

# Steel castings for general engineering uses

The European Standard EN 10293:2005 has the status of a  
British Standard

ICS 77.140.80

# National foreword

This British Standard is the official English language version of EN 10293:2005. It supersedes BS 3100:1991 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/6, Steel castings, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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## Summary of pages

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English version

## Steel castings for general engineering uses

Aciers moulés d'usage général

Stahlguss für allgemeine Anwendungen

This European Standard was approved by CEN on 14 February 2005.

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# Contents

Page

|                                                                              |    |
|------------------------------------------------------------------------------|----|
| Foreword.....                                                                | 3  |
| Introduction .....                                                           | 4  |
| 1 Scope .....                                                                | 5  |
| 2 Normative references .....                                                 | 5  |
| ■ 3 Terms and definitions .....                                              | 5  |
| ● 4 Information to be supplied by the purchaser .....                        | 5  |
| 5 Designation .....                                                          | 5  |
| 6 Manufacture.....                                                           | 5  |
| 6.1 Manufacturing process .....                                              | 5  |
| ■ 6.1.1 Melting .....                                                        | 5  |
| 6.1.2 Heat treatment.....                                                    | 5  |
| 6.2 Welding operations.....                                                  | 6  |
| ■ 6.2.1 General.....                                                         | 6  |
| 6.2.2 Production welding.....                                                | 6  |
| ■ 6.3 Further processing .....                                               | 6  |
| 7 Requirements .....                                                         | 6  |
| ■ 7.1 General.....                                                           | 6  |
| 7.2 Material .....                                                           | 6  |
| 7.2.1 Chemical composition .....                                             | 6  |
| 7.2.2 Mechanical properties .....                                            | 8  |
| 7.3 Casting.....                                                             | 13 |
| ■ 7.3.1 Chemical composition .....                                           | 13 |
| 7.3.2 Mechanical properties .....                                            | 13 |
| ■ 7.3.3 Non destructive testing .....                                        | 13 |
| ■ 7.3.4 Conditions of the casting.....                                       | 13 |
| ■ 7.3.5 Mass of the casting.....                                             | 13 |
| ■ 7.3.6 Additional requirements regarding the condition of the casting ..... | 13 |
| 8 Testing and documents on material testing .....                            | 13 |
| ■ 8.1 General.....                                                           | 13 |
| ■ 8.2 Inspection and testing.....                                            | 13 |
| ■ 8.3 Test unit sampling .....                                               | 13 |
| ■ 8.4 Samples (test blocks) .....                                            | 13 |
| 8.5 Test methods.....                                                        | 14 |
| ■ 8.6 Invalidation of tests .....                                            | 14 |
| ■ 8.7 Retests .....                                                          | 14 |
| ■ 8.8 Sorting and reprocessing .....                                         | 14 |
| ■ 9 Identification and marking .....                                         | 14 |
| ■ 10 Packaging and surface protection .....                                  | 14 |
| ■ 11 Complaints .....                                                        | 14 |
| Annex A (informative) Guidance data for welding .....                        | 15 |
| Bibliography .....                                                           | 16 |

## Foreword

This document (EN 10293:2005) has been prepared by Technical Committee ECISS/TC 31 “Steel castings”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2005, and conflicting national standards shall be withdrawn at the latest by October 2005.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

## Introduction

This document retains the same format for clauses as EN 1559-1:1997 and EN 1559-2:2000. It should be used in conjunction with these standards. Where no text is given under a paragraph heading, the corresponding paragraph of EN 1559-1:1997 and EN 1559-2:2000 applies.

The structure of this document is as follows:

- clauses and subclauses preceded by ■ indicates no additional conditions to EN 1559-1<sup>1)</sup> and EN 1559-2<sup>1)</sup>;
- clauses and subclauses marked with a single dot • indicate that the conditions shall be agreed at the time of enquiry and order;
- subclauses marked with two dots ●● indicate that conditions may be agreed at the time of enquiry and order (optional);
- subclauses without dot marking are mandatory.

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1) When a complementary information is given in a clause or subclause of this document (versus the same clause or subclause of EN 1559-1:1997 or EN 1559-2:2000) it is preceded by “in addition to EN 1559-2:2000”.

## 1 Scope

This document applies to steel castings:

- for general engineering uses. Its uses include machinery (mechanical, electrical...), automotive industries, railroad, armament, agricultural equipment, mining ...

In cases where castings are joined by welding by the founder, this document applies.

In cases where castings are welded:

- to wrought products (plates, tubes, forgings...), or
- by non founders

this document does not apply.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1559-2:2000, *Founding — Technical conditions of delivery — Part 2: Additional requirements for steel castings*

## ■ 3 Terms and definitions

## ● 4 Information to be supplied by the purchaser

In cases of grades with different mechanical properties relating to heat treatment conditions the purchaser shall specify the heat treatment symbol (see Clause 5).

## 5 Designation

In addition to EN 1559-2:2000:

- for a steel grade which can be delivered to different strength levels, according to the heat treatment, a suffix shall be added in accordance with Table 3. For example: G26CrMo4 + QT1.

## 6 Manufacture

### 6.1 Manufacturing process

#### ■ 6.1.1 Melting

#### 6.1.2 Heat treatment

Unless otherwise agreed, the type of heat treatment shall comply with Table 3.

