# Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

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**KTA 1408.2** (2017-11)

## Quality Assurance of Weld Filler Metals and Welding Consumables for Pressure- and Activity-Retaining Systems in Nuclear Power Plants
## Part 2: Manufacture

(Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende Komponenten in Kernkraftwerken; Teil 2: Herstellung)

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

| November 2017 | Quality Assurance of Weld Filler Metals and Welding Consumables for Pressure- and Activity-Retaining Systems in Nuclear Power Plants<br>Part 2: Manufacture | KTA 1408.2 |
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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 D) 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” require in 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” the integrity of the pressure retaining walls as well as 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 initial materials,
b) production of the weld filler metals and welding consumables, and
c) observation of the prescribed processing conditions.

(4) When manufacturing weld filler metals and welding consumables, care shall be taken to ensure that the basic materials are of the desired quality, that the identity of the materials is traceable in the course of manufacture and that the required properties are obtained. Tests shall be carried out to ensure that these aims are achieved.

(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

KTA 3401.3 Steel Containment Vessels; Part 3: Manufacture.

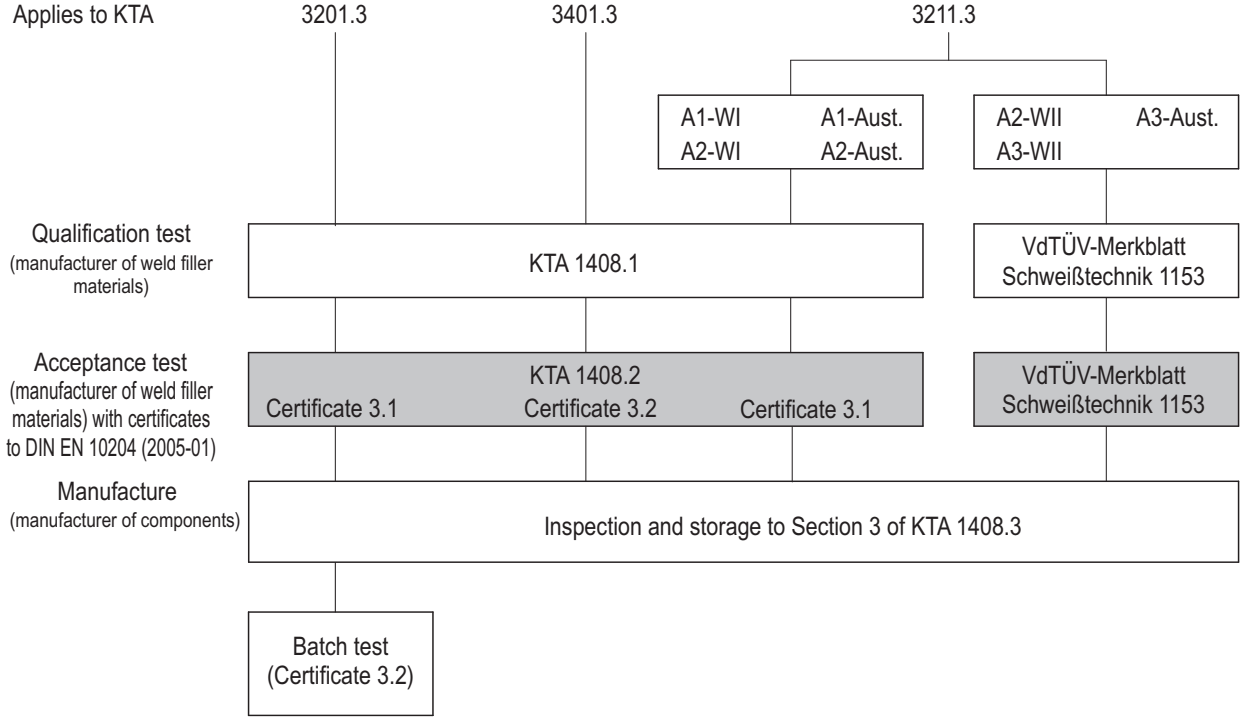
These safety standards specify the requirements for welds which are produced using the weld filler metals and welding consumables dealt with in this safety standard.

## 1 Scope

(1) This safety standard applies to the manufacture 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:

a) the components of the primary circuit (KTA 3201),
b) the steel containment vessels (KTA 3401),
c) the 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 the certificates to be submitted by the manufacturer, the requirements with respect to manufacture, the in-process inspections during fabrication and the tests of the weld filler metals and welding consumables. These requirements shall be taken into account when ordering the materials.




A1, A2, A3 : Test groups
W I, W II : Materials groups
Further details on these values can be found in safety standards KTA 3211.1 and KTA 3211.3.

**Figure 1-1:** Requirements regarding weld filler metals and welding consumables

## 2 Definitions

(1) Purchase specification

A purchase specification is a document accompanying an order which specifies the properties of the item of supply as well as the technical data to be adhered to.

