Acknowledgements

This presentation summarizes the great work led by:

- **The ANSI RIA R15.06 Safety Standard Sub-committee**
- **The ISO 10218 Safety Standards Committees (TC 184/ SC2 WG3)**

Gratitude is extended to the R15.06 Subcommittee, the ISO TC 184/SC 2 WG 3, and the companies who sponsor their employees to participate in standards development activities.

New Standard!

- ANSI/RIA R15.06-2012 is in your notebooks and available for purchase!
  - National adoption ISO 10218-1 & -2.
  - Provides updates to ANSI/RIA R15.06-1999
    - ISO 10218-1 and -2, which started using1999 R15.06 as the base.
  - Available at RIA (paper copy) or ANSI (electronic copy) web stores.

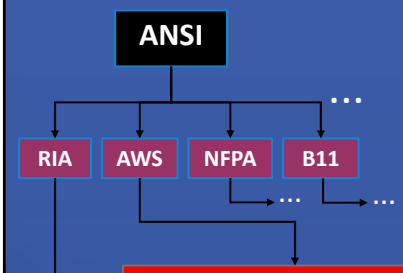
Topics

- Standards, how they are developed, and why they are relevant.
  - ANSI, ISO, CSA
- How OSHA uses standards.
- Transitioning to the 2012 ANSI/RIA R15.06.
- What's new in the 2012 ANSI/RIA R15.06.
- Benefits of using the new standard
- Q&A

Why Standards?

- **Level the playing field** when all players meet the standard(s).
- Provide **risk management** assistance by helping to **limit liability** for products meeting standard(s).
- Help meet **market demands** (presuming the market demands compliance with the standard(s)).
- Standards **lower costs** by standardizing designs & mfg.
- Globally harmonized standards **allow products to be global**, rather than regional designs. Equipment can be shipped between facilities of global companies.

ANSI Standards Framework



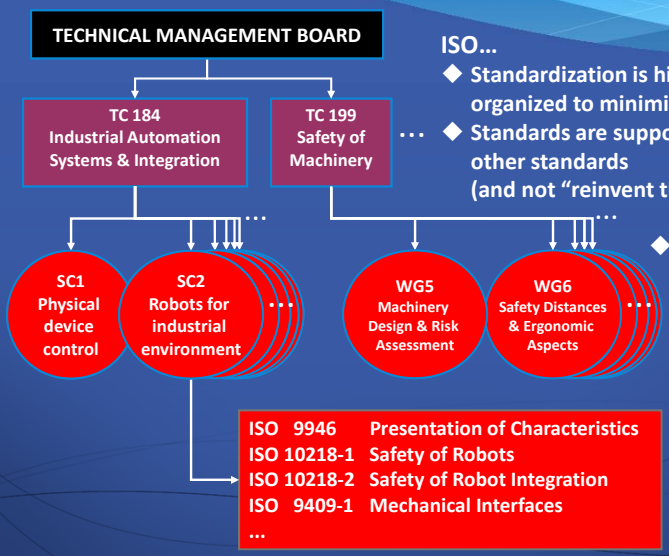
ANSI…

- **Standards are based on market demand without oversight as to technical content.**
- **Accredits an organization to be a SDO (Standards Development Organization) for a specific market/ scope.**
- **Oversight of ANSI stds development is to its processes and the development procedures.**
- **Standards do not have to use the work of other ANSI standards.**

Over 240 standards about weld materials, techniques, certification, safety of weld robot systems, …

ANSI/ RIA R15.02 Design of Robot Control Pendants **- inactive**
ANSI/ RIA R15.05 Performance Characteristics **- inactive**
ANSI/ RIA R15.06 Safety of Robots,
+ Integration of Robots, Robot Systems, Robot Cells
ANSI/ RIA R15.07 Robot Offline Programming **- inactive**
RIA TR15.106, TR15.206, and more

ISO Standards Framework



ISO…

- Standardization is highly structured and organized to minimize overlapping scopes.
- Standards are supposed to use the work of other standards (and not "reinvent the wheel").
- For harmonized standards (EN ISO), CEN Consultants (technical experts) review the content to judge whether the standard complies with the various EU Directives.

Standards Comparison

- **ANSI Standards and Technical Reports**
  - Are voluntary – unless adopted as a regulation (law).
    - Can be adopted by OSHA (unusual) or other jurisdiction (state, county, city…) For example, UL 1740 has been adopted by some states and localities.
  - Applies to one or more of the following:
    - the manufacturer of the component (e.g., connectors, cable, fasteners, component machine such as a conveyor).
    - the integrator of the component or machine.
    - the user of the component or machine (company using the machine).
  - Compliance can be used as a
    - Means of complying with OSHA requirements of a safe workplace (since there are many more ANSI standards than regulations) but NOT presumption of compliance.
    - Civil legal defense for providing a safe workplace based on current practices.