## 6.2 Welding operations

### ■ 6.2.1 General

#### 6.2.2 Production welding

In addition to EN 1559-2:2000:

- information on preheat and interpass temperatures as well as on postweld heat-treatment is given in Annex A.

### ■ 6.3 Further processing

## 7 Requirements

### ■ 7.1 General

#### 7.2 Material

##### 7.2.1 Chemical composition

In addition to EN 1559-2:2000:

- the chemical composition determined by a cast analysis shall conform to the values given in Table 1;
- elements unspecified in Table 1 of this document shall not be intentionally added without agreement of the purchaser other than for the purpose of finishing the heat. If not otherwise agreed the maximum values in % (by mass) given in Table 2 shall be applicable;
- permissible deviations between the specified cast analysis and the check analysis on test blocks are indicated in Table 1 of EN 1559-2:2000.

Table 1 — Chemical composition (cast analysis), (% by mass)

| Designation     |        | C    |      | Si   | Mn   |      | P     | S                  | Cr    |       | Mo   |      | Ni   |      | V    |      | W    |
|-----------------|--------|------|------|------|------|------|-------|--------------------|-------|-------|------|------|------|------|------|------|------|
| Name            | Number | min. | max. | max. | min. | max. | max.  | max.               | min.  | max.  | min. | max. | min. | max. | min. | max. | max. |
| GE200           | 1.0420 | -    | -    | -    | -    | -    | 0,035 | 0,030              | -     | -     | -    | -    | -    | -    | -    | -    | -    |
| GS200           | 1.0449 | -    | 0,18 | 0,60 | -    | 1,20 | 0,030 | 0,025              | -     | -     | -    | -    | -    | -    | -    | -    | -    |
| GE240           | 1.0446 | -    | -    | -    | -    | -    | 0,035 | 0,030              | -     | -     | -    | -    | -    | -    | -    | -    | -    |
| GS240           | 1.0455 | -    | 0,23 | 0,60 | -    | 1,20 | 0,030 | 0,025              | -     | -     | -    | -    | -    | -    | -    | -    | -    |
| GE300           | 1.0558 | -    | -    | -    | -    | -    | 0,035 | 0,030              | -     | -     | -    | -    | -    | -    | -    | -    | -    |
| G17Mn5          | 1.1131 | 0,15 | 0,20 | 0,60 | 1,00 | 1,60 | 0,020 | 0,020 <sup>a</sup> | --    | -     | -    | -    | -    | -    | -    | -    | -    |
| G20Mn5          | 1.6220 | 0,17 | 0,23 | 0,60 | 1,00 | 1,60 | 0,020 | 0,020 <sup>a</sup> | -     | -     | -    | -    | -    | 0,80 | -    | -    | -    |
| G24Mn6          | 1.1118 | 0,20 | 0,25 | 0,60 | 1,50 | 1,80 | 0,020 | 0,015              | -     | -     | -    | -    | -    | -    | -    | -    | -    |
| G28Mn6          | 1.1165 | 0,25 | 0,32 | 0,60 | 1,20 | 1,80 | 0,035 | 0,030              | -     | -     | -    | -    | -    | -    | -    | -    | -    |
| G20Mo5          | 1.5419 | 0,15 | 0,23 | 0,60 | 0,50 | 1,00 | 0,025 | 0,020 <sup>a</sup> | -     | -     | 0,40 | 0,60 | -    | -    | -    | -    | -    |
| G10MnMoV6-3     | 1.5410 | -    | 0,12 | 0,60 | 1,20 | 1,80 | 0,025 | 0,020              | -     | -     | 0,20 | 0,40 | -    | -    | 0,05 | 0,10 | -    |
| G15CrMoV6-9     | 1.7710 | 0,12 | 0,18 | 0,60 | 0,60 | 1,00 | 0,025 | 0,020 <sup>a</sup> | 1,30  | 1,80  | 0,80 | 1,00 | -    | -    | 0,15 | 0,25 | -    |
| G17CrMo5-5      | 1.7357 | 0,15 | 0,20 | 0,60 | 0,50 | 1,00 | 0,025 | 0,020 <sup>a</sup> | 1,00  | 1,50  | 0,45 | 0,65 | -    | -    | -    | -    | -    |
| G17CrMo9-10     | 1.7379 | 0,13 | 0,20 | 0,60 | 0,50 | 0,90 | 0,025 | 0,020 <sup>a</sup> | 2,00  | 2,50  | 0,90 | 1,20 | -    | -    | -    | -    | -    |
| G26CrMo4        | 1.7221 | 0,22 | 0,29 | 0,60 | 0,50 | 0,80 | 0,025 | 0,020 <sup>a</sup> | 0,80  | 1,20  | 0,15 | 0,30 | -    | -    | -    | -    | -    |
| G34CrMo4        | 1.7230 | 0,30 | 0,37 | 0,60 | 0,50 | 0,80 | 0,025 | 0,020 <sup>a</sup> | 0,80  | 1,20  | 0,15 | 0,30 | -    | -    | -    | -    | -    |
| G42CrMo4        | 1.7231 | 0,38 | 0,45 | 0,60 | 0,60 | 1,00 | 0,025 | 0,020 <sup>a</sup> | 0,80  | 1,20  | 0,15 | 0,30 | -    | -    | -    | -    | -    |
| G30CrMoV6-4     | 1.7725 | 0,27 | 0,34 | 0,60 | 0,60 | 1,00 | 0,025 | 0,020 <sup>a</sup> | 1,30  | 1,70  | 0,30 | 0,50 | -    | -    | 0,05 | 0,15 | -    |
| G35CrNiMo6-6    | 1.6579 | 0,32 | 0,38 | 0,60 | 0,60 | 1,00 | 0,025 | 0,020 <sup>a</sup> | 1,40  | 1,70  | 0,15 | 0,35 | 1,40 | 1,70 | -    | -    | -    |
| G9Ni14          | 1.5638 | 0,06 | 0,12 | 0,60 | 0,50 | 0,80 | 0,020 | 0,015              | -     | -     | -    | -    | 3,00 | 4,00 | -    | -    | -    |
| GX9Ni5          | 1.5681 | 0,06 | 0,12 | 0,60 | 0,50 | 0,80 | 0,020 | 0,020              | -     | -     | -    | -    | 4,50 | 5,50 | -    | -    | -    |
| G20NiMoCr4      | 1.6750 | 0,17 | 0,23 | 0,60 | 0,80 | 1,20 | 0,025 | 0,015 <sup>a</sup> | 0,30  | 0,50  | 0,40 | 0,80 | 0,80 | 1,20 | -    | -    | -    |
| G32NiCrMo8-5-4  | 1.6570 | 0,28 | 0,35 | 0,60 | 0,60 | 1,00 | 0,020 | 0,015              | 1,00  | 1,40  | 0,30 | 0,50 | 1,60 | 2,10 | -    | -    | -    |
| G17NiCrMo13-6   | 1.6781 | 0,15 | 0,19 | 0,50 | 0,55 | 0,80 | 0,015 | 0,015              | 1,30  | 1,80  | 0,45 | 0,60 | 3,00 | 3,50 | -    | -    | -    |
| G30NiCrMo14     | 1.6771 | 0,27 | 0,33 | 0,60 | 0,60 | 1,00 | 0,030 | 0,020              | 0,80  | 1,20  | 0,30 | 0,60 | 3,00 | 4,00 | -    | -    | -    |
| GX3CrNi13-4     | 1.6982 | -    | 0,05 | 1,00 | -    | 1,00 | 0,035 | 0,015              | 12,00 | 13,50 | -    | 0,70 | 3,50 | 5,00 | -    | -    | -    |
| GX4CrNi13-4     | 1.4317 | -    | 0,06 | 1,00 | -    | 1,00 | 0,035 | 0,025              | 12,00 | 13,50 | -    | 0,70 | 3,50 | 5,00 | -    | -    | -    |
| GX4CrNi16-4     | 1.4421 | -    | 0,06 | 0,80 | -    | 1,00 | 0,035 | 0,020              | 15,50 | 17,50 | -    | 0,70 | 4,00 | 5,50 | -    | -    | -    |
| GX4CrNiMo16-5-1 | 1.4405 | -    | 0,06 | 0,80 | -    | 1,00 | 0,035 | 0,025              | 15,00 | 17,00 | 0,70 | 1,50 | 4,00 | 6,00 | -    | -    | -    |
| GX23CrMoV12-1   | 1.4931 | 0,20 | 0,26 | 0,40 | 0,50 | 0,80 | 0,030 | 0,020              | 11,30 | 12,20 | 1,00 | 1,20 | -    | 1,00 | 0,25 | 0,35 | 0,50 |

