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General-purpose steel castings with enhanced weldability and higher toughness

Technical delivery conditions

DIN 17 182

Stahlgußsorten mit verbesserter Schweißeignung und Zähigkeit für allgemeine Verwendungszwecke; technische Lieferbedingungen

Supersedes June 1985 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

The symbol ● denotes items which shall, the symbol ●● denoting items which may, be agreed upon at the time of ordering.

1 Scope and field of application

This standard, in conjunction with DIN 1690 Parts 1 and 2, specifies technical delivery conditions for steel castings made from the steel grades specified in table 1 and having the mechanical properties specified in table 3. Such castings are used predominantly at temperatures between −10 and 300 °C.

Further relevant specifications are given in DIN 1681, DIN 17 205, DIN 17 245, *Stahl-Eisen-Werkstoffblätter* (Iron and steel materials sheets) (SEW) 520 and 685.

2 Concept

For the purposes of this standard, steel castings with enhanced weldability and higher toughness are castings made from unalloyed or low-alloy steel having similar strength characteristics as the steel specified in DIN 1681, but a much higher impact strength and, owing to their low carbon content (0,23 % or less), are highly suitable for welding.

3 Designation

The designation to be used when ordering shall give the name of the product (steel casting), the DIN number (DIN 17 182), the material designation or number, and the symbol denoting heat treatment condition or strength class.

Example:

Designation of a steel casting complying with this standard, made of a material identified by material designation GS-20 Mn 5 (material number 1.1120), supplied in the quenched and tempered condition (V):

Steel casting DIN 17 182 – GS-20 Mn 5 V

or

Steel casting DIN 17 182 – 1.1120 V

Note. The material designations given in table 1 have been taken from the Explanatory notes to the 1983 edition of *DIN-Normenheft* (Standardization booklet) 3, and the material numbers, from DIN 17 007 Part 2.

4 Steel grades

The materials covered in this standard are classified according to their chemical composition and their mechanical properties at ambient temperature.

5 Requirements

5.1 Steelmaking process

The steel shall be made in an electric furnace using the oxygen method or an equivalent method.

●● If so agreed, the purchaser shall be informed of the steelmaking process used.

5.2 Heat treatment condition

5.2.1 Steel castings shall be supplied in one of the heat treatment conditions specified in table 3.

● In the case of grades GS-20 Mn 5 and GS-13 MnNi 6 4, the heat treatment condition or strength class shall be agreed at the time of ordering.

Table 6 gives guideline values for heat treatment temperatures.

5.2.2 ●● Where machined castings are supplied, the purchaser shall be permitted to request that they be stress-relieved. Stress-relieving will not be necessary where the castings are either quenched and tempered or fabrication-welded after machining, and where the rate of cooling from the tempering or annealing temperature to 300 °C is less than 25 K/h.

5.3 Chemical composition

5.3.1 The chemical composition, as determined by cast analysis, shall be in compliance with table 1.

5.3.2 Where a product analysis of a cast-on test piece is to be carried out, the results may deviate from the values given in table 1 by the amounts listed in table 2.

5.3.3 ●● Subject to agreement, deviations from the specifications given in subclauses 5.3.1 and 5.3.2 are permitted, provided the mechanical properties, weldability, and the performance of the finished product are not adversely affected. If necessary, limit deviations shall be agreed at the time of ordering.

5.4 Mechanical properties

5.4.1 The values of mechanical properties specified in table 3, as determined on a cast-on test piece or a separately cast test piece, shall be complied with.

The values of yield stress, tensile strength and impact energy specified in table 3 shall apply for test pieces and

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products having the maximum ruling section thicknesses specified.

●● Where elongation at fracture is to be determined on test pieces taken from the product, the required value shall be the subject of agreement.

5.4.2 Impact energy shall be determined on three test pieces. The minimum values specified shall apply for the mean from these three, it being permitted for one single value to be lower than the specified minimum value, but not less than 70 % of that value.

5.4.3 Guideline values for impact transition temperature are given in table 4.

5.5 Surface quality

5.5.1 The general surface quality requirements specified in DIN 1690 Part 2 shall be complied with.

Note. In the case of castings for heavy-duty valves, the requirements specified in DIN 1690 Part 10 shall be complied with.

