

**Additive manufacturing of
metals — Process characteristics
and performance — Metal powder
bed fusion process to meet critical
applications**

*Fabrication additive de métaux — Caractéristiques et
performances du procédé — Procédé de fusion sur lit de poudre
métallique en vue de répondre aux applications critiques*

**Second edition
2024-07**

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Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Personnel requirements	2
5 Digital data	2
5.1 Digital data records	2
5.2 Digital data processing	2
6 PBF equipment requirements	3
6.1 General	3
6.2 Build consumables	3
6.2.1 Build platform	3
6.2.2 Shielding gases	3
6.2.3 Powder spreading device	3
6.2.4 Compressed air	3
6.3 Auxiliary tools and equipment	4
6.4 Machine operating software	4
6.5 Environmental controls	4
7 Feedstock requirements	4
7.1 Purchasing feedstock	4
7.2 Control of feedstock	4
8 Qualification	5
8.1 Design checks	5
8.1.1 Part files	5
8.1.2 Machining allowance	5
8.1.3 Orientation and location	5
8.1.4 Parts nesting	5
8.2 Pre-build checks	5
8.2.1 General	5
8.2.2 Maintenance and calibration status	5
8.2.3 PBF machine elements and systems	6
8.2.4 Build chamber environment	6
8.2.5 Build platform	6
8.2.6 Powder spreading device	6
8.2.7 Gas supply	6
8.2.8 Feedstock condition and quantity	6
8.2.9 Baseline machine and process parameters	7
8.3 Periodic preventive maintenance	7
8.3.1 General	7
8.3.2 Energy delivery verification	7
8.3.3 Z-axis movement	7
8.3.4 Compressed air	7
8.3.5 Oxygen and vacuum	7
8.3.6 Laser field alignment (LFA)	7
8.3.7 Other recommended preventive maintenance	8
8.4 Machine, process, and part qualification	8
8.4.1 Process qualification	8
8.4.2 Build platform	8
8.4.3 Test specimens	8
8.4.4 Requalification	9
8.5 Consolidated material and part	9

ISO/ASTM 52904:2024(en)

8.5.1	Material properties	9
8.5.2	Part properties	10
8.5.3	Non-conformities	10
9	Manufacturing plan and documentation	10
9.1	Manufacturing plan	10
9.2	Documentation	11
Annex A (informative) Example of a manufacturing plan		12
Bibliography		15

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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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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 technologies*, based on a partnership agreement between ISO and ASTM International with the aim to create a common set of ISO/ASTM standards on additive manufacturing, 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.

This second edition cancels and replaces the first edition (ISO/ASTM 52904:2019), which has been technically revised.

The main changes are as follows:

- The structure of the document is modified to reflect the following workflow: Personnel – Digital data – PBF equipment – Feedstock – Qualification – Manufacturing plan;
- Original [Clauses 8](#) “Control of machine operating system software”, [Clauses 9](#) “Auxiliary tools and contamination” and [Clauses 11](#) “External environmental controls” have been merged to a new [Clause 6](#) “PBF equipment requirements”;
- New structure and examples for the manufacturing plan, consistent with the new workflow;
- [9.2](#) “Documentation” is added to the manufacturing plan;
- [Figure 1](#) was updated.

Introduction

Operation and production control of machines and processes for powder bed fusion (PBF) in critical applications are described in this document. Critical applications can be subject to regulation. This is one way of meeting quality requirements. The supplier/manufacturer can also ensure quality of components through validation and verification of the AM process, as per internal procedures and requirements, and inspection of the CTQs (critical to quality) of the AM components, as per customer agreement.

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Additive manufacturing of metals — Process characteristics and performance — Metal powder bed fusion process to meet critical applications

1 Scope

WARNING — This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this document to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

This document covers the operation and production control of metal powder bed fusion (PBF) machines and processes for areas of critical applications. A critical application is assumed once failing parts-functionality leads to immediate threats.

This document is applicable for production of parts and mechanical test specimens using powder bed fusion (PBF) with both laser and electron beams.