(2) Production unit

a) Wire and strip electrodes, filler wires and welding rods
A production unit of wire and strip electrodes as well as filler wires and welding rods is defined as a combination of heat and product size.

b) Rod electrodes
A production unit of rod electrodes is the consistently uniform combination of a powder mixture of a consistent recipe, core wire heat and diameter, fabricated on a single production line, in a single shift.
If the coating mass of a production unit consists of several powder mixtures, their identity shall be individually demonstrated. The type of identity check is specified when auditing the manufacturer.
A powder mixture unit shall be understood to be the largest homogeneous mixture and depends on the size of the mixing container. Depending on the type of process, it may be wet or dry.

c) Flux cored electrodes
A production unit of flux cored electrodes is the consistently uniform combination of powder mixture of a consistent recipe and heat of the electrode coating as well as its diameter, and must be manufactured on a single production line in a single shift.

d) Fluxes
A production unit of fluxes is that amount of flux which is produced using a consistent recipe and consistent manufacturing conditions in a given production period and applying consistent testing procedures. The production period shall be specified during the initial audit of the manufacturer.

e) Inert gases
A production unit of inert gases need not be specified. The question of batch size shall be clarified on the occasion of the initial audit of the manufacturer.

(3) Batch

A batch is that amount of weld filler metals whose properties or conditions are determined by means of tests. A production unit can be subdivided into several batches.

(4) 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 tests/inspections required by this safety standard shall be conducted on the basis of a respective order by the competent authority.

(5) Welding consumables

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

(6) Weld filler metal

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

## 3 Certification of the manufacturer

(1) The manufacturer shall initially submit to the authorized inspector certificates regarding his quality assurance measures and his technical production capabilities.

(2) The manufacturer shall have at his disposal a quality assurance department that is independent of production and that, during manufacture and within the scope of the final inspection, performs tests in accordance with written criteria.

(3) 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) The procedure for assuring the identity of basic materials and finished products shall be specified within the scope of the initial certification.

(5) The authorized inspector shall periodically, generally at two year intervals, examine the assurance of quality during the manufacture of weld filler metals and welding consumables. A detailed report shall be drawn up regarding the initial certification with particular emphasis on the quality assurance measures taken. The periodic verifications should confirm that all the measures taken are continuously adhered to.

(6) If weld filler metals and welding consumables are manufactured at several production facilities, certifications are required for each of these production facilities. The verification by the authorized inspector shall also extend to supply stores (e.g. suppliers who are not manufacturers).

(7) The authorized inspector shall issue a certificate on each periodic verification to the manufacturer or supplier concerned.

*N o t e :*
*The requirements regarding the manufacturing plant are considered as being fulfilled if a verification in accordance with Sec. 4 of VdTÜV-Merkblatt Schweißtechnik 1153 in conjunction with DIN EN 12074 has been carried out.*

## 4 Tests and inspections during manufacture

### 4.1 Receiving inspection of the basic materials for weld filler metals and welding consumables

(1) The order specifications for the constituent materials for wines and bands shall specify at least the requirement for a melt analysis and an unambiguous allocation of the constituent materials to the melt. The manufacturer of the constituent materials shall certify that the smallest unit supplied comes from only a single melt.

(2) With respect to each supplied unit of the constituent material (e.g. ring or coil) the manufacturer shall carry out a quantitative analysis of the chemical composition in order to confirm the quality and identity of the constituent material,

(3) The constituent materials for fluxes, coatings and filler metals shall be supplied in compliance with the order specification and shall be subjected to a receiving inspection.

### 4.2 Ensuring the traceability of identity during manufacture of weld filler metals and welding consumables

#### 4.2.1 Ensuring the traceability of identity of wire and strip electrodes as well as filler wires and welding rods

(1) Prior to the cutting or processing of wire rings or coils, their traceability of identity shall be ensured.

(2) Each wire ring or coil shall consist of only one melt. It is not admissible to attach finished products to each other by welding.

#### 4.2.2 Ensuring the traceability of identity of strip electrodes and flux cored electrodes

(1) Prior to the cutting or processing of wire or band rings, their traceability of identity shall be ensured.

(2) Each wire or band ring shall consist of only one melt. It is not admissible to attach finished products to each other by welding.

(3) If the coating or filler mass of a production unit consists of several mixtures (weighed-in portions), it shall be demonstrated for each mixture that they are equivalent.

**4.2.3** Ensuring the traceability of identity of fluxes

The tests for equivalence of partial quantities for the production units shall be carried out in accordance with the specifications laid down within the scope of the initial audit of the manufacturer's works.

**4.2.4** Ensuring the traceability of identity of inert gases

Prior to filling the inert gases into containers an analysis of the gases to be filled, in the case of mixed gases an analysis of the gas components shall be carried out.

## 5 Acceptance tests

**5.1** Type and extent of testing

The specifications in **Table 5-1** shall be used as the basis for the type and extent of the tests to be performed on the respective products. If, in exceptional cases, specific tests are required which exceed the extent of testing in accordance with **Table 5-1**, these tests shall be separately agreed upon in the purchase specification. Their scope shall be specified at the same time. In the case of weld filler metals for containment vessels, the processing conditions shall be specified and shall be observed. In the case of weld filler metals for submerged-arc welding on the containment vessel, the mechanical and technological data of the weld metal shall additionally be determined.

