SMS group

# Manufacturing instructions
## Blank parts and semi-finished products

**SN 200-2**

ICS 25.020

**IMPORTANT !**
**Please note the corresponding correction/revision !**

Supersedes SN 200-2:2016-05

This copy will not be updated in case of changes !

## Table of contents



## Introduction

The manufacturing requirements specified in this part of SN 200 are used to achieve the relevant SMS product quality. Consequently, these requirements must always be satisfied unless otherwise stipulated in drawings, purchase order documents, and/or other manufacturing documents. This standard is indicated as a binding document in drawings (title blocks), contracts and/or purchase order documents. If the requirements cannot be fulfilled, SMS group must be consulted.

## 1 Scope

This company standard specifies the requirements made on cast or forged blanks and the technical delivery conditions of semi-finished products used for the manufacture of SMS group products.





Edited by:
**SMS group**
**Standards Office**

## 2 Normative references

The following documents, quoted herein either in whole or in part, are required for the application of the present document. Dated references refer only to the edition of the date indicated. Undated references refer to the most recent edition of the respective document inclusive of all revisions.

| | |
|---|---|
| DIN EN 1369:2013-01 | Founding - Magnetic particle testing |
| DIN EN 1370:2012-03 | Founding - Examination of surface condition |
| DIN EN 1371-1:2012-02 | Founding - Liquid penetrant testing - Part 1: Sand, gravity die and low pressure die castings |
| DIN EN 1559-1 | Founding - Technical conditions of delivery - Part 1: General |
| DIN EN 1559-2 | Founding - Technical conditions of delivery - Part 2: Additional requirements for steel castings |
| DIN EN 1559-3 | Founding - Technical conditions of delivery - Part 3: Additional requirements for iron castings |
| DIN EN 10021 | General technical delivery conditions for steel products |
| DIN EN 10029:2011-02 | Hot-rolled steel plates 3 mm thick or above - Tolerances on dimensions and shape |
| DIN EN 10160:1999-09 | Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method) |
| DIN EN 10163-2:2005-03 | Delivery requirements for surface conditions of hot-rolled steel plates, wide flats and sections - Part 2: Plate and wide flats |
| DIN EN 10204:2005-01 | Metallische Erzeugnisse; Arten von Prüfbescheinigungen |
| DIN EN 10228-1:2016-10 | Non-destructive testing of steel forgings - Part 1: Magnetic particle inspection |
| DIN EN 10228-2:2016-10 | Non-destructive testing of steel forgings - Part 2: Penetrant testing |
| DIN EN 10228-3:2016-10 | Non-destructive testing of steel forgings - Part 3: Ultrasonic testing of ferritic or martensitic steel forgings |
| DIN EN 10228-4:2016-10 | Non-destructive testing of steel forgings - Part 4: Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings |
| DIN EN 10247:2017-09 | Micrographic examination of the non-metallic inclusion content of steels using standard pictures |
| DIN EN 10308: 2002-03 | Non-destructive testing - Ultrasonic testing of steel bars |
| DIN EN 12680-1:2003-06 | Founding - Ultrasonic testing - Part 1: Steel castings for general purposes |
| DIN EN 12680-3:2012-02 | Founding - Ultrasonic testing - Part 3: Spheroidal graphite cast iron castings |
| DIN EN 13018:2016-06 | Non-destructive testing - Visual testing - General principles |
| DIN EN ISO 945-1:2019-10 | Microstructure of cast irons - Part 1: Graphite classification by visual analysis |
| DIN EN ISO 8062-3:2008-09 | Geometrical Product Specifications (GPS) - Dimensional and geometrical tolerances for moulded parts - Part 3: General dimensional and geometrical tolerances and machining allowances for castings (ISO 8062-3:2007) |
| DIN EN ISO 9712 | Non-destructive testing - Qualification and certification of NDT personnel |
| DIN EN ISO 11970:2016-08 | Specification and qualification of welding procedures for production welding of steel castings |
| DIN EN ISO 18286:2010-11 | Hot-rolled stainless steel plates - Tolerances on dimensions and shape |
| EN ISO/IEC 17025 | General requirements for the competence of testing and calibration laboratories |
| ISO 10474:2013-07 | Steel and steel products - Inspection documents |

## 3 Terms and definitions

The following terms and definitions are valid for the application of this document.

**3.1**
**Casting**
Casting is a manufacturing process. Casting produces parts whose final shape and dimensions - except for subsequent metal-cutting working - are directly obtained through the solidification of liquid steel, iron and non-ferrous metals in molds usually made of sand, fireclay or other refractory materials.

**3.2**
**Semi-finished products [DIN EN 10079:2007-06]**
A semi-finished product is a product made by means of:
continuous casting and - where necessary - subsequent rolling, forging or slitting; die casting;
rolling, forging or slitting of ingots or continuous casting with big sections; intended in general for transformation into flat or long products by means of hot rolling, hot forging or for the manufacture of forged parts.

**3.3**
**Blank part [DIN 199-1:2002-03]**
Part produced without metal-cutting working intended for the manufacture of a defined object which still needs working.
Note: Blank parts (blanks) are e.g. castings, forgings, pressings.

**3.4**
**Forging**

Forging is the hot shaping of blooms (ingots, forged or rolled semi-finished products, continuously cast parts) in the form of forging with the grain, open die forging or closed-die forging to obtain a shape close to the finished shape for the further processing of the component. The shaping process creates a largely uniform and dense structure over the whole cross-section.

# 4 Casting

## 4.1 Basic specifications

Castings shall be produced in compliance with the specifications of the technical delivery conditions of the series of standards DIN EN 1559-1, DIN EN 1559-2 and DIN EN 1559-3.
The use of chaplets and fillers shall always be agreed with SMS group before the beginning of manufacture. Dross allowances on parts made of spheroidal graphite cast iron shall always be removed by machining or it shall be agreed with SMS group prior to manufacture that they need not be removed from the casting.