5.5.2 ●● Where special agreement has not been reached regarding the internal and external condition, the products shall fulfil the requirements of severity level 5 as specified in DIN 1690 Part 2.

5.6 Welding

5.6.1 The general welding requirements specified in DIN 1690 Part 1 shall be complied with.

5.6.2 Filler metals shall be selected as a function of the steel grade, the product geometry, the stresses expected in service, and the post-weld heat treatment. Where annealing is carried out after welding, the filler metal shall be carefully selected so that the product continues to comply with the requirements specified for mechanical properties. Suggested filler metals of proven suitability are given in table 5.

5.6.3 The preheat temperature and interpass temperature shall be selected as a function of the steel grade, the welding conditions, and the ruling section thickness and geometry of the product. As a rule, the preheat temperature should be higher as internal stresses increase. Where the maximum section thickness is between 30 and 80 mm, and where manual metal-arc welding with covered electrode is used as the welding process, the preheat and interpass temperatures should be between 100 and 250 °C.

For the purposes of this standard and as a departure from DIN 32 524, the interpass temperature is defined as the temperature at the middle of the weld bead before the next run is welded. Use of a thermocrayon to measure the interpass temperature is not permitted.

5.6.4 Where annealing is carried out after welding, the annealing temperature for grades GS-16 Mn 5 and GS-20 Mn 5 shall be between 600 and 640 °C. Where castings are quenched and tempered, the annealing temperature shall be a minimum of 20 K and a maximum of 50 K below the tempering temperature, which shall be specified by the casting manufacturer.

6 Testing and inspection documents

6.1 General

The general requirements for testing and for inspection documents specified in DIN 1690 Part 1 shall be complied with.

6.2 Inspection documents

6.2.1 ● Castings shall be supplied with a DIN 50 049 inspection document, the type of document being the subject of agreement at the time of ordering.

In the case of third party inspection, the purchaser's representative or the testing agency shall be stated at the time of ordering and, where required, on the inspection document (e.g. DIN 50 049 – 3.1 C inspection certificate).

6.2.2 Where it has been agreed to issue a DIN 50 049 inspection certificate or inspection report, this shall include the following particulars:

a) the results of cast analysis for all elements specified in table 1 for the relevant steel grade;
b) the results of testing for compliance with the values for mechanical properties specified in table 3;
c) in the case of castings assigned to severity levels S 01 to S 3 or V 1 to V 3 as specified in DIN 1690 Part 2, the results of non-destructive testing used to verify the general casting quality and basis for assignment to a particular severity level;
d) The results of any additional tests agreed upon;
e) symbol denoting heat treatment condition and, where required, the strength class;
f) marking (cf. clause 7);
g) inspector's mark.

6.3 Tests on the castings supplied

6.3.1 General

The castings supplied, or a batch therefrom, shall be tested in accordance with DIN 1690 Parts 1 and 2, taking into account the specifications of subclauses 6.3.2 to 6.3.4.

6.3.2 Tests to be carried out

Castings shall be subjected to the tests referred to in subclause 6.2.2, items a) to d).

6.3.3 Scope of testing

Where it has been agreed to test batches of castings for compliance with the requirements specified in table 3, the mass of a batch shall be a maximum of:

a) 2500 kg where it consists of products made from the same material or originating from same cast;
b) 1500 kg where it consists of products from the same heat treatment batch.

Remainders with a total mass of not more than half the maximum amounts specified above may be distributed uniformly among the other batches.

Testing of batches as delivered is not permitted.

When testing products originating from the same cast, not more than four batches per cast need be tested.

6.3.4 Non-destructive testing

To determine the internal and external condition, test pieces shall be taken and subjected to non-destructive testing in accordance with DIN 54 111 Part 2, *Stahl-Eisen-Prüfblätter* (Iron and steel test sheets) (SEP) 1922, 1935 and 1936.

6.4 Sampling

Sampling shall be carried out in accordance with DIN 1690 Part 1, the maximum section thickness of cast-on test pieces or those cast separately being 150 mm.

