
Aditivna proizvodnja kovin - Kvalifikacija - 2. del: Kvalifikacija upravljalcev strojev in naprav za PBF-LB (ISO/ASTM DIS 52926-2:2022)

Additive manufacturing of metals - Qualification principles - Part 2: Qualification of operators for PBF-LB (ISO/ASTM DIS 52926-2:2022)

Additive Fertigung ; Grundsätze der Qualifizierung ; Teil 2: Qualifizierung von Maschinenbedienern für PBF-LB (ISO/ASTM DIS 52926-2:2022)

Fabrication additive des métaux - Principes de qualification - Partie 2: Qualification des opérateurs pour PBF-LB (ISO/ASTM DIS 52926-2:2022)

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Part 2: Qualification of operators for PBF-LB

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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).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 Technical Committee ISO/TC 261, *Additive manufacturing*, Joint Group JG 74, *Personnel Qualifications* in cooperation with ASTM Committee F42, *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.

ISO/ASTM 52926 consists on the following parts, under the general title *Additive manufacturing – Qualification principles*:

- *Part 1: General qualification of operators*
- *Part 2: Qualification of operators for PBF-LB*
- *Part 3: Qualification of operators for PBF-EB*
- *Part 4: Qualification of operators for DED-LB*
- *Part 5: Qualification of operators for DED-Arc*

A list of all parts of the ISO/ASTM 52926 series can be found on the ISO website.

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.

Introduction

For many companies, additive manufacturing represents an alternative to established manufacturing processes. The trend towards complex components, decentralised production and customer specific products allows an economically feasible use for more and more areas. This also applies to many series applications, which comprise completely different demands on the efficiency of the processes. In particular, components used in industry (automotive industry, mechanical engineering, railway sector, aerospace, process and industrial plants, medical technology, etc.) are subject to high demands in terms of quality and safety. The current lack of norms and standards means that processes for the production of components have to be defined from the scratch for each individual case, which causes a great effort and allows little transparency and thus little trust of other stakeholders in the processes.

If industrially used components are manufactured using additive manufacturing processes, it shall be proven that these meet the requirements. To this end, the production chain and environment shall be designed in such a way that the process quality and the resulting product quality are always consistent and reproducible. To assure the before mentioned consistency and reproducibility, is of utmost importance to assure that the involved workforce is adequately qualified for the several production stages.

ISO/ASTM 52926 series describes the activities and responsibilities of the operators in the field of the Additive Manufacturing technology. Its aim is to specify the qualification tests to be employed in the assessment of AM operators' skills when operating AM machines, especially in regulated industries, such as automotive industry, mechanical engineering, the railway sector, , process and industrial plants or medical technology, consideration of the criteria defined within the framework of this ISO create a basis for fulfilling the requirements for specific products.

This document describes the constraints and requirements for an operator to be certified for Powder Bed Fusion – Laser Beam (PBF-LB).

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Additive Manufacturing of metals — Qualification principles —

Part 2: Qualification of operators for PBF-LB

1 Scope

This document describes the capabilities and responsibilities required for the qualification of the operators on the field of the Additive Manufacturing technologies dealing with metallic parts production, specifically for the employment of powder bed fusion – laser beam with metals (PBF-LB/M).

This document defines criteria for the theoretical and practical assessment of personnel operating PBF-LB/M machines. The activities and procedures foreseen to be performed by the PBF-LB/M operator are also part of the standard.

This document is intended to provide an outline for qualification of machine operators in general industrial applications. Where industry-specific requirements exist for the qualification of operators, such as ISO/ASTM 52942 for aerospace applications, those industry-specific standards shall be used instead of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all 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 — Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900, ISO/ASTM 52926-1 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 <https://www.electropedia.org/>

4 Operator qualification

4.1 General

The qualification test for operators shall follow a suitable documented procedure or manufacturing plan. Example of such document is contained in [Annex A](#).

Prior to the assessment, the AM operator shall have received the necessary amount of theoretical and practical training (example of 24 hours of training) or prior equivalent experience in a PBF-LB/M operator role.

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Qualifications of operators in PBF-LB/M shall follow the assessment criteria for this technology defined in [section 4.2](#).

NOTE For recommendations in terms of training, education and assessment minimum requirements, see Bibliography.

4.2 Assessment procedures

4.2.1 General

The assessment principles are described in ISO/ASTM 52926-1, chapter 4.3.

The theoretical test shall cover all the contents defined in this document and it is recommended to have at least 20 number of questions covering the topics given in the section from [4.2.1](#) to [4.2.7](#). Each question has 4 possible answers and only one it is correct. The candidate shall achieve a minimum score of 60 % to pass the theoretical test (ISO/ASTM 52926-1).

The practical test shall show that the operator demonstrates the practical skills to conduct all the necessary process steps for a specific AM process and machine in accordance with a manufacturing plan.

4.2.2 Aspects of PBF-LB/M

The topics cover general characteristics of PBF-LB/M systems and additional specific skills that should be considered/evaluated in accordance to the activities expected to be the responsibility of the operator in their actual work environment.

- Recognise different AM Metal processes.
- Recognise the advantages and limitations of PBF-LB/M processes.
- Describe the PBF-LB/M systems, including the components and their functions.
- Recognise the characteristics of the PBF-LB build platform, feedstock and other consumables.
- Recognise the PBF-LB/M parameters and the influence of their adjustment on the as built part.
- Recognise the interaction of the main process energy source (laser beam) with the feedstock.
- Recognise the interaction of the process heat source (build chamber / platform heating system) with the feedstock.
- Identify the problems associated with inadequate preparation and setup of the build. (i.e. build platform installation, installation of spreading device system, handling and storage of feedstock, application of the shielding and process gases used in PBF-LB/M).
- Follow work instructions created by, for example, AM Coordination personnel.
- Recognise the factors or events that can affect the qualification status of the PBF-LB equipment.
- Follow Environmental, Health & Safety (EHS) procedures in all manufacturing steps.

NOTE Guidance for EHS considerations and requirements is provided in ISO/ASTM 52931 and ISO/ASTM 52938-1.

4.2.3 Feedstock activities

- Follows and recognizes procedures for identification, loading, removal, and life cycle management of feedstock, ensuring cleanliness of canisters and transfer equipment used and demonstrate awareness of the risk of cross-contamination.