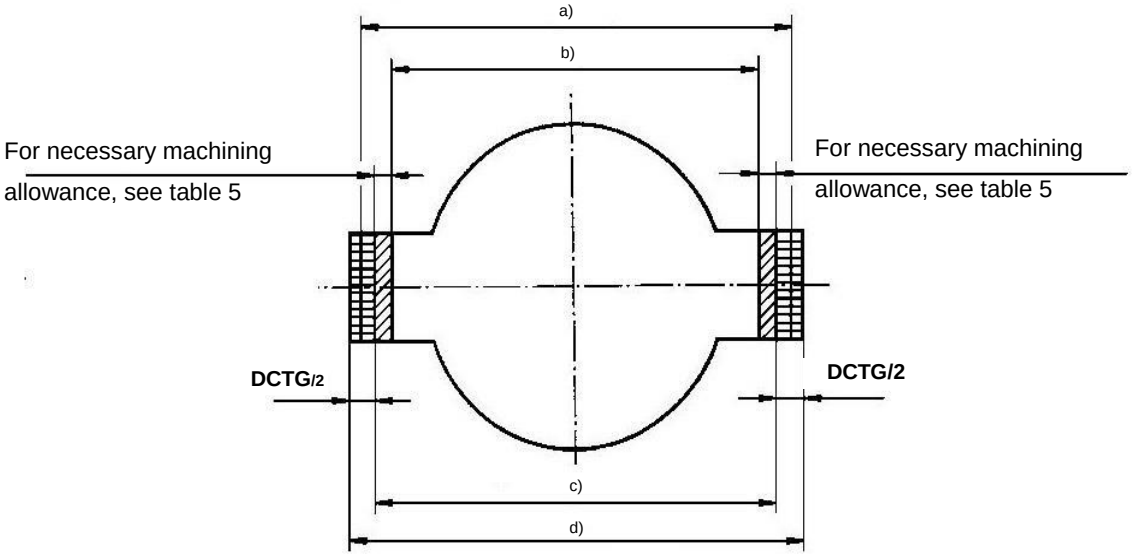
## 4.2 Surface qualities

The following surface qualities apply in accordance with DIN EN 1370:2012-03.

| For cast steel and non-ferrous metals: | | For cast iron: | |
|---|---|---|---|
| **4S1** | for blasted surfaces | **3S1** | for blasted surfaces |
| **4S2** | for ground surfaces | **3S2** | for ground surfaces |

## 4.3 General tolerances

The authoritative standard for the definition of the general tolerances is DIN EN ISO 8062-3:2008-09. The general tolerances shown in Table 3 apply to unmachined surfaces of raw castings. Half the respective general casting tolerance is applicable to a dimension between a machined surface and an unmachined surface. The values of the general tolerances in Table 3 are shown in Table 1 and Table 2 on the basis of the dimensional tolerance grade DCTG. The tolerance limits are defined in Fig. 1.




a) Nominal dimension of the raw casting
b) Dimensions after finish-machining
c) Minimum dimension
d) Maximum dimension

**Fig. 1 - Tolerance limits**

### 4.3.1 Degrees of accuracy

The dimensional tolerance grade DCTG according to DIN EN ISO 8062-3:2008-09 to be applied to a workpiece is determined by the biggest dimension of the workpiece (raw casting). On the basis of the nominal dimension range in which the biggest workpiece dimension lies, the DCTG grade for cast steel is determined according to Table 1, that for cast iron according to Table 2.

The tolerance values of all dimensions of the workpiece shall hence be taken from Table 3 from the column of the DCTG grade determined. When smaller casting tolerances are required, they are indicated on the drawing at the respective nominal dimension.

**Table 1 – DCTG tolerance grade for cast steel (GS)** (dimensions in mm)

| Raw casting nominal dimension | | | | Dimens. tolerance grade DCTG for | |
|---|---|---|---|---|---|
| | | | | Linear dim. [a] | Wall thicknesses |
| - | ≤ | 25 | | 12 | 13 |
| > | 25 | ≤ | 400 | 13 | 14 |
| > | 400 | ≤ | 1600 | 14 | 15 |
| > | 1600 | ≤ | 10000 | 15 | 16 |

[a] Lengths, widths, heights, center distances, diameters and radii.

**Table 2 – DCTG tolerance grade for cast iron (GJS / GJL)** (dimensions in mm)

| Raw casting nominal dimension | | | | Dimens. tolerance grade DCTG for | |
|---|---|---|---|---|---|
| | | | | Linear dim. [a] | Wall thicknesses |
| > | 25 | ≤ | 100 | 11 | 12 |
| > | 100 | ≤ | 400 | 12 | 13 |
| > | 400 | ≤ | 1000 | 13 | 14 |
| > | 1000 | ≤ | 1600 | 14 | 15 |
| > | 1600 | ≤ | 10000 | 15 | 16 |

[a] Lengths, widths, heights, center distances, diameters and radii.

