Standards and Regulations

TEAM HARP (TEAM D)
MRSD PROJECT - II
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Agenda

ANSI/RIA R15.06 Parts 1 (American National Standard for Industrial Robots and Robot Systems - Safety Requirements: [Industrial] Robots)

ANSI/RIA R15.06 Parts 2 (American National Standard for Industrial Robots and Robot Systems - Safety Requirements: [Industrial] Robot Systems and Integration)


SAFETY FIRST
Avoid harmful UV rays

Introduction

Safety must be a conscious effort on the part of all parties.

Applicable throughout the life cycle of the robot.

Protective measures are applied, using the hierarchy of risk control, until risk reaches an acceptable level.

Necessary components in workplace safety are the maintenance of, and adherence to, the system safety design.

Personnel skills, training, and attitude are important factors in the administrative portion of the safety management system.

Introduction

An industrial robot system frequently is not a stand-alone machine, but rather part of a cell or larger system, which interacts with other machines and equipment.

The regulation assigns "Stakeholders" specific responsibilities. The robot manufacturer is addressed in Part 1, while the integrator and installer are addressed in Part 2.

This information and instructions are intended to ensure that the user has the necessary information to safely use the equipment furnished to them.

The user, while not specifically addressed, has the responsibility to use this information in developing training and safe work practices.

Part 1 - Safety Requirements: Industrial Robots

This part specifies requirements and guidelines for the inherent safe design, protective measures and information for use of industrial robots.

It describes basic hazards associated with robots and provides requirements to eliminate, or adequately reduce, the risks associated with these hazards.

This part 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.

This part does not apply to non-industrial robots, although the safety principles established can be utilized for these other robots.

Part 2 - Safety Requirements: Industrial Robot Systems and Integration

Identifying particular hazards relevant to installing industrial robots with the purpose of providing a safe work environment.

Risks associated with installation, programming, operation, and maintenance.

- The design, manufacturing, installation, operation, maintenance and decommissioning of the industrial robot system or cell.
- Necessary information for the design, manufacturing, installation, operation, maintenance and decommissioning of the industrial robot system or cell.
- Component devices of the industrial robot system or cell.

Part 1 - Safety Requirements: Industrial Robots

Terms and Definitions

Actuating control: mechanical mechanism within a control device.

Automatic mode/operation: state in which the robot is executing its programmed task as intended.

End-effector: device specifically designed for attachment to the mechanical interface to enable the robot to perform its task.

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

Hazard Identification and Risk Assessment

Particular consideration for hazard assessment given to:

- The intended operations at the robot, including teaching, maintenance, setting and cleaning
- Unexpected start-up
- Access by personnel from all directions
- Reasonably foreseeable misuse of the robot
- The effect of failure in the control system
- Application specific

Other Significant Hazards

Mechanical

- Intended and unintended motion
- Ejection of end-effector or tools
- Loose clothing or long hair
- Collisions with people and environment

Electrical

- Contact with live parts or connections
- High Voltage end-effectors

Thermal

- Extreme hot or cold surfaces associated with end-effector function

Noise, Vibration, Radiation, Hazardous Substances (lubrication, cooling, hydraulic), Ergonomic, Environmental