Specifications related to specific fields of application are provided in respective standards.

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 8573-1, *Compressed air — Part 1: Contaminants and purity classes*

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

ISO/ASTM 52907, *Additive manufacturing — Feedstock materials — Methods to characterize metal powders*

ISO 17295, *Additive manufacturing — General principles — Part positioning, coordinates and orientation*

ISO/ASTM 52926-1, *Additive manufacturing of metals — Qualification principles — Part 1: General qualification of operators*

ISO/ASTM/TS 52930:2021, *Additive manufacturing — Qualification principles — Installation, operation and performance (IQ/OQ/PQ) of PBF-LB equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900 and ISO/ASTM 52926-1 and the following apply.

ISO and IEC maintain terminology 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/>

3.1

powder spreading device

recoater

portion of the machine that comes in contact with and spreads feedstock across the build area

Note 1 to entry: The actual component that is in direct contact with the powder during spreading of a new layer can typically be a blade, a rake, a roller, or a brush.

4 Personnel requirements

The personnel involved in operating the PBF-equipment shall be qualified in accordance with the part manufacturer or sector specific requirements (see ISO/ASTM 52926-1 and ISO/ASTM 52926-2 for PBF-LB operators or ISO/ASTM 52926-1 and ISO/ASTM 52926-3 for PBF-EB operators).

Records of qualification shall be maintained by the manufacturer in accordance with manufacturer or sector specific requirements (e.g. ISO 9001, ISO 13485, ANSI/ASQC C1, AS 9100).

5 Digital data

5.1 Digital data records

Unless otherwise agreed, the part manufacturer shall maintain records of all software, CAD, and part nesting layouts used in the production of parts, including:

- PBF machine operation software version, as recorded on the manufacturing plan (see [Clause 9](#));
- Customer supplied or customer approved CAD files;
- Modifications to the customer CAD files, which shall be in accordance with [Clause 8](#), and files such as AMF and STL that are converted from customer-supplied CAD files. The party that performs the translation from native CAD format to triangulated format (e.g. AMF, STL) is also responsible for performing a quality check of the translated file to ensure there are no unacceptable errors (e.g. bad/free edges, overlapping or intersecting triangles) and confirm that all required geometrical features are still present;
- Slice or layer files used by the PBF machines;
- Record of part nesting and build layout (e.g. data-preparation files; screenshots of isometric view);
- PBF machine build log file

Any other customer-supplied electronic data, dimensional drawings, statement of work, PBF machine log file, or combination thereof, shall be maintained and saved. Multiple build cycles in a manufacturing lot shall be recorded with their unique manufacturing plan number.

The record retention period shall be as required for the relevant application/sector, or where not otherwise specified, shall be a minimum of 5 years.

5.2 Digital data processing

The part manufacturer shall have a manual or automated method for engineering file configuration control to ensure that the correct file designation on the purchase order is processed via PBF and, if necessary, final machining.

If the build model is modified from the original form received from the customer (e.g. to add machining allowance), the modification shall be performed in an engineering file format that allows for geometric inspection of the preform. The customer shall be informed and shall validate the modifications carried out. Support structures added to aid PBF processing shall not be considered as modifications to the original form. Modified CAD files shall be verified in the same manner as described in [8.1](#).

When engineering files, such as CAD files, are converted to triangulated surfaces for purposes of PBF processing, parameters used for the triangulation resolution of surfaces (e.g. chord height) shall be specified and recorded.

All CAD file translations necessary to support PBF processing, shall be configuration controlled.

6 PBF equipment requirements

6.1 General

Requirements for the following aspects are available in ISO/ASTM TS 52930:

- build consumables (build platform, recoater, gases, filters, etc.) see ISO/ASTM TS 52930:2021 6.4.2.1;
- auxiliary tools and equipment;
- machine operating software;
- environmental controls.

For PBF-LB, the part manufacturer shall specify shielding gases that, as a minimum, includes consideration of the gas composition and compatibility with the feedstock grade, build platform used and the PBF machine.

