

Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 3211.1 (2017-11)

**Pressure- and activity-retaining components of systems
outside the primary circuit**

Part 1: Materials

(Druck- und aktivitätsführende Komponenten von Systemen
außerhalb des Primärkreises; Teil 1: Werkstoffe)

Please note:

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

Editor:

KTA-Geschäftsstelle c/o Bundesamt fuer kerntechnische Entsorgungssicherheit (BfE) • Willy-Brandt-Strasse 5 • 38226 Salzgitter • Germany
Telephone +49-30-18-333-1621 • Telefax +49-30-18-333-1629

KTA SAFETY STANDARD

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Pressure- and activity-retaining components of systems outside the primary circuit; Part 1: Materials

KTA 3211.1

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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 Bundesanzeiger of 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:

KTA-Geschaftsstelle c/o BfE, Willy-Brandt-Strasse 5, D-38226 Salzgitter, Germany or kta-gs@bfe.bund.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, 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.

Fundamentals

(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 and the Radiological Protection Ordinance (StrlSchV) and further detailed in the Safety Requirements for Nuclear Power Plants as well as in the Interpretations on the Safety Requirements for Nuclear Power Plants.

(2) No. 3.1 of the Safety Requirements for Nuclear Power Plants requires the use of qualified materials as well as the assurance and maintenance of the quality features during manufacturing. The safety requirement no. 3.4 sets forth further design and fabrication requirements for the pressure-retaining walls of components outside the primary circuit. KTA safety standard 3211.1 defines provisions to be made to meet these requirements within their scope of application. For this purpose it also draws upon numerous individually cited rules from conventional engineering, especially DIN Standards. For the pressure- and activity-retaining components of systems outside the primary circuit the requirements of the aforementioned safety requirements are further concretised with the following safety standards

KTA 3211.2 Design and Analysis,

KTA 3211.3 Manufacture

KTA 3211.4 In-service Inspections and Operational Monitoring, as well as with

KTA 3206 Break Preclusion Verifications for Pressure-Retaining Components in Nuclear Power Plants.

(3) KTA 3211.1 specifically defines the requirements to be imposed on:

- a) organizations involved in manufacturing,
- b) manufacture of materials and product forms as well as their chemical composition, mechanical and technological characteristics, physical characteristics, heat treatment and further processing,
- c) methods for testing and verifying the required quality of materials and product forms, such as destructive and non-destructive examinations,
- d) provision of documents for documentation of the test and inspection results.

1 Scope

(1) This safety standard shall apply to the materials and product forms of the pressure-retaining walls of pressure- and activity-containing light-water-reactor systems and components that do not belong to the reactor-coolant pressure boundary but have relevance specifically to reactor engineered safety. This definition shall include systems and components meeting one of the following criteria:

- a) The plant section is necessary for accident control by means of shutdown, maintenance of long-term subcriticality and direct residual heat removal. Requirements for components in systems involved only indirectly in residual heat removal - in other words the closed cooling-water systems and secondary cooling-water systems which do not carry activity - shall be established on a plant-specific basis with consideration of the multiple design (e.g., redundancy-type, diversity-type).
- b) Considerable energy is released in the event of failure of the plant section, and the consequences of failure are not limited by structural provisions, spatial separation or other

safety provisions to an extent that is acceptable for nuclear safety.

- c) Failure of the plant section can lead directly or via a chain of conceivable subsequent events to an accident as defined by § 49 of the Radiation Protection Ordinance.

(2) The following components fall within the scope of application of this safety standard:

- a) pressure vessels,
- b) piping systems and piping-system parts,
- c) pumps and
- d) valves and fittings

including the integral zones of the component support structures.

(3) This safety standard shall not apply to:

- a) piping systems and to valves and fittings of DN 50 size or smaller,
- b) internals of components (that are not part of the pressure-containing wall) and accessories,
- c) systems and plant sections that perform auxiliary functions for the systems in question here,
- d) system parts in which the system pressure is determined exclusively by the geodetic pressure head in the suction zone,
- e) parts for force and power transmission to pumps and to valves and fittings as well as inspections for verification of functional capability,
- f) weld filler metals and welding consumables,
- g) small parts.

Note:

Small parts are subject to the stipulations of Section 10 and of Table 2-3 of KTA 3211.3.

2 Definitions

(1) Loading temperature, lowest

The lower of the pressure-test temperature or lowest operating temperature is designated the lowest loading temperature.

(2) Production welding

Production welding means welding performed prior to delivery to the customer to ensure the stipulated quality of cast pieces.

(3) Construction welding

Construction welding is a welded joint between two cast pieces performed prior to delivery to the customer to produce a complete unit.

(4) Test groups A1, A2 and A3

The components in the scope of application of this safety standard shall be classified in test groups A1, A2 or A3 depending on design data and dimensions, with consideration of the planned materials and stresses. KTA 3211.2 defines the criteria for classification of a component.

Note:

The allocation to the test groups is made by the licence holder by agreement with the authorized inspector.

(5) Room temperature

The temperature range for the room temperature is $(23 \pm 5) ^\circ\text{C}$ for the mechanical tests laid down in this safety standard.

(6) Noise

Depending on the test conditions, randomly distributed additional signals in the screen image due to reflections from the structure of the material, its surface condition or the specimens.

(7) Noise level

Noise level means the 95 % value of the cumulative frequency of the echo heights of the noise in the examined volume free from defects.

(8) 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 shall be performed on the basis of applications made by the competent authority.

(9) Ultrasonic testing, selected

Selected ultrasonic testing means testing where the acceptance criteria refer to the finished component. To this end, it is required to know the shape and final dimensions of the components to be fabricated from the test object as well as their location in the test object.

(10) Ultrasonic testing, global

Global ultrasonic testing means testing where the acceptance criteria have been determined globally without reference to a finished component.

(11) Reference block

A reference block is a block corresponding to the test object with respect to test-relevant characteristics (e.g. material, forging direction, shape, wall thickness) and that contains reference flaws (e.g. notches, bores) adapted to the individual testing task.

(12) Material group W I or W II

The ferritic materials for manufacturing components within the scope of application of this safety standard are classified in material groups W I or W II according to their quality features, especially chemical composition and toughness characteristics. The allocation of materials to test groups is defined in KTA 3211.2.

(13) Acceptance criteria for non-destructive testing

Non-destructive testing acceptance criteria refer to the sum of all stipulations used to determine whether an indication can be evaluated to be acceptable without taking further measures (requirements of test instruction have been met) or whether further measures need be taken. The acceptance criteria contain both quantitative stipulations in form of acceptance limits (e.g. amplitude height, extension of indication, frequency, and distance between indications) and descriptive stipulations (e.g. linear or rounded indication, indication on surface or across volume, accumulation of indications).

3 General principles**3.1 Selection of materials**

(1) Materials appropriate for the intended use shall be selected, with consideration of the mechanical, thermal and chemical loadings as well as the design conditions to KTA 3211.2.

(2) The materials shall safely withstand the loadings during the pressure test, during operation and all specified plant conditions. Any materials on which welding is to be performed shall be suitable for welding.

Note:

The selection of material shall be made by the purchaser, if necessary after consultation with the material manufacturer.

3.2 Appraisal of the materials

(1) The materials shall be appraised to determine whether they are suitable for the intended use and the planned processing conditions.

(2) Ferritic steels for service in material group W I shall be appraised with reference to the manufacturer and to the product form by agreement with the authorized inspector.

(3) As regards nature and scope of appraisal tests, all other steels shall be treated as steels for conventional pressure vessel plants subject to supervision. If these steels for use in conventional pressure vessel plants subject to supervision have already been approved, they shall qualify as appraised.

(4) If in individual cases a material is used outside the scope of validity of its approval, or if a different material is used, a special appraisal shall be required. The special appraisal shall be mentioned in the inspection certificate.

3.3 General quality-assurance requirements

The stipulations in KTA 1401 shall apply to the general quality-assurance requirements.

3.4 Requirements to be met by the manufacturer

(1) The manufacturer shall possess facilities that permit proper and state-of-the-art production of materials and product forms.

(2) The manufacturer shall possess test and inspection facilities that permit testing and inspection of the materials and product forms in accordance with the applicable DIN standards or other rules pertinent to the conduct of materials testing and inspection. The test equipment shall correspond to DIN 51 220 and be inspected in accordance with DIN 51 220. Within the measuring range of the test equipment, the permitted measuring inaccuracy of the forces measuring equipment shall not exceed $\pm 1 \%$. Upon request, the test reports to DIN 51 220 shall be submitted to the authorized inspector. If test facilities of other agencies are employed, they shall be subject to the same stipulations.

(3) The manufacturer shall have access in its own works or at other agencies to facilities with which the non-destructive examinations required by this safety standard can be performed.

(4) Mechanized or automated facilities to be employed for the non-destructive examinations required by this safety standard shall undergo an appraisal by the authorized inspector.

(5) Lists of necessary procedure instructions for the production and testing facilities shall be compiled.

(6) Through quality monitoring with corresponding recordings, the manufacturer shall ensure proper manufacture and processing of the materials and product forms as well as adherence to the governing technical rules.

(7) The manufacturer shall employ skilled personnel capable of performing the tests and examinations properly. Personnel performing visual inspections shall be informed on the manufacturing process and have vision to comply with the requirements of DIN EN ISO 9712, which shall be checked every 12 months. For personnel performing non-destructive tests the requirements of Section 11.1.3 apply.

(8) The manufacturer shall be entitled to issue inspection certificates only if he employs an authorized inspection representative qualified in accordance with the conditions of DIN EN 10204. The name and stamp of the manufacturer's authorized inspection representative shall be announced to the authorized inspector.

(9) If welding work is performed on the product forms in the course of manufacture, the manufacturer shall employ his own supervisory staff and welders qualified to DIN EN ISO 9606-1 in conjunction with AD-2000 Merkblatt HP 9. Only qualified welders shall be used for the welding jobs. The reevaluation of

welder qualification must be acquired to clause 9.3 a) or clause 9.3 b) of DIN EN ISO 9606-1. The welding supervisor shall be a member of the staff of the manufacturer's works and be named to the authorized inspector.

(10) A procedure by which all deviations from the quality requirements observed during production are reported to the responsible agency shall be set forth in writing.

(11) The manufacturer shall have a quality department that is independent of the production department.

(12) The organizational classification and assignment of duties of the manufacturer's authorized inspection representative, test supervisory personnel, NDT operators and quality department and, if applicable, the welding supervisory personnel, shall be set forth in writing.

(13) The authorized inspector shall review whether the requirements have been met before production can be started. The review shall be repeated at intervals of about one to two years, unless the authorized inspector can be convinced by other means that the conditions are still being met.

3.5 Design approval

Subject to design approval by the authorized inspector are

- test instructions for non-destructive testing procedures RT, UT and ET,
- material testing and sampling plans for product forms for production of components from ferritic steels of material group W1, if sampling is not clearly defined in the Sections relating to product forms, and
- documents for cast pieces according to the stipulations in Sections 5.7.2, 6.7.2, 7.7.2 and 9.2.2.

3.6 In-process inspection by the authorized inspector to § 20 of the Atomic Energy Act

The authorized inspector shall have the right to be present during the manufacturing processes. However, he shall not impair the manufacturing operations.

3.7 Verification of quality characteristics

(1) The quality characteristics of the materials and product forms shall be determined by tests and examinations, which shall be performed in the manufacturer's works.

(2) The quality characteristics of the materials and product forms shall be verified by inspection certificates to DIN EN 10204. The governing stipulations for the required type of quality verification shall be those in the following Sections relating to product forms. Confirmation that the requirements of this safety standard have been met shall be required in the certificates.

(3) inspection certificates 3.2 shall be confirmed or be established by the authorized inspector to § 20 of the Atomic Energy Act.

3.8 Marking

The product forms shall be clearly and durably marked, if at all possible without notching, in accordance with the stipulations in the following Sections relating to product forms. The use of code characters is permitted. The complete text of the marking shall be indicated in the inspection certificates. A clear correlation between the inspection certificates and product forms shall be possible at all times.

3.9 Repairs

(1) Any necessary repairs shall be reported to the authorized inspector. Further action shall be determined in consultation with the authorized inspector.

(2) Repairs by welding shall be subject to the stipulations of KTA 3211.3.

(3) Production weldings on cast pieces are not repairs within the meaning of this safety standard.

3.10 Material characteristic data for design analysis

The characteristic data critical to strength design analysis shall be taken from **Annex A**, from the appropriate DIN standards, VdTÜV material sheets or, in the case of special steels, from the authorized inspector's appraisal.

4 Generally applicable stipulations for materials and material tests

4.1 General

(1) The requirements for material characteristics shall apply to the final condition of the components after the in-process inspection and pressure test. On the basis of the tests and examinations to be performed on materials and product forms, the material characteristics shall be verified on sufficiently large test coupons in the heat-treatment conditions required for the particular purpose.

(2) The products shall have smooth surfaces consistent with the forming method employed. Impermissible surface irregularities shall be eliminated. The resulting depressions shall be ground flush. The wall thickness shall not be less than the allowable minimum nominal wall thickness.

(3) Finish and surface quality of the products shall be specified in the purchase order. In this regard, the surface requirements according to Section 11.1 shall be taken into account.

4.2 Allowable materials

Materials shall be allowable if they fulfill the prerequisites of Section 3.1 and their suitability has been established in accordance with Section 3.2 of this safety standard. Materials approved for the individual products are given in Sections 5 to 10.

4.3 Requirements for the materials and their product forms

4.3.1 Ferritic steels of material group W I

Ferritic steels of material group W I shall meet the following conditions:

- In the notched-bar impact test on transverse specimens at the lowest operating temperature (including accidents) or at the temperature at which the primary membrane stress is higher than 50 N/mm², the smallest individual value of impact energy of the base metal, weld metal and heat-affected zone shall not be less than 68 J, and the smallest individual value of lateral expansion shall not be less than 0.9 mm.
- The smallest individual value of upper shelf impact energy, determined on transverse specimens, shall not be less than 100 J. This only applies to the base metal.
- The impact energy, determined on transverse specimens, shall not be less than 41 J at the test temperature of 0 °C. Only one individual value below the required mean value shall be permitted, and it shall not be smaller than 29 J. This requirement applies to the base metal, the weld metal and the heat-affected zone.

For cast steel the specimen direction is not specified.

4.3.2 Ferritic steels of material group W II

Ferritic steels of material group W II shall meet the following conditions:

- a) The values of the chemical composition determined in the ladle analysis shall not exceed 0.020 % P and 0.015 % S. In addition, the processability shall be considered when defining the chemical composition, especially the permissible contents of microalloying elements.
- b) In the notched-bar impact bend test on transverse specimens, the mean value shall not be less than 41 J
- ba) at the test temperature of 0 °C if the lowest loading temperature is lower than 20 °C, or
- bb) at the test temperature of 20 °C if the lowest loading temperature is higher than or equal to 20 °C.

Only one individual value below the required mean value shall be permitted, and it shall not be smaller than 29 J.

The requirement applies for the base metal, the weld metal and the heat-affected zone.

For cast steel the specimen direction is not specified.

4.3.3 Austenitic steels

Austenitic steels shall meet the following conditions:

- a) The steels shall be resistant to intergranular corrosion in the production conditions in question.
- b) Steels for hot (operating temperature ≥ 200 °C during continuous operation) reactor water containing product forms and components in boiling water reactor plants shall be resistant to IGSCC and have a cobalt content not exceeding 0.2 %. Details are specified in the product-form related Sections.
- c) The chemical composition shall be defined such that hot cracks do not develop during welding.
- d) In the case of steels for product forms with a wall thickness greater than 16 mm or DN greater than 150 mm, the impact energy value of the base metal, weld metal and heat-affected zone, determined on transverse specimens at the test temperature of 20 °C, shall not be less than 70 J (mean value of three specimens, smallest individual value not less than 60 J) in the solution-annealed and quenched condition, or 55 J (mean value of three specimens, smallest individual value not less than 40 J) in the annealed condition.
- e) For parts on which welding work without weld filler metal will be performed during further processing, the deposited base metal shall have a delta ferrite content of 2 % to 10 % (ferrite number 2 to 11) to **Annex C**. For parts on which welding work with weld filler metal will be performed during further processing, the deposited base metal shall have a delta ferrite content of 1 % to 10 % (ferrite number 1 to 11) to **Annex C**. A close ferrite lattice structure is not permitted in either case. Deviations are permitted if the characteristics of the welded joint satisfy the stipulations of KTA 3211.3.
- f) For rolled and forged product forms made of austenitic steels as well as parts made from such forms, the required ultrasonic examinability, the further processability and the specified mechanical and technological characteristics shall not be impaired by coarse-grained microstructural zones.

Note:

Based on available experience, every effort should be made to achieve a grain size corresponding to a characterizing number larger than or equal to 4 to DIN EN ISO 643.

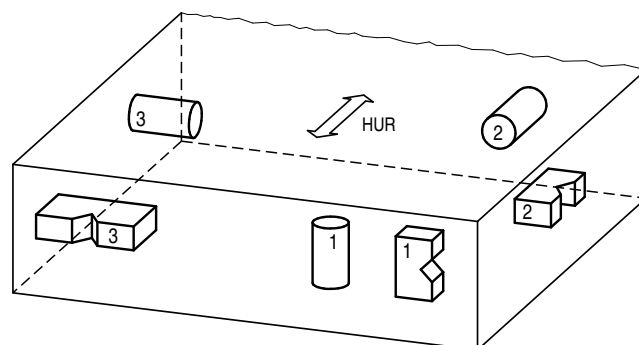
4.3.4 Steels for special loads

If special loads such as erosion, corrosion and wear are present, materials matched to the requirements of the particular application shall be employed. The conditions for such materials shall be defined on a case-by-case basis by agreement with the authorized inspector.

4.4 Testing and examination of materials and product forms

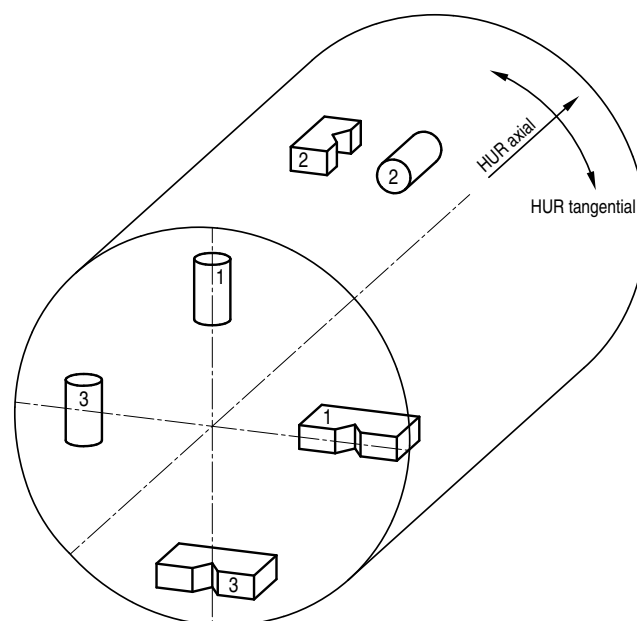
4.4.1 Designation of specimen direction in product forms

The following designations shall be used to describe the direction of specimens in product forms (see **Figures 4-1** and **4-2**):



- 1: Perpendicular specimen
2: Longitudinal specimen
3: Transverse specimen
HUR: Main forming direction

Figure 4-1: Designation of specimen directions for flat products



Specimen No.	Specimen direction relative to		
	Product geometry	Main forming direction (HUR)	
		tangential	axial
1	radial	perpendicular	perpendicular
2	axial	transverse	longitudinal
3	tangential	longitudinal	transverse

Figure 4-2: Designation of specimen directions for rotationally symmetric product forms

- a) Designation based on direction relative to fibre:

Longitudinal specimens (L):

Longitudinal axis of specimen in the main forming direction; for notched-bar impact specimens, the notch axis shall be perpendicular to the plane of the transverse and longitudinal directions.



