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Additive manufacturing — Qualification principles — Qualifying machine operators of laser metal powder bed fusion machines and equipment used in aerospace applications

Fabrication additive — Principes de qualification — Qualification des opérateurs machine des machines à fusion laser sur lit de poudre et équipements utilisés dans les applications aérospatiales

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Contents

Page

Foreword ..... **iv**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **1**

4 Qualification **2**
4.1 General 2
4.2 Essential variables and-range of qualification 2
4.2.1 General 2
4.2.2 Powder material group 2
4.2.3 Machine model 3
4.3 Evidence of visual acuity 3
4.4 Theoretical test 3
4.5 Practical test 3

5 Qualification test certificate **4**

6 Validity of testing **4**
6.1 General 4
6.2 Period of validity 4
6.3 Requalification test 4
6.4 Supplementary test 5

Annex A (normative) **Content of the theoretical assessment** **6**

Annex B (normative) **Content of the practical assessment** **7**

Annex C (informative) **Example of qualification test certificate for operators of laser metal powder bed fusion machines** **9**

Annex D (informative) **Example of an additive manufacturing procedure specification (APS)** **11**

Bibliography **13**

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).

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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 and in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 438, *Additive manufacturing*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement)..

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 — Qualification principles — Qualifying machine operators of laser metal powder bed fusion machines and equipment used in aerospace applications

1 Scope

This document specifies requirements for the qualification of operators of laser metal powder bed fusion machines and equipment for additive manufacturing in aerospace applications.

This document is applicable if the operator qualification testing is required by contract or by application standards in the field of aerospace.

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

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

ISO 18490, *Non-destructive testing — Evaluation of vision acuity of NDT personnel*

EN 4179, *Aerospace series — Qualification and approval of personnel for non-destructive testing*

NAS 410, *NAS CERTIFICATION & QUALIFICATION OF NONDESTRUCTIVE TEST PERSONNEL*

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
examiner
person who has been appointed to verify conformance to the applicable standard

Note 1 to entry: In certain cases, an external independent examiner can be required.

[SOURCE: ISO 14732:2013, 3.12]

3.2
examining body
organization that has been appointed to verify conformance to the applicable standard

Note 1 to entry: In certain cases, an external independent examining body can be required.

[SOURCE: ISO 14732:2013, 3.13]

3.3
operator
person who operates laser metal powder bed fusion machines and equipment for additive manufacturing

3.4
additive manufacturing procedure specification
APS
document that has been qualified and provides the required variables of the additive manufacturing process to ensure repeatability during production

3.5
preliminary additive manufacturing procedure specification
PAPS
document containing the required variables of the additive manufacturing procedure which has yet to be qualified

4 Qualification

4.1 General

There shall be a coordinator designated, in writing, as responsible for the operator qualification test, requalification and disqualification. The coordinator shall have knowledge and experience relevant to the laser powder bed fusion process, and be acceptable to the responsible authority.

Qualification tests of operators shall include the following aspects:

a) theoretical test;

b) practical test;

c) evidence of visual acuity.

The practical test for operators shall follow an additive manufacturing procedure specification. An example of an additive manufacturing procedure specification (APS) is given in Annex D.

4.2 Essential variables and-range of qualification

4.2.1 General

The qualification of operators of laser metal powder bed fusion machines for additive manufacturing is based on essential variables. For each essential variable, a range of qualification is defined. If the operator has to work outside the range of qualification, a new qualification test is required. The essential variables are:

a) powder material groups;

b) machine model.

NOTE For machine model, see 4.2.3.

4.2.2 Powder material group

The theoretical test in the framework of the qualification scope shall be adapted according to the powder material group in use for production.

Material group A: unalloyed steels, low-alloyed steels, high-alloyed ferritic steels.

Material group B: austenitic, martensitic and precipitation hardening steels.