6.2 Build consumables

6.2.1 Build platform

The part manufacturer shall specify a build platform specification that, as a minimum, includes consideration of the following:

- compatibility of the substrate material grade with the feedstock grade and any shielding gases used;
- geometrical requirements, such as size, thickness and parallelism requirements;
- where the build platform is intended to be reused, sufficient additional thickness beyond the minimum specified by the machine manufacturer to allow for thinning during subsequent recovery of the build surface with each reuse;
- surface finish and cleanliness requirements.

6.2.2 Shielding gases

For PBF-LB, the part manufacturer shall specify shielding gases that, as a minimum, includes consideration of the following:

- gas composition and purity;
- compatibility with the feedstock and build platform used;
- PBF machine requirements.

6.2.3 Powder spreading device

The part manufacturer shall specify and select the type of powder spreading device that is used and its material with consideration of the material compatibility with feedstock and consolidated material.

6.2.4 Compressed air

Compressed air requirements for the PBF machine shall be in accordance with the machine manufacturer's recommendations, under consideration of ISO 8573-1.

6.3 Auxiliary tools and equipment

Auxiliary equipment (e.g. sieves, hand tools, power tools, powder storage containers, powder transport systems and delivery mechanism to machine) shall be cleaned and maintained in a manner to prevent cross contamination from different feedstock types, gases, dust, and foreign objects.

Particular care shall be taken with tools being used in the PBF machine build chamber to prevent contamination of the feedstock. Any tool or accessories used in the build chamber, such as spatulas, wrenches, vacuum attachments or similar, shall be non-contaminating to the feedstock.

Cooling systems/chillers, where used, shall be operated in accordance with the cooling system manufacturer's recommendations.

6.4 Machine operating software

Refer to ISO/ASTM TS 52930 for software and data control requirements.

6.5 Environmental controls

Temperature and humidity controls in the workplace and storage areas shall be in accordance with the machine and feedstock manufacturers' specifications (see material safety datasheet provided with the feedstock) and any limits specified by the part manufacturer. Temperature and humidity shall be controlled and monitored to ensure the environment history is traceable to storage or build requirements.

7 Feedstock requirements

7.1 Purchasing feedstock

Feedstock shall be purchased in accordance with the specifications of the quality management system (QMS), for example included within an approved supplier list (ASL).

The part manufacturer shall provide a feedstock purchase specification against which feedstock may be ordered and accepted. The requirements stated in the feedstock purchase specification shall include, as a minimum, those specified by ISO/ASTM 52907, which covers:

- product description (alloy designation);
- powder storage and handling;
- powder sampling;
- powder characterization;
- documentation and traceability.

Third-party certification of powder may be included as a requirement within the purchase specification, where required.

The feedstock supplier shall supply the powder in accordance with the requirements of the feedstock purchase specification (and hence, ISO/ASTM 52907). All feedstock shall be provided with a certificate of conformity from the feedstock supplier, declaring that the feedstock meets the feedstock purchase specification requirements.

7.2 Control of feedstock

All documentation received with the feedstock (e.g. certificate of conformity, safety datasheet) shall be referenced within the manufacturing plan (see [Clause 9](#)) and retained by the part manufacturer (see [5.1](#)).

Feedstock shall be stored in appropriate containers to prevent contamination and moisture absorption.

The part manufacturer shall produce a feedstock use specification that describes requirements against which the feedstock shall be sampled, tested, and monitored prior to approving for use.

Used feedstock that conforms to the requirements outlined within the feedstock use specification may be utilized, unless specifically prohibited by the customer for particular parts.

The history of powder mass added (virgin powder) should be recorded.

