AMable

Guide to Additive Manufacturing Standards

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Guide to Additive Manufacturing Standards

Stakeholders from producing industry and machine manufacturing strive for new standards that regulate Additive Manufacturing activities. Although many were initiated or revised thought the last couple of years, a lot of work is still to be done.

AMable partners and experts, in collaboration with several experiments and SMEs, have identified recurrent needs in standardisation. This list compares the identified standard needs to the existing standards. It therefore also provides information about specific gaps and if those are presently being considered by any technical committee This list allows all stakeholders from production companies to equipment providers to see if it is worth waiting for a publicly disclosed standard or if it is time to engage.

For more information and access to the full and updated list of current standards, please consult the websites of ISO/TC 261[1] [2] and of ASTM Committee F42[3].

[1] https://www.iso.org/committee/629086.html
[2] https://committee.iso.org/home/tc261
[3] https://www.astm.org/COMMITTEE/F42.htm

Need	Status	Scope
General		
Decision Support: Additive vs. Subtractive characteristics of the general AM process and ranks the pros/cons or strengths/weaknesses of each process, allowing users to make informed decisions about which AM process best suits their need	**Standard Available?**	No
	Is there any Work in Progress?	No
Standardized Design for Additive Manufacturing Process Chain	**Standard Available?**	**ISO/ASTM DIS 52920 - Additive manufacturing —Qualification principles — Requirements for industrial additive manufacturing sites** This document defines the requirements for manufacturing sites, in which additive manufacturing techniques are used (referred to below as additive manufacturing sites), which are independent of the material and manufacturing method used. This document specifies criteria for additive manufacturing processes as well as quality-relevant characteristics and factors along the process chain and defines activities and sequences within an additive manufacturing site. This document is applicable to the additive manufacturing technologies defined according to E DIN EN ISO/ASTM 52900:2018-06 and follows an approach oriented to the manufacturing process. *Note: This standard defines the requirements for an AM facility and has the AM process chain indirectly referred in the document.*
	Is there any Work in Progress?	No
In-Process Monitoring	**Standard Available?**	No

	Is there any Work in Progress?	**ISO/ASTM AWI TR 52905 - Additive manufacturing of metals — Non-destructive testing and evaluation — Defect detection in parts** This document categorises Additive Manufacturing (AM) defects in DED and PBF laser and electron category of processes, provides a review of relevant current NDT standards, details NDT methods that are specific to AM and complex 3D geometries and outlines existing non-destructive testing techniques that are applicable to some AM types of defects. This document is aimed at users and producers of AM processes, and it applies, in particular, to the following: — Safety critical AM applications; — Assured confidence in AM; — Reverse engineered products manufactured by AM; — Test bodies wishing to compare requested and actual geometries. **ISO/ASTM DTR 52906 - Additive manufacturing — Non-destructive testing and evaluation — Intentionally seeding flaws in parts** This practice describes the operation and production control of metal powder bed fusion (PBF) machines and processes to meet critical applications such as commercial aerospace components and medical implants. The requirements contained herein are applicable for production components and mechanical test specimens using powder bed fusion (PBF) with both laser and electron beams. 1.2 This standard 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 standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. 1.3 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.
Design		
Process-Specific Design Guidelines	**Standard Available?** Available only for PBF: - Metals - **ISO/ASTM 52911-1:2019** - Polymers - **ISO/ASTM 52911-2:2019**	**ISO/ASTM 52911-1:2019 - Additive manufacturing — Design — Part 1: Laser-based powder bed fusion of metals** This document specifies the features of laser-based powder bed fusion of metals (LB-PBF-M) and provides detailed design recommendations. Some of the fundamental principles are also applicable to other additive manufacturing (AM) processes, provided that due consideration is given to process-specific features. This document also provides a state of the art review of design guidelines associated with the use of powder bed fusion (PBF) by bringing together relevant knowledge about this process and by extending the scope of ISO/ASTM 52910. **ISO/ASTM 52911-2:2019 - Additive manufacturing — Design — Part 2: Laser-based powder bed fusion of polymers** This document specifies the features of laser-based powder bed fusion of polymers (LB-PBF-P) and provides detailed design recommendations. Some of the fundamental principles are also applicable to other additive manufacturing (AM) processes, provided that due consideration is given to process-specific features. This document also provides a state-of-the-art review of design guidelines associated with the use of powder bed fusion (PBF) by bringing together relevant knowledge about this process and by extending the scope of ISO/ASTM 52910.
	Is there any Work in Progress?	**ISO/ASTM AWI 52911-3 - Design — Part 3: Electron beam PBF of metals** This document specifies the features of electron beam powder bed fusion of metals (PBF-EBPBF-EB/M) and provides detailed design recommendations. Some of the fundamental principles are also applicable to other additive manufacturing (AM) processes, provided that due consideration is given to process-specific features. This document also provides a state of the art review of design guidelines associated with the use of powder bed fusion (PBF) by bringing together relevant knowledge about this process and by extending the scope of ISO/ASTM52910. **(ISO/ASTM 52922) - F3413 – 19 - Guide for Additive Manufacturing — Design — Directed Energy Deposition** This document specifies the features of Directed Energy Deposition (DED) and provides detailed design recommendations. This document also provides a state-of-the-art review of design guidelines associated with the use of DED by bringing together relevant knowledge about this process and by extending the scope of ISO/ASTM 52910. Some of the fundamental principles are also applicable to other additive manufacturing (AM) processes, provided that due consideration is given to process-specific features.
	Standard Available?	No