**Table 3 – General tolerances for castings** (dimensions in mm)

| Raw casting nominal dimension | | | | Overall casting tolerance [a] | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Dimens. tolerance grade DCTG for linear dimensions and wall thicknesses | | | | | |
| | | | | 11 | 12 | 13 | 14 | 15 | 16 |
| - | ≤ | 25 | | 3.2 | 4.6 | 6 | 8 | 10 | 12 |
| > | 25 | ≤ | 40 | 3.6 | 5 | 7 | 9 | 11 | 14 |
| > | 40 | ≤ | 63 | 4 | 5.6 | 8 | 10 | 12 | 16 |
| > | 63 | ≤ | 100 | 4.4 | 6 | 9 | 11 | 14 | 18 |
| > | 100 | ≤ | 160 | 5 | 7 | 10 | 12 | 16 | 20 |
| > | 160 | ≤ | 250 | 5.6 | 8 | 11 | 14 | 18 | 22 |
| > | 250 | ≤ | 400 | 6.2 | 9 | 12 | 16 | 20 | 25 |
| > | 400 | ≤ | 630 | 7 | 10 | 14 | 18 | 22 | 28 |
| > | 630 | ≤ | 1000 | 8 | 11 | 16 | 20 | 25 | 32 |
| > | 1000 | ≤ | 1600 | 9 | 13 | 18 | 23 | 29 | 37 |
| > | 1600 | ≤ | 2500 | 10 | 15 | 21 | 26 | 33 | 42 |
| > | 2500 | ≤ | 4000 | 12 | 17 | 24 | 30 | 38 | 49 |
| > | 4000 | ≤ | 6300 | 14 | 20 | 28 | 35 | 44 | 56 |
| > | 6300 | ≤ | 10000 | 16 | 23 | 32 | 40 | 50 | 64 |

[a] The tolerance zone shall be arranged symmetrically to the nominal dimension.

### 4.3.2 Offset

Unless otherwise specified, the offset of the casting surfaces shall be within the tolerances stated in Table 3.

### 4.3.3 Outer and inner curvatures

For outer and inner curvatures the tolerance zone according to Table 3 is arranged in such a way that the lower tolerance limit is always zero.

*Example:*
Nominal dimension of the curvature 20 mm, casting tolerance grade DCTG 13; Table 3 states a tolerance of 6 mm; the lower tolerance limit applicable to the curvatures is 0, the upper limit is 6 mm. To reduce the risk of cracking, the minimum values in Table 4 shall be observed for inner curvatures on the basis of the wall thicknesses.

**Table 4 - Inner curvatures** (dimensions in mm)

| Wall thickness | Inner curvature min. |
|---|---|
| to 10 | 6 |
| > 10 to 30 | 10 |
| > 30 | 0.33 x wall thickness |

## 4.4 Machining allowances

Machining allowances on raw castings are excess material which is removed by subsequent machining to eliminate defects resulting from casting from the surface and to achieve the desired surface condition and the necessary dimensional accuracy. The actual amount of material to be removed by machining also depends on the actual dimensions of the raw casting. These actual dimensions may vary within the range of the specified and permissible general tolerances or the tolerance indicated for a dimension. Allowance is to be understood as allowance for every surface to be machined; this means that the allowance is required two times on rotational bodies or when machining takes place on two sides.
The data in Table 5 are based on SMS group experience and deviate from the machining allowances specified in DIN EN ISO 8062-3:2008-09. The machining allowance depends on the biggest outside dimension of the raw casting and not on the casting tolerance grade DCTG.

Irrespective of Table 5, the foundry is responsible for providing sufficient machining allowance to achieve the condition specified on the drawing and dross-free surfaces.

**Table 5 – Machining allowances for castings (SMS group specific)** (dimensions in mm)

| Nominal dimension range (biggest length, width, height or biggest diameter of casting) | Cast steel GS | | Cast iron EN-GJL | | Cast iron EN-GJS | | |
|---|---|---|---|---|---|---|---|
| | Per surface | for upper faces or faces in vertical position in the mold (taper) additionally | Per surface | for upper faces or faces in vertical position in the mold (taper) additionally | Per surface | for vertical faces (taper) additionally | for upper faces additionally (dross layer) |
| to **30** | 4 | 2 | 4 | 2 | 4 | 2 | 5 to 45 |
| > **30** to **50** | 5 | | | | | | |
| > **50** to **80** | 6 | | | | | | |
| > **80** to **120** | | | | | | | |
| > **120** to **180** | | | | | | | |
| > **180** to **250** | 7 | | 5 | | 5 | | |
| > **250** to **315** | | | | | | | |
| > **315** to **400** | 8 | | | | | | |
| > **400** to **500** | | | | | | | |
| > **500** to **630** | 10 | 3 | 6 | | 6 | | 20 to 110 |
| > **630** to **800** | | | | | | | |
| > **800** to **1000** | 12 | | 8 | | 8 | | |
| > **1000** to **1250** | | | | | | | |
| > **1250** to **1600** | 14 | 4 | 10 | | 10 | | 50 to 240 |
| > **1600** to **2000** | 16 | | 12 | 3 | 12 | 3 | |
| > **2000** to **2500** | | | | | | | |
| > **2500** to **3150** | 18 | 5 | 15 | 4 | 15 | 4 | 110 to 500 |
| > **3150** to **4000** | 20 | | 17 | | 17 | | |
| > **4000** to **6300** | 25 | | | | | | |
| > **6300** to **10000** | 30 | 7 | 20 | 5 | 20 | 5 | |
| Hole not cored by foundry | up to dia. 100 mm | | up to dia. 80 mm | | | | |

## 4.5 Production welds

Production welds are allowed provided that the material-specific requirements are fulfilled. For this purpose, proven welding methods, welding instructions and appropriately qualified welders must be available. Before the beginning of a production weld, the intended welding procedure shall be submitted to SMS group for approval in the form of a welding procedure specification (WPS) according to DIN EN ISO 11970:2016-08.

Areas where repairs are necessary shall be documented in a sketch. The sketch shall show the exact positions of the repaired areas on the casting and their sizes (length, width and depth).

The repairs shall always be examined using the magnetic particle method according to DIN EN 1369:2013-01 or penetrant testing according to DIN EN 1371-1:2012-02 for quality level 1 and the production welds using the ultrasonic testing according to DIN EN 12680-1:2003-06 for severity level 1.

## 4.6 Tests/inspections

### 4.6.1 Basic specifications

The following sections 4.6.3 to 4.6.5 shall be complied with when specifications for the inspection of castings are made in the manufacturing documents.
If no indications are made in the manufacturing documents, the inspection specifications for semi-finished products of section 6 are applicable.

