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Additive manufacturing — System performance and reliability — Acceptance tests for laser metal powder-bed fusion machines for metallic materials for aerospace application

Fabrication additive — Performance et fiabilité du système — Essais de réception pour machines de fusion laser sur lit de poudre pour les matériaux métalliques pour l'application aérospatiale

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 261, *Additive manufacturing*, in cooperation with ASTM F 42, *Additive Manufacturing Technologies*, on the basis of a partnership agreement between ISO and ASTM International with the aim to create a common set of ISO/ASTM standards on additive manufacturing.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Additive manufacturing — System performance and reliability — Acceptance tests for laser metal powder-bed fusion machines for metallic materials for aerospace application

1 Scope

This document specifies requirements and test methods for the qualification and re-qualification of laser beam machines for metal powder bed fusion additive manufacturing for aerospace applications.

It can also be used to verify machine features during periodic inspections or following maintenance and repair activities.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11146 (all parts), *Lasers and laser-related equipment — Test methods for laser beam widths, divergence angles and beam propagation ratios*

ISO 11554, *Optics and photonics — Lasers and laser-related equipment — Test methods for laser beam power, energy and temporal characteristics*

ISO/ASTM 52900, *Additive manufacturing — General principles — Part 1: Fundamentals and vocabulary*

ISO/ASTM 52921, *Standard terminology for additive manufacturing — Coordinate systems and test methodologies*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900, ISO/ASTM 52921 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
scanning speed
relative linear speed of the laser beam movement in the plane of the build platform (working plane)

3.2
warm-up time
time from switching on the machine until the build cycle can be started, as specified by the machine manufacturer

3.3
feeding platform
platform that moves incrementally to supply powder to the *powder spreading device* (3.4)

3.4
powder spreading device
powder supply mechanism, which distributes and evenly spreads the powder on the build surface

3.5
rated laser power
the maximum power capability as specified by the laser manufacturer

3.6
minimum beam waist position
focal spot location at which the beam has the most concentrated energy and the smallest cross sectional area

4 Equipment

Equipment shall be installed, operated and maintained according to the documented instructions.

5 Environmental and operational conditions

The environmental and operational conditions during qualification testing shall meet the requirement ranges if specified by the machine manufacturer and shall conform to the conditions which are specified by a machine user during production, as examples the following:

a) temperature;

b) humidity;

c) services/utilities (e.g. supply of electrical power, compressed air, shielding gas, water);

d) shocks/vibrations;

e) chamber pressure

f) process gas purity.

Health and safety measures relating to laser radiation and to fire and explosion protection shall be observed.

6 Qualification testing

6.1 General

The qualification testing of laser beam machines for metal powder bed fusion additive manufacturing shall comprise as a minimum the requirements specified in 6.2 to 6.7.

The measurement shall be performed with a calibrated measuring instrument according to the measuring instrument instructions.

6.2 Laser beam tests

6.2.1 Testing the laser power for continuous wave lasers

The laser power shall be measured. The measurement should be performed according to ISO 11554, as applicable.

The nominal machine power settings shall be compared with the actual values. The measurement shall be performed with a calibrated measuring instrument at the point of use (i.e. inside the build chamber). The instrument shall be capable of accurate measurement of the actual laser power range.