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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

DRAFT INTERNATIONAL STANDARD

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Robotics — Safety requirements for robot systems in an industrial environment —

Part 1: Robots

ICS: 25.040.30

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 299, *Robotics*.

This third edition cancels and replaces the second edition (ISO 10218-1:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

- Incorporating safety requirements for industrial robots intended for use in collaborative applications into the standard (formerly, the content of ISO/TS 15066:2016);
- Clarifying requirements for functional safety;
- Adding requirements for cybersecurity to the extent that it applies to industrial robot safety.

A list of all parts in the ISO 10218 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 10218 has been created in recognition of the particular hazards that are presented by robotics in an industrial environment. Part 1 of ISO 10218 addresses robots as incomplete machines, while Part 2 addresses robots integrated into complete machines (systems) for specific applications.

This part of ISO 10218 is a type-C standard as outlined in ISO 12100.

When provisions of a type-C standard are different from those which are stated in type-A or type-B standards, the provisions of the type-C standard take precedence over the provisions of the other standards for machines that have been designed and built in accordance with the provisions of the type-C standard.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered and indicated in the Scope of this part of ISO 10218.

NOTE Not all of the hazards identified by ISO 10218-1 apply to every robot, nor will the level of risk associated with a given hazardous situation be the same from robot to robot. Consequently, the safety requirements, or the protective measures, or both, can vary from what is specified in ISO 10218-1. A robot manufacturer's risk assessment can be conducted to determine what the protective measures should be.

In recognition of the variable nature of hazards with different uses of industrial robots, ISO 10218 is divided into two parts. This part of ISO 10218 provides requirements for the assurance of safety in the design and construction of the robot. Since safety in the application of industrial robots is influenced by the design and application of the robot system, ISO 10218-2 provides guidelines for the safeguarding of operators during integration, installation, functional testing, programming, operation, maintenance and repair.

Both parts of ISO 10218 deal with robotics in an industrial environment. Other standards cover such topics as coordinate systems and axis motions, general characteristics, performance criteria and related testing methods, terminology, and mechanical interfaces. It is noted that these standards are interrelated and related to other International Standards.

For ease of reading this part of ISO 10218, the words “robot” and “robot system” refer to “industrial robot” and “industrial robot system” as defined in ISO 10218-1 and ISO 10218-2.

This part of ISO 10218 has been updated based on experience gained since the release of ISO 10218-1 and ISO 10218-2 in 2011. This standard remains aligned with minimum requirements of a harmonized type-C standard for robots in an industrial environment.

Where appropriate, the guidance contained in ISO/TS 15066:2016 on the safety of collaborative robot systems was added to ISO 10218. Most of ISO/TS 15066 was incorporated into ISO 10218-2, since human-robot collaborative applies to the application and not the robot alone. Safety functions that enable a collaborative task could be embedded in the robot or could be provided by a protective device, or a combination of the robot and a protective device.

It is important to note that the term “collaborative robot” is not used in ISO 10218-1 as only the application can be developed, verified and validated as a collaborative application. In addition, the term “collaborative operation” is not used in this edition.

Revisions include, but are not limited to,

- category 2 stopping functions,
- definitions,
- functional safety requirements,
- marking,
- mode selection,

- power and force limiting requirements,
- power loss requirements.

This part of ISO 10218 is not applicable to robots that were manufactured prior to its publication date.

Robotics — Safety requirements for robot systems in an industrial environment —

Part 1: Robots

1 Scope

This part of ISO 10218 specifies requirements and guidelines for the inherently safe design, protective measures and information for use of robots for an industrial environment. It describes basic hazards associated with robots and provides requirements to eliminate, or adequately reduce, the risks associated with these hazards.

This part of ISO 10218 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 this part of ISO 10218.

This part of ISO 10218 does not apply to undersea, defence, law enforcement, military and space robots, medical and healthcare, prosthetics and other aids for the physically impaired, service or consumer products, tele operated manipulators, and micro robots (displacement less than 1 mm).

NOTE 1 Requirements for robot systems, integration, and applications are covered in ISO 10218-2.