**5.2** Test coupon forms and number of test specimens

(1) For the testing of weld metal according to **Table 5-1**, test coupons to DIN EN ISO 15792-1 shall be. For welding rods to be used for tungsten inert as welding (TIG) and having a diameter of 2.4 mm or more, and for rod electrodes with a core wire diameter of 2.5 mm, a form 1.2 test coupon, and in all other cases a form 1.3 test coupon shall be used. In the case of austenitic rod electrodes with a core wire diameter of more than 2.5 mm, and in the case of austenitic wire electrodes for inert gas welding with a diameter of 1 mm or more, a form 1.2 test coupon shall be used.

(2) For testing the hot cracking susceptibility of weld metals of ferritic-perlitic and martensitic weld filler metals as well as austenitic weld filler metals with a delta ferrite content exceeding 3 % (determination to **Annex C**), a twin fillet weld specimen to DIN EN ISO 17641-2 shall be produced. For types "B" and "RB" rod electrodes to DIN EN ISO 2560 as well as for type „Mo B" rod electrodes to DIN EN ISO 3580 the above-mentioned test is not required. For rod electrode types MnMo, Mn1Ni, 1NiMo and Mn1NiMo to DIN EN ISO 18275 one specimen of each production unit shall be tested.

(3) For weld filler metals to DIN EN ISO 636, DIN EN ISO 14341, and DIN EN ISO 17632 and for type MoSi weld filler metals to DIN EN ISO 21952 the test for hot cracking susceptibility is not required.

(4) For weld filler metals made of nickel alloys and for austenitic weld filler metals with a delta ferrite content of 3 % or less (determination to **Annex C**) in the weld metal, the ring segment test specimen in accordance with **Annex B** shall be used.

(5) Within the scope of KTA 3211.3 the test for susceptibility to hot cracking shall be omitted for weld filler metals to be used for ferritic-perlitic and martensitic steels.

(6) For the mechanical-technological testing of the weld metal, the set of specimens should consist of a round tensile test specimen in accordance with DIN 50125 with a specimen diameter $d_0$ = 10 mm and of one set of impact test specimens (3 V-notch specimens).

**5.3** Requirements

**5.3.1** Chemical composition

(1) The chemical composition of the products or the weld metal shall not exceed

a) the limits specified during the qualification test in accordance with KTA 1408.1

or

b) the limits specified in the individual test report if the regulations in clause 4.3 (4) of KTA 1408.1 are applied

whereas the trace elements specified in clause 4.5.5.7 of KTA 1408.1 need not be determined in the acceptance test. If additional elements are to be tested for, this shall be laid down in the purchase specification.

(2) The chemical composition of the inert gases shall comply with Sections 6 and 7 of DIN EN ISO 14175.

**5.3.2** Mechanical properties

(1) Minimum requirements

The minimum requirements to be met during the tests are to be specified

a) during the qualification test in accordance with KTA 1408.1

or

b) in the individual test report if the regulations in clause 4.3 (4) of KTA 1408.1 are applied

and shall be met in the acceptance test.

(2) Tensile test

Where applicable, the yield strength ($R_{eL}$), 0.2 %-proof stress ($R_{p0.2}$), 1.0 %-proof stress ($R_{p1.0}$), tensile strength ($R_m$), elongation after fracture (A) and reduction of area (Z) shall be determined.

All tests shall be carried out at room temperature (RT).

(3) Notched bar impact test

The absorbed energy ($KV_2$) shall be determined on V-notch test specimens at room temperature, where a 2 mm radius striker shall be used. In the case of weld filler metals to be used in the manufacture of containment vessels, the absorbed energy shall be determined at 5 °C unless a different testing temperature was specified when placing the order.

**5.3.3** Susceptibility to hot cracking

The test coupon shall not show any cracks.

**5.3.4** Determination of hydrogen

In the case of weld filler metals for the manufacture of the containment vessel in accordance with KTA 3401.3 and in the case of other weld filler metals where a hydrogen determination is required in accordance with other KTA safety standards, the content of diffusible hydrogen shall be determined in accordance with DIN EN ISO 3690, once per production unit but at least once per 5000 kg of rod electrodes, flux cored electrodes and flux.

## 6 Identification marking

(1) Weld filler metals shall be marked to DIN EN ISO 544 and fluxes to DIN EN ISO 14174. In addition, the following requirements shall be met:

a) Each wire ring and each coil, each cardboard box of rod electrodes and welding rods as well as each flux packaging unit shall be marked with the stamp of the manufacturer's authorized inspection representative,

b) in the case of weld filler metals for the containment vessel, the weld filler metals shall additionally be marked with the stamp of the authorized inspector.

c) The welding flux packaging units shall be numbered consecutively during filling. If, as a result of the kind of filling and the consecutive numbering, the packaging units can be assigned to the number of the production unit as well as to a specific consignment, only one packaging unit of each pallet shall be stamped by the manufacturer's authorized inspection representative or, in the case of weld filler metals for the containment vessel, by the authorized inspector.

