



Cast Stainless Steel for High Temperature Components

1 Scope

This material standard applies to those grades of stainless steel castings used in automotive and allied industries requiring high temperature heat resistant service. This standard specifies compositional requirements for the casting. Any specific material property required from a particular casting or section of that casting shall be identified on the engineering drawing. Wrought stainless steels are discussed in GMW3161.

1.1 Material Description. Cast stainless steel has excellent strength, ductility and heat resistance. Steel castings can be welded and are easily adapted to other steel fabrications. Grades for GMW3164, their approximate upper use temperatures, and matrix microstructures are listed in Table 1.

1.2 Symbols. Not applicable.

1.3 Applicability. Stainless steel castings described in this specification are primarily used for exhaust manifolds and turbo charger housings requiring high temperature heat resistance.

1.4 Remarks. Appendix A, Table A1 contains a worldwide cross reference chart between GMW3164 and industry standards, and is presented for reference only. Requirements provided in GMW3164 may differ from those in other specifications. Cross referenced alloys are not interchangeable with their GMW3164 counterpart.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ANSI/AWS A5.9	DIN 1.4826	DIN 1.4849	ISO 6506
ASTM A297	DIN 1.4837	EN 10295	UNS J94224
ASTM A751	DIN 1.4848	ISO 6892	

2.2 GM Standards/Specifications.

GMW3059	GMW3161	GMW14058
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3 Requirements

3.1 Chemical Requirements. The chemical composition is a mandatory requirement. Chemical composition is used as the mandatory requirement since it will most accurately reflect material performance at elevated temperature. The chemical compositional requirements are shown in Table 2. A chemical analysis of each metal heat shall be made by the foundry from a representative test sample that is taken during pouring. The chemical analysis shall conform to the requirements specified for the respective grade listed in Table 2 when tested per ASTM A751.

Table 1: GMW3164 Grades, Upper Use Temperatures and Matrix Microstructures

Grade	Upper Use Temperature (°C) ^{Note 1}	Matrix Microstructure
Cr17Si	950	Ferritic
Cr20Ni10Nb	950	Austenitic
Cr25Ni21NbW	975	Austenitic
Cr26Ni26W2Nb	1000	Austenitic
Ni38Cr18SiNb	1020	Austenitic

Grade	Upper Use Temperature (°C) ^{Note 1}	Matrix Microstructure
Cr26Ni14Nb2	1025	Austenitic
Cr25Ni12SiNb	1050	Austenitic
Cr25Ni20Si	1050	Austenitic
Cr26Ni22W3Nb	1050	Austenitic

Note 1: Upper use temperatures are based on oxidation temperature limits and are approximate. These temperatures are guides only.

Table 2: Mandatory Chemical Composition (in % by Mass)

Grade	C	Si	Mn	Cr	Ni	Mo	W	Nb	S	P	N	Fe
Cr17Si	0.25 to 0.45	1.00 to 2.00	1.0 max.	17.0 to 20.0	0.9 max.	0.50 max.	1.5 to 2.00	0.60 max.	0.05 max.	0.04 max.	-	Bal
Cr20Ni10Nb	0.25 to 0.50	2.00 max.	1.5 max.	19.0 to 23.0	9.0 to 14.0	0.50 max.	0.60 max.	1.2 to 1.8	0.15 max.	0.04 max.	-	Bal
Cr25Ni21NbW	0.25 to 0.35	1.50 max.	1.5 max.	23.0 to 27.0	20.5 to 22.0	-	0.50 to 2.00	1.00 to 2.00	0.10 max.	0.04 max.	-	Bal
Cr26Ni26W2Nb	0.25 to 0.35	1.50 max.	1.5 max.	23.0 to 28.0	24.0 to 28.0	-	1.50 to 3.00	1.00 to 2.00	0.10 max.	0.04 max.	-	Bal
Ni38Cr18SiNb	0.30 to 0.50	1.00 to 2.50	2.0 max.	18.0 to 21.0	36.0 to 39.0	0.50 max.	0.60 max.	1.20 to 1.80	0.04 max.	0.04 max.	-	Bal
Cr26Ni14Nb2	0.40 to 0.50	0.80 to 1.25	0.75 to 1.10	24.0 to 27.0	12.0 to 15.0	0.50 max.	-	1.70 to 2.10	0.11 to 0.15	0.04 max.	0.08 to 0.40	Bal
Cr25Ni12SiNb	0.30 to 0.50	1.00 to 1.80	2.00 max.	24.00 to 27.00	11.00 to 14.00	0.50 max.	-	1.30 to 1.70	0.030 max.	0.040 max.	-	Bal
Cr25Ni20Si	0.30 to 0.50	1.00 to 2.50	2.0 max.	24.0 to 27.0	19.0 to 22.0	0.50 max.	0.60 max.	0.60 max.	0.04 max.	0.04 max.	-	Bal
Cr26Ni22W3Nb	0.35 to 0.45	2.00 max.	2.0 max.	23.0 to 28.0	20.5 to 23.0	-	1.50 to 4.00	0.50 to 2.00	0.10 max.	0.04 max.	-	Bal