### 4.6.2 Qualification of inspectors

The inspectors shall be sufficiently trained and experienced so that they are able to properly perform the following tests/inspections in conformity with the specified instructions. The qualification of testers for nondestructive testing (NDT) of castings shall be in accordance with DIN EN ISO 9712; evaluation shall be carried out by an inspector/tester (at least level 2). Comparable country-specific qualifications will be accepted.

### 4.6.3 Inspections of cast steel (GS)

#### 4.6.3.1 Internal quality

The Table 6 to Table 8 show SMS group specific requirements made on the basis of DIN EN 12680-1:2003-06. Where no requirements are specified, DIN EN 12680-1:2003-06 shall be applied. When required, the specifications with regard to quality levels are indicated on the drawing or in product-specific SN standards. The minimum requirement for SMS group components is severity level 3 for the surface zone and severity level 4 for the core zone according to DIN EN 12680-1:2003-06.

**Table 6 – Requirements for ultrasonic testability** (dimensions in mm)

| Wall thickness | Smallest detectable flat-bottomed hole diameter according to item 5.2 of DIN EN 12680-1:2003-06 |
|---|---|
| ≤ 300 | 3 |
| > 300 to ≤ 400 | 4 |
| > 400 to ≤ 600 | 6 |
| > 600 | 8 |

**Table 7 – Recording levels for reflectors, based on a 2MHz ultrasonic probe**

| Wall thickness (in mm) | Tested area (in mm) | Reflectors without measurable extent | Reflectors with measurable extent | Back wall echo reduction |
|---|---|---|---|---|
| | | Diameter of equivalent flat-bottomed hole min. (in mm) | | (dB) |
| ≤ 300 | Surface and core zones | 4 | 3 | >12 |
| > 300 to ≤ 400 | | 6 | 4 | |
| > 400 to ≤ 600 | | 6 | 6 | |
| > 600 | | 8 | 8 | |
| - | Special surface zone | 3 | 3 | |

**Table 8 – Acceptance limits for volumetric reflectors (SMS group specific)**

| Feature | Unit | Zone [a] | Severity level | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | | | 3 | | | 4 | | |
| **Casting wall thickness in tested area** | **mm** | | **-** | **≤ 50** | **> 50 ≤ 100** | **> 100 ≤ 600 [b]** | **≤ 50** | **> 50 ≤ 100** | **> 100 ≤ 600 [b]** | **≤ 50** | **> 50 ≤ 100** | **> 100 ≤ 600 [b]** |
| **Reflectors without measurable extent [c]** | | | | | | | | | | | | |
| Biggest diameter of equivalent flat-bottomed hole | mm | Surface zone | 3 | 8 | | | | | | | | |
| | | Core | | | | | | | | | | |
| Number of reflectors to be recorded within a frame of 100 mm x 100 mm | pcs. | Surface zone | 3 | 3 | 5 | | 6 | | | Not used as criterion | | |
| | | Core | | Not used as criterion | | | | | | | | |
| Acceptance limit for back wall echo reduction | max dB | - | 6 | 12 | | | | | | | | |
| **Reflectors with measurable extent** | | | | | | | | | | | | |
| Biggest diameter of equivalent flat-bottomed hole | mm | Surface zone | 3 | 8 | | | | | | | | |
| | | Core | | | | | | | | | | |
| Max. extent of reflector in wall thickness direction | % | Surface zone | Not permitted | 15% of zone thickness | | | | | | | | |
| | | Core | | 15% of wall thickness | | | | | | | | |
| Max. length without measurable width | mm | Surface zone | | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 |
| | | Core | | 75 | 75 | 100 | 75 | 75 | 120 | 100 | 100 | 150 |
| Largest individual area [d] | mm² | Surface zone | | 600 | 1000 | 1000 | 600 | 2000 | 2000 | 2000 | 2000 | 2000 |
| | | Core | | 10000 | 10000 | 15000 | 15000 | 15000 | 20000 | 15000 | 15000 | 20000 |
| Largest total area per reference area [d] | mm² | Surface zone | | 10000 | 10000 | 10000 | 10000 | 10000 | 10000 | 10000 | 15000 | 15000 |
| | | Core | | 10000 | 15000 | 15000 | 15000 | 15000 | 20000 | 15000 | 20000 | 20000 |
| Reference area | mm² | - | | 150 000 (≈ 390 mm x 390 mm) | | | 100 000 (≈ 320 mm x 320 mm) | | | | | |
| Acceptance limit for back wall echo reduction | max dB | - | 6 | 12 | | | | | | | | |

[a] Zone pattern: Surface zone = t/3 but max. 100 mm, core zone = remaining core area, t = wall thickness in testing area
[b] Unless otherwise stipulated, the recording and acceptability limit ERG 8 mm applies to wall thicknesses over 600 mm, but min. 6dbB above signal noise.
[c] Every reflector which exceeds the limits of one criterion shall be treated as not acceptable. Indications which exceed the acceptance limits shall be reported in writing to the SMS group Quality Inspection.
[d] Indications located at distances of less than 25 mm shall be regarded as one indication.

#### 4.6.3.2 External condition

The external condition shall be examined in the areas marked on the drawing using the magnetic particle method as in DIN EN 1369:2013-01 or penetrant testing as in DIN EN 1371-1:2012-02. The specifications are given on the drawing or in product-specific SN standards. Raw castings and finish-machined castings for SMS group shall comply with the following minimum quality levels according to DIN EN 1369:2013-01 and DIN EN 1371-1:2012-02:

- Non-linear indications SM 3 and SP 3
- Linear indications LM/AM 5 and LP/AP 5

The recoding of the quality levels from DIN EN 1369:1997-02 to DIN EN 1369:2013-01 and from DIN EN 1371-1:1997-10 to DIN EN 1371-1:2012-02 is shown in Annex A (normative).

