Updates to ISO 10218-2 & -2:2011 Preview of the Next Edition…

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Disclaimer…

This presentation is based on draft FDIS (Final Draft International Standard) documents submitted for ballot.

Contents could change before balloting due to European Harmonization (more later).

The published documents could have wording changes to facilitate translations to other languages.

Timeline

- Part 1 & Part 2 FDIS drafts were submitted in 2022.

- Due to issues in Europe, a HAS consultant (evaluates for harmonization) has not YET been assigned.

- Time from submittal to publication and harmonisation relies on ISO and EU. Since it is now the end of September, maybe by the end of Q2 or Q3 2023.

- After the ISO revisions are published, then R15.06 will be updated to these newest editions.

Globally accepted safety standards!

Australia, Canada (CSA), China (GB), Europe (EN), Japan (JIS), Korea (KSB), Russia (GOSH R), Singapore (SS), UK (BSI) and USA (ANSI/RIA) work in ISO to develop these robotic safety standards, then **nationally adopt** in their own countries. *Brazil refers to them, while Mexico intends to adopt.*

Example of ISO 10218-1 & -2 being nationally adopted by the USA as ANSI/RIA R15.06
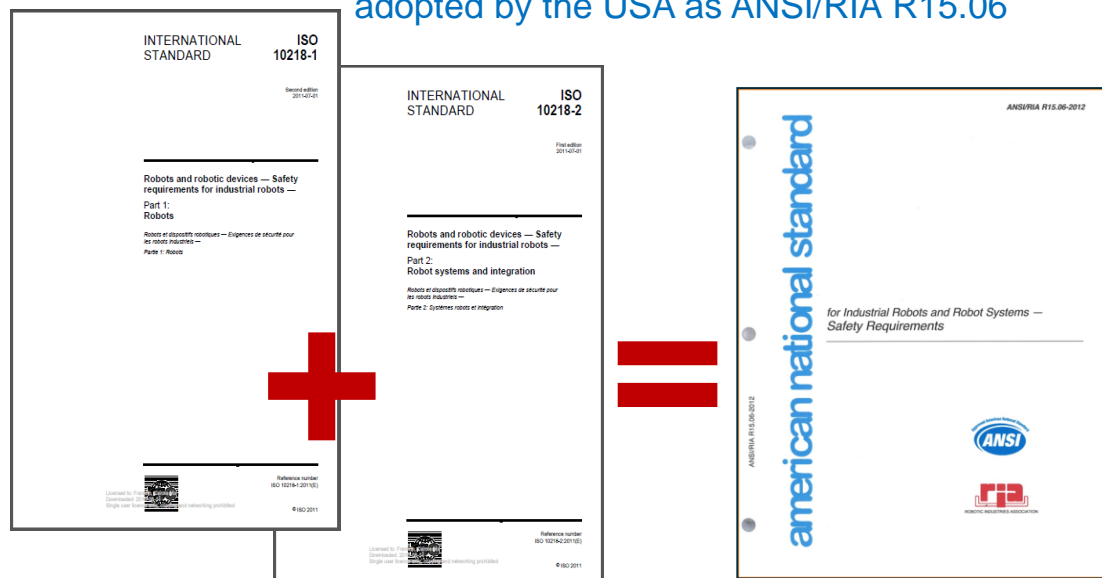
EN ISO 10218-1 & -2 are adopted (EN) and are harmonized *(listed in the MD Official Journal)*

ISO 10218-1, -2: adopted or used…

Europe: Harmonized EN standards
EN ISO 10218-1:2011, EN ISO 10218-2:2011

Australia: AS 4024.3301 & 4024.3302:2017

Brazil: reference only

Canada* : CSA Z434-14 (Part 1 and Part 2)
Part 2 deviations: mostly added USER requirements