(2) The packaging units for inert gases shall be marked with the trade name and standard designation, manufacturer's identification marking and composition of the gas. A certification to the effect that the requirements of this safety standard have been complied with shall be affixed to gas cylinders by the manufacturer's authorized inspection representative in the form of a label that will be self-destructing when being removed. In the case of tank trucks, this certification shall be contained in the shipping documents.

## 7 Documentation

(1) All tests shall be documented in writing to ensure traceability to the manufacturer.

(2) Documents leading to the issue of type 3.2 acceptance test certificates in accordance with **Annex A**, shall be filed in the intermediate file.

(3) The acceptance test certificates for weld filler metals and welding consumables in accordance with **Annex A** shall be filed in the final file.

*N o t e :*
*Specifications concerning both intermediate and final file are contained in KTA 1404.*

## 8 Acceptance test certificate

(1) The acceptance test to Section 5 shall be certified by acceptance test certificate 3.1 to DIN EN 10204.

(2) An acceptance test certificate 3.2 to DIN EN 10204 is required for weld filler metals to be used in the manufacture of containment vessels. Acceptance test certificates 3.2 shall be confirmed or be established by the authorized inspector.

*N o t e :*
*See **Annex A** for samples of acceptance test certificates.*

| Weld filler metals or welding consumables | Outer condition of product | Chemical composition of product | Weld metal tests | | | | |
|---|---|---|---|---|---|---|---|
| | | | Mechanical tests 3 ) 6) | Chemical composition | Resistance to intergranular corrosion 2) | Hot cracking susceptibility 1) 6) | Delta ferrite content 5) |
| I. Rod electrodes and flux cored electrodes | The test of outer condition shall performed within quality assurance during production of the consignment and is thus considered an advanced acceptance test | — | once per production unit, at least once per 5000 kg | once per powder mixture unit | once per production unit, at least once per 5000 kg | once per powder mixture unit | once per production unit, at least once per 5000 kg |
| II. Wire and strip electrodes for submerged arc and electroslag welding | | once per 1000 kg or per weight of the rolled wire ring 7) | — | — | — | — | — |
| III. Wire electrodes for MIG and MAG welding | | — | once per production unit, at least once per 5000 kg | once per 1000 kg or per weight of the rolled wire ring 7) | once per production unit, at least once per 5000 kg | once per 1000 kg or per weight of the rolled wire ring 7) | once per production unit, at least once per 5000 kg |
| TIG welding rods | | | | once per 500 kg | | once per 500 kg | |
| IV. Fluxes for submerged arc and electroslag welding | | once per 500 kg and sieve analysis 4) | — | — | — | — | — |
| V. Weld filler metals for hardfacings | | once per 500 kg for fluxes and rods for hardfacing | — | once per production unit, max. 1000 kg; at least once per powder mixture unit for coating or filling | — | — | — |
| VI. Inert gases | — | once per consignment | — | — | — | — | — |

1) To clause 5.2 (2)

2) Only for corrosion-resistant weld filler metals as far as such a requirement is contained in the purchase specification.

3) Only for weld metals with austenitic, ferritic-perlitic or martensitic structure.

4) If substantiated in the authorized inspector's report, larger testing-batches are possible, although they shall not exceed 10,000 kg.

5) The delta ferrite content should be determined for austenitic weld filler metals in accordance with Annex C, for other weld filler metals also by metallographic examination, if such a requirement is contained in the order specification.

6) The test is only required for the following dimensions:

Rod electrodes: core rod diameter of at least 2.5 mm
TIG welding rods: diameter of at least 2.4 mm
Wire electrodes: diameter of at least 1.0 mm

When testing smaller dimensions, the determination of the weld metal analysis will suffice.

7) In case of weights exceeding 1000 kg.

**Table 5-1:** Batch size, type and extent of acceptance tests

## Annex A

## Acceptance test certificates

**ACCEPTANCE TEST CERTIFICATE 3.1/3.2** [1)]
(to DIN EN 10204)

for rod and inert gas wire electrodes,
filler rods and flux cored wires
as well as welding rods

Test no.: _____

Purchaser: _____ Purchase no.: _____

Manufacturer: _____ Manufacturer's no.: _____

Test requirements: _____ Trade name: _____

Test object: _____ Data sheet no.: _____

Quantity supplied: _____ Dimension: _____

Production unit no./heat no.: _____

_____

Stamp of Authorized inspector/
manufacturer's authorized inspection representative [1)]

Manufacturer's mark:

Marking on the product: _____

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 $l_0$ % | | Reduction of area % |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.2 % | 1.0 % | | | | |
| Requirements | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Notched bar impact test:

| Specimen no. | Specimen form | Heat treatment | Test temp. °C | Notch orientation | Impact energy absorbed $KV_2$ J | | Lateral expansion |
|---|---|---|---|---|---|---|---|
| | | | | | Individual value | Average value | mm |
| Requirements | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Chemical composition of the all-weld metal (where required, manufacturer's certificate):

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

Annex 1

_____ _____

Place and date

Authorized inspector/
manufacturer's authorized inspection representative [1)]

[1)] Delete if not applicable

**ANNEX 1** to Acceptance test certificate 3.1/3.2 [1)]

for rod and inert gas wire electrodes,
filler rods and flux cored wires
as well as welding rods

Test no.: _____

Welding data for the production of the 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/
manufacturer's authorized inspection representative [1)]

[1)] Delete if not applicable

**ACCEPTANCE TEST CERTIFICATE 3.1/3.2** [1)]
(to DIN EN 10204)

for wire and strip-type electrodes for
submerged arc and electroslag welding as well as for rods
and flux for hardfacing

Test no.: _____

Purchaser: _____ Purchase no.: _____

Manufacturer: _____ Manufacturer's no.: _____

Test requirements: _____ Trade name: _____

Test object: _____ Data sheet no.: _____

Quantity supplied: _____ Dimension: _____

Production unit no./heat no.: _____

Stamp of Authorized inspector/
manufacturer's authorized inspection representative [1)]

Manufacturer's mark:

Test results:

Chemical composition of the product:

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

Other tests:

_____

_____

_____

_____

_____

Place and Date

Authorized inspector/
manufacturer's authorized inspection representative [1)]

[1)] Delete if not applicable

**ACCEPTANCE TEST CERTIFICATE 3.1/3.2** [1)]
(to DIN EN 10204)

for weld flux

Test no.: _____

Purchaser: _____ Purchase no.: _____

Manufacturer: _____ Manufacturer's no.: _____

Test requirements: _____ Trade name: _____

Test object: _____ Grain size: _____

Quantity supplied: _____

Production unit no./heat no.: _____

Stamp of Authorized inspector/ manufacturer's authorized inspection representative [1)] Manufacturer's mark:

Test results:

1. Sieve analysis
2. Visual inspection for external condition
3. Chemical composition: for the production unit no. .....
   Specimen no. ..... analyses of the consignment were performed, the results of which are within the reference limits on which the qualification report for the weld flux performed by the Technical Inspection Authority (TÜV) ..... is based.
   The results of the analyses are available to the authorized inspector in charge.
   The requirements are met.

Place and date

Authorized inspector/
manufacturer's authorized inspection representative [1)]

[1)] Delete if not applicable

**ACCEPTANCE TEST CERTIFICATE 3.1/3.2** [1)]
(to DIN EN 10204)

for inert gases

Test no.: _____

Purchaser: _____ Purchase no.: _____

Manufacturer: _____ Manufacturer's no.: _____

Test requirements: _____ Trade name: _____

Test object: _____

Quantity supplied: _____

Stamp of Authorized inspector/
manufacturer's authorized inspection representative [1)]

Manufacturer's mark:

Test results:

Chemical composition: For the above quantity supplied analyses of the consignment were performed, the results of which are within the reference limits of DIN EN ISO 14175.

The results of the analyses are available to the authorized inspector in charge.

The requirements are met.

Place and date

Authorized inspector/
manufacturer's authorized inspection representative [1)]

[1)] Delete if not applicable

# Annex B

## Testing for susceptibility to hot cracking (ring segment specimen)

### B 1 General

(1) This testing method applies to austenitic weld filler metals with a delta ferrite content of 3 % or less as well as to weld filler metals of nickel alloys.

(2) The test applies to metal arc welding with rod electrodes as well as to metal and tungsten inert gas welding.

### B 2 Test coupon

**B 2.1** Test coupon form

The test specimen shall consist of four square segments of equal size into which, on one-side, an annular groove is machined after tack welding is completed on both sides (**Figure B-1**).

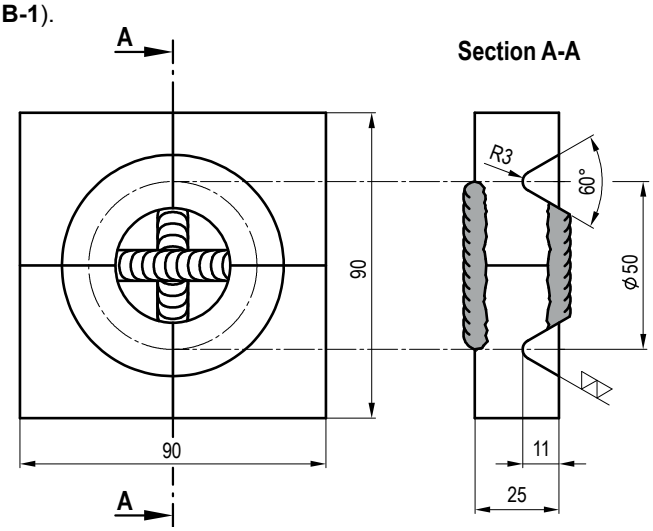



**Figure B-1:** Test coupon form

**B 2.2** Base metals

(1) For the test coupon the base metal X6 CrNiTi 18-10 (material no. 1.4541), X6CrNiNb18-10 (material no. 1.4550) or X6CrNiMoTi17-12-2 (material no. 1.4571) to DIN EN 10088-2 shall be used unless another material is specified in the purchase specification.

