



Adaptive Automation in Assembly For BLUE collar workers
satisfaction in Evolvable context

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Deliverable D7.3

**Report on the standardization landscape
and applicable standards**

Partner responsible	UNE/IK4-TEKNIKER
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List of authors

Company	Author	Contribution
UNE	Marta FERNÁNDEZ	Main document
TEK	Jon LARREINA	Relation of main standards with WPs and expected contribution to standardization. Initiatives
CRAN	Sarah FLETCHER	Relation of main standards with and expected contribution standardization
ENG	Angelo MARGUGLIO	Relation of main standards with and expected contribution standardization

List of reviewers

Company	Reviewer	Contribution
TEK	Jon Larreina	Document review
ENG	Angelo Marguglio	Document review
ILL	Giuseppe Donvito	Document review
CRAN	Sarah Fletcher	Document review

Executive summary

D7.3 is the first deliverable for task T7.3 “Standardization activities” inside WP7 “Impact maximization: Exploitation, Standardization and Dissemination”.

It collects information on the standardization landscape to provide information for other WP, ensure compatibility and interoperability of A4BLUE and facilitate the acceptance and utilization by the market of the developed solutions.

The Spanish Association for Standardization, recently called UNE, and previously called AENOR, as National Standardization Body (NSB), member of CEN-CENELEC has been subcontracted by A4BLUE (IK4-TEKNIKER – the coordinator) to provide support regarding the standardization tasks included in the project (WP7 – Impact Maximization: Exploitation, Standardization and Dissemination).

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Abbreviations and acronyms

CEN	European Committee for Standardization
CENELEC (CLC)	European Committee for Standardization in the Electrical field
CWA	CEN or CENELEC Workshop Agreement
EN	European Standard
FA	Frankfurt Agreement
ISO	International Organization for Standardization; International Standard
NSB	National Standardization Body
PAS	Publicly Available Specification
SC	Subcommittee
TC	Technical Committee
TR	Technical Report
TS	Technical Specification
VA	Vienna Agreement
WG	Working Group
WP	Work Package
UNE	Spanish Association for Standardization
BSI	British Standards Institution

1 Introduction

1.1 Summary and scope

The purpose of this report D7.3 is to provide information on the standardization landscape and applicable standards relevant for the A4BLUE Project. It pretends to provide starting information for the work packages ensuring compatibility and interoperability with already existing solutions by identifying existing standards and standards under development at European and international levels in the fields of Industry 4.0, Adaptive Automation, Human Machine Interaction, Augmented\Virtual reality, and Human Centric Approach.

1.2 Project presentation overview

The main objective of A4BLUE is the development and evaluation of a new generation of sustainable and adaptive workplaces dealing with the evolving requirements of manufacturing processes and human variability.

A4BLUE will introduce adaptive automation mechanisms for an efficient and flexible execution of tasks, ensuring a constant and safe human-machine interaction as well as advanced and personalised worker assistance systems including virtual/augmented reality and knowledge management capabilities to support them in the assembly and training related activities.

Furthermore, A4BLUE will provide methods and tools to determine the optimal degree of automation of the new assembly processes by combining and balancing social and economic criteria to maximize long term worker satisfaction and overall process performance.

1.3 Short introduction about standardization

Standards are voluntary technical documents that set out requirements for a specific item, material, component, system or service, or describes in detail a particular method, procedure or best practice. Standards are developed and defined through a process of sharing knowledge and building consensus among technical experts nominated by interested parties and other stakeholders - including businesses, consumers and environmental groups, among others. These experts are organized in Technical Committees (TCs), which are subdivided in Subcommittees (SCs) or Working Groups (WGs). These TCs are included in the structure of the Standardization Organizations (National, European and International, with the respective mirror committees) and work following their internal regulations.

The standardization bodies operate at National (UNE, AFNOR, BSI, DIN, etc.), Regional (CEN, CENELEC, ETSI) or International (ISO, IEC, ITU) level. Sometimes there are different standardization bodies at the same level, but covering different fields. This is the case of ISO (general), IEC (electrical) and ITU (telecommunications) at International level, or CEN, CENELEC and ETSI at European level in the same way.

There are also different kinds of standardization documents. The most widespread is the standard, which has a different code depending on the organization under it was developed, e.g. EN for European Standards, ISO for International standards. Other types of documents are Technical Specifications (TS), Technical Reports (TR) and Workshop Agreements (CWA). Further Amendments to the standards are identified by adding A1, A2, etc. at the end of the standard code.

The formal definition of a standard is a “document, established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context”. These include requirements and/or recommendations in relation to products, systems, processes or services. European Standards (ENs) are documents that have been ratified by one of the three

European Standardization Organizations (ESOs), CEN, CENELEC or ETSI; recognized as competent in the area of voluntary technical standardization as for the EU Regulation 1025/2012.

At European level, all the members of CEN shall adopt EN standards as national standards and have to withdraw any existing national standard which could conflict with them. A summary of the characteristics of the different standardization documents can be found in **¡Error! No se encuentra el origen de la referencia..**

Type	International code	European code	National code	Main characteristics
Standard	ISO IEC	EN	UNE, NF, BS, DIN, etc. When adopting: UNE-EN, NF-EN, UNE-ISO, NF-ISO, etc.	<ul style="list-style-type: none"> • Elaboration: 3 years • 2 steps of member approval • European: compulsory national adoption • Revision: every 5 years
Technical Specification	ISO/TS IEC/TS	CEN/TS CLC/TS	When adopting: UNE-CEN/TS, NF- CEN/TS, UNE- ISO/TS, NF- ISO/TS, etc.	<ul style="list-style-type: none"> • Elaboration: 21 months • 1 step of member approval or internal approval in TC • European: optional national adoption • Revision: at 3 years (upgrading to EN or deletion)
Technical Report	ISO/TR IEC/TR	CEN/TR CLC/TR	When adopting: UNE-CEN/TR, NF- CEN/TR, UNE- ISO/TR, NF- ISO/TR, etc.	<ul style="list-style-type: none"> • Elaboration: free timeframe • Internal approval in TC • European: optional national adoption • No revision required
Workshop Agreement	IWA	CWA	Variable	<ul style="list-style-type: none"> • Elaboration: free timeframe (usually few months) • Internal approval in the Workshop • European: optional national adoption • Revision: at 3 years (upgrading to EN or deletion)

Table 1 – Characteristics of different standardization documents

European and International Standardization Organizations (e.g. CEN and ISO) have signed formal agreements in order to avoid duplication of efforts and promote global relevance of standards, which allows to adopt or develop in parallel each other's standards with the same content and code.

The technical collaboration between ISO and CEN was formalized through the Vienna Agreement (VA).

European standards developed through the Vienna Agreement have EN ISO codification while International Standards developed through the Vienna Agreement remain only with ISO code.

CENELEC has close cooperation with its international counterpart, the International Electrotechnical Commission (IEC) through the Frankfurt Agreement (FA).

As a result, new electrical standards projects are jointly planned between CENELEC and IEC, and where possible most are carried out at international level. This means that CENELEC will first offer a New Work Item (NWI) to its international counterpart. If accepted, CENELEC will cease working on the NWI. If IEC refuses, CENELEC will work on the standards content development, keeping IEC closely informed and giving IEC the opportunity to comment at the public enquiry stage. CENELEC and IEC vote in parallel (both organizations are voting in the same time) during the standardization process. If the outcome of the parallel voting is positive, CENELEC will ratify the European standard and the IEC will publish the international standard. Close to 80% of CENELEC standards are identical to or based on IEC publications.

National standards could also be proposed as a base for new European or International standards.

The following Figure 1 shows the possible tracks of the standards.

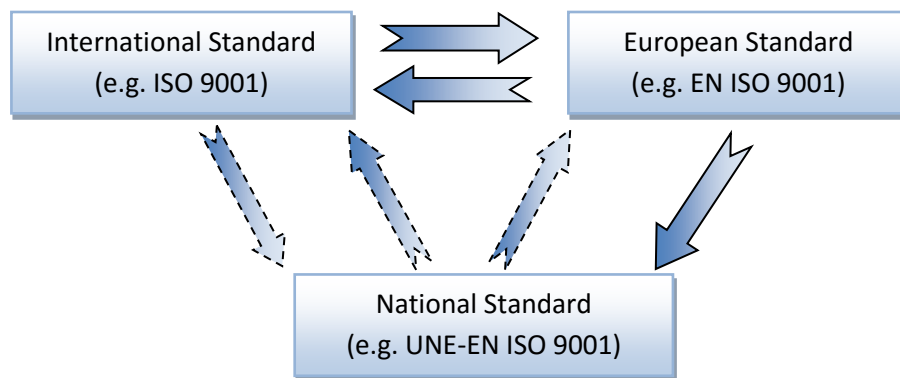


Figure 1 – Possible tracks of standards adoption

Therefore, the code of any standard is the combination of the above mentioned issues, and could be explained as shown in Figure 2.

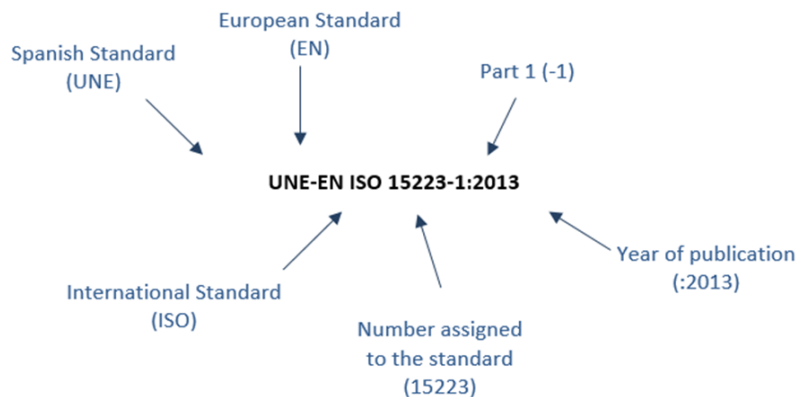


Figure 2 – Example of identification of elements in the code of a standard

2 Methodology

For the identification of standards and standards under development relevant for A4BLUE project the following methodology has been followed:

1. A list of key concepts was prepared to act as a starting point for the identification of standardization areas.
2. For the selection of the key concepts the aims and goals of the project and the levels in which the project should integrate were taken into account. Also the needs of the use cases were considered. The list was agreed by UNE and A4BLUE partners.

The final list of key concepts used for the search is shown in Table 2 **Error! No se encuentra el origen de la referencia..**

Key concepts
1. Advanced automation technologies and their applications
2. Anthropometrics
3. Augmented reality
4. Ergonomics
5. Ergonomics of human-system interaction
6. Ethics in robot design
7. Health and safety
8. Industrial automation systems
9. Industrial-process measurement, control and automation
10. Interoperability
11. Internet of Things (IoT)
12. IT Security techniques
13. Learning, education and training
14. Lighting
15. Personal protective equipment
16. Robot/robotics
17. Safety of machinery
18. Universal accessibility and design for all
19. Vibration
20. Virtual reality

Table 2 – List of key concepts acting as a starting point for the identification of standardization areas

3. Both standards and standards under development were identified for each standardization area, together with the technical committee responsible for the respective standards.

The search covered the European standardization developed by the European Committee for Standardization (CEN), European Committee for Standardization in the Electrical field CENELEC (CLC) and International standardization developed by the International Organization for

Standardization (ISO) and IEC (electro technical). The databases and websites used for the search are referred in Chapter 6.

Only in an exceptionally way a standard of a national standardization body has been considered (British Standards Institution).

4. As a result of the searching process a first draft was prepared by UNE including 560 developed standards and standards under development and 33 technical bodies. Also information about some relevant standards was provided by A4BLUE partners as an input.

The draft was filtered in order to refine the information and enable the development of a simplified second draft.

A second draft was prepared by UNE including 220 references and 23 technical bodies. Information with the standards and standards under development that were circulated to A4BLUE partners is shown in Annex A.

5. As a final stage, A4BLUE partners were asked to identify those references that really should be considered for the project, specifying in what WP it would be used, how the standard would influence/impact the project implementations and risks/opportunities from technical and business perspective.

They were also asked to indicate if any contribution to the respective standard was expected and whether they considered relevant to contact the technical committee responsible for the standard development.

The interaction with the identified standardization technical committee could take place through:

- The participation of one or more A4BLUE partners in the technical body (Standardization is an open activity and all interested parties may participate in a CEN/CENELEC/ISO/IEC technical committee through the designation of National Standardization Bodies/National Mirror Committee or as organization liaison representative in a CEN/TC).
 - The participation through the formal liaison of the A4BLUE Project with main CEN/TC(s) to participate directly as liaison organization which intends to make technical contributions to their works.
 - The dissemination of the A4BLUE Project progress by delivering reports to the relevant TCs Secretaries or by attending relevant technical committees meetings.
6. As a result of all the process described above a list of standards relevant for A4BLUE has been identified (see Chapter 3).

They have been classified as:

- Standards to be considered as a compliance requirement: it should be decided if the standards will represent a requirement for the WP developments at design/development phases.
- Standards to be used as guidelines: it would be interesting to keep them in mind as they could be helpful, but they will not represent a requirement.

Annex B shows the scopes for the standards in Chapter 3.

7. Apart from official standardization activities, there are other private standardization initiatives that could be relevant for the project. Information about them has been provided by the partners. They are shown in Chapter 4.