% = Percent, Bal = Balance, C = Carbon, Cr = Chromium, Fe = Iron, max. = Maximum, Mn = Manganese, Mo = Molybdenum, N = Nitrogen, Nb = Niobium, Ni = Nickel, P = Phosphorus, S = Sulfur, Si = Silicon, W = Tungsten

3.2 Mechanical Properties. Mandatory room temperature mechanical properties at 23 °C ± 5 °C associated with each grade via separately cast and machined test samples are listed in Table 3. Additional mechanical property testing on the casting itself, excluding hardness testing, may be conducted by agreement between the purchaser and the supplier. Any mechanical property testing on the casting shall have the test locations noted on the drawing and sampling plan agreed upon by the purchaser and the supplier.

Table 3: Mandatory Mechanical Properties at Room Temperature (23 °C ± 5 °C)

Grade	Tensile Strength (MPa) Minimum	Yield Strength (MPa) Minimum	Elongation (%) Minimum	Hardness HBW ^{Note 1}
Cr17Si	450	345	0.5	200 to 280
Cr20Ni10Nb	450	230	5	165 to 235
Cr25Ni21NbW	490	235	5	165 to 235
Cr26Ni26W2Nb	490	235	5	165 to 235
Ni38Cr18SiNb	420	220	4	160 to 230
Cr26Ni14Nb2	515	240	7	187 to 248
Cr25Ni12SiNb	450 ^{Note 2}	220 ^{Note 2}	6	160 to 240
Cr25Ni20Si	450	220	8	170 to 240
Cr26Ni22W3Nb	490	235	2	165 to 235

Note 1: Hardness values use a 10 mm ball and a 3000 kg load. Reference ISO 6506 for minimum thicknesses required when using this diameter and load.

Note 2: Values are taken from EN 10295, DIN 1.4837 without Nb.

3.2.1 Hardness. Brinell hardness shall be taken in accordance with ISO 6506. The material hardness range, described in Table 3, is a mandatory requirement and is measured on the prepared smooth casting surface. Other hardness methods, such as cast surface penetrators, can be used if these methods are validated against ISO 6506, and are agreed upon by supplier and customer.

3.2.2 Tensile Properties. Mandatory tensile properties shall be measured on specimens machined from separately cast samples. Thickness of the cast test sample shall be similar to critical casting sections per ISO 6892.

3.2.2.1 The separately cast samples shall be poured into molds made from sand aggregate that is similar to the aggregate used in production molds. Samples shall cool in the mold until their surfaces are a completely gray color with no tint of red observable. The samples can then be removed from the mold and allowed to air cool.

3.2.2.2 Porosity, shrink or other discontinuities within a test piece represent an invalid test, thus the data must be discarded. The evaluation of such discontinuities shall be done at a magnification not exceeding 100x.

3.3 Physical Requirements. Reference values for physical properties are shown in Appendix A, Table A2. These properties have been gathered from textbooks and are meant to be used for comparative purposes only.

3.4 Additional Requirements.

3.4.1 Casting Requirements. Castings shall conform to the dimensions and tolerances specified on the casting drawing. Harmful discontinuities, e.g., sand and slag inclusions, cold laps, scabs, porosity, etc., that may be detrimental to subsequent processing or to the service performance are not permitted. Casting surfaces shall be smooth and free from scale.

3.4.1.1 Repairs may be made on small random inclusions and minor porosity defects by welding. See Table 4 for weld filler grades per ANSI/AWS A5.9. Repairable defects for exhaust manifolds shall not be deeper than 1.0 mm on runners and 4.0 mm on flanges. Weld repairs shall be finish ground so that the weld deposit blends into the natural contours of the cast part and does not reduce the wall thickness or project into the gas flow passage to affect the flow. Utilize Gas Tungsten Arc Welding (GTAW) with argon as the protective atmosphere per GMW14058. Ferritic Cr17Si may be preheated to 300 °C to 500 °C as suggested by EN 10295.

3.4.1.2 The following defects are not repairable:

- Interior areas (gas passage)
- Hot tears and cracks
- Sponge porosity that extends through the entire wall

3.4.2 All materials supplied to this standard must comply with GMW3059, **Restricted and Reportable Substances**, including the requirement to submit a full material composition disclosure to GM via the International Material Data System (IMDS) or via a completed GMW3059 report form.