International Standard

ISO/ASTM 52967

Additive manufacturing for aerospace — General principles — Part classifications for additive manufactured parts used in aviation

Fabrication additive pour l'aérospatiale — Principes généraux — Classification de pièces pour les pièces produites par fabrication additive utilisées dans l'aviation

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11

Email: copyright@iso.org
Website: www.iso.org

ASTM International
100 Barr Harbor Drive, PO Box C700
West Conshohocken, PA 19428-2959, USA
Phone: +610 832 9634
Fax: +610 832 9635
Email: khooper@astm.org
Website: www.astm.org

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Foreword

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Introduction

The use of additive manufacturing (AM) technology allows designs that may not be achieved with traditional manufacturing methods. It is important to understand the risk associated with the AM usage by understanding the consequence of failure (including the loss of intended function) of the usage. Such information can be beneficial in establishing consistent manufacturing, inspection, or qualification processes relative to a defined risk scale, which can serve as supporting data when seeking regulatory approval of an AM part. A part classification scheme based on a part's consequence of failure can provide a consistent risk metric. Without carefully defined part classes, the ability to accurately gauge the consequence of failure associated with additively manufactured aviation parts within and across programs, projects, and suppliers becomes exceedingly difficult, resulting in mitigations that are either not commensurate or inconsistent. The part classification scheme documented here does not affect a part's functional requirements, but rather is used to group additive manufacturing aviation parts into categories which can be used in downstream standards. For example, this classification scheme can be used in material and process specifications to determine the appropriate levels of process control, thermal post processing, qualification, and inspection to ensure AM parts meet their application requirements. This classification scheme does not specify how the classification is used in any downstream processes. The use of the classification shall be left to the cognizant engineering or production entities, or downstream documents which reference this standard.

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Additive manufacturing for aerospace — General principles — Part classifications for additive manufactured parts used in aviation

1 Scope

1.1 This practice is intended to be used to assign part classifications across the aviation industries that use AM to produce parts.

1.2 This practice is applicable to all AM technologies defined in ISO/ASTM 52900 used in aviation.

1.3 This practice is intended to be used to establish a metric for AM parts in downstream documents.

1.4 This practice is not intended to establish criteria for any downstream processes, but rather to establish a metric that these processes can use.

1.5 The part classification metric could be utilized by the engineering, procurement, non-destructive inspection, testing, qualification, or certification processes used for AM aviation parts.

1.6 The classification scheme in this practice establishes a consistent methodology to define and communicate the consequence of failure associated with AM aviation parts.

1.7 This practice is not intended to supersede the requirements and definitions of the applicable regulations or policies, including but not limited to the ones listed in Annex A1.

Tables A.1.1-A.1.3 align the existing regulations and guidance with the four part classes established herein. However, this alignment should not be construed as an alignment of the existing regulations to each other.

1.9 The material or process, or both, in general does not affect the consequence of failure of a part, therefore the classification scheme defined in this document may be used outside AM.

1.10 The user of this standard should not assume regulators' endorsement of this standard as accepted mean of compliance.

1.11 *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.*

1.12 *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.*

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2 Referenced Documents

2.1 *ISO/ASTM Standards:* [1)]

52900 Additive Manufacturing – General principles – Fundamentals and vocabulary

2.2 *United States Department of Defense Standards:*[2)]

MIL-STD-882 Standard Practice System Safety

MIL-STD-1530 Aircraft Structural Integrity Program (ASIP)

MIL-STD-1798 Mechanical Equipment and Subsystems Integrity Program

2.3 *NASA Standard:*[3)]

NASA-STD-6030 Additive Manufacturing Requirements for Spaceflight Systems

2.4 *AWS Standard:*[4)]

AWS D20 Specification for Fabrication of Metal Components using Additive Manufacturing

2.5 *AMS Standard:*[5)]

AMS2175 Castings, Classification and Inspection of

2.6 *FAA Regulations and Guidance Materials:*

AC43-18 Fabrication of Aircraft Parts by Maintenance Personnel[6)7]

AC25.571 Damage Tolerance and Fatigue Evaluation of Structure[7]

AC25.1309 System Design and Analysis[7]

AC33.70-1 Guidance Material for Aircraft Engine Life-Limited Parts Requirements[7]

AC33-8 Guidance for Parts Manufacturer Approval of Turbine Engine and Auxiliary Power Unit Parts under Test and Computation[7]

14CFR27.602 Critical Part[7)]

14CFR33.75 Safety Analysis[8]

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1) This specification is under the jurisdiction of ASTM Committee F42 on Additive Manufacturing Technologies and is the direct responsibility of Subcommittee F42.07 on Applications. Current edition approved July 1, 2022. Published August 2022. DOI: 10.1520/F3572-22.

2) Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, https://quicksearch.dla.mil.

3) Available Online: https://standards.nasa.gov/standard/nasa/nasa-std-6030.

4) Available from American Welding Society (AWS), 8669 NW 36 St., #130, Miami, FL 33166-6672, http://www.aws.org.

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

6) Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, https://www.faa.gov/regulations_policies/advisory_circulars/.

7) Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, https://www.faa.gov/regulations_policies/faa_regulations

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3 Terminology

3.1 *Definitions of Terms:*

3.1.1 Terminology in ISO/ASTM 52900 shall apply.

4 Part Classification Designations

4.1 *Classifications:*

4.1.1 All aviation parts produced using AM shall be classified in accordance with the four part classifications defined in Table 1 and following the information found in Annex A1.

TABLE 1 — Part Classifications

Classification	Consequence of Failure	Non-exhaustive Examples
A	High	Part whose failure can directly affect continued safe flight and landing
		Part whose failure can result in serious or fatal injury to passengers or cabin crews
		Part whose failure requires exceptional piloting skill of flight crew to compensate
B	Medium	Part whose failure can indirectly affect continued safe flight and landing
		Part whose failure can result in minor injury to flight crew, passengers, or cabin crews
		Part whose failure can result in significant increase in workload of flight crew
C	Low	Part whose failure has no effect on continued safe flight and landing
		Part whose failure has no effect on flight crew, passengers, or cabin crew
		Part whose failure can result in slight reduction in operational/functional capabilities
		Part whose failure can result in slight increase in workload of flight crew
D	Negligible or No Effect	Part whose failure would pose no risk of damage to other equipment or injury to the ground personnel
		Parts not affecting operational/functional capabilities

4.2 *Applicability:*

4.2.1 The cognizant engineering or production entity shall determine the part classification considering the consequence of the failure of the part and the functional or systems requirements. The applicant for a design or production approval must seek individual guidance from their respective regulatory body concerning the use of this specification as part of a design or production approval.

4.3 *Alignment with Regulations and Policies:*

4.3.1 In order to evaluate if the part classification scheme is practical, the scheme was compared with the regulations and the guidance materials which are currently used in the aviation industry. Reference documents from both military (Table A.1.1) and civilian (Table A.1.2) domains covering both structural and non-structural aspects were reviewed. Other documents specific to spaceflight and broader non-aviation applications were also reviewed (Table A.1.3) as reference. The four-classification scheme works well with existing aviation regulatory documents. When establishing the specific methods of compliance, the user should refer to the original regulations (such as the ones listed in Annex A1).

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