



Designation: F3674 – 24

Standard Practice for Additive Manufacturing – Part Grades for Automotive¹

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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 grading scheme based on a part's consequence of failure can provide a consistent risk metric. Without carefully defined part grades, the ability to accurately gauge the consequence of failure associated with additively manufactured automotive parts within and across programs, projects, and suppliers becomes exceedingly difficult, resulting in mitigations that are either not commensurate or inconsistent. The part grading scheme documented here does not affect a part's functional requirements, but rather is used to group additive manufacturing automotive parts into categories which can be used in downstream standards. For example, this grading 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 grading scheme does not specify how the grading is used in any downstream processes. The use of the grade shall be left to the cognizant engineering organization (CEO) or production entities, or downstream documents which reference this standard.

1. Scope

1.1 This practice is intended to be used to assign part grade across the automotive industry. For this standard the term classification was changed to grade to avoid confusion with existing classifications in the automotive industry.

1.2 See Practice F3572 for aviation part classifications and NASA-STD-6030 for spaceflight part classifications.

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

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

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

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

1.7 The grading scheme in this practice establishes a consistent methodology to define and communicate the consequence of failure associated with AM automotive parts.

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

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

1.10 *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.*

1.11 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

¹ This test method is under the jurisdiction of ASTM Committee F42 on Additive Manufacturing Technologies and is the direct responsibility of Subcommittee F42.07 on Applications.

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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

E1316 Terminology for Nondestructive Examinations

F3572 Practice for Additive Manufacturing – General Principles – Part Classifications for Additive Manufactured Parts Used in Aviation

2.2 *ISO/ASTM Standard*:²

52900 Additive manufacturing — General principles — Fundamentals and vocabulary

2.3 *NASA Standard*:³

NASA-STD-6030 ADDITIVE MANUFACTURING REQUIREMENTS FOR SPACEFLIGHT SYSTEMS

3. Terminology

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

3.2 Terminology relating to Cognizant Engineering Organization (CEO) in Terminology **E1316** shall apply.

² For referenced ASTM or ISO/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.

³ Available from <https://standards.nasa.gov>.

4. Part Grade Designations

4.1 *Grades*—All automotive parts produced using AM shall be graded in accordance with the part grades defined in **Table 1**.

4.2 *Applicability*:

4.2.1 The Cognizant Engineering Organization (CEO) shall be responsible for assigning each part a grade. This standard adapts the levels of control from most stringent to least stringent across four grades, Grade A to D respectively. Interpretation guidance is given for assistance in assigning part grade; however, the CEO may assign any grade to the part that suits the risk tolerance and desired levels of control for production of the part. *This standard does not purport to address all the necessary requirements and controls for parts of any given grade.*

NOTE 1—Determining the characteristics of grade based on consequence of failure, end effects, and criticality analyses requires close examination by the CEO. Every application, product, or process may be weighted and assessed differently by independent organizations seeking to use this standard. The CEO is responsible to establish threshold limits and required part acceptance criteria when determining part grade. CEO determinations of part grades are only applicable to the CEO's organization for each specific part.

4.2.2 This guidance is offered to assist the CEO in determining part grade. The basis of determining part grade in this guidance is solely based on the consequence of failure. In some cases, the CEO may wish to include the likelihood of failure in the determination of part grade to set the appropriate levels of control according to prevailing risk tolerance.

4.2.3 Provided guidance is illustrated in **Fig. 1**.