3 Relevant standards for A4BLUE

3.1 Standards to be considered as compliance requirements

Standard code/ technical body	Standard Title	Relating WP	Contribution to standardization
Interoperability			
IEC 62541 (IEC/TC 65/SC 65E) EN 62541 (CLC/TC 65 X) FA. IEC Lead	OPC unified architecture Part 3: Address Space Model Part 4: Services Part 5: Information Mode Part 6: Mappings Part 7: Profiles Part 8: Data Access Part 9: Alarms and conditions Part 10: Programs Part 11: Historical Access Part 13: Aggregates Part 100: Device Interface	WP2 – During the architecture design phase (T2.1 and T2.2), this standard will be considered to provide CPS enabling connectivity (see T4.1). WP4 – Specifically, in task T4.1 CPS enabling connectivity and management, OPC UA is intended to be used to connect automation mechanisms as CPS in to the A4BLUE framework through the Mediation Services and provide plug-and-produce capabilities.	Main contribution to the standard might come from its usage and dissemination of the A4BLUE framework which may include this standard. Other possible contributions could be reporting possible failures, improvement or any other kinds of suggestions to the OPC Foundation.
IEC 62264 (IEC/ TC 65/SC 65E) EN 62264 (CLC/TC 65X) FA. IEC Lead	Enterprise-control system integration - Part 1: Models and terminology Part 2: Object and attributes for enterprise-control system integration Part 3: Activity models of manufacturing operations management Part 4: Objects models attributes for manufacturing operations management integration Part 5: Business to manufacturing transactions Part 6: Messaging Service Model (Also known as ISA-95)	WP2 – As in the case of OPC UA, this standard will be considered to provide CPS enabling connectivity during the architecture design phase (T2.1 and T2.2). On the other hand, the virtual asset representation may be, at least partially, based on this standard. WP4 – Integration between legacy systems (e.g. MES – Manufacturing Execution System) and the A4BLUE framework may use this standard and its XML implementation B2MML (Business to Manufacturing Markup Language) in task T4.1 CPS enabling connectivity and management.	Main contribution to the standard might come from its usage and dissemination of the A4BLUE framework which may include this standard.

Standard code/ technical body	Standard Title	Relating WP	Contribution to standardization
IEC 62714-1:2014 (IEC/TC 65/SC 65E) EN 62714-1:2014 (CLC/TC 65X) FA IEC Lead	Engineering data exchange format for use in industrial automation systems engineering - Automation Markup Language Part 1: Architecture and general requirements Part 2: Role class libraries Part 3: Geometry and kinematics	AutomationML is an XML- based data format for planning production and automation systems with the aim of realizing the digital factory of the future. It can be useful in WP3 and WP5.	Potentially: Usage and dissemination. AIRBUS is member of AutomationML.
Safety on machinery/ robot/robotics			
ISO 12100:2010 (ISO/TC 199/WG 5) EN ISO 12100:2010 (CEN/TC 114) VA. ISO lead	Safety of machinery - General principles for design - Risk assessment and risk reduction	WP4 – It may be used in T4.2 Safety risk management and T4.4 Automations implementation in the design of the automation mechanisms’ mechanical part and the risk assessment methodology and guidelines for the mechanism.	Potentially: Usage and dissemination.
ISO 13849-1:2015 (ISO/TC 199) EN ISO 13849- 1:2015 (CEN/TC 114) VA. ISO lead	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design	WP4 – It may be used in T4.2 Safety risk management and T4.4 Automations implementation in the design of automation mechanisms’ control systems related to safety.	Potentially: Usage and dissemination.
IEC 60204-1: 2016 IEC/TC 44 EN 60204-1	Safety of machinery – Electrical equipment of machines – Part 1: General requirements	WP4 – It may be used in T4.2 Safety risk management and T4.4 Automations implementation in the design of automation mechanisms’ electrical circuits.	Potentially: Usage and dissemination.
ISO 10218 (ISO/TC 299) EN ISO 10218 (CEN/TC 310)	Robots and robotic devices - Safety requirements for industrial robots Part 1: Robots	WP4 – It may be used in T4.2 Safety risk management and T4.4 Automations implementation in the design of industrial robots’ safety systems and the risk	Potentially: Usage and dissemination.

Standard code/ technical body	Standard Title	Relating WP	Contribution to standardization
VA. ISO lead	Part 2: Robot systems and integration	assessment guidelines for industrial robots' safety systems.	
ISO/TS 15066:2016 (ISO/TC 299)	Robots and robotic devices – Collaborative robots	Possible usage in: WP3 – usability assessment, automation level KPIs WP4 – HMI evaluation	Potentially: with respect to supplying new knowledge of human-automation systems design.
Ergonomics/ ergonomics of human-system interaction			
ISO 6385:2016 (ISO/TC 159/SC 1/WG 1) EN ISO 6385:2016 (CEN/TC 122/WG2) VA. ISO lead	Ergonomics principles in the design of work systems	Possible usage in: WP2 – usability test design WP3 – usability assessment, optimal automation level KPIs WP4 – HMI evaluation WP5 – AR training design WP6 – HF evaluation	Potentially: with respect to supplying new knowledge of human-automation systems e.g. self-optimising automation, optimal automation levels (linked to human / worker characteristics including satisfaction), etc.
ISO 10075 (ISO/TC 159/SC 1/WG 2)	Ergonomic principles related to mental workload -- General terms and definitions Part 2: Design principles	Possible usage in: WP3 – usability assessment, optimal automation level KPIs WP4 – HMI evaluation WP5 – AR training design WP6 – HF evaluation	No
ISO 9241-110:2006 (ISO/TC 159/SC 4) EN ISO 9241-110:2006 (CEN/TC 122/WG 5) VA. ISO lead	Ergonomics of human-system interaction. Ergonomics of human-system interaction - Part 110: Dialogue principles	Possible usage in: WP3 – usability assessment WP4 – HMI evaluation WP6 – HF evaluation	No
ISO 14915-1:2002 (ISO/TC 159/SC 4) EN ISO 14915-1:2002	Software ergonomics for multimedia user interfaces -- Part 1: Design principles and framework	Possible usage in: WP4 – HMI evaluation WP5 – AR training design	-

Standard code/ technical body	Standard Title	Relating WP	Contribution to standardization
(CEN TC 122/WG5) VA ISO Lead			

3.2 Standards to be used as guidelines

Standard code	Standard Title	Relating WP	Contribution to standardization
Safety of machinery			
ISO 14738: 2002 (ISO/TC 159/SC 3) EN ISO 14738:2008 (CEN/TC 122/WG 1) Non ISO CEN parallel process	Safety of machinery -- Anthropometric requirements for the design of workstations at machinery	WP6 – HF evaluation	No
EN 614- 2:2000+A1:2008	Safety of machinery - Ergonomic design principles - Part 2: Interactions between the design of machinery and work tasks	WP4 – automation design	No.
EN 894 (CEN/TC 122)	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 Part 2: Displays Part 3: Control actuators Part 4: Location and arrangement of displays and control actuators	WP3 – usability assessment, WP4 – automation design	No
ISO 11161:2007/ Amd 1:2010 (ISO/TC 199)	Safety of machinery -- Integrated manufacturing systems -- Basic requirements -- Amendment 1	WP4 – safety risk assessment and automation design	No

Standard code	Standard Title	Relating WP	Contribution to standardization
EN 981:1996+A1:2008 (CEN/TC 122)	Safety of machinery - System of auditory and visual danger and information signals	WP4 – safety risk assessment and interaction mechnisms	No
EN 842:1996 +A1:2008 (CEN/TC 122)	Safety of machinery - Visual danger signals - General requirements, design and testing	WP4 – safety risk assessment and interaction mechnisms	No
EN 1005 (CEN/TC 122)	Safety of machinery - Human physical performance Part 2: Manual handling of machinery and component parts of machinery (1005- 3:2002+A1:2008) Part 4: Evaluation of working postures and movements in relation to machinery (1005- 4:2005+A1:2008) Part 5: Risk assessment for repetitive handling at high frequency (1005- 5:2007)	WP4 – safety risk assessment and interaction mechnisms	No
IT security techniques			
EN ISO/IEC 27002:2017 (ISO/IEC JTC 1/ SC 27/WG 1) (CEN/SS F12)	Information technology - Security techniques - Code of practice for information security controls (ISO/IEC 27002:2013 including Cor 1:2014 and Cor 2:2015)	WP2 - The security middleware is intended to create a secure integration layer for the different components of the RI, therefore it will take care of IEC27002 standard, but without looking for compliance.	No
ISO/IEC 27005:2011 (ISO/IEC JTC 1/SC 27/WG 1)	Information technology -- Security techniques -- Information security risk management	WP2 -Security risk assessment	No

Standard code	Standard Title	Relating WP	Contribution to standardization
Ergonomics/ ergonomics of human-system interaction			
ISO 26800:2011 (ISO/TC 159/SC 1/WG 1) EN ISO 26800:2011 (CEN/TC 122) VA. ISO lead	Ergonomics - General approach, principles and concepts	WP1 – HF best practice guide content	No
Ethics in robot design			
BS 8611 (BSI AMT/10 Robotics)	Robots and robotic devices. Guide to the ethical design and application of robots and robotic systems	WP3 – usability assessment, optimal automation level KPIs WP4 – HMI evaluation WP5 – AR training design	Potentially: with respect to supplying new knowledge about ethical considerations for industrial robotic systems e.g. self-optimising automation that is linked to personal data (e.g. characteristics / satisfaction), personal data monitoring via digital systems, requirements of collaborative robot systems, etc.
Software development			
IEC 61499 (IEC/TC 65B) EN 61499 (CLC/TC 65X) FA IEC Lead	Function blocks Part 1: Architecture Part 2: Software tool requirements Part 4: Rules for compliance profiles	WP2 - Although not yet mainstream, it can be considered in WP2 (where it could guide for instance the event manager design and implementation), but it will not be mandatory.	No

No relevant standards under development have been identified.

4 Initiatives

4.1 RAMI 4.0

A key aspect of the A4BLUE framework is the design of the architecture that supports the whole A4BLUE concept. Several initiatives are analysed as guidance and usage for such design process. Among them, RAMI 4.0, the Reference Architecture Model Industrie 4.0, is highlighted as one of the main supporting references which is presented as a reference architecture model for semantic technologies and their benefits for automation and its associated technologies.

This reference architecture for Industrie 4.0 is the result of cooperation between several institutions. In particular, experts from Technical Committees 7.21, “Industrie 4.0”, and 7.20, “Cyber-Physical Systems” of the VDI/VDE Society for Measurement and Automatic Control (GMA) have made a major contribution to the results.

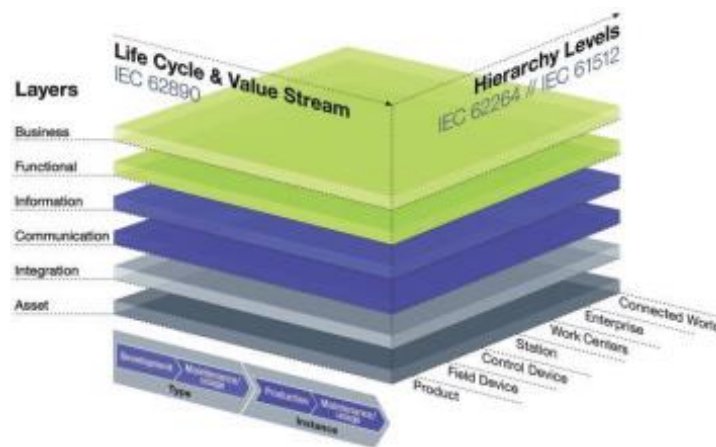


Figure 3 – Reference architecture model for Industrie 4.0 (RAMI4.0)

RAMI 4.0 is a three-dimensional map showing how to approach the issue of Industrie 4.0 in a structured manner: (a) Layers dimension. It corresponds to IT thinking, and represents views such as business processes, functional descriptions, communications behaviour, or assets; (b) Product life cycle and its value streams dimension; (c) Hierarchy levels dimension, representing the location of functionalities and responsibilities within the factories/plants, which extends ISA-95’s (IEC 62264) hierarchy including the perspective of the product and the connected world. RAMI 4.0 ensures that all participants involved in Industrie 4.0 discussions understand each other

RAMI 4.0 is a Service-Oriented Architecture which breaks down complex processes into easy-to-grasp packages, including data privacy and IT security.

RAMI 4.0 integrates, in its conception, several standards such as the aforementioned ISA-95 (IEC 62264) standard for its hierarchy levels, which has been already considered for T4.1, and IEC 62890¹ for the value stream and life cycle approach, which defines a consistent data model for the whole life cycle.

Thus, this initiative will be considered in the workpackage for the A4BLUE conceptualization and architecture (WP2) and, specifically, in the tasks T2.1 Reference model for evolving assembly systems and T2.2 A4BLUE functional and modular architecture. A possible contribution to this initiative comes from its usage and dissemination along the project and suggestions on enhancements to the working groups in charge for the development of RAMI 4.0 reference architecture.

¹ IEC 62890 - Life-cycle management for systems and products used in industrial-process measurement, control and automation

4.2 AR/VR initiatives

One of the main problems in the AR/VR field is the lack of consistency in the way that VR software interacts with VR hardware, which is called “API fragmentation”. The elements that need to be standardized are the device interface and the application interface.

The current situation is that there are no official standards (“de iure”) for AR/VR industry although there are some standards de facto that try to factorize the effort for writing modular software components.

Fortunately, some initiatives have been launched to work on VR industry standardization. Open-Source Virtual Reality (OSVR) offers free and open-source code to implement both device and application layers that support many devices. OpenVR, from Valve, is a software development kit and application programming interface for supporting SteamVR and other virtual reality headset devices. OpenVR has collaborated with the OSVR initiative. OpenSceneGraph is an open source 3D graphics application programming interface, used by application developers in virtual reality among other applications.

Recently, the OpenXR initiative has been launched by the Khronos group which involves companies such as Google, Intel, Oculus, Valve and Samsung to combine lessons learned from building OSVR, OpenVR and proprietary APIs. The initiative intends to create device and application interfaces to establish a new standard.

Furthermore, the IEEE P2048 Standard for Virtual Reality and Augmented Reality Working Group is currently working on the development of eight standards covering general applications.

In the A4BLUE project, the consortium will focus on existing or new initiatives on AR/VR standardization maintained by communities. ILOGIC already uses opensource frameworks like OpenVR and OpenSceneGraph and has contributed to these communities in the past sharing part of their development coming from real projects. A4BLUE will use AR/VR open frameworks and contribute to initiatives whenever possible, and will also disseminate the corresponding results. Besides, A4BLUE will watch the standards listed in the Annex A (A.3 and A.20) in order to consider also their applicability along the project.

4.3 eCl@ss

eCl@ss is an industry-wide standardization for product classification and description. It is a hierarchical and semantic system for grouping materials, products and services according to a logical structure with a level detail that corresponds to the product specific properties that can be described using properties according to ISO 13584 and IEC 61360. Feature lists with standardized properties and value tables enable accurate description and subsequent identification of products and services.

eCl@ss could contribute in A4BLUE particularly in task T2.3 Virtual Asset Representation in the WP2 – Conceptualization and architecture and in task T3.4 Collaborative asset management and automation evaluation tools in WP3 – Methods and tools for adaptive automation and worker satisfaction.

