal dimension is ≥ 6 mm	3.1	3.2
5. Visual inspection and dimensional check: Each part	3.1	3.2
See **Table 8-1** c) regarding ultrasonic testing of parts under tensile stress in thickness direction. Products with thicknesses ≥ 6 mm shall at least meet the requirements of quality class S_1 according to DIN EN 10160 for the body and E_1 for the edge zone.		
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number (the plate, sheet or strip number may also be used as specimen number), inspector's mark, Z 25 (if demonstrated)		

1) Repair welding is not permitted.

2) Where the materials S235J0 and S235JR are loaded in thickness direction, the test shall be performed on each rolled panel in acc. with test no. 3.2.

Materials test sheet 2: Hot rolled bars made of structural carbon steels according to DIN EN 10025-2

MATERIALS TEST SHEET		**WPB 2**
Load attachment points		
Product form: Hot-rolled bars		
Materials: S235J0 (1.0114), S235J2 (1.0117), S235JR (1.0038), S355J2 (1.0577), S355K2 (1.0596)		
Requirements: DIN EN 10025-1, DIN EN 10025-2 [1)]		
Tests and inspections	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Chemical composition: Ladle analysis	3.1	3.1
2. Attestation of heat treatment condition or of as-delivered condition	3.1	3.1
3. Tensile test at room temperature: One specimen per melt and test unit	3.1	3.2
4. Notched bar impact test at test temperature according to DIN EN 10025-2 and nominal dimensions according to DIN EN 10025-1: One set of impact test specimens per tensile test specimen	3.1	3.2
5. Visual inspection and dimensional check: Each part	3.1	3.2
6. Ultrasonic testing: For bar steel with product thicknesses ≥ 30 mm each part subject to 100 % in acc. with **Annex B**	3.1	3.2
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark		
1) Repair welding is not permitted.		

Materials test sheet 3: Forged bars and open-die forgings made of general structural steels according to DIN EN 10250-2

MATERIALS TEST SHEET		**WPB 3**
Load attachment points		
Product form: Forged bars and open-die forgings		
Materials: S235JRG2 (1.0038), S235J2G3 (1.00116), S355J2G3 (1.0570)		
Requirements: DIN EN 10250-1, DIN EN 10250-2 1)		
Tests and inspections	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Chemical composition: Ladle analysis	3.1	3.1
2. Attestation of heat treatment condition	3.1	3.1
3. Tensile test at room temperature: One specimen per melt and test unit	3.1	3.2
4. Notched bar impact test at test temperature according to DIN EN 10250-2: One set of impact test specimens per tensile test specimen, as far as the nominal dimension is ≥ 15 mm	3.1	3.2
5. Visual inspection and dimensional check: Each part	3.1	3.2
6. Ultrasonic testing: For bar steel with product thicknesses ≥ 30 mm and forgings with a weight in final heat treatment condition ≥ 300 kg, each part subject to 100 % in acc. with **Annex B**	3.1	3.2
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark		
1) Repair welding is not permitted.		

Materials test sheet 4: Welded tubes made of carbon steels according to DIN EN 10217-1

MATERIALS TEST SHEET	**WPB 4**
Load attachment points	
Product form: Welded tubes	
Materials: P235TR1 (1.0254), P235TR2 (1.0255), P265TR1 (1.0258), P265TR2 (1.0259)	
Requirements: DIN EN 10217-1 [1]	
Tests and inspections	Inspection certificate according to DIN EN 10204 for additional requirements according to section 4.2
1. Chemical composition: Ladle analysis	3.1
2. Attestation of heat treatment condition or of as-delivered condition	3.1
3. Tensile test at room temperature (base material): Lot size and extent of testing in acc. with DIN EN 10217-1 no. 10.1, Table 12 and Table 13	3.1
4. Tensile test at room temperature transverse to the weld seam (at an outside diameter D_A > 508 mm): Lot size and extent of testing in acc. with DIN EN 10217-1 no 10.1, Table 12 and Table 13	3.1
5. Notched bar impact test at test temperature of 0 °C (base material) in the case of materials no. 1.0255 and 1.0259: One set of impact test specimen per tensile test specimen	3.1
6. Flattening test or drift-expanding test: Lot size and extent of testing in acc. with DIN EN 10217-1 no 10.1, Table 12 and Table 13	3.1
7. Weld bend test on submerged-arc welded tubes: Lot size and extent of testing in acc. with DIN EN 10217-1 no 10.1, Table 12 and Table 13	3.1
8. Non-destructive testing of weld seams: In acc. with section 11.11 of DIN EN 10217-1	3.1
9. Tightness test: Each tube in acc. with section 11.8 of DIN EN 10217-1	3.1
10. Visual inspection and dimensional check: Each tube	3.1
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark, type of tube in acc. with DIN EN 10217-1 Table 1	
[1] Repair welding in the base material is not permitted.	

Materials test sheet 5: Seamless tubes made of carbon steels according to DIN EN 10216-1

MATERIALS TEST SHEET	**WPB 5**
Load attachment points	
Product form: Seamless tubes	
Materials: P235TR1 (1.0254), P235TR2 (1.0255), P265TR1 (1.0258), P265TR2 (1.0259)	
Requirements: DIN EN 10216-1 1)	
Tests and inspections	Inspection certificate according to DIN EN 10204 for additional requirements according to section 4.2
1. Chemical composition: Ladle analysis	3.1
2. Attestation of heat treatment condition or of as-delivered condition	3.1
3. Tensile test at room temperature: Lot size and extent of testing in acc. with DIN EN 10216-1 no 10.1, Table 10 and Table 11	3.1
4. Notched bar impact test at test temperature of 0 °C in the case of materials no. 1.0255 and 1.0259: One set of impact test specimen per tensile test specimen	3.1
5. Tightness test: Each tube in acc. with section 11.4 of DIN EN 10216-1	3.1
5. Visual inspection and dimensional check: Each tube	3.1
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark	
1) Repair welding is not permitted.	

Materials test sheet 6: Seamless or welded hot finished hollow sections of structural carbon steels according to DIN EN 10210-1

MATERIALS TEST SHEET		**WPB 6**
Load attachment points		
Product form: Hot finished hollow sections (seamless or welded)		
Materials: S275J0H (1.0149), S275J2H (1.0138), S355J0H (1.0547), S355J2H (1.0576)		
Requirements: DIN EN 10210-1 [1)]		
Tests and inspections	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Chemical composition: Ladle analysis	3.1	3.1
2. Attestation of heat treatment condition or of as-delivered condition	3.1	3.1
3. Tensile test at room temperature: One specimen per melt, test unit and nominal dimension each	3.1	3.2
4. Notched bar impact test at test temperature according to DIN EN 10210-1: One set of impact test specimens per tensile test specimen, as far as the nominal dimension is ≥ 6 mm	3.1	3.2
5. Visual inspection and dimensional check: Each part	3.1	3.2
6. Non-destructive testing of the weld seam: Each part over its full length in acc. with section 9.4 of DIN EN 10210-1	3.1	3.2
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark		
[1)] Repair welding in the base material is not permitted.		

Materials test sheet 7: Bars and forgings made of quenched and tempered steels according to DIN EN ISO 683-1, DIN EN ISO 683-2 or SEW 550

MATERIALS TEST SHEET		**WPB 7**
Load attachment points		
Product form: Bars and forgings		
Materials: Quenched and tempered steels according to DIN EN ISO 683-1, DIN EN ISO 683-2 or SEW 550		
Requirements: DIN EN ISO 683-1 [1)], DIN EN ISO 683-2 [1)] or SEW 550		
Tests and inspections The performance of the following tests and inspections shall be verified for the quenched and tempered condition	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Chemical composition: Ladle analysis	3.1	3.1
2. Attestation of heat treatment condition	3.1	3.1
3. Hardness test for verification of uniform heat treatment: On one end of each part three measuring points each	3.1	3.1
4. Tensile test at room temperature: One specimen per melt, dimensional range and heat treatment batch each	3.1	3.2
5. Notched bar impact test at room temperature: One set of impact test specimens per tensile test specimen, as far as the nominal dimension is ≥ 15 mm	3.1	3.2
6. Visual inspection and dimensional check: Each part	3.1	3.2
7. Materials identification check for alloyed steels: Each part, e.g. by spectroscopy	3.1	3.1
8. Ultrasonic testing: For bar steel with product thicknesses ≥ 30 mm and forgings with a weight in final heat treatment condition ≥ 300 kg each part subject to 100 % in acc. with **Annex B**	3.1	3.2
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark		
1) Repair welding is not permitted.		

Materials test sheet 8: Plates, sheets and strips made of austenitic steels according to DIN EN 10088-2 and of ferritic-austenitic steels according to DIN EN 10028-7

MATERIALS TEST SHEET			**WPB 8**
Load attachment points			
Product form: Plates, sheets and strips			
Materials: Austenitic steels according to DIN EN 10088-2, X2CrNiMoN22-5-3 (1.4462) according to DIN EN 10028-7			
Requirements: DIN EN 10088-2 [1)], DIN EN 10028-7 [1)]			
Tests and inspections	Inspection certificate according to DIN EN 10204 for		
	additional requirements according to section 4.2	increased requirements according to section 4.3	core components according to section 4.4
1. Chemical composition: Ladle analysis	3.1	3.1	3.1
2. Attestation of heat treatment condition	3.1	3.1	3.1
3. Check for intergranular corrosion resistance [2)]: One specimen per melt and heat treatment batch each	3.1	3.1	3.1
4. Tensile test at room temperature: One specimen according to DIN EN 10088-2 Table 21, in the case of X2CrNiMoN22-5-3 (1.4462) lot size and extent of testing on acc. with DIN EN 10028-7 Table 16	3.1	3.2	3.1
5. Notched bar impact test at room temperature: One set of impact test specimen per tensile test specimen [3)]	3.1	3.2	3.1
6. Visual inspection and dimensional check: Each part; surface condition in acc. with purchaser's specification	3.1	3.2	3.1
7. Material identification check: Each part, e.g. by spectroscopy	3.1	3.1	3.1
See **Table 8-1** ser. no. c) regarding ultrasonic testing of parts under tensile stress in thickness direction. Products with thicknesses ≥ 6 mm shall at least meet the requirements of quality class S_1 according to DIN EN 10307 for the body and E_1 for the edge zone.			
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number (the plate, sheet or strip number may also be used as specimen number), inspector's mark			

1) Repair welding is not permitted.

2) According to DIN EN ISO 3651-2 procedure A sensitisation T1 or T2 (in the case of material 1.4462 also procedures B and C) and only if the parts are being welded and are in contact with water.

3) Only for steel X2CrNiMoN22-5-3 (1.4462) as far as thickness of plate/sheet s ≥ 10 mm.

Materials test sheet 9: Bars and forgings made of austenitic steels according to DIN EN 10088-3 or DIN EN 10250-4 and of ferritic-austenitic steels according to DIN EN 10222-5 or DIN EN 10272

MATERIALS TEST SHEET			**WPB 9**
Load attachment points			
Product form: Bars and forgings			
Materials: Austenitic steels according to DIN EN 10088-3 or DIN EN 10250-4 as well as X2CrNiMoN22-5-3 (1.4462) according to DIN EN 10222-5 or DIN EN 10272			
Requirements: DIN EN 10088-3 [1)], DIN EN 10250-4 [1)], DIN EN 10222-5 [1)] or DIN EN 10272 [1)]			
Tests and inspections	Inspection certificate according to DIN EN 10204 for		
	additional requirements according to section 4.2	increased requirements according to section 4.3	core components according to section 4.4
1. Chemical composition: Ladle analysis	3.1	3.1	3.1
2. Attestation of heat treatment condition	3.1	3.1	3.1
3. Check for intergranular corrosion resistance [2)]: One specimen per melt and heat treatment batch each	3.1	3.1	3.1
4. Tensile test at room temperature: One specimen according to DIN EN 10088-3 Table 26 or section 11 of DIN EN 10250-1 or section 7 of DIN EN 10222-1 or DIN EN 10272 Table 14	3.1	3.2	3.1
5. Visual inspection and dimensional check: Each part; surface condition in acc. with purchaser's specification	3.1	3.2	3.1
6. Material identification check: Each part, e.g. by spectroscopy	3.1	3.1	3.1
7. Ultrasonic testing: For bar steel with product thicknesses ≥ 30 mm and forgings with a weight in final heat treatment condition ≥ 300 kg, each part subject to 100 % in acc. with **Annex B**	3.1	3.2	
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark			

1) Repair welding is not permitted.

2) According to DIN EN ISO 3651-2 procedure A sensitisation T1 or T2 (in the case of material 1.4462 also procedures B and C) and only if the parts are being welded and are in contact with water.