Documents

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Transverse specimens (Q):

Longitudinal axis of specimen transverse to the main forming direction; for notched-bar impact specimens, the notch axis shall be perpendicular to the plane of the transverse and longitudinal directions.

Perpendicular specimens (S):

Longitudinal axis of specimen perpendicular to the plane of the transverse and longitudinal directions; for notched-bar impact specimens, the notch axis shall be in the main forming direction.

b) Designation based on direction relative to product geometry:**Axial specimens (A):**

Longitudinal axis of specimen parallel to the axis of rotational symmetry; for notched-bar impact specimens, the notch axis shall be perpendicular to the cylindrical surface.

Tangential specimens (T):

Longitudinal axis of specimen in the circumferential direction; for notched-bar impact specimens, the notch axis shall be perpendicular to the cylindrical surface.

Radial specimens (R):

Longitudinal axis of specimen perpendicular to the cylindrical surface; for notched-bar impact specimens, the notch axis shall be in the main forming direction.

4.4.2 Location of specimens in product forms

The specimen location shall be identified as follows: as regards depth below the surface, by the location of the specimen axis; as regards distance from the edge, by the location of the cross section to be inspected. Further particulars are defined in the following Sections relating to product forms.

4.4.3 Size of test coupons

(1) The quantity of material to be taken shall be large enough to provide an adequate quantity of material for substitute specimens in addition to the material for verification of mechanical and technological characteristics.

(2) If further specimen quantities are needed for additional tests, the number and dimensions of the additional test coupons shall be specified in the purchase order. In the case of castings, additional test plates from the heats used for these coupons shall be kept available if required.

4.4.4 Marking of test coupons and specimens

For the acceptance tests, the test coupons shall be marked legibly and clearly before removal from the product form, and the specimens shall be marked likewise before specimen removal from the test coupon. The specimen marking shall permit exact correlation with its location in the product form.

4.4.5 Heat-treatment conditions of specimens

(1) All test coupons shall be heat-treated on and together with the product form (normalizing, quenching and tempering, solution annealing and quenching).

(2) If the product forms are not delivered in the heat-treatment condition governing establishment of the characteristics, but receive this heat treatment only in the course of further processing, the material manufacturer shall perform tests on specimens from test coupons subjected to corresponding heat treatment.

Note:

Unless otherwise stipulated in the appraisal, stress-relief annealing shall not constitute the heat treatment governing establishment of the mechanical and technological characteristics.

(3) Should simulated stress-relief annealing be required in **Annex A** or in the authorized inspector's appraisal, it shall be performed in accordance with the conditions stipulated therein.

4.4.6 Tests and test methods to be employed**4.4.6.1 General**

(1) The stipulations of clause 4.4.6 shall apply if performance of the tests cited in the following is required in the Sections relating to product forms and if nothing to the contrary is expressly stipulated there.

(2) The particulars needed for materials testing and taken from the classification into test and material groups per KTA 3211.2 shall be announced to the material or product-form manufacturer in the purchase order.

4.4.6.2 Chemical analysis

(1) The content by mass of elements specified for the respective material shall be determined during ladle and product analyses.

(2) DIN EN ISO 14284 shall apply to the specimen taking and preparation.

(3) In case of doubt the chemical composition shall be determined by the test method developed by the Chemists Committee of the Association of German Ferrous Metallurgists (VDEh) (see Manual for the Ferrous Metallurgy Laboratory [1]).

4.4.6.3 Hardness test

(1) Hardness tests shall be performed to DIN EN ISO 6506-1 and DIN EN ISO 6506-4 or to DIN EN ISO 6507-1 and DIN EN ISO 6507-4.

(2) Other hardness test methods may also be used, subject to approval of the authorized inspector.

4.4.6.4 Tensile test

Tensile tests shall be performed to DIN EN ISO 6892-1 and DIN EN ISO 6892-2. Where method A is used, the strain rates recommended by the standard shall be used. Tensile test specimens to DIN 50125 may also be used.

4.4.6.5 Notched-bar impact bend test

Notched-bar impact bend tests shall be performed to DIN EN ISO 148-1 on specimens with V-notch using a striker with 2 mm radius (KV₂). One set consisting of three specimens shall be tested. Where specimens with a width less than 10 mm are used, the impact energy determined shall be converted proportionally to the specimen width to the standard specimen if the test has been conducted at the upper shelf of impact energy. Otherwise, the conversion factor of impact energy to the standard specimen value shall be decided in each individual case.

4.4.6.6 Impact energy vs. temperature curves

(1) In the case of product forms belonging to test group A 1 or A 2 notched-bar impact bend tests to clause 4.4.6.5 shall be performed at a minimum of four temperatures to plot impact energy vs. temperature curves.

(2) The temperatures shall be chosen such that they encompass the upper shelf of impact energy, characterized by a dull fracture surface representing a proportion of about 100 % of the total fracture surface, as well as the transition to brittle fracture behaviour, characterized by a dull fracture surface

representing a proportion of about 50% of the total fracture surface.

(3) A set of three specimens shall be tested at each test temperature. For all notched-bar specimens of ferritic steels used to plot impact energy vs. temperature curves, the lateral expansion and the proportion of dull fracture surface as a percentage of total fracture surface shall be determined according to DIN EN ISO 148-1.

4.4.6.7 Technological tests on pipes

The technological tests on pipes shall be performed to:

- DIN EN ISO 8492 - Flattening test or
- DIN EN ISO 8493 - Drift test or
- DIN EN ISO 8495 - Ring expanding test or
- DIN EN ISO 8496 - Ring tensile test

4.4.6.8 Metallographic examinations

(1) The microstructural condition shall be determined by preparing micrographs at a magnification that permits an unequivocal evaluation.

(2) The grain-size characterizing number shall be determined to DIN EN ISO 643.

4.4.6.9 Determination of delta ferrite content

(1) If required in the Sections relating to product forms, the delta ferrite content of products of austenitic steels or austenitic cast steel shall be determined by one of the following methods:

- a) metallographic determination in the as-delivered condition,
- b) metallographic determination on the bead-on-plate test specimen,
- c) theoretical estimation from the chemical composition, using De Long's method [2].

(2) The Sections relating to product forms specify which of the methods indicated under (1) a) to c) is to be employed.

(3) If the theoretical estimate yields ferrite numbers lower than 3, the delta ferrite content shall also be determined metallographically on the bead-on-plate test specimen.

(4) Details on how to perform the methods cited under (1) a) to c) are described in **Annex C**.

(5) The particular method to be employed shall be indicated in the inspection certificate.

4.4.6.10 Corrosion-resistance testing

The resistance to intergranular corrosion shall be verified to DIN EN ISO 3651-2.

4.4.6.11 Materials identification check

(1) The materials identification check shall be carried out using a spectrometric method.

(2) For pieces that have undergone a product analysis, it is permitted to acknowledge that analysis as the materials identification check.

4.4.6.12 Dimensional check

Before shipment of the products, the dimensions and tolerances specified in the purchase order shall be checked.

4.4.6.13 Visual inspection

During the acceptance procedure, all products shall be subjected to a visual inspection in which case the following shall be checked:

- a) the compliance of the product surface with the required surface condition in due consideration of subsequent surface coating, if any,
- b) the surface condition with regard to surface irregularities,
- c) the compliance of the products with the number of items given and the identification marking, and
- d) the product surface for compliance with the given cleanliness requirements.

4.4.6.14 Non-destructive tests and examinations

The stipulations of Section 11 shall apply.

4.5 Re-examinations

(1) Test results that are based on incorrect taking or preparation of the test specimens (test specimen sets), on incorrect performance of the test or on a random narrow flaw location in one test specimen are invalid. The examination shall be repeated.

(2) Should the results of a properly performed examination fail to meet the above requirements, the following actions shall be taken:

- a) Lotwise examination
 - aa) The test coupon from which the unsatisfactory specimen (or specimen set) was taken shall be excluded from the lot. It shall be replaced by two further test coupons from the lot, and the required examinations shall be repeated on those coupons.
 - ab) The examination shall qualify as passed if the results of the re-examination meet the requirements.
 - ac) The lot shall be rejected if any result of the two re-examinations fails to meet the requirements. However, a check examination of the characteristic found to be out of specification is permitted on each individual piece of the lot.
- b) Individual examination
 - ba) For each unsatisfactory specimen (or specimen set), two further specimens (or specimen sets) from the same sampling location shall be examined.
 - bb) The results of both examinations shall meet the requirements.

(3) Should it be impossible by appropriate heat treatment to eliminate the reason for the unsatisfactory result of an examination, a new heat treatment shall be required, after which the test unit shall be submitted again for examination.

(4) The cause of the unsatisfactory result of the first examination shall be investigated.

5 Product forms of ferritic steels of material group W I

5.1 Flat products

5.1.1 Materials

(1) The following steel grades may be used:

- a) steel grades to Section A 1
- b) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

(2) The materials shall meet the requirements of clause 4.3.1.

5.1.2 Additional requirements for the materials

(1) Flat products with nominal thicknesses equal to or larger than 15 mm subjected to loading perpendicular to the rolled surface shall at least meet the requirements of quality class Z35 to DIN EN 10164. This shall be specified in the purchase order.

(2) For flat products with nominal thicknesses equal to or greater than 150 mm, the smallest individual value of impact energy absorbed (transverse specimens) at the middle of the flat product thickness at 80 °C shall not be less than 68 J.

(3) When flat products are used for tubesheets, the same requirements as for specimens longitudinal to or transverse to the main rolling direction shall apply for the room-temperature yield point or 0.2 % proof stress and tensile strength of standard specimens perpendicular to the flat product surface. This shall be specified in the purchase order.

(4) The surface finish shall satisfy the stipulations of DIN EN 10163-2 Class B Subgroup 3.

5.1.3 Tests and examinations

5.1.3.1 Sampling and specimen preparation

(1) The sampling locations are stipulated in Section A 1.

(2) The following specimens shall be taken for the tensile test at room temperature:

- a) For flat products with nominal thicknesses not exceeding 40 mm, flat tensile-test specimens containing both rolled surfaces.
- b) For flat products with nominal thicknesses larger than 40 mm, flat tensile-test specimens at least 40 mm thick containing at least one intact rolled surface.

(3) The following specimens shall be taken for the tensile test at elevated temperature:

- a) for flat products with nominal thicknesses smaller than 12 mm, flat tensile-test specimens or round tensile-test specimens,
- b) for flat products with nominal thicknesses equal to or larger than 12 mm up to and including 40 mm, round tensile-test specimens,
- c) for flat products with nominal thicknesses larger than 40 mm, round tensile-test specimens with the specimen axis at one quarter of nominal thickness under the rolled surface (test diameter equal to or larger than 10 mm).

(4) The notched-bar impact bend test shall be subject to the following requirements:

As regards the specimens for notched-bar impact testing one side of the specimen shall be located as close as possible to the rolling surface in case of wall thicknesses ≤ 40 mm. In case of nominal thicknesses exceeding 40 mm the specimen axis shall be located at a distance of one quarter of the thickness of the product form below the rolling surface.

(5) Transverse specimens shall be used for the tensile and notched-bar impact bend tests.

(6) Specimens for determination of the reduction of area at fracture on perpendicular specimens shall be taken and be prepared in accordance with the stipulations in DIN EN 10164.

(7) Standard specimens shall be used for determination of the room-temperature yield point or 0.2 % proof stress and tensile strength on specimens perpendicular to the flat product surface.

5.1.3.2 Extent of tests and examinations

(1) The chemical composition shall be determined by performing:

- a) One ladle analysis per heat.
 - b) One product analysis on one sampling location in each of two rolled plates per heat.
- (2) The mechanical and technological characteristics shall be determined by performing:
- a) One room-temperature tensile test per sampling location.
 - b) One elevated-temperature tensile test per heat, dimensional range and a total weight of at most 30 metric tons. The test temperature is defined in Section A 1 or in the authorized inspector's appraisal.
 - c) Room-temperature tensile tests to DIN EN 10164 per rolled plate for flat products with nominal thicknesses equal to or larger than 15 mm, in order to determine the reduction of area at fracture, whenever the quality class Z35 is required acc. to clause 5.1.2 (1).
 - d) One notched-bar impact bend test to clause 4.4.6.5 per sampling location at 33 °C or at the lowest operating temperature, whichever is lower, for flat products with nominal thicknesses equal to or larger than 5 mm. Notwithstanding the foregoing, the impact energy for steel grade 15 MnNi 6 3 shall be determined at 0 °C.
 - e) Notched-bar impact bend tests at one sampling location for determination of the impact energy vs. temperature curve to clause 4.4.6.6 per heat, dimensional range and identical heat treatment for flat products with nominal thicknesses equal to or larger than 10 mm and not exceeding 38 mm, and per rolled plate for plates with nominal thicknesses exceeding 38 mm. At least four test temperatures shall be used, of which two shall be 0 °C and the lowest loading temperature. This test may be waived for flat products of steel grade 15 MnNi 6 3.
 - f) One notched-bar impact bend test to clause 4.4.6.5 at one sampling location per rolled plate, to determine the upper shelf impact energy for flat products with nominal thicknesses larger than 16 mm. This test may be performed during determination of the impact energy absorbed vs. temperature curves. In general, 80 °C shall be selected as the test temperature. The test shall be performed only in test group A 1, and may be waived if the value of impact energy absorbed determined per d) is equal to or greater than 100 J.
 - g) One notched-bar impact bend test to clause 4.4.6.5 at 80 °C at one sampling location in the middle of the flat product thickness of each rolled plate for plates with nominal thicknesses equal to or greater than 150 mm, unless otherwise stipulated in the appraisal.
- (3) Each rolled plate shall be subjected to a materials identification check.
- (4) Each flat product shall be subjected to a visual inspection of its external finish.
- (5) The dimensional and shape accuracy of each rolled plate shall be measured.
- (6) The Sections 11.1 and 11.2 as well as the Sections 11.1 and 11.4 in the case of flat products for tube sheets shall apply to the non-destructive tests and examinations.

5.1.4 Marking

(1) Each flat product shall be marked with the following information:

- a) manufacturer's symbol,
- b) steel grade (for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164),
- c) heat number,
- d) specimen number,
- e) authorized inspector's mark



(2) The marking shall be applied such that it appears upright when viewed in the main rolling direction of the rolled plate.

5.1.5 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, materials identification check and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The steel making process, the delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons shall be indicated in the inspection certificate 3.1.

(2) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

5.2 Dished or pressed product forms made from flat products

5.2.1 Materials

(1) The following steel grades may be used:

- a) steel grades to Section A 1,
- b) other steel grades that meet the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

(2) The materials shall meet the requirements of clause 4.3.1.

5.2.2 Additional requirements for the materials

The requirements of clauses 5.1.2 (1), (2) and (4) shall apply.

5.2.3 Starting products

(1) Starting products shall be subject to the stipulations in Section 5.1.

(2) If the finished parts are tested individually in accordance with clause 5.2.4.2, the tests to clause 5.1.3.2 (2) as well as the corresponding verifications can be omitted.

(3) For the tests to clauses 5.1.3.2 (3) to (5), an inspection certificate 3.1 to DIN EN 10204 will suffice.

Note:

The stipulations of KTA 3211.3 shall apply to welded joints made with the starting products and remaining in the finished parts.

5.2.4 Tests and examinations of dished or pressed product forms made from flat products

5.2.4.1 Sampling and specimen preparation

(1) For product forms with a diameter or length equal to or smaller than 3000 mm, the tests or examinations shall be performed on one part per rolled plate and heat-treatment lot. The maximum permissible lot size shall be 10 parts.

Note:

Correlation of parts with the rolled plate can be achieved, for example, through the specimen number of the starting products.

(2) For product forms with a diameter or length greater than 3000 mm, each part shall be tested.

(3) One test coupon shall be taken from each part to be examined. In the case of length or diameter exceeding 6 m an additional test coupon shall be taken at the opposite side.

(4) The test coupons shall be taken such that transverse specimens can be machined. Deviations up to 20 degrees from the theoretical transverse direction are permitted for heads (ends) and similar parts. If this is not possible, a different way of sampling shall be agreed with the authorized inspector.

(5) Round tensile-test specimens with a test diameter equal to or larger than 10 mm shall be made for both the room-temperature and elevated-temperature tensile tests. For nominal thicknesses larger than 40 mm, the specimen axis shall be located at a distance of one quarter of the product-form thickness under the rolled surface.

For product-form thicknesses that do not permit a test diameter of 10 mm, the largest possible diameter shall be chosen.

(6) For nominal wall thicknesses equal to or smaller than 40 mm, one side of the specimens for the notched-bar impact bend test shall be as close as possible to the rolled surface. For nominal wall thicknesses larger than 40 mm, the specimen axis shall be located at a distance of one quarter of the product-form thickness under the rolled surface.

5.2.4.2 Extent of tests and examinations

(1) The mechanical and technological characteristics shall be determined by performing:

- a) One room-temperature tensile test per sampling location.
- b) One elevated-temperature tensile test per heat, dimensional range and total weight of at most 30 metric tons. The test temperature is defined in Section A 1 or in the authorized inspector's appraisal.
- c) Room-temperature tensile tests to DIN EN 10164 in order to determine the reduction of area at fracture in the case of product forms with nominal wall thicknesses equal to or larger than 15 mm, if as per clause 5.1.2 (1) quality class Z35 is required. This test may be waived if it has already been performed on the rolled plate and documented with an inspection certificate 3.2 to DIN EN 10204.

Note:

Correlation of parts with the rolled plate can be achieved, for example, through the specimen number of the starting products.

- d) One notched-bar impact bend test to clause 4.4.6.5 per sampling location at 33 °C or at the lowest operating temperature, whichever is lower, for nominal wall thicknesses equal to or larger than 5 mm. Notwithstanding the foregoing, the impact energy for steel grade 15 MnNi 6 3 shall be determined at 0 °C.
- e) Notched-bar impact bend tests at one sampling location for determination of the impact energy vs. temperature curve to clause 4.4.6.6 per heat, dimensional range and heat-treatment lot for product forms with nominal wall thicknesses equal to or larger than 10 mm and not exceeding 38 mm, and per rolled plate for product forms with nominal wall thicknesses exceeding 38 mm. At least four test temperatures shall be used, of which two shall be 0 °C and the lowest loading temperature. This test may be waived for product forms of steel grade 15 MnNi 6 3.
- f) One notched-bar impact bend test to clause 4.4.6.5 at one sampling location of each part to be tested to determine the upper shelf impact energy for product forms with nominal wall thicknesses larger than 16 mm. This test may be performed during determination of the impact energy vs. temperature curve.

In general, 80 °C shall be selected as the test temperature. The test shall be performed only in test group A 1, and may be waived if the value of impact energy determined per d) is equal to or greater than 100 J.

- g) One notched-bar impact bend test to clause 4.4.6.5 per sampling location at 80 °C in the middle of the product-form thickness for product forms with nominal wall thicknesses equal to or greater than 150 mm, unless otherwise stipulated in the appraisal.

- (2) Each product form shall be subjected to a materials identification check.
- (3) Each product form shall be subjected to a visual inspection of its external finish.
- (4) The dimensional and shape accuracy of each product form shall be measured.
- (5) The Sections 11.1 and 11.3 shall apply to the non-destructive tests and examinations.

