"A Productive, Affordable and Reliable solution for large scale manufacturing of metallic components by combining laser-based ADDItive and Subtractive processes with high Efficiency"

Contract No: 723440

Thematic Priority: FOF-13-2016. Photonics Laser-based production

D6.7 Updated report on existing standards and on the business plan of relevant ISO/TCs

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PHOTONICS21

PHOTONICS PUBLIC PRIVATE PARTNERSHIP

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Factories of the Future

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Dissemination Level: PU: Public

Version log

Version	Date	Responsible	Organization	Description
0.1	15-10-2019	Renato OTTONE	GAN	Internal document to inform partner on the outcomes of ISO/TC 261 14th plenary meeting held in Senlis, France on September 2019
1.0	02-03-2020	Renato OTTONE	GAN	Updated draft to include the outcomes of the 15th ISO/TC 261 15th plenary meeting, submitted for internal revision
1.1	16-03-2020	Renato OTTONE	GAN	Second draft including received contributions from project stakeholders
2.0	30-03-2020	Renato OTTONE	GAN	Final Draft

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1. INTRODUCTION

1.1. BACKGROUND

This document extends and updates the content and the scope of Deliverable D6.3 − *Report on the business plan of ISO/TC 261 as well as on standards of other ISO and CEN TCs that are relevant for AM technology* and the scope of Deliverable D6.5 – *Report on proposed extensions to existing standards that are relevant to AM including the opportunity of developing IWA(s)* as well as the content of the internal D6.7 preliminary draft that was made available to project stakeholders to update them on the outcomes of the 14th ISO/TC 261 plenary meeting held in Senlis, France on September 2019.

The content of this document also includes the outcomes of the 5th CEN/TC 438 plenary meeting held in Frankfurt on November 2019 (with participation of the author by teleconference) and of the outcomes of the series of meetings of ISO/TC 261 held in El Paso, Texas between February 10 and February 14, 2020 with the physical participation of the author of this document.

PARADDISE project representatives are very actively participating to the work ISO/TC 261 Technical Committee including all its Working Groups and including a significant number of Joint ISO/TC 261 – ASTM F42 Groups.

The PARADDISE project maintains a liaison with CEN/TC 438 *Additive Manufacturing* and is very actively participating to its works.

This document also includes information related to the resolution of scope conflicts between ISO/TC 261, *Additive Manufacturing* and ISO/TC 184/SC 1, *Physical device control* and ISO/TC 184/SC 4, *Industrial data* as well as information on standards related to AM that are under the jurisdiction of those two ISO/TC 184 subcommittees.

Information is also provided on the on going activities of the CEN/TC 54 and CEN/TC 438 JWG 11 addressing special requirements for pressure vessel and components manufactured applying Additive Manufacturing technologies.

1.2. SCOPE OF THE DOCUMENT

The objectives of this deliverable are the following:

1. Provide comprehensive information required to understand the Business Plan of ISO/TC 261, *Additive manufacturing* and, as a reflex, to identify the corresponding activities of CEN/TC 438, *Additive manufacturin*g.
2. Briefly report on the activities of ISO/TC 135, *Non-destructive testing*, complemented by considerations to standards developed by ASTM E07 technical committee on NDT that are specifically applicable to Additive Manufacturing technologies.
3. Provide recommendations for standardization activities to be addressed after PARRADISE project termination including follow up on standardisation requests that were proposed at the 5th CEN/TC 438 plenary meeting.

2. BUSINESS PLAN OF ISO/TC 261

The official Business Plan of ISO/TC 261, *Additive Manufacturing* updated to 07/02/2020 is available at:
https://isotc.iso.org/livelink/livelink/fetch/2000/2122/687806/ISO_TC_261__Additive_manufacturing_.pdf?nodeid=14655650&vernum=-2

Accurate information is provided in this deliverable D6.7 that relates to documents updated to the last joint ISO/TC 261 and ASTM F42 committees meetings that were held in El Paso, Texas, between 10/02/2020 and 14/02/2020.

Most significant information is extracted from the following documents:

[1] ISO_TC261_N0772 Secretariat report,

[2] ISO-TC261_N0762 Resolutions adopted at the 14th plenary meeting.

[3] ISO-TC261_N0764 Report of the 15th plenary meeting.

Such document may be made available by Renato Ottone, upon request from PARADDISE project partners or from qualified EC services.

2.1. UPDATED STRUCTURE OF ISO/TC 261

General information on the structure of ISO/TC 261 is available at:
https://www.iso.org/committee/629086.html

Some modification to the general structure is expected to be published shortly in application of the resolutions taken at the 15th plenary meeting held on 14/02/2020.

Table 1 provides an overview of current Working Groups (WG) and Joint Working Groups (JWG) that are under the umbrella of the cooperation between ISO/TC 261 and ASTM F42 technical committees, including their identification as well as the identification of Convenors, Secretariats and Secretary.

Table 1 – Overview of current ISO/TC 261 WGs and JWGs

WG or JWG Number	Identification	Convenor(s)	Secretariat and secretary
WG1	Terminology	Dr. Klas Boivie	SIS, Sweden Mrs. Katarina Widström
WG2	Processes, systems and materials	Dr. Marius Lakomiec	DIN, Germany Mr. Yavuz Anik
WG3	Test methods	Mr. Benoît Verquin	AFNOR, France Mr. Olivier Coissac
WG4	Data and design	Dr. Eujin Pei	BSI, Great Britain Mr. Hazel Cochrane
WG6	Environment, health and safety	Mr. François Richard	SCC, Canada Mr. Daniel Langlais

WG or JWG Number	Identification	Convenor(s)	Secretariat and secretary
JWG 10 (ex JWG 5)	Joint ISO/TC 261 - ISO/TC 44/SC 14 WG: Additive manufacturing in aerospace	Mr. Ralph Kropp and Dr. Simon Jahn	DIN, Germany Mrs. Claudia Bernhardt
JWG 11 (ex JWG 7)	Joint ISO/TC 261 - ISO/TC 61/SC 9 WG, Additive manufacturing for plastics	Dr. Mario Monzón and Dr. Myung Ho Kim	DIN, Germany Dr. Felix Seidel
JWG 12	ISO/TC 261/JWG 8 “Additive Manufacturing for Surgical Implants”	Still subject to the approval of ISO/TC 61/SC 9 and ISO/TC 150/SC 1	

Currently, Mr. Renato Ottone is active in all ISO/TC 261 WGs and JWGs.

The updated list of ISO/TC 261 WGs and JWGs members may be made available by Renato Ottone, upon request from PARRADISE project partners or from qualified EC services.

Table 2 provides additional details on the current structure, including: (i) the identification of Joint ISO/TC261-ASTM F42 Groups (JG), (ii) their title, (iii) the corresponding ISO/TC261 mirror Working Group (WG) and Joint ISO Working Group (JWG), (iv) the scope of the JGs and (v) their relevance to PARRADISE project.

It shall be noticed that participation to Joint ISO/TC 261 – ASTM F42 Groups, originally restricted to a limited number of experts to be appointed by each organization is now relaxed as per Resolution 224/2020 – *Lifting access restrictions for participation of experts in ISO/TC 261 JGs*.

