



# Introduction to Robot Safety and Risk Assessment



# Featuring: RIA TR R15.306



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A3 Robotics Trainer

# Industrial Robots

- Key in:
  - Productivity
    - Continuous repeatability
  - Reliability
    - Always the same precision quality
  - Worker safety
    - Eliminates the 3 D's
      - Dull, Dirty, and Dangerous

# Cost

- Mostly fixed – one time
  - Little incremental – process related
- Content
  - Don't ask for raises
- Competitive
  - Allows re-shoring of production

# Industrial Robot Safety

- International industry segment
- ISO Standard widely accepted
  - ISO 10218-1; Robot
  - ISO 10218-2; Integration
- Domestically
  - RIA R15.06 in US
  - CSA Z434 in Canada

# ISO 10218-1

- Requirements for the manufacturer
- Meet Functional Safety – ISO 13849-1
- Provide specific safety functions
- Provides Information for Use
- Part 1 of R15.06

# ISO 10218-2

- Requirements for the integrator; entire supply chain
- Guidance for designing robot installations
- Importance of Risk Assessment
- Part 2 in R15.06



# Collaborative Applications

- Introduced by requirements in ISO 10218-1
  - Amplified by additional requirements in ISO 10218-2
- Additional Guidance and Risk Assessment
- Can be done with any qualifying robot

# Collaborative Applications

- There are **NO** collaborative industrial robots
- There **ARE** industrial robots with the necessary safety features to used in collaborative applications

# Power and Force Limited Robots



# PFL Robots

- Intended for collaborative applications
- Especially useful for assembly functions
- Robot itself provides features for safety
- All determined by Risk Assessment

# Used in Collaborative Application

- Possible with appropriate robot features
- Possible with appropriate application design
- All depends on Risk Assessment



# Purpose of risk assessments

- To identify health and safety hazards and evaluate the risks presented within the workplace
- To evaluate the effectiveness and suitability of existing control measures
- To ensure additional controls (including procedural) are implemented wherever the remaining risk is considered to be anything other than low.
- To prioritize further resources if needed to ensure the above.

# **ISO 12100 - Safety of machinery - General principles for design - Risk assessment and risk reduction**

- Specifies basic terminology, principles and a methodology for achieving safety in the design of machinery.
- It specifies principles of risk assessment and risk reduction to help designers in achieving this objective.
- Procedures are described for identifying hazards and estimating and evaluating risks during relevant phases of the machine life cycle, and for the elimination of hazards or the provision of sufficient risk reduction.

# Why Risk Assessment?

- Each robot system is unique
- Variety of methodologies
  - Task, Hazard, FMEA
- R15.06 requires it
  - Task-based risk assessment
  - Responsibility of the integrator
  - User involvement



# Failure Modes and Effects Analysis (FMEA)

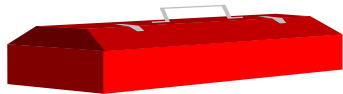
- **“Failure modes”** means the ways, or modes, in which a product or process might fail. Failures are any errors or defects, especially ones that affect safety, and can be potential or actual.
- **“Effects”** are the potentially harmful consequences of a failure.
- **“Analysis”** is the study of the failure modes and their effects. This uses a failure mode’s severity, frequency of occurrence, and chance of detection.

# Hazard-based Risk Assessment

- A systematic approach to identify all hazards associated with the operation of a machine
- A methodology to select the appropriate safeguard to mitigate the hazard to allow personnel to work safely on the machine

# Task-based Risk Assessment

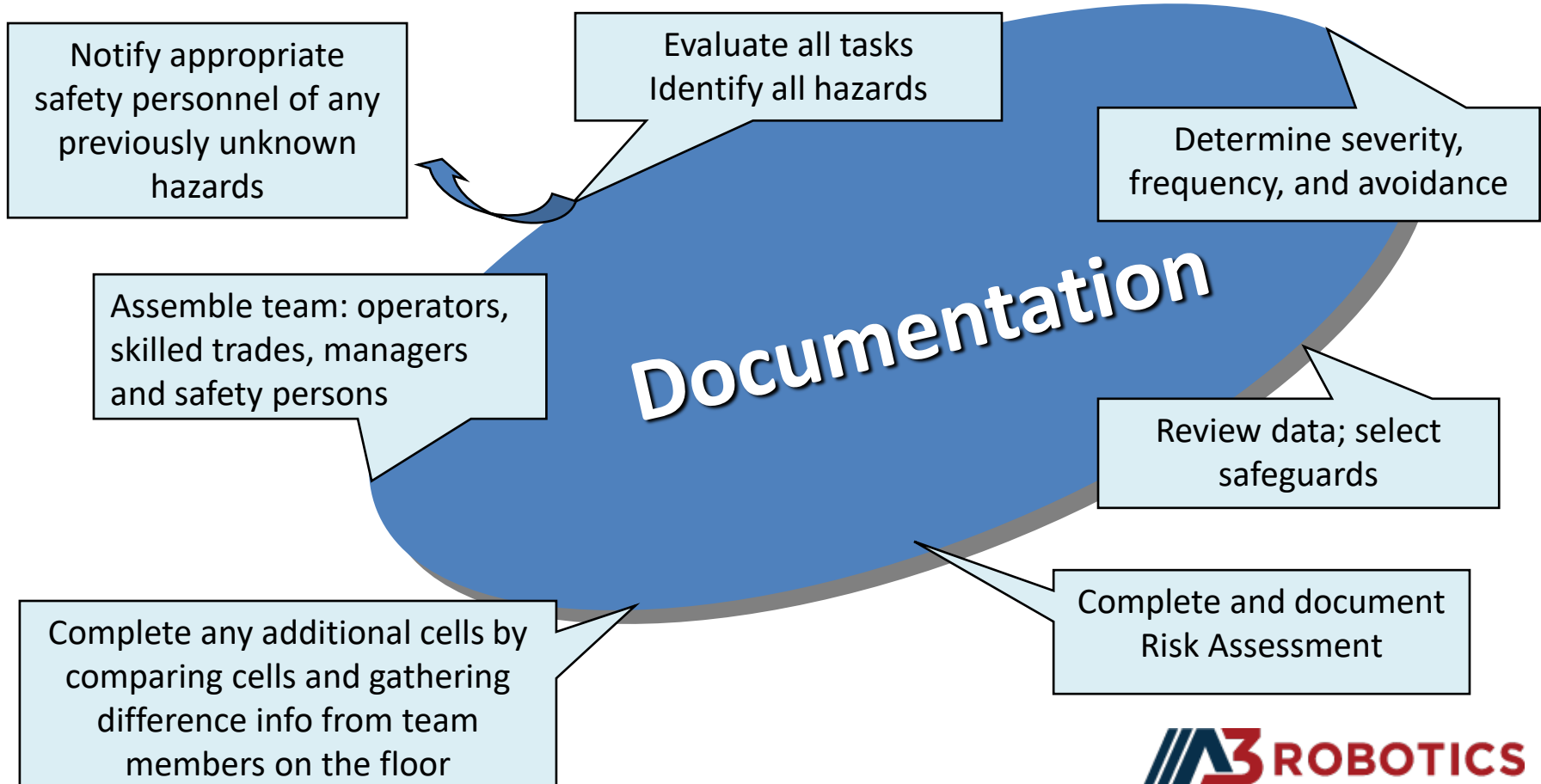
- A systematic approach to identify all tasks and associated hazards
- A methodology to select the appropriate safeguard for each task/hazard pair
- Verification that the safeguard has reduced the risk of injury



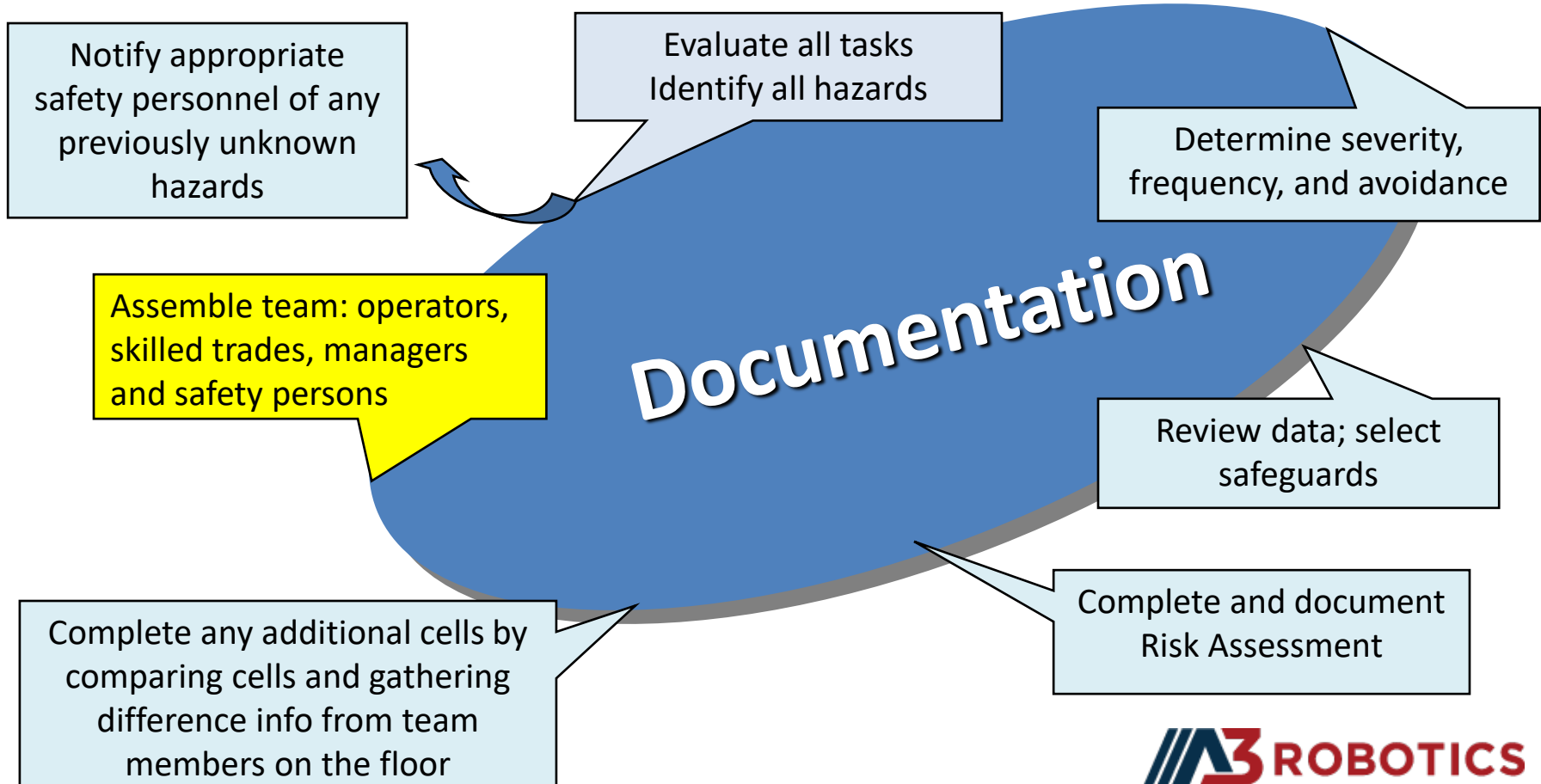
# RIA TR R15.306-2016

- Task-based Risk Assessment Methodology
- Satisfies requirement of R15.06
- Allows determination of Functional Safety
- Usable on any automated equipment