#### 4.6.4 Testing of spheroidal graphite cast iron (EN-GJS)

##### 4.6.4.1 Internal quality

Ultrasonic testing used to determine the internal condition shall be made in accordance with DIN EN 12680-3:2012-02. The requirements made on the internal condition of castings in spheroidal graphite cast iron are shown on the drawing or specified in product-specific SN standards. The minimum requirement for SMS group components is severity level 3 for the surface zone and severity level 4 for the core zone according to DIN EN 12680-3: 2012-02.
When testing for proper spheroidal graphite formation, a sound speed of 5600m/s must be adhered to.

##### 4.6.4.2 External condition

The external condition shall be examined in the areas marked on the drawing using the magnetic particle method as in DIN EN 1369:2013-01 or penetrant testing as in DIN EN 1371-1:2012-02. The specifications are given on the drawing or in product-specific SN standards.
Raw castings and finish-machined castings for SMS group shall comply with the following minimum quality levels according to DIN EN 1369:2013-01 and DIN EN 1371-1:2012-02:

- Non-linear indications SM 3 and SP 3
- Linear indications LM/AM 5 and LP/AP 5

The recoding of the quality levels from DIN EN 1369:1997-02 to DIN EN 1369:2013-01 and from DIN EN 1371-1:1997-10 to DIN EN 1371-1:2012-02 is shown in Annex. 1.

#### 4.6.5 Testing of lamellar graphite cast iron (EN-GJL)

##### 4.6.5.1 Internal quality

The internal condition shall be checked in the form of structural examinations in accordance with DIN EN ISO 945-1:2019-10.

##### 4.6.5.2 External condition

Visual examination of the external condition shall be made in accordance with DIN EN 13018:2016-06 and/or DIN EN 1370:2012-03.

### 4.7 Documentation

The data and results of the examinations and tests listed below shall be reported to SMS group by the foundry or the manufacturing shop in an inspection certificate 3.1 according to DIN EN 10204:2005-01 and/or ISO 10474:2013-07:

- Chemical analysis of each melting heat contained in the supply.
- Result of hardness testing and the mechanical properties of every melting heat and heat-treatment unit.
- If so required, the result of elevated-temperature tensile testing at maximum working temperature of the material for heat-resistant steels for every melting heat and heat-treatment unit.
- Results of nondestructive testing as specified on the drawing.
- Results of other examinations/tests if specified on the drawing.

# 5 Forging

## 5.1 Basic specifications

Important! Please note the revision / correction SN 200-2/A1!

Unless special requirements are made, the technical delivery conditions and quality specifications can be found in the relevant DIN, DIN EN, ISO or SEW standards. The degree of stretching ≥ 3 shall be set in a way (referred to the largest diameter or wall thickness) that homogeneous forging is effected, upsetting operations ƛS (even before start of stretching) shall not be considered in the calculation/determination.

When particular requirements have to be fulfilled, the quality specifications for forgings are shown on the drawing in the form of drawing stickers. Heat treatment shall be carried out or arranged for by the forging and/or the manufacturing shop.

Note:
The following sections shall be complied with when specifications for the inspection of forgings are made in the manufacturing documents. If no indications are made in the manufacturing documents, the inspection specifications for semi-finished products of section 6.3 are applicable.

## 5.2 Tests/inspections

### 5.2.1 Qualification of inspectors

The inspectors shall be sufficiently trained and experienced so that they are able to properly perform the following tests/inspections in conformity with the specified instructions. The qualification of testers for nondestructive testing (NDT) of forgings shall be in accordance with DIN EN ISO 9712 with evaluation carried out by an inspector/tester (at least level 2). Comparable country-specific qualifications will be accepted.

### 5.2.2 Surface condition

Forgings supplied in as-forged condition shall be considered acceptable when the specified quality class can be fulfilled. When forgings are supplied in machined condition, the surface quality shall correspond to the required quality class according to Table 9.

**Table 9 - Surface qualities**

| **Surface quality** | **Quality class and roughness Ra** | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| | **≤ 25 µm** | **≤ 12.5 µm** | **≤ 12.5 µm** | **≤ 6.3 µm** |
| Machined surface [a)] | x | x | x | x |
| [a)] „x“ marks the quality class which can be attained at the specified roughness. | | | | |

### 5.2.3 Internal quality

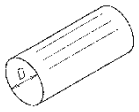
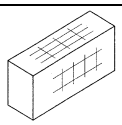
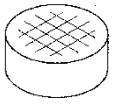
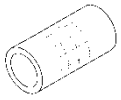
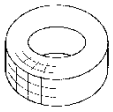
When examination of the internal condition is stipulated, this examination shall be made using ultrasonic testing according to DIN EN 10228-3:2016-10 or DIN EN 10228-4:2016-10 as well as to DIN EN 10247:2017-09.

#### 5.2.3.1 Performance of ultrasonic testing

Testing shall be made using the manual-contact pulse-echo technique, the sizes of indications shall be determined using the DGS (**D**istance **G**rain **S**ize) method. The necessary minimum scanning coverage depends on the type of the forging and on whether grid scanning or 100% scanning coverage is specified in the order or drawing.

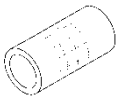
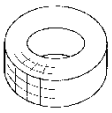
Table 10 specifies the requirements for scanning coverage of the forging types 1, 2 and 3 with perpendicular incidence. Table 11 stipulates the requirements on scanning coverage with angular sound incidence for the forging types 3a and 3b at a ratio of outside diameter to inside diameter of less than 1.6. The depth which can be covered in circumferential scanning is limited by the angle of incidence and the diameter of the forging.