<sup>a</sup> For castings of ruling thickness < 28 mm, S ≤ 0,030 % (by mass) is permitted.

**Table 2 — Maximum contents of unspecified elements (% by mass)**

| Steel types                                              | Cr   | Mo   | Ni   | V                 | Cu   | Cr + Mo + Ni + V + Cu |
|----------------------------------------------------------|------|------|------|-------------------|------|-----------------------|
| non alloy steels                                         | 0,30 | 0,12 | 0,40 | 0,03              | 0,30 | 1,00                  |
| alloy steels                                             | 0,30 | 0,15 | 0,40 | 0,05 <sup>a</sup> | 0,30 | —                     |
| <sup>a</sup> 0,08 % V for steels with Cr ≥ 10 % by mass. |      |      |      |                   |      |                       |

### 7.2.2 Mechanical properties

In addition to EN 1559-2:2000:

**7.2.2.1** The mechanical properties shall conform to the values given in Table 3.

These values apply up to the maximum wall thickness given in Table 3. They are verified on test blocks of relevant thickness (see 8.4.1 of EN 1559-2:2000). In all cases the maximum wall thickness of test blocks shall be limited to 150 mm.

- In cases where the ruling thickness defined by the purchaser is above the maximum thickness given in Table 3, the foreseeable lowering of the mechanical properties shall be agreed.

**7.2.2.2** The yield strength values at room temperature correspond to 0,2 % proof strength ( $R_{p0,2}$ ).

- **7.2.2.3** In cases where two impact values are given, at test temperature in Table 3 the purchaser shall state which impact value is required. If there is no such statement in the enquiry and order the impact test shall be conducted at room temperature.