Currently, Mr. Renato Ottone (GAN) is active in the following JGs: JG 54, JG 57, JG 58, JG 59, JG 60, JG 61, JG 69 JG 72, JG 74, JG 77 and JG 78.

Table 2 – Details of ISO/TC 261 structure

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 51	Terminology	WG 1	ISO	JG51 is a Joint Group for Terminology, developing standards that establishes and defines terms used in Additive Manufacturing, as defined in the international standard ISO/ASTM 52900 regarding aspects of additive shaping principles and building physical 3D geometries by successive addition of material. JG51 consults members on the definitions of new terms and to explain the meaning of technical words or phrases derived from work within ISO/TC 261 and ASTM F42.	Medium

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 52	Standard test artefacts	WG 3	ASTM	JG52 is a Joint Group for Standard Test Artefacts for Additive Manufacturing, developing standards that describe test piece geometries using quantitative and qualitative measurements to assess the performance of an Additive Manufacturing (AM) system. The primary characterization of AM systems obtained by this standard is to use geometric accuracy, surface finish, and minimum feature sizes of the test piece. Comparing results from one machine, the test piece can be built and measured when a new machine is installed as a performance baseline, or used to periodically evaluate the performance or diagnose a fault in one AM system. The test piece may be used as a demonstration of capabilities for a contract between a buyer and seller of AM parts or AM systems.	Medium
JG 53	Standard Specification for Extrusion Based Additive Manufacturing of Plastic Materials	WG 3	Dormant	ISO/TC261/JG53 is a Joint Group for Requirements for Purchased AM Parts, developing standards to specify the elements to be exchanged between the customer and the part provider or vendor, such as the order information, part definition data, raw material requirements, final part characteristics and properties, inspection requirements, and part acceptance methods, to ensure that the resulting part meets the customers' requirements. The standard allows for any AM process and any material type, considering different requirements based on the classification of the criticality and the expected end use of the parts.	Low

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 54	Design guidelines	WG 4	ASTM	ISO/TC261/JG54 is a Joint Group for Design Rules in Additive Manufacturing, developing standards to homogenize the fundamental design-process-material correlations within Additive Manufacturing (AM) processes. Design rules are prescriptive guidelines or explicit constraints that provide an insight into manufacturability during the design and planning process. The design rules contain knowledge and provide both experts and non-experts with a way of making meaningful changes to part geometries without compromising manufacturability, and as a means to constrain a design space, defining the boundaries of a design feature for given processes and material parameters.	High
JG 55	Standard Specification for Extrusion Based Additive Manufacturing of Plastic Materials	WG 3	ASTM	ISO/TC261/JG55 is a Joint Group for Material Extrusion Based Additive Manufacturing of Plastic Materials, developing standards for feedstock materials (Part 1); and process-equipment, and final part specification (Part 2). The standard describes the requirements for plastic materials used in extrusion based Additive Manufacturing (AM) processes such as unfilled, filled, special additives (e.g. flame retardants, stabilizers, etc.) and reinforced plastic materials. It also describes the requirements and assuring component integrity for plastic parts created using material extrusion-based AM processes, including the process, equipment and operational parameters.	Low
JG 56	Standard Practice for Metal Powder Bed Fusion to Meet Rigid Quality Requirements	WG 2	Dormant	ISO/TC261/JG56 is a Joint Group for developing a Standard Practice for Metal Powder Bed Fusion Process to Meet Critical Applications, describing the operation and production control to meet rigid quality requirements such as commercial aerospace components and medical implants. The requirements contained herein are applicable to production components and mechanical test specimens produced using either laser or electron beam.	Low

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 57	Specific design guidelines on powder bed fusion	WG 4	ISO	ISO/TC261/JG57 is a Joint Group for process specific Design Guidelines and Standards. In focus is the designing of parts that need to be manufactured by means of additive manufacturing processes to support first time right production. It includes recommendations and best practices to achieve build accuracy and integrated features, as well as design recommendations such as allowing for powder removal, achieving adequate wall thickness, minimizing warpage, etc.	Low
JG 58	Qualification, quality assurance and post processing of powder bed fusion metallic parts	WG 2	ISO	ISO/TC261/JG58 is a Joint Group for Qualification, Quality Assurance, and Post-Processing of Powder Bed Fusion Metallic Parts, developing standards for methods and procedures for testing and qualification of various characteristics of Additive Manufactured metal parts. The standard specifies the qualification of feedstock material such as particle size distribution, flowability, chemical composition and morphology and also defines testing procedures and values to be obtained to meet defined quality levels.	Low
JG 59	NDT for AM parts	WG3	ISO	ISO/TC261/JG59 is a Joint Group for Non-destructive Testing of Additive Manufactured Parts, developing a guide that will include post-process NDT of Additive Manufacturing (AM) for metallic parts. It will cover several sectors and a similar framework can be applied to other materials such as ceramics and polymers, etc. This guide will present current capabilities to detect Additive Manufacturing (AM) flaws and those that require new standards using a selection tool. In-process NDT and metrology standards will also be referenced in the guide. New NDT methods that arise will be referenced in this standard via document updates.	High

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 60	Guide for intentionally seeding flaws in additively manufactured (AM) parts	WG 2	ASTM	ISO/TC261/JG60 is a Joint Group for Intentionally Seeding Flaws in Additively Manufactured (AM) Parts, developing standards for best-practices to intentionally seed components with flaws of prescribed geometry and location to confirm that non-destructive testing methods are capable of detecting those defects.	Low (powder)
JG 61	Guide for anisotropy effects in mechanical properties of AM parts	WG 3	ASTM	ISO/TC261/JG612 is a Joint Group for Orientation and Location Dependence Mechanical Properties for Metal Additive Manufacturing, developing standards for the field of mechanical testing of metals made by Additive Manufacturing. Vendors and manufacturers will use the standard to partially qualify parts and components to meet certain load bearing capability, damage tolerance, fracture and fatigue properties.	Medium
JG 62	Guide for conducting round robin studies for additive manufacturing	WG 3	ASTM	ISO/TC261/JG61 is a Joint Group for developing specifications and guidance on how to conduct and interpret results of round robin testing in Additive Manufacturing to enable the acquisition of reliable and high-quality data. The goal of Design of Experiments (DOE) for round robin testing is to minimize the variability in the feedstock, sequence of manufacturing operations and part test methods such as mechanical properties, chemical composition and geometric tolerances.	Low
JG 63	Test methods for characterization of powder flow properties for AM applications	WG 3	ISO	ISO/TC261/JG63 is a Joint Group for Test Methods for the Characterization of Powder Flow Properties for Additive Manufacturing Applications, developing standards for evaluating the flow properties of powders intended for Additive Manufacturing (AM), considering factors that influence powder behaviour and introducing test methodologies and protocols for characterizing the flow properties of powders to create consistency across all applications and sectors. It is intended to provide guidance to all users in the AM process from powder producers and suppliers through to machinery manufacturers and end-users.	Low