NOTE 2 Additional hazards can be created by specific applications (e.g. welding, laser cutting, machining). These system-related hazards need to be considered during robot system design. See ISO 10218-2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4413, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

ISO 9283, *Manipulating industrial robots — Performance criteria and related test methods*

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

ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

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

ISO 13850, *Safety of machinery — Emergency stop function — Principles for design*

ISO 14118, *Safety of machinery — Prevention of unexpected start-up*

IEC 60073, *Basic and safety principles for man-machine interface, marking and identification - Coding principles for indicators and actuators*

IEC 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 61000-1-2, *Electromagnetic compatibility (EMC) - Part 1-2: General - Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena*

IEC 61310-1, *Safety of machinery - Indication, marking and actuation - Part 1: Requirements for visual, acoustic and tactile signals*

IEC 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

IEC 62745 IEC-62745, *Safety of machinery - Requirements for cableless control systems of machinery*

IEC 82079-1:2012-08, *Preparation of instructions for use - Structuring, content and presentation – Part 1: General principles and detailed requirements*

3 Terms and definitions used in ISO 10218

For the purposes of this document, the terms and definitions given in ISO 12100 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 application

intended use and purpose of the robot (3.17) or robot system (3.18), i.e. the process, the task(s)

EXAMPLE Manipulating, processing, machining, inspection, spot welding, painting, assembly, palletizing.

3.2 collaborative application

an application that contains one or more collaborative task(s) (3.3)

Note 1 to entry: Collaborative applications can include non-collaborative tasks

3.3 collaborative task

a portion of the robot sequence where both the robot system (3.18) and operator(s) (3.23) are within the same safeguarded space (3.40.5)

Note 1 to entry: The task can be collaborative, co-existing, or co-located.

3.4 compliant

exhibiting deformation of material or mechanism when subjected to a force; the reciprocal of stiff; e.g., compliant linkage, compliant surface

Note 1 to entry: ISO 8373:2012 contains the definition of compliance.

3.5 robot actuator

powered mechanism that converts energy to effect motion of the manipulator (3.6)

Note 1 to entry: Energy can be electrical, hydraulic, pneumatic or more.

3.6 manipulator

mechanism consisting of an arrangement of segments, jointed or sliding relative to one another

Note 1 to entry: A manipulator (3.6) includes robot actuators (3.5).

3.7**fixture**

device used to fixate an item as part of the handling or assembling process in a robot system, but not as an end-effector (3.9)

3.8**mechanical interface**

end-effector (3.9) flange mounting surface at the end of the manipulator (3.6) to which the end-effector is attached

3.9**end-effector**

device specifically designed for attachment to the mechanical interface to enable the robot (3.17) to perform its task

EXAMPLE Gripper, welding gun, spray gun.

Note 1 to entry: End-effectors are sometimes known as end-of-arm tooling (EOAT).

3.10**gripper**

end-effector (3.9) designed for grasping workpieces

Note 1 to entry: Grip, grasp, grasping and releasing are defined in ISO 14539:2000.

3.11**payload**

payload is the mass of all that is attached to the manipulator (3.6), including the end-effector (3.9) and workpiece. The payload can be, but is not limited to, the payload attached to the mechanical interface (3.8) of the robot (3.17).

3.12**mechanical power**

mechanical rate of doing work, or the amount of energy consumed per unit time

Note 1 to entry: Power does not pertain to the electrical power rating on an electronic device, such as a motor.

3.13**drive power**

energy source or sources enabling the robot actuators (3.5) to execute force or torque

3.14**energy source**

electrical, mechanical, hydraulic, pneumatic, chemical, thermal, potential, kinetic or other source of power

3.15**hazardous motion**

motion that is likely to cause personal physical injury or damage to health

3.16**axis**

mechanical joint

3.16.1**auxiliary axis**

additional axis that is not physically part of the manipulator (3.6) and is controlled by the robot controller

Note 1 to entry: Controlled means that there is feedback signal(s) to enable closed loop control by the robot controller.

3.16.2

external axis

additional axis, not physically part of the manipulator (3.6), that is not powered and not controlled by the robot controller.

Note 1 to entry: External axis integration is in Part 2.

3.17

industrial robot robot

automatically controlled, reprogrammable multipurpose manipulator(s) (3.6), programmable in three or more axes (3.16), which can be either fixed in place or mobile for use in industrial automation applications

Note 1 to entry: The industrial robot includes:

- the manipulator (3.6), including robot actuators (3.5) controlled by the robot controller;
- the robot controller.