Table 3 — Mechanical properties

| Designation |        | Heat treatment <sup>a</sup> |                                    |                 | Thickness         | Mechanical properties                                |                                           |                       |                          |                        |
|-------------|--------|-----------------------------|------------------------------------|-----------------|-------------------|------------------------------------------------------|-------------------------------------------|-----------------------|--------------------------|------------------------|
|             |        |                             |                                    |                 |                   | Tensile test at room temperature                     |                                           |                       | Impact test <sup>b</sup> |                        |
| Name        | Number | Symbol <sup>c</sup>         | Normalizing or austenitizing<br>°C | Tempering<br>°C | <i>t</i><br>mm    | <i>R</i> <sub>p0,2</sub><br>MPa <sup>d</sup><br>min. | <i>R</i> <sub>m</sub><br>MPa <sup>d</sup> | <i>A</i><br>%<br>min. | <i>KV</i><br>J<br>min.   | Temperature<br>°C      |
| GE200       | 1.0420 | + N                         | 900 to 980 <sup>e</sup>            | -               | $t \leq 300$      | 200                                                  | 380 to 530                                | 25                    | 27                       | RT <sup>f</sup>        |
| GS200       | 1.0449 | +N                          | 900 to 980 <sup>e</sup>            | -               | $t \leq 100$      | 200                                                  | 380 to 530                                | 25                    | 35                       | RT <sup>f</sup>        |
| GE240       | 1.0446 | + N                         | 900 to 980 <sup>e</sup>            | -               | $t \leq 300$      | 240                                                  | 450 to 600                                | 22                    | 27                       | RT <sup>f</sup>        |
| GS240       | 1.0455 | +N                          | 880 to 980 <sup>e</sup>            | -               | $t \leq 100$      | 240                                                  | 450 to 600                                | 22                    | 31                       | RT <sup>f</sup>        |
| GE300       | 1.0558 | + N                         | 880 to 960 <sup>e</sup>            | -               | $t \leq 30$       | 300                                                  | 600 to 750                                | 15                    | 27                       | RT <sup>f</sup>        |
|             |        |                             |                                    |                 | $30 < t \leq 100$ | 300                                                  | 520 to 670                                | 18                    | 31                       | RT <sup>f</sup>        |
| G17Mn5      | 1.1131 | + QT                        | 920 to 980 <sup>e g</sup>          | 600 to 700      | $t \leq 50$       | 240                                                  | 450 to 600                                | 24                    | 27<br>70                 | -40<br>RT <sup>f</sup> |
| G20Mn5      | 1.6220 | + N                         | 900 to 980 <sup>e</sup>            | -               | $t \leq 30$       | 300                                                  | 480 to 620                                | 20                    | 27<br>50                 | -30<br>RT <sup>f</sup> |
|             |        | + QT                        | 900 to 980 <sup>e g</sup>          | 610 to 660      | $t \leq 100$      | 300                                                  | 500 to 650                                | 22                    | 27<br>60                 | -40<br>RT <sup>f</sup> |
| G24Mn6      | 1.1118 | + QT1                       | 880 to 950 <sup>g</sup>            | 520 to 570      | $t \leq 50$       | 550                                                  | 700 to 800                                | 12                    | 27                       | - 20                   |
|             |        | + QT2                       |                                    | 600 to 650      | $t \leq 100$      | 500                                                  | 650 to 800                                | 15                    | 27                       | - 30                   |
|             |        | + QT3                       |                                    | 650 to 680      | $t \leq 150$      | 400                                                  | 600 to 800                                | 18                    | 27                       | - 30                   |
| G28Mn6      | 1.1165 | + N                         | 880 to 950 <sup>e</sup>            |                 | $t \leq 250$      | 260                                                  | 520 to 670                                | 18                    | 27                       | RT <sup>f</sup>        |
|             |        | + QT1                       | 880 to 950 <sup>g</sup>            | 630 to 680      | $t \leq 100$      | 450                                                  | 600 to 750                                | 14                    | 35                       | RT <sup>f</sup>        |
|             |        | + QT2                       | 880 to 950 <sup>g</sup>            | 580 to 630      | $t \leq 50$       | 550                                                  | 700 to 850                                | 10                    | 31                       | RT <sup>f</sup>        |
| G20Mo5      | 1.5419 | + QT                        | 920 to 980 <sup>g</sup>            | 650 to 730      | $t \leq 100$      | 245                                                  | 440 to 590                                | 22                    | 27                       | RT <sup>f</sup>        |

"to be continued"

Table 3 (continued)