Design Guide for Post-processing	**Is there any Work in Progress?** *Note: This topic is already covered in Design standards*	**ISO/ASTM CD 52908 - Additive Manufacturing of Metals — Post-processing methods — Quality assurance and post processing of powder bed fusion metallic parts** This document sets requirements for the qualification, quality assurance and post processing for metal parts made by powder bed fusion. This standard defines methods and procedures for testing and qualification of various characteristics of additively manufactured metal parts, in accordance to ISO 17296-3:2014 Classes H and M. The standard is intended to be used by part providers and/or customers of parts. This standard is a top-level standard in the hierarchy of additive manufacturing standards in that it is intended to apply to metallic parts made by additive manufacturing. The standard defines qualification procedures where appropriate to meet defined quality levels.
Design for 3D Printed Electronics and Integration of electronics on AM built parts	**Standard Available?**	**ISO/ASTM FDIS 52950 - Additive manufacturing — General principles — Overview of data processing** This document covers the principal considerations which apply to data exchange for additive manufacturing. It specifies terms and definitions which enable information to be exchanged describing geometries or parts such that they can be additively manufactured. The data exchange method outlines file type, data enclosed formatting of such data and what this can be used for. *Note: This standard has topics for AM 3D geometry, but nothing directed to printed electronics.* **IPC-2292**: Design Standard for Printed Electronics on Flexible Substrates This document establishes specific requirements for the design of printed electronic applications and their forms of component mounting and interconnecting structures on flexible substrates.
	Is there any Work in Progress?	No
Design documentation of complex structures, geometries and features possible by AM	**Standard Available?** *Note: Design standards often describe some of the features possible for AM parts.*	**ISO/ASTM 52902 - Additive manufacturing — Test artifacts — Geometric capability assessment of additive manufacturing systems** This document covers the general description of benchmarking test piece geometries along with quantitative and qualitative measurements to be taken on the benchmarking test piece(s) to assess the performance of additive manufacturing (AM) systems. This performance assessment can serve the following two purposes: — AM system capability evaluation; — AM system calibration. The benchmarking test piece(s) is (are) primarily used to quantitatively assess the geometric performance of an AM system. This document describes a suite of test geometries, each designed to investigate one or more specific performance metrics and several example configurations of these geometries into test piece(s). It prescribes quantities and qualities of the test geometries to be measured but does not dictate specific measurement methods. Various user applications can require various grades of performance. This document discusses examples of feature configurations, as well as measurement uncertainty requirements, to demonstrate low and high grade examination and performance. This document does not discuss a specific procedure or machine settings for manufacturing a test piece, which are covered by ASTM F 2971 and other relevant process specific specifications. *Note: In this standard, artifacts are described with different features, which demonstrates the capabilities of AM machines. CAD files of the artifacts are available.*
	Is there any Work in Progress?	No
Materials		

Functionally Graded Materials	**Standard Available?**	**ISO/ASTM 52912:2019 - Additive manufacturing — Design — Functionally graded additive manufacturing** The use of Additive Manufacturing (AM) enables the fabrication of geometrically complex components by accurately depositing materials in a controlled way. Technological progress in AM hardware, software, as well as the opening of new markets demand for higher flexibility and greater efficiency in today's products, encouraging research into novel materials with functionally graded and high-performance capabilities. This has been termed as Functionally Graded Additive Manufacturing (FGAM), a layer-by-layer fabrication technique that involves gradationally varying the ratio of the material organization within a component to meet an intended function. As research in this field has gained worldwide interest, the interpretations of the FGAM concept requires greater clarification. The objective of this technical report is to present a conceptual understanding of FGAM. The current state of art and capabilities of FGAM technology will be reviewed alongside with its challenging technological obstacles and limitations. Here, data exchange formats and some of the recent application is evaluated, followed with recommendations on possible strategies in overcoming barriers and future directions for FGAM to take off.
	Is there any Work in Progress?	No
AM Powders (particle size, distribution, spreadability, flowability, re-usage, stratification, storage...)	**Standard Available?**	**ISO/ASTM 52907:2019 - Feedstock materials — Methods to characterize metal powders** This document provides technical specifications for metallic powders intended to be used in additive manufacturing and covers the following aspects: — documentation and traceability; — sampling; — particle size distribution; — chemical composition; — characteristic densities; — morphology; — flowability; — contamination; — packaging and storage. This document does not deal with safety aspects. In addition, this document gives specific requirements for used metallic powders in additive manufacturing.
	Is there any Work in Progress?	**ISO/ASTM DTR 52913-1 – Feedstock materials — Part 1: Parameters for characterization of powder flow properties** This Technical Report applies the principal requirements to measure the parameters that characterize the flow properties of powders for powder based additive manufacturing processes. This International Technical Report applies variables which have an influence on flow properties and the necessary information in a test report. This International Report is aimed for test equipment manufacturers, material suppliers and additive manufacturing machine users **ISO/ASTM AWI 52928 - Feedstock materials — Powder life cycle management** This document specifies requirements and describes aspects for the lifecycle management of metal feedstock materials for powder based additive manufacturing processes. Those aspects include: -Powder properties, -Powder lifecycle, -Test methods and, -Powder quality assurance. **F3049 – 14 - Standard Guide for Characterizing Properties of Metal Powders Used for AM Processes** 1.1 This guide introduces the reader to techniques for metal powder characterization that may be useful for powder-based additive manufacturing processes including binder jetting, directed energy deposition, and powder bed fusion. It refers the reader to other, existing standards that may be applicable for the characterization of virgin and used metal powders processed in additive manufacturing systems. 1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard. 1.3 This standard 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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
AM Filaments and Pellets (re-usage, storage...) Consumables (AM wires and so on)	**Standard Available?**	No
	Is there any Work in Progress?	No