5.2.5 Marking

- (1) Each product form shall be marked with the following information:
 - a) symbol of the manufacturer of the product form,
 - b) steel grade (for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164),
 - c) heat number,
 - d) specimen number and
 - e) authorized inspector's mark.
- (2) In the case of lotwise examination, the product form from which the specimens were taken shall additionally be marked.
- (3) The marking shall be applied such that it appears upright when viewed in the main rolling direction of the rolled plate.

5.2.6 Verification of quality characteristics

- (1) The results of the materials identification check and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons shall be indicated in the inspection certificate 3.1.
- (2) The forming method shall be indicated in inspection certificate 3.1 to DIN EN 10204.
- (3) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with the inspection certificate 3.1 as an inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.
- (4) The inspection certificate of the starting product shall be attached to the inspection certificate 3.2.

5.3 Forgings, bars and rolled rings

5.3.1 Materials

- (1) The following steel grades may be used:
 - a) steel grades to Section A 2,
 - b) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.
- (2) The materials shall meet the requirements of clause 4.3.1.

5.3.2 Additional requirements for the materials

For products with heat-treatment thicknesses greater than 150 mm and heat-treatment weights heavier than 500 kg, the smallest individual value of impact energy (transverse specimens) at the middle of the wall thickness at 80 °C shall not be less than 68 J.

Note:

Heat-treatment thickness and heat-treatment weight designate the wall thickness and piece weight of the product forms in the condition in which the heat treatment governing establishment of the mechanical and technological characteristics is performed.

5.3.3 Tests and examinations

5.3.3.1 Sampling and specimen preparation

5.3.3.1.1 Test units

- (1) Unless otherwise required in clause 5.3.3.2, the following is required:
 - a) Pieces with heat-treatment weights lighter than or equal to 100 kg may be grouped as test units of 1000 kg each.
 - b) Pieces with heat-treatment weights heavier than 100 kg and equal to or lighter than 500 kg from the same heat, with similar dimensions and from the same heat-treatment lot shall be grouped as test units containing at most 10 parts.
 - c) Pieces with heat-treatment weights heavier than 500 kg shall be tested individually.

5.3.3.1.2 Sampling locations

- (1) For forged hollow parts, e.g., for shell courses, nozzles or valve bodies, specimens shall be taken from one end as a function of inside diameter D_i as follows: from one sampling location for D_i equal to or smaller than 500 mm; from two sampling locations separated by 180 degrees for D_i between 500 mm and 2000 mm; and from three sampling locations separated by 120 degrees for D_i larger than 2000 mm.
- (2) At the opposite end, specimens shall be taken from one sampling location for normalized or air quenched and tempered forgings having a finished length longer than 5000 mm and for liquid quenched and tempered forgings having a finished length longer than 2000 mm. For pieces with inside diameters smaller than or equal to 500 mm, this sampling location shall be offset by 180 degrees relative to that at the other end (see **Figures 5.3-1** and **5.3-2**).

Note:

Finished length designates the length of the product form during the governing heat treatment, less the length of the test coupons.

- (3) For seamless rolled or forged rings or flanges, specimens shall be taken from the circumference or end of the flange. They may also be taken from the end of the welding end, if the heat-treatment wall thickness of the welding end is equal to that of the flange. Specimens shall be taken as follows: from one sampling location for inside diameters D_i smaller than or equal to 1000 mm; from two sampling locations separated by 180 degrees for D_i between 1000 mm and 2000 mm; and from three locations separated by 120 degrees for D_i larger than 2000 mm (see **Figure 5.3-3**).
- (4) For plates such as tubesheets, tube plates or blanking-off covers with heat-treatment weights lighter than 1000 kg, specimens shall be taken from one sampling location. If permitted by the forging method employed, this location shall be in the top or bottom zone (see **Figure 5.3-4**).
- (5) For plates with heat-treatment weights equal to or heavier than 1000 kg, specimens shall be taken from two sampling locations. If permitted by the forging method employed, these locations shall be in the top and bottom zones (see **Figure 5.3-4**).
- (6) For bars, specimens shall be taken at one end as a function of the diameter D of the bars: from one sampling location for D smaller than or equal to 500 mm and from two sampling locations separated by 180 degrees for D larger than 500 mm.

(7) In the case of

- a) normalized or air quenched and tempered bars having a finished length longer than 5000 mm
- b) liquid quenched and tempered bars having a finished length longer than 2000 mm

specimens shall be taken from one sampling location at the opposite end. For bars having diameters smaller than or equal to 500 mm, this location shall be offset by 180 degrees relative to that at the other end.

5.3.3.1.3 Sampling depth

(1) For normalized and air quenched and tempered parts, the specimens shall be taken from at least one quarter of the governing heat-treatment thickness but at most 80 mm under the heat-treatment surfaces.

(2) For liquid quenched and tempered parts, except for plates with heat-treatment thicknesses larger than 320 mm, the specimens shall be taken from at least one quarter of the governing heat-treatment thickness but at most 80 mm under the governing heat-treatment surface and at least from the middle of the governing heat-treatment thickness (s/2) and at most 160 mm under the other surfaces.

(3) For liquid quenched and tempered plates with heat-treatment thicknesses larger than 320 mm, the specimens shall be taken from at least 80 mm under the heat-treatment surfaces.

(4) For parts with a governing heat-treatment thickness larger than 150 mm and a heat-treatment weight heavier than 500 kg, samples shall be taken additionally at one location from the middle of the governing heat-treatment thickness (s/2).

Note:

In the case of plates for tubesheets, the question of whether this requirement is met shall be verified in the appraisal by the impact energy at the middle of the wall thickness.

5.3.3.1.4 Specimen direction

(1) Transverse specimens shall be taken for tensile tests and notched-bar impact bend tests if geometrically possible and nothing to the contrary is stipulated in Section A 2 or in the authorized inspector's appraisal.

(2) Notwithstanding the foregoing, longitudinal specimens or axial specimens may be taken from bars, specifically for tensile tests if the diameter or greatest length of a cross-sectional edge is smaller than 160 mm, or for notched-bar impact bend tests if the diameter or the greatest length of a cross-sectional edge is smaller than 68 mm.

5.3.3.2 Extent of tests and examinations

(1) The following procedures shall be performed for the chemical analysis:

- a) One ladle analysis per heat.
- b) One product analysis on one sampling location in each of two separately manufactured pieces per heat.
- c) One product analysis on each piece for piece weights equal to or heavier than 5000 kg.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) One hardness test per piece to verify uniformity for pieces grouped together in test units.

Note:

Verification of uniformity shall be acknowledged if the difference between the highest and lowest hardness values in a test unit does not exceed 30 HB units.

- b) One room-temperature tensile test per sampling location.
- c) For pieces of similar dimension, one elevated-temperature tensile test per heat and heat-treatment lot. The test temperature is defined in Section A 2 or in the authorized inspector's appraisal.

d) One notched-bar impact bend test to clause 4.4.6.5 per sampling location at 33 °C or at the lowest operating temperature, whichever is lower. Notwithstanding the foregoing, the impact energy absorbed for steel grade 15 MnNi 6 3 shall be determined at 0 °C.

e) Notched-bar impact bend tests for determination of the impact energy vs. temperature curve to clause 4.4.6.6.

ea) per heat and heat-treatment lot for pieces with heat-treatment weights equal to or lighter than 500 kg

eb) per piece, at one sampling location, for pieces with heat-treatment weights equal to or heavier than 500 kg.

At least four test temperatures shall be used, of which two shall be 0 °C and the lowest loading temperature. This test may be waived for pieces of steel grade 15 MnNi 6 3 with wall thicknesses smaller than or equal to 150 mm.

f) One notched-bar impact bend test to clause 4.4.6.5 at one sampling location per test unit to verify the upper shelf impact energy for pieces with heat-treatment weights equal to or heavier than 150 kg in the normalized or air quenched and tempered condition and equal to or heavier than 50 kg in the liquid quenched and tempered condition. It shall be demonstrated that the smallest individual value of upper shelf impact energy is equal to or larger than 100 J. This test may be performed during determination of the impact energy vs. temperature curves. In general, 80 °C shall be selected as the test temperature. The test shall be performed only in test group A 1, and may be waived if the value of impact energy determined per d) is equal to or greater than 100 J. This test may be waived for pieces of steel grade 15 MnNi 6 3 with wall thicknesses smaller than or equal to 150 mm.

g) One notched-bar impact bend test to clause 4.4.6.5 at 80 °C at one sampling location in the middle of the thickness for products with heat-treatment weights heavier than 500 kg and heat-treatment thicknesses larger than 150 mm, unless otherwise stipulated in the appraisal.

(3) Each piece shall be subjected to a materials identification check.

(4) Each piece shall be subjected in the as-delivered condition to a visual inspection of its external finish.

(5) A dimensional check of each piece shall be performed.

(6) The Sections 11.1 and 11.4 shall apply to the non-destructive tests and examinations.

5.3.4 Marking

(1) Each piece shall be marked with the following information:

- a) manufacturer's symbol,
- b) steel grade,
- c) heat number,
- d) specimen number,
- e) authorized inspector's mark.

(2) In the case of lotwise examination, the piece from which the specimens were taken shall additionally be marked.

5.3.5 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, materials identification check and non-destructive tests and examinations shall be recorded in the appraisal.

nations performed by the manufacturer, and if necessary of the hardness test shall be documented with an inspection certificate 3.1 to DIN EN 10204. The steel making process, the delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons shall be indicated in the inspection certificate 3.1.

(2) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

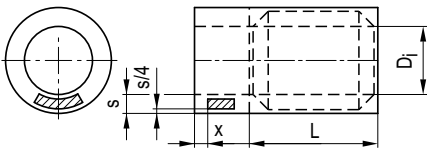
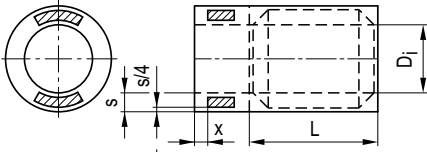
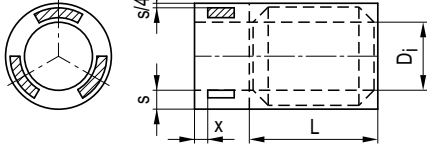
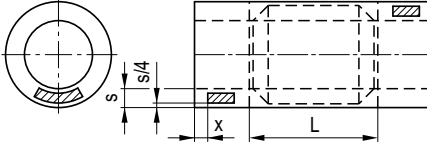
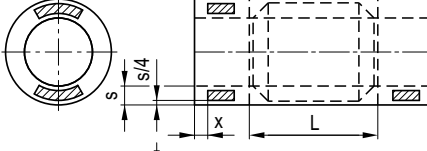
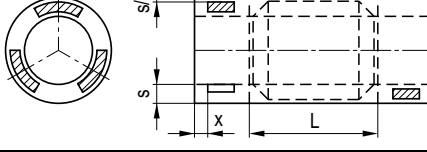
No.	Finished length	Inside diameter D_i	Examples for sampling
1	Normalized and air quenched and tempered pieces: $L \leq 5000$ mm Pieces quenched and tempered in liquid: $L \leq 2000$ mm	≤ 500 mm	 for normalized and air quenched and tempered pieces: $x = s/4$
2		> 500 mm up to ≤ 2000 mm	 for pieces quenched and tempered in liquid: $x = s/2$
3		> 2000 mm	
4	Normalized and air quenched and tempered pieces: $L > 5000$ mm Pieces quenched and tempered in liquid: $L > 2000$ mm	≤ 500 mm	
5		> 500 mm up to ≤ 2000 mm	
6		> 2000 mm	

Figure 5.3-1: Examples for sampling from forged hollow parts

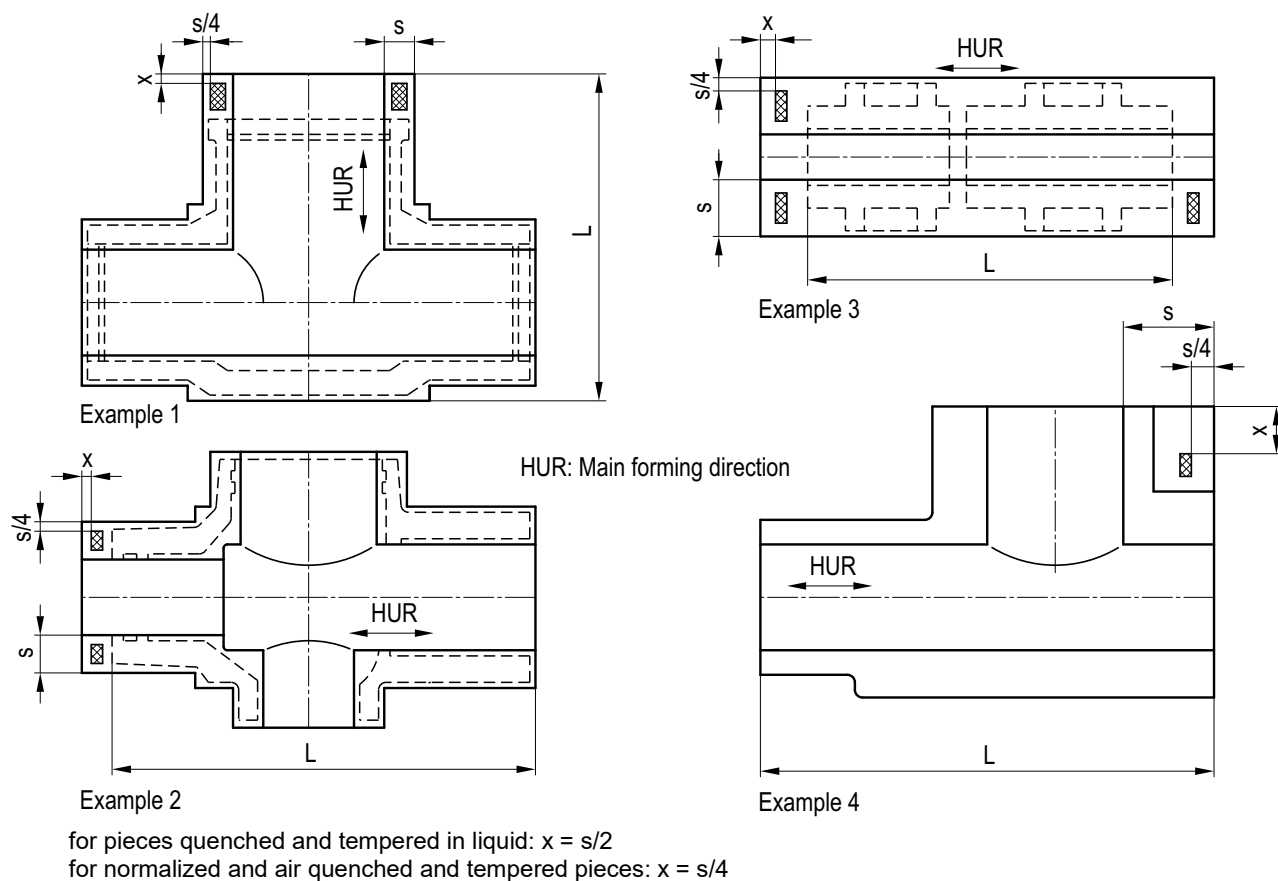
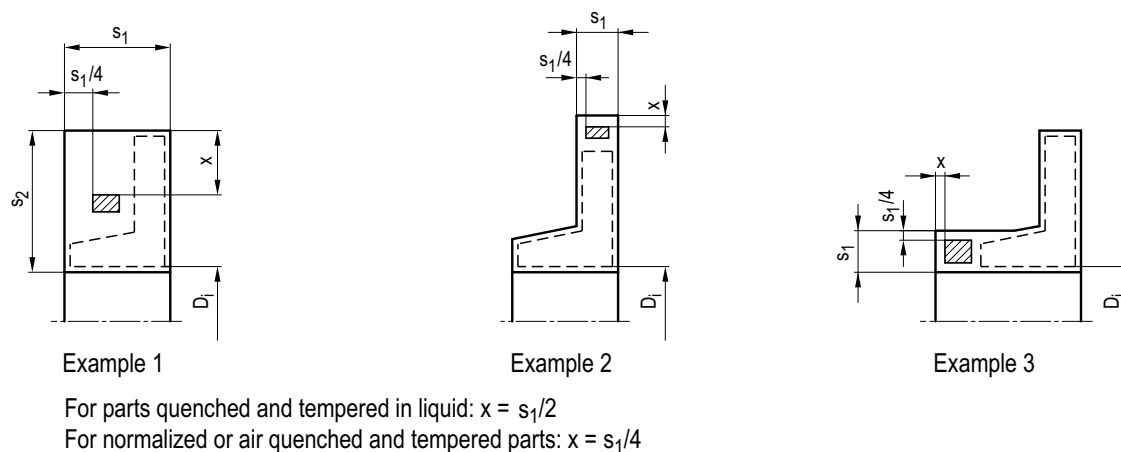
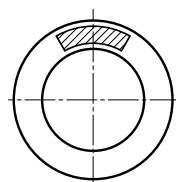


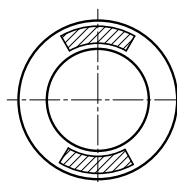
Figure 5.3-2: Examples for sampling from forged valve bodies



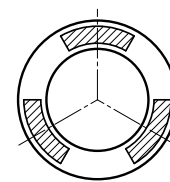
a) Examples for sampling



$D_i \leq 1000 \text{ mm}$



$1000 \text{ mm} < D_i \leq 2000 \text{ mm}$



$D_i > 2000 \text{ mm}$

b) Distribution of sampling locations on the circumference or at the end as a function of inside diameter

Figure 5.3-3: Examples for sampling from seamless rolled or forged rings or flanges

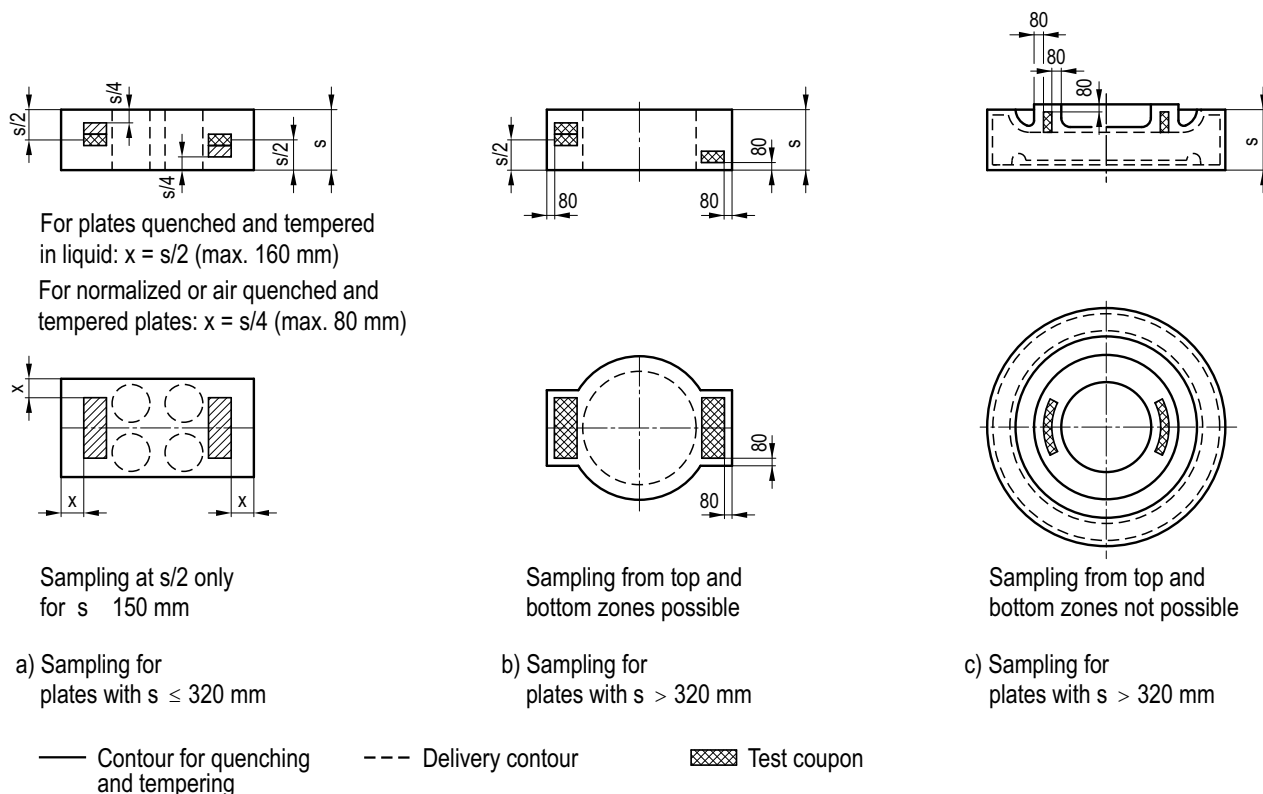


Figure 5.3-4: Examples for sampling from forged plates

5.4 Seamless pipes larger than DN 50

5.4.1 Scope

(1) The stipulations of this Section shall apply to seamless, rolled or pressed pipes larger than DN 50.