| Designation              |        | Heat treatment <sup>a</sup> |                                    |                 | Thickness            | Mechanical properties                                |                                           |                       |                          |                        |
|--------------------------|--------|-----------------------------|------------------------------------|-----------------|----------------------|------------------------------------------------------|-------------------------------------------|-----------------------|--------------------------|------------------------|
|                          |        |                             |                                    |                 |                      | Tensile test at room temperature                     |                                           |                       | Impact test <sup>b</sup> |                        |
| Name                     | Number | Symbol <sup>c</sup>         | Normalizing or austenitizing<br>°C | Tempering<br>°C | <i>t</i><br>mm       | <i>R</i> <sub>p0,2</sub><br>MPa <sup>d</sup><br>min. | <i>R</i> <sub>m</sub><br>MPa <sup>d</sup> | <i>A</i><br>%<br>min. | <i>KV</i><br>J<br>min.   | Temperature<br>°C      |
| G10MnMoV6-3              | 1.5410 | + QT1                       | 950 to 980 <sup>e</sup>            | 640 to 660      | <i>t</i> ≤ 50        | 380                                                  | 500 to 650                                | 22                    | 27<br>60                 | -20<br>RT <sup>f</sup> |
|                          |        |                             |                                    |                 | 50 < <i>t</i> ≤ 100  | 350                                                  | 480 to 630                                | 22                    | 60                       | RT <sup>f</sup>        |
|                          |        |                             |                                    |                 | 100 < <i>t</i> ≤ 150 | 330                                                  | 480 to 630                                | 20                    | 60                       | RT <sup>f</sup>        |
|                          |        |                             |                                    |                 | 150 < <i>t</i> ≤ 250 | 330                                                  | 450 to 600                                | 18                    | 60                       | RT <sup>f</sup>        |
|                          |        | + QT2                       | 950 to 980 <sup>g</sup>            | 640 to 660      | <i>t</i> ≤ 50        | 500                                                  | 600 to 750                                | 18                    | 27<br>60                 | -20<br>RT <sup>f</sup> |
|                          |        |                             |                                    |                 | 50 < <i>t</i> ≤ 100  | 400                                                  | 550 to 700                                | 18                    | 60                       | RT <sup>f</sup>        |
|                          |        |                             |                                    |                 | 100 < <i>t</i> ≤ 150 | 380                                                  | 500 to 650                                | 18                    | 60                       | RT <sup>f</sup>        |
|                          |        |                             |                                    |                 | 150 < <i>t</i> ≤ 250 | 350                                                  | 460 to 610                                | 18                    | 60                       | RT <sup>f</sup>        |
|                          |        | +QT3                        | 950 to 980 <sup>g</sup>            | 740 to 760      | <i>t</i> ≤ 100       | 400                                                  | 520 to 650                                | 22                    | 27                       | -20                    |
|                          |        |                             |                                    | +600 to 650     |                      |                                                      |                                           |                       | 60                       | RT <sup>f</sup>        |
| G15CrMoV6-9 <sup>h</sup> | 1.7710 | + QT1                       | 950 to 980 <sup>g</sup>            | 650 to 670      | <i>t</i> ≤ 50        | 700                                                  | 850 to 1 000                              | 10                    | 27                       | RT <sup>f</sup>        |
|                          |        | + QT2                       | 950 to 980 <sup>g</sup>            | 610 to 640      | <i>t</i> ≤ 50        | 930                                                  | 980 to 1 150                              | 6                     | 27                       | RT <sup>f</sup>        |
| G17CrMo5-5               | 1.7357 | + QT                        | 920 to 960 <sup>e g</sup>          | 680 to 730      | <i>t</i> ≤ 100       | 315                                                  | 490 to 690                                | 20                    | 27                       | RT <sup>f</sup>        |
| G17CrMo9-10              | 1.7379 | + QT                        | 930 to 970 <sup>e g</sup>          | 680 to 740      | <i>t</i> ≤ 150       | 400                                                  | 590 to 740                                | 18                    | 40                       | RT <sup>f</sup>        |
| G26CrMo4                 | 1.7221 | + QT 1                      | 880 to 950 <sup>e g</sup>          | 600 to 650      | <i>t</i> ≤ 100       | 450                                                  | 600 to 750                                | 16                    | 40                       | RT <sup>f</sup>        |
|                          |        |                             |                                    |                 | 100 < <i>t</i> ≤ 250 | 300                                                  | 550 to 700                                | 14                    | 27                       | RT <sup>f</sup>        |
|                          |        | + QT 2                      | 880 to 950 <sup>g</sup>            | 550 to 600      | <i>t</i> ≤ 100       | 550                                                  | 700 to 850                                | 10                    | 18                       | RT <sup>f</sup>        |
| G34CrMo4                 | 1.7230 | + QT 1                      | 880 to 950 <sup>g</sup>            | 600 to 650      | <i>t</i> ≤ 100       | 540                                                  | 700 to 850                                | 12                    | 35                       | RT <sup>f</sup>        |
|                          |        |                             |                                    |                 | 100 < <i>t</i> ≤ 150 | 480                                                  | 620 to 770                                | 10                    | 27                       | RT <sup>f</sup>        |
|                          |        |                             |                                    |                 | 150 < <i>t</i> ≤ 250 | 330                                                  | 620 to 770                                | 10                    | 16                       | RT <sup>f</sup>        |
|                          |        | + QT 2                      | 880 to 950 <sup>g</sup>            | 550 to 600      | <i>t</i> ≤ 100       | 650                                                  | 830 to 980                                | 10                    | 27                       | RT <sup>f</sup>        |

"to be continued"

Table 3 (continued)