**Table 10 – Scope of inspection with straight-beam probes**

| Type | Grid scanning [a] | | | 100% scanning [a] [b] |
|---|---|---|---|---|
| | Shape | Diameter D in mm | Scan. paths [b] [c] | |
| 1 | 1a  | $D \leq 200$<br>$200 < D \leq 500$<br>$500 < D \leq 1000$<br>$D > 1000$ | 2 at 90°<br>3 at 60°<br>4 at 45°<br>6 at 30° | 100% scan around at least 180° of the cylindrical surface |
| | 1b  | Scanning along the lines of a square-link grid on two surfaces perpendicular to each other [c] [d] | | 100% scan on two surfaces at right angle to each other |
| 2 |  | Scanning along the lines of a square-link grid around 360° on the shell face and on one end face | | 100% scan around at least 180° on the shell face and 100% of one end face |
| 3 | 3a  | Scanning along the lines of a square-link grid around 360° on the outer surface area [d] | | 100% scan around 360° on the outer surface area |
| | 3b and 3c [e]  | Scanning along the lines of a square-link grid around 360° on the outer surface area and on one end face [d] | | 100% scan around 360° on the outer surface area and on one end face |
| 4 | The scanning coverage shall be specified in the inquiry and in the order. | | | |

a) When additional sound incidence directions (e.g. in both axial directions for type 3a) are specified, they shall be indicated in the inquiry and the order.
b) 100% means at least 10% overlap of the consecutive scanning paths.
c) For the types 1a and 1b the number of scanning paths shall be doubled by including the opposite scanning faces if a hole makes it impossible to reach the opposite surface.
d) The grid spacing shall be equal to the thickness of the component up to a maximum of 200 mm.
e) 3b = expanded, 3c = ring rolled

**Table 11 – Scope of inspection with angular sound incidence**

| Type | Grid scanning [a] | | 100% scanning [a] [b] |
|---|---|---|---|
| 3 | 3a  | Scanning in both directions along 360° circumferential grid lines the spacing of which, up to a maximum of 200 mm, is equal to the radial thickness | 100% scan of the outer surface area in both circumferential directions |
| | 3b  | | |
| 4 | The scanning coverage shall be specified in the inquiry or order. | | |

a) Additional scanning coverage may be carried out if specified in the inquiry or order.
b) 100% means at least 10% overlap of the consecutive scanning paths.

#### 5.2.3.2 Recording levels and acceptance limits

The data in Table 12 and Table 13 specify the recording levels and acceptance levels to be met in the respective quality classes.
The sensitivity of the testing system (testing unit, probe, cable) shall be sufficient to ensure the detection of the smallest discontinuities according to the requested recording and acceptance levels.

**Table 12 – Quality classes, recording levels and acceptance levels when using straight-beam probes**

| **Quality class** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| **Recording levels** | | | | |
| Flat bottomed holes (FBH) $d_{eg}$ in mm of diameter | > 8 | > 5 | > 3 | > 2 |
| R ratio for abrupt attenuation of the backwall echo [a) b)] | ≤ 0.1 | ≤ 0.3 | ≤ 0.5 | ≤ 0.6 |
| **Acceptance levels** | | | | |
| FBH in isolated point discontinuities $d_{eg}$ in mm of diameter | ≤ 12 | ≤ 8 | ≤ 5 | ≤ 3 |
| FBH for discontinuities with extent or grouped discontinuities $d_{eg}$ in mm of diameter | ≤ 8 | ≤ 5 | ≤ 3 | ≤ 2 |

a) $R = \frac{Fn}{Fo,n}$ with n = 1 for t ≥ 60 mm and n = 2 for t < 60 mm
$F_n$ amplitude (height on screen) of the nth attenuated backwall echo
Fo,n amplitude (height on screen) of the nth backwall echo in the nearest discontinuity-free section of the range of $F_n$.
b) If the backwall echo reduction is so heavy that the recording level is not attained, further examinations are required.
Ratio R applies only if heavy backwall echo reduction is caused by the presence of a discontinuity.

**Table 13 – Quality classes, recording levels and acceptance levels when using angle-beam probes**

| **Quality class** | **1 [a)]** | **2** | **3** | **4** |
|---|---|---|---|---|
| **Recording level** | | | | |
| Flat bottomed holes (FBH) $d_{eg}$ in mm of diameter | - | > 5 | > 3 | > 2 |
| **Acceptance levels** | | | | |
| FBH for isolated discontinuities $d_{eg}$ in mm of diameter | - | ≤ 8 | ≤ 5 | ≤ 3 |
| FBH for discontinuities with extent or grouped discontinuities $d_{eg}$ in mm of diameter | - | ≤ 5 | ≤ 3 | ≤ 2 |

a) Testing for quality class 1 not possible with angle-beam probes.

#### 5.2.4 External condition

The external condition shall be examined in the areas marked on the drawing using the magnetic particle method as in DIN EN 10228-1:2016-10 or penetrant testing as in DIN EN 10228-2:2016-10. Unless otherwise specified in the drawing, quality class 3 according to DIN EN 10228-1:2016-10 or DIN EN 10228-2:2016-10 shall be complied with as a minimum requirement.

### 5.3 Documentation

The data and results of the examinations and tests listed below shall be reported to SMS group by the forging shop or the manufacturing shop in an inspection certificate 3.1 according to DIN EN 10204:2005-01 and/or ISO 10474:2013-07:

- Chemical analysis of each melting heat contained in the supply.
- Result of hardness testing and the mechanical properties of every melting heat and heat-treatment unit.
- If so required, the result of elevated-temperature tensile testing at maximum working temperature of the material for heat-resistant steels for every melting heat and heat-treatment unit.
- Results of nondestructive testing as specified on the drawing.
- Results of other examinations/tests if specified on the drawing.

## 6 Semi-finished products

### 6.1 Basic specifications

The designation "St" shall be used for component parts in steel for which no particular strength requirements are made.

The selection of the starting material and the semi-finished product for the manufacture of the component is left to the discretion of the workshop.