When approved by the customer, used powder generated from a build cycle may be blended with virgin powder to maintain a powder quantity large enough for the next build cycle. Combining multiple sources of used powder (i.e., multiple machines operating with the same feedstock) for reuse may also be permitted when every constituent of the resultant blend is shown to conform to the use specification requirements prior to blending. All used powder shall be sieved with a mesh size appropriate for removing any agglomerations prior to testing to requirements in the feedstock use specification and subsequent blending with virgin or other conforming, used powder. All powder sieves used to manufacture parts shall have a certificate of conformance that they were manufactured to a recognized standard, such as ISO 9044 or ASTM E11. The critical powder attributes impacting qualifications, as stated in the feedstock use specification shall be analysed regularly, with period specified by the manufacturer.

NOTE ISO/ASTM 52928 provides guidance on powder life cycle management.

8 Qualification

8.1 Design checks

8.1.1 Part files

All part files related to the digital geometry (e.g. STL, AMF) shall match the intended revision.

8.1.2 Machining allowance

Ensure that machining allowance is added to part(s) where required.

8.1.3 Orientation and location

The manufacturing plan shall specify the build file name and rev. The build file contains information on the part orientation and location on the build platform.

8.1.4 Parts nesting

Ensure that the build platform part nesting has been recorded according to [5.1](#).

8.2 Pre-build checks

8.2.1 General

This section describes pre-build checks applied to all builds independently of their purpose (e.g. periodic preventive maintenance, machine/process qualification, scaling/calibration builds, etc.). The pre-build checks shall cover applicable process variables as stated in ISO/ASTM TS 52930:2021, 6.4.2.1, with special attention to [8.2](#).

8.2.2 Maintenance and calibration status

Check that the maintenance and calibration status of all equipment called out on the manufacturing plan (see [8.3](#)) are up to date.

8.2.3 PBF machine elements and systems

Ensure correct type, proper function, and cleanliness of all elements and sub-systems of the PBF machine (e.g. filter condition, laser windows, powder containers, chiller liquids, etc.) in accordance with the machine manufacturer's specification.

Where used, in-process monitoring equipment and instrumentation shall be setup according to the manufacturer's instructions and confirmed to be ready for use (e.g. within a service or calibration interval).

8.2.4 Build chamber environment

Should be cleaned prior to every process in accordance with the machine manufacturer's specification. In case of fully automatic machine with frequent production loading/unloading, the machine manufacturer shall specify the cleaning frequencies and procedures. Instructions for cleaning laser windows shall be determined by the manufacturer and records of such cleanings documented.

8.2.5 Build platform

Ensure that the build platform material matches that specified in the manufacturing plan (see [Clause 9](#)).

Build platforms shall be visually inspected and rejected for any obvious damage or non-conformity. The build platform shall be installed in the PBF machine in accordance with the machine manufacturer's specification (e.g. levelling, fastening).

Where the build platform will be integral to the final part, additional qualification requirements apply to prove the interface between substrate and deposited material.

8.2.6 Powder spreading device

Before initiating a PBF machine build, the machine operator shall visually inspect the powder spreading device and verify that:

- it is free from any chips, scratches, debris or deformities;
- there is a consistent clearance between the element and the build platform (plane-parallelism) at all locations;
- it is installed in accordance with the machine manufacturer's recommendations.

Only qualified recoater materials shall be used on the PBF machine in accordance with [6.2.3](#). The type of the powder spreading device shall be recorded on the manufacturing plan.

8.2.7 Gas supply

Where gas is used, the following should be checked prior to operation:

- correct gas supplied, as specified in the manufacturing plan;
- ensure appropriate inert/vacuum environment and gas flow settings for feedstock loading and machine operation (for example: residual oxygen content, volume flow);
- availability of sufficient gas to complete the build.

8.2.8 Feedstock condition and quantity

Verify that the required feedstock is available in the specified condition and that a sufficient quantity is available for the build.

8.2.9 Baseline machine and process parameters

Ensure that the process parameters (e.g. beam offset, beam parameters, input energy) are compatible, qualified in accordance with ISO/ASTM TS 52930 and selected appropriate to the requirements of the build.

