RECLAIM

Refurbishment and re-manufacturing of large industrial equipment

STANDARDS MAKE IT CIRCULAR
RECLAIM STANDARDIZATION TOOLKIT

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FOREWORD

The increasing spread of of sustainable development axioms in its social, environmental and economic values in coherence with the United Nations Bruntland Commission of 1987 criteria, has brought the Circular Economy back to the fore in recent years.
The Circular Economy, as a set of conservative transformation processes of resources and better reuse of existing physical assets, is increasingly attractive to promote sustainable economic growth.
RECLAIM - RE-manufaCturing and Refurbishment LArge Industrial equipment has a dual value, providing the methodologies for redesigning and reconstructing old or obsolete physical assets instead of decommissioning and redeveloping them for a new more sustainable use.
To this end, RECLAIM, after an in-depth and complete analysis of all the numerous ISO-IEC-CEN standards published and in the process of being approved, relating to the complex technical problems during the life cycle of physical assets, provides an overview of the standards to be used and of the 4.0 Enabling Technologies to make Reegineering processes more efficient and compliant with standards.
RECLAIM allows you to evaluate the feasibility of reusing physical assets and to redesign and rebuild them effectively and efficiently and to obtain, once retrained, regulatory compliance and better performance in terms of added competitiveness and lifespan values.
The RECLAIM project, which provides guidelines, methodologies and a standardization toolkit, is an important knowledge tool for designers, entrepreneurs, researchers and builders for any Remanufacturing and Refurbishement project.

Ing. Franco Santini
President CEN Technical Committee 319 "Maintenance"

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ACRONYMS AND DEFINITIONS

3D	Collection of vertices in 3D space, connected by various geometric entities such as triangles, lines, curved surfaces, etc. ISO/IEC 18038:2020(en)
Artificial Intelligence	Capability of a functional unit to perform functions that are generally associated with human intelligence such as reasoning and learning ISO/IEC 2382:2015(en)
Augmented Reality	Interactive experience of a real-world environment whereby the objects that reside in the real world are augmented by computer-generated perceptual information iso/iec 18038:2020(en)
Big data analytics	Extensive datasets — primarily in the characteristics of volume, variety, velocity, and/or variability — that require a scalable architecture for efficient storage, manipulation, and analysis ISO/IEC TR 20547-5:2018(en)
CEN	European Committee for Standardisation
Circular Economy	Economy that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles [SOURCE: Adapted from Ellen macarthur Foundation] ISO 20400:2017(en)
Condition monitoring and diagnostic	Condition monitoring: acquisition and processing of information and data that indicate the state of a machine (1.10) over time Note 1 to entry: The machine state deteriorates if faults (1.8) or failures (1.7) occur. ISO 13372:2012(en)
	Diagnostics: examination of symptoms (9.4) and syndromes (4.9) to determine the nature of faults (1.8) or failures (1.7) (kind, situation, extent) ISO 13372:2012(en)
Cybersecurity	Preservation of confidentiality, integrity and availability of information in the Cyberspace Note 1 to entry: In addition, other properties, such as authenticity, accountability, non-repudiation, and reliability can also be involved. Note 2 to entry: Adapted from the definition for information security in ISO/IEC 27000:2009. ISO/IEC 27032:2012(en)
Data management	The activities of defining, creating, storing, maintaining and providing access to data and associated processes in one or more information systems ISO/IEC TR 10032:2003
Digital Twin	Digital asset (3.10) on which services (3.7) can be performed that provide value to an organization. Note 1 to entry: The descriptions comprising the digital twin can include properties of the described asset, IIOT (3.24) collected data, simulated or real behaviour patterns, processes that use it, software that operates on it, and other types of information. Note 2 to entry: The services can include simulation, analytics such as diagnostics or prognostics, recording of provenance and service history. EXAMPLE:A digital model of an aircraft that allows crew training in a simulator; a stream of vibration readings that allows analysis of bearing wear; maintenance records that enable certification checks or total operation time computation. ISO/TS 18101-1:2019(en)
Electronic, electrical, or electromechanical part	Device that performs an electronic, electrical, or electromechanical (EEE) function, including electro-optical devices, and consists of one or more elements so joined together that they cannot normally be disassembled without destroying the functionality of the device ISO 14621-1:2019(en)
Environmental management	Part of the management system (3.1.1) used to manage environmental aspects (3.2.2), fulfil compliance obligations (3.2.9), and address risks and opportunities (3.2.11) iso 14001:2015(en)
Health and safety*	OH&S objective : objective (3.16) set by the organization (3.1) to achieve specific results consistent with the OH&S policy (3.15) ISO 45001:2018(en)
IEC	International elechtrotecnical commission
Industrial Data	Industrial organization: identity, interfaces and responsibilities of all participants in the supplier chain for a project ISO 16091:2018(en)

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	Data: set of values of qualitative or quantitative variables ISO 21378:2019(en)
Innovation management	Management (3.1.2) with regard to innovation (3.1.1) Note 1 to entry: Innovation management can include establishing an innovation vision (3.3.1.1), innovation strategy (3.3.4.1), innovation policy (3.3.2.1) and innovation objectives (3.3.3.1), and organizational structures and innovation processes (3.1.5.1) to achieve those objectives through planning, support, operations, performance (3.7.1)evaluation (3.8.3) and improvement (3.1.7). ISO 56000:2020(en)
IoT	Infrastructure of interconnected objects, people, systems, and information resources together with intelligent services to allow them to process information of the physical and the virtual world and react ISO/IEC 20924:2018(en)
ISO	International standard organisation
Life cycle	Consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal ISO 14040:2006
Maintenance	Combination of all technical , administrative and managerial action during the life cycle of an item intended to retain it in, ore restore it to a stae in which it can perform the required function . Note 1 to entry: technical maintenance actions include observation, analyses of item state (e.g. Inspection, monitoring, testing, diagnosis, prognosis, etc.) And active maintenance actions (e.g. Repair, refurbishment) note 2 to entry: see also the definition of improvement and modification note 3: see annex a UNI EN 13306:2018
Management system	Set of interrelated or interacting elements of an organization to establish policies and objectives and processes to achieve those objectives ISO 20257-1:2020(en)
Product Life Cycle	Period of time from the first idea to the ultimate disposal of a product Note 1 to entry: The product life cycle is divided into defined periods called phases in which activities that belong together are grouped, e.g. Product concept, design, production etc. The beginning and ending of phases require definite decisions (e.g. Releases). ISO 15226:1999(en)
Production engineering	Technical processes to define, design, and construct or assemble a product ISO/IEC/IEEE 24765:2017(en)
Quality management	Management (3.3.3) with regard to quality (3.6.2) Note 1 to entry: Quality management can include establishing quality policies (3.5.9) and quality objectives (3.7.2), and processes (3.4.1) to achieve these quality objectives through quality planning (3.3.5), quality assurance (3.3.6), quality control (3.3.7), and quality improvement (3.3.8). ISO 9000:2015(en)
R&I	Research and innovation
Refurbishment	Modification and improvements to an existing item to bring it up to an acceptable condition [SOURCE: ISO 6707-1:2014, 7.1.50, modified — to apply the concept to a specific item versus plant, building or civil engineering works.] ISO/TR 15686-11:2014(en)
Remanufacturing	Process by which value is added to component parts of end-of-life machines in order to return them to their original same-as-new condition or better ISO 16714:2008(en)
Requirement	Need or expectation that is stated Note 1 to entry: Specified requirements can be stated in normative documents such as regulations, standards and technical specifications. Note 2 to entry: Specified requirements can be detailed or general. ISO/IEC 17000:2020(en)
Robotic	Industrial robot: automatically controlled, reprogrammable (2.4), multipurpose (2.5)manipulator (2.1), programmable in three or more axes (4.3), which can be either fixed in place or mobile for use in industrial automation applications Note 1 to entry: The industrial robot includes: the manipulator, including actuators (3.1); the controller, including teach pendant (5.8) and any communication interface (hardware and software). Note 2 to entry: This includes any integrated additional axes.

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	ISO 8373:2012(en)
Sensor network	System of spatially distributed sensor nodes interacting with each other and, depending on applications, possibly with other infrastructure in order to acquire, process, transfer, and provide information extracted from its environment with a primary function of information gathering and possible control capability Note 1 to entry: Distinguishing features of a sensor network can include: wide area coverage, use of radio networks, flexibility of purpose, self-organization, openness and providing data for multiple applications. ISO/IEC 20005:2013(en)
Social responsibility	Responsibility of an organization (2.12) for the impacts (2.9) of its decisions and activities on society and the environment (2.6), through transparent and ethical behaviour (2.7) that contributes to sustainable development (2.23), including health and the welfare of society; takes into account the expectations of stakeholders (2.20); is in compliance with applicable law and consistent with international norms of behaviour (2.11); and is integrated throughout the organization (2.12) and practised in its relationships Note 1 to entry: Activities include products, services and processes. Note 2 to entry: Relationships refer to an organization's activities within its sphere of influence (2.19). ISO 26000:2010(en)
Statistical Method	Method to collect, analyse and interpret data under the influence of randomness Note 1 to entry: Data refer to numerical or non-numerical facts or information. ISO 3534-2:2006(en)
Technical Committee	Technical committees repsonsabile for developing standards document
UNI	Ente Italiano di Normazione

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1. INTRODUCTION

The document provides a first informative guidelines on existing standardisation activities at EU and international level relevant in the context of the EU project **RECLAIM - RE-manufaCturing and Refurbishment LArge Industrial equipMent** [1] project. This report will guide you in the standards jungle in order to build an horizontal approach for circular economy strategies for large industrial machinery through standardisation.

Furthermore this document will provide necessary knowledge on standardisation landscape to develop the RECLAIM activities promoting interoperability, compliance of project results and avoiding duplication of existing knowledge. It is intended as starting guidelines on standardisation for refanumacturing and refurbishment, based on RECLAIM approach, for researchers, entrepreneurs, business associations, technological clusters and experts in the field.

This toolkit will be updated each year.

The document introduce **RECLAIM project** (Chap. 2). Secondly an **overview of standardisation system and process**, explaining its potential as innovation and technology transfer booster is provided (Chap. 3).
Chap. 4 will provide description of **RECLAIM consolidated view** describing the logical framework, technological areas and process basing used for standards mapping
Chapter 5 will provide an **analysis of existing standards**, both published and under development, and related **standardisation Technical Committees** at EU (CEN) and international (ISO) level. Whether possible, the document makes reference to relevant EU national standard. The standards will be classified following RECLAIM consolidated view.
Conclusion will summarize standardisation state of the art and identified gaps to be taken into account as first input for RECLAIM standardisation roadmap.

The report is aimed at complementing the **RECLAIM standardisation toolkit**, an online tool publicly available on RECLAIM website (https://www.reclaim-project.eu/resources/).

It is possible to download against payment the full text of selected standards from ISO[2] and National Standardisation Body catalogues. A free preview is available.

2. RECLAIM project

RECLAIM - RE-manufaCturing and Refurbishment LArge Industrial equipMent is an European project financed under **EU** programme Horizon 2020 in *DT-FOF-06-2019 - Refurbishment and re-manufacturing of large industrial equipment (IA)* call.
The topic aimed at financing R&I demonstration projects to establish the feasibility of lifetime extension of large industrial equipment covering refurbishment and/or upgrading of large industrial equipment, re-manufacturing and re-use of equipment approach among others.
RECLAIM solutions aim to both **extend machinery lifetime** while also **improving productivity and performance.** The project focuses on harnessing digital analytics, the Internet of Things (IoT) and

[1] https://www.reclaim-project.eu/
[2] https://www.iso.org/store.html

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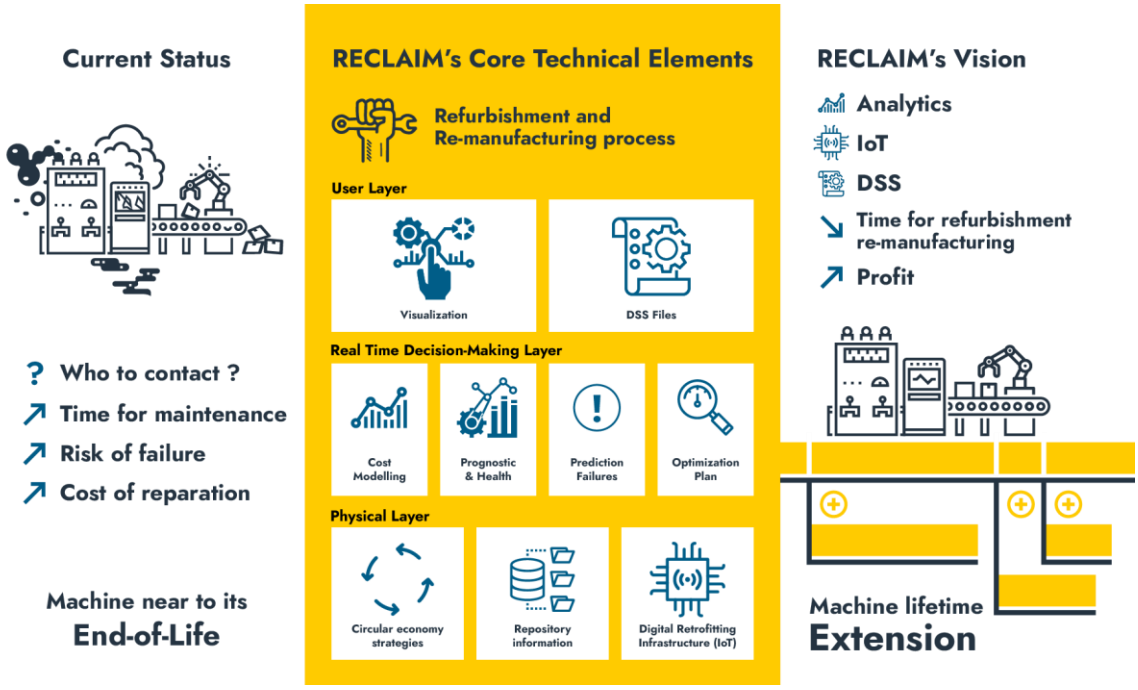
circular economy strategies to improve predictive maintenance and upgrade legacy machines responsibly and effectively (Fig. 1).

Figure 1 RECLAIM Concept



Source: https://www.reclaim-project.eu/

The project involves 22 partners from 9 European countries:

- **5 demonstration cases** in welding, robotics and enamelling, woodworking, shoe making and textile machinery value chain will validate the RECLAIM approach.
- **7 research centers** and **3 non-profit organisations**
- **7 industrial partners and SMEs**

UNI, Italian standardisation body acknowledged by EU Reg. 1025/2012 official member of European (CEN) and international (ISO) standardisation body, is RECLAIM standardisation task leader (*Task 7.3 - WP7 - Sustainability assessment methods for the verification of Machinery refurbished/ re-manufactured parts.*)

Standardisation activities aim at boosting RECLAIM exploitation, enhancing international market acceptance, quality and utilisation of project solutions. It will foster interoperability, compliance with existing standards as well as providing the necessary knowledge to develop project activities.

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3. STANDARDIZATION

3.1 What is standardisation

3.1.1 Standardisation system

The standardisation system is structured according to “different layers or levels”, starting from the national one, up to the European and International level. The three different levels of the standardisation activities are strictly connected and are based on the principle that duplication and overlapping are to be avoided.

At European level the standardisation system is defined and regulated by a specific EU Regulation 1025/2012, in which the European Parliament and the Council addressed standardisation by defining its role and underlying the role of standardisation to “boost the competitiveness of enterprises by facilitating the free movement of goods and services, network interoperability, means of communication, technological development and innovation.” In addition to this, standardisation is considered as an important tool to support innovation as it can be used to transfer the results of R&I into the market.
In general, standardisation supports the social and economic development by developing voluntary European standards – or better standardisation deliverables – related to products, materials, services, organisations, processes and addressing their safety, quality, performance, interoperability, requirements, etc.. In short, standardisation supports economic activity, boosts productivity, increases trade within the European Single Market and allows businesses of all sizes, including SMEs, to access markets around the world. In this sense, standards are important tools to support SMEs competitiveness.
Standardisation is governed by the principles of: consensus, openness, transparency, national commitment and technical coherence.

The European Committee for Standardization (CEN) and the European Committee for Electro technical Standardisation (CENELEC) are two private European non-profit organisations. Their mission is to support needs of the market and of the different stakeholders, such as industry and commerce, service providers, public authorities and regulators, academia and research centres, European trade associations and interest groups representing environmentalists, consumers, trade unions as well as small and medium enterprises, and other public and private institutions.

Their aim is also to promote a unique European Standardisation System, leading the implementation of best practice in standardisation around the world. With this specific regard, CEN and CENELEC support international standardisation and cooperate closely with the International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC).

CEN membership is based on 34 National Standardisation Bodies who represent CEN in their country, and their country in CEN. CEN and its Members are committed to cooperating with key organisations at national, European and international level, for the development of sound partnership relations.

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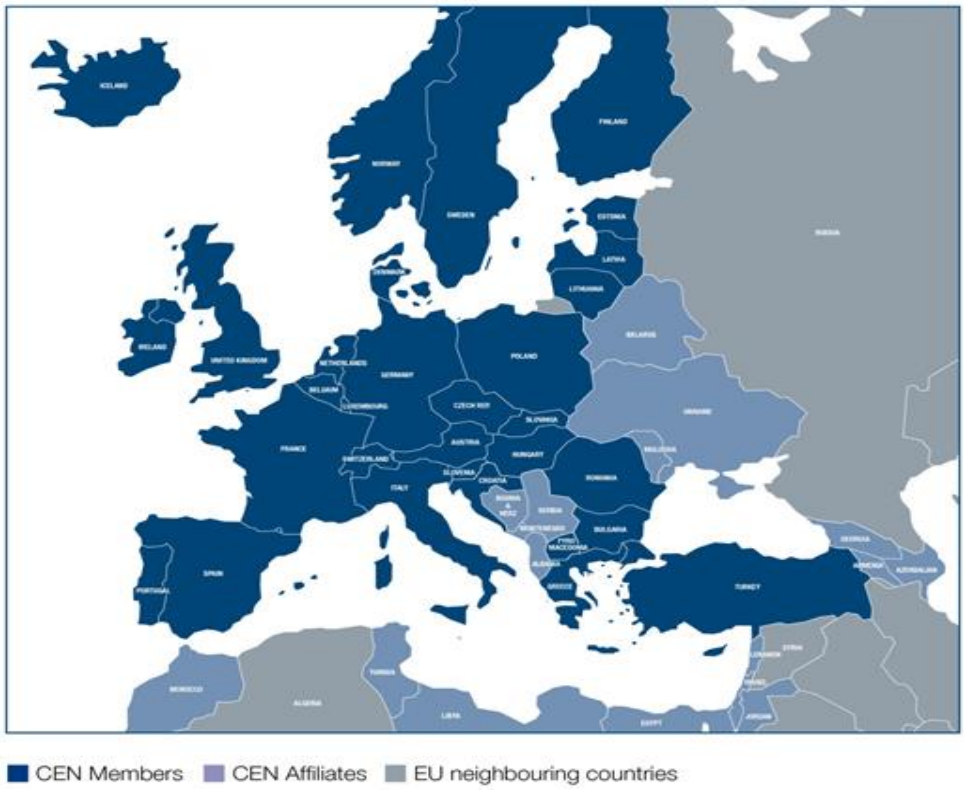
Figure 2 CEN and CENELEC members



Source CEN/CENELEC

The European standardisation community and network include more than 200.000 experts coming from different countries and from the different stakeholders, i.e. business, industry and commerce; service providers; consumers, environmental and societal organisations; public authorities and regulators; and other public and private institutions.
European standards – or more generally standardisation deliverables - are market-driven and voluntary. They are developed through a transparent, balanced and consensus-based process in which relevant stakeholders are involved, with the aim to produce high-quality technical documents for products, materials, services, organisations and processes. Standards may deal with: quality, safety, security, interoperability, performance, accessibility and environmental requirements.

The European standardisation system is structured and organised in different Technical Committees (TCs), dealing with specific issues (e.g. CEN/TC 319 Maintenance), which are subdivided in Subcommittees (SCs) or Working Groups (WGs), according to the complexity of the areas of interest to be addressed. These TCs are included, with their respective mirror committees or working groups, in the structure of the different Standardisation Organisations (National, European and International), with their respective mirror committees.
The coherence of the European standardisation system is based on the fact that all the members of CEN shall adopt EN standards as national standards and have to withdraw existing national standards which conflict with them.

Moreover; there are specific agreements between the European and International Standardisation Organisations (e.g. CEN and ISO) as they have signed formal agreements to avoid duplication of efforts

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and promote global relevance of standards, which allows the development and adoption in parallel of the respective standards, which have the same content and identification code. The technical collaboration between CEN and ISO was formalised back in 1991 thanks to the Vienna Agreement (VA).

In this context, UNI - Italian Organisation for Standardisation - is the Italian national standardisation body. It represents Italy in CEN and ISO. It is a private, non-profit association founded in 1921 appointed by the Italian government and the European Union to develop, approve and publish technical standards in all economic sectors (industry, trade and services) except for the electric and electro-technical ones. UNI carries out standardisation activities in all industrial, commercial and service sectors. As all standardisation bodies, UNI is also a meeting point between different stakeholders, such as the business world, research institutions, public administrations, universities, education and training authorities, consumers and societal stakeholders. UNI has more than 6.000 affiliated among which there are many industrial associations representing large, small, medium and micro enterprises coming from all industrial sectors, with the exception of the electrostechnical one

3.1.2 Standardisation documents

According to EU Regulation 1025/2012, a standard is "a technical specification, adopted by a recognised standardisation body, for repeated or continuous application, with which compliance is not compulsory". So standards and the other standardisation deliverables are voluntary technical documents developed by a specific technical body – a Technical Committee (TC), a Working group (WG), a Subcommittee (SC) or a CEN Workshop (CEN/WS).

There are different kinds of standardisation deliverables, each with their characteristics are summarised in the table here below

Type	Standard	Technical Specification	Technical Report	Workshop Agreement
International standard	ISO IEC	ISO/TS IEC/TS	ISO/TR IEC/TR	IWA
European Standard	EN	CEN/TS CLC/TS	CEN/TR CLC/TR	CWA
National Standard	UNI, DIN, NF, UNE, etc. UNI EN, DIN EN, etc. UNI ISO, DIN ISO UNI EN ISO, DIN EN ISO,	UNI CEN/TS, DIN CEN/TS, etc.	UNI CEN/TR, DIN CEN/TR, etc.	Variabile
Main characteristics	– Elaboration: 3 years – 2 steps for approval – At EU level: compulsory national adoption Revision: every 5 years	– Elaboration: 21 months – 1 step for approval or internal approval in TC – At EU level: optional national adoption	– Elaboration: free timeframe – Internal approval in TC – At EU level: optional national adoption No revision required	– Elaboration: free timeframe (usually few months) – Internal approval in the Workshop – At EU level: optional national adoption

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		Revision: at 3 years (upgrading to EN or deletion)		Revision: at 3 years (upgrading to EN or deletion)

Based on the table above, herebelow an explanatory example on how to read a code of a standard:

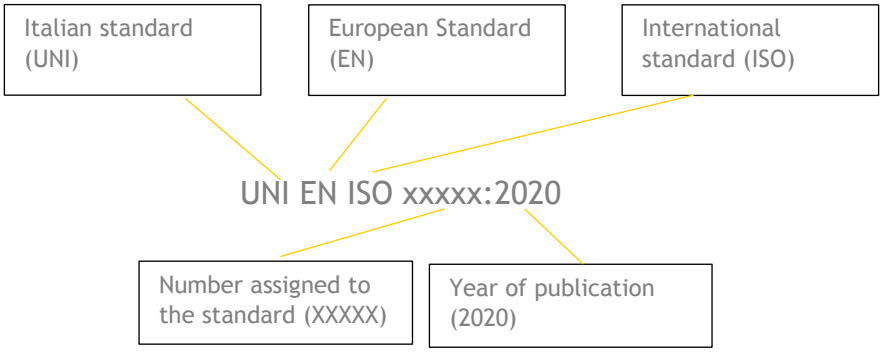
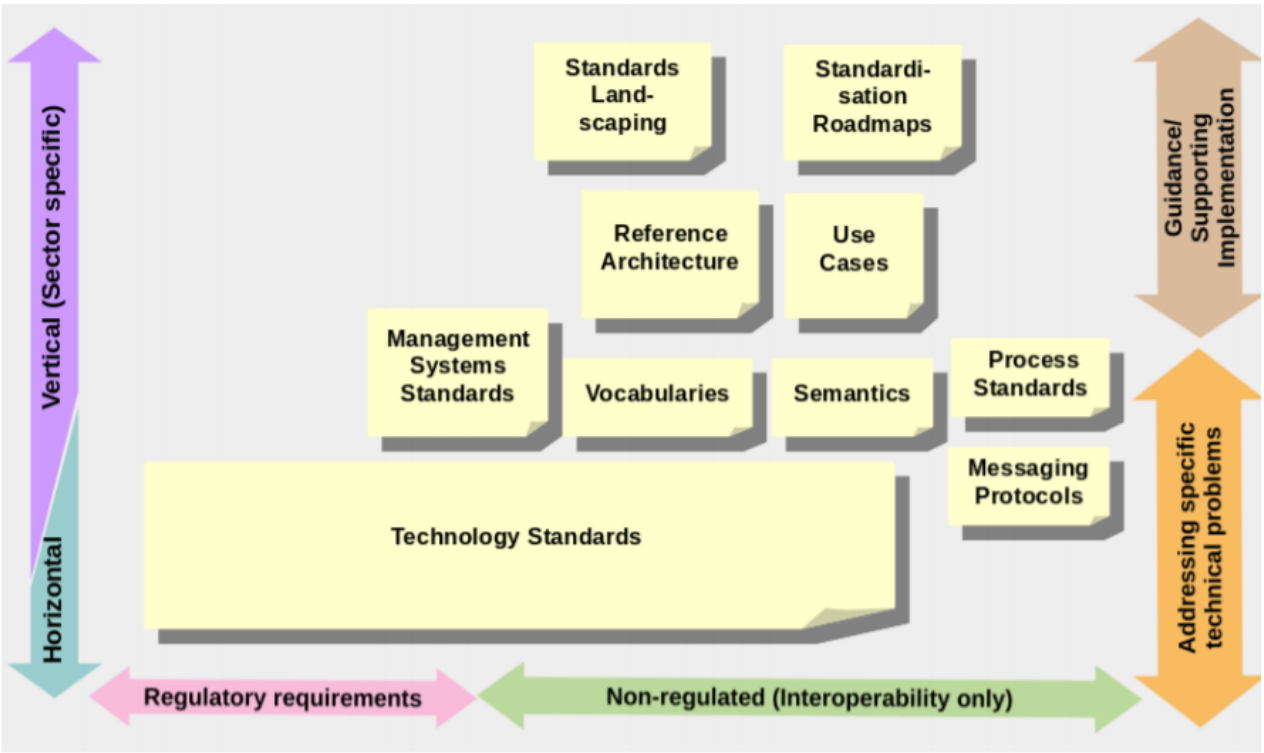


Figure 3 **Standardisation landscape**



Source: Validation Report on Standardisation Harmonisation, October 2019

The typical development process of an EN and ISO standard is described in the following scheme:

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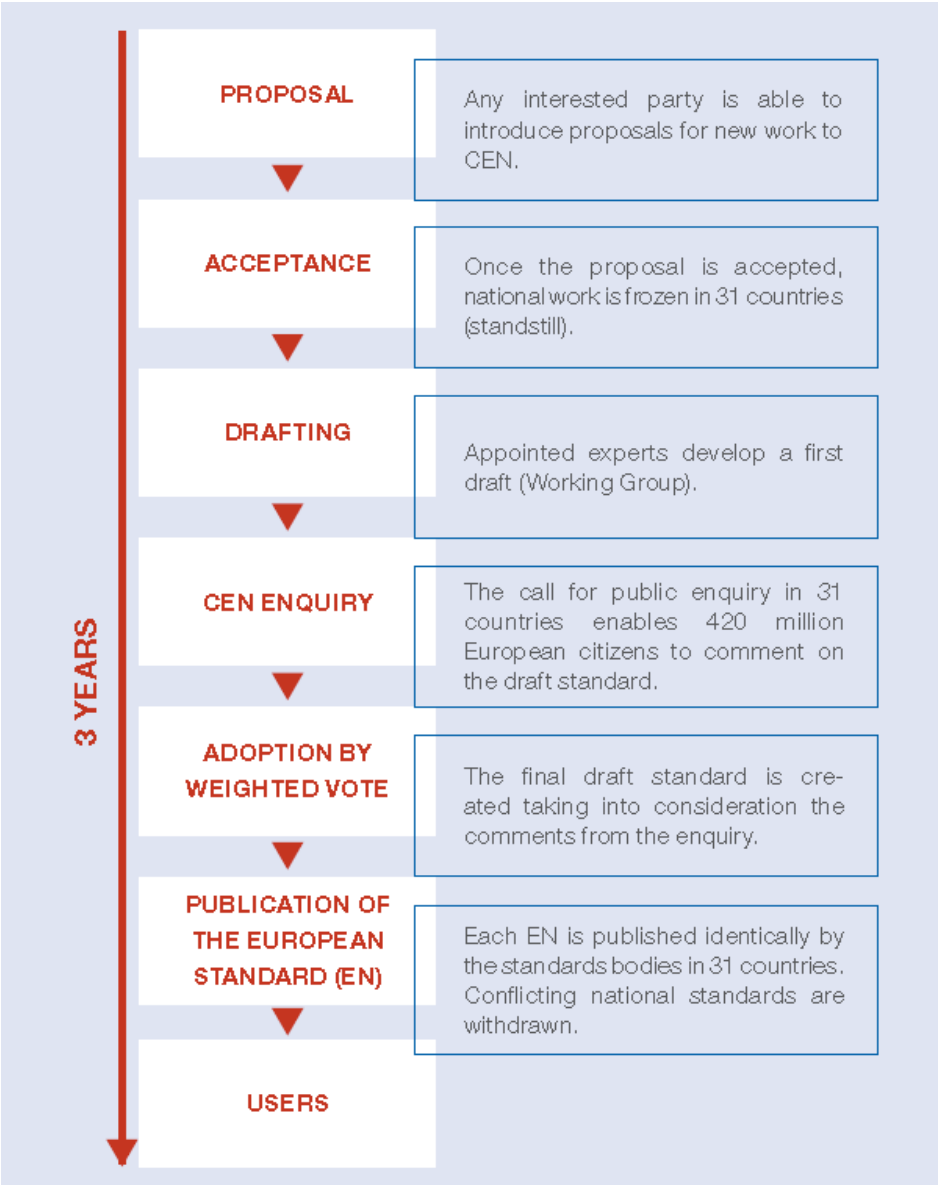
Figure 4 Standardisation process



Source – CEN Compass

3.2 Standards and innovation

Standardisation is a valuable tool to support and boost innovation as it can create a foundational framework from which innovators can design specific solutions. In fact, standardisation helps to bridge the gap between research, innovation and global market impact by building customer trust and confidence in new innovative solutions – such that early standards development enables faster mass-market adoption of new technologies, products and services.

European Framework Programmes like Horizon 2020 and Horizon Europe pay particular attention to the impact of research and innovation in developing, supporting and implementing EU policies, and support the uptake of innovative solutions in industry and society to address global challenges. This

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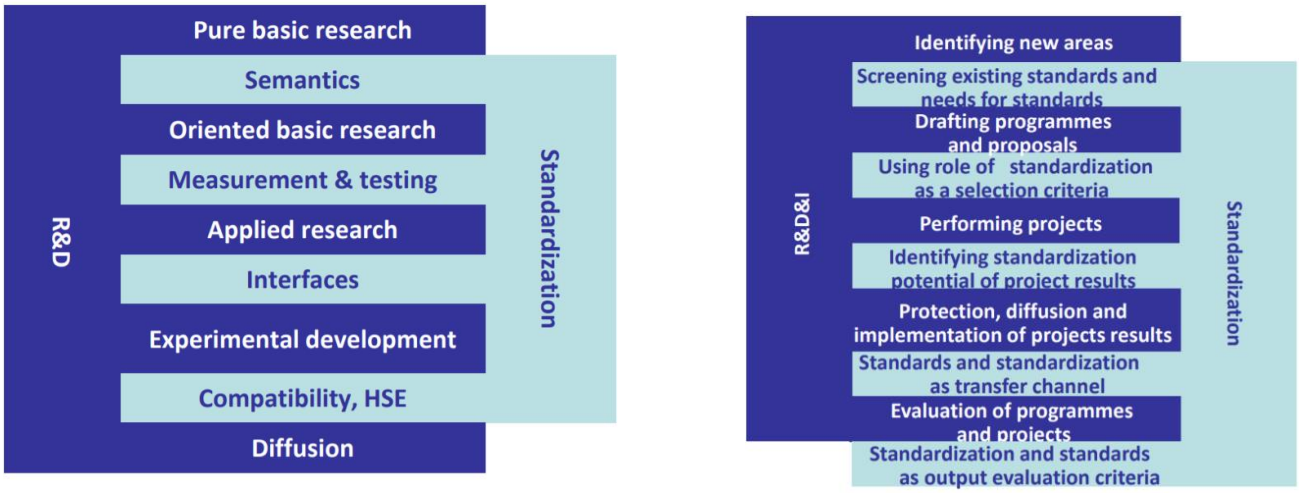
strategic objective emphasises the market relevance of standards when research and innovation is combined with standardisation.

Many funding calls under the Framework Programmes request projects to contribute to standardisation and the main reason for this approach is that standardisation may:

- disseminate research and innovation knowledge to industry, society and public administrations
- facilitate market acceptance by enabling interoperability and compatibility of innovative solutions with existing products, services, systems and processes
- facilitate trade by diminishing technical barriers
- facilitate technology transfer
- support networking between different stakeholders, including scientific and commercial collaborators

In addition to this, it can be recognised simultaneously at European and international level thanks to the agreements at place between CEN, CENELEC, ISO and IEC.

