Safety Standards

of the

Nuclear Safety Standards Commission (KTA)

KTA 3205.3 (2018-10)

Component Support Structures with Non-Integral Connections; Part 3: Series-Production Standard Supports

(Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen
Teil 3: Serienmäßige Standardhalterungen)

The previous versions of this safety standard were issued in 1989-06 and 2006-11

If there is any doubt regarding the information contained in this translation, the German wording shall apply.

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KTA SAFETY STANDARD

October 2018	**Component Support Structures with Non-Integral Connections; Part 3: Series-Production Standard Supports**	KTA 3205.3

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2006-11 (BAnz. No. 163a of August 31, 2007)

Contents

PLEASE NOTE: Only the original German version of the present safety standard represents the joint resolution of the 35-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in Bundesanzeiger (BAnz) of April 24, 2019.
Copies of the German versions of KTA safety standards may be mail-ordered through Wolters Kluwer Deutschland GmbH (info@wolterskluwer.de). Downloads of the English translations are available at the KTA website: www.kta-gs.de

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Comments by the Editor:

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

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

Basic Principles

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

(2) Based on the Safety Requirements for Nuclear Power Plants (SiAnf) the present safety standard specifies the requirements for series-production standard supports which need to be qualification tested. These supports include, e.g., rigid standard supports and hangers, shock absorbers, dampers, and rigid struts.

(3) Component support structures with integral connections to the primary coolant circuit or to systems outside the primary coolant circuit are dealt with in series KTA 3201 and KTA 3211, respectively. Component support structures with non-integral connections are dealt with in safety standards KTA 3205.1 and KTA 3205.2.

(4) The safety-related function of standard supports is the transfer of forces from the supported component into the load-carrying parts of the power plant. Movable standard supports shall normally allow for additional relative movements.

(5) The aim of the present safety standard is to achieve a simplification by standardizing the requirements for the qualification testing of standard supports. These qualification tests shall normally verify the quality characteristics specified by the manufacturer with a view to the intended application range of the standard support. Upon a successful completion of the qualification test, the usual tests and inspections of individual standard supports during the manufacturing process can be reduced to a minimum.

(6) In addition to the requirements for the qualification test, the present safety standard deals with the manufacture, testing and inspection as well as the requirements for planning, assembly and commissioning. Furthermore, the present safety standard includes specifications for in-service inspections and maintenance and the documentation of standard supports.

(7) Those parts of standard supports which fall under the scope of the present safety standard and have not been subjected to a qualification test shall meet the requirements of KTA 3205.1 or KTA 3205.2, respectively.

(8) Qualification-tested standard supports may be used in various applications. The extent of the tests and inspections and the participation of the plant vendor, the plant operator, and the authorized expert in these tests and inspections during assembly, commissioning, in-service inspections and documentation depend on the respective requirements to be fulfilled by the standard supports.

1 Scope

(1) The present safety standard applies to series-production standard supports – hereinafter referred to as standard supports – which are used in the component support structures specified in KTA 3205.1 and KTA 3205.2 up to a design temperature of 350 °C and which are subjected to a qualification test.

(2) The present safety standard deals with rigid standard supports, e.g.,

a) weld-on eye plates, weld-on plates and lugs made of metal plates,

b) tie rods, threaded rods and pins made of steel bars,

c) eye nuts, clevises, turnbuckles and couplings made of forgings or metal plates,

d) bearing elements,

e) weld-on brackets and weld-in rods made of welded plates, sections or forgings,

f) vertical clamps, horizontal clamps and dynamic clamps (e.g. for shock absorbers and rigid struts),

g) pipe clamp bases, clamps with weld-on parts, e.g., slide bearings,

h) beams, consoles, supported consoles and plane frames made of steel component.

(3) In addition, movable standard supports and rigid struts are addressed, e.g.

a) spring hangers, spring supports, constant hangers and constant supports (hereinafter referred to as hangers),

b) hydraulic and mechanical shock absorbers (hereinafter referred to as shock absorbers),

c) viscoelastic vibration dampers (hereinafter referred to as dampers),

d) rigid struts.

(4) Parts welded onto the component, e.g., shear lugs, serving as connection between the component and the standard support, are not within the scope of the present safety standard.

(5) The qualification test of standard supports smaller than or equal to DN 50 is dealt with in Section 12.

2 Definitions

Note:

The nomenclature of the equations are listed in Appendix G.

(1) Load cases

Load Cases are defined as follows (cf. Tables 4-2 and 4-3 of KTA 3205.1,):

Load Case H:	(Main loads) Allowable constant and temporary standard loads (B1 and B2) and the component loads A (cf. Table 4-3 of KTA 3205.1)
Load Case HZ:	(Main and additional loads) Allowable constant and temporary standard loads (B1 and B2) and the component loads B and P (cf. Table 4-3 of KTA 3205.1)
Load Case HS:	(Main and special loads) Allowable loads from the load combinations 4 through 7 (cf. Table 4-3 of KTA 3205.1). In the present safety standard HS includes the Load Cases HS2/HS3 as specified in KTA 3205.1.

(2) Load chains for standard supports

Load chains consist of several rigid or movable standard supports arranged either in series or in parallel.

(3) Nominal load

The nominal load F_N is a component-specific characteristic load. It shall be determined by analysis or if required experimentally. The nominal load is defined component dependently as follows:

Spring hangers:	the maximum theoretical spring force, cf. **Figures B 2-1** and **B 2-2,**
Constant hanger:	the maximum set load, cf. **Figure C 2-2,**
Shock absorbers:	the maximum allowable damping force for dynamic excitation at the operating temperature
All other components:	load smaller than or equal to the load of Load Case H (when applying the σ_{zul}-procedure - Allowable Strength Design (ASD)), load smaller than or equal to the design value for the load capacity F_{Rd} divided by 1.5 (when applying the method of partial safety factors - Load and Resistance Factor design (LRFD))

For rigid struts, shock absorbers and dynamic pipe clamps, the nominal loads are determined from the smaller values from tensile or compressive loading.

(4) Authorized expert

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

(5) Series-produced products

Series-produced products are products that are fabricated in similar design and quality and in larger quantities at manufacturing facilities.

Note:

Series-produced products are generally manufactured without prior knowledge regarding their later application.

(6) Standard supports, movable

Movable standard supports are series-produced non-integral component support structures or parts thereof, which are similar to each other in design and quality. The function of movable standard supports is to allow for a relative movement between the component supported and the load-absorbing support structure in the direction of the load applied during specified normal operation.

(7) Standard supports, rigid

Rigid standard supports are series-produced non-integral component support structures or parts thereof, which are similar to each other in design and quality. The function of rigid standard supports is the transfer of loads between the component and the support structure without any relative movement.

3 Qualification Test

3.1 General Requirements

(1) Qualification tests shall only be carried out after completion of the development of a specific type of standard support.

(2) Qualification tests shall be performed as investigations by analysis and, if so required, as experimental tests.

(3) For the performance of experimental tests, such test equipment and measuring instrumentation shall be used which are suitable to verify that the quality requirements specified in the present safety standard have been met.

3.2 Applications

The manufacturer of the standard support or the plant supplier shall submit the application for the qualification test to the authorized expert together with the documents listed in the following paragraph.

3.3 Documents

The licensee shall create the following documents and submit them for a review:

a) description of the quality assurance system of the manufacturing plant as detailed in KTA 1401,

b) materials specification identifying the tests to be carried out and certificates to be issued,

c) test schedule for the fabrication,

d) work and test instructions by the manufacturer,

e) welding procedure specifications unless they are included in work instructions,

f) list of all documents including their latest state of revision which are needed to determine the identity of the standard support,

g) function description (the function description shall, as far as necessary, include information on the application range, task and function of the standard support),

h) design data sheet including all data which characterize the standard support; in the case of, e.g., a constant hanger this includes information on:

  ha) nominal load,

  hb) minimum and maximum set loads,

  hc) allowable loads for Load Cases H, HZ and HS, and the design value for the load capacity

  hd) entire travel range,

  he) allowable tolerances of pre-set values,

  hf) load deviation under vertical tension

  hg) load deviation under oblique tension,

  hh) operating temperatures,

  hi) ambient conditions,

i) assembly and detail drawings,

k) parts list including allocation of the respective materials specifications,

l) strength calculations,

m) component related extent of testing,

n) application instructions; as far as necessary, these include information regarding:

  na) packaging and storage,

  nb) installation and assembly,

  nc) maintenance.

3.4 Testing Program for Qualification Tests

(1) The testing program shall describe the type of tests and inspections, the testing equipment and the execution of the tests and inspections. The chronological order and the extent of the test steps shall be as specified in Appendix A through Appendix F for some of the standard supports. For other standard supports a testing program on the basis of these appendices shall be agreed upon with the authorized expert.

(2) The experimental tests under static loading shall be performed at room temperature unless otherwise specified in the cited appendices.

(3) Cyclic load tests are only required for those standard supports subjected to cyclic loadings, e.g., dampers, rigid struts and shock absorbers with their connected parts.

(4) The experimental tests shall be performed in the presence of the authorized expert.

3.5 Certificate for the Qualification Test (Test Certificate)

Following the successful performance of the qualification test, a test certificate shall be issued by the authorized expert responsible for the qualification test; this certificate shall include the following information:

a) test number,

b) designation of the standard support including its state of revision,

c) list of the test documents,

d) manufacturer of the standard support and his qualification,

e) testing program including the test steps,

f) evaluation of the test results,

g) conditions for the application,

h) testing organization, name and signature.

3.6 Period of Validity of the Qualification Test

(1) The period of validity of the qualification test shall be limited to 3 years beginning with the successful performance of the theoretical and experimental tests.

(2) Upon application by the manufacturer, the term of validity shall be extended by another 3 year period, provided, neither the product nor the quality assurance system have been modified.

3.7 Modifications

(1) The authorized expert who certified the qualification test shall be notified of any modification of the qualification-tested standard support.

(2) In the case of modifications that influence the safety related function of the standard support, e.g., change in design or use of a lower-strength material, a supplementary qualification test or, if necessary, a new qualification test as specified in Sections 3.1 through 3.6 shall be performed.

3.8 Considering Qualification-Tested Standard Supports in the Design Planning Stage

3.8.1 Suitability regarding the intended application

(1) If qualification-tested standard supports as specified in the present safety standard are planned to be used in a nuclear power plant, the properties confirmed by the qualification test shall satisfy the conditions of the intended application. A certificate stating that these conditions are met shall be obtained from the authorized expert.

(2) If this test reveals that, regarding the intended application, other or additional requirements have to be fulfilled, it shall be ensured that an agreement is reached with the authorized expert regarding the further procedure.

3.8.2 Rigid elements

(1) Austenitic metal plates shall be inserted between austenitic pipelines and any non-alloyed or low-alloyed steels of the pipe-enclosing components.

(2) For slide bearing guides, sufficient clearance (play) shall be provided regarding the operating condition. Under operating conditions, the total clearance should not exceed 3 mm.

(3) Pipe clamp bases and clamps shall be secured in their position on the pipe if axial forces or torsional moments are expected (cf. Section 12).

(4) In the case of clamps in connection with rigid struts, shock absorbers or dampers, it shall be verified that the clamps will not be dislocated or twisted when subjected to the design loads. This may be verified based on a form fit, a permanent frictional fit, or a stable positioning under the design loads.

3.8.3 Connecting elements

Bolts should not be subjected to bending forces in the threaded region. Deviations from the plane-parallel bearing surfaces of bolt heads and nuts are allowed, provided, the angle does not exceed ± 1°.

3.8.4 Spring hangers and spring supports

(1) The specified travel range s_S shall be specified such that the travel reserve s_R are not utilized (cf. **Figure B 2-2**). The travel reserve to be provided shall be at least 20 % of the specified travel range, but at least 5 mm in each end position.

(2) In the case of spring supports, the horizontal forces shall be limited to 7 % of the vertical load by suitable design measures.

(3) The allowable load for the blocked condition shall be 1.5-fold nominal load.

3.8.5 Constant hangers and constant supports

(1) The specified travel ranges s_S shall be specified such that the travel reserves s_R are not utilized (cf. **Figure C 2-1**). The travel reserve to be provided shall be at least 10 % of the specified travel range, but at least 5 mm in each end position.