Note 2 to entry: This includes any auxiliary axes (3.16.1) that are integrated into the kinematic solution.

Note 3 to entry: The following are considered industrial robots for this part of ISO 10218:

- hand-guided robots;
- the manipulating portions of mobile robots;
- power and force limited robots;
- robots with built-in speed and separation monitoring safety functions.

3.18

industrial robot system robot system

machine comprising:

- industrial robot (3.17);
- end-effector(s) (3.9);
- any end-effector sensors and equipment (e.g. vision systems, adhesive dispensing, weld controller) needed to support the intended task;
- task program;

Note 1 to entry: The robot system requirements, including those for controlling hazards, are contained in ISO 10218-2.

3.19

robot application industrial robot application

a machine comprising:

- industrial robot system (3.18);
- workpiece(s);
- any obstacle or object that has influence on the risk assessment of the intended use

3.20 industrial robot cell robot cell

one or more robot systems including associated machinery and equipment and the associated safeguarded space(s) ([3.40.5](#)) and protective measures

3.21 integration

act of combining a robot ([3.17](#)) with an end-effector ([3.9](#)) and other equipment or another machine (including additional robot systems ([3.18](#)) to form a complete machine capable of performing useful work such as production of parts

Note 1 to entry: This act of machine building can include the requirements for the installation of the system.

3.22 integrator

entity that designs, provides, manufactures, or assembles robot systems or integrated manufacturing systems and oversees the safety strategy, including the protective measures, control interfaces and interconnections of the control system

Note 1 to entry: The integrator can be a manufacturer, assembler, engineering company or the user.

3.23 operator

person or persons using, operating, adjusting, maintaining, cleaning, repairing, troubleshooting, transport, commissioning and disassembling

Note 1 to entry: This definition includes person or persons that can be expected at or near machinery, even if not performing a task associated with the specific machinery.

3.24 user

entity that uses robot systems ([3.18](#)) and is responsible for the operator(s) ([3.23](#)) associated with the robot system ([3.18](#))

3.25 industrial environment

workplace where the public is restricted from access or not reasonably expected to be present for the intended tasks and robot applications ([3.19](#))

3.26 mode operating mode

characterization of the way and the extent to which the operator ([3.23](#)) intervenes in the control equipment

Note 1 to entry: In the context of this standard, mode refers to the control state of the robot, e.g. automatic, manual, other.

3.26.1 manual mode

control state that allows for the direct control by an operator ([3.23](#))

Note 1 to entry: Sometimes referred to as teach mode where program points and robot attributes are set.

3.26.2 automatic mode

control state that allows executing programmed tasks

[SOURCE: ISO 8373:2012, definition 5.3.10.1]

3.27

span-of-control

predetermined portion of the machinery that is under control of a specific device for safety function (3.26)

Note 1 to entry: A protective device could initiate a stop of a machine or a portion of a machine.

EXAMPLE An emergency stop pushbutton could cause a local stop or a global stop. See ISO 13850 for span-of-control of emergency stops.

3.28

single point of control

ability to operate the robot (3.17) such that initiation of robot motion is only possible from one source of control and cannot be overridden from another initiation source

[SOURCE: ISO 8373:2012, 5.19]

3.29

local control

state of the system or portions of the system in which operation is affected from the control panel or teach pendant (3.31) of the individual machine(s) only

3.30

control station

part of the robot system (3.18) which contains one or more control devices intended to activate or deactivate functions of the system or parts of the system

Note 1 to entry: The control station can be fixed in place (e.g. control panel) or movable (e.g. teach pendant).

3.31

pendant

teach pendant

hand-held unit linked to the control system with which a robot (3.17) can be programmed, moved, or actuated

3.32

program

3.32.1

control program

inherent set of instructions which defines the capabilities, actions, and responses of a robot (3.17)

Note 1 to entry: This type of program is fixed and usually not modified by the user.

3.32.2

task program

set of instructions for motion and auxiliary functions that define the specific intended task of the robot system (3.18)

Note 1 to entry: This type of program is generated by the integrator or user.

Note 2 to entry: An application (3.1) is a general area of work; a task is specific within the application.