Methods of evaluation of feedstock polymer powder materials for PBF	**Standard Available?**	No
	Is there any Work in Progress?	**ISO/ASTM DIS 52924 - AM of polymers — Feedstock materials — Qualification of materials for laser-based PBF of parts** 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.
Characterization and acceptance criteria of AM microstructures	**Standard Available?**	No
	Is there any Work in Progress? *Note 1: Standards ISO/ASTM CD 52908, ISO/ASTM TS 52930 and ISO/ASTM DIS 52920 mention some topics on characterization and acceptance criteria but nothing on AM microstructures* *Note 2: ISO/ASTM AWI 52939 provides tables with criteria and test procedure but also nothing on AM microstructures*	**ISO/ASTM CD 52908 - Additive manufacturing of metals — Finished Part properties — Post-processing, inspection and testing of parts produced by powder bed fusion** This document sets requirements for the qualification, quality assurance and post processing for metal parts made by powder bed fusion. This standard defines methods and procedures for testing and qualification of various characteristics of additively manufactured metal parts, in accordance to ISO 17296-3:2014 Classes H and M. The standard is intended to be used by part providers and/or customers of parts. This standard is a top-level standard in the hierarchy of additive manufacturing standards in that it is intended to apply to metallic parts made by additive manufacturing. The standard defines qualification procedures where appropriate to meet defined quality levels. **ISO/ASTM TS 52930 - Additive manufacturing — Qualification principles — Installation, operation and performance (IQ/OQ/PQ) of PBF-LB equipment** This guideline addresses IQ, OQ, and PQ issues directly related to the AM machine and connected equipment. Physical facility, personnel, process and material issues are only included to the extent necessary to support machine qualification. **ISO/ASTM DIS 52920 - Additive manufacturing — Qualification principles — Requirements for industrial additive manufacturing sites** This document defines the requirements for manufacturing sites, in which additive manufacturing techniques are used (referred to below as additive manufacturing sites), which are independent of the material and manufacturing method used. This document specifies criteria for additive manufacturing processes as well as quality-relevant characteristics and factors along the process chain and defines activities and sequences within an additive manufacturing site. This document is applicable to the additive manufacturing technologies defined according to E DIN EN ISO/ASTM 52900:2018-06 and follows an approach oriented to the manufacturing process. **ISO/ASTM AWI 52945 - Additive manufacturing for Automotive — Qualification principles — Generic machine evaluation and specification of Key Performance Indicators for PBF-LB/M processes** This document defines the methodology for generic AM-machine evaluation in automotive environment using objective test criteria and provides the framework for an objective AM-machine evaluation and comparison. This document finds application in benchmarks, preparation of purchase decisions, but also AM-machine evaluation within the machine procurement, acceptance, and qualification process. The methodology and performance characteristics are introduced to enable evaluation on an objective and quantitative basis. The documentation resulting from the AM-machine evaluation is used to obtain a reliable orientation selection and evaluation of PBF-LB/M AM-machines. Furthermore, this document specifies machine KPIs in the context of machine procurement, production planning and production of PBF-LB/M components. It aims to reach a detailed understanding between machine supplier and machine customer with respect to the acceptance criteria during the procurement process and evaluation of machine performance during running production. This document is applicable to the additive manufacturing technology LPBF-M defined in ISO/ASTM 52900. **ISO/ASTM AWI 52939 - Additive Manufacturing for construction — Qualification principles — Structural and infrastructure elements** This document defines the requirements for building and construction projects in which additive manufacturing techniques are used. The requirements are independent of the material and printing method used. This document specifies the criteria for additive manufacturing processes and quality-relevant characteristics and factors along the process chain and defines activities and sequences within an additive manufacturing site/project. This standard applies to all additive manufacturing technologies in building and construction of