Design Requirement and Protective Measures

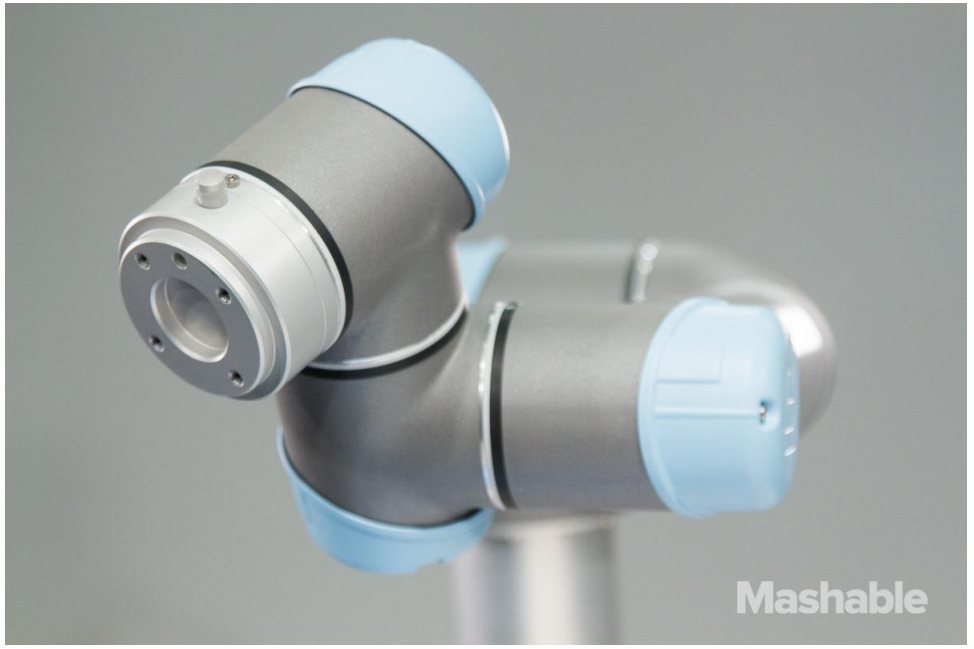
The robot shall be designed in accordance with the principles of ISO 12100 for relevant hazards.
Significant hazards such as sharp edges are not dealt with by this part

General Requirements

- Power Transmission Components
- Power loss or change
- Component malfunction
- Sources of energy
- Stored energy
- Electromagnetic compatibility (EMC)
- Electrical equipment

Actuation Controls

- Protection from unintended operation
- Status indication
- Labelling
- Single point of control



Actuation Controls

Robot stopping function

- Emergency stop
- Protective stop

Speed Control

- Reduced speed control operation
- Safety-rated reduced speed control
- Safety-rated monitored speed

Operational Modes

- Automatic
- Manual reduced speed
- Manual high speed

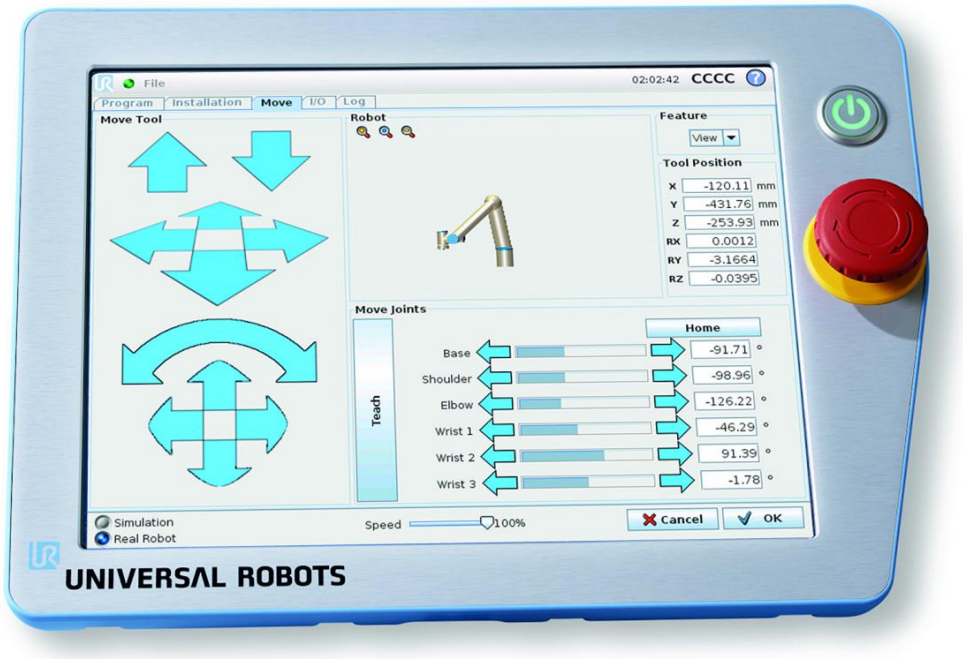
Safety Input Function	Worst Case		
	Detection Time	De-energizing Time	Reaction Time
Robot emergency stop	250 ms	1000 ms	1250 ms
Emergency stop button	250 ms	1000 ms	1250 ms
System emergency stop	250 ms	1000 ms	1250 ms
Safeguard stop	250 ms	1000 ms	1250 ms
Safeguard reset input	250 ms	1000 ms	1250 ms
Reduced mode	250 ms	1000 ms	1250 ms

