

Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 1408.3 (2017-11)

**Quality Assurance of Weld Filler Metals and Welding
Consumables for Pressure- and Activity-Retaining
Systems in Nuclear Power Plants**

Part 3: Processing

(Qualitätssicherung von Schweißzusätzen und -hilfsstoffen
für druck- und aktivitätsführende Komponenten in Kernkraft-
werken; Teil 3: Verarbeitung)

Previous versions of this Safety Standard
were issued 1985-06, 2008-11 and 2015-11

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

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KTA SAFETY STANDARD

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Quality Assurance of Weld Filler Metals and Welding
Consumables for Pressure- and Activity-Retaining Systems
in Nuclear Power Plants;
Part 3: Processing

KTA 1408.3

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PLEASE NOTE: Only the original German version of this safety standard represents the joint resolution of the 35-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in the Federal Gazette (Bundesanzeiger) on May 17th, 2018. Copies of the German versions of the KTA safety standards may be mail-ordered through the Wolters Kluwer Deutschland GmbH (info@wolterskluwer.de). Downloads of the English translations are available at the KTA website (<http://www.kta-gs.de>).

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

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Comments by the editor:

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

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

Translator's note:

In this translation distinction is still made between "weld filler metals" and "consumables", whereas the latest EN ISO standards (see e.g. Annex B) use only the term "welding consumables" for all types of filler metals, electrodes, wires, rods, fluxes, pastes, etc.

Fundamentals

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the task of specifying those safety-related requirements which shall be met with regard to precautions to be taken in accordance with the state of science and technology against damage arising from the construction and operation of the plant (Sec. 7, para. (2), subpara. (3) Atomic Energy Act - AtG) in order to attain the protective goals specified in AtG and the Radiological Protection Ordinance (StrlSchV) and further detailed in the Safety Requirements for Nuclear Power Plants (SiAnf) and the SiAnf-Interpretations.

(2) The "Safety Requirements for Nuclear Power Plants" no. 3.4 "Requirements for the reactor coolant pressure boundary and the pressure-retaining walls of components of the external systems" and no. 3.6 "Requirements for the containment system" require the integrity of the pressure retaining walls and in requirement no. 5 (3) a documentation showing that the current condition of the safety-relevant measures and equipment fulfils the applicable requirements. Thus, to ensure proper weld connections, it follows that weld filler metals and welding consumables shall be subject to special quality assurance.

(3) When manufacturing, storing and using weld filler metals and welding consumables, it is essential that such properties are obtained and maintained which ensure that the welds meet the requirements over the entire scheduled operating time. This will be achieved by careful

- a) selection of the basic materials,
- b) production of the weld filler metals and welding consumables, and
- c) observation of the prescribed processing conditions.

(4) By appropriate storage of weld filler metals and welding consumables it shall be ensured that their properties will not change. The specified conditions shall be observed during processing. Weld filler metals and welding consumables for the manufacture of components of the primary circuit shall be subjected to a batch test at the processing facility. For this purpose, test weldings shall be carried out, and it shall be demonstrated

by means of tests that the results obtained comply with those of the qualification test to KTA 1408.1.

(5) The safety standards of the KTA 1408 series are closely related to the following safety standards:

- KTA 3201.3 Components of the Reactor Coolant Pressure Boundary of Light Water Reactors; Part 3: Manufacture,
- KTA 3211.3 Pressure- and Activity-Retaining Components Outside the Primary Circuit; Part 3: Manufacture, and
- KTA 3401.3 Steel Containment Vessels; Part 3: Manufacture.

