A3 ROBOTICS | INTERNATIONAL ROBOT SAFETY Conference

Introduction to Industrial Robot Safety ISO 10218 Parts 1 and 2

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Topics

- Industrial robot safety standards development
  - ISO 10218-1,-2
  - ANSI/RIA R15.06
- Key terms and concepts
- Complementary documents (TRs)

ISO 10218-1, -2

- Full Titles
  - ISO 10218-1:2011, Robots and robotic devices – Safety requirements for industrial robots – Part 1: Robots
    - Sets requirements to robot manufacturers
  - ISO 10218-2:2011, Robots and robotic devices – Safety requirements for industrial robots – Part 2: Robot systems and integration
    - Sets requirements to integrators
- Developed within ISO TC299/ WG3
  - TC299 – 27 participating countries and 14 observing countries
  - WG3 – 20 represented organizations

ANSI/RIA R15.06

- Full title
  - American National Standard for Industrial Robots and Robot Systems – Safety Requirements
- Published in 2012
- National adoption of ISO 10218-1, -2
  - Both parts are under one cover
- Part 2 deviations
  - Normative references
  - Bibliography for R15.06

Deviation Details

- Normative references for USA compliance

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

NOTE (ANSI) – ANSI/ISO 12100 can be used for USA compliance.

ISO 13849-1:2006, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

NOTE (ANSI) – B11.TR6 can be used in the USA for reference regarding Control Reliability.

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

NOTE (ANSI) – Applicable sections of NFPA 79 and ANSI B11.19 can be used for USA compliance.

- Bibliography for R15.06 are not found in 10218

The references contained in Part 1 and Part 2 and their respective Bibliographies are references used in the original ISO documents. They are appropriate for compliance with this standard and for conformance with International Standards or when an EU Declaration of Conformity is required.

The following documents (listed alphabetically, not by significance) contain useful information in application of robot systems and some contain similar but not identical information as some of the references in this standard:

Title change with next revision

- ISO 10218-1:202X, Robotics – Safety requirements – Part 1: Industrial robots
- ISO 10218-2:202X, Robotics – Safety requirements – Part 2: Industrial robot systems, robot applications and robot cells