(2) Constant hangers and constant supports shall be chosen such that within the planned adjustment range a load setting of ± 15 % is possible without limitation of the travel reserves.

(3) In the case of constant supports, the horizontal forces shall be limited to 7 % of the vertical load by suitable design measures.

(4) In the blocked condition the allowable load shall be the 1.5-fold nominal load.

3.8.6 Mechanical and hydraulic shock absorbers

For shock absorbers, a travel reserve of at least 10 mm shall be provided in each end position.

3.8.7 Viscoelastic vibration dampers

(1) Dampers shall damp operational oscillations over the entire travel range expected during normal operation. However, during start-up and shut-down operations they shall normally not significantly influence the components. This requires considering the resistance forces that are dependent on the temperature of the damping medium and the velocity of the piston, both values to be specified by the manufacturer.

(2) The damping behavior shall normally be adapted to the operating temperature of the pipeline. To this end, a damping medium shall be chosen in consultation with the manufacturer that is suited to the temperature occurring within the medium.

Note:

At lower temperatures than the operating temperature, the damper can react with larger dynamic parameters.

(3) For dampers, a travel reserve of at least 10 mm shall be provided in each end position.

4 Requirements Regarding Design and Construction

4.1 Loads

(1) For each standard support as far as applicable, the allowable loads for Load Cases H, HZ and HS and the design value for the load capacity shall be specified.

Note:

In the present safety standard HS encompasses the Load Cases HS2/HS3 detailed in KTA 3205.1. The design value for the load capacity is defined in DIN EN 1993-1-1.

(2) Standard supports which are subjected to oblique tension or oblique compression loading shall be capable of absorbing the additional lateral forces acting perpendicular to the main direction of load application.

(3) The allowable load and the design value for the load capacity shall be specified for the blocked condition and for the end position of hangers. The allowable load shall be assigned to Load Case HZ.

(4) For load chains, the allowable load of the standard component shall be either

a) the lowest allowable load in the respective load case, or

b) the lowest design value for the load capacity.

4.2 Design Temperatures

(1) The design shall be based on the temperatures corresponding to the intended application.

(2) If the temperature distribution is not verified, the design temperature of the standard support and its parts (cf. **Figure 4-1**) shall be as specified in the following wherein T_M is the design temperature of the pipeline:

a) Parts located inside the thermal insulation:

aa) parts immediately adjacent to the component:

$T = (T_M - 20\ K)$ (4-1)

ab) bolts and nuts:

$T = (T_M - 30\ K)$ (4-2)

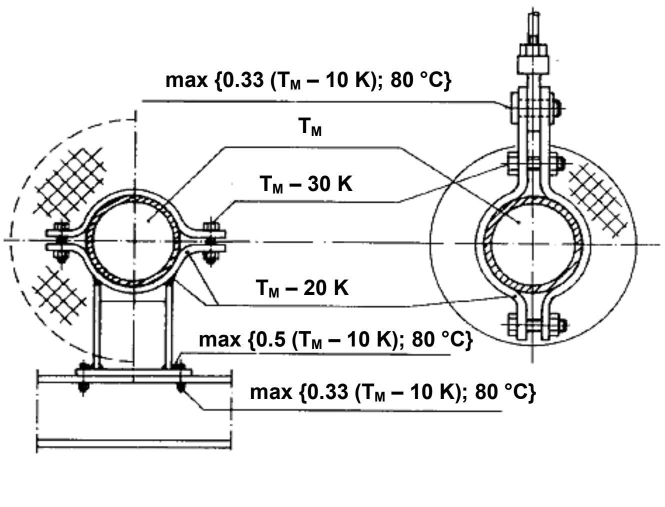


Figure 4-1: Temperature distribution

b) Parts outside of the thermal insulation:

ba) in constructional parts immediately connected to the adjacent parts:

$T = \max \{0.5 \cdot (T_M - 10\ K); 80\ °C\}$ (4-3)

bb) in connecting pins or bolts and nuts:

in frictional fit clamp bases:

$T = \max \{0,33 \cdot (T_M - 10\ K); 80\ °C\}$ (4-4)

in clamps: 80 °C

bc) in all other parts, out to the contact area of the steel component: 80 °C.

(3) For standard supports the functionality of which must be sustained during design basis accidents with ambient temperatures exceeding 80 °C, the design shall be based on correspondingly higher temperatures.

4.3 Structural Design

4.3.1 General requirements

(1) Standard supports shall be designed such that their functionality is maintained under the occurring ambient conditions, e.g., dirt or humidity. With regard to their application under special ambient conditions, e.g., corrosive media, the qualification test shall be supplemented, if necessary. The surface of standard supports shall normally be such that their decontamination is possible.

(2) Observing the boundary conditions of the standard support, the welding execution class, EXC, shall be specified prior to the suitability test and shall be documented in the test schedule. The execution class, EXC, shall be specified by applying the procedure in accordance with DIN EN 1090. At least, consequence class CC2 in accordance with DIN EN 1090 shall be specified.

(3) Welds welded from both sides shall be preferred to one-side welds. One-sided fillet welds are only allowed for the connection of closed parts or if transmitted local bending moments are considered in the design.

(4) Single-layer welds are only allowed for weld thicknesses smaller than or equal to 5 mm.

(5) For those weld seams located within the flow of force (verification using partial safety factors) or those whose quality class must be verified (verification using the σ_{zul}-concept), the extent of testing shall be as specified in KTA 3205.1. Sec. 7.9.2.4, and KTA 3205.2, Sec. 7.8.2.2. The testability of these weld seams shall be ensured.

(6) The thread engagement of threaded parts shall normally be at least 0.8·d for suitable material combinations; d represents the nominal diameter of the threaded part. The admissibility of shorter thread engagement shall be individually verified.

(7) If tensile-loading in the through-thickness direction is expected for product forms made from ferritic steel with a wall thickness greater than 20 mm, the weldings shall be verified to be Quality Class Z25 in accordance with DIN EN 10164.

(8) The slenderness ratio of standard supports subjected to compressive loadings may not be larger than 150.

(9) In the case of slotted holes subjected to loadings perpendicular to their longitudinal axis, a sufficiently large edge distance shall be observed.

(10) Standard supports with non-metallic parts including their lubricants shall normally not lose their functionality up to a radiation dose of 10^5 Gy during their specified service life.

(11) Manufacturing tolerances of the dimensions that are decisive during planning of the plant or are essential for the function of the standard support shall be specified.

4.3.2 Rigid elements

(1) The minimum dimensions for load-bearing parts are:

a) welding lugs and weld-on eye plates 6 mm,

b) clamps 5 mm,

c) weld-on plates 8 mm,

d) bolts, pins, threaded rods 10 mm.

Exceptions are allowed in well-founded cases.

(2) Sharp edges shall be chamfered. This applies in particular to edges of cuts, bore-holes and clamps on the side contacting the pipe.

(3) The thread of U-bolts may not directly contact the pipe.

(4) Where pipe-enclosing parts made of non-alloyed and low-alloyed steels with a nominal diameter exceeding DN 50 are cold formed, the minimum radii for S 235 or S 355 shall be as required in accordance with DIN EN 10025-1.

(5) In case austenitic steels are cold formed, the minimum radii shall basically be chosen such that the degree of cold forming is smaller than or equal to 15 %. In case the degree of cold forming exceeds 15 %, it shall be verified in each individual case that even after cold forming the residual elongation A_5 is at least 15 %.

(6) The dimensions of the clamp shall be chosen such that the legs of the clamp are parallel to each other in the assembled condition.

(7) Austenitic metal plates inserted between the pipeline and the clamp shall be secured in their position, e.g., by flanging.

(8) Pipe clamp bases shall be designed such that jamming can be excluded. Slide plates and slide coatings shall be secured in their respective positions. The instructions specified by the manufacturer shall be observed.

4.3.3 Connecting elements

(1) Bolted connections shall be secured. Suitable securing elements for bolts are, e.g., securing plates, lock nuts and counter nuts. A planned pre-tensioning may also be regarded as a securing measure.

(2) Pins shall be secured, e.g., with washers and cotter pins. Lock rings are allowable provided, the clearance (play) between bore-hole and pin is smaller than 0.5 mm and corrosion can be excluded.

4.3.4 Hangers

(1) Hangers shall normally have a suitably designed casing suited for the transmission of forces; these casings shall be provided with inspection openings. In addition, care shall be taken that any penetrating water can run off.

(2) Springs shall be protected by suitable measures against surface damage.

(3) The design and analysis of compression springs shall comply with the requirements of DIN EN 13906-1. The spring plates shall be designed and centered such that no friction occurs between the spring and the casing wall.

(4) It shall be ensured that only such springs are used that retain their functionality even after 48 hours of thermal loading at 80 °C and at maximum spring tension.

(5) It shall be possible by simple means to block hangers in any position within their nominal travel range.

(6) A freedom of movement of at least 4° from the main direction of loading shall be possible.

4.3.5 Shock absorbers, rigid struts and their connected parts

(1) Hydraulic as well as mechanical shock absorbers shall be designed such that the load-absorbing function acts exclusively in the case of a dynamic loading on the components. The shock absorbers shall be capable of equally absorbing tensile or compressive forces.

(2) The position of the piston rod shall be made visible by marking the scale of the travel range and marking the possible end position. The travel reserves shall be specifically marked.

(3) A freedom of movement of at least 5° from the connecting axis shall be possible. The maximum possible stroke shall normally be at least 100 mm.

(4) The lifetime of the wear parts, e.g., bearings, seals or guides, shall be specified.

(5) Local jointly acting shock absorbers shall basically be arranged as statically determined structures. Deviations are allowable, provided, they are properly verified.

(6) The overall clearance of rigid struts, including connected parts, shall be less than 0.5 mm in the case of pins or body-fit bolts up to a diameter of 33 mm; if larger diameter pins or bolts are used the clearance shall be less than 1.5 % of the bolt diameter.

(7) The length of the rigid strut shall be adjustable for all types and sizes. The maximum allowable adjustment of each ball bushing joint shall be visibly marked.

(8) The eccentricity v_o between eye and rod axis shall not be greater than 1 mm for lengths smaller than or equal to 1000 mm and not greater than L/1000 for lengths L greater than 1000 mm.

4.3.6 Dampers

(1) Dampers shall be designed such that the load-absorbing function acts exclusively in the case of a dynamic loading on the components. They shall be capable of absorbing loads in any of the specified directions and shall damp operational oscillations over the entire travel range.

(2) The initial position, end position and operating position of the damper piston shall be visibly marked. The travel reserves shall be specially marked.

(3) The response of dampers shall be free of play.

(4) The damping medium shall be capable of regenerating itself even after having been overloaded. After the regeneration the damper shall be fully functional.

(5) The dynamic characteristics of dampers such as operating load, damping resistance and equivalent stiffness shall be specified for each direction of movement at the specified operating temperature and within the specified frequency range. The dynamic characteristics apply to the working position of the damper piston; this shall normally be the center position of the piston. The tolerances for each damper shall be specified in the test certificate of the qualification test.

(6) Dampers which are not self-supporting shall be provided with a mounting device for their assembly.

(7) The damper piston and damper pot shall both be designed for a sustained 0.1-fold nominal load.

5 Verification of Allowable Loads and Design Value of Load Capacity

5.1 Allowable Loads

(1) The allowable load shall be verified as follows:

a) A verification by analysis without supplementary experimental tests is allowable, provided, calculable geometries are given.

b) A verification by analysis with supplementary experimental tests is required if the structure can only be modelled by approximation. In this case, experimental tests shall be performed for selected sizes which shall cover the entire range of application. This applies to rigid struts, eye nuts, clevises, turnbuckles, clamps, and pipe clamp bases.

c) Without verification by analysis, an experimental test shall be performed for each parameter, e.g., physical dimension, material and direction of load application.

(2) The load capacity shall be verified in such a way that the procedure can be reproduced.

(3) The stress analyses shall be performed as specified in KTA 3205.1, Sec. 4.

(4) The maximum allowable load for Load Case H shall be calculated on the basis of the maximum transmittable loads as determined by experimental tests (ultimate load P_{Tr}, buckling load P_K or yield load P_F); this analysis shall be based on the design factors listed in **Table 5-1**; herby, the yield load shall be determined for a permanent elongation of 0.2 % of the initial measured length (cf. **Figure A 2-1**) of the individual elements of the rigid standard support, and for a permanent elongation of 1 % of the initial measured length of hanger clamps.