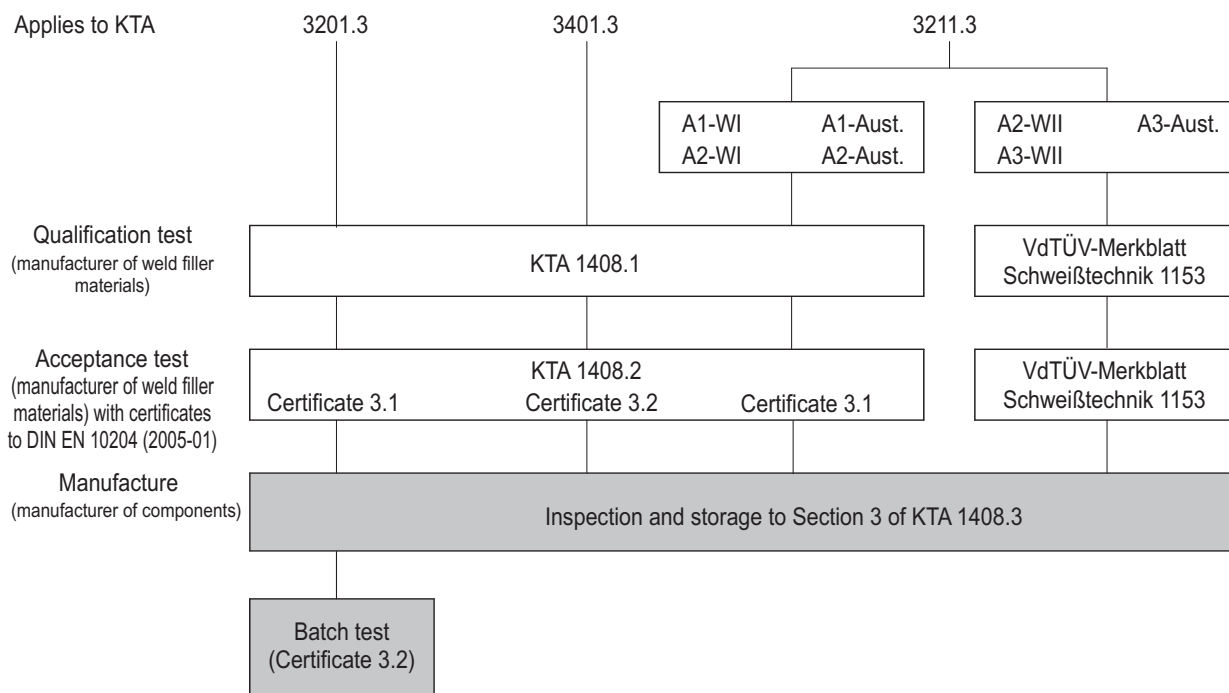
These safety standards specify the requirements for welds which are produced using the weld filler metals and welding consumables dealt with in this safety standard.

1 Scope

(1) This safety standard applies to the processing of weld filler metals and welding consumables (see **Figure 1-1**) which are to be used in the fabrication of product forms, parts and subassemblies for pressure-retaining walls of components of stationary nuclear power plants with light water reactors. These include the:

- a) components of the primary circuit (KTA 3201),
- b) steel containment vessels (KTA 3401),
- c) pressure- and activity-retaining components of systems outside the primary circuit (KTA 3211) - only Class 2 components -, except for the austenitic steels A2-WII, A3-WII and A3.

(2) This safety standard covers receiving inspections, storage and release of weld filler metals and welding consumables as well as their inspection during processing. In addition, this safety standard describes the batch testing of those weld filler metals and welding consumables which are used in the manufacture of primary circuit components.



A1, A2, A3 : Test groups

WI, WII : Materials groups

Further details on these values can be found in safety standards KTA 3211.1 and KTA 3211.3.

Table 1-1: Requirements regarding weld filler metals and welding consumables

2 Definitions

(1) Batch within the scope of the batch test

A batch is an individual production unit of rod and wire electrodes, welding rods or filler rods as, well as a combination of a single production unit each of weld fluxes and wire electrodes for submerged-arc or electroslag welding.

(2) Authorized inspector

The authorized inspector for the tests and inspections to be conducted in accordance with this safety standard is the authorized inspector called in by the licensing or supervisory authority in accordance with Section 20 of the Atomic Energy Act. The inspections/reviews required by this safety standard are performed based on orders of the competent authority.

(3) Weld consumables

Consumables are products which make possible and alleviate the welding process, e.g. inert gas, flux or paste.