3.33

task programming

teach

teach programming

programming of the task performed r by

- a) manually by lead-through; or
- b) using a teach pendant (3.31) to move the robot (3.17) through the desired positions; or

- c) using a teach pendant ([3.31](#)) to program without causing motion; or
- d) using algorithm(s) with sensor data

3.34**program verification**

execution of a task program for confirming the robot path and process performance

Note 1 to entry: Verification can include the total path traced by the tool centre point during the execution of a task program or a segment of the path. The instructions can be executed in a single instruction or continuous instruction sequence. Verification is used in new applications and in fine tuning/editing of existing ones.

3.35**safe state**

state of the Equipment Under Control (EUC) when safety is achieved

Note 1 to entry: In going from a potentially hazardous condition to the final safe state, the EUC may have to go through a number of intermediate safe states. For some situations, a safe state exists only so long as the EUC is continuously controlled. Such continuous control may be for a short or an indefinite period of time.

[SOURCE: IEC 61508-4:2010, 3.1.13, modified]

3.36**safety function**

function of the machine whose failure can result in an immediate increase of the risk(s)

[SOURCE: ISO 12100:2010, 3.30 and ISO 13849-1:2015, 3.1.20]

3.36.1**monitored standstill**

safety function ([3.36](#)) that monitors a condition where the robot ([3.17](#)) is stopped with drive power active

Note 1 to entry: In ISO 10218-1:2011, this type of stop was called “safety-rated monitored stop”.

3.36.2**output, safety function**

output signal having a specified safety-related performance

3.36.3**input, safety function**

input signal having a specified safety-related performance

3.36.4**soft axis and space limiting****soft limit**

safety function(s) ([3.36](#)) with monitored limit(s) placed on the range of motion of the robot ([3.17](#))

3.36.5**output, soft axis and space limiting****output, soft limit**

safety function output of the state of the robot position relative to a soft axis or space safety function limit

Note 1 to entry: For example, the robot position can be inside or outside the limit(s) of the soft axis and space limiting safety function(s).

3.37**protective stop**

type of interruption of operation that causes a cessation of motion for protective and safeguarding purposes and which retains the program logic to facilitate a restart

3.38

simultaneous motion

motion of two or more robots at the same time under the control of a single control station ([3.30](#)), and which may be coordinated or may be synchronous

Note 1 to entry: A teach pendant ([3.31](#)) is an example of a single control station ([3.30](#)).

Note 2 to entry: Coordination can be done as master/slave.

[SOURCE: ISO 8373:2012, [5.14](#)]

3.39

limiting device

means that reduce the range of motion to a portion of the maximum space ([3.40.2](#))

Note 1 to entry: The ISO 12100:2012 definition of a limiting device is broader, encompassing more than motion. In ISO 12100, it is a device that prevents a machine or hazardous machine condition(s) from exceeding a designed limit (space limit, pressure limit, load moment limit, etc.).

3.40 spaces – see [Annex B](#) for illustration of robot and robot system spaces

3.40.1

space

three-dimensional volume

Note 1 to entry: In the context of ISO 10218-1, space refers to the robot ([3.17](#)).

Note 2 to entry: In the context of ISO 10218-2, space refers to either the robot system ([3.18](#)) or robot application ([3.19](#)).

3.40.2

maximum space

space that can be reached by the moving parts of the robot ([3.17](#))

Note 1 to entry: In the context of ISO 10218-1, maximum space refers to the robot ([3.17](#)).

Note 2 to entry: In the context of ISO 10218-2, maximum space refers to either the robot system ([3.18](#)) or robot application ([3.19](#)).

3.40.3

operating space

portion of the restricted space ([3.40.4](#)) that is used while performing all motions commanded by the task program

Note 1 to entry: In the context of ISO 10218-1, operating space refers to the robot ([3.17](#)).

Note 2 to entry: In the context of ISO 10218-2, operating space refers to either the robot system ([3.18](#)) or the robot application ([3.19](#)).

3.40.4

restricted space

portion of the maximum space ([3.40.2](#)) restricted by limiting devices ([3.39](#))

Note 1 to entry: When the restricted space refers to the robot system ([3.18](#)), this includes the space reached by the end-effector ([3.9](#)), see ISO 10218-2.

Note 2 to entry: When the restricted space refers to the robot application ([3.19](#)), this includes the space reached by the end-effector ([3.9](#)) and workpiece(s). see ISO 10218-2.