Note:

For forged pipes Section 5.3 shall apply.

(2) The stipulations of this Section shall also apply to pipes equal to or smaller than DN 50 if pipe elbows larger than DN 50 are made from such pipes.

(3) The stipulations of this Section shall not apply to pipes for vessel shells.

5.4.2 Materials

(1) The following steel grades may be used:

- steel grades to Section A 3,
- other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

(2) The materials shall meet the requirements of clause 4.3.1.

5.4.3 Additional requirements for the materials

Pipes with nominal wall thicknesses equal to or larger than 15 mm and subject to loading perpendicular to the surface shall at least meet the requirements of quality class Z35 to DIN EN 10164. This shall be specified in the purchase order.

5.4.4 Tests and examinations

5.4.4.1 Sampling and specimen preparation

- The pipes shall be tested in manufacturing lengths.
- Specimens shall be taken from the ends of manufacturing lengths.

(3) Transverse specimens shall be taken for tensile tests and notched-bar impact bend tests. If this is not possible, it is permitted to take longitudinal specimens.

(4) Notched-bar impact bend tests shall be performed only for pipes with nominal wall thicknesses equal to or larger than 10 mm.

(5) For tensile tests carried out on round tensile test specimens and for notched-bar impact bend tests, the test coupons shall be taken such that they are located at one quarter of the wall thickness under the outside surface and at one half of the wall thickness under the end face or as close as possible to that location.

(6) Specimens for determination of reduction of area at fracture on perpendicular specimens shall be taken at the same location as for the room-temperature tensile-test specimens.

5.4.4.2 Extent of tests and examinations

(1) The following procedures shall be performed for the chemical analysis:

- One ladle analysis per heat.
- One product analysis on each of two manufacturing lengths per heat.

(2) The mechanical and technological characteristics shall be determined by performing:

- Room-temperature tensile tests for every 20 manufacturing lengths of the same heat, dimension and heat treatment
 - at one end of one manufacturing length for pipes of normalized or air quenched and tempered steels
 - at both ends of one manufacturing length for pipes of liquid quenched and tempered steels.
- One elevated-temperature tensile test per heat, dimension and heat treatment if the design temperature is higher than 100 °C. The test temperature is defined in Section A 3 or in the authorized inspector's appraisal.

- c) Room-temperature tensile tests to DIN EN 10164 in order to determine the reduction of area at fracture on perpendicular specimens from one sampling location every 20 manufacturing lengths of the same heat, dimension and heat treatment for pipes with nominal wall thicknesses equal to or larger than 15 mm, if as per clause 5.1.2 (1) quality class Z35 is required. This test may be waived for steel grades for which it was demonstrated in the material appraisal that the mean value of reduction of area at fracture is at least 45 % and that none of the individual values is smaller than 35 %.
- d) One notched-bar impact bend test to clause 4.4.6.5 at 33 °C or at the lowest operating temperature, whichever is lower, at one end of one manufacturing length per 20 manufacturing lengths of the same heat, dimension and heat treatment for pipes of normalized or air quenched and tempered steels with nominal thicknesses not exceeding 38 mm, and at one end of each manufacturing length for pipes with nominal thicknesses exceeding 38 mm. For pipes of steel grade 15 MnNi 6 3, the test temperature shall be 0 °C.
- e) One notched-bar impact bend test to clause 4.4.6.5 at 33 °C or at the lowest operating temperature, whichever is lower, at both ends of one manufacturing length per 20 manufacturing lengths of the same heat, dimension and heat treatment for pipes of liquid quenched and tempered steels with nominal wall thicknesses equal to or smaller than 16 mm, and at both ends of each manufacturing length for pipes with nominal wall thicknesses larger than 16 mm.
- f) Notched-bar impact bend tests for determination of an impact energy vs. temperature curve to clause 4.4.6.6 at one end of one manufacturing length per heat, dimension and heat treatment for pipes with nominal wall thicknesses equal to or larger than 10 mm. At least four test temperatures shall be used, of which two shall be 0 °C and the lowest loading temperature. This test may be waived for pipes of steel grade 15 MnNi 6 3.
- g) One notched-bar impact bend test to clause 4.4.6.5 at one end of each manufacturing length to determine the upper shelf impact energy for pipes of normalized or air quenched and tempered steels with nominal wall thicknesses larger than 38 mm as well as for pipes of liquid quenched and tempered steels with nominal wall thicknesses larger than 16 mm. This test may be performed during determination of the impact energy vs. temperature curves. In general, 80 °C shall be selected as the test temperature. This test shall be performed only in test group A 1, and may be waived if the value of impact energy determined per d) or e) is equal to or greater than 100 J.
- h) Technological tests per **Table 5.4-1** at both ends of each manufacturing length for pipes with nominal wall thicknesses equal to or smaller than 40 mm.

Nominal wall thickness s of the pipes in mm	Nominal outside diameter of the pipes in mm	
	≤ 146	> 146
$s < 2$	Flattening test	—
$2 \leq s \leq 16$	Ring expanding test ¹⁾	Ring tensile test
$16 < s \leq 40$	Flattening test	Ring tensile test
¹⁾ The drift test also may be performed.		

Table 5.4-1: Dimensional ranges for application of the technological tests to pipes

- (3) The Sections 11.1 and 11.5.1 shall apply to the non-destructive tests and examinations.
- (4) Each pipe shall be subjected to a materials identification check.
- (5) The inside and outside surfaces of each pipe shall be subjected to a visual inspection.
- (6) The diameter and wall thickness shall be checked for dimensional accuracy at both ends of each pipe.
- (7) Each pipe shall be examined for leak tightness in accordance with DIN EN 10216-2.

5.4.5 Marking

- (1) Each pipe shall be marked at both ends, 300 mm from the ends, with the following information:
- manufacturer's symbol,
 - steel grade, for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164) and
 - authorized inspector's mark.
- (2) Each pipe shall additionally be marked at one end with the following information:
- heat number,
 - pipe number.

5.4.6 Verification of quality characteristics

- (1) The results of the ladle analysis, product analysis, materials identification check, tightness test and non-destructive tests and examinations performed by the manufacturer shall be documented with inspection certificates 3.1 to DIN EN 10204. The steel making process, the delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons shall be indicated in the inspection certificate 3.1.
- (2) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

5.5 Seamless pipe elbows larger than DN 50

5.5.1 Scope

- (1) This Section shall apply to seamless pipe elbows (weld-in elbows) made by cold or hot forming followed by heat treatment (normalization; quenching and tempering).
- (2) This Section shall not apply to pipe bends made with inductive bending machines or by cold forming with or without subsequent heat treatment. These pipe bends are subject to the requirements of KTA 3211.3 Section 6.

5.5.2 Materials

- (1) The following steel grades may be used:
- steel grades to Section A 3 and
 - other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.
- (2) The materials shall meet the requirements of clause 4.3.1.
- (3) For finished pipe elbows, the values of the mechanical and technological characteristics to Section A 3 shall apply even if forged hollow parts are used as starting products.

5.5.3 Starting products

- (1) Forged hollow parts to Section 5.3 or seamless pipes to Section 5.4 shall basically be used as starting products.
- (2) Starting products that have not been completely examined and heat-treated to the stipulations in Sections 5.3 or 5.4 may also be used, provided
 - a) the finished pipe elbows are examined individually to clause 5.5.4.2 and
 - b) the non-destructive tests and examinations of the starting products have been carried out according to the requirements in Section 11.4 or Section 11.5.1 prior to forming.

In this case the determination of mechanical and technological characteristics and the corresponding verification may be waived for the starting products. An inspection certificate 3.1 to DIN EN 10204 shall then be adequate for visual inspection and dimensional check of the starting products.

5.5.4 Tests and examinations of pipe elbows

5.5.4.1 Sampling and specimen preparation

- (1) Specimens shall be taken from the ends of the pipe elbows in conformity with the authorized inspector's appraisal.
- (2) The test coupons shall be located at one quarter of the wall thickness under the outside surface and at one half of the wall thickness under the end face or as close as possible to that location.
- (3) Transverse specimens shall be used for tensile tests and notched-bar impact bend tests, provided that they can be taken from unstraightened test coupons. If this is not possible, longitudinal specimens shall be tested.
- (4) Notched-bar impact bend tests shall be performed only for pipe elbows with nominal wall thicknesses equal to or larger than 10 mm.
- (5) If starting products that have not been completely examined and heat-treated to the stipulations in Sections 5.3 or 5.4 are used, test coupons shall be taken from both ends of pipe elbows with an arc length greater than 3000 mm, measured along the outside of the bend.
- (6) In all other cases, test coupons shall be taken from only one end of the pipe elbow.
- (7) If the pipe elbows are not tested individually, test units consisting of pipe elbows of the same heat, dimension and heat treatment shall be formed for determination of mechanical and technological characteristics.
- (8) For the room-temperature tensile tests and for the notched-bar impact bend tests, the number of pipe elbows per test unit shall not exceed:
 - a) 30 pieces for pipe elbows smaller than DN 200
 - b) 20 pieces for pipe elbows equal to or larger than DN 200 and smaller than DN 350
 - c) 10 pieces for pipe elbows equal to or larger than DN 350.

5.5.4.2 Extent of tests and examinations

- (1) The chemical composition shall be verified on the starting product.
- (2) The mechanical and technological characteristics shall be determined by performing:
 - a) One room-temperature tensile test for each sampling location of one pipe elbow per test unit, and for each sampling location of each pipe elbow in the case of individual testing.

- b) One elevated-temperature tensile test for one sampling location of one pipe elbow per heat, dimension and heat treatment, and for one sampling location of each pipe elbow in the case of individual testing. The test temperature is defined in Section A 3 or in the authorized inspector's appraisal.
- c) One notched-bar impact bend test to clause 4.4.6.5 at 33 °C or at the lowest operating temperature, whichever is lower, for each sampling location of one pipe elbow per test unit for pipe elbows of normalized or air quenched and tempered steels with nominal wall thicknesses not exceeding 38 mm, as well as for pipe elbows of liquid quenched and tempered steels with nominal wall thicknesses not exceeding 16 mm. For greater wall thicknesses as well as in the case of individual testing, this test shall be performed at each sampling location of each pipe elbow. For pipe elbows of steel grade 15 MnNi 6 3, the test temperature shall be 0 °C.
- d) Notched-bar impact bend tests for determination of an impact energy vs. temperature curve to clause 4.4.6.6 for one sampling location of one pipe elbow per heat, dimension and heat treatment for pipe elbows with nominal wall thicknesses equal to or larger than 10 mm. At least four test temperatures shall be used, of which two shall be 0 °C and the lowest loading temperature. This test may be waived for pipe elbows of steel grade 15 MnNi 6 3.
- e) One notched-bar impact bend test to clause 4.4.6.5 to determine the upper shelf impact energy at one sampling location of each elbow for pipe elbows of normalized or air quenched and tempered steels with nominal wall thicknesses exceeding 38 mm as well as for pipe elbows of liquid quenched and tempered steels with nominal wall thicknesses exceeding 16 mm. This test may be performed during determination of the impact energy vs. temperature curves. In general, 80 °C shall be selected as the test temperature. This test shall be performed only in test group A 1, and may be waived if the value of impact energy determined per d) or e) is equal to or greater than 100 J.
- f) For pipe elbows grouped together as test units, one hardness test per pipe elbow to verify uniformity.

Note:

Verification of uniformity shall be acknowledged if the difference between the highest and lowest hardness values in a test unit does not exceed 30 HB units.

- (3) The Sections 11.1 and 11.6.1 shall apply to the non-destructive tests and examinations.
- (4) Each pipe elbow shall be subjected to a materials identification check.
- (5) The inside and outside surfaces of each pipe elbow shall be subjected to a visual inspection.
- (6) For each pipe elbow, the wall thickness and, depending on the purchase order, either the outside or inside diameter shall be measured over the arc length, including the ends, and to a sufficient extent over the circumference. The smallest wall thickness as well as the ovality shall be determined.

5.5.5 Marking

- (1) Each pipe elbow shall be marked with the following information:
 - a) manufacturer's symbol,
 - b) steel grade (for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164),
 - c) heat number,
 - d) pipe-elbow number,
 - e) authorized inspector's mark.



5.5.6 Verification of quality characteristics

(1) The results of the materials identification check and of non-destructive tests and examinations performed by the manufacturer as well as of hardness test, if any, shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons shall be indicated in the inspection certificate 3.1.

(2) The forming process used shall be indicated in the inspection certificate 3.1 to DIN EN 10204.

(3) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

(4) The inspection certificate of the starting product shall be attached to the inspection certificate 3.2.

5.6 Seamless fittings larger than DN 50

Note:

The nominal diameter of a reducer or of a tee shall refer to the end with the larger diameter.

5.6.1 Scope

(1) This Section shall apply to the following seamless fittings:

- a) reducers made by cold or hot forming,
- b) tees fabricated to the liqued bulge method

followed by heat treatment (normalization; quenching and tempering)

5.6.2 Materials

(1) The following steel grades may be used:

- a) steel grades to Section A 3 and
- b) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

(2) The materials shall meet the requirements of clause 4.3.1.

(3) For fabricated fittings, the values of the mechanical and technological characteristics to Section A 3 shall apply even if forged hollow parts are used as starting products.

5.6.3 Starting products

(1) Forged hollow parts to Section 5.3 or seamless pipes to Section 5.4 shall basically be used as starting products.

(2) Starting products that have not been completely examined and heat-treated to the stipulations in Sections 5.3 or 5.4 may also be used, provided

- a) the finished pipe elbows are examined individually to clause 5.6.4.2 and
- b) the non-destructive tests and examinations of the starting products have been carried out according to the requirements in Section 11.4 or Section 11.5.1 prior to forming.

In this case the determination of mechanical and technological characteristics and the corresponding verification may be waived for the starting products. An inspection certificate 3.1 to DIN EN 10204 shall then be adequate for visual inspection and dimensional check of the starting products.

5.6.4 Tests and examinations of fittings

5.6.4.1 Sampling and specimen preparation

(1) Specimens shall be taken from one end of the fittings in conformity with the authorized inspector's appraisal.

(2) The test coupons shall be located at one quarter of the wall thickness under the outside surface and at one half of the wall thickness under the end face or as close as possible to that location.

(3) Transverse specimens shall be used for tensile tests and notched-bar impact bend tests, provided that they can be taken from unstraightened test coupons. If this is not possible, longitudinal specimens shall be tested.

(4) Notched-bar impact bend tests shall be performed only for fittings with nominal wall thicknesses equal to or larger than 10 mm.

(5) If the fittings are not tested individually, test units consisting of fittings of the same heat, dimension and heat treatment shall be formed for determination of mechanical and technological characteristics.

(6) For the room-temperature tensile tests and for the notched-bar impact bend tests, the number of fittings per test unit shall not exceed:

- a) 30 pieces for fittings smaller than DN 100
- b) 10 pieces for fittings equal to or larger than DN 100.

5.6.4.2 Extent of tests and examinations

(1) The chemical composition shall be verified on the starting product.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) One room-temperature tensile test per test unit.
- b) One elevated-temperature tensile test per heat, dimension and heat treatment, if the design temperature is higher than 100 °C. The test temperature is defined in Section A 3 or in the authorized inspector's appraisal.
- c) One notched-bar impact bend test to clause 4.4.6.5 at 33 °C or at the lowest operating temperature, whichever is lower, on one piece per test unit for fittings of normalized or air quenched and tempered steels with nominal wall thicknesses not exceeding 38 mm, as well as for fittings of liquid quenched and tempered steels with nominal wall thicknesses not exceeding 16 mm. For fittings of steel grade 15 MnNi 6 3, the test temperature shall be 0 °C.
- d) Notched-bar impact bend tests for determination of an impact energy vs. temperature curve to clause 4.4.6.6 on one piece per heat, dimension and heat-treatment lot for fittings with nominal wall thicknesses equal to or larger than 10 mm. At least four test temperatures shall be used, of which two shall be 0 °C and the lowest loading temperature. This test may be waived for fittings of steel 15 MnNi 6 3.
- e) One notched-bar impact bend test to clause 4.4.6.5 on each piece to determine the upper shelf impact energy for fittings of normalized or air quenched and tempered steels with nominal wall thicknesses exceeding 38 mm as well as for fittings of liquid quenched and tempered steels with nominal wall thicknesses exceeding 16 mm. In general, 80 °C shall be selected as the test temperature. This test may be performed during determination of the energy absorbed vs. temperature curves. This test shall be performed only in test group A 1, and may be waived if the value of energy absorbed determined per d) or e) is equal to or greater than 100 J.

- f) For fittings grouped together as test units, one hardness test per fitting to verify uniformity.

Note:

Verification of uniformity shall be acknowledged if the difference between the highest and lowest hardness values in a test unit does not exceed 30 HB units.

- (3) Each fitting shall be subjected to a materials identification check.
- (4) The inside and outside surfaces of each fitting shall be subjected to a visual inspection.
- (5) For each fitting, the ovality, diameter and thickness shall be measured at the ends.
- (6) The Sections 11.1 and 11.7.1 shall apply to the non-destructive tests and examinations.

5.6.5 Marking

- (1) Each fitting shall be marked with the following information:
- manufacturer's symbol,
 - steel grade (for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164),
 - heat number,
 - fitting number or test lot number,
 - authorized inspector's mark.

5.6.6 Verification of quality characteristics

- (1) The results of the materials identification check and of non-destructive tests and examinations performed by the manufacturer as well as of hardness test, if any, shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons shall be indicated in the inspection certificate 3.1.
- (2) The forming process used shall be indicated in the inspection certificate 3.1 to DIN EN 10204.
- (3) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.
- (4) The inspection certificate of the starting product shall be attached to the inspection certificate 3.2.

5.7 Castings

5.7.1 Materials

- (1) The following cast-steel grades may be used:
- GS-C 25 S to Section A 4 and
 - other cast-steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.
- (2) The materials shall meet the requirements of clause 4.3.1.

5.7.2 Requirements for casting condition

- (1) As regards their general internal quality and external finish, the castings shall meet the conditions of **Table 11-6** applicable to their test group.

- (2) Feeder heads and large casting-related thickenings that impair amenability of castings to heat treatment shall be eliminated before normalization or quenching and tempering.