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 64	Additive Manufacturing File Format (AMF)	WG 4	ASTM	ISO/TC261/JG64 is a joint group for Additive Manufacturing File Format (AMF) and AMF Solid Modelling Support, i. e. Voxel Information, Constructive Solid Geometry Representations and Solid Texturing, working on further evolutions to the AMF standard. In addition to these activities, the Joint Group coordinates standard activities with ISO/TC 292 “Security and resilience” on AMF authentication and security applications.	Low
JG 65	Specification for AM stainless steel alloy with PBF	Disbanded			
JG 66	Technical specification on metal powders	WG 2	ISO	ISO/TC261/JG66 is a Joint Group for Technical Specification on Metal Powders, compiling standards for documentation and traceability, sampling, particle size distribution, chemical composition, characteristic densities, morphology, flowability, thermal characteristics, cleanliness, and packaging and storage. It does not cover safety aspects but provides specific requirements for used metallic powders in Additive Manufacturing.	Medium
JG 67	Technical report for the design of functionally graded additive manufactured parts	WG 4	ISO	ISO/TC261/JG67 is a Joint Group for Functionally Graded Additive Manufacturing (FGAM), developing a technical report for current practices regarding FGAM. The document will clarify the definitions of terms, current software that can simulate FGAM materials with discrete or continuous variation of mechanical properties, outlining key manufacturing processes, providing examples of materials that have been used to produce FGAM parts, as well as their potential applications.	Low

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 68	EH&S for 3D printers	WG 6	ISO	ISO/TC261/JG 68 is a Joint Group that specifies a test method to determine the emissions of Fine particles, Ultrafine Particles and the other hazardous substances from Material Extrusion (ME) additive manufacturing processes, which builds three dimensional parts by selectively dispensing melted thermoplastic filaments through a nozzle. This test method is primarily intended for ME processes which are often used in non-industrial environments such as schools, homes and office spaces.	Low
JG 69	EH&S for use of metallic materials	WG 6	ISO	ISO/TC261/JG69 is a Joint Group developing guidelines related to Environment, Health and Safety (EHS) aspects in all Additive Manufacturing processes that use metallic materials in powder or wire form, consisting from the supply of feedstock to the delivery of parts. The guidelines include, but are not limited to the identification of hazards, risk assessment, recommendations for protective and preventive measures, verification protocols, and waste disposal management.	High
JG 70	Optimized medical image data	WG 4	ISO	ISO/TC261/JG70 is a Joint Group that develops guidelines for the standard specification for optimized medical image data for Additive Manufacturing. The data is generated from static modalities such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Positron Emission Tomography (PET), Single-Photon Emission Computed Tomography (SPECT); as well as Dynamic modalities such as ultrasound and optical image data. This Joint Group addresses medical-specific data quality requirements and approaches for medical image data acquisition to obtain accurate medical models and devices based on real human information. This data can also be applicable for veterinary surgery.	Low

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 71	Powder quality assurance	WG 2	ASTM	ISO/TC261/JG71 is a Joint Group developing guidelines related to the feedstock for metal Powder Bed Fusion (PBF) processes to comply to the Nadcap PBF accreditation checklist. This covers the purchasing specifications, powder lifecycle management in terms of receiving, storage and disposal, and the reuse of metal powders. The guidelines include specifying the attributes of metal powders that affect the performance of the PBF processes which influences part quality, procedures for feedstock reuse in metal PBF, as well as different re-use schemas in terms of how many times the powder can be reused, powder sieving techniques, storage, handling prior to reuse, batch control, traceability and the effects of the PBF process on powder.	Medium (PBF)
JG 72	Machine - Production process qualification	WG 2	ASTM	ISO/TC261/JG72 is a Joint Group developing guidelines related to the operating procedures of metal Powder Bed Fusion (PBF) machines, including best practices for cleaning the machines after routine build changes, when changing material types and periodic maintenance. Additionally, this guide covers the initial quality requirements and metrics for metal PBF machines and identifies key machine attributes that affect part quality. The guidelines cover how to establish upper and lower limits for each parameter to create fixed processes for machine qualification, guidelines for risk assessment for Critical to Quality (CTQ) machine attributes for initial qualification, operational qualification and part qualification.	Medium (PBF)
JG 73	Digital product definition and data management	WG 4	ASTM	ISO/TC261/JG73 is a Joint Group developing guidelines related to digital data configuration control, data integrity checks, and enterprise work flow for files used in the metal Powder Bed Fusion (PBF) process. The guideline covers digital product data workflows, file formats used for printing, automated and manual methods for receiving digital data and build cycle information in the PBF process that can be used for product quality assurance. The guidelines cover saving and storing the build cycle data in order to meet quality system requirements.	Medium (PBF)

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 74	Personnel training	JWG 5 (JWG 10)	ISO	ISO/TC261/JG74 is a joint group developing standards related to personnel qualifications based on the different roles necessary for metal additive manufacturing processes. This may include powder technicians; build set-up engineers, machine operators and other personnel necessary for the production of metal additive manufactured parts.	High
JG 75	Industrial conformity assessment at additive manufacturing centres	WG 2	ISO	ISO/TC 261/JG75 is a joint group developing a standard related on performance levels for industrial additive manufacturing centers. The document will include quality assurance control throughout the entire manufacturing workflow. The standard focus on the AM specifics to achieve high quality serial production in additive manufacturing centers. NOTE: Once the AM standard on performance levels is established the JG 75 planning to elaborate a standard on conformity assessment.	High
JG 76	Revision of ISO 17296-3 & ASTM F3122-14	WG 3	ISO	The main objective of Group 76 is to adapt existing test procedures for additive manufacturing. This group identifies existing standards in terms of procedures (mechanical tests, metrology ...) applicable to AM. Information will have to be determined in order to take into account the test analysis from samples carried out by AM: orientation, location of build, manufacturing strategy, surface finish, heat treatment, volume of the build job ... This work will lead JG 76 to define the best appropriate test procedure link to the final part and collect necessary information for data reporting. This JG 76 activity covers metal, polymer and ceramic materials.	Medium

JG Number	Title	Related to ISO/WG	Led by:	Scope	Priority for PARADDISE
JG 77	Test method of sand mold for metal casting	WG 3	ISO	To be made available by Dr. Kiwamu Hashida, JG 77 convenor Preliminary proposal: ISO/TC261/JG77 is a Joint Group for testing sand mold for metalcasting produced by binder jetting and powder bed fusion additive manufacturing processes, developing standards to define specified methodologies to measure properties of sand mold for metalcasting made by AM, such as bending strength and gas permeability, etc. The standards enable to provide appropriate means evaluating AM made mold property to be shared by international stakeholders such as AM machine supplier, castings foundry and casting products user.	Low
JG 78	Safety regarding AM-machines (relating to harmonized European Standards, Type C-Standard)	WG 6	ISO	ISO/TC 261/JG 78 is a Joint group for drafting safety standards for additive manufacturing machines used for the 7 process categories as identified in ISO 17296-2 and using all different types of materials (e.g. metals, polymers and ceramics) as feedstock. The purpose of this group is to draft standards to be harmonized regarding the European Machinery Directive in order to give presumption of conformity to this Directive for the essential requirements covered by the standard.	High

2.2. ANNOTATED WORK PROGRAM OF ISO/TC 261

The general ISO/TC 261 work program is available at:
https://www.iso.org/committee/629086/x/catalogue/p/0/u/1/w/0/d/0

For each listed standard, the link provides a preview containing the Table of Content, the Foreword, the Introduction and the Scope of the document. Preliminary Work Items (PWI) are not listed. The detailed work program of ISO/TC 261 (including the PWI) is contained in document ISO-TC261_N0671 2019-09-10 that may be made available on request to Renato Ottone by PARRADISE project partners and/or by qualified EC services.