5 Conclusions

As a result of the study of the standardization landscape through the methodology explained above, several standards relevant for the A4BLUE project have been found.

- 12 standards are highly relevant and might be considered as a compliance requirement for the outputs of the project: they refer to WP2, WP3, WP4, WP5 and WP6, but are specially linked to WP4. They refer to connectivity, architecture design, safety risk management, usability, optimal automation level KPI, HMI evaluation, HF evaluation and AR training.

In the future it might be possible to contribute to those standards through standards usage information and through the dissemination of the A4BLUE framework which may include those standards. There will also be possible to report failures, improvement or any other kinds of suggestions. Furthermore, It also might be possible to contribute in the future supplying new knowledge of human-automation systems, self-optimising automation, optimal automation levels (linked to human / worker characteristics including satisfaction), etc.

- 12 standards could be used as guidelines as they could be useful for WP, WP2, WP3, WP4, WP5 and WP6. They refer to architecture, information security control, ergonomics, safety of machinery and robots. They could be applied in design guidance and usability analysis. Regarding future contribution to standardisation it might be possible to contribute supplying new knowledge about ethical considerations for industrial robotic systems.

Private standardization initiatives (Reference Architecture Model Industrie 4.0 and AR/VR initiatives) have also been identified as relevant for the project. Information about them has been provided by the partners. It might be possible to contribute in the future to communities developing those initiatives sharing with them part of the developments from A4BLUE.

To be able to use the standardization system as a tool for dissemination of the project results an interaction with the market stakeholders there will be necessary to decide the type A4BLUE's interaction of with the standardization technical committees relevant for A4BLUE (see Table 3). UNE would provide with the necessary technical support required for that interaction.

Technical committee	Topic
CEN/TC 114	Safety of machinery
CEN/TC 122	Ergonomics
CEN/TC 122/WG1	Anthropometry
CEN/TC 122/WG2	Ergonomic design principles
CEN/TC 122/WG5	Ergonomics of human-system interaction
CEN/TC 310	Advanced automation technologies and their applications
ISO/TC 159	Ergonomics
ISO/TC 159/SC 1 /WG 1	Principles of ergonomics and ergonomic design
ISO/TC 159/SC1/WG 2	Ergonomic principles related to mental work
ISO/TC 159/SC3	Anthropometry and biomechanics
ISO/TC 159/SC4	Ergonomics of human-system interaction
ISO/TC 159/SC4/WG 5	Software ergonomics of human-computer interaction
ISO/TC 159/SC4/WG 6	Human-centred design processes for interactive systems

Technical committee	Topic
ISO/TC 184	Automation systems and integration
ISO/TC 184/SC 4	Industrial data
ISO/TC 199	Safety of machinery
ISO/TC 199/WG5	General principles for the design of machinery and risk assessment
ISO TC 299	Robotics
CLC/TC 44 X	Safety of machinery- Electrotechnical aspects
CLC/TC 65X	Industrial-process measurement, control and automation
IEC/TC 44	Safety of machinery - Electrotechnical aspects
IEC/TC 65	Industrial-process measurement, control and automation
IEC/TC 65B	Measurement and control devices
IEC/TC 65/SC 65E	Devices and integration in enterprise systems
ISO/IEC JTC 1	Information Technology
ISO/IEC JTC 1/SC 27	IT Security techniques
ISO/IEC JTC 1/SC 27/WG1	Information security management systems
ISO/IEC JTC 1/SC 27/WG3	Security evaluation, testing and specification
British Standards AMT/10	Robotics

Table 3 - Standardization technical committees relevant to A4BLUE

6 References

- [1]. CEN Website (www.cen.eu)
- [2]. CENELEC Website (www.cenelec.eu)
- [3]. CEN/CENELEC Projex Online database (projex.cen.eu) (restricted to authorized users)
- [4]. ISO Website (www.iso.org)
- [5]. ISO Project Portal (isotc.iso.org) (restricted to authorized users)
- [6]. IEC Website (www.iec.ch)

Annex A Standardization areas relevant for A4BLUE

This annex provides information about standardization bodies, standards and standards under development found relevant for the list of key concepts agreed by A4BLUE coordinator and partners.

The following areas have been considered

A.1	Standardization on advanced automation technologies and their applications	27
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A.17	Standardization on safety of machinery	45
A.18	Standardization on universal accessibility and design for all.....	51
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A.1 Standardization on advanced automation technologies and their applications

A.1.1 Technical Committees

CEN/TC 310 Advanced automation technologies and their applications

“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 standardization 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”.

ISO/TC 184 Automation systems and integration

“Standardization in the field of automation systems and their integration for design, sourcing, manufacturing, production and delivery, support, maintenance and disposal of products and their associated services. Areas of standardization include information systems, automation and control systems and integration technologies.

Note: There will be active collaboration with the relevant technical committees responsible for areas such as machines, manufacturing resources and facilities, robotics, electrical and electronic equipment, PLC for general application, quality management, industrial safety, information technologies, multi-media capabilities, and multi-modal communication networks”.

A.1.2 Standards to be considered

Code	Name	Technical committees
EN ISO 11354-1:2011	Advanced automation technologies and their applications - Requirements for establishing manufacturing enterprise process interoperability - Part 1: Framework for enterprise interoperability (ISO 11354-1:2011)	CEN/TC 310
ISO 11354-2:2015	Advanced automation technologies and their applications - Requirements for establishing manufacturing enterprise process interoperability -- Part 2: Maturity model for assessing enterprise interoperability	ISO/TC 184/SC 5

A.1.3 Standards under development to be considered

Code	Name	Technical committees
ISO/NP 11354-3	Advanced automation technologies and their applications - Requirements for establishing manufacturing enterprise process interoperability -- Part 3: Requirements for	ISO/TC 184/SC 5

Code	Name	Technical committees
	information and communication technology-enabled enterprise interoperability	

A.2 Standardization on anthropometrics

A.2.1 Technical Committees

CEN/TC 122 Ergonomics

“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”.

ISO/TC 159 Ergonomics

“Standardization in the field of ergonomics, in particular, general ergonomics principles, anthropometry and biomechanics, ergonomics of human system interaction and ergonomics of the physical environment, addressing human characteristics and performance, and methods for specifying, designing and evaluating products, systems, services, environments and facilities

Excluded: Standardization of purely technical matters not related to human characteristics and abilities”.

A.2.2 Standards to be considered

Code	Name	Technical committees
EN ISO 15537:2004	Principles for selecting and using test persons for testing anthropometric aspects of industrial products and designs (ISO 15537:2004)	CEN/TC 122
ISO 11226:2000	Ergonomics -- Evaluation of static working postures	ISO/TC 159/SC 3
ISO/TS 20646:2014	Ergonomics guidelines for the optimization of musculoskeletal workload	ISO/TC 159/SC 3
ISO 11226:2000/ Cor 1:2006	Ergonomics -- Evaluation of static working postures -- Technical Corrigendum 1	ISO/TC 159/SC 3
ISO 15537:2004	Principles for selecting and using test persons for testing anthropometric aspects of industrial products and designs	ISO/TC 159/SC 3
ISO 15535:2012	General requirements for establishing anthropometric databases	ISO/TC 159/SC 3/WG 1

A.2.3 Standards under development to be considered

No standards under development identified.

A.3 Standardization on augmented reality

A.3.1 Technical Committees

ISO/IEC JTC 1 Information Technology

“Standardization in the field of information technology”.

A.3.2 Standards to be considered

Code	Name	Technical committees
ISO/IEC 23000-13:2014	Information technology - Multimedia application format (MPEG-A) -- Part 13: Augmented reality application format	ISO/IEC JTC 1/SC 29/WG 11
ISO/IEC 23000-13:2014/ Amd 1:2015	Information technology - Multimedia application format (MPEG-A) -- Part 13: Augmented reality application format -- Amendment 1: ARAF reference software and conformance	ISO/IEC JTC 1/SC 29/WG 11
ISO/IEC 23000-13/ DAmD 1	Information technology - Multimedia application format (MPEG-A) -- Part 13: Augmented reality application format -- Amendment 1: Reference software and conformance for ARAF	ISO/IEC JTC 1/SC 29/WG 11

A.3.3 Standards under development to be considered

Code	Name	Technical committees
ISO/IEC AWI 21858	Information model for mixed and augmented reality (MAR) contents	ISO/IEC JTC 1/SC 24/WG 9
ISO/IEC AWI 18040	Information technology -- Computer graphics, image processing and environmental data representation and coding of audio, picture, multimedia and hypermedia information -- Live actor and entity representation in mixed and augmented reality (MAR)	ISO/IEC JTC 1/SC 24/WG 9
ISO/IEC CD 18039	Information technology -- Computer graphics, image processing and environmental data representation and coding of audio, picture, multimedia and hypermedia information -- Mixed and augmented reality reference model	ISO/IEC JTC 1/SC 24/WG 9

Code	Name	Technical committees
ISO/IEC AWI 18038	Information technology -- Computer graphics, image processing and environmental data representation and coding of audio, picture, multimedia and hypermedia information -- Sensor representation in mixed and augmented reality (MAR)	ISO/IEC JTC 1/SC 24/WG 9
ISO/IEC NP 23000-14	Information technology -- Multimedia application format (MPEG-A) -- Part 14: Augmented reality reference model	ISO/IEC JTC 1/SC 29/WG 11

A.4 Standardization on ergonomics

A.4.1 Technical Committees

*CEN/TC 122 Ergonomics**

*ISO/TC 159 Ergonomics**

*The scope has been specified in other sections.

A.4.2 Developed standards to be considered

Code	Name	Technical committees
EN ISO 26800:2011	Ergonomics - General approach, principles and concepts (ISO 26800:2011)	CEN/TC 122
EN ISO 10075-1:2000	Ergonomic principles related to mental work-load - Part 1: General terms and definitions (ISO 10075:1991)	CEN/TC 122
EN ISO 10075-2:2000	Ergonomic principles related to mental workload - Part 2: Design principles (ISO 10075-2:1996)	CEN/TC 122
EN ISO 28803:2012	Ergonomics of the physical environment - Application of international standards to people with special requirements (ISO 28803:2012)	CEN/TC 122
EN ISO 28802:2012	Ergonomics of the physical environment - Assessment of environments by means of an environmental survey involving physical measurements of the environment and subjective responses of people (ISO 28802:2012)	CEN/TC 122
EN ISO 6385:2016	Ergonomics principles in the design of work systems (ISO 6385:2016)	CEN/TC 122
ISO 10075-3:2004	Ergonomic principles related to mental workload -- Part 3: Principles and requirements concerning methods for measuring and assessing mental workload	ISO/TC 159/SC 1/WG 2

Code	Name	Technical committees
ISO/TR 12295:2014	Ergonomics -- Application document for International Standards on manual handling (ISO 11228-1, ISO 11228-2 and ISO 11228-3) and evaluation of static working postures (ISO 11226)	ISO/TC 159/SC 3/WG 4
ISO 11228-1:2003	Ergonomics -- Manual handling -- Part 1: Lifting and carrying	ISO/TC 159/SC 3/WG 4
ISO 11228-2:2007	Ergonomics -- Manual handling -- Part 2: Pushing and pulling	ISO/TC 159/SC 3/WG 4
ISO 11228-3:2007	Ergonomics -- Manual handling -- Part 3: Handling of low loads at high frequency	ISO/TC 159/SC 3/WG 4
ISO 9355-1:1999	Ergonomic requirements for the design of displays and control actuators -- Part 1: Human interactions with displays and control actuators	ISO/TC 159/SC 4
ISO 1503:2008	Spatial orientation and direction of movement -- Ergonomic requirements	ISO/TC 159/SC 4
ISO 14915-1:2002	Software ergonomics for multimedia user interfaces -- Part 1: Design principles and framework	ISO/TC 159/SC 4
ISO 14915-3:2002	Software ergonomics for multimedia user interfaces -- Part 3: Media selection and combination	ISO/TC 159/SC 4
ISO 14915-2:2003	Software ergonomics for multimedia user interfaces -- Part 2: Multimedia navigation and control	ISO/TC 159/SC 4
ISO/TR 22411:2008	Ergonomics data and guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities	ISO/TC 159/WG 2

A.4.3 Standards under development to be considered

No standards under development have been identified.

A.5 Standardization on ergonomics of human-system interaction

A.5.1 Technical Committees

*CEN/TC 122 Ergonomics**

*ISO/TC 159 Ergonomics**

*The scope has been identified in other sections.

