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Standard Guide for Nondestructive Examination of Metal Additively Manufactured Aerospace Parts After Build¹

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^{ε1} NOTE—The caption for Fig. 10 was editorially corrected in August 2020.

1. Scope

1.1 This guide discusses the use of established and emerging nondestructive testing (NDT) procedures used to inspect metal parts made by additive manufacturing (AM).

1.2 The NDT procedures covered produce data related to and affected by microstructure, part geometry, part complexity, surface finish, and the different AM processes used.

1.3 The parts tested by the procedures covered in this guide are used in aerospace applications; therefore, the inspection requirements for discontinuities and inspection points in general are different and more stringent than for materials and components used in non-aerospace applications.

1.4 The metal materials under consideration include, but are not limited to, aluminum alloys, titanium alloys, nickel-based alloys, cobalt-chromium alloys, and stainless steels.

1.5 The manufacturing processes considered use powder and wire feedstock, and laser or electron energy sources. Specific powder bed fusion (PBF) and directed energy deposition (DED) processes are discussed.

1.6 This guide discusses NDT of parts after they have been fabricated. Parts will exist in one of three possible states: (1) raw, as-built parts before post-processing (heat treating, hot isostatic pressing, machining, etc.), (2) intermediately machined parts, or (3) finished parts after all post-processing is completed.

1.7 The NDT procedures discussed in this guide are used by cognizant engineering organizations to detect both surface and volumetric flaws in as-built (raw) and post-processed (finished) parts.

1.8 The NDT procedures discussed in this guide are computed tomography (CT, Section 7, including microfocus CT), eddy current testing (ET, Section 8), optical metrology (MET,

Section 9), penetrant testing (PT, Section 10), process compensated resonance testing (PCRT, Section 11), radiographic testing (RT, Section 12), infrared thermography (IRT, Section 13), and ultrasonic testing (UT, Section 14). Other NDT procedures such as leak testing (LT) and magnetic particle testing (MT), which have known utility for inspection of AM parts, are not covered in this guide.

1.9 Practices and guidance for in-process monitoring during the build, including guidance on sensor selection and in-process quality assurance, are not covered in this guide.

1.10 This guide is based largely on established procedures under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of the appropriate subcommittee therein.

1.11 This guide does not recommend a specific course of action for application of NDT to AM parts. It is intended to increase the awareness of established NDT procedures from the NDT perspective.

1.12 Recommendations about the control of input materials, process equipment calibration, manufacturing processes, and post-processing are beyond the scope of this guide and are under the jurisdiction of ASTM Committee F42 on Additive Manufacturing Technologies. Standards under the jurisdiction of ASTM F42 or equivalent are followed whenever possible to ensure reproducible parts suitable for NDT are made.

1.13 Recommendations about the inspection requirements and management of fracture critical AM parts are beyond the scope of this guide. Recommendations on fatigue, fracture mechanics, and fracture control are found in appropriate end user requirements documents, and in standards under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture.

NOTE 1—To determine the deformation and fatigue properties of metal parts made by additive manufacturing using destructive tests, consult Guide F3122.

NOTE 2—To quantify the risks associated with fracture critical AM parts, it is incumbent upon the structural assessment community, such as ASTM Committee E08 on Fatigue and Fracture, to define critical initial flaw sizes (CIFS) for the part to define the objectives of the NDT.

1.14 This guide does not specify accept-reject criteria used in procurement or as a means for approval of AM parts for

¹ This guide is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.10 on Specialized NDT Methods.

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