		structural and infrastructure building elements for residential and commercial applications and follows an approach oriented to the manufacturing process.
Material Properties (yield strength, ultimate tensile strength, reduction in area, elongation, Young's modulus...)	**Standard Available?**	No
	Is there any Work in Progress?	**ISO/ASTM AWI 52909 - Additive manufacturing — Finished part properties — Orientation and location dependence of mechanical properties for metal powder bed fusion** This document covers supplementary guidelines for evaluation of mechanical properties including static/quasi-static and dynamic testing of metals made by additive manufacturing (AM) to standardize terminology that intended to be used when reporting results from testing of directly printed samples or those excised from printed parts made by this technique or both. This document is provided to leverage already existing standards. Guidelines are provided to standardize the measurements of mechanical properties and reporting for additively manufactured metallic samples as well as those excised from components. 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 standard to establish appropriate safety, health and environmental practices and determine the applicability of regulatory limitations prior to use. This document expands upon the nomenclature of ISO/ASTM 52900 and principles of ISO/ASTM 52921 and extends them specifically to metal additive manufacturing. The application of this document is primarily intended to provide guidance on orientation designations in cases where meaningful orientation/direction for AM cannot be obtained from available test methods. **F3122 – 14 - Standard Guide for Evaluating Mechanical Properties of Metal Materials Made via AM Processes** 1.1 This standard serves as a guide to existing standards or variations of existing standards that may be applicable to determine specific mechanical properties of materials made with an additive manufacturing process. 1.2 As noted in many of these referenced standards, there are several factors that may influence the reported properties, including material, material anisotropy, method of material preparation, porosity, method of specimen preparation, testing environment, specimen alignment and gripping, testing speed, and testing temperature. These factors should be recorded, to the extent that they are known, according to Practice F2971 and the guidelines of the referenced standards. 1.3 The following standards are not referred to directly in the guide but also have information that may be useful in the testing of metal test specimens made via additive manufacturing: A370, A1058, B211, B348, B557, B565, B724, B769, E3, E6, E7, E290, E467, E468, E837, E915, E1049,E1823, E1942. 1.4 Units—The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard. 1.5 This standard 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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
Data		
Data formats and data management in several stages of the manufacturing workflow (DfAM, simulation, path planning, sensing and monitoring)	**Standard Available?**	**ISO/ASTM 52950:2021 - Additive manufacturing — General principles — Overview of data processing** This document covers the principal considerations which apply to data exchange for additive manufacturing. It specifies terms and definitions which enable information to be exchanged describing geometries or parts such that they can be additively manufactured. The data exchange method outlines file type, data enclosed formatting of such data and what this can be used for. This document — enables a suitable format for data exchange to be specified, — describes the existing developments for additive manufacturing of 3D geometries, — outlines existing file formats used as part of the existing developments, and — enables understanding of necessary features for data exchange, for adopters of this document. This document is aimed at users and producers of additive manufacturing processes and associated software systems. It applies wherever additive processes are used, and to the following fields in particular: — producers of additive manufacturing systems and equipment including software; — software engineers involved in CAD/CAE systems; — reverse engineering systems developers; — test bodies wishing to compare requested and actual geometries. **ISO/ASTM 52915:2020 - Specification for additive manufacturing file format (AMF) Version 1.2** This document provides the specification for the Additive Manufacturing File Format (AMF), an interchange format to address the current and future needs of additive manufacturing technology. This document specifies the requirements for the preparation, display

		and transmission for the AMF. When prepared in a structured electronic format, strict adherence to an extensible markup language (XML)[1] schema supports standards-compliant interoperability.
	Is there any Work in Progress?	**ISO/ASTM CD TR 52918 - Additive manufacturing– Data formats — File format support, ecosystem and evolutions** This document aims to provide an updated, comprehensive technical report on the current status of AMF support in the community, its ecosystem, including alternative standards and consortiums, and to list and evaluate potential features and evolutions which are susceptible to further extent its support. **ISO/ASTM DIS 52920 - Additive manufacturing — Qualification principles — Requirements for industrial additive manufacturing sites** This document defines the requirements for manufacturing sites, in which additive manufacturing techniques are used (referred to below as additive manufacturing sites), which are independent of the material and manufacturing method used. This document specifies criteria for additive manufacturing processes as well as quality-relevant characteristics and factors along the process chain and defines activities and sequences within an additive manufacturing site. This document is applicable to the additive manufacturing technologies defined according to E DIN EN ISO/ASTM 52900:2018-06 and follows an approach oriented to the manufacturing process.
File formats and compatibility with machines	**Standard Available?**	**ISO/ASTM 52918 – Additive manufacturing — Data formats — File format support, ecosystem and evolutions** This document aims to provide an updated, comprehensive technical report on the current status of AMF support in the community, its ecosystem, including alternative standards and consortiums, and to list and evaluate potential features and evolutions which are susceptible to further extent its support. **ISO/ASTM 52950:2021 - Additive manufacturing — General principles — Overview of data processing** This document covers the principal considerations which apply to data exchange for additive manufacturing. It specifies terms and definitions which enable information to be exchanged describing geometries or parts such that they can be additively manufactured. The data exchange method outlines file type, data enclosed formatting of such data and what this can be used for. This document — enables a suitable format for data exchange to be specified, — describes the existing developments for additive manufacturing of 3D geometries, — outlines existing file formats used as part of the existing developments, and — enables understanding of necessary features for data exchange, for adopters of this document. This document is aimed at users and producers of additive manufacturing processes and associated software systems. It applies wherever additive processes are used, and to the following fields in particular: — producers of additive manufacturing systems and equipment including software; — software engineers involved in CAD/CAE systems; — reverse engineering systems developers; — test bodies wishing to compare requested and actual geometries.
	Is there any Work in Progress?	No
Health, Safety & Environment		
Environmental Health and Safety: Protection of Machine Operators	**Standard Available?**	No
	Is there any Work in Progress? Yes **ISO/ASTM AWI 52938-1** - AM of metals — Environment, health and safety — Part 1: Safety requirements for PBF-LB machines	**ISO/ASTM CD 52931 - Additive manufacturing of metals — Environment, health and safety — General principles for use of metallic materials** This document provides a guide for risk assessment and implementation of prevention and protection measures relating to additive manufacturing with metallic feedstocks (e.g. powders, wires, …). The risks covered by this document concern the entire process value chain, from the reception of the raw material to the output of the parts for delivery. The management of waste and discharges is also taken into account. **ISO/ASTM CD 52932 - Additive manufacturing of polymers — Environment, health and safety — Test method for the determination of particle emission rates from desktop ME printers** This standard specifies test methods to determine particle emissions (including ultrafine particles) and chemical substances (VOC, aldehydes) from Material Extrusion (ME) processes often used in nonindustrial environments such as school, homes and office spaces in