China: GB 11291.1-2011 & GB 11291.2:2013

India: Intended adoption

Japan *: JIS B 8433-1:2015 & JIS B 8433-2:2015

Korea: KSBISO10218-1 & KSBISO10218-2

Mexico: Intended adoption

Russia: GOSH R 60.1.2.1-2016 & GOSH R 60.1.2-2016
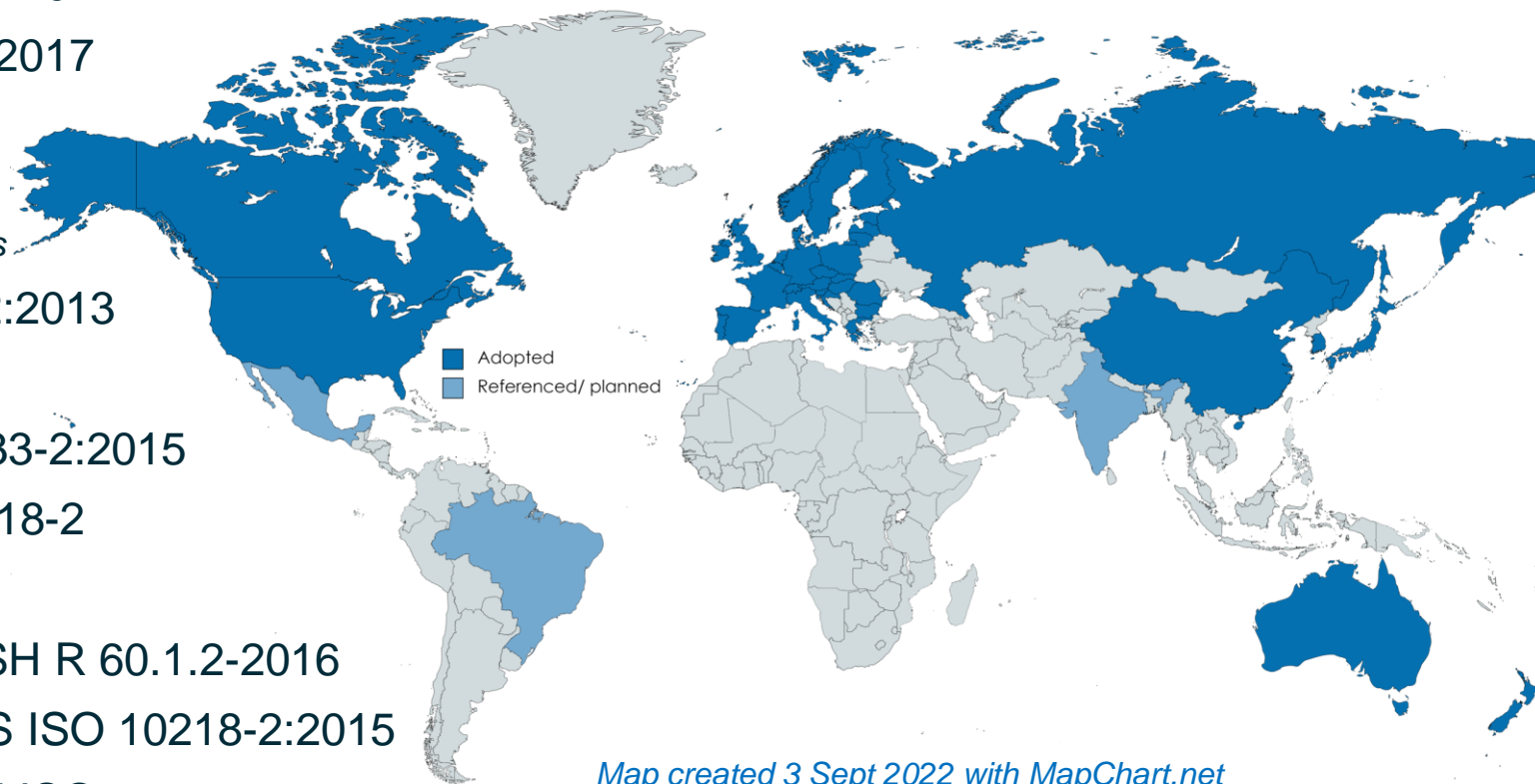
Singapore: SS ISO 10218-1:2015 & SS ISO 10218-2:2015

UK: BS EN ISO 10218-1:2011 & BS EN ISO 10218-2:2011

USA: ANSI/RIA R15.06-2012 (includes Part 1 and Part 2)

* Referenced in regulations

Adopted
Referenced/ planned

Map created 3 Sept 2022 with MapChart.net

Source: ISO/DIS 10218-1.2, -2 results of 2016 ballots with added research 3 Sept 2022

Robotic safety standards have performed well

The high participation globally (countries and #s) combined with the global acceptance has resulted in the following benefits:

1) Robot manufacturers have 1 design for the world.

2) Robot integrators have 1 standard to apply (not multiple).

3) Robot users (who can also be integrators) and their workers enjoy the results of the safety requirements.