7 Marking

7.1 Castings shall be marked with the material designation and the manufacturer's mark.

7.2 The requirements specified in DIN 1690 Part 1, regarding the marking of castings supplied with an inspection certificate, also apply to castings supplied with an inspection report.

Table 1. **Steel grades and their chemical composition as determined by cast analysis**

Material designation	number	Content, as a percentage by mass								
		C	Si ≤	Mn	P ≤	S ≤	Cr ≤	Mo	Ni	Others
GS-16 Mn 5	**1.1131**	0,15 to 0,20	0,60	1,00 to 1,50	0,020	0,015	0,30	≤ 0,15	≤ 0,40	–
GS-20 Mn 5	**1.1120**	0,17 to 0,23								
GS-8 Mn 7	**1.5015**	0,06 to 0,10	0,60	1,50 to 1,80	0,020	0,015	0,20	–	–	Nb ≤ 0,05 V ≤ 0,10 N ≤ 0,02
GS-8 MnMo 7 4	**1.5430**	0,06 to 0,10	0,60	1,50 to 1,80	0,020	0,015	0,20	0,30 to 0,40	–	Nb ≤ 0,05 V ≤ 0,10 N ≤ 0,02
GS-13 MnNi 6 4	**1.6221**	0,08 to 0,15	0,60	1,00 to 1,70	0,020	0,010	0,30	≤ 0,20	0,80 to 1,20	Nb ≤ 0,05 V ≤ 0,10 N ≤ 0,02

Table 2. **Amounts by which the chemical composition as determined by product analysis may deviate from the limiting values specified for cast analysis**

Element	Limiting values as determined by cast analysis, as in table 1, as a percentage by mass	Limit deviation for product analysis[1], as a percentage by mass
C	≤ 0,10 > 0,10 to ≤ 0,23	± 0,01 ± 0,02
Si	≤ 0,60	+ 0,05
Mn	≥ 1,00 to ≤ 1,80	± 0,10
P	≤ 0,020	+ 0,003
S	≤ 0,015	+ 0,003
Cr	≤ 0,30	+ 0,05
Mo	≤ 0,40	± 0,05
N	≤ 0,02	+ 0,01
Nb	≤ 0,05	+ 0,01
Ni	≤ 1,20	± 0,08
V	≤ 0,10	+ 0,01

1) If a number of product analyses are to be carried out, the deviations shown by an element within one cast shall lie either only above the upper limit or below the lower limit of the range specified for the cast analysis, but not both at the same time.

Table 3. **Mechanical properties at ambient temperature of steel castings**[1]

Material designation	Material number	Heat treatment condition	Wall thickness, in mm	Min. upper yield stress, R_{eH}[2] [3], in N/mm²	Tensile strength, R_m[2], in N/mm²	Min. elongation at fracture, A_5, in %	Min. impact energy (ISO-V), A_v[2] [4], in J
GS-16 Mn 5	**1.1131**	Normalized (N)	Up to 50	260	430 up to 600	25	65
			Over 50 up to 100	230	430 up to 600	25	45
GS-20 Mn 5	**1.1120**	Normalized (N)	Up to 50	300	500 up to 650	22	55
			Over 50 up to 100	280	500 up to 650	22	40
			Over 100 up to 160	260	480 up to 630	20	35
			Over 160	240	450 up to 600		
GS-20 Mn 5	**1.1120**	Quenched and tempered (V)	Up to 50	360	500 up to 650	24	70
			Over 50 up to 100	300	500 up to 650	24	50
			Over 100 up to 160	280	500 up to 650	22	40
GS-8 Mn 7	**1.5015**	Quenched and tempered (V)	Up to 60	350	500 up to 650	22	80
GS-8 MnMo 7 4	**1.5450**	Quenched and tempered (V)	Up to 300	350	500 up to 650	22	80
GS-13 MnNi 6 4	**1.6221**	Quenched and tempered (V I)	Up to 500	300	460 up to 610	22	80
		Quenched and tempered (V II)	Up to 200	340	480 up to 630	20	80

1) The values specified apply for cast-on test pieces or those cast separately.
2) The values specified apply for test pieces taken from the product.
3) If there is no pronounced yield stress, the values shall apply for the 0,2 % proof stress.
4) Represents the mean from three test pieces.