Figure 5 The Integrated Approach: Standardization at the Service of Research and Innovation



Source: Standards + Innovation 2020

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4. METHODOLOGY

For the construction of the architecture, the RECLAIM work plan already defines a set of nine building blocks. The RECLAIM architecture will consist of those building blocks in order to provide a profound basis for equipment refurbishment and remanufacturing.

Figure 6 **Overview of the Building Blocks for the RECLAIM architecture**

Building Block 1	**Adaptive Smart Sensorial Network and Digital Retrofitting Infrastructure**	A distributed and adaptive smart sensor service to collect and process data for industrial cloud/edge environments and IoT introduction into the manufacture ecosystem, including IoT controllers to be attached at existing devices and machines in order to retrieve data and enabling predictive maintenance tasks.
Building Block 2	**Embedded Cybersecurity for IoT devices**	Embed cybersecurity endpoint protection into the design and development processes of Digital Retrofitting Infrastructure but also in the post market phase.
Building Block 3	**Decision Support Framework (DSF) for Optimal Lifetime-Extension Strategies**	The DSF component is designed to support and improve the effectiveness of decisions concerning the refurbishment and re-manufacturing of production infrastructure. The DSF will include tools such as the Cost Modelling and Financial Analysis tool, the Adaptive Sensorial Network and Fog computing framework (IoT Platform), the Prognostic and Health Management Toolkit, the Fault Diagnosis and Predictive Maintenance Simulation Engine using Digital Twin, and the Optimisation Toolkit for Refurbishment and Re-manufacturing Planning.
Building Block 4	**Cost Modelling and Financial Analysis Toolkit**	The cost modelling will carry out cost estimation and analysis by using the combination of parametric costing and activity-based costing methods. The cost model will take into account all type of life extension strategies and activities for carrying out refurbishment and re-manufacturing of the industrial equipment, as well as the resources needed for each activity.
Building Block 5	**Prognostic and Health Management Toolkit**	The prognostics and health management (PHM) provides a peer-to-peer health evaluation as well as component prediction methods to increase equipment (machine) lifetime, productivity and service quality
Building Block 6	**Fault Diagnosis and Predictive Maintenance Simulation Engine using Digital Twin**	This building block is to monitor and predict the performance and status of factory assets. This will allow providing to the user all the features needed to schedule the maintenance works on the machines to: avoid failures being predicted by the "Prognostic and Health" algorithms defined in the building block 5; to perform proper maintenance planning, optimizing the production throughput and reducing the production lines stoppages.
Building Block 7	**Optimization Toolkit for Refurbishment & Re-manufacturing Planning**	This component aims to support the planning optimization through multi-variable monitoring of the machine's operational parameters where the effects of variable changes will be possible to determine and combine known best practices methodologies for model-based plat-site/shop-floor control.

Source: RECLAIM D2.1 Initial requirements specification

The main goal of the **RECLAIM's Considated View** (Figure 7) is to set all the partners into the same level of understanding, being somewhere between the project arquitecutre where the main components are detailed and the technologies to be used in the project. Its idea is to be more easy to read and a guideline throughout the whole project to anyone that wants to use the RECLAIM approach. In Figure 7 the main building blocks for the Consolidated View are presented.

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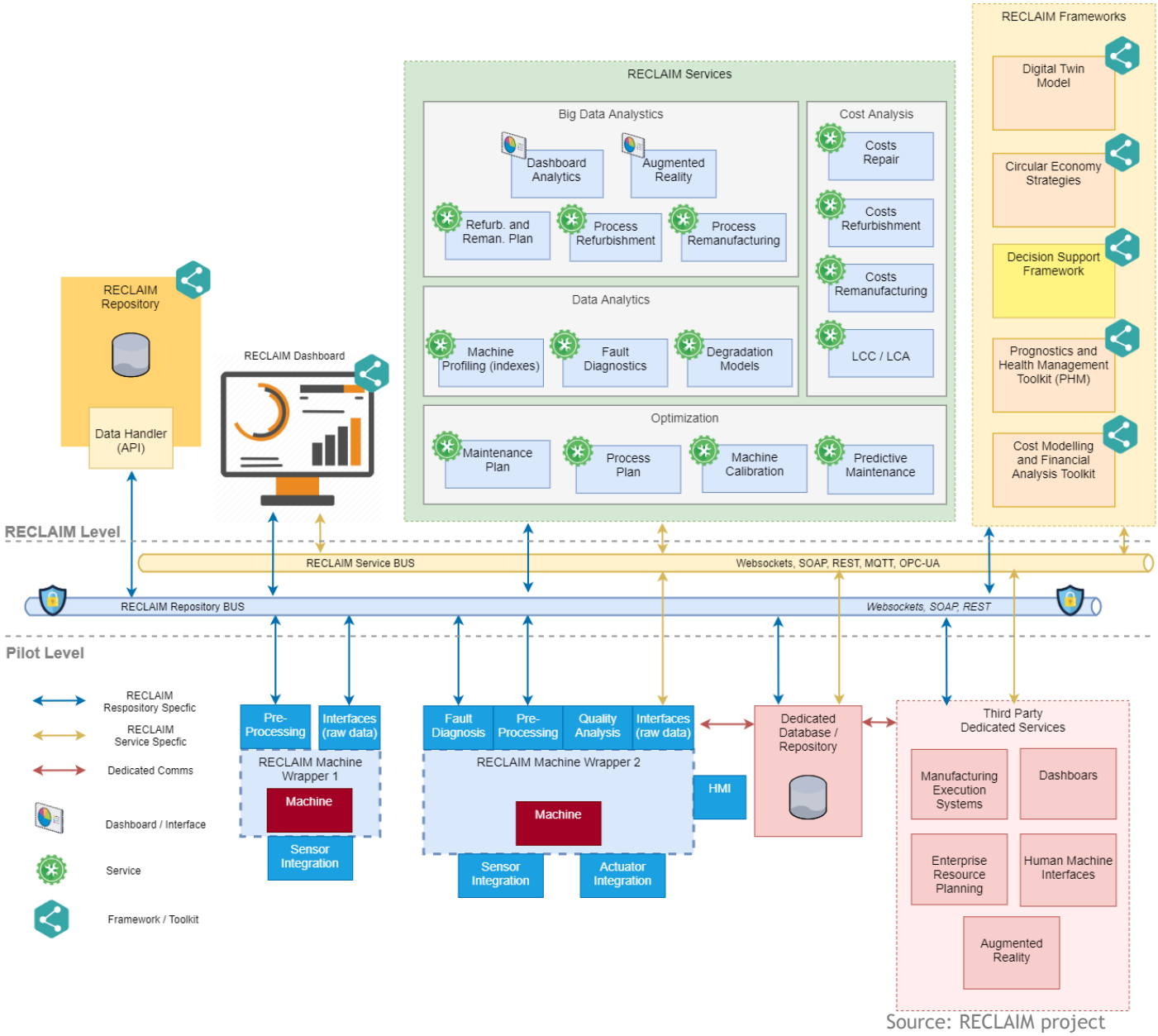
Figure 7 RECLAIM Consolidated View based on the concept of Services and Frameworks



Source: RECLAIM project

For this specific case of RECLAIM, an approach based on **Services and Frameworks** was developed. Since in this project 5 different pilots are being developed but most of the technology will be common, like digital twin approach, decision support tools, cost analysis, etc., a flexible approach was defined so anyone can use it with no restrictions as soon as the main functionalities are fully understood.

A **Service** is the most elementary, atomic software component existing in RECLAIM, which could be an algorithm for Health-index calculation or Anomaly Detection with no GUI or a Holistic Lifecycle Model with a GUI. The main purpose is to depend only on its own for the processing and not external applications. There might be cases where an algorithm depends on multiple external algorithms (e.g. Decision Support Framework – DSF), but this should not be the case for Services.

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A **Framework** is a more complex concept in RECLAIM, and it can be composed of multiple Services executed in a sequential and parallel way, making up a pipeline (e.g. on one hand, the Prognostic and Health Management Toolkit - PHM can make use of Degradation Models and Predictive Maintenance external Services, and on the other hand, can have its own private applications, internal database and dashboard). Although being more complex than Services, Frameworks can also be used by other Frameworks as part of their pipelines.

In the project, also a common graphical user interface will be developed to avoid having multiple tools for data visualisation and configuration. To this intent, the **RECLAIM Dashboard** is defined. The visual feedback to both technical and industrial partners is essential in both development and testing phases. For technical partners a visual feedback needs to be used so all the acceptance tests defined in the requirements should be successfully passed and used in real industrial scenario. Additionally, for the industrial parterns, a dashboard is important mainly to easily read and assess the improvements introduced by RECLAIM technologies and report the business value and competitive advantage it really brings to the company.

The RECLAIM repository was defined so all the partners that do not possess any database infrastructure can rely on a technology provided by the project. This will be definitely a central piece in the project since most of the data generated and exchanged among services and frameworks will be registered in this repository. Both historical and dynamic data from the machines will be stored in such a repository, so a data handler is also part of this component to ensure a standardised access to the data.
Last, but not the least, the project also defines **two different ways of communication.** One of them is called the RECLAIM Repository bus and aims at establishing a communication to the repository in a bidirectional way, where data can be access and stored on demand. This can be seen as a place where historical data should exist and persist for long periods of time. Normally, such data is used by decision support tools so long-term strategic decision can be made. Additionally, the RECLAIM Service bus aims for a more direct communication among services and frameworks, without the need to pass throughout the repository. Hence, this can be seen as a more peer-to-peer communication where near “real-time” data can be exchanged. Moreover, most of the time it is not practical or not even necessary to store all data in a database, so only when necessary, some services / frameworks should store their outputs. This direct communication is also important in the hierarchical dependability of frameworks and services, where the main perspective of a framework is to orchestrate a set of services. If a direct bus is not established, the realisation of such a technology will be hard to achieve.

As introduced and previously detailed in this section, the main idea is to **allow different pilots to use different parts of this consolidated view**. In the project, each pilot will have its instance of the RECLAIM Consolidated View. Since pilots are in different degrees of technology and digitalisation maturity, a great amount of flexibility is required since specific implementations for each pilot is not achievable with the context of RECLAIM budget. This way, it is possible for a pilot to make use of most of the RECLAIM technologies like dashboard, repository and a set of services / frameworks, where the effort would be mostly on the interfaces among all these blocks. On the other hand, if a pilot already possesses an internal database and a set of dashboards, only some services / frameworks might be used. Hence the red boxes on the bottom right corner of the Consolidated View figure. If a component is already available on the pilot side (red box), only the necessary components need to be used. This flexibility allows the whole project to 1) reduce the effort in the development phase

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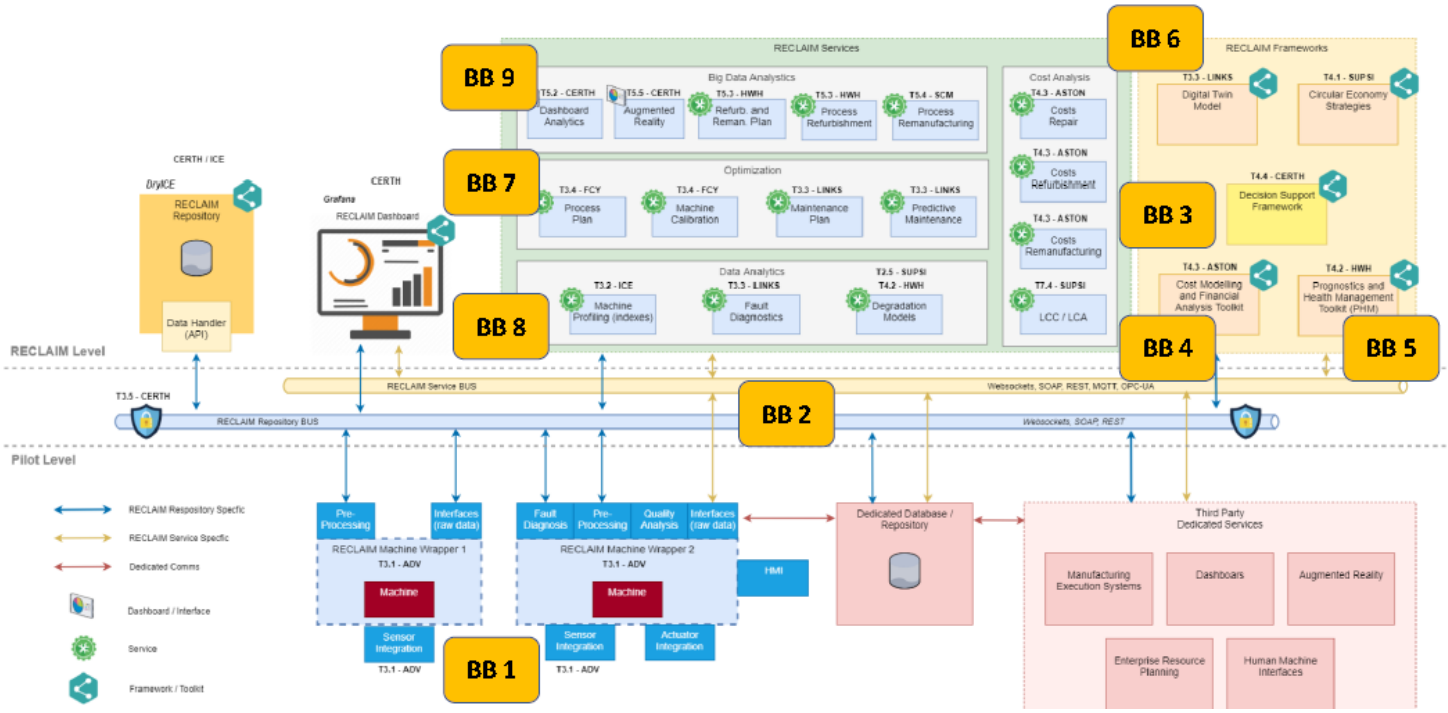
due to the component by different pilots, and 2) only use what is really necessary for the pilots to be successful, focusing on what is relevant.

After an initial analysis of requirements specification[3] RECLAIM building block have been synchronised with the consolidated view, allowing to put individual emphasises on the building blocks depending on the individual pilots' and stakeholders' needs, as well as future needs not in focus at the moment (Figure 8).

Figure 8 RECLAIM Consolidated View based on the concept of Services and Frameworks and building block



Source: RECLAIM project

5. STANDARDISATION TOOLKIT

5.1 SUMMARY

5.1.1 Main findings

a. WHERE?

The study mapped 36 ISO/IEC Technical Committees and 12 CEN/CENELEC Technical Committees. Unsurprisingly, the international level is the main copetition teathre: 13 ISO TCs have a European TCs mirror focusing on cross sectoral features with dedicated Regulatory field (e.g. safety[4], environmental management and performance, communication/labelling) and cybersecurity.

[3] D2.1 Initial requirements specification - Michael Peschl, Niels Mitzschke, João Reis, 17/07/2020
[4] Machinery Directive 2006/42/EC - https://ec.europa.eu/growth/sectors/mechanical-engineering/machinery_en

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b. WHAT?

The report maps 277 international and EU standards, covering 33 KEY AREAS (Figure 9 and Figure 10). Granularity increases analysing SC level, as stated in In coherence with ISO and CEN TC findings, 20% of mapped standards are elaborated at EU level: international standards prevails.

Figure 9 Standards and Key Areas

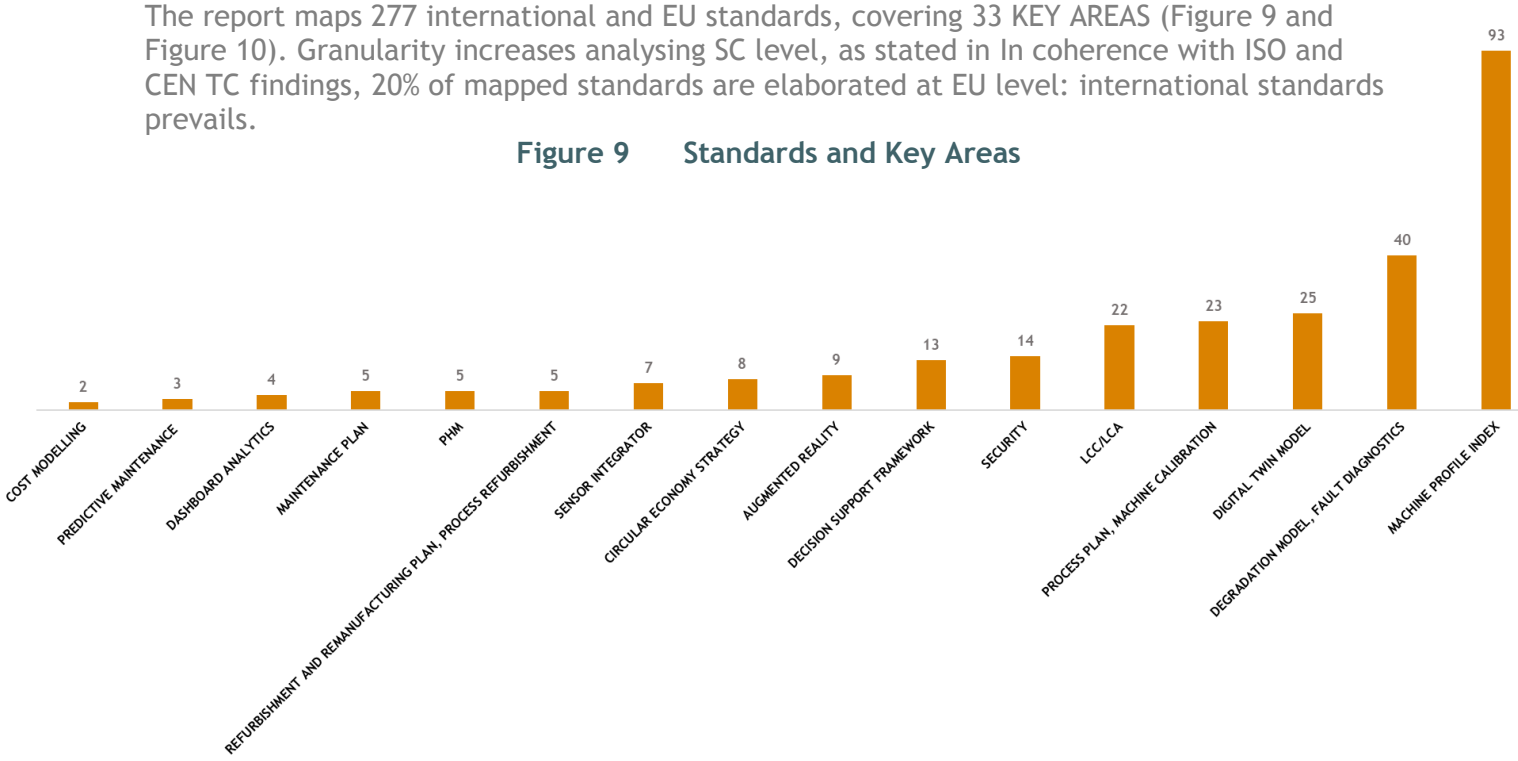
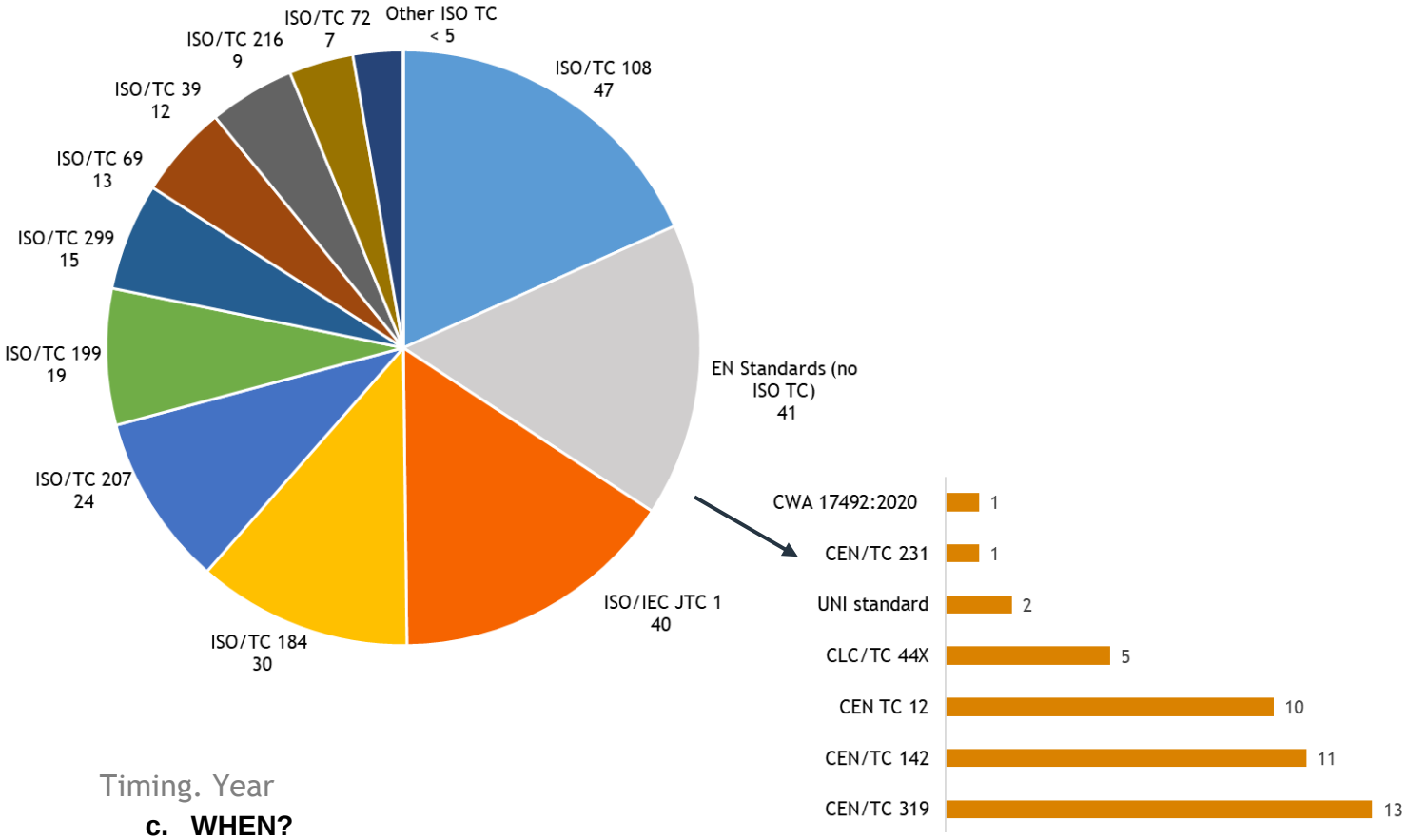


Figure 10 Number of standards per ISO and CEN TC



Timing. Year

c. WHEN?

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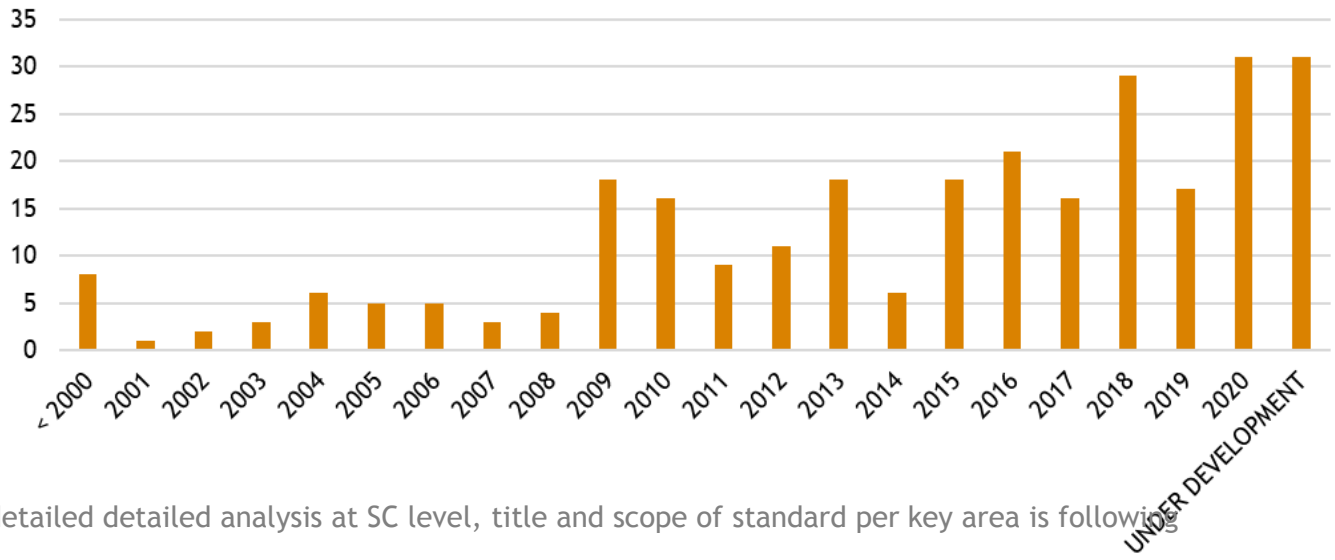
More than 80% of analysed standards were issued or updated after 2009 and 47% in the last 5 years at present year. Considering average standard life cycle and development process (3 year[5]) and growth rate of standardisation activities (+160% in 2000-2010, 94% in 2011-2020), tasks, scope and expected results are fully coherent with global and EU standards ecosystem. It demonstrates that te project can provide valuable input for future standardisation activities in the related TC.
31 standards are under development or being updated in which RECLAIM results can impact.

Figure 11 Number of developed and updated standards (EU and global) per year



A detailed detailed analysis at SC level, title and scope of standard per key area is following

5.2.1 Methodology

Standards mapping is based on the following methodology (Fig. 3):

a. KEY AREAS have been identified, following RECLAIM consolidated view services and framework. In order to align it with standardisation terminology, each KEY AREA has been labelled with KEY WORDS;
b. KEY WORDS are definition selected from existing standards (See par. ACRONYMS AND DEFINITION) in coherence with RECLAIM consolidated view: they will build a common terminology and understanding of each service and framework. Considering the transversal nature of each KEY AREA, KEY WORDS might be repeated for several KEY AREA;
c. DESCRIPTORS, defined per each keywords, will describe type of characteristics of keywords the standards will help you to address (e.g. key performance indicator, terminology…);

Finally, relevant ISO and CEN TC and related standards have been selected. Whenever a standard makes references to both CEN and ISO TC, it means that it has been adopted and aknowledged both at international and European level. Otherwise it means that it has been aknowledged only at international (ISO) or European (CEN) level in the related TC.
National standards, which represent a very important asset for RECLAIM scope (e.g. DIN SPEC 91345:2016-04 - Referenzarchitekturmodell Industrie 4.0 (RAMI4.0)[6]) will be analysed aftwards with a dedicated report.

[5] https://boss.cen.eu/reference%20material/Guidancedoc/Pages/GoodPract.aspx
[6] https://www.beuth.de/de/technische-regel/din-spec-91345/250940128

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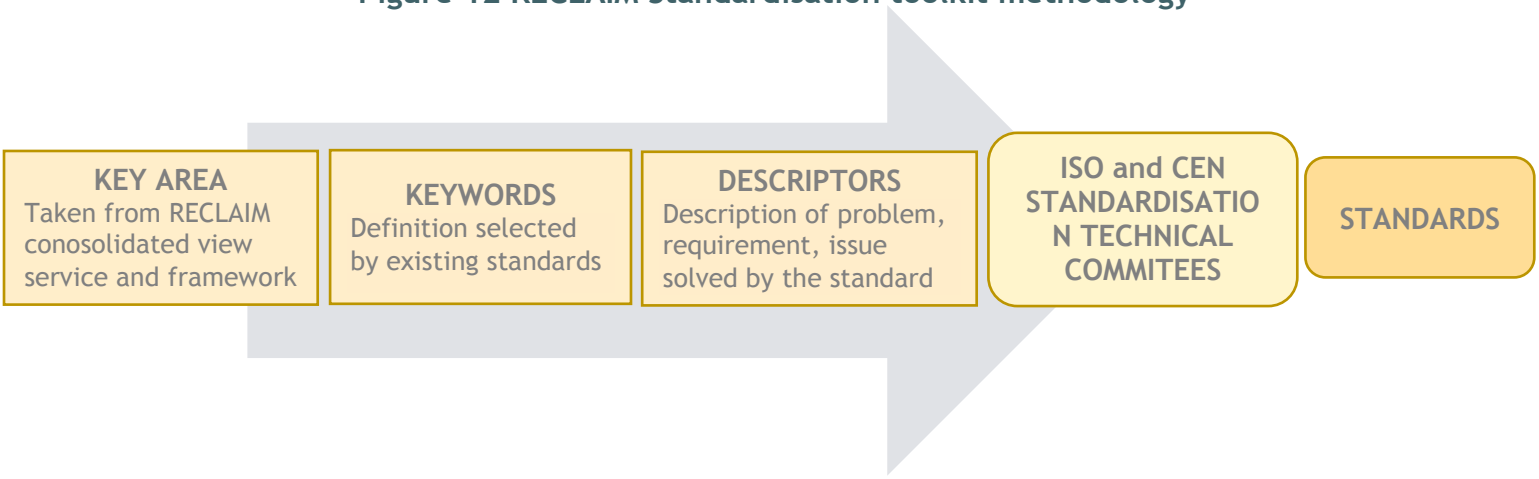
Considering the transversality of RECLAIM consolidated view and the complexity of standard content, one standard might be used for several purpose and KEY AREA (ANNEX 1)

Figure 12 RECLAIM Standardisation toolkit methodology



5.2 RECLAIM Services

5.2.1 Data Analytics: standardisation initiatives and Technical Commitees

KEY AREA: DEGRADATION MODEL AND FAULT DIAGNOSTIC

Definition of an holistic model of the machine life cycle, based on estimation of machine average life expectancy. It will provide information for effective life cycle management analysing historical failure metrics measurements, defining a predicting machine based on statistical reliability models of past failures. In parallel developlment of a comprehensive framework for predictive and preventive control and management based on highly sophisticated data analysis models (physical & statistical) will complete the framework.

The following standardisation technical committees have been identified, to provide knowledge and compliance with statistical methods as well as condition monitoring general guidelines and requirements for physical and statistical data analysis model (Table 1).
List of relevant standards elaborated by thos TCs are provided in Table 2.
Life cycle related standards will be analysed in LCA/LCC in Chap 5.1.5.