- (3) The casting technique shall be designed according to the principles of controlled solidification. For castings with nominal widths equal to or larger than 200 mm, the gate and feeder technique shall be explained on the basis of the saturation calculation as well as drawings illustrating the position of the feeders, feed zones and specimen location.

Note:

The feature characterizing the dimensions of the body or case shall be the nominal width, as follows:

- for pumps, the nominal width of the pressure nozzle,
- for valves, the largest nominal width involved,
- for safety valves, the nominal width of the inlet nozzle.

- (4) For each casting model, the description of the casting technique shall be attached to the interim file (internal manufacturer documentation) for retention by the manufacturer.

- (5) Together with the drawing of the casting in the as-delivered condition, the following documents shall generally be submitted as standard plans for the design approval:

- test and inspection sequence plan and heat-treatment plan, in case of differences from the standard production scheme to **Figure 5.7-1**,
 - for forgings of test group A 1 with nominal widths equal to or larger than 200 mm, instructions for the non-destructive examinations as well as a coordinate reference system (reference-point grid),
 - for prototypes of test groups A 2 and A 3 with nominal widths equal to or greater than 200 mm a film location plan and a radiation source plan,
 - welding procedure qualification and welding procedure sheet for production welds and if applicable construction welds (see **Annex B**),
 - test and inspection sequence plan for construction welds, if necessary.
- f) list of planned production control tests.

- (6) If changes are made compared with the conditions stipulated in the welding procedure sheet, or if a different welding method is chosen, the welding procedure sheet shall be amended accordingly and resubmitted for design approval.

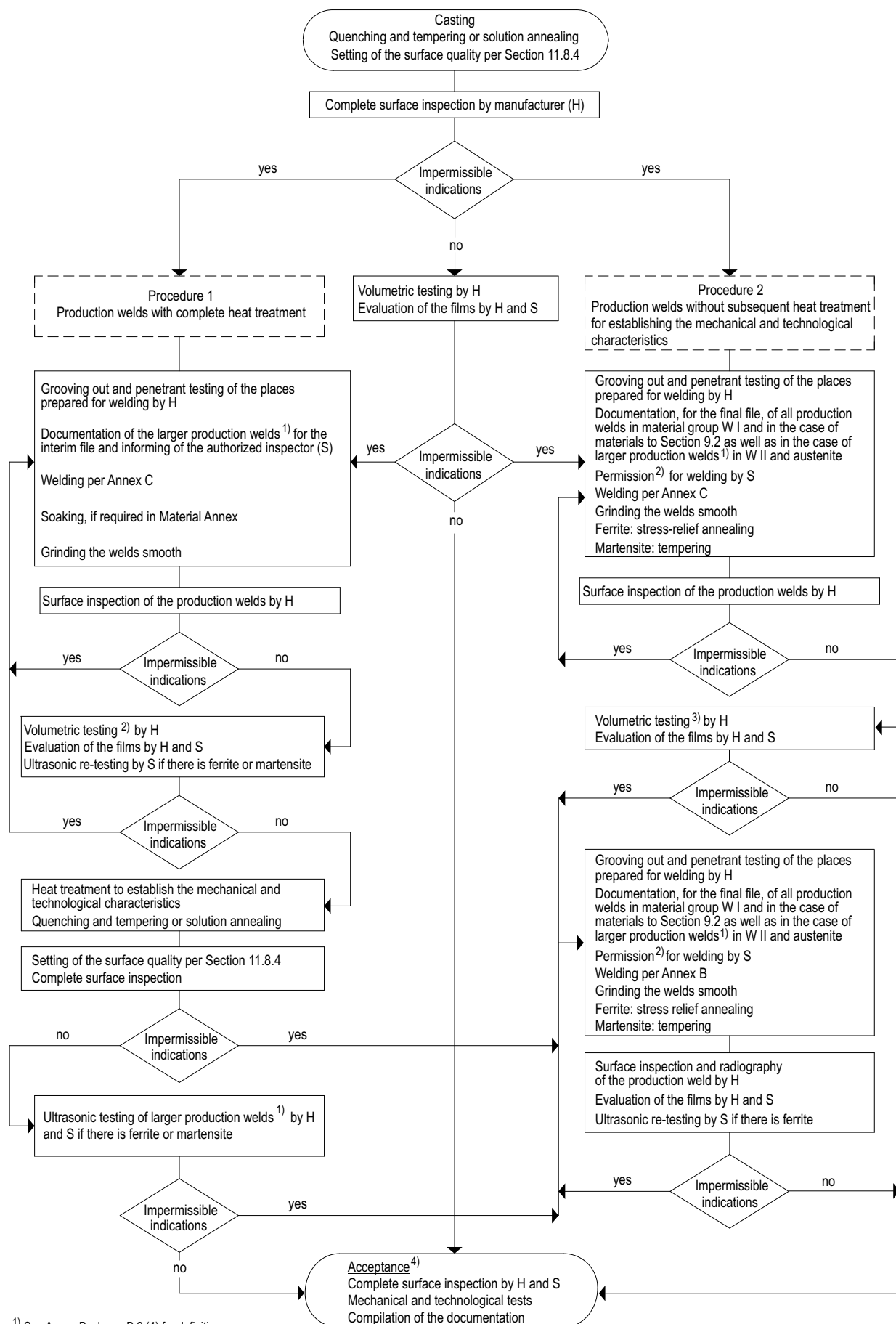
5.7.3 Tests and examinations

5.7.3.1 Sampling and specimen preparation

- (1) Castings with a delivery weight equal to or lighter than 500 kg shall be tested in lots, and castings with a delivery weight heavier than 500 kg shall be tested individually.
- (2) The number of sampling locations shall be as indicated in **Table 5.7-1**.

Product weight (delivery weight) in kg	Test unit	Number of sampling locations
≤ 100	At most 2500 kg per heat, dimension and heat-treatment lot	1
> 100 up to ≤ 500	At most 10 pieces, but not more than 2500 kg per heat, dimension and heat-treatment lot	1
> 500 up to ≤ 1000	Individual piece	1
> 1000	Individual piece	2

Table 5.7-1: Number of sampling locations on castings made of ferritic steels of material group 1.1



¹⁾ See Annex B, clause B 2 (4) for definition of larger production weld.

²⁾ Applies only to material group W I, test group A 1 and in the case of materials to Section 9.2.

³⁾ Note when there are additional volumetric examinations: Radiographed welds and casting zones with permissible indications need not be re-tested.

⁴⁾ If, in exceptional cases in the course of further processing, it becomes necessary for the component manufacturer to perform production welds in order to eliminate casting defects in an advanced state of processing, then deviations relative to the standard production scheme shall be permissible by agreement with the authorized inspector.

Figure 5.7-1: Production scheme for cast steel cases and bodies made of ferritic, austenitic or martensitic cast-steel grades

(3) The specimens shall be taken from cast-on test blocks to DIN EN 1559-2 or from overlengths. Separately cast test blocks are permitted only for castings with piece weights equal to or lighter than 150 kg.

(4) The test blocks shall be provided in sufficient number and size that the prescribed specimens can be taken.

(5) The thickness of the cast-on test blocks shall correspond to the governing wall thickness. In this connection, the governing wall thickness shall be the thickness of the wall subjected to pressure loading, and not the thickness of cast-on flanges or local thickenings.

(6) Cast-on test blocks at the gate system are not permitted.

(7) For castings with piece weights heavier than 1000 kg, the position of the cast-on test coupons on the casting shall be documented by a photograph or in a sketch.

5.7.3.2 Extent of tests and examinations

(1) The following procedures shall be performed for the chemical analysis:

- a) One ladle analysis per heat.
- b) One product analysis for one sampling location per test unit.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) One room-temperature tensile test per sampling location. The value of reduction of area at fracture shall also be determined for information.
- b) One elevated-temperature tensile test per heat, dimension and heat-treatment lot. The test temperature is defined in Section A 4 or in the authorized inspector's appraisal. The value of reduction of area at fracture shall also be determined for information.
- c) One notched-bar impact bend test to clause 4.4.6.5 per sampling location at 33 °C or at the lowest operating temperature, whichever is lower.
- d) Notched-bar impact bend tests for determination of an impact energy vs. temperature curve to clause 4.4.6.6 at one sampling location per test unit. At least four test temperatures shall be used, of which two shall be 33 °C or the lowest loading temperature and 0 °C.
- e) One notched-bar impact bend test to clause 4.4.6.5 to verify the upper shelf impact energy at one sampling location per test unit. In general, this test shall be performed at 80 °C. The test shall be performed only in test group A 1, and may be waived if the notched-bar impact bend test at the lower of 33 °C or the lowest loading temperature has already verified that the requirements are met.
- f) One hardness test on each piece to verify uniformity of the quenching and tempering treatment in the case of lotwise examination of castings of quenched and tempered steel.

(3) The Sections 11.1 and 11.8 shall apply to the non-destructive tests and examinations.

(4) Each casting shall be subjected to a materials identification check.

(5) Each casting shall be subjected in the as-delivered condition to a visual inspection.

(6) Each casting shall be subjected in the as-delivered condition to a dimensional check.

(7) Each casting shall be subjected in a condition suitable for the purpose, generally by the further processor, to a tightness test in the form of an internal pressure test, which shall be performed to DIN 50104. Pressurizing fluid, test pressure and pressure-loading duration shall be indicated in the purchase

order. The test pressure has to be limited to ensure that a safety margin against the yield point or 0.2 % proof stress at room temperature of at least 1.1 is achieved.

5.7.4 Marking

(1) Each casting shall be marked with the following information:

- a) manufacturer's symbol,
- b) steel grade,
- c) heat number,
- d) specimen number and
- e) authorized inspector's mark.

5.7.5 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, materials identification check and non-destructive tests and examinations performed by the manufacturer as well as of the hardness test, if any, shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons shall be indicated in the inspection certificate 3.1.

(2) The results of mechanical and technological tests, visual inspection, dimensional check, tightness test and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with the inspection certificate 3.1 as an inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

(3) For castings with piece weights heavier than 1000 kg, a photograph or a sketch of the location of the cast-on test blocks on the casting shall be attached to the inspection certificate.

6 Product forms of ferritic steels of material group W II

6.1 Flat products

6.1.1 Materials

(1) The following steel grades may be used:

- a) 15 MnNi 6 3 to Section A 1
- b) P275NH (1.0486) to DIN EN 10028-3 in conjunction with VdTÜV material sheet 352/1
- c) P355NH (1.0565) to DIN EN 10028-3 in conjunction with VdTÜV material sheet 354/1
- d) 16Mo3 (1.5415) to DIN EN 10028-2
- e) P235GH (1.0345) to DIN EN 10028-2
- f) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

(2) The materials shall meet the requirements of clause 4.3.1.

(3) The selection of materials shall be based on the lowest operating temperature.

6.1.2 Additional requirements for the materials

(1) Flat products with nominal thicknesses equal to or larger than 15 mm which are subjected to loading perpendicular to the rolled surface shall at least meet the requirements of quality class Z25 to DIN EN 10164. This shall be specified in the purchase order.

(2) When flat products are used for tubesheets, the same requirements as for specimens longitudinal to or transverse to the main rolling direction shall apply for the room-temperature yield point or 0.2 % proof stress and tensile strength of standard specimens perpendicular to the flat product surface. This shall be specified in the purchase order.

(3) The surface finish shall satisfy the stipulations of DIN EN 10163-2 Class B Subgroup 3.

6.1.3 Tests and examinations

6.1.3.1 Sampling and specimen preparation

(1) Specimens shall be taken in accordance with the DIN standards and VdTÜV material sheets referred to in 6.1.1 (1). For steel grade 15 MnNi 6 3 clause 5.1.3 shall apply.

(2) Specimens for determination of the reduction of area at fracture on perpendicular specimens shall be taken and prepared to the stipulations in DIN EN 10164.

6.1.3.2 Extent of tests and examinations

(1) The following procedures shall be performed for the chemical analysis:

- a) One ladle analysis per heat.
- b) One product analysis on one sampling location of one rolled plate per heat.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) One room-temperature tensile test per sampling location.
- b) One tensile test at a temperature of 300 °C per heat, dimensional range and total weight of at most 30 metric tons.
- c) Room-temperature tensile tests to DIN EN 10164 per rolled plate for flat products with nominal thicknesses equal to or larger than 15 mm, in order to determine the reduction of area at fracture, whenever the quality class Z25 is required acc. to clause 6.1.2 (1).
- d) One notched-bar impact bend test to clause 4.4.6.5 per sampling location at 0 °C or at 20 °C for nominal thicknesses equal to or larger than 5 mm.
- e) Notched-bar impact bend tests for determination of an impact energy vs. temperature curve to clause 4.4.6.6 at one sampling location per heat, dimensional range and identical heat treatment for flat products with nominal thicknesses equal to or larger than 10 mm. At least four test temperatures shall be used, of which one shall be 0 °C or 20 °C. This test may be waived for flat products of steel grade 15 MnNi 6 3.

(3) Each rolled plate shall be subjected to a materials identification check.

(4) Each flat product shall be subjected to a visual inspection.

(5) The dimensional and shape accuracy of each rolled plate shall be measured.

(6) The Sections 11.1 and 11.2 shall apply to the non-destructive tests and examinations, the Sections 11.1 and 11.4 in the case of flat products for tubesheets.

6.1.4 Marking

(1) Each flat product shall be marked at least with the following information:

- a) manufacturer's symbol,
- b) steel grade (for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164),

- c) heat number,
- d) specimen number and
- e) authorized inspector's mark.

(2) The marking shall be applied such that it appears upright when viewed in the main rolling direction.

6.1.5 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, materials identification check and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The steel making process, the delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons, if any, shall be indicated in the inspection certificate 3.1.

(2) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

6.2 Dished or pressed product forms made from flat products

6.2.1 Materials

Section 6.1.1 shall apply to the materials.

6.2.2 Additional requirements for the materials

The requirements of Section 6.1.2 shall apply.

6.2.3 Starting products

(1) Starting products shall be subject to the stipulations in Section 6.1.

(2) If the finished parts are tested individually to clause 6.2.4.2, the tests to clause 6.1.3.2 (2) as well as the corresponding verifications can be omitted.

Note:

The stipulations of KTA 3211.3 shall apply to welded joints made with the starting plates and remaining in the finished parts.

6.2.4 Testing and examination of dished or pressed product forms made from flat products

6.2.4.1 Sampling and specimen preparation

(1) For product forms with a diameter or length equal to or smaller than 3000 mm, the tests or examinations shall be performed on one part per rolled plate and heat-treatment lot. The maximum permissible lot size shall be 10 parts.

Note:

Correlation of parts with the rolled plate can be achieved, for example, through the specimen number of the starting products.

(2) For product forms with a diameter or length greater than 3000 mm, each part shall be tested. For lengths or diameters exceeding 6 m one test coupon each shall be taken at two opposite sides.

(3) One test coupon shall be taken from each part to be examined regardless of its diameter or length.

(4) The test coupons shall be taken such that transverse specimens can be machined. Deviations up to 20 degrees from the theoretical transverse direction are permitted for

heads (ends) and similar parts. If this is not possible, a different type of sampling shall be agreed with the authorized inspector.

(5) Round tensile-test specimens with a test diameter equal to or larger than 10 mm shall be made for both the room-temperature and elevated-temperature tensile tests. For nominal wall thicknesses larger than 40 mm, the specimen axis shall be located at a distance of one quarter of the product-form thickness under the rolled surface.

For product-form thicknesses that do not permit a test diameter of 10 mm, the largest possible diameter shall be chosen.

(6) For nominal wall thicknesses equal to or smaller than 40 mm, one side of the specimens for the notched-bar impact bend test shall be as close as possible to the rolled surface. For nominal wall thicknesses larger than 40 mm, the specimen axis shall be located at a distance of one quarter of the product-form thickness under the rolled surface.

6.2.4.2 Extent of tests and examinations

(1) The mechanical and technological characteristics shall be determined by performing:

- a) One room-temperature tensile test per sampling location.
- b) One tensile test at a temperature of 300 °C per heat, dimensional range and total weight of at most 30 metric tons.
- c) Room-temperature tensile tests to DIN EN 10164 per rolled plate for product forms with nominal thicknesses equal to or larger than 15 mm, in order to determine the reduction of area at fracture, whenever the quality class Z25 is required acc. to clause 6.1.2 (1). This test may be waived if it has already been performed on the rolled plate and documented with an inspection certificate 3.2 to DIN EN 10204.

Note:

Correlation of parts with the rolled plate can be achieved, for example, through the specimen number.

- d) One notched-bar impact bend test to clause 4.4.6.5 per sampling location at 0 °C or at 20 °C for nominal wall thicknesses equal to or larger than 5 mm.
- e) Notched-bar impact bend tests for determination of an impact energy vs. temperature curve to clause 4.4.6.6 at one sampling location per heat, dimensional range and heat-treatment lot for product forms with nominal wall thicknesses equal to or larger than 10 mm. At least four test temperatures shall be used, of which one shall be 0 °C or 20 °C. This test may be waived for product forms of steel grade 15 MnNi 6 3.

(2) Each product form shall be subjected to a materials identification check.

(3) Each product form shall be subjected to a visual inspection.

(4) The dimensional and shape accuracy of each product form shall be measured.

(5) The Sections 11.1 and 11.3 shall apply to the non-destructive tests and examinations.

6.2.5 Marking

(1) Each finished part shall be marked at least with the following information:

- a) symbol of the manufacturer of the product form,
- b) steel grade (for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164),
- c) heat number,
- d) specimen number and
- e) authorized inspector's mark.

(2) In the case of lotwise examination, the product form from which the specimens were taken shall also be marked.

(3) The marking shall be applied such that it appears upright when viewed in the main rolling direction of the rolled plate.

6.2.6 Verification of quality characteristics

(1) The results of the materials identification check and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons, if any, shall be indicated in the inspection certificate 3.1.

(2) The forming method shall be indicated in the inspection certificate 3.1 to DIN EN 10204.

(3) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

(4) The inspection certificate of the starting product shall be attached to the inspection certificate 3.2.

6.3 Forgings, bars and rolled rings

6.3.1 Materials

(1) The following steel grades may be used:

- a) 15 MnNi 6 3 to Section A 2
- b) P250GH (1.0460) to DIN EN 10273 or DIN EN 10222-2
- c) 16Mo3 (1.5415) to DIN EN 10273 or DIN EN 10222-2
- d) P355NH (1.0565) to DIN EN 10273 in conjunction with VdTÜV material sheet 354/1 or DIN EN 10222-4 in conjunction with VdTÜV material sheet 354/3
- e) P355QH1 (1.0571) to DIN EN 10222-4 in conjunction with VdTÜV material sheet 354/3
- f) P235GH (1.0345) to DIN EN 10273
- g) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

(2) The materials shall meet the requirements of clause 4.3.2.

(3) The selection of materials shall be based on the lowest operating temperature.

6.3.2 Tests and examinations

6.3.2.1 Sampling and specimen preparation

6.3.2.1.1 Test units

(1) Unless otherwise stipulated in clause 6.3.2.2, pieces with heat-treatment weights between 100 kg and equal to or lighter than 500 kg from the same heat, with similar dimensions and from the same heat-treatment lot shall be grouped as test units containing at most 10 parts, while pieces with heat-treatment weights lighter than or equal to 100 kg may be grouped as test units of 1000 kg each.

(2) Pieces with heat-treatment weights heavier than 500 kg shall be tested individually.

6.3.2.1.2 Sampling locations

(1) For forged hollow parts, e.g., for shell courses, nozzles or valve bodies, specimens shall be taken from one end as a

function of inside diameter D_i as follows: from one sampling location for D_i equal to or smaller than 500 mm; from two sampling locations separated by 180 degrees for D_i between 500 mm and 2000 mm; and from three sampling locations separated by 120 degrees for D_i larger than 2000 mm.