The robotics industry is fortunate to have a high level of interest in safety (look around the room). We "enjoy" low injury statistics, and we strive to drive these numbers lower…

2011 – 2018: German industrial robot applications have increased tremendously since 2011, but not injuries...

Source:
Dr. Matthias Umbreit of DGUV.

Available to the public from Deutsche Gesetzliche Unfallversicherung (DGUV).

Arbeitsunfälle = Injuries where the person was away from work for at least 3 days (72 to 170 annually)

Neue Unfallrenten = Injuries resulting in new pensions e.g. loss of arm or hand (0 to 5)

Tödliche Arbeitsunfalle = Fatalities (0 to 2 annually)
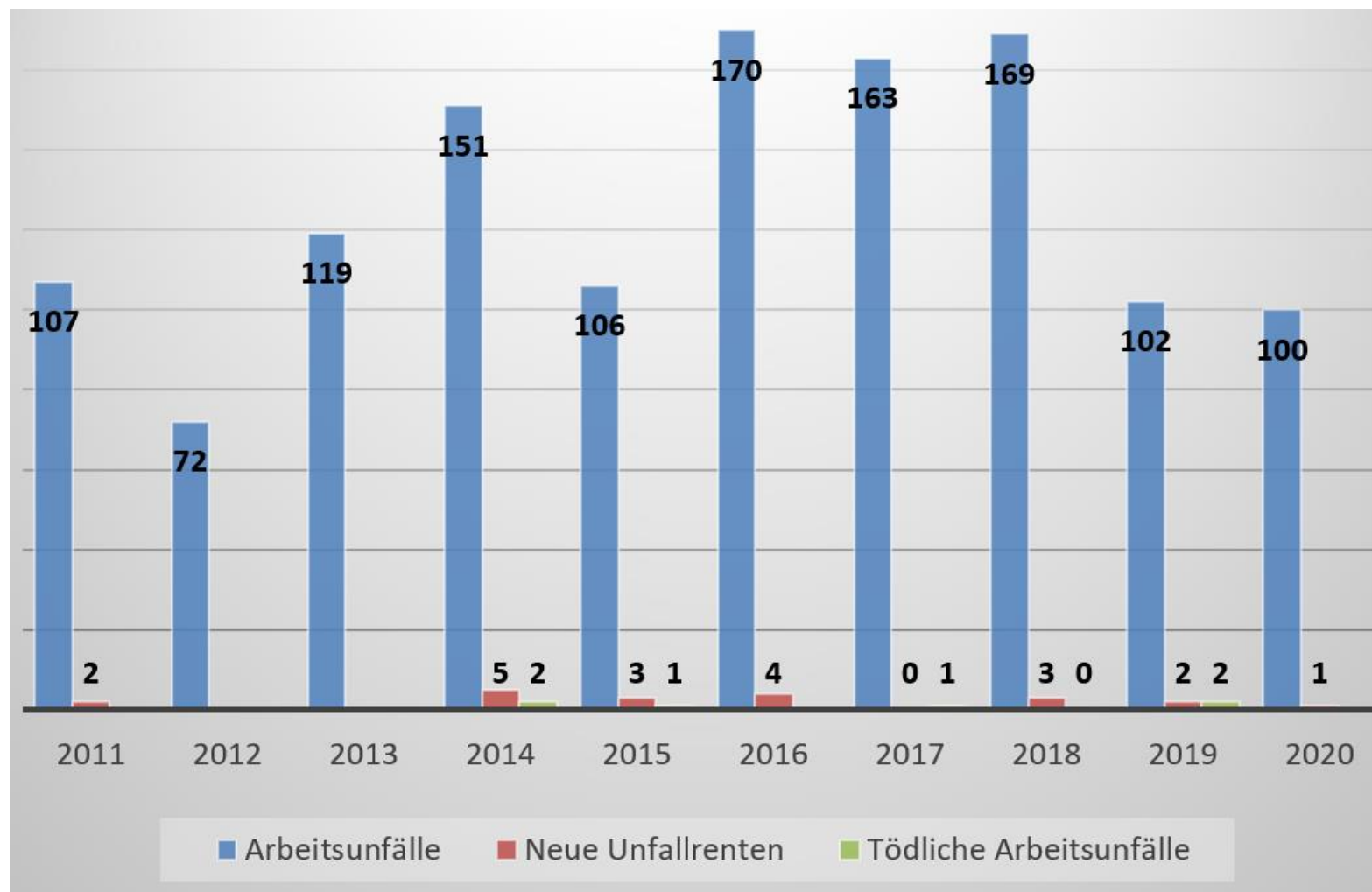
The goal is to reduce injuries and fatalities to ZERO. Look up "Vision Zero".