Table 3 provides an extract of the referred document with the identification of priority for PARRADISE project of each individually listed document.

For the convenience of the reader, documents are listed in reference number sequence, include published standards and also includes Preliminary Work Items (PWI).

Table 3 – Extract of ISO/TC 261 work programme (including published standards and PWI)

Document Reference Number	Title	Developed by:	Project leader and Notes	Priority for PARADDISE
ISO 17296-2:2015	Additive manufacturing — General principles — Part 2: Overview of process categories and feedstock	WG 2	Published	Medium
ISO 17296-3:2014	Additive manufacturing — General principles — Part 3: Main characteristics and corresponding test methods	WG 3	Published	Medium
ISO 17296-4:2014	Additive manufacturing — General principles — Part 4: Overview of data processing	WG 4	Under revision. Will become ISO/ASTM 52950	Medium
ISO 27547-1:2010	Plastics — Preparation of test specimens of thermoplastic materials using mouldless technologies — Part 1: General principles, and laser sintering of test specimens	JWG 7 (JWG 11)	Published Confirmed in 2015 Will be replaced by ISO/ASTM WD 52936-1	Low
ISO/ASTM 52900:2015	Additive manufacturing — General principles — Terminology	JG 51	Under revision	High
ISO/ASTM DIS 52900	Additive manufacturing — General principles — Fundamentals and vocabulary	JG 51	Klas Boivie	High
ISO/ASTM 52901:2017	Additive manufacturing — General principles — Requirements for purchased AM parts	JG 53	Published	High
ISO/ASTM 52902:2019	Additive manufacturing — Test artifacts — Geometric capability assessment of additive manufacturing systems	JG 52	Under revision	High
ISO/ASTM AWI 52902	Additive manufacturing — Test artifacts — Geometric capability assessment of additive manufacturing systems	JG 52	Swan Moylan	High
ISO/ASTM 52903-1:2020	Additive manufacturing — Standard specification for material extrusion based additive manufacturing of plastic materials — Part 1: Feedstock materials	JG 55	Published	Low
ISO/ASTM DIS 52903-2	Additive manufacturing — Standard specification for material extrusion based additive manufacturing of plastic materials — Part 2: Process — Equipment	JG 55	Ralph Buoniconti	Low
ISO/ASTM CD 52903-3	Additive manufacturing — Standard specification for material extrusion based additive manufacturing of plastic materials — Part 3: Final parts	JG 55	Project cancelled. See Resolution 202/2019	N/A

Document Reference Number	Title	Developed by:	Project leader and Notes	Priority for PARADDISE
ISO/ASTM 52904:2019	Additive manufacturing — Process characteristics and performance — Practice for metal powder bed fusion process to meet critical applications	JG 56	Published	Low
ISO/ASTM DTR 52905	Additive manufacturing — General principles — Non-destructive testing of additive manufactured products	JG 59	Ben Dutton	High
ISO/ASTM CD TR 52906	Additive manufacturing — Non-destructive testing and evaluation — Standard guideline for intentionally seeding flaws in parts	JG 60	(Steve James) Ben Dutton	Medium
ISO/ASTM 52907:2019	Additive manufacturing — Feedstock materials — Methods to characterize metal powders	JG 66	Published	Low (PBF)
ISO/ASTM AWI 52908	Additive manufacturing — Post-processing methods — Standard specification for quality assurance and post processing of powder bed fusion metallic parts	JG 58	Stephan Braun	Low
ISO/ASTM AWI 52909	Additive manufacturing — Finished part properties — Orientation and location dependence of mechanical properties for metal powder bed fusion	JG 61	Jan Dzugan	Low
ISO/ASTM 52910:2018	Additive manufacturing — Design — Requirements, guidelines and recommendations	JG 54	Published	High
ISO/ASTM 52911-1:2019	Additive manufacturing — Design — Part 1: Laser-based powder bed fusion of metals	JG 57	Published	Low
ISO/ASTM 52911-2:2019	Additive manufacturing — Design — Part 2: Laser-based powder bed fusion of polymers	JG 57	Published	Low
ISO/ASTM PWI 52911-3	Additive manufacturing — Technical design guideline for powder bed fusion — Part 3: Standard guideline for electron-based powder bed fusion of metals	JG 57	Nik Hrabe	Low
ISO/ASTM CD TR 52912	Additive manufacturing - Design - Functionally graded additive manufacturing	JG 67	Eujin Pei	Low
ISO/ASTM PWI 52913	Additive manufacturing — Process characteristics and performance — Standard test methods for characterization of powder flow properties	JG 63	Maik Grebe	Medium (PBF)

Document Reference Number	Title	Developed by:	Project leader and Notes	Priority for PARADDISE
ISO/ASTM PWI 52914	Additive manufacturing — Design — Standard guide for material extrusion processes	JG 54	David Rosen	Low
ISO/ASTM 52915:2016	Specification for additive manufacturing file format (AMF) Version 1.2	JG 64	Under revision	Low
ISO/ASTM DIS 52915	Specification for additive manufacturing file format (AMF) Version 1.3	JG 64	Jérémie Farret	Low
ISO/ASTM WD 52916	Additive manufacturing — Data formats — Standard specification for optimized medical image data	JG 70	Wonbong Lim	Low
ISO/ASTM NP 52917	Additive manufacturing — Round Robin Testing — Guidance for conducting Round Robin studies	WG 3	Peter Woolliams	Low
ISO/ASTM CD TR 52918	Additive manufacturing — Data formats — File format support, ecosystem and evolutions	JG 64	Jérémie Farret	Low
ISO/ASTM WD 52919-1	Additive manufacturing — Test method of sand mold for metalcasting — Part 1: Mechanical properties	JG 77	Kiwamu Hashida	Low
ISO/ASTM WD 52919-2	Additive manufacturing — Test method of sand mold for metalcasting — Part 2: Physical properties	JG 77	Kiwamu Hashida	Low
ISO/ASTM PWI 52920-1	Additive manufacturing — Qualification principles — Part 1: Conformity assessment for AM System in industrial use	JG 75	Gregor Reischle	High
ISO/ASTM WD 52920-2	Additive manufacturing — Qualification principles — Part 2: Conformity assessment at Industrial additive manufacturing centers	JG 75	Gregor Reischle	High
ISO/ASTM 52921:2013	Standard terminology for additive manufacturing — Coordinate systems and test methodologies	(was) JG 51	Under revision	Medium
ISO/ASTM DIS 52921	Additive manufacturing — General principles — Standard practice for part positioning, coordinates and orientation	WG 3	Hokan Brodin	Medium
ISO/ASTM PWI 52922	Additive manufacturing — Design — Directed energy deposition	JG 54	David Rosen	High
ISO/ASTM PWI 52923	Additive manufacturing — Design decision support	JG 54	Andrew Triantaphyllou	High