Standards

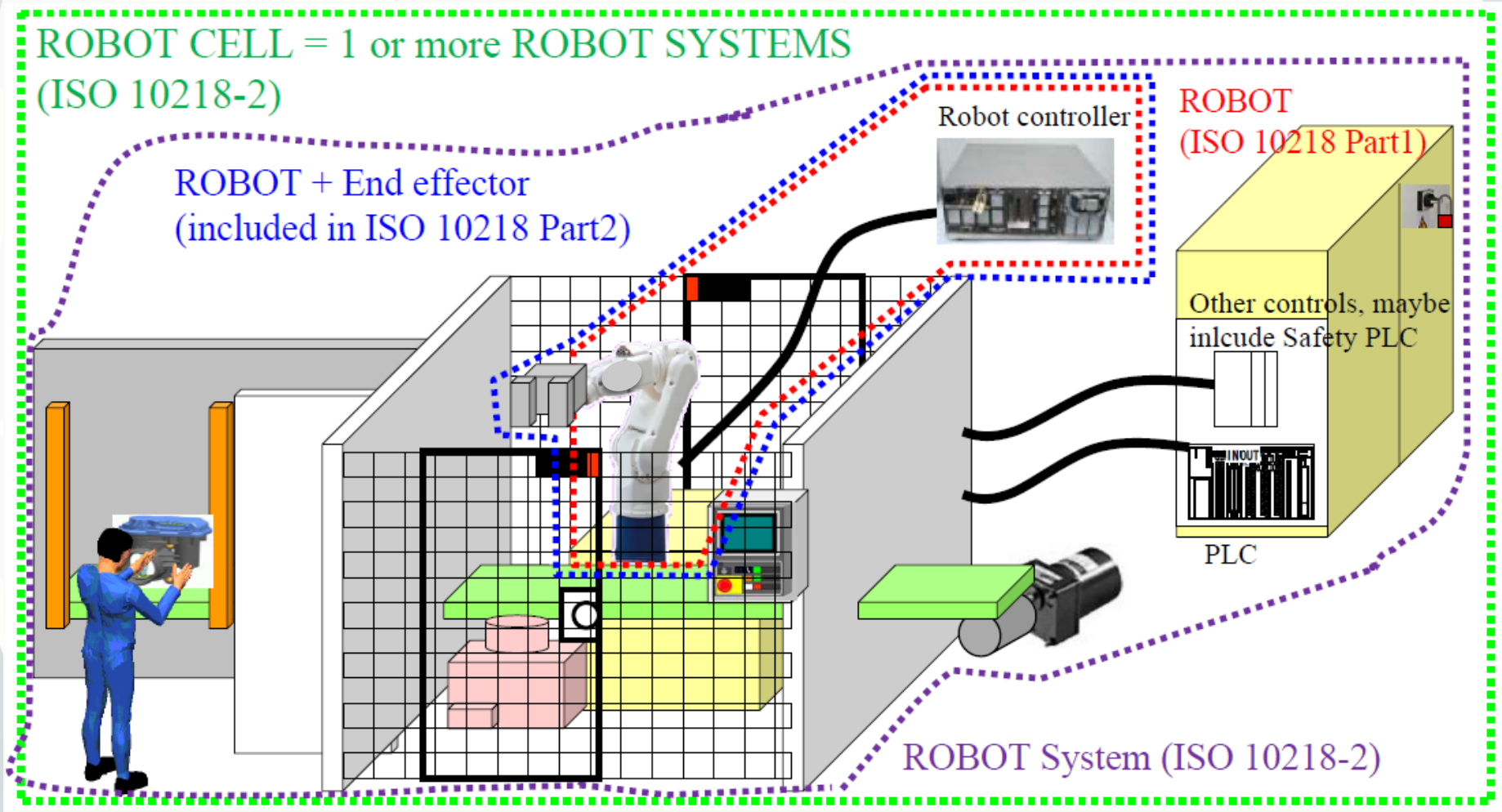
- Provide a **voluntary** means to achieve a desired outcome
- Can become **compulsory** (i.e., law) when adopted by a regulatory agency
- Drafted by a **volunteer** committee of representatives of concerned interests such as manufacturers of robots and safety devices, users, regulators, suppliers, integrators, consultants, and academia
    - Balanced across multiple disciplines
- Developed under the backing of a **national** or **international** organization which provides rules and guidance on the standards development process
- Development utilizes a **consensus** process throughout the drafting
    - Consensus implies a majority agreement to the guidance, but does not imply unanimous agreement

Key Terms and Concepts

Key Terms and Concepts

- Industrial Robot
  - Automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications
- Industrial Robot System
  - System comprising:
    - Industrial robot;
    - End-effector(s);
    - Any machinery, equipment, devices, external auxiliary axes or sensors supporting the robot performing its task
- Industrial Robot Cell
  - One or more robot systems including associated machinery and equipment and the associated safeguarded space and protective measures

Robot, System, Cell



Key Terms and Concepts (cont.)

- Normative vs Informative guidance
  - A **normative** element describes the scope of the document or sets out provisions
    - The “required” items are identifiable by the word “shall”
    - Normative **references** identify requirements found in other standards
  - An **informative** element provides information intended to assist the understanding or use of the document.
    - They are the “good practice” guidance identifiable by the word “should”
    - “Notes” are always informative

Key Terms and Concepts (cont.)

- Permissive vs Capability guidance
  - A **permissive** guidance element describes a design feature that is allowed/permitted
    - The **permitted** item is identifiable by the word “may”

    Example: “A robot system **may** be network enabled for remote access.”
  - A **capable** guidance element describes a design feature that gives a machine the capability to perform a certain way.
    - The **capable** item is identifiable by the word “can”

    Example: “Robot systems **can** have a potentially large operating volume.”

Key Terms and Concepts (cont.)

- Practicable
  - Reducing a risk to a level that represents the point, objectively assessed, at which the time, trouble, difficulty, and cost of further reduction becomes unreasonably disproportionate to the additional risk reduction obtained

Example: “Whenever **practicable**, control devices and control stations shall be located so that the operator is able to observe the working area or hazard zone.”

Key Terms and Concepts (cont.)