Materials test sheet 10: Seamless tubes made of austenitic steels according to DIN EN 10216-5

MATERIALS TEST SHEET		**WPB 10**
Load attachment points		
Product form: Seamless tubes		
Materials: Austenitic stainless steels according to DIN EN 10216-5		
Requirements: DIN EN 10216-5 (test category 2) [1]		
Tests and inspections	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Chemical composition: Ladle analysis	3.1	3.1
2. Attestation of heat treatment condition	3.1	3.1
3. Check for intergranular corrosion resistance [2]: One specimen per melt and heat treatment batch each	3.1	3.1
4. Tensile test at room temperature: Lot size and extent of testing in acc. with DIN EN 10216-5 Table 15	3.1	3.2
5. Technological test procedures: Type and extent of testing in acc. with DIN EN 10216-5 Table 15 and Table 16	3.1	3.2
6. Visual inspection and dimensional check: Each tube, surface condition in acc. with purchaser's specification	3.1	3.2
7. Material identification check: Each tube, e.g. by spectroscopy	3.1	3.1
8. Non-destructive testing: Type and extent of testing in acc. with DIN EN 10216-5 Table 15	3.1	3.2
9. Tightness test: Each tube in acc. with DIN EN 10216-5 Table 15	3.1	3.1
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark		

1) Repair welding is not permitted.

2) According to DIN EN ISO 3651-2 procedure A sensitisation T1 or T2 and only if the parts are being welded and are in contact with water.

N o t e :
Materials test sheet WPB 11 was deleted.

Materials test sheet 12: Bolts and nuts ≤ M 39 according to DIN EN ISO 898-1, DIN EN ISO 898-2 and DIN EN ISO 3269

<table>
<tr><td colspan="2">MATERIALS TEST SHEET</td><td>WPB 12</td></tr>
<tr><td colspan="3">Load attachment points</td></tr>
<tr><td colspan="3">Product form: Bolts and nuts ≤ M 39</td></tr>
<tr><td colspan="3">Materials: Property classes
Bolts 4.6, 5.6, 6.8, 8.8 and 10.9
Nuts 5, 8 and 10</td></tr>
<tr><td colspan="3">Requirements: Bolts: DIN EN ISO 898-1, DIN EN ISO 3269, DIN EN 26157-3
(Testing of mechanical properties in accordance with DIN EN ISO 898-1, test series MP1. Where test series MP1 is not practicable, test series FF1 plus retempering test may be performed on bolts of property classes 8.8 and 10.9.)
Nuts: DIN EN ISO 898-2, DIN EN ISO 3269, DIN EN ISO 6157-2
In the case of electroplated corrosion protection coatings additionally: DIN EN ISO 4042
In the case of hot dip galvanizing additionally: DIN EN ISO 10684 and guideline “Manufacture of hot dip galvanized bolts” [8]</td></tr>
<tr><td rowspan="2">Tests and inspections</td><td colspan="2">Inspection certificate according to DIN EN 10204
for</td></tr>
<tr><td>additional requirements according to section 4.2</td><td>increased requirements according to section 4.3</td></tr>
<tr><td>Proof (by continuous recording in the manufacturer's works) that the requirements regarding mechanical properties, surface condition, corrosion protection coating and dimensional accuracy have been met</td><td>2.2 1) or 3.1 2)</td><td>2.2 1) or 3.1 2)</td></tr>
<tr><td colspan="3">Material identification:
Bolts in acc. with DIN EN ISO 898-1
Nuts in acc. with DIN EN ISO 898-2</td></tr>
<tr><td colspan="3">1) In lieu of the inspection certificate 2.2 stamping will suffice if the manufacturer is approved in acc. with VdTÜV technical leaflet MB WERK 1253/4.
2) For bolts of property classes 8.8 and 10.9 as well as for nuts of property classes 8 and 10 an inspection certificate 3.1 is required.</td></tr>
</table>

Materials test sheet 13: Bolts and nuts made of austenitic steels according to DIN EN ISO 3506-1, DIN EN ISO 3506-2 and DIN EN ISO 3269

<table>
<tr><td colspan="3">MATERIALS TEST SHEET</td><td>WPB 13</td></tr>
<tr><td colspan="4">Load attachment points</td></tr>
<tr><td colspan="4">Product form: Bolts and nuts ≥ M 10 and ≤ M 39</td></tr>
<tr><td colspan="4">Materials: Property classes 50, 70 and 80
Steel group: A2, A3, A4 and A5</td></tr>
<tr><td colspan="4">Requirements: DIN EN ISO 3506-1, DIN EN ISO 3506-2, DIN EN ISO 3269, DIN EN 26157-3, DIN EN ISO 6157-2</td></tr>
<tr><td rowspan="2">Tests and inspections</td><td colspan="3">Inspection certificate according to DIN EN 10204
for</td></tr>
<tr><td>additional requirements according to section 4.2</td><td>increased requirements according to section 4.3</td><td>core components according to section 4.4</td></tr>
<tr><td>Proof (by continuous recording in the manufacturer's works) that the requirements regarding mechanical properties, surface condition and dimensional accuracy have been met</td><td>2.2 1)</td><td>2.2 1)</td><td>2.2 1)</td></tr>
<tr><td colspan="4">Material identification:
In acc. with DIN EN ISO 3506-1, DIN EN ISO 3506-2</td></tr>
<tr><td colspan="4">1) In lieu of the inspection certificate 2.2 stamping will suffice if the manufacturer is approved in acc. with VdTÜV technical leaflet MB WERK 1253/4.</td></tr>
</table>

Materials test sheet 14: Bolts and studs, thread rolled, head bolts with forged-on head, and subsequently heat-treated

MATERIALS TEST SHEET		**WPB 14**
Load attachment points		
Product form: Bolts and studs, thread rolled, head bolts with forged-on head, heat-treated		
Materials: DIN EN ISO 683-1, DIN EN ISO 683-2, creep-resisting and heat resisting materials according to DIN EN 10269, 1.4313 +QT780 according to DIN EN 10088-3 or DIN EN 10250-4		
Requirements: DIN EN ISO 683-1, DIN EN ISO 683-2, DIN EN 10269, DIN EN ISO 3269, DIN EN 26157-1, DIN EN ISO 898-1, DIN EN 10088-3, DIN EN 10250-4 and supplementary sheet to this materials test sheet In the case of electroplated corrosion protection coatings additionally: DIN EN ISO 4042 In the case of hot dip galvanizing additionally: DIN EN ISO 10684 and guideline “Manufacture of hot dip galvanized bolts” [8]		
Tests and inspections	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Tests on basic material (bar)		
1.1 Chemical composition: Ladle analysis	2.2	3.1
1.2 Materials identification check for alloyed steels: Each bar	2.2	3.1
1.3 Ultrasonic testing: For bars with thicknesses ≥ 30 mm each part in acc. with **Annex B**	3.1	3.2
2. Tests on finished parts based on DIN EN ISO 898-1 test series MP1:		
2.1 Heat treatment condition including confirmation of dephosphorization	3.1	3.1
2.2 Hardness test for verification of uniform heat treatment on 10 % of all bolts and studs	3.1	3.1
2.3 Tensile test at room temperature: Number of test specimen sets according to DIN EN ISO 3269 and supplementary sheet to this materials test sheet 1)	3.1	3.2
2.4 Notched bar impact test at room temperature: In the case of bolts and studs ≥ M16 one set of impact test specimen per tensile test specimen	3.1	3.2
2.5 Surface inspection: Procedure and evaluation based on DIN EN 26157-1	3.1	3.2
2.6 Visual inspection and dimensional check: In acc. with DIN EN ISO 3269 (number of random samples: 20) 1)	3.1	3.2
2.7 Test of edge decarburization and carburization 2): Based on DIN EN ISO 898-1 Number of specimens according to DIN EN ISO 3269 and supplementary sheet to this materials test sheet 1)	3.1	3.1
3. Compliance with the requirements of DIN EN ISO 4042 regarding the electroplated corrosion protection coatings as well as the requirements of DIN EN ISO 10684 and the guideline “Manufacture of hot dip galvanized bolts” [8]	3.1	3.1
Material identification: Manufacturer's mark, steel grade, melt number, inspector's mark		
1) All specimens shall meet the requirements (acceptance number A_C = 0). 2) Not required for material 1.4313 +QT780.		

Supplementary sheet to materials test sheet WPB 14: Sampling plan for destructive testing of mechanical properties

Number of pieces	Number of specimen sets for mechanical testing
≤ 200	1
> 200 up to ≤ 400	2
> 400 up to ≤ 800	3
> 800 up to ≤ 1200	4
> 1200 up to ≤ 1600	5
> 1600 up to ≤ 3000	6
> 3000 up to ≤ 3500	7
> 3500	DIN EN ISO 3269
If it is proved that the bolts and studs delivered are of the same melt and heat treatment testing of 4 specimen sets irrespective of the number of pieces will suffice.	

Materials test sheet 15: Welded tubes made of austenitic steels according to DIN EN 10217-7

MATERIALS TEST SHEET		**WPB 15**
Load attachment points		
Product form: Welded tubes		
Materials: Austenitic stainless steels according to DIN EN 10217-7		
Requirements: DIN EN 10217-7 (test category 2) [1]		
Tests and inspections	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Chemical composition: Ladle analysis	3.1	3.1
2. Attestation of heat treatment condition	3.1	3.1
3. Check for intergranular corrosion resistance [2]: One specimen per melt and heat treatment batch each	3.1	3.1
4. Tensile test at room temperature: Lot size and extent of testing in acc. with DIN EN 10217-7 section 10.1 and Table 13	3.1	3.2
5. Technological tests: Type and extent of testing acc. to DIN EN 10217-7 Tables 13 and 14	3.1	3.2
6. Visual inspection and dimensional check: Each tube; surface condition in acc. with purchaser's specification	3.1	3.2
7. Material identification check: Each tube, e.g. by spectroscopy	3.1	3.1
8. Non-destructive testing: Type and extent of testing acc. to DIN EN 10217-7 section 11.11 and Table 13	3.1	3.2
9. Tightness test: Each tube in acc. with section 11.8 of DIN EN 10217-7	3.1	3.1
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark		

[1] Repair welding in the base material is not permitted.

[2] According to DIN EN ISO 3651-2 procedure A sensitisation T1 or T2 and only if the parts are being welded and are in contact with water.

Materials test sheet 16: Bars and forgings made of stainless martensitic steels according to DIN EN 10088-3 or DIN EN 10250-4

MATERIALS TEST SHEET		**WPB 16**
Load attachment points		
Product form: Bars and forgings		
Materials: X17CrNi16-2 - QT800 (1.4057), X39CrMo17-1 - QT750 (1.4122), X3CrNiMo13-4 - QT780 (1.4313), X5CrNiCuNb16-4 - P800 (1.4542), X5CrNiCuNb16-4 - P930 (1.4542)		
Requirements: DIN EN 10088-3 [1)] or DIN EN 10250-4 [1)]		
Tests and inspections	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Chemical composition: Ladle analysis	3.1	3.1
2. Attestation of heat treatment condition (for 1.4313 indication of strength grade)	3.1	3.1
3. Tensile test at room temperature: Test lot and extent of testing according to DIN EN 10088-3 Table 26 or section 11 of DIN EN 10250-1	3.1	3.2
4. Notched bar impact test at room temperature: Test lot and extent of testing as for tensile test (only for nominal dimension ≥ 15 mm)	3.1	3.2
5. Hardness test for verification of uniform heat treatment: On one end of each part three measuring points each	3.1	3.1
6. Visual inspection and dimensional check: Each part, surface quality and dimensions in acc. with purchaser's specification	3.1	3.2
7. Material identification check: Each part, e.g. by spectroscopy	3.1	3.1
8. Ultrasonic testing: For bar steel with product thicknesses ≥ 30 mm and forgings with a weight in final heat treatment condition ≥ 300 kg, each part subject to 100 % in acc. with **Annex B**	3.1	3.2
Material identification: Manufacturer's mark, steel grade, melt number, specimen number or identification number, inspector's mark		
1) Repair welding is not permitted.		

Materials test sheet 17: Plates, sheets and strips made of zirconium alloys

MATERIALS TEST SHEET	**WPB 17**
Load attachment points	
Product form: Plates, sheets and strips with thicknesses s ≤ 4.7 mm	
Materials: Zirconium alloys Grade R60802 or Grade R60804	
Requirements: ASTM B352/B352M	
Tests and inspections	Inspection certificate according to DIN EN 10204 for core components according to section 4.4
1. Chemical composition [1]: 1.1 On the ingot (ladle analysis) One specimen of head, middle and tail of each ingot	3.1
1.2 On the plate, sheet or strip (product analysis) One specimen per lot (considered to be a material identification check)	3.1
2. Tensile test at room temperature: One specimen in longitudinal and transverse direction each per lot in acc. with DIN EN ISO 6892-1 or ASTM E8/E8M	3.1
3. Corrosion resistance Two specimens per lot according to ASTM G2/G2M Test duration 72 h	3.1
4. Visual inspection and dimensional check: Each part, surface quality and dimensions in acc. with purchaser's specification	3.1
Material identification: Identification marking, melt number or ingot number or lot number, specimen number or plate, sheet, strip number respectively	
[1] The oxygen content is limited to 0.09 % up to 0.16 %.	