Document Reference Number	Title	Developed by:	Project leader and Notes	Priority for PARADDISE
ISO/ASTM CD 52924	Additive manufacturing — Qualification principles — Classification of part properties for additive manufacturing of polymer parts	JWG 11	Andreas Wegner	Low
ISO/ASTM WD 52925	Additive manufacturing — Qualification principles — Qualification of polymer materials for powder bed fusion using a laser	JWG 11	Peter Keller	Low
ISO/ASTM PWI 52926-1	Additive manufacturing — Qualification principles — Part 1: Qualification of machine operators for metallic parts production	JG 74	Eurico Assunção	High
ISO/ASTM PWI 52926-2	Additive manufacturing — Qualification principles — Part 2: Qualification of machine operators for metallic parts production for PBF-LB	JG 74	Eurico Assunção	Low
ISO/ASTM PWI 52926-3	Additive manufacturing — Qualification principles — Part 3: Qualification of machine operators for metallic parts production for PBF-EB	JG 74	Eurico Assunção	Low
ISO/ASTM PWI 52926-4	Additive manufacturing — Qualification principles — Part 4: Qualification of machine operators for metallic parts production for DED-LB	JG 74	Eurico Assunção	High
ISO/ASTM PWI 52926-5	Additive manufacturing — Qualification principles — Part 5: Qualification of machine operators for metallic parts production for DED-Arc	JG 74	Eurico Assunção	Low
ISO/ASTM PWI 52927	Additive manufacturing — Process characteristics and performance - Test methods	JG 76	To be defined	High
ISO/ASTM PWI 52928	Powder life cycle management	JG 71	Alexander Elsen	High
ISO/ASTM NP TS 52930	Guideline for installation/operation/performance qualification (IQ/OQ/PQ) of laser-beam powder bed fusion equipment for production manufacturing	JG 72	Karl D'Ambrosio	Low
ISO/ASTM AWI 52931	Additive manufacturing — Environmental health and safety — Standard guideline for use of metallic materials	JG 69	Lionel Ridosz	High
ISO/ASTM WD 52932	Additive manufacturing — Environmental health and safety — Standard test method for determination of particle emission rates from desktop 3D printers using material extrusion	JG 68	Kyungho Park	Low

Document Reference Number	Title	Developed by:	Project leader and Notes	Priority for PARADDISE
ISO/ASTM PWI 52933	Additive manufacturing — 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	JG 68	Kyungho Park	Low
ISO/ASTM PWI 52934	Additive manufacturing — Environmental health and safety — Standard guideline for hazard risk ranking and safety defense	JG 69	Project cancelled Scott Wigen	High
ISO/ASTM WD 52936-1	Additive manufacturing — Qualification principles — Laser-based powder bed fusion of polymers — Part 1: General principles, preparation of test specimens	JWG 11	Mario Monzon	Low
ISO/ASTM DIS 52941	Additive manufacturing — System performance and reliability — Standard test method for acceptance of powder-bed fusion machines for metallic materials for aerospace application	JWG 10	Ralph Kropp	Medium
ISO/ASTM DIS 52942	Additive manufacturing — Qualification principles — Qualifying machine operators of metal powder bed fusion machines and equipment used in aerospace applications	JWG 10	Ralph Kropp	Medium
ISO/ASTM PWI 52943-1	Additive manufacturing — Process characteristics and performance — Part 1: Standard specification for directed energy deposition using wire and beam in aerospace applications	JWG 10	Holger Krüger	Low
ISO/ASTM PWI 52943-2	Additive manufacturing — Process characteristics and performance — Part 2: Standard specification for directed energy deposition using wire and arc in aerospace applications	JWG 10	Holger Krüger	Low
ISO/ASTM PWI 52943-3	Additive manufacturing — Process characteristics and performance — Part 3: Standard specification for directed energy deposition using laser blown powder in aerospace applications	JWG 10	Holger Krüger	High
ISO/ASTM PWI 52944	Additive manufacturing — Process characteristics and performance — Standard specification for powder bed processes in aerospace applications	JWG 10	Holger Krüger	Medium
ISO/ASTM DIS 52950	Additive manufacturing — General principles — Overview of data processing	JG 67	Eujin Pei Will replace ISO 17296-4	Medium

Document Reference Number	Title	Developed by:	Project leader and Notes	Priority for PARADDISE
ISO/ASTM PWI 52951	Additive manufacturing — Data packages for AM parts	JG 73	Paul Witherell	Low

3. CEN/TC 438 ACTIVITIES

3.1. GENERAL CONSIDERATIONS ON CEN/TC 438 BUSINESS PLAN

CEN/TC 438 Business Plan is available at:

https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:1961493&cs=1725A335494BA95FA4CC9FE85A6F6B4B1

The main objectives of CEN/TC 438 are:

- To provide a complete set of European standards on processes, test procedures, quality parameters, supply agreements, fundamentals and vocabulary based, as far as possible, on international standardization work.

  The aim is to apply the Vienna Agreement[1] with ISO/TC 261 "Additive Manufacturing" to ensure consistency and harmonization.
- To strengthen the link between European Research programs and standardization in additive manufacturing.
- To ensure visibility to the European standardization in additive manufacturing by centralizing standardization initiatives in Europe on additive manufacturing.

3.2. PUBLISHED STANDARDS AND WORK PROGRAM

Table 4 provides the updated list of CEN/TC 438 published standards and standards in its work program.

Table 4 – CEN/TC 438 work program (including published standards)

Project reference	Title	Status
EN ISO 17296-2:2016	Additive manufacturing — General principles - Part 2: Overview of process categories and feedstock (ISO 17296-2:2015)	Published
EN ISO 17296-3:2016	Additive manufacturing — General principles — Part 3: Main characteristics and corresponding test methods (ISO 17296-3:2014)	Published
EN ISO 17296-4:2016	Additive manufacturing — General principles — Part 4: Overview of data processing (ISO 17296-4:2014)	Published

[1] https://share.ansi.org/shared%20documents/Standards%20Activities/Background%20Papers/Supporting%20Documents/ISOCEN%20VA.pdf