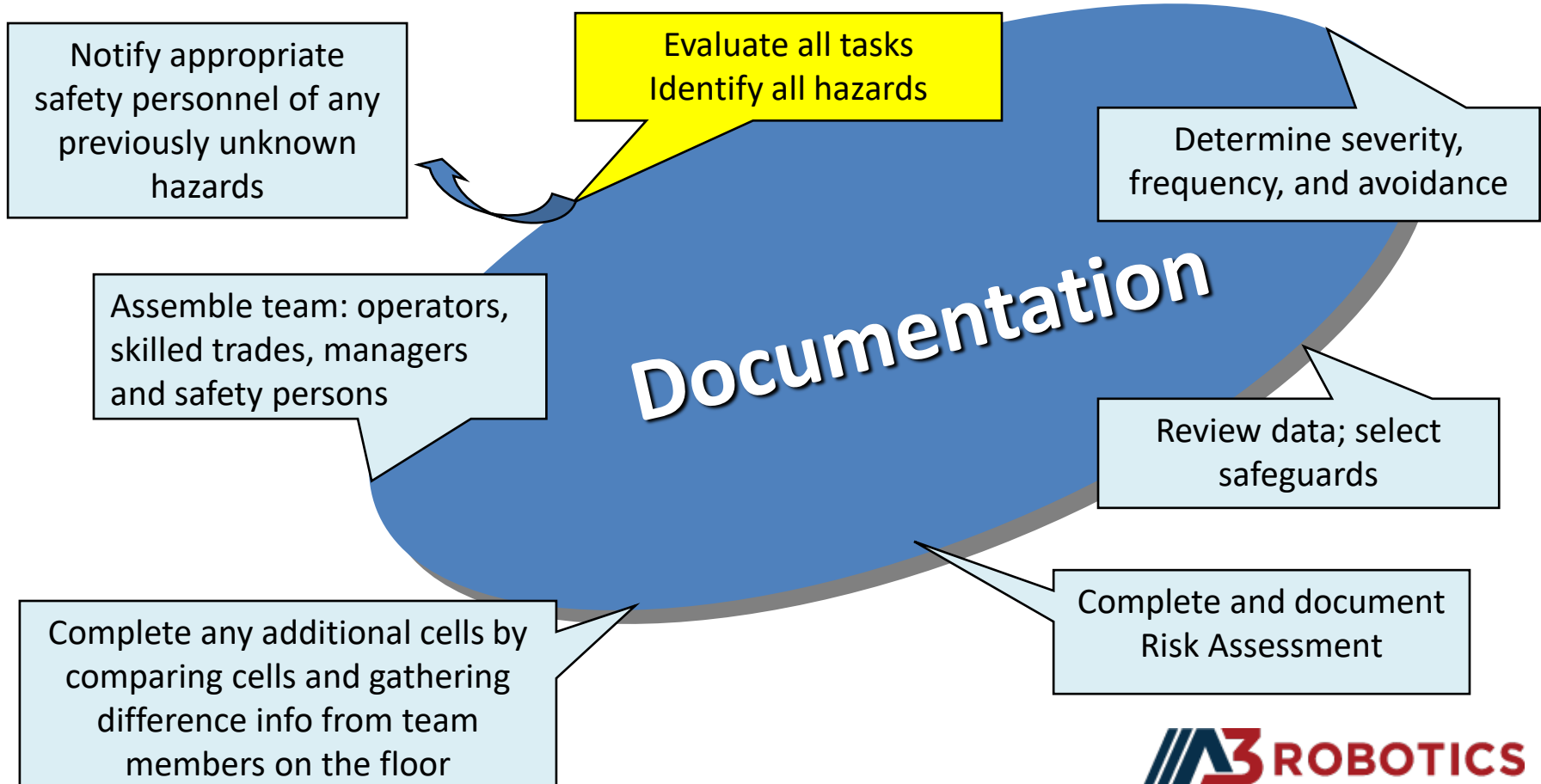
# Executing the Risk Process



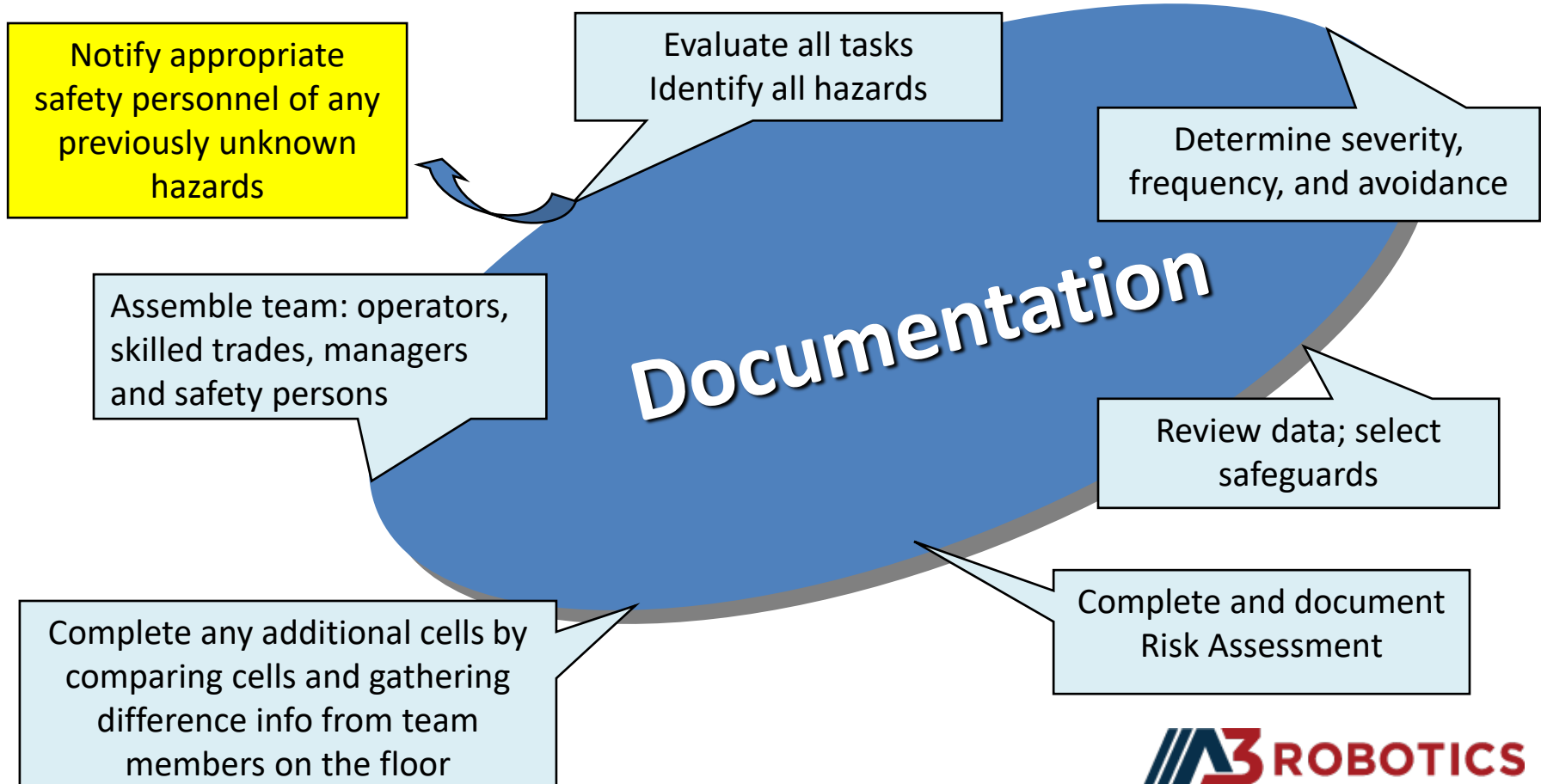
# Executing the Risk Process



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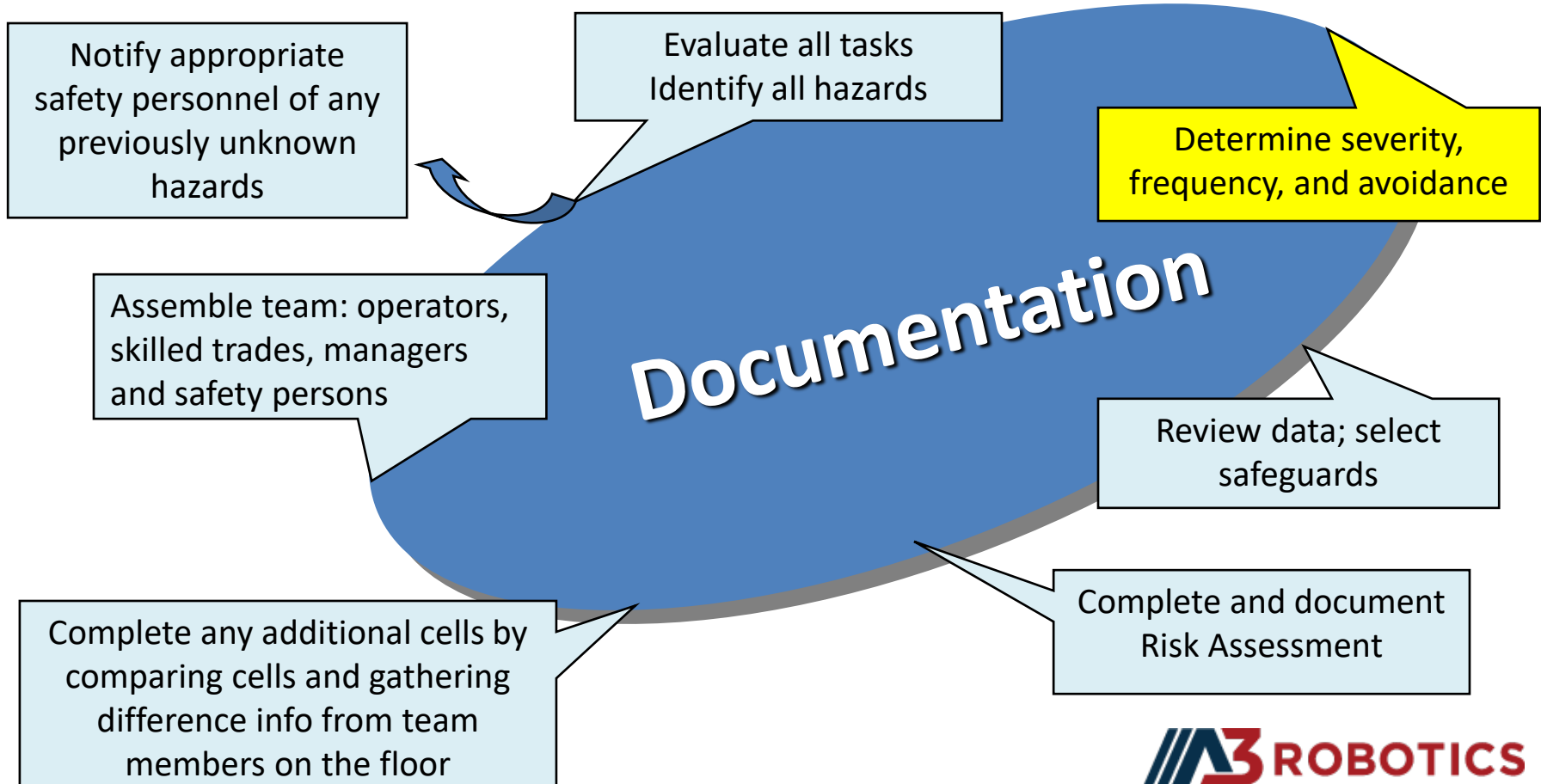