Materials test sheet 18: Forged bars and open-die forgings made of weldable fine grain structural steel according to DIN EN 10222-4

MATERIALS TEST SHEET		**WPB 18**
Load attachment points		
Product form: Forged bars and open-die forgings		
Materials: P355QH1 (1.0571), P420QH (1.8936)		
Requirements: DIN EN 10222-1 [1)] und DIN EN 10222-4 [1)]		
Tests and inspections	Inspection certificate according to DIN EN 10204 for	
	additional requirements according to section 4.2	increased requirements according to section 4.3
1. Chemical composition: Ladle analysis	3.1	3.1
2. Heat treatment condition	3.1	3.1
3. Tensile test at room temperature: Test lot and extent of testing according to section 7 of DIN EN 10222-1	3.1	3.2
4. Notched bar impact test at test temperature according to DIN EN 10222-4 Table 5: Test lot and extent of testing as for tensile test (only for nominal dimension ≥ 15 mm)	3.1	3.2
5. Visual inspection and dimensional check: Each part, surface quality and dimensions in acc. with purchaser’s specification	3.1	3.2
6. Material identification check: Each part, e.g. by spectroscopy	3.1	3.1
7. Ultrasonic testing: For bar steel with product thicknesses ≥ 30 mm and forgings with a weight in final heat treatment condition ≥ 300 kg, each part subject to 100 % in acc. with **Annex B**	3.1	3.2
Material identification: Manufacturer's mark, steel grade, melt number, specimen number, inspector's mark		
[1)] Repair welding is not permitted.		

Annex B

Non-destructive testing (NDT)

Contents

B 1 Scope

(1) This Annex applies to the performance of non-destructive tests and contains procedural requirements and evaluation criteria for non-destructive testing.

(2) Deviations from this Annex may be possible in justified individual cases.

Note:
The procedure, extent and point in time of NDT are laid down in material test sheets as well as in test and inspection sequence plans for final inspection.

B 2 General specifications

B 2.1 Personnel

(1) Test supervisors shall have the technical knowledge required to perform their tasks and know the possibilities of application as well as limits of test procedures. The test supervisory personnel

a) in case of production tests, shall have basic knowledge of the fabrication processes used and of the characteristic appearance of fabrication imperfections; they shall normally be independent from the fabrication department and the authorized inspector shall be notified of their names;

b) in case of in-service inspections, shall be familiar with the characteristic features of operationally caused defects.

The test supervisory personnel is responsible for the application of the test procedure and for the details of the implementation of the test in accordance with the relevant specifications. They are responsible for the employment of qualified and certified NDT operators. This applies also to the employment of personnel not belonging to the works. The test supervisory personnel shall sign the test report.

(2) The test supervisory personnel shall have been qualified and certified for the examination procedures in the relevant product or industrial sectors at least with level 2 according to DIN EN ISO 9712. For radiographic and ultrasonic testing level 3 qualification and certification is required.

(3) The NDT operators shall have been qualified and certified according to DIN EN ISO 9712 for the applicable examination procedure in the relevant product or industrial sectors. For radiographic and ultrasonic testing at least level 2 qualification and certification is required.

B 2.2 Equipment and test fluids

The measuring and testing equipment to be used shall be monitored. The type and intervals of monitoring shall be fixed by the equipment manufacturer with a view to the accuracy of the equipment. The testing of such measuring and testing equipment shall be certified.

B 2.3 Requirements for surfaces

(1) The surfaces shall be free from scale, weld spatters or any other contaminants. Any grooves or notches affecting the test result shall be eliminated.

(2) The arithmetical mean deviation of the assessed profile (average roughness) Ra according to DIN EN ISO 4287 shall not exceed

a) 10 µm for surface inspection by magnetic particle and penetrant testing,

b) 20 µm for ultrasonic testing on the scanning and opposite surface if it is used as reflection surface.

(3) In the case of waviness of the scanning surfaces for ultrasonic testing the waviness shall be so little as to provide sufficient probe shoe contact. This is generally the case if the distance between probe shoe surface and scanning surface does not exceed 0.5 mm at any point.

(4) Coatings with a thickness up to and including 50 µm are permitted when performing non-destructive examinations, except for surface inspection by penetrant testing.

(5) Upon completion of the examination the parts shall be properly cleaned to remove test liquid residuals.

B 2.4 Point in time of NDT during production testing

The product forms shall be tested in the as-delivered condition and weld seams in the final-heat treatment condition, where possible, and prior to any coating.

B 3 NDT procedural requirements

B 3.1 Visual inspection

Visual inspection shall be performed according to DIN EN ISO 17637.

B 3.2 Surface inspection by magnetic particle and penetrant testing

B 3.2.1 Viewing conditions

(1) The viewing conditions of DIN EN ISO 3059 shall be met. In addition, the requirements of para. (2) to (5) shall be observed.

(2) The eyes of the operator shall have at least 5 minutes to adapt to the light conditions.

(3) For the purpose of better detectability of defects sufficient contrast shall be provided in magnetic particle testing by the use of suitable media (e.g. fluorescent detection media or application of a thin colour coat only slightly covering the underground). UV-A radiation may additionally be used to improve the contrast in penetrant testing using fluorescent penetrants.

(4) During the examination the angle of viewing shall not deviate by more than 30 degrees from the surface normal. During viewing the distance to the test surface shall normally be approximately 300 mm.

(5) For the inspection auxiliary means (e.g. magnifying glasses, contrast-improving spectacles, mirrors) are permitted.

B 3.2.2 Magnetic particle testing

B 3.2.2.1 Methods and performance of examination

Magnetic particle testing shall be performed according to DIN EN ISO 9934-1 using the wet technique and in accordance with the following requirements.

B 3.2.2.1.1 Methods

(1) Where magnetisation is achieved in partial areas by the current flow technique or yoke magnetisation, AC magnetisation shall normally be used.

(2) The residual magnetic field strength shall not exceed 800 A/m unless a lower value is required. Where the specified value is exceeded, the part shall be demagnetised and the value of the residual magnetic field strength be recorded.

(3) For the magnetic particle testing techniques the following identifying characters shall be used:

Magnetic particle testing technique		Characters
Yoke magnetization	with permanent magnet	JD
	with electromagnet	JE
Magnetization by current carrying-conductors	with coil	LS
	with other conductors (cable)	LK
Magnetization by current flow	self-induced current	SS
	induced current flow	SI

B 3.2.2.1.2 Contact areas in case of current flow technique

(1) Where the test is performed by current flow technique, consumable electrodes (e.g. lead fin alloys) shall be used, if possible. It shall be ensured that in the contact areas overheating of the material to be tested is avoided.

(2) Where overheating has occurred the overheated areas shall be marked, ground over after the examination and be subject to surface inspection, preferably by magnetic particle testing using yoke magnetisation.

B 3.2.2.1.3 Direction of magnetisation

Each location on the surface shall be tested from two directions of magnetisation offset by approximately 90 degrees.

B 3.2.2.1.4 Magnetic field strength

(1) In the case of AC magnetisation the tangential field strength on the surface shall normally be at least 2 kA/m and shall not exceed 6.5 kA/m.

Note:

a) The required magnetic flux density in the test object surface of at least 1 Tesla will be obtained in low-alloy or low-carbon steels with high relative permeability as early as at a tangential field strength of 2 kA/m.

b) For other steels with lower permeability a higher field strength may be required.

c) Where magnetisation is too high, structural indications (spurious indications) may cover relevant indications.

(2) It shall be checked by measurements that these values are adhered to or test conditions shall be determined under which these values may be obtained.

B 3.2.2.1.5 Magnetisation times

The following guide values apply with respect to the application of the magnetic particles and magnetisation:

a) Magnetisation and wetting: at least 3 seconds

b) Post-magnetisation time: at least 5 seconds.

B 3.2.2.2 Detection media

(1) Detection media shall be used that have been type-tested in accordance with DIN EN ISO 9943-2. Verification of such type testing shall be submitted to the authorized inspector.

(2) Magnetic particles with an average grain size smaller than or equal to 8 µm shall be used. Depending on application, black, fluorescent or coloured powders may be used.

(3) Immediately prior to wetting the surface care shall be taken to ensure that the magnetic powder is distributed uniformly in the carrier liquid and is kept in suspension. Prior to and during testing the powder suspension shall be spot-checked by suitable pre-magnetised calibration blocks.

B 3.2.2.3 Test instruments

The test instruments shall meet the requirements of DIN EN ISO 9934-3.

B 3.2.3 Penetrant testing

B 3.2.3.1 Test system

(1) Colour contrast penetrants shall preferably be used. Fluorescent penetrants or fluorescent colour contrast penetrants may be used.

(2) Solvents or water or both in combination may be used as penetrant remover.

(3) Only solvent based wet developers shall be used. Dry developers may only be applied on the test surface by electrostatic spraying.

(4) For the test system at least sensitivity class “highly sensitive” according to DIN EN ISO 3452-2 shall be adhered to.

(5) The suitability of the test system (penetrant, solvent remover and developer) shall be demonstrated by type testing according to DIN EN ISO 3452-2. Verification shall be submitted to the authorized inspector.

(6) Penetrants in test equipment and partly used open tanks (except for aerosol cans) shall be monitored by the user using the reference block 2 according to DIN EN ISO 3452-3. In this test the penetration and development times shall not exceed the times specified for the evaluation. The examination sensitivity obtained shall be recorded.

B 3.2.3.2 Performance

(1) Penetrant testing shall be performed in accordance with DIN EN ISO 3452-1 and the following requirements.

(2) The penetration time shall be at least half an hour.

(3) Immediately after drying of the developer a first inspection shall normally be made. A further inspection shall normally be made not earlier than half an hour after the first inspection has passed.

(4) Further points in time of inspection are required if indications are detected during one of the inspections or if essential changes of indications or additional indications are detected compared with the previous inspection.

(5) The evaluation shall be made in due consideration of all inspection results.

B 3.3 Radiographic testing

(1) Radiographic testing of weld seams shall be performed according to DIN EN ISO 17636-1 class B.

(2) The image quality indicators according to DIN EN ISO 19232-1 shall be used.

B 3.4 Ultrasonic testing

B 3.4.1 Requirements for test frequencies, transducer dimension and scanning positions

The test frequency, transducer dimension and scanning positions are laid down in sections B 4 to B 6. These specifications are considered guide values from which deviations are possible in justified cases.

B 3.4.2 Performance

B 3.4.2.1 Basic specifications for ultrasonic testing

(1) Depending on design and material, the tests on product forms shall be performed based on the standards DIN EN 10228-3, DIN EN 10228-4 or DIN EN 10308.

(2) The test shall be performed in a state of simple geometry (with plane-parallel or cylindrical surfaces, pre-machined where required) in which case the full volume shall be tested.

(3) Section B 6 shall apply to ultrasonic testing of weldings.

B 3.4.2.2 Test instructions

The details for ultrasonic testing shall be laid down in test instructions if

a) it is required by the standards applied,

b) parts are tested for which test instructions are required in section B4,

c) the geometries to be tested are not covered by sections B 4 and B 5,

d) attachment weld seams are to be tested.

B 3.4.2.3 Setting the testing level

(1) The testing level shall be set on the test object, on calibration block no. 1 according to DIN EN ISO 2400 or on calibration block No. 2 according to DIN EN ISO 7963 or on reference blocks by using suitable reference reflectors.

(2) The reference block must correspond to the test object as regards the test-relevant characteristics (material, constructional design, shape, wall thickness, heat treatment). The wall thickness of the reference block shall deviate not more than 10 % from that of the test object.

(3) Reference reflectors may be back walls, notches and boreholes.

(4) Setting the testing level shall be carried out according to DIN EN ISO 16811.

B 4 Performance and evaluation of testing on ferritic product forms

B 4.1 Bars

B 4.1.1 Surface inspection

(1) The entire surface shall be tested in its finished condition. Magnetic particle testing shall preferably be used.

(2) The magnetic particle test shall be performed and evaluated in compliance with the requirements of DIN EN 10228-1, quality class 4. In addition, the stipulations laid down in B 3.2.2 shall apply. The evaluation shall be made during post-magnetization.

(3) The penetrant test shall be performed and evaluated in compliance with the requirements of DIN EN 10228-2, quality class 4. In addition, the stipulations laid down in B 3.2.3 shall apply.

B 4.1.2 Ultrasonic testing

B 4.1.2.1 Performance

Section B 3.4 applies to the performance of ultrasonic testing.

B 4.1.2.2 Scanning positions, scanning conditions and evaluation

(1) The scanning positions for round bars are shown in **Figure B-1**, those for rectangular or polygonal bars in **Figure B-2**.

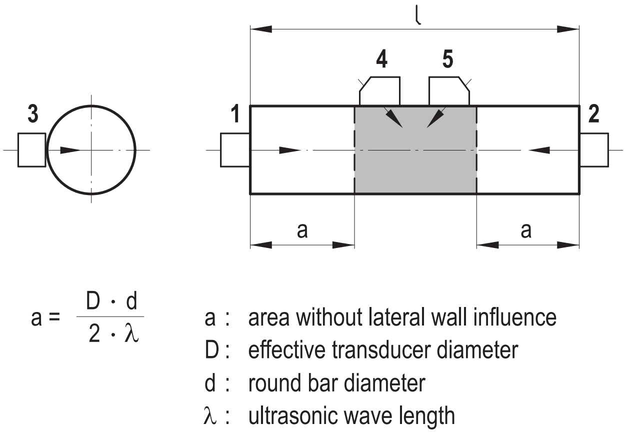


Figure B-1: Scanning positions for round bars

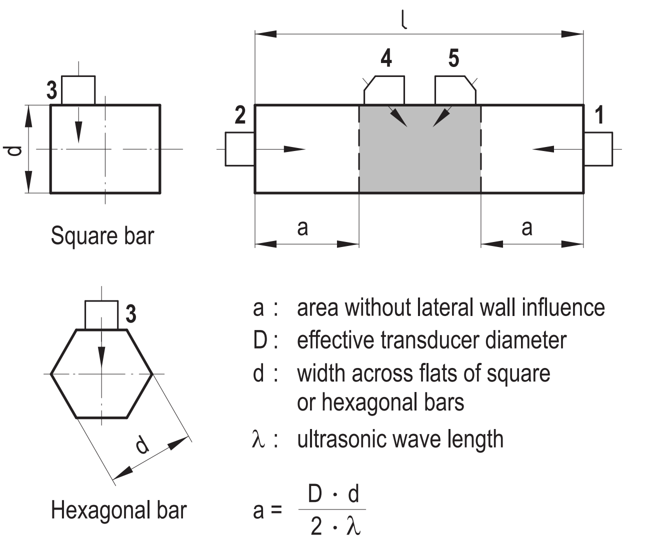


Figure B-2: Scanning positions for rectangular or polygonal bars

(2) On bars with diameters or side lengths exceeding 30 mm ultrasonic testing shall be performed according to DIN EN 10228-3 to an extent of 100 % in due consideration of the stipulations in (3) and (4).

