



**SLOVENSKI STANDARD**  
**oSIST prEN ISO/ASTM 52926-3:2022**  
**01-marec-2022**

---

**Aditivna proizvodnja kovin - Kvalifikacija - 3. del: Kvalifikacija upravljalcev strojev in naprav za PBF-EB (ISO/ASTM DIS 52926-3:2022)**

Additive manufacturing of metals - Qualification principles - Part 3: Qualification of operators for PBF-EB (ISO/ASTM DIS 52926-3:2022)

Additive Fertigung - Grundsätze der Qualifizierung - Teil 3: Qualifizierung von Maschinenbedienern für die Herstellung von metallischen Bauteilen mittels PBF-EB (ISO/ASTM DIS 52926-3:2022)

Fabrication additive des métaux - Principes de qualification - Partie 3: Qualification des opérateurs pour PBF-EB (ISO/ASTM DIS 52926-3:2022)

[oSIST prEN ISO/ASTM 52926-3:2022](https://standards.iteh.ai/catalog/standards/sist/5265f41e-d7d7-44d2-b865-1c89f37a3c7c/osist-pr-en-iso-astm-52926-3-2022)

**Ta slovenski standard je istoveten z: prEN ISO/ASTM 52926-3**  
[52926-3-2022](https://standards.iteh.ai/catalog/standards/sist/5265f41e-d7d7-44d2-b865-1c89f37a3c7c/osist-pr-en-iso-astm-52926-3-2022)

---

**ICS:**

|           |               |                               |
|-----------|---------------|-------------------------------|
| 03.100.30 | Vodenje ljudi | Management of human resources |
| 25.030    | 3D-tiskanje   | Additive manufacturing        |

**oSIST prEN ISO/ASTM 52926-3:2022**      **en,fr,de**

**iTeh STANDARD  
PREVIEW  
(standards.iteh.ai)**

[oSIST prEN ISO/ASTM 52926-3:2022](https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022)

<https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022>

# DRAFT INTERNATIONAL STANDARD

## ISO/ASTM DIS 52926-3

ISO/TC 261

Secretariat: DIN

Voting begins on:  
2022-02-04

Voting terminates on:  
2022-04-29

---

---

## Additive Manufacturing of metals — Qualification principles —

### Part 3: Qualification of operators for PBF-EB

ICS: 03.100.30; 25.030

**iTeh STANDARD  
PREVIEW  
(standards.iteh.ai)**

[oSIST prEN ISO/ASTM 52926-3:2022](https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022)  
<https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022>

This document is circulated as received from the committee secretariat.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

**ISO/CEN PARALLEL PROCESSING**



Reference number  
ISO/ASTM DIS 52926-3:2022(E)

© ISO/ASTM International 2022

**iTeh STANDARD  
PREVIEW  
(standards.iteh.ai)**

[oSIST prEN ISO/ASTM 52926-3:2022](https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022)  
[https://standards.iteh.ai/catalog/standards/sist/5265f41e-  
d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-  
52926-3-2022](https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022)



**COPYRIGHT PROTECTED DOCUMENT**

© ISO/ASTM International 2022

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester. In the United States, such requests should be sent to ASTM International.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11

Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

ASTM International  
100 Barr Harbor Drive, PO Box C700  
West Conshohocken, PA 19428-2959, USA  
Phone: +610 832 9634  
Fax: +610 832 9635  
Email: [khooper@astm.org](mailto:khooper@astm.org)  
Website: [www.astm.org](http://www.astm.org)

# Contents

|   | Page     |
|---|----------|
| Foreword.....   | iv       |
| Introduction.....   | v        |
| <b>1 Scope.....</b>   | <b>1</b> |
| <b>2 Normative references.....</b>                                | <b>1</b> |
| <b>3 Terms and definitions.....</b>                               | <b>1</b> |
| <b>4 Operator qualification.....</b>                              | <b>1</b> |
| 4.1 General.....  | 1        |
| 4.2 Assessment procedures.....                                    | 2        |
| 4.2.1 General.....  | 2        |
| 4.2.2 Aspects related to PBF-EB/M.....                            | 2        |
| 4.2.3 Feedstock activities.....                                   | 2        |
| 4.2.4 System set-up activities.....                               | 3        |
| 4.2.5 Manufacturing/Build activities.....                         | 3        |
| 4.2.6 Post-processing activities.....                             | 3        |
| 4.2.7 Quality related activities.....                             | 4        |
| <b>Annex A (informative) Example of a manufacturing plan.....</b> | <b>5</b> |
| <b>Bibliography.....</b>  | <b>7</b> |

**iTeh STANDARD**  
**PREVIEW**  
**(standards.iteh.ai)**

[oSIST prEN ISO/ASTM 52926-3:2022](https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022)  
<https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022>

## ISO/ASTM DIS 52926-3:2022(E)

## 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](http://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](http://www.iso.org/patents)).

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](http://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 of the following parts, under the general title *Additive manufacturing – Qualification principles*:

- *Part 1: General qualification of machine 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](http://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, the aerospace industry, 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 describes the constraints and requirements for an operator to be certified for Powder Bed Fusion – Electron Beam (PBF-EB).

[oSIST prEN ISO/ASTM 52926-3:2022](https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022)

<https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022>

**iTeh STANDARD  
PREVIEW  
(standards.iteh.ai)**

[oSIST prEN ISO/ASTM 52926-3:2022](https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022)

<https://standards.iteh.ai/catalog/standards/sist/5265f41e-d767-44d2-b863-1c89f377a5c7/osist-pren-iso-astm-52926-3-2022>



# Additive Manufacturing of metals — Qualification principles —

## Part 3: Qualification of operators for PBF-EB

### 1 Scope

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

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

This document is intended to provide guidance for qualification of machine operators in general industrial applications.

### 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 following 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-EB/M operator role.

## ISO/ASTM DIS 52926-3:2022(E)

Qualifications of operators in PBF-EB/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 related to PBF-EB/M

The topics cover general characteristics of PBF-EB/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-EB/M processes
- Describe the PBF-EB/M systems, including the components and their functions.
- Recognise the characteristics of the PBF-EB build platform, feedstock and other consumables.
- Recognise the PBF-EB/M parameters and the influence of their adjustment on the as built part.
- Recognise the interaction of the main process energy source (electron 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 process gases used in PBF-EB/M).
- Follow work instructions created by, for example, the PBF-EB/M Process Engineer.
- Recognise the factors or events that can affect the qualification status of the PBF-EB equipment
- Follow Environmental, Health and Safety (EHS) procedures in all manufacturing steps.

NOTE Guidance for EHS considerations and requirements is provided in ISO/ASTM 52931

#### 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.

NOTE Guidance for feedstock life cycle management considerations and requirements is provided in ISO/ASTM 52928