A.5.2 Developed standards to be considered

Code	Name	Technical committees
CEN ISO/TR 9241-100:2011	Ergonomics of human-system interaction - Part 100: Introduction to standards related to software ergonomics (ISO/TR 9241-100:2010)	CEN/TC 122
EN ISO 9241-110:2006	Ergonomics of human-system interaction - Part 110: Dialogue principles (ISO 9241-110:2006)	CEN/TC 122
EN ISO 9241-154:2013	Ergonomics of human-system interaction - Part 154: Interactive voice response (IVR) applications (ISO 9241-154:2013)	CEN/TC 122
EN ISO 9241-161:2016	Ergonomics of human-system interaction - Part 161: Guidance on visual user-interface elements (ISO 9241-161:2016)	CEN/TC 122
EN ISO 9241-20:2009	Ergonomics of human-system interaction - Part 20: Accessibility guidelines for information/communication technology (ICT) equipment and services (ISO 9241-20:2008)	CEN/TC 122
EN ISO 9241-210:2010	Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems (ISO 9241-210:2010)	CEN/TC 122
EN ISO 9241-300:2008	Ergonomics of human-system interaction - Part 300: Introduction to electronic visual display requirements (ISO 9241-300:2008)	CEN/TC 122
EN ISO 9241-302:2008	Ergonomics of human-system interaction - Part 302: Terminology for electronic visual displays (ISO 9241-302:2008)	CEN/TC 122
EN ISO 9241-303:2011	Ergonomics of human-system interaction - Part 303: Requirements for electronic visual displays (ISO 9241-303:2011)	CEN/TC 122
EN ISO 9241-304:2008	Ergonomics of human-system interaction - Part 304: User performance test methods for electronic visual displays (ISO 9241-304:2008)	CEN/TC 122
EN ISO 9241-306:2008	Ergonomics of human-system interaction - Part 306: Field assessment methods for electronic visual displays (ISO 9241-306:2008)	CEN/TC 122
EN ISO 9241-307:2008	Ergonomics of human-system interaction - Part 307: Analysis and compliance test methods for electronic visual displays (ISO 9241-307:2008)	CEN/TC 122

Code	Name	Technical committees
CEN ISO/TR 9241-331:2013	Ergonomics of human-system interaction - Part 331: Optical characteristics of autostereoscopic displays (ISO/TR 9241-331:2012)	CEN/TC 122
EN ISO 9241-910:2011	Ergonomics of human-system interaction - Part 910: Framework for tactile and haptic interaction (ISO 9241-910:2011)	CEN/TC 122
EN ISO 9241-920:2016	Ergonomics of human-system interaction - Part 920: Guidance on tactile and haptic interactions (ISO 9241-920:2009)	CEN/TC 122
EN ISO 9241-171:2008	Ergonomics of human-system interaction - Part 171: Guidance on software accessibility (ISO 9241-171:2008). <i>This standard revises ISO/TS 16071:2003 Ergonomics of human-system interaction</i>	CEN/TC 122
ISO/TR 16982:2002	Ergonomics of human-system interaction -- Usability methods supporting human-centred design	ISO/TC 159/SC 4
ISO 9241-129:2010	Ergonomics of human-system interaction -- Part 129: Guidance on software individualization	ISO/TC 159/SC 4
ISO 13407:1999	Human-centred design processes for interactive systems	ISO/TC 159/SC 4
ISO/TR 18529:2000	Ergonomics -- Ergonomics of human-system interaction -- Human-centred lifecycle process descriptions	ISO/TC 159/SC 4/WG 6

A.5.3 Standards under development to be considered

Code	Name	Technical committees
prEN ISO 9241-11	Ergonomics of human-system interaction - Part 11: Usability: Definitions and concepts (ISO/DIS 9241-11:2016)	CEN/TC 122
prEN ISO 9241-392	Ergonomics of human-system interaction - Part 392: Ergonomic recommendations for the reduction of visual fatigue from stereoscopic images (ISO 9241-392:2015)	CEN/TC 122
prEN ISO 9241-960	Ergonomics of human-system interaction - Part 960: Framework and guidance for gesture interactions (ISO/DIS 9241-960:2015)	CEN/TC 122
FprEN ISO 9241-112	Ergonomics of human-system interaction - Part 112: Principles for the presentation of information (ISO/FDIS 9241-112:2016)	CEN/TC 122

Code	Name	Technical committees
ISO/DIS 9241-125	Ergonomics of human-system interaction -- Part 125: Guidance on visual presentation of information	ISO/TC 159/SC 4
ISO/DIS 9241-333	Ergonomics of human-system interaction -- Part 333: Stereoscopic displays using glasses	ISO/TC 159/SC 4
ISO/DIS 9241-220	Ergonomics of human-system interaction -- Part 220: Processes for enabling, executing and assessing human-centred design within organizations	ISO/TC 159/SC 4/WG 6

A.6 Standardization on ethics in robot design

A.6.1 Technical Committees

British Standards AMT/10 Robotics

“Under the direction of the Standards Policy and Strategy Committee, is responsible for the UK input to ISO/TC 299 and some elements of CEN/TC 310 for standards in the field of robots, robotic devices and autonomous systems, industrial robots, medical care robots and personal care robot safety”.

A.6.2 Developed standards to be considered

Code	Name	Technical committees
BS 8611:	Robots and robotic devices. Guide to the ethical design and application of robots and robotic systems	AMT/10 Robotics

A.6.3 Standards under development to be considered

No relevant standards under development identified.

A.7 Standardization on health and safety

A.7.1 Technical Committees

ISO/PC 283 Occupational health and safety management systems

“Development of a standard on occupational health and safety management systems. *Requirements with guidance for use.*”

A.7.2 Developed standards to be considered

No relevant developed standards identified.

A.7.3 Standards under development to be considered

Code	Name	Technical committees
ISO/DIS 45001	Occupational health and safety management systems -- Requirements with guidance for use	ISO/PC 283/WG 1

A.8 Standardization on industrial automation system

A.8.1 Technical Committees

CLC/TC 65X Industrial-process measurement, control and automation

“To contribute, support and coordinate the preparation of international standards for systems and elements used for industrial process measurement, control and automation at CENELEC level. To coordinate standardization activities which affect integration of components and functions into such systems including safety and security aspects. This CENELEC work of standardization is to be carried out for equipment and systems and closely coordinated with IEC TC65 and its subcommittees with the objective of avoiding any duplication of work while honoring standing agreements between CENELEC and IEC.”

ISO/ TC 184 Automation systems and integration

“Standardization in the field of automation systems and their integration for design, sourcing, manufacturing, production and delivery, support, maintenance and disposal of products and their associated services. Areas of standardization include information systems, automation and control systems and integration technologies.

Note: There will be active collaboration with the relevant technical committees responsible for areas such as machines, manufacturing resources and facilities, robotics, electrical and electronic equipment, PLC for general application, quality management, industrial safety, information technologies, multi-media capabilities, and multi-modal communication networks.”

IEC/TC65 Industrial-process measurement, control and automation

“To prepare international standards for systems and elements used for industrial-process measurement and control concerning continuous and batch processes.

To co-ordinate the standardization of those features of related elements which affect suitability for integration into such systems. The work of standardization outlined above is to be carried out in the international fields for equipment and systems operating with electrical, pneumatic, hydraulic, mechanical or other systems of measurement and/or control.”

A.8.2 Developed standards to be considered

Code	Name	Technical committees
EN 62714-1:2014	Engineering data exchange format for use in industrial automation systems engineering - Automation markup language - Part 1: Architecture and general requirements	CLC/TC 65X

Code	Name	Technical committees
EN 62714-2:2015	Engineering data exchange format for use in industrial automation systems engineering - Automation markup language - Part 2: Role class libraries	CLC/TC 65X
EN 62439-1:2010	Industrial communication networks - High availability automation networks - Part 1: General concepts and calculation methods	CLC/TC 65X
EN 62439-1:2010/ A1:2012	Industrial communication networks - High availability automation networks - Part 1: General concepts and calculation methods	CLC/TC 65X
EN 62439-2:2010	Industrial communication networks - High availability automation networks - Part 2: Media Redundancy Protocol (MRP)	CLC/TC 65X
EN 62439-3:2012	Industrial communication networks - High availability automation networks - Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)	CLC/TC 65X
EN 62439-4:2010	Industrial communication networks - High availability automation networks - Part 4: Cross-network Redundancy Protocol (CRP)	CLC/TC 65X
EN 62439-4:2010/ A1:2012	Industrial communication networks - High availability automation networks - Part 4: Cross-network Redundancy Protocol (CRP)	CLC/TC 65X
EN 62439-5:2010	Industrial communication networks - High availability automation networks - Part 5: Beacon Redundancy Protocol (BRP)	CLC/TC 65X
EN 62439-6:2010	Industrial communication networks - High availability automation networks - Part 6: Distributed Redundancy Protocol (DRP)	CLC/TC 65X
EN 62439-7:2012	Industrial communication networks - High availability automation networks - Part 7: Ring-based Redundancy Protocol (RRP)	CLC/TC 65X
EN 62439-7:2012/ AC:2015	Industrial communication networks - High availability automation networks - Part 7: Ring-based Redundancy Protocol (RRP)	CLC/TC 65X
ISO 23570-1:2005	Industrial automation systems and integration -- Distributed installation in industrial applications -- Part 1: Sensors and actuators	ISO/TC 184/SC 1

Code	Name	Technical committees
IEC 62443-2-1:2010	Industrial communication networks - Network and system security - Part 2-1: Establishing an industrial automation and control system security program	IEC/ TC 65
IEC 62443-2-4:2015	Security for industrial automation and control systems - Part 2-4: Security program requirements for IACS service providers	IEC/ TC 65
IEC 62443-2-4:2015/ COR1:2015	Corrigendum 1 - Security for industrial automation and control systems - Part 2-4: Security program requirements for IACS service providers	IEC/ TC 65
IEC 62443-3-3:2013	Industrial communication networks - Network and system security - Part 3-3: System security requirements and security levels	IEC/ TC 65
IEC 62443-3-3:2013/ COR1:2014	Corrigendum 1 - Industrial communication networks - Network and system security - Part 3-3: System security requirements and security levels	IEC/ TC 65

A.8.3 Standards under development to be considered

Code	Name	Technical committees
prEN 62714-3:2016	Engineering data exchange format for use in industrial automation systems engineering - Automation Markup Language - Part 3: Geometry and kinematics	CLC/TC 65X
FprEN 62439-X:2015	Industrial communication networks - High availability automation networks	CLC/TC 65X
IEC 62443-2-4/ AMD1 ED1	Security for industrial automation and control systems - Part 2-4: Security program requirements for IACS service providers	IEC/ TC 65
IEC 62443-3-2 ED1	Security for industrial automation and control systems - Part 3-2: Security risk assessment and system design	IEC/ TC 65
IEC 62443-4-1 ED1	Industrial communication networks - Security for industrial and control systems - Part: 4-1: Product development requirements	IEC/ TC 65
IEC 62443-4-2 ED1	Industrial communication networks - Security for industrial automation and control systems - Part 4-2: Technical security requirements for IACS components	IEC/ TC 65

A.9 Standardization on industrial process measurement, control and automation

A.9.1 Technical Committees

CLC/TC 65X Industrial-process measurement, control and automation

“To contribute, support and coordinate the preparation of international standards for systems and elements used for industrial process measurement, control and automation at CENELEC level. To coordinate standardisation activities which affect integration of components and functions into such systems including safety and security aspects. This CENELEC work of standardisation is to be carried out for equipment and systems and closely coordinated with IEC TC65 and its subcommittees with the objective of avoiding any duplication of work while honouring standing agreements between CENELEC and IEC.”

A.9.2 Developed standards to be considered

Code	Name	Technical committees
EN 61069-1:2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 1: Terminology and basic concepts	CLC/TC 65X
EN 61069-2:2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 2: Assessment methodology	CLC/TC 65X
EN 61069-3:2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 3: Assessment of system functionality	CLC/TC 65X
EN 61069-4:2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 4: Assessment of system performance	CLC/TC 65X
EN 61069-5:2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 5: Assessment of system dependability	CLC/TC 65X
EN 61069-6:2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 6: Assessment of system operability	CLC/TC 65X
EN 61069-7:2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 7: Assessment of system safety	CLC/TC 65X
EN 61069-8:2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 8: Assessment of other system properties	CLC/TC 65X

Code	Name	Technical committees
EN 62381:2012	Automation systems in the process industry - Factory acceptance test (FAT), site acceptance test (SAT) and site integration test (SIT)	CLC/TC 65X

A.9.3 Standards under development to be considered

No relevant standards under development identified.

A.10 Standardization on interoperability

A.10.1 Technical Committees

IEC/SC65 E Devices and integration in enterprise systems

“To prepare international standards to specify digital representation of device properties and functions, methodologies and applications supporting automation of engineering processes, including diagnostic and maintenance techniques.”

A.10.2 Developed standards to be considered

Code	Name	Technical committees
IEC 62541-3:2015	OPC unified architecture - Part 3: Address Space Model	IEC/SC 65E
IEC 62541-4:2015	OPC Unified Architecture - Part 4: Services	IEC/SC 65E
IEC 62541-5:2015	OPC Unified Architecture - Part 5: Information Model	IEC/SC 65E
IEC 62541-6:2015	OPC unified architecture - Part 6: Mappings	IEC/SC 65E
IEC 62541-7:2015	OPC unified architecture - Part 7: Profiles	IEC/SC 65E
IEC 62541-8:2015	OPC Unified Architecture - Part 8: Data Access	IEC/SC 65E
IEC 62541-9:2015	OPC Unified Architecture - Part 9: Alarms and conditions	IEC/SC 65E
IEC 62541-10:2015	OPC Unified Architecture - Part 10: Programs	IEC/SC 65E
IEC 62541-11:2015	OPC Unified Architecture - Part 11: Historical Access	IEC/SC 65E
IEC 62541-13:2015	OPC Unified Architecture - Part 13: Aggregates	IEC/SC 65E
IEC 62541-100:2015	OPC Unified Architecture - Part 100: Device Interface	IEC/SC 65E
IEC 62264-1:2013	Enterprise-control system integration - Part 1: Models and terminology	IEC/SC 65E
IEC 62264-2:2013	Enterprise-control system integration - Part 2: Object and attributes for enterprise-control system integration	IEC/SC 65E

Code	Name	Technical committees
IEC 62264-3:2016	Enterprise-control system integration - Part 3: Activity models of manufacturing operations management	IEC/SC 65E
IEC 62264-4:2015	Enterprise-control system integration - Part 4: Objects models attributes for manufacturing operations management integration	IEC/SC 65E
IEC 62264-5:2016	Enterprise-control system integration - Part 5: Business to manufacturing transactions	IEC/SC 65E
IEC PAS 62264-6:2016	Enterprise-control system integration - Part 6: Messaging Service Model	IEC/SC 65E

A.10.3 Standards under development to be considered

No relevant standards under development have been identified.

A.11 Standardization on internet of things

A.11.1 Technical Committees

ISO/IEC JTC 1 Information Technology

“Standardization in the field of information technology”.

A.11.2 Developed standards to be considered

No relevant developed standards have been identified.

A.11.3 Standards under development to be considered

Code	Name	Technical committees
ISO/IEC CD 30141	Internet of Things Reference Architecture (IoT RA)	ISO/IEC JTC 1/WG 10
ISO/IEC AWI 21823-1	Internet of things (IoT) -- Interoperability for internet of things systems -- Part 1: Framework	ISO/IEC JTC 1/WG 10
ISO/IEC CD 20924	Information technology -- Internet of Things (IoT) -- Definition and vocabulary	ISO/IEC JTC 1/WG 10
ISO/IEC PDTR 22417	Information technology -- Internet of things (IoT) use cases	ISO/IEC JTC 1/WG 10
ISO/IEC 29161:2016	Information technology -- Data structure -- Unique identification for the Internet of Things	ISO/IEC JTC 1/SC 31/WG 2

A.12 Standardization on IT security techniques

A.12.1 Technical Committees

ISO/IEC JTC 1 Information Technology

“Standardization in the field of information technology”.

IEC TC 65 Industrial-process measurement, control and automation

“To prepare international standards for systems and elements used for industrial-process measurement and control concerning continuous and batch processes. To co-ordinate the standardization of those features of related elements which affect suitability for integration into such systems. The work of standardization outlined above is to be carried out in the international fields for equipment and systems operating with electrical, pneumatic, hydraulic, mechanical or other systems of measurement and/or control.”