Standards Comparison

- **OSHA Standards**
  - Are regulatory standards (required by law).
  - Are NOT comprehensive. There are VERY few OSHA machine safety standards (e.g., mechanical power presses, forging machines, cooperage machines).
    There is NO OSHA robot standard, however OSHA references R15.06 as being the standard applicable to robot systems.
  - Applies to the USER (the company that uses the machine).
    There can be requirements that apply to EMPLOYEES (example lock-out).

Standards Comparison

- **ISO Standards, Technical Specifications, & Technical Reports**
  - **Are voluntary unless adopted as a regulation (by a country).**
  - **Are meant to allow globalization of trade by unifying border requirements.**
  - **Are often adopted by the EU as a harmonized standard which means that the EN ISO standard provides a presumption of conformity (complies with Directives).**
  - **Applies to SUPPLIER of the component or machine:**
    - **the manufacturer of the component or machine.**
    - **the integrator of the component or machine (if the USER acts a the supplier, the USER is required to comply).**
  - **Compliance can be used as a**
    - **A LEGAL presumption of conformity with the machinery directive (if harmonized).**
    - **Civil legal defense of providing a safe workplace based on industry practices.**

Standards Comparison

- **Country Workplace Safety Standards**
  - **Are regulatory standards (required by law). This is same as OSHA for the USA.**
  - **In Europe, each country has its own workplace safety requirements, PLUS**
    - **Compliance with the Directives is a legal requirement, where EN standards compliance provides the means by which to meet the Directives. Suppliers have to meet the Directives for product import and sales within the EU.**
    - **The USER is required to acquire & use products complying with Directives.**
  - **Applies to the USER. There can be requirements that apply to EMPLOYEES.**

ISO Robot Safety Standards Activity

more details by Jeff Fryman (next speaker)

- **ISO 10218-1 Robots & -2 Integration published in 2011.**
  - These standards are based on the 1999 R15.06.
  - 1999 R15.06 was split into two parts: robot manufacturer (-1) and requirements for systems (with end-effectors) & integrators (-2).
  - USA provided input to the ISO 10218 standards development: R15.06 met between ISO meetings to review & develop input.
- TS (Technical Specification) 15066 is in process. It is a about collaborative robots and their use. It is a TS because more application knowledge is needed before publishing a collaborative robot standard.
- The need of "robotic device" and "robots integrated on AGV" documents have been identified.

Canada Robot Safety Standards Activity

- **CAN CSA Z434 update is expected to be published in 2013.**
  - Consists of ISO 10218-1, ISO 10218-2, Canadian deviations (additions), & User requirements interspersed throughout.
  - There are additional addendums to aid in the use of the new standard.
- **CSA Z434 will contain all ISO requirements (clearly shown) as the Canadian deviations and additions.**
  - This means that robot standards for CSA, ANSI, ISO, and EN ISO are harmonized to be almost the same.
    AND
  - Because both the Z434 and R15.06 are adoptions of ISO 10218-1 and ISO 10218-2, it is easy to compare and see differences.

What's next?

Transitioning to the ANSI/RIA R15.06: 2012

ANSI / RIA Robot Safety Standards Activity

- **ANSI RIA R15.06 – 2012 = ISO 10218-1 + ISO 10218-2 + R15.06 (Foreword + Introduction + Bibliography).**
  - **-1: Robot arm and its controller ONLY! No end-effector**
    - **Stakeholder – Robot Manufacturer**
    - **Equivalent to Clause 4 ONLY of 1999 R15.06.**
  - **-2: Industrial robot system & integration**
    - **Stakeholders – Integrator, Installer, and also the User if/ when the User acts as the designer, integrator or modifier.**
    - **Equivalent to Clauses 5 & 6 of 1999 R15.06.**

1999 → 2012 R15.06 Transition

- R15.06–1999 can be used until the end of 2014.
  - During this ~ 2 year transition, there is a choice of using EITHER the 1999 R15.06 (R2009) or new 2012 R15.06. This allows:
    - Transition for on-going projects and for constituents to become comfortable after 13 years with 1999 R15.06 and for added information:
      - RIA TR 15.306 – a risk assessment methodology, however other methodologies are acceptable so long as the outcome is as stringent as TR15.306 method. Update of the methodology in R15.06-1999.
      - RIA TR 15.406 – safeguarding (w/ ISO safeguarding information). This is an update to the materials that were included in R15.06-1999.
      - USER requirements.
      - Collaborative robots/ collaborative application guidance.
      - Manual Work Stations (work station is a hindering device preventing entry).
      - Guidelines for moving robot cells or reutilizing existing robots.