8.3 Periodic preventive maintenance

8.3.1 General

PBF machines shall undergo preventive maintenance by qualified personnel in accordance with the machine manufacturer's recommended frequency (for example, minimum of every six months or after a given number of build hours). PBF machines where preventive maintenance has lapsed more than 3 months shall not be used to meet the requirements herein.

Record of maintenance activity shall be documented, dated, signed by qualified personnel, and approved by part manufacturer quality assurance. The status of maintenance shall be displayed on exterior of PBF machine showing date of service and next due date or readily accessible in a maintenance software. Maintenance operations shall be controlled by a documented procedure (e.g. ASTM E2910-12).

The maintenance procedure shall confirm the effective function and operations of each major machine and machine component that affects product quality. This shall include, but not be limited to the requirements set in the following subclauses of [8.3](#).

8.3.2 Energy delivery verification

The instructions for checking the characteristics of the delivering energy source (laser or electron beam) shall be determined by the machine manufacturer and recorded, e.g. laser-power, focus diameter, power distribution profile, laser overlaps, beam positioning. The characteristics shall be measured and documented in a regular manner, according to the machine provider's recommendation or manufacturer's specification requirements. Additional measurements shall be considered in case of abnormal process results or significant deviations within destructive testing of sacrificial specimens.

NOTE 1 ISO/ASTM 52941 provides information on acceptance testing on PBF-LB machines used for aerospace applications.

NOTE 2 Reductions in laser power may be as result of a dirty laser window.

8.3.3 Z-axis movement

Ensure that software-controlled and actual layer movements are within the machine provider's recommendation or manufacturer's specification requirements.

8.3.4 Compressed air

Compressed air required for the PBF machine shall be checked at each preventive maintenance for any contamination. Verify proper pressure and check all fittings and connections.

8.3.5 Oxygen and vacuum

Oxygen sensors shall be replaced in accordance with the machine provider's recommended schedule and calibrated at a minimum of two oxygen concentration points. Vacuum shall meet the machine provider's recommendation and shall have a method for calibration.

8.3.6 Laser field alignment (LFA)

The LFA on multiple-laser systems shall be calibrated according to the machine provider's recommendations. The machine manufacturer shall provide tolerance requirements for laser field alignment.

8.3.7 Other recommended preventive maintenance

Ensure that further recommended preventive maintenance, as listed in the machine operation or service manual, is performed, e.g. seals used to maintain inert or vacuum environment.

8.4 Machine, process, and part qualification

8.4.1 Process qualification

Prior to the process qualification, a manufacturing plan (in accordance with [Clause 9](#)) that specifies the manufacturing steps and sequence shall be created. The manufacturing plan shall specify all boundary conditions (e.g. process parameters, feedstock specification, shielding gas setting, etc.) used for execution of the job.

The start of build cycle, build run time and build end time, including any cool down time, shall be recorded on the manufacturing plan.

Based on the manufacturing plan, multiple build jobs shall be manufactured to produce sufficient test specimen(s) in statistically significant quantity for the purpose of qualification. Once the qualification build results have been validated, the parameters used for the qualification builds are recorded as PBF baseline parameters, and establish the parameters for subsequent builds. Ongoing production is monitored through comparison to production control charts, generated by the process qualification (see ISO/ASTM TS 52930).

8.4.2 Build platform

The part manufacturer shall use a build platform in accordance with that specified on the manufacturing plan and conforming to [6.2.1](#).

All build platforms shall be serialized, describing, at a minimum, the material. Dissimilar materials (build platform versus part) may be used provided the part meets the chemical composition engineering callouts. Contamination of the part by the build platform material shall be avoided for non-hybrid parts.

8.4.3 Test specimens

Test specimens (consolidated material) shall be evaluated for all required properties as specified by an appropriate PBF material standard or a standard applicable to an identical chemical composition within conventional manufacturing technologies (molding, casting, milling). If no appropriate standard is available, the following properties shall be evaluated:

- chemical composition;
- mechanical properties:
 - hardness (optional, dependant on the material);
 - yield strength;
 - ultimate tensile strength;
 - break elongation;
- physical properties:
 - relative density (the 100 % reference value shall be displayed).