(5) Based on the maximum allowable load for Load Case H, the allowable loads for Load Cases HZ and HS shall be determined dependent on the kind of load applied, on the temperature and on the allowable stresses specified in KTA 3205.1, Sec. 4.

(6) If no permanent deformations appear when rigid standard supports are subjected to a 2-fold nominal load, F_N, or if the ultimate load is greater than a 4-fold F_N, then a 1.5-fold F_N shall be assumed for the loading of Load Case HZ and a 1.7-fold F_N for the loading of Load Case HS.

(7) The ultimate load of shock absorbers under static tensile stress shall be greater than a (2.4 • K_2)-fold F_N and the buckling load under static compressive load shall be greater than a 2.5-fold F_N.

(8) For shock absorbers, the nominal load, F_N , is the allowable load for all load cases on the basis of the qualification tests, provided, the vibration tests specified under Section D 3.2.4 have been completed successfully. Where the overload test specified under Section D 3.2.5 has been completed successfully, the allowable load shall be a 1.5-fold F_N for dynamic loads resulting from design basis earthquake, if the verification is carried out by means of an equivalent static method; in all other special dynamic load cases of Load Case HS (including the superposition of various load cases), the allowable load shall be a 1.7-fold F_N.

(9) In addition to paragraph (3), rigid struts shall fulfill the following requirement:

If the additional tests and inspections specified under Section F 3.2.4, have been completed successfully, then a 1.5-fold F_N shall be assumed for the loading of Load Case HZ and a 1.7-fold F_N for the loading of Load Case HS.

(10) For hangers, the nominal load F_N is the allowable load for all load cases on the basis of the qualification tests, provided, the tests and inspections specified in the Appendices were completed successfully. For the blocked condition, a 1.5-fold F_N shall be assumed as the allowable load.

(11) For dampers, the nominal load F_N is the allowable load for all load cases on the basis of the qualification test, provided, the tests and inspections specified in Appendix E have been completed successfully.

5.2 Design Value of the Load Capacity

The design value of the load capacity (procedure applying partial safety factors) shall be calculated as follows:

a) qualification-tested components that have a load ratio H : HZ : HS equaling 1 : 1.15 : 1.5:

$$F_{Rd} = 1.5\ F_{(\text{Load Case H})} \qquad (5\text{-}1)$$

b) qualification-tested components that have a load ratio H : HZ : HS equaling 1 : 1.15 : 1.7:

$$F_{Rd} = 1.7\ F_{(\text{Load Case H})} \qquad (5\text{-}2)$$

Component	Ultimate Load 1) P_{Tr}	Yield Load P_F	Buckling Load P_K	Maximum Allowable Load of Load Case H
Rigid standard supports	4.0 or 2.4 • K_2	1.6 • K_3	—	$= \min\left(\frac{P_{Tr}}{4}; \frac{P_F}{1.6\,K_3}\right)$ or $= \min\left(\frac{P_{Tr}}{2.4\,K_2}; \frac{P_F}{1.6\,K_3}\right)$
Hanger clamps	4.0 or 2.4 • K_2	1.6 • K_3	—	
Rigid struts / Shock absorbers	4.0 or 2.4 • K_2	—	2.5	$= \min\left(\frac{P_{Tr}}{4}; \frac{P_K}{2.5}\right)$ or $= \min\left(\frac{P_{Tr}}{2.4\,K_2}; \frac{P_K}{2.5}\right)$
Dampers	4.0 or 2.4 • K_2	—	2.5	
Hangers	4.0 or 2.4 • K_2	—	—	$= \frac{P_{Tr}}{4}$ or $= \frac{P_{Tr}}{2.4\,K_2}$

1) The values specified for P_{Tr} may be used equivalently. Except in the case of pipe clamp bases, they refer to tensile loadings.

The following shall be applied

$$K_2 = \frac{R_m \text{ tensile test}}{R_m \text{ material standard}}$$

for ferritic materials:

$$K_3 = \frac{R_{eH} \text{ tensile test}}{R_{eH} \text{ material standard}}$$

for austenitic materials:

$$K_3 = \frac{R_{p0,2} \text{ tensile test}}{R_{p0,2} \text{ material standard}}$$

These factors may also be determined from the minimum and maximum values specified in the material standards.
For standard supports made of austenitic materials, the factors for the design against the buckling load shall be specified in each individual case.

Table 5-1: Design factors for determining the maximum allowable load for Load Case H from experimentally determined loads

6 Requirements Regarding Materials

(1) The allowable materials are specified in KTA 3205.1, Section 6. Materials other than those listed therein are allowable, provided, their suitability for the intended purpose has been acknowledged by the authorized expert responsible for the qualification test.

(2) The materials specified in KTA 3205.1, Section 6, shall be subjected to the materials tests of the corresponding material test sheets specified in KTA 3205.1 and the product forms shall be certified in accordance with DIN EN 10204.

(3) Small parts (e.g., washers, split pins and pins) shall be certified by Inspection Certificate 2.1 and springs by Inspection Certificate 3.1 in accordance with DIN EN 10204.

(4) Weld filler materials and consumables shall be compatible with the respective welding procedures and shall meet the requirements in accordance with DIN EN 13479. This requirement is met by weld filler materials and consumables that were qualification-tested in accordance with VdTÜV MB SCHW 1153.

(5) In the case of standard supports which are exclusively within the scope of KTA 3205.2, the materials tests for the different product forms made of steel S 235 shall be performed and certified as follows:

a) metal plates 2.2 in accordance with 10204

b) steel bars and rods 2.2 in accordance with 10204

c) steel sections, pipes 2.2 in accordance with 10204

(6) The tests and inspections required for connecting elements in accordance with DIN EN ISO 898-1 and DIN EN ISO 898-2 shall be performed by the manufacturer. The requirements of material test sheets specified in KTA 3205.1 shall be met.

(7) Where metal plates made of ferritic steels are tensile loaded in the through-thickness direction, it shall be ensured that for thicknesses greater than or equal to 20 mm the metal plates are qualified in accordance with DIN EN 10164 and have been examined for laminations in the attachment weld area. The corresponding quality class of the weld shall basically be as specified in Table 7-1 of KTA 3205.1. The quality class of the weld may also be specified in accordance with DIN EN 1993-1-10

taking the weld seam configuration and the preheating into account.

(8) If components with an already completed documentation (e.g., storage material) are intended to be used, a comparative study shall be performed to show that the requirements of the present safety standard are met.

(9) Up to a radiation dose of 10^5 Gy, the hydraulic oil and the damping medium shall continue to meet the following characteristics:

a) pour point: ≤ - 40 °C (does not apply to bituminous damping media),

b) flash point: ≥ 300 °C,

c) ignition point: ≥ 400 °C.

(10) The hydraulic oil and the damping medium shall be resistant to ageing, humidity and water vapor. In addition, they shall not be corrosive nor toxic. The manufacturer certificate is regarded as verification.

7 Manufacturing Requirements

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

(2) The manufacturer shall prove his suitability for performing the welding tasks. This entails fulfill the requirements in accordance with DIN EN 1090-2, Appendix A, Table A.3, that must be met regarding the specified execution class.

(3) The manufacturing shall fulfill the requirements in KTA 3205.1, Section 7.1, paras. (1) through (3).

(4) The manufacturer shall specify in writing the tasks and responsibilities within the scope of his quality assurance system.

(5) The persons or organizations performing the quality-assuring activities by quality controls or tests and inspections shall be independent of the persons or organizations responsible for fabrication.

(6) The authorized expert is entitled to assure himself at any time in the course of manufacture that the requirements under paragraphs (2) through (5) are fulfilled.

(7) Equipment and machines for the tasks of welding, forming and testing shall be subjected to maintenance and inspection at regular intervals. This shall be confirmed to the authorized expert.

(8) The fabrication processes shall be surveilled (e.g., welder qualification tests, procedure qualification tests for welding and forming). This shall be confirmed to the authorized expert.

8 Tests and Inspections

8.1 Testing During Fabrication

The current production series shall be tested by the quality control department of the manufacturer following the test schedule. In addition, the authorized expert shall randomly supervise the testing.

8.2 Testing of the Finished Standard Support

8.2.1 Rigid standard supports and rigid struts

(1) 5 % of the rigid standard supports and rigid struts shall be subjected to visual inspections and dimensional checks. Included in these inspections shall be the first item and the last item of each production series.

(2) The tests and inspections shall be confirmed by the manufacturer.

8.2.2 Hangers

(1) The following tests and inspections shall be performed by the manufacturer on each hanger:

a) Visual inspections and dimensional checks,

b) Functional tests:

ba) checking of adjustment values,

bb) executing the load-travel curve over the specified travel range; additionally, in the case of constant hangers, the load-travel diagram shall be generated and evaluated.

bc) checking the marks for the cold and hot load as well as for the blocking of the cold load, and transferring these setpoints into the list of adjustment settings,

bd) checking the travel reserves and, if necessary, also regarding movements resulting from dynamic loads, and transferring these values into the list of adjustment settings.

(2) Normally, 10 % of the hangers of a production series shall be subjected to these tests and inspections in the presence of the authorized expert, including the recording of the load-travel diagram for spring hangers and constant hangers. If sufficient experience is available, the extent of attendance in these tests and inspections by the authorized expert may be reduced accordingly upon mutual agreement. The tests and inspection shall be certified by the authorized expert in accordance with the corresponding attendance.

(3) The fulfilment of the requirements for springs as specified under Section 4.3.4, paragraph (4) shall be confirmed to the authorized expert.

8.2.3 Shock absorbers

(1) The following tests and inspections shall be performed by the manufacturer on each shock absorber:

a) Visual inspections and dimensional checks,

b) Functional tests:

ba) measuring the frictional resistance and the breakaway resistance,

bb) measuring the stroke,

bc) measuring the response acceleration in the case of mechanical shock absorbers, and recording of a diagram,

bd) measuring the lockup velocity in the case of hydraulic shock absorbers, and recording of a diagram,

be) measuring the piston rod movement upon reversal of the direction of load application for the nominal load, F_N, at a frequency of 5 Hz and room temperature, and recording of a diagram. If the available test equipment does not permit achieving the test load, another suitable test method shall be selected.

bf) checking the bypass velocity.

(2) Hydraulic shock absorbers shall, additionally, be examined for the following characteristics:

a) checking the level of the hydraulic fluid by means of the level indicator,

b) visual inspection for leak tightness,

c) checking the venting by means of a suitable method.

(3) Normally, 10 % of the shock absorbers of a production series, but at least two shock absorbers, shall be subjected to these tests and inspections in the presence of the authorized expert. If sufficient experience is available, the extent of attendance in these tests and inspections by the authorized expert may be reduced accordingly upon mutual agreement.

(4) Every fiftieth shock absorber but at least one and no more than five shock absorbers of each production series shall be tested for the required quality characteristics which were confirmed within the scope of the qualification test; the tests and inspections shall comprise the following:

In addition to the tests and inspections specified in Section 8.2.3 paragraphs (1) and (2), the dynamic function of the shock absorber under vibrating loads shall be determined at three different frequencies between 2 Hz and 15 Hz in the presence of the authorized expert. The loading duration at each frequency shall normally last for no less than least 10 seconds. In the respective mid-position, the shock absorbers shall be subjected to travel- and force-controlled alternating loads until the nominal load F_N is reached. Force and travel shall be recorded both as a function of time and in parametric graphs (phase diagrams).

If the available test equipment does not permit achieving the test load, another suitable test method shall be selected.

(5) The test results and that the requirements have been fulfilled shall be confirmed by the authorized expert in the test report.

8.2.4 Dampers

(1) For each type of damper, the following tests and inspections shall be performed by the manufacturer on each batch supplied and each operating temperature:

a) Visual inspections and dimensional checks,

b) Functional tests:

   ba) measurement of the entire travel range,

   bb) measurement of the damping resistance both horizontally and vertically for the following frequencies and amplitudes:

1	20	35	Hz
10	0.75	0.1	mm

   bc) measurement of 1.7-fold nominal load, F_N , by means of stroke- or force-controlled 4-cycle-beat excitation (modulated sine wave in accordance with DIN EN 60068-2-57), observing the allowable deflection,

   bd) determination of the adjustment resistance at specified velocities and temperatures.