- Risk Assessment
  - The identification of hazards, estimation of the risk and elimination of the hazard or reduction in risk through protective measures
    - Carried out by robot manufacturer when complying with Part 1
    - Carried out by system integrator when complying with Part 2
      - When the User of machinery modifies the equipment, they are acting as an integrator and Part 2 applies to them

- Functional Safety
  - Refers to ISO 13849 and IEC 62061 for Performance Level and Safety Integrity Level determination/requirements respectively

Key Terms and Concepts (cont.)

- “Collaborative Robot”
  - Refers to robots with incorporated technologies which permit them to be used in collaborative applications
  - Types of collaborative applications
    - Safety-rated monitored stop (not considered collaborative in next revision)
    - Hand guiding (HGC)
    - Speed and separation monitoring (SSM)
    - Power and force limiting (PFL)

Key Terms and Concepts (cont.)

- Verification and Validation

  Verification is more of a static method of checking the identification of hazards and selected risk reduction measures. Typically done during development phase.

  (i.e., Is the risk reduction measure appropriate and is it used appropriately?)

  Validation is more of a dynamic process of testing the applied risk reduction measures. Performed on the completed system.

  (i.e., Are the safety functions working correctly?)

Key Terms and Concepts (cont.)

- Verification and Validation (cont.)
  - **6.2 Verification and validation methods**

    Verification and validation can be satisfied by methods including but not limited to:

    — A visual inspection;
    — B practical tests;
    — C measurement;
    — D observation during operation;
    — E review of application-specific schematics, circuit diagrams and design material;
    — F review of task-based risk assessment;
    — G review of specifications and information for use.

  - **Table F.1 – Means of verification of the safety requirements and measures**

Subclause	Applicable safety requirements and/or measures	Verification and/or validation method (see 6.2)						
		A	B	C	D	E	F	G
5.2	**General requirements**							
5.2.1	Fixed or moveable guards are installed to prevent exposure to hazards such as shafts, gears, drive belts, or linkages	X			X			
5.2.1	Fixed guards intended to be removed for routine service have captive hardware		X					X
5.2.1	Movable guards are interlocked with the hazardous movements in such a way that the hazardous movements come to a stop before the hazards can be reached		X	X	X	X		

Key Terms and Concepts (cont.)

- Information for Use
  - Part 1

7.1 General

Markings (e.g. signs, symbols) and instructional material (e.g. manuals for operation, maintenance) shall be provided by the manufacturer in accordance with ISO 12100 and IEC 60204-1.

  - Part 2

7.1 General

Information for use shall contain the information and instructions necessary for the correct use of the system and shall provide information and warnings to the user about any residual risks. Information for use from component machine manufacturers shall also be included.

It shall consist of items such as documents, signs, signals, symbols or diagrams used to convey important safety-related information to the user.

Complementary Documents

Complementary Documents

- TR R15.306-2016 Task-based Risk Assessment Methodology
  - Key references ISO 12100, ISO 13849 and ANSI B11.0
- ~~TR R15.406-2014 Safeguarding~~ (Withdrawn)
  - Referenced ISO 11161, ISO 13855, ISO 13857, ANSI B11.19, ANSI B11.20
- TR R15.506 Applicability of R15.06-2012 for Existing Applications
  - To be updated after completion of 10218 revision
- TR R15.606-2016 Collaborative Robots (Applications)
  - Adoption of ISO TS15066
- TR R15.706 User Responsibilities
  - Currently under revision for a R15.06 Part 3

Complementary Documents (cont.)

- TR R15.806-2018 Testing Methods for Power & Force Limited Collaborative Applications
  - PFL robots are NOT to be considered safe “out of the box”
- TR R15.1006 Testing Methods for Speed and Separation Monitoring Collaborative Applications (UNDER DEVELOPMENT)
  - Validation of separation distances in SSM applications
- RIA/ISO/TR 20218-1:2020 End-effectors
  - Safety measures for design and integration of end-effectors
- RIA/ISO/TR 20218-2:2020 Manual Load/Unload Stations
  - Alternative methods of impeding access to robot cells