Table 1 DEGRADATION MODEL AND FAULT DIAGNOSTIC: list of relevant CEN and ISO Technical Committes (TCs)

ISO AND CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems[7] Standardization of the procedures, processes and equipment requirements uniquely related to the technical activity of condition monitoring and diagnostics of machines systems in which selected physical parameters associated with an operating machine system are periodically or continuously sensed, measured and recorded for the interim purpose of reducing, analyzing, comparing and displaying the data and information so obtained	ISO/TC 108/SC 5/WG 4 Tribology-based monitoring and diagnostics ISO/TC 108/SC 5/WG 11 Thermal imaging ISO/TC 108/SC 5/WG 17 Condition monitoring and diagnostics applications ISO/TC 108/SC 5/WG 18 Condition monitoring management

[7] https://www.iso.org/committee/51538.html

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and for the ultimate purpose of using this interim result to support decisions related to the operation and maintenance of the machine system.	
ISO/TC 69/SC 4 - Applications of statistical methods in product and process management[8]	ISO/TC 69/SC 4/WG 11 Process capability and performance ISO/TC 69/SC 4/WG 12 Implementation of statistical Process Control
CEN/TC 319 - Maintenance Standardization in the field of maintenance as far as generic standards which are generally applicable are concerned	CEN/TC 319/WG 10 Maintenance within physical asset management CEN/TC 319/WG 11 Condition assessment methodologies CEN/TC 319/WG 12 Risk based inspection framework (RBIF) CEN/TC 319/WG 13 Maintenance process CEN/TC 319/WG 14 Maintenance engineering CEN/TC 319/WG 15 Safety and maintenance CEN/TC 319/WG 4 Terminology CEN/TC 319/WG 6 Maintenance performance and indicators CEN/TC 319/WG 8 Maintenance functions and maintenance management

[8] https://www.iso.org/committee/49774.html

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Table 2 DEGRADATION MODEL AND FAULT DIAGNOSTIC: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 14830-1:2019 - Condition monitoring and diagnostics of machine systems -- Tribology-based monitoring and diagnostics General requirements and guidelines	This document specifies requirements and guidelines for the analysis of lubricating oils, hydraulic fluids, synthetic fluids and greases. Tests for electrical insulating oils and heat transfer oil are outside the scope of this document.	Condition monitoring and diagnostic	Tribology	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
CEN/TS 17385:2019 - Method for condition assessment of immobile constructed assets	Methodologies of condition assessment for all types of structures	Condition monitoring and diagnostic	Methodology		CEN/TC 319 - Maintenance
ISO 10817-1:2011- Rotating shaft vibration measuring systems - Part 1: Relative and absolute sensing of radial vibration	Details of how to obtain reproducible measurement results in order to enable the monitoring and evaluation of shaft vibrations according to the ISO 7919 series. As such, it is concerned primarily with the measurement of shaft vibrations for large machines (e.g. steam turbine generator sets, gas turbines, industrial turbosets, hydraulic machines). This part of ISO 10817 is applicable to radial vibration measuring systems on shafts, both for absolute and relative measurements. It covers the sensing device (i.e. transducer), signal conditioning, attachment methods and calibration procedures.	Condition monitoring and diagnostic	Vibration, measurement, shaft	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	
ISO 13372:2013 Condition monitoring and diagnostics of machines — Vocabulary	terms used in condition monitoring and diagnostics of machines. It is intended to provide users and manufacturers of condition monitoring and diagnostics systems with a common vocabulary.	Condition monitoring and diagnostic	Terminology	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 13373-1:2006 - Condition monitoring and diagnostics of machines - Vibration condition monitoring - Part 1: General procedures	Measurement and data collection functions of machinery vibration for condition monitoring. It is intended to promote consistency of measurement procedures and practices, which usually concentrate on rotating machines. Because of the diversity of approaches to condition monitoring, recommendations specific to a particular kind of monitoring programme will be addressed in additional parts of ISO 13373. This part of ISO 13373 is a basic document which presents recommendations of a general nature, encompassing: measurement methods, measurement parameters, transducer selection, transducer location, transducer attachment, data collection, machine operating conditions, vibration monitoring systems, signal conditioning systems, interfaces with data-	Condition monitoring and diagnostic	Vibration	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
	processing systems, continuous monitoring, and periodic monitoring.				
ISO 13373-2:2016 - Condition monitoring and diagnostics of machines -- Vibration condition monitoring - Part 2: Processing, analysis and presentation of vibration data	general guidelines for the measurement and collection of data on machine vibration, for the purpose of monitoring their state. It is aimed to promote consistency of procedures and measurement practices that usually focus on rotating machines. Given the diversity between the approaches to the monitoring of the conditions, in other parts of the ISO 13373 reference will be made to the specific recommendations in a particular type of monitoring program. The vibrational state of a machine can be monitored using measurements of the vibrations of a bearing or on a support and / or by means of measurements of the vibrations of rotating elements of the machine structure. Measurements may be continuous or discontinuous and normally provides guidance for both measurement methods.	Condition monitoring and diagnostic	Vibration, measurement, shaft	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	
ISO 13373-3:2016 - Condition monitoring and diagnostics of machines -- Vibration condition monitoring - Part 3: Guidelines for vibration diagnosis	Guidelines for general procedures to be considered during the course of diagnosis of the vibrational state of rotating machinery. It is intended to be used by operators, engineers and technicians and provides a practical approach structured to fault diagnosis. In addition, it provides examples of common faults to a wide range of machines. Guidelines for specific machines will be provided in other standards of the ISO 13373 series.	Condition monitoring and diagnostic	Vibration, diagnosis	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	
ISO 13373-7:2017 - Condition monitoring and diagnostics of machines — Vibration condition monitoring — Part 7: Diagnostic techniques for machine sets in hydraulic power generating and pump-storage plants	ISO 13373-7:2017 gives guidelines for specific procedures to be considered when carrying out vibration diagnostics of various types of machine sets in hydraulic power generating and pump-storage plants (hydropower units). It is intended to be used by condition monitoring practitioners, engineers and technicians and provides a practical step-by-step vibration-based approach to fault diagnosis. In addition, it includes a number of examples for a range of machine and component types and their associated fault symptoms.	Condition monitoring and diagnostic	Vibration, hydraulic power generating, pump storage plant	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 13373-9:2017 - Condition monitoring and diagnostics of machines — Vibration condition monitoring — Part 9: Diagnostic techniques for electric motors	ISO 13373-9 specifies procedures to be considered when carrying out vibration diagnostics of various types of electric motors. The four motor types covered by ISO 13373-9 are squirrel-cage induction, wound-rotor induction, salient-pole and DC motors. NOTE The first two types are defined in ISO 20958. ISO 13373-9 is mostly applicable to motors with power above 15 kW. ISO 13373-9 is intended to be used by condition monitoring practitioners, engineers and technicians and provides a practical step-by-step vibration-based approach to fault diagnosis. In addition, it gives a number of examples for a range of machine and component types and their associated fault symptoms. The procedures presented in ISO 13373-9 can, in some cases, be applied to other types of electrical machines, such as generators, but there can be other specific techniques associated with such machines that are not included in ISO 13373-9. The use of non-vibration quantities, such as voltage and current, to identify and analyse vibration-related faults in electric motors is outside the scope of ISO 13373-9.	Condition monitoring and diagnostic	Vibration, Electric motor	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	
ISO 13374-3:2012 - Condition monitoring and diagnostics of machines - Data processing, communication and presentation - Part 3: Communication	The various computer software systems written for condition monitoring and diagnostics (CM&D) of machines that are currently in use cannot easily exchange data or operate in a plug-and-play fashion without an extensive communication infrastructure. The standard specifies requirements for data communication for an open condition monitoring and diagnostics (CM&D) reference information architecture and for a reference processing architecture. Software design professionals require communications to be defined for exchange of CM&D information between software systems. The standard facilitates the interoperability of CM&D systems.	Condition monitoring and diagnostic	Data communication	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 13379-1:2012 - Condition monitoring and diagnostics of machines - Data interpretation and diagnostics techniques - Part 1: General guidelines	General procedures that can be used to determine the condition of a machine relative to a set of baseline parameters. Changes from the baseline values and comparison to alarm criteria are used to indicate anomalous behaviour and to generate alarms: this is usually designated as condition monitoring. Additionally, procedures that identify the cause(s) of the anomalous behaviour are given in order to assist in the determination of the proper corrective action: this is usually designated as diagnostics. This standard gives guidelines for the data interpretation and diagnostics of machines. It is intended to — allow the users and manufacturers of condition monitoring and diagnostics systems to share common concepts in the fields of machine diagnostics; — enable users to prepare the necessary technical characteristics that are used for the further diagnosis of the condition of the machine; — give an appropriate approach to achieve a diagnosis of machine faults. Machine sets covered by this standard include industrial machines such as turbines, compressors, pumps, generators, electrical motors, blowers, gearboxes, and fans.	Condition monitoring and diagnostic	Data analysis, diagnosis	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 13379-2:2015- Condition monitoring and diagnostics of machines - Data interpretation and diagnostics techniques - Part 2: Data-driven applications	Procedures to implement data-driven monitoring and diagnostic methods to facilitate the work of analysis carried out by specialist staff of a monitoring centre.	Condition monitoring and diagnostic	Data analysis, diagnosis	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 13381-1:2016 - Condition monitoring and diagnostics of machines - Prognostics - Part 1: General guidelines	Guidance for the development and application of prognosis processes. It is intended to: allow the developers, providers, users and manufacturers to share common concepts of prognostics; enable users to determine the data, characteristics, processes and behaviours necessary for accurate prognosis; outline appropriate approaches and processes to prognostics development; introduce prognostics concepts in order to facilitate future systems and training. The prognosis, which requires estimates of future conditions of the machine, not a strictly mathematical process, but requires a statistical approach and witnesses. It is divided into the following phases: identification of problems (deviations from normal conditions); diagnosis of faults and their causes; prognosis of the future evolution of the defect; recommendations and actions; post-mortem analysis. For this legislation on the prognosis of the health status of the machine	Condition monitoring and diagnostic	Prognostics	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
	provides for the definition of guidelines, approaches and concepts rather than having standardized procedures and methodologies.				
ISO 18434-1:2011 - Condition monitoring and diagnostics of machines - Thermography - Part 1: General procedures	Application of infrared thermography (IRT) to machinery condition monitoring and diagnostics, where "machinery" includes machine auxiliaries such as valves, fluid and electrically powered machines, and machinery-related heat exchanger equipment. In addition, IR applications pertaining to machinery performance assessment are addressed. It introduces the terminology of IRT as it pertains to condition monitoring and diagnostics of machines; describes the types of IRT procedures and their merits; provides guidance on establishing severity assessment criteria for anomalies identified by IRT; outlines methods and requirements for carrying out IRT of machines, including safety recommendations; provides information on data interpretation, and assessment criteria and reporting requirements; provides procedures for determining and compensating for reflected apparent temperature, emissivity, and attenuating media. ISO 18434-1:2008 also encompasses testing procedures for determining and compensating for reflected apparent temperature, emissivity, and attenuating media when measuring the surface temperature of a target with a quantitative IRT camera.	Condition monitoring and diagnostic	Methodology, termography	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 19283:2020 - Condition monitoring and diagnostics of machines — Hydroelectric generating units	This document focuses on recommended condition monitoring techniques for detecting and diagnosing developing machine faults associated with the most common potential failure modes for hydro unit components. It is intended to improve the reliability of implementing an effective condition monitoring approach for hydroelectric generating units (hydro units). It is also intended to help create a mutual understanding of the criteria for successful hydro unit condition monitoring and to foster cooperation between the various hydropower stakeholders. This document is intended for end-users, contractors, consultants, service providers, machine manufacturers and instrument suppliers. This document is machine-specific and is focused on the generator, shaft/bearing assembly, runner (and impeller for pumped storage applications), penstock (including the main inlet valve), spiral case and the upper draft tube of hydro units. It is primarily intended for medium to large sized hydro units with more than 50 MVA installed capacity, but it is equally valid for smaller units in many cases. It is applicable to various types of turbines such as Francis, Kaplan, Pelton, Bulb and other types. Generic auxiliary systems such as for lubrication and cooling are outside the scope, with the exception of some monitoring techniques that are related to condition monitoring of major systems covered by this document, such as oil analysis. Transmission systems, civil works and the foundation are outside the scope. This document covers online (permanently installed) and portable instrument condition monitoring and diagnostic techniques for operational hydro units. Offline machine testing, i.e. that which is only done during shutdown, although very important, is not part of the scope of this document. Nor is one-time acceptance and performance testing within the scope. The condition monitoring techniques presented in this document cover a wide range of continuous and interval-based monitoring techniques under generalized conditions for a wide range of applications. Therefore, the actual monitoring approach required for a specific application can be different than that which is recommended in this generalized document.	Condition monitoring and diagnostic	Hydroelectric units	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 20958:2013 - Condition monitoring and diagnostics of machine systems — Electrical signature analysis of three-phase induction motors	Guidelines for the online techniques recommended for the purposes of condition monitoring and diagnostics of machines, based on electrical signature analysis. ISO 20958:2013 is applicable to three-phase induction motors.	Condition monitoring and diagnostic	Induction motors	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 22096:2011 - Condition monitoring and diagnostics of machines - Acoustic emission	It specifies the general principles required for the application of acoustic emission to condition monitoring and diagnostics of machinery operating under a range of conditions and environments. It is applicable to all machinery and associated components and covers structure-borne measurements only.	Condition monitoring and diagnostic	Acoustic emission	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 29821-1:2011 - Condition monitoring and diagnostics of machines - Ultrasound - Part 1: General guidelines	Methods and requirements for carrying out condition monitoring and diagnostics of machines using airborne and structure-borne ultrasound. It provides measurement, data interpretation, and assessment criteria. This technique is typically carried out on operating machinery under a range of conditions and environments. This is a passive technique that detects acoustic anomalies produced by machines	Condition monitoring and diagnostic	Methodology, ultrasound	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 10816-3:2018 - Mechanical vibration -- Evaluation of machine vibration by measurements on non-rotating parts -- Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15 000 r/min when measured in situ	ISO 10816-3:2009 gives criteria for assessing vibration measurements when made in situ. The criteria specified apply to machine sets having a power above 15 kW and operating speeds between 120 r/min and 15 000 r/min.	Mechanical vibration	Measurement	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	
ISO 10816-6:2015 - Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts - Part 6: Reciprocating machines with power ratings above 100 kW	The standard provides criteria for measuring vibration in reciprocating machines with power greater than 100 kW.	Mechanical vibration	Measurement	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 10816-7:2009 - Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 7: Rotodynamic pumps for industrial applications, including measurements on rotating shafts	ISO 10816-7:2009 gives instructions for the evaluation of vibration on rotodynamic pumps for industrial applications with nominal power above 1 kW. It defines the special requirements for evaluation of vibration when the vibration measurements are made on non-rotating parts (bearing housing vibration).	Mechanical vibration	Measurement	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 18312-1:2012 - Mechanical vibration and shock — Measurement of vibration power flow from machines into connected support structures — Part 1: Direct method	This part of ISO 18312 specifies a method for evaluating the vibration power emitted by machines or pipelines, referred to hereinafter as machines, under operational conditions on to supporting structures to which the machines are directly connected via bolted joints. This part of ISO 18312 specifies the method for evaluating the vibration power components emitted in the six degrees of freedom of a Cartesian coordinate system at each joint, i.e. three translations and three rotations. The vibration power is determined by processing the signals from force and velocity (or acceleration) transducers mounted on to the bolted joints under operational conditions of interest. This method is applicable for machines under the assumption that their vibration can be characterized by a stationary random process. The components of emitted vibration power in the frequency domain are obtained by computing the cross-spectrum of the force and velocity measurement pairs with a given narrow band width at each bolted joint. This direct method assumes that the supporting structures are adequately rigid and, hence, it is not applicable to cases where the foundation or supporting structures are resilient, which will potentially go into a state of resonance within the frequency range of interest. Practical frequency limits of the method are specified in this part of ISO 18312. This part of ISO 18312 can be used in operational conditions for: a) specification of vibration power emission of machines at the (bolted) joints; b) identification of vibration power severity; c) resolving diagnostics issues; d) planning vibration control measures.	Mechanical vibration	Measurement	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 18312-2:2012 - Mechanical vibration and shock — Measurement of vibration power flow from machines into connected support structures — Part 1: Indirect method	This part of ISO 18312 specifies a method for evaluating the vibration power emitted by machines or pipelines (referred to hereinafter as machines) on to supporting structures to which the machines are connected through vibration isolators. This part of ISO 18312 also specifies the method for evaluating the vibration power components emitted in the six degrees of freedom of a Cartesian coordinate system at each joint, i.e. three translations and three rotations. The vibration power is determined by processing the signals from two sets of velocity (or acceleration) transducers mounted at the isolator connection points, one set on the machine side (input) and the other on the foundation side (output). This method is applicable for machines under the assumption that their vibration can be characterized by a stationary random process. The components of emitted vibration power are computed using the cross-spectra of the two sets of velocity in narrow band (or one third-octave) and the dynamic stiffness characteristics of the isolator over the frequency range of interest. The upper frequency limits of this method are established in this part of ISO 18312. This part of ISO 18312 can be used for: a) evaluating a machinery system from isolator design concept; b) obtaining data for preparation of technical requirements for allowable machine vibration power emission; c) determining appropriate and cost-effective vibration control procedures; d) solving diagnostics issues.	Mechanical vibration	Measurement	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	
ISO 18431-1:2016 - Mechanical vibration and shock - Signal processing - Part 1: General introduction	The Standard defines the mathematical transformations, including the physical units, that convert each category of vibration and shock data into a form that is suitable for quantitative comparison between experiments and for quantitative specifications. It is applicable to the analysis of vibration that is deterministic or random, and transient or continuous signals. Extreme care is to be exercised to identify correctly the type of signal being analysed in order to use the correct transformation and units, especially with the frequency domain analysis. The data may be obtained experimentally from measurements of a mechanical structure or obtained from numerical simulation of a mechanical structure. This category of data is very broad because there is a wide variety of mechanical structures, for example, microscopic instruments, musical instruments, automobiles, manufacturing machines, buildings and civil structures. The data can determine the response of machines or of humans to mechanical vibration and shock.	Mechanical vibration	Measurement	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 18431-2:2004 - Mechanical vibration and shock — Signal processing — Part 2: Time domain windows for Fourier Transform analysis	ISO 18431-2:2004 specifies the algebraic functions which describe a selected set of time domain windows used for pre-processing digitally sampled vibration and shock data as a precursor to Discrete Fourier Transform spectral analysis. This selected set consists of Hanning, flat-top and rectangular time windows.	Mechanical vibration	Fourier transform analysis	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	
ISO 18431-3:2014 - Mechanical vibration and shock — Signal processing — Part 3: Methods of time-frequency analysis	ISO 18431-3:2014 specifies methods for the digital calculation of a time-frequency analysis of a given sampled measurement of a physical or engineering quantity, such as acceleration, force, or displacement, over an interval of time. Several mathematical formulations of time-frequency transformations are given with requirements for recording of parameters and recommendations.	Mechanical vibration	Time frequency analysis	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	
ISO 18431-4:2007 - Mechanical vibration and shock — Signal processing — Part 4: Shock-response spectrum analysis	ISO 18431-4:2006 specifies methods for the digital calculation of a shock-response spectrum (SRS) given an acceleration input, by means of digital filters. The filter coefficients for different types of shock-response spectra are given together with recommendations for adequate sampling frequency.	Mechanical vibration	Shock response spectrum analysis	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	
ISO 2041:2018 - Mechanical vibration, shock and condition monitoring — Vocabulary	This document defines terms and expressions unique to the areas of mechanical vibration, shock and condition monitoring.	Mechanical vibration	Terminology	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	
ISO 20816-1:2017 - Mechanical vibration - Measurement and evaluation of machine vibration - Part 1: General guidelines	This document establishes general conditions and procedures for the measurement and evaluation of vibration using measurements made on rotating, non-rotating and non-reciprocating parts of complete machines. It is applicable to measurements of both absolute and relative radial shaft vibration with regard to the monitoring of radial clearances, but excludes axial shaft vibration. The general evaluation criteria, which are presented in terms of both vibration magnitude and change of vibration, relate to both operational monitoring and acceptance testing. They have been provided primarily with regard to securing reliable, safe, long-term operation of the machine while minimizing adverse effects on associated equipment. Guidelines are also presented for setting operational limits. This document does not include consideration of torsional vibration.	Mechanical vibration	Measurement	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 20816-9:2020 - Mechanical vibration — Measurement and evaluation of machine vibration — Part 9: Gear units	requirements for determining and classifying mechanical vibration of individually housed, enclosed, speed increasing or speed reducing gear units. It specifies methods for measuring housing and shaft vibrations, and the types of instrumentation, measurement methods and testing procedures for determining vibration magnitudes. Vibration grades for acceptance are included.Torsional vibration measurements are outside the scope of this document. It applies to a gear unit operating within its design speed, load, temperature and lubrication range for acceptance testing at the manufacturer's facility. By agreement between manufacturer and customer and/or operator, it can be used for guidelines for on-site acceptance testing and for routine operational measurements. This document applies to gear units of nominal power rating from 10 kW to 100 MW and nominal rotational speeds between 30 r/min and 12 000 r/min (0,5 Hz to 200 Hz). This document does not apply to special or auxiliary drive trains, such as integrated gear-driven compressors, pumps, turbines, etc., or gear type clutches used on combined-cycle turbo generators and power take-off gears. The evaluation criteria provided in this document can be applied to the vibration of the main input and output bearings of the gearbox and to the vibration of internal shaft bearings. They can have limited application to the evaluation of the condition of those gears. Specialist techniques for evaluating the condition of gears are outside the scope of this document. This document establishes provisions under normal steady-state operating conditions for evaluating the severity of the following in-situ broad-band vibration: a) structural vibration at all main bearing housings or pedestals measured radially (i.e. transverse) to the shaft axis; b) structural vibration at thrust bearing housings measured in the axial direction; c) vibration of rotating shafts radially (i.e. transverse) to the shaft axis at, or close to, the main bearings; d) structural vibration on the gear casing. NOTE Vibration occurring during non-steady-state conditions (when transient changes are taking place), including run up or run down, initial loading and load changes are outside the scope of this document.	Refurbishment	Gears	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 20816-5:2018 - Mechanical vibration — Measurement and evaluation of machine vibration — Part 5: Machine sets in hydraulic power generating and pump-storage plants	This document provides guidelines for evaluating the vibration measurements made at the bearings, bearing pedestals or bearing housings and also for evaluating relative shaft vibration measurements made on machine sets in hydraulic power generating and pump-storage plants when the machine is operating within its normal operating range. The normal operating ranges for each type of turbine covered by this document are defined in Annex A. This document is applicable to machine sets in hydraulic power generating plants and in pump-storage plants with typical rotational speeds of 60 r/min to 1 000 r/min fitted with shell or pad (shoe) type oil-lubricated bearings. NOTE The current database includes machine speeds ranging from 60 r/min to 750 r/min (with a very small sample of 1 000 r/min machines). This document defines different limit values of bearing housing and shaft vibration depending on the type of turbine, the orientation of the shaft (i.e. horizontal or vertical) and for each of the bearing locations. This document is based on statistical analysis and provides criteria for the most common types of turbines, pump-turbines and pumps. For specific information on which types of units are covered in this document, see Annex A. Machine sets covered by this document can have the following configurations: a) generators driven by hydraulic turbines; b) motor-generators driven by pump-turbines; c) motor-generators driven by hydraulic turbines and separate pumps; d) pumps driven by electric motors. This document is not applicable to the following unit configurations, parameters and operating conditions: hydraulic machines with water-lubricated bearings; hydraulic machines or machine sets having rolling element bearings (for these machines, see IEC 62006 and/or ISO 10816-3); pumps in thermal power plants or industrial installations (for these machines, see ISO 10816-7); electrical machines operating as motors except for the use of these machines in pump-storage applications; hydro generators operating as synchronous condensers (with the water in the turbine depressed by compressed air); assessment of absolute bearing housing vibration displacement; assessment	Remanufacturing	Hydropower units	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
	of axial vibration; assessment of transient conditions; non-synchronous operation; assessment of vibration of the generator stator core or the stator frame level. Measurements made of the bearing housing vibration and shaft vibration occurring in machine sets in hydraulic power generating and pump-storage plants can be used for the following purposes: 1) Purpose A: to prevent damage arising from excessive vibration magnitudes; 2) Purpose B: to monitor changes in vibrational behaviour in order to allow diagnosis and/or prognosis. The criteria are applicable for the vibration produced by the machine set itself. Special investigation is needed for vibration transmitted to the machine set from external sources, e.g. transmitted to the machine via the station foundations.				
ISO 16269-8:2019 - Statistical interpretation of data - Part 8: Determination of prediction intervals	This part of ISO 16269 specifies methods of determining prediction intervals for a single continuously distributed variable. These are ranges of values of the variable, derived from a random sample of size n, for which a prediction relating to a further randomly selected sample of size m from the same population may be made with a specified confidence.	Statistical method	Data analytics	ISO/TC 69/SC 4 - Applications of statistical methods in product and process management	
ISO 22514-1:2014 - Statistical methods in process management -- Capability and performance General principles and concepts	ISO 2514-1:2014 describes the fundamental principles of capability and performance of manufacturing processes. It has been prepared to provide guidance about circumstances where a capability study is demanded or necessary to determine if the output from a manufacturing process or the production equipment (a production machine) is acceptable according to appropriate criteria. Such circumstances are common in quality control when the purpose for the study is part of some kind of production acceptance. These studies can also be used when diagnosis is required concerning a production output or as part of a problem solving effort. The methods are very versatile and have been applied for many situations. ISO 2514-1:2014 is applicable to the following: organizations seeking confidence that their product characteristics requirements are fulfilled; organizations seeking confidence from their suppliers that their product specifications are and will be satisfied; those internal or external to the organization who audit it for conformity with the product requirements; and those internal to the organization who deal with analysing and evaluating the existing production situation to identify areas for process improvement.	Statistical method	Data analytics		

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 22514-2:2018 - Statistical methods in process management -- Capability and performance - Part 2: Process capability and performance of time-dependent process models	This document describes a procedure for the determination of statistics for estimating the quality capability or performance of product and process characteristics. The process results of these quality characteristics are categorized into eight possible distribution types. Calculation formulae for the statistical measures are placed with every distribution. The statistical methods described in this document only relate to continuous quality characteristics. They are applicable to processes in any industrial or economical sector.	Statistical method	Data analytics	ISO/TC 69/SC 4 - Applications of statistical methods in product and process management	
ISO 22514-3:2010 - Statistical methods in process management - Capability and performance - Part 3: Machine performance studies for measured data on discrete parts	This part of ISO 22514 prescribes the steps to be taken in conducting short- term performance studies that are typically performed on machines where parts produced consecutively under repeatability conditions are considered. The number of observations to be analysed will vary according to the patterns the data produce, or if the runs (the rate at which items are produced) on the machine are low in quantity.	Statistical method	Data analytics	ISO/TC 69/SC 4 - Applications of statistical methods in product and process management	
ISO 22514-4:2018 - Statistical methods in process management - Capability and performance - Part 4: Process capability estimates and performance measures	This part of ISO 22514 describes process capability and performance measures that are commonly used.	Statistical method	Data analytics	ISO/TC 69/SC 4 - Applications of statistical methods in product and process management	
ISO 22514-6:2013 - Statistical methods in process management -- Capability and performance Process capability statistics for characteristics following a multivariate normal distribution	ISO 22514-6:2013 provides methods for calculating performance and capability statistics for process or product quantities where it is necessary or beneficial to consider a family of singular quantities in relation to each other. The methods provided here mostly are designed to describe quantities that follow a bivariate normal distribution. In principle, this part of ISO 22514 can be used for multivariate cases. ISO 22514-6:2013 does not offer an evaluation of the different provided methods with respect to different situations of possible application of each method. For the current state, the selection of one preferable method might be done following the users preferences. The purpose is to give definitions for different approaches of index calculation for performance and capability in the case of a multiple process or product quantity description.	Statistical method	Data analytics	ISO/TC 69/SC 4 - Applications of statistical methods in product and process management	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 22514-7:2012 - Statistical methods in process management — Capability and performance — Part 7: Capability of measurement processes	ISO 22514-7:2012 defines a procedure to validate measuring systems and a measurement process in order to state whether a given measurement process can satisfy the requirements for a specific measurement task with a recommendation of acceptance criteria. The acceptance criteria are defined as a capability figure or a capability ratio.	Statistical method	Data analytics	ISO/TC 69/SC 4 - Applications of statistical methods in product and process management	
ISO 22514-8:2014 - Statistical methods in process management -- Capability and performance Machine performance of a multi-state production process	ISO 22514-8:2014 aims to define the evaluation method to quantify the short-term capability of a production process (capacity of the production tool, widely termed capability), i.e. the machine performance index, to ensure compliance to a toleranced measurable product characteristic, when said process does not feature any kind of sorting system. If the production process integrates a sorting system, then this one (clearing away nonconforming parts) should be analysed independently. ISO 22514-8:2014 does not aim to define evaluation methods of the capability of a production process that is gauged through long-term observation (capability process or performance process indices). ISO 22514-8:2014 defines the principles guiding the development of indicators for quantifying capability, and the statistical methods to be employed. The characteristics used to evaluate production process capability have statistical distributions, and it is presumed, a priori, that at least one of these distributions is multi-modal. A distribution is presumed to be multimodal if it results from the marked effect of at least one cause inducing a significant difference between the produced items. ISO 22514-8:2014 applies, for example, to characteristics generated by processes such as the following: multi-cavity casting, multi-fixture machining, batch load treatments. Each cavity, fixture, or position in the batch load corresponds to a different state. The multi-state process can be understood as the result of the combination of different states within the same process (e.g. cavity, fixture, position in the batch load).	Statistical method	Data analytics	ISO/TC 69/SC 4 - Applications of statistical methods in product and process management	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO/TR 18532:2010 - Guidance on the application of statistical methods to quality and to industrial standardization	This Technical Report describes a broad range of statistical methods applicable to the management, control and improvement of processes. This Technical Report demonstrates the advantages in the application of statistical methods in as simple and efficient a manner as possible so that they become accessible to the many rather than to the few. As an introduction to the subject, three examples are given in Clause 4 to focus attention on some of the wider questions at issue. These examples suggest how statistical thinking coupled with the use of simple statistical tools and technical and operational knowledge of the process can help in improving designs, process efficiency and performance and product conformity to specification.	Statistical method	Data analytics	ISO/TC 69/SC 4 - Applications of statistical methods in product and process management	

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KEY AREA: MACHINE PROFILING INDEX

The present key area refers to information and specifications for the industrial machines under examination (e.g. machinery specifications/ functionalities/ performance/ capacity, production history and maintenance data, estimated future changes in the production demand and machinery usage).

The following standardisation technical committees have been identified as relevant for this RECLAIM service (Tab 3). They provide knowledge to assess main condition monitoring and mechanical vibration parameters, methodologies, testing methods and process that influence machinery performance.
Specific attention has been provided to safety specification in coherence with their influence on performance and maintenance. Safety technical specification has been analysied both at sectoral and horizontal level (e.g. Directive 2006/42/EC): it will facilitate compliance of RECLAIM solution with existing Regulations.
List of relevant standards elaborated by those TCs are provided in Table 4.

Table 3 MACHINE PROFILING INDEX: list of relevant CEN and ISO Technical Committes (TCs)

ISO AND CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/TC 72/SC 8 - Safety requirements for textile machinery[9]	ISO/TC 72/SC 8/WG 1 Safety requirements for textile machinery
ISO/TC 39/SC 4 - Woodworking machines[10]	ISO/TC 39/SC 4/WG 3 Nomenclature and acceptance conditions
ISO/TC 299 Robotics[11] Standardization in the field of robotics, excluding toys and military applications	ISO/TC 299/SG 1 Study group on gaps and structure ISO/TC 299/WG 1 Vocabulary and characteristics ISO/TC 299/WG 2 Service robot safety ISO/TC 299/WG 3 Industrial safety ISO/TC 299/WG 4 Service robot performance ISO/TC 299/WG 6 Modularity for service robots
ISO/TC 216 Footwear Standardization of test methods, terminology and performance requirements for components for footwear; test methods and terminology for whole shoe. Excluded: footwear for professional use (already covered by ISO / TC 94) and sizing system designation and marking for boots and shoes (dealt with by ISO / TC 137).	ISO/TC 216/WG 1 Minimum performance requirements and test methods for components for footwear
ISO/TC 199 - Safety of machinery[12] Standardization of basic concepts and general principles for safety of machinery incorporating terminology, methodology, guards and safety devices within the framework of ISO / IEC Guide 51 and in cooperation with other ISO and IEC technical committees. Excluded: product safety standards, as defined in ISO / IEC Guide 51, and which are explicitly covered by the work of other ISO or IEC technical committees.	ISO/TC 199/WG 3 - Safety of integrated manufacturing systems ISO/TC 199/WG 5 - General principles for the design of machinery and risk assessment ISO/TC 199/WG 6 - Safety distances and ergonomic aspects ISO/TC 199/WG 8 - Safe Control Systems ISO/TC 199/WG 11 - Permanent means of access to machinery ISO/TC 199/WG 12 - Human-machine-interaction
ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems Standardization of the procedures, processes and equipment requirements uniquely related to the technical activity of condition monitoring and diagnostics of machines systems in which selected physical parameters associated with an operating machine system are periodically or continuously sensed, measured and recorded for the interim purpose of reducing, analyzing, comparing and displaying the data and information so obtained and for the ultimate purpose of using this	ISO/TC 108/SC 5/WG 4 Tribology-based monitoring and diagnostics ISO/TC 108/SC 5/WG 11 Thermal imaging ISO/TC 108/SC 5/WG 17 Condition monitoring and diagnostics applications ISO/TC 108/SC 5/WG 18 Condition monitoring management

[9] https://www.iso.org/committee/50022.html
[10] https://www.iso.org/committee/48390.html
[11] https://www.iso.org/committee/5915511.html
[12] https://www.iso.org/committee/54604.html

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ISO AND CEN TECHNICAL COMMITTEE	RELEVANT WG
interim result to support decisions related to the operation and maintenance of the machine system.	
ISO/TC 108 - Mechanical vibration, shock and condition monitoring[13] Standardization in the fields of mechanical vibration and shock and the effects of vibration and shock on humans, machines, vehicles (air, sea, land and rail) and stationary structures, and of the condition monitoring of machines and structures, using multidisciplinary approaches. Specific areas of current interest include the standardization of: • terminology and nomenclature in the fields of mechanical vibration, mechanical shock and condition monitoring; • measurement, analysis and evaluation of vibration and shock e.g. signal processing methods, structural dynamics analysis methods, transducer and vibration generator calibration methods, etc.; • active and passive control methods for vibration and shock, e.g. balancing of machines, isolation and damping; • evaluation of the effects of vibration and shock on humans, machines, vehicles (air, sea, land and rail), stationary structures and sensitive equipment; • vibration and shock measuring instrumentation, e.g. transducers, vibration generators, signal conditioners, signal analysis instrumentation and signal acquisition systems; • measurement methods, instrumentation, data acquisition, processing, presentation, analysis, diagnostics and prognostics, using all measurement variables required for the condition monitoring of machines; • training and certification of personnel in relevant areas.	
ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	ISO/TC 108/SC 2/WG 1 - Rotordynamics and vibration of machines ISO/TC 108/SC 2/WG 7 - Vibration of machines with active magnetic bearings ISO/TC 108/SC 2/WG 10 - Basic techniques for vibration diagnostics
CLC/TC 44X - Safety of machinery: electrotechnical aspects[14] To prepare harmonized standards primarily relating to electrical and electronic equipment and systems of machines (including a group of machines working together in a co-ordinated manner excluding higher-level systems aspects) not portable by hand while working but which may include mobile equipment. The equipment covered commences at the point of connection of the electrical supply to the machine. To prepare harmonized standards for safety related equipment, using electrotechnology, intended to be used to satisfy the essential safety requirements of the Council of the European Communities directives covering safety of machinery that is outside the scope of any other Technical Committee. To co-ordinate with CEN, all matters concerning the safety of machinery. To advise the Technical Board (BT) on all matters concerning machine	
CEN TC 114 - Safety of machinery The standardization of general principles for safety of machinery incorporating terminology and methodology. It elaborates EU Standards on safety of machinery which presumed to comply with the essential health and safety requirements of the Machinery Directive (2006/42/EC) covered by these documents;	Working Group 1 'Basic concepts' Working Group 2 'Safety distances' – Working Group 3 'Terminology Working Group 6 'Safe control systems' (jointly with CENELEC/TC 44X) Working Group 7 'Two-hand controls' (jointly with CENELEC/TC 44X) Working Group 8 'Pressure-sensitive mats and similar devices' (jointly with CENELEC/TC 44X) Working Group 13 'Radiation' – Working Group 14 'Risk assessment'

[13] https://www.iso.org/committee/51402.html
[14] https://www.cenelec.eu/dyn/www/f?p=104:7:1435672943448901::::FSP_ORG_ID,FSP_LANG_ID:1257239,25