| Designation       |        | Heat treatment <sup>a</sup> |                                 |              | Thickness            | Mechanical properties                                    |                                               |                           |                            |                          |
|-------------------|--------|-----------------------------|---------------------------------|--------------|----------------------|----------------------------------------------------------|-----------------------------------------------|---------------------------|----------------------------|--------------------------|
|                   |        |                             |                                 |              |                      | Tensile test at room temperature                         |                                               |                           | Impact test <sup>b</sup>   |                          |
| Name              | Number | Symbol <sup>c</sup>         | Normalizing or austenitizing °C | Tempering °C | <i>t</i><br><br>mm   | <i>R</i> <sub>p0,2</sub><br><br>MPa <sup>d</sup><br>min. | <i>R</i> <sub>m</sub><br><br>MPa <sup>d</sup> | <i>A</i><br><br>%<br>min. | <i>KV</i><br><br>J<br>min. | Temperature<br><br>°C    |
| G42CrMo4          | 1.7231 | + QT1                       | 880 to 950 g                    | 600 to 650   | <i>t</i> ≤ 100       | 600                                                      | 800 to 950                                    | 12                        | 31                         | RT <sup>f</sup>          |
|                   |        |                             |                                 |              | 100 < <i>t</i> ≤ 150 | 550                                                      | 700 to 850                                    | 10                        | 27                         | RT <sup>f</sup>          |
|                   |        |                             |                                 |              | 150 < <i>t</i> ≤ 250 | 350                                                      | 650 to 800                                    | 10                        | 16                         | RT <sup>f</sup>          |
|                   |        | + QT2                       | 880 to 950 g                    | 550 to 600   | <i>t</i> ≤ 100       | 700                                                      | 850 to 1 000                                  | 10                        | 27                         | RT <sup>f</sup>          |
| G30CrMoV6-4       | 1.7725 | + QT1                       | 880 to 950 g                    | 600 to 650   | <i>t</i> ≤ 100       | 700                                                      | 850 to 1 000                                  | 14                        | 45                         | RT <sup>f</sup>          |
|                   |        |                             |                                 |              | 100 < <i>t</i> ≤ 150 | 550                                                      | 750 to 900                                    | 12                        | 27                         | RT <sup>f</sup>          |
|                   |        |                             |                                 |              | 150 < <i>t</i> ≤ 250 | 350                                                      | 650 to 800                                    | 12                        | 20                         | RT <sup>f</sup>          |
|                   |        | + QT2                       | 880 to 950 g                    | 530 to 600   | <i>t</i> ≤ 100       | 750                                                      | 900 to 1 100                                  | 12                        | 31                         | RT <sup>f</sup>          |
| G35CrNiMo6-6      | 1.6579 | + N                         | 860 to 920 <sup>e</sup>         |              | <i>t</i> ≤ 150       | 550                                                      | 800 to 950                                    | 12                        | 31                         | RT <sup>f</sup>          |
|                   |        |                             |                                 |              | 150 < <i>t</i> ≤ 250 | 500                                                      | 750 to 900                                    | 12                        | 31                         | RT <sup>f</sup>          |
|                   |        | + QT1                       | 860 to 920 <sup>e</sup> g       | 600 to 650   | <i>t</i> ≤ 100       | 700                                                      | 850 to 1 000                                  | 12                        | 45                         | RT <sup>f</sup>          |
|                   |        |                             |                                 |              | 100 < <i>t</i> ≤ 150 | 650                                                      | 800 to 950                                    | 12                        | 35                         | RT <sup>f</sup>          |
|                   |        |                             |                                 |              | 150 < <i>t</i> ≤ 250 | 650                                                      | 800 to 950                                    | 12                        | 30                         | RT <sup>f</sup>          |
|                   |        | + QT2                       | 860 to 920 g                    | 510 to 560   | <i>t</i> ≤ 100       | 800                                                      | 900 to 1 050                                  | 10                        | 35                         | RT <sup>f</sup>          |
| G9Ni14            | 1.5638 | + QT                        | 820 to 900 g                    | 590 to 640   | <i>t</i> ≤ 35        | 360                                                      | 500 to 650                                    | 20                        | 27                         | - 90                     |
| GX9Ni5            | 1.5681 | + QT                        | 800 to 850 g                    | 570 to 620   | <i>t</i> ≤ 30        | 380                                                      | 550 to 700                                    | 18                        | 27<br>100                  | - 100<br>RT <sup>f</sup> |
| G20NiMoCr4        | 1.6750 | + QT                        | 880 to 930 <sup>e</sup> g       | 650 to 700   | <i>t</i> ≤ 150       | 410                                                      | 570 to 720                                    | 16                        | 27<br>40                   | - 45<br>RT <sup>f</sup>  |
| G32NiCrMo8-5-4    | 1.6570 | + QT1                       | 880 to 920 <sup>e</sup> g       | 600 to 650   | <i>t</i> ≤ 100       | 700                                                      | 850 to 1 000                                  | 16                        | 50                         | RT <sup>f</sup>          |
|                   |        |                             |                                 |              | 100 < <i>t</i> ≤ 250 | 650                                                      | 820 to 970                                    | 14                        | 35                         | RT <sup>f</sup>          |
|                   |        | + QT2                       | 880 to 920 <sup>e</sup> g       | 500 to 550   | <i>t</i> ≤ 100       | 950                                                      | 1 050 to 1 200                                | 10                        | 35                         | RT <sup>f</sup>          |
| G17NiCrMo13-6     | 1.6781 | + QT                        | 890 to 930 <sup>e</sup> g       | 600 to 640   | <i>t</i> ≤ 200       | 600                                                      | 750 to 900                                    | 15                        | 27                         | - 80                     |
| "to be continued" |        |                             |                                 |              |                      |                                                          |                                               |                           |                            |                          |

"to be continued"