Table 4. **Guideline values for impact transition temperature** (for 27 J)

Material		Heat treatment condition	Wall thickness, in mm	Approx. impact transition temperature (for 27 J), in °C
designation	number			
GS-16 Mn 5	**1.1131**	Normalized (N)	Up to 50	- 25
			Over 50 up to 100	- 15
GS-20 Mn 5	**1.1120**	Normalized (N)	Up to 50	- 20
			Over 50 up to 100	- 10
			Over 100 up to 160	0
			Over 160	
GS-20 Mn 5	**1.1120**	Quenched and tempered (V)	Up to 50	- 30
			Over 50 up to 100	- 20
			Over 100 up to 160	- 10
GS-8 Mn 7	**1.5015**	Quenched and tempered (V)	Up to 60	- 40
GS-8 MnMo 7 4	**1.5450**	Quenched and tempered (V)	Up to 300	- 40
GS-13 MnNi 6 4	**1.6221**	Quenched and tempered (V I)	Up to 500	- 40
		Quenched and tempered (V II)	Up to 200	- 40

Table 5. **Information on welding**[1]) (for guidance purposes)

Material		Heat treatment condition	Suitable filler metal as specified in DIN 8529 Part 1 (symbol)	Preheat and interpass temperature, in °C[2])	Annealing temperature after welding, in °C
designation	number				
GS-16 Mn 5	**1.1131**	Normalized (N)	E 51 43 B[3]) [4])	100 to 250	600 to 640
GS-20 Mn 5 N	**1.1120**	Normalized (N)	E 51 55 B[3]) [4])		600 to 640
GS-20 Mn 5 V	**1.1120**	Quenched and tempered (V)			[5])
GS-8 Mn 7	**1.5015**	Quenched and tempered (V)	ESY 42 65 Mn B		
GS-8 MnMo 7 4	**1.5450**	Quenched and tempered (V)	ESY 46 64 Mo B		
GS-13 MnNi 6 4	**1.6221**	Quenched and tempered (V I)	ESY 50 75 Mn 1 Ni B		
		Quenched and tempered (V II)			

[1]) Cf. subclause 5.6.
[2]) Cf. subclause 5.6.3.
[3]) Filler metal as specified in DIN 1913 Part 1.
[4]) Cf. subclause 5.6.2.
[5]) Cf. subclause 5.6.4.

Table 6. **Guideline temperatures for heat treatment**[1])

Material		Normalizing	Quenching and tempering		
designation	number	Austenitizing temperature, in °C[2])	Austenitizing temperature, in °C	Quenching medium	Tempering temperature, in °C[3])
GS-16 Mn 5	**1.1131**	910 to 960	–	–	–
GS-20 Mn 5 N	**1.1120**	910 to 960	–	–	–
GS-20 Mn 5 V	**1.1120**	–	890 to 940[4])	Liquid	610 to 660
GS-8 Mn 7	**1.5015**	–	900 to 980[4])	Air, Liquid	600 to 640
GS-8 MnMo 7 4	**1.5450**	–	900 to 980[4])	Air, Liquid	600 to 640
GS-13 MnNi 6 4 V I	**1.6221**	–	860 to 930[4])	Air	550 to 620
GS-13 MnNi 6 4 V II	**1.6221**	–	860 to 930[4])	Liquid	600 to 650

[1]) Where stress-relieving is required after machining, one of the temperatures specified in table 5 for annealing after welding shall be used.

[2]) Final cooling in still or moving air.

[3]) Final cooling in still air or in a furnace.

[4]) It is recommended that the casting be normalized prior to quenching and tempering.