# Executing the Risk Process

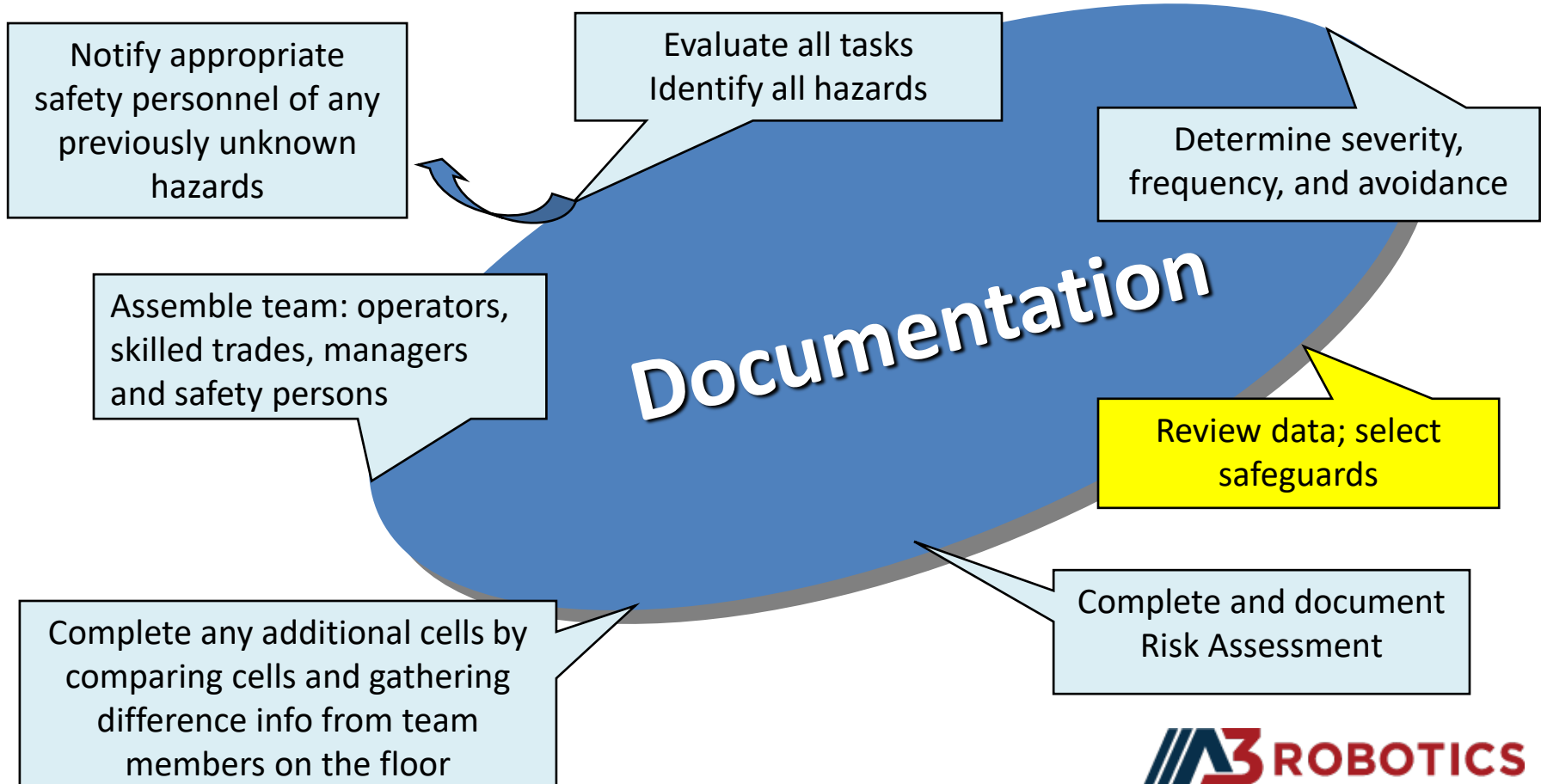




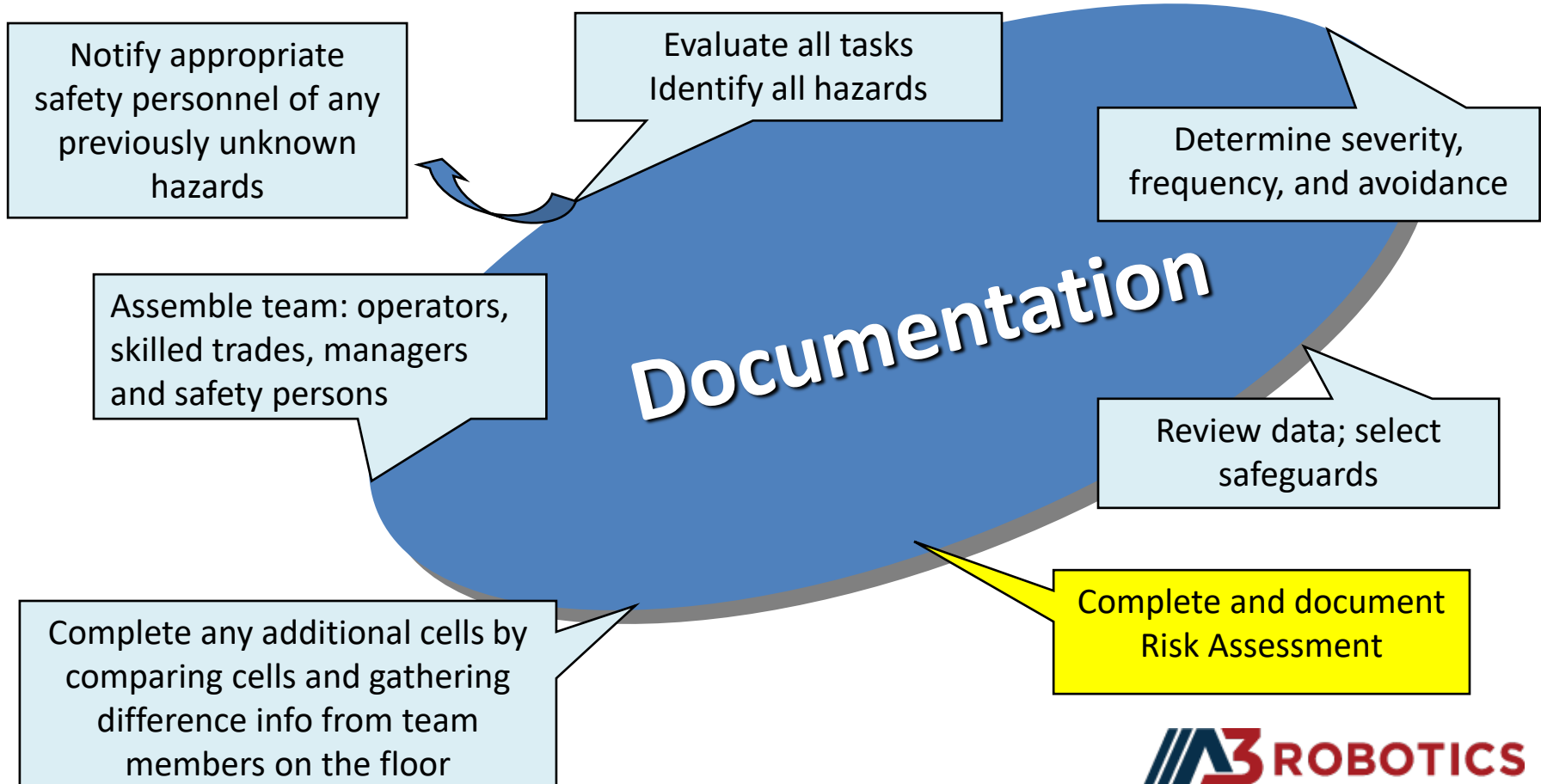
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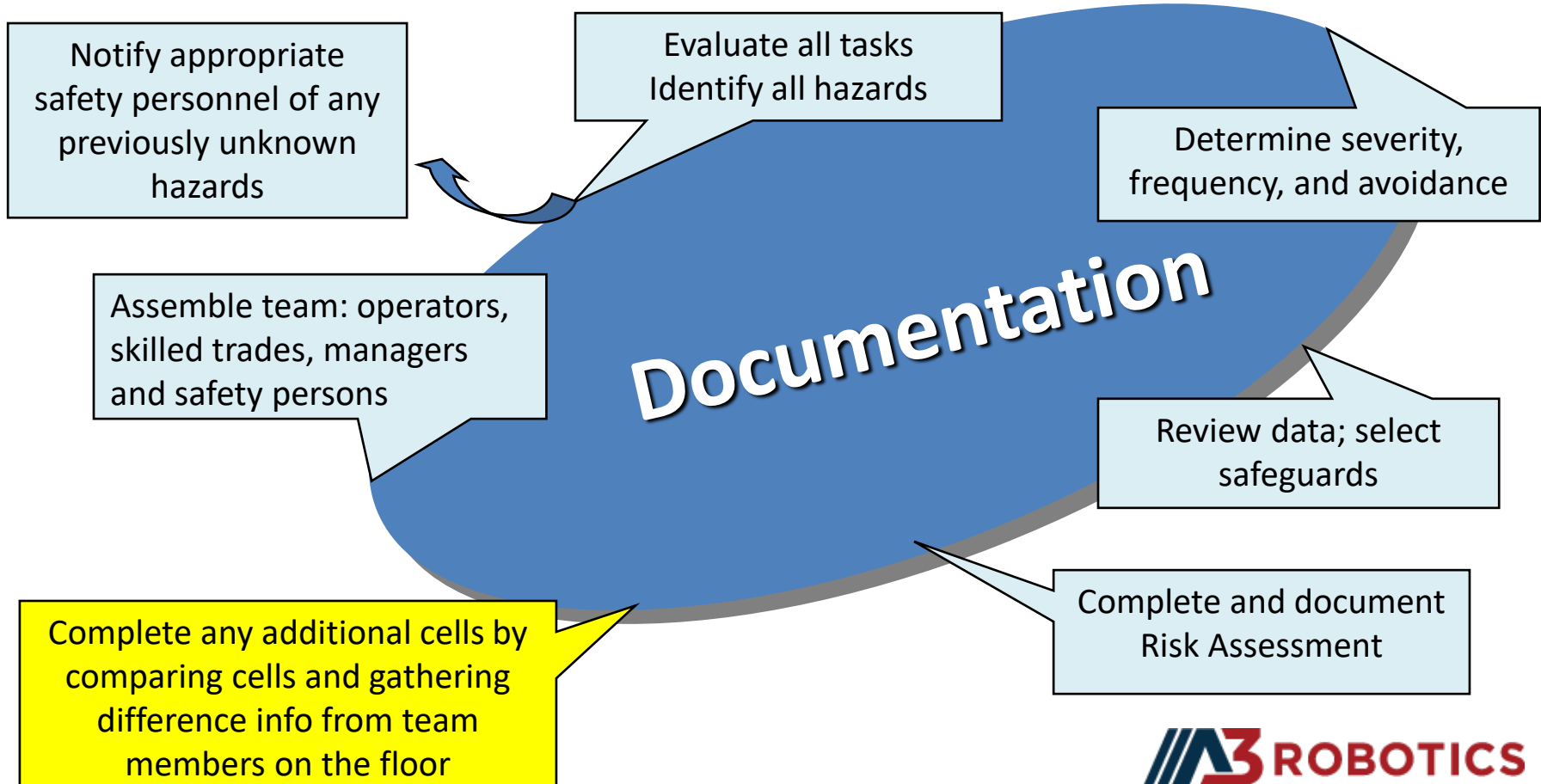
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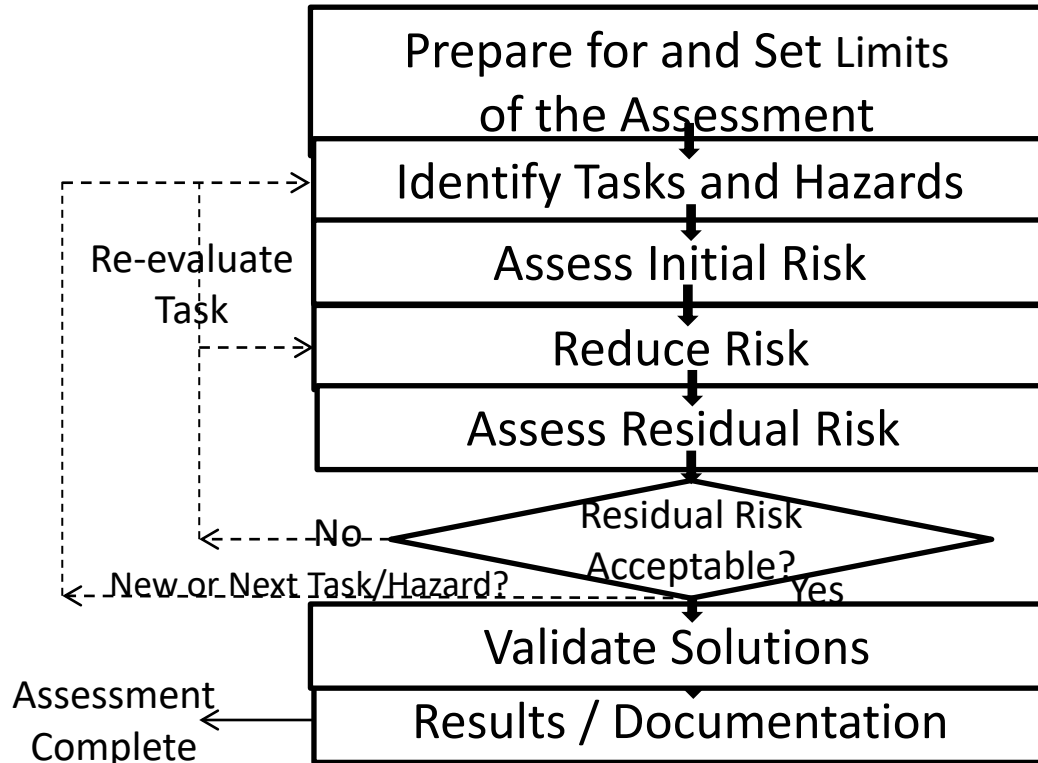
# Executing the Risk Process



# Executing the Risk Process



# TR R15.306 Process



# Preparation

- Assemble the team
  - Operator(s)
  - Maintainers/skilled trades
  - Engineers/management
- Set up the room
- Facilitator
- Documentation

# Documentation

SHEET 1 OF       

RISK ASSESSMENT REPORT		
Company:	Location:	Date:
Robot/Cell Identification:	Accomplished by:	
Robot Manufacturer and Model Number:	Date of Manufacture:	
Approved by:	Date:	Review/revision date:
General description of application (Narrative):		
General comments:		

To be accomplished in accordance with ANSI/RIA R15.06-2012

# Documentation

RISK ASSESSMENT TASK LIST			
	TASKS	HAZARDS	NOTES
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			



# Documentation

RISK ASSESSMENT HAZARD LIST					
	HAZARD	SEVERITY	EXPOSURE	AVOIDANCE	RISK LEVEL
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
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# Documentation