Table 3 (concluded)

| Designation     |        | Heat treatment <sup>a</sup> |                                    |                                         | Thickness            | Mechanical properties                                    |                                               |                           |                            |                       |
|-----------------|--------|-----------------------------|------------------------------------|-----------------------------------------|----------------------|----------------------------------------------------------|-----------------------------------------------|---------------------------|----------------------------|-----------------------|
|                 |        |                             |                                    |                                         |                      | Tensile test at room temperature                         |                                               |                           | Impact test <sup>b</sup>   |                       |
| Name            | Number | Symbol <sup>c</sup>         | Normalizing or austenitizing<br>°C | Tempering<br>°C                         | <i>t</i><br><br>mm   | <i>R</i> <sub>p0,2</sub><br><br>MPa <sup>d</sup><br>min. | <i>R</i> <sub>m</sub><br><br>MPa <sup>d</sup> | <i>A</i><br><br>%<br>min. | <i>KV</i><br><br>J<br>min. | Temperature<br><br>°C |
| G30NiCrMo14     | 1.6771 | + QT1                       | 820 to 880 <sup>e</sup> g          | 600 to 680                              | <i>t</i> ≤ 100       | 700                                                      | 900 to 1 050                                  | 9                         | 30                         | RT <sup>f</sup>       |
|                 |        |                             |                                    |                                         | 100 < <i>t</i> ≤ 150 | 650                                                      | 850 to 1 000                                  | 7                         | 30                         | RT <sup>f</sup>       |
|                 |        |                             |                                    |                                         | 150 < <i>t</i> ≤ 250 | 600                                                      | 800 to 950                                    | 7                         | 25                         | RT <sup>f</sup>       |
|                 |        | + QT2                       | 820 to 880 <sup>e</sup> g          | 550 to 600                              | <i>t</i> ≤ 50        | 1 000                                                    | 1 100 to 1 250                                | 7                         | 20                         | RT <sup>f</sup>       |
|                 |        |                             |                                    |                                         | 50 < <i>t</i> ≤ 100  | 1 000                                                    | 1 100 to 1 250                                | 7                         | 15                         | RT <sup>f</sup>       |
| GX3CrNi13-4     | 1.6982 | + QT                        | 1 000 to 1 050 <sup>e</sup>        | 670 to 690 <sup>e</sup><br>+ 590 to 620 | <i>t</i> ≤ 300       | 500                                                      | 700 to 900                                    | 15                        | 27                         | - 120                 |
| GX4CrNi13-4     | 1.4317 | + QT                        | 1 000 to 1 050 <sup>e</sup>        | 590 to 620                              | <i>t</i> ≤ 300       | 550                                                      | 760 to 960                                    | 15                        | 50                         | RT <sup>f</sup>       |
| GX4CrNi16-4     | 1.4421 | + QT1                       | 1 020 to 1 070 <sup>e</sup>        | 580 to 630                              | <i>t</i> ≤ 300       | 540                                                      | 780 to 980                                    | 15                        | 60                         | RT <sup>f</sup>       |
|                 |        | + QT2                       | 1 020 to 1 070 <sup>e</sup>        | 450 to 500                              | <i>t</i> ≤ 300       | 830                                                      | 1 000 to 1 200                                | 10                        | 27                         | RT <sup>f</sup>       |
| GX4CrNiMo16-5-1 | 1.4405 | + QT                        | 1 020 to 1 070 <sup>e</sup>        | 580 to 630                              | <i>t</i> ≤ 300       | 540                                                      | 760 to 960                                    | 15                        | 60                         | RT <sup>f</sup>       |
| GX23CrMoV12-1   | 1.4931 | + QT                        | 1 030 to 1 080 <sup>e</sup> g      | 700 to 750                              | <i>t</i> ≤ 150       | 540                                                      | 740 to 880                                    | 15                        | 27                         | RT <sup>f</sup>       |

<sup>a</sup> Temperature (for information only).

<sup>b</sup> If two impact values are given, see 7.2.2.3.

<sup>c</sup> + N means: Normalizing, + QT or + QT1 or + QT2 means: Quenching (air or liquid) + Tempering.

<sup>d</sup> 1 MPa = 1N/mm<sup>2</sup>.

<sup>e</sup> Cooling in air (for information only).

<sup>f</sup> RT means Room Temperature.

<sup>g</sup> Cooling in liquid (for information only).

<sup>h</sup> This grade G15CrMoV6-9 is applicable for short time uses at elevated temperature and the following yield strength values can be agreed:

|                   |                                      |        |        |        |
|-------------------|--------------------------------------|--------|--------|--------|
|                   | <i>R</i> <sub>p0,2</sub> min.<br>MPa |        |        |        |
|                   | 350 °C                               | 450 °C | 500 °C | 550 °C |
| G15CrMoV6-9 + QT1 | 610                                  | 550    | 510    | 420    |
| + QT2             | 750                                  | 670    | 610    | 520    |

### ●● 7.2.3 Other properties (magnetic properties)

By agreement at the enquiry and order, values as indicated in Table 4 for the magnetic induction shall be required. In this case the measuring procedure to be used to determine magnetic induction shall be agreed.

**Table 4 — Magnetic properties**

| Designation |        | Minimum magnetic induction in Tesla at a field intensity of |          |           |
|-------------|--------|-------------------------------------------------------------|----------|-----------|
|             |        | 2,5 kA/m                                                    | 5,0 kA/m | 10,0 kA/m |
| Name        | Number |                                                             |          |           |
| GE200       | 1.0420 | 1,45                                                        | 1,60     | 1,75      |
| GE240       | 1.0446 | 1,40                                                        | 1,55     | 1,70      |
| GE300       | 1.0558 | 1,30                                                        | 1,50     | 1,65      |

## 7.3 Casting

### ■ 7.3.1 Chemical composition

### 7.3.2 Mechanical properties

In addition to EN 1559-2:2000:

- the values of yield and tensile strength given in Table 3 also apply to the casting itself up to the maximum wall thickness stated.