(2) Weld filler metals are considered to be “not susceptible to hot cracking” if the test demonstrates that the welds are free from cracks.

**B 2.3** Preparation

(1) Four square parts each with a thickness of 25 mm and an edge length of 45 mm shall be prepared such that they can be used to produce the test coupon (**Figure B-1**) by means of tack welding. Rolling scale needs not be removed. The contact surfaces shall be face-ground prior to tack welding.

(2) In the case of combination of different base metals, segments A and C as well as segments B and D shall consist of the same base metal.

**B 2.4** Work sequence (Figure B-2)

a) Grind surfaces 1-0 of parts A and B as well as surfaces 3-0 of parts C and D.
b) Clamp parts A and B as well as C and D together.
c) Join parts A and B as well as C and D by tack welds on both sides (25 mm long).
d) Grind surfaces 4-0-2 of tack-welded parts A-B and C-D.
e) Clamp tack-welded parts A-B and C-D together.
f) Join tack-welded parts A-B and C-D by tack welds on both sides (50 mm long).

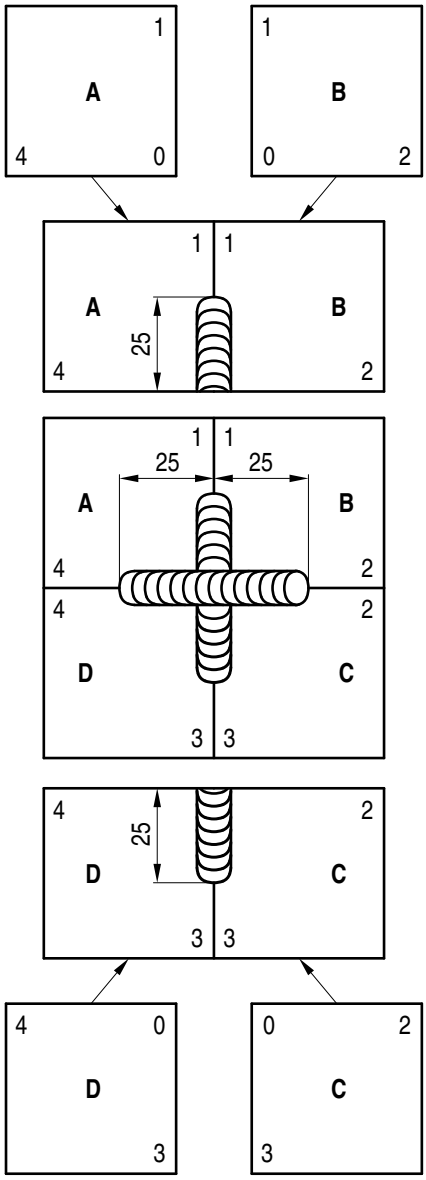



**Figure B-2:** Preparation of test coupon

**B 2.5** Annular groove

After tack welding, an annular groove shall be machined into one side of the test specimen; the dimensions of the groove shall be as indicated in **Figure B-1**. The use of cooling liquids during mechanical processing is not permitted.

## B 3 Production of test specimens

**B 3.1** Welding conditions

Type of current, polarity and type of inert gas shall be in compliance with the welding conditions under which the weld filler metals to be tested are required to be non-susceptible to hot cracking.

**B 3.2** Diameter of the weld filler metal

For the production of the test specimens, the diameters of the weld filler metals to be supplied in accordance with the purchase specification shall be used.

**B 3.3** Welding position

The test specimen shall be welded in flat position.

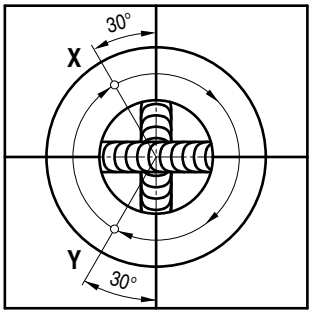



**Figure B-3:** Welding of test coupon

**B 3.4** Welding

Welding shall be carried out clockwise from Point X (**Figure B-3**) to Point Y, without weaving and in an uninterrupted process. After the specimen has cooled down to approximately room temperature and the weld surface and groove have been cleaned, welding shall be restarted clockwise from Point Y to Point X, again without weaving and in an uninterrupted process. The welding speeds for distances X-Y and Y-X shall be specified by the manufacturer depending on the weld filler metal and the welding method unless particular stipulations are contained in the purchase specification.

## B 4 Evaluation

(1) After the test specimen has cooled to room temperature, the cleaned annular weld shall be examined for surface cracks by the dye penetrant method.