[illegible]

# Software

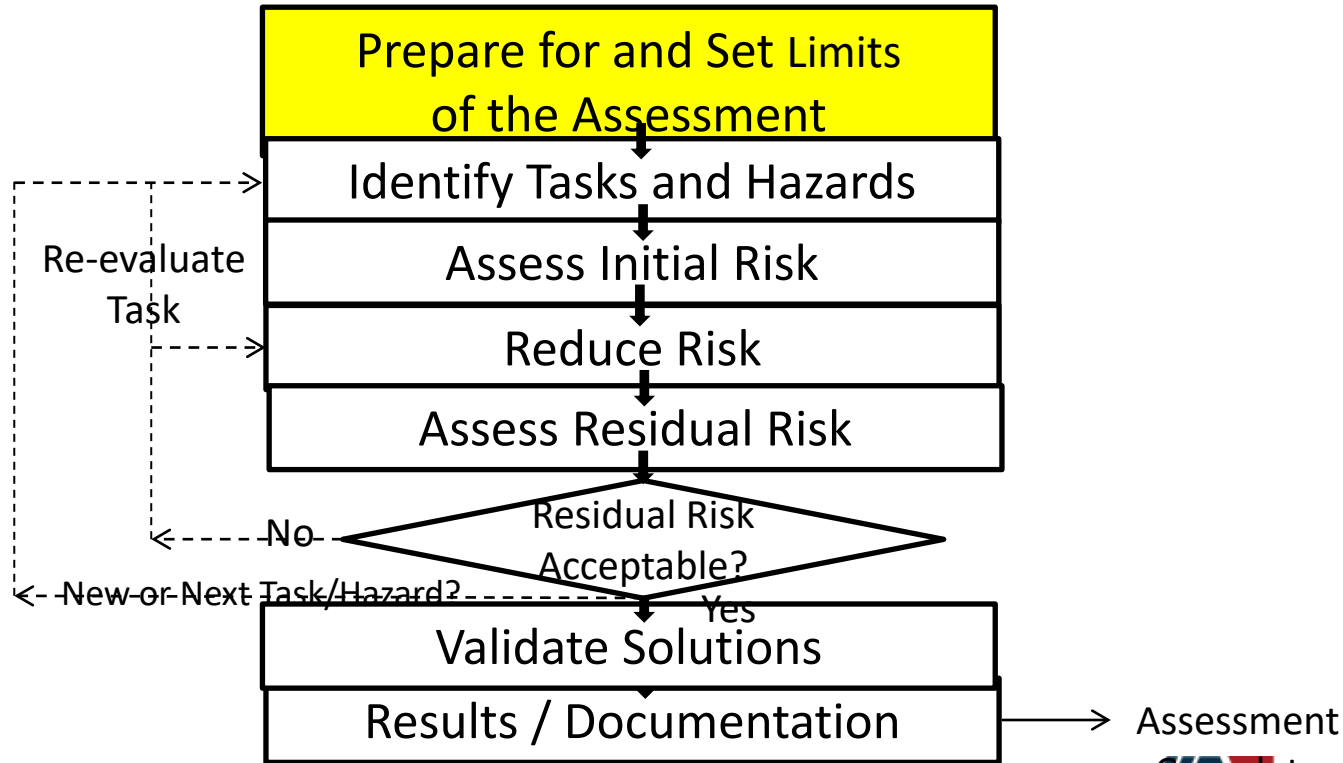
Edit	Delete	Task	Sub Task	Hazards	S	E	A	R	PL - Cat.	Safeguards	Protective Procedure	Verification	Validation
<a href="#">Edit</a>	<a href="#">Delete</a>	Loading/Unloading		Struck by Robot	S2	E1		M	PL d Cat. 2	- Perimeter		N	Denied (Only)
<a href="#">Edit</a>	<a href="#">Delete</a>	Loading/Unloading		Unexpected Robot Motion	S2	E2	A2	H	PL d Cat. 3				
<a href="#">Edit</a>	<a href="#">Delete</a>	Loading/Unloading		Slip/Trip	S2	E2	A1	M	PL d Cat. 2				
<a href="#">Edit</a>	<a href="#">Delete</a>	Simple Maintenance- Integral To Production		Pinch Points	S1	E2		L	PL c Cat. 2				
<a href="#">Edit</a>	<a href="#">Delete</a>	Loading/Unloading		Struck by Robot -- Torso and below	S2	E2	A2	H	PL d Cat. 3				

Hazard Analysis		Risk Assessment											
Robot	User	Task	Hazard	Severity	Exposure	Avoidance	Risk Category	Solution(s)					
Waterjet cutter	operator(s)	material movement/load/unload	crushing	S2	E2	A1	R2A	Design area to eliminate the wear cut resistant gloves					
1 Waterjet cutter	operator(s)	material movement/load/unload	sharp edges	S2	E2	A1	R2A	Keep work area clear					
2 Waterjet cutter	operator(s)	material movement/load/unload	slip/fall from same level	S2	E2	A1	R2A	Use two operators or a lift					
3 Waterjet cutter	operator(s)	material movement/load/unload	excessive weight	S2	E2	A2	R1	Lockout robot and turntable					
4 Waterjet cutter	operator(s)	material movement/load/unload	between robot/turntable	S2	E2	A2	R1	Lockout turntable, use control					
5 Waterjet cutter	operator(s)	clear jams	robot	S2	E2	A2	R1	Install OSHA 42" handrails					
6 Waterjet cutter	operator(s)	clear jams	turntable	S2	E2	A2	R1	Clean area prior to doing work					
7 Waterjet cutter	operator(s)	clear jams	slip/fall from height	S2	E1	A1	R2B	lockout water when inside					
8 Waterjet cutter	operator(s)	clear jams	slip/fall from same level	S2	E2	A1	R2A	lockout water when inside					
9 Waterjet cutter	operator(s)	clear jams	levels > 90 dba	S2	E2	A1	R2A	Wear bump cap/hard hat					
10 Waterjet cutter	operator(s)	clear jams	high pressure air/fluids	S2	E2	A1	R2A	Lockout robot and turntable					
11 Waterjet cutter	operator(s)	clear jams	obstructions	S1	E2	A1	R3A	Use horizontal light curtain					
12 Waterjet cutter	operator(s)	operator load/unload	turntable	S2	E2	A2	R1	Clean area prior to doing work					
13 Waterjet cutter	operator(s)	operator load/unload	debris	S2	E2	A1	R2A	Use two operators or lift a					
14 Waterjet cutter	operator(s)	operator load/unload	excessive weight	S2	E2	A2	R1	wear cut resistant gloves					
15 Waterjet cutter	operator(s)	operator load/unload	sharp edges	S2	E2	A1	R2A	Lockout robot and turntable					
16 Waterjet cutter	operator(s)	clean robot	between robot/turntable	S2	E2	A2	R1	Lockout electric control panel					
17 Waterjet cutter	operator(s)	clean robot	robot	S2	E2	A2	R1	Lockout robot. Use control					
18 Waterjet cutter	operator(s)	clean robot	electrical shock	S2	E2	A2	R1	Lockout turntable. Use control					
19 Waterjet cutter	operator(s)	clean robot	turntable	S2	E2	A2	R1	Clean area prior to doing work					
20 Waterjet cutter	operator(s)	clean robot	debris	S2	E2	A1	R2A	lockout water when inside					
21 Waterjet cutter	operator(s)	clean robot	high pressure air/fluids	S2	E2	A1	R2A						
22 Waterjet cutter	operator(s)	clean robot											
23 Waterjet cutter	operator(s)	clean robot											

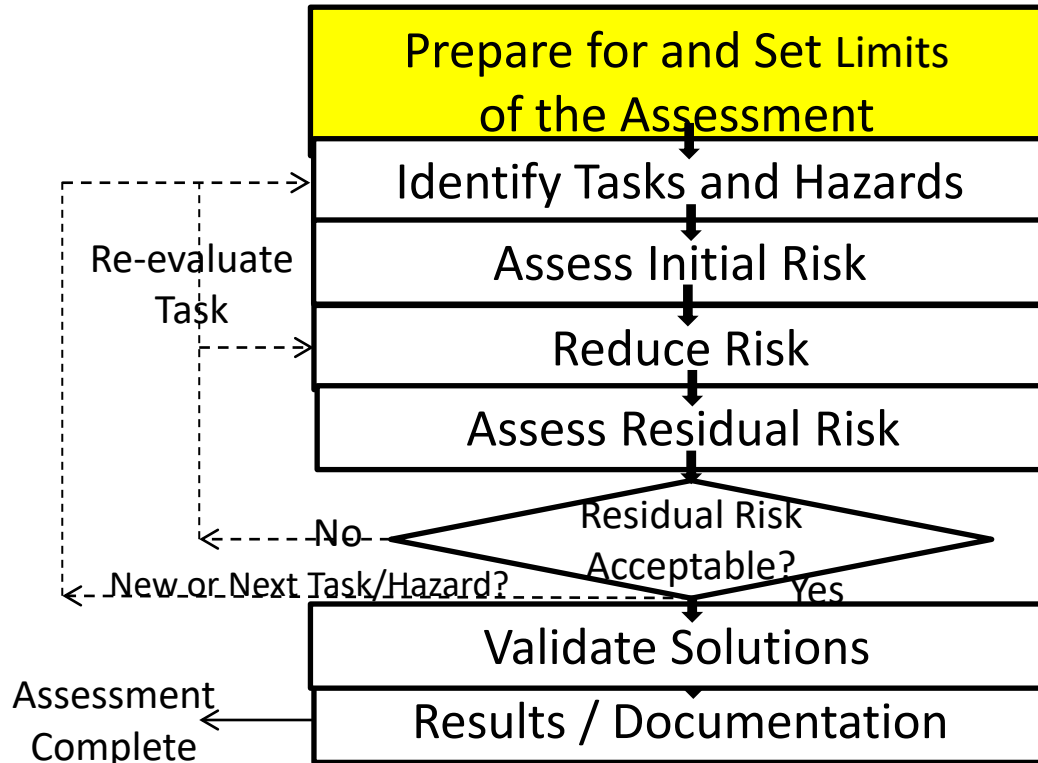
  

Severity	Exposure	Avoidance	Risk Category
<input checked="" type="checkbox"/> S2 Serious Injury More than First-aid	<input checked="" type="checkbox"/> E2 Frequent Exposure	<input type="checkbox"/> A2 Not Likely	R1
	<input type="checkbox"/> E1 Infrequent Exposure	<input checked="" type="checkbox"/> A1 Likely	R2A
	<input type="checkbox"/> E2 Frequent Exposure	<input type="checkbox"/> A2 Not Likely	R2B
	<input type="checkbox"/> E1 Infrequent Exposure	<input checked="" type="checkbox"/> A1 Likely	R2C
<input type="checkbox"/> S1 Slight Injury First-aid	<input checked="" type="checkbox"/> E2 Frequent Exposure	<input type="checkbox"/> A2 Not Likely	R3A
	<input type="checkbox"/> E1 Infrequent Exposure	<input checked="" type="checkbox"/> A1 Likely	R3B
	<input type="checkbox"/> E2 Frequent Exposure	<input type="checkbox"/> A2 Not Likely	R3C
	<input type="checkbox"/> E1 Infrequent Exposure	<input checked="" type="checkbox"/> A1 Likely	R4

# TR R15.306 Process



# TR R15.306 Process



# Define Intended Use

- Describe the application
- Describe the process
- Define the stage of development
- Define who need access to the robot
- Define who needs protection
- Define the limits associated with the robot, system and its intended use

# Implementation Stages

- Design/development
- Integration/installation
- Verification/testing
- **Production operation**