(2) At the opposite end, specimens shall be taken from one sampling location for normalized or air quenched and tempered forgings having a finished length longer than 5000 mm and for liquid quenched and tempered forgings having a finished length longer than 2000 mm. For pieces with inside diameters smaller than or equal to 500 mm, this sampling location shall be offset by 180 degrees relative to that at the other end (according to **Figures 5.3-1** and **5.3-2**).

Note:

Finished length designates the length of the product form during the governing heat treatment, less the length of the test coupons.

(3) For seamless rolled or forged rings or flanges, specimens shall be taken from the circumference or end of the flange. They may also be taken from the end of the welding end, if the heat-treatment thickness of the welding end is equal to that of the flange. Specimens shall be taken as follows: from one sampling location for inside diameters D_i smaller than or equal to 1000 mm; from two sampling locations separated by 180 degrees for D_i between 1000 mm and 2000 mm; and from three sampling locations separated by 120 degrees for D_i larger than 2000 mm (according to **Figure 5.3-3**).

(4) For plates such as tubesheets, tube plates or blanking-off covers with heat-treatment weights lighter than 1000 kg, specimens shall be taken from one sampling location. If permitted by the forging method employed, this location shall be in the top or bottom zone (according to **Figure 5.3-4**).

(5) For plates with heat-treatment weights equal to or heavier than 1000 kg, specimens shall be taken from two sampling locations. If permitted by the forging method employed, these locations shall be in the top and bottom zones (according to **Figure 5.3-4**).

(6) For bars, specimens shall be taken at one end as a function of the diameter D of the bars: from one sampling location for D smaller than or equal to 500 mm; and from two sampling locations separated by 180 degrees for D larger than 500 mm.

(7) In the case of

- a) normalized or air quenched and tempered bars having a finished length longer than 5000 mm and
- b) liquid quenched and tempered bars having a finished length longer than 2000 mm

specimens shall be taken from one sampling location at the opposite end. For bars having diameters smaller than or equal to 500 mm, this location shall be offset by 180 degrees relative to that at the other end.

6.3.2.1.3 Sampling depth

The requirements of the DIN standards or VdTÜV material sheets applicable for the respective product form shall apply. In the case of steel 15 MnNi 6 3 the specimens shall be taken from at least one quarter of the governing heat-treatment thickness but at most 80 mm under the heat-treatment surfaces.

6.3.2.1.4 Specimen direction

(1) Transverse specimens shall be taken for tensile tests and notched-bar impact bend tests if geometrically possible and nothing to the contrary is stipulated in the authorized inspector's appraisal.

(2) Notwithstanding the foregoing, longitudinal specimens or axial specimens taken from bars are permitted, specifically for

tensile tests if the diameter or greatest length of a cross-sectional edge is smaller than 160 mm, or for notched-bar impact bend tests if the diameter or the greatest length of a cross-sectional edge is smaller than 68 mm.

6.3.2.2 Extent of tests and examinations

(1) The following procedures shall be performed for the chemical analysis:

- a) One ladle analysis per heat.
- b) One product analysis on in each of two separately manufactured products per heat. If possible, the top zone of one piece and the bottom zone of the other shall be tested. For piece weights equal to or heavier than 5000 kg, one product analysis shall be performed on one sampling location of each piece. It possible, the top or bottom of the starting ingot shall be tested.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) One hardness test per piece to verify uniformity for pieces grouped together in test units.

Note:

Verification of uniformity shall be acknowledged if the difference between the highest and lowest hardness values in a test unit does not exceed 30 HB units.

- b) One room-temperature tensile test per sampling location.
- c) For pieces of similar dimension, one elevated-temperature tensile test per heat and heat-treatment lot.
- d) One notched-bar impact bend test to clause 4.4.6.5 per sampling location at 0 °C or at 20 °C.
- e) Notched-bar impact bend tests for determination of an impact energy vs. temperature curve to clause 4.4.6.6 at one sampling location per heat and heat-treatment lot for pieces with heat-treatment weights greater than 150 kg. At least four test temperatures shall be used, of which one shall be 0 °C or 20 °C.

(3) The Sections 11.1 and 11.4 shall apply to the non-destructive tests and examinations.

(4) Each piece shall be subjected to a materials identification check.

(5) Each piece shall be subjected in the as-delivered condition to a visual inspection.

(6) A dimensional check of each piece shall be performed.

6.3.3 Marking

(1) Each piece shall be marked at least with the following information:

- a) manufacturer's symbol,
- b) steel grade,
- c) heat number,
- d) specimen number or test lot number,
- e) authorized inspector's mark.

(2) In the case of lotwise examination, the piece from which the specimens were taken shall additionally be marked.

6.3.4 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, materials identification check and non-destructive tests and examinations performed by the manufacturer, and if necessary of the hardness test shall be documented with an inspection certificate 3.1 to DIN EN 10204. The steel making process, the delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as

simulated stress-relief annealing temperature and holding time of test coupons, if any, shall be indicated in the inspection certificate 3.1.

(2) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

6.4 Seamless pipes larger than DN 50

6.4.1 Scope

(1) The stipulations of this Section shall apply to seamless, rolled or pressed pipes larger than DN 50.

Note:

For forged pipes Section 6.3 shall apply.

(2) The stipulations of this Section shall also apply to pipes equal to or smaller than DN 50 if pipe elbows larger than DN 50 are made from such pipes.

(3) The stipulations of this Section shall not apply to pipes for vessel shells.

6.4.2 Materials

(1) The following steel grades may be used:

- a) 15 MnNi 6 3 to Section A 3
- b) P235GH (1.0345) to DIN EN 10216-2,
- c) P275NL1 (1.0488) to DIN EN 10216-3 in conjunction with VdTÜV material sheet 352/2,
- d) P355NH (1.0565) to DIN EN 10216-3 in conjunction with VdTÜV material sheet 354/2,
- e) 16Mo3 (1.5415) to DIN EN 10216-2 and
- f) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

(2) The materials shall meet the requirements of clause 4.3.2.

(3) The selection of materials shall be based on the lowest operating temperature.

6.4.3 Additional requirements for the materials

Pipes with nominal wall thicknesses equal to or larger than 15 mm and subjected to loading perpendicular to the rolled surface shall at least meet the requirements of quality class Z25 to DIN EN 10164. This shall be specified in the purchase order.

6.4.4 Tests and examinations

6.4.4.1 Sampling and specimen preparation

Specimens shall be taken in accordance with the DIN standards and VdTÜV material sheets referred to in 6.4.2 and in the case of steel grade 15 MnNi 6 3 in accordance with Section 5.4.4.

6.4.4.2 Extent of tests and examinations

(1) The following procedures shall be performed for the chemical analysis:

- a) One ladle analysis per heat.
- b) One product analysis on each of two manufacturing lengths per heat.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) Room-temperature tensile tests in compliance with the requirements for test category 2 in the DIN standards referred to in 6.4.2, but in the case of steel grade 15 MnNi 6 3 one room-temperature tensile test for every 50 manufacturing lengths of the same heat, dimension and heat treatment at one end of one manufacturing length.
- b) One tensile test at 300 °C per heat, dimension and heat treatment, if the design temperature is higher than 100 °C.
- c) Room-temperature tensile tests to DIN EN 10164 per tensile test specimen to a) on perpendicular specimens in order to determine the reduction of area at fracture for pipes with nominal wall thicknesses equal to or larger than 15 mm, whenever the quality class Z25 is required acc. to clause 6.4.3. This test may be waived for steel grades for which it was demonstrated in the material appraisal that the mean value of reduction of area at fracture is at least 35 % and that none of the individual values is smaller than 25 %.

d) One notched-bar impact bend test to clause 4.4.6.5 at 0 °C or 20 °C

da) per tensile test specimen to a) for pipes of normalized or air quenched and tempered steels with nominal wall thicknesses equal to or larger than 10 mm up to and including 38 mm,

db) at one end of each manufacturing length for pipes of normalized or air quenched and tempered steels with nominal wall thicknesses exceeding 38 mm,

dc) per tensile test specimen to a) for pipes of liquid quenched and tempered steels at both ends of one manufacturing length in the case of nominal wall thicknesses equal to or larger than 10 mm up to and including 16 mm and at both ends of each manufacturing length for pipes exceeding 16 mm.

For pipes of steel grade 15 MnNi 6 3, the test temperature shall be 0 °C.

e) Notched-bar impact bend tests for determination of the impact energy vs. temperature curve to clause 4.4.6.6 at one end of one manufacturing length per heat, dimension and heat treatment for pipes with nominal wall thicknesses exceeding 16 mm. At least four test temperatures shall be used, of which one shall be 0 °C or 20 °C. This test may be waived for pipes of steel grade 15 MnNi 6 3.

f) Technological tests for pipes with nominal wall thicknesses equal to or smaller than 40 mm per tensile test specimen to a) using test methods in compliance with the DIN standards referred to in 6.4.2. In the case of pipes made of steel grade 15 MnNi 6 3 at both ends of each manufacturing length using test methods to **Table 5.4-1**.

(4) The Sections 11.1 and 11.5.2 shall apply to the non-destructive tests and examinations.

(5) Each pipe shall be subjected to a materials identification check.

(6) The inside and outside surfaces of each pipe shall be subjected to a visual inspection.

(7) The diameter and wall thickness shall be checked for dimensional accuracy at both ends of each pipe.

(8) Each pipe shall be examined for leak tightness to DIN EN 10216-2 or DIN EN 10216-3.

6.4.5 Marking

(1) Each pipe shall be marked at both ends at least with the following information:

- a) manufacturer's symbol,



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- b) steel grade and number of the DIN standard, for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164,
- c) heat number,
- d) pipe number,
- e) test category and
- f) authorized inspector's mark.

6.4.6 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, materials identification check, tightness test and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The steel making process, the delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons, if any, shall be indicated in the inspection certificate 3.1.

(2) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

6.5 Seamless pipe elbows larger than DN 50

6.5.1 Scope

(1) This Section shall apply to seamless pipe elbows (weld-in elbows) made by cold or hot forming followed by heat treatment (normalization; quenching and tempering).

(2) This Section shall not apply to pipe bends made with inductive bending machines or by cold forming with or without subsequent heat treatment. These pipe bends shall be subject to the requirements of KTA 3211.3 Section 6.

6.5.2 Materials

(1) The Sections 6.3.1 and 6.4.2 apply to the materials.

(2) For finished pipe elbows, the values of the mechanical and technological characteristics for pipes shall apply even if forged hollow parts are used as starting products.

6.5.3 Starting products

(1) Forged hollow parts to Section 6.3 or seamless pipes to Section 6.4 shall basically be used as starting products.

(2) Starting products that have not been completely examined and heat-treated per the stipulations in Sections 6.3 or 6.4 may also be used, provided

- a) the finished pipe elbows are examined individually per clause 6.5.4.2 and
- b) the non-destructive tests and examinations of the starting products have been carried out according to the requirements in Section 11.4 or Section 11.5.1 prior to forming.

In this case, the determination of mechanical and technological characteristics and the corresponding verification may be waived for the starting products. An inspection certificate 3.1 to DIN EN 10204 shall then be adequate for visual inspection and dimensional check of the starting products.

6.5.4 Tests and examinations of pipe elbows

6.5.4.1 Sampling and specimen preparation

(1) Specimens shall be taken from the ends of the pipe elbows in conformity with the authorized inspector's appraisal.

(2) Transverse specimens shall be tested in the tensile tests and notched-bar impact bend tests, provided that they can be taken from unstraightened test coupons. If this is not possible, longitudinal specimens shall be tested.

(3) If starting products that have not been completely examined and heat-treated to the stipulations in Sections 6.3 or 6.4 are used, test coupons shall be taken from both ends of pipe elbows with a chord length greater than 3000 mm, measured along the outside of the bend.

(4) In all other cases, test coupons shall be taken from only one end of the pipe elbow.

(5) If the pipe elbows are not tested individually, test units consisting of pipe elbows of the same heat, dimension and heat treatment shall be formed for determination of mechanical and technological characteristics.

(6) For the room-temperature tensile tests and for the notched-bar impact bend tests, the number of pipe elbows per test unit shall not exceed:

- a) 50 pieces for pipe elbows smaller than DN 200
- b) 25 pieces for pipe elbows equal to or larger than DN 200 and smaller than DN 350
- c) 10 pieces for pipe elbows equal to or larger than DN 350.

6.5.4.2 Extent of tests and examinations

(1) The chemical composition shall be verified on the basis of the starting product.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) One room-temperature tensile test on one pipe elbow per test unit.
- b) One tensile test at 300 °C on one pipe elbow per heat, dimension and heat treatment, if the design temperature is higher than 100 °C.
- c) One notched-bar impact bend test to clause 4.4.6.5 at 0 °C or at 20 °C on one pipe elbow per test unit for pipe elbows with nominal wall thicknesses equal to or larger than 10 mm. For pipe elbows of steel grade 15 MnNi 6 3, the test temperature shall be 0 °C.
- d) Notched-bar impact bend tests for determination of the impact energy vs. temperature curve to clause 4.4.6.6 on one pipe elbow per heat, dimension and heat treatment for pipe elbows with nominal wall thicknesses exceeding 16 mm. At least four test temperatures shall be used, of which one shall be 0 °C or 20 °C. This test may be waived for pipe elbows of steel grade 15 MnNi 6 3.
- e) For pipe elbows grouped together as test units, one hardness test per pipe elbow to verify uniformity.

Note:

Verification of uniformity shall be acknowledged if the difference between the highest and lowest hardness values in a test unit does not exceed 30 HB units.

(3) The Sections 11.1 and 11.6.2 shall apply to the non-destructive tests and examinations.

(4) Each pipe elbow shall be subjected to a materials identification check.

(5) The inside and outside surfaces of each pipe elbow shall be subjected to a visual inspection.

(6) For each pipe elbow, the wall thickness and, depending on the purchase order, either the outside or inside diameter shall be measured over the arc length, including the ends, and to a sufficient extent over the circumference. The smallest wall thickness as well as the ovality shall be determined.

6.5.5 Marking

(1) Each pipe elbow shall be marked at least with the following information:

- manufacturer's symbol,
- steel grade (for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164),
- heat number,
- elbow number,
- authorized inspector's mark.

6.5.6 Verification of quality characteristics

(1) The results of the materials identification check and non-destructive tests and examinations performed by the manufacturer as well as the hardness test, if any, shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons, if any, shall be indicated in the inspection certificate 3.1.

(2) The forming process used shall be indicated in the inspection certificate 3.1 to DIN EN 10204.

(3) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

(4) The inspection certificate of the starting product shall be attached to the inspection certificate 3.2.

6.6 Seamless fittings larger than DN 50

Note:

The nominal diameter of a reducer or of a tee shall refer to the end with the larger diameter.

6.6.1 Scope

(1) This Section shall apply to the following seamless fittings:

- reducers made by cold or hot forming,
- tees fabricated to the liqued bulge method followed by heat treatment (normalization; quenching and tempering).

6.6.2 Materials

(1) The Sections 6.3.1 and 6.4.2 apply to the materials.

(2) For fabricated fittings, the values of the mechanical and technological characteristics for pipes shall apply even if forged hollow parts are used as starting products.

6.6.3 Starting products

(1) Forged hollow parts to Section 6.3 or seamless pipes to Section 6.4 shall basically be used as starting products.

(2) Starting products that have not been completely examined or heat-treated to the stipulations in Sections 6.3 or 6.4 may also be used, provided

- the finished fittings are examined individually per clause 6.6.4.2 and
- the non-destructive tests and examinations of the starting products have been carried out according to the requirements in Section 11.4 or Section 11.5.2 prior to forming.

In this case the determination of mechanical and technological characteristics and the corresponding verification may be waived for the starting products. An inspection certificate 3.1 to DIN EN 10204 shall then be adequate for visual inspection and dimensional check of the starting products.

6.6.4 Tests and examinations of fittings

6.6.4.1 Sampling and specimen preparation

(1) Specimens shall be taken from the ends of the fittings in conformity with the authorized inspector's appraisal.

(2) Transverse specimens shall be tested in the tensile tests and notched-bar impact bend tests, provided that they can be taken from unstraightened test coupons. If this is not possible, longitudinal specimens shall be tested.

(3) If the fittings are not tested individually, test units consisting of fittings of the same heat, dimension and heat treatment shall be formed for determination of mechanical and technological characteristics.

(4) For the room-temperature tensile tests and for the notched-bar impact bend tests, the number of fittings per test unit shall not exceed:

- at most 50 pieces for fittings with nominal diameters smaller than 100,
- at most 25 pieces for fittings of unalloyed steels with nominal diameters equal to or larger than 100, or at most 10 pieces for such fittings of alloyed steels.

6.6.4.2 Extent of tests and examinations

(1) The chemical composition shall be verified on the basis of the starting product.

(2) The mechanical and technological characteristics shall be determined by performing:

- One room-temperature tensile test per test unit.
- One tensile test at 300 °C per heat, dimension and heat treatment, if the design temperature is higher than 100 °C.
- One notched-bar impact bend test to clause 4.4.6.5 at 0 °C or at 20 °C on one piece per test unit for fittings with nominal wall thicknesses equal to or larger than 10 mm. For fittings of steel grade 15 MnNi 6 3 the test temperature shall be 0 °C.
- Notched-bar impact bend tests for determination of the impact energy vs. temperature curve to clause 4.4.6.6 on one piece per heat, dimension and heat treatment for fittings with nominal wall thicknesses exceeding 16 mm. At least four test temperatures shall be used, of which one shall be 0 °C or 20 °C. This test may be waived for pipe elbows of steel grade 15 MnNi 6 3.
- For fittings grouped together as test units, one hardness test on each fitting to verify uniformity.

Note:

Verification of uniformity shall be acknowledged if the difference between the highest and lowest hardness values in a test unit does not exceed 30 HB units.

(3) The Sections 11.1 and 11.7.2 shall apply to the non-destructive tests and examinations.



- (4) Each fitting shall be subjected to a materials identification check.
- (5) The inside and outside surfaces of each fitting shall be subjected to a visual inspection.
- (6) For each fitting, the ovality, diameter and thickness shall be measured at the ends.

6.6.5 Marking

- (1) Each fitting shall be marked at least with the following information:
 - a) manufacturer's symbol,
 - b) steel grade (for steels with guaranteed reduction of area at fracture perpendicular to the product surface additionally quality class to DIN EN 10164),
 - c) heat number,
 - d) fitting number or test lot number,
 - e) authorized inspector's mark.

6.6.6 Verification of quality characteristics

- (1) The results of the materials identification check and non-destructive tests and examinations performed by the manufacturer as well as the hardness test, if any, shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons, if any, shall be indicated in the inspection certificate 3.1.
- (2) The forming process used shall be indicated in the inspection certificate 3.1 to DIN EN 10204.
- (3) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.
- (4) The inspection certificate of the starting product shall be attached to the inspection certificate 3.2.

6.7 Castings

6.7.1 Materials

- (1) The following cast-steel grades may be used:
 - a) GP240GH+QT (1.0619+QT) to DIN EN 10213,
 - b) other cast-steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.
- (2) The materials shall meet the requirements of clause 4.3.2.
- (3) The selection of materials shall be based on the lowest operating temperature.

6.7.2 General requirements for casting finish

- (1) As regards their general internal and external finish, the castings shall satisfy the stipulations of **Table 11-6** applicable to their test group.
- (2) Feeder heads and large casting-related thickenings that impair amenability of castings to heat treatment shall be eliminated before the heat treatment for establishment of the mechanical and technological characteristics.