		an Emission Test Chamber (ETC) under specified test conditions. This standard comprises a preparation method in a controlled ETC of temperature, humidity, air exchange rate, and monitoring, storage, analysis, calculation and reporting of emission rates. This standard provides a specific process for standard operating conditions of 3D printer and test sample to evaluate particle emission rates and chemical concentrations during the 3D printing operation with thermoplastic materials. **ISO/ASTM WD 52933 - Environment, health and safety — Consideration for the reduction of hazardous substances emitted during the operation of the non-industrial ME type 3D printer in workplaces, and corresponding test method** This international standard has been developed in close cooperation of ISO/TC 261 and ASTM F 42 on 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. This standard refers to the assessment of hazardous substances emitted during operation of ME-type 3D printers installed in schools or public places for educational and hands-on purposes, and basic countermeasures for reducing the substances. This standard provides the necessary information and test procedures to reflect the characteristics of AM process based on the previous international standards related to indoor air quality and to assess hazardous substances from AM workplace. With the temporal and spatial elements of AM workplace excluded, it can be performed by using the following standard to measure hazardous substances emitted during operation of the ME-type 3D printer. ISO/ASTM CD 52932, Additive manufacturing - Environment, Health, and Safety - Test method for determination of particle and chemical emission rates from desktop 3D printer material extrusion. **ISO/ASTM AWI 52938-1 - Additive manufacturing of metals — Environment, health and safety — Part 1: Safety requirements for PBF-LB machines** This document deals with the technical requirements and the means for their verification for Additive Manufacturing (AM) machines using a bed of metallic powder and a laser herein designated as machine. This document deals with all significant hazards, hazardous situations or hazardous events during all phases of the life of the machine (ISO 12100:2010, 5.4), as listed in Annex A, caused by AM machines using a bed of metallic powder and a laser when used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer. This document does not deal with hazards which can occur: —during construction; —operating in potentially explosive atmospheres. This document is not applicable to machines manufactured before the date of its publication
Machine Calibration and Preventative Maintenance	**Standard Available?**	**ISO/ASTM 52904 - Additive manufacturing — Process characteristics and performance — Practice for metal powder bed fusion process to meet critical applications** 1.1 This practice describes the operation and production control of metal powder bed fusion (PBF) machines and processes to meet critical applications such as commercial aerospace components and medical implants. The requirements contained herein are applicable for production components and mechanical test specimens using powder bed fusion (PBF) with both laser and electron beams. 1.2 This standard 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 standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. 1.3 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee. Note: it includes some points of Preventive Maintenance – maintenance intervals, maintenance manual.
	Is there any Work in Progress? Standards that provide some info but not extensive on the topic: **ISO/ASTM 52908** Only for PBF	**ISO/ASTM 52908 - Additive manufacturing of metals — Finished Part properties — Post-processing, inspection and testing of parts produced by powder bed fusion** This document sets requirements for the qualification, quality assurance and post processing for metal parts made by powder bed fusion. This standard defines methods and procedures for testing and qualification of various characteristics of additively manufactured metal parts, in accordance to ISO 17296-3:2014 Classes H and M. The standard is intended to be used by part providers and/or customers of parts. This standard is a top-level standard in the hierarchy of additive manufacturing standards in that it is intended to apply to metallic parts made by additive manufacturing. The standard defines qualification procedures where appropriate to meet defined quality levels. **ISO/ASTM 52920 - Qualification principles — Requirements for industrial additive manufacturing sites** This document defines the requirements for manufacturing sites, in which additive manufacturing techniques are used (referred to below as additive manufacturing sites), which are independent of the material and manufacturing method used. This document specifies