## 6.2 Technical delivery conditions

### 6.2.1 Basic specifications

The technical delivery conditions are specified in DIN EN 10021 and in the respective standards for semi-finished products. Suitability for welding shall be taken into account. The DIN and DIN EN standards for semi-finished products are the relevant standards with regard to the general tolerances of steel products.

### 6.2.2 Plates

Thickness and flatness tolerances of the steel plates used are subject to DIN EN 10029:2011-02, table 1, class A and table 4, class N; plates in stainless steel are subject to DIN EN ISO 18286:2010-11, table 1 and table 6, class N.
Steel plates and stainless steel plates over 400 mm are also subject to the permissible tolerances indicated in DIN EN 10029:2011-02 and DIN EN ISO 18286:2010-11 for the nominal thickness range from 250 to 400 mm. Use shall be made of plates fulfilling the surface condition of class A as in DIN EN 10163-2:2005-03.

### 6.2.3 Pipes

Pipes in steel shall be delivered to the place of use without further treatment as specified in the technical delivery conditions. Pipes in stainless and acid-resistant steel shall be delivered to the place of use in metallically bright pickled or descaled condition and without further treatment.

## 6.3 Inspection

### 6.3.1 Basic specifications

When the inspections below have been carried out on the semi-finished product, the component parts need not be inspected again. It shall be ensured, however, that the components are really made from the inspected semi-finished product. The manufacturer's laboratory carrying out the examination shall be qualified for the chemical analysis and the non-destructive testing in accordance with DIN EN ISO/IEC 17025 or comparable national standards.

### 6.3.2 Semi-finished products made of steel

#### 6.3.2.1 Plate

Non-alloy steel plate with a thickness **≥ 100 mm** and a yield point of at least 250 MPa related to the smallest standardized material thickness shall be tested as follows:

- Ultrasonic testing as specified in DIN EN 10160:1999-09 (quality class S2/E2)
- Tensile strength and/or hardness testing

Alloy steel plate with a thickness **≥ 80 mm** and a yield point of at least 250 MPa related to the smallest standardized material thickness shall be tested as follows:

- Chemical analysis
- Ultrasonic testing as specified in DIN EN 10160:1999-09 (quality class S2/E2)
- Tensile strength and/or hardness testing

#### 6.3.2.2 Round bar

Non-alloy steel round bars with a **Ø ≥ 150 mm** shall be tested as follows:

- Ultrasonic testing as specified in DIN EN 10228-3:2016-10 and/or DIN EN 10308:2002-03 (Type 1a grid scanning, quality class 2)
- Tensile strength and/or hardness testing

Alloy steel round bars with a **Ø ≥ 80 mm** shall be tested as follows:

- Chemical analysis
- Ultrasonic testing as specified in DIN EN 10228-3:2016-10 and/or DIN EN 10308:2002-03 (Type 1a grid scanning, quality class 2)
- Tensile strength and/or hardness testing.

#### 6.3.2.3 Square bars

Non-alloy steel square bars of lateral length **≥ 150 mm** shall be tested as follows:

- Ultrasonic testing as specified in DIN EN 10228-3:2016-10 and/or DIN EN 10308:2002-03 (Type 1b grid scanning, quality class 2)
- Tensile strength and/or hardness testing

Alloy steel square bars of lateral length **≥ 80 mm** shall be tested as follows:

- Chemical analysis
- Ultrasonic testing as specified in DIN EN 10308:2002-03 (Type 1b grid scanning, quality class 2)
- Tensile strength and/or hardness testing

#### 6.3.2.4 Flat bars

Non-alloy steel flat bars with a width **≥ 150 mm** and a thickness **≥ 100 mm** and a yield point of at least 250 MPa related to the smallest standardized material thickness shall be tested as follows:

- Ultrasonic testing as specified in DIN EN 10228-3:2016-10 and/or DIN EN 10308:2002-03 (Type 1b grid scanning, quality class 2)
- Tensile strength and/or hardness testing

Alloy steel flat bars with a width **≥ 80 mm** and a thickness **≥ 80 mm** and a yield point of at least 350 MPa related to the smallest standardized material thickness shall be tested as follows:

- Chemical analysis
- Ultrasonic testing as specified in DIN EN 10228-3:2016-10 and/or DIN EN 10308:2002-03 (Type 1b grid scanning, quality class 2)
- Tensile strength and/or hardness testing

#### 6.3.2.5 Rings

Non-alloy steel rings with a width **≥ 150 mm** and a thickness **≥ 100 mm** and a yield point of at least 250 MPa related to the smallest standardized material thickness shall be tested as follows:

- Ultrasonic testing as specified in DIN EN 10228-3:2016-10 (Type 3 grid scanning, quality class 2)
- Tensile strength and/or hardness testing

Alloy steels ring with a width **≥ 80 mm** and a thickness **≥ 80 mm** and a yield point of at least 350 MPa related to the smallest standardized material thickness shall be tested as follows:

- Chemical analysis
- Ultrasonic testing as specified in DIN EN 10228-3:2016-10 (Type 3 grid scanning, quality class 2)
- Tensile strength and/or hardness testing

#### 6.3.2.6 Pipes

Pipes shall be tested as specified in the technical delivery conditions for the respective pipes.

### 6.3.3 Semi-finished products made non-ferrous metals

Semi-finished products in non-ferrous metals shall be tested by the supplier as specified in the technical delivery conditions.

## 6.4 Documentation

If the inspections/tests specified in this SN have been made on the semi-finished products, component parts generally need not be certified individually again.

The results of the required testing for

- plates, round bars, square bars, flat bars and rings from 6.3.2.1 to 6.3.2.5
- semi-finished products made of non-ferrous metals from section 6.3.3

shall be certified with inspection certificate 3.1 DIN EN 10204:2005-01 and/or ISO 10474:2013-07.