(4) Weld filler metal

A material added during the welding process and contributing to the formation of a welded joint.

3 Inspection and storage

3.1 General

(1) The processor (manufacturer of parts, subassemblies and components) of weld filler metals and welding consumables shall perform receiving inspections and material flow controls up to the welding location in accordance with written specifications.

(2) The processor shall demonstrate to the authorized inspector the effectiveness of the measures taken to avoid confusion of weld filler metals and welding consumables during processing.

3.2 Receiving inspection

(1) The quantities of weld filler metals and welding consumables supplied shall be checked with respect to their allocation to the acceptance test certificates and to the proper condition of the packaging.

(2) For each smallest packaging unit allocation to the corresponding acceptance test certificate shall be ensured.

3.3 Storage

(1) Weld filler metals and welding consumables shall be properly stored in their undamaged original packaging (if special conditions prevail, e.g. sea transportation, special types of packaging may be agreed upon).

The materials shall be stored separately and away from those weld filler metals and welding consumables which are needed for the manufacture of conventional components. Unless otherwise specified by the manufacturer of weld filler metals and welding consumables (hereinafter referred to as manufacturer), the following storage conditions shall be met:

- a) a maximum relative humidity of 60%,
- b) a minimum temperature of 18 °C.

(2) Prior to processing, rod and flux cored electrodes as well as fluxes shall be dried in accordance with the manufacturer's specifications. During extended interruption of welding, the rod and flux cored electrodes as well as fluxes from packages already opened shall be stored in accordance with the manufacturer's instructions, if necessary in heated drying chambers. It shall be ensured that no confusion of materials occurs.

(3) Unless short periods are specified by the manufacturer, weld filler metals and welding consumables from current production shall be tested during production with regard to their further usability after a storage period of two years, starting from the time of the acceptance test; these tests shall be performed by agreement with the manufacturer. Further tests regarding their usability shall be carried out at one year's intervals.

If extended storage periods cannot be avoided, for example as a result of interruption of work, the weld filler metals and welding consumables shall be tested for usability immediately prior to restarting the production.

3.4 Release for processing

(1) As soon as a satisfactory receiving inspection of weld filler metals and welding consumables has been performed, they may be released for processing by the processor's production-independent quality assurance department.

(2) For weld filler metals and welding consumables which are used in the manufacture of components of the primary circuit of light water reactors, a release in compliance with the above-mentioned conditions also requires a batch test certificate in accordance with Section 4.4.

3.5 Inspection during processing

Consumption records shall be kept such as to ensure traceability of the weld filler metals and welding consumables from the location of use to the place and time of reception.

3.6 Repeated use of fluxes

The repeated use of fluxes is only permitted if the amount of flux that is extracted is reprocessed by dust removal, dry storage and addition of new flux. This requirement shall also be met in the case of procedure qualifications and welder qualification tests.

4 Batch testing

4.1 Principles

(1) Batch tests are only required for weld filler metals and welding consumables to be used in the manufacture of components of the primary circuit of light water reactors. In these tests

- a) the requirements of the suitability test in accordance with KTA 1408.1

or

- b) where the regulations in clause 4.3 (4) of KTA 1408.1 are applied the requirements of the individual material appraisal shall be met.

(2) Prior to processing the weld filler metals and welding consumables intended for the welding of parts shall be subjected to a batch test for each production unit at the processing facility.

(3) In the case of small quantities supplied, a batch test at the processing plant may be waived by agreement with the authorized inspector if the acceptance test at the manufacturer's works has been carried out in the presence of the authorized inspector and under such processing conditions as prevail at the processing facility.

(4) Prior to carrying out the batch test the following batch-test related documents shall be available and shall have been reviewed by the authorized inspector:

- a) welding procedure sheet,
- b) heat treatment plan,
- c) materials testing and specimen removal plan.

(5) With regard to form and contents, the documents required for documentation purposes shall comply with Sec. 4 of KTA 3201.3.

(6) The test coupon for the batch test shall be welded in the presence of both the processor's welding supervisor and the authorized inspector. The tests specified in Section 4.2 shall be carried out by the processor and, as far as required, in the presence of the authorized inspector.