A.12.2 Developed standards to be considered

Code	Name	Technical committees
ISO/IEC 27002:2013	Information technology -- Security techniques -- Code of practice for information security controls	ISO/IEC JTC 1/SC 27/WG 1
ISO/IEC 27002:2013/Cor 1:2014	Information technology -- Security techniques -- Code of practice for information security controls -- Technical Corrigendum 1	ISO/IEC JTC 1/SC 27/WG 1
ISO/IEC 27002:2013/Cor 2:2015	Information technology -- Security techniques -- Code of practice for information security controls -- Technical Corrigendum 2	ISO/IEC JTC 1/SC 27/WG 1
ISO/IEC 27005:2011	Information technology -- Security techniques -- Information security risk management	ISO/IEC JTC 1/SC 27/WG 1
ISO/IEC 15408-1:2009	Information technology -- Security techniques -- Evaluation criteria for IT security -- Part 1: Introduction and general model	ISO/IEC JTC 1/SC 27/WG 3
ISO/IEC 15408-2:2008	Information technology -- Security techniques -- Evaluation criteria for IT security -- Part 2: Security functional components	ISO/IEC JTC 1/SC 27/WG 3
ISO/IEC 15408-3:2008	Information technology -- Security techniques -- Evaluation criteria for IT security -- Part 3: Security assurance components	ISO/IEC JTC 1/SC 27/WG 3
IEC TS 62443-1-1:2009	Industrial communication networks - Network and system security - Part 1-1: Terminology, concepts and models	IEC/TC 65

Code	Name	Technical committees
IEC 62443-2-1:2010	Industrial communication networks - Network and system security - Part 2-1: Establishing an industrial automation and control system security program	IEC/TC 65

A.12.3 Standards under development to be considered

Code	Name	Technical committees
ISO/IEC NP 15408-4	Information technology -- Security techniques -- Evaluation criteria for IT security -- Part 4: Framework for the specification of evaluation methods and activities	ISO/IEC JTC 1/SC 27/WG 3
ISO/IEC NP 15408-5	Information technology -- Security techniques -- Evaluation criteria for IT security -- Part 5: Pre-defined packages of security requirements	ISO/IEC JTC 1/SC 27/WG 3
ISO/IEC PDTS 19608	Guidance for developing security and privacy functional requirements based on ISO/IEC 15408	ISO/IEC JTC 1/SC 27/WG 3
ISO/IEC CD 20543	Information technology -- Security techniques -- Test and analysis methods for random bit generators within ISO/IEC 19790 and ISO/IEC 15408	ISO/IEC JTC 1/SC 27/WG 3

A.13 Standardization on learning, education and training

A.13.1 Technical Committees

ISO/IEC JTC 1 Information Technology

“Standardization in the field of information technology”.

A.13.2 Developed standards to be considered

Code	Name	Technical committees
ISO/IEC 19778-1:2015	Information technology -- Learning, education and training -- Collaborative technology -- Collaborative workplace -- Part 1: Collaborative workplace data model	ISO/IEC JTC 1/SC 36/WG 2
ISO/IEC PDTR 20821	Learning environment components for automated contents adaptation	ISO/IEC JTC 1/SC 36/WG 2

A.13.3 Standards under development to be considered

No relevant standards under development identified.

A.14 Standardization on lighting

A.14.1 Technical Committees

CEN/TC 169 Light and lighting

“Standardization in the field of vision, photometry and colorimetry, involving natural and man-made radiation over the UV, the visible and the IR regions of the spectrum, and application subjects covering all usages of light, indoors and outdoors, including environmental and aesthetic effects.”

ISO/TC 274 Light and lighting

“Standardization in the field of application of lighting in specific cases complementary to the work items of the International Commission on Illumination (CIE) and the coordination of drafts from the CIE, in accordance with the Council Resolution 19/1984 and Council Resolution 10/1989 concerning vision, photometry and colorimetry, involving natural and man-made radiation over the UV, the visible and the IR regions of the spectrum, and application subjects covering all usage of light, indoors and outdoors, energy performance, including environmental, non-visual biological and health effects.”

A.14.2 Developed standards to be considered

Code	Name	Technical committees
EN 12464-1:2011	Light and lighting - Lighting of work places - Part 1: Indoor work places	CEN/TC 169
EN 12464-2:2014	Light and lighting - Lighting of work places - Part 2: Outdoor work places	CEN/TC 169
ISO 8995-1:2002	Lighting of work places -- Part 1: Indoor	ISO/TC 274
ISO 8995-1:2002/ Cor 1:2005	Lighting of work places -- Part 1: Indoor -- Technical Corrigendum 1	ISO/TC 274

A.14.3 Standards under development to be considered

No relevant standards under development identified.

A.15 Standardization on personal protective equipment

A.15.1 Technical Committees

*CEN/TC 122 Ergonomics**

*The scope is specified in 3.2

A.15.2 Developed standards to be considered

Code	Name	Technical committees
EN 13921:2007	Personal protective equipment - Ergonomic principles	CEN/TC 122

A.15.3 Standards under development to be considered

No relevant standards under development identified.

A.16 Standardization on robot/robotics

A.16.1 Technical Committees

CEN/TC 310 Advanced automation technologies and their applications

“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 standardization 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 utilize other standards and technologies beyond the scope of TC310, such as machines, equipment, information technologies, multi-media capabilities, and multi-modal communications networks.”

ISO/TC 299 Robotics

“Standardization in the field of robotics, excluding toys and military applications.”

A.16.2 Developed standards to be considered

Code	Name	Technical committees
ISO/TS 15066:2016	Robots and robotic devices -- Collaborative robots	ISO/TC 299

A.16.3 Standards under development to be considered

Code	Name	Technical committees
ISO/NP 10218	Manipulating industrial robots - Safety	CEN/TC 310
ISO/NP TR 20218-1	Robots and robotic devices -- Safety requirements for industrial robots -- Part 1: Industrial robot system end of arm tooling (end-effector)	ISO/TC 299
ISO/NP TR 20218-2	Robots and robotic devices -- Safety requirements for industrial robots -- Part 2: Industrial robot system manual load stations	ISO/TC 299
ISO/CD TR 23482-1	Robotics -- Application of ISO 13482 -- Part 1: Safety-related test methods	ISO/TC 299/WG 2

A.17 Standardization on safety of machinery

A.17.1 Technical Committees

CEN/TC 114 Safety of machinery

“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. anti-vibration gloves), vibration isolators (e.g. resilient materials) and suspension systems (e.g. seats).”

CEN/TC 122 Ergonomics*

*The scope has been specified in other section.

CEN/TC 310 Advanced automation technologies and their applications*

*The scope has been specified in other section.

CLC/TC 44X Safety of machinery: electrotechnical aspects

“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 machinery.”

ISO/TC 159 Ergonomics*

*The scope has been specified in other section.

ISO/TC 199 Safety of machinery

“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.”

IEC TC 3 Information structures and elements, identification and making principles, documentation and graphical symbols

“To prepare standards for the electrotechnical and related fields regarding:

- 1) Methods and rules associated with the human interpretation of information. This refers to:
 - presentation of information in technical documentation,

- graphical symbols for use in technical documentation,
 - graphical symbols for the human interaction with equipment.
- 2) Methods and rules associated with the handling of information in computer sensible form. This refers to:
- information models for the purpose of technical documentation and the exchange of technical information, and the identification of further needs for such models,
 - definition of data element types and data sets for use in information models and technical documentation, and for exchange of technical information.
 - t includes definition and co-ordination of the information required during the whole life cycle of a device, system, or plant.
- 3) General and safety application concerning the man-machine interface, marking and identification in electrical installations and equipment, marking systems and general rules for:
- the meanings of colours and alternative means, when used for marking and identification,
 - the arrangement of indicating devices and actuators,
 - coding principles for indicating and actuating devices,
 - terminal designation of electrical and electronic components, apparatus and equipment,
 - the termination designation of certain designated conductors,
 - marking of electrical and electronic equipment with ratings related to supply and to its properties,
 - marking of bare and insulated conductors.

These standards are principally intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104: Guide to the drafting of Safety Standards, and the role of committees with Safety Pilot Functions and Safety Group Functions, and in ISO/IEC Guide 51: Guidelines for the inclusion of safety aspects in standards.”

IEC/TC 44 Safety of machinery - Electrotechnical aspects

“Standardization in the field of the application of electro-technical equipment and systems to machinery (including a group of machines working together in a coordinated 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 machinery.

Standardization of interfaces (excluding local area networks and fieldbus) between control equipment and the electro-technical equipment of machinery.

Standardization of electrotechnical equipment and systems relating to the safeguarding of persons from hazards of the machinery, its associated equipment and the environment.

To coordinate with ISO all matters concerning the safety of machinery.”

A.17.2 Developed standards to be considered

Code	Name	Technical committees
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)	CEN/TC 114
EN ISO 13849-1:2015	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015)	CEN/TC 114
EN ISO 13849-2:2012	Safety of machinery - Safety-related parts of control systems - Part 2: Validation (ISO 13849-2:2012)	CEN/TC 114
CEN/TR 614-3:2010	Safety of machinery - Part 3: Ergonomic principles for the design of mobile machinery	CEN/TC 122
EN 1005-2:2007	Safety of machinery - Human physical performance Part 2: Manual handling of machinery and component parts of machinery	CEN/TC 122
EN 1005-3:2002+A1:2008	Safety of machinery - Human physical performance - Part 3: Recommended force limits for machinery operation	CEN/TC 122
EN 1005-4:2005+A1:2008	Safety of machinery - Human physical performance - Part 4: Evaluation of working postures and movements in relation to machinery	CEN/TC 122
EN 13861:2011	Safety of machinery - Guidance for the application of ergonomics standards in the design of machinery	CEN/TC 122
EN 547-1:1996+A1:2008	Safety of machinery - Human body measurements - Part 1: Principles for determining the dimensions required for openings for whole body access into machinery	CEN/TC 122
EN 547-2:1996+A1:2008	Safety of machinery - Human body measurements - Part 2: Principles for determining the dimensions required for access openings	CEN/TC 122
EN 547-3:1996+A1:2008	Safety of machinery - Human body measurements - Part 3: Anthropometric data	CEN/TC 122
EN 614-1:2006+A1:2009	Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles	CEN/TC 122
EN 894-1:1997+A1:2008	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	CEN/TC 122

Code	Name	Technical committees
EN 894-3:2000+A1:2008	Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 3: Control actuators	CEN/TC 122
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	CEN/TC 122
<u>EN 842:1996</u> <u>+A1:2008</u>	Safety of machinery - Visual danger signals - General requirements, design and testing	CEN/TC 122
EN 981:1996+A1:2008	Safety of machinery - System of auditory and visual danger and information signals	CEN/TC 122
EN ISO 10218-1:2011	Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots (ISO 10218-1:2011)	CEN/TC 310
EN ISO 10218-2:2011	Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robot systems and integration (ISO 10218-2:2011)	CEN/TC 310
CLC/TS 62046:2008	Safety of machinery - Application of protective equipment to detect the presence of persons	CLC/TC 44X
EN 61310-1:2008	Safety of machinery - Indication, marking and actuation - Part 1: Requirements for visual, acoustic and tactile signals	CLC/TC 44X
EN 61310-2:2008	Safety of machinery - Indication, marking and actuation - Part 2: Requirements for marking	CLC/TC 44X
EN 61310-3:2008	Safety of machinery - Indication, marking and actuation - Part 3: Requirements for the location and operation of actuators	CLC/TC 44X
ISO 14738:2002	Safety of machinery -- Anthropometric requirements for the design of workstations at machinery	ISO/TC 159/SC 3
ISO 14738:2002/ Cor 1:2003	Safety of machinery -- Anthropometric requirements for the design of workstations at machinery -- Technical Corrigendum 1	ISO/TC 159/SC 3
ISO 14738:2002/ Cor 2:2005	Safety of machinery -- Anthropometric requirements for the design of workstations at machinery -- Technical Corrigendum 2:	ISO/TC 159/SC 3
ISO 15534-1:2000	Ergonomic design for the safety of machinery -- Part 1: Principles for determining the dimensions required for openings for whole-body access into machinery	ISO/TC 159/SC 3

Code	Name	Technical committees
ISO 15534-2:2000	Ergonomic design for the safety of machinery -- Part 2: Principles for determining the dimensions required for access openings	ISO/TC 159/SC 3
ISO 15534-3:2000	Ergonomic design for the safety of machinery -- Part 3: Anthropometric data	ISO/TC 159/SC 3
ISO 11161:2007/ Amd 1:2010	Safety of machinery -- Integrated manufacturing systems -- Basic requirements -- Amendment 1	ISO/TC 199
ISO/TR 14121-2:2012	Safety of machinery -- Risk assessment -- Part 2: Practical guidance and examples of methods	ISO/TC 199
ISO 11161:2007	Safety of machinery -- Integrated manufacturing systems -- Basic requirements	ISO/TC 199
ISO 11161:2007/ Amd 1:2010	Safety of machinery -- Integrated manufacturing systems -- Basic requirements -- Amendment 1	ISO/TC 199
ISO/TR 14121-2:2012	Safety of machinery -- Risk assessment -- Part 2: Practical guidance and examples of methods	ISO/TC 199
ISO 13851:2002	Safety of machinery -- Two-hand control devices -- Functional aspects and design principles	ISO/TC 199
IEC 60152:1963	Basic and safety principles for man-machine interface, marking and identification - Identification of equipment terminals, conductor terminations and conductors	IIEC/TC 3
IEC 60445:2010	Basic and safety principles for man-machine interface, marking and identification - Actuating principles	IIEC/TC 3
IEC 62061:2005	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	IEC/TC 44
IEC 62061:2005/ AMD1:2012	Amendment 1 - Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	IEC/TC 44
IEC 62061:2005/ AMD2:2015	Amendment 2 - Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	IEC/TC 44
IEC 62061:2005 +AMD1:2012 +AMD2:2015 CSV/COR1:2015	Corrigendum 1 - Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	IEC/TC 44

