NOTICE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

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National Policy

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SUBJ: Additive Manufacturing in Maintenance, Preventive Maintenance, and Alteration of Aircraft, Aircraft Engines, Propellers, and Appliances

1. Purpose of This Notice. This notice provides an introduction and awareness regarding the use of Additive Manufacturing (AM) technology in the maintenance, preventive maintenance, and alteration of aircraft, aircraft engines, propellers, and appliances.

2. Audience. The primary audience for this notice is Flight Standards Service (AFS) personnel who provide certification and surveillance of air agencies and air operators that are involved in the maintenance, preventive maintenance, and alteration of aircraft, aircraft engines, propellers, and appliances. The secondary audience may include other Federal Aviation Administration (FAA) management, operational, and administrative employees, as appropriate.

3. Where You Can Find This Notice. You can find this notice on the MyFAA employee website at https://employees.faa.gov/tools_resources/orders_notices/. Inspectors can access this notice through the Flight Standards Information Management System (FSIMS) at http://fsims.avs.faa.gov. Operators can find this notice on the FAA's website at http://fsims.faa.gov. This notice is available to the public at http://www.faa.gov/regulations_policies/orders_notices/.

4. Background. New generation aircraft, aircraft engines, propellers, and appliances are being manufactured using advanced materials, production processes, fabrication processes, and technological equipment. This has resulted in advanced maintenance, preventive maintenance, and alteration techniques and processes which in the past have not been commonly used in maintaining or altering aircraft and may not be supported by current FAA guidance.

a. AM Technology. AM technology is a new process of joining materials to make objects using computer-generated three-dimensional (3-D) model data, creating a part. AM builds a part, layer by layer, using a variety of materials that are available in fine powders and wire, ranging from different types of metals to plastics and composite materials. This method is unique compared to traditional subtractive manufacturing processes (e.g., machining, milling, extruding, and grinding) that remove material from a larger mass, resulting in a finished part. Some other names for AM are 3-D printing, additive fabrication, additive processes, additive techniques, additive layer manufacturing, layer manufacturing, and freeform fabrication.

b. Additive Manufacturing National Team (AMNT). In response to AM becoming prevalent in the aerospace industry, the FAA has commissioned an AMNT. This team is dedicated to accomplishing the following:

(1) Applying Safety Risk Management (SRM) philosophy for the identification and application of AM as appropriate for high-risk products and the identification of hazardous AM process elements.

(2) Evaluating the need for policy, guidance, and rulemaking.

(3) Supporting research in support of policy, guidance, and rulemaking.

(4) Supporting industry development of new standards and specifications for AM.

(5) Supporting the development of training for engineers and inspectors.

(6) Harmonizing policy with other agencies.

(7) Supporting the development of instructions for continued airworthiness (ICA) for maintenance and inspection.

(8) Facilitating the development of robust process and inspection conformity requirements.

c. Changes in Manufacturing Operations. A number of suppliers have incorporated AM processes into their manufacturing operations to produce technologically advanced aircraft components that would not be possible using traditional manufacturing methods and are more cost effective than traditional methods.

d. Lack of Industrywide Standards. To date, aerospace companies, engineering associations, and government agencies have made little progress in developing adequate industrywide accepted aerospace standards and qualification/certification guidelines for AM materials and processes. Without such standards, each end-user is left to define his or her own material requirements and process instructions. Studies have identified over 150 variables that may need to be controlled for a given AM machine to produce stable and repeatable parts, demonstrating an increased risk to the aerospace industry due to the lack of adequate standards.

5. Action. As AM technology evolves in the production environment, it’s expected that these same processes will be applied to the maintenance, preventive maintenance, and alteration of aircraft, engines, propellers, and appliances. Title 14 of the Code of Federal Regulations (14 CFR) part 43, § 43.13 requires that all maintenance be performed in such a manner and use materials of such a quality that the condition of the aircraft, airframe, aircraft engine, propeller, or appliance worked on will be at least equal to its original or properly altered condition. Compliance with existing regulations must be demonstrated whether a part is being maintained or altered using AM technology or traditional/conventional methods. When the current rules were created, they were based on traditional metallic application and the use of verified specifications. Therefore, the means of compliance will change, and additional considerations will need to be addressed.

a. Considerations. If during the course of an aviation safety inspector's (ASI) normal surveillance activity he or she encounters AM technology being applied in the maintenance, preventive maintenance, and alteration of an aircraft, aircraft engine, propeller, or appliance, the following must be considered:

(1) Process Control. AM requires close process control to produce consistently sound results. As such, all producers/maintainers must utilize an AM process specification that will prescribe best practices for application of AM processes. This specification should utilize data acceptable to or approved by the Administrator.

(2) Manual/Quality System. Maintenance providers that hold a 14 CFR part 145 certification or have a maintenance program authorized under a 14 CFR part 121 or 14 CFR part 135 certificate should ensure that their required manual/quality system adequately addresses any unique aspect of an AM process.

(3) Performance Standards. Maintenance, preventive maintenance, or alterations accomplished using AM technology must be performed in a manner acceptable to the Administrator as required by § 43.13.

(4) Repair Classification. It is the operator's responsibility to classify repairs as major or minor. Major repairs and alterations must be performed in accordance with technical data approved by the FAA and be classified as major or minor in accordance with part 43 appendix A.

(a) Exclusive reliance on part 43 appendix A might result in the misclassification of some repairs and alterations to critical parts, because the part 43 appendix A list does not include evolving airplane design, construction, and repair techniques such as AM.

(b) A minor repair could be reclassified as a major repair if the repair is accomplished using AM technology that is not documented in industry-wide aerospace standards.

(5) Data Approval. Consider an Aircraft Certification Office (ACO)-coordinated field approval of data developed by a maintenance provider to support the use of AM technology.

> **Note:** In circumstances where AM processes use the same material as traditional processes (e.g., using 2024 aluminum powder versus a part forged or machined from solid 2024 aluminum), the parts should not be considered equivalent without proper evaluation.

6. Distribution. This notice will be distributed to AFS divisions located at FAA headquarters in Washington, DC; regional AFS offices at the branch level; all certificate-holding district offices (CHDO); and all Flight Standards District Offices (FSDO).

7. Disposition. The information contained in this notice will not be incorporated into FAA Order 8900.1. The AMNT is developing a checklist that will facilitate Type/Production/Repair Certification and Surveillance oversight activity of AM products. This document will be distributed when available. As AM technology evolves and more definitive guidance is developed, Order 8900.1 will be updated. Send questions concerning AM to the Aircraft Maintenance Division, Special Programs Branch (AFS-320) at 9-AWA-AFS-300-Maintenance@faa.gov.

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