Designation: A 732/A732M – 05

Standard Specification for Castings, Investment, Carbon and Low Alloy Steel for General Application, and Cobalt Alloy for High Strength at Elevated Temperatures[1]

This standard is issued under the fixed designation A 732/A732M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers carbon and low-alloy steel and cobalt alloy castings made by the investment casting process.

1.2 Fifteen grades of steel and two cobalt alloy grades are covered.

1.3 Supplementary requirements of an optional nature are provided for use at the option of the purchaser. The supplementary requirements shall apply only when specified individually by the purchaser in the purchase order or contract.

1.4 This specification is expressed in both inch-pound units and SI units; however, unless the purchase order or contract specifies the applicable *M* specification designation (SI units), the inch-pound units shall apply. The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with this standard.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

A 957 Specification for Investment Castings, Steel and Alloy, Common Requirements, for General Industrial Use

A 994 Guide for Editorial Procedures and Form of Product Specifications for Steel, Stainless Steel, and Related Alloys

A 997 Practice for Investment Castings, Surface Accepted Standards, Visual Examination

E 21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials

E 139 Practice for Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

3. Ordering Information

3.1 Orders for castings under this specification should include the following information:

3.1.1 Quantity,

3.1.2 ASTM designation and issue date,

3.1.3 Grade designation (Tables 1 and 2), and

3.1.4 Description of casting by part, pattern, or drawing number. (Dimensional tolerances and machined surfaces shall be indicated on the casting drawing.).

3.2 The purchaser should specify any of the following information to describe adequately the desired material:

3.2.1 Heat-treat condition (see 5.1 and 5.2),

3.2.2 Repair welding (see Section 8 and Specification A 957),

3.2.3 Source inspection, if any (see Specification A 957), and

3.2.4 Supplementary requirements required (marking, certification, mechanical properties, NDT, and the like).

4. General Requirements

4.1 Material furnished to this specification shall conform to the requirements of Specification A 957, including any supplementary requirements that are indicated on the purchase order. Failure to comply with the requirements of Specification A 957 constitutes nonconformance with this specification. In case of conflict of this specification and Specification A 957, this specification shall prevail.

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[1] This specification is under the jurisdiction of ASTM committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.18 on Castings.

Current edition approved Jan. 1, 2005. Published January 2005. Originally approved in 1976. Last previous edition approved in 2002 as A 732/A 732M – 02.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

TABLE 1 Chemical Requirements

Grade	1A	2A,2Q	3A,3Q	4A,4Q	5N	6N	7Q	8Q
Type	Low Carbon IC 1020[A]	Medium Carbon IC 1030	Medium Carbon IC 1040	Medium Carbon IC 1050	Vanadium IC 6120	Manganese Molybdenum IC 4020	Chromium Molybdenum IC 4130	Chromium Molybdenum IC 4140
Carbon	0.15 to 0.25	0.25 to 0.35	0.35 to 0.45	0.45 to 0.55	0.30 max	0.35 max	0.25 to 0.35	0.35 to 0.45
Manganese	0.20 to 0.60	0.70 to 1.00	0.70 to 1.00	0.70 to 1.00	0.70 to 1.00	1.35 to 1.75	0.40 to 0.70	0.70 to 1.00
Phosphorus, max	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Sulfur, max	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
Silicon	0.20 to 1.00	0.20 to 1.00	0.20 to 1.00	0.20 to 1.00	0.20 to 0.80	0.20 to 0.80	0.20 to 0.80	0.20 to 0.80
Nickel								
Chromium							0.80 to 1.10	0.80 to 1.10
Molybdenum						0.25 to 0.55	0.15 to 0.25	0.15 to 0.25
Vanadium					0.05 to 0.15			
Residual Elements:								
Copper	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Nickel	0.50	0.50	0.50		0.50	0.50		0.50
Chromium	0.35	0.35	0.35		0.35	0.35		
Molybdenum + Tungsten	0.25				0.25			
Tungsten		0.10	0.10	0.10		0.25	0.10	0.10
Total content of these residual elements	1.00	1.00	1.00	0.60	1.00	1.00	0.60	1.00