# Implementation Stages

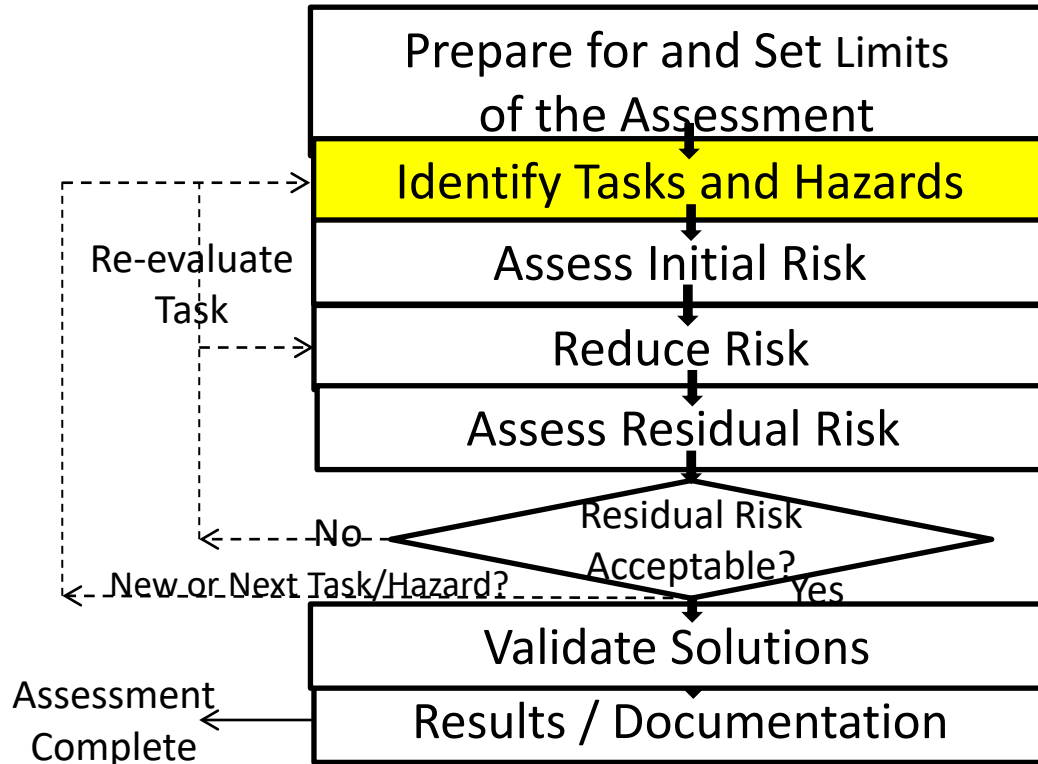
- Maintenance
- Training
- Research and development
- Re-application
- De-commissioning



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- Describe the process
- Define the stage of development
- Define who need access to the robot
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- Define the limits associated with the robot, system and its intended use

# TR R15.306 Process



# Task/Hazard Identification

- Identify all reasonably foreseeable tasks associated with the robot and robot system and the stage of development
- Identify hazards associated with each task
- Repeat until all task/hazard combinations are determined

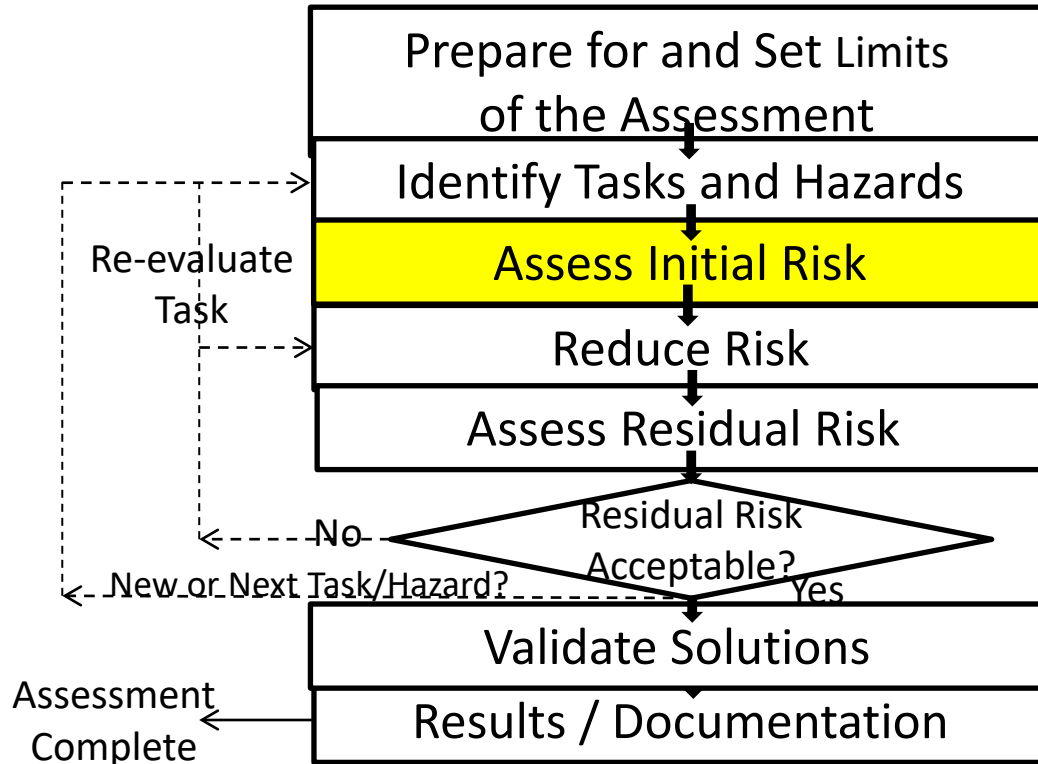
# Hazards

- **Moving components**
- **Trapping or crushing**
- **Power sources**
- **Stored Energy**
- Hazardous materials or atmospheres
- Loose objects, projectiles
- Interference – EMC  
Electromagnetic compatibility
- Vibration, shock
- Ergonomics
- Slips, trips and falls
- Moving, handling
- Protective failures
- Noise
- Inadvertent operation
- Actions and Human errors

# Task/Hazard Identification

- Identify all reasonably foreseeable tasks associated with the robot and robot system and the stage of development
- Identify hazards associated with each task
- Repeat until all task/hazard combinations are determined

# TR R15.306 Process



## Table 1 – Injury severity, exposure, and avoidance categories

Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )
Injury Severity	Serious – S3	Normally non-reversible
	Moderate – S2	Normally reversible
	Minor – S1	First aid
Exposure	Prevented – E0*	Appropriate safeguard installed (*only 2 <sup>nd</sup> time through)
	High – E2	Typically more than once per hour
	Low – E1	Typically less than once per day or shift
Avoidance	Not possible – A3	Trapping situation
	Not likely – A2	Insufficient clearance
	Likely – A1	Sufficient clearance

# Reasonable Expectations

- Dispassionate evaluation of risk
  - Personnel are assets of a company
  - Will injured personnel return to work?
- The sky is **NOT** falling
  - Can something happen, but will it?
- Murphy is alive and well!



# INJURY SEVERITY FACTOR

Factor	Rating	Criteria (Examples) – choose most likely <i>Read criteria from the top for each factor</i>
Injury Severity	Serious S3	<p>Normally non-reversible; likely will not return to the same job after recovery from incident:</p> <ul style="list-style-type: none"> <li>- fatality</li> <li>- limb amputation</li> <li>- long term disability</li> <li>- chronic illness</li> </ul> <p>If any of the above are applicable, the rating is SERIOUS</p>
	Moderate S2	<p>Normally reversible; likely will return to the same job after recovery from incident:</p> <ul style="list-style-type: none"> <li>- broken bones</li> <li>- severe laceration</li> <li>- short hospitalization</li> <li>- short term disability</li> <li>- lost time (multi-day)</li> <li>- fingertip amputation (not thumb)</li> </ul> <p>If any of the above are applicable, the rating is MODERATE</p>
	Minor S1	<p>First aid; no recovery required before returning to job:</p> <ul style="list-style-type: none"> <li>- bruising</li> <li>- small cuts</li> <li>- no loss time (multi-day)</li> <li>- does not require attention by a medical doctor</li> </ul> <p>If any of the above are applicable, the rating is MINOR</p>

# EXPOSURE FACTOR

Factor	Rating	Criteria (Examples) – choose most likely <i>Read criteria from the top for each factor</i>
Exposure	Prevented E0	<ul style="list-style-type: none"> <li>– Exposure to hazard(s) is eliminated/controlled/limited by inherently safe design measures.</li> <li>– Use of guards prevents exposure or access to the hazard(s) (see Part 2, 5.10). If an interlocked guard is selected, the following bullet must also be met.</li> <li>– If functional safety is used as a risk reduction measure, the functional safety performance (PL) meets or exceeds the required functional safety performance (PL<sub>r</sub>). See Part 2, 5.2.</li> </ul> <p>If any of the above are applicable, the rating is PREVENTED</p>
	High E2	<ul style="list-style-type: none"> <li>– Typically more than once per day or shift</li> <li>– Frequent or multiple short duration</li> <li>– Situations which could lead to increase in the duration of a task, not to include teaching tasks</li> </ul> <p>If any of the above are applicable, the rating is HIGH</p>
	Low E1	<ul style="list-style-type: none"> <li>– Typically less than or once per day or shift</li> <li>– Occasional short durations</li> </ul> <p>If either of the above are applicable, the rating is LOW</p>

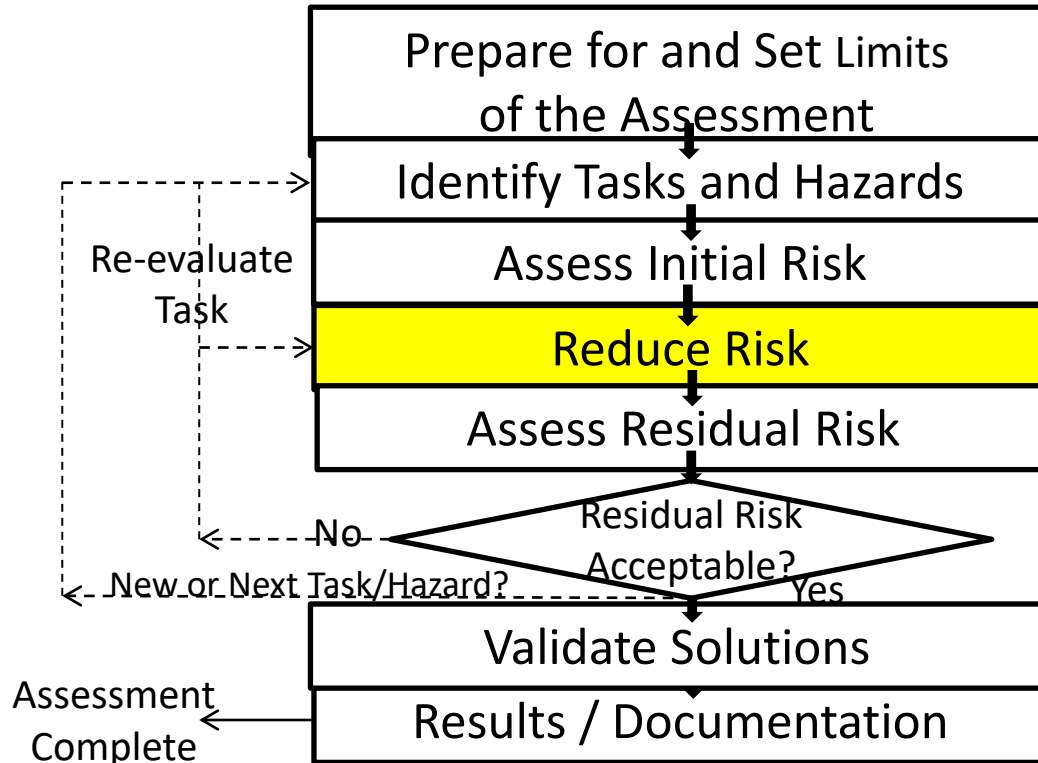
# AVOIDANCE FACTOR

Factor	Rating	Criteria (Examples) – choose most likely <i>Read criteria from the top for each factor</i>
Avoidance	Not possible A3	<ul style="list-style-type: none"> <li>– Insufficient clearance to move out of the way and safety-rated reduced speed control is NOT used</li> <li>– The robot system or cell layout causes the operator to be trapped, with the escape route toward the hazard</li> <li>– Safeguarding is not expected to offer protection from the process hazard (e.g. explosion or eruption hazard)</li> </ul> <p>If any of the above are applicable, the rating is NOT POSSIBLE</p>
	Not likely A2	<ul style="list-style-type: none"> <li>– Insufficient clearance to move out of the way and safety-rated reduced speed control IS used</li> <li>– Obstructed path to move to safe area</li> <li>– Hazard is moving faster than reduced speed (250 mm/sec)</li> <li>– Inadequate warning/reaction time</li> <li>– The hazard is imperceptible</li> </ul> <p>If any of the above are applicable, the rating is NOT LIKELY</p>
	Likely A1	<ul style="list-style-type: none"> <li>– Sufficient clearance to move out of the way</li> <li>– Hazard is incapable of moving greater than reduced speed (250 mm/sec)</li> <li>– Adequate warning/reaction time</li> <li>– Positioned in a safe location away from the hazard</li> </ul> <p>If any of the above are applicable, the rating is LIKELY</p>

## Table 2 – Risk level decision matrix

Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level
S1 – Minor	E0 - Prevented		NEGLECTABLE
	A1 - Likely		
	E1 - Low	A2/A3 - Not likely/possible	LOW
	E2 - High		
S2 – Moderate	E0 - Prevented		MEDIUM
	A1 - Likely		
	E1 - Low	A2/A3 - Not likely/possible	HIGH
	E2 - High		
S3 – Serious	E0 - Prevented		LOW
	E1 - Low	A1/A2 - Likely/Not likely	HIGH
	E2 - High		
	A3 - Not possible		VERY HIGH


