



Designation: F3607 – 22

Standard Specification for Additive Manufacturing – Finished Part Properties – Maraging Steel via Powder Bed Fusion¹

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1. Scope

1.1 This specification covers additive manufacturing of parts via full-melt laser beam powder bed fusion (PBF-LB) processing of maraging steel alloys. Parts made using this processing method are typically used in applications that require mechanical properties similar to wrought products, either as fabricated or heat treated. Products built to this specification may require additional post-processing in the form of machining, polishing, etc., to meet necessary surface finish and dimensional requirements.

1.2 Maraging steel (MS) is a class of precipitation hardened steel, where aging heat treatment is used to form precipitates and, consequently, achieve significantly increased hardness and strength. This specification focuses specifically on 300 grade maraging steel, which corresponds to UNS K93120 and EN1.2709. MS grade 300 has higher concentrations of cobalt and titanium than lower grades.

1.3 This specification is intended for the use of purchasers or producers, or both, of additively manufactured maraging steel parts for defining the requirements and ensuring part properties.

1.4 Users are advised to use this specification as a basis for obtaining parts that will meet the minimum acceptance requirements established and revised by consensus of committee members.

1.5 User requirements considered more stringent may be met by the addition to the purchase order of one or more supplementary requirements, which include, but are not limited to, those listed in Supplementary Requirements in Sections S1 to S3.

1.6 The values stated in SI units are to be regarded as standard. All units of measure included in this guide are accepted for use with the SI.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
- A579/A579M Specification for Superstrength Alloy Steel Forgings
- A1080/A1080M Practice for Hot Isostatic Pressing of Steel, Stainless Steel, and Related Alloy Castings
- B213 Test Methods for Flow Rate of Metal Powders Using the Hall Flowmeter Funnel
- B311 Test Method for Density of Powder Metallurgy (PM) Materials Containing Less Than Two Percent Porosity
- B769 Test Method for Shear Testing of Aluminum Alloys
- B855 Test Method for Volumetric Flow Rate of Metal Powders Using the Arnold Meter and Hall Flowmeter Funnel
- B964 Test Methods for Flow Rate of Metal Powders Using the Carney Funnel
- D3951 Practice for Commercial Packaging
- E3 Guide for Preparation of Metallographic Specimens
- E8/E8M Test Methods for Tension Testing of Metallic Materials
- E9 Test Methods of Compression Testing of Metallic Materials at Room Temperature
- E10 Test Method for Brinell Hardness of Metallic Materials
- E18 Test Methods for Rockwell Hardness of Metallic Materials

¹ This specification is under the jurisdiction of ASTM Committee F42 on Additive Manufacturing Technologies and is the direct responsibility of Subcommittee F42.05 on Materials and Processes.

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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.

E23 Test Methods for Notched Bar Impact Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E92 Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials

E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

E238 Test Method for Pin-Type Bearing Test of Metallic Materials

E353 Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

E399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials

E407 Practice for Microetching Metals and Alloys

E466 Practice for Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials

E606 Test Method for Strain-Controlled Fatigue Testing

E647 Test Method for Measurement of Fatigue Crack Growth Rates

E1417 Practice for Liquid Penetrant Testing

E1742 Practice for Radiographic Examination

E1820 Test Method for Measurement of Fracture Toughness

E2234 Practice for Sampling a Stream of Product by Attributes Indexed by AQL

E2762 Practice for Sampling a Stream of Product by Variables Indexed by AQL

F2924 Specification for Additive Manufacturing Titanium-6 Aluminum-4 Vanadium with Powder Bed Fusion

F2971 Practice for Reporting Data for Test Specimens Prepared by Additive Manufacturing

F3122 Guide for Evaluating Mechanical Properties of Metal Materials Made via Additive Manufacturing Processes

G1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens

2.2 ISO/ASTM Standards:²

52900 Terminology for Additive Manufacturing – General Principles – Terminology

52901 Guide for Additive Manufacturing – General Principles – Requirements for Purchased AM Parts

52904 Additive Manufacturing – Process Characteristics and Performance – Practice for Metal Powder Bed Fusion Process to Meet Critical Applications

52921 Terminology for Additive Manufacturing – Coordinate Systems and Methodologies

52930 Additive manufacturing – Qualification principles – Installation, operation and performance (IQ/OQ/PQ) of PBF-LB equipment

52941 Additive manufacturing – System performance and reliability – Acceptance tests for laser metal powder-bed fusion machines for metallic materials for aerospace application

52942 Additive manufacturing – Qualification principles –

Qualifying machine operators of laser metal powder bed fusion machines and equipment used in aerospace applications

2.3 ASQ Standard:³

ASQ C1 Specification of General Requirements for a Quality Program

2.4 ISO Standards:⁴

ISO 6506-1 Metallic materials – Brinell hardness test – Part 1: Test method

ISO 6507-1 Metallic materials – Vickers hardness test – Part 1: Test method

ISO 6508 Metallic materials – Rockwell hardness test – Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)

ISO 9001 Quality management system – Requirements

ISO 13485 Medical devices – Quality management systems – Requirements for regulatory purposes

2.5 SAE Standards:⁵

AMS 2759/3 Heat Treatment, Precipitation-Hardening Corrosion-Resistant, Maraging, and Secondary Hardening Steel Parts

AS 9100 Quality Management Systems – Requirements for Aviation, Space and Defense Organizations

2.6 ASME Standard:⁶

ASME B46.1 Surface Texture

3. Terminology

3.1 Definitions:

3.1.1 Terminology relating to additive manufacturing in Terminology ISO/ASTM **52900** shall apply.

3.1.2 Terminology relating to coordinate systems in Terminology ISO/ASTM **52921** shall apply.

3.1.3 Terminology relating to the ordering of additive manufacturing parts in ISO/ASTM **52901** shall apply.

3.1.4 Terminology in Specification **F2924** shall apply.

4. Condition

4.1 Unless otherwise specified herein, all conditions shall meet the requirements in each section of this standard.

4.1.1 Condition SA parts shall be solution annealed in accordance with Section **15**.

4.1.2 Condition HIP parts shall be hot isostatically pressed in accordance with Section **16**.

4.1.3 Condition AGED parts shall be subject to an aging treatment in accordance with Section **15**.

4.1.4 The purchaser may specify multiple conditions on the purchase order such as Condition SA/AGED or SA/HIP.

³ Available from American Society for Quality (ASQ), 600 N. Plankinton Ave., Milwaukee, WI 53203, <http://www.asq.org>.

⁴ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.

⁵ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

⁶ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.