Note:
For straight beam scanning the requirements of DIN EN 10228-3 are also met by DIN EN 10308.

(3) In case of diameters or side lengths exceeding 60 mm straight beam scanning in axial direction shall be performed additionally (positions 1 and 2); where in this case no distance between recording level and noise level of at least 6 dB can be adhered to over the entire length of the bar, the test shall be performed in the cut-to-length condition or using 45° angle beam scanning in both axial directions (positions 4 and 5).

(4) The following shall apply to the evaluation:

a) for straight beam scanning on bars with diameters or side lengths equal to or less than 60 mm: quality class 3
b) for straight beam scanning on bars with diameters or side lengths exceeding 60 mm: quality class 2
c) for angle beam scanning: quality class 2

according to DIN EN 10228-3 and the recording levels and acceptance criteria resulting herefrom.

B 4.2 Bolts and trunnions

B 4.2.1 Surface inspection

The surface inspection shall be performed and evaluated in accordance with B 4.1.1.

B 4.2.2 Ultrasonic testing

B 4.2.2.1 Extent and point in time of testing

The test shall be performed in a state of simple geometry (with plane-parallel or cylindrical surfaces, pre-machined where required) in which case the full volume shall be tested. Edges with weld preparation, if any, shall be indicated for testing. When examining the weld edge areas the conditions of testing after welding shall be considered.

B 4.2.2.2 Scanning conditions

(1) The parts shall be tested such that each volumetric area is tested from at least two scanning positions offset by approximately 90 degrees. If this cannot be done by straight beam scanning, angle beam scanning from two opposite directions shall be performed for each straight-beam scanning omitted.

(2) For rough-turned cylindrical non-stepped bolts and trunnions the scanning positions of B 4.1.2.2 shall apply.

(3) **Figure B-3** shows examples of scanning positions for rough-turned stepped bolts and trunnions.

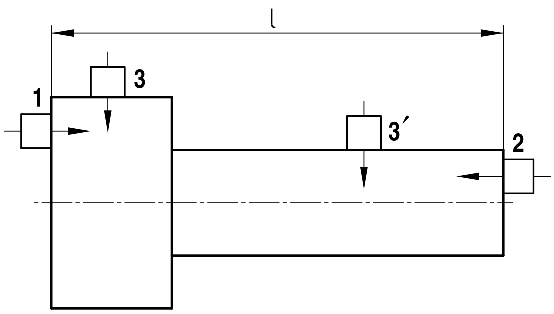


Figure B-3: Scanning positions for stepped bolts and trunnions (example)

(4) Test instructions shall be established for bolts and trunnions, if the scanning conditions of subparas 2 and 3 cannot be applied (e.g. due to specific geometric conditions).

B 4.2.2.3 Evaluation

The evaluation shall be made in accordance with **Table B-1**.

Scanning positions	1 and 2	3
Recording level (diameter of equivalent flat bottom hole d_{eq} in mm)	$60 < d \leq 120 : 4$ $d > 120 : 6$	$d \leq 60 : 3$ $60 < d \leq 120 : 4$ $d > 120 : 6$
Permissible excess of echo amplitude over the recording level, dB	< 6	< 6
Permissible half-amplitude length [1]), mm	≤ 10	≤ d, maximum 50
Allowable frequency of indication per metre	5	$d \leq 60 : 3$ $d > 60 : 5$

[1]) When evaluating the half-amplitude length of reflectors, the probe displacement at a signal amplitude drop of 6 dB to the maximum echo height shall be determined.

Table B-1: Evaluation of ultrasonic testing on bolts and trunnions

B 5 Performance and evaluation of testing on product forms made of austenitic steels (rolled or forged components)

B 5.1 Surface inspection

(1) The entire surface shall be tested in its finished condition.

(2) The requirements according to DIN EN 10228-2, quality class 4, shall apply to the performance and evaluation. In addition, the stipulations laid down in B 3.2.1 and B 3.2.3 apply.

B 5.2 Ultrasonic testing

B 5.2.1 Extent and point in time of testing

The test shall be performed in a state of simple geometry (with plane-parallel or cylindrical surfaces, pre-machined where required) in which case the full volume shall be tested.

B 5.2.2 Determination of testability

(1) For the purpose of determining the test object testability the back wall echoes shall be determined in a grid by straight-beam scanning in wall thickness direction. In areas of non-parallel or non-concentric walls reference echoes shall be used for this test (e.g. bores available, edges or through transmission).

(2) For the area with the largest determinable sound attenuation it shall be proved that the required recording levels can be observed.

B 5.2.3 Scanning conditions

The specifications of section B 4 shall apply to the scanning conditions. The test frequencies shall normally range from 2 MHz to 4 MHz.

B 5.2.4 Performance and Evaluation

(1) The performance shall be made in accordance with the respective specifications of section B 4, however, the standard DIN EN 10228-4 shall be used instead of DIN EN 10228-3.

(2) The following shall apply to the evaluation:

a) quality class 2 for straight beam scanning on bars with diameters or side lengths equal to or less than 250 mm,

b) quality class 3 for straight beam scanning on bars with diameters or side lengths exceeding 250 mm

according to DIN EN 10228-4 and the recording levels and acceptance criteria resulting herefrom.

B 6 Performance and evaluation of testing on welded connections between ferritic steels

B 6.1 General

The examination area shall include the weld metal and the adjacent base metal on both sides over a width of

a) 10 mm on each side for wall thicknesses equal to or smaller than 30 mm,

b) 20 mm on each side for wall thicknesses exceeding 30 mm.

B 6.2 Ultrasonic testing of weld junction areas for plates under tensile stress in thickness direction

Ultrasonic testing of the weld junction areas on plates shall be effected in accordance with DIN EN 10160. The tested weld junction areas shall meet the requirements of quality class E_4 of DIN EN 10160, Table 5. The test shall be performed with the recording level of 3 mm disc shaped reflector.

B 6.3 Visual inspection of weld seams

B 6.3.1 Performance

The visual inspection shall be performed according to DIN EN ISO 17637.

B 6.3.2 Evaluation

The evaluation of imperfections in fusion-welded joints of steel, nickel, titanium and their alloys (beam welding excluded) is carried out according to DIN EN ISO 5817 and the evaluation of electron and laser-beam welded joints in steel, nickel, titanium and their alloys according to DIN EN ISO 13919-1. The requirements of quality level B shall be met in each case.

B 6.4 Surface inspection of weld seams

B 6.4.1 Performance

(1) Surface inspection shall be performed in accordance with clause B 3.2.2 or B 3.2.3.

(2) As far as practicable, magnetic particle testing shall be performed. The evaluation shall be made during post-magnetization.

B 6.4.2 Evaluation

(1) Indications which suggest the presence of crack-like defects are not permitted. Indications with a maximum extension equal to or smaller than 1.5 mm detected by magnetic particle testing and indications equal to or smaller than 3 mm detected by penetrant testing shall not be included in the evaluation. Indications proved to be non-metallic inclusions as well as rounded indications up to an extension of 6 mm are permitted.

(2) The frequency of permissible indications may locally be up to 3 per 100 mm weld seam length.

(3) In the case of larger dimensions or frequency or systematically occurring irregularities these locations shall be repaired or decision shall be made jointly with the authorized inspector on the acceptability of the component.

B 6.5 Radiographic testing of weld seams

(1) Radiographic testing shall be performed and evaluated in accordance with section B 3.3.

(2) For the evaluation acceptance level 1 according to DIN EN ISO 10675-1 applies.

B 6.6 Ultrasonic testing of weld seams

B 6.6.1 Butt welds

(1) All butt welds shall be scanned from both sides for presence of longitudinal and of transverse defects. The scanning positions are shown in **Table B-2**. Setting the testing level shall preferably be performed in accordance with the DGS method. When the reference block method or the DAC method is used, the reference reflectors to **Figure B-4** shall be used for setting the testing level.

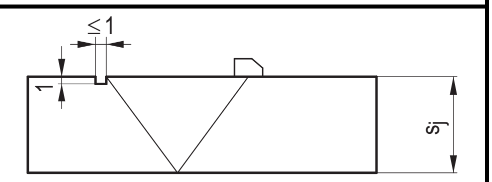
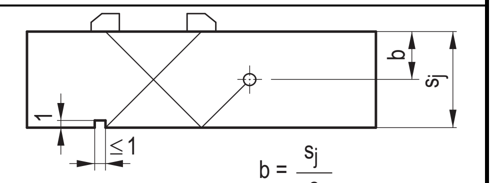
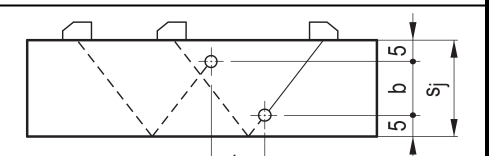
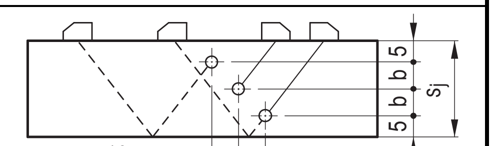
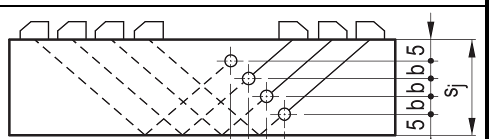
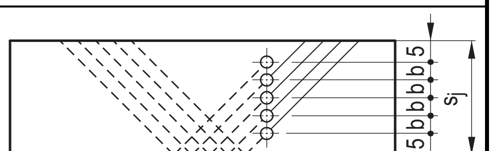
Wall thickness or nominal wall thickness of the test object, mm	Side view of the reference block
$s \leq 10$	
$10 < s \leq 15$	 $b = \frac{s_j}{2}$
$15 < s \leq 20$	 $b = s_j - 10$
$20 < s \leq 40$	 $b = \frac{s_j - 10}{2}$
$40 < s \leq 80$	 $b = \frac{s_j - 10}{3}$
$s > 80$	 $b = \frac{s_j - 10}{4}$
The length of the reference reflectors shall be at least the beam width referred to a 20 dB echo amplitude decrease regarding the maximum sound path to the reference reflector.	

Figure B-4: Reference blocks for setting the testing level when using the DAC method- or the reference block method

(2) The scanning conditions shall be taken from **Table B-3**. The beam angle in the test for transverse defects shall normally be selected such that the angle of incident on defects which are perpendicular to the surface is as small as possible.

(3) In the case of differing nominal wall thicknesses the greater nominal wall thickness shall govern the determination of the number of beam angles and the smaller nominal wall thickness shall govern the determination of the recording level.

(4) The evaluation of longitudinal defects shall be made in accordance with **Tables B-4** and **B-5**.

(5) The recording level for the examination for transverse defects shall be taken from **Table B-4**. Indications reaching or exceeding the recording level are permitted only if they occur individually and as spots and if they are not accompanied by frequent indications up to 12 dB below the recording level.

(6) In the case of unacceptable indications it may be demonstrated by further examinations (e.g. by radiography, by telltale holes) that the use of the part or component is permitted.

(7) Where recordable echoes are to be classified as indications due to external contour, control measurements to detect the cause of indication shall be performed.

(8) Where, by measurement of the projection distances on the test piece, it shall be proved that the echoes recorded on both sides of the weld are caused by the two faces of an unmachined weld root and not by weld defects, the exact projection distance shall be determined on reference blocks. If the locations of the reflections are found to be distinctly separate from each other, the indications are considered due to external contour. Where a distance of less than 3 mm is found, the reflections shall not be treated as separate reflections.

(9) Indications due to external contour shall be entered in the test reports with indication of location, position and size.

B 6.6.2 Attachment weld seams

(1) The ultrasonic testing of attachment weld seams shall be performed according to DIN EN ISO 17640 test class B.

(2) For the evaluation acceptance level 2 according to DIN EN ISO 11666 applies.

B 7 Performance and evaluation of testing on welded connections between austenitic steels

B 7.1 General

The area to be tested shall include the weld metal and the adjacent base metal on both sides over a width of

a) 10 mm on each side for wall thicknesses equal to or smaller than 30 mm,
b) 20 mm on each side for wall thicknesses exceeding 30 mm.