# TR R15.306 Process



# Select Safeguarding Devices

- Prevent access to the hazard
- Cause the hazard to cease before access
- Prevent unintended operation
- Contain parts and tooling
  - Loose objects, flying projectiles
- Control other process hazards
  - Noise, laser, radiation

## Table 3 – Hierarchy of risk reduction measures

<p style="text-align: center;"><b>More preferred</b></p>  <p style="text-align: center;"><b>Less preferred</b></p>	<b>Inherently Safe Design Measures</b>	<b>Elimination</b>	<ul style="list-style-type: none"> <li>• Process design, redesign or modification including changing layout to eliminate hazards (e.g. falls, hazardous materials, noise, confined spaces, eliminating pinch points, or reduce manual handling)</li> </ul>
		<b>Substitution</b>	<ul style="list-style-type: none"> <li>• Use of less hazardous materials</li> <li>• Intrinsically safe (energy containment)</li> <li>• Reduce energy (e.g. lower speed, force, amperage, pressure, temperature, volume or noise)</li> </ul>
		<b>Limit Interaction</b>	<ul style="list-style-type: none"> <li>• Eliminate or reduce human interaction in the process</li> <li>• Automate tasks, automate material handling (e.g. lift tables, conveyors, balancers)</li> </ul>
	<b>Safeguarding and Complementary Protective Measures</b>	<b>Safeguards and Safety-Related Parts of the Control System (SRP/CS)</b>	<ul style="list-style-type: none"> <li>• Guards</li> <li>• Interlocks or interlocking devices</li> <li>• Sensitive protective equipment</li> <li>• Two-hand control devices</li> <li>• Safety controls and logic</li> <li>• Safety-related functions and safety parameters or configurations, (e.g. safety-rated speed, position, location, axis limits)</li> <li>• Integration of protective devices, possibly including complementary protective measures</li> </ul>
		<b>Complementary Protective Measures</b>	<ul style="list-style-type: none"> <li>• Fall prevention or safe access: platforms or guard railing (building codes or standards can apply)</li> <li>• Measures for escape and rescue of people</li> <li>• Measures for safe access to machinery</li> <li>• Provisions for easy or safe handling of machines and their heavy component parts</li> <li>• Energy isolation or dissipation means</li> <li>• Controlled selection of operating modes</li> <li>• Enabling devices</li> <li>• Emergency stop devices and functions</li> </ul>
	<b>Information for Use</b>	<b>Warnings and Awareness Means</b>	<ul style="list-style-type: none"> <li>• Flashing lights, beacons or strobes</li> <li>• Audible alarms, beepers, horns or sirens</li> <li>• Signs, placards, markings or labels</li> </ul>
		<b>Administrative Controls</b>	<ul style="list-style-type: none"> <li>• Training and safe job procedures</li> <li>• Confined space policy and procedures</li> <li>• Control of hazardous energy procedures (lock-out) used with energy isolation or dissipation means</li> <li>• Rotation of workers, changing work schedule</li> <li>• Equipment safety inspections</li> <li>• Hazard communications</li> </ul>
		<b>Personal Protective Equipment (PPE)</b>	<ul style="list-style-type: none"> <li>• Safety glasses, face shields, respirators, hearing protection</li> <li>• Safety harnesses or lanyards</li> <li>• Gloves, hard hats, clothing or footwear used for specific safety purposes (e.g. Kevlar sleeves, metatarsal protection)</li> </ul>

# Inherently Safe Design

Inherently Safe Design Measures	Elimination	<ul style="list-style-type: none"><li>• Process design, redesign or modification including changing layout to eliminate hazards (e.g. falls, hazardous materials, noise, confined spaces, eliminating pinch points, or reduce manual handling)</li></ul>
	Substitution	<ul style="list-style-type: none"><li>• Use of less hazardous materials</li><li>• Intrinsically safe (energy containment)</li><li>• Reduce energy (e.g. lower speed, force, amperage, pressure, temperature, volume or noise)</li></ul>
	Limit Interaction	<ul style="list-style-type: none"><li>• Eliminate or reduce human interaction in the process</li><li>• Automate tasks, automate material handling (e.g. lift tables, conveyors, balancers)</li></ul>



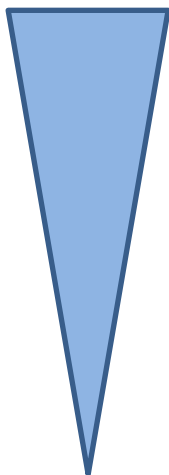
# Safeguarding Measures

Safeguarding and Complementary Protective Measures	Safeguards and Safety- Related Parts of the Control System (SRP/CS)	<ul style="list-style-type: none"><li>• Guards</li><li>• Interlocks or interlocking devices</li><li>• Sensitive protective equipment</li><li>• Two-hand control devices</li><li>• Safety controls and logic</li><li>• Safety-related functions and safety parameters or configurations, (e.g. safety-rated speed, position, location, axis limits)</li><li>• Integration of protective devices, possibly including complementary protective measures</li></ul>
	Complementary Protective Measures	<ul style="list-style-type: none"><li>• Fall prevention or safe access: platforms or guard railing (building codes or standards can apply)</li><li>• Measures for escape and rescue of people</li><li>• Measures for safe access to machinery</li><li>• Provisions for easy or safe handling of machines and their heavy component parts</li><li>• Energy isolation or dissipation means</li><li>• Controlled selection of operating modes</li><li>• Enabling devices</li><li>• Emergency stop devices and functions</li></ul>

# Information for Use

Information for Use	Warnings and Awareness Means	<ul style="list-style-type: none"><li>• Flashing lights, beacons or strobes</li><li>• Audible alarms, beepers, horns or sirens</li><li>• Signs, placards, markings or labels</li></ul>
	Administrative Controls	<ul style="list-style-type: none"><li>• Training and safe job procedures</li><li>• Confined space policy and procedures</li><li>• Control of hazardous energy procedures (lock-out) used with energy isolation or dissipation means</li><li>• Rotation of workers, changing work schedule</li><li>• Equipment safety inspections</li><li>• Hazard communications</li></ul>
	Personal Protective Equipment	<ul style="list-style-type: none"><li>• Safety glasses, face shields, respirators, hearing protection</li><li>• Safety harnesses or lanyards</li><li>• Gloves, hard hats, clothing or footwear used for specific safety purposes (e.g. Kevlar sleeves, metatarsal protection)</li></ul>

## Table 4 – Minimum risk reduction measures as a function of the risk level

	Risk Reduction Measure	Risk Level						
		VERY HIGH	HIGH	MEDIUM	LOW	NEGLIGIBLE		
<div>Most Preferred</div> <div></div> <div>Least Preferred</div>	Elimination	One or a combination of Elimination, Substitution, and Safeguarding or SRP/CS is REQUIRED to reduce risks to an acceptable level.			One or any combination of the Risk Reduction Measures that will acceptably reduce the Risk Level may be used			
	Substitution							
	Safeguarding SRP/CS							
	Warnings and Awareness Means	Complementary Protective Measures may be used in conjunction with the above risk reduction measures but shall not be used as the primary risk reduction factor.						
	Administrative Controls							
	PPE							

# Functional Safety

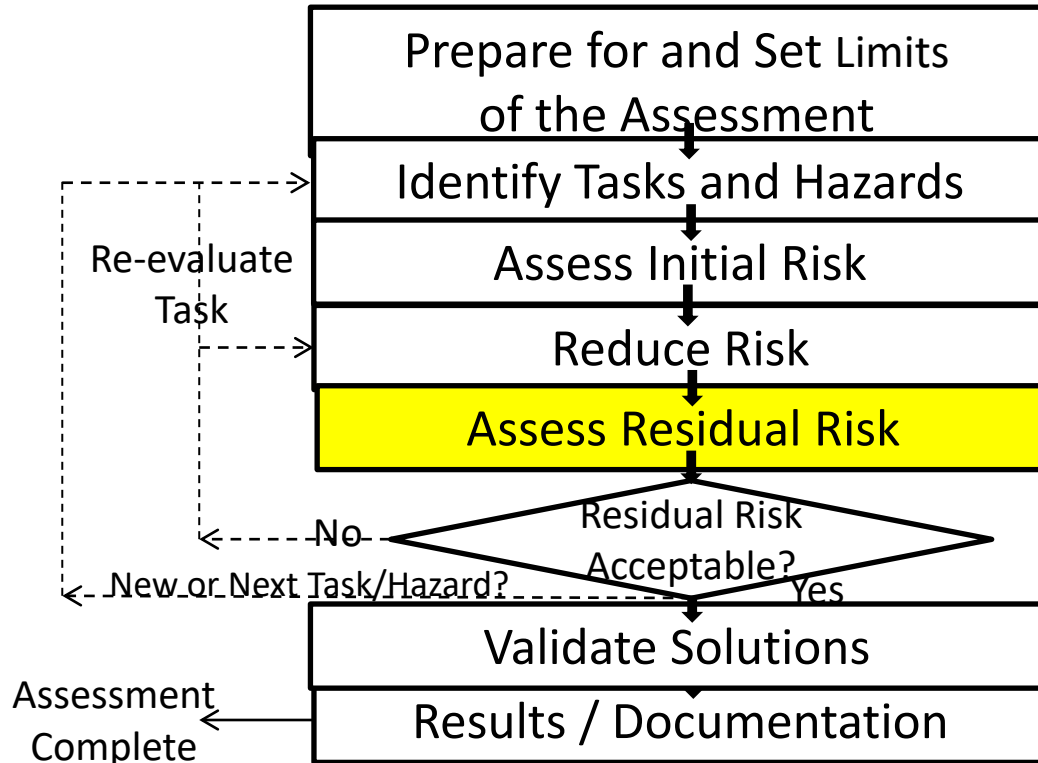
# SRP/CS

**Safety Related Part  
of the Control System**

# Functional Safety

Risk Level	Minimum SRP/CS requirements	
	$PL_r$	Structure Category
<b>NEGLIGIBLE</b> (see 6.5.3.1)	<b>b</b>	-
<b>LOW</b>	<b>c</b>	<b>2</b>
<b>MEDIUM</b>	<b>d</b>	<b>2</b>
<b>HIGH</b>	<b>d</b>	<b>3</b>
<b>VERY HIGH</b> (see 6.5.3.2)	<b>e</b>	<b>4</b>

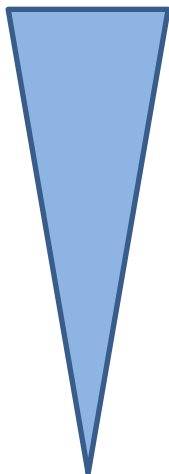
# TR R15.306 Process



## Table 2 – Risk level decision matrix

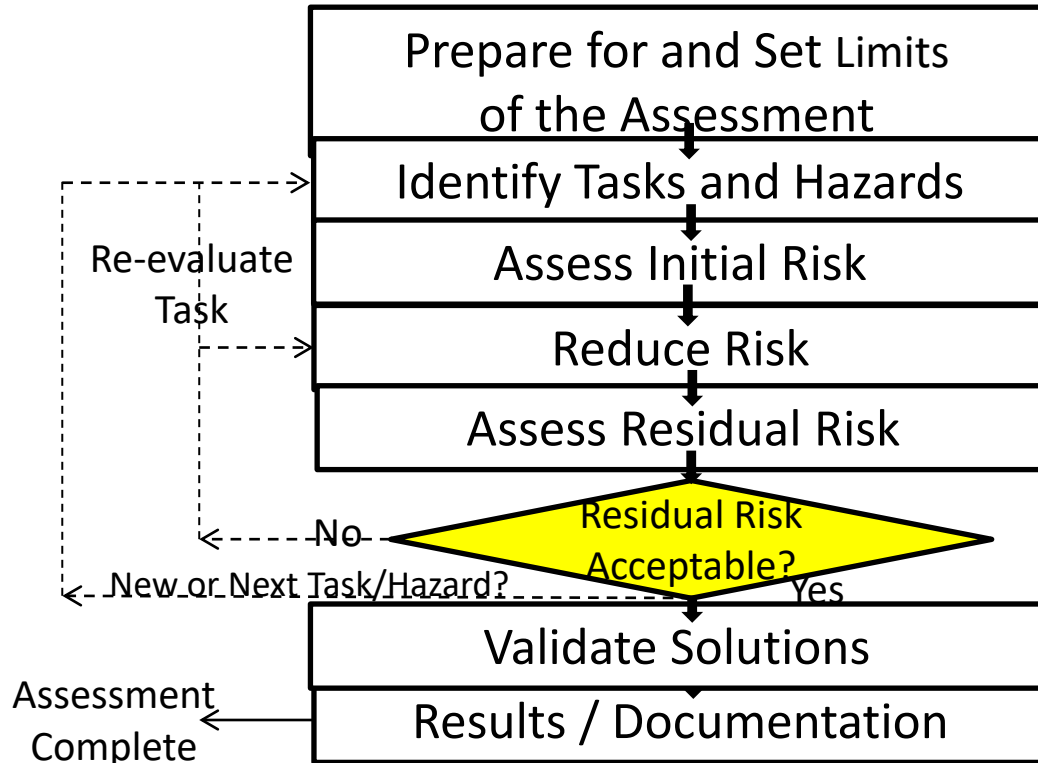
Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level
S1 – Minor	E0 - Prevented		NEGLECTABLE
	E1 - Low	A1 - Likely	
		A2/A3 - Not likely/possible	LOW
	E2 - High		
S2 – Moderate	E0 - Prevented		MEDIUM
	E1 - Low	A1 - Likely	
		A2/A3 - Not likely/possible	HIGH
	E2 - High		
S3 – Serious	E0 - Prevented		LOW
	E1 - Low	A1/A2 - Likely/Not likely	HIGH
		A3 - Not possible	
	E2 - High		VERY HIGH