1999 → 2012 R15.06 Transition

- GREAT progress towards global harmonization.
- Part 1: MORE safety embedded into robots (some are OPTIONS).
  - With the new embedded safety technology, robot systems can be integrated to a smaller workspace, comply with safety requirements, and result in cost savings while personnel are safeguarded.
    - Case studies have shown large savings in space and cost.
    - Easier to provide safe integration of enabling circuitry, associated equipment, …
- Standards Lag Technology and Innovation. While standards writers try to allow for new technology, it is difficult to envision requirements for something that is not yet known.
  - NOTE: New R15.06 allows for wireless controls (excluded by error in language in 1999) and it allows collaborative operation (of which some forms of collaborative operation are brand new innovations that the market has not addressed yet).

ANSI Robot Safety Standards Activity

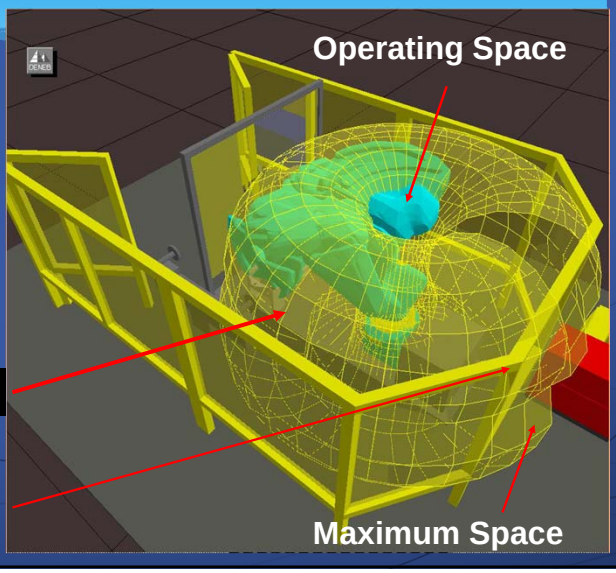
- **Due to the NEW R15.06**, the following Standards and Technical Reports will be withdrawn at the end of 2014 *(when the 1999 R15.06 is withdrawn)*:
  - **ANSI RIA R15.06–1999**: Robot Mfg, Integration and Use Safety.
  - **RIA TR 15.106–2006**: Teaching Multiple Robots.
    - *Applicable ONLY when using the **1999 R15.06**.*
  - **RIA TR 15.206–2008**: Guidelines for Implementing ISO 10218-1 and complying with ANSI RIA R15.06–1999.
    - *Applicable ONLY when using the **1999 R15.06**.*
  - **ANSI / RIA / ISO 10218-1: 2007**
    - *Applicable ONLY when using the **1999 R15.06**.*