3.40.5**safeguarded space**

the space where safeguards are active

Note 1 to entry: This sometimes refers to the space within perimeter safeguarding. See distance guard, (3.51).

Note 2 to entry: The safeguarded space can change dynamically.

Note 3 to entry: This definition applies to Part 2.

3.41 zone**3.41.1****hazard zone**

any space within and/or around machinery in which a person can be exposed to a hazard

[SOURCE: ISO 12100:2010, 3.11]

3.41.2**task zone**

any predetermined space within and/or around the robot system (3.18) in which personnel can perform a specified activity

3.42**tool centre point****TCP**

point defined for a given application with regard to the mechanical interface (3.8) coordinate system.

Note 1 to entry: The TCP setting defines the location of the TCP relative to the mechanical interface (3.8).

3.43**manual load/unload station**

part of the robot system (3.18) designed for the direct manual intervention for the placement and removal of parts or workpieces for processing by the robot system

3.44**validation**

confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

[SOURCE: ISO 9000:2015, 3.8.13]

3.45**verification**

confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

[SOURCE: ISO 9000:2015, 3.8.12]

3.46**body model**

representation of the human body consisting of individual body segments characterized by biomechanical properties

3.47**contact, quasi-static**

contact between an operator (3.23) and part of a robot system (3.18), where the operator body part can be clamped between a moving part of a robot system and another fixed or moving part of the robot cell (3.20)

3.48

contact, transient

brief contact between an operator (3.23) and part of a robot system (3.18), where the operator body part is not clamped and can recoil or retract from the moving part of a robot system

3.49

protective separation distance

shortest permissible distance between any moving hazardous part of the robot system (3.18) and any operator (3.23)

Note 1 to entry: This value can be fixed or variable.

3.50

safeguard

guards or protective devices (3.53)

Note 1 to entry: Protective device include a broad range of means by which to reduce or control risks, e.g. interlocking devices for guards, sensitive protective equipment (SPE), safety functions, limiting device and limited movement control device.

[SOURCE: ISO 12100, 3.26, modified with addition of note]

3.51

distance guard

guard that does not completely enclose a hazard zone (3.41.1), but which prevents or reduces access by its dimensions and its distance from the hazard zone

EXAMPLE Perimeter guard or tunnel guard.

3.52

impeding device

any physical obstacle (low barrier, rail, fixture, etc.) which, without totally preventing access to a hazard zone (3.41.1), reduces the probability of access to this zone by offering an obstruction to free access

[SOURCE: ISO 12100:2010, 3.29]

3.53

protective device

safeguard other than a guard

Note 1 to entry: Examples of types of protective devices include:

- **active optoelectronic protective device (AOPD):** device whose sensing function is performed by optoelectronic emitting and receiving elements detecting the interruption of optical radiation, generated within the device, by an opaque object present in the specified detection zone.

Note 2 to entry: IEC 61496 gives detailed provisions.

- **enabling device:** additional manually operated device used in conjunction with a start control and which, when continuously actuated, allows a machine to function.
- **hold-to-run control device:** control device which initiates and maintains machine functions only as long as the manual control (actuator) is actuated.
- **interlocking device (interlock):** mechanical, electrical or other type of device, the purpose of which is to prevent the operation of hazardous machine functions under specified conditions (generally as long as a guard is not closed).
- **limiting device:** device which prevents a machine or hazardous machine condition(s) from exceeding a designed limit (space limit, pressure limit, load moment limit, etc.).
- **limited movement control device:** control device, a single actuation of which, together with the control system of the machine, permits only a limited amount of travel of a machine element.

- **mechanical restraint device:** device which introduces into a mechanism a mechanical obstacle (for example, wedge, spindle, strut, scotch) which, by virtue of its own strength, can prevent any hazardous movement.
- sensitive protective equipment (SPE) : equipment for detecting persons or parts of persons which generates an appropriate signal to the control system to reduce risk to the persons detected.

Note 3 to entry: The signal can be generated when a person or part of a person goes beyond a predetermined limit — for example, enters a hazard zone — (tripping) or when a person is detected in a predetermined zone (presence sensing), or in both cases.