(2) Normally, about 10 % of the dampers, but at least two dampers, shall be subjected to these tests and inspections in the presence of the authorized expert. The test results shall be confirmed by the authorized expert in the test report. If sufficient experience is available, the extent of attendance in these tests and inspections by the authorized expert may be reduced accordingly by mutual agreement.

8.3 Certification

(1) The manufacturer shall issue a certificate evidencing the tests and inspections performed on the finished standard support; the certificate shall include the following information:

a) test requirements,

b) materials and materials tests,

c) final inspections,

d) functional tests,

e) markings,

f) test result.

(2) The certificate shall be accompanied by the following documents:

a) a list of adjustment settings for hangers,

b) diagrams and test reports for constant hangers, constant supports, shock absorbers and dampers.

9 Markings

(1) Rigid standard supports including rigid struts shall be marked at least as follows:

a) manufacturer,

b) type or type code; material identification in the case of tie rods.

(2) Movable standard supports shall be marked at least as follows:

a) manufacturer,

b) type or type code,

c) nominal load,

d) travel range,

e) hot and cold load (only for movable hangers),

f) serial number,

g) acceptance stamp of the manufacturer,

h) position number; it shall be affixed at the latest in the course of assembly of the support in the nuclear power plant.

(3) The markings shall be durable and may not be detachable.

(4) Standard supports manufactured as specified in the present safety standard shall be marked visibly reflecting the scope of KTA 3205.1 or KTA 3205.2.

10 Assembly and Commissioning

10.1 Documents

(1) The following documents shall be present for performing the assembling tasks:

a) technical drawings of the component support structures including parts lists or equivalent documents and

b) assembly and operating instructions.

(2) The following documents shall be present for performing the on-site inspections:

a) list of the movable standard supports including information as to values of the specified and actual loads and nominal travel ranges, and

b) certificate of the manufacturer regarding the test and inspection of the finished standard support.

10.2 General Requirements

(1) The assembly and commissioning of movable standard supports may only be carried out by instructed personnel observing the instructions for installation and assembly.

(2) Where steel component parts are joined by on-site welding to complete the standard supports, the tests and inspections specified under Sections 8.1 and 8.2.1 shall be performed and shall be certified as specified under Section 8.3.

(3) When performing welding tasks on the pipeline systems or on steel structures, care shall be taken to ensure that the welding currents do not flow through shock absorbers, constant hangers or constant supports. If electric bridge connectors cannot be used, the shock absorbers, constant hangers or constant supports shall be removed.

(4) Load adjustments on constant hangers or constant supports may only be made by personnel properly instructed by the manufacturer. The adjustments shall be recorded.

(5) During transport and storage, standard supports shall be protected against damage as well as against dirt and humidity.

(6) The fluid level of hydraulic shock absorbers shall be monitored observing the instructions by the manufacturer.

10.3 On-Site Inspections

For the proper execution of on-site tests and inspections the assembly firm shall create a final inspection plan which shall include the following information:

a) receiving inspection of the standard supports,

b) checking that the installed standard supports are in compliance with the technical drawings,

c) inspecting the securing elements of bolted connections,

d) inspecting the structural attachments regarding the force- and form-fitness of the connections,

e) inspecting the on-site welds regarding their conformance with the test schedule,

f) inspecting the guides regarding sufficient clearance (play),

g) inspecting the mounting position of movable standard supports regarding their unrestrained freedom of movement with respect to thermal expansion and dynamic load applications taking the travel reserve into consideration, as well as inspecting the freedom of movement relative to the main loading direction or the connecting axis,

h) inspecting the fluid level of hydraulic shock absorbers,

i) inspecting the actual position under cold and hot load conditions after the operating load has been applied to the entire support system and the hanger blocking was removed,

k) inspecting the actual position after subsequent return to the cold load condition.

10.4 Certification

The on-site tests and inspections shall be summarized in lists and shall be certified. The records of the load adjustments shall be attached.

11 In-Service Inspections

11.1 General Requirements

In-service inspections shall be performed on all standard supports that involve relative movements.

11.2 Execution

(1) In-service inspections shall be executed as specified in the testing manual of the power plant. In particular, the extent of the inservice inspections, the inspection intervals, the performance of the inspections based on checklists, the inspection responsibilities and the type of documentation shall be specified.

(2) When preparing the test and inspection documents, the following shall be considered:

a) inspection recommendations of the manufacturer of the standard support, including information regarding results from the qualification tests,

b) visual inspections regarding, e.g.,
dirt,
wear marks,
damages,
visible deformations,
freedom of movement,
actual position in the cold load condition and, as far as possible, actual position in the hot load condition,
mounting position of standard supports,

c) for hydraulic shock absorbers additionally lifetime, monitoring for leak tightness and the level indicators of the medium.

(3) Additional in-service functional tests of shock absorbers shall be performed by mutual agreement with the authorized expert. A test report shall be prepared and shall be confirmed by the authorized expert.

12 Standard Supports of Pipelines, Valves and Fittings with a Nominal Diameter Smaller Than or Equal to DN 50

(1) Standard supports for pipelines, valves and fittings with a nominal diameter smaller than or equal to DN 50 shall fulfil the requirements specified under Sections 10 and 11.

(2) Rigid elements may have smaller dimensions than specified in Section 4.3.2, paragraph (1), provided, sufficient corrosion protection is applied.

(3) Frictional fit between clamp and pipe is allowable. A verification of the secured positioning is not required. The allowable resulting normal force shall be determined based on a design factor of 2.4 • K_2 as listed in **Table 5-1**. The design factor for determining the allowable loading from the experimentally determined friction forces shall be at least 1.7.

13 Documentation

(1) All of the following documents, test records, test reports and certifications as well as further records as follows shall become part of the documentation, the distribution and filing of which shall be as listed in **Table 13-1**:

a) Application documents for the qualification test,

b) Test records of the qualification test,

c) Certifications of the qualification test performed (test certificate), including design data sheet,

d) Materials certificates,

e) Documents for manufacturing,

f) Certification of the tests and inspections of the finished standard support (manufacturer certificate), including lists of adjustment settings, diagrams and test records,

g) Documents for assembly,

h) Certifications of on-site inspections,

i) Documents for in-service inspections and for maintenance,

k) Test records of in-service inspections, and

l) Test reports on functional tests performed within the scope of in-service inspections.

(2) The documents of qualification testing shall be stored at the manufacturing plant for at least 7 years after the end of the period of validity of the respective qualification test.

(3) Documents under paragraph (1), items a) through f), shall be stored at the manufacturing plant.

(4) Documents under paragraph (1), items c) and f) through l), shall be included into the final documentation of the plant operator.

(5) The documents may be included into the respective documentation in the form of originals, copies or microfilms.

(6) Whenever qualification-tested standard components under the scope of KTA 3205.2 are deployed for standard supports within the scope of KTA 3205.1, the documentation required as specified in KTA 3205.2 shall be specified in each individual case.

Type of test and inspection	Type of document in accordance with Section 13, paragraph (1)	Manufacturer of standard support	Operator of nuclear power plant
Qualification tests	a) b) c)	X X X	– – X
Fabrication tests and inspections	d) e) f)	X X X	– – X
Final inspections	g) h)	– –	X X
In-service inspections	i) k) l)	– – –	X X X

Table 13-1: Remaining of the documents

Appendix A

Testing Program for the Qualification Test of Rigid Standard Supports

A 1 Scope

Appendix A applies to the testing program for the experimental tests to be carried out within the scope of the qualification test of rigid standard supports.

A 2 Definitions and Explanations

Initial measured length, L_0

The initial measured length L_0 is generally equal to the geometric reference length. For threaded rods and turnbuckles, L_0 is equal to the length of the component and for clamps, L_0 is equal to the outer pipe diameter d_a (cf. **Figure A 2-1**).

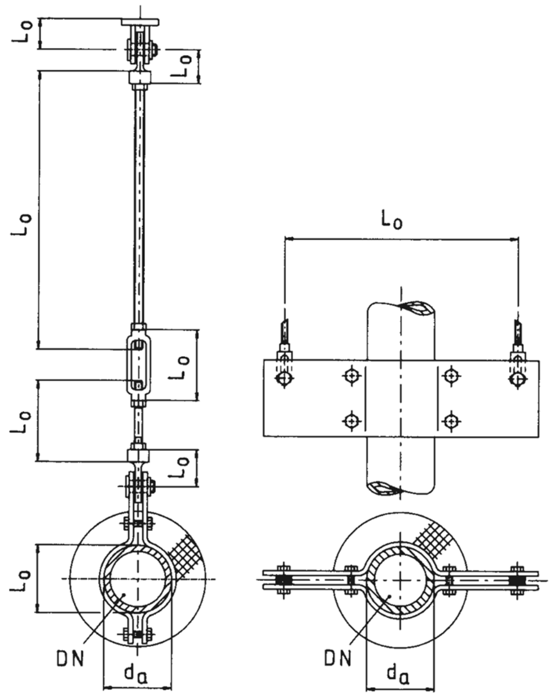


Figure A 2-1: Initial measured length, L_0

A 3 Testing Program

A 3.1 Execution of the Tests and Inspections

(1) If it is required, within the scope of qualification test, that the allowable loads determined from the strength calculation must be confirmed or verified by experimental tests, three tests shall be performed each on three different sizes of each type of rigid standard support.

(2) If it is required, within the scope of the qualification test, that the allowable loads must be determined by experimental tests, three tests each shall be performed for each type and size of rigid standard support and for each direction of load application.

(3) The specified mounting position of the standard support shall be observed in the test arrangement.

A 3.2 Extent of Testing

(1) The yield load or the ultimate load shall be determined as basis for determining the maximum allowable load as listed in **Table 5-1**.

(2) For rigid standard supports subjected to oblique loads under a larger angle than 5° as a result of oblique tension or oblique compression (e.g., in the case of pipe clamp bases), an additional experimental test with oblique tension or oblique compression shall be performed.

(3) The experimental tests may be terminated whenever a test load of a 5-fold nominal load is achieved.

(4) Dynamic pipe clamps (e.g., for shock absorbers and rigid struts) shall additionally be tested as specified under Section F 3.2.2, paragraph (1) of Appendix F.

A 4 Evaluation of Test Results

(1) The evaluation of the test results shall be based on the smallest measured yield load or ultimate load.

(2) The allowable load to be determined from **Table 5-1** for Load Case H shall be greater than or equal to the maximum operating load.

(3) Dynamic pipe clamps for shock absorbers and rigid struts which were subjected to additional tests as specified under Section F 3.2.2, paragraph (1) of Appendix F, shall be evaluated as specified under Section F 4.2 of Appendix F.

A 5 Documentation

All tests and inspections shall be recorded in test record. These test records shall become part of the documentation.

Appendix B

Testing Program for the Qualification Test of Spring Hangers and Spring Supports

B 1 Scope

Appendix B applies to the testing program for the experimental tests to be carried out within the scope of the qualification test of spring hangers and supports.

B 2 Definitions and Explanations

The essential details for the function of spring hangers or spring supports are shown in the force-travel-diagrams of **Figures B 2-1** and **B 2-2**.

$$F = F_{min} + \frac{F_N - F_{min}}{s_N} \cdot s$$

$F_{is,o}$: actual force at increasing load

$F_{is,u}$: actual force at decreasing load

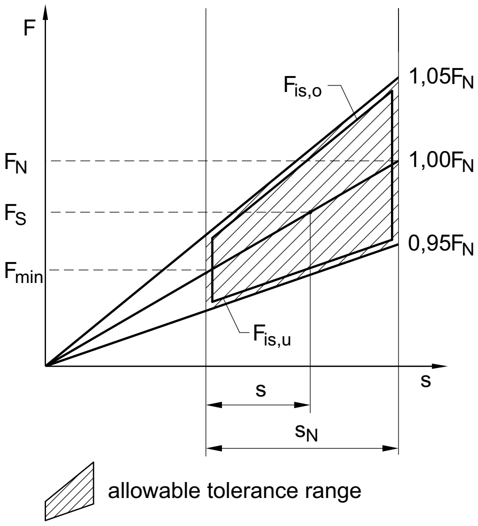
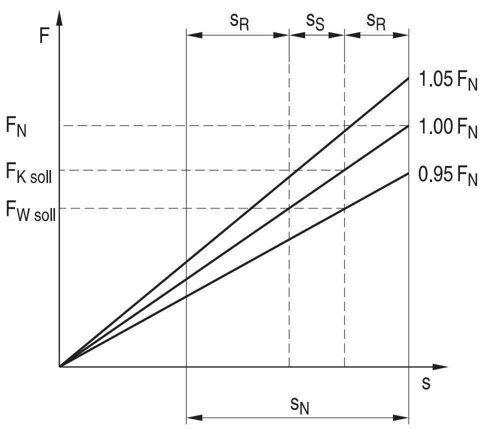


Figure B 2-1: Force-travel-diagram for spring hangers or spring supports



F_K : cold load

F_W : hot load

Figure B 2-2: Adjustment range for spring hangers and supports

B 3 Testing Program

B 3.1 Execution of the Tests and Inspections

(1) Two spring hangers or two spring supports of each type and size shall be subjected to the tests and inspections listed in **Table B 3-1**.