Testing specifications and inspection documents for pipes shall be complied with and submitted in accordance with the ordering specifications and the respective national and international standards.

# Annex. 1
# (normative)
# Recoding of the quality levels in casting

## A.1 Recoding of the quality levels of linear (LM) and aligned (AM) indications

The individual quality levels are specified on the basis of the degree of stressing (static, dynamic) of the component or assembly. Table A.1 shows the recoding of the quality level in table 3 of DIN EN 1369:1997-02 into those in table 2 of DIN EN 1369:2013-01.

Upon presentation of a drawing, the inspector shall recode the quality levels of DIN EN 1369:1997-02 according to table A.1 and perform the testing as specified by the quality levels of DIN EN 1369:2013-01.

**Table A.1 – Recoding of quality levels**

| Quality levels of DIN EN 1369:2013-01 | Quality levels of DIN EN 1369:1997-02 | | |
|---|---|---|---|
| | Wall thickness class a<br>t ≤ 16 mm | Wall thickness class b<br>16 mm < t ≤ 50 mm | Wall thickness class c<br>t > 50 mm |
| LM 001<br>AM 001 | LM 001<br>AM 001 | LM 001<br>AM 001 | LM 001<br>AM 001 |
| LM 01<br>AM 01 | LM 01<br>AM 01 | LM 01<br>AM 01 | LM 01<br>AM 01 |
| LM 1<br>AM 1 | LM 1<br>AM 1 | - | - |
| LM 2<br>AM 2 | LM 2<br>AM 2 | LM 1<br>AM 1 | - |
| LM 3<br>AM 3 | LM 3<br>AM 3 | LM 2<br>AM 2 | LM 1<br>AM 1 |
| LM 4<br>AM 4 | LM 4<br>AM 4 | LM 3<br>AM 3 | LM 2<br>AM 2 |
| LM 5<br>AM 5 | LM 5<br>AM 5 | LM 4<br>AM 4 | LM 3<br>AM 3 |
| LM 6<br>AM 6 | - | LM 5<br>AM 5 | LM 4<br>AM 4 |
| LM 7<br>AM 7 | - | - | LM 5<br>AM 5 |

NOTE: t - wall thickness

### A.2 Recoding of the quality levels of linear (LP) and aligned (AP) indications

The individual quality levels are specified on the basis of the degree of stressing (static, dynamic) of the component or assembly. Table A.2 shows the recoding of the quality level in table 3 of DIN EN 1371-1:1997-10 into those in table 2 of DIN EN 1371-1:2012-02.

Upon presentation of a drawing, the inspector shall recode the quality levels of DIN EN 1371:1997-10 according to table A.2 and perform the testing as specified by the quality levels of DIN EN 1371:2012-02.

**Table A.2 – Recoding of quality levels**

| **Quality levels of DIN EN 1371-1:2012-02** | **Quality levels of DIN EN 1371-1:1997-10** | | |
|---|---|---|---|
| | **Wall thickness class a t ≤ 16 mm** | **Wall thickness class b 16 mm < t ≤ 50 mm** | **Wall thickness class c t > 50 mm** |
| LP 001<br>AP 001 | LP 001<br>AP 001 | LP 001<br>AP 001 | LP 001<br>AP 001 |
| LP 01<br>AP 01 | LP 01<br>AP 01 | LP 01<br>AP 01 | LP 01<br>AP 01 |
| LP 1<br>AP 1 | LP 1<br>AP 1 | - | - |
| LP 2<br>AP 2 | LP 2<br>AP 2 | LP 1<br>AP 1 | - |
| LP 3<br>AP 3 | LP 3<br>AP 3 | LP 2<br>AP 2 | LP 1<br>AP 1 |
| LP 4<br>AP 4 | LP 4<br>AP 4 | LP 3<br>AP 3 | LP 2<br>AP 2 |
| LP 5<br>AP 5 | LP 5<br>AP 5 | LP 4<br>AP 4 | LP 3<br>AP 3 |
| LP 6<br>AP 6 | - | LP 5<br>AP 5 | LP 4<br>AP 4 |
| LP 7<br>AP 7 | - | - | LP 5<br>AP 5 |
| NOTE: t - wall thickness | | | |

## Bibliography

| | |
|---|---|
| DIN 199-1:2003-03 | Technical product documentation |
| DIN EN 1369:1997-02 | Founding - Magnetic particle testing |
| DIN EN 1370:1997-10 | Founding - Surface roughness inspection by visualtactile comparators |
| DIN EN 10079:2007-06 | Definition of steel products |
| SN 200-2 | Manufacturing Instructions - Blank parts and semi-finished products |
| SN 200-3 | Manufacturing Instructions - Thermal cutting and bending |
| SN 200-4 | Manufacturing Instructions - Welding |
| SN 200-5 | Manufacturing Instructions - Mechanical processing |
| SN 200-6 | Manufacturing Instructions - Assembly and disassembly |
| SN 200-7 | Manufacturing Instructions - Corrosion protection |
| SN 200-8 | Manufacturing Instructions - Inspection |

## Revisions

Revisions as against SN 200-2:2016-05:

| | |
|---|---|
| Editorial changes; | Introduction added;<br>Updating of the normative references;<br>Revision document SN 200-2/A1:2018-09 incorporated |
| Section 4.6.4.1 | Sound speed determined |
| Section 4.7 | Added |
| Section 5.1 | Degree of stretching added |
| Section 6.2.3 | Completely revised and prepared anew |
| Section 6.4 | Parts taken over from Section 6.3 and partly prepared anew |
| Annex A (normative) | Requirements for the inspector added |

### Previous editions

SN 200:1971-09, 1975-11,1978-01, 1981-01,1985-01, 1992-03, 1996-03, 1999-09, 2003-09, 2007-02, 2010-09
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