If you know R15.06 (ISO 10218-1,-2:2011)...

Time has shown that **when everyone is comfortable** with a standard that has advancing technology – **it is TIME TO UPDATE**!!!!

- We learn from new applications and experiences!

- We push to do better!

This update has been in progress for almost 5 years...

Revision goals

Keep EU harmonization status

- 2011 are harmonized (listed in the Official Journal of the MD) which is very important for 1/3 of the world (Europe).
- Has become more difficult than in 2011, even though the EU machinery requirements are the same.

Clean-up errors

Acknowledge & address technology advancements

Improve functional safety and "collaborative" requirements

More requirements compared to 2011

Longer & more detailed

- Part 1 Robot: roughly 2x longer
- Part 2 Robot application: more than 2.5x longer

Better separation between Part 1 and Part 2

Closer match to the EU Machinery Directive (MD) even though the MD has not changed in all these years…

- Expect to keep Harmonization (Official Journal of the MD)
- More "hard" or specified requirements

Mechanics and brake system

Part 1 Section 5.1.2; Part 2 Section 5.2.2

• The design shall take into account wear and fatigue

• Selection of materials shall take into account use, foreseeable misuse, toxicity...

• Some lifting equipment requirements apply, e.g. over dimensioning (x1.25 for static and x1.1 for dynamic loads)

• Corners, edges and projections shall be reduced as much as reasonably practicable

Part 1 Section 5.1.8; Part 2 Section 5.2.8

• The brake system is explicitly mentioned regarding dimensioning factors

• There shall be a way to test the brake system (position holding), which can be a procedure (see Information for Use)

Temperature & overheating

Part 1 Section 5.1.6; Part 2 Section 5.2.6

- Temperatures of accessible parts shall be in accordance with ISO 13732.

- The design principles of ISO 19353 shall be applied to reduce the risk of fire. If the risk cannot be completely removed by design, then functional safety is required.

  - Likely that temperature monitoring of relevant parts will be a safety function with the PL determined by the design risk assessment

Robot classes: Part 1 only, Section 5.1.17

Class I robots shall comply with ALL of the below:

- Less than 10kg

- Capable* of less than 50N force

- Capable* of less than 250mm/s

* The capability of the robot is considered without the use of any form of limiting functions, it shall be the unrestricted max performance of the robot.

Class I robots have much lower requirements for safety functions and are not required to have a 3PE (including not required to have a 3PE integrated in the teach pendant.

Class II robots

- Robots that do not comply with **all of the Class I requirements above**

- Any robot which does not test or claim Class I

Part 1 Annex E: Test methodology for Class I robots

Hazardous energy control

Part 1 Section 5.1.12; Part 2 Section 5.2.12

Means to isolate from energy sources shall be provided.

It <robot or robot application> shall be capable of being locked or secured in the de-energized position.

Control station requirements

Part 1, Section 5.2.9 + 5.4.2.2; Part 2, Section 5.7.8

Part 1 & Part 2:

- Any **portable control station** (teach pendant, control panel, smart phone, tablet, etc) **which is capable of initiating motion or other potentially hazardous situations**, shall have an EStop and a 3-position enabling device

  - EStop and 3-position enabling device requirements do not apply for control units which only monitor and do NOT cause motion or control the robot

Part 1: Enabling device will be mandatory (except for Class I robots) on all robot teach pendants (portable control stations).

Part 2: Stationary control stations are required to be installed OUTSIDE the motion of the application. If the control station is capable of initiating motion or other potential hazardous situations, it shall have an E-Stop.

Functional safety – BIG changes…

Part 1, Section 5.3.3 and Part 2, Section 5.5

Many safety functions are listed, of which some are mandatory, some are conditional if a capability is provided and some are optional. More safety functions are required.

Some new safety functions have lower PL requirements, e.g.,

- Single point of control (Performance Level a = PL a)
- Manual high-speed time limitation (PL a)
- External control enable (PL a)
- E-Stop (PL c)
- Normal stop (PL a)
- Start interlock (PL b)
- Restart interlock (PL b)
- Reset (PL a)

Functional safety
– does this mean redundant safety *(category 3)*?