(2) Spring hangers or spring supports with comparable properties may be grouped together to be tested as one size-unit.

(3) The specified mounting position of the standard support shall be observed in the test arrangement.

B 3.2 Extent of Testing

B 3.2.1 Quasi-static tests

(1) Two spring hangers or the two spring supports shall be subjected to quasi-static tests in their blocked condition.

(2) During the tests involving oblique tension or oblique compression, the casings of the spring hangers or spring supports shall be fixed in their position, depending on the type.

B 3.2.2 Vibration test

(1) One spring hanger or one spring support shall be subjected to a vibration test.

(2) With the spring hanger or spring support in mid-position ($s = 0.5 \cdot s_N$), vibrations shall be applied in a controlled way in the following order, with the following travel amplitudes and the following frequency guide values:

$1.0 \cdot 10^3$ cycles at	± 20 mm and	1 Hz
$2.0 \cdot 10^4$ cycles at	± 5 mm and	5 Hz
$1.8 \cdot 10^6$ cycles at	± 0.5 mm and	15 Hz
$2.0 \cdot 10^4$ cycles at	± 5 mm and	5 Hz
$1.0 \cdot 10^3$ cycles at	± 20 mm and	1 Hz

(3) If the nominal travel range s_N is smaller than 40 mm, the tests shall be performed for 10^3 cycles at $\pm 0.5 \cdot s_N$.

(4) After the vibration test, the quasi-static tests except for oblique tension tests in case of spring hangers or oblique compression tests in case of spring supports shall be repeated.

B 3.2.3 Ultimate load test

(1) One spring hanger or one spring support shall be subjected to an ultimate load test to determine its load capacity. Subsequently, the spring hanger or spring support shall be disassembled and inspected visually for weak spots.

(2) The ultimate load test may be terminated whenever a test load of a 5-fold nominal load F_N is achieved.

B 4 Evaluation of Test Results

B 4.1 Quasi-Static Tests

(1) Spring hangers subjected to vertical tension and spring supports subjected to vertical compression shall be able to withstand a load of $2.5 \cdot F_N$ without permanent deformations (cf. **Table 5-1**).

(2) Within the nominal travel range s_N spring hangers or spring supports shall fulfill the following requirements:

a) for vertical tensile loading of spring hangers or for vertical compression of spring supports:

$$\frac{|F_S - F_{ist,o}|}{|F_S|} \leq 0.05 \qquad \text{(B 4-1)}$$

$$\frac{|F_S - F_{ist,u}|}{|F_S|} \leq 0.05 \qquad \text{(B 4-2)}$$

b) for a 4° oblique tensile loading of spring hangers or a 4° oblique loading of spring supports, corresponding to a lateral force of 7 %:

$$\frac{|F_S - F_{ist,o}|}{|F_S|} \leq 0.06 \qquad \text{(B 4-3)}$$

$$\frac{|F_S - F_{ist,u}|}{|F_S|} \leq 0.06 \qquad \text{(B 4-4)}$$

B 4.2 Vibration Test

(1) The vibration test is considered successful if the subsequently performed quasi-static tests meet the requirements specified under Section B 4.1.

(2) Signs of wear are allowable, provided, they do not affect the functionality of the equipment.

B 4.3 Ultimate Load Test

The allowable load to be determined as listed in **Table 5-1** shall be greater than or equal to the nominal load, F_N.

B 5 Documentation

All tests and inspections shall be recorded in test records. These records shall become part of the documentation.

Tests	Number of Tests	Spring Hanger No. 1 Spring Support No. 1	Spring Hanger No. 2 Spring Support No. 2
Quasi-Static Tests			
a) loading at 2.5 • F_N (blocked)	1	X	X
b) vertical tension for spring hanger and vertical compression for spring support with $v \leq 1$ mm/s	3	X	X
c) 4° oblique tension for spring hangers and 4° oblique compression for spring supports [1] with $v \leq 1$ mm/s	3	X	X
d) checking the travel scale	—	X	X
Vibration Test			
a) vibration	—	X	—
b) load 2.5 • F_N	1	X	—
c) vertical tension for spring hangers and vertical compression for spring supports with $v \leq 1$ mm/s	3	X	—
d) checking the travel scale	—	X	—
e) visual inspection for signs of wear	—	X	—
f) surface crack inspection	—	X	—
Ultimate Load Test			
a) vertical tension for spring hanger and vertical compression for spring support	1	—	X
b) visual inspection	—	—	X
[1] It is also allowable to apply a lateral force of 0.07 • F_N simultaneously with force F_N			

Table B 3-1: Tests and inspections of spring hangers and spring supports

Appendix C

Testing Program for the Qualification Test of Constant hangers and Constant Supports

C 1 Scope

Appendix C applies to the testing program for the experimental tests to be carried out within the scope of the qualification test of constant hangers and constant supports.

C 2 Definitions and Explanations

The essential details regarding the function of a constant hanger or a constant support are presented by the force-travel diagram for constant hangers or a constant supports in **Figure C 2-1**.

C 3 Testing Program

C 3.1 Execution of the Tests and Inspections

(1) Two constant hangers or two constant supports of each type and size shall be subjected to the tests and inspections listed in **Table C 3-1.**

(2) The specified mounting position of the standard support shall be observed in the test arrangement.

C 3.2 Extent of Testing

C 3.2.1 Quasi-static tests

(1) The two constant hangers or constant supports shall be subjected to quasi-static tests.

(2) During tests involving oblique tension or oblique compression, the casings of the constant hangers or constant supports shall be fixed in their position. These tests need only be carried out if, in the actual application, the housing is rigidly attached to the structure.

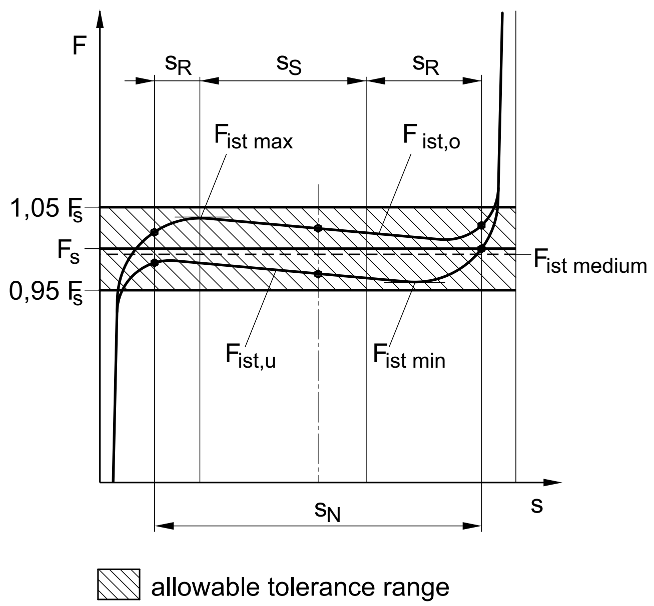


Figure C 2-1: Force-travel diagram for constant hangers and constant supports

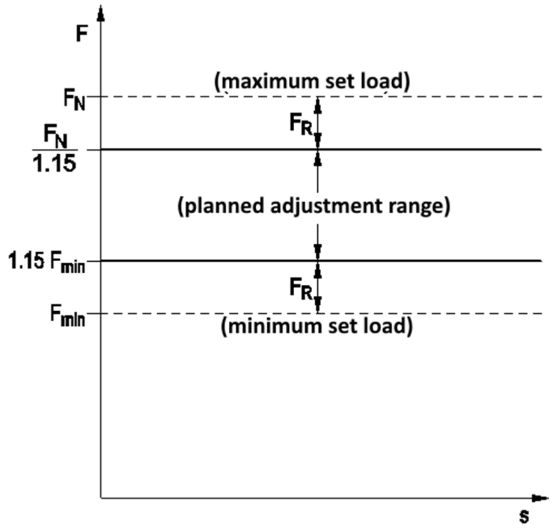


Figure C 2-2: Adjustment range for constant hangers

C 3.2.2 Vibration test

(1) Prior to the vibration test, on one constant hanger or one constant support three force-travel diagrams shall be recorded one after the other at adjustment setting of either F_N or $(F_{s\ max} + F_{s\ min})/2$.

(2) Subsequently, with the constant hanger or constant support being in mid-position, vibrations shall be applied in a controlled way in the following order, with the following stroke amplitudes and following frequency guide values:

$2.0 \cdot 10^4$ cycles at ± 5 mm and 5 Hz
$1.8 \cdot 10^6$ cycles at ± 0.5 mm and 15 Hz
$2.0 \cdot 10^4$ cycles at ± 5 mm and 5 Hz
$1.0 \cdot 10^4$ cycles at ± 0.4 s_N and 1 Hz

(3) After the vibration test, the quasi-static tests listed as items a) and b) in **Table C 3-1** shall be repeated.

(4) In addition, it shall be checked whether, considering the allowable load deviations, at least 15 % of the load reserves (F_R in **Figure C 2-2**) can be adjusted without restricting the travel reserves.

(5) Finally, the constant hanger or the constant support shall be disassembled and examined for signs of wear and for incipient cracks by means of a surface crack inspection.

C 3.2.3 Temperature test

After having been subjected for 48 h to a temperature of 80 °C and subsequently cooled-down to room temperature, the force-travel diagram for one constant hanger or one constant support adjusted for F_N shall be recorded.

C 3.2.4 Ultimate load test

(1) One constant hanger or one constant support shall be subjected to an ultimate load test. Subsequently, the constant hanger or the constant support shall be disassembled and visually inspected for possible weak spots.

(2) The ultimate load test may be terminated whenever a test load of a 5-fold nominal load, F_N, is achieved.

C 4 Evaluation of Test Results

C 4.1 Quasi-Static Tests

(1) Constant hangers subjected to vertical tension and constant supports subjected to vertical compression shall be able to withstand a load of 2.5 • F_N without any permanent deformations.

(2) Within the nominal travel range s_N constant hangers shall fulfill the following requirements:

a) for vertical tensile loading of constant hangers or for vertical compression of constant supports with a velocity v smaller than or equal to 1 mm/s:

$$\frac{|F_S - F_{ist,min}|}{|F_S|} \leq 0.05 \qquad \text{(C 4-1)}$$

$$\frac{|F_S - F_{ist,max}|}{|F_S|} \leq 0.05 \qquad \text{(C 4-2)}$$

b) for a 4° oblique tensile loading of constant hangers or a 4° oblique compression loading of constant supports, corresponding to a lateral force of 7 %:

$$\frac{|F_S - F_{ist,min}|}{|F_S|} \leq 0.06 \qquad \text{(C 4-3)}$$

$$\frac{|F_S - F_{ist,max}|}{|F_S|} \leq 0.06 \qquad \text{(C 4-4)}$$

c) based on items a) and b), the maximum tolerance for mid-load is:

$$\frac{|F_S - F_{ist,mid}|}{|F_S|} \leq 0.02 \qquad \text{(C 4-5)}$$

(3) Constant hangers shall also comply with the above tolerances at the adjustment settings F_N and F_{min} if vertical tension is applied. The same applies to constant supports under vertical compression.

C 4.2 Vibration Test

(1) The vibration test is considered successful if the subsequently performed quasi-static tests meet the requirements specified under Section C 4.1.

(2) Signs of wear are allowable, provided, they do not affect the functionality of the equipment.

