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Robots for industrial environments — Safety requirements —

Part 1: Robot

Robots pour environnements industriels — Exigences de sécurité — Partie 1: Robot

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10218-1 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 2, *Robots for industrial environments*.

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This first edition cancels and replaces ISO 10218:1992, which has been technically revised.

This wholly revised International Standard updates the document to bring it better in line with ISO 12100 and the requirements to identify and respond in a type C standard to unique hazards, in this standard for industrial robots. New technical requirements include, but are not limited to, safety-related control system performance, robot stopping function, enabling device, programme verification, wireless pendant criteria, control of simultaneous motion, collaborating robot criteria, and updated design for safety requirements.

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ISO 10218 consists of the following parts, under the general title *Robots for industrial environments — Safety requirements*:

— *Part 1: Robot*

The following parts are under preparation:

— *Part 2: Robot system and integration*

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Introduction

ISO 10218 has been created in recognition of the particular hazards that are presented by industrial robots and industrial robot systems.

This document is a type C standard as stated in ISO 12100-1.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this document.

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

Hazards associated with robots are well recognized, but the sources of the hazards are frequently unique to a particular robot system. The number and type(s) of hazard(s) are directly related to the nature of the automation process and the complexity of the installation. The risks associated with these hazards vary with the type of robot used and its purpose and the way in which it is installed, programmed, operated and maintained.

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

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In recognition of the variable nature of hazards with different uses of industrial robots, ISO 10218 is divided into two parts; Part 1 provides guidance for the assurance of safety in design and construction of the robot. Since safety in the application of industrial robots is influenced by the design and application of the particular robot system integration, Part 2 will provide guidelines for the safeguarding of personnel during robot integration, installation, functional testing, programming, operation, maintenance and repair.

NOTE 2 While noise is generally considered a hazard associated with the industrial environment, the robot as defined in 3.18 cannot be considered the final machine, rather the robot system as defined in 3.20 is the machine for noise consideration. Therefore the hazard due to noise will be dealt with in ISO 10218-2.

ISO 10218 is not applicable to robots which were manufactured prior to its publication date.

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Robots for industrial environments — Safety requirements —

Part 1: Robot

1 Scope

This part of ISO 10218 specifies requirements and guidelines for the inherent safe design, protective measures and information for use of industrial robots, as defined in Clause 3. It describes basic hazards associated with robots and provides requirements to eliminate, or adequately reduce, the risks associated with these hazards.

Noise as a potential hazard is not dealt with in this part of ISO 10218, but will be fully covered in Part 2.

This part of ISO 10218 does not apply to non-industrial robots although the safety principles established in ISO 10218 may be utilized for these other robots. Examples of non-industrial robot applications include, but are not limited to: undersea, military and space robots, tele-operated manipulators, prosthetics and other aids for the physically impaired, micro-robots (displacement < 1 mm), surgery or healthcare, and service or consumer products.

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NOTE 1 Requirements for robot systems, integration, and installation are covered in Part 2.

NOTE 2 Additional hazards may be created by specific applications (e.g. welding, laser cutting, machining). These hazards may need to be considered during robot design.

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2 Normative references

The following referenced documents are indispensable for the application 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 9283:1998, *Manipulating industrial robots — Performance criteria and related test methods*

ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

ISO 13849-1:1999, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

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

ISO 13855, *Safety of machinery — Positioning of protective equipment with respect to the approach speeds of parts of the human body*

ISO 14121:1999, *Safety of machinery — Principles for risk assessment*

IEC 60204-1:2005, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

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IEC 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) — Part 6: Generic standards — Section 4: Emission standard for industrial environments*

3 Terms and definitions

For the purposes of this document, the definitions given in ISO 12100-1 and the following terms and definitions apply.

3.1
actuating control
a) mechanical mechanism within a control device

EXAMPLE A rod which opens contacts.

b) device which initiates a (un)locking sequence

EXAMPLE Specialized key.

3.2
automatic mode
operating mode in which the robot control system operates in accordance with the task programme

[ISO 8373:1994, definition 5.3.8.1]

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3.3
automatic operation
state in which the robot is executing its programmed task as intended

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[ISO 8373:1994, definition 5.5]

3.4
collaborative operation
state in which purposely designed robots work in direct cooperation with a human within a defined workspace

3.5
collaborative workspace
workspace within the safeguarded space of the robot work cell, where the robot and a human can perform tasks simultaneously during production operation

3.6
coordinated motion
control wherein the axes of the robot arrive at their respective end points simultaneously, giving a smooth appearance to the motion and control wherein the motions of the axes are such that the tool centre point (TCP) moves along a prescribed path (line, circle, or other)

3.7
cycle
single execution of a task programme

[ISO 8373:1994, definition 6.22]

3.8
drive power
energy source or sources for the robot actuators

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3.9
end-effector
device specifically designed for attachment to the mechanical interface to enable the robot to perform its task

EXAMPLES Gripper, nutrunner, welding gun, spray gun.

