



Designation: F3091/F3091M – 14 (Reapproved 2021)

Standard Specification for Powder Bed Fusion of Plastic Materials¹

This standard is issued under the fixed designation F3091/F3091M; 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 describes a method for defining requirements and ensuring component integrity for plastic parts created using powder bed fusion processes. Materials include unfilled formulations and formulations containing fillers, functional additives (for example, flame retardant), and reinforcements or combinations thereof. Processes include all powder bed fusion processes as defined in Terminology [F2792](#).

1.2 This specification is intended for use by manufacturers of plastic parts using powder bed fusion and for customers procuring such parts.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 *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.*

1.5 *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

[D638](#) Test Method for Tensile Properties of Plastics

[D4000](#) Classification System for Specifying Plastic 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.

[D6779](#) Classification System for and Basis of Specification for Polyamide Molding and Extrusion Materials (PA)

[D6980](#) Test Method for Determination of Moisture in Plastics by Loss in Weight

[E11](#) Specification for Woven Wire Test Sieve Cloth and Test Sieves

[F2792](#) Terminology for Additive Manufacturing Technologies (Withdrawn 2015)³

2.2 ISO/ASTM Standard:²

[ISO/ASTM 52921](#) Standard Terminology for Additive Manufacturing – Coordinate Systems and Test Methodologies

2.3 ISO Standards:⁴

[ISO 527-1](#) Determination of tensile products – Part 1: General principles

[ISO 3310-1](#) Test Sieves – Technical Requirements and Testing – Part 1: Test Sieves of Metal Wire Cloth

[ISO 9001](#) Quality management systems – Requirements

[ISO 13485](#) Medical Devices – Quality Management System

[ISO 15512](#) Plastics – Determination of Water Content – Second Edition

2.4 Other Standards:

[AS9100](#) Quality Systems – Aerospace – Model for Quality Assurance in Design, Development, Production, Installation and Servicing⁵

[ASQC C1](#) Standard C1 Specification of General Requirements for a Quality Program⁶

3. Terminology

3.1 Additional definitions are listed in Terminology [F2792](#).

3.2 Definitions:

3.2.1 *batch processing, n*—powder preparation and delivery process in which a powder batch is blended using specific quantities of virgin and used powder for use as feedstock, sometimes in quantities larger than the machine build volume or feed region(s) or both.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁵ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

⁶ Available from American Society for Quality (ASQ), 600 N. Plankinton Ave., Milwaukee, WI 53203, <http://www.asq.org>.

3.2.2 *build cycle, n*—single cycle in which one or more components are built up in layers in the process chamber of the machine.

3.2.3 *build volume, n*—total usable volume available in the machine for building parts.

3.2.4 *continuous feed processing, n*—powder preparation and delivery process in which a powder batch is dynamically blended in a steady state process to deliver feedstock as needed to the powder bed.

3.2.5 *customer, n*—entity that receives end use parts from a part manufacturer.

3.2.6 *feed region, n*—in batch processing, the location(s) in the machine where feedstock is stored and from which a portion of the feedstock is repeatedly conveyed to the part bed during the build cycle.

3.2.7 *feedstock, n*—the bulk raw material supplied to the additive manufacturing building process.

3.2.8 *master bounding box, n*—the orthogonally oriented minimum perimeter bounding box which encloses all of the parts in a single build.

3.2.9 *nesting, n*—parts that are made in one build cycle and are located such that their arbitrarily oriented minimum bounding boxes will overlap.

3.2.9.1 *Discussion*—For a definition of the arbitrarily oriented minimum bounding boxes, see **ISO/ASTM 52921**.

3.2.10 *overflow region, n*—the location(s) in the machine where excess powder is stored during a build cycle.

3.2.10.1 *Discussion*—Feedstock is usually conveyed to the powder bed in excess of the volume needed.

3.2.11 *part cake, n*—powder remaining in the powder bed at the end of a build cycle surrounding the fabricated components.

3.2.12 *part manufacturer, n*—entity that processes materials and produces parts using additive manufacturing equipment.

3.2.13 *powder batch, n*—powder used as feedstock that may be used powder, virgin powder or a blend of the two.

3.2.14 *powder lot, n*—quantity of virgin powder produced under traceable, controlled conditions from a single unifying manufacturing process cycle and provided with source documentation as described in **6.2.2**.

3.2.14.1 *Discussion*—Source documentation is also referred to as a “certificate of conformance”, “factory certificate”, or “certificate of analysis”.

3.2.15 *powder vendor, n*—entity that supplies or distributes virgin powder.

3.2.16 *used powder, n*—powder that has been processed in at least one previous build cycle.

3.2.16.1 *Discussion*—Subcategories may include powder from the part cake, feed, and overflow region.

3.2.17 *virgin powder, n*—unused powder from a single powder lot.

4. Process Classification

4.1 *Class I*—Most rigorous process classification intended for use in producing the highest quality parts with the highest degree of confidence through detailed traceability required in quality documents.

4.2 *Class II*—A rigorous process classification intended for use in producing high-quality parts with less traceability than Class I.

4.3 *Class III*—A general process classification intended for use as a guideline in processing quality parts using best practices with minimum traceability.

4.4 Specific class-dependent recommendations and requirements are described regarding fabrication of test specimens (7.1), mechanical property testing (7.4.2, **Table 1**), powder batch identification (8.5.4 – 8.5.6), multiple laser systems (8.7.3.1), part certification (13.3 – 13.5) and quality program requirements (S3). Additional requirements may be negotiated between the customer and part manufacturer.

5. Part Ordering Information

5.1 Orders for parts to this specification shall include the following information:

5.1.1 Reference to this ASTM International standard, process classification (Section 4), materials classification (Section 6), material and process certification requirements, number of test specimens as needed (Section 7), post-processing requirements (8.8), definition of general dimensional characteristics and tolerance (Section 9), part marking requirements (Section 14), packaging requirements (Section 15), digital product definition (CAD model), customer purchase order number and quantity in pieces.

5.2 Orders for parts may include the following information:

5.2.1 Engineering drawings, bill of materials, assembly instructions, manufacturing plan and special engineering requirements (Section 7).

FIG. 1 Specifications for Mechanical Testing of Powder Bed Fusion Polymer Parts^A

Specification	Class I	Class II	Class III
Build certification	A minimum of three XY or YX tension specimens with at least one specimen above and below the build envelope and ZX or ZY tension specimens staggered at edges of the master bounding box such that all layers of the build envelope fall within a tension specimen gage length.	A minimum of three ZX or ZY tension specimens at the edge of the master bounding box. If the build height is less than 57 mm [2.25 in.], use instead two XZ and two YZ specimens outside the build envelope. ^B	No tension specimens needed unless requested by customer.

^A For part orientation notation, see **ISO/ASTM 52921**. For multiple laser systems, see **8.7.3.1**.

^B For Test Method **D638** or ISO 527, subsized tension specimens may be used for ZX or ZY samples for build heights less than 57 mm [2.25 in.].