(7) Test coupon welding shall be carried out using the welding process selected as well as the welding parameters specified for component manufacture. Test coupon welding may also be carried out in the course of a procedure qualification or a preceding welder qualification test even if the test coupon involves a combination of several welding processes, weld filler metals or welding consumables. In this case, the weld cross-section for each welding process shall correspond to the weld cross-section of the all-weld metal (test coupon type 1.2 to DIN EN ISO 15792-1 or higher).

(8) The test coupons shall be dimensioned such that it will be possible to remove the required test specimens including retest specimens, where required.

(9) The chemical composition of the weld metal shall be within the limits

- laid down for welder qualification testing to KTA 1408.1 or
- of the individual material appraisal in the event of applying the rules of KTA 1408.1, clause 4.3 (4)

in which case the trace elements specified in KTA 1408.1, clause 4.5.5.7 need not be determined within batch testing. Where an additional check for trace elements has to be made, this shall be indicated in the purchase specification.

(10) The NDT operators shall have been qualified and certified to DIN EN ISO 9712 in the product sector "welded products" for the applicable examination procedure.

4.2 Performance and testing

4.2.1 Weld filler metals for ferritic welds

(1) Welding shall be carried out on a type 1.3 test coupon to DIN EN ISO 15792-1 using the base metal of the procedure qualification.

(2) The base metal shall be analyzed with respect to its alloying elements (see Material Annexes of KTA 3201.1). This test shall be documented by acceptance test certificate 3.1 to DIN EN 10204.

(3) If a different base metal is used, a type 1.4 test coupon to DIN EN ISO 15792-1 shall be chosen. In this case, the weld metal shall be tested in a condition unaffected by the base metal.

Note:

If, with respect to a certain weld metal, the same results are obtained by means of different types of welds, other test coupons than those specified in DIN EN ISO 15792-1 may be used by agreement with the authorized inspector.

(4) The test shall be carried out in a simulated heat treatment condition which comprises all heat treatments specified with respect to the welded part, including those performed after repairs, if any. The heat treatment shall be carried out on the test coupon.

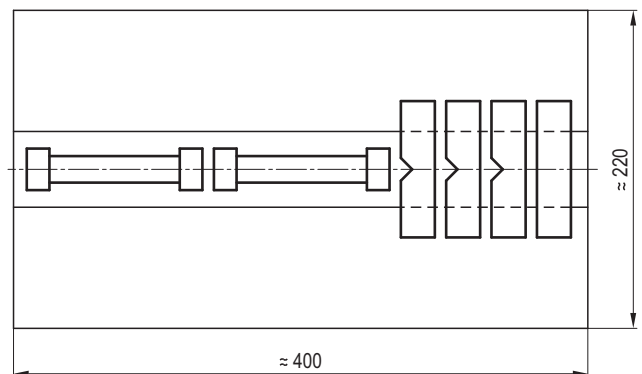
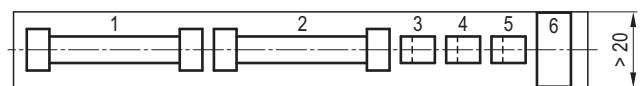
(5) The test specimens shall be removed from the weld metal of the test coupon in accordance with **Figure 4-1**, and the following tests shall be performed:

- Determination of the chemical composition of the weld metal in accordance with cl. 4.5.5.7 of KTA 1408.1.
- One longitudinal tensile test specimen to DIN 50125; performance of test in accordance with DIN EN ISO 6892-1 at room temperature.

c) One longitudinal hot tensile test specimen to DIN 50125, performance of test in accordance with DIN EN ISO 6892-2 at design temperature.

d) One set of impact test specimens (3 V-notch test specimens) from the cover bead region. Type VWT notch orientation to DIN EN ISO 9016. Performance of test in accordance with DIN EN ISO 148-1 using a 2 mm radius striker at 33 °C (when using the batch on the reactor pressure vessel for a circumferential weld in the belt-line area: 20 °C).