[ISO 8373:1994, definition 3.11]

3.10
energy source
any electrical, mechanical, hydraulic, pneumatic, chemical, thermal, potential, kinetic, or other sources of power

3.11
hazardous motion
any motion that is likely to cause personal physical injury or damage to health

3.12
limiting device
device that restricts the maximum space by stopping or causing to stop all robot motion and is independent of the control programme and the task programmes

3.13
local control
state of the system or portions of the system in which the system is operated from the control panel or pendant of the individual machines only

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[ISO 8373:1994, definition 5.3.8.2 modified]

3.14
manual mode
control state that allows the generation, storage, and playback of positional data points

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3.15
pendant
teach pendant
hand-held unit linked to the control system with which a robot can be programmed or moved

[ISO 8373:1994, definition 5.8]

3.16 Programme

3.16.1
control programme
inherent set of instructions which defines the capabilities, actions, and responses of a robot system

NOTE This programme is fixed and usually not modified by the user.

[ISO 8373:1994, definition 5.1.2]

3.16.2
task programme
set of instructions for motion and auxiliary functions that define the specific intended task of the robot system

NOTE 1 This type of programme is normally generated by the user.

NOTE 2 An application is a general area of work, a task is specific within the application.

[ISO 8373:1994, definition 5.1.1]

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3.16.3
task programming
act of providing the **task programme** (3.16.2)

[ISO 8373:1994, definition 5.2.1]

3.16.4
programmer
person designated to prepare the task programme

[ISO 8373:1994, definition 2.17]

3.16.5
programme path
path traced by the TCP during the execution of a task programme

3.16.6
programme verification
execution of a task programme for the purpose of confirming the robot path and process performance

NOTE Verification may include the total programme path or a segment of the path. The instructions may be executed in a single instruction or continuous instruction sequence. Verification is used in new applications and in fine tuning/editing of existing ones.

3.17
protective stop
type of interruption of operation that allows an orderly cessation of motion for safeguarding purposes and which retains the programme logic to facilitate a restart

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3.18
robot
industrial robot
automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications

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NOTE 1 The robot includes:

— the manipulator (including actuators);

— the controller including teach pendant, and any communication interface (hardware and software).

NOTE 2 This includes any additional axes which are controlled by the robot controller.

NOTE 3 The following devices are considered industrial robots for the purpose of this part of ISO 10218:

a) hand-guided robots;

b) the manipulating portions of mobile robots;

c) collaborating robots.

[ISO 8373:1994, definition 2.6 modified]

3.19
robot actuator
powered mechanism that converts electrical, hydraulic, or pneumatic energy to effect motion

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3.20
robot system
industrial robot system
system comprising:

— robot;

— end-effector(s);

— any equipment, devices, or sensors required for the robot to perform its task

NOTE The robot system requirements are contained in ISO 10218-2.

[ISO 8373:1994, definition 2.14 modified]

3.21
simultaneous motion
motion of two or more robots at the same time under the control of a single control station and which may be coordinated or may be synchronous with common mathematical correlation

EXAMPLE 1 Example of a single control station may be a teach pendant.

EXAMPLE 2 Coordination can be done as master/slave.

3.22
single point of control
ability to operate the robot such that initiation of robot motion is only possible from one source of control and cannot be overridden from another initiation source

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3.23
singularity
condition caused by the collinear alignment of two or more robot axes resulting in unpredictable robot motion and velocities

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3.24
reduced speed control
slow speed control
mode of robot motion control where the speed is limited to $\leqslant$ 250 mm/s to allow persons sufficient time to either withdraw from the hazardous motion or stop the robot

3.25
space
three dimensional volume encompassing the movements of all robot parts through their axes

3.25.1
maximum space
space which can be swept by the moving parts of the robot as defined by the manufacturer, plus the space which can be swept by the end-effector and the workpiece

[ISO 8373:1994, definition 4.8.1]

3.25.2
restricted space
portion of the maximum space restricted by limiting devices that establish limits which will not be exceeded

[ISO 8373:1994, definition 4.8.2 modified]

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3.25.3
operating space
operational space
portion of the restricted space that is actually used while performing all motions commanded by the task programme

[ISO 8373:1994, definition 4.8.3]

3.25.4
safeguarded space
space defined by the perimeter safeguarding devices

3.26
teach (programming)
programming performed by

a) manually leading the robot end-effector; or

b) manually leading a mechanical simulating device; or

c) using a teach pendant to move the robot through the desired actions

[ISO 8373:1994, definition 5.2.3]

3.27
teacher
person who provides the robot with a specific set of instructions to perform a task

NOTE See **programmer** (3.16.4).

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3.28
tool centre point
TCP
point defined for a given application with regard to the mechanical interface coordinate system

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[ISO 8373:1994, definition 4.9]

3.29
user
entity that uses robots and is responsible for the personnel associated with the robot operation

4 Hazard identification and risk assessment

Annex A contains a list of hazards that can be present with robots. A hazard analysis shall be carried out to identify any further hazards that may be present.

A risk assessment shall be carried out on those hazards identified in the hazard identification. This risk assessment shall give particular consideration to:

a) the intended operations at the robot, including teaching, maintenance, setting, and cleaning;

b) unexpected start-up;

c) access by personnel from all directions;

d) reasonably foreseeable misuse of the robot;

e) the effect of failure in the control system; and

f) where necessary, the hazards associated with the specific robot application.

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