B 7.2 Ultrasonic testing of weld junction areas for plates under tensile loading in thickness direction

Ultrasonic testing of the weld junction areas on plates shall be effected in accordance with DIN EN 10307. The examined weld junction areas shall meet the requirements of quality class E_4 of DIN EN 10307, Table 5. The test shall be performed with the recording level of 3 mm disc shaped reflector.

B 7.3 Visual inspection of weld seams

B 7.3.1 Performance

The visual inspection shall be performed according to DIN EN ISO 17637.

B 7.3.2 Evaluation

The evaluation of imperfections in fusion-welded joints of steel, nickel, titanium and their alloys (beam welding excluded) is carried out according to DIN EN ISO 5817 and the evaluation of electron and laser-beam welded joints in steel, nickel, titanium and their alloys according to DIN EN ISO 13919-1. The requirements of quality level B shall be met in each case.

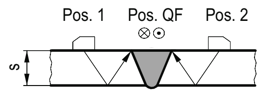
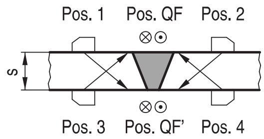
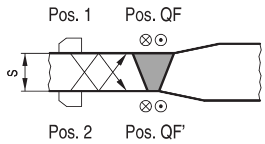
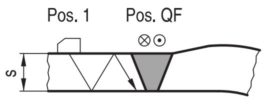
B 7.4 Surface inspection of weld seams

Surface inspection shall be performed and evaluated in accordance with section B 6.4 using penetrant testing according to section B 3.2.3.

B 7.5 Radiographic testing of weld seams

(1) Radiographic testing shall be performed in accordance with section B 3.3.

(2) For the evaluation the requirements of acceptance level 1 according to DIN EN ISO 10675-1 apply.

Ser. No.	Accessibility for scanning	Required surface condition of the weld seam	Scanning positions	
1	From both sides of the weld seam and from one surface at one skip distance	—		**Test for longitudinal defects:** Positions 1 and 2 at p 1) **Test for transverse defects:** Position QF at p in the two opposite directions on the weld seam 2).
2	From both sides of the weld seam and from both surfaces at ½ skip distance	—		**Test for longitudinal defects:** Positions 1 up to 4 at p/2 **Test for transverse defects:** Position QF at p or QF and QF′ at p/2, each in the two opposite directions on the weld seam 2)
3	From one side of the weld seam and from both surfaces at one skip distance	Outside and inside machined flat		**Test for longitudinal defects:** Positions 1 and 2 at p **Test for transverse defects:** Position QF at p or QF and QF′ at p/2, each in the two opposite directions on the weld seam
4	From one side of the weld seam and from one surface at 1 ½ skip distances. If s > 40 mm, second beam angle at one skip distance.	Outside and inside machined flat		**Test for longitudinal defects:** Position 1 at 3/2 p If s ≤ 20 mm position 1 using 60 degrees permitted. If s > 40 mm position 1 with second angle at p **Test for transverse defects:** Position QF at p in the two opposite directions on the weld seam

p : skip distance

1) In the case of wall thicknesses > 40 mm, this shall only apply to the smaller beam angle, the evaluation up to p/2 shall be sufficient for the large beam angle.

2) Where the test for transverse defects is not possible on the weld seam, the test may be performed at the base material surface adjacent to the weld seam (in an acute angle as possible to the weld seam).

Table B-2: Scanning positions for butt welds

Nominal wall thickness s, mm	s ≤ 20	20 < s ≤ 40	s > 40
Beam angle, general	70 degrees	60 degrees	45 degrees and 60 degrees
Beam angle in direction of curvature or in the case of wall thickness transitions	45 degrees up to 60 degrees	45 degrees up to 60 degrees	35 degrees up to 45 degrees and 60 degrees up to 70 degrees
Frequency, MHz	4	2 to 4	2 to 4

Table B-3: Scanning conditions for butt welds

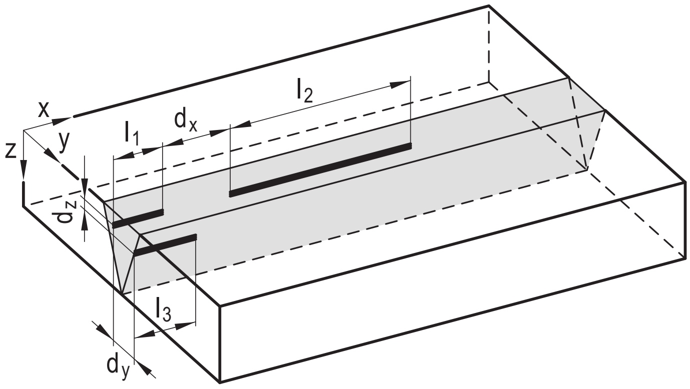
Reference reflector	Circular arc of calibration block no. 1 or no. 2 or side-drilled hole with a diameter of 3 mm or notch with a depth of 1 mm
Evaluation method	DGS or reference block method or DAC method
Recording level	$8 \le s \le 15$ 1.5 mm disc shaped reflector or 50 % echo amplitude of side-drilled hole or notch $15 \le s \le 40$: 2 mm disc shaped reflector or 50 % echo amplitude of side-drilled hole $s > 40$: 3 mm disc shaped reflector or 50 % echo amplitude of side-drilled hole
Permissible excess over the recording level	< 6 dB [1)]
Permissible length of recordable indications	in accordance with **Table B-5**
Permissible distances between recordable indications	For every two indications the distance of which is smaller than twice the length of the larger indication, the indication distance shall be covered by the evaluation. In this connection, particularly the orientation of the indications in relation to each other and in the weld seam, their reflection behaviour from different scanning directions and the wall thickness shall be taken into consideration. The following generally applies: a) Indications of the same position in depth direction (d_z < 2.5 mm) and the same position in width direction (d_y < 5 mm) shall have a distance from each other in the direction of welding of at least the length of the longer indication ($d_x \ge L_2$). Otherwise, the indications are considered to be continuous. Where more than two indications follow each other closely, they shall be compared to each other in pairs and shall fulfil the above criteria. b) Indications of the same position in width direction (d_y < 5 mm) shall have a distance from each other in thickness direction d_z exceeding half the length of the longer indication, but not less than 10 mm. c) Indication of the same position in depth direction (d_z < 2.5 mm) located side by side shall have a distance d_y of at least 10 mm in width direction. 
1) Per metre of weld seam an indication with a length ≤ 10 mm may exceed the recording level by up to 12 dB. When calculating the cumulative length this indication shall be considered with 10 mm.	

Table B-4: Evaluation of ultrasonic testing on butt welds

Nominal wall thickness s [1)] in mm	Maximum allowable length [1)] of individual reflectors	Allowable cumulated length (sum of individual reflector's lengths) per reference length [2)]
$15 < s \le 40$	≤ 25 mm, but ≤ s	$\le 1.5 \cdot s$
$40 < s \le 60$	≤ 30 mm	$\le 1.5 \cdot s$
$60 < s \le 120$	≤ 40 mm	$\le 2 \cdot s$
$s > 120$	≤ 50 mm	$\le 2 \cdot s$
1) When evaluating the length of reflectors, the probe displacement at a signal amplitude drop of 6 dB to the maximum echo height shall be determined (half-amplitude length). 2) The reference length is $6 \cdot s$.		

Table B-5: Acceptance length of recordable indications detected by ultrasonic testing for longitudinal defects

Annex C

Design of load attachment points and representation of the delimitation between load attachment point and load for several examples

Note:

☐ Load attachment point

■ Load

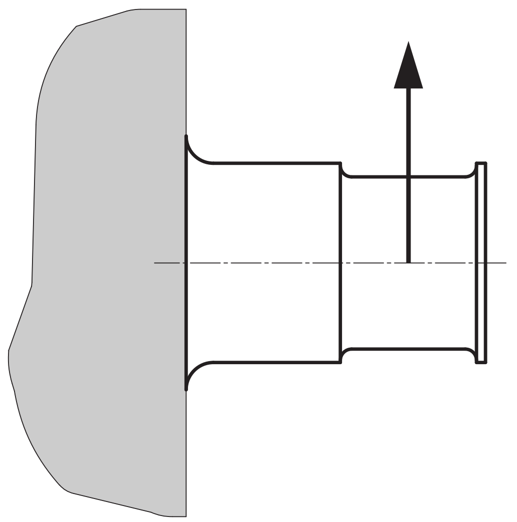
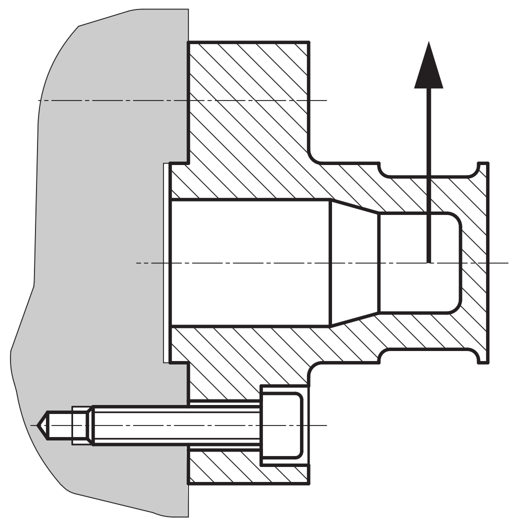


Fig. C-1: Trunnion (as integral part of load)



The internal thread in the load still belongs to the load attachment point, the sorrounding volume belongs to the load.

Fig. C-2: Trunnion (bolted on)

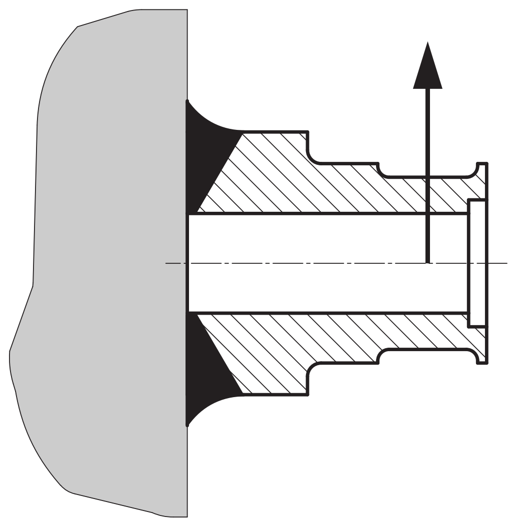
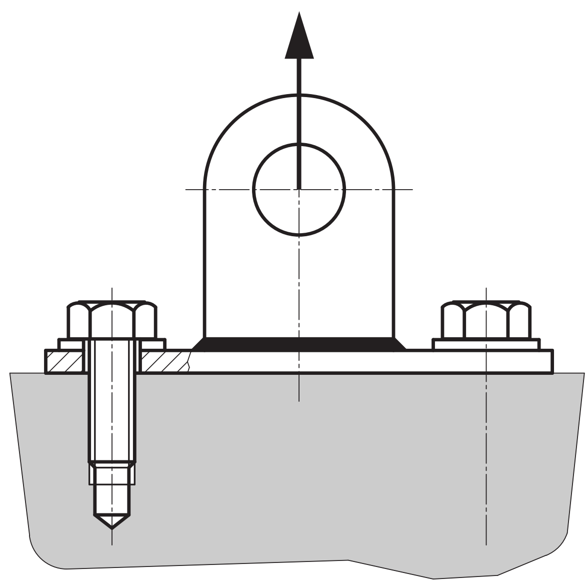


Fig. C-3: Trunnion (welded on)



The internal thread in the load still belongs to the load attachment point, the sorrounding volume belongs to the load.