Pendant controls

Pendant emergency stop function

Initiating automatic operation

Cableless or detachable teach controls



Pendant controls

Collaborative operation requirements

- Safety-rated monitored stop
- Hand guiding
- Speed and separation monitoring
- Power and force limiting by inherent design or control

Singularity protection

Axis Limiting

- Mechanical and electro-mechanical axis limiting devices
- Safety-rated soft axis and space limiting
- Dynamic limiting devices

	Worst Case			
Limiting Safety Function	Trueness	Detection Time	De-energizing Time	Reaction Time
Joint position	1.15 °	100 ms	1000 ms	1100 ms
Joint speed	1.15 °/s	250 ms	1000 ms	1250 ms
TCP position	20 mm	100 ms	1000 ms	1100 ms
TCP orientation	1.15 °	100 ms	1000 ms	1100 ms
TCP speed	50 mm/s	250 ms	1000 ms	1250 ms
TCP force	25 N	250 ms	1000 ms	1250 ms
Momentum	3 kg m/s	250 ms	1000 ms	1250 ms
Power	10 W	250 ms	1000 ms	1250 ms

Setup Instructions

Movement without drive power

Requirement to be able to drive the robot manually in emergency or abnormal operation

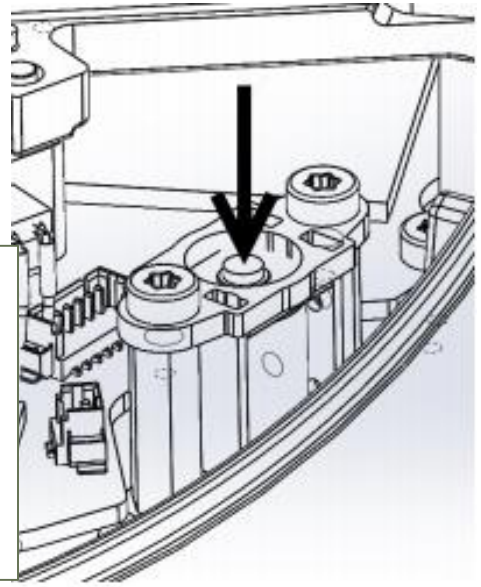
Provisions for lifting

Eye hooks, labeled lifting points need to be provided for large installments; lifting recommendations for smaller robots

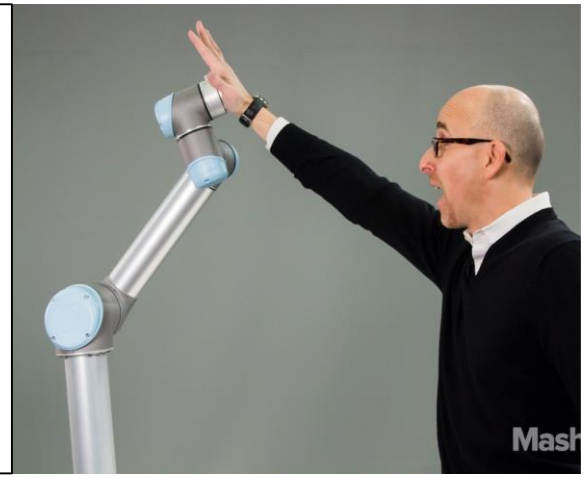
Electrical connectors

Prevent cross-connection and designed to prevent unintended separation

UR5 joints can be back driven with 500N of force or by removing brake underneath the joint guard (shown right)



Lift both tubes of the robot arm at the same time when moving it from the packaging to the installation place. Hold the robot in place until all mounting bolts are securely tightened at the base of the robot