- (3) The casting technique shall be designed according to the principles of controlled solidification. For castings with nominal widths equal to or larger than 200 mm, the gate and feeder technique shall be explained on the basis of the saturation calculation as well as drawings illustrating the position of the feeders, feed zones and specimen location.

- (4) For each casting model, the description of the casting technique shall be attached to the interim file (internal manufacturer documentation) for retention by the manufacturer.

Note:

The feature characterizing the dimensions of the body or case shall be the nominal width, as follows:

- a) for pumps, the nominal width of the pressure nozzle,
- b) for valves, the largest nominal width involved,
- c) for safety valves, the nominal width of the inlet nozzle.

- (5) Together with the drawing of the casting in the as-delivered condition, the following documents shall generally be submitted as standard plans for the design approval:

- a) test and inspection sequence plan and heat-treatment plan, in case of differences from the standard production scheme to **Figure 5.7-1**,
- b) for prototypes of test groups A 2 and A 3 with nominal widths equal to or greater than 200 mm a film location plan and a radiation source plan,
- c) welding procedure qualification and welding procedure sheet for production welds and if applicable construction welds (see **Annex B**),
- d) test and inspection sequence plan for construction welds, if necessary.
- e) list of planned production control tests.

- (6) If changes are made compared with the conditions stipulated in the welding procedure sheet, or if a different welding method is chosen, the welding procedure sheet shall be amended accordingly and resubmitted for design approval.

6.7.3 Tests and examinations

6.7.3.1 Sampling and specimen preparation

- (1) Castings with a delivery weight equal to or lighter than 500 kg shall be tested in lots, and castings with a delivery weight heavier than 500 kg shall be tested individually. The number of sampling locations shall be as indicated in **Table 5.7-1**.

- (2) The specimens shall be taken from cast-on test blocks to DIN EN 1559-2 or from overlenghts. Separately cast test blocks are permitted only for castings with piece weights equal to or lighter than 50 kg. The test blocks shall be provided in sufficient number and size that the prescribed specimens can be taken.

- (3) The thickness of the cast-on test blocks shall correspond to the governing wall thickness. In this connection, the governing wall thickness shall be the thickness of the wall subjected to pressure loading, and not the thickness of cast-on flanges or local thickenings.

- (4) Cast-on test blocks at the gate system are not permitted.

- (5) For castings with piece weights heavier than 1000 kg, the position of the cast-on test blocks on the casting shall be documented by a photograph or in a sketch.

6.7.3.2 Extent of tests and examinations

- (1) The following procedures shall be performed for the chemical analysis:

- a) One ladle analysis per heat.
- b) One product analysis for one sampling location per test unit.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) One room-temperature tensile test per sampling location. The value of reduction of area at fracture shall also be determined for information.
- b) One tensile test at 350 °C per heat, dimension and heat-treatment lot, if the design temperature is higher than 100 °C.
- c) One notched-bar impact bend test to clause 4.4.6.5 per sampling location at 0 °C or at 20 °C.
- d) One hardness test on each piece to verify uniformity of the quenching and tempering treatment in the case of lotwise examination of castings of quenched and tempered steel.

(3) The Sections 11.1 and 11.8 shall apply to the non-destructive tests and examinations.

(4) Each casting shall be subjected to a materials identification check.

(5) Each casting shall be subjected in the as-delivered condition to a visual inspection.

(6) Each casting shall be subjected in the as-delivered condition to a dimensional check.

(7) Each casting shall be subjected in a condition suitable for the purpose, generally by the further processor, to a tightness test in the form of an internal pressure test, which shall be performed to DIN 50104. Pressurizing fluid, test pressure and pressure-loading duration shall be indicated in the purchase order. The test pressure has to be limited to ensure that a safety margin against the yield point or 0.2 % proof stress at room temperature of at least 1.1 is achieved.

6.7.4 Marking

(1) Each casting shall be marked at least with the following information:

- a) manufacturer's symbol,
- b) cast-steel grade,
- c) heat number,
- d) specimen number and
- e) authorized inspector's mark.

6.7.5 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, materials identification check and non-destructive tests and examinations performed by the manufacturer as well as of the hardness test, if any, shall be certified with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions as well as simulated stress-relief annealing temperature and holding time of test coupons, if any, shall be indicated in the inspection certificate 3.1.

(2) The results of mechanical and technological tests, visual inspection, dimensional check, tightness test and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer. For castings with piece weights heavier than 1000 kg, a photograph or a sketch of the location of the cast-on test blocks on the casting shall be attached to the inspection certificate.

7 Product forms of austenitic steels

7.1 Flat products

7.1.1 Materials

(1) The following steel grades may be used:

- a) X6CrNiNb18-10 (1.4550) to DIN EN 10028-7,
- b) X6CrNiTi18-10 (1.4541) to DIN EN 10028-7,
- c) X6CrNiMoTi17-12-2 (1.4571) to DIN EN 10028-7,
- d) X6CrNiMoNb17-12-2 (1.4580) to DIN EN 10028-7 and
- e) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

(2) The materials shall meet the requirements of clause 4.3.3.

(3) For hot (operating temperature $T \geq 200$ °C during continuous operation) reactor water containing product form and components in BWR plants only the steel grade to clause (1) a), and only with the following additional requirements for the chemical composition shall be used:

$C \leq 0,03 \%$

$Si \leq 0,5 \%$

$P \leq 0,025 \%$

$S \leq 0,010 \%$

$18,0 \% \leq \% Cr \leq 19,0 \%$

$13 \cdot \% C \leq \% Nb \leq 0,65 \%$

$Co \leq 0,2 \%$

The inspection certificate shall show the nitrogen content.

7.1.2 Additional requirements for the materials

The surfaces shall be free of ferritic impurities which are relevant for the corrosion resistance of the product form. Scale layers from hot forming or heat treatment shall be removed. Tempering colours from hot forming or heat treatment shall be avoided by taking appropriate measures. Decision on the permissibility of tempering colours up to and including "yellow" shall be made in each individual case.

7.1.3 Tests and examinations

7.1.3.1 Sampling and specimen preparation

(1) Room-temperature tensile tests shall be performed using

- a) for flat products with nominal thicknesses equal to or smaller than 30 mm, flat tensile-test specimens containing both rolled surfaces,
- b) for flat products with nominal thicknesses exceeding 30 mm and equal to or smaller than 75 mm, flat tensile-test specimens at least 30 mm thick, containing at least one intact rolled surface.

(2) Elevated-temperature tensile tests shall be performed using,

- a) for flat products with nominal thicknesses equal to or smaller than 12 mm, flat tensile-test or round tensile-test specimens,
- b) for flat products with nominal thicknesses exceeding 12 mm, round tensile-test specimens.

(3) The notched-bar impact bend test shall be subject to the following requirements:

- a) For flat products with nominal thicknesses smaller than or equal to 30 mm, specimens shall be taken from 2 mm under the rolled surface.
- b) For flat products with nominal thicknesses exceeding 30 mm and equal to or smaller than 75 mm, specimens shall be taken from 1/4 of the flat product thickness under the rolled surface.

(4) The sampling depth for flat products with nominal thicknesses exceeding 75 mm shall be subject to the stipulations in the authorized inspector's appraisal.

(5) The specimens shall be taken as transverse specimens such that the specimens are located halfway between long edges and centerline of the flat products.

(6) The number of sampling locations shall be as required in DIN EN 10028-7.

7.1.3.2 Extent of tests and examinations

(1) The following procedures shall be performed for the chemical analysis:

- a) One ladle analysis per heat.
- b) One product analysis on one sampling location of one flat product per heat. The nitrogen content shall be documented.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) One room-temperature tensile test per sampling location.
- b) One tensile test at 350 °C per heat, dimensional range and heat-treatment lot, if the design temperature in test group A 1 is higher than 200 °C and in test groups A 2 and A 3 is higher than 300 °C.
- c) One room-temperature notched-bar impact bend test to clause 4.4.6.5 per sampling location for flat products with nominal thicknesses exceeding 16 mm.

(3) One test for resistance to intergranular corrosion to DIN EN ISO 3651-2 with prior annealing (1/2 h at 650 °C) shall be performed per heat, dimensional range and heat-treatment lot.

(4) One bead-on-plate test to determine the delta ferrite content to **Annex C** shall be performed per heat, if values smaller than 3 are found in calculation of the ferrite number from the chemical composition in the ladle analysis.

(5) Each flat product shall be subjected to a materials identification check.

(6) Each flat product shall be subjected to a visual inspection.

(7) The dimensional and shape accuracy of each flat product shall be measured.

(8) The Sections 11.1 and 11.2 as well as the Sections 11.1 and 11.4 in the case of flat products for tube sheets shall apply to the non-destructive tests and examinations.

7.1.4 Marking

(1) Each flat product shall be marked at least with the following information:

- a) manufacturer's symbol,
- b) steel grade,
- c) heat number,
- d) specimen number,
- e) authorized inspector's mark.

(2) The marking shall be applied transverse to the rolling direction. For flat products cut from strip, roller stamping in the longitudinal direction is also permitted.

7.1.5 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, test for resistance to intergranular corrosion, determination of the delta ferrite content, materials identification check and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The steel making process and the delivery condition of the product form stating heat treatment tempera-

tures, holding times and cooling conditions shall be indicated in the inspection certificate 3.1.

(2) For flat products of test groups A 1 and A 2, the results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer. For flat products of test group A 3, the stipulations shall be the same as for steels for conventional pressure vessel plants subject to supervision to AD 2000-Merkblatt W 2.

7.2 Dished or pressed product forms made from flat products

7.2.1 Materials

The materials shall meet the requirements of clause 7.1.1.

7.2.2 Additional requirements for the materials

The requirements of clause 7.1.2 shall apply.

7.2.3 Tests and examinations of the starting products

(1) Starting products shall be subject to the stipulations in Section 7.1.

(2) If the finished parts are tested individually to clause 7.2.4.2, the tests to clause 7.1.3.2 (2) as well as the corresponding verifications shall not be required.

Note:

The stipulations of KTA 3211.3 shall apply to welded joints made with the starting products and remaining in the finished parts.

7.2.4 Tests and examinations of dished or pressed product forms made from flat products

7.2.4.1 Sampling and specimen preparation

(1) For product forms with a diameter or length smaller than or equal to 500 mm and a wall thickness smaller than or equal to 16 mm, the mechanical tests shall be performed on one part per heat, thickness range and heat-treatment lot. The maximum permissible lot size shall be 20 parts, but the lot weight shall not exceed 500 kg.

(2) For product forms with a diameter or length greater than 500 mm or wall thickness greater than 16 mm, each part shall be tested individually, in which case

- a) for product forms with a diameter or length greater than 500 mm and equal to or smaller than 6000 mm or a wall thickness greater than 16 mm one test coupon shall be taken,
- b) for product forms with a diameter or length greater than 6000 mm one test coupon each from two opposite sides shall be taken.

(3) The test coupons shall be taken such that transverse specimens can be machined. Deviations up to 20 degrees from the theoretical transverse direction are permitted for heads (ends) and similar parts. In making the specimens, plastic deformation of the specimen in the zone of the gauge length shall be avoided. If applicable, a different type of sampling or procedure for making specimens shall be agreed with the authorized inspector.

(4) The stipulations of clause 7.1.3.1 and of DIN EN 10028-7 shall apply as relevant to sampling.



7.2.4.2 Extent of tests and examination

- (1) The mechanical and technological characteristics shall be determined by performing:
 - a) One room-temperature tensile test per sampling location.
 - b) One tensile test at 350 °C per heat, thickness range and heat-treatment lot, if the design temperature in test group A 1 is higher than 200 °C and in test groups A 2 and A 3 is higher than 300 °C.
 - c) One notched-bar impact bend test to clause 4.4.6.5 at room temperature per sampling location for product forms with nominal wall thicknesses larger than 16 mm.
- (2) One test for resistance to intergranular corrosion to DIN EN ISO 3651-2 with prior annealing (1/2 h at 650 °C) shall be performed per heat, dimensional range and heat-treatment lot.
- (3) One bead-on-plate test to determine the delta ferrite content to **Annex C** shall be performed per heat, if values smaller than 3 are found in calculation of the ferrite number from the chemical composition in the ladle analysis. This test may be replaced by a corresponding test of the starting products.
- (4) Each product form shall be subjected to a materials identification check.
- (5) Each product form shall be subjected to a visual inspection.
- (6) The dimensional and shape accuracy of each product form shall be measured.
- (7) The Sections 11.1 and 11.3 shall apply to the non-destructive tests and examinations.

7.2.5 Marking

- (1) Each product form shall be marked at least with the following information:
 - a) manufacturer's symbol,
 - b) steel grade,
 - c) heat number,
 - d) specimen number,
 - e) authorized inspector's mark.
- (2) In the case of lotwise examination, the product form from which the specimens were taken shall additionally be marked.
- (3) The marking shall be applied such that it appears upright when viewed in the main rolling direction of the rolled plate.

7.2.6 Verification of quality characteristics

- (1) The results of the test for resistance to intergranular corrosion, determination of the delta ferrite content, materials identification check and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions shall be indicated in the inspection certificate 3.1.
- (2) The forming method shall be indicated in the inspection certificate 3.1.
- (3) For product forms of test groups A 1 and A 2, the results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection

certificate 3.2 established by the manufacturer. For product forms of test group A 3, the stipulations shall be the same as for steels for conventional pressure vessel plants subject to supervision to AD 2000-Merkblatt W 2.

7.3 Forgings, bars and rolled rings

7.3.1 Materials

- (1) The following steel grades may be used:
 - a) X6CrNiNb18-10 (1.4550) to DIN EN 10222-5 or DIN EN 10272,
 - b) X6CrNiTi18-10 (1.4541) to DIN EN 10222-5 or DIN EN 10272,
 - c) X6CrNiMoTi17-12-2 (1.4571) to DIN EN 10222-5 or DIN EN 10272,
 - d) X6CrNiMoNb17-12-2 (1.4580) to DIN EN 10272 and
 - e) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

- (2) The materials shall meet the requirements of clause 4.3.3.

(3) For hot (operating temperature $T \geq 200$ °C during continuous operation) reactor water containing product form and components in BWR plants only the steel grade to clause (1) a), and only with the following additional requirements for the chemical composition shall be used:

$C \leq 0,03$ %

$Si \leq 0,5$ %

$P \leq 0,025$ %

$S \leq 0,010$ %

$18,0 \leq (\% Cr) \leq 19,0$

$13 \times (\% C) \leq (\% Nb) \leq 0,65$

$Co \leq 0,2$ %

The inspection certificate shall show the nitrogen content.

7.3.2 Additional requirements for the materials

The surfaces shall be free of ferritic impurities which are relevant for the corrosion resistance of the product form. Scale layers from hot forming or heat treatment shall be removed. Tempering colours from hot forming or heat treatment shall be avoided by taking appropriate measures. Decision on the permissibility of tempering colours up to and including "yellow" shall be made in each individual case.

7.3.3 Tests and examinations

7.3.3.1 Test units

- (1) Pieces from the same heat, with similar dimensions and from the same heat-treatment lot shall be grouped as test units weighing at most 500 kg.
- (2) Pieces with heat-treatment weights heavier than 500 kg or governing dimensions exceeding 250 mm shall be tested individually.

7.3.3.2 Sampling for forgings and rings

7.3.3.2.1 Sampling location

Specimens shall be taken from one end face of the pieces. For heat treatment weights exceeding 2500 kg specimens shall be taken from both ends of the forging. At diameters exceeding 1000 mm the specimens shall be taken offset by 180 degrees. Unless otherwise stipulated, specimens shall be taken from one piece per test unit.



7.3.3.2.2 Sampling depth

- (1) The requirements of the DIN standards applicable for the respective product form shall apply.
- (2) If the exact sampling location cannot be given in advance for any pieces, it shall be specified by agreement with the authorized inspector.

7.3.3.2.3 Specimen direction

- (1) Specimens shall be taken transverse to the main forming direction.
- (2) Longitudinal specimens are permitted in the following cases: tensile-test specimens for pieces with a cross-sectional area corresponding to solid parts with a diameter smaller than 160 mm; and notched-bar impact-test specimens for pieces with a cross-sectional area corresponding to solid parts with a diameter smaller than 100 mm.

7.3.3.3 Sampling for bars**7.3.3.3.1 Sampling location**

- (1) Specimens shall be taken from one end of the bars.
- (2) Unless otherwise stipulated, specimens shall be taken from one piece per test unit.

7.3.3.3.2 Sampling depth

- (1) For bars with a diameter or heat-treatment thickness smaller than or equal to 25 mm, specimens shall be taken from the core of the bars.
- (2) For bars with a diameter or heat-treatment thickness larger than 25 mm and smaller than or equal to 160 mm, specimens shall be taken at least 12.5 mm under the surface.
- (3) The sampling depths for bars with larger diameter or larger heat-treatment thickness shall be determined by the stipulations in the authorized inspector's appraisal.
- (4) The distance of the sampling location from the end faces shall be at least 25 mm.

7.3.3.3.3 Specimen direction

Longitudinal specimens shall be taken for bars with a diameter or heat-treatment thickness smaller than or equal to 100 mm, and transverse specimens shall be taken for bars with a diameter or heat-treatment thickness larger than 100 mm.

7.3.3.4 Extent of tests and examinations

- (1) The following procedures shall be performed for the chemical analysis:
 - a) One ladle analysis per heat.
 - b) One product analysis per heat. The nitrogen content shall be documented.
- (2) The mechanical and technological characteristics shall be determined by performing:
 - a) One room-temperature tensile test per sampling location.
 - b) One tensile test at 350 °C per heat, similar dimension and heat-treatment lot, if the design temperature in test group A 1 is higher than 200 °C and in test groups A 2 and A 3 is higher than 300 °C.
 - c) One notched-bar impact bend test to clause 4.4.6.5 at room temperature per sampling location.
- (3) One test for resistance to intergranular corrosion to DIN EN ISO 3651-2 with prior annealing (1/2 h at 650 °C) shall be performed per heat, similar dimension and heat-treatment lot.

(4) One bead-on-plate test to determine the delta ferrite content shall be performed per heat, if values of ferrite number smaller than 3 are calculated by the procedure of **Annex C** from the chemical composition in the ladle analysis.

(5) The Sections 11.1 and 11.4 shall apply to the non-destructive tests and examinations.

(6) Each piece shall be subjected to a materials identification check.

(7) Each piece shall be subjected to a visual inspection.

(8) A dimensional check shall be performed for each piece.

7.3.4 Marking

(1) Each piece shall be marked durably at least with the following information:

- a) manufacturer's symbol,
- b) steel grade,
- c) heat number,
- d) specimen number,
- e) authorized inspector's mark.

(2) In the case of lotwise examination, the piece from which the specimens were taken shall additionally be marked.

7.3.5 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, test for resistance to intergranular corrosion, determination of the delta ferrite content, materials identification check and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions shall be indicated in the inspection certificate 3.1.

(2) For pieces of test groups A 1 and A 2, the results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer. For pieces of test group A 3, the stipulations shall be the same as for steels for conventional pressure vessel plants subject to supervision to AD 2000-Merkblatt W 2

7.4 Seamless pipes larger than DN 50**7.4.1 Scope**

(1) The stipulations of this Section shall apply to seamless, rolled or pressed pipes larger than DN 50.

Note:

For forged pipes Section 7.3 shall apply.

(2) The stipulations of this Section shall also apply to pipes equal to or smaller than DN 50 if pipe elbows larger than DN 50 are made from such pipes.

7.4.2 Materials

(1) The following steel grades may be used:

- a) X6CrNiNb18-10 (1.4550) to DIN EN 10216-5,
- b) X6CrNiTi18-10 (1.4541) to DIN EN 10216-5,
- c) X6CrNiMoTi17-12-2 (1.4571) to DIN EN 10216-5,
- d) X6CrNiMoNb17-12-2 (1.4580) to DIN EN 10216-5 and
- e) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.