Grade	9Q	10Q	11Q	12Q	13Q	14Q	15A
Type	Chrome Nickel Molybdenum IC 4330	Chrome Nickel Molybdenum IC 4340	Nickel Molyb-denum IC 4620	Chromium Vanadium IC 6150	Chrome Nickel Molybdenum IC 8620	Chrome Nickel Molybdenum IC 8630	Chromium IC 52100
Carbon	0.25 to 0.35	0.35 to 0.45	0.15 to 0.25	0.45 to 0.55	0.15 to 0.25	0.25 to 0.35	0.95 to 1.10
Manganese	0.40 to 0.70	0.70 to 1.00	0.40 to 0.70	0.65 to 0.95	0.65 to 0.95	0.65 to 0.95	0.25 to 0.55
Phosphorus, max	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Sulfur, max	0.045	0.045	0.045	0.045	0.045	0.045	0.045
Silicon	0.20 to 0.80	0.20 to 0.80	0.20 to 0.80	0.20 to 0.80	0.20 to 0.80	0.20 to 0.80	0.20 to 0.80
Nickel	1.65 to 2.00	1.65 to 2.00	1.65 to 2.00		0.40 to 0.70	0.40 to 0.70	
Chromium	0.70 to 0.90	0.70 to 0.90		0.80 to 1.10	0.40 to 0.70	0.40 to 0.70	1.30 to 1.60
Molybdenum	0.20 to 0.30	0.20 to 0.30	0.20 to 0.30		0.15 to 0.25	0.15 to 0.25	
Vanadium				0.15 min			
Residual Elements:							
Copper	0.50	0.50	0.50	0.50	0.50	0.50	0.50
				0.50			0.50
Chromium			0.35				
Molybdenum + Tungsten				0.10			
Tungsten	0.10	0.10	0.10		0.10	0.10	0.10
Total content of these residual elements	0.60	1.00	1.00	1.00	1.00	1.00	0.60

[A] Investment Casting (IC) numbers are to be used only for nomenclature comparison.

TABLE 2 Chemical Requirements-Cobalt Alloys

Grade	21	31
Carbon	0.20–0.30	0.45–0.55
Manganese, max.	1.00	1.00
Silicon, max	1.00	1.00
Phosphorus, max	0.040	0.040
Sulfur, max	0.040	0.040
Chromium	25.0–29.0	24.5–26.5
Nickel	1.7–3.8	9.5–11.5
Cobalt	remainder	remainder
Molybdenum	5.0–6.0	...
Tungsten	...	7.0–8.0
Iron, max.	3.00	2.00
Boron	0.007 max	0.005–0.015

5. Heat Treatment

5.1 Steel castings shall be heat treated either by full annealing, normalizing, normalizing and tempering, or quenching and tempering to obtain the specified properties or other properties that have been agreed upon within each grade. In this latter instance, Supplementary Requirement S23 shall be used.

5.1.1 Heat treatment shall be performed after the castings have been allowed to cool below the transformation range.

5.2 Cobalt alloy castings shall be supplied in the as-cast condition unless otherwise agreed upon by supplier and purchaser.

5.3 Definitions of terms relating to heat treatment shall be in accordance with Terminology A 941.

6. Chemical Composition

6.1 The castings shall conform to the requirements for chemical composition specified in Table 1 and Table 2.

7. Quality

7.1 The surface of the casting shall be examined visually to meet the requirements of Practice A 997. Acceptance criteria to be mutually agreed upon between supplier and purchaser.

7.2 The castings shall not be peened or plugged or impregnated.

8. Repair by Welding

8.1 Welding shall be accomplished with a filler metal that produces a weld deposit with a chemical composition similar to the casting. Castings ordered in the annealed condition or for subsequent hardening shall be annealed after weld repairs. Castings ordered heat treated shall be post weld heat treated in accordance with the qualified welding procedure after weld repairs with the exception of Grades 1A and 2A where post weld heat treatment is optional.

8.2 Welds shall be inspected to the same quality standards as are used to inspect the castings.

9. Keywords

9.1 alloy steel; carbon steel; cobalt alloys; investment castings; steel castings

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall not apply unless specified in the purchase order. A list of standardized supplementary requirements for use at the option of the purchaser is included in Specification A 957. Those ordinarily considered suitable for use with this specification are given below, together with additional supplementary requirements that are applicable only to this specification. Other supplementary requirements enumerated in Specification A 957 may be used with this specification upon agreement between supplier and purchaser.

S1. Magnetic Particle Inspection

S2. Radiographic Inspection

S3. Liquid Penetrant Inspection

S6. Certification

S7. Prior Approval of Major Weld Repairs

S8. Marking

S13. Unspecified Elements

S16. Weld Repair Charts

S19. Decarburization

S23. Mechanical Properties

S23.1 Mechanical properties other than those specified in Table S24 may be ordered for each of the grades. The properties shall be agreed upon between the supplier and the purchaser.

S24. Tension Test (Castings Heat Treated by Supplier)

S24.1 Tensile properties shall be determined from material representing each re-melted heat. The results shall conform to the requirements specified in Table S24, or to properties agreed upon, and shall be reported to the purchaser or his representative. See Specification A 957 for additional details and requirements.

S25. Tension Test (Castings Heat Treated by Purchaser)

S25.1 The supplier shall heat treat a tension specimen from a re-melted heat of same primary heat to determine whether the castings are capable of being heat treated to the specified properties. The results shall conform to the requirements specified in Table S24, or to properties agreed upon, and shall be reported to the purchaser or his representative. See Specificatioin A 957 for additional details and requirements.