	ISO/ASTM 52920 General applications **ISO/ASTM 52939** – For construction and building Very complete about the topic: **ISO/ASTM PWI 52930** - Only for PBF-LB	criteria for additive manufacturing processes as well as quality-relevant characteristics and factors along the process chain and defines activities and sequences within an additive manufacturing site. This document is applicable to the additive manufacturing technologies defined according to E DIN EN ISO/ASTM 52900:2018-06 and follows an approach oriented to the manufacturing process. **ISO/ASTM 52939 - Additive Manufacturing for construction — Qualification principles — Structural and infrastructure elements** This document defines the requirements for building and construction projects in which additive manufacturing techniques are used. The requirements are independent of the material and printing method used. This document specifies the criteria for additive manufacturing processes and quality-relevant characteristics and factors along the process chain and defines activities and sequences within an additive manufacturing site/project. This standard applies to all additive manufacturing technologies in building and construction of structural and infrastructure building elements for residential and commercial applications and follows an approach oriented to the manufacturing process. **ISO/ASTM PWI 52930 - Additive manufacturing — Qualification principles — Installation, operation and performance (IQ/OQ/PQ) of PBF-LB equipment** This guideline addresses IQ, OQ, and PQ issues directly related to the AM machine and connected equipment. Physical facility, personnel, process and material issues are only included to the extent necessary to support machine qualification.
Processes		
Standardization of DED processes	**Standard Available?**	No
	Is there any Work in Progress?	**F3187 – 16 - Standard Guide for Directed Energy Deposition of Metals** 1.1 Directed Energy Deposition (DED) is used for repair, rapid prototyping and low volume part fabrication. This document is intended to serve as a guide for defining the technology application space and limits, DED system set-up considerations, machine operation, process documentation, work practices, and available system and process monitoring technologies. 1.2 DED is an additive manufacturing process in which focused thermal energy is used to fuse materials by melting as they are being deposited. 1.3 DED Systems comprise multiple categories of machines using laser beam (LB), electron beam (EB), or arc plasma energy sources. Feedstock typically comprises either powder or wire. Deposition typically occurs either under inert gas (arc systems or laser) or in vacuum (EB systems). Although these are the predominant methods employed in practice, the use of other energy sources, feedstocks and atmospheres may also fall into this category. 1.4 The values stated in SI units are to be regarded as standard. All units of measure included in this guide are accepted for use with the SI. 1.5 This standard 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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use**.** *Note: This document is intended to serve as a guide for defining the technology application space and limits, DED system set-up considerations, machine operation, process documentation, work practices, and available system and process monitoring technologies.*
Material Jetting - flow rate, temperature, viscosity, pressure level, wetting of the orifice plate, etc.	**Standard Available?**	No
	Is there any Work in Progress?	No
Sector Specific – Medical and Aerospace		
	Standard Available?	No

Medical Imaging Consistency - medical imaging data can be consistently and accurately transformed into a 3D printed object	**Is there any Work in Progress?**	**ISO/ASTM PRF TR 52916 - Additive manufacturing for medical — Data — Optimized medical image data** This standard includes the creation of optimized data for Medical Additive Manufacturing (MAM). These data are generated from static modalities, such as magnetic resonance imaging (MRI), computed tomography (CT), positron emission tomography (PET), and single photon emission computed tomography (SPECT), and from dynamic modalities, such as ultrasound and optical image data. The standard addresses medical-specific data quality requirements, and medical image data acquisition processing and optimization approaches for accurate solid medical models, based on real human and animal data. Acquisition of medical computer-aided design (CAD) data for sophisticated medical technology is based on two-dimensional (2D) medical images such as CT and MRI images. In order to obtain accurate and precise data, the resolution and quality of the original image are important. However, results may differ based on the operator behaviour during editing, because anatomical medical images may have lower boundary clarity and there are points that cannot be automatically classified. In addition, the non-uniform intensity of noise and radiation of the original image can cause errors. Therefore, as the efforts to evaluate for medical image data acquisition processing and to reduce errors are closely related to the quality of medical care, it is necessary to standardize a series of optimization methods in order to digitize medical images and integrate them for utilization.
Design guidelines for medical devices to assure cleanability after production at different stages (at the manufacturing process, after processing, for reusage of the device)	**Standard Available?**	No
	Is there any Work in Progress?	**ASTM F3357-19 - Standard Guide for Designing Reusable Medical Devices for Cleanability** 1.1 This guide is intended to provide manufacturers of reusable medical devices design feature guidance to minimize debris retention after use and increase ease of removal of contaminants and cleaning product residuals from devices during cleaning/rinsing and also prepare for subsequent processing steps (for example, sterilization or disinfection). 1.2 This standard 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 standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. 1.3 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.
Fast-track checklist and indication of appropriate methods/tools to support a multi-criteria decision process aiming to identify the most adapted technology to produce a part for a specific industrial sector (e.g. medtech, aerospace)	**Standard Available?**	No
	Is there any Work in Progress?	No