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ISO AND CEN TECHNICAL COMMITTEE	RELEVANT WG
	Working Group 17 'Permanent access to machines and industrial plant'
CEN/TC 231 - Mechanical vibration and shock Standardization in the field of mechanical vibration and shock, including: - methods for measuring and evaluating mechanical vibration and shock; - methods for assessing human exposure to mechanical vibration and shock in any kind of environment; - description of the effects caused by human exposure to mechanical vibration and shock and guidelines for the reduction of these effects; - methods for evaluating the effects of mechanical vibration and shock on structures; - methods for reducing by machine design, risks resulting from exposure to mechanical vibration and shock; - methods for measuring and assessing the vibration and shock reduction characteristics of personal protective equipment (e.g. antivibration gloves), vibration isolators (e.g. resilient materials) and suspension systems (e.g. seats).[15]	
CEN TC 122 - Ergonomics[16] Standardisation in the field of ergonomics principles and requirements for the design of work systems and work environments, including machinery and personal protective equipment, to promote the health, safety and well-being of the human operator and the effectiveness of the work systems.	CEN/TC 122/WG 1Anthropometry CEN/TC 122/WG 11Ergonomics of the Physical Environment CEN/TC 122/WG 2Ergonomic design principles CEN/TC 122/WG 4Biomechanics CEN/TC 122/WG 5Ergonomics of human-system interaction
CEN/TC 142 - Woodworking machines - Safety[17] Standardization of design and manufacture in the field of safety of machines and tools for the processing of wood and similar materials, destined for processing by the machines and tools, taking account of the European Machinery Directive, and of the purpose for which the machine is intended for use. By extension it also applies to facilities and equipment for conditioning of wood. Similar materials are wood materials (chip board, fibre board, plywood etc) cork, cane, shell, amber, ivory, horn and wood substitutes. Conditioning means e.g. drying, steaming, impregnation	CEN/TC 142/WG 10Chip and dust extraction systems CEN/TC 142/WG 13Common requirements and safety of integrated fed machines CEN/TC 142/WG 8Tooling
CEN/TC 214 - Textile machinery and accessories[18] Standardization in the fields of safety of : - machinery used to transform natural and man-made fibres into textile products; - machinery used for industrial laundering (including ironing) and dry-cleaning.	CEN/TC 214/WG 1Safety requirements for textile machinery CEN/TC 214/WG 3Safety requirements for industrial laundering machinery CEN/TC 214/WG 4 Measurement and reduction of noise CEN/TC 214/WG 5Eco Design ENER Lot 24 Performance Measurement of Washing Machines and Dryer for industrial use
CEN/TC 310 - Advanced automation technologies and their applications[19] Standardization in the field of automation systems and technologies and their application and integration to ensure the availability of the standards required by industry for design, sourcing, manufacturing and delivery, support, maintenance and disposal of products and their associated services. Areas of standardisation may include enterprise modelling and system architecture, information and its supporting systems, robotics for fixed and mobile robots in industrial and specific non-industrial environments, automation and control equipment and software, human and mechanical aspects, integration technologies and system operational aspects. These standards may utilise other standards and technologies beyond the scope of TC310, such as machines, equipment, information technologies, multi-media capabilities, and multi-modal communications networks.	CEN/TC 310/WG 1 Systems architecture

[15] https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6212&cs=13A9546A646E08E594E6C9F4A458361D3
[16] https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6104&cs=17B26A46FEC153FA622114FF1C49C7C75
[17] https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6124&cs=1E9AAF9196118A76789531EEA7F1CE01C
[18] https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6195&cs=1F4D8779741FDF9A2847B8E761E072AF5
[19] https://standards.cen.eu/dyn/www/f?p=204:29:0::::FSP_ORG_ID,FSP_LANG_ID:6291,25&cs=177A62E5D6166A215A3F2386765AA214E#1

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Table 4 MACHINE PROFILING INDEX: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 19085-13:2020 - Woodworking machines -- Safety Multi-blade rip sawing machines with manual loading and/or unloading	This document gives the safety requirements and measures for stationary multi-blade rip sawing machines manually loaded and/or unloaded, hereinafter referred to as "machines", designed to cut solid wood and material with similar physical characteristics to wood. It deals with all significant hazards, hazardous situations and events as listed in Clause 4 relevant to machines, when operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse. Also, transport, assembly, dismantling, disabling and scrapping phases are taken into account. NOTE For relevant but not significant hazards, e.g. sharp edges of the machine frame, see ISO 12100:2010. This document does not deal with specific hazards related to the combination of single machines with any other machine as part of a line. It is not applicable to machines: — with all saw blades spindles mounted below the workpiece support/level only; — intended for use in potentially explosive atmosphere; — manufactured prior to its publication.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety
EN 12044:2010 - Footwear, leather and imitation leather goods manufacturing machines - Cutting and punching machines - Safety requirements	This European Standard is applicable to shoe and leather presses used in the manufacture of footwear, leather and imitation leather goods and other related components. These machines are: Sole attaching presses (open and closed types); Sole and insole moulding machines; Back part moulding machines; Backer, lining and toe puff attaching presses; Ironing presses; Marking, stamping, labelling and embossing machines; Stitch marking machines; Upper preforming machines; Automatic shoe and leather presses; Premoulding machines for thermoplastic counters and counter forming machines; Integrated manufacturing systems; Presses with mobile stations and rotary configuration; Folding presses; Activating presses; Relasting and last slipping machines; Top piece attaching presses; Leather button covering machines. Cutting and punching machines; Eyelet, hook and decorative nail attaching machines; Presses used for shoe repair and orthopaedic works	Footwear industry	Safety	ISO/TC 216 Footwear	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN 1218-1:2009 - Safety of woodworking machines - Tenoning machines - Part 1: Single end tenoning machines with sliding table	This document specifies all the significant hazards, hazardous situations and events as listed in Clause 4 which are relevant to single end tenoning machines with sliding table, hereinafter referred to as "machines", designed to cut solid wood, chipboard, fibreboard, plywood and also these materials where they are covered with plastic laminate or edgings. This standard does not apply to: a) machines where the tenon is produced only by means of saw blades; b) machines where the design speed of any tool spindle exceeds 6000 min-1; c) machines where the average sliding table feed speed in either direction exceeds 25 m min-1 + 5%; d) combined machines used for tenoning (see EN 940:1997); e) tenoning attachments on a vertical spindle moulding machine (see EN 848-1:2007). NOTE Single and double end tenoning machines fed by chain or chains are dealt with in EN 1218-2. Single end tenoning machines where the tenon is produced only by means of saw blades are dealt with in EN 1218-3. This European Standard is primarily applicable to machines which are manufactured after the date of issue of his standard.	Woodworking machine	Safety		CEN/TC 142 - Woodworking machines - Safety
EN 1218-2:2009 - Safety of woodworking machines - Tenoning machines - Part 2: Double end tenoning and/or profiling machines fed by chain or chain	This document deals with all the significant hazards, hazardous situations and events as listed in Clause 4 which are relevant to double end tenoning and/or profiling machines fed by chain or chains, hereinafter referred to as the machine, designed to cut solid wood, chipboard, fibreboard or plywood and also these materials where they are covered with plastic laminate or edgings. The workpiece is fed passed the tools by an integrated feed. This document does not apply to: a) double end tenoning and/or profiling machines fed by chain or chains with a complete enclosure as defined in 3.3.11; b) transportable machines. This document does not deal with any hazards relating to: c) mechanical loading of the workpiece to a single machine; or d) single machine being used in combination with any other machine (as part of a line); or e) use of tools working between the machine halves (see 3.1); or f) use of laser. For Computer Numerically Controlled (CNC) machines this document does not cover hazards related to Electro-Magnetic Compatibility (EMC). NOTE 1 The requirements of this document apply to all machines whatever their method of control e.g. electromechanical and/or electronic. This document is primarily directed to machines which are manufactured after the date of publication by CEN. NOTE 2 Single end tenoning machines with sliding table are dealt with in EN 1218-1:1999. Single end tenoning machines where the tenon is produced only by means of saw blades are dealt with in EN 1218-3. Single end profiling machines fed by chain or chains are dealt with in EN 1218-5.	Woodworking machine	Safety		CEN/TC 142 - Woodworking machines - Safety

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN 1218-5:2010 - Safety of woodworking machines - Tenoning machines - Part 5: One side profiling machines with fixed table and feed rollers or feed chain	This document specifies all significant hazards, hazardous situations and events as listed in Clause 4 which are relevant to one side profiling machines with fixed table and feed rollers or feed chain hereinafter referred to as "machines", where the loading and unloading is manual and where the maximum work-piece height capacity is 200 mm. The machine is designed to process in one pass one side of solid wood, chip board, fibreboard or plywood and also these materials where they are covered with plastic laminate. The work-piece is fed through the processing units by an integrated feed consisting of rollers or a chain. This document does not apply to transportable machines. This document does not deal with any hazards relating to: a) mechanical loading and/ or unloading of the work-piece; or b) a machine being used in combination with any other machine (as part of a line); or c) use of laser. For Computer Numerically Controlled (CNC) machines this document does not cover hazards related to Electro-Magnetic Compatibility (EMC). NOTE 1 The requirements of this document apply to all machines whatever their method of control e.g. electromechanical and/or electronic. This document is primarily directed to machines which are manufactured after the date of publication by CEN. NOTE 2 Single end tenoning machines with sliding table are dealt with in EN 1218-1:1999. Double end tenoning and/or profiling machines fed by chain or chains are dealt with in EN 1218-2. Single end tenoning machines where the tenon is produced only by means of saw-blades are dealt with in EN 1218-3.	Woodworking machine	Safety		CEN/TC 142 - Woodworking machines - Safety
EN 12387:2010 - Footwear, leather and imitation leather goods manufacturing machines - Noise test code - Common requirements	Tent applies to the following machines including their additional equipment intended for the repair of footwear, leather and imitation leather goods as well as for the manufacture and repair of orthopaedic shoes hereafter called "Shoe Repair Machines": Polishing machines; Trimming machines; Scouring machines; Finishing machines; Orthopaedic finishing machines; Heel and sole press; Activating unit - Adhesive; Orthopaedic vacuum moulding press; Orthopaedic presses; Extraction equipment; Powered ranging device; Edge inking or staining machines; Mechanism for stationary nailing and stapling tools. These machines can be standing alone or combined in a modular system for shoe repairs or the production of orthopaedic shoes including the lasts.	Footwear industry	Safety	ISO/TC 216 Footwear	
EN 12545:2009 - Footwear, leather and imitation leather goods manufacturing machines - Noise test code - Common requirements	This noise test code specifies common requirements necessary to carry out efficiently and under standardised conditions the determination, declaration and verification of the noise emission characteristics of the following leather and imitation leather goods and footwear manufacturing machinery: - Cutting and punching machines (EN 12044); - Roughing, scouring, polishing and trimming machines (EN 930); - Footwear moulding machines (EN 1845); - Lasting machines (EN 931); - Nailing machines (EN 12653); - Modular shoe repair equipment (EN 12387); - Shoe and leather presses (EN 12203); - Splitting, skiving, cutting, cementing and cement drying machines (EN 13457).	Footwear industry	Safety	ISO/TC 216 Footwear	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
	Common requirements given in this standard are complemented by specific requirements on noise given in the above mentioned C-type standards.				
EN 12653:2010 - Footwear, leather and imitation leather manufacturing machines - Nailing machines - Safety requirements	This standard is applicable to nailing machines used in the footwear manufacturing industry, namely: heel attaching machines; heel nailing machines; gang nailing machines.	Footwear industry	Safety	ISO/TC 216 Footwear	
EN 12750:2013 - Safety of woodworking machines - Four sided moulding machines	This European Standard deals with all significant hazards, hazardous situations and events as listed in Clause 4, which are relevant to stationary four sided moulding machines with a maximum working width of 350 mm and a maximum speed of the integrated work-piece feed of 200 m/min, with electrical and/or electronic control system, hereafter referred to as "machines" designed to cut solid wood, chipboard, fibreboard, plywood and also these materials where these are covered with plastic laminate or edgings when they are used as intended and under the conditions foreseen by the manufacturer, including reasonably foreseeable misuse of the machine (see 6.3 c)). For the definition of a stationary machine, see 3.22. This European Standard deals also with hazards relating to the following optional work units: - universal spindle; - glass bead cutting unit. This European Standard is not applicable to machines designed for machining logs which have not previously been machined. This European Standard does not deal with any hazards relating to: a) in-feed devices (magazines, hoppers, etc.); for mechanical in-feed devices which also prevent access to the in-feed opening, see 5.3.7.2; b) the combination of single machines with any other machine as part of a line; c) out-feed devices (e.g. mechanical handling systems) except for hazards related to ejection from the machine due to climb cutting. This European Standard is not applicable to four sided moulding machines which are manufactured before the date of its publication as EN.	Woodworking machine	Safety		CEN/TC 142 - Woodworking machines - Safety

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN 12779:2016 - Safety of woodworking machines - Chip and dust extraction systems with fixed installation - Safety requirements	This European Standard deals with the significant hazards, hazardous situations and events relevant for chip and dust extraction systems for fixed installation and for connection with machines for working on solid wood (including hard wood) and wood-based materials, when they are used as intended and under the conditions foreseen by the manufacturer, including reasonably foreseeable misuse. This European Standard deals also with the technical requirements to minimize the hazards in connection with the temporary storage of wood dust and chips in a silo, bin or container including charging and discharge systems. This European standard does not apply to: a) chip and dust extraction systems with filters installed indoors (covered by prEN 16770); b) extraction equipment (e.g. extraction hoods, ducts) within a woodworking machine including the outlet to which the extraction system is connected; c) chip and dust extraction systems designed for KST values above 200 bar ms−1; d) mechanical conveying systems between filter and storage facility; e) extraction systems and conveying systems with underpressure below 0,3 bar or overpressure above 0,3 bar; f) storage devices for pressed wood products (e.g. pellets) and humid shavings. Requirements for containers are not dealt with in this standard. This European Standard is not applicable to machines which are manufactured before the date of its publication as EN.	Woodworking machine	Safety		CEN/TC 142 - Woodworking machines - Safety
EN 13457:2010 - Footwear, leather and imitation leather goods manufacturing machines - Splitting, skiving, cutting, cementing and cement drying machines - Safety requirements	This document applies to splitting, skiving, edge trimming, strip cutting, cementing and cement drying machines used in the manufacture of footwear, leather and imitation leather goods and other related components. This document specifies safety requirements for construction, transport, installation, adjustment, setting, teaching or process change-over, operation, cleaning, maintenance, decommissioning, dismantling and disposal for machines. It takes account of intended use , foreseeable misuse, component and system failure	Footwear industry	Safety	ISO/TC 216 Footwear	
EN 16770:2018 - Safety of woodworking machines - Chip and dust extraction systems for indoor installation - Safety requirements	This document deals with all significant hazards, hazardous situations and events as listed in Clause 4, relevant for chip and dust extraction systems for indoor use designated to be connected to woodworking machines, when they are used as intended and under the conditions foreseen by the manufacturer, including reasonably foreseeable misuse.	Woodworking machine	Safety		CEN/TC 142 - Woodworking machines - Safety
EN 1845:2008 - Footwear manufacturing machines - Footwear moulding machines - Safety requirements	This European Standard applies to footwear moulding machines which are intended for use in the shoe industry for the production of footwear and footwear components. These machines are: direct-on sole moulding machines (see Figures 1, 2 and 3); unit sole and footwear component moulding machines (see Figures 4 to 10); full shoe and boot moulding machines (see Figure 11). This European Standard applies also to the mentioned machines when used for other products than footwear and footwear components, as far as these products require no other changes than a different mould.	Footwear industry	Safety	ISO/TC 216 Footwear	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN 547-1:2009 - Safety of machinery - Human body measurements - Part 1: Principles for determining the dimensions required for openings for whole body access into machinery	This European Standard specifies the dimensions of openings for whole body access as applied to machinery as defined in EN 292-1. It provides the dimensions to which the values given in EN 547-3 are applicable. Values for additional space requirements are given in annex A.	Machinery	Safety		CEN TC 114 - Safety of machinery
EN 547-2:2009 - Safety of machinery - Human body measurements - Part 2: Principles for determining the dimensions required for access openings	This European Standard specifies the dimensions of openings for access as applied to machinery as defined in EN 292-1. It provides the dimensions to which the values given in EN 547-3 are applicable. Values for additional space requirements are given in annex A.	Machinery	Safety		CEN TC 114 - Safety of machinery
EN 547-3:2009 - Safety of machinery - Human body measurements - Part 3: Anthropometric data	This European Standard specifies current requirements for human body measurements (anthropometric data) that are required by EN 547-1 and EN 547-2 for the calculation of access opening dimensions as applied to machinery.	Machinery	Safety		CEN TC 114 - Safety of machinery
EN 60204-1:2018/prA1 (pr=71665) - Safety of machinery - Electrical equipment of machines - Part 1: General requirements	Safety of machinery - Electrical equipment of machines - Part 1: General requirements	Electronic, electrical, or electromechanical part	Safety		CLC/TC 44X - Safety of machinery: electrotechnical aspects
EN 614-1:2009 - Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles	This European Standard establishes the ergonomic principles to be followed during the process of design of machinery. This European Standard applies to the interactions between operators and machinery when installing, operating, adjusting, maintaining, cleaning, dismantling, repairing or transporting equipment, and outlines the principles to be followed in taking the health, safety and well-being of the operator into account. This European Standard provides a framework within which the range of more specific ergonomics standards and other related standards relevant to machinery design should be applied.	Machinery	Ergonomics		CEN TC 122 - Ergonomics
EN 614-2:2009 - Safety of machinery - Ergonomic design principles - Part 2: Interactions between the design of machinery and work tasks	This European Standard is directed to designers and manufacturers of machinery and other work equipment. It will also be helpful to those who are concerned with the use of machinery and work equipment, e.g. to managers, organizers, operators and supervisors.	Machinery	Ergonomics		CEN TC 122 - Ergonomics

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN 691-1:2012 - Safety of woodworking machines - Part 1: Common requirements	This European Standard applies for woodworking machines with cutting tools and/or sanding tools as defined in 3.1, when they are used as intended and under the conditions foreseen by the manufacturer. This European Standard deals with some but not all significant hazards, hazardous situations and events relevant to woodworking machines: those that are common to most of such machines and are listed in Clause 4.	Woodworking machine	Safety		CEN/TC 142 - Woodworking machines - Safety
EN 842:2009 - Safety of machinery - Visual danger signals - General requirements, design and testing	This European Standard describes criteria for the perception of visual danger signals in the area that people are intended to perceive and to react to such a signal. It specifies the safety and ergonomic requirements and the corresponding physical measurements and subjective visual check.	Machinery	Safety		CEN TC 114 - Safety of machinery
EN 847-3:2013 - Tools for woodworking - Safety requirements - Part 3: Clamping devices	This European Standard specifies all hazards arising from the use of clamping devices for the fastening of milling tools and circular saw blades on woodworking machines and specifies the methods for the elimination or reduction of these hazards by the design of the clamping device and by the provision of information. This European Standard does not apply to arbors for spindle moulding machines in accordance with EN 848 1 or to clamping flanges for circular sawing blades to be used on circular sawing machines in accordance with the standard series EN 1870 and does not cover hazard related to the connection of the clamping device with the machine. Bore mounted tools which are mounted on an interchangeable arbor should be considered as a shank mounted tool. NOTE For definition of "woodworking machines", see EN 847 1.	Woodworking machine	Safety		CEN/TC 142 - Woodworking machines - Safety
EN 848-2:2013 - Safety of woodworking machines - One side moulding machines with rotating tool - Part 2: Single spindle hand fed/integrated fed routing machines	This document specifies all significant hazards, hazardous situations and events as listed in Clause 4 which are relevant to stationary and displaceable single spindle hand fed/integrated fed routing machines with fixed head but allowing only movement along the axis of the tool during machining hereinafter referred to as "machines" designed to cut solid wood, chip board, fibreboard, plywood and also these materials if they are covered with plastic laminate, edgings or veneer when they are used as intended and under the conditions foreseen by the manufacturer. This document does not apply to inverted pin routers and radial arm routers (machines where the work piece is fixed and the tool head is manually moved); NC boring machines and NC routing machines; hand-held routers or any adaptation permitting their use in a different mode, e.g. bench mounting; routing machines set up on a bench or a table similar to a bench, which are intended to carry out work in a stationary position, capable of being lifted by one person by hand. The bench can also be an integrated part of the machine if it consists of hinged legs which can be extended down. This document is not applicable to single spindle hand fed/integrated fed routing machines which are manufactured before the date of its publication as EN.	Woodworking machine	Safety		CEN/TC 142 - Woodworking machines - Safety

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN 894-1:2009 - Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 1: General principles for human interactions with displays and control actuators	This European Standard applies to the design of displays and control actuators on machinery. It specifies general principles for human interaction with displays and control actuators, to minimise operator errors and to ensure an efficient interaction between the operator and the equipment.	Machinery	Ergonomics		CEN TC 122 - Ergonomics
EN 894-2:2009 - Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 2: Displays	This European Standard gives guidance on the selection, design and location of displays to avoid potential ergonomic hazards associated with their use. It specifies ergonomics requirements and covers visual, audible and tactile displays.	Machinery	Ergonomics		CEN TC 122 - Ergonomics
EN 894-3:2009 - Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 3: Control actuactors	This European Standard gives guidance on the selection, design and location of control actuators so that they are adapted to the requirements of the operators, are suitable for the control task in question and take account of the circumstances of their use.It applies to manual control actuators used in equipment for occupational and private use. It is particularly important to observe the recommendations in this European Standard where operating a control actuator may lead to injury or damage to health, either directly or as a result of a human error.	Machinery	Ergonomics		CEN TC 122 - Ergonomics
EN 894-4:2010 - Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 4: Location and arrangement of displays and control actuators	This European Standard contains ergonomic requirements for the location and arrangement of displays and control actuators in order to avoid hazards associated with their use.	Machinery	Ergonomics		CEN TC 122 - Ergonomics
EN 930:2010 - Footwear, leather and imitation leather goods manufacturing machines - Roughing, scouring, polishing and trimming machines - Safety requirements	This standard applies to the following machines which are intended to work material for the manufacture of footwear: - Automatic and manual roughing, scouring and polishing machines; - Automatic and manual edge contour trimming machines.	Footwear industry	Safety	ISO/TC 216 Footwear	
EN 931:2010 - Footwear manufacturing machines - Lasting machines - Safety requirements	This standard is applicable to lasting machines used in the footwear manufacturing industry, namely: Adhesive fore part lasting machines; Hand operated adhesive side lasting machines; Adhesive seat lasting machines; Adhesive seat and side lasting machines; Hand operated tack/staple side lasting machines; Tack seat lasting machines; Tack seat and side thermocement lasting machines; Tack heel seat and thermocent side lasting machines; Tack heel seat and	Footwear industry	Safety	ISO/TC 216 Footwear	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
	thermocent + tack side lasting machies; This standard does not apply to lasting machines which process granular thermocement.				
EN ISO 10218-1:2012 - Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots	This part of ISO 10218 specifies requirements and guidelines for the inherent safe design, protective measures and information for use of industrial robots. It describes basic hazards associated with robots and provides requirements to eliminate, or adequately reduce, the risks associated with these hazards.	Robotic	Safety	ISO/TC 299 - Robotics	CEN/TC 310 - Advanced automation technologies and their applications
EN ISO 10218-2:2011 - Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robot systems and integration	This part of ISO 10218 specifies safety requirements for the integration of industrial robots and industrial robot systems as defined in ISO 10218-1, and industrial robot cell(s). The integration includes the following:a) the design, manufacturing, installation, operation, maintenance and decommissioning of the industrialrobot system or cell;b) necessary information for the design, manufacturing, installation, operation, maintenance anddecommissioning of the industrial robot system or cell;c) component devices of the industrial robot system or cell.This part of ISO 10218 describes the basic hazards and hazardous situations identified with these systems,and provides requirements to eliminate or adequately reduce the risks associated with these hazards.Although noise has been identified to be a significant hazard with industrial robot systems, it is not considered in this part of ISO 10218. This part of ISO 10218 also specifies requirements for the industrial robot system as part of an integrated manufacturing system. This part of ISO 10218 does not deal specifically with hazards associated with processes (e.g. laser radiation, ejected chips, welding smoke). Other standards can be applicable to these process hazards.	Robotic	Safety	ISO/TC 299 - Robotics	CEN/TC 310 - Advanced automation technologies and their applications
EN ISO 11111-1:2016 - Textile machinery - Safety requirements - Part 1: Common requirements	ISO 11111-1:2016 specifies safety requirements for frequently occurring hazards common to the types of textile machinery and the hazards of certain machine elements covered by ISO 11111-2 to ISO 11111-7. The standard series is complemented by the type C standards ISO 9902 (all parts) with respect to noise emission measurement and ISO 23771 with respect to measures for the reduction of noise emissions. ISO 11111-1:2016 is applicable to machinery plant and related equipment intended to be used in the textile industry for the following purposes: opening, cleaning, blending, carding, preparation subsequent to carding, spinning and other processing of fibres (staple and filament) and other materials to form yarn or nonwoven material (including felts); winding, doubling, twisting, texturing, etc., of yarns and the processing of yarns p reparatory to weaving and knitting; weaving, knitting, lace-making and similar utilization of yarn, etc., to form fabric; forming of braid, cord, strand, rope, twine, net, etc., except take-up reels of stranding and laying machinery; processing, including the pretreatment, bleaching, dyeing, printing and finishing of	Textile machinery	Safety	ISO/TC 72/SC 8 - Safety requirements for textile machinery	CEN/TC 214 - Textile machinery and accessories

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
	fibre, yarn, fabric, braid, cord, etc., and final assembly for dispatch; piece-dyeing of made-up goods; finishing of warp and weft knitting, including hosiery, other than assembly of the finished product (e.g. sewing); manufacturing of carpets by weaving, tufting and other processes. ISO 11111-1:2016 applies to all machinery, plant and equipment used during the processes listed above, including equipment to enable automated operation of the machines and processes in either free-standing or complex installations, such as pneumatic fibre transportation, but excluding other transportation between the interfaces of the machines. NOTE 1 The standard for a specific textile machine will normally consist of two parts: this part of ISO 11111 and the specific part of ISO 11111 relevant to that machine. However, in the case of nonwoven lines, which are covered by ISO 11111-3, ISO 11111-2, ISO 11111-6 and ISO 11111-7 are also to be taken into account. ISO 11111-1:2016 does not deal with specific requirements for pressure containment. NOTE 2 In the EU and EFTA, specific directives for pressure vessels and electromagnetic compatibility, among others, exist. ISO 11111 (all parts) addresses hazards arising from the transport, assembly and commissioning of the machinery, its adjustment, use, maintenance, decommissioning, dismantling and disposal. Manual loading/unloading is considered to be part of the normal operation of the machinery. ISO 11111-1:2016 and the other parts of ISO 11111 are not applicable to machinery, plant and related equipment used for manufacturing continuous filaments and man-made fibres up to and including the formation of the first textile package (e.g. continuous filament cheese, staple fibre bale), hackling and carding of flax and similar, manufacturing of spun-bonded and melt-blown nonwovens, forming and making up of garments, household and industrial textile goods, and the pressing and die cutting of nonwoven fabric, laundering and dry cleaning of made-up textile goods, servicing of textile machines (e.g. machines for card wire mounting, cleaning machines for components of printing machines), and certain cutting devices, e.g. log-slitting device, laser cutting, high pressure water jets, ultrasonic device. NOTE 3 The machines and equipment				
EN ISO 11111-2:2016 - Textile machinery - Safety requirements - Part 2: Spinning preparatory and spinning machines	ISO 11111-2:2005, taken together with ISO 11111-1, specifies significant hazards and corresponding safety requirements and/or measures for spinning preparatory and spinning machinery. It is applicable to all machinery, plant and related equipment intended to be used for the opening, cleaning, blending, wool scouring, baling, carding, tow cutting and stretch breaking, spinning preparation subsequent to carding and spinning.	Textile machinery	Safety	ISO/TC 72/SC 8 - Safety requirements for textile machinery	CEN/TC 214 - Textile machinery and accessories
EN ISO 11111-3:2016 - Textile machinery - Safety requirements - Part 3: Nonwoven machinery	ISO 11111-3:2005, taken together with ISO 11111-1, ISO 11111-2, ISO 11111-6 and ISO 11111-7, specifies significant hazards and corresponding safety requirements and/or measures for nonwoven machinery. It is applicable to all machinery, plant and related equipment intended to be used for opening, cleaning, blending, carding, needle punching, cylinder drying, and batching.	Textile machinery	Safety	ISO/TC 72/SC 8 - Safety requirements for textile machinery	CEN/TC 214 - Textile machinery and accessories

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN ISO 11111-4:2016 - Textile machinery - Safety requirements - Part 4: Yarn processing, cordage and rope manufacturing machinery	ISO 11111-4:2005, taken together with ISO 11111-1, specifies significant hazards and corresponding safety requirements and/or measures for yarn processing, cordage and rope manufacturing machinery. It is applicable to all machinery, plant and related equipment intended to be used for the doubling, twisting, texturing, reeling, winding, ball winding, cordage, rope manufacturing and braiding.	Textile machinery	Safety	ISO/TC 72/SC 8 - Safety requirements for textile machinery	CEN/TC 214 - Textile machinery and accessories
EN ISO 11111-5:2016 - Textile machinery - Safety requirements - Part 5: Preparatory machinery to weaving and knitting	ISO 11111-5:2005, taken together with ISO 11111-1, specifies significant hazards and corresponding safety requirements and/or measures for preparatory machinery to weaving and knitting.	Textile machinery	Safety	ISO/TC 72/SC 8 - Safety requirements for textile machinery	CEN/TC 214 - Textile machinery and accessories
EN ISO 11111-6:2016 - Textile machinery - Safety requirements - Part 6: Fabric manufacturing machinery	ISO 11111-6:2005, taken together with ISO 11111-1, specifies significant hazards and corresponding safety requirements and/or measures for fabric manufacturing machinery. It is applicable to all machinery, plant and related equipment intended to be used for weaving, knitting and tufting.	Textile machinery	Safety	ISO/TC 72/SC 8 - Safety requirements for textile machinery	CEN/TC 214 - Textile machinery and accessories
EN ISO 11111-7:2016 - Textile machinery - Safety requirements - Part 7: Dyeing and finishing machinery	ISO 11111-7:2005, taken together with ISO 11111-1, specifies significant hazards and corresponding safety requirements and/or measures for dyeing and finishing machinery.	Textile machinery	Safety	ISO/TC 72/SC 8 - Safety requirements for textile machinery	CEN/TC 214 - Textile machinery and accessories
EN ISO 12100:2010 - Safety of machinery - General principles for design - Risk assessment and risk reduction	It specifies basic terminology, principles and a methodology for achieving safety in the design of machinery. It specifies principles of risk assessment and risk reduction to help designers in achieving this objective. These principles are based on knowledge and experience of the design, use, incidents, accidents and risks associated with machinery. Procedures are described for identifying hazards and estimating and evaluating risks during relevant phases of the machine life cycle, and for the elimination of hazards or sufficient risk reduction. Guidance is given on the documentation and verification of the risk assessment and risk reduction process. ISO 12100:2010 is also intended to be used as a basis for the preparation of type-B or type-C safety standards. It does not deal with risk and/or damage to domestic animals, property or the environment.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 13849-1:2016 - Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design	This part of ISO 13849 provides safety requirements and guidance on the principles for the design and integration of safety-related parts of control systems (SRP/CS), including the design of software.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 13849-2:2013 - Safety of machinery - Safety-related parts of	ISO 13849-2:2012 specifies the procedures and conditions to be followed for the validation by analysis and testing of the specified safety functions, the category achieved, and the performance level achieved by the safety-related parts of a control system (SRP/CS) designed in accordance with ISO 13849-1	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
control systems - Part 2: Validation					
EN ISO 13850:2015 - Safety of machinery - Emergency stop function - Principles for design	ISO 13850:2015 Standard specifies functional requirements and design principles for the emergency stop function on machinery, independent of the type of energy used. It does not deal with functions such as reversal or limitation of motion, deflection of emissions (e.g. radiation, fluids), shielding, braking or disconnecting, which can be part of the emergency stop function. The requirements for this International Standard apply to all machines, with exception to: machines where an emergency stop would not reduce the risk; hand-held or hand-operated machines. NOTE The requirements for the realization of the emergency stop function based on electrical/electronic technology are described in IEC 60204-1.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 13851:2019 - Safety of machinery - Two-hand control devices - Principles for design and selection	This document specifies the safety requirements of a two-hand control device (THCD) and the dependency of the output signal from the actuation by hand of the control actuating devices. This document describes the main characteristics of THCDs for the achievement of safety and sets out combinations of functional characteristics for three types. It does not apply to devices intended to be used as enabling devices, as hold-to-run devices or as special control devices.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 13854:2020 - Safety of machinery - Minimum gaps to avoid crushing of parts of the human body	ISO 13854:2017 enables the user (e.g. standard makers, designers of machinery) to avoid hazards from crushing zones. It specifies minimum gaps relative to parts of the human body and is applicable when adequate safety can be achieved by this method. ISO 13854:2017 is applicable to risks from crushing hazards only and is not applicable to other possible hazards, e.g. impact, shearing, drawing-in.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 13857:2020 - Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs	This document establishes values for safety distances in both industrial and non-industrial environments to prevent machinery hazard zones being reached. The safety distances are appropriate for protective structures. It also gives information about distances to impede free access by the lower limbs.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 14118:2018 - Safety of machinery - Prevention of unexpected start-up	ISO 14118:2017 specifies requirements for designed-in means aimed at preventing unexpected machine start-up to allow safe human interventions in danger zones.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 14119:2013 - Safety of machinery - Interlocking devices associated with guards - Principles for design and selection	This International Standard specifies principles for the design and selection — independent of the nature of the energy source — of interlocking devices associated with guards. This International Standard covers the parts of guards which actuate interlocking devices.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery

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EN ISO 14120:2015 - Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards	This International Standard specifies general requirements for the design, construction, and selection of guards provided to protect persons from mechanical hazards.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 14159:2008 - Safety of machinery - Hygiene requirements for the design of machinery	This International Standard specifies hygiene requirements of machines and provides information for the intended use to be provided by the manufacturer. It applies to all types of machines and associated equipment used in applications where hygiene risks to the consumer of the product can occur. This International Standard does not cover requirements relative to the uncontrolled egress of microbiological agents from the machine.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 18217:2015 - Safety of woodworking machines - Edge-banding machines fed by chain(s)	ISO 18217:2015 deals with all significant hazards, hazardous situations, and events as listed in Clause 4, which are relevant to edge banding machines fed by chains with manual loading and unloading and maximum work-piece height capacity of 100 mm, when they are used as intended and under the conditions foreseen by the manufacturer, including reasonably foreseeable misuse. The work-piece is fed through the processing units by an integrated feed. Feeding chains also include "feeding belts". For the purpose of this International Standard, an edge banding machine fed by chains is hereinafter referred to as "machine". The machine is designed to process in one pass, one end (single end machine), or both ends (double end machine) panels of wood materials with similar physical characteristics as wood, as well as gypsum plaster boards. Edges to be applied by the machine can be made of paper, melamine, plastic or composite materials, aluminium or light alloy, veneer or solid wood. ISO 18217:2015 also applies to machines fitted with the following: ? auxiliary devices essential for edge banding machines fed by chains (see 3.1); ? sanding belt units; ? fixed or movable workpiece support; ? automatic tool changing; ? automatic panel returner. ISO 18217:2015 also includes information to be provided by the manufacturer to the user. ISO 18217:2015 does not deal with any hazards relating to the following: a) systems for loading and unloading of the work-piece to a single machine other than automatic panel returner; b) single machine being used in combination with any other machine (as part of a line); c) wireless mobile control sets; d) additional equipment for grooving and for cutting by circular saw blade, installed out of the integral enclosure and/or whose tools protrude out of the integral enclosure; e) plasma unit, power laser unit, and hot-air-jet unit. ISO 18217:2015 applies to machines that are manufactured after the date of issue of this International Standard.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety

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EN ISO 19085-1:2017 - Woodworking machines - Safety - Part 1: Common requirements	ISO 19085-1:2017 gives the safety requirements and measures to reduce risks related to woodworking machines arising during operation, adjustment, maintenance, transport, assembly, dismantling, disabling and scrapping and which are common to machines used in the woodworking industry. It is applicable to woodworking, stationary and displaceable machines when they are used as intended and under the conditions foreseen by the manufacturer. NOTE 1 For relevant but not significant hazards, e.g. sharp edges of the machine frame, see ISO 12100:2010. ISO 19085-1:2017 is intended to be used in conjunction with the other parts of ISO 19085, applicable to specific machine types. ISO 19085-1:2017 is not applicable to machines intended for use in potential explosive atmospheres or to machines manufactured prior to the date of its publication. NOTE 2 Machines for capturing and extracting dust are covered by EN 12779 and EN 16770.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety
EN ISO 19085-10:2019 - Woodworking machines - Safety - Part 10: Building site saws (contractor saws)	This document gives the safety requirements and measures for displaceable building site saws, designed to cut wood and materials with similar physical characteristics to wood. It deals with all significant hazards, hazardous situations and events, relevant to the machines, when operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety
EN ISO 19085-11:2020 - Woodworking machines - Safety - Part 11: Combined machines	This document gives the safety requirements and measures for stationary and displaceable combined woodworking machines, having at least two separately usable working units and with manual loading and unloading of the workpiece, hereinafter referred to as "machines". The integrated working units can be of these types only: a sawing unit; a moulding unit; a planing unit. The machines are designed to cut solid wood and material with similar physical characteristics to wood. This document deals with all significant hazards, hazardous situations and events as listed in Clause 4, relevant to the machines, when operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety
EN ISO 19085-2:2017 - Woodworking machines - Safety - Part 2: Horizontal beam panel circular sawing machines	This international standard deals with all significant hazards, hazardous situations and events as listed in Clause 4 which are relevant to horizontal beam panel sawing machines with the saw carriage of the front cutting line mounted below the workpiece support, which are manually or mechanically loaded and/or unloaded, hereinafter referred to as "machines", when they are operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse. Also transport, assembly, dismantling, disabling and scrapping phases have been taken into account.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN ISO 19085-3:2018 - Woodworking machines - Safety requirements - Part 3: Numerically controlled (NC) boring and routing machines	This international standard deals with all significant hazards, hazardous situations and events as listed in Clause 4 which are relevant to horizontal beam panel sawing machines with the saw carriage of the front cutting line mounted below the workpiece support, which are manually or mechanically loaded and/or unloaded, hereinafter referred to as "machines", when they are operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse. Also transport, assembly, dismantling, disabling and scrapping phases have been taken into account.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety
EN ISO 19085-4:2018 - Woodworking machines - Safety - Part 4: Vertical panel circular sawing machines	ISO 19085-4:2018 gives the safety requirements and measures for manually loaded and unloaded stationary vertical panel sawing machines, hereinafter referred to as "machines". ISO 19085-4:2018 deals with all significant hazards, hazardous situations and events as listed in Clause 4 relevant to machines, when operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse. Also, transport, assembly, dismantling, disabling and scrapping phases are taken into account.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety
EN ISO 19085-5:2017 - Woodworking machines - Safety - Part 5: Dimension saws	ISO 19085-5:2017 gives the safety requirements and measures for stationary and displaceable dimension saws, hereinafter referred to as "machines", designed to cut wood and material with similar physical characteristics to wood. NOTE 1 For the definitions of stationary and displaceable machines, see ISO 19085-1:2017, 3.4 and 3.5. ISO 19085-5:2017 deals with all significant hazards, hazardous situations and events as listed in Clause 4, relevant to the machines, when operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse. Also, transport, assembly, dismantling, disabling and scrapping phases have been taken into account. NOTE 2 For relevant but not significant hazards, e.g. sharp edges of the machine frame, see ISO 12100. ISO 19085-5:2017 is also applicable to machines fitted with one or more of the following devices/additional working units, whose hazards have been dealt with: device for the main saw blade and scoring saw blade to be raised and lowered; device to tilt the main saw blade and scoring saw blade for angled cutting; device for scoring; device for grooving with milling tool with a width not exceeding 20 mm; demountable power feed unit; post-formed edge pre-cutting unit; power-operated sliding table; workpiece clamping. NOTE 3 Dimension saws are used for ripping, cross cutting, dimensioning and grooving. ISO 19085-5:2017 is not applicable to machines intended for use in potentially explosive atmospheres or to machines manufactured prior to the date of its publication.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN ISO 19085-6:2018 - Woodworking machines - Safety - Part 6: Single spindle vertical moulding machines ("toupies")	ISO 19085-6:2017 gives the safety requirements and measures for stationary and displaceable hand-fed single spindle vertical moulding machines, hereinafter referred to as "machines", designed to cut wood and materials with similar physical characteristics to wood. It deals with all significant hazards, hazardous situations and events as listed in Clause 4, relevant to the machines when they are operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety
EN ISO 19085-7:2019 - Woodworking machines - Safety - Part 7: Surface planing, thickness planing, combined surface/thickness planing machines	This document gives the safety requirements and measures for stationary and displaceable, surface planing machines, also called jointers, thickness planing machines, also called planers or single surface planers, combined surface/thickness planing machines with fixed cutterblock position, with an integrated feed in thicknessing mode, with or without demountable power feed device in planing mode and with manual loading and unloading of the work-piece, hereinafter referred to as "machines". The machines are designed to cut solid wood and material with similar physical characteristics to wood.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN ISO 19085-8:2018 - Woodworking machines - Safety - Part 8: Belt sanding and calibrating machines for straight workpieces	ISO 19085-8:2017 gives the safety requirements and measures for stationary calibrating and sanding machines, with an integrated feed and one or more sanding belt units positioned above and/or below the work piece level, with manual or automatic loading and/or unloading, hereinafter referred to as "machines". ISO 19085-8:2017 deals with all significant hazards, hazardous situations and events as listed in Clause 4, relevant to the machines, when operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer, including reasonably foreseeable misuse. Also, transport, assembly, dismantling, disabling and scrapping phases have been taken into account. NOTE 1 For relevant but not significant hazards, e.g. sharp edges of the machine frame, see ISO 12100:2010. ISO 19085-8:2017 is also applicable to machines fitted with one or more of the following devices/additional working units, whose hazards have been dealt with: transversal sanding unit; cleaning brushing unit; satining roller unit; disk brushing unit; texturing brushing roller unit; texturing brushing belt unit; cutterblock unit; texturing band saw unit; spiked roller unit; antistatic bars;conveyor directly controlled by the machine; additional work piece vacuum clamping device. The machines are designed to calibrate and/or sand work pieces, in shape of panels or beams, consisting of: a) solid wood; b) material with similar physical characteristics to wood (see ISO 19085-1:2017, 3.2); c) gypsum boards, gypsum bounded fibreboards; d) composite materials with core consisting of e.g. polyurethane or mineral material; e) composite boards made from the materials listed above; f) all materials listed above, also already lacquered. ISO 19085-8:2017 does not deal with hazards related to: specific devices other than those listed above; access through in-feed and out-feed openings of machines with a work piece height capacity greater than 550 mm; systems for automatic loading and/or unloading of the work piece to/from a single machine; NOTE 2 Loading the machine manually includes manually placing the work piece onto a conveyor directly controlled by the machine. Unloading the machine manually includes manually removing the work piece from a conveyor directly controlled by the machine. interfacing of the machine with any other machine. ISO 19085-8:2017 is not applicable to machines intended for use in potentially explosive atmosphere and to machines manufactured prior to the date of its publication.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety
EN ISO 19085-9:2020 - Woodworking machines - Safety - Part 9: Circular saw benches (with and without sliding table)	This document gives the safety requirements and measures for stationary and displaceable circular saw benches (with or without sliding table and/or demountable power feed unit), also known as "table saws" (in the USA), hereinafter referred to as "machines", designed to cut wood and material with similar physical characteristics to wood. It deals with all significant hazards, hazardous situations and events as listed in Clause 4 relevant to these machines when they are operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse.	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines	CEN/TC 142 - Woodworking machines - Safety

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN ISO 19353:2019 - Safety of machinery - Fire prevention and fire protection	This document specifies methods for identifying fire hazards resulting from machinery and for performing a risk assessment. It gives the basic concepts and methodology of protective measures for fire prevention and protection to be taken during the design and construction of machinery. The measures consider the intended use and reasonably foreseeable misuse of the machine. It provides guidelines for consideration in reducing the risk of machinery fires to acceptable levels through machine design, risk assessment and operator instructions.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
EN ISO 19952:2005- Footwear - Vocabulary	ISO 19952:2005 defines terms used in the footwear industry, in English, French, Spanish and Italian. The terms and their definitions are listed alphabetically in English. In the annexes, all the terms are listed alphabetically in English, French, Spanish and Italian, so that the user of this International Standard can easily find the corresponding definition and the equivalent terms in the different languages. ISO 19952:2005 is intended to facilitate communication in the footwear sector.	Footwear industry	Terminology	ISO/TC 216 Footwear	
EN ISO 20607:2019 - Safety of machinery - Instruction handbook - General drafting principles	This document specifies requirements for the machine manufacturer for preparation of the safety-relevant parts of an instruction handbook for machinery. This document establishes the principles which are indispensable to provide information on residual risks.	Machinery	Safety	ISO/TC 199 - Safety of machinery	CEN TC 114 - Safety of machinery
FprEN IEC 61496-1:2020 (pr=67695) - Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests	UNDER DEVELOPMENT	Electronic, electrical, or electromechanical part	Safety		CLC/TC 44X - Safety of machinery: electrotechnical aspects
FprEN IEC 61496-2:2020 (pr=67697) - Safety of machinery - Electro-sensitive protective equipment - Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs)	UNDER DEVELOPMENT	Electronic, electrical, or electromechanical part	Safety		CLC/TC 44X - Safety of machinery: electrotechnical aspects

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 10816-8:2015 - Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts - Part 8: Reciprocating compressor systems	Procedures and guidelines for the measurement and classification of mechanical vibration of reciprocating compressor systems. The vibration values are defined primarily to classify the vibration of the compressor system and to avoid fatigue problems with parts in the reciprocating compressor system, i.e. foundation, compressor, dampers, piping, and auxiliary equipment mounted on the compressor system. The standard applies to reciprocating compressors mounted on rigid foundations with typical rotational speed ratings greater than 120 r/min and up to and including 1 800 r/min. The general evaluation criteria which are presented relate to operational measurements. The criteria are also used to ensure that machine vibration does not adversely affect the equipment directly mounted on the machine, e.g. pulsation dampers and the pipe system. The standard applies to reciprocating compressors mounted on rigid foundations with typical rotational speed ratings greater than 120 r/min and up to and including 1 800 r/min. The general evaluation criteria which are presented relate to operational measurements. The criteria are also used to ensure that machine vibration does not adversely affect the equipment directly mounted on the machine, e.g. pulsation dampers and the pipe system.	Mechanical vibration	Measurement	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	
ISO 13374-4:2015 - Condition monitoring and diagnostics of machine systems — Data processing, communication and presentation — Part 4: Presentation	Requirements for presentation of information for technical analysis and decision support in an open architecture for condition monitoring and diagnostics. Software design professionals need to present diagnostic/prognostic data, health information, advisories, and recommendations on computer displays and in written report formats to end-users. This part of ISO 13374 provides standards for the display of this information in CM&D systems.	Condition monitoring and diagnostic	Data presentation	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 14539:2000 - Manipulating industrial robots — Object handling with grasp-type grippers — Vocabulary and presentation of characteristics	This International Standard focuses on the functionalities of end effectors and concentrates on grasp-type grippers as defined in 4.1.2.1. This International Standard provides terms to describe object handling and terms of functions, structures, and elements of grasp-type grippers. Annex A, which is informative, provides formats for presenting characteristics of grasp-type grippers. This part can be used in the following ways: a) End effector manufacturers can present the characteristics of their products to robot users. b) Robot users can specify the requirements of end effectors they need. c) Robot users can describe the characteristics of the objects to be handled and of handling the objects in their specific robot applications. This International Standard is also applicable to simple handling systems which are not covered by the definition of manipulating industrial robots, such as pick-and-place or master-slave units.	Robotic	Object handling	ISO/TC 299 - Robotics	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 16587:2004 - Mechanical vibration and shock — Performance parameters for condition monitoring of structures	ISO 16587:2004 describes the performance parameters for assessing the condition of structures, including types of measurement, factors for setting acceptable performance limits, data acquisition parameters for constructing uniform databases, and internationally accepted measurement guidance (e.g. terminology, transducer calibration, transducer mounting and approved transfer function techniques). The procedures relate to in-service monitoring of structures, and include all components and sub-assemblies necessary to provide the functioning of the structure as a complete entity. The monitoring is intended to be ongoing in nature through the lifecycle of the structure. The target industries for ISO 16587:2004 include: construction, infrastructure, transportation, power generation, oil and gas, and leisure and entertainment. ISO 16587:2004 is applicable to stationary structures, such as: buildings, bridges and tunnels, towers, masts and antennae, tanks and silos, retaining walls and dams, jetties and other shore-side structures, offshore platforms, pressure vessels, and pipelines. Non-stationary structures (e.g. self-propelled ships) and mobile structures (e.g. offshore jack-up platforms) are excluded from ISO 16587:2004.	Mechanical vibration	KPI	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	
ISO 17359:2011 - Condition monitoring and diagnostics of machines - General guidelines	Guidelines for the general procedures to be considered when setting up a condition monitoring programme for machines and includes references to associated standards required in this process. ISO 17359:2011 applies to all machines.	Condition monitoring and diagnostic	Framework	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 18095:2018 - Condition monitoring and diagnostics of power transformers	Guidelines for the monitoring techniques to be considered when setting up a condition monitoring programme for power transformers and includes references to associated standards required in this process. It is intended to help in the implementation of a coherent condition monitoring and condition-based maintenance programme, such as described following ISO 17359. ISO 18095:2018 is applicable to single-phase alternating current power transformers of ≥ 1 kVA and three phase alternating current power transformers of ≥ 5 kVA.	Condition monitoring and diagnostic	Power transformer	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 18434-2:2019 - Condition monitoring and diagnostics of machine systems — Thermography — Part 2: Image interpretation and diagnostics	Interpretation of infrared thermograms as part of a programme for condition monitoring and diagnostics of machine systems.IR applications pertaining to machinery performance are addressed. This document is intended to: provide guidance on establishing severity assessment criteria for anomalies identified by IRT; outline methods and requirements for carrying out thermography of machine systems, including safety recommendations; provide information on image interpretation, assessment criteria and reporting requirements.	Condition monitoring and diagnostic	Termography, diagnosis	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 21289:2008 - Mechanical vibration and shock — Parameters to be specified for the acquisition of vibration data	ISO 21289:2008 identifies a set of parameters to be specified, as applicable, for vibration measurements, analysis, reporting and archiving. It is intended for use in the testing of structures, machines, vehicles, sensitive equipment and other dynamic systems. ISO 21289:2008 applies to measurements made by modern data acquisition systems, including digital signal processors, using readily available commercial instrumentation. It can be applied to a variety of common vibration measurement types, including time history, spectrum and frequency-response function measurements.	Mechanical vibration	KPI, vibration	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	
ISO 7919-3:2009 - Mechanical vibration — Evaluation of machine vibration by measurements on rotating shafts — Part 3: Coupled industrial machines	ISO 7919-3:2008 gives guidelines for applying evaluation criteria of shaft vibration under normal operating conditions, measured at or close to the bearings of coupled industrial machines.	Mechanical vibration	Measurement	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	
ISO 9946:199 - Manipulating industrial robots — Presentation of characteristics	This International Standard specifies how characteristics of robots shall be presented by the manufacturer.	Robotic	Product characteristic	ISO/TC 299 - Robotics	
ISO/AWI 11161 - Safety of machinery — Integration of machinery into a system — Basic requirements	UNDER DEVELOPMENT	Machinery	Safety	ISO/TC 199 - Safety of machinery	
ISO/AWI 19665 - Calibration of conditioning amplifiers for dynamic application	UNDER DEVELOPMENT	Condition monitoring and diagnostic	Vibration	ISO/TC 108 - Mechanical vibration, shock and condition monitoring	
ISO/CD TR 22100-1 - Safety of machinery — Relationship with ISO 12100 — Part 1: How ISO 12100 relates to type-B and type-C standards	UNDER DEVELOPMENT		How ISO 12100 relates to type-B and type-C standards		
ISO/DIS 13849-1 - Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design	UNDER DEVELOPMENT	Machinery	Safety	ISO/TC 199 - Safety of machinery	
ISO/DIS 8373 - Robotics — Vocabulary	UNDER DEVELOPMENT	Robotic	Terminology	ISO/TC 299 - Robotics	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO/FDIS 22166-1 - Robotics — Modularity for service robots — Part 1: General requirements	UNDER DEVELOPMENT	Robotic	Modularity	ISO/TC 299 - Robotics	
ISO/TR 14121-2:2013 - Safety of machinery - Risk assessment - Part 2: Practical guidance and examples of methods	gives practical guidance on conducting risk assessment for machinery in accordance with ISO 12100 and describes various methods and tools for each step in the process. It gives examples of different measures that can be used to reduce risk and is intended to be used for risk assessment on a wide variety of machinery in terms of complexity and potential for harm. Its intended users are those involved in the design, installation or modification of machinery (for example, designers, technicians or safety specialists).	Machinery	Risk assessment	ISO/TC 199 - Safety of machinery	
ISO/TR 19201:2013 - Mechanical vibration — Methodology for selecting appropriate machinery vibration standards	ISO/TR 19201:2013 provides guidance for selecting appropriate vibration standards for specific machine types, and thus selecting the appropriate vibration measurement and evaluation method. Synopses are given of ISO 10816 (evaluation of machine vibration on non-rotating parts) and ISO 7919 (evaluation of machine vibration on rotating parts), together with further International Standards related to machinery. ISO/TR 19201:2013 provides an overview of the relevant International Standards, giving a summary of their scopes. It also provides a theoretical, analytical basis for establishing whether vibration measurements should be carried out on non-rotating parts, rotating shafts or both for those machines where no previous experience exists. It is not intended to supersede established manufacturers' or users' practical experience with specific machine types since there can be specific features associated with a particular machine which lead to a different selection of the most relevant measurement procedure. The aim of ISO/TR 19201:2013 is not to equip the reader with all the technical details provided in the International Standards necessary to carry out a measurement or evaluation task on a particular machine; rather it guides the reader to the appropriate International Standards. It is these International Standards that provide the necessary details; and then, with suitable training, the reader is in a position to carry out the measurement or evaluation task.	Mechanical vibration	Measurement	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	
ISO/TR 20218-1:2018 - Robotics — Safety design for industrial robot systems — Part 1: End-effectors	This document provides guidance on safety measures for the design and integration of end-effectors used for robot systems. The integration includes the following: the manufacturing, design and integration of end-effectors; the necessary information for use. This document provides additional safety guidance on the integration of robot systems, as described in ISO 10218-2:2011.	Robotic	Safety	ISO/TC 299 - Robotics	
ISO/TR 20218-2:2017 Robotics — Safety design for industrial robot systems — Part 2: Manual load/unload stations	ISO/TR 20218-2:2017 is applicable to robot systems for manual load/unload applications in which a hazard zone is safeguarded by preventing access to it. For this type of application, it is important to consider the need for both access restrictions to hazard zones and for ergonomically suitable work places. ISO/TR 20218-2:2017 supplements ISO 10218-2:2011 and provides additional information and guidance on reducing the risk of intrusion into the hazard zones in the design and safeguarding of manual load/unload installations.	Robotic	Safety	ISO/TC 299 - Robotics	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO/TS 15066:2016 - Robots and robotic devices — Collaborative robots	ISO/TS 15066:2016 specifies safety requirements for collaborative industrial robot systems and the work environment, and supplements the requirements and guidance on collaborative industrial robot operation given in ISO 10218-1 and ISO 10218-2. ISO/TS 15066:2016 applies to industrial robot systems as described in ISO 10218-1 and ISO 10218-2. It does not apply to non-industrial robots, although the safety principles presented can be useful to other areas of robotics. NOTE This Technical Specification does not apply to collaborative applications designed prior to its publication.	Robotic	Collaborative robot	ISO/TC 299 - Robotics	
EN 12786:2013 - Safety of machinery - Requirements for the drafting of the vibration clauses of safety standards	This European Standard gives guidance for the writers of harmonized type-C machinery safety standards on how to deal with vibration where hand-transmitted vibration and/or whole-body vibration is identified as a significant hazard. This European Standard also gives guidance on how to deal with the requirement for declaration of the vibration emission of portable hand-held and/or hand-guided machinery and for mobile machinery. This European Standard supplements EN ISO 12100.	Machinery	Safety	-	CEN/TC 231 - Mechanical vibration and shock
ISO/WD 5124 - Robotics — Services provided by service robots — Safety management systems requirements	UNDER DEVELOPMENT	Robotic	Safety	ISO/TC 299 - Robotics	-
ISO/WD TR 21260 - Safety of machinery — Mechanical safety data for physical contacts between moving machinery or moving parts of machinery and persons	UNDER DEVELOPMENT	Machinery	Safety	ISO/TC 199 - Safety of machinery	-
prEN IEC 60204-32 (pr=70891) - Safety of machinery - Electrical equipment of machines - Part 32: Requirements for hoisting machines	UNDER DEVELOPMENT	Electronic, electrical, or electromechanical part	Safety		CLC/TC 44X - Safety of machinery: electrotechnical aspects
prEN IEC 62061 (pr=64505) - Safety of machinery - Functional safety of safety-related control systems	UNDER DEVELOPMENT	Electronic, electrical, or electromechanical part	Safety		CLC/TC 44X - Safety of machinery: electrotechnical aspects

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5.2.2 Optimization: standardization initiatives and Technical committees

KEY AREA – MAINTENANCE PLAN

Basing on the Digital Twin Model developed, the user will be able to perform proper maintenance planning, optimizing the production and reducing the production lines stoppages. Standardisation Technical Committees and standards are summed up below.

KEY AREA – PREDICTIVE MAINTENANCE

Based on the Digital Twin model and data gathering possible implementation of use agent-based solutions for distributed intelligence solutions for fault diagnosis, troubleshooting, remaining useful life prediction will be investigated. As a result, the main component of the RECLAIM system for machinery fault diagnosis and predictive maintenance will be developed.

The following relevant standardisation technical committees have been identified (Tab 5). They provide initial knowledge on maintenance planning focusing on indicators, maintenance risk management, condition assessment and maintenance process. All these elements must be taken into account to properly plan maintenance, select and elaborate right data and provide the necessary knowledge framework on content and process to be predicted.
List of relevant standards elaborated by thos TCs are provided in Table 5, Table 6 and Table 7.

Table 5 MAINTENANCE PLAN AND PREDICTIVE MAINTENANCE: list of relevant CEN and ISO Technical Committes (TCs)

CEN TECHNICAL COMMITTEE	RELEVANT WG
CEN/TC 319 - Maintenance[20] Standardization in the field of maintenance as far as generic standards which are generally applicable are concerned	CEN/TC 319/WG 10 Maintenance within physical asset management CEN/TC 319/WG 11 Condition assessment methodologies CEN/TC 319/WG 12 Risk based inspection framework (RBIF) CEN/TC 319/WG 13 Maintenance process CEN/TC 319/WG 14 Maintenance engineering CEN/TC 319/WG 15 Safety and maintenance CEN/TC 319/WG 4 Terminology CEN/TC 319/WG 6 Maintenance performance and indicators CEN/TC 319/WG 8 Maintenance functions and maintenance management
CWA 17492:2020 - Predictive control and maintenance of data intensive industrial processes[21] This document contains a methodology detailing the machine/deep learning techniques that should be employed, through the different steps to be followed, with the aim to predict industrial processes or equipment drifts and trigger alarms and potentially help to improve overall equipment effectiveness or the workshop performances.	

[20] https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6300&cs=1A64AA79FCFDE906561AFDA09269B3123
[21] https://www.cencenelec.eu/research/CWA/Pages/default.aspx

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Table 6 MAINTENANCE PLAN: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	CEN TECHNICAL COMMITTEE
prEN 17485 - Maintenance - Maintenance within physical asset management - Framework for improving the value of the physical assets through their whole life cycle (UNDER DEVELOPMENT)	This European Standard introduces methods and procedures when applying physical asset management as a framework to take into account the maintenance function within organisations strategic and tactical decision on physical assets and when applying physical asset management as a framework to maintenance activities. It also introduces at a methodological level the relationship between organizational strategic plan and the maintenance management system and describes at a procedural level the interrelations between maintenance process and all the other physical asset management processes. This European Standard may be applied to managing the physical assets of organizations of all sizes especially goods producing organisations. However, if specific standards exist for a particular application, those standards may also be considered. This European standard introduces methods and procedures for all the levels and functions of the organisations' management such as corporate planning management, plant management, technical management, production management, financial management, asset management, maintenance management, quality management etc. This European Standard consists of guidance and recommendations and is not intended to be used for certification, regulatory, or contractual use.	Maintenance	Life cycle impact	CEN/TC 319 Maintenance
EN 13460:2009 - Maintenance - Documentation for maintenance	European Standard specifies general guidelines for the technical documentation to be supplied with an item, before it is ready to be put into service, in order to support its maintenance.the documentation of information to be established within the operational phase of an item, in order to support the maintenance requirements,	Maintenance	Documentation	CEN/TC 319 Maintenance
EN 16646:2015 - Maintenance - Maintenance within physical asset management	Introduces physical asset management as a framework for maintenance activities. It also introduces the relationship between organizational strategic plan and maintenance management system and describes the interrelations between maintenance process and all the other physical asset management processes. It addresses the role and importance of maintenance within physical asset management system during the whole life cycle of an item. This European standard can be applied to production organizations of all sizes. However, if specific standards exist for a particular application or field of industry, those documents should also be considered. This European standard consists of guidance and recommendations and is not intended to be used for certification, regulatory, or contractual use.	Maintenance	Management system	CEN/TC 319 Maintenance
EN 16991:2018 - Risk-based inspection framework	This European Standard specifies the Risk-Based Inspection Framework (RBIF) and gives guidelines for Risk-Based Inspection and Maintenance (RBIM) in hydrocarbon and chemical process industries, power generation and other industries where RBI is applicable. Although RBIF encompasses both inspection and maintenance, this document focuses primarily on Risk-Based Inspection (RBI) and its applicability within the context of RBIM. The RBIF thereby supports optimization of operations and maintenance as well as asset integrity management.	Maintenance	Risk assessment	CEN/TC 319 Maintenance

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Table 7 PREDICTIVE MAINTENANCE: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	CEN TECHNICAL COMMITTEE
CWA 17492:2020 - Predictive control and maintenance of data intensive industrial processes	The document contains a methodology detailing the machine/deep learning techniques that should be employed, through the different steps to be followed, with the aim to predict industrial processes or equipment drifts and trigger alarms and potentially help to improve overall equipment effectiveness or the workshop performances. NOTE The triggered alarms are related to the process in such a way a small deviation affecting the production can be detected in advance, but these alarms are not related to safety. This document can be used as a guide by: - Manufacturing plant managers: it contains two examples of real use cases that show the possibilities offered by machine/deep learning techniques applied to the control and optimization of manufacturing processes and to the predictive maintenance of plant machinery; - Data Scientists: The actual use cases shown reflect the problems they will face when applying these techniques in an industrial environment, which has its own characteristics.	Maintenance	Predictive analytics	CWA 17492:2020 - Predictive control and maintenance of data intensive industrial processes
EN 15341:2019 - Maintenance - Maintenance Key Performance Indicators	Key Performance Indicators (KPIs) of the Maintenance Function and gives guidelines to define a set of suitable indicators, to appraise and to improve effectiveness, efficiency and sustainability in the maintenance of the existing physical assets either industrial, infrastructures, facilities, civil buildings or transportation systems, etc. in the framework of the external and internal influencing factors.	Maintenance	KPI	CEN/TC 319 - Maintenance
EN 17007:2018 - Maintenance process and associated indicators	This European Standard provides a generic description of the maintenance process. It specifies the characteristics of all the processes, parts of maintenance process, and establishes a maintenance model to gives guidelines for defining indicators. This European Standard is applicable to all organizations (company, institution, agency, etc.) in charge of maintaining physical assets. Therefore, it has been established without a particular organization in mind and does not aim to propose one. This description could be adapted based on the type and size of organization chosen to perform the maintenance, the complexity of the systems maintained and the scope of the external contracted services. The purpose of the breakdown into processes and the representation of their inter-relationships is to help maintenance personnel, and particularly management at different levels, to: clearly identify the actions to be taken in order to meet the overall objectives set by Management in terms of maintenance; delegate responsibilities that ensure the realization of the actions with the required performance levels; for each process, clearly determine: a) the necessary inputs and their origin; b) the required results and their intended uses; - monitor and quantitatively assess the performance obtained at various levels of the breakdown into processes; - improve the collection and the distribution of data. This standard does not cover software maintenance itself, but applies to items containing software.	Maintenance	KPI	CEN/TC 319 - Maintenance

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KEY AREA – PROCESS PLAN, MACHINE CALIBRATION

The goal of this key area is to address the challenging problem for factories to find the optimal time to carry out refurbishment/ remanufacturing during the whole life cycle of the industrial equipment. Key performance indicators (KPI) will be defined representing manufacturing process performance in the sense of remanufacturing/refurbishment time schedules, operational costs or other aspects. It will enable the control scenario calibration/fine-tuning in a real-time manner employing machine learning and optimization techniques in terms of refurbishment/ remanufacturing planning optimization and will be driven by the enterprise operational mode, which can be determined either by end users or automatically.

The following relevant standardisation Technical Committees have been identified (Tab 8). They provide initial knowledge on product Life cycle assessment in terms of timelines and related technical documentation. Industrial data requirements connected to production planning, quality of data in terms of shopfloor/plant floor. Artificial Intelligence use case and requirement (mostly under development) are inestaged aswell. Finally maintenance KPI, process, engineering and associated indicators will support the definition of KPI; maintenance by design perspective is also included.

List of relevant standards elaborated by thos TCs are provided in Table 9.