Fig. C-4: Lifting lug (bolted on)

Note:

Load attachment point

Load

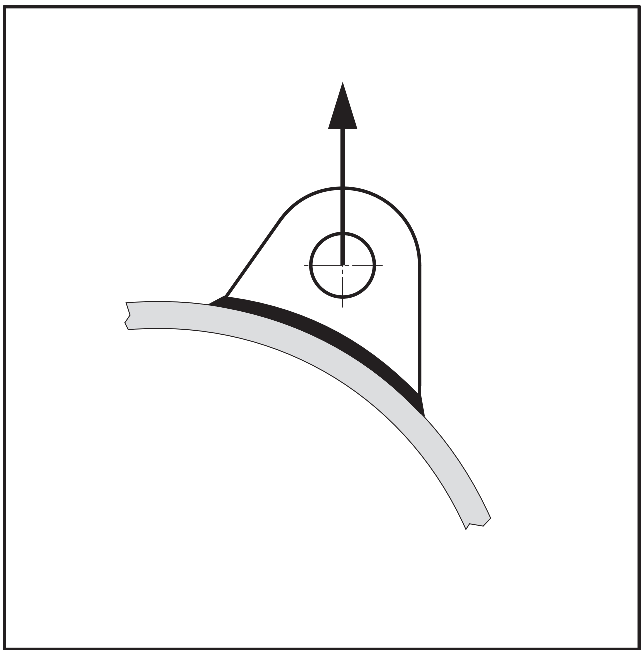


Fig. C-5: Eyelet (welded on)

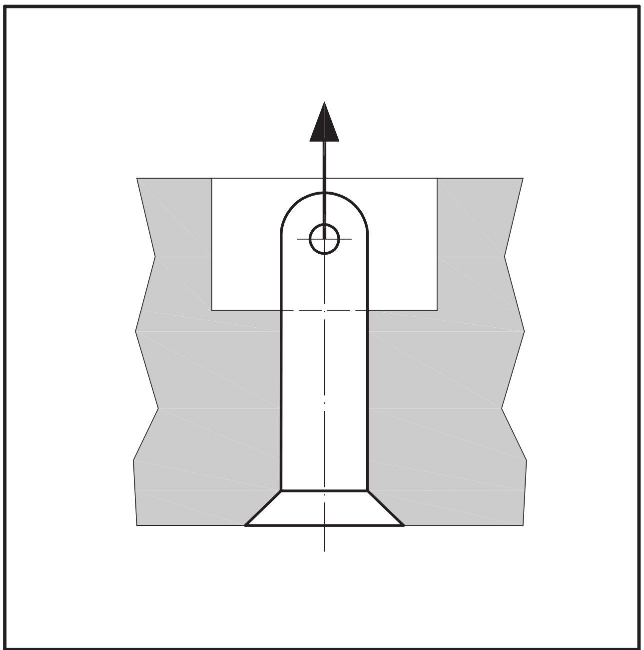


Fig. C-6: Tie bar anchored in concrete

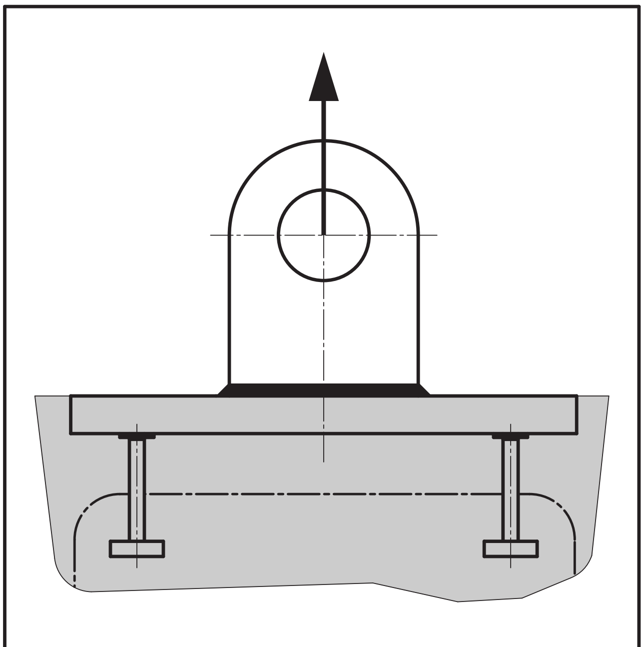


Fig. C-7: Lifting lug (under building regulation approved, welded-on an anchor plate anchored in concrete)

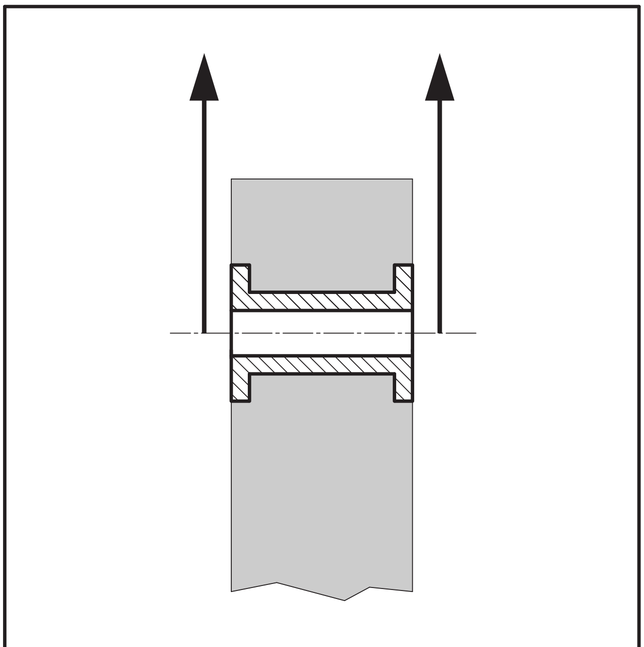
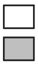


Fig. C-8: Reinforcement bolt bushing anchored in concrete

Note:



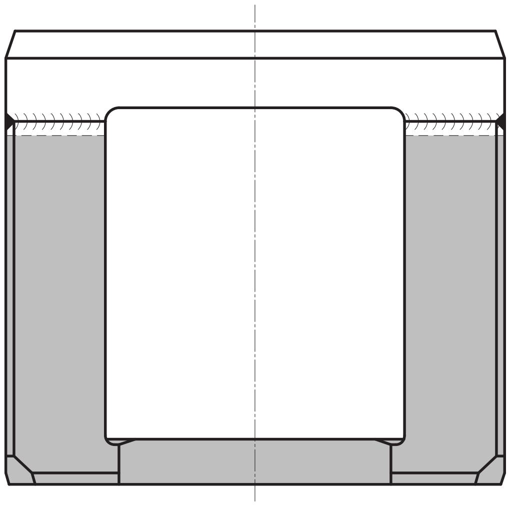


Fig. C-9: Fuel assembly head for PWR

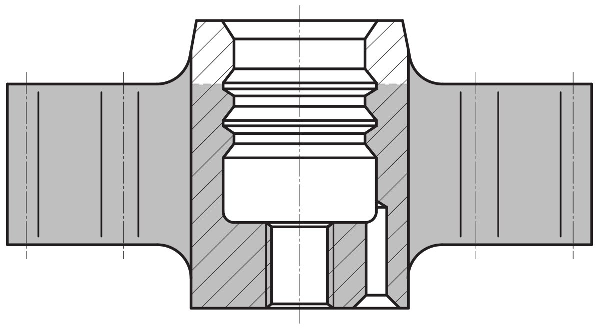


Fig. C-10: Control rod spider for PWR

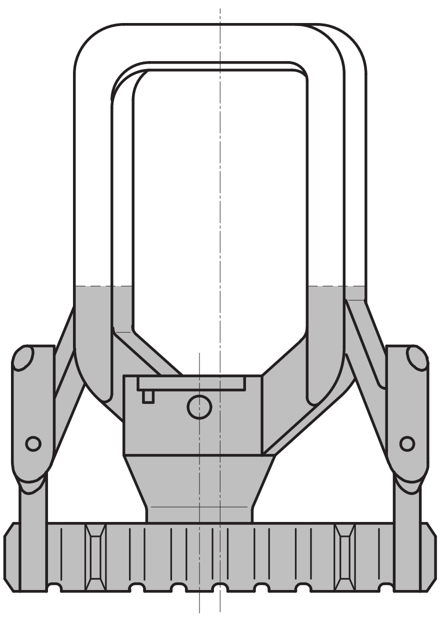


Fig. C-11: Fuel assembly head for BWR

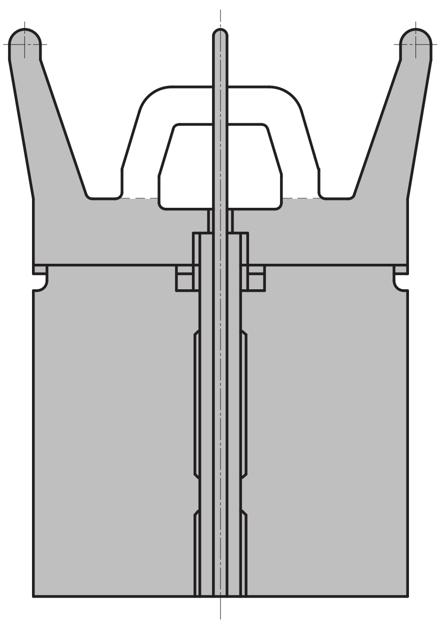


Fig. C-12: Control rod head for BWR

Annex D

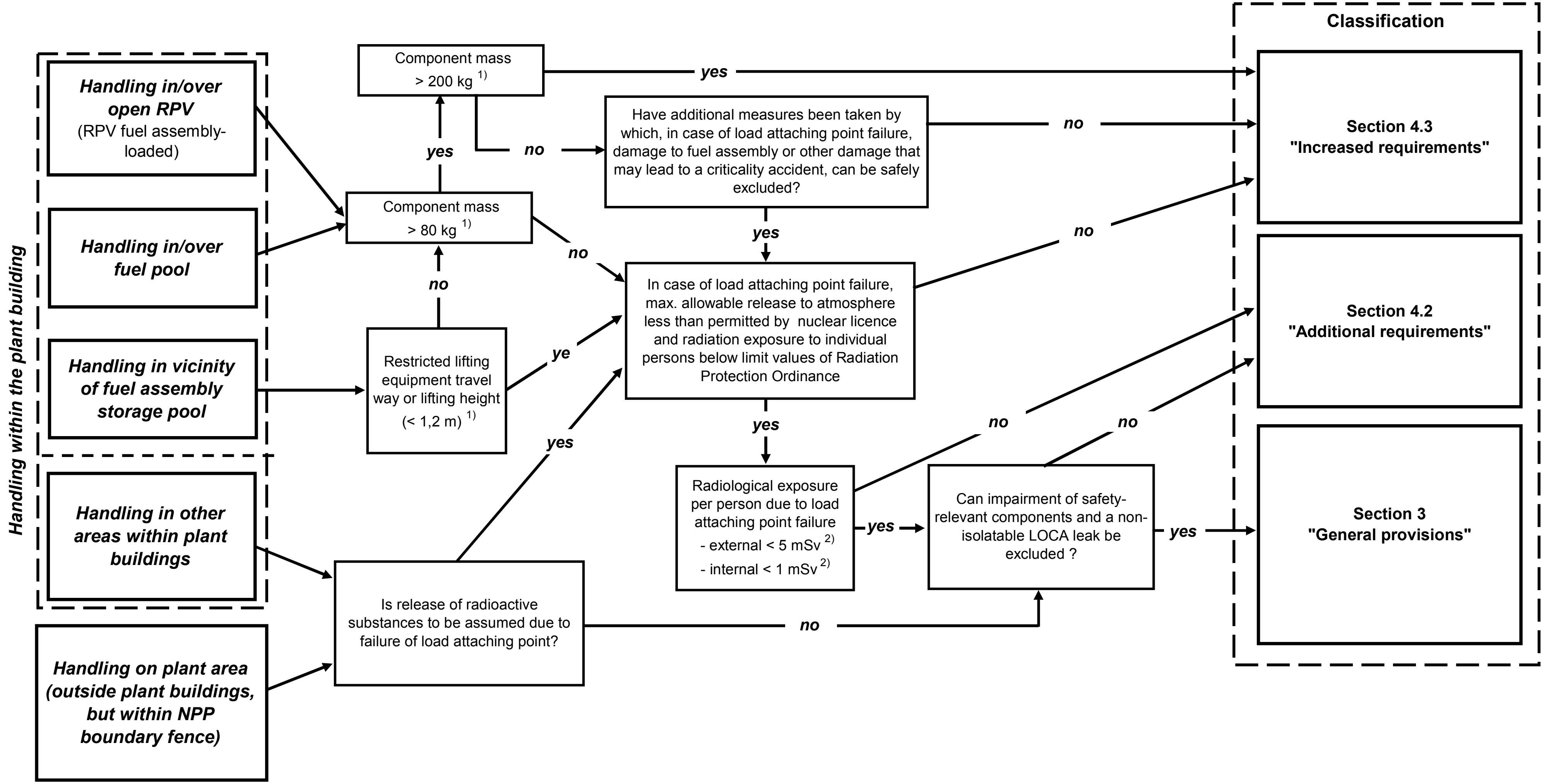
Examples for the classification of load attachment points

No.	Component	Additional requirements according to section 4.2	Increased requirements according to section 4.3
1	Reactor pressure vessel cover		X
2	Stud tensioner for reactor pressure vessel cover bolts	X	
3	Sluice gate for separate cask pool, sluice gate between reactor well and set-down area as well as sluice gate between fuel element storage pool and set-down area		X
4	Horizontal slab over reactor well and set-down area		X
5	Spent fuel transport container		X

Table D-1: Examples for a PWR plant

No.	Component	Additional requirements according to section 4.2	Increased requirements according to section 4.3
1	Reactor pressure vessel cover		X
2	Stud tensioner for reactor pressure vessel cover bolts	X	
3	Shielding slab in reactor well		X
4	Sluice gate between fuel element storage pool and set-down pool		X
5	Spent fuel transport container		X
6	Container for radioactive waste, provided it is handled in the storage pool area (e.g. container of the type MOSAIK and SAB)		X

Table D-2: Examples for a BWR plant



1) The numerical values are based on experience and are guide values only. Attachment points shall be classified in due consideration of the actual conditions (inter alia location of use, component geometry) within the nuclear licensing and supervisory procedure.

2) Attachment points shall be classified in due consideration of the actual conditions (inter alia location of use, frequency and duration of transport operations) within the nuclear licensing and supervisory procedure.

Figure D-1: Examples for procedural steps of classifying load attachment points

Annex E

Regulations and literature referred to in this Safety Standard

(The references exclusively refer to the version given in this annex. Quotations of regulations referred to therein refer to the version available when the individual reference below was established or issued.)