Part 1, Section 5.3.3 and Part 2, Section 5.5

Part 1 ONLY: NO provision is allowed to use a risk assessment to result in lower requirement than specified in Annex C.

- **Category 3 will not be required if the PFH_D is below 4.43E-7/h.**
  Achieving this with a single channel architecture is difficult.

Part 2 ONLY: Either each safety function shall meet the requirements of Annex C or the PLr as determined by a comprehensive risk assessment.

- **Where PLd is be required, the safety function shall achieve PLd using either a Category 3 architecture or the PFH_D shall be less than 4.43 x 10-7/h.**

- **Provides an informative risk estimation methodology.**

Part 1: comparison of specified safety function functions

Revision Clause	Required in existing?	Name (some optional or conditional upon a capability)	Draft 2023: PLr
5.1.6		[over-temperature]	*To ref standards*
5.1.8		position holding monitoring	PLd…
5.2.4		Interlocking devices (for guards)	PLd…
5.2.7.2.3		manual mode, high-speed time limitation	PL a
5.2.7.2.1		manual mode, general	PLd…
5.2.7.2.2		manual mode, reduced-speed (not required with Class I robots)	PLd…
5.2.7.2.3		manual mode, high-speed – optional	PLd…
5.2.7.3		mode activation	PLd…
5.2.8.3		external control enable	PL a
5.4.2	**PL d Cat 3**	emergency stop	PL c, SIL 1
5.4.3	**PL d Cat 3**	protective stop	PLd…
5.4.4		normal stop	PL a

Part 1: comparison of specified safety function functions

UNIVERSAL ROBOTS

Revision Clause	Required in existing?	Name (some optional or conditional upon a capability)	Draft 2023: PLr
5.5.1		single point of control	PL a
5.5.2.1		start interlock	PL b
5.5.2.2		restart interlock	PL b
5.5.3		reset	PL a
5.5.4.1		reduced-speed	PLd…
5.5.4.2		monitored-speed	PLd…
5.5.5		enabling function	PLd…
5.5.6		monitored standstill	PLd…
5.5.6, 7.5.5		stopping time limiting, optional	PLd…
5.5.7, 7.5.5		stopping distance limiting, optional	PLd…
5.5.6		simultaneous motion	PLd…
5.7.1		axis limiting, if done by 5.7.3 & 5.7.4, meet the relevant clause	PLd…
5.7.3		electro-mechanical limiting	PLd…
5.7.4		software based limiting	PLd…

Part 1: comparison of specified safety function functions

Revision Clause	Required in existing?	Name (some are optional)	Draft 2023: PLr
5.7.5		dynamic limiting, optional	PL a
5.10.2		hand-guided controls (HGC), optional	PL b
5.10.2		hand-guided controls activate, if HGC provided	PL b
5.10.2		hold-to-run control, if HGC provided	PL a
5.10.3		speed and separation monitoring, optional	PLd…
5.10.4		power and force limiting, optional	PLd…

Part 2: comparison is similar or possibly longer depending on application complexity

Are all these safety functions needed?

Maybe not needed for all applications, but needed for most…

Difficult to add safety functions at the time of integration that are relevant to the robot & could have been supplied with the robot.

Robots that meet the revised standards will be easier for integration because of these safety functions.

Both Part 1 and Part 2 section 7 require that MORE information be provided to enable integration (Part 1) and use (Part 2).

Status indication and warning devices

Part 1, Section 5.2.5; Part 2, Section 5.7.4

- Wording is more detailed.

- Status information has examples.

- Requirements now link to ISO 12100, IEC 60204-1 and IEC 60073, previously only IEC 60204-1 was mentioned

Single point of control

Part 1, Section 5.2.7:

- Significant changes to the wording, small actual changes to the requirements.
- Requires that there be 1 point of control.
- PL a required.

Part 2, Section 5.7.5:

- Single-point-of-control shall be provided when the robot system or robot application or robot cell is under local control (5.7.6.2).
- Only one source of control shall be accepted at one time.
- More requirements for local control and remote control (reference 5.7.6).
- PL a likely to be required.