Table 8 PROCESS PLAN, MACHINE CALIBRATION: list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/TC 299 - Robotics[22] Standardization in the field of robotics, excluding toys and military applications	ISO/TC 299/WG 1 Vocabulary and characteristics ISO/TC 299/WG 3 Industrial safety ISO/TC 299/WG 4 Service robot performance ISO/TC 299/WG 6 Modularity for service robot
ISO/TC 207/SC 5 - Life cycle assessment[23] Standardization in the field of life cycle assessment and related environmental management tools for products and organizations. It includes life cycle based resource efficiency and eco-efficiency assessment, and encompasses consideration of a life cycle perspective in the assessment of impacts from the extraction of raw materials to the final disposal of waste.	ISO/TC 207/SC 5/WG 12 Life cycle assessment -- Requirements and guidelines
ISO/TC 199 - Safety of machinery[24] Standardization of basic concepts and general principles for safety of machinery incorporating terminology, methodology, guards and safety devices within the framework of ISO / IEC Guide 51 and in cooperation with other ISO and IEC technical committees. Excluded: product safety standards, as defined in ISO / IEC Guide 51, and which are explicitly covered by the work of other ISO or IEC technical committees.	NA
ISO/TC 184/SC 4 - Industrial data[25]	ISO/TC 184/SC 4/WG 8 Joint ISO/TC 184/SC 4 - ISO/TC 184/SC 5 WG: Manufacturing process and management information ISO/TC 184/SC 4/WG 13 Industrial Data Quality ISO/TC 184/SC 4/WG 15 Digital manufacturing ISO/TC 184/SC 4/TF 2/SC 4 Reference model for industrial data
ISO/TC 10 - Technical product documentation[26] Standardization and coordination of technical product documentation (TPD), including technical drawings, model based (3D), computer based (2D) or manually produced for technical purposes throughout the product life cycle, to	ISO/TC 10/WG 16 3D models: Presentation of product definition dataISO/TC 10/WG 20 Design and documentation for manufacture, assembly, disassembly and end-of-life processing

[22] https://www.iso.org/committee/5915511.html
[23] https://www.iso.org/committee/54854.html
[24] https://www.iso.org/committee/54604.html
[25] https://www.iso.org/committee/54158.html
[26] https://www.iso.org/committee/45986.html

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ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
facilitate preparation, management, storage, retrieval, reproduction, exchange and use	
ISO/IEC JTC 1/SC 42 - Artificial intelligence[27] Standardization in the area of Artificial Intelligence: serve as the focus and proponent for JTC 1's standardization program on Artificial Intelligence, provide guidance to JTC 1, IEC, and ISO committees developing Artificial Intelligence application	ISO/IEC JTC 1/SC 42/AG 2 AI Systems Engineering ISO/IEC JTC 1/SC 42/WG 3 Trustworthiness ISO/IEC JTC 1/SC 42/WG 4 Use cases and applications
CEN/TC 319 - Maintenance[28] Standardization in the field of maintenance as far as generic standards which are generally applicable are concerned	CEN/TC 319/WG 6 Maintenance performance and indicators
CEN SS/26 Environmental Management[29]	

[27] https://www.iso.org/committee/6794475.html
[28] https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6300&cs=1A64AA79FCFDE906561AFDA09269B3123
[29] https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6339&cs=11C19D747C5A64B73BAC77610CA57D560

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Table 9 PROCESS PLAN, MACHINE CALIBRATION: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN 17007:2018 - Maintenance process and associated indicators	This European Standard provides a generic description of the maintenance process. It specifies the characteristics of all the processes, parts of maintenance process, and establishes a maintenance model to gives guidelines for defining indicators. This European Standard is applicable to all organizations (company, institution, agency, etc.) in charge of maintaining physical assets. Therefore, it has been established without a particular organization in mind and does not aim to propose one. This description could be adapted based on the type and size of organization chosen to perform the maintenance, the complexity of the systems maintained and the scope of the external contracted services. The purpose of the breakdown into processes and the representation of their inter-relationships is to help maintenance personnel, and particularly management at different levels, to: clearly identify the actions to be taken in order to meet the overall objectives set by Management in terms of maintenance; delegate responsibilities that ensure the realization of the actions with the required performance levels; for each process, clearly determine: a) the necessary inputs and their origin; b) the required results and their intended uses; - monitor and quantitatively assess the performance obtained at various levels of the breakdown into processes; - improve the collection and the distribution of data. This standard does not cover software maintenance itself, but applies to items containing software.	Maintenance	KPI, process		CEN/TC 319 - Maintenance
EN ISO 14044:2018 - Environmental management - Life cycle assessment - Requirements and guidelines	It specifies requirements and provides guidelines for life cycle assessment (LCA) including: definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, relationship between the LCA phases, and conditions for use of value choices and optional elements. ISO 14044:2006 covers life cycle assessment (LCA) studies and life cycle inventory (LCI) studies.	Product Life Cycle	Guidelines	ISO/TC 207/SC 5 - Life cycle assessment	CEN SS/26 Environmental Management

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 13584-1:2001 Industrial automation systems and integration — Parts library — Part 1: Overview and fundamental principle	provides a representation of parts library information together with the necessary mechanisms and definitions to enable parts library data to be exchanged, used and updated. The exchange may be between different computer systems and environments associated with the complete life cycle of the products where the library parts may be used, including product design, manufacture, use, maintenance, and disposal. The standard provides a generalized structure for a parts library system and does not define a fully detailed implementable parts library system. This part of ISO 13584 provides an overview of the ISO 13584 standard and its structure. The following are within the scope of this part of ISO 13584: a summary of the content of the other parts of the ISO 13584 standard series; fundamental principles upon which the ISO 13584 standard is based. The following are outside the scope of this part of ISO 13584: the information models defined for capturing parts library data; the definition of the implementation resources needed to process parts library data.	Industrial Data	Library	ISO/TC 184/SC 4 - Industrial data	
ISO 15226:1999 - Technical product documentation — Life cycle model and allocation of documents	This International Standard gives a method of establishing a flexible life cycle model and gives guidance on efficient and easy-to-understand handling technical documents during the product life cycle. The product life cycle takes different company-specific requirements into account, in accordance with project management techniques. For general use in connection with non-company-specific requirements, procedures, processes and products, it may be necessary to establish a standardized life-cycle model with defined phases. This International Standard is intended for use in companies, bodies of authority and other organizations who deal with manufactured products, with the compilation and use of technical documents during the product life cycle. It is not applicable either to services or software. This International Standard is intended to be an aid in controlling and coordinating documents, in accordance with ISO 9001, ISO 9002, and ISO 9003.	Product Life Cycle	Technical documentation	ISO/TC 10 - Technical product documentation	
ISO 15531-43:2006 - Industrial automation systems and integration — Industrial manufacturing management data — Part 43: Manufacturing flow management data: Data model for flow monitoring and manufacturing data exchange	It addresses the representation of information related to manufacturing flow management, through the development of a conceptual model of the processes and of the flows of materials and information.	Industrial Data	Manufacturing flow	ISO/TC 184/SC 4 - Industrial data	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 18828-2:2016 - Industrial automation systems and integration — Standardized procedures for production systems engineering — Part 2: Reference process for seamless production planning	ISO 18828-2:2016 describes a reference planning process for seamless production planning. The scope of the discussed reference process focusses on the planning of production systems such as make-to-stock or assemble-to-order production. The analysis of the process activities has been limited to those within the production planning. The following aspects are within the scope of ISO 18828-2:2016: general overview of the reference planning process; basic principles of the process model; description of each level identified within the reference planning process for production planning; structure of activities and relations within each planning discipline; dependencies of interdisciplinary activities. The following items are outside the scope of ISO 18828-2:2016: material requirement planning/manufacturing resource planning; production order control; production process; early stage product design; order management, inventory management, purchasing, transportation, warehousing; production facilities planning/manufacturing facilities planning (physical plant and equipment), including any kind of resource that is not directly related to the manufacturing process; value chain (inbound logistics, operations management, outbound logistics, marketing and sales); resource visualization; process simulation.	Production engineering	Production planning	ISO/TC 184/SC 4 - Industrial data	
ISO 18828-3:2017 - Industrial automation systems and integration — Standardized procedures for production systems engineering — Part 3: Information flows in production planning processes	ISO 18828-3:2017 describes the information flows identified for each planning discipline within production planning, according to ISO 18828-2. The following aspects are within the scope of ISO 18828-3:2017: general overview of the main information flows within the reference planning process; basic pattern to describe the main information flows; detailed description of every main information flow; state notation structure of the main information flows objects; detailed descriptions for each information object state; proposal of checklists for benchmarking information objects. The following items are outside the scope of ISO 18828-3:2017: information flows to intersecting areas, including high-level planning; data models for production planning; complete description of all possible information flows/objects within production planning; workflow engines for automated production planning; production facilities planning/manufacturing facilities planning (physical plant and equipment); including any kind of resource that is not directly related to the manufacturing process; value chain (inbound logistics, operations management, outbound logistics, marketing and sales);process simulation/safeguarding; investment planning during production process management.	Production engineering	Information flow	ISO/TC 184/SC 4 - Industrial data	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 18828-4:2018 - Industrial automation systems and integration — Standardized procedures for production systems engineering — Part 4: Key performance indicators (KPIs) in production planning processes	ISO 18828-4:2018 specifies a set of key performance indicators in production planning, which allow comparison and monitoring of the production planning process in a standardized framework. As a first step, the utilization of the KPIs is elaborated in order to organize the indicators in a multi-level system taking different ranges of the planning process into account. This development of a multi-level system represents the core of ISO 18828-4:2018. The scope of the planning processes discussed in ISO 18828-4:2018 is limited to production planning for products in series production. Only tasks carried out within the production planning process are considered in this approach. All key indicators presented are recommendations and can also be used in accordance with the general validity of the reference process from ISO 18828-2 and relate to the content described in ISO 18828-4:2018.	Production engineering	Production planning	ISO/TC 184/SC 4 - Industrial data	
ISO 18828-4:2018 - Industrial automation systems and integration — Standardized procedures for production systems engineering — Part 4: Key performance indicators (KPIs) in production planning processes	ISO 18828-4:2018 specifies a set of key performance indicators in production planning, which allow comparison and monitoring of the production planning process in a standardized framework. As a first step, the utilization of the KPIs is elaborated in order to organize the indicators in a multi-level system taking different ranges of the planning process into account. This development of a multi-level system represents the core of ISO 18828-4:2018. The scope of the planning processes discussed in ISO 18828-4:2018 is limited to production planning for products in series production. Only tasks carried out within the production planning process are considered in this approach. All key indicators presented are recommendations and can also be used in accordance with the general validity of the reference process from ISO 18828-2 and relate to the content described in ISO 18828-4:2018.	Production engineering	KPI	ISO/TC 184/SC 4 - Industrial data	
ISO 18828-5:2019 - Industrial automation systems and integration — Standardized procedures for production systems engineering — Part 5: Manufacturing change management	This document specifies a formal description of the manufacturing change management (MCM) processes to provide an organizational and technical solution for the comprehensive mapping and processing of changes between production planning and operations. The aim of this document is to uniformly capture and track change measures, and to sensibly forecast and coordinate the capacities required for change processes in the planning and production departments. This document presents a data-oriented view for implementation of MCM. The most important aspect of the data-oriented view is that the central change element is linked to the objects of the digital factory (i.e. the process, the product and the resource). The basis for MCM and the different views presented in this document are production planning processes. ISO/TR 18828-1 gives an overview of the ISO 18828 series and links the MCM to the other parts of ISO 18828, focussing on production planning processes, as well as information flows and key performance indicators. The following aspects are covered within this document: processes of MCM; roles in MCM; data-oriented view of MCM; workflow of MCM.	Production engineering	Manufacturing change management	ISO/TC 184/SC 4 - Industrial data	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 20534:2018 - Industrial automation systems and integration — Formal semantic models for the configuration of global production networks	This document specifies a formal logic-based concept specialization approach to support the development of manufacturing reference models that underpin the necessary business specific knowledge models needed to support the configuration of global production networks.This document specifies the following: the formal sematic model approach; hierarchical levels for property specialization; contexts for each level; key properties at each level; property relationships; property axioms; applicability rules. The following are within the scope of this document: production networks for discrete product manufacture; formal semantics for the configuration of global production networks; system level formal semantics; designed system formal semantics; manufacturing business system formal semantics; global production systems network formal semantics. The following are outside the scope of this document: in-factory formal semantics; formal semantics for the operation of global production networks.	Industrial Data	Manufacturing reference model	ISO/TC 184/SC 4 - Industrial data	
ISO 9283:1998 - Manipulating industrial robots — Performance criteria and related test methods	This International Standard describes methods of specifying and testing the following performance characteristics of manipulating industrial robots: pose accuracy and pose repeatability; multi-directional pose accuracy variation; distance accuracy and distance repeatability; position stabilization time; position overshoot; drift of pose characteristics; exchangeability; path accuracy and path repeatability; path accuracy on reorientation; cornering deviations; path velocity characteristics; minimum posing time; static compliance; weaving deviations.	Robotic	Performance	ISO/TC 299 - Robotics	
ISO 9787:2013 - Robots and robotic devices — Coordinate systems and motion nomenclatures	ISO 9787:2013 defines and specifies robot coordinate systems. It also provides nomenclature, including notations, for the basic robot motions. It is intended to aid in robot alignment, testing, and programming. ISO 9787:2013 applies to all robots and robotic devices as defined in ISO 8373.	Robotic	Code	ISO/TC 299 - Robotics	
ISO/CD TR 22100-5 - Safety of machinery — Relationship with ISO 12100 — Part 5: Implications of embedded Artificial Intelligence-machine learning	UNDER DEVELOPMENT	Artificial Intelligence	Safety	ISO/TC 199 - Safety of machinery	
ISO/IEC AWI TR 24027 - Information technology — Artificial Intelligence (AI) — Bias in AI systems and AI aided decision making	UNDER DEVELOPMENT	Artificial Intelligence	Bias	ISO/IEC JTC 1/SC 42 - Artificial intelligence	
ISO/IEC CD 23053 Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML)	UNDER DEVELOPMENT	Artificial Intelligence	Artificial Intelligence	ISO/IEC JTC 1/SC 42 - Artificial intelligence	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO/IEC CD 23894 - Information Technology — Artificial Intelligence — Risk Management	UNDER DEVELOPMENT	Artificial Intelligence	Risk assessment	ISO/IEC JTC 1/SC 42 - Artificial intelligence	
ISO/TR 13309:1995 - Manipulating industrial robots — Informative guide on test equipment and metrology methods of operation for robot performance evaluation in accordance with ISO 9283	Supplies information on the state-of-the-art of test equipment operating principles. Additional information is provided that describes the applications of current test equipment technology to ISO 9283.	Robotic	Performance	ISO/TC 299 - Robotics	
ISO/TR 18828-1:2018 - Industrial automation systems and integration — Standardized procedures for production systems engineering — Part 1: Overview	Describes the framework of the ISO 18828 series in seamless production planning. The following are within the scope of this document: general overview of the framework of the ISO 18828 series, quintessential description of each part; inter-relational aspects and appliance of the framework. The following are outside the scope of this document: detailed process descriptions; detailed data flows; detailed KPIs; detailed data models; in-depth discussion of the parts of the ISO 18828 series.	Production engineering	Framework	ISO/TC 184/SC 4 - Industrial data	
ISO/WD TR 22100-5 - Safety of machinery — Relationship with ISO 12100 — Part 5: Implications of embedded Artificial Intelligence-machine learning	UNDER DEVELOPMENT	Cybersecurity	Machine Learning	ISO/TC 199 - Safety of machinery	
Maintenance — Maintenance engineering — Requirements	*UNDER DEVELOPMENT*	Maintenance	Engineering		CEN/TC 319 - Maintenance
Maintenance function and management	*UNDER DEVELOPMENT*	Maintenance	Management system		CEN/TC 319 - Maintenance
Performance and condition assessment within physical asset management	*UNDER DEVELOPMENT*	Maintenance	Performance		CEN/TC 319 - Maintenance
UNI 11454:2012 - Maintenance - Maintenance within physical asset design	This standard specifies principles, criteria, methodologies and procedures, as well as informative elements and indicators relating to maintenance. They are to be considered and included in the design process of a physical asset in order to ensure over the life cycle the characteristics, levels of performance and lifetime expected, as posted in the general terms and conditions of contract and related technical specifications.	Maintenance	KPI, design		

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5.2.3 Big Data analytics: standardisation initiatives and Technical Committees

KEY AREA – AUGMENTED REALITY

This key area aims at developing novel visualization and localization mechanisms to display information on equipment refurbishment and remanufacturing operations based on the data provided by the Adaptive Sensorial Network. The key modules are: i) Indoor localization and 3D registration module, ii) Augmented Reality (AR visualisation module, iii) Context-based multi-modal interaction module, iv) real-time 3D annotation module.

The following relevant standardisation technical committees have been identified (Tab 10). They provide initial knowledge on 3D representation, reference model and related interoperability code and languages. List of relevant standards elaborated by those TCs are provided in Table 11.

Table 10 AUGMENTED REALITY: list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation[30]	ISO/IEC JTC 1/SC 24/WG 6 Augmented reality continuum presentation and interchange ISO/IEC JTC 1/SC 24/WG 7 Image processing and interchange ISO/IEC JTC 1/SC 24/WG 8 Environmental representation ISO/IEC JTC 1/SC 24/WG 9 Augmented reality continuum concepts and reference model
ISO/TC 184/SC 4 - Industrial data[31]	ISO/TC 184/SC 4/JWG 16 Joint ISO/TC 184/SC 4 - ISO/IEC JTC 1/SC 24 - ISO/TC 171/SC 2 WG: Formats for visualization and other derived forms of product data

[30] https://www.iso.org/committee/45252.html
[31] https://www.iso.org/committee/54158.html

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Table 11 AUGMENTED REALITY: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO/IEC 18025:2014 - Information technology — Environmental Data Coding Specification (EDCS)	ISO/IEC 18025:2014 provides mechanisms to specify unambiguously objects used to model environmental concepts.	Augmented Reality	Environmental data	ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation
ISO/IEC 18038:2020 - Information technology — Computer graphics, image processing and environmental representation — Sensor representation in mixed and augmented reality	This document defines the framework and information reference model for representing sensor-based 3D mixed-reality worlds. It defines concepts, an information model, architecture, system functions, and how to integrate 3D virtual worlds and physical sensors in order to provide mixed-reality applications with physical sensor interfaces. It defines an exchange format necessary for transferring and storing data between physical sensor-based mixed-reality applications. This document specifies the following functionalities: a) representation of physical sensors in a 3D scene; b) definition of physical sensors in a 3D scene; c) representation of functionalities of each physical sensor in a 3D scene; d) representation of physical properties of each physical sensor in a 3D scene; e) management of physical sensors in a 3D scene; f) interface with physical sensor information in a 3D scene. This document defines a reference model for physical sensor-based mixed-reality applications to represent and to exchange functions of physical sensors in 3D scenes. It does not define specific physical interfaces necessary for manipulating physical devices, but rather defines common functional interfaces that can be used interchangeably between applications. This document does not define how specific applications are implemented with specific physical sensor devices. It does not include computer generated sensor information using computer input/output devices such as a mouse or a keyboard. The sensors in this document represent physical sensor devices in the real world.	Augmented Reality	Framework	ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO/IEC 18039:2019 . Information technology — Computer graphics, image processing and environmental data representation — Mixed and augmented reality (MAR) reference model	This document defines the scope and key concepts of mixed and augmented reality, the relevant terms and their definitions and a generalized system architecture that together serve as a reference model for mixed and augmented reality (MAR) applications, components, systems, services and specifications. This architectural reference model establishes the set of required sub-modules and their minimum functions, the associated information content and the information models to be provided and/or supported by a compliant MAR system. The reference model is intended for use by current and future developers of MAR applications, components, systems, services or specifications to describe, compare, contrast and communicate their architectural design and implementation. The MAR reference model is designed to apply to MAR systems independent of specific algorithms, implementation methods, computational platforms, display systems and sensors or devices used. This document does not specify how a particular MAR application, component, system, service or specification is designed, developed or implemented. It does not specify the bindings of those designs and concepts to programming languages or the encoding of MAR information through any coding technique or interchange format. This document contains a list of representative system classes and use cases with respect to the reference model.	Augmented Reality	Reference architecture	ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation
ISO/IEC 18040:2019 - Information technology — Computer graphics, image processing and environmental data representation — Live actor and entity representation in mixed and augmented reality (MAR)	This document defines a reference model and base components for representing and controlling a single LAE or multiple LAEs in an MAR scene. It defines concepts, a reference model, system framework, functions and how to integrate a 2D/3D virtual world and LAEs, and their interfaces, in order to provide MAR applications with interfaces of LAEs. It also defines an exchange format necessary for transferring and storing LAE-related data between LAE-based MAR applications. This document specifies the following functionalities: a) definitions for an LAE in MAR; b) representation of an LAE; c) representation of properties of an LAE; d) sensing of an LAE in a physical world; e) integration of an LAE into a 2D/3D virtual scene; f) interaction between an LAE and objects in a 2D/3D virtual scene; g) transmission of information related to an LAE in an MAR scene. This document defines a reference model for LAE representation-based MAR applications to represent and to exchange data related to LAEs in a 2D/3D virtual scene in an MAR scene. It does not define specific physical interfaces necessary for manipulating LAEs, that is, it does not define how specific applications need to implement a specific LAE in an MAR scene, but rather defines common functional interfaces for representing LAEs that can be used interchangeably between MAR applications.	Augmented Reality	Entity representation	ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation
ISO/IEC 18520:2019 - Information technology — Computer graphics, image processing and environmental data representation — Benchmarking of vision-based spatial registration and	This document identifies the reference framework for the benchmarking of vision-based spatial registration and tracking (vSRT) methods for mixed and augmented reality (MAR). The framework provides typical benchmarking processes, benchmark indicators and trial set elements that are necessary to successfully identify, define, design, select and apply benchmarking of vSRT methods for MAR. It also provides definitions for terms on benchmarking of vSRT methods for MAR.	Augmented Reality	Spatial registration trackin	ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
tracking methods for mixed and augmented reality (MAR)	In addition, this document provides a conformance checklist as a tool to clarify how each benchmarking activity conforms to this document in a compact form by declaring which benchmarking processes and benchmark indicators are included and what types of trial sets are used in each benchmarking activity.			
ISO/IEC 19775-2:2015 - Information technology — Computer graphics, image processing and environmental data representation — Extensible 3D (X3D) — Part 2: Scene access interface (SAI)	ISO/IEC 19775-2:2015 specifies a standard set of services that are made available by a browser so that an author can access the scene graph while it is running. Such access is designed to support inspection and modification of the scene graph.	3D	Scene Access Interface	ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation
ISO/PAS 17506:2012 Industrial automation systems and integration — COLLADA digital asset schema specification for 3D visualization of industrial data	ISO/PAS 17506:2012 describes the COLLADA schema. COLLADA is a COLLAborative Design Activity that defines an XML-based schema to enable 3D authoring applications to freely exchange digital assets without loss of information, enabling multiple software packages to be combined into extremely powerful tool chains. The purpose of ISO/PAS 17506:2012 is to provide a specification for the COLLADA schema in sufficient detail to enable software developers to create tools to process COLLADA resources. In particular, it is relevant to those who import to or export from digital content creation (DCC) applications, 3D interactive applications and tool chains, prototyping tools, real-time visualization applications such as those used in the video game and movie industries, and CAD tools.	3D	Industrial data	ISO/TC 184/SC 4 - Industrial data
ISO/IEC 19776-2:2015 - Information technology — Computer graphics, image processing and environmental data representation — Extensible 3D (X3D) encodings — Part 2: Classic VRML encoding	ISO/IEC 19775-2:2015, Extensible 3D (X3D), defines a system that integrates 3D graphics and multimedia. Conceptually, each X3D file is a 3D time-based space that contains graphic and aural objects that can be dynamically modified through a variety of mechanisms. This part of ISO/IEC 19776 defines a mapping of the abstract objects in X3D to a specific encoding using the technique defined in ISO/IEC 14772 ? Virtual reality modeling language (VRML). Each Classic VRML-encoded X3D file: a. supports all of the purposes of X3D files defined in ISO/IEC 19775; and b. encodes X3D constructs in Classic VRML format. A Classic VRML-encoded X3D file may be referenced from files using other encodings and may itself reference X3D files encoded using other encodings. Such files can only be processed by browsers which conform to all of the utilized encodings.	3D	Virtual reality modelling language	ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation
ISO/TS 10303-1230:2005 - Industrial automation systems and integration — Product data representation and exchange — Part 1230: Application module: Configuration controlled 3D parts and assemblies	ISO/TS 10303-1230:2005 specifies the application module for Configuration controlled 3d parts and assemblies.The following are within the scope of ISO/TS 10303-1230:2005:products that are three-dimensional parts and assemblies; configuration control data and product definition data; shape representations that includes advanced boundary representation, faceted boundary representation, manifold manifold surfaces with topology, geometrically bounded surface and wireframe geometry, wireframe with topology, and constructive solid geometry in three-dimensions; geometric presentation of geometric shape representations by the application of colours, layers and groups; geometric and dimensional tolerances applied to geometric shape representations; textual annotation and notes applied to geometric shape representations.	3D	Configuration and assembly	ISO/TC 184/SC 4 - Industrial data

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO/TS 10303-403:2010 Industrial automation systems and integration — Product data representation and exchange — Part 403: Application module: AP203 configuration controlled 3D design of mechanical parts and assemblies	ISO/TS 10303-403:2010-03 specifies the application module for AP203 configuration controlled 3D design of mechanical parts and assemblies. The following are within the scope of ISO/TS 10303-403:2010-03: products that are mechanical parts and assemblies; product definition data and configuration control data pertaining to the design phase of a product's development; representation of an instance of a part in an assembly through its usage in a sub-assembly; three dimensional shape representations of a part that includes: geometrically and topologically bounded wireframe models; geometrically bounded surface models; topologically bounded solid models with facetted, elementary and advanced faces; non surface bounded solid models including constructive solid geometry, curve swept and other swept solids, thickened face solid; solids with construction history; topologically bounded manifold surface and subsurface and non manifold surface models; topologically bounded compound models; geometric validation properties to allow the translation of geometric shape representations (advanced boundary representation and faceted boundary representation solids) to be checked for quality; geometric and dimensional tolerances applied to geometric shape representations; materials and their composition of chemical substance; composite material structure and shape; catalogue data characterized by property value pairs; three dimensional presentation of product data: arranging geometric elements in layers and groups and assigning colours; presentation styles for points, curves, surfaces and sections, including hatching and tiling; saved views of particular camera positions and sections; textual annotation and notes applied to geometric elements; presentation of geometric and dimensional tolerances; technical drawings as two dimensional presentation of product data.	3D	Mechanical design	ISO/TC 184/SC 4 - Industrial data

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KEY AREA – DASHBOARD ANALYTICS

Industrial analytics are used to identify and recognize machine operational and behavioural patterns provide accurate prediction and make decisions with no lack of confidence. Data analytics suite will be developed to support situational awareness, based on: perception, comprehension and projection. Moreover, the suite will gain knowledge from descriptive analytics (gain insight from historical or current data streams), predictive analytics (creation of predictive models utilizing statistical and machine learning techniques for the identification of machine and processes behaviours) and prescriptive analytics (find optimal solutions based on descriptive and predictive analytics aspects).

KEY AREA – REFURBISHMENT AND REMANUFACTURING PLAN, PROCESS REFURBISHMENT

The key area aims at developing a classification scheme for individual identification of those machine parts that need refurbishment. Particular attention will be laid on the disassembly part, including inputs for design of future machines (design for manufacturing, assembly and disassembly approach), and to the "Inspection, diagnosis and sorting of parts". Focus on robotics and electromechanical system will be provided.

The following relevant standardisation technical committees have been identified (Tab 12 and Tab 13). They provide initial knowledge on Big data analytics and related statistical methods as well as trustworthiness and transparency model whenever applicable. List of relevant standards elaborated by thos TCs are provided in Table 14 and Table 15.

Table 12 DASHBOARD ANALYTICS: list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/TC 69 - Applications of statistical methods[32] Standardization in the application of statistical methods, including generation, collection (planning and design), analysis, presentation and interpretation of data. ISO Council, by Council Resolution 12 / 1959 and Council Resolution 26 / 1961 has entrusted ISO / TC 69 with the function of advisor to all ISO technical committees in matters concerning the application of statistical methods in standardization.	ISO/TC 69/WG 3 Statistical interpretation of data ISO/TC 69/WG 12 Big data analytics
ISO/IEC JTC 1/SC 42 - Artificial intelligence[33] Standardization in the area of Artificial Intelligence: serve as the focus and proponent for JTC 1's standardization program on Artificial Intelligence Provide guidance to JTC 1, IEC, and ISO committees developing Artificial Intelligence applications	ISO/IEC JTC 1/SC 42/WG 3 Trustworthiness

Table 13 REFURBISHMENT AND REMANUFACTURING PLAN, PROCESS REFURBISHMENT: list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
American National Standards Institute [ANSI][34] American Standard National Institute	
ISO/TC 10 - Technical product documentation Standardization and coordination of technical product documentation (TPD), including technical drawings, model based (3D), computer based (2D) or manually produced for technical purposes throughout the product life cycle, to facilitate preparation, management, storage, retrieval, reproduction, exchange and use.	ISO/TC 10/WG 20 Design and documentation for manufacture, assembly, disassembly and end-of-life processing
ISO/TC 299 - Robotics[35] Standardization in the field of robotics, excluding toys and military applications	ISO/TC 299/WG 4 Service robot performance

[32] https://www.iso.org/committee/49742.html
[33] https://www.iso.org/committee/6794475.html
[34] https://www.ansi.org/
[35] https://www.iso.org/committee/5915511.html

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Table 14 DASHBOARD ANALYTICS: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO/AWI 3534-5 Statistics — Vocabulary and symbols — Part 5: Terms used in big data (predictive analytics)	UNDER DEVELOPMENT	Big data	Predictive analytics	ISO/TC 69 - Applications of statistical methods
ISO/AWI TR 23347 - Statistics — Big Data Analytics — Data Science Life Cycle	UNDER DEVELOPMENT	Big data	Data Life cycle	ISO/TC 69 - Applications of statistical methods
ISO/AWI TR 23348 - Statistics — Big Data Analytics — Model Validation	UNDER DEVELOPMENT	Big data	model	ISO/TC 69 - Applications of statistical methods
ISO/TR 16355-8:2020 - Applications of statistical and related methods to new technology and product development process - Part 8: Guidelines for commercialization and life cycle	This document describes after optimization of product design to address non-functional requirements, for example, test, produce, commercialize, deliver, support, and eventually retire a product from the market and provides guidance on the use of the applicable tools and methods. The goal is to identify and assure key processes and measures in order to satisfy and deliver value to customers and stakeholders.	Statistical method	Data analytics	ISO/TC 69 - Applications of statistical methods
ISO/IEC TR 24028:2020 Information technology — Artificial intelligence — Overview of trustworthiness in artificial intelligence	This document surveys topics related to trustworthiness in AI systems, including the following: approaches to establish trust in AI systems through transparency, explainability, controllability, etc.; engineering pitfalls and typical associated threats and risks to AI systems, along with possible mitigation techniques and methods; and approaches to assess and achieve availability, resiliency, reliability, accuracy, safety, security and privacy of AI systems. The specification of levels of trustworthiness for AI systems is out of the scope of this document.	Artificial Intelligence	Trustworthiness	ISO/IEC JTC 1/SC 42 - Artificial intelligence

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Table 15 REFURBISHMENT AND REMANUFACTURING PLAN, PROCESS REFURBISHMENT: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ANSI RIC001.1-2016 - Specifications For The Process Of Remanufacturing	defines and provides a benchmark for the process of remanufacturing, and establishes specifications that characterize the remanufacturing process and differentiate remanufacturing from other practices.	Remanufacturing	Framework	American National Standards Institute [ANSI]
ISO 8887-1:2017 - Technical product documentation — Design for manufacturing, assembling, disassembling and end-of-life processing — Part 1: General concepts and requirements	ISO 8887-1:2017 specifies the requirements for the preparation, content and structure of technical product documentation (TPD) of design output for the cycles of manufacturing, assembling, disassembling and end-of-life processing of products. It describes the TPD needed at the critical stages of a design process. It identifies and describes methods and conventions appropriate to the preparation of documentation, in whatever form, necessary to realize a design including the application to multiple life cycles. It extends beyond specification for the manufacturing and assembling of products to incorporate guidance on the ultimate reusing, recovering, recycling and disposing of the components and materials used.	Remanufacturing	Disassembly	ISO/TC 10 - Technical product documentation
ISO 9409-1:2004 - Manipulating industrial robots — Mechanical interfaces — Part 1: Plates	ISO 9409-1:2004 defines the main dimensions, designation and marking for a circular plate as mechanical interface. It is intended to ensure the exchangeability and to keep the orientation of hand-mounted end effectors. It does not define other requirements of the end effector coupling device. It does not contain any correlation of load-carrying ranges, as it is expected that the appropriate interface is selected depending on the application and the load-carrying capacity of the robot.	**Robotic**	**Plate**	ISO/TC 299 - Robotics
ISO 9409-2:2002 - Manipulating industrial robots — Mechanical interfaces — Part 2: Shafts	ISO 9409-2:2002 defines the main dimensions, designation and marking for a shaft with cylindrical projection as mechanical interface. It is intended to ensure the exchangeability and to keep the orientation of hand-mounted end effectors. ISO 9409-2:2002 does not contain any correlation of load-carrying ranges. The mechanical interfaces specified in ISO 9409-2:2002 will also find application in simple handling systems which are not covered by the definition of manipulating industrial robots, such as pick-and-place or master-slave units.	**Robotic**	**Shaft**	ISO/TC 299 - Robotics

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5.2.4 Cost Modelling: standardisation initiatives and Technical Committees

No relevant standards nor Technical Committees has been identified at the present moment.

5.2.5 Life Cycle Assessment and Life Cycle Costs (LCA and LCC): standardisation initiatives and Technical Committees

KEY AREA – LIFE CYCLE COST, LIFE CYCLE ANALYSIS (LCC – LCA)

RECLAIM Environmental Life Cycle Assessment (LCA) will measure the current sustainability performances of a machine in order to increase users' awareness on their machines' sustainability performances and provide benchmarks, i.e. a set of measures of the facilities sustainability performances to be used as a reference during new machine designand to to automatically generate reports.

It will finally support the definition of recommendable sustainability-driven lifetime-extension methods to be adopted (Repair, Reuse; Remanufacturing, Recycling).

The following relevant standardisation technical committees have been identified (Tab 16), focusing on international LCA standards. List of relevant standards elaborated by thos TCs are provided in Table 17.