- **two-hand control device:** control device which requires at least simultaneous actuation by both hands in order to initiate and to maintain hazardous machine functions, thus providing a protective measure only for the person who actuates it.

Note 4 to entry: ISO 13851 gives detailed provisions.

[SOURCE: ISO 12100:2010, 3.18]

3.54

protective measure:

measure intended to achieve risk reduction, implemented:

- by the designer (inherently safe design, safeguarding and complementary protective measures, information for use); and/or
- by the user (organization: safe working procedures, supervision, permit-to-work systems; provision and use of additional safeguards; use of personal protective equipment; training).

[SOURCE: ISO 12100:2010, 3.19]

3.55

sensitive protective equipment

SPE

equipment for detecting persons or parts of persons which generates an appropriate signal to the control system to reduce risk to the persons detected

[SOURCE: ISO 12100:2010, 3.28.5]

3.55.1

presence-sensing device

PSD

sensitive protective equipment that creates a sensing field, area or plane for detecting the presence of a body part or the whole of a person

Note 1 to entry: Pressure-sensitive protective devices can be used as tripping devices as well as presence-sensing devices, as mentioned in ISO 12100:2010, Note to 3.28.5 .

[SOURCE: ISO 13856-3:2013, [3.2](#)]

3.55.2

electro-sensitive protective equipment

ESPE

assembly of devices and/or components working together for protective tripping or presence-sensing purposes and comprising at a minimum:

- a sensing device,
- controlling/monitoring devices,
- output signal switching devices

[SOURCE: ISO 13855:2010, 3.1.4 and IEC 61496-1:2004, 3.5]

3.55.3**pressure-sensitive protective device
PSPD**

sensitive protective equipment of the “mechanically activated trip” type intended to detect the touch of a person or body part of a person and which can also act as impeding device

Note 1 to entry: A pressure-sensitive protective device consists of a sensor or sensors, which generates a signal when pressure is applied to part of its outer surface, and a control unit, which responds to the signal from the sensor and generates an output signal(s) to the control system of a machine.

Note 2 to entry: Pressure-sensitive protective devices can be used as tripping devices as well as presence-sensing devices, as mentioned in ISO 12100:2010, Note to 3.28.5 .

Note 3 to entry: For the definitions of sensitive protective equipment and impeding device, see ISO 12100:2010, 3.28.5 and 3.29, respectively.

[SOURCE: ISO 13856-3:2013, [3.1](#)]

3.56 Abbreviations

Symbol or Abbreviation	Term	Definition or occurrence
SPE	Sensitive Protective Equipment	3.50 , 3.53 , 3.55
3P	3-Position <3-Position <i>Enabling Device</i> >	5.13.1 , 5.13.2 , 5.13.3
EOAT	End-Of-Arm Tooling	3.9
PFL	Power and Force Limiting	5.14.3 , 5.13.5, Annex C ,
HGC	Hand-Guided Control	5.14.3
PL	Performance Level	5.3.2 , 5.3.3 , Annex C , Annex D
PFH _d	average Probability of dangerous Failure per Hour	Annex D
PPE	Personal Protective Equipment	Part 2
SIL	Safety Integrity Level	5.3.2 , 5.3.3
EMC	Electromagnetic Compatibility	5.1.7
TCP	Tool Centre Point	3.42 , 5.1.3 , 5.1.9 , 5.5.1 , 5. Figure 2 , 5.5.2
PSPD	Pressure Sensitive Protective Device	3.55.3
ESPE	Electro-sensitive Protective Equipment	3.55.2
PSD	Presence Sensing Device	3.55.1

4 Risk Assessment**4.1 General**

A robot manufacturer shall perform a risk assessment. This risk assessment shall include:

- Determine the limits of the robot;
- a hazard identification to identify any hazards present on the robot being assessed.

NOTE 1 [Annex A](#) contains a list of hazards that can be present with robots.

- the intended operations of the robot, including programming/teaching, maintenance, setup, configuration and cleaning;
- unexpected start-up;

- e) reasonably foreseeable misuse of the robot;
- f) the effect of failure in the control system, e.g. by a FMEA (failure mode effects analysis). See IEC 60812.

NOTE 2 ISO 12100 provides requirements and guidance in performing hazard identification and risk reduction.

NOTE 3 Risk assessment requirements for robot systems, integration, and installation are covered in ISO 10218-2.