(6) The weld metal shall meet the requirements of KTA 1408.1, section 4.9 with respect to the mechanical properties to be obtained.



1: Tensile test specimen

2: Hot tensile test specimen

3 to 5: Impact test specimen

6: Specimen for chemical analysis

Figure 4-1: Test specimen location (schematic) in the test coupon for batch tests on ferritic weld metal

4.2.2 Weld filler metals for welds of austenitic steels and nickel alloys

(1) For each production unit a test coupon to DIN EN ISO 6847 shall be welded. Post-weld heat treatment is not required.

(2) The following tests shall be performed:

- Determination of the chemical composition of the weld metal in accordance with cl. 4.5.5.7 of KTA 1408.1.
- Microsection taken transversely to the welding direction; evaluation at an enlargement of at least 200:1. The test result shall meet the requirements of Table 9-6 of KTA 3201.3.

4.2.3 Weld filler metals for weld claddings of austenitic steels and nickel alloys

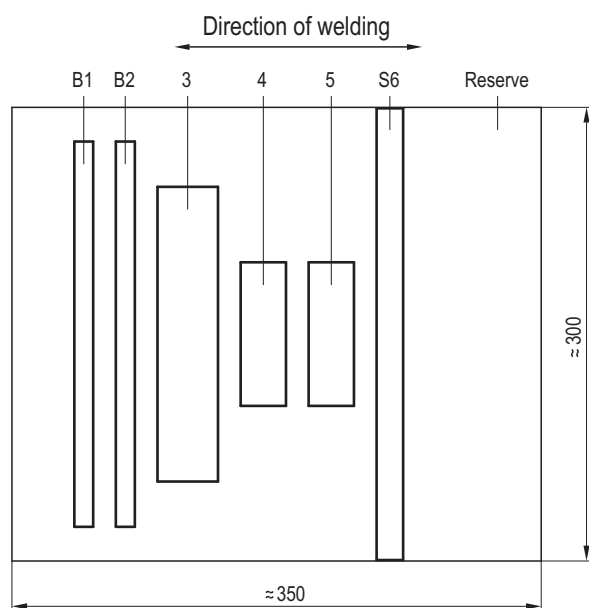
(1) With respect to weld claddings, a batch test shall be performed to demonstrate that weld filler metals and welding consumables are capable of being welded with the intended base metal in accordance under the conditions of the procedure qualification (cf. clause 9.4.4.1 of KTA 3201.3). In general, test coupon welding shall be carried out on a plane plate; in the case of weldings with band electrodes inside pipework, it shall be carried out on a pipe.

(2) The base metal used shall be that specified for the part, or a comparable base metal shall be used.

(3) The test shall be carried out in a simulated heat treatment state which comprises all heat treatments specified for the welded part, including those performed after repairs, if any.

(4) The following tests shall be performed (see **Figure 4-2**):

- Surface examination using the liquid penetrant technique. Each pass shall be tested unless multi-pass welding is specified without intermediate cooling.
- Chemical analysis of the cladding at and 2 mm below the surface in accordance with clause 9.4.3.3 of KTA 3201.3.
- Test of austenitic steels for resistance to intergranular corrosion in accordance with clause 9.4.3.4 of KTA 3201.3 on at least two specimens. The testing zone shall be 2 mm below the surface.
- Metallographic examination including test for freedom from hot cracking and determination of the delta ferrite content on a microsection in accordance with clause 9.4.3.5.4 of KTA 3201.3.
- Two side-bend test specimens taken transversely to the direction of welding in accordance with clause 9.4.3.2 of KTA 3201.3.



B1 to B2: Side-bend test specimen

3: Specimen for chemical analysis

4 to 5: IGC test specimen of CrNi steels

S6: Macro/microsections; delta ferrite content of CrNi steels

Figure 4-2: Test specimen location (schematic) in the test coupon for batch tests on weld filler metals for weld claddings of austenitic steels and nickel alloys

4.2.4 Weld filler metals for hardfacings

(1) A batch test shall be used to demonstrate that the weld filler metals are capable of being welded on one of the specified base metals in accordance with the conditions and requirements of the procedure qualification. This test coupon welding

may be carried out in accordance with DIN 32525-4 or within the scope of an advance welder qualification test.