Code	Name	Technical committees
IEC 62061:2005/ COR1:2005	Corrigendum 1 - Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	IEC/TC 44
IEC 61496-1:2012/ COR1:2015	Corrigendum 1 Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests	IEC/TC 44
IEC 62061:2005/ COR2:2008	Corrigendum 2 - Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	IEC/TC 44
IEC 60204:2016 SER	Safety of machinery - Electrical equipment of machines - ALL PARTS	IEC/TC 44
IEC 60204-1:2016	Safety of machinery - Electrical equipment of machines - Part 1: General requirements	IEC/TC 44
IEC 60204-1:2016 RLV	Safety of machinery - Electrical equipment of machines - Part 1: General requirements	IEC/TC 44
IEC 60204-11:2000	Safety of machinery - Electrical equipment of machines - Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV	IEC/TC 44
IEC 61496-1:2012	Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests	IEC/TC 44
ISO 13850:2006	Safety of machinery - Emergency stop - Principles for design	IEC/TC 44
IEC 62061:2005 +AMD1:2012 +AMD2:2015 CSV	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	IEC/TC 44
IEC 62061:2005 +AMD1:2012 CSV	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	IEC/TC 44
IEC 61310-1:2007	Safety of machinery - Indication, marking and actuation - Part 1: Requirements for visual, acoustic and tactile signals	IEC/TC 44
IEC 61310-2:2007	Safety of machinery - Indication, marking and actuation - Part 2: Requirements for marking	IEC/TC 44
IEC 61310-3:2007	Safety of machinery - Indication, marking and actuation - Part 3: Requirements for the location and operation of actuators	IEC/TC 44

A.17.3 Standards under development to be considered

Code	Name	Technical committees
FprEN 62745:2016	Safety of machinery - Requirements for the interfacing of cableless controllers to machinery	CLC/TC 44X
prEN 62998-721	Safety of machinery - Electro-sensitive protective equipment - Safety-related sensors used for protection of person	CLC/TC 44X
ISO/PWI 14122-5	Safety of machinery -- Permanent means of access to machinery -- Part 5: Mobile machinery	ISO/TC 199/WG 11
ISO/AWI 21260	Safety of Machinery -- Mechanical safety data for physical contacts between moving machinery and people	ISO/TC 199/WG 12
IEC 62046 ED3	Safety of machinery – Application of protective equipment to detect the presence of persons	IEC/TC 44
IEC 62998-721 ED1	Safety of machinery - Electro-sensitive protective equipment - Safety-related sensors used for protection of person	IEC/TC 44
IEC 62061 ED2	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	IEC/TC 44
ISO/IEC 17305 ED1	Safety of machinery - Safety functions of control systems	IEC/TC 44
IEC 63074 ED1	Security aspects related to functional safety of safety-related control systems	IEC/TC 44

A.18 Standardization on universal accessibility and design for all

A.18.1 Technical Committees

*ISO/IEC JTC 1 Information technology**

*ISO/TC 159 Ergonomics**

*The scope has been specified in other sections.

A.18.2 Developed standards to be considered

Code	Name	Technical committees
ISO/IEC TR 29138-1:2009	Information technology -- Accessibility considerations for people with disabilities -- Part 1: User needs summary	ISO/IEC JTC 1
ISO/IEC TR 29138-2:2009	Information technology -- Accessibility considerations for people with disabilities -- Part 2: Standards inventory	ISO/IEC JTC 1
ISO/IEC TR 29138-3:2009	Information technology -- Accessibility considerations for people with disabilities -- Part 3: Guidance on user needs mapping	ISO/IEC JTC 1
ISO/IEC TS 20071-11:2012	Information technology -- User interface component accessibility -- Part 11: Guidance for alternative text for images	ISO/IEC JTC 1/SC 35/WG 6
ISO/IEC 24786:2009	Information technology -- User interfaces -- Accessible user interface for accessibility settings	ISO/IEC JTC 1/SC 35/WG 6
ISO 24505:2016	Ergonomics -- Accessible design -- Method for creating colour combinations taking account of age-related changes in human colour vision	ISO/TC 159/SC 5

A.18.3 Standards under development to be considered

No Standards under development identified.

A.19 Standardization on vibration

A.19.1 Technical Committees

ISO TC 108 Mechanical vibration, shock and condition monitoring

“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. “

A.19.2 Developed standards to be considered

No relevant developed standards identified.

A.19.3 Standards under development to be considered

Code	Name	Technical committees
ISO/DTR 19664	Human response to vibration - Guidance and terminology for instrumentation and equipment for the assessment of daily vibration exposure at the workplace according to the requirements of health and safety	ISO/TC 108/SC 3/WG 1

A.20 Standardization on virtual reality

A.20.1 Technical Committees

ISO/IEC JTC 1 Information Technology

“Standardization in the field of information technology”

A.20.2 Standards to be considered

Code	Name	Technical committees
ISO/IEC 14772-1:1997	Information technology -- Computer graphics and image processing -- The Virtual Reality Modeling Language --Part 1: Functional specification and UTF-8 encoding	ISO/IEC JTC 1/SC 24/WG 6
ISO/IEC 14772-1:1997/ Amd 1:2003	Information technology -- Computer graphics and image processing -- The Virtual Reality Modeling Language --Part 1: Functional specification and UTF-8 encoding -- Amendment 1: Enhanced interoperability	ISO/IEC JTC 1/SC 24/WG 6
ISO/IEC 14772-2:2004	Information technology -- Computer graphics and image processing -- The Virtual Reality Modeling Language (VRML) Part 2: External authoring interface (EAI)	ISO/IEC JTC 1/SC 24/WG 6

A.20.3 Standards under development to be considered

No relevant standards under development identified.

Annex B Scopes for relevant standards

This chapter specifies the scopes of the standards on Chapter 3.

IEC 62541-3:2015 OPC unified architecture - Part 3: Address Space Model

This part of IEC 62541 describes the OPC Unified Architecture (OPC UA) *AddressSpace* and its *Objects*. This part of IEC 62541 is the OPC UA meta model on which OPC UA information models are based.

https://webstore.iec.ch/preview/info_iec62541-3%7Bed2.0%7Db.pdf

IEC 62541-4:2015 OPC Unified Architecture - Part 4: Services

This part of IEC 62541 defines the OPC Unified Architecture (OPC UA) *Services*. The *Services* described are the collection of abstract Remote Procedure Calls (RPC) that are implemented by OPC UA *Servers* and called by OPC UA *Clients*. All interactions between OPC UA *Clients* and *Servers* occur via these *Services*. The defined *Services* are considered abstract because no particular RPC mechanism for implementation is defined in this part.

IEC 62541-6 specifies one or more concrete mappings supported for implementation. For example, one mapping in IEC 62541-6 is to XML Web Services. In that case the *Services* described in this part appear as the Web service methods in the WSDL contract.

Not all OPC UA *Servers* will need to implement all of the defined *Services*. IEC 62541-7 defines the *Profiles* that dictate which *Services* need to be implemented in order to be compliant with a particular *Profile*.

https://webstore.iec.ch/preview/info_iec62541-4%7Bed2.0%7Db.pdf

IEC 62541-5:2015 OPC Unified Architecture - Part 5: Information Model

This part of IEC 62541 defines the Information Model of the OPC Unified Architecture. The Information Model describes standardised *Nodes* of a *Server's AddressSpace*. These *Nodes* are standardised types as well as standardised instances used for diagnostics or as entry points to server-specific *Nodes*. Thus, the Information Model defines the *AddressSpace* of an empty OPC UA *Server*. However, it is not expected that all *Servers* will provide all of these *Nodes*.

https://webstore.iec.ch/preview/info_iec62541-5%7Bed2.0%7Db.pdf

IEC 62541-6:2015 OPC unified architecture - Part 6: Mappings

This part of IEC 62541 specifies the OPC Unified Architecture (OPC UA) mapping between the security model described in IEC TR 62541-2, the abstract service definitions, described in IEC 62541-4, the data structures defined in IEC 62541-5 and the physical network protocols that can be used to implement the OPC UA specification.

<https://webstore.iec.ch/publication/21993>

IEC 62541-7:2015 OPC unified architecture - Part 7: Profiles

This part of IEC 62541 describes the OPC Unified Architecture (OPC UA) *Profiles*. The *Profiles* in this document are used to segregate features with regard to testing of OPC UA products and the nature of the testing (tool based or lab based). This includes the testing performed by the OPC Foundation provided OPC UA CTT (a self-test tool) and by the OPC Foundation provided Independent certification test labs. This could equally as well refer to test tools provided by another organization or a test lab provided by another organization.

What is important is the concept of automated tool based testing versus lab based testing.

The scope of this standard includes defining functionality that can only be tested in a lab and defining the grouping of functionality that is to be used when testing OPC UA products either in a lab or using automated tools. The definition of actual *TestCases* is not within the scope of this document, but the general categories of *TestCases* are within the scope of this document.

<https://webstore.iec.ch/publication/21992>

IEC 62541-8:2015 OPC Unified Architecture - Part 8: Data Access

This part of IEC 62541 is part of the overall OPC Unified Architecture (OPC UA) standard series and defines the information model associated with Data Access (DA). It particularly includes additional *VariableTypes* and complementary descriptions of the *NodeClasses* and *Attributes* needed for Data Access, additional *Properties*, and other information and behaviour.

The complete address space model, including all *NodeClasses* and *Attributes* is specified in IEC 62541-3. The services to detect and access data are specified in IEC 62541-4.

<https://webstore.iec.ch/publication/21991>

IEC 62541-9:2015 OPC Unified Architecture - Part 9: Alarms and conditions

This part of IEC 62541 specifies the representation of *Alarms* and *Conditions* in the OPC Unified Architecture. Included is the *Information Model* representation of *Alarms* and *Conditions* in the OPC UA address space.

https://webstore.iec.ch/preview/info_iec62541-9%7Bed2.0%7Db.pdf

IEC 62541-10:2015 OPC Unified Architecture - Part 10: Programs

This part of IEC 62541 is part of the overall OPC Unified Architecture (OPC UA) standard series and defines the information model associated with *Programs*. This includes the description of the *NodeClasses*, standard *Properties*, *Methods* and *Events* and associated behaviour and information for *Programs*.

The complete address space model including all *NodeClasses* and *Attributes* is specified in IEC 62541-3. The services such as those used to invoke the *Methods* used to manage *Programs* are specified in IEC 62541-4.

https://webstore.iec.ch/preview/info_iec62541-10%7Bed2.0%7Db.pdf

IEC 62541-11:2015 OPC Unified Architecture - Part 11: Historical Access

This part of IEC 62541 is part of the overall OPC Unified Architecture standard series and defines the *information model* associated with Historical Access (HA). It particularly includes additional and complementary descriptions of the *NodeClasses* and *Attributes* needed for Historical Access, additional standard *Properties*, and other information and behaviour.

The complete *AddressSpace* Model including all *NodeClasses* and *Attributes* is specified in IEC 62541-3. The predefined *Information Model* is defined in IEC 62541-5. The *Services* to detect and access historical data and events, and description of the *ExtensibleParameter* types are specified in IEC 62541-4.

This standard includes functionality to compute and return *Aggregates* like minimum, maximum, average etc. The *Information Model* and the concrete working of *Aggregates* are defined in IEC 62541-13.

https://webstore.iec.ch/preview/info_iec62541-11%7Bed1.0%7Db.pdf

IEC 62541-13:2015 OPC Unified Architecture - Part 13: Aggregates

This part of IEC 62541 is part of the overall OPC Unified Architecture specification series and defines the information model associated with *Aggregates*.

https://webstore.iec.ch/preview/info_iec62541-13%7Bed1.0%7Db.pdf

IEC 62541-100:2015 OPC Unified Architecture - Part 100: Device Interface

This part of IEC 62541 is an extension of the overall OPC Unified Architecture standard series and defines the information model associated with *Devices*. This part of IEC 62541 describes three models which build upon each other as follows:

- the (base) Device Model is intended to provide a unified view of devices irrespective of the underlying device protocols;
- the Device Communication Model adds Network and Connection information elements so that communication topologies can be created;
- the Device Integration Host Model finally adds additional elements and rules required for host systems to manage integration for a complete system. It allows reflecting the topology of the automation system with the devices as well as the connecting communication networks.

https://webstore.iec.ch/preview/info_iec62541-100%7Bed1.0%7Db.pdf

IEC 62264-1:2013 Enterprise-control system integration - Part 1: Models and terminology

This part of the IEC 62264 series describes the manufacturing operations management domain (Level 3) and its activities, and the interface content and associated transactions within Level 3 and between Level 3 and Level 4. This description enables integration between the manufacturing operations and control domain (Levels 3, 2, 1) and the enterprise domain (Level 4). The interface content between Level 3 and Level 2 is only briefly discussed.

The goals are to increase uniformity and consistency of interface terminology and reduce the risk, cost, and errors associated with implementing these interfaces. IEC 62264-1 can be used to reduce the effort associated with implementing new product offerings. The goal is to have enterprise systems and control systems that inter-operate and easily integrate.

The scope of this part of IEC 62264 is limited to:

- a presentation of the enterprise domain and the manufacturing operations and control domain;
- the definition of three hierarchical models; a functional hierarchy model, a role-based equipment hierarchy model, and a physical asset equipment hierarchy model;
- a listing of the functions associated with the interface between manufacturing operations and control functions and enterprise functions; and
- a description of the information that is shared between manufacturing operations and control functions and enterprise functions.

https://webstore.iec.ch/preview/info_iec62264-1%7Bed2.0%7Db.pdf

IEC 62264-2:2013 Enterprise-control system integration - Part 2: Object and attributes for enterprise-control system integration

This part of IEC 62264 specifies generic interface content exchanged between manufacturing control functions and other enterprise functions. The interface considered is between Level 3 manufacturing systems and Level 4 business systems in the hierarchical model defined in IEC 62264-1. The goal is to reduce the risk, cost, and errors associated with implementing the interface.

Since this standard covers many domains, and there are many different standards in those domains, the semantics of this standard are described at a level intended to enable the other standards to be mapped to these semantics. To this end this standard defines a set of elements contained in the generic interface, together with a mechanism for extending those elements for implementations.

The scope of IEC 62264-2 is limited to the definition of object models and attributes of the exchanged information defined in IEC 62264-1.