Project reference	Title	Status
EN ISO/ASTM 52900:2017	Additive manufacturing — General principles — Terminology (ISO/ASTM 52900:2015)	Published
EN ISO/ASTM 52901:2018	Additive manufacturing - General principles - Requirements for purchased AM parts (ISO/ASTM 52901:2017)	Published
EN ISO/ASTM 52902:2019	Additive manufacturing - Test artifacts - Geometric capability assessment of additive manufacturing systems (ISO/ASTM 52902:2019)	Published
EN ISO/ASTM 52907:2019	Additive manufacturing - Feedstock materials - Methods to characterize metal powders (ISO/ASTM 52907:2019)	Published
EN ISO/ASTM 52910:2019	Additive manufacturing - Design - Requirements, guidelines and recommendations (ISO/ASTM 52910:2018)	Published
EN ISO/ASTM 52911-1:2019	Additive manufacturing - Design - Part 1: Laser-based powder bed fusion of metals (ISO/ASTM 52911-1:2019)	Published
EN ISO/ASTM 52911-2:2019	Additive manufacturing - Design - Part 2: Laser-based powder bed fusion of polymers (ISO/ASTM 52911-2:2019)	Published
EN ISO/ASTM 52915:2017	Specification for additive manufacturing file format (AMF) Version 1.2 (ISO/ASTM 52915:2016)	Published
EN ISO/ASTM 52921:2016	Standard terminology for additive manufacturing — Coordinate systems and test methodologies (ISO/ASTM 52921:2013)	Published
prCEN/ISO/ASTM TR 52912	Technical Report for the Design of Functionally Graded Additive Manufactured Parts	Under Drafting
prEN ISO 52950	Additive manufacturing - General principles - Overview of data processing (ISO/ASTM/DIS 52950:2019)	Under Enquiry
prEN ISO/ASTM 52900	Additive manufacturing - General principles - Terminology (ISO/ASTM DIS 52900:2018)	Under Approval
prEN ISO/ASTM 52903-2	Additive manufacturing - Standard specification for material extrusion based additive manufacturing of plastic materials - Part 2: Process - Equipment (ISO/ASTM/DIS 52903-2:2018	Under Drafting
prEN ISO/ASTM 52904	Additive manufacturing - Process characteristics and performance - Practice for metal powder bed fusion process to meet critical applications (ISO/ASTM 52904:2019)	Under Enquiry
prEN ISO/ASTM 52905	Additive manufacturing -- General principles -- Nondestructive testing of additive manufactured products	Under Drafting
prEN ISO/ASTM 52908	Additive manufacturing - Post-processing methods - Standard specification for quality assurance and post processing of powder bed fusion metallic parts	Under Drafting
prEN ISO/ASTM 52909	Additive manufacturing - Finished part properties - Orientation and location dependence of mechanical properties for metal powder bed fusion	Under Drafting
prEN ISO/ASTM 52915 rev	Specification for additive manufacturing file format (AMF) Version 1.3	Under Approval
prEN ISO/ASTM 52916	Additive manufacturing -- Data formats -- Standard specification for optimized medical image data	Under Drafting

Project reference	Title	Status
prEN ISO/ASTM 52917	Additive manufacturing -- Round Robin Testing -- Guidance for conducting Round Robin studies	Under Drafting
prEN ISO/ASTM 52919-1	Additive manufacturing -- Test method of sand mold for metalcasting -- Part 1: Mechanical properties	Under Drafting
prEN ISO/ASTM 52919-2	Additive manufacturing -- Test method of sand mold for metalcasting -- Part 2: Physical properties	Under Drafting
prEN ISO/ASTM 52921	Additive manufacturing - General principles - Standard practice for part positioning, coordinates and orientation (ISO/ASTM DIS 52921:2019)	Under Approval
prEN ISO/ASTM 52924	Additive manufacturing - Qualification principles - Quality grades for additive manufacturing of polymer parts	Under Approval
prEN ISO/ASTM 52925	Additive manufacturing -- Qualification principles -- Qualification of polymer materials for powder bed fusion using a laser	Under Approval
prEN ISO/ASTM 52926-1	Additive manufacturing — Qualification principles — Part 1: Qualification of machine operators for metallic parts production	Under Drafting
prEN ISO/ASTM 52926-2	Additive manufacturing — Qualification principles — Part 2: Qualification of machine operators for metallic parts production for PBF-LB	Under Drafting
prEN ISO/ASTM 52926-3	Additive manufacturing — Qualification principles — Part 3: Qualification of machine operators for metallic parts production for PBF-EB	Under Drafting
prEN ISO/ASTM 52926-4	Additive manufacturing — Qualification principles — Part 4: Qualification of machine operators for metallic parts production for DED-LB	Under Drafting
prEN ISO/ASTM 52926-5	Additive manufacturing — Qualification principles — Part 5: Qualification of machine operators for metallic parts production for DED-Arc	Under Drafting
prEN ISO/ASTM 52931	Additive manufacturing -- Environmental health and safety -- Standard guideline for use of metallic materials	Under Drafting
prEN ISO/ASTM 52932	Additive manufacturing -- Test method for determination of particle emission rates from desktop 3D printer-Material extrusion	Under Drafting
prEN ISO/ASTM 52933	Additive manufacturing -- 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	Under Drafting
prEN ISO/ASTM 52936-1	Additive manufacturing - Qualification principles - Laser-based powder bed fusion of polymers - Part 1: General principles, preparation of test specimens	Under Drafting
prEN ISO/ASTM 52941	Additive manufacturing - System performance and reliability - Standard test method for acceptance of powder-bed fusion machines for metallic materials for aerospace application (ISO/ASTM/DIS 52941:2019)	Under Approval
prEN ISO/ASTM 52942	Additive manufacturing - Qualification principles - Qualifying machine operators of metal powder bed fusion machines and equipment used in aerospace applications (ISO/ASTM/DIS 52942:2019)	Under Approval

Project reference	Title	Status
prEN ISO/ASTM 52950	Additive manufacturing - General principles - Overview of data processing (ISO/ASTM/DIS 52950:2019)	Under approval

3.3. COOPERATION BETWEEN CEN/TC 438 AND CEN/TC 54 ON PRESSURE VESSELS

As PARADDISE solutions could also be advantageously applied to the manufacturing of pressure vessels and components, this subclause provides information related to the development of prEN 13455-14, *Unfired pressure vessels – Part 14: Additional requirements for pressure equipment and pressure components fabricated with additive manufacturing methods*.

The drafting and maintenance of EN 13455 series of standards is under the responsibility of CEN/TC 54 – *Unfired pressure vessels* and applies to unfired pressure vessels and components with a maximum allowable pressure greater than 0,5 bar gauge but may be used for vessels operating at lower pressures, including vacuum.

EN 13445 series of standards provides rules for the design, fabrication, and inspection of pressure vessels. It provides one means of conforming to essential safety requirements of the Pressure Equipment Directive 2014/68/CE (so called PED). Through the publication of its reference in the Official Journal of European Union, it gives presumption of conformity to the essential safety requirements identified in Annex ZA of each Part.

It also provides documents addressing additional requirements for pressure vessels and components made of specific materials or fabricated applying specific processes.

As the application of Additive Manufacturing technologies may provide significant benefits to the manufacturing of Pressure Equipment, the stakeholders of CEN/TC 54 decided to work on the drafting of prEN 13455-14, *Unfired pressure vessels – Part 14: Additional requirements for pressure equipment and pressure components fabricated with additive manufacturing methods.*

To properly tackle the issue, it was indispensable to seek for competences related to both Pressure Equipment and Additive Manufacturing standardization expertise.