Table 16 LCC and LCA: list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/TC 251 - Asset management[36] Standardization in the field of asset management.	ISO/TC 251/WG 5 Finance
ISO/TC 207/SC 5 - Life cycle assessment[37] Standardization in the field of life cycle assessment and related environmental management tools for products and organizations. It includes life cycle based resource efficiency and eco-efficiency assessment, and encompasses consideration of a life cycle perspective in the assessment of impacts from the extraction of raw materials to the final disposal of waste.	ISO/TC 207/SC 5/WG 12 Life cycle assessment -- Requirements and guidelines
ISO/TC 207/SC 4 - Environmental performance evaluation[38] Standardization in the field of environmental performance evaluation in support of sustainability	ISO/TC 207/SC 4/WG 5 Environmental Technology Verification ISO/TC 207/SC 4/WG 8 Environmental performance evaluation
ISO/TC 207/SC 3 - Environmental labelling[39] Standardization in the field of communication on the environmental aspects of products, i.e. goods and services, including the related programmes and verification procedures. Such communication includes environmental labels and declarations which describe products by qualitative features or by one or more quantitative parameters	NA
ISO/TC 207/SC 1 - Environmental management systems[40] Standardization in the field of environmental management systems to support the achievement of sustainability.	ISO/TC 207/SC 1/WG 11 Applying ISO 14001 framework to environmental aspects by topic areas

[36] https://www.iso.org/committee/604321.html
[37] https://www.iso.org/committee/54854.html
[38] https://www.iso.org/committee/54846.html
[39] https://www.iso.org/committee/54836.html
[40] https://www.iso.org/committee/54818.html

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ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/TC 207 - Environmental management[41] Standardization in the field of environmental management systems and tools in support of sustainable development. Excluded: test methods of pollutants, setting limit values and levels of environmental performance, and standardization of products. Note: The TC for environmental management will have close cooperation with ISO / TC 176 in the field of environmental systems and audits.	NA
ISO/IEC JTC 1/SC 32 - Data management and interchange[42] Standards for data management within and among local and distributed information systems environments.	NA
CEN SS/26 Environmental Management	NA

[41] https://www.iso.org/committee/54808.html
[42] https://www.iso.org/committee/45342.html

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Table 17 LCC and LCA: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
CEN ISO/TS 14027:2018 - Environmental labels and declarations - Development of product category rules	ISO/TS 14027:2017 provides principles, requirements and guidelines for developing, reviewing, registering and updating PCR within a Type III environmental declaration or footprint communication programme based on life cycle assessment (LCA) according to ISO 14040 and ISO 14044 as well as ISO 14025, ISO 14046 and ISO/TS 14067. It also provides guidance on how to address and integrate additional environmental information, whether or not it is based on LCA in a coherent and scientifically sound manner according to ISO 14025.	Environmental management system	Environmental label	ISO/TC 207/SC 3 - Environmental labelling	CEN SS/26 Environmental Management
EN ISO 14001:2015 - Environmental management systems - Requirements with guidance for use	This International Standard specifies the requirements for an environmental management system that an organization can use to enhance its environmental performance. This International Standard is intended for use by an organization seeking to manage its environmental responsibilities in a systematic manner that contributes to the environmental pillar of sustainability. This International Standard helps an organization achieve the intended outcomes of its environmental management system, which provide value for the environment, the organization itself and interested parties. Consistent with the organization's environmental policy, the intended outcomes of an environmental management system include: — enhancement of environmental performance; — fulfilment of compliance obligations; — achievement of environmental objectives. This International Standard is applicable to any organization, regardless of size, type and nature, and applies to the environmental aspects of its activities, products and services that the organization determines it can either control or influence considering a life cycle perspective. This International Standard does not state specific environmental performance criteria. This International Standard can be used in whole or in part to systematically improve environmental management. Claims of conformity to this International Standard, however, are not acceptable unless all its requirements are incorporated into an organization's environmental management system and fulfilled without exclusion.	Environmental management system	Performance	ISO/TC 207/SC 1 - Environmental management systems	CEN SS/26 Environmental Management
EN ISO 14004:2016 - Environmental management systems - General guidelines on implementation	This International Standard provides guidance on the establishment, implementation, maintenance and improvement of an environmental management system with the potential to integrate it into the core business process. The guidelines in this International Standard are applicable to any organization, regardless of its size, type, location or level of maturity. While the guidelines in this International Standard are consistent with the ISO 14001 environmental management system model, they are not intended to provide interpretations of the requirements of ISO 14001.	Environmental management system	EMS	ISO/TC 207/SC 1 - Environmental management systems	CEN SS/26 Environmental Management

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN ISO 14005:2019 - Environmental management systems - Guidelines for a flexible approach to phased implementation	This document gives guidelines for a phased approach to establish, implement, maintain and improve an environmental management system (EMS) that organizations, including small and medium-sized enterprises (SMEs), can adopt to enhance their environmental performance. The phased approach provides flexibility that allows organizations to develop their EMS at their own pace, over a number of phases, according to their own circumstances. Each phase consists of six consecutive stages. The system's maturity at the end of each phase can be characterized using the five-level maturity matrix provided in Annex A. This document is applicable to any organization regardless of their current environmental performance, the nature of the activities undertaken or the locations at which they occur. The phased approach enables an organization to develop a system that ultimately satisfies the requirements of ISO 14001. The guidance does not cover those elements of specific systems that go beyond ISO 14001 and it is not intended to provide interpretations of the requirements of ISO 14001.	Environmental management system	Phase approach	ISO/TC 207/SC 1 - Environmental management systems	CEN SS/26 Environmental Management
EN ISO 14006:2020 - Environmental management systems - Guidelines for incorporating ecodesign	This document gives guidelines for assisting organizations in establishing, documenting, implementing, maintaining and continually improving their management of ecodesign as part of an environmental management system (EMS). This document is intended to be used by organizations that have implemented an EMS in accordance with ISO 14001, but it can also help in integrating ecodesign using other management systems. The guidelines are applicable to any organization regardless of its type, size or product(s) provided. This document is applicable to product-related environmental aspects and activities that an organization can control and those it can influence. This document does not establish specific environmental performance criteria.	Environmental management system	Ecodesign	ISO/TC 207/SC 1 - Environmental management systems	CEN SS/26 Environmental Management
EN ISO 14020:2002 - Environmental labels and declarations - General principles	This International Standard establishes guiding principles for the development and use of environmental labels and declarations. It is intended that other applicable standards in the ISO 14020 series be used in conjunction with this International Standard. This International Standard is not intended for use as a specification for certification and registration purposes. NOTE Other International Standards in the series are intended to be consistent with the principles set forth in this International Standard. Other standards currently in the ISO 14020 series are ISO 14021, ISO 14024 and ISO/TR 14025 (see Bibliography).	Environmental management system	Environmental label	ISO/TC 207/SC 3 - Environmental labelling	CEN SS/26 Environmental Management
EN ISO 14021:2016 - Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling)	ISO 14021:2016 specifies requirements for self-declared environmental claims, including statements, symbols and graphics, regarding products. It further describes selected terms commonly used in environmental claims and gives qualifications for their use. This International Standard also describes a general evaluation and verification methodology for self-declared environmental claims and specific evaluation and verification methods for the selected claims in this International Standard.	Environmental management system	Environmental label	ISO/TC 207/SC 3 - Environmental labelling	CEN SS/26 Environmental Management

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN ISO 14024:2018 - Environmental labels and declarations - Type I environmental labelling - Principles and procedures	ISO 14024:2018 establishes the principles and procedures for developing Type I environmental labelling programmes, including the selection of product categories, product environmental criteria and product function characteristics, and for assessing and demonstrating compliance. ISO 14024:2018 also establishes the certification procedures for awarding the label.	Environmental management system	Environmental label	ISO/TC 207/SC 3 - Environmental labelling	CEN SS/26 Environmental Management
EN ISO 14025:2010 - Environmental labels and declarations - Type III environmental declarations - Principles and procedures	This International Standard establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations. It specifically establishes the use of the ISO 14040 series of standards in the development of Type III environmental declaration programmes and Type III environmental declarations. This International Standard establishes principles for the use of environmental information, in addition to those given in ISO 14020.	Environmental management system	Environmental label	ISO/TC 207/SC 3 - Environmental labelling	CEN SS/26 Environmental Management
EN ISO 14031:2013 - Environmental management - Environmental performance evaluation - Guidelines	guidance on the design and use of environmental performance evaluation (EPE) within an organization. It is applicable to all organizations, regardless of type, size, location and complexity. This International Standard does not establish environmental performance levels. The guidance in this International Standard can be used to support an organization's own approach to EPE, including its commitments to compliance with legal and other requirements, the prevention of pollution, and continual improvement.	Environmental management system	Performance	ISO/TC 207/SC 4 - Environmental performance evaluation	CEN SS/26 Environmental Management
EN ISO 14034:2018 - Environmental management - Environmental technology verification (ETV)	ISO 14034:2016 specifies principles, procedures and requirements for environmental technology verification (ETV).	Environmental management system	Performance	ISO/TC 207/SC 4 Environmental performance evaluation	CEN SS/26 Environmental Management
EN ISO 14040:2006 - Environmental management - Life cycle assessment - Principles and framework	This International Standard describes the principles and framework for life cycle assessment (LCA) including) the goal and scope definition of the LCA,b) the life cycle inventory analysis (LCI) phase,c) the life cycle impact assessment (LCIA) phase,d) the life cycle interpretation phase,e) reporting and critical review of the LCA,f) limitations of the LCA,g) relationship between the LCA phases, andh) conditions for use of value choices and optional elements. This International Standard covers life cycle assessment (LCA) studies and life cycle inventory (LCI) studies. It does not describe the LCA technique in detail, nor does it specify methodologies for the individual phases of the LCA.	Product Life Cycle	Framework	ISO/TC 207/SC 5 - Life cycle assessment	CEN SS/26 Environmental Management

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN ISO 14045:2012 - Environmental management - Eco-efficiency assessment of product systems - Principles, requirements and guidelines	Describes the principles, requirements and guidelines for eco-efficiency assessment for product systems including a) the goal and scope definition of the eco-efficiency assessment; b) the environmental assessment; c) the product system value assessment; d) the quantification of eco-efficiency; e) interpretation (including quality assurance); f) reporting; g) critical review of the eco-efficiency assessment. Requirements, recommendations and guidelines for specific choices of categories of environmental impact and values are not included. The intended application of the eco-efficiency assessment is considered during the goal and scope definition, but the actual use of the results is outside the scope of this International Standard. This International Standard is not intended to be used as a single base for contractual or regulatory purposes or registration and certification.	Environmental management system	Assessment	ISO/TC 207/SC 4 - Environmental performance evaluation	CEN SS/26 Environmental Management
EN ISO 14050:2010 - Environmental management - Vocabulary	This International Standard defines terms of fundamental concepts related to environmental management, published in the ISO 14000 series of International Standards.	Environmental management system	Terminology	ISO/TC 207 - Environmental management	CEN SS/26 Environmental Management
EN ISO 14063:2020 - Environmental management — Environmental communication — Guidelines and examples	This document gives guidelines to organizations for general principles, policy, strategy and activities relating to both internal and external environmental communication. It uses proven and well-established approaches for communication, adapted to the specific conditions that exist in environmental communication. It is applicable to all organizations regardless of their size, type, location, structure, activities, products and services, and whether or not they have an environmental management system in place. It can be used in combination with any of the ISO 14000 family of standards, or on its own. NOTE 1 A reference table to the ISO 14000 family is provided in Annex A. NOTE 2 ISO 14020, ISO 14021, ISO 14024, ISO 14025 and ISO 14026 provide specific environmental communication tools and guidance relating to product labels and declarations.	Environmental management system	Environmental communication	ISO/TC 207/SC 4 Environmental performance evaluation	CEN SS/26 Environmental Management

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO/DIS 14009 - Environmental management systems — Guidelines for incorporating material circulation in design and development	This document provides guidelines to assist organizations in establishing, documenting, implementing, maintaining and continually improving material circulation in their design and development in a systematic manner, using an environmental management system (EMS) framework. These guidelines are intended to be used by those organizations that implement an EMS in accordance with ISO 14001. The guidelines can also help in integrating material circulation strategies in design and development when using other management systems. The guidelines can be applied to any organization regardless of its size or activity. This document provides guidelines for design strategies on material circulation to achieve the material efficiency objectives of an organization, by focusing on the following aspects: Type and quantity of materials in products, Product lifetime extension, Recovery of products, parts, and materials. In design and development, many aspects are considered, such as safety, performance, and cost. Although important, they are not addressed in this document.	Environmental management system	Ecodesign	ISO/TC 207/SC 1 - Environmental management systems	
ISO/TR 14047:2012 - Environmental management — Life cycle assessment — Illustrative examples on how to apply ISO 14044 to impact assessment situations	Provide examples to illustrate current practice of life cycle impact assessment according to ISO 14044:2006. These examples are only a sample of all possible examples that could satisfy the provisions of ISO 14044. They offer "a way" or "ways" rather than the "unique way" of applying ISO 14044. They reflect the key elements of the life cycle impact assessment (LCIA) phase of the LCA. The examples presented in ISO/TR 14047:2012 are not exclusive and other examples exist to illustrate the methodological issues described.	Product Life Cycle	Life cycle impact	ISO/TC 207/SC 5 - Life cycle assessment	CEN SS/26 Environmental Management
ISO/TR 14049:2012 - Environmental management — Life cycle assessment — Illustrative examples on how to apply ISO 14044 to goal and scope definition and inventory analysis	ISO/TR 14049:2012 provides examples about practices in carrying out a life cycle inventory analysis (LCI) as a means of satisfying certain provisions of ISO 14044:2006. These examples are only a sample of the possible cases satisfying the provisions of ISO 14044. They offer "a way" or "ways" rather than the "unique way" for the application of ISO 14044. These examples reflect only portions of a complete LCI study.	Product Life Cycle	Inventory	ISO/TC 207/SC 5 - Life cycle assessment	CEN SS/26 Environmental Management
ISO/TS 14048:2006 - Environmental management - Life cycle assessment - Data documentation format	It provides the requirements and a structure for a data documentation format, to be used for transparent and unambiguous documentation and exchange of Life Cycle Assessment (LCA) and Life Cycle Inventory (LCI) data, thus permitting consistent documentation of data, reporting of data collection, data calculation and data quality, by specifying and structuring relevant information.	Product Life Cycle	Data format	ISO/TC 207/SC 5 - Life cycle assessment	CEN SS/26 Environmental Management

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO/TS 14072:2015 - Environmental management - Life cycle assessment - Requirements and guidelines for organizational life cycle assessment	ISO/TS 14072:2014 provides additional requirements and guidelines for an effective application of ISO 14040 and ISO 14044 to organizations. This Technical Specification details: - the application of Life Cycle Assessment (LCA) principles and methodology to organizations, - the benefits that LCA can bring to organizations by using LCA methodology at organizational level, - the system boundary, - specific considerations when dealing with LCI, LCIA, and interpretation, and the limitations regarding reporting, environmental declarations, and comparative assertions. This Technical Specification applies to any organization that has interest in applying LCA. It is not intended for the interpretation of ISO 14001 and specifically covers the goals of ISO 14040 and ISO 14044.	Product Life Cycle	Organisation	ISO/TC 207/SC 5 - Life cycle assessment	CEN SS/26 Environmental Management
ISO/WD TS 14074 - Environmental management — Life cycle assessment — Principles, requirements and guidelines for normalization, weighting and interpretation	UNDER DEVELOPMENT	Environmental management system	Life cycle assessment	ISO/TC 207/SC 5 - Life cycle assessment	

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5.3 RECLAIM Frameworks

5.3.1 Digital Twin model: standardisation initiatives and Technical committees

The key area will build the Digital Twin Model to monitor and predict the performance and status of factory assets, using the data collected by the platform implemented. It will provide input for the development of maintenance plan and predictive maintenance strategy.

The following standardisation technical committees have been identified (Tab. 18). They focus on industrial data, to be gathered by the digital model, reference architecture and existing digital twin model. Specific attention is provided to condition monitoring and machine diagnosicselement to be mapped by the digital twin.
Relevant standards are summed up in table 19.

Table 18 DIGITAL TWIN : list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/IEC JTC 1/SC 32 - Data management and interchange[43] Standards for data management within and among local and distributed information systems environments. SC 32 provides enabling technologies to promote harmonization of data management facilities across sector-specific areas. Specifically, SC 32 standards include: reference models and frameworks for the coordination of existing and emerging standards; definition of data domains, data types, and data structures, and their associated semantics; languages, services, and protocols for persistent storage, concurrent access, concurrent update, and interchange of data; methods, languages, services, and protocols to structure, organize, and register metadata and other information resources associated with sharing and interoperability, including electronic commerce.	ISO/IEC JTC 1/SC 32/WG 1 eBusiness ISO/IEC JTC 1/SC 32/WG 2 MetaData ISO/IEC JTC 1/SC 32/WG 3 Database language
IEC/TC 65 - Industrial-process measurement, control and automation[44] To prepare international standards for systems and elements used for industrial process measurement, control and automation. To coordinate standardization activities which affect integration of components and functions into such systems including safety and security aspects. This work of standardization is to be carried out in the international fields for equipment and systems.	SC 65E Devices and integration in enterprise systems WG 16 Digital Factory WG 23 Smart Manufacturing Framework and Concepts for industrial-process measurement, control and automation WG 24 Asset Administration Shell for Industrial Applications
ISO/TC 10/SC 6 - Mechanical engineering documentation[45]	NA
ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems[46] Standardization of the procedures, processes and equipment requirements uniquely related to the technical activity of condition monitoring and diagnostics of machines systems in which selected physical parameters associated with an operating machine system are periodically or continuously sensed, measured and recorded for the interim purpose of reducing, analyzing, comparing and displaying the data and information so obtained and for the ultimate purpose of	ISO/TC 108/SC 5/WG 17 Condition monitoring and diagnostics applications ISO/TC 108/SC 5/WG 18 Condition monitoring management ISO/TC 108/SC 5/AG E Strategic planning ISO/TC 108/SC 5/WG 4 Tribology-based monitoring and diagnostics

[43] https://www.iso.org/committee/45342.html
[44] https://www.iec.ch/dyn/www/f?p=103:7:0:::FSP_ORG_ID,FSP_LANG_ID:1250,25#:~:text=TC%2065%20Scope,process%20measurement%2C%20control%20and%20automation.&text=This%20work%20of%20standardization%20is,fields%20for%20equipment%20and%20systems.
[45] https://www.iso.org/committee/46064.html
[46] https://www.iso.org/committee/51538.html

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ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
using this interim result to support decisions related to the operation and maintenance of the machine system.	
ISO/TC 184/SC 4 - Industrial data	ISO/TC 184/SC 4/WG 8 Joint ISO/TC 184/SC 4 - ISO/TC 184/SC 5 WG: Manufacturing process and management information ISO/TC 184/SC 4/WG 13 Industrial Data Quality ISO/TC 184/SC 4/WG 15 Digital manufacturing

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Table 19 DIGITAL TWIN: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
IEC 63278-1 ED1 - Asset administration shell for industrial applications - Part 1: Administration shell structure	ND	Industrial data	Asset administration shell	IEC/TC 65 - Industrial-process measurement, control and automation
ISO 10303-1:1994 - Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles	Provides a representation of product information along with the necessary mechanisms and definitions to enable product data to be exchanged. Applies to the representation of product information, including components and assemblies; the exchange of product data, including storing, transferring, accessing, and archiving. Defines the basic principles of product information representation and exchange used in ISO 10303.	Industrial Data	Data representation	ISO/TC 184/SC 4 - Industrial data
ISO 13374-1:2006 - Condition monitoring and diagnostics of machines - Data processing, communication and presentation - Part 1: General guidelines	General guidelines for software specifications related to data processing, communication, and presentation of machine condition monitoring and diagnostic information.	Condition monitoring and diagnostic	Data processing, guidelines	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems
ISO 13374-2:2010 - Condition monitoring and diagnostics of machines - Data processing, communication and presentation - Part 2: Data processing	requirements for a reference information model and a reference processing model to which an open condition monitoring and diagnostics (CM&D) architecture needs to conform. Software design professionals require both an information model and a processing model to adequately describe all data processing requirements. ISO 13374-2:2007 facilitates the interoperability of CM&D systems.	Condition monitoring and diagnostic	Data processing	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO 15531-1:2004 - Industrial automation systems and integration — Industrial manufacturing management data — Part 1: General overview	It provides a general overview of the whole ISO 15531 standard (MANDATE). It specifies its scope and provides a number of basic definitions on which the whole standard is built in accordance with the "General system theory" and the concepts defined in APICS dictionary. Its informative annexes provide a description of the relationships between MANDATE and other standards (especially ISO/TC 184 standards), as well as a clarification of the concepts of "capability and capacity" as they are used in MANDATE and other standards that refer explicitly or implicitly to the system theory. MANDATE address the modelling of manufacturing management data such as: Resources management data (Resource model); Time related features (Time model); Flow management data in manufacturing (Flow management model). MANDATE, in association with STEP, PLIB and other SC 4 (or non SC 4) standards, may be used in any software application that addresses manufacturing management related information such as resources management data, flow management data. As such, the standard is intented at facilitating information exchanges between software applications such as E.R.P., manufacturing management software, maintenance management software, quotation software, etc. MANDATE has been written in EXPRESS. During the development phases of the MANDATE standard, the compatibility of the standard with the ISO 10303 (STEP) standard has been the subject of a thorough analysis.	Industrial Data	Framework	ISO/TC 184/SC 4 - Industrial data
ISO 15531-31:2004 - Industrial automation systems and integration — Industrial manufacturing management data — Part 31: Resource information model	It describes the universe of discourse of this International Standard as well as the resources information model. It provides the main principles used in this series of parts of ISO 15531.	Industrial Data	Resource information model	ISO/TC 184/SC 4 - Industrial data
ISO 15531-32:2005 - Industrial automation systems and integration — Industrial manufacturing management data: Resources usage management — Part 32: Conceptual model for resources usage management data	ISO 15531-32:2005 specifies the full description of the conceptual model for resources usage management data, based on the resource information model and basic principles described in ISO15531-31. The following are within the scope of ISO 15531-32:2005. the description of the conceptual resource information model and related definitions for resource usage management data; the EXPRESS description of the model and related entities; the EXPRESS-G diagram of the model.	Industrial Data	Usage management	ISO/TC 184/SC 4 - Industrial data

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO 15531-42:2005 Industrial automation systems and integration — Industrial manufacturing management data — Part 42: Time Model	ISO 15531-42:2005 specifies a generic framework for the description of topological properties applicable to a wide range of one dimension domains. Developments made in ISO 15531-42:2005 are focused on the time domain, thus providing a universal, self consistent model, independent of any event that may occur, or has already occurred, at a given point in time. The time model specified in ISO 15531-42:2005 enables any software application to provide an accurate time reference to any related event or sequence of events, whether in the past, in the present or in the future. This time model may be used by any application that needs to reference events, actions or sequences of action linked to time or intervals of time simultaneously. According to this, the scope of ISO 15531-42:2005 includes the following: the description of the topological properties of an one dimension domain; the description of the time model and of the related definitions; the EXPRESS definitions of entities, attributes and schemas as prescribed in ISO 10303-11 (the reference manual of the EXPRESS language); the EXPRESS-G diagrams of the model as prescribed in ISO 10303-11.	Industrial Data	Time model	ISO/TC 184/SC 4 - Industrial data
ISO 15531-44:2017 - Industrial automation systems and integration — Industrial manufacturing management data — Part 44: Information modelling for shop floor data acquisition	It addresses the modelling of the data collected from data acquisition systems at control level to be stored at the manufacturing management level and processed further at this level for any management purpose. The following are within the scope of ISO 15531-44:2017: quantitative or qualitative data collected from data acquisition systems at the control or management level to be stored at the management level and used later on to manage manufacturing; time stamping and time measurement provided from data acquisition systems for control and management data. The following are outside the scope of ISO 15531-44:2017: any data only related to remote and real time measurement and management; product definition data as modelled in the ISO 10303 series; catalogue and library data as modelled in ISO 13584 and ISO 15926; control data that are only used at the control level as well as those that are not used for manufacturing management.	Industrial Data	Data acquisition	ISO/TC 184/SC 4 - Industrial data

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO 17599:2015 - Technical product documentation (TPD) — General requirements of digital mock-up for mechanical products	ISO 17599:2015 specifies the requirements for the classification, composition, modelling, review, application, and management of digital mock-up. This International Standard for mechanical products is applicable to the building, management, review, and application of digital mock-up	Digital Twin	Digital mock up	ISO/TC 10/SC 6 - Mechanical engineering documentation
ISO 18629-1:2004 - Industrial automation systems and integration — Process specification language — Part 1: Overview and basic principles	ISO 18629-1:2004 provides a general overview of the different series of parts of ISO 18629, which defines a process specification language aimed at identifying, formally defining and structuring the semantic concepts intrinsic to the capture and exchange of process information related to discrete manufacturing.	Industrial Data	Process spefication	ISO/TC 184/SC 4 - Industrial data
ISO/CD TR 24464 -Automation systems and integration — Industrial data — Visualization elements of digital twins	UNDER DEVELOPMENT	Digital Twin	Visual element	ISO/TC 184/SC 4 - Industrial data
ISO/DIS 23247-1 - Automation systems and integration — Digital Twin framework for manufacturing — Part 1: Overview and general principles	UNDER DEVELOPMENT	Digital Twin	Framework	ISO/TC 184/SC 4 - Industrial data
ISO/DIS 23247-2 - Automation systems and integration — Digital Twin framework for manufacturing — Part 2: Reference architecture	UNDER DEVELOPMENT	Digital Twin	Reference architecture	ISO/TC 184/SC 4 - Industrial data
ISO/DIS 23247-3 - Automation systems and integration — Digital Twin framework for manufacturing — Part 3: Digital representation of manufacturing elements	UNDER DEVELOPMENT	Digital Twin	Digital representatin	ISO/TC 184/SC 4 - Industrial data
ISO/DIS 23247-4 - Automation systems and integration — Digital Twin framework for manufacturing — Part 4: Information exchange	UNDER DEVELOPMENT	Digital Twin	Data exchange	ISO/TC 184/SC 4 - Industrial data
ISO/IEC 11404:2007 - Information technology — General-Purpose Datatypes (GPD)	nomenclature and shared semantics for a collection of datatypes commonly occurring in programming languages and software interfaces, referred to as the General-Purpose Datatypes (GPD). It specifies both primitive datatypes, in the sense of being defined ab initio without reference to other datatypes, and non-primitive datatypes, in the sense	Data management	Terminology	ISO/IEC JTC 1/SC 32 - Data management and interchange

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
	of being wholly or partly defined in terms of other datatypes. The specification of datatypes in ISO/IEC 11404:2007 is "general-purpose" in the sense that the datatypes specified are classes of datatype of which the actual datatypes used in programming languages and other entities requiring the concept "datatype" are particular instances. These datatypes are general in nature; thus, they serve a wide variety of information processing applications. ISO/IEC 11404:2007 expressly distinguishes three notions of datatype: the conceptual, or abstract, notion of a datatype, which characterizes the datatype by its nominal values and properties; the structural notion of a datatype, which characterizes the datatype as a conceptual organization of specific component datatypes with specific functionalities; and the implementation notion of a datatype, which characterizes the datatype by defining the rules for representation of the datatype in a given environment. ISO/IEC 11404:2007 defines the abstract notions of many commonly used primitive and non-primitive datatypes which possess the structural notion of atomicity. ISO/IEC 11404:2007 does not define all atomic datatypes; it defines only those which are common in programming languages and software interfaces. ISO/IEC 11404:2007 defines structural notions for the specification of other non-primitive datatypes, and provides a means by which datatypes not defined herein can be defined structurally in terms of the GPDs defined herein. ISO/IEC 11404:2007 defines a partial terminology for implementation notions of datatypes and provides for the use of this terminology in the definition of datatypes. The primary purpose of this terminology is to identify common implementation notions associated with datatypes and to distinguish them from conceptual notions. ISO/IEC 11404:2007 specifies the required elements of mappings between the GPDs and the datatypes of some other language. ISO/IEC 11404:2007 does not specify the precise form of a mapping, but rather the required information content of a mapping.			

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO/IEC 19763-1:2015 - Information technology — Metamodel framework for interoperability (MFI) — Part 1: Framework	ISO/IEC19763-1:2015 (Metamodel framework for interoperability) (MFI) family of standards. As the first part of MFI, this part provides an overview of the whole of MFI. In particular, the purpose, the underlying concepts, the overall architecture and the requirements for the development of other standards within the MFI family are described. MFI provides a set of normative metamodels to enable the registration of many different types of model. Each of these metamodels is expressed as a UML Class Diagram.	Data management	Interoperability	ISO/IEC JTC 1/SC 32 - Data management and interchange
ISO/IEC TR 19583-1:2019 - Information technology — Concepts and usage of metadata — Part 1: Metadata concepts	Basic concept of metadata, and its relationship to both data and metamodels.	Data management	Metadata	ISO/IEC JTC 1/SC 32 - Data management and interchange
ISO/IEC TR 9789:1994 - Information technology — Guidelines for the organization and representation of data elements for data interchange — Coding methods and principles	Provides general guidance on the manner on which data can be expressed by codes. Describes the objectives of coding, the characteristics, advantages and disadvantages of different coding methods, the features of codes and gives guidelines for the design of codes. Examples of applications are ISO 9735:1988, ISO 8601:1988, ISO 3166:1993.	Data management	Data coding	ISO/IEC JTC 1/SC 32 - Data management and interchange
ISO/TS 18876-1:2003 - Industrial automation systems and integration — Integration of industrial data for exchange, access and sharing — Part 1: Architecture overview and description	It establishes an architecture and methodology for integrating industrial data for exchange, access and sharing. The following activities are supported: integrating data which may be: from different sources or different contexts, described by different models, or defined in different modelling languages; sharing data among applications through systems integration architectures; resolving conflict between models developed with different objectives; translating data between different encodings; translating models between different modelling languages. The following is within the scope of ISO/TS 18876-1:2003: the architecture and an outline of the methodology.	Industrial Data	Methodology	ISO/TC 184/SC 4 - Industrial data

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO/TS 18876-2:2003 - Industrial automation systems and integration — Integration of industrial data for exchange, access and sharing — Part 2: Integration and mapping methodology	ISO/TS 18876-2:2003 specifies methods for the following: creating and extending integration models; evaluating and selecting an integration model that can integrate two or more application models; creating an application model that is a constrained subset of an integration model to support particular application domain requirements for exchange, sharing, or both; creating a mapping specification between an application model and an integration model. The following are within the scope of ISO/TS 18876-2:2003: modelling language independent methods for creating and extending an integration model; methods for integrating an application model with an integration model; mapping language independent methods for mapping an application model to an integration model; criteria for the selecting modelling languages and mapping languages that can be used within the specified methods for integration and mapping. The following are outside the scope of ISO/TS 18876-2:2003: the structure and content of particular integration models; methods for creating and extending particular integration models; methods for mapping application models to particular integration models. NOTE The specific methods that apply to mappings between particular application models and integration models depend on the modelling paradigm(s) applied and on the structure and content of the models.	Industrial Data	Mapping	ISO/TC 184/SC 4 - Industrial data
ISO/TS 29002-10:2009 - Industrial automation systems and integration — Exchange of characteristic data — Part 10: Characteristic data exchange format	ISO/TS 29002-10:2009 specifies a conceptual information model and an exchange file format for characteristic data. The conceptual model is in Unified Modeling Language (UML). The physical file format is based on Extensible Markup Language (XML).	Industrial Data	Data exchange	ISO/TC 184/SC 4 - Industrial data
ISO/TS 29002-4:2009 - Industrial automation systems and integration — Exchange of characteristic data — Part 4: Basic entities and types	ISO/TS 29002-4:2009 specifies a conceptual information model and an exchange file format for basic entities and types that are used as a resource by other parts of ISO/TS 29002. The conceptual model is in Unified Modeling Language (UML). The physical data format is based on Extensible Markup Language (XML). ISO/TS 29002-4:2009 defines types for language code, country code, currency code, uniform resource identifier, and Abstract Syntax Notation One (ASN.1) identifier. It defines an entity for human-readable text that has been localized into one or more languages. The resources in ISO/TS 29002-4:2009 are used by the models in ISO/TS 29002-6 and ISO/TS 29002-20.	Industrial Data	Data management	ISO/TC 184/SC 4 - Industrial data

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO/TS 29002-5:2009 Industrial automation systems and integration — Exchange of characteristic data — Part 5: Identification scheme	ISO/TS 29002-5:2009 specifies the data elements and a syntax for an unambiguous identifier for an administered item. The identifier is called an "international registration data identifier" (IRDI), as specified in ISO/IEC 11179-5. An administered item is any registry item for which administrative information is recorded. For the purposes of ISO/TS 29002-5:2009, an administered item can be a concept or concept information element in a concept dictionary. "Concept information element" includes things such as terminology (terms, abbreviations, definitions, images, symbols), assignment of a concept to a class of similar concepts (the concept type), and references to source documents. ISO/TS 29002-5:2009 was developed as a common resource to provide a level of interoperability between implementations of ISO 13584 and ISO/TS 22745. Its use is not restricted to these standards, however. It can be restricted through implementation profiles by standards that reference it. It can also be implemented without restriction.	Industrial Data	Data identification	ISO/TC 184/SC 4 - Industrial data

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5.3.2 Circular Economy Strategies: standardisation initiatives and Technical committees

The key area will define effective strategies to pursue Circular Economy-driven machine lifetime extension, considering all the stakeholders belonging to the machinery value-chain (e.g. users, service providers, OEMs, components manufacturers, machine designers). Strateies will be based on stakeholders' contribution to renew existing processes (e.g. ecodesign for remanufacturing, etc.) to support effectively the creation of a circular Economy-driven machinery value chain.

The following standardisation technical committees have been identified (Tab. 20). They focus on recent Circular Economy metrics and use cases, still under development, as well as innovation management techniques to gather stakeholders input. LCA and environmental related issus will have to taken into account, in close synergies with the LCC/LCA key area.
Relevant standards ar elisted in Table 21.

Table 20 CIRCULAR ECONOMY STRATEGY: list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/TC 323 - Circular economy[47] Standardization in the field of Circular Economy to develop frameworks, guidance, supporting tools and requirements for the implementation of activities of all involved organizations, to maximize the contribution to Sustainable Development. Excluded: Aspects of Circular Economy already covered by existing committees. Note: In parallel, the ISO TC 323 works in cooperation with existing committees on subjects that may support Circular Economy.	ISO/TC 323/WG 1 Framework, principles, terminology, and management system standard ISO/TC 323/WG 2 Guidance for implementation and sectoral applications ISO/TC 323/WG 3 Measuring circularity ISO/TC 323/WG 4 Specific issues of circular economy
ISO/TC 279 - Innovation management[48] Standardization of terminology tools and methods and interactions between relevant parties to enable innovation.	ISO/TC 279/WG 1 Innovation management system ISO/TC 279/WG 2 Terminology, terms and definitions ISO/TC 279/WG 3 Tools and methods
ISO/TMBG Technical Management Board - groups[49] The TMB is the governance body responsible for the general management of the technical committee structure within ISO.	