(2) After the surface crack examination, the specimen shall be broken at the four separation points in order to be able to verify fusion at the root.

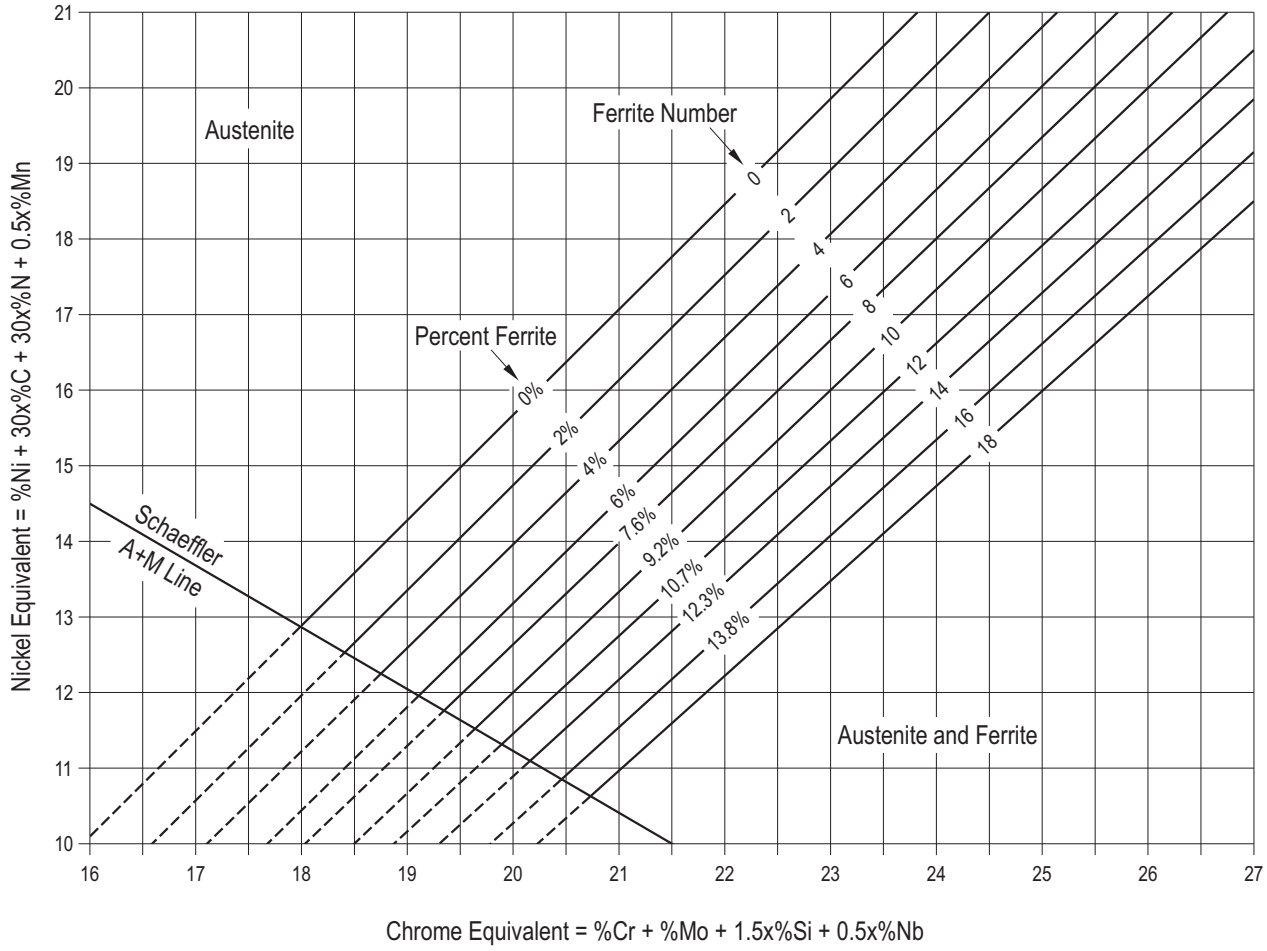
## B 5 Test report

The test report shall contain the following information:

a) weld filler metals (trade name and DIN designation, production unit),
b) welding consumables (e.g. inert gas),
c) base metal or combinations of base metals,
d) welding process,
e) amount of inert gas,
f) current source, amperage, current type, polarity,
g) average weld thickness, measured from base of groove at three points and rounded to 0.1 mm,
h) test results
   ha) If no crack was found - “not susceptible to hot cracking”;
   hb) If cracks were found, information on position, direction, number and length of the cracks as well as details of the evaluation;
i) deviations, if any, from the specifications of this Annex;
k) identification of tester and date of testing.