### ■ 7.3.3 Non destructive testing

### ■ 7.3.4 Conditions of the casting

#### ● 7.3.4.1 General (shape, dimensions and tolerances)

#### ■ 7.3.4.2 Fettling and finishing

### ■ 7.3.5 Mass of the casting

### ■ 7.3.6 Additional requirements regarding the condition of the casting

## 8 Testing and documents on material testing

### ■ 8.1 General

### ■ 8.2 Inspection and testing

### ■ 8.3 Test unit sampling

### ■ 8.4 Samples (test blocks)

## 8.5 Test methods

- a) tensile test at room temperature;
- b) tensile test at elevated temperature only for grade G15CrMoV6-9 ;
- c) impact test;
- d) ferrite content test not applicable;
- e) hardness test;
- f) homogeneity of test units (hardness test);
- g) pressure or leak testing;
- h) intergranular corrosion test not applicable;
- i) tests for magnetic properties only for grades GE200, GE240, GE300;
- j) other tests for any other properties shall be agreed.

## ■ 8.6 Invalidation of tests

## ■ 8.7 Retests

## ■ 8.8 Sorting and reprocessing

## ■ 9 Identification and marking

## ■ 10 Packaging and surface protection

## ■ 11 Complaints

## Annex A (informative)

### Guidance data for welding

**Table A.1 — Guidance data for welding**

| Designation     |        | Preheat temperature <sup>a</sup> | Interpass temperature max. | Post weld heat treatment |
|-----------------|--------|----------------------------------|----------------------------|--------------------------|
| Name            | Number | °C                               | °C                         | °C                       |
| GE200           | 1.0420 | 20 to 150                        | 350                        | none                     |
| GS200           | 1.0449 | 20 to 150                        | 350                        | none                     |
| GE240           | 1.0446 | 20 to 150                        | 350                        | none                     |
| GS240           | 1.0455 | 20 to 150                        | 350                        | none                     |
| GE300           | 1.0558 | 150 to 300                       | 350                        | ≥ 650                    |
| G17Mn5          | 1.1131 | 20 to 150                        | 350                        | none                     |
| G20Mn5          | 1.6220 | 20 to 150                        | 350                        | none                     |
| G24Mn6          | 1.1118 | 20 to 150                        | 350                        | b                        |
| G28Mn6          | 1.1165 | 20 to 150                        | 350                        | b                        |
| G20Mo5          | 1.5419 | 20 to 200                        | 350                        | ≥ 650 <sup>b</sup>       |
| G10MnMoV6-3     | 1.5410 | 20 to 150                        | 350                        | none or <sup>b</sup>     |
| G15CrMoV6-9     | 1.7710 | 200 to 300                       | 350                        | b                        |
| G17CrMo5-5      | 1.7357 | 150 to 250                       | 350                        | ≥ 650 <sup>b</sup>       |
| G17CrMo9-10     | 1.7379 | 150 to 250                       | 350                        | ≥ 680 <sup>b</sup>       |
| G26CrMo4        | 1.7221 | 150 to 300                       | 350                        | b                        |
| G34CrMo4        | 1.7230 | 200 to 350                       | 400                        | b                        |
| G42CrMo4        | 1.7231 | 200 to 350                       | 400                        | b                        |
| G30CrMoV6-4     | 1.7725 | 200 to 350                       | 400                        | b                        |
| G35CrNiMo6-6    | 1.6579 | 200 to 350                       | 400                        | b                        |
| G9Ni14          | 1.5638 | 20 to 200                        | 300                        | ≥ 560                    |
| GX9Ni5          | 1.5681 | 20 to 200                        | 350                        | b                        |
| G18NiMoCr3-6    | 1.6759 | 20 to 200                        | 350                        | b                        |
| G20NiMoCr4      | 1.6750 | 150 to 300                       | 350                        | b                        |
| G32NiCrMo8-5-4  | 1.6570 | 200 to 350                       | 400                        | ≥ 560                    |
| G17NiCrMo13-6   | 1.6781 | 20 to 200                        | 350                        | ≥ 560                    |
| G30NiCrMo14     | 1.6771 | 300 to 350                       | 350                        | b                        |
| GX3CrNi13-4     | 1.6982 | 20 to 200                        | c                          | c                        |
| GX4CrNi13-4     | 1.4317 | 100 to 200                       | 300                        | d                        |
| GX4CrNi16-4     | 1.4421 | no preheat                       | 200                        | d                        |
| GX4CrNiMo16-5-1 | 1.4405 | no preheat                       | 200                        | d                        |
| GX23CrMoV12-1   | 1.4931 | 20 to 450                        | 450                        | ≥ 680 <sup>e</sup>       |

<sup>a</sup> The preheating temperature is related to the geometry, the thickness of the casting and climate conditions.

<sup>b</sup> The post weld heat treatment temperature shall be at least 20 K but not more than 50 K below the tempering temperature, (e.g.: for a tempering temperature of 650 °C the post weld heat treatment temperature shall be between 600 °C and 630 °C).

<sup>c</sup> At the discretion of the manufacturer unless otherwise agreed.

<sup>d</sup> Same as normal tempering temperature.

<sup>e</sup> After cooling to a temperature between 80 °C to 130 °C.

## Bibliography

- [1] EN 1559-1:1997, *Founding — Technical conditions of delivery — Part 1: General*



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