System Layout & Robot Space

Robot has the freedom to move more than is needed to perform task

Maximum Space

The robot can exit safeguarded space

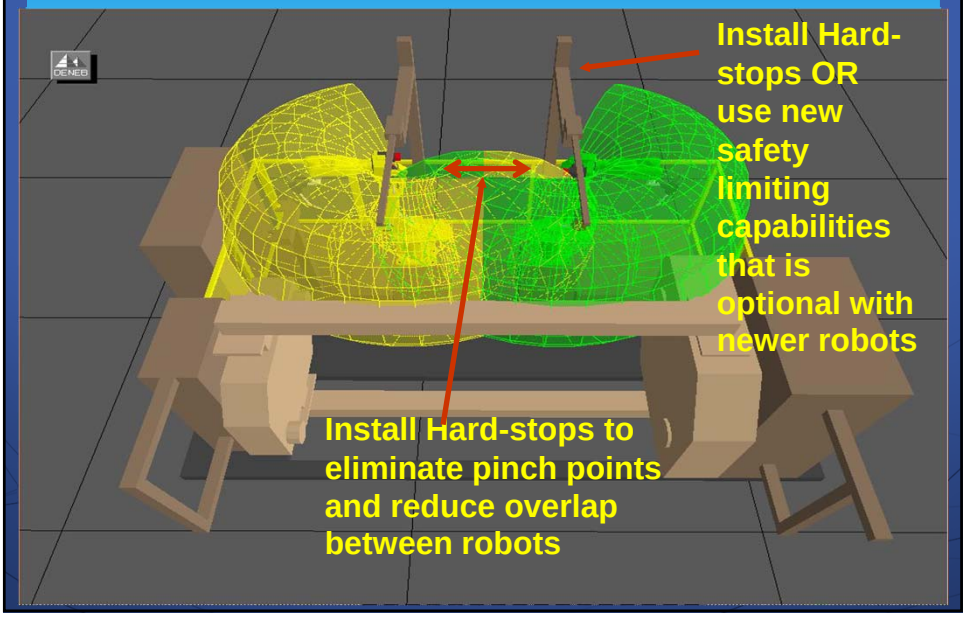


System Layout & Robot Space

* **restricted space**: That portion of the maximum space to which a robot is restricted by limiting devices. The **maximum distance that the robot, end-effector, and work piece can travel after the limiting device is actuated defines the boundaries of the restricted space** of the robot system.

* **safeguarded space**: The space defined by the perimeter safeguarding devices.

Limiting Motion / Restricting the Space

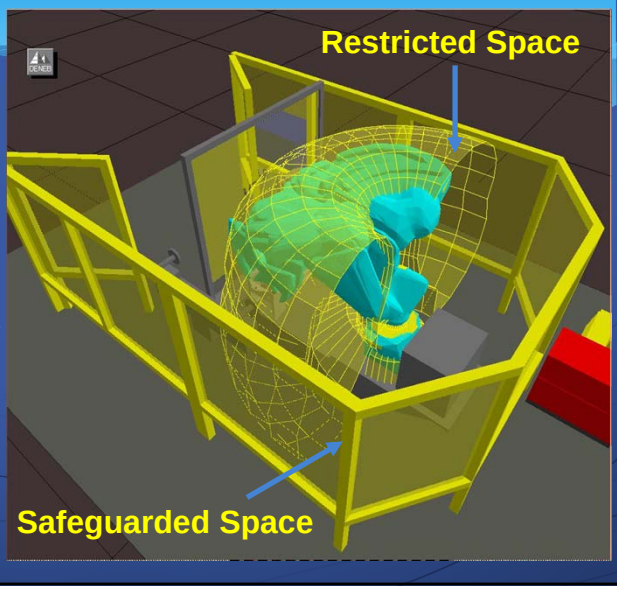


System Layout & Robot Space

AFTER LIMITING:
If required, you could access controller or other equipment with motor power on

Number of pinch point hazards have been reduced

Robot is contained to the safeguarded space



ISO (and R15.06) Language

- Shall = mandatory
- Should = recommendation or good practice
  can be **very strong** or advisory
- May = allowed / have permission
- Can = possible or a capability (statement of fact).

- Notes used throughout the document are informative, intended to provide explanations and additional information.

Described in the R15.06 Introduction

Game Changers!

1. Changes in terminology
2. Risk assessment requirements
3. Changes to fixed guard dimensions
4. Collaborative robot operation
5. Updates to controls circuitry

1. Terminology Changes

- **Robot** → **Robot, NO end effector**
- **Robot system** → **Robot(s) w/ end effector and any task equipment**
- **Robot cell** → **Robot system(s) & all within safeguarded space**
- **Slow speed** → **Reduced speed**
- **Safety stop** → **Protective stop**
- **Teach mode*** → **MANUAL reduced speed MODE***
  ** teach is a task using manual mode*
- **APV** → **MANUAL high speed MODE or "Hi-speed APV"**

Terminology

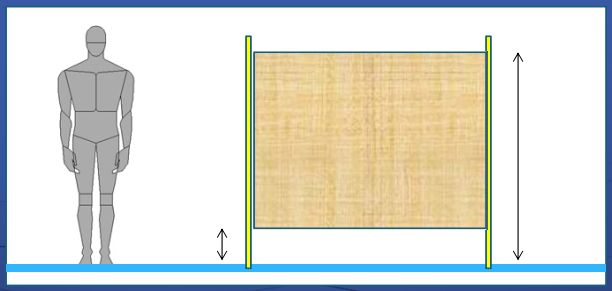
- Monitored standstill function (Part 1, 5.5.3)
  = Stop Cat 2 per NFPA79 (IEC 60204)
  - Power is ON and motion is monitored to be "standstill"
  - Equivalent to Drive STO (Safe-Torque-Off of drives).
- **Operator = ALL PERSONNEL**, not simply production personnel (see RIA R15.06-2012 Introduction)

2. Robot Risk Assessment

- Risk Assessments are required in 2012 but were optional in 1999.
- Risk Assessment specifications.
  - Integrators shall provide the risk assessment RESULTS to the end-user.
  - Risk assessment allows tailoring the system to the safety needs (safe and lean)
  - Real-life validations and on-going change management needed (see new applicability doc)