This part of IEC 62264 standard does not define attributes to represent the object relationships.

https://webstore.iec.ch/preview/info_iec62264-2%7Bed2.0%7Db.pdf

IEC 62264-3:2016 Enterprise-control system integration - Part 3: Activity models of manufacturing operations management

This part of IEC 62264 defines activity models of manufacturing operations management that enable enterprise system to control system integration. The activities defined in this document are consistent with the object models definitions given in IEC 62264-1. The modelled activities operate between business planning and logistics functions, defined as the Level 4 functions and the process control functions, defined as the Level 2 functions of IEC 62264-1. The scope of this document is limited to:

- a model of the activities associated with manufacturing operations management, Level 3 functions;
- an identification of some of the data exchanged between Level 3 activities.

https://webstore.iec.ch/preview/info_iec62264-3%7Bed2.0%7Db.pdf

IEC 62264-4:2015 Enterprise-control system integration - Part 4: Objects models attributes for manufacturing operations management integration

This part defines object models and attributes exchanged between Level 3 manufacturing operations management activities defined in IEC 62264-3.

https://webstore.iec.ch/preview/info_iec62264-4%7Bed1.0%7Db.pdf

IEC 62264-5:2016 Enterprise-control system integration - Part 5: Business to manufacturing transactions

This part of IEC 62264 defines transactions in terms of information exchanges between applications performing business and manufacturing activities associated with Levels 3 and 4.

The exchanges are intended to enable information collection, retrieval, transfer and storage in support of enterprise-control system integration. This part of IEC 62264 is consistent with the IEC 62264-2 and IEC 62264-4 object models attributes. This standard also defines transactions that specify how to exchange the objects defined in IEC 62264-2, IEC 62264-4 and this standard. Other uses of the transaction model are not defined in this part.

The models covered in this standard are:

- Personnel model
- Equipment model
- Physical asset model
- Material model
- Process segment model
- Operations capability model
- Operations definition mode

- Operations schedule model
- Operations performance model
- Resource relationship network model
- Work capability model
- Work definition model
- Work schedule model
- Job list model
- Work performance model
- Workflow specification model
- Work calendar
- Work record
- Work alert model

https://webstore.iec.ch/preview/info_iec62264-5%7Bed2.0%7Db.pdf

IEC PAS 62264-6:2016 Enterprise-control system integration - Part 6: Messaging Service Model

This part of IEC 62264, which is a PAS, defines a model of a set of messaging services for information exchanges across Levels 3 and 4, and within Level 3, between applications performing business and manufacturing

https://webstore.iec.ch/preview/info_iecpas62264-6%7Bed1.0%7Den.pdf

ISO 12100:2010 Safety of machinery - General principles for design - Risk assessment and risk reduction

This International Standard 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 the provision of sufficient risk reduction. Guidance is given on the documentation and verification of the risk assessment and risk reduction process.

This International Standard 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.

NOTE 1 Annex B gives, in separate tables, examples of hazards, hazardous situations and hazardous events, in order to clarify these concepts and assist the designer in the process of hazard identification.

NOTE 2 The practical use of a number of methods for each stage of risk assessment is described in ISO/TR 14121-2.

<https://www.iso.org/obp/ui/#iso:std:iso:12100:ed-1:v1:en>

ISO 13849-1:2015 Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design

ISO 13849-1:2015 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. For these parts of SRP/CS, it specifies characteristics that include the performance level required for

carrying out safety functions. It applies to SRP/CS for high demand and continuous mode, regardless of the type of technology and energy used (electrical, hydraulic, pneumatic, mechanical, etc.), for all kinds of machinery. It does not specify the safety functions or performance levels that are to be used in a particular case. This part of ISO 13849 provides specific requirements for SRP/CS using programmable electronic system(s). It does not give specific requirements for the design of products which are parts of SRP/CS. Nevertheless, the principles given, such as categories or performance levels, can be used.

NOTE 1 Examples of products which are parts of SRP/CS: relays, solenoid valves, position switches, PLCs, motor control units, two-hand control devices, pressure sensitive equipment. For the design of such products, it is important to refer to the specifically applicable International Standards, e.g. ISO 13851, ISO 13856-1 and ISO 13856-2.

NOTE 2 For the definition of required performance level, see 3.1.24.

NOTE 3 The requirements provided in this part of ISO 13849 for programmable electronic systems are compatible with the methodology for the design and development of safety-related electrical, electronic and programmable electronic control systems for machinery given in IEC 62061. NOTE 4 For safety-related embedded software for components with PLr = e, see IEC 61508?3:1998, Clause 7.

This standard will be revised by ISO/PWI 13849-1.

<https://www.iso.org/standard/69883.html>

IEC 60204-1:2016 Safety of machinery - Electrical equipment of machines - Part 1: General requirements

IEC 60204-1:2016 applies to electrical, electronic and programmable electronic equipment and systems to machines not portable by hand while working, including a group of machines working together in a coordinated manner. The equipment covered by this part of IEC 60204 commences at the point of connection of the supply to the electrical equipment of the machine. This sixth edition cancels and replaces the fifth edition published in 2005. It constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

- added requirements to address applications involving power drive systems (PDS);
- revised electromagnetic compatibility (EMC) requirements;
- clarified overcurrent protection requirements;
- requirements for determination of the short circuit current rating of the electrical equipment;
- revised protective bonding requirements and terminology;
- reorganization and revision to Clause 9, including requirements pertaining to safe torque off of PDS, emergency stop, and control circuit protection;
- revised symbols for actuators of control devices;
- revised technical documentation requirements;
- general updating to current special national conditions, normative standards, and bibliographical references.

<https://webstore.iec.ch/publication/26037>

ISO 10218-1:2011 Robots and robotic devices - Safety requirements for industrial robots

ISO 10218-1:2011 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.

ISO 10218-1:2011 does not address the robot as a complete machine. Noise emission is generally not considered a significant hazard of the robot alone, and consequently noise is excluded from the scope of ISO 10218-1:2011.

ISO 10218-1:2011 does not apply to non-industrial robots, although the safety principles established in ISO 10218 can be utilized for these other robots.

<https://www.iso.org/standard/51330.html>

ISO 10218-2:2011 Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robot systems and integration

ISO 10218-2:2011 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:

- the design, manufacturing, installation, operation, maintenance and decommissioning of the industrial robot system or cell;
- necessary information for the design, manufacturing, installation, operation, maintenance and decommissioning of the industrial robot system or cell;
- component devices of the industrial robot system or cell.

ISO 10218-2:2011 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. ISO 10218-2:2011 also specifies requirements for the industrial robot system as part of an integrated manufacturing system. ISO 10218-2:2011 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.

<https://www.iso.org/standard/41571.html>

IEC 62714-1:2014 Engineering data exchange format for use in industrial automation systems engineering - Automation markup language - Part 1: Architecture and general requirements

This part of IEC 62714 specifies general requirements and the architecture of AML for the modelling of engineering information which is exchanged between engineering tools for industrial automation and control systems. Its provisions apply to the export/import applications of related tools.

This part of IEC 62714 does not define details of the data exchange procedure or implementation requirements for the import/export tools.

<https://webstore.iec.ch/publication/7388>

ISO 6385:2016 Ergonomics principles in the design of work systems

This International Standard establishes the fundamental principles of ergonomics as basic guidelines for the design of work systems and defines relevant basic terms. It describes an integrated approach to the design of work systems, where ergonomists will cooperate with others involved in the design, with attention to the human, the social and the technical requirements in a balanced manner during the design process.

Users of this International Standard will include executives, managers, workers (and their representatives, when appropriate) and professionals, such as ergonomists, project managers and designers who are involved in the design or redesign of work systems. Those who use this International Standard can find a general knowledge of ergonomics (human factors), engineering, design, quality and project management helpful.

The term “work system” in this International Standard is used to indicate a large variety of working situations, including permanent and flexible work places. The intention of this International Standard is to assist in the improvement, (re)design or change of work systems. Work systems involve combinations of workers and equipment, within a given space and environment, and the interactions between these components within a work organization. Work systems vary in complexity and characteristics, for example, the use of temporary work systems. Some examples of work systems in different areas are the following:

- production, e.g. machine operator and machine, worker and assembly line;
- transportation, e.g. driver and car or lorry, personnel in an airport;
- support, e.g. maintenance technician with work equipment;
- commercial, e.g. office worker with workstation, mobile worker with a tablet computer, cook in a restaurant kitchen;
- other areas like health care, teaching and training.

The observance of ergonomic principles applies to all phases throughout the life cycle of the work system from conception through development, realization and implementation, utilization, maintenance and support to decommissioning.

The systems approach in this International Standard gives guidance to the users of this International Standard in existing and new situations.

The definitions and ergonomic principles specified in this International Standard apply to the design of optimal working conditions with regard to human well-being, safety and health, including the development of existing skills and the acquisition of new ones, while taking into account technological and economic effectiveness and efficiency.

The principles in this International Standard are applicable to many other human activities, e.g. in the design of products for domestic and leisure activities. A more general description of the principles in this International Standard can be found in ISO 26800.

NOTE 1 This International Standard is considered to be the core ergonomic standard for work systems from which many others on specific issues are derived.

Note 2 Although elements of the system can be the same, this International Standard is not intended to be applied to systems used in a non-work context (e.g. the use of a vehicle for private purposes).

<https://www.iso.org/obp/ui/#iso:std:iso:6385:ed-3:v1:en>

ISO 10075:1991 Ergonomic principles related to mental work-load -- General terms and definitions

This Standard represents an extension of ISO 6385, Subclauses 3.7 to 3.9, describing terms and definitions in more detail. Annex A forms an integral part of this standard.

This standard is being revised by prEN ISO 10075-1

<https://www.iso.org/standard/18045.html>

ISO 10075-2:1996 Ergonomic principles related to mental workload -- Part 2: Design principles

This part of ISO 10075 gives guidance on the design of work systems, including task and equipment design and design of the workplace, as well as working conditions, emphasizing mental workload and its effects, as specified in ISO 10075. It applies to the adequate design of work and use of human capacities, with the intention to provide for optimal working conditions with respect to health and safety, well-being, performance, and effectiveness, preventing over- as well as underload in order to avoid the impairing effects described in ISO 10075.

Mental workload is the effect of a complex interaction of individual, technical, organizational and social factors. Thus personal, technical and organizational factors and the effects of their interactions have to be taken into account in the design of work systems. However, this part of ISO 10075 includes the design of technical and organizational factors only, and does not apply to problems of selection, training or social factors.

This part of ISO 10075 provides guidelines for system design. It does not address problems of measurement of mental workload or its effects.

This part of ISO 10075 refers to all kinds of human work activities (see ISO 10075), not only to those which would be described as cognitive or mental tasks in a restricted sense, but also to those with primarily physical workload.

This part of ISO 10075 is thus relevant to all those engaged in the design and use of work systems, e.g. system and equipment designers, employers' and employees' representatives.

This part of ISO 10075 is applicable to the design of new work systems as well as to the redesign of existing ones undergoing substantial revision.

<https://www.iso.org/obp/ui/#iso:std:iso:10075:-2:ed-1:v1:en>

This standard will be revised by PWI 10075-2

EN ISO 10075-2:2000 Ergonomic principles related to mental workload - Part 2: Design principles (ISO 10075-2:1996)

https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP_PROJECT,FSP_ORG_ID:3557,6104&cs=19D5425E1544C165C8867724C64006009

ISO 9241-110:2006 Ergonomics of human-system interaction -- Part 110: Dialogue principles

This part of [ISO 9241](#) sets forth ergonomic design principles formulated in general terms (i.e. presented without reference to situations of use, application, environment or technology) and provides a framework for applying those principles to the analysis, design and evaluation of interactive systems.

While this part of ISO 9241 is applicable to all types of interactive systems, it does not cover the specifics of every context of use (e.g. safety critical systems, collaborative work).

It is intended for the following types of users:

- designers of user interface development tools and style guides to be used by user interface designers;
- user interface designers, who will apply the guidance during the development process;
- developers, who will apply the guidance during design and implementation of system functionality;
- buyers, who will reference this part of ISO 9241 during product procurement;
- evaluators, who are responsible for ensuring that products meet its recommendations.

This part of ISO 9241 focuses on dialogue principles related to the ergonomic design of the dialogue between user and interactive system, and does not consider any other aspect of design such as marketing, aesthetics or corporate design.

The list of recommendations for each of the dialogue principles is not exhaustive.

<https://www.iso.org/standard/38009.html>

ISO 14915-1:2002 Software ergonomics for multimedia user interfaces -- Part 1: Design principles and framework

This part of ISO 14915 establishes design principles for multimedia user interfaces and provides a framework for handling the different considerations involved in their design. It addresses user interfaces for applications that incorporate, integrate and synchronize different media. This includes static media such as text, graphics, or images, and dynamic media such as audio, animation, video or media related to other sensory modalities. Detailed design issues within a single medium (e.g. the graphical design of an animation sequence) are only addressed as far as they imply ergonomic consequences for the user.

This part of ISO 14915 gives requirements and recommendations for the ergonomic design of multimedia applications mainly intended for professional and vocational activities such as work or learning. It does not specifically address applications outside this area such as entertainment, although some recommendations can also be applicable in such domains.

This part of ISO 14915 is applicable to software aspects related to multimedia user interfaces and does not address hardware or implementation issues. The ergonomic requirements and recommendations described in this part of ISO 14915 can be realized through very different techniques, e.g. the delivery system, a scripting language, or the application.

The focus of this part of ISO 14915 is on multimedia presentation issues. Multimodal input which uses different media such as speech in combination with pointing for entering information is not considered in the recommendations provided.

<https://www.iso.org/standard/25578.html>

ISO/TS 18152:2010 Ergonomics of human-system interaction — Specification for the process assessment of human-system issues

This Technical Specification presents a human-systems (HS) model for use in ISO/IEC 15504-conformant assessment of the maturity of an organization in performing the processes that make a system usable, healthy and safe. It describes processes that address human-system issues and the outcomes of these processes. It details the practices and work products associated with achieving the outcomes of each process.

The model describes processes for specifying and evaluating usability, health and safety, but it does not address all processes relating to their achievement.

The model will always be tailored to the specific organizational and system context prior to use in assessment. Annex D provides advice on tailoring process models for a range of uses.

The HS model does not define the roles or competencies of staff who perform HS processes.

This Technical Specification is intended for use by process assessors and those developing process assessment models and tools. It may be informative for those responsible for human factors activities and human factors specialists. The latter groups of readers should familiarise themselves with the vocabulary of process modelling and process assessment prior to reading this Technical Specification. The Bibliography lists informative standards and texts.