C 4.3 Temperature Test

The temperature test is considered successful if the recorded force-travel curve lies within the tolerance ranges of equations C 4-1, C 4-2 and C 4-5.

C 4.4 Ultimate load test

The allowable load to be determined as listed in **Table 5-1** shall be greater than or equal to the nominal load F_N.

C 5 Documentation

All tests and inspections shall be recorded in test records. These records shall become part of the documentation.

Tests	Number of Tests	Constant Hanger No. 1 Constant Support No. 1	Constant Hanger No. 2 Constant Support No. 2
Quasi-static tests			
a) load 2.5 • F_N (blocked)	1	X	X
b) vertical tension for constant hanger and vertical compression for constant support with v ≤ 1 mm/s	3	X	X
c) 4° oblique tension for constant hanger and 4° oblique compression for constant support [1)] with v ≤ 1 mm/s	3	X	X
d) vertical tension for constant hanger and vertical compression for constant support at F_{min}	3	X	X
e) vertical tension for constant hanger and vertical compression for constant support at F_N	3	X	X
Vibration tests			
a) vertical tension for constant hanger and vertical compression for constant support with v ≤ 1 mm/s	3	X	—
b) vibration	—	X	—
c) loading of 2.5 • F_N (full scale deflection)	1	X	—
d) vertical tension for constant hanger and vertical compression for constant support with v ≤ 1 mm/s	3	X	—
e) checking the load adjustment range	1	X	X
f) visual inspection for signs of wear	—	X	—
g) surface crack inspection	—	X	—
Temperature tests			
a) vertical tension for constant hanger and vertical compression for constant support with v ≤ 1 mm/s	3	—	X
b) temperature exposure (48 h, 80 °C)	1	—	X
c) vertical tension for constant hanger and vertical compression for constant support with v ≤ 1 mm/s	3	—	X
Ultimate load test			
a) vertical tension for constant hanger and vertical compression for constant support	1	—	X
b) visual inspection	1	—	X
1) It is also allowable to apply a lateral force of 0.07 • F_N simultaneously to the force F_N.			

Table C 3-1: Tests and inspections of constant hangers and constant supports

Appendix D

Testing Program for the Qualification Test of Mechanical and Hydraulic Shock Absorbers

D 1 Scope

Appendix D applies to the testing program for the experimental tests to be carried out within the scope of the qualification test of mechanical and hydraulic shock absorbers.

Note:

(1) The shock absorber as such also includes its connecting bracket and pins.

(2) This Appendix D does not cover loads resulting from operational vibrations.

D 2 Definitions and Explanations

The essential details regarding the function of a shock absorber are shown in **Figure D 2-1**.

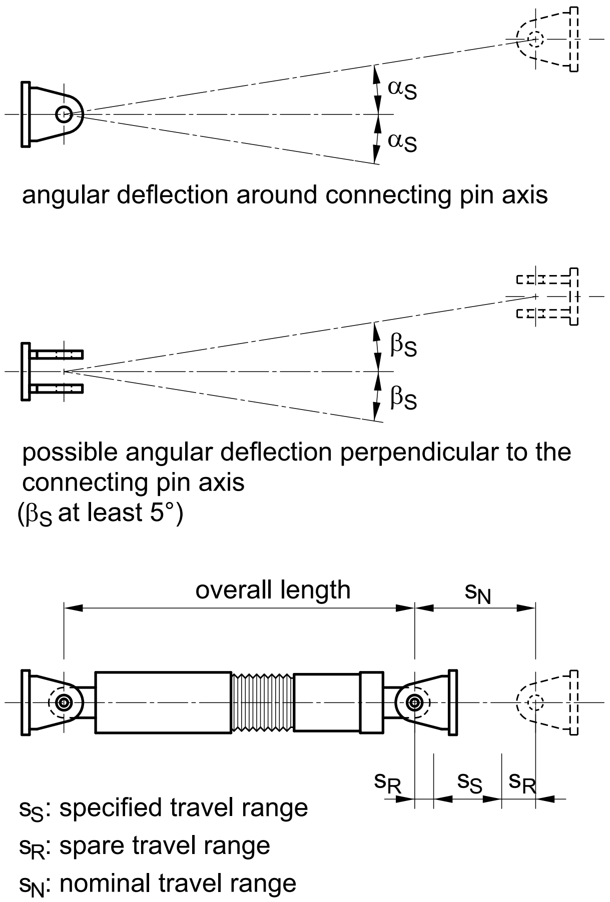


Figure D 2-1: Freedom of movements of a shock absorber

D 3 Testing Program

D 3.1 Execution of the Tests and Inspections

(1) Three shock absorbers of each type and size shall be subjected to the tests and inspections listed in **Table D 3-1**.

(2) Shock absorbers shall be positioned horizontally and at their mid-stroke-position.

D 3.2 Extent of Testing

D 3.2.1 Verification of the resistance to ageing for non-metallic materials

(1) If shock absorbers contain components made of non-metallic materials, these components shall be subjected to artificial ageing simulating the radiation and temperature exposure corresponding to their operating life and operating conditions. This test shall normally result in data required for specifying the duration of operation, e.g., for the seals (at least 8 years), in order to ensure proper functioning of the shock absorber.

(2) The program for verifying the resistance to ageing shall be specified taking the respective material into consideration. The functional tests and the continuous-load test shall be performed on one shock absorber of each type and size.

(3) The resistance to ageing shall be verified by the following tests:

a) materials tests of untreated materials,

b) materials tests of aged materials regarding radiation (40 years) and regarding temperature (stepwise, each step 4 years), including:

   ba) Functional test of the shock absorber with materials aged by radiation,

   bb) Long-term test with 2.0 • 10^5 load cycles; the frequency and load shall be specified,

   bc) Functional test of the shock absorber with materials aged by temperature (4 years),

   bd) Long-term test with 2.0 • 10^5 load cycles; the frequency and load shall be specified,

   be) This procedure shall be repeated until the shock absorber begins to fail.

D 3.2.2 Dimensional check

A dimensional check shall be performed based on the technical drawing. In addition, the nominal travel range s_N and the freedom of movement perpendicular to the connecting pin axis shall be measured.

D 3.2.3 Functional test

D 3.2.3.1 Forces and response behavior

The following shall be measured at room temperature:

a) frictional resistance and breakaway resistance,

b) stroke,

c) response acceleration or lockup velocity,

d) bypass velocity, and

e) piston rod movement during change of direction of the load application for the nominal load F_N and a frequency of 5 Hz.

D 3.2.3.2 Cyclic loadings

(1) Starting from its mid-stroke position, the dynamic function of the shock absorber shall be tested under oscillating loads. The piston rod movement lengths s_a and s_b shall be measured (cf. **Figure D 3-1**).

(2) These tests shall be performed at frequencies of 1, 2, 5, 10, 15, 20, 25, 30 and 35 Hz. The loading duration at each frequency shall normally be at least 10 seconds long.

(3) The force and the stroke shall be recorded both as a function of time and in a parameter representations (phase diagram) as shown in **Figures D 3-1** and **D 3-2**.

(4) During the tests of hydraulic shock absorbers, they shall be observed with a view to loss of hydraulic oil. Oil droplets or oil films are not allowable. Functional tests shall also be carried out at a fluid level of 90 %, provided, the functionality of the shock absorber is still ensured at this fluid level.

Tests	**Hydraulic Shock Absorber No.**			**Mechanical Shock Absorber No.**		
	1	**2**	**3**	**1**	**2**	**3**
Dimensional check	X	X	X	X	X	X
Check of the characteristics of the hydraulic oil	X	–	–	–	–	–
Functional test at room temperature	X	X	X	X	X	X
Functional test at 90 % level of hydraulic oil, if necessary	X	–	–	–	–	–
Vibration test at 80 °C	–	X	–	–	X	–
Vibration test at 150 °C	–	–	X	–	–	X
Functional test at room temperature	–	X	X	–	X	X
Surface crack inspection	–	X	X	–	X	X
Overload test at 1.7 • F_N	–	X	–	–	X	–
Ultimate load test with tensile loading	–	–	X	–	–	X
Ultimate load test with compressive loading	X [1]	–	–	–	X [1]	–
Visual inspection of the individual parts	X	X	X	X	X	X
Checking the characteristics of the hydraulic oil (oil from the shock absorber)	–	X	X	–	–	–
Ageing program (Shock absorber No. 1 may be used for this test)	X	–	–	X	–	–

[1] May be substituted by a verification by analysis.

Table D 3-1: Test and inspections of hydraulic and mechanical shock absorbers

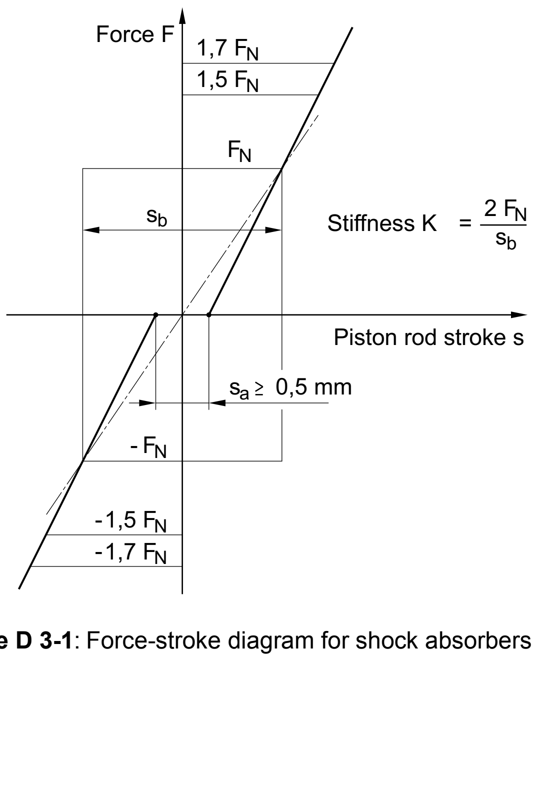


Figure D 3-1: Force-stroke diagram for shock absorbers

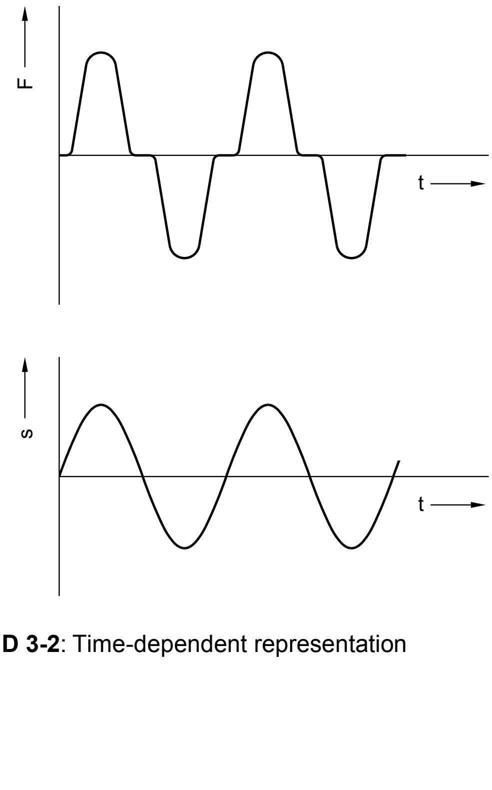


Figure D 3-2: Time-dependent representation

D 3.2.4 Vibration test

(1) One shock absorber of each type and size shall be subjected at 80 °C and at 150 °C to the following load cycles at a frequency of approximately 10 Hz.

a) at 80 °C

The collective of load cycles below corresponds to $1.0 \cdot F_N$ at 10,000 load cycles.

$1.5 \cdot F_N$	25	load cycles
$1.0 \cdot F_N$	3,300	load cycles
$0.5 \cdot F_N$	47,000	load cycles
$0.1 \cdot F_N$	$1.8 \cdot 10^6$	load cycles

In the case of mechanical shock absorbers and only in well-founded cases and in agreement with the authorized expert, the verification at $0.1 \cdot F_N$ may be reduced to 330,000 load cycles, provided, it is ensured that, in the actual application, the occurring number of load cycles will not be exceeded.

b) at 150 °C

$1.5 \cdot F_N$	25	load cycles
$1.0 \cdot F_N$	1,800	load cycles
$0.5 \cdot F_N$	18,000	load cycles
$0.1 \cdot F_N$	72,000	load cycles

(2) Subsequently, the functional test shall be repeated and evaluated.