Unexpected start

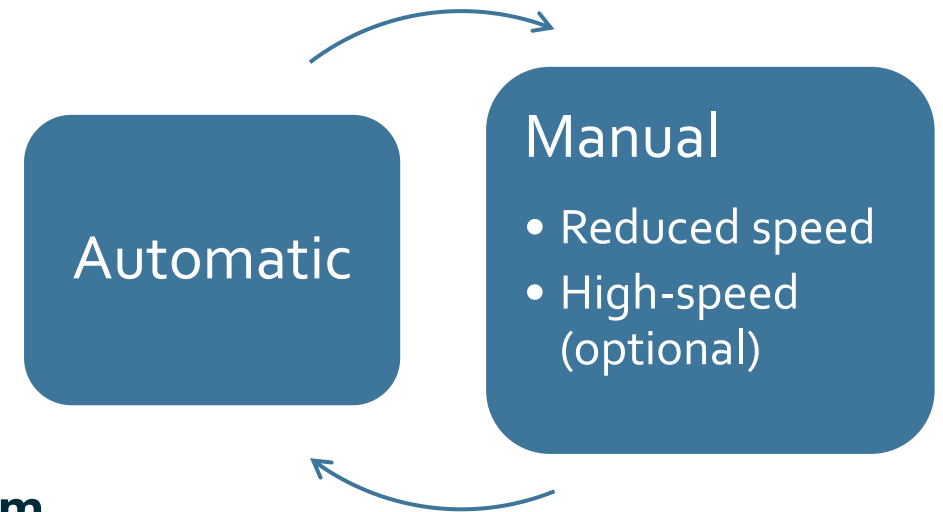## Part 1, Section 5.2.2; Part 2, Section 5.7.3

- More detailed requirements, with direct requirement to comply with ISO 14118.

- Required to provide the means for "securing or locking". *See ISO 14118, 3.3, 5.3.*

- Requirements for a start interlock and a restart interlock → safety functions

Operational modes

Part 1, Section 5.2.8; Part 2, 5.7.2

- **Automatic and reduced-speed manual modes required**
- **High-speed manual mode is optional**
- **The active mode shall be monitored by the safety system**
- **Activation of the selected mode is a safety function**
- **Mode selection is not required to be a safety function**
  - **In Part 1, there is a graphic to help with this concept.**

Part 2:

- **If high-speed manual mode is provided, there are more rigorous safeguarding requirements.**
- **Detailed requirements about modes associated with active protective devices and safety functions.**

Automatic

Manual
- Reduced speed
- High-speed (optional)

Cybersecurity

Part 1, Section 5.1.16; Part 2, Section 5.2.16

- **A cybersecurity assessment is required**

- **Part 1:** No specific requirements are described
  Part 2: If the cybersecurity assessment has identified that a threat could result in (safety) risk(s), cybersecurity measures shall be provided to prevent unauthorized access to the control system(s)

- **Reference to IEC 62443 for information and requirements**

NOTE: As a reasonable "guess", Security Level 2 (as defined in the IEC 62443 series) might result for parts of the system which can affect safety (start, stop, modification of safety settings, etc.) and Security Level 1 for other parts.

Auxiliary axes

Part 1, Section 5.1.9

If the robot has the capability to control auxiliary axes, the **following safety functions shall take the axes into account**:

- Position holding (essentially the brake system)

- Speed monitoring (reduced-speed manual mode and also high-speed manual mode if it is provided)

- Space limiting

Part 2, see next slide.

Auxiliary axes

Part 2, Section 5.2.9

Additional axes that are associated with lifting or holding a suspended mass (e.g., machinery, sub-assemblies, equipment, the robot, a payload) shall comply with relevant requirements (5.2.1, 5.2.2, 5.2.8, 5.5, 5.6, 5.7).

When additional axis motion can affect the TCP speed in reduced-speed manual mode, the requirements of reduced-speed (5.5.6.1) shall apply to the additional axes.

Collaborative?

Part 1, Section 5.10; Part 2, 5.14

"Collaborative operation" removed from both documents, plus there is …

- NO collaborative robot,
- NO collaborative mode.
- NO speed specified as being "collaborative"

Collaborative describes an application: NOT a mode & NOT a robot.

- Part 1 details REQUIREMENTS (+ safety functions) if a robot manufacturer claims PFL, SSM or HGC.
- Part 2 details REQUIREMENTS (+ safety functions to implement) for an application to comply with PFL, SSM or HGC.

Part 2: Safeguarding

Safeguarding is described in much greater detail.

Information for use

Section 7

**More detailed requirements for documentation.
More content in the information for use is required.**

**Much more focus on documentation of
safety functions.**

- Part 1: More annexes, mostly informative – except the new normative Annex C for safety functions.
- Part 2: More annexes, mostly informative.