(2) The materials shall meet the requirements of clause 4.3.3.

(3) For hot (operating temperature $T \geq 200$ °C during continuous operation) reactor water containing product form and components in BWR plants only the steel grade to clause (1) a), and only with the following additional requirements for the chemical composition shall be used:

$C \leq 0,03$ %

$Si \leq 0,5$ %

$P \leq 0,025$ %

$S \leq 0,010$ %

$18,0 \leq (\% Cr) \leq 19,0$

$13 \times (\% C) \leq (\% Nb) \leq 0,65$

$Co \leq 0,2$ %

The inspection certificate shall show the nitrogen content.

7.4.3 Additional requirements for the materials

The surfaces shall be free of ferritic impurities which are relevant for the corrosion resistance of the product form. Scale layers from hot forming or heat treatment shall be removed. Tempering colours from hot forming or heat treatment shall be avoided by taking appropriate measures. Decision on the permissibility of tempering colours up to and including "yellow" shall be made in each individual case.

7.4.4 Testing and examinations

7.4.4.1 Sampling and specimen preparation

Specimens shall be taken in compliance with the requirements in DIN EN 1026-5. The distance between pipe end and sampling location of tensile and notched-bar impact bend test specimens shall be at least equal to the nominal wall thickness but shall not exceed 25 mm.

7.4.4.2 Extent of tests and examinations

(1) The following procedures shall be performed for the chemical analysis:

- One ladle analysis per heat.
- One product analysis per heat. The nitrogen content shall be documented.

(2) The mechanical and technological characteristics shall be determined by performing:

- Room-temperature tensile tests in compliance with the requirements for test category 2 in DIN EN 10216-5.
- One tensile test at 350 °C per heat, dimensional range and heat-treatment lot, if the design temperature for pipes of test group A 1 is higher than 200 °C and for pipes of test groups A 2 and A 3 is higher than 300 °C.
- One room-temperature notched-bar impact bend test to clause 4.4.6.5 per tensile test specimen to a) for pipes with nominal wall thicknesses exceeding 16 mm.
- For pipes with wall thicknesses smaller than or equal to 40 mm, technological tests in compliance with the requirements in DIN EN 1026-5.

(3) One test for resistance to intergranular corrosion to DIN EN ISO 3651-2 with prior annealing (1/2 h at 650 °C) shall be performed per heat, dimension and heat-treatment lot.

(4) One bead-on-plate test to determine the delta ferrite content shall be performed per heat, if the calculation to **Annex C** yields values of ferrite number smaller than 3 from the chemical composition in the ladle analysis.

(5) Each pipe shall be subjected to a materials identification check.

(6) The inside and outside surfaces of each pipe shall be subjected to a visual inspection.

(7) The dimensional and shape accuracy of each pipe shall be measured at both ends.

(8) The Sections 11.1 and 11.5.3 shall apply to the non-destructive tests and examinations.

(9) Each pipe shall be examined for leak tightness to DIN EN 10216-5.

7.4.5 Marking

(1) Each pipe shall be marked durably at least with the following information at one end:

- manufacturer's symbol,
- dimensions of the pipe,
- steel grade and number of the DIN standard,
- heat number,
- test category,
- mark of the delivery condition,
- pipe number,
- authorized inspector's mark.

7.4.6 Verification of quality characteristics

(1) The results of the ladle analysis, product analysis, test for resistance to intergranular corrosion, determination of the delta ferrite content, materials identification check, tightness test and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The steel making process and the delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions shall be indicated in the inspection certificate 3.1.

(2) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.

(3) For pipes of test group A 3 and wall thicknesses smaller than or equal to 5.6 mm, an inspection certificate 3.1 to DIN EN 10204 will suffice.

7.5 Seamless pipe elbows larger than DN 50

7.5.1 Scope

(1) This Section shall apply to seamless pipe elbows (weld-in elbows) made by cold or hot forming followed by heat treatment (solution annealing and quenching).

(2) This Section shall not apply to pipe bends made with inductive bending machines or by cold forming with or without subsequent heat treatment. These pipe bends shall be subject to the requirements of KTA 3211.3 Section 6.

7.5.2 Materials

(1) The materials shall meet the requirements of clauses 7.3.1 and 7.4.2.

(2) For finished pipe elbows, the values of the mechanical and technological characteristics for pipes shall apply even if forged hollow parts are used as starting product.

7.5.3 Additional requirements for the materials

The requirements of clauses 7.3.2 and 7.4.3 shall apply.

7.5.4 Starting products

- (1) Forged hollow parts to Section 7.3 or seamless pipes to Section 7.4 shall basically be used as starting products.
- (2) Starting products that have not been completely examined per the stipulations in Sections 7.3 or 7.4 may also be used, provided
 - a) the finished pipe elbows are examined individually per clause 7.5.5.2 and
 - b) the non-destructive tests and examinations of the starting products have been carried out according to the requirements in Section 11.4 or Section 11.5.3 prior to forming.
- (3) If the finished pipe elbows are examined individually to clause 7.5.5.2, the determination of mechanical and technological characteristics and the corresponding verification may be waived for the starting products. An inspection certificate 3.1 to DIN EN 10204 shall then be adequate for visual inspection and dimensional check of the starting products.

7.5.5 Tests and examinations of pipe elbows

7.5.5.1 Sampling and specimen preparation

- (1) Specimens shall be taken from the ends of the pipe elbows in conformity with the authorized inspector's appraisal.
- (2) The distance between pipe-elbow end and sampling location shall be at least equal to the nominal wall thickness but shall not exceed 25 mm. Deviations from the foregoing are permitted by agreement with the authorized inspector.
- (3) Transverse specimens shall be tested in the tensile tests and notched-bar impact bend tests, provided that they can be taken from unstraightened test coupons. If this is not possible, longitudinal specimens shall be tested.
- (4) For pipe elbows with nominal wall thicknesses larger than or equal to 20 mm, specimens shall be taken from the middle of the pipe wall if at all possible.
- (5) If the pipe elbows are not tested individually, test units consisting of pipe elbows of the same heat, dimension and heat treatment shall be formed for determination of mechanical and technological characteristics.
- (6) For the room-temperature tensile tests and for the notched-bar impact bend tests, the number of pipe elbows per test unit shall not exceed:
 - a) 50 pieces for pipe elbows smaller than DN 200
 - b) 25 pieces for pipe elbows larger than or equal to DN 200 to smaller than DN 350
 - c) 10 pieces for pipe elbows larger than or equal to DN 350.

7.5.5.2 Extent of tests and examinations

- (1) The chemical composition shall be verified on the basis of the starting product.
- (2) The mechanical and technological characteristics shall be determined by performing:
 - a) One room-temperature tensile test on one pipe elbow per test unit or, in the case of individual testing, on each pipe elbow.
 - b) One tensile test at 350 °C on one pipe elbow per heat, dimension and heat-treatment lot, if the design temperature for pipe elbows of test group A 1 is higher than 200 °C and for pipe elbows of test groups A 2 and A 3 is higher than 300 °C.
 - c) One notched-bar impact bend test to clause 4.4.6.5 at room-temperature per test unit for wall thicknesses exceeding 16 mm.
- (3) One test for resistance to intergranular corrosion to DIN EN ISO 3651-2 with prior annealing (1/2 h at 650 °C) shall be performed per heat, dimension and heat-treatment lot.

- (4) One bead-on-plate test to determine the delta ferrite content to **Annex C** shall be performed per heat, if values smaller than 3 are found in calculation of the ferrite number from the chemical composition in the ladle analysis. This test may be replaced by a corresponding test on the starting product.
- (5) Each pipe elbow shall be subjected to a materials identification check.
- (6) The inside and outside surfaces of each pipe elbow shall be subjected to a visual inspection.
- (7) For each pipe elbow, the wall thickness and, depending on the purchase order, either the outside or inside diameter shall be measured over the arc length, including the ends, and to a sufficient extent over the circumference. The smallest wall thickness as well as the ovality shall be determined.
- (8) The Sections 11.1 and 11.6.3 shall apply to the non-destructive tests and examinations.

7.5.6 Marking

- (1) Each pipe elbow shall be marked at least with the following information:
 - a) manufacturer's symbol,
 - b) steel grade with abbreviation for the type of construction in compliance with the requirements in the DIN standard for the starting product,
 - c) heat number,
 - d) elbow number or test lot number and
 - e) authorized inspector's mark,
 - f) designation „X“ in the case of hot-finished elbows (of the Hamburg type) from the steel grades X6CrNiTi18-10 and X6CrNiMoTi18-10.

7.5.7 Verification of quality characteristics

- (1) The results of the test for resistance to intergranular corrosion, determination of the delta ferrite content, materials identification check and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions shall be indicated in the inspection certificate 3.1.
- (2) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.
- (3) The acceptance inspection certificate of the starting product shall be attached to the inspection certificate 3.2.
- (4) For pipe elbows of test group A 3 with wall thicknesses smaller than or equal to 5.6 mm, an inspection certificate 3.1 to DIN EN 10204 will suffice.

7.6 Seamless fittings larger than DN 50

Note:

The nominal diameter of a reducer or of a tee shall refer to the end with the larger diameter.

7.6.1 Scope

- (1) This Section shall apply to the following seamless fittings:
 - a) reducers made by cold or hot forming,
 - b) tees fabricated to the liqued bulge method followed by heat treatment (solution annealing and quenching).

7.6.2 Materials

- (1) The materials shall meet the requirements of clauses 7.3.1 and 7.4.2.
- (2) For the mechanical and technological characteristics of fabricated fittings, the values of the mechanical and technological characteristics for pipes shall apply even if forged hollow parts are used as starting products.

7.6.3 Additional requirements for the materials

The requirements of clauses 7.3.2 and 7.4.3 shall apply.

7.6.4 Starting products

- (1) Forged hollow parts to Section 7.3 or seamless pipes to Section 7.4 shall basically be used as starting products.
- (2) Starting products that have not been completely examined per the stipulations in Sections 7.3 or 7.4 may also be used, provided
 - a) the finished pipe elbows are examined individually per clause 7.6.5.2 and
 - b) the non-destructive tests and examinations of the starting products have been carried out according to the requirements in Section 11.4 or Section 11.5.3 prior to forming.
- (3) If the finished pipe elbows are examined individually to clause 7.6.5.2, the determination of mechanical and technological characteristics and the corresponding verification may be waived for the starting products. An inspection certificate 3.1 to DIN EN 10204 shall then be adequate for visual inspection and dimensional check of the starting products.

7.6.5 Tests and examinations of fittings

7.6.5.1 Sampling and specimen preparation

- (1) Specimens shall be taken from the ends of the fittings in conformity with the authorized inspector's appraisal.
- (2) The test coupons shall be located at one half of the wall thickness under the end face or as close as possible to that location.
- (3) Transverse specimens shall be tested in the tensile tests and notched-bar impact bend tests, provided that they can be taken from unstraightened test coupons. If this is not possible, longitudinal specimens shall be tested.
- (4) For fittings with nominal thicknesses larger than or equal to 20 mm, specimens shall be taken from the middle of the pipe wall if at all possible.
- (5) If the fittings are not tested individually, test units consisting of fittings of the same heat, dimension and heat-treatment lot shall be formed for determination of characteristics.
- (6) For the room-temperature tensile tests and for the notched-bar impact bend tests, the number of fittings per test unit shall not exceed:
 - a) 50 pieces for fittings smaller than DN 100
 - b) 10 pieces for fittings larger than or equal to DN 100

7.6.5.2 Extent of tests and examinations

- (1) The chemical composition shall be verified on the basis of the starting product.
- (2) The mechanical and technological characteristics shall be determined by performing:
 - a) One room-temperature tensile test per test unit.
 - b) One tensile test at 350 °C per heat, dimension and heat-treatment lot, if the design temperature for fittings of test

group A 1 is higher than 200 °C and for fittings of test groups A 2 and A 3 is higher than 300 °C.

- c) One notched-bar impact bend test to clause 4.4.6.5 at room-temperature per test unit for wall thicknesses exceeding 16 mm.
- (3) One test for resistance to intergranular corrosion to DIN EN ISO 3651-2 with prior annealing (1/2 h at 650 °C) shall be performed per heat, dimension and heat-treatment lot.
- (4) One bead-on-plate test to determine the delta ferrite content to **Annex C** shall be performed per heat, if values smaller than 3 are found in calculation of the ferrite number from the chemical composition in the ladle analysis. This test may be replaced by a corresponding test on the starting product.
- (5) Each fitting shall be subjected to a materials identification check.
- (6) The inside and outside surfaces of each fitting shall be subjected to a visual inspection.
- (7) For each fitting the ovality, diameter and wall thickness shall be measured at the ends.
- (8) The Sections 11.1 and 11.7.3 shall apply to the non-destructive tests and examinations.

7.6.6 Marking

- (1) Each fitting shall be marked at least with the following information:
 - a) manufacturer's symbol,
 - b) steel grade with abbreviation for the type of construction in compliance with the requirements in the DIN standard for the starting product,
 - c) heat number,
 - d) number of the fitting or test lot number,
 - e) authorized inspector's mark,
 - f) designation „X“ in the case of hot-finished fittings from the steel grades X6CrNiTi18-10 and X6CrNiMoTi18-10.

7.6.7 Verification of quality characteristics

- (1) The results of the test for resistance to intergranular corrosion, determination of the delta ferrite content, materials identification check and non-destructive tests and examinations performed by the manufacturer shall be documented with an inspection certificate 3.1 to DIN EN 10204. The delivery condition of the product form stating heat treatment temperatures, holding times and cooling conditions shall be indicated in the inspection certificate 3.1.
- (2) The results of mechanical and technological tests, visual inspection, dimensional check and non-destructive tests and examinations shall be confirmed by the authorized inspector and combined with inspection certificate 3.1 as inspection certificate 3.2 to DIN EN 10204 issued by him. Alternatively, these tests shall be confirmed by the authorized inspector on an inspection certificate 3.2 established by the manufacturer.
- (3) The inspection certificate of the starting product shall be attached to the inspection certificate 3.2.
- (4) For fittings of test group A 3 with wall thicknesses smaller than or equal to 5.6 mm, an inspection certificate 3.1 to DIN EN 10204 will suffice.

7.7 Castings

7.7.1 Materials

- (1) The following cast-steel grades may be used:
 - a) GX5CrNiNb19-11 (1.4552) to DIN EN 10213,

- b) GX5CrNiMoNb19-11-2 (1.4581) to DIN EN 10213 and
 - c) other steel grades meeting the prerequisites of Section 3 in combination with the stipulations in the authorized inspector's appraisal.
- (2) The materials shall meet the requirements of clause 4.3.3.

7.7.2 General requirements for casting condition

- (1) The base metal shall have a delta ferrite content corresponding to ferrite numbers of 2 to 12 to **Annex C**.
- (2) As regards their general internal and external finish, the castings shall satisfy the stipulations of **Table 11-6** applicable to their test group.
- (3) Feeder heads and large casting-related thickenings that impair the heat treatment of the casting shall be eliminated before the heat treatment for establishment of the mechanical and technological characteristics.
- (4) The casting technique shall be designed according to the principles of controlled solidification. For castings with nominal widths larger than or equal to 200 mm, the gate and feeder technique shall be explained on the basis of the saturation calculation as well as drawings illustrating the position of the feeders, feed zones and specimen location.
- (5) For each casting model, the description of the casting technique shall be attached to the interim file (internal manufacturer documentation) for retention by the manufacturer.

Note:

The feature characterizing the dimensions of the body or case shall be the nominal width, as follows:

- a) for pumps, the nominal width of the pressure nozzle,
 - b) for valves, the largest nominal width involved,
 - c) for safety valves, the nominal width of the inlet nozzle.
- (6) Together with the drawing of the casting in the as-delivered condition, the following documents shall generally be submitted as standard plans for the design approval:
- a) test and inspection sequence plan and heat-treatment plan, in case of differences from the standard production scheme to **Figure 5.7-1**.
 - b) for castings of test group A 1 with nominal widths equal to or larger than 200 mm, instructions for the non-destructive examinations as well as a coordinate reference system (reference-point grid).
 - c) for prototypes of test groups A 2 and A 3 with nominal widths greater than 200 mm a film location plan and a radiation source plan,
 - d) welding procedure qualification and welding procedure sheet for production welds and if applicable construction welds (see **Annex B**)
 - e) test and inspection sequence plan for construction welds, if necessary.
 - f) list of planned production control tests.
- (7) If changes are made compared with the conditions stipulated in the welding procedure sheet, or if a different welding method is chosen, the welding procedure sheet shall be re-submitted for design approval in this respect.

7.7.3 Tests and examinations

7.7.3.1 Sampling and specimen preparation

- (1) Castings with a delivery weight lighter than or equal to 500 kg shall be tested in lots, and castings with a delivery weight heavier than 500 kg shall be tested individually.
- (2) The number of sampling locations shall be as indicated in **Table 5.7-1**.

(3) The specimens shall be taken from cast-on test blocks to DIN EN 1559-2 or from overlenghts. Separately cast test blocks are permitted only for castings with piece weights equal to or lighter than 50 kg. The test blocks shall be provided in sufficient number and size that the prescribed specimens can be taken.

(4) The thickness of the cast-on test blocks shall correspond to the governing wall thickness. In this connection, the governing nominal wall thickness shall be the thickness of the wall subjected to pressure loading, and not the thickness of cast-on flanges or local thickenings.

(5) Cast-on test blocks at the gate system are not permitted.

(6) For castings with piece weights heavier than 1000 kg, the position of the cast-on test blocks on the casting shall be documented by a photograph or in a sketch.

7.7.3.2 Extent of tests and examinations

(1) The following procedures shall be performed for the chemical analysis:

- a) One ladle analysis per heat.
- b) One product analysis for one sampling location per test unit. The nitrogen content shall be documented.

(2) The mechanical and technological characteristics shall be determined by performing:

- a) One room-temperature tensile test per sampling location.
- b) One tensile test at 350 °C per heat, dimension and heat-treatment lot, if the design temperature for castings of test group A 1 is higher than 200 °C and for castings of test groups A 2 and A 3 is higher than 300 °C.
- c) One notched-bar impact bend test to clause 4.4.6.5 at room-temperature per sampling location.

(3) One test for resistance to intergranular corrosion to DIN EN ISO 3651-2 with prior annealing (1/2 h at 650 °C) shall be performed per heat, dimension and heat-treatment lot.

(4) The delta ferrite content shall be determined from the nitrogen content by the method of **Annex C**. If the value of the ferrite number calculated from the chemical composition per the ladle analysis is smaller than 3, the delta ferrite content shall be determined metallographically per heat.

(5) The Sections 11.1 and 11.8 shall apply to the non-destructive tests and examinations.

(6) Each casting shall be subjected to a materials identification check.

(7) Each casting shall be subjected in the as-delivered condition to a visual inspection.

(8) Each casting shall be subjected in the as-delivered condition to a dimensional check.

(9) Each casting shall be subjected in a condition suitable for the purpose, generally by the further processor, to a tightness test in the form of an internal pressure test, which shall be performed to DIN 50104. Pressurizing fluid, pressure level and pressure-loading duration shall be indicated in the purchase order. The test pressure has to be limited to ensure that a safety margin against the 0.2 % proof stress at room temperature of at least 1.1 is achieved.

7.7.4 Marking

(1) Each casting shall be marked at least with the following information:

- a) manufacturer's symbol,
- b) cast-steel grade,
- c) heat number,
- d) specimen number and
- e) authorized inspector's mark.