## Annex C

### Phase diagram for weld metal of stainless steel (Delong diagram, Rev. Jan. 1973) and table for evaluation purposes

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|---|---|---|---|---|---|---|---|---|---|
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| | | | | | | | | | |
| | | | | | | | | | |
| Si % | x 1.5 | | | | | | | | |
| Cr | x 1.0 | | | | | | | | |
| Mo | x 1.0 | | | | | | | | |
| Nb | x 0.5 | | | | | | | | |
| Cr-Equivalent | | | | | | | | | |
| C % | x 30 | | | | | | | | |
| Mn | x 0.5 | | | | | | | | |
| Ni | x 1.0 | | | | | | | | |
| N | x 30 | | | | | | | | |
| Ni-Equivalent | | | | | | | | | |
| % Ferrite | | | | | | | | | |

Nickel and chromium equivalents shall be calculated on the basis of the analysis of the weld metal. If the nitrogen content is unknown, 0.06 % shall be used for TIG weld metals and weld metals of coated electrodes, and 0.08 % for MIG/MAG weld metals. If an exact chemical analysis is performed the diagram of the Welding Research Council shows the ferrite numbers within a tolerance of ± 3 in approximately 90 % of all cases for alloy groups 308, 309, 316 and 317.

## Annex D

## 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 20th 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 20th July 2001 (BGBl. I p. 1714; 2002 I p. 1459), last amended in accordance with article 10 by article 6 of the law dated 27th January 2017 (BGBl. I p. 114, 1222) |
| SiAnf | (2015-03) | Safety Requirements for Nuclear Power Plants (SiAnf) as Amended and Promulgated on March 3rd 2015 (BAnz. AT 30.03.2015 B2) |
| Interpretations on the SiAnf | (2015-03) | Interpretations on the Safety Requirements for Nuclear Power Plants of November 22nd 2012, as Amended on March 3rd 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 1408.3 | (2017-11) | Quality Assurance of Weld Filler Metals and Consumables for Pressure and Activity-Retaining Systems in Nuclear Power Plant; Part 3: Manufacture |
| 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 544 | (2011-06) | Welding consumables - Technical delivery conditions for filler materials and fluxes - Type of product, dimensions, tolerances and markings (ISO 544:2011); German version EN ISO 544:2011 |
| DIN EN ISO 636 | (2016-05) | Welding consumables - Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine-grain steels - Classification (ISO 636:2004); German version EN ISO 636:2015 |
| DIN EN ISO 2560 | (2010-03) | Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification (ISO 2560:2009); German version EN ISO 2560:2009 |
| DIN EN ISO 3580 | (2017-08) | Welding consumables - Covered electrodes for manual metal arc welding of creep-resisting steels - Classification (ISO 3580:2017); German version EN ISO 3580:2017 |
| DIN EN ISO 3690 | (2012-07) | Welding and allied processes. Determination of hydrogen content in steel arc weld metal (ISO 3690:2012); German version EN ISO 3690:2012 |
| 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 10088-2 | (2014-12) | Stainless steels. Part 2: Technical delivery conditions for sheet/plate and strip for general purposes; German version EN 10088-2:2014 |
| DIN EN 10204 | (2005-01) | Metallic materials - Types of inspection documents; German version EN 10204:2004 |
| DIN EN 12074 | (2000-07) | Welding consumables - Quality requirements for manufacture, supply and distribution of consumables for welding and allied processes; German version EN 12074:2000 |
| DIN EN ISO 14174 | (2012-05) | Welding consumables - Fluxes for submerged arc welding and electroslag welding - Classification (ISO 14174:2012); German version EN ISO 14174:2012 |

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|---|---|---|
| DIN EN ISO 14175 | (2008-06) | Welding consumables - Gases and gas mixtures for fusion welding and allied processes (ISO 14175:2008); German version EN ISO 14175:2008 |
| DIN EN ISO 14341 | (2011-04) | Welding consumables - Wire electrodes and deposits for gas shielded metal arc welding of non alloy and fine grain steels - Classification (ISO 14341:2010); German version EN ISO 14341:2011 |
| DIN EN ISO 15792-1 | (2012-01) | Welding consumables - Test methods - Part 1: 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 EN ISO 17632 | (2016-05) | Welding consumables - Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels - Classification (ISO 17632:2015); German version EN ISO 17632:2015 |
| DIN EN ISO 17641-2 | (2016-03) | Destructive tests on welds in metallic materials - Hot cracking tests for weldments - Arc welding processes - Part 2: Self-restraint tests (ISO 17641-2:2015); German version EN ISO 17641-2:2015 |
| DIN EN ISO 18275 | (2012-07) | Welding consumables - Covered electrodes for manual metal arc welding of high-strength steels - Classification (ISO 18275:2011); German version EN ISO 18275:2012 |
| DIN EN ISO 21952 | (2012-08) | Welding consumables - Wires electrodes, wires, rods and deposits for gas-shielded arc welding of creep-resisting steels - Classification (ISO 21952:2012); German version EN ISO 21952:2012 |
| DIN 50125 | (2016-12) | Testing of metallic materials - Tensile test pieces |
| VdTÜV Merkblatt Schweißtechnik 1153 | (2009-07) | Guidelines for the suitability testing of welding filler materials; Welding Technology 1153 |