The natural approach would have been to create a Joint Working Group including experts from CEN/TC 54 – *Unfired pressure vessels* and CEN/TC 438 – *Additive manufacturing* but, as CEN rules do not foresee the creation of Joint Working Groups, the two involved Technical Committees agreed on the creation of a Working Group (WG 11) acting within the framework of CEN/TC 54, where the Chairperson is nominated by CEN/TC 54 and the Secretary is nominated by CEN/TC 438. Experts to CEN/TC 54/WG 11 are nominated by CEN National Member Bodies (NMB) that are active within each one of the two concerned Technical Committees.

The structure of the preliminary working draft (WD) of the document was derived from the structure of EN 13455-10 and it provides requirements in addition to the general

requirements for unfired pressure vessels under EN 13445-1:2014, EN 13445-2:2014, EN 13445-3:2014, EN 13445-4:2014 and EN 13445-5:2014.

The specification of requirements related to the application of different Additive Manufacturing processes is addressed in specific normative Annexes that, for the moment being, concern Directed Energy Deposition (DED) and Powder Bed Fusion (PBF) technologies related to the fabrication of metallic components.

The current draft of the document may be made available by Renato Ottone, upon request from PARADDISE project partners or from qualified EC services.

3.4. CONSIDERATION TO STANDARDIZATION PRIORITIES IDENTIFIED BY PARADDISE

The PARADDISE project has a liaison status with CEN/TC 438 under CEN/CENELEC Guide 25 rule and has identified the following topics to be addressed by future EN standards:

1. Design guidelines for Additive and Hybrid Manufacturing,
2. Health and safety issues including:
   - Operator exposure to metal powders,
   - Hybrid machine tool safety,
   - Laser reflection issues
3. Qualification of Equipment, Operators and Processes in AM for aerospace applications.

CECIMO[2] is supporting the development of type C harmonized standards related to the application of the Machinery Directive[3] to Additive Manufacturing equipment. Such development is aligned with item 2 of PARADDISE project standardization priorities.

CEN/TC 438 is attributing due consideration to PARADDISE project priorities and to CECIMO's requests. The secretary of CEN/TC 438, Mr. Olivier Coissac, has personally attend the meeting of CECIMO's Additive Manufacturing Committee that was held in Brussel on the 8th of October.

The issue was addressed at the 5th TC/438 plenary meeting (partecipated in telerconference by Renato Ottone) and it was deciderd that the type-C standard will be developed under the umbrella of ISO/TC 261 – ASTM 42 cooperation, with the possible support of ISO/TC 39/SC 10, *Machine tools safety*.

The following resolutions were taken during the 15th ISO/TC 261 meeting:

- **Resolution 234/2020 – Establishment of ISO/TC 261/JG 78 "Safety regarding AM-machines (relating to harmonized European Standards, Type C-Standard)"**
  ISO/TC 261 "Additive manufacturing" - acknowledging the market need for the

[2] https://www.cecimo.eu/news/cecimo-press-release-additive-manufacturing-to-be-soon-at-the-center-stage-of-the-european-regulations/
[3] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32006L0042

Establishment of ISO/TC 261/JG78with regard to "Safety regarding AM-machines (relating to harmonized European Standards, Type C-Standard)",
- acknowledging the recommendation by ISO/TC 261/JAG "ISO/TC 261 - ASTM F42 Steering group on JG activities",
- establishes ISO/TC 261/JG 78 "Safety regarding AM-machines (relating to harmonized European Standards, Type C-Standard)" with the following scope: *ISO/TC 261/JG 78 is a Joint group for drafting safety standards for additive manufacturing machines used for the 7 process categories as identified in ISO 17296-2 and using all different types of materials (e.g. metals, polymers and ceramics) as feedstock. The purpose of this group is to draft standards to be harmonized regarding the European Machinery Directive in order to give presumption of conformity to this Directive for the essential requirements covered by the standard*.
- allocates JG 78 to the parent committees ISO/TC 261/WG 6 and ASTM F42 06.

– **Resolution 235/2020 – Appointment of convenor for ISO/TC 261/JG 78 "Safety regarding AM machines (relating to harmonized European Standards, Type C-Standard)"**
ISO/TC 261 "Additive manufacturing"
- acknowledging the recommendation by ISO/TC 261/JAG "ISO/TC 261 - ASTM F42 Steering group on JG activities",
- acknowledging the specific expertise needed for leading the work of ISO/TC 261/JG 78,
- acknowledging the expertise and competence of Valentine Hermitant and Olivier Coissac (both AFNOR) in the covered field of ISO/TC 261/JG 78,
- acknowledging there are no other applications for the position of convenor of ISO/TC 261/JG 78,
- appoints Valentine Hermitant (AFNOR) as convenor.

– **Resolution 236/2020 – Registration of a preliminary work item ISO/ASTM PWI 52938-1 Additive manufacturing — Environmental Health & Safety — Part 1: Safety requirements for PBF-LB machine using metallic feedstock**
ISO/TC 261 "Additive manufacturing"
- decides to register a preliminary work item ISO/ASTM PWI 52938-1 *Additive manufacturing — Environmental Health & Safety —Part 1: Safety requirements for PBF-LB machine using metallic feedstock*
- assigns the project leadership to Valentine Hermitant,
- assigns the project to ISO/TC 261/JG 78,
- requests the Committee Manager to seek approval of ASTM F 42 to register a joint ISO/ASTM standard project.

Renato Ottone is a member of ISO/TC 261 JG 78 and he is actively partecipating to the drafting of the referred document that is currently available as ISO_TC261_JG78_N001 and can be made available, upon request, to PARADDISE project partners and to qualified EC services.

4. ISO/TC 184/SC 1 AND ISO/TC 184/SC 5 ACTIVITIES RELEVANT TO AM

ISO/TC 184 – *Automation systems and integration* addresses standardization in the field of automation systems and their integration for design, sourcing, manufacturing, production and delivery, support, maintenance and disposal of products and their associated services. Areas of standardization include information systems, automation and control systems and integration technologies.

ISO/TC 184/SC 1 – *Physical device control* has published

- ISO14649-17:2020*, Industrial automation systems and integration — Physical device control — Data model for computerized numerical controllers — Part 17: Process data for additive manufacturing* that directly relates to Additive Manufacturing technologies.

The DIS ballot of the document collected 30 pages of comments including very negative comments from the ISO/TC 261 liaison officer.

All comments were addressed by ISO/TC 184/SC 1/WG 7 – *Data modelling for integration of physical devices* during the meeting held on September 24, 2019 and the amended document resolved all conflicts with standard AM terminology.

Renato Ottone is a member of ISO/TC 184/SC 1/WG 7 and may provide, on request, additional information to PARADDISE project partners.