This Technical Specification is intended to be used in conjunction with ISO 13407 and ISO/IEC 15504. The latter standard provides the framework in which the process descriptions in this Technical Specification may be used. This Technical Specification defines an additional category of processes for use with other process standards, for example ISO/IEC 12207 and ISO/IEC 15288.

NOTE 1 Readers of this Technical Specification are expected to be familiar with ISO 13407 and ISO/IEC 15504.

The HS model can be applied to the specification, design, assessment and operation of manned or embedded systems, hardware and software. The HS model can be applied to generic systems (for

example consumer products), bespoke systems (for example control or defence systems) and systems which continuously change to meet changes in the business or user environment (for example management information systems). However, it will need to be tailored for each application.

NOTE 2 Copyright release for the process descriptions: Users of this Technical Specification may freely reproduce the process descriptions contained in Clause 7 and Annex A as part of any Process Assessment Model, or as part of any demonstration of compatibility with this Technical Specification, so that it can be used for its intended purpose.

<https://www.iso.org/obp/ui/#iso:std:iso:ts:18152:ed-1:v1:en>

ISO/TR 16982:2002 Ergonomics of human-system interaction -- Usability methods supporting human-centred design

This Technical Report provides information on human-centred usability methods which can be used for design and evaluation. It details the advantages, disadvantages and other factors relevant to using each usability method.

It explains the implications of the stage of the life cycle and the individual project characteristics for the selection of usability methods and provides examples of usability methods in context.

The main users of this Technical Report will be project managers. This Technical Report therefore addresses technical human-factors and ergonomics issues only to the extent necessary to allow managers to understand their relevance and importance in the design process as a whole.

Such issues are dealt with more fully in ISO 9241 which is complementary to this Technical Report and is aimed at system developers, specifiers and purchasers of systems. Nonetheless, all parties involved in human-centred system development, including the end users of systems, should find the guidance in this Technical Report relevant.

The guidance in this Technical Report can be tailored for specific design situations by using the lists of issues characterizing the context of use of the product to be delivered. Selection of appropriate usability methods should also take account of the relevant life-cycle process.

This Technical Report is restricted to methods that are widely used by usability specialists and project managers.

It does not specify the details of how to implement or carry out the usability methods described.

NOTE Most methods require the involvement of human-factors specialists. It may be inappropriate for them to be used by individuals without adequate skills and knowledge.

<https://www.iso.org/obp/ui/#iso:std:iso:tr:16982:ed-1:v1:en>

ISO/TS 15066:2016 Robots and robotic devices -- Collaborative robots

This Technical Specification 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.

This Technical Specification 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.

<https://www.iso.org/obp/ui/#iso:std:iso:ts:15066:ed-1:v1:en>

IEC 61499-1:2012 Function blocks - Part 1: Architecture

This part of IEC 61499 defines a generic architecture and presents guidelines for the use of *function blocks* in distributed industrial-process measurement and control systems (IPMCSs).

This architecture is presented in terms of implementable reference *models*, textual syntax and graphical representations. These models, representations and syntax can be used for:

- the specification and standardization of *function block types*;
- the functional specification and standardization of system elements;
- the implementation independent specification, analysis, and validation of distributed IPMCSs;
- the *configuration, implementation, operation, and maintenance* of distributed IPMCSs;
- the exchange of *information* among *software tools* for the performance of the above *functions*.

This part of IEC 61499 does not restrict or specify the functional capabilities of IPMCSs or their system elements, except as such capabilities are represented using the elements defined herein. IEC 61499-4 addresses the extent to which the elements defined in this standard may be restricted by the functional capabilities of compliant systems, subsystems, and devices.

Part of the purpose of this standard is to provide reference models for the use of function blocks in other standards dealing with the support of the system life cycle, including system planning, design, implementation, validation, operation and maintenance. The models given in this standard are intended to be generic, domain independent and extensible to the definition and use of function blocks in other standards or for particular applications or application domains. It is intended that specifications written according to the rules given in this standard be concise, implementable, complete, unambiguous, and consistent.

NOTE 1 The provisions of this standard alone are not sufficient to ensure interoperability among devices of different vendors. Standards complying with this part of IEC 61499 can specify additional provisions to ensure such interoperability.

NOTE 2 Standards complying with this part of IEC 61499 can specify additional provisions to enable the performance of *system, device, resource* and *application* management *functions*.

https://webstore.iec.ch/preview/info_iec61499-1%7Bed2.0%7Db.pdf

IEC 61499-2:2012 Function blocks - Part 2: Software tool requirements

This part of IEC 61499 defines requirements for *software tools* to support the following systems engineering tasks enumerated in IEC 61499-1:

- the specification of *function block types*;
- the functional specification of *resource types* and *device types*;
- the specification, analysis, and validation of distributed IPMCSs;
- the *configuration, implementation, operation, and maintenance* of distributed IPMCSs;
- the exchange of *information* among *software tools*.

It is assumed that such software tools may be used in the context of an Engineering Support System (ESS) as described in IEC 61499-1.

It is beyond the scope of this standard to specify the entire life cycle of industrial-process measurement and control systems (IPMCSs), or the entire set of tasks and activities required to support an IPCMS over its life cycle. However, other standards which do specify such tasks and activities may extend or modify the requirements specified in this part of IEC 61499.

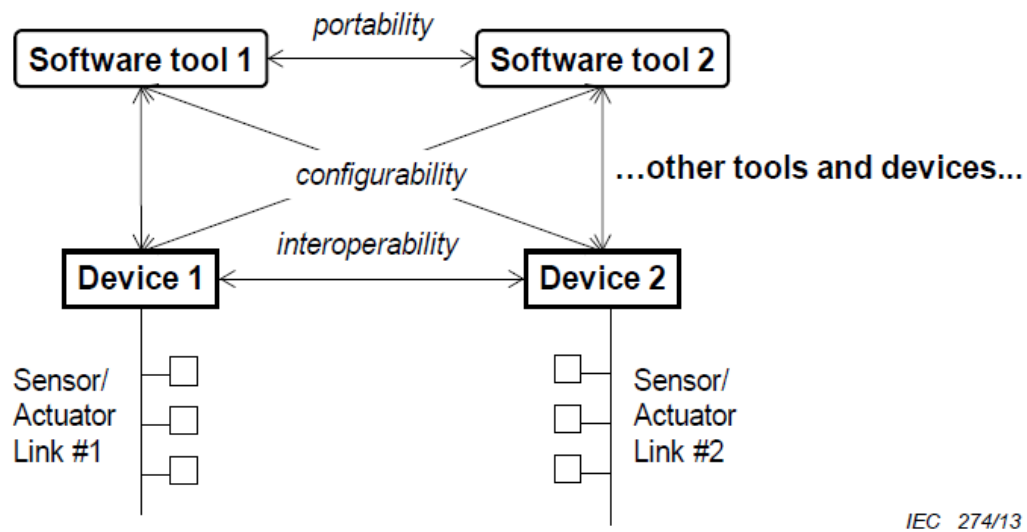
https://webstore.iec.ch/preview/info_iec61499-2%7Bed2.0%7Db.pdf

IEC 61499-4:2013 Function blocks - Part 4: Rules for compliance profiles

This part of IEC 61499 defines rules for the development of *compliance profiles*, which specify the features of IEC 61499-1 and 61499-2 to be implemented in order to promote the following *attributes* of IEC 61499-based *systems, devices* and *software tools*:

- interoperability of devices from multiple suppliers;
- portability of software between software tools of multiple suppliers; and
- configurability of devices from multiple vendors by software tools of multiple suppliers.

These attributes are illustrated the following figure.



IEC 274/13

Figure 4 – IEC 61499-4:2013 Function blocks: *compliance profiles*

NOTE 1 The sensor/actuator links designated #1 and #2 in Figure 1 may be non-interoperable. However, it is intended that systems complying with a particular profile may show the transfer of *events* and *data* from sensors on one link to actuators on another link using appropriately configured and interconnected *service interface function blocks*.

NOTE 2 Compliance profiles may extend their scope beyond that shown in Figure 1 to include interoperability of sensors and actuators.

NOTE 3 Suppliers of *software tools* ensure that their products conform to the requirements of IEC 61499-2 as well as any specific requirements defined in compliance profiles applicable to their particular software tools.

The specification of provisions for the facilitation of device *interchangeability* is beyond the scope of this part of IEC 61499.

https://webstore.iec.ch/preview/info_iec61499-4%7Bed2.0%7Db.pdf

ISO/IEC 27002:2013 Information technology -- Security techniques -- Code of practice for information security controls

This International Standard gives guidelines for organizational information security standards and information security management practices including the selection, implementation and management of controls taking into consideration the organization's information security risk environment(s).

This International Standard is designed to be used by organizations that intend to:

- a) select controls within the process of implementing an Information Security Management System based on ISO/IEC 27001;
- b) implement commonly accepted information security controls;
- c) develop their own information security management guidelines.

https://webstore.iec.ch/preview/info_isoiec27002%7Bed2.0%7Den.pdf

This standard has been modified by two corrigendum

- ISO/IEC 27002:2013/COR1:2014
- ISO/IEC 27002:2013/COR2:2015

ISO 26800:2011 Ergonomics - General approach, principles and concepts

This International Standard presents the general ergonomics approach and specifies basic ergonomics principles and concepts. These are applicable to the design and evaluation of tasks, jobs, products, tools, equipment, systems, organizations, services, facilities and environments, in order to make them compatible with the characteristics, the needs and values, and the abilities and limitations of people.

The provisions and guidance given by this International Standard are intended to improve the safety, performance, effectiveness, efficiency, reliability, availability and maintainability of the design outcome throughout its life cycle, while safeguarding and enhancing the health, well-being and satisfaction of those involved or affected.

The intended users of this International Standard are designers, ergonomists and project managers, as well as managers, workers, consumers (or their representatives) and procurers. It also serves as a reference standard for standards developers dealing with ergonomics aspects.

This International Standard provides the basis for other, more detailed, context-specific ergonomics International Standards.

<https://www.iso.org/obp/ui/#iso:std:iso:26800:ed-1:v1:en>

ISO/TS 20646:2014 Ergonomics guidelines for the optimization of musculoskeletal workload

ISO/TS 20646:2014 provides information and guidelines to properly utilize various ergonomics standards concerning the factors related to musculoskeletal workload (MSWL), and helps develop activities to reduce or optimize MSWL in workplaces and non-professional activities, in an effective and efficient manner. The activities are intended to be based on a risk assessment. ISO/TS 20646:2014 is intended primarily for employers, ergonomics and occupational health-related staff and workers in enterprises, and workers. Prevention of MSWL is not always a matter of reducing the load. The approach to reducing MSWL also involves assessing the work environment and organization as a system to identify how changes can help to safely manage MSWL. Although it provides ideas of effective and efficient measures to reduce or optimize MSWL, ISO/TS 20646:2014 does not certify the complete prevention of health problems caused by MSWL.

<https://www.iso.org/obp/ui/#iso:std:iso:ts:20646:ed-1:v2:en>

ISO 14738:2002 Safety of machinery – Anthropometric requirements for the design of workstations at machinery

This International Standard establishes principles for deriving dimensions from anthropometric measurements and applying them to the design of workstations at non-mobile machinery. It is based on current ergonomic knowledge and anthropometric measurements.

This International Standard specifies the body's space requirements for equipment during normal operation in sitting and standing positions. This International Standard does not specifically include space demands for maintenance, repairing and cleaning work.

This International Standard does not give recommendations specifically for visual display terminal workstations at machinery. For this purpose ISO 9241-5 can be used in conjunction with this International Standard.

Situations where people are to be prevented from reaching a hazard are dealt with in ISO 13852.

<https://www.iso.org/obp/ui/#iso:std:iso:14738:ed-1:v1:en>

this standard has been modified by two corrigendum

- ISO 14738:2002/Cor 1:2003

NOTE The existence of this corrigendum should be confirmed with the ISO/TC 159/SC 3 secretariat. It appears on ISO project portal but not in ISO web

- ISO 14738:2002/Cor 2:2005

<https://www.iso.org/obp/ui/#iso:std:iso:14738:ed-1:v1:cor:2:v1:en>

ISO 1503:2008 Spatial orientation and direction of movement -- Ergonomic requirements

This International Standard sets out design principles, procedures, requirements and recommendations for the spatial orientation and direction of movement of controls and displays used in tool machines, industrial robots, office machines, earth-moving machinery, transportation (automobiles, railway electric cars/rolling stock, aircraft, ships, etc.), information, daily commodities, public utilities and the operational components of building facilities.

It lays down basic requirements for determining the operating direction of controls and the moving directions or changing states of the target object, as well as other relations.

This International Standard

- defines three dimensional axes, the observer, viewing systems, linear movement, rotary movement, two-dimensional and three-dimensional movements in a dynamic space sequentially,
- describes the four principles for determining the operating direction of a control, the moving direction of a target object and/or display,
- provides GUI (graphical user interface) design requirements and recommendations that integrate the relationship between the computer operation and the movement of images on-screen in line with human characteristics and to promote safety and efficiency in computer-assisted tasks,
- sets out design principles and recommendations for determining the moving directions of a target object and the controls of a combined control system using a multi-direction control that easily realizes the complex operations intended by the user/operator as they are often seen in industrial apparatuses for business use, and
- gives principles and recommendations for the direction design of existing, as well as new, systems.

NOTE Ergonomics requirements or recommendations given in this International Standard can also be applied to designing the direction of movement of other industrial goods, such as medical equipment, TV or PC game devices and relevant machines/devices.

<https://www.iso.org/standard/40302.html>

BS 8611:2016 Robots and robotic devices. Guide to the ethical design and application of robots and robotic systems

BS 8611 gives guidelines for the identification of potential ethical harm. Significant ethical hazards are presented for various robot applications.

The standard also provides additional guidelines to eliminate or reduce the risks associated with these ethical hazards to an acceptable level. These cover safe design, protective measures and information for the design and application of robots.

The standard builds on existing safety requirements for different types of robots, covering industrial, personal care and medical.

The standards notes that ethical hazards are broader than physical hazards. Most physical hazards are associated with psychological ones due to associated fear and stress. Thus, physical hazards imply ethical hazards and safety design features are part of ethical design. Safety elements are covered by safety standards however; this British Standard is concerned with the ethical elements.

These guidelines are intended for use by robot and robotics device designers and managers. It's also felt that the general public will benefit from the standard wherever end-products have effectively considered these guidelines.

<http://shop.bsigroup.com/ProductDetail?pid=000000000030320089>