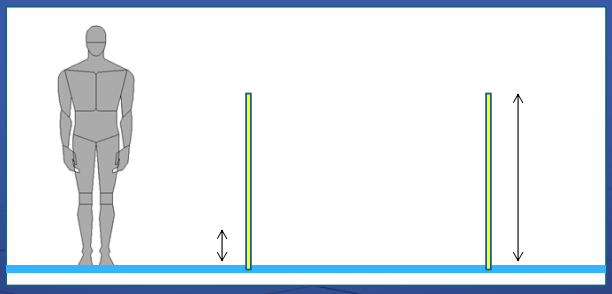
Perimeter Guard Dimension Comparison

	R15.06-1999	ISO 10218 R15.06-2012	CSA Z434
Lower Dimension, max	300mm (12”)	180mm (7”)	150mm (6”)
Upper Dimension, min	1500mm (60”)	1400mm (55”)	1800mm (72”)



Perimeter Safeguarding using an ESPE

	R15.06-1999	ISO 10218 R15.06-2012	CSA Z434
Lower Dimension, max	300mm (12”)	300mm (12”)	300mm (12”)
Upper Dimension, min	1200mm (48”)	600mm (48”)	600mm (48”)



Clearance Dimensions

- Robot cells **can** occupy a smaller footprint for 2012 compliance as compared to 1999.
  - **Clearance requirements based on anticipated tasks**
    - Clearance must be **20”** (not 18”).
    - **Clearance only required if personnel will be exposed to pinching/ crushing/ trapping hazard(s) when performing tasks (including teach and minor servicing).**
      - **Note: With High Speed Manual: Clearance is required regardless of task locations.**

4. Collaborative Terminology Additions

- **Collaborative… Part 1, 5.10 & Part 2, 5.11**
  - Collaborative Robot, Definition: Part 1, 3.4 & Part 2, 3.2
  - robot designed for direct interaction with a human within a defined collaborative workspace (3.3)
  - Collaborative Workspace, Definition: Part 1, 3.5 & Part 2, 3.3
  - workspace within the safeguarded space where the robot and a human can perform tasks simultaneously during production operation

NOTE: It is an OPTION for robots to be equipped and ready for collaborative operation and collaborative applications.

And the requirements for collaborative are still being determined (hence ISO TS 15066).

Collaborative Operation

- Four types of collaborative operation
  - Safety-rated monitored stop
    - Operator may interact with robot.
    - Automatic operation may resume when the human leaves the collaborative workspace (requires safeguarding).
  - Hand-guiding operation is allowed with various requirements to ensure safety.
    - Speed and separation monitoring
      - Robot/hazard speed is reduced the closer an operator is to the hazard area.
    - Power and force limiting
      - Addressed in forthcoming TS 15066.

5. Safety Control System

- ISO 13849-1 and IEC 62061 provide performance metrics for Functional Safety
  - Can quantify performance, determine requirements, and validate compliance
- "Control Reliable" is a concept
- A controls system meeting PL=d and structure category 3 is considered to be ~ requirements described as control reliability :
  - A single fault does not lead to the loss of the safety function;
  - The fault shall be detected before the next safety function demand;
  - When the fault occurs, the safety function is performed and a safe state shall be maintained until the detected fault is corrected;
  - Reasonably foreseeable faults shall be detected.

Benefits

- GREAT progress towards global harmonization.
- Part 1: MORE safety embedded (some are OPTIONS).
  - With the new embedded safety technology, robot systems can be integrated to a smaller workspace, comply with safety requirements, and result in cost savings while personnel are safeguarded.
    - Case studies have shown large savings in space and cost.
    - Easier to provide safe integration of enabling circuitry, associated equipment, …
- Functional safety concept provides mechanism for validating safety circuitry.

Benefits

- **Control of simultaneous motion.**
- **Collaborative robots / operation.**
  - ISO is developing a TS on the topic because it is so new.
- **Wireless pendants allowed** and expected to become available.
  - Currently battery requirements for use presently make the pendants too heavy.
- Robot manufacturers have a **GLOBAL design** (savings through the whole supply chain).
- Robot integrators can have **GLOBAL solutions**.
- Users can have **GLOBAL solutions that can be much more easily moved between country locations**.

What's Next?

- R15 Technical Reports
  - Safeguarding
  - Risk Assessment
  - Reuse/Redeployment of Existing Robot Systems
- ISO TS (Technical Specification) 15066
  - Collaborative Operation
- New ISO Projects
  - Robots for personal care
  - Mobile service robots
  - Vocabulary
- OTHER…

Thank you!

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