Quality/qualifications of critical components (e.g. in aerospace).	**Standard Available?**	**ISO/ASTM 52904:2019 - Additive manufacturing — Process characteristics and performance — Practice for metal powder bed fusion process to meet critical applications** 1.1 This practice describes the operation and production control of metal powder bed fusion (PBF) machines and processes to meet critical applications such as commercial aerospace components and medical implants. The requirements contained herein are applicable for production components and mechanical test specimens using powder bed fusion (PBF) with both laser and electron beams. 1.2 This standard 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 standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. 1.3 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.
	Is there any Work in Progress?	No
AM in producing medicine	**Standard Available?**	No
	Is there any Work in Progress?	No
Cleanliness of Medical AM Parts	**Standard Available?**	**ISO 10993 - Biological evaluation of medical devices — Part 1: Evaluation and testing within a risk management process** This document specifies: — the general principles governing the biological evaluation of medical devices within a risk management process; — the general categorization of medical devices based on the nature and duration of their contact with the body; — the evaluation of existing relevant data from all sources; — the identification of gaps in the available data set on the basis of a risk analysis; — the identification of additional data sets necessary to analyze the biological safety of the medical device; — the assessment of the biological safety of the medical device. This document applies to evaluation of materials and medical devices that are expected to have direct or indirect contact with: — the patient's body during intended use; — the user's body, if the medical device is intended for protection (e.g., surgical gloves, masks and others). This document is applicable to biological evaluation of all types of medical devices including active, non-active, implantable and non-implantable medical devices. This document also gives guidelines for the assessment of biological hazards arising from: — risks, such as changes to the medical device over time, as a part of the overall biological safety assessment; — breakage of a medical device or medical device component which exposes body tissue to new or novel materials. Other parts of ISO 10993 cover specific aspects of biological assessments and related tests. Device-specific or product standards address mechanical testing. This document excludes hazards related to bacteria, moulds, yeasts, viruses, transmissible spongiform encephalopathy (TSE) agents and other pathogens. **ASTM F2100-11 - Standard Specification for Performance of Materials Used in Medical Face Masks** This specification covers the classifications, performance requirements, and test methods for the materials used in the construction of medical face masks that are used in health care services such as surgery and patient care. Medical face mask material performance is based on testing for bacterial filtration efficiency, differential pressure, sub-micron particulate filtration efficiency, resistance to penetration by synthetic blood, and flammability. This specification does not address all aspects of medical face mask design and performance, the effectiveness of medical face mask designs as related to the barrier and breathability properties, and respiratory protection, which may be necessary for some health care services. Note: Non-AM standards that can be interesting: **EN 14605:2009 + A1:2009 -** Protective clothing against liquid chemicals - performance requirements for clothing with liquid-tight (Type 3) or spray-tight (Type 4) connections, including items providing protection to parts of the body only **EN 149:2001 EN 149 -** Respiratory protective devices - Filtering half masks to protect against particles - Requirements, testing, marking **EN 166:2001 -** Personal Eye Protection Standard

	Is there any Work in Progress?	**ISO 4007:2018 - Personal protective equipment — Eye and face protection — Vocabulary** This document defines and explains the principal terms used in the field of personal eye and face protection. *Note: ISO has compiled a list to support global efforts in dealing with the COVID-19 crisis, some of them related to the cleanliness of medical parts. They are freely available in read-only format, at https://www.iso.org/covid19*
Personnel Qualification		
Machine Operator Training and Qualification	**Standard Available?** *Note: Only for PBF*	**ISO/ASTM 52942:2020 - Additive manufacturing — Qualification principles — Qualifying machine operators of laser metal powder bed fusion machines and equipment used in aerospace applications** 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.
	Is there any Work in Progress?	**ISO/ASTM CD 52926-1 - Additive Manufacturing of metals — Qualification principles — Part 1: General qualification of operators** This document describes the activities and responsibilities of the operators on the field of the Additive Manufacturing technologies dealing with metallic parts production. This document is intended to provide guidance 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. **ISO/ASTM CD 52926-X – AM of metals — Qualification principles — Part X: General qualification of machine operators** (The following scope is the same for all the parts, with exception of the process: **PBF-LB**, **PBF-EB**, **DED-LB**, **DED-Arc**) X= 1 X=2 - for PBF-LB X=3 - for PBF-EB X=4 - for DED-LB X=5 - for DED-Arc 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 "X". 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 "X" 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.
Training/qualification i.e. of AM engineers	**Standard Available?**	No
	Is there any Work in Progress?	**ISO/ASTM CD 52935 - Additive manufacturing of metals — Qualification principles — Qualification of coordinators for metallic parts production** This standard specifies personnel qualification requirements for industrial manufacturing centres regarding coordination of additive manufacturing (AM) production. The AM Coordinator is responsible for translating part requirements into manufacturing requirements, such as: - Assessing whether part information (likely beyond 3d file) is complete - Assessing whether the part can be manufactured as specified and selecting appropriate manufacturing processes. - Managing the quality control aspects of manufacturing (e.g. route card). **ISO/ASTM AWI 52937 - Additive Manufacturing of metals — Qualification principles — Qualification of designers** This standard specifies personnel qualification criteria for the theoretical and practical assessment of designers covering multiple Metal Additive Manufacturing (AM) processes. The activities and procedures foreseen to be performed by the designer are also part of the standard. The Designer's responsibilities related to AM are to: - Finalise a part request for processing by the manufacturing responsible for the coordination and supervision tasks (ISO/ASTM 52935); - Consider the economic viability of the CAD file for the selected material