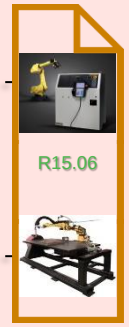
Current State of Standards, TS and TR

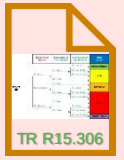
ISO

CURRENT

ria
Robotic Industries Association

CURRENT





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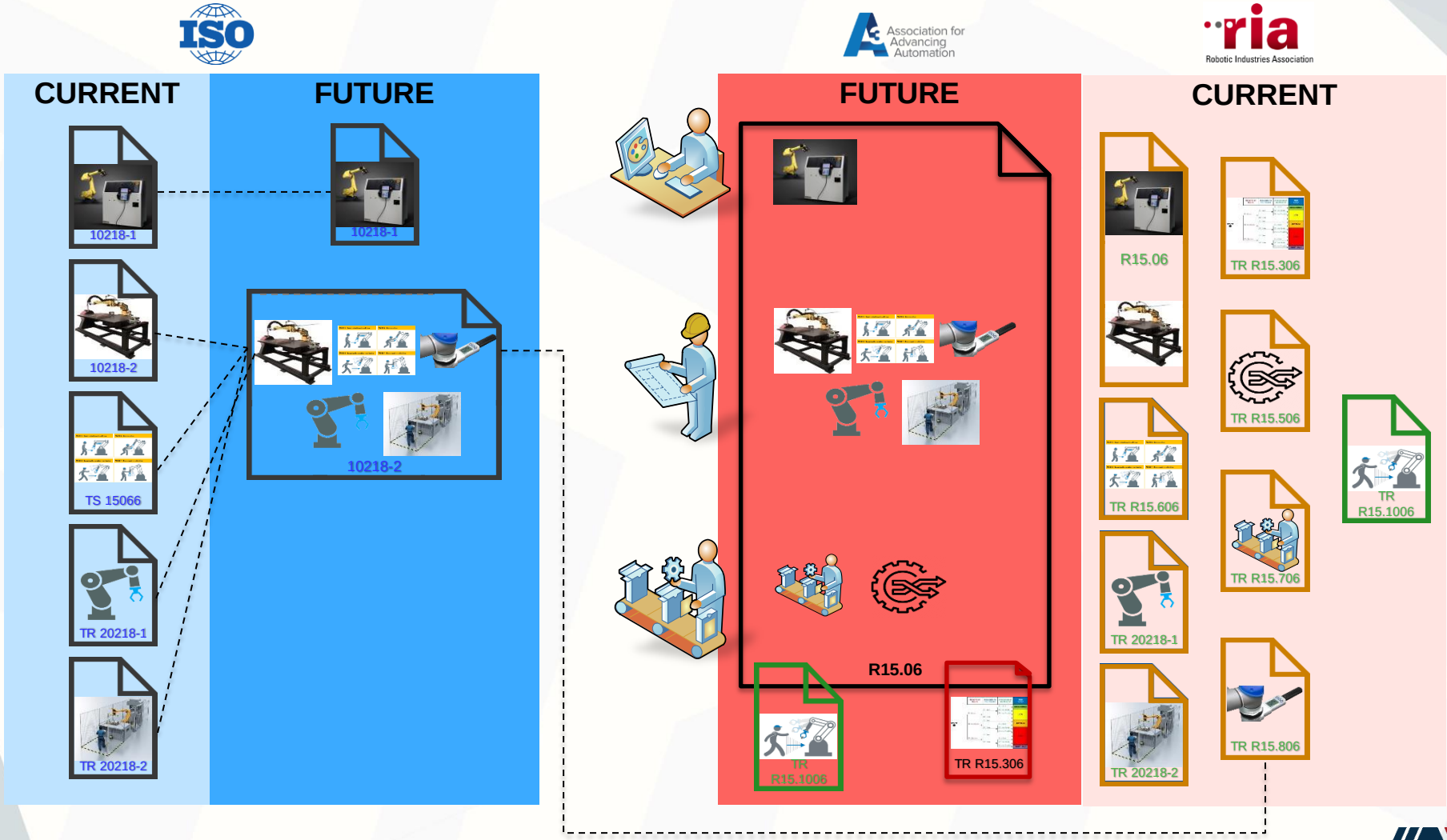
Projected New 10218 and R15.06



Summary

- ISO 10218 and ANSI/RIA R15.06 are essentially the same.
- Standards are created by volunteers from a variety professional disciplines.
- Standards provide normative and informative guidance and can be used as a means to achieve regulatory compliance.
- Functional safety ensures that safety functions relying on a control system will be effective for the associated risk(s).
- “Collaborative” describes a robot application or system NOT a type of robot

QUESTIONS?

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The Power of Dreams

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