(3) Surface crack inspections and, if necessary, dimensional checks shall be performed on bearing and sliding surfaces, on load-bearing welds as well as on hinge parts.

(4) Prior to and after the vibration tests, the characteristics of the hydraulic oil shall be checked for compliance with the data specified by the manufacturer.

D 3.2.5 Overload test

(1) One shock absorber already tested at 80 °C shall be subjected fifty times to $1.7 \cdot F_N$ at a frequency greater than or equal to 3 Hz.

(2) Subsequently, this shock absorber shall be disassembled and examined for incipient cracks and permanent deformations.

D 3.2.6 Ultimate load test

(1) One ultimate load test shall be performed under tension and one under compression. These tests may be terminated whenever a 5-fold nominal load F_N is achieved.

(2) Subsequently, this shock absorber shall be disassembled and visually inspected for possible weak spots.

(3) The ultimate load test under compressive load may be substituted by a verification by analysis. This applies, in particular, to shock absorbers incorporating an extension.

D 4 Evaluation of Test Results

D 4.1 Verification of Resistance to Ageing

Sufficient resistance to ageing is given if the functional capability of the shock absorber is still maintained after the vibration tests.

D 4.2 Dimensional Check

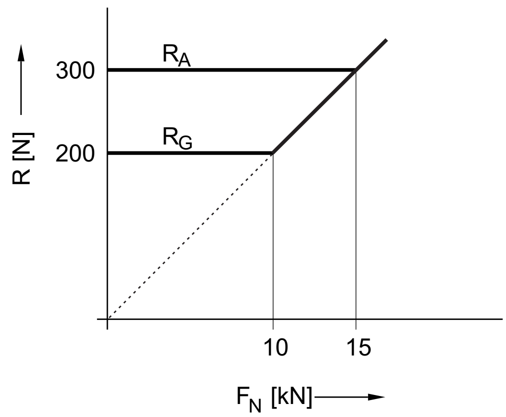
The dimensional data specified by the manufacturer as well as the requirements under Section 4.3.5 shall be observed.

D 4.3 Functional Test

D 4.3.1 Frictional resistance and breakaway resistance

(1) The frictional resistance shall be smaller than the larger value of $0.02 \cdot F_N$ and 200 N (cf. **Figure D 4-1**).

(2) The breakaway resistance shall be smaller than the larger value of $0.02 \cdot F_N$ and 300 N (see **Figure D 4-1**).



R_A : breakaway resistance

R_G : frictional resistance

Figure D 4-1: Frictional resistance and breakaway resistance dependent on F_N , the nominal load

D 4.3.2 Response acceleration

For mechanical shock absorbers, the response acceleration at room temperature shall be between 0.1 m/s^2 and 0.22 m/s^2 for a uniformly increasing acceleration.

D 4.3.3 Lockup velocity

For hydraulic shock absorbers, the lockup velocity shall be between 3 mm/s and 6 mm/s at room temperature for a uniformly increasing velocity.

D 4.3.4 Bypass velocity

(1) Following the response of the hydraulic shock absorber at nominal load F_N and an unchanging uniform movement, the bypass velocity may be between 0.2 mm/s and 2 mm/s at room temperature.

(2) In the case of mechanical shock absorbers which lock when responding and unlock in the follow-up mode, the bypass velocity may be zero for a brief period of time.

D 4.3.5 Piston rod movement

Note:

The piston rod movement is the sum of the following:

a) the response stroke as a result of the physical mode of operation,

b) the elastic behavior resulting from load application, and

c) the clearance at the connection points.

(1) The piston rod travel, s_b , shall not exceed the values shown in **Table D 4-1** when the direction of loading changes up to the nominal load, F_N smaller than or equal to 750 kN (cf. **Figure D 3-1**).

Temperature	Frequency	
	1 Hz to 3 Hz	> 3 Hz
Room temperature	± 0.025 • s_N max. 8 mm	± 0.02 • s_N
150 °C	± 0.04 • s_N max. 12 mm	± 0.04 • s_N

Table D 4-1: Piston rod travel length s_b dependent on temperature and frequency

(2) Upon reversal of the load direction, the piston rod travel length s_a (cf. **Figure D 3-1**), until the beginning of load build-up shall not be less than 0.5 mm.

(3) In the case of shock absorbers for a nominal load F_N larger than 750 kN, the allowable values of s_a and s_b shall be specified in agreement with the authorized expert.

D 4.4 Vibration Test

The vibration test is considered successful if the subsequently performed functional test meets the requirements of Section D 4.3.

D 4.5 Overload Test

Upon completion of the overload test, the shock absorber shall not show any permanent deformations. Cracks are not allowable.

D 4.6 Ultimate Load Test

The allowable load to be determined as listed in **Table 5-1** shall be greater than or equal to the nominal load, F_N.

D 5 Documentation

All tests and inspections shall be recorded in test reports. These reports shall become part of the documentation.

Appendix E

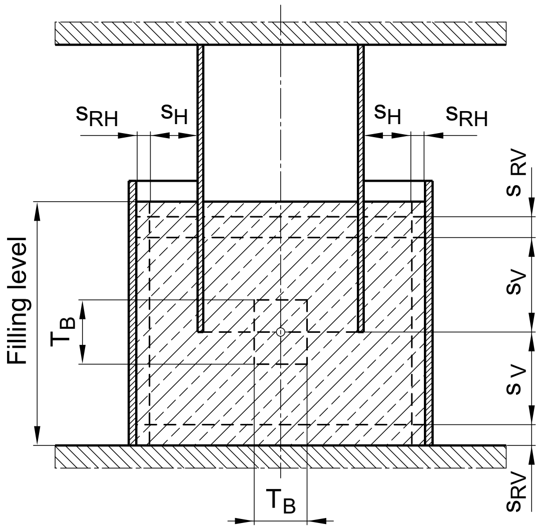
Testing Program for the Qualification Test of Viscoelastic Vibration Dampers (Dampers)

E 1 Scope

Appendix E applies to the testing program for the experimental tests which shall be performed within the scope of the qualification test of viscoelastic vibration dampers (dampers) within the frequency range between 1 Hz and 35 Hz.

E 2 Definitions and Explanations

(1) The essential details regarding the function of a damper are shown in **Figure E 2-1**.



⟡ : mid-position in operating (hot) condition
s_V : maximum allowable vertical stroke
s_H : maximum allowable horizontal stroke
s_{RV}: vertical travel reserve, at least 10 mm
s_{RH}: horizontal travel reserve, at least 10 mm
T_B : tolerance range at mid-position

The allowable deviation of the mid-position in operating condition shall be specified for each type of damper in the qualifcation test certificate.

Figure E 2-1: Freedom of movement of the damper

(2) Operating temperature of damping medium

The operating temperature of the damping medium is the temperature reached in the damping medium during continuous operation for the specified load case.

(3) Dynamic characteristics

a) Damping resistance

The damping resistance is the quotient of the force amplitude and the velocity amplitude of the vibration.

b) Equivalent stiffness

The equivalent stiffness is the quotient of the force amplitude and the stroke amplitude

(c) Nominal load

The nominal load is the maximum allowable damping force which is admissible at operating temperature and under dynamic excitation.

E 3 Testing Program

E 3.1 Execution of the Tests and Inspections

(1) Two dampers of each type and size shall be subjected to the tests listed in **Table E 3-1**.

(2) The specified mounting position of the dampers shall be considered in the test arrangement.

E 3.2 Extent of Testing

E 3.2.1 Verification of the resistance to ageing of non-metallic materials

The extent of testing for verifying the resistance to ageing shall be specified for the respective material. This test shall normally result in data required for specifying the duration of operation for the bellows and the damping medium.

E 3.2.2 Dimensional check

A dimensional check shall be performed on the basis of the technical drawings. In addition, the nominal travel range, the travel reserves also during tilting, as well as the tilting angle shall be determined.

E 3.2.3 Damping medium

The temperature dependent characteristics of the damping medium, in particular its viscosity, shall be checked against the data specified by the manufacturer.

Tests	Damper No. 1	Damper No. 2
Verification of resistance to ageing	X	X
Dimensional check	X	X
Damping medium, characteristics	X	X
Functional tests:		
Dynamic characteristics		
Damping resistance	X	X
Equivalent stiffness	X	X
Adjustment resistance		
Medium at room temperature	X	–
Medium at operating temperature	–	X
Vibration test	X	X
Overload test	X	X
Visual inspection and surface crack inspection of the welds	X	X
Ultimate load test [1]	X	X

[1] May be substituted by a calculational analysis.

Table E 3-1: Extent of testing for dampers

E 3.2.4 Functional test

E 3.2.4.1 Dynamic characteristics

(1) The dynamic characteristics defined under Section E 2, paragraph (3) shall be determined.

(2) The following tests shall be performed dependent on the damping medium used, both, at room temperature and at the specified maximum operating temperature, in a vertical and horizontal direction of load application and starting at the mid-position of the damper piston:

a) Determination of the damping resistance and the equivalent stiffness for the following frequencies and amplitudes:

1	2	5	10	20	30	35	Hz
10	5	3	2	0.75	0.25	0.1	mm

   aa) Measurement of the damping resistance with stroke-controlled continuous sine excitation for a test duration of 10 seconds,

   ab) Measurement of the equivalent stiffness for shock-type loadings, each with 5 load cycles of a 4-cycle-beat excitation (modulated sinus in accordance with DIN EN 60068-2-57).

b) Determination of the adjustment resistance using the values specified by the manufacturer.

(3) Between two tests a pause in testing of up to 30 minutes in the case of large test amplitudes and up to 5 minutes in the case of small test amplitudes may be taken.

(4) The evaluation amplitudes shall be formed separately for each quantity to be evaluated as the average value of the amplitudes of the compressive and tensile load ranges.

E 3.2.5 Vibration test

The vibration test shall consist of $2 \cdot 10^6$ load cycles at a frequency of 15 Hz and an amplitude of 0.1 mm.

E 3.2.6 Overload test

(1) The nominal load specified by the manufacturer must in each case be proved by an overload test in a specified frequency range using displacement or force-controlled 4-cycle-beat excitations (modulated sine in accordance with DIN EN 60068-2-57) or continuous sine loading. The test frequency and test amplitude shall normally be set such that at least the 1.7-fold nominal load is reached under considering the permissible deflection.

(2) After this test, the individual parts shall normally be subjected to a visual inspection including a surface crack inspection of the welds.

E 3.2.7 Ultimate load test

The ultimate load test may be substituted by a calculational analysis.

E 4 Evaluation of Test Results

E 4.1 Verification of Resistance to Ageing

The resistance to ageing is verified if the functional capability of the damper is maintained after the tests.

E 4.2 Dimensional Check

The dimensional data specified by the manufacturer shall have been observed.

E 4.3 Damping Medium

The damping medium shall fulfil the requirements specified by the manufacturer.

E 4.4 Functional Test

(1) The damping resistance and the equivalent stiffness shall be plotted as a function of the frequency and shall meet the requirements specified by the manufacturer.

(2) The adjustment resistance shall not exceed 2 % of the nominal load.

E 4.5 Overload Test

Upon completion of the overload test, the dampers shall not show any permanent deformations nor any cracks.

E 5 Documentation

All tests and inspections shall be recorded in test records. These records shall become part of the documentation.

Appendix F

Test and Program for the Qualification Test of Rigid struts

F 1 Scope

Appendix F applies to the testing program for the experimental tests to be carried out within the scope of the qualification test of rigid struts.

F 2 Definitions and Explanations

(1) The essential details regarding the function of a rigid strut are shown in **Figure F 2-1**.

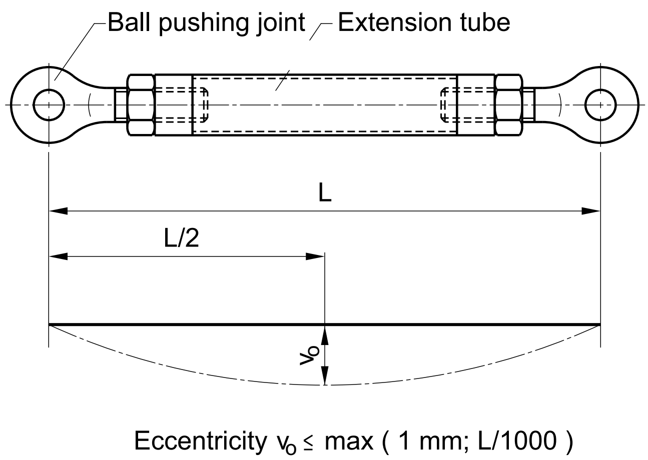


Figure F 2-1: Rigid strut

(2) Rigid struts consist of a rigid component as connecting element and two ball bushing joints.