Atomic Energy Act (AtG)		Act on the Peaceful Utilization of Atomic Energy and the Protection against its Hazards (Atomic Energy Act) in the Version Promulgated on July 15, 1985 (BGBl. I, p. 1565), most recently changed by article 239 of the Ordinance dated June 19, 2020 (BGBl. I, p. 1328
StrlSchG		Act on the Protection against the Harmful Effect of Ionising Radiation (Radiation Protection Act - StrlSchG) of June 27, 2017 (BGBl. I, p. 1966), most recently changed by Article 5, Sec. 1 of the Act dated October 23, 2020 (BGBl. I p. 2232)
StrlSchV		Ordinance on the Protection against the Harmful Effect of Ionising Radiation (Radiation Protection Ordinance - StrSchV) of November 29, 2018 (BGBl. I, p. 2034, 2036), most recently changed by Article 1 of the Ordinance dated November 20, 2020 (BGBl. I p. 2502)
SiAnf	(2015-03)	Safety Requirements for Nuclear Power Plants (SiAnf) as Promulgated on March 3, 2015 (BAnz AT 30.03.2015 B2)
Interpretations	(2015-03)	Interpretations of the Safety Requirements for Nuclear Power Plants of November 22, 2012, as Amended on March 3, 2015 (BAnz. AT 30.03.2015 B3)
KTA 1202	(2017-11)	Requirements for the testing manual
KTA 1401	(2017-11)	General Requirements Regarding Quality Assurance
KTA 1404	(2013-11)	Documentation during the Construction and Operation of Nuclear Power Plants
KTA 3201.2	(2017-11)	Components of the Reactor Coolant Pressure Boundary of Light Water Reactors; Part 2: Design and analysis
KTA 3201.4	(2016-11)	Components of the reactor coolant pressure boundary of light water reactors; Part 4: In-service inspections and operational monitoring
KTA 3204	(2017-11)	Reactor Pressure Vessel Internals
KTA 3604	(2005-11)	Storage, Handling and Plant-internal Transport of Radioactive Substances in Nuclear Power Plants (with the Exception of Fuel Assemblies)
KTA 3902	(2020-12)	Design of lifting equipment in nuclear power plants
DIN EN ISO 683-1	(2018-09)	Heat-treatable steels, alloy steels and free-cutting steels - Part 1: Non-alloy steels for quenching and tempering (ISO 683-1:2016); German version EN ISO 683-1:2018
DIN EN ISO 683-2	(2018-09)	Heat-treatable steels, alloy steels and free-cutting steels - Part 2: Alloy steels for quenching and tempering (ISO 683-2:2016); German version EN ISO 683-2:2018
DIN EN 818-4	(2008-12)	Short link chain for lifting purposes – Safety - Part 4: Chain slings - Grade 8; German version EN 818-4:1996+A1:2008
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 898-1:2009); German version EN ISO 898-1:2009
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 ISO 965-2	(1999-11)	ISO general purpose metric screw threads - Tolerances - Part 2: Limits of sizes for general purpose external and internal screw threads; medium quality (ISO 965-2:1998); Corrigendum 2017-03
DIN EN 1090-2	(2018-09)	Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures; German version EN 1090-2:2018
DIN EN 1990	(2010-12)	Eurocode: Basis of structural design; German version EN 1990:2002 + A1:2005 + A1:2005/AC:2010
DIN EN 1990/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode: Basis of structural design / including corrigendum A1 (2012-08)
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

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 / including corrigendum A1 (2015-05)
DIN EN 1992-1-1	(2011-01)	Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings; German version EN 1992-1-1:2004 + AC:2010 / including corrigendum A1 (2015-03)
DIN EN 1992-1-1/NA	(2011-01)	National Annex - Nationally determined parameters - Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings / including corrigendum A1 (2015-05)
DIN EN ISO 2400	(2013-01)	Non-destructive testing - Ultrasonic testing - Specification for calibration block No. 1 (ISO 2400:2012); German version EN ISO 2400:2012
DIN EN ISO 3059	(2013-03)	Non-destructive testing - Penetrant testing and magnetic particle testing - Viewing conditions (ISO 3059:2012); German version EN ISO 3059:2012
DIN EN ISO 3269	(2020-01)	Fasteners - Acceptance inspection (ISO 3269:2019); German version EN ISO 3269:2019
DIN EN ISO 3452-1	(2014-09)	Non-destructive testing - Penetrant testing - Part 1: General principles (ISO 3452-1:2013, Corrected version 2014-05-01); German version EN ISO 3452-1:2013
DIN EN ISO 3452-2	(2014-03)	Non-destructive testing - Penetrant testing - Part 2: Testing of penetrant materials (ISO 3452-2:2013); German version EN ISO 3452-2:2013
DIN EN ISO 3452-3	(2014-03)	Non-destructive testing - Penetrant testing - Part 3: Reference test blocks (ISO 3452-3:2013); German version EN ISO 3452-3:2013
DIN EN ISO 3506-1	(2010-04)	Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs (ISO 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 (ISO 3506-2:2009); German version EN ISO 3506-2:2009
DIN EN ISO 3651-2	(1998-08)	Determination of resistance to intergranular corrosion of stainless steels - Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels - Corrosion test in media containing sulphuric acid (ISO 3651-2:1998); German version EN ISO 3651-2:1998
DIN EN ISO 4042	(2018-11)	Fasteners - Electroplated coating systems (ISO 4042:2018); German version EN ISO 4042:2018
DIN EN ISO 4287	(2010-07)	Geometrical product specification (GPS). Surface texture: Profile method. Terms, definitions and surface texture parameters. (ISO 4287:1997); German version of EN ISO 4287:1998
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 6157-2	(2004-10)	Fasteners - Surface discontinuities - Part 2: Nuts (ISO 6157-2:1995); German version EN ISO 6157-2:2004
DIN EN ISO 6892-1	(2017-02)	Metallische Werkstoffe - Zugversuch - Teil 1: Prüfverfahren bei Raumtemperatur (ISO 6892-1:2016); Deutsche Fassung EN ISO 6892-1:2016
DIN EN ISO 7963	(2010-12)	Non-destructive testing - Ultrasonic testing - Specification for calibration block No. 2 (ISO 7963:2006); German version EN ISO 7963:2010
DIN EN ISO 9712	(2012-12)	Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712:2012); German version EN ISO 9712:2012
DIN EN ISO 9934-1	(2017-03)	Non-destructive testing - Magnetic particle testing - Part 1: General principles (ISO 9934-1:2016); German version EN ISO 9934-1:2016
DIN EN ISO 9934-2	(2015-12)	Non-destructive testing - Magnetic particle testing - Part 2: Detection media (ISO 9934-2:2015); German version EN ISO 9934-2:2015
DIN EN ISO 9934-3	(2015-12)	Non-destructive testing - Magnetic particle testing - Part 3: Equipment (ISO 9934-3:2015); German version EN ISO 9934-3:2015
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	(2019-10)	Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels; German version EN 10025-2:2019
DIN EN 10028-7	(2016-10)	Flat products made of steels for pressure purposes - Part 7: Stainless steels; German version EN 10028-7:2016
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 10160	(1999-09)	Ultrasonic testing of steel flat product of thickness equal to or greater than 6 mm (reflection method); German version EN 10160:1999
DIN EN 10164	(2018-12)	Steel products with improved deformation properties perpendicular to the surface of the product - Technical delivery conditions; German version EN 10164:2018
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 hollow sections of non-alloy and fine grain steels - Part 1: Technical delivery conditions; German version EN 10210-1:2006
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 10216-1:2002 + A1:2013
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, Corrigendum 2015-01
DIN EN 10217-1	(2005-04)	Welded steel tubes for pressure purposes - Technical delivery conditions - Part 1: Non-alloy steel tubes with specified room temperature properties; German version EN 10217-1:2002 + A1:2005
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 10222-1	(2017-06)	Steel forgings for pressure purposes - Part 1: General requirements for open die forgings; German version EN 10222-1:2017
DIN EN 10222-4	(2017-06)	Steel forgings for pressure purposes - Part 4: Weldable fine grain steels with high proof strength (includes Amendment A1:2001); German version EN 10222-4:2017
DIN EN 10222-5	(2017-06)	Steel forgings for pressure purposes - Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels; German version EN 10222-5:2017
DIN EN 10228-1	(2016-10)	Non-destructive testing of steel forgings - Part 1: Magnetic particle inspection; German version EN 10228-1:2016
DIN EN 10228-2	(2016-10)	Non-destructive testing of steel forgings - Part 2: Penetrant testing; German version EN 10228-2:2016
DIN EN 10228-3	(2016-10)	Non-destructive testing of steel forgings - Part 3: Ultrasonic testing of ferritic or martensitic steel forgings; German version EN 10228-3:2016
DIN EN 10228-4	(2016-10)	Non-destructive testing of steel forgings - Part 4: Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings; German version EN 10228-4:2016
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 10250-4	(2000-02)	Open die steel forgings for general engineering purposes - Part 4: Stainless steels; German version EN 10250-4:1999 / Correction 2008-12
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 10307	(2002-03)	Non-destructive testing - Ultrasonic testing of austenitic and austenitic-ferritic stainless steels flat products of thickness equal to or greater than 6 mm (reflection method); German version EN 10307:2001
DIN EN 10308	(2002-03)	Non-destructive testing - Ultrasonic testing of steel bars; German version EN 10308:2001
DIN EN ISO 10675-1	(2017-04)	Non-destructive testing of welds - Acceptance levels for radiographic testing - Part 1: Steel, nickel, titanium and their alloys (ISO 10675-1:2016); German version EN ISO 10675-1:2016
DIN EN ISO 10684	(2011-09)	Fasteners - Hot dip galvanized coatings (ISO 10684:2004 + Cor. 1:2008); German version EN ISO 10684:2004 + AC:2009
DIN EN ISO 11666	(2018-05)	Non-destructive testing of welds - Ultrasonic testing - Acceptance levels (ISO 11666:2010); German version EN ISO 11666:2018
DIN EN 13001-1	(2015-06)	Cranes - General design - Part 1: General principles and requirements; German version EN 13001-1:2015
DIN EN 13001-2	(2014-12)	Crane safety - General design - Part 2: Load actions; German version EN 13001-2:2014
DIN EN 13001-3-1	(2019-03)	Cranes - General Design - Part 3-1: Limit States and proof competence of steel structure; German version EN 13001-3-1:2012+A2:2018
DIN EN 13018	(2016-06)	Non-destructive testing - Visual testing - General principles; German version EN 13018:2016

DIN EN 13414-1	(2020-03)	Steel wire rope slings - Safety - Part 1: Slings for general lifting service; German version EN 13414-1:2003+A2:2008
DIN EN 13414-2	(2009-02)	Steel wire rope slings - Safety - Part 2: Specification for information for use and maintenance to be provided by the manufacturer; German version EN 13414-2:2003+A2:2008
DIN EN ISO 13919-1	(2020-03)	Electron and laser-beam welded joints - Requirements and recommendations on quality levels for imperfections - Part 1: Steel, nickel, titanium and their alloys (ISO 13919-1:2019); German version EN ISO 13919-1:2019
DIN 15018-1	(1984-11)	Cranes; Steel structures; Verification and analyses
DIN 15018-2	(1984-11)	Cranes; Steel structures; Principles of design and construction
DIN EN ISO 15614-1	(2017-12)	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 15614-1:2017); German version EN ISO 15614-1:2017
DIN EN ISO 16811	(2014-06)	Non-destructive testing - Ultrasonic testing - Sensitivity and range setting (ISO 16811:2012); German version EN ISO 16811:2014
DIN EN ISO 17636-1	(2013-05)	Non-destructive testing of welds - Radiographic testing - Part 1: X- and gamma-ray techniques with film (ISO 17636-1:2013); German version EN ISO 17636-1:2013
DIN EN ISO 17637	(2017-04)	Non-destructive testing of welds - Visual testing of fusion-welded joints (ISO 17637:2016); German version EN ISO 17637:2016
DIN EN ISO 17640	(2019-02)	Non-destructive testing of welds - Ultrasonic testing - Techniques, testing levels, and assessment (ISO 17640:2018); German version EN ISO 17640:2018
DIN 18800-7	(2008-11)	Steel structures - Part 7: Execution and constructor's qualification
DIN EN ISO 19232-1	(2013-12)	Non-destructive testing - Image quality of radiographs - Part 1: Determination of the image quality value using wire-type image quality indicators (ISO 19232-1:2013); German version EN ISO 19232-1:2013
DIN 25449	(2016-04)	Reinforced and pre-stressed concrete components in nuclear facilities - Safety concept, actions, design and construction
DIN EN 26157-1	(1991-12)	Fasteners; surface discontinuities; bolts, screws and studs subject to general requirements (ISO 6157-1:1988); German version EN 26157-1:1991
DIN EN 26157-3	(1991-12)	Fasteners; surface discontinuities; bolts, screws and studs subject to special requirements (ISO 6157-3:1988); German version EN 26157-3:1991
SEW 550	(1976-08)	Steels for larger forgings, quality regulations
VDI 2230 Sheet 1	(2015-11)	Systematic calculation of high duty bolted joints; joints with one cylindrical bolt
VdTÜV MB SCHW 1153	(2017-12)	Welding Technology 1153; Guidelines for the suitability testing of welding filler materials
VdTÜV MB WERK 1253/1		Materials 1253-1; List of TÜV approved manufacturers of materials *(the latest edition of this VdTÜV technical leaflet shall be used)*
VdTÜV MB WERK 1253/4		Materials 1253-4; List of TÜV approved screws and nuts manufacturers (machining operators) renunciating an inspection certificate in accordance with DIN EN 10204 *(the latest edition of this VdTÜV technical leaflet shall be used)*
ASTM B352/B352M	(2017)	Standard Specification for Zirconium and Zirconium Alloy Sheet, Strip, and Plate for Nuclear Application, ASTM International, West Conshohocken, PA, 2017
ASTM E8/E8M	(2016)	Standard Test Methods for Tension Testing of Metallic Materials, ASTM International, West Conshohocken, PA, 2016
ASTM G2/G2M	(2019)	Standard Test Method for Corrosion Testing of Products of Zirconium, Hafnium, and Their Alloys in Water at 680 °F [360 °C] or in Steam at 750 °F [400 °C], ASTM International, West Conshohocken, PA, 2019
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Annex F (informative)

Changes with respect to the edition 2012-11 and explanations

(1) The section “Fundamentals“, first subpara. was adapted to take over the uniform text relevant to all KTA safety standards and the second subpara. was supplemented by the stipulations set by the Safety Requirements for Nuclear Power Plants as well as the Interpretations on the Safety Requirements for Nuclear Power Plants.