## Table 4 – Minimum risk reduction measures as a function of the risk level

	Risk Reduction Measure	Risk Level						
		VERY HIGH	HIGH	MEDIUM	LOW	NEGLIGIBLE		
<div><div>Most Preferred</div><div></div><div>Least Preferred</div></div>	Elimination	One or a combination of Elimination, Substitution, and Safeguarding or SRP/CS is REQUIRED to reduce risks to an acceptable level.			One or any combination of the Risk Reduction Measures that will acceptably reduce the Risk Level may be used			
	Substitution							
	Safeguarding SRP/CS							
	Warnings and Awareness Means	Complementary Protective Measures may be used in conjunction with the above risk reduction measures but shall not be used as the primary risk reduction factor.						
	Administrative Controls							
	PPE							



# TR R15.306 Process



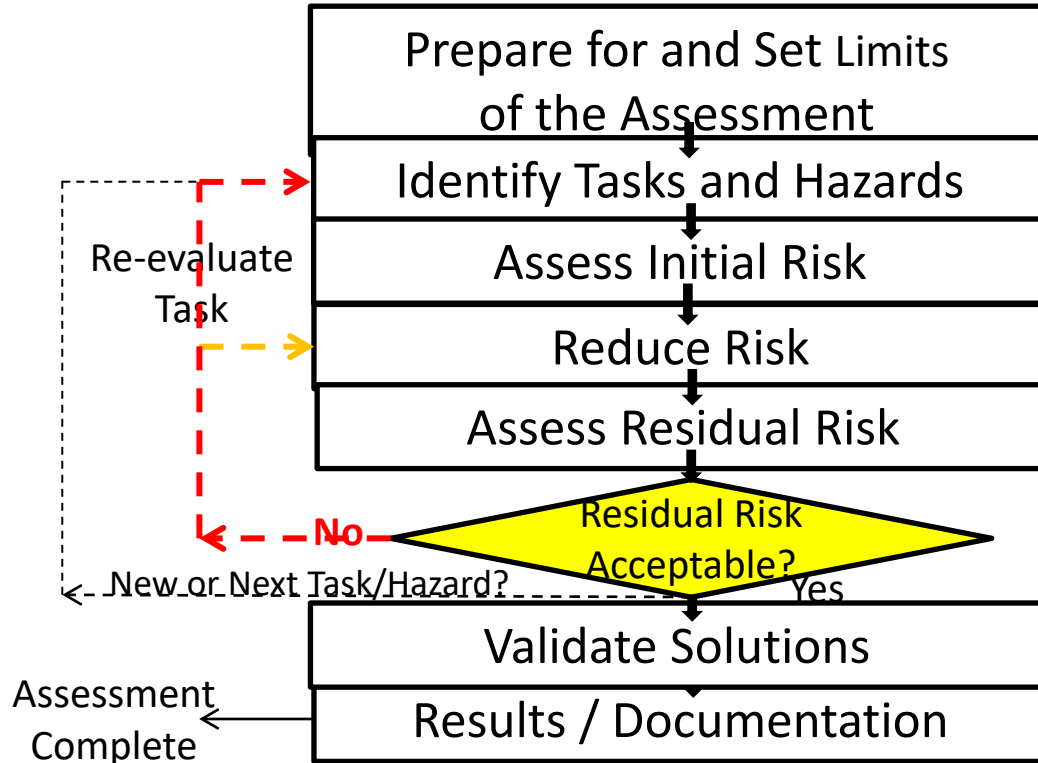
# Residual Risk Defined

- Residual Risk is the level of risk remaining after controls have been implemented. Controls are altered until the residual risk is at an acceptable level or until it cannot practically be further reduced.

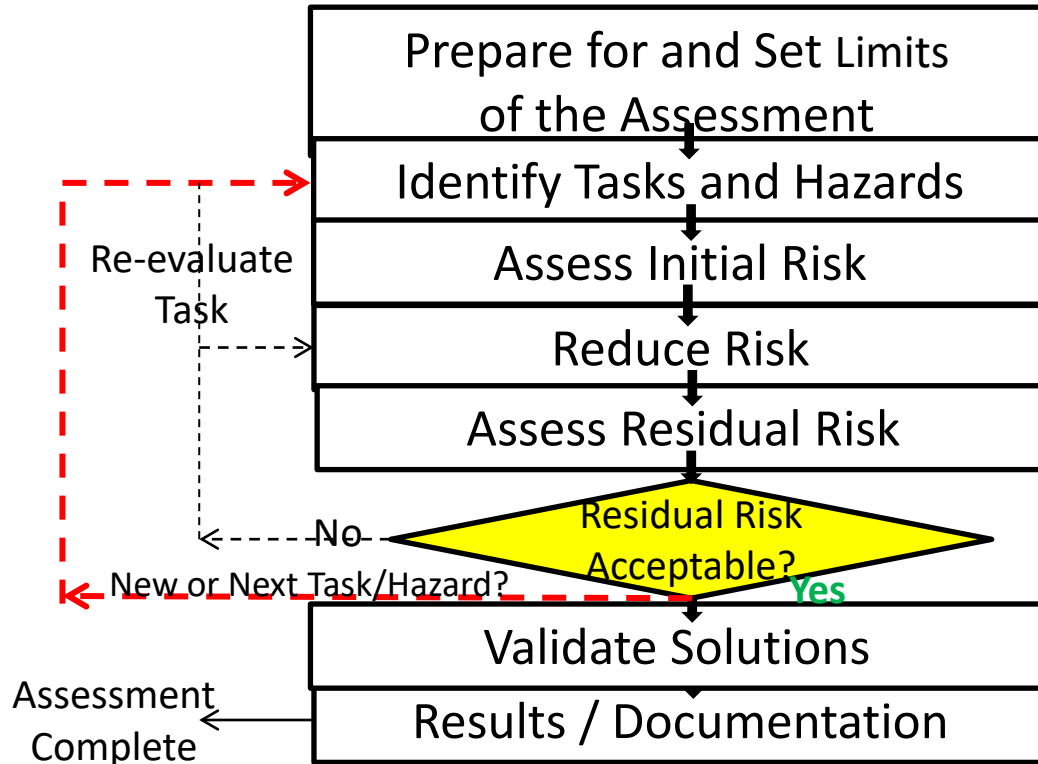
# Acceptable Residual Risk

- RIA TR R15.306 says risk is acceptable when a **low** or **negligible** risk level is reached the second time through the decision matrix.