ISO/TC 184/SC 4 – *Industrial data* has 765 published standards and 153 standards under development.
Its Working Group WG 12 – *STEP product modelling and resources* is responsible for the development of the huge ISO 10303 series of standards that include the following documents:

- ISO/DIS 10303-242.2, *Industrial automation systems and integration — Product data representation and exchange — Part 242: Application protocol: Managed model-based 3D engineering* that also contains requirements related to Additive Manufacturing and
- ISO/TS 10303-1835, *Industrial automation systems and integration — Product data representation and exchange — Part 1835: Application module: Additive manufacturing part and build information*

Renato Ottone is a member of ISO/TC 184/SC 4/WG 12 and may provide, on request, additional information to PARADDISE project partners.

4.1. CONFLICTS BETWEEN ISO/TC 261, ISO/TC 184/SC 1 AND ISO/TC 184/SC 4

There have been some issues, submitted by ISO/TC 184/SC 4, at the level of the ISO Technical Management Board (TMB), opposing to the proposed change of ISO/TC 261 scope.

The TMB has postponed decision on the subject matter and has requested the Chairmen and the Committee Managers of the two involved Technical Committees to contact each other seeking for consensus.

As it was not possible to reach consensus, ISO/TC 261 decided to withdraw its request for scope change and decided to establish the ISO/TC 261/AHG for the coordination of work with ISO/TC 184/SC1 and SC4.

The appointed Chairman is Martin Schäfer (SIEMENS) and the appointed Secretary is Jérémie Farret.

5. ISO/TC 135 AND ASTM E07 STANDARDS ON NDT

Parts produced by PARADDISE solutions will need to undergo non-destructive testing (NDT) to prove conformance to specifications. The selection of the NDT technology to be applied will depend on the specific requirements of different target sectors (e.g. aerospace, automotive, construction, etc …) Information in this chapter is meant to provide preliminary inputs to PARADDISE stakeholders.

The scope of ISO/TC 135 – *Non-destructive testing* is (textually) the following:

Standardization covering non-destructive testing as applied generally to constructional materials, components and assemblies, by means of:

- glossary of terms;
- methods of test;
- performance specifications for testing equipment and ancillary apparatus.

Excluded:

- quality levels;
- specifications for electrical equipment and apparatus, which fall within the range of IEC Committees.

The structure of ISO/TC 135 is presented in Table 5, that also includes the number of published standards and standards under development that are under the responsibility of individual ISO/TC 135 subcommittees (SC).

Table 5 – Structure of ISO/TC 135 – Non-destructive testing

Subcommittee	Name	Published standards	Standards under development
ISO/TC 135/SC 2	Surface methods	14	2
ISO/TC 135/SC 3	Ultrasonic testing	20	4
ISO/TC 135/SC 4	Eddy current testing	7	0
ISO/TC 135/SC 5	Radiographic testing	26	2
ISO/TC 135/SC 6	Leak testing	4	0
ISO/TC 135/SC 7	Personnel qualification	7	1
ISO/TC 135/SC 8	Thermographic testing	3	2

Subcommittee	Name	Published standards	Standards under development
ISO/TC 135/SC 9	Acoustic emission testing	10	1

Table 6 contains the work program of ISO/TC 135

Table 6 – Work program of ISO/TC 135 – Non-destructive testing

Document reference	Title	SC
ISO/CD 3452-1	Non-destructive testing — Penetrant testing — Part 1: General principles	SC 2
ISO/CD 3452-2	Non-destructive testing — Penetrant testing — Part 2: Testing of penetrant materials	SC 2
ISO/DIS 22232-1	Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 1: Instruments	SC 3
ISO/DIS 22232-2	Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 2: Probes	SC 3
ISO/DIS 22232-3	Non-destructive testing — Characterization and verification of ultrasonic test equipment — Part 3: Combined equipment	SC 3
ISO/DIS 23243	Non-destructive testing — Terminology — Terms used in ultrasonic testing with phased arrays	SC 3
ISO/PRF 21432	Non-destructive testing — Standard test method for determining residual stresses by neutron diffraction	SC 5
ISO/DIS 23159	Non-destructive testing — Gamma ray scanning method on process columns	SC 5
ISO/WD 9712	Non-destructive testing — Qualification and certification of NDT personnel	SC 7
ISO/AWI 18251-2	Non-destructive testing — Infrared thermography — Part 2: Testing method for integrated performance	SC 8
ISO/WD 22290	Non-destructive testing — Infrared thermographic testing — Thermoelastic stress measuring method — General Principles	SC 8
ISO/AWI 24367	Non-destructive testing — Acoustic emission testing —Metallic pressure equipment	SC 9

5.1. OTHER NDT STANDARDS RELATED TO AM

We recall here two documents developed by ISO/TC 261 that are related to NDT:

- ISO/ASTM DTR 52905 *Additive manufacturing — General principles — Non-destructive testing of additive manufactured products* and
- ISO/ASTM CD TR 52906 *Additive manufacturing — Non-destructive testing and evaluation — Standard guideline for intentionally seeding flaws in parts*

It is also worth considering the work of ASTM International E07 – *Nondestructive testing* Technical Committee, Subcommittee E07.10 – *Specialized NDT Methods* that is developing the following documents:

- WK47031 *Nondestructive Testing of Metal Additively Manufactured Metal Aerospace Parts After Build*[4]
- WK62181 *Standard Guide for In-Situ Monitoring (IPM) of Metal Additively Manufactured Aerospace Parts*[5]

6. CONCLUSIONS

This deliverable reports updated information on relevant standards and on the Business Plan of Technical Committees that are relevant for the exploitation of PARADDISE results.

Chapter 2 provides comprehensive information useful to understand the Business Plan of ISO/TC 261, *Additive manufacturing* including: the structure of the TC, the identification and the scope of the various Joint ISO/TC261 & ASTM F42 Groups (JG) as well as the interrelation between such JGs and ISO/TC 261 Working Groups (WG) and Joint Working Groups (JWG) established between ISO/TC 261 and other ISO Technical Committee. The annotated work program in 2.2 provides information updated to the 30th of March 2020.

Chapter 3 provides general considerations related to CEN/TC 438 – *Additive Manufacturing* Business Plan, reports on published standards and standards under development, considers requirements for pressure vessels made via AM technologies and recalls on the standardization priorities identified by PARADDISE.

Chapter 4 provides information on standards developed by SC 1 – *Physical device control* and SC 4 – *Industrial data* of ISO/TC 184 – *Automation systems and integration* that are relevant to AM technologies and to PARADDISE, including information on the resolution of issues related to possible scopes overlap with ISO/TC 261 to be resolved by improved cooperation.

Chapter 5 lists ISO/TC 135 – *Non-destructive testing* standards that might be relevant to AM produced parts and also informs on specific documents that are under development by ASTM E07 Technical Committee.

6.1. ADDITIONAL STANDARDIZATION ACTIVITIES TO BE ADDRESSED

PARADDISE consortium project partners are encouraged to maintain strong commitment to follow-up and development of standards related to the project exploitable results otherwise they shall be prepared to have to comply to industrial standards drafted with the participation of their best competitors!

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[4] https://www.astm.org/WorkItems/WK47031.htm

[5] https://www.astm.org/DATABASE.CART/WORKITEMS/WK62181.htm