(2) The requirements for the analytical and structural design in section 5 were supplemented by specifications that, as an alternative to the design according to the global safety concept previously based on DIN 15018-1 and DIN 15018-2, allow a design of structural steel components according to the partial safety concept based on the standard series DIN EN 13001. Requirements for the application of standard series DIN EN 13001 (e.g. regarding the applicable dynamic factor) were specified in accordance with the new requirements in KTA 3902 and KTA 3903 such that an approximately same level of safety is ensured in the entire load chain as with the previous regulations in KTA 3902/3903/3905. In detail, the following changes were made in KTA 3905:

a) For the purpose of adapting the terms to those used in actual standards, at all locations the term “general stress analysis” was replaced by “stress analysis” and the term “analysis for cyclic operation” - as far as applicable - by “fatigue analysis”. In addition, the term “live load factor” was replaced by the term “dynamic factor” used in DIN EN 13001.

b) In sections 5.1, 5.2 and 5.8, requirements for the dimensioning of load attachment points based on the DIN EN 13001 series of standards have been added.

   Here, the application of the standard series DIN EN 13001 to austenitic steels was limited to such cases where according to section 6.3.3 of DIN EN 13001-3-1 a fatigue analysis is not required. This restriction is necessary since the edition 2019-03 of DIN EN 13001-3-1 for the first time applies also to austenitic steels according to DIN EN 10088-3, even though this standard in the fatigue analysis makes no difference between ferritic and austenitic steels. The applicability of the fatigue analysis according to DIN EN 13001-3-1 to austenitic steels within the range of application of KTA 3905 could not be verified sufficiently so far. Whenever necessary, specifications regarding the fatigue analysis of austenitic structural steel components within the range of application of KTA 3905 designed acc. to DIN EN 13001-3-1 shall be made in each individual case.

   Sections 5.3 to 5.7 have not been supplemented by provisions on the application of the partial safety concept since

   ba) there is no adequate standardised basis for trunnions, bolts, tie rods and similar parts (section 5.3),

   bb) bolted connections (section 5.4) within the scope of application of KTA 3905 are to be designed exclusively on the basis of VDI 2230 Part 1,

   bc) the application of loads into structural concrete components (section 5.5) and core components (section 5.7) does not fall within the scope of application of the DIN EN 13001 series of standards and

   bd) ropes and chains (section 5.6) within the scope of KTA 3905 are not permitted as load attachment points.

(3) In section 5, the following changes were also been made:

a) In clause 5.1.5.1 (7) the standard DIN EN ISO 13919-1 was taken over in addition to DIN EN ISO 5817 as for the assessment of welded joints, since electron-beam and laser welding is allowed too.

b) The provision regarding bolts according to materials test sheet WPB 14 laid down up to now in clause 5.4.2.2 (2) was taken over into clause 5.4.1.2 (2), since it applies also to load attachment points according to section 4.2.

c) An error was corrected in equations 5.4-2 and 5.4-3.

d) In section 5.8 “Analytical proof using the finite element method” the following changes were made:

   da) In clauses 5.8.2.1 (5) to (7) several modifications and further specifications were made for the purpose of clarification.

   db) The yield stress values specified in clause 5.8.2.1 (7) c) have been adapted so that they correspond - with exclusive reference to $R_{p0.2}$ - to the values specified in KTA 3201.2, thus

   - in load case H a value of $\sigma_F = 1.50 \cdot S_m$

   - in load case HZ a value of $\sigma_F = 1.65 \cdot S_m$

   - in load case HS a value of $\sigma_F = 1.80 \cdot S_m$

   shall be used and the specified loading shall not exceed 67 % of the lower bound collapse load as per clause 7.7.4.1 of KTA 3201.2.

   dc) In the new section 5.8.3 specifications were added which, in accordance with the specifications in section B 3.3 of KTA 3902, allow a design stress verification using the partial safety concept according to DIN EN 13001-3-1.

It was discussed whether the specifications for the fatigue analysis of bolted connections in section 5.4.1.3 need to be specified more precisely because the VDI 2230 Sheet 1 on which the verification is based does not contain any specifications for the range of less than 10^4 stress cycles . After a detailed discussion of the facts, no changes were made to the specifications in Section 5.4.1.3 for the following reasons:

- If bolted connections are tightened several times, stress amplitudes can occur as a result of the repeated tightening processes which exceed the permissible dynamic strength value at $N_z = 10^4$ according to VDI 2230 Sheet 1, taking into account the safety factors acc. to KTA 3902.
- The requirements specified in KTA 3905 for the dimensioning of bolted connections (see Section 5.4.1.2) and the increased safety factors for the fatigue analysis compared to VDI 2230 Sheet 1 lead to a safe design of the bolted connections, where in general the required precautions to be taken against damage are also ensured in the case of a (small) number of load changes resulting from dismantling and reassembly processes.
- The discussion of the case did not reveal any indications of safety-related deficits in existing bolted connections that were designed in accordance with the specifications in KTA 3905, which would indicate that the necessary precautions against damage are not ensured.

For special cases of bolted connection design, it was recommended to check the permissibility of extrapolating the Wöhler curve, if necessary taking into account the safety factors used in the verification process, in cases where the stress amplitude from tightening processes exceeds the permissible dynamic strength value at $N_z = 10^4$ according to VDI 2230 Sheet 1.

(4) In section 6 “Materials” the following changes were made:

a) The requirements regarding corrosion protection coatings of ferritic bolts and nuts formulated so far with reference to DIN 18800-7 were updated based on the specifications in DIN EN 1993-1-8/NA and in the new standard DIN EN ISO 4042:2018-11, which takes into account, among other things, the up-to-date knowledge about hydrogen embrittlement and prevention measures.

b) For hot dip galvanized fasteners, for which a manufacture in accordance with DSV-GAV guideline was required in DIN 18800-7, according to the state of standardization the application of the now available standard DIN EN ISO 10684 and the current DSV-GAV guideline was specified for the manufacture of hot dip galvanized bolts.

c) The rules for applying inspection certificates to DIN EN 10204, edition 1995-08, contained up to now in section 6.2.2, were deleted since for new fabrications only DIN EN 10204, edition 2005-01, is applicable. Despite this fact, the following certificates are recognized upon individual checking if stored material is used:

   ca) instead of inspection certificate 3.1 to DIN EN 10204 (2005-01) also inspection certificate 3.1.B to DIN EN 10204 (1995-08),

   cb) instead of inspection certificate 3.2 to DIN EN 10204 (2005-01) also inspection certificate 3.1.C to DIN EN 10204 (1995-08).

d) The ambiguous provisions in section 6.4 regarding the transfer of markings were clarified and adapted to the provisions in other KTA Safety Standards (see e.g. section 6.4 of KTA 3903, section 9.1.2 of KTA 3211.3).

(5) The following changes were made in section 7 “Design approval”:

a) In clause 7.1.1.1 a) it was added that the execution class (EXC) of welds shall be specified in the design data sheet if certification for welding according to DIN EN 1090-2 is applied.

b) In clauses 7.1.1.5 and 7.1.2.4 the qualification of operating personnel was added, since not only manual or partly mechanized welding is allowed, but also fully mechanized and automated welding.

(6) In section 8 “Final inspection” the following changes were made:

a) In clause 8.1 (1) b), the attestation of welding qualification was supplemented by requirements that permit certification in accordance with DIN EN 1090-2. It was assumed that load attachment points within the scope of application of KTA 3905 are always under dynamic loading, so that the application of execution class EXC4 is appropriate. The chosen requirement is to ensure that the manufacturer is able to produce the EXC4 execution class.

b) Since both manual and automatic welding is allowed, the qualification test certificate of operating personnel of fully mechanized and automatic welding units was added in 8.1 (1) c).

c) In clause 8.1 (1) d) it was clarified that the requirements according to section B 2.1 apply to NDT supervisors and NDT personnel.

(7) In section 10 “In-service inspections” the following changes were made:

a) In clause 10.1.3 (2), the regulation regarding the time of testing, if load attachment points are not used for a long time, was put more precisely.

b) In clause 10.1.4, the term "discontinuity" was replaced by the term "conspicuous indication" used in current standards for visual testing.

c) The formulation in clause 10.1.5 was simplified and is now consistent with the formulation in KTA 3903.

(8) The requirements regarding the bolting torque and the design of preloaded bolted connections in Table 8-1 (serial no. k), in Table 9-1 (serial no. 1 f) and in Table 10-1 (serial no. 1 c) formulated up to now with reference to DIN 18800-7 were revised in such a way that the specifications in the design approval documents are decisive.

(9) For brand new transport and storage containers, it would not be appropriate to carry out complete in-service tests and inspections of the load attachment points after just 3 years. If the container is properly preserved and stored, no inadmissible aging effects are to be expected. With the new footnote 4 in Table 10-1, a scope of tests and inspections was defined for the load attachment points on brand new containers that is appropriate from a safety point of view.

(10) In order to avoid any misunderstandings, the stipulations in 11.1 (8) were phrased more precisely regarding circumstances of waiving a new design approval.

(11) The material test sheets (WPB) in Annex A were completely updated in order to adapt them to the current state of standards. The footnotes for the use of inspection certificates in accordance with DIN EN 10204 (1995-08) were deleted from all material test sheets (see explanation under (4) c). In addition, the following changes were made:

a) In material test sheets WPB 8 and WPB 9 the footnote 2 was adapted to VdTÜV Material Sheet 418. This material sheet provides that for the material 1.4462 the methods C and the heat treatment T1 shall be used in the intergranular corrosion test.

b) In the material test sheets WPB 12 and WPB 14 requirements for corrosion protection coatings of ferritic bolts and the corresponding inspection certificates were additionally included.

(12) Annex B "Non-destructive testing" was revised based on the current standards. In addition to the adaptation to current standards, primarily the following changes were made:

a) In section B 3.2, some simplifications and clarifications were made which result from the current versions of standards used. In most cases formulations identical to those in other KTA Safety Standards (e.g. KTA 3211.1, KTA 3211.3) were used.

b) The requirements for ultrasonic testing of product forms in section B 3.4.2 were updated in accordance with the stipulation in KTA 3205.1 (2017-11) and are specified based on the standards DIN EN 10228-3, DIN EN 10228-4 and DIN EN 10308. Here it was possible to dispense with specifications for adaptation of the probe to curved surfaces (including the previous Figure B-1), as DIN EN ISO 16811 contains sufficient requirements for this.

c) The specifications for surface inspection on bars in section B 4.1.1 were adapted to the current state of the standards with reference to DIN EN 10228-1 and DIN EN 10228-2. The now required quality class 4 sets the same requirements as those specified in KTA 3205.1 for bars and in KTA 3211.1 for bars and forgings.

d) The requirements for performing and evaluating ultrasonic testing of ferritic bars (section B 4.1.2) were updated by taking over the relevant provisions contained in section B 4.1.2 of KTA 3205.1 (2017-11) and in section 11.4.3.3.1 of KTA 3211.1 (2017-11) and are specified based on DIN EN 10228-3 and DIN EN 10308. As a result, the previous Tables B-1, B-3 and B-4 were omitted.

e) In Table B-1 (former Table B-2), the title was changed to "bolts and trunnions" to adapt it to the wording in the Safety Standard. The scanning positions 4 and 5 are not applicable to bolts and trunnions and were deleted.

f) The requirements for performing and evaluating ultrasonic testing on bars made of austenitic steel were updated by taking over the relevant provisions contained in section B 5.2.4 of KTA 3205.1 (2017-11). In accordance with the specifications in DIN EN 10228-4 for classification, the specified quality classes ensure a test sensitivity which corresponds to a recording level of 3 mm disc shaped reflector for forgings with a thickness up to 75 mm and to a recording level of 5 mm disc shaped reflector for forgings with a thickness exceeding 75 mm.

g) In clauses B 6.3.2 and B 7.3.2 the standard DIN EN ISO 13919-1 was taken over in addition to DIN EN ISO 5817 as for the assessment of welds, since electron-beam and laser welding is allowed too.

(12) In Figures C-2 and C-4 it was made clear that in the case of bolted on load attachment points, the internal thread in the load still belongs to the load attachment point.

(13) Annex E “Regulations and literature referred to in this Safety Standard“ was totally adapted to the current state of standardization and to the regulations used in the Safety Standard.