[47] https://www.iso.org/committee/7203984.html
[48] https://www.iso.org/committee/4587737.html
[49] https://www.iso.org/committee/54996.html

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Table 21 CIRCULAR ECONOMY STRATEGY: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO 26000:2010 - Guidance on social responsibility	Guidance to all types of organizations, regardless of their size or location, on:a) concepts, terms and definitions related to social responsibility;b) the background, trends and characteristics of social responsibility;c) principles and practices relating to social responsibility;d) the core subjects and issues of social responsibility;e) integrating, implementing and promoting socially responsible behaviour throughout the organization and, through its policies and practices, within its sphere of influence;f) identifying and engaging with stakeholders; andg) communicating commitments, performance and other information related to social responsibility.This Standard is intended to assist organizations in contributing to sustainable development, to encourage them to go beyond legal compliance, to promote common understanding in the field of social responsibility, and to complement other instruments and initiatives for social responsibility, not to replace them.This Standard is not a management system standard, it is not intended for certification purposes or regulatory or contractual use.	Social responsibility	Stakeholder	ISO/TMBG Technical Management Board - groups
ISO 56002:2019 - Innovation management -- Innovation management system -- Guidance	This document provides guidance for the establishment, implementation, maintenance and continual improvement of an innovation management system. All the guidance within this document is generic and intended to be applicable to all types of organizations, regardless of type, sector, or size, and to all types of innovations (e.g. product, service, process, model, method, ranging from incremental to radical) and approaches (e.g. internal and open innovation, user-, market-, technology- and design-driven innovation activities)	Innovation management	Framework	ISO/TC 279 - Innovation management
ISO 56003:2019 - Innovation management - Tools and methods for innovation partnership - Guidance	This document provides a guidance for innovation partnerships. It describes the innovation partnership framework (see Clause 4 to Clause 8) and the sample corresponding tools (see Annex A to Annex E) to: decide whether to enter an innovation partnership, identify, evaluate and select partners, align the perceptions of value and challenges of the partnership, manage the partner interactions. The guidance provided by this document is relevant for any type of partnerships and collaborations and it is intended to be applicable to any organizations, regardless of its type, size, product/service provided.	Innovation management	Stakeholder	ISO/TC 279 - Innovation management
ISO/CD TR 59031 - Circular economy - Performance-based approach - Analysis of cases studies	UNDER DEVELOPMENT	Circular Economy	Use case	ISO/TC 323 - Circular economy
ISO/WD 59004 Circular economy — Framework and principles for implementation	UNDER DEVELOPMENT	Circular Economy	Framework	ISO/TC 323 - Circular economy

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE
ISO/WD 59010 - Circular economy — Guidelines on business models and value chains	UNDER DEVELOPMENT	Circular Economy	Value chain	ISO/TC 323 - Circular economy
ISO/WD 59020 Circular economy — Measuring circularity framework	UNDER DEVELOPMENT	Circular Economy	KPI	ISO/TC 323 - Circular economy
UNI/PdR 18:2016 - Social responsibility in organizations - Guidance to the application of UNI ISO 26000	Social responsibility in organizations - Guidance to the application of UNI ISO 26000	Social responsibility	Stakeholder	

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5.3.3 Decision Support Framework: standardisation initiatives and Technical Committees

This key area Decision Support Framework (DSF) will include input from sensorial network, the optimization layer, cost modelling and analysis, circular economy strategy to provide decision support to machinery operators and machinery manufacturers concerning which is the most suitable remanufacturing/refurbishment strategy. All available data, collected from the sensorial network (fused and modelled) will be fed onto the proposed DSF. Further methodologies will be developed with the procedures to be followed for the execution of the refurbishment and/or re-manufacturing. These methodologies will include both steps to be followed when the process is to be performed throughout the machine and when the process is to be performed on parts of the machine. Through this task the stakeholders will be aware of the steps to be taken before the refurbishment or/and remanufacturing process begins.

The following standardisation Technical Committees have been identified (Table 22). They focus on Ecodesign integration in product development, as key driver for strategic decision. Data features connected to the development of DSF are taken into account. Finally quality management, safety features as well as maintenance skills and management features are evaluated, to provide a more aware decision system. Related standards are listed in Table 23.

Table 22 DECISION SUPPORT FRAMEWORKS: list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/IEC JTC 1/SC 32 - Data management and interchange[50] Standards for data management within and among local and distributed information systems environments. SC 32 provides enabling technologies to promote harmonization of data management facilities across sector-specific areas. Specifically, SC 32 standards include: reference models and frameworks for the coordination of existing and emerging standards; definition of data domains, data types, and data structures, and their associated semantics; languages, services, and protocols for persistent storage, concurrent access, concurrent update, and interchange of data; methods, languages, services, and protocols to structure, organize, and register metadata and other information resources associated with sharing and interoperability, including electronic commerce.	ISO/IEC JTC 1/SC 32/WG 1 eBusiness
ISO/TC 283 - Occupational health and safety management[51] Standardization in the field of occupational health and safety management to enable an organization to control its OH&S risks and improve its OH&S performance.	ISO/TC 283/WG 2 Psychological health and safety in the workplace ISO/TC 283/WG 3 Implementation ISO/TC 283/WG 4 Performance evaluation
ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems[52] Standardization of the procedures, processes and equipment requirements uniquely related to the technical activity of condition monitoring and diagnostics of machines systems in which selected physical parameters associated with an operating machine system are periodically or continuously sensed, measured and recorded for the interim purpose of reducing, analyzing, comparing and displaying the data and information so obtained and for the ultimate purpose of using this interim result to support decisions related to the operation and maintenance of the machine system.	ISO/TC 108/SC 5/WG 7 Training and accreditation in the field of condition monitoring and diagnostics ISO/TC 108/SC 5/WG 17 Condition monitoring and diagnostics applications ISO/TC 108/SC 5/WG 18 Condition monitoring management
ISO/TC 176 - Quality management and quality assurance Standardization in the field of quality management (generic quality management systems and supporting technologies), as well as quality management standardization in specific sectors at the request of the affected sector and the ISO Technical Management Board.	ISO/TC 176/TG 1 Communications and product support ISO/TC 176/SC 3 Supporting technologies

[50] https://www.iso.org/committee/45342.html
[51] https://www.iso.org/committee/4857129.html
[52] https://www.iso.org/committee/51538.html

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ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
Note : ISO/TC 176 is also entrusted with an advisory function to all ISO and IEC technical committees to ensure the integrity of the generic quality system standards and the effective implementation of the ISO/IEC sector policy on quality management systems deliverables.	
ISO/TC 176/SC 2 - Quality systems[53]	ISO/TC 176/SC 2/AG 1 Strategic planning and operations
ISO/TC 207 - Environmental management[54] Standardization in the field of environmental management systems and tools in support of sustainable development. Standardization in the field of maintenance as far as generic standards which are generally applicable are concernedExcluded: test methods of pollutants, setting limit values and levels of environmental performance, and standardization of products. Note: The TC for environmental management will have close cooperation with ISO / TC 176 in the field of environmental systems and audits.	ISO/TC 207/SC 1 Environmental management systems ISO/TC 207/SC 2 Environmental auditing and related environmental investigations ISO/TC 207/SC 3 Environmental labelling ISO/TC 207/SC 4 Environmental performance evaluation ISO/TC 207/SC 5 Life cycle assessment
CEN/TC 319 - Maintenance[55] Standardization in the field of maintenance as far as generic standards which are generally applicable are concerned	CEN/TC 319/WG 11 Condition assessment methodologies CEN/TC 319/WG 6 Maintenance performance and indicators CEN/TC 319/WG 8 Maintenance functions and maintenance management

[53] https://www.iso.org/committee/53896.html
[54] https://www.iso.org/committee/54808.html
[55] https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6300&cs=1A64AA79FCFDE906561AFDA09269B3123

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Table 23 DECISION SUPPORT FRAMEWORK: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
EN 13269:2016- Maintenance - Guideline on preparation of maintenance contracts	This European Standard provides guidance on the preparation of private contracts for maintenance work. It can be applied to cross-border as well as national company/maintenance contractor relationships, the whole range of maintenance services including planning, management and control in addition to maintenance operations, every type of item with the exception of computer software unless the software has to be maintained as an integral part of, and together with, technical equipment. It does not provide standard forms for maintenance contracts, determine rights and obligations between company and maintenance contractor, provide rules for agreements with public administrations.	Maintenance	Contract		CEN/TC 319 - Maintenance
EN 13306:2018 - Maintenance - Maintenance terminology	Generic terms and definitions for the technical, administrative and managerial areas of maintenance. It is not intended to terms which are used for the maintenance of software only.	Maintenance	Terminology		CEN/TC 319 - Maintenance
EN ISO 9000:2015 - Quality management systems - Fundamentals and vocabulary	ISO 9000:2015 describes the fundamental concepts and principles of quality management which are universally applicable to the following: organizations seeking sustained success through the implementation of a quality management system; customers seeking confidence in an organization's ability to consistently provide products and services conforming to their requirements; organizations seeking confidence in their supply chain that their product and service requirements will be met; organizations and interested parties seeking to improve communication through a common understanding of the vocabulary used in quality management; organizations performing conformity assessments against the requirements of ISO 9001; providers of training, assessment or advice in quality management; developers of related standards. ISO 9000:2015 specifies the terms and definitions that apply to all quality management and quality management system standards developed by ISO/TC 176	Management system	Quality	ISO/TC 176 - Quality management and quality assurance	
EN ISO 9001:2015 - Quality management systems - Requirements	Requirements for a quality management system when an organization: a) needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, and b) aims to enhance customer satisfaction through the effective application of the system, including processes for improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements. All the requirements of this International Standard are generic and are intended to be applicable to any organization, regardless of its type or size, or the products and services it provides	Management system	Quality	ISO/TC 176 - Quality management and quality assurance	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO 10006:2018 - Quality management - Guidelines for quality management in projects	This document gives guidelines for the application of quality management in projects. It is applicable to organizations working on projects of varying complexity, small or large, of short or long duration, being an individual project to being part of a programme or portfolio of projects, in different environments, and irrespective of the kind of product/service or process involved, with the intention of satisfying project interested parties by introducing quality management in projects. This can necessitate some tailoring of the guidance to suit a particular project.	Management system	Quality	ISO/TC 176/SC 2 - Quality systems	
ISO 18436-1:2013 - Condition monitoring and diagnostics of machines - Requirements for qualification and assessment of personnel - Part 1: Requirements for assessment bodies and the assessment process	The standard defines both the requirements of the authorities issuing the certificates to the staff in charge of monitoring and diagnostics of machines, the identification of faults and corrective actions taken and the procedures for the certification of personnel.	Maintenance	Staff, assessment	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 18436-3:2013 - Condition monitoring and diagnostics of machines - Requirements for qualification and assessment of personnel - Part 3: Requirements for training bodies and the training process	The vibration analysis to monitor the machine status and identification of faults has played a key role in many industries, supported by other non-invasive techniques such as infrared thermography, and ultrasonic acoustic emissions, the ' lubricant analysis and comparison with the initial characteristic electrical parameters (fingerfrints) This part standard defines the requirements for bodies operating training programmes for personnel who perform machinery condition monitoring, identify machine faults, and recommend corrective action. They also come from Annex A to the criteria for qualification of trainers.	Maintenance	Staff, training	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
ISO 45001:2018 - Occupational health and safety management systems -- Requirements with guidance for use	Requirements for an occupational health and safety (OH&S) management system, and gives guidance for its use, to enable organizations to provide safe and healthy workplaces, by preventing work-related injury and ill health, as well as by proactively improving its OH&S performance. This document is applicable to any organization, regardless of its size, type and activities, that wishes to establish, implement and maintain an OH&S management system to improve occupational health and safety, eliminate hazards and minimize OH&S risks (including system deficiencies), take advantage of OH&S opportunities, and address OH&S management system nonconformities associated with its activities. This document helps an organization to achieve the intended outcomes of its OH&S management system, that is: a) continual improvement of OH&S performance; b) fulfilment of legal requirements and other requirements; c) achievement of OH&S objectives.	Health and safety	Management system	ISO/TC 283 - Occupational health and safety management	

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TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO/IEC 15944-1:2011 - Information technology — Business operational view — Part 1: Operational aspects of open-edi for implementation	ISO/IEC 15944-1:2011 addresses the fundamental requirements of the commercial and legal frameworks and their environments on business transactions, and also integrates the requirements of the information technology and telecommunications environments. In addition to the existing strategic directions of "portability" and "interoperability", the added strategic direction of ISO/IEC JTC 1 of "cultural adaptability" is supported in ISO/IEC 15944-1:2011. It also supports requirements arising from the public policy/consumer environment, cross-sectorial requirements and the need to address horizontal issues. It integrates these different sets of requirements. ISO/IEC 15944-1:2011 allows constraints [which include legal requirements, commercial and/or international trade and contract terms, public policy (e.g. privacy/data protection, product or service labelling, consumer protection), laws and regulations] to be defined and clearly integrated into Open-edi through the BOV. This means that terms and definitions in ISO/IEC 15944-1:2011 serve as a common bridge between these different sets of business operational requirements, allowing the integration of code sets and rules defining these requirements to be integrated into business processes electronically. ISO/IEC 15944-1:2011 contains a methodology and tool for specifying common business practices as parts of common business transactions in the form of scenarios, scenario attributes, roles, Information Bundles and Semantic Components. It achieves this by 1) developing standard computer processable specifications of common business rules and practices as scenarios and scenario components; and thus 2) maximizing the re-use of these components in business transactions.	Data management	Use case	ISO/IEC JTC 1/SC 32 - Data management and interchange	
ISO/IEC 15944-2:2015 - Information technology — Business operational view — Part 2: Registration of scenarios and their components as business objects	ISO/IEC 15944-2:2015 specifies procedures to be followed in establishing, maintaining, and publishing registers of unique, unambiguous and permanent identifiers and meanings that are assigned to Open-edi scenarios and scenario components. In order to accomplish this purpose, ISO/IEC 15944-2:2015 specifies elements of information that are necessary to provide identification and meaning to the registered items and to manage the registration of these items. ISO/IEC 15944-2:2015 defines the procedures to be applied by qualified JTC1 Registration Authority(ies) appointed by the ISO and IEC council to maintain a register(s) of Open-edi scenarios and/or scenario components for the purpose of their reusability.	Data management	Use case	ISO/IEC JTC 1/SC 32 - Data management and interchange	

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ISO/IEC 15944-5:2008 - Information technology — Business operational view — Part 5: Identification and referencing of requirements of jurisdictional domains as sources of external constraints	ISO/IEC 15944-5:2008 is directed at being able to identify and reference laws and regulations impacting eBusiness scenarios and scenario components as external constraints. The primary source of such external constraints is jurisdictional domains. ISO/IEC 15944-5:2008 focuses on addressing the simple, i.e. definable, aspects of external constraints for which the source is a jurisdictional domain. A useful characteristic of external constraints is that at the sectoral, national and international levels, etc. focal points and recognized authorities often already exist. The rules and common business practices in many sectoral areas are already known. Use of ISO/IEC 15944-5:2008 (and related standards) will facilitate the transformation of these external constraints (business rules) into specified, registered and reusable scenarios and scenario components. The Business Transaction Model, explained in ISO/IEC 15944-1, has two classes of constraints, namely: those which are self-imposed and agreed to as commitments among the parties themselves, i.e. internal constraints; and those which are imposed on the parties to a business transaction based on the nature of the good, service and/or rights exchanged, and the nature of the commitment made among the parties (including ability to make commitments, the location, etc.), i.e. external constraints. The focus of ISO/IEC 15944-5:2008 is on external constraints. Jurisdictional domains are the primary source of external constraints. ISO/IEC 15944-5:2008 provides the key concepts required for addressing the legal environment in developing the Business Operational View of business transactions and scenarios which involve and are required to support external constraints. It begins with an exploration of the jurisdictional domain as a source of external constraint on the business process, both from the perspective of a Person and as a Public Administration. It then presents key constraints governing ISO/IEC 15944-5:2008 through principles and rules. It examines a key element in business transactions, that of the use of language. Jurisdictions can identify and, in some cases, impose the use of language in a business transaction. In this regard, the ISO/IEC 15944-5:2008 looks at the relationship of the constraint imposed by a jurisdictional domain on the choice of language used. Public policy constraints are also examined and key requirements for their inclusion in external constraints are identified, especially where they can affect the modelling of Open-edi scenarios and the business transaction components of	Data management	Legal constraint	ISO/IEC JTC 1/SC 32 - Data management and interchange	

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	Persons, data and processes. In particular, there is a set of rules that govern the identification and categories of jurisdictional domains as individual states as well as sets of entities, both regional and international. ISO/IEC 15944-5:2008 also focuses on the identification of rules governing the formation and identification of jurisdictional domains. It identifies the more primitive subtypes of jurisdictional domains and includes two approaches for the unambiguous identification of referencing of (subtypes of) jurisdictional domain. ISO/IEC 15944-5:2008 also provides checklists, through the use of templates, to guide the user through the mechanics of determining the source of the external constraint(s) where these are jurisdictional domains and determining the adequacy of the scenario specification as well as those of the scenario components. Annexes provide elaboration on the points raised in the main body.				
ISO/TR 14062:2007 - Environmental management - Integrating environmental aspects into product design and development	This Technical Report describes concepts and current practices relating to the integration of environmental aspects into product design and development, where "product" is understood to cover both goods and services.	Environmental management system	Ecodesign	ISO/TC 207 - Environmental management	CEN SS/26 Environmental Management

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5.3.4 Cost Modelling and Financial Analysis toolkit: standardisation initiatives and Technical committees

This key area will carry out cost estimation and analysis: based on the selected refurbishment/remanufacturing scenarios, cost breakdown structure will be defined. The cost model will take into account all type of life extension strategies and refurbishment and/or remanufacturing activities.

Table 24 DECISION SUPPORT FRAMEWORKS: list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/IEC JTC 1/SC 32 - Data management and interchange[56] Standards for data management within and among local and distributed information systems environments. SC 32 provides enabling technologies to promote harmonization of data management facilities across sector-specific areas: • reference models and frameworks for the coordination of existing and emerging standards; • definition of data domains, data types, and data structures, and their associated semantics; • languages, services, and protocols for persistent storage, concurrent access, concurrent update, and interchange of data; • methods, languages, services, and protocols to structure, organize, and register metadata and other information resources associated with sharing and interoperability, including electronic commerce.	
ISO/TC 251 - Asset management[57]	ISO/TC 251/AHG 3 - Guidance for investment and other asset management decision-making to optimize value when facing multiple criteria and competing goals

[56] https://www.iso.org/committee/45342.html
[57] https://www.iso.org/committee/604321.html

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Table 25 DECISION SUPPORT FRAMEWORKS: list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO/IEC 15944-4:2015 - Information technology — Business operational view — Part 4: Business transaction scenarios — Accounting and economic ontology	ISO/IEC 15944-4:2015 provides a set of UML class diagrams and conceptual explanations that circumscribe the Open-edi Business Transaction Ontology (OeBTO). It explains the mechanics of a business transaction state machine, the procedural component of an OeBTO, and the (internal) constraint component of OeBTO, its repository for business rules. ISO/IEC 15944-4:2015 addresses collaborations among independent trading partners as defined in ISO/IEC 15944-1. ISO/IEC 15944-4:2015 applies to both binary collaborations (buyer and seller) and mediated collaborations (buyer, seller, third-party). The ontological features described herein propose standards only for the Business Operational View (BOV), that is, the business aspects of business transactions as they are defined in ISO/IEC 15944-1.	Data management	Ontology	ISO/IEC JTC 1/SC 32 - Data management and interchange	
ISO/TS 55010:2019 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management	This document gives guidelines for the alignment between financial and non-financial asset management functions, in order to improve internal control as part of an organization's management system. Alignment of these functions will enable the realization of value derived from the implementation of asset management detailed within ISO 55000, ISO 55001 and ISO 55002, particularly ISO 55002:2018, Annex F. The guidance in this document is consistent with the requirements of ISO 55001 for an asset management system but does not add new requirements to ISO 55001 or provide interpretations of the requirements of ISO 55001. For an example of an organization aligning its asset management functions, see Annex F.	Life cycle cost modelling	Asset management	ISO/TC 251 - Asset management	

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5.3.5 Prognotisc and Health Management Toolkit (PHM)

The present key area refers to peer to peer health evaluation as well as component prediction methods to increase equipment (machine) lifetime, productivity and service quality. The framework will contain a number of physical and virtual tools to be integrated for diagnostics and prognostics in manufacturing in order to provide a significant contribution on enhancing operations and maintenance
intelligence

The following standardisation Technical Committees have been identified as relevant for this RECLAIM service (Tab 26). They provide knowledge to assess main condition monitoring diagnostic related to data management.
List of relevant standards elaborated by thos TCs are provided in Table 27.

Table 26 PROGNOTISC AND HEALTH MANAGEMENT TOOLKIT (PHM): list of relevant CEN and ISO Technical Committes (TCs)

ISO and CEN TECHNICAL COMMITTEE	RELEVANT WG
ISO/TC 184/SC 4 - Industrial data[58]	ISO/TC 184/SC 4/WG 13 Industrial Data Quality ISO/TC 184/SC 4/WG 15 Digital manufacturing
ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems[59]	ISO/TC 108/SC 5/WG 18 Condition monitoring management ISO/TC 108/SC 5/WG 17 Condition monitoring and diagnostics applications ISO/TC 108/SC 5/WG 4 Tribology-based monitoring and diagnostics
ISO/IEC JTC 1/SC 32 - Data management and interchange[60]	

[58] https://www.iso.org/committee/54158.html
[59] https://www.iso.org/committee/51538.html
[60] https://www.iso.org/committee/45342.html

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Table 27 PROGNOTISC AND HEALTH MANAGEMENT TOOLKIT (PHM): list of relevant standards

TITLE	SCOPE	KEYWORD	DESCRIPTORS	ISO/IEC TECHNICAL COMMITTEE	CEN TECHNICAL COMMITTEE
ISO/IEC TR 10032:2003 - Information technology — Reference Model of Data Management	ISO/IEC TR 10032:2003 defines the ISO Reference Model of Data Management. It establishes a framework for coordinating the development of existing and future standards for the management of persistent data in information systems. ISO/IEC TR 10032:2003 defines common terminology and concepts pertinent to all data held within information systems. Such concepts are used to define more specifically the services provided by particular data management components, such as database management systems or data dictionary systems. The definition of such related services identifies interfaces which may be the subject of future standardization. ISO/IEC TR 10032:2003 does not specify services and protocols for data management. ISO/IEC TR 10032:2003 is neither an implementation specification for systems, nor a basis for appraising the conformance of implementations. The scope of ISO/IEC TR 10032:2003 includes processes which are concerned with handling persistent data and their interaction with processes particular to the requirements of a specific information system. This includes common data management services such as those required to define, store, retrieve, update, maintain, backup, restore and communicate applications and dictionary data. The scope of ISO/IEC TR 10032:2003 includes consideration of standards for the management of data located on one or more computer systems, including services for distributed database management. ISO/IEC TR 10032:2003 does not include within its scope common services normally provided by an operating system including those processes which are concerned with specific types of physical storage devices, specific techniques for storing data, and specific details of communications and human computer interfaces.	Data management	Data management	ISO/IEC JTC 1/SC 32 - Data management and interchange	
ISO/PWI 18255 - Management of condition monitoring of machine systems	UNDER DEVELOPMENT	Condition monitoring and diagnostic	Management	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	

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ISO/TR 9007:1987 - Information processing systems — Concepts and terminology for the conceptual schema and the information base	This Technical Report type 3 contains the fundamental concepts and terminology for the conceptual schema, the information base, and the mechanisms involved in manipulating them. The approaches and associated languages described in the appendices A through H are intended to be explanatory only.	Data management	Information Processing system	ISO/IEC JTC 1/SC 32 - Data management and interchange	

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6. CONCLUSION

The report provide a first extensive overview of standardisation area affecting RECLAIM approach, including both IT and operational layer perspective. It is intended to be a first exercise starting from authors' perspective, to be continuously updated according to evolution of standardisation environment and market feedback.
Several standardisation area and Technical Committees (see Annex 1) has been identified. In general they contribute to each single Key area and building blocks of RECLAIM consolidated view, but lack of an overall **coherence and holistic view**.
As an example, machinery health management and KPI documents do not take into account the life cycle perspective. Same issue accounts for safety, security and data reference model standard: they need to be linked and integrated inot condition monitoring perspective and reinterpreted, if the case, into the machinery extended lifecycle.

Basing on that, a more interoperable, synergic and integrated approach in standardisation, especially between IT/OT, life cycle and interoperability, is needed to implement effectively RECLAIM consolidated view. In particular, main identified challenges are:

- Identify and holistic and cross sectoral definition of remanufacturing and refurbishment,
- Take into account life cycle perspective in remanufacturing and refurbishment strategy and its impact on machinery lifetime extension in terms of safety, investment, strategy ….
- Identifiy horizontal, interoperable and cross sectoral KPIs for maintenance, health and prognostic management of machinery
- Consider interoperability of IT, data architecture and reference model in different machine and value chain
- Consider impact of remanufacturing on management system in term of quality, safety as well as skills

The identified gaps will have to be integrated according to standardisation need assessment.

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USEFUL LINKS

RECLAIM
https://www.reclaim-project.eu/
https://cordis.europa.eu/project/id/869884/it

International Standard Organisation (ISO)
https://www.iso.org/home.html

European Committee for Standardization (CEN), European Committee for Electrotechnical Standardization (CENELEC)
https://www.cencenelec.eu/News/Pages/default.aspx

Horizon 2020 programme
https://ec.europa.eu/programmes/horizon2020/en

Italian Standardisation Body (UNI)
https://www.uni.com/

Standards + Innovation
https://www.standardsplusinnovation.eu/

Machinery Directive 2006/42/EC EU section _ DG Internal Market, Industry, Entrepreneurship and SMEs
https://ec.europa.eu/growth/sectors/mechanical-engineering/machinery_en

Standards Watch StandICT
https://www.standict.eu/standards-watch

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ANNEX1 RECLAIM standardisation Toolkit overview: KEY AREAS, KEYWWORDS, DESCRIPTORS and STANDARDIZATION TECHNICAL COMMITTEES

This table is aimed at highliting complementarity and synergies of standardisation Technical Commitees ad related RECLAIM consolidated view key area.

KEY AREA	KEYWORD	DESCRIPTORS	ISO AND CEN TC	OTHER RELEVANT KEY AREA
AUGMENTED REALITY	Augmented Reality	Environmental data Framework Reference architecture Entity representation Spatial registration tracking	ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation ISO/TC 184/SC 4 - Industrial data	DASHBOARD ANALYTICS PHM DIGITAL TWIN MODEL
	3D	Scene Access Interface Virtual reality modelling language Configuration and assembly Mechanical design		
CIRCULAR ECONOMY STRATEGY	Social responsibility	Stakeholder	ISO/TMBG Technical Management Board - groups ISO/TC 279 - Innovation management ISO/TC 323 - Circular economy	DECISION SUPPORT FRAMEWORK LCC/LCA
	Innovation management	Framework Stakeholder		
	Circular Economy	Use case		
		Framework		
		Value chain		
		KPI		
COST MODELLING	Life cycle cost modelling	Asset management	ISO/TC 251 - Asset management ISO/IEC JTC 1/SC 32 - Data management and interchange	DECISION SUPPORT FRAMEWORK LCC/LCA
	Data management	Ontology		
DASHBOARD ANALYTICS	Big data	Predictive analytics Data Life cycle model	ISO/TC 69 - Applications of statistical methods ISO/IEC JTC 1/SC 42 - Artificial intelligence	DEGRADATION MODEL, FAULT DIAGNOSTIC PREDICTIVE MAINTENANCE
	Artificial Intelligence	Trustworthiness		
DECISION SUPPORT FRAMEWORK	Maintenance	Contract	CEN/TC 319 - Maintenance	MACHINE PROFILE INDEX
	Management system	Quality	ISO/TC 176/SC 2 - Quality systems ISO/TC 176 - Quality management and quality assurance	
	Maintenance	Staff, assessment	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
		Staff, training		

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KEY AREA	KEYWORD	DESCRIPTORS	ISO AND CEN TC	OTHER RELEVANT KEY AREA
	Health and safety	Management system	ISO/TC 283 - Occupational health and safety management	
	Environmental management system	Ecodesign	ISO/TC 207 - Environmental management CEN SS/26 Environmental Management	
DEGRADATION MODEL, FAULT DIAGNOSTICS	Condition monitoring and diagnostic	Tribology Methodology Data communication Data analysis, diagnosis Prognostics	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems CEN/TC 319 - Maintenance	PREDICTIVE MAINTENANCE MAINTENANCE PLAN DASHBOARD ANALYTICS PHM LCC/LCA
	Maintenance	Life cycle impact		
	Statistical method	Data analytics	ISO/TC 69/SC 4 - Applications of statistical methods in product and process management	
DIGITAL TWIN MODEL	Digital Twin	Digital mock up Visual element Framework Reference architecture Digital representation Data exchange	ISO/TC 10/SC 6 - Mechanical engineering documentation ISO/TC 184/SC 4 - Industrial data	PREDICTIVE MAINTENANCE
LCC/LCA	Environmental management system	Assessment Ecodesign EMS Environmental communication Environmental label Performance Phased approach Ecodesign Environmental label Life cycle assessment Performance Terminology	ISO/TC 207/SC 1 - Environmental management systems ISO/TC 207/SC 3 - Environmental labelling ISO/TC 207/SC 4 - Environmental performance evaluation ISO/TC 207/SC 5 - Life cycle assessment CEN SS/26 Environmental Management	DECISION SUPPORT FRAMEWORK CIRCULAR ECONOMY STRATEGIES
MACHINE PROFILE INDEX	Woodworking machine	Safety	ISO/TC 39/SC 4 - Woodworking machines CEN/TC 142 - Woodworking machines - Safety	DECISION SUPPORT FRAMEWORK DEGRADATION MODEL, FAULT DIAGNOSTIC MAINTENANCE PLAN
	Footwear industry	Safety Terminology	ISO/TC 216 Footwear	
	Machinery	Safety Ergonomics	ISO/TC 199 - Safety of machinery	

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KEY AREA	KEYWORD	DESCRIPTORS	ISO AND CEN TC	OTHER RELEVANT KEY AREA
		Risk assessment	CEN TC 114 - Safety of machinery ISO/TC 159 Ergonomics CEN TC 122 - Ergonomics	PREDICTIVE MAINTENANCE
	Electronic, electrical, or electromechanical part	Safety	CLC/TC 44X - Safety of machinery: electrotechnical aspects	
	Robotic	Code Collaborative robot Safety Modularity Object handling Performance Plate Shaft Product characterictic Terminology	ISO/TC 299 - Robotics CEN/TC 310 - Advanced automation technologies and their applications	
	Textile machinery	Safety	ISO/TC 72/SC 8 - Safety requirements for textile machinery CEN/TC 214 - Textile machinery and accessories	
	Mechanical vibration	KPI Measurement Fourier transform analysis Time frequency analysis Shock response spectrum analysis Vibration	ISO/TC 108 - Mechanical vibration, shock and condition monitoring ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	

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KEY AREA	KEYWORD	DESCRIPTORS	ISO AND CEN TC	OTHER RELEVANT KEY AREA
	Condition monitoring and diagnostic	Acoustic emission Vibration Data presentation Diagnosis Framework Hydroelectric units Measurement Shaft hydraulic power generating Induction motors pump storage plant Electric motor Power transformer Termography Ultrasound	ISO/TC 108 - Mechanical vibration, shock and condition monitoring SO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
MAINTENANCE PLAN	Maintenance	Documentation Management system Risk assessment	CEN/TC 319 - Maintenance	DEGRADATION MODEL, FAULT DIAGNOSTIC MAINTENANCE PLAN
PROGNOSTICA HEALTH MANAGEMENT TOOLKIT	Industrial Data	3d model	ISO/TC 184/SC 4 - Industrial data	DEGRADATIO MODEL, FAULT DIAGNOSTIC
	Condition monitoring and diagnostic	Diagnosis Management Performance	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
	Data management	Data coding Information Processing system Data management Terminology	ISO/IEC JTC 1/SC 32 - Data management and interchange	
PREDICTIVE MAINTENANCE	Maintenance	Predictive analytics Terminology	CEN/TC 319 - Maintenance	DEGRADATION MODEL, FAULT DIAGNOSTICS MAINTENANCE PLAN
PROCESS PLAN, MACHINE CALIBRATION	Maintenance	Design Engineering Management system KPI Performance Process	CEN/TC 319 - Maintenance	DEGRADATION MODEL, FAULT DIAGNOSTIC MAINTENANCE PLAN MACHINE PROFILE INDEX
	Product Life Cycle	Data format Data representation Framework	ISO/TC 184/SC 4 - Industrial data ISO/TC 207/SC 5 - Life cycle assessment	LCC/LCA

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KEY AREA	KEYWORD	DESCRIPTORS	ISO AND CEN TC	OTHER RELEVANT KEY AREA
		Guidelines Inventory Life cycle impact Technical documentation	ISO/TC 10 - Technical product documentation CEN SS/26 Environmental Management	
	Industrial Data	Data acquisition Data exchange Data identification Data management Library Framework Resource model information Usage management Time model Manufacturing flow Mapping Methodology Organisation Process specification Manufacturing reference model	ISO/TC 184/SC 4 - Industrial data	
	Condition monitoring and diagnostic	Terminology Data processing Guidelines	ISO/TC 108/SC 5 - Condition monitoring and diagnostics of machine systems	
	Production engineering	Production planning Framework Information flow Manufacturing change management KPI	ISO/TC 184/SC 4 - Industrial data	
	Artificial Intelligence	Safety Bias Risk assessment Trustworthiness	ISO/TC 199 - Safety of machinery ISO/IEC JTC 1/SC 42 - Artificial intelligence FOCUS GROUP ON AI	
	Data management	Use case Ontology Legal constraint Interoperability Metadata	ISO/IEC JTC 1/SC 32 - Data management and interchange	
	Cybersecurity	Machine Learning	ISO/TC 199 - Safety of machinery	

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KEY AREA	KEYWORD	DESCRIPTORS	ISO AND CEN TC	OTHER RELEVANT KEY AREA
REFURBISHMENT AND REMANUFACTURING PLAN, PROCESS REFURBISHMENT, PROCESS REMANUFACTURING	Remanufacturing	Framework, Hydropower units Disassembly	American National Standards Institute [ANSI] ISO/TC 10 - Technical product documentation	Not Relevant
	Refurbishment	Gears	ISO/TC 108/SC 2 - Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures	
SECURITY	Cybersecurity	Safety Digital evidence General model Incident investigation system Information secuirty management Information security ocntrol Measurement Functional components Security assurance Privacy Terminology Vulnerability	ISO/TC 199 - Safety of machinery ISO/IEC JTC 1/SC 27 - Information security, cybersecurity and privacy protection CEN/CLC/JTC 13 - Cybersecurity and Data Protection	Not Relevant
SENSOR INTEGRATOR	Sensor network	Application layer Collaborative information process Reference architecture Test methods	ISO/IEC JTC 1/SC 41 - Internet of Things and related technologies	Not Relevant
	IoT	Reference architecture		
		Use case		

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