Standards and other documents referred to

DIN 1681	Steel castings for general engineering purposes; technical delivery conditions
DIN 1690 Part 1	Technical delivery conditions for castings made from metallic materials; general conditions
DIN 1690 Part 2	Technical delivery conditions for steel castings; classification into severity levels on the basis of non-destructive testing
DIN 1690 Part 10	Technical delivery conditions for steel castings; additional specifications for heavy-duty fittings
DIN 1913 Part 1	Covered electrodes for the joining of unalloyed and low alloy steel by welding; classification and technical delivery conditions
DIN 8529 Part 1	Covered electrodes for the joining of high tensile fine-grained structural steel by welding; basic covered electrodes; classification, designation and technical delivery conditions
DIN 17 007 Part 2	Material numbers; main group 1: steel
DIN 17 205	Quenched and tempered steel castings for general applications; technical delivery conditions
DIN 17 245	High-temperature ferritic cast steel; technical delivery conditions
DIN 32 524	Measurement of preheat temperature, interpass temperature and hold temperature during welding
DIN 50 049	Inspection documents for the delivery of metallic materials
DIN 54 111 Part 2	Non-destructive testing of metallic materials using X-rays or gamma rays; radiographs of castings made from ferrous materials

Stahl-Eisen-Werkstoffblatt 520[1]) *Hochfester Stahlguß mit guter Schweißeignung* (High strength steel castings with good weldability)

Stahl-Eisen-Werkstoffblatt 685[1]) *Kaltzäher Stahlguß* (Steel castings with low temperature toughness)

Stahl-Eisen-Prüfblatt 1922[1]) *Ultraschallprüfung von Gußstücken aus ferritischem Stahl* (Ultrasonic testing of castings made from ferritic steel)

Stahl-Eisen-Prüfblatt 1935[1]) *Oberflächenrißprüfung von Gußstücken aus Stahl; Magnetpulverprüfung* (Crack detection on steel castings by means of magnetic powder inspection)

Stahl-Eisen-Prüfblatt 1936[1]) *Oberflächenrißprüfung von Gußstücken aus Stahl; Eindringprüfung* (Crack detection on steel castings by means of penetrant inspection)

DIN-Normenheft 3 – 1983 *Kurznamen und Werkstoffnummern der Eisenwerkstoffe in DIN-Normen und Stahl-Eisen-Werkstoffblättern* (Ferrous material designations and numbers as used in DIN Standards and Steel and iron materials sheets)

Previous edition

DIN 17 182: 06.85.

Amendments

The following amendments have been made to the June 1985 edition.

a) DIN 1690 Parts 1 and 2 are the basic standards referred to.
b) Steel grades GS-8 Mn 7, GS-8 MnMo 7 4 and GS-13 MnNi 6 4 are included for the first time.
c) Some of the requirements for chemical composition have been amended.
d) The amounts by which the chemical composition as determined on a cast-on test piece may deviate from the limiting values specified for cast analysis have been specified.
e) It is now specified that one of the three values of impact energy may be lower, by not more than 30 %, than the specified minimum value.
f) Guideline values for impact transition temperature have been given.
g) The values specified for yield stress, tensile strength and impact energy also apply to the product.
h) A maximum section thickness of test pieces has been increased from 100 to 150 mm.
i) Specifications regarding welding have been made.
j) Testing of batches as delivered is no longer permitted.
k) The batch size has been defined.
l) The number of test pieces per cast to be tested has been defined.
m) Reference to relevant *Stahl-Eisen-Prüfblätter* has been made with regard to the sampling procedures to be followed for non-destructive testing.
n) The types of inspection documents to be issued have been specified.
o) Marking details have been specified.

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[1]) Obtainable from *Verlag Stahleisen mbH*, Postfach 10 51 45, D-4000 Düsseldorf 1.

Explanatory notes

This standard has been prepared by Technical Committee 11 *Stahlguß* of the *Normenausschuß Eisen und Stahl* (Steel and Iron Standards Committee). A revision of this standard was necessary following adoption of additional steel grades.

This standard does not specify requirements for the mechanical properties of steel castings at elevated temperature (such being specified in DIN 17 245). In the case of steel grade GS-20 Mn 5, however, the following design factors may be used, which have been taken from the May 1988 edition of *AD-Merkblatt* (AD Instruction sheet) W 5.

Steel grade	Wall thickness, in mm	Factor (K), in N/mm², for a design temperature, in °C, of						
		20 (50)	100 (120)	150	200	250	300	350
GS-20 Mn 5 N	≤ 40	300	216	205	197	193	186	178
	>40 ≤ 100	260	184	173	166	161	154	146
GS-20 Mn 5 V	≤ 40	360	264	253	246	241	234	226
	>40 ≤ 100	300	216	205	197	193	186	178

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