NOTE 4 Whether an application can be collaborative is determined by compliance with ISO 10218-2.

4.2 Hazard elimination or risk reduction

Risk shall be estimated for each identified hazard. Identified hazards shall be eliminated where practicable. When further risk reduction is necessary, protective measures shall be implemented to reduce risk to an acceptable level. Having identified the hazards, it is necessary to assess the risks associated with the robot before applying appropriate measures to adequately reduce the risks. Risks shall be eliminated or reduced first by design or by substitution, then by safeguarding and other complementary measures. Any residual risks shall then be reduced by other measures (e.g. warnings, signs, training).

The measures for the reduction of risks are listed below in their order of priority, according to ISO 12100:2010, 6.1:

- a) inherently safe design measures;
- b) safeguarding and/or complementary protective measures, taking into account the intended use and the reasonably foreseeable misuse;
- c) information for use.

NOTE For robot system and robot application requirements, see ISO 10218-2:2021, 4.

5 Design requirements and protective measures

5.1 Robot design

The robot shall be designed in accordance with the principles of ISO 12100 for identified hazards. As required in [clause 4](#), if hazards exist that are not eliminated by inherently safe design, then safeguarding and/or complementary protective measures shall be implemented to reduce the risks due to these hazards.

For safety measures concerning information, see [clause 7](#), Information for Use.

5.1.1 Mechanical strength and stability

Robots shall be designed and constructed to prevent hazardous situation(s) which result from failure due to fatigue and wear, taking due account to the lifecycle intended use (e.g. installation, operating conditions and maintenance in accordance with the Information for Use). The materials used shall be chosen on the basis of the specifications (e.g. resistance to corrosion, abrasion, impacts, temperatures, fatigue, brittleness, ageing).

Robots shall be stable such that tipping and falling-over are prevented by:

- packaging, support or lifting means for transportation and lifting;
- specified mounting to affix the robot securely for installation, operation and use.

5.1.2 Position holding

If the loss of power will lead to a hazard due to gravity affecting the manipulator, the robot shall have a means for maintaining robot position without drive power (e.g. brakes, pins, or other technology).

In case of being required for safety, position holding shall fulfil one of the following requirements:

- use of appropriate design margins;
- failure of the position holding function shall not cause a hazardous situation, e.g. the axis slowly drops, lowers, drifts or sinks;

5.1.3 Auxiliary axis (axes)

Robot controlled auxiliary axis (axes) is an optional capability.

An auxiliary axis can be part of the robot's overall kinematic solution, allowing for coordinated motion between the manipulator and the auxiliary axis or axes.

When the auxiliary axis motion affects the TCP speed in manual reduced-speed, the requirements of reduced speed ([5.5.1](#)) shall apply to the auxiliary axis (axes).

When a monitored speed safety function is provided with the robot, this safety function (see [5.5.2](#)) shall also be provided for the auxiliary axis (axes).

5.1.4 Power loss or change

Loss or change of electrical, hydraulic or pneumatic power to the robot shall not result in a hazardous situation.

Re-initiation of power shall not lead to any hazardous movement(s).

NOTE See IEC 60204-1 for electrical power supply requirements. See ISO 4413 for hydraulics and ISO 4414 for pneumatics requirements.

5.1.5 Component malfunction

Robot components shall be designed, constructed, secured, or contained so that risks caused by breaking or loosening, or releasing stored energy are reduced to an acceptable level.

5.1.6 Hazardous energy

5.1.6.1 General

Hazardous energy can take many forms: kinetic, gravity, electrical, pneumatic, hydraulic, thermal, chemical, radioactive. The sources of these energies can sometimes be readily identified; however, often the sources are hidden or not obvious, e.g. accumulators, capacitors, batteries, springs, counterbalances, flywheels, heat as an outcome due to friction or other reactions.

5.1.6.2 Control and controlled release of stored energy

Stored energy shall not to cause hazardous situation(s). A means shall be provided for the controlled release of stored hazardous energy according to ISO 14118. If the hazardous energy is kinetic (e.g. spring balancer, gas balancer), the robot shall have means to secure it in the de-energized position according to ISO 14118.

Safety function(s) that hold position (see [5.1.2](#)) shall be provided to prevent uncontrolled release or movement of hazardous energy.