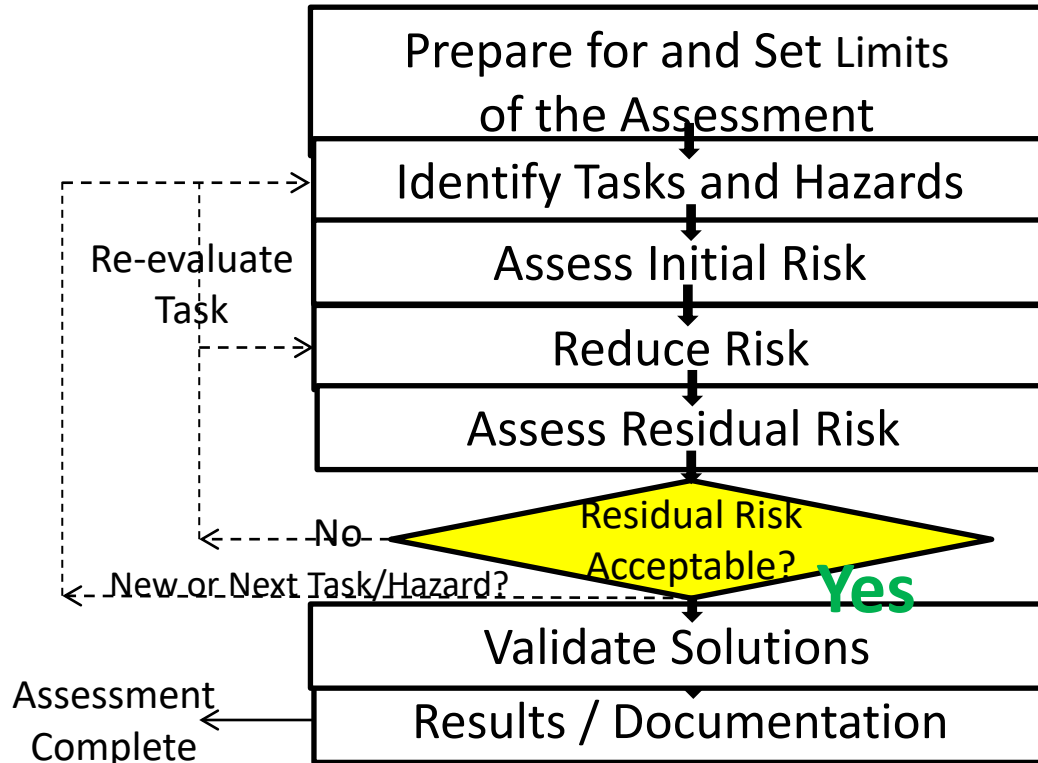
# TR R15.306 Process



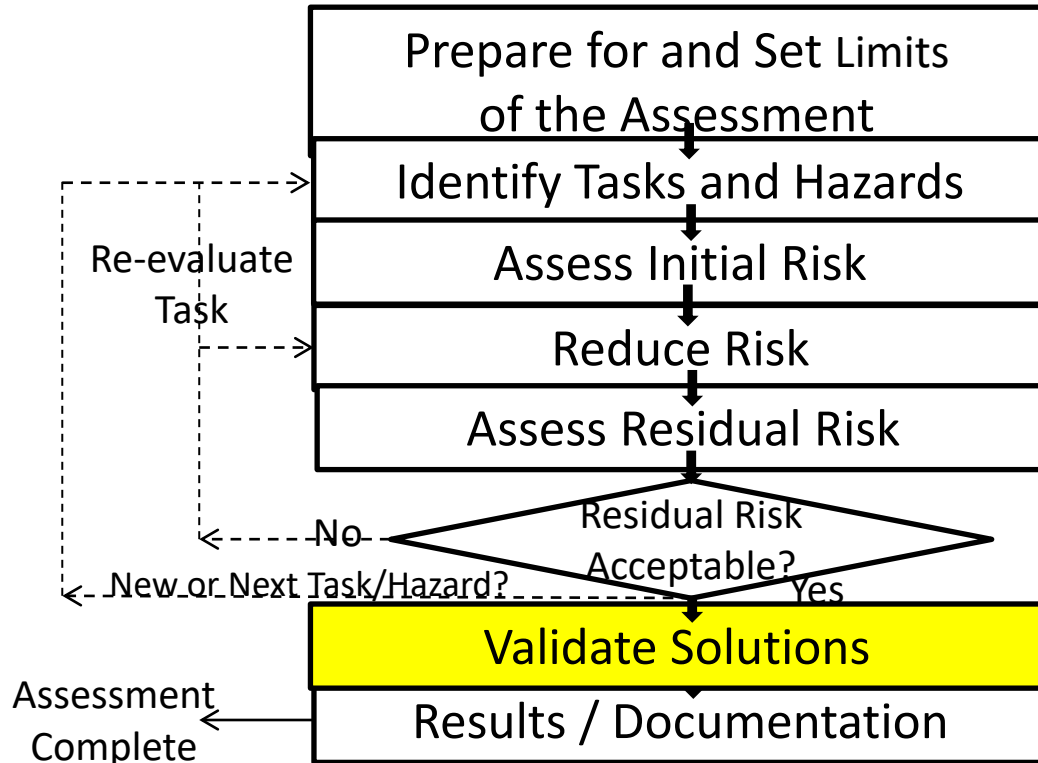
# TR R15.306 Process



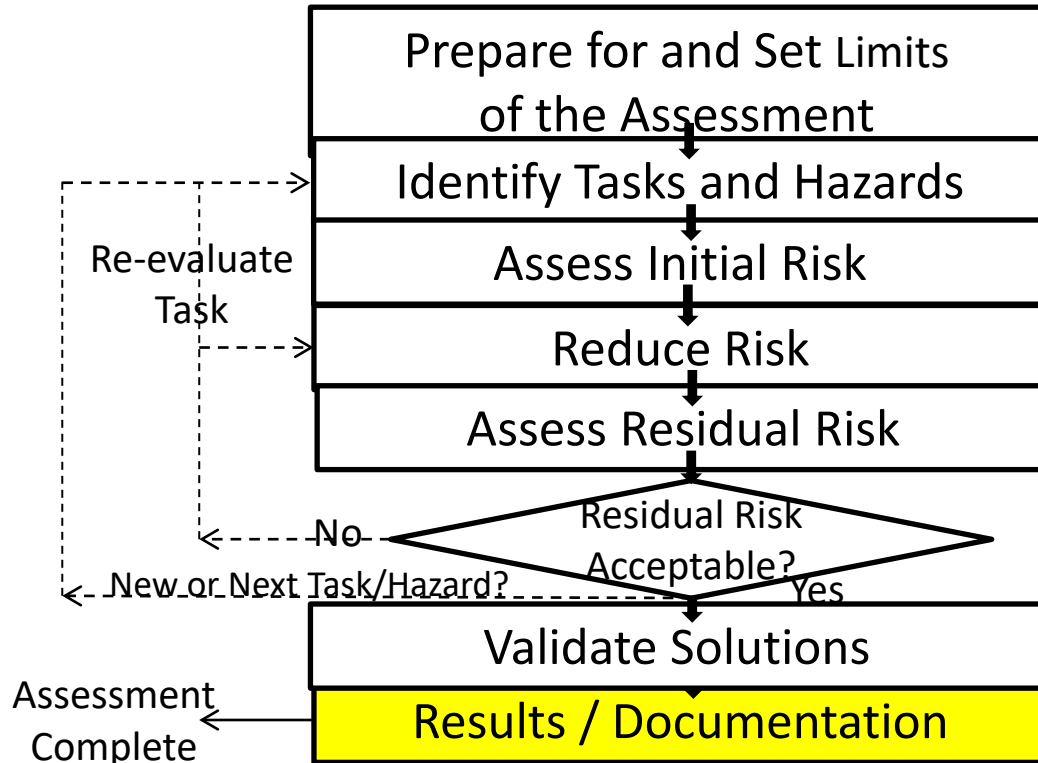
# TR R15.306 Process



# TR R15.306 Process

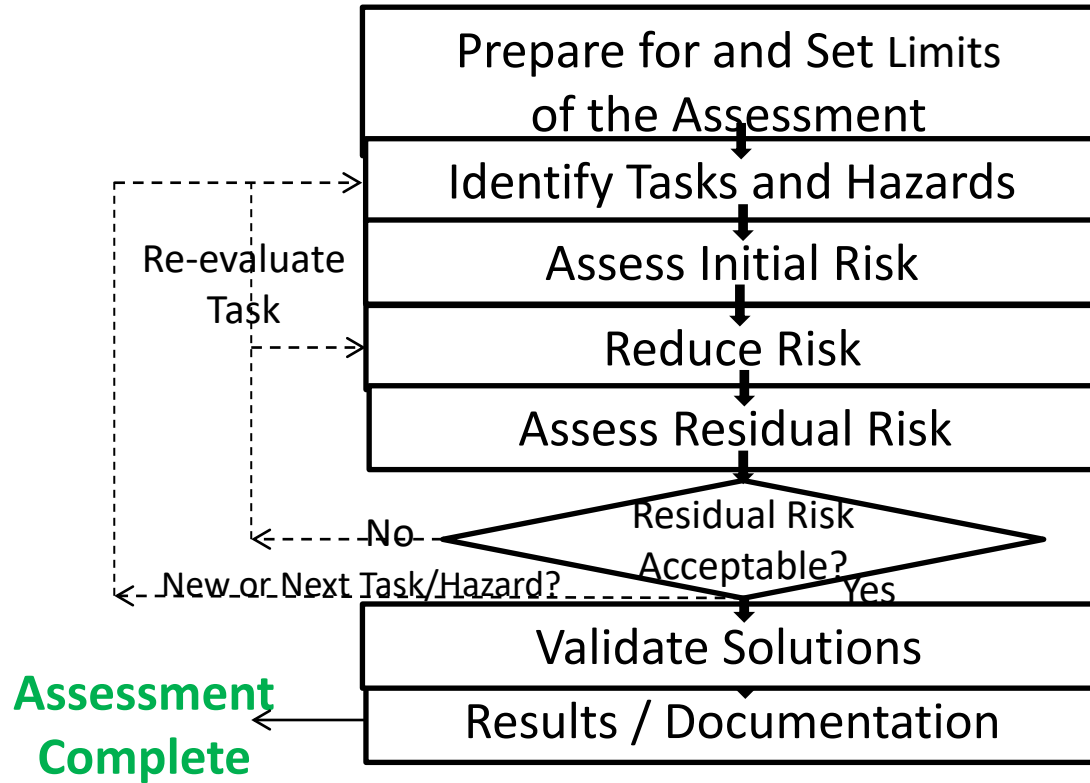


# TR R15.306 Process





# TR R15.306 Process



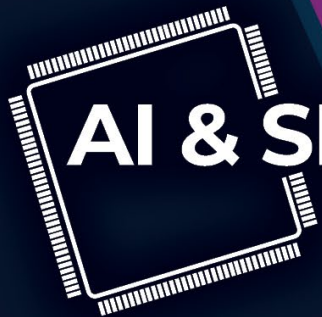


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PITTSBURGH, PENNSYLVANIA

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*THANK YOU!*

# Contact Information



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# Practical Exercise

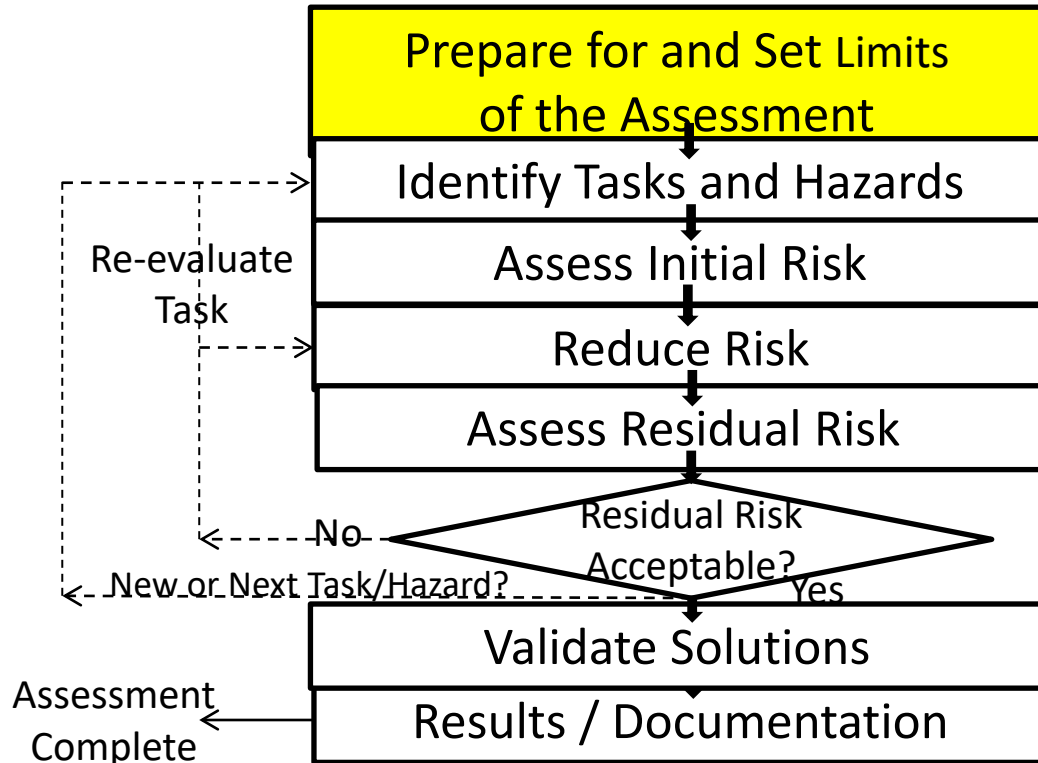
Robotic Waterjet Work Cell

Using  
RIA TR R15.306

Task-based  
Risk Assessment  
Methodology



# TR R15.306 Process



रप्ट robotic production technology  
**JetTool**

**CAUTION**  
DO NOT OPERATE THIS  
EQUIPMENT WITH PERSONS  
INSIDE OF THE ENCLOSURE.  
DOING SO CAN RESULT IN  
SERIOUS INJURY OR DEATH.

**CAUTION**

herology







RPT  
**JetTool**

5303

CAUTION  
ROTATING  
WALL

B

CAUTION  
ROTATING  
WALL

B

POS B





5302

JetTool

JetTool

1206241801 PROP MTC 2/10/00

87

Industrial & Waste Disposal  
274-0821





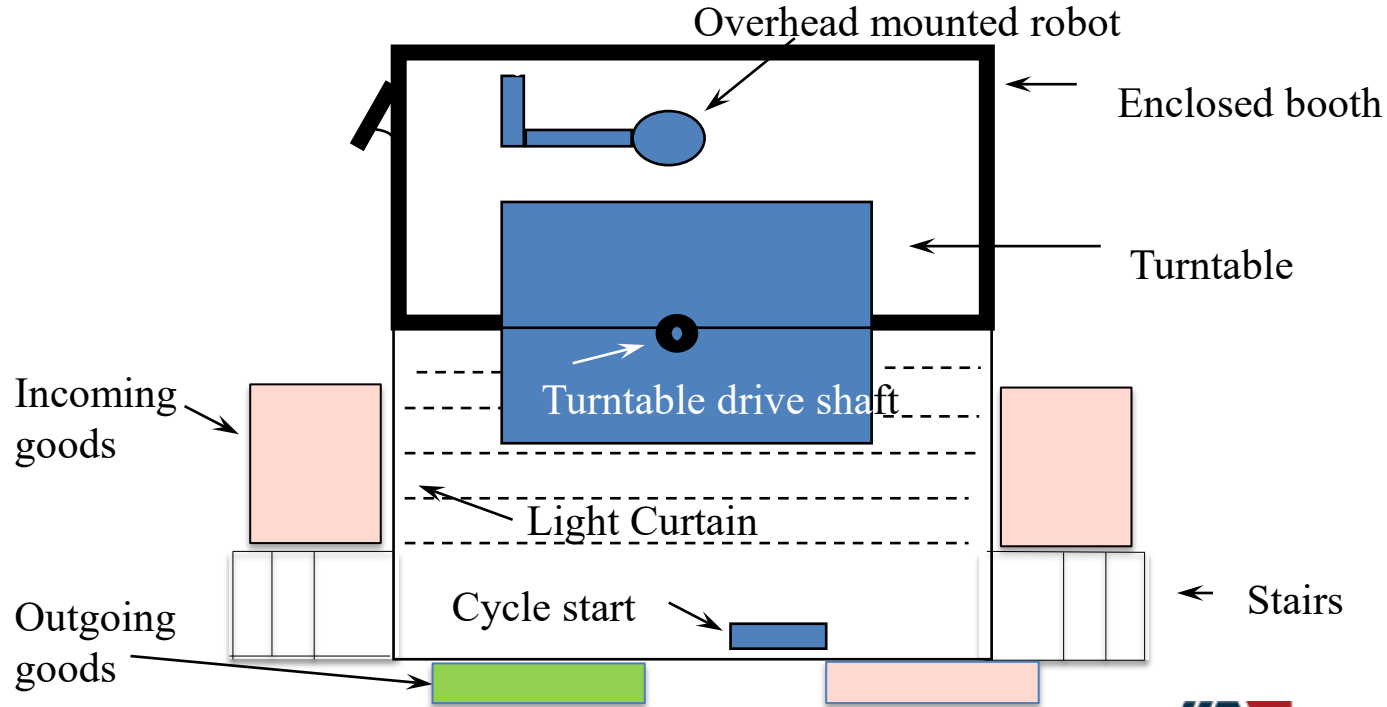