(2) The following tests shall be performed:

- Surface examination using the liquid penetrant technique.
- Chemical analysis of the main alloying elements in the surface machined to final thickness of the corresponding part.
- Metallographic examination (macrosection taken transversely to the direction of welding).
- Hardness test (HRC) of the machined surface.

(3) If hardfacing is to be applied on a buttered layer, the latter shall be subjected to a surface examination using the liquid penetrant technique prior to applying the hardfacing.

4.3 Retention of residual specimens

Clause 11.1.4 of KTA 3201.3 shall apply to the retention of residual test coupons and test specimens, untested test specimens and reserve test specimens.

4.4 Certification of batch test

(1) The proper performance of the batch test and the results obtained shall be certified by the authorized inspector by acceptance test certificate 3.2 to DIN EN 10204 in accordance with **Annex A**. Acceptance test certificates 3.2 shall be confirmed or be established by the authorized inspector or by the technical inspecting agency tasked by him.

(2) The results of the chemical analyses and the resistance to intergranular corrosion shall be certified by acceptance test certificate 3.1 to DIN EN 10204 and be attached to the above-mentioned acceptance test certificate.

5 Documentation

(1) The following applies with respect to the establishment of documents covering tests and inspections:

- Section 4.2 of KTA 3201.3 for components of the reactor coolant pressure boundary of of Light Water Reactors,
- Section 11 of KTA 3401.3 for steel containment vessels,
- Section 4.2 of KTA 3211.3 for pressure- and activity-retaining components of systems outside the primary circuit.

(2) The certifications of tests and inspections shall be included as part of the documentation of those parts, subassemblies or components for which the weld filler metals and welding consumables were used.

(3) Documents needed for the preparation of a Type 3.2 acceptance test certificate in accordance with **Annex A** shall be included as part of the interim file. The final acceptance test certificate concerning the batch test itself and the weld filler metals and welding consumables used for the batch test in accordance with **Annex A** shall be included as part of the final file.

Note:

Requirements concerning both interim and final files are contained in KTA 1404.

Annex A

Acceptance Test Certificate

ACCEPTANCE TEST CERTIFICATE 3.2

(to DIN EN 10204)

for batch test

Purchaser: _____ Test no.: _____
 Manufacturer: _____ Purchase no.: _____
 Test requirements: _____ Manufacturer's no.: _____
 Trade name: _____
 Test object: _____
 Quantity supplied: _____
 Dimension: _____
 Production unit no./heat no.: _____
 Identification marking of the weld filler metals: _____

Results of the test on the all-weld metal

Tensile tests:

Specimen no.	Dimension mm	Heat treatment	Test temp. °C	Yield strength MPa		Tensile strength MPa	Elongation		Reduction of area %
				0.2 %	1 %		l ₀	%	
Requirements									

Notched bar impact test:

Specimen no.	Specimen form	Heat treatment	Test temp. °C	Notch orientation	Impact energy absorbed KV ₂ J		Lateral expansion mm
					Individual value	Average value	
Requirements							

Chemical composition of the all-weld metal (acceptance test certificate 3.1, if any):

	C %	Si %	Mn %	P %	S %					
Requirement										
Test result										

Annex 1

 Place and date

 Authorized inspector

ANNEX 1 to Acceptance Test Certificate 3.2

for batch test

Weld filler metal trade name: _____

Test no.: _____

Weld filler metal heat no.: _____

Manufacturer's no.: _____

Welding data for the manufacture of all-weld metal:

Specimen no.	Type of current, polarity	Current A	Voltage V	Welding rate cm/min	Shielding gas	Shielding gas consumption l/min	Preheating Working temperature °C

Heat treatment:

Other tests:

Remarks:

Place and date

Authorized inspector

Annex B

Regulations referred to in this Safety Standard

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

Atomic Energy Act (AtG)		Act on the Peaceful Utilization of Atomic Energy and the Protection against its Hazards (Atomic Energy Act) of December 23, 1959 (BGBl. I, p. 814) as Amended and Promulgated on July 15, 1985 (BGBl. I, p. 1565), last amended by article 2 (2) of the law dated 20 th July 2017 (BGBl. I 2017, no. 52, p. 2808)
StrlSchV		Ordinance on the Protection against Damage and Injuries Caused by Ionizing Radiation (Radiation Protection Ordinance) dated 20 th July 2001 (BGBl. I p. 1714; 2002 I p. 1459), last amended in accordance with article 10 by article 6 of the law dated 27 th January 2017 (BGBl. I p. 114, 1222)
SiAnf	(2015-03)	Safety Requirements for Nuclear Power Plants (SiAnf) as Amended and Promulgated on March 3 rd 2015 (BANz. AT 30.03.2015 B2)
Interpretations on the SiAnf	(2015-03)	Interpretations on the Safety Requirements for Nuclear Power Plants of November 22 nd 2012, as Amended on March 3 rd 2015 (BANz. AT 30.03.2015 B3)
KTA 1404	(2013-11)	Documentation during the Construction and Operation of Nuclear Power Plants
KTA 1408.1	(2017-11)	Quality Assurance of Weld Filler Metals and Consumables for Pressure and Activity-Retaining Systems in Nuclear Power Plant; Part 1: Qualification test
KTA 1408.2	(2017-11)	Quality Assurance of Weld Filler Metals and Consumables for Pressure and Activity-Retaining Systems in Nuclear Power Plant; Part 2: Manufacture
KTA 3201.1	(2017-11)	Components of the Reactor Coolant Pressure Boundary of Light Water Reactors; Part 1: Materials and Product Forms
KTA 3201.3	(2017-11)	Components of the Reactor Coolant Pressure Boundary of Light Water Reactors; Part 3: Manufacture
KTA 3211.1	(2017-11)	Pressure- and Activity-Retaining Components of Systems Outside the Primary Circuit Part 1: Materials
KTA 3211.3	(2017-11)	Pressure- and Activity-Retaining Components of Systems Outside the Primary Circuit; Part 3: Manufacture
KTA 3401.3	(1986-11)	Steel Reactor Safety Containment; Part 3: Manufacture
DIN EN ISO 148-1	(2017-05)	Metallic materials - Charpy pendulum impact test - Part 1: Test method (ISO 148-1:2016); German version EN ISO 148-1:2016
DIN EN ISO 6847	(2013-11)	Welding consumables - Deposition of a weld metal pad for chemical analysis (ISO 6847:2013); German version EN ISO 6847:2013
DIN EN ISO 6892-1	(2017-02)	Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2016); German version EN ISO 6892-1:2016
DIN EN ISO 6892-2	(2011-05)	Metallic materials - Tensile testing - Part 2: Method of test at elevated temperature (ISO 6892-2:2011); German version EN ISO 6892-2:2011
DIN EN ISO 9016	(2013-02)	Destructive tests on welds in metallic materials - Impact tests - Test specimen location, notch orientation and examination (ISO 9016:2012); German version EN ISO 9016:2012
DIN EN ISO 9712	(2012-12)	Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712:2012); German version EN ISO 9712:2012
DIN EN 10204	(2005-01)	Metallic materials - Types of inspection documents; German version EN 10204:2004
DIN EN ISO 15792-1	(2012-01)	Welding consumables - Test methods - Test methods for all-weld metal test specimens in steel, nickel and nickel alloys (ISO 15792-1:2000 + Amd 1:2011); German version EN ISO 15792-1:2008 + A1:2011
DIN 32525-4	(2010-05)	Welding consumables - Testing of welding consumables by means of weld metal specimens - Part 4: Test piece for determining the hardness of surfacing
DIN 50125	(2016-12)	Testing of metallic materials – Tensile test pieces
VdTÜV Merkblatt Schweißtechnik 1153	(2012-10)	Guidelines for the suitability testing of welding filler materials; Welding Technology 1153