Verification and Validation of Safety Requirements and Protective Measures

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

Part 2 - Safety Requirements: Industrial Robots Systems and Integration

Terms and Definitions

Collaborative Workspace -- workspace within the safeguarded space where the robot and a human can perform tasks simultaneously during production operation

Distance Guard -- guard that does not completely enclose a danger zone, but which prevents or reduces access by virtue of its dimensions and its distance from the danger zone

Safe State -- condition of a machine or piece of equipment where it does not present an impending hazard

Restricted Space -- Portion of the maximum space restricted by limiting devices that establish limits which will not be exceeded

Operational Space -- Portion of the restricted space that is actually used while performing all motions commanded by the task program

Hazard Identification

Why are robots dangerous?

Robots are capable of high energy movements through a large operational space

The initiation of movement and the path of the robot arm are difficult to predict and can vary

The operating space of the robot can overlap a portion of other robots' operating space or the work zones of other machines and related equipment

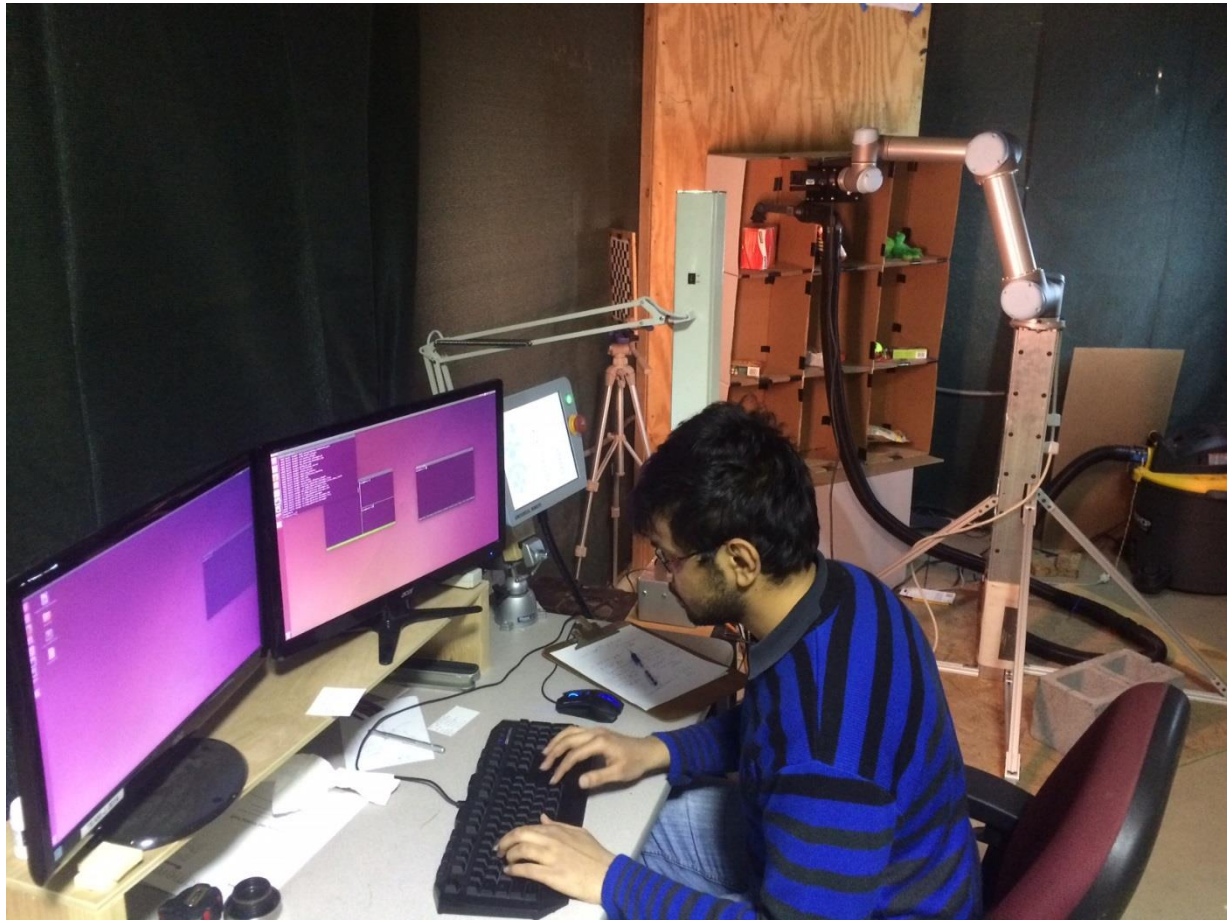
Hazard Identification and Risk Assessment