Further properties may be tested as agreed upon by the part manufacturer and customer.

Test specimens' geometries shall be selected in accordance with appropriate standards (for example ASTM E8/E8M, ISO 6892-1, ISO/ASTM 52908). Tension test blanks and additional test specimens shall be placed, at a minimum, in five locations on the build platform as shown in [Figure 1](#). Due to anisotropic material characteristics, different specimen orientations should be considered regarding the later application and

especially the orientation of sacrificial specimen for posterior quality control. For the identification of mechanical properties from the tensile test, at least the upright specimen orientation (Z-orientation; polar angle $\theta = 0^\circ$) shall be selected in accordance with ISO 17295.

ISO/ASTM 52927 and ISO/ASTM 52908 provide guidance on evaluating mechanical properties of metal materials made using PBF. The customer may require other qualification tests. Properties published in material data sheets shall be based on the results of the process qualification. A qualification record that indicates the qualification status of the machine shall be available.

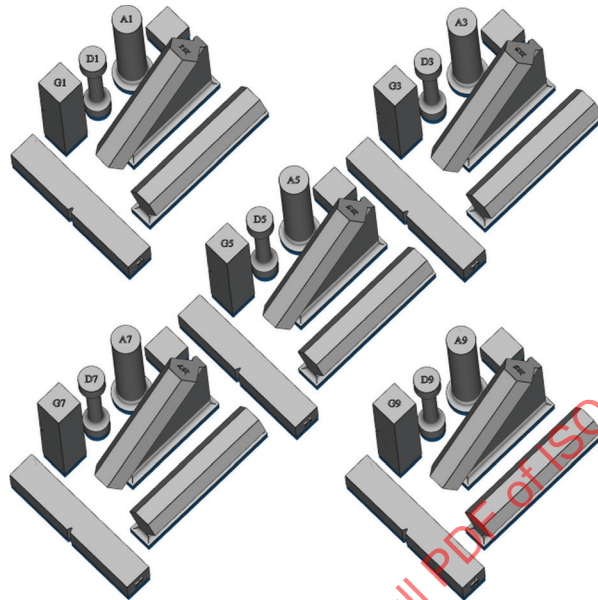


Figure 1 — Example of tension test blanks and additional test specimens placed in five locations on a build platform

The tension test specimen may be tested in the “as built” surface condition, provided that this specimen condition is indicated in the material data sheet.

To frequently control undisturbed process conditions, reference parts/specimens, that were applied throughout the process qualification, shall be included in each built and tested.

For the reference part(s)/test specimens to be representative of future parts, all post-build activities, if any, on the specimens shall be consistent with the future parts (e.g. thermal post-processing).

8.4.4 Requalification

At a minimum, the manufacturer shall re-perform (or at least partially re-perform in case of sufficient evidence) the qualification procedure to verify property-specific location and dispersion bandwidths upon the occurrence of one of the following:

- A machine or its sub-systems that could affect part quality is moved to a new location, including relocation within existing facility;
- A machine is upgraded, recalibrated, or repaired and the repairs involve any critical machine components (e.g. the laser or electron beam delivery, optics, feedstock delivery or platform positioning mechanism).

8.5 Consolidated material and part

8.5.1 Material properties

Reporting of material properties of the consolidated material shall be done in accordance with a conventional manufacturing standardized material specification, if available. Where no standardized

material specification exists, a bespoke material specification shall be created that, as a minimum, includes the following properties:

- chemical composition;
- mechanical properties:
 - hardness (optional, dependant on the material);
 - yield strength;
 - ultimate tensile strength;
 - break elongation;
- physical properties:
 - relative density (the 100 % reference value shall be displayed).

The additive manufacturer shall provide a declaration of conformity with the part to confirm adherence to the material specification (e.g. EN 10204:2004, Type 3.1/3.2).