		& process (typically, optimise geometry for buildability with consideration of design and manufacturing allowances); - Consider the inherent benefits provided by AM processes (e.g. geometric complexity, customisation, consolidation); - Use best-practice techniques when creating the build geometry and specifying position, coordinates and orientation for the selected AM process (see Annex A); - Specify final part requirements in line with both the intended application and production method (e.g. indicate areas for additional features, further post-processing, checks of critical dimensions, etc.). Where an existing design is being considered/adapted for AM, consider whether previous requirements, such as surface finish, are a requirement of the application or an artefact of the previous manufacturing method used; - Translation of the CAD file and any subsequent file processing and quality checks to deliver the ready-to-print file.
Post-Processing		
Process-specific Post-processing (heat treatments, HIP, Surface finishing, post cure)	**Standard Available?**	No
	Is there any Work in Progress? Yes *Note: Only for PBF*	**ISO/ASTM AWI 52908 - Additive manufacturing — Post-processing methods — Standard specification for quality assurance and post processing of powder bed fusion metallic parts** This document sets requirements for the qualification, quality assurance and post processing for metal parts made by powder bed fusion. This standard defines methods and procedures for testing and qualification of various characteristics of additively manufactured metal parts, in accordance to ISO 17296-3:2014 Classes H and M. The standard is intended to be used by part providers and/or customers of parts. This standard is a top-level standard in the hierarchy of additive manufacturing standards in that it is intended to apply to metallic parts made by additive manufacturing. The standard defines qualification procedures where appropriate to meet defined quality levels. **F3301-18[a] - Standard for Additive Manufacturing – Post Processing Methods – Standard Specification for Thermal Post-Processing Metal Parts Made Via Powder Bed Fusion** 1.1 This standard specifies the requirements for thermal post-processing of parts produced via metal powder bed fusion to achieve the required material properties and microstructure to meet engineering requirements. This standard is intended to be referenced by Material Part Property specifications for powder bed fusion. Currently, this standard includes thermal post-processing for the materials including titanium alloys, cobalt 28 chromium 6 molybdenum, alloy UNS N07718, alloy UNS N06625, alloy, UNS 31603 and AlSi10Mg. This specification will be updated as new powder bed fusion material heat treatments are developed. 1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard. 1.3 This standard 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 standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.
Defects and NDE (Non-Destructive Evaluation)		
Terminology for AM Flaws	**Standard Available?**	No
	Is there any Work in Progress?	**ISO/ASTM DTR 52905 - Additive manufacturing of metals — Non-destructive testing and evaluation — Defect detection in parts** This document categorizes Additive Manufacturing (AM) defects in DED and PBF laser and electron category of processes, provides a review of relevant current NDT standards, details NDT methods that are specific to AM and complex 3D geometries and outlines existing non-destructive testing techniques that are applicable to some AM types of defects. This document is aimed at users and producers of AM processes and it applies, in particular, to the following: — Safety critical AM applications; — Assured confidence in AM; — Reverse engineered products manufactured by AM; — Test bodies wishing to compare requested and actual geometries.
	Standard Available?	No

Dimensioning and Tolerancing Requirements	**Is there any Work in Progress?**	**ISO/ASTM CD TR 52918 - Additive manufacturing — Data formats — File format support, ecosystem and evolutions** This document aims to provide an updated, comprehensive technical report on the current status of AMF support in the community, its ecosystem, including alternative standards and consortiums, and to list and evaluate potential features and evolutions which are susceptible to further extent its support. *Note: In this standard it is identified other standard: ISO 10303-242 – where the aim is dimensional and geometrical tolerance data.* **ISO/ASTM PRF TR 52916 - Additive manufacturing for medical — Data — Optimized medical image data** This standard includes the creation of optimized data for Medical Additive Manufacturing (MAM). These data are generated from static modalities, such as magnetic resonance imaging (MRI), computed tomography (CT), positron emission tomography (PET), and single photon emission computed tomography (SPECT), and from dynamic modalities, such as ultrasound and optical image data. The standard addresses medical-specific data quality requirements, and medical image data acquisition processing and optimization approaches for accurate solid medical models, based on real human and animal data. Acquisition of medical computer-aided design (CAD) data for sophisticated medical technology is based on two-dimensional (2D) medical images such as CT and MRI images. In order to obtain accurate and precise data, the resolution and quality of the original image are important. However, results may differ based on the operator behavior during editing, because anatomical medical images may have lower boundary clarity and there are points that cannot be automatically classified. In addition, the non-uniform intensity of noise and radiation of the original image can cause errors. Therefore, as the efforts to evaluate for medical image data acquisition processing and to reduce errors are closely related to the quality of medical care, it is necessary to standardize a series of optimization methods in order to digitize medical images and integrate them for utilization. *Note: High relevance in tolerancing. Has plenty of information and examples but very focused in Medical AM.*

AMable

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