Technical Risk Reduction

Elimination of hazards by design

Design the robot system to allow tasks to be performed from outside the safeguarded space

Provision of other safeguards when interventions have to occur within the safeguarded space



Hazard Identification and Risk Assessment

Robot Layout Design

- Route traffic around robot
- Intuitive robot controls
- Visibility of operations
- Proper ventilation
- Accessible emergency stop devices

Safety Requirement and Protective Measures

Single fault in any of these parts should not lead to the loss of the safety

Whenever reasonably practicable, the single fault shall be detected at or before the next demand upon the safety function

When the single fault occurs, the safety function is always performed and a safe state shall be maintained until the detected fault is corrected

All reasonably foreseeable faults shall be detected

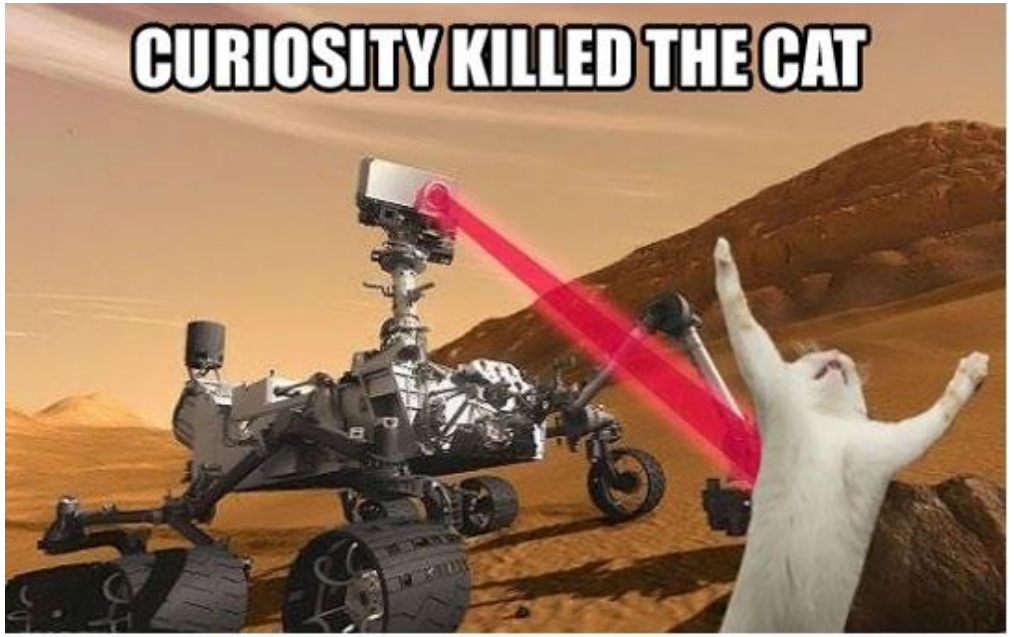
Safety Requirement and Protective Measures

Design and Installation

- Taking into account environmental conditions (temperature, humidity, lighting)
- Controls/person - outside the safeguarded space.
- The robot system should be unresponsive to any external commands
- Meet the requirements specified by manufacturers

End-effector (end of arm tooling) requirements

- Integral lighting suitable for the operations
- Illumination shall be at least - 500 lx



Safety Requirement and Protective Measures

Emergency stop function

The actuation of an emergency stop function shall stop all robot motion and other hazardous functions in the cell

Have a single emergency stop function affecting all relevant parts of the system.

Protective stop

The robot system shall have one or more protective stop circuits designed for the connection of external protective devices.