Due to anisotropic material characteristics, different specimen orientations should be considered regarding the later application and especially the orientation of sacrificial specimen for posterior quality control. For the identification of mechanical properties from the tensile test, at least the upright specimen orientation (Z-orientation; polar angle $\theta = 0^\circ$) shall be selected in accordance with ISO 17295.

8.5.2 Part properties

Part specifications shall be agreed between the customer and part manufacturer.

NOTE ISO/ASTM 52901 provides requirements for purchased AM parts.

The additive manufacturer shall provide a declaration of conformity with the part to confirm adherence to the part specification (e.g. EN 10204:2004, Type 3.1/3.2).

8.5.3 Non-conformities

Unplanned interruptions and failures during the build cycle shall be considered as a failed process, rejected, and recorded.

Rejected parts that were not affected by the build error may be accepted, subject to agreement between involved parties (e.g. customer, manufacturer, inspection body).

9 Manufacturing plan and documentation

9.1 Manufacturing plan

The additive manufacturer should produce a manufacturing plan as specified by ISO/ASTM 52900 (see [Annex A](#)).

The manufacturing plan should contain the sequence of PBF and QC operations and at a minimum shall contain the following:

- PBF machine operation software version (see [5.1](#));
- reference of unique build cycles within a manufacturing lot (see [5.2](#));
- environmental conditions (see [6.5](#));
- feedstock documentation references (see [7.2](#));

- part orientation and placement (see [8.1.3](#));
- prebuild checks completed (see [8.2](#));
- reference of machine used and maintenance / calibration status (see [8.2.2](#));
- start of build cycle, build run time and build end time including any cool down time (see [8.4.1](#));
- thermal processing operations (see [8.4.3](#));
- non-conformance records (see [8.5.3](#)).

9.2 Documentation

Documentation deliverable to the customer shall be agreed between the contracting parties. The following [Table 1](#) on documentation proposals provide guidance on which documentation could be applicable.

Table 1 — Example of possible items to cover by the documentation

	Requirement document	Validation document
Personnel	Qualification requirements (see Clause 4)	Qualification record (see Clause 4)
Digital data	Specification of the part (see 5.2)	Validation document
	Customer supplied data (e.g. CAD-file)	Validation document
	CAD-files generated by manufacturer (e.g. translations, point cloud data)	Quality check report (see 5.1 and 5.2)
	Build files (build layout, slice files)	Build job report (build log file, see 5.1)
PBF Equipment	Installation and maintenance requirements (see 6.1)	Equipment installation and maintenance records (see 8.3)
	Build platform specification (see 6.2.1)	Build platform certificate of conformity
	Gas specification (see 6.2.2 and 6.2.4)	Gas certificate
	Recoater specification (see 6.2.3)	Delivery note
	Calibration	Calibration report
	Facility procedures (see 6.3 , 6.5 and 8.2)	Inspection records for auxiliary tools and equipment (see 6.3), calibration certificates for instrumentation (see 6.5), checklists (see 8.2)
Feed-stock	Feedstock purchase specification (see 7.1)	Feedstock certificate (e.g. ISO/ASTM 52907) Documentation received with the feedstock (see 7.2)
	Feedstock use specification (see 7.2)	Traceability records for reused powder (see 7.2)
Manu-factur-ing	Definition of process-details and sequence (see 8.4.1)	Manufacturing plan (see 9.1)
	Process qualification requirements (e.g. inspection and test-plan, see 8.4.1)	Control charts (see 8.4.1)
Consolidat-ed material	Definition of material properties (material specifica-tion, see 8.5.1)	Declaration of conformity (see 8.5.1)
Part	Definition of part properties (see 8.5.2)	Declaration of conformity (see 8.5.2)
	Customer supplied data (e.g. CAD-file)	Geometrical inspection report
	Specification of the part (see 5.2)	Geometrical inspection report
	Confirmation of successful completion of all steps specified by the manufacturing plan	Completed set of manufacturing records (e.g. fulfilled manufacturing plan, checklists)