(3) The eccentricity resulting from a previous deflection or misalignment shall not exceed the values specified in Section 4.3.5 (8).

F 3 Testing Program

F 3.1 Execution of the Tests

(1) Two rigid struts of each type and size shall be subjected to the tests and inspections listed in **Table F 3-1**.

Test	Rigid Strut No. 1	Rigid Strut No. 2
Dimensional check	X	X
Measurement of the eccentricity	–	X
Measurement of the clearance (play)	X	–
Vibration test	X	–
Surface crack inspection	X	–
Ultimate load test a) tension (5° angular deflection)	X	–
b) compression (maximum length)	–	X

Table F 3-1: Extent of testing for rigid struts

(2) The two ends of the rigid struts shall be connected to the corresponding component parts and tested in this form.

(3) The rigid struts shall be subjected to both tension and compression, with the compressive load tests being performed at their maximum length.

(4) Unless otherwise specified for the individual case, the tests shall be performed at room temperature in a horizontally mounted position,

F 3.2 Extent of Testing

F 3.2.1 Dimensional check

A dimensional check, including measurement of the clearance (play), shall be performed on the basis of the technical drawings.

F 3.2.2 Vibration test

(1) One rigid strut of each type and size shall be subjected to a vibration test at about 10 Hz under the following loads and load cycles:

$1.5 \cdot F_N$	25	load cycles
$1.0 \cdot F_N$	3,300	load cycles
$0.5 \cdot F_N$	47,000	load cycles
$0.1 \cdot F_N$	330,000	load cycles

The collective of load cycles above corresponds to $1.0 \cdot F_N$ at 10,000 load cycles.

(2) After the vibration test, surface crack inspections shall be performed on the ball bushing joints and welds, and the clearance (play) of the tested support arrangement shall be measured.

F 3.2.3 Ultimate load test

(1) One rigid strut each shall be subjected to tensile forces and the other to compressive forces until they fail. The rigid strut which was also subjected to the vibration test shall be used for the tensile loading.

(2) The ball bushing joints shall be tested at 150 °C for the most unfavorable direction of load application.

(3) For the test involving tensile loads, the eye of the ball bushing joint shall be turned about 5° in relation to the plane of the ball bushing joint; an angle of 0° shall be set in the tests involving compressive loads.

F 3.2.4 Additional Tests

(1) If a 1.5-fold nominal load for Load Case HZ and 1.7-fold nominal load for Load Case HS shall be allowed, then the following additional tests shall be performed for each size:

a) One rigid strut for which the decisive factor regarding size is the compressive loading, shall be subjected to a dynamic load of

   $1.7 \cdot F_N \cdot 1.2$ $(= 2.04 \cdot F_N)$

b) One rigid strut for which the decisive factor regarding size is the tensile loading, shall be subjected to a dynamic load of

   $1.7 \cdot K_2 \cdot F_N \cdot 1.1$ $(= 1.87 \cdot K_2 \cdot F_N)$

(2) The rigid struts to be tested shall have been produced from the same batches as the rigid struts used for determining the ultimate load.

(3) The dynamic tests shall be performed at a frequency of 6 Hz and shall comprise at least 7 load cycles.

F 4 Evaluation of test results

F 4.1 Dimensional Check

The dimensional data specified by the manufacturer as well as the requirements regarding clearance and eccentricity shall be observed.

F 4.2 Vibration Test

(1) The vibration test is considered successful if the subsequently performed measurement of the total clearance does not result in a value larger than 2 % of the bolt diameter or larger than 1.5 mm.

(2) The surface crack examination may not reveal any cracks.

F 4.3 Ultimate load test

(1) The allowable load to be determined as listed in **Table 5-1** shall be greater than or equal to the nominal load, F_N.

(2) It is allowable to determine the buckling load P_K by means of a load deformation measurement from the critical buckling load, P_{Kr} , (cf. **Figure F 4-1**).

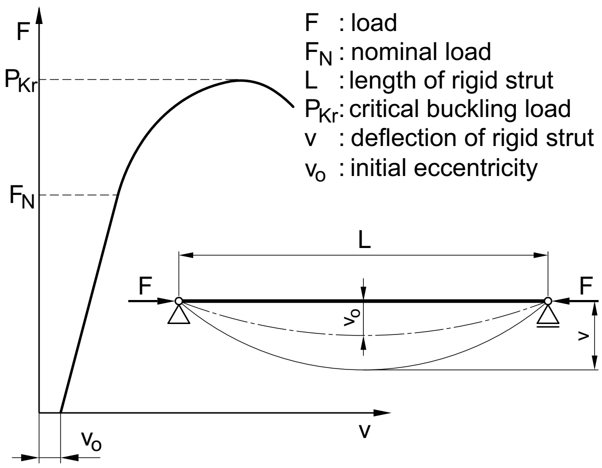


Figure F 4-1: Load-deflection diagram of buckled bars

F 4.4 Additional Tests

The additional tests are considered successful if the clearance (play) of the overall arrangement does not exceed 3 mm after the loadings.

F 5 Documentation

All tests and inspections shall be recorded in test records. These records shall become part of the documentation.

Appendix G

Nomenclature

A_5	residual elongation
d	nominal diameter of threaded part
DN	nominal diameter of the pipeline
F	force or loading
$F_{ist,o}$	actual force during loading
$F_{ist,u}$	actual force during load relief
F_K	cold load
F_W	hot load
F_N	nominal load, a component-specific characterizing load
F_R	load reserve for constant hangers and constant supports
F_{RD}	design value for the load capacity
F_S	specified load
H, HZ, HS	load cases with corresponding design criteria
K	stiffness
L	length
L_0	initial measured length
P_F	yield load
P_K	buckling load
P_{Kr}	critical buckling load
P_{Tr}	ultimate load
R_A	breakaway resistance
R_{eH}	yield strength (at room temperature)
R_G	frictional resistance
R_m	tensile strength (at room temperature)
$R_{p0,2}$	0.2 % yield strength (at room temperature)
s	piston rod movement; maximum possible travel range
s_N	nominal travel range of moveable standard support
s_R	travel reserve
s_S	specified travel range; calculated by thermal expansions and dynamic loadings, if any
s_H	maximum allowable horizontal stroke
s_V	maximum allowable vertical stroke
s_{RH}	travel reserve in horizontal direction
s_{RV}	travel reserve in vertical direction
T_B	tolerance range at mid-position
T_M	design temperature of the pipeline
v	deflection of the rigid strut
v_o	eccentricity, initial eccentricity

Appendix H

Regulations Referred to in the Present 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)

AtG		Act on the peaceful utilization of atomic energy and the protection against its hazards (Atomic Energy Act – AtG) of December 23, 1959, revised version of July 15, 1985 (BGBl. I, p. 1565), most recently changed by Article 1 of the Act of July 10 ,2018 (BGBl. I, p. 1122, 1124)
StrlSchV		Ordinance on the protection from damage by ionizing radiation (Radiological Protection Ordinance – StrlSchV) of July 20, 2001 (BGBl. I, p. 1714; 2002 I, p. 1459), most recently changed as called for in Article 10 by Article 6 of the Act of. January 27, 2017 (BGBl. I, p. 114, 1222)
SiAnf	(2015-03)	Safety requirements for nuclear power plants of November 22, 2012, revised version of March 3, 2015 (BAnz AT of March 30, 2015 B2)
SiAnf-Interpretations	(2015-03)	Interpretations of the safety requirements for nuclear power plants of November 22, 2012, revised version of March 3, 2015 (BAnz AT of March 30, 2015 B3)
KTA 1401	(2017-11)	General requirements regarding quality assurance
KTA 3201.1	(2017-11)	Components of the reactor coolant pressure boundary of light water reactors; Part 1: Materials and product forms
KTA 3201.2	(2017-11)	Components of the reactor coolant pressure boundary of light water reactors; Part 2: Design and analysis
KTA 3201.3	(2017-11)	Components of the reactor coolant pressure boundary of light water reactors; Part 3: Manufacture
KTA 3201.4	(2016-11)	Components of the reactor coolant pressure boundary of light water reactors; Part 4: Inservice inspections and operational monitoring
KTA 3205.1	(2018-10)	Component support structures with non-integral connections; Part 1: Component support structures with non-integral connections for components of the primary circuit of light water reactors
KTA 3205.2	(2018-10)	Component support structures with non-integral connections; Part 2: Component support structures with non-integral connections for pressure and activity-retaining components in systems outside the primary circuit
KTA 3211.1	(2017-11)	Pressure and activity retaining components of systems outside the primary circuit; Part 1: Materials
KTA 3211.2	(2013-11)	Pressure and activity retaining components of systems outside the primary circuit; Part 2: Design and analysis
KTA 3211.3	(2017-11)	Pressure and activity retaining components of systems outside the primary circuit; Part 3: Manufacture
KTA 3211.4	(2017-11)	Pressure and activity retaining components of systems outside the primary circuit; Part 4: Inservice inspections and operational monitoring
DIN EN 1090-1	(2012-02)	Execution of steel structures and aluminium structures - Part 1: Assessment and verification of constancy of performance of steel components and aluminium components for structural use; German version EN 1090-1:2009+A1:2011
DIN EN 1090-2	(2011-10)	Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures; German version EN 1090-2:2008+A1:2011
DIN EN 1090-3	(2008-09)	Execution of steel structures and aluminium structures - Part 1: Assessment and verification of constancy of performance of steel components and aluminium components for structural use; German version EN 1090-3:2008
DIN EN 1990	(2010-12)	Eurocode: Basis of structural design; German version EN 1990:2002 + A1:2005 + A1:2005/AC:2010
DIN EN 1990/NA	(2010-12)	National Annex - Nationally determined parameters - Eurocode: Basis of structural design

DIN EN 1990/NA/A1	(2012-08)	National Annex - Nationally determined parameters - Eurocode: Basis of structural design; Amendment A1
DIN EN 1993-1-1	(2010-12)	Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings; German version EN 1993-1-1:2005 + AC:2009
DIN EN 1993-1-1/A1	(2014-07)	Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings; German version EN 1993-1-1:2005/A1:2014
DIN EN 1993-1-1/NA	(2015-08)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings
DIN EN 1993-1-10	(2010-12)	Eurocode 3: Design of steel structures - Part 1-10: Material toughness and through-thickness properties; German version EN 1993-1-10:2005 + AC:2009
DIN EN 1993-1-10 /NA	(2016-04)	National Annex - Nationally determined parameters - Eurocode 3: Design of steel structures - Part 1-10: Material toughness and through-thickness properties
DIN EN 10025-1	(2005-02)	Hot rolled products of structural steels - Part 1: General technical delivery conditions; German version prEN 10025-1:2004
DIN EN 10164	(2005-03)	Steel products with improved deformation properties perpendicular to the surface of the product - Technical delivery conditions; German version EN 10164:2004
DIN EN 10204	(2005-01)	Metallic products - Types of inspection documents; German version EN 10204:2004
DIN EN 13479	(2005-03)	Welding consumables - General product standard for filler metals and fluxes for fusion welding of metallic materials; German version EN 13479:2004
DIN EN 13906-1	(2013-11)	Cylindrical helical springs made from round wire and bar - Calculation and design - Part 1: Compression springs; German version EN 13906-1:2013
DIN EN 60068-2-57, VDE 0468-2-57	(2015-10)	Environmental testing - Part 2-57: Tests - Test Ff: Vibration - Time-history and sine-beat method (IEC 60068-2-57:2013); German version EN 60068-2-57:2013
DIN EN ISO 898-1	(2013-05)	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread (ISO 898-1:2013); German version EN ISO 898-1:2013
DIN EN ISO 898-2	(2012-08)	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes - Coarse thread and fine pitch thread (ISO 898-2:2012); German version EN ISO 898-2:2012
VdTÜV MB SCHW 1153	(2012-10)	Guidelines for the qualification test of weld filler materials