Safety Requirement and Protective Measures

End Effector

The forces created by the load/ end-effectors are within the load capacity

Wrist plates and accessories properly align

Detachable tools are securely attached while in use

Release of detachable tools only occurs in designated locations

Emergency recovery procedure

Instructions for fault recovery of robot system-related equipment

Robot manufacturer's instructions on emergency movement of the robot without drive power.

If signs or labels shall be affixed or instructions for affixing shall be provided.

Verification and Validation of Safety Requirements and Protective Measures

- Visual inspection
- Practical tests
- Measurement
- Observation during operation
- Review of application-specific schematics, circuit diagrams and design material
- Review of safety-related application software and/or software documentation
- Review of task-based risk assessment
- Review of layout drawings and documents

Information for use

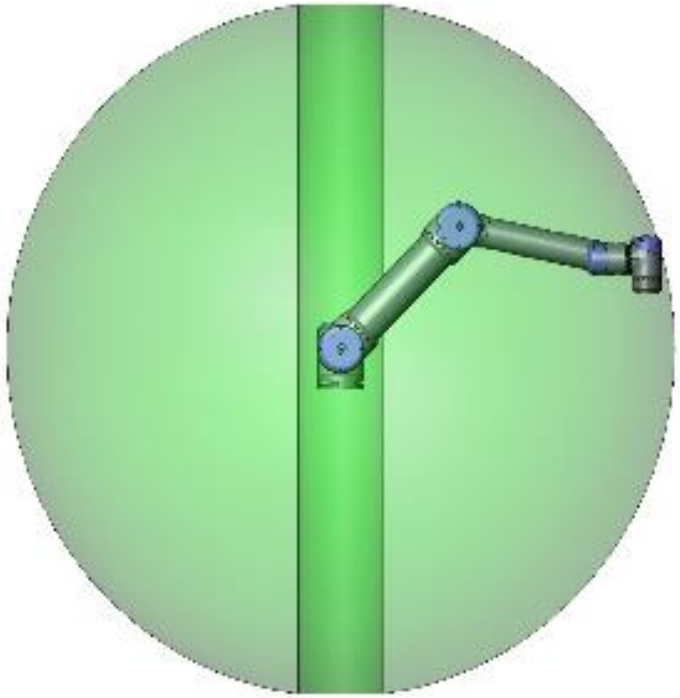
Installation -- Assembly and mounding conditions

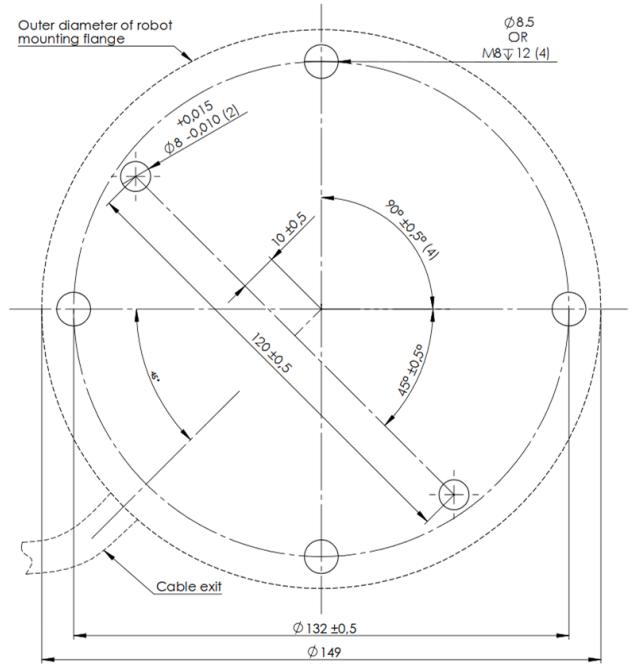
Startup procedure -- Equipment properly connected and emergency stop is functional

Use of system -- Fault identification and emergency recovery, periodic functional testing

Robot Specific -- Workspace definition and breaking time

Marking -- Full business name and address of manufacturer





Radius

850 mm/33.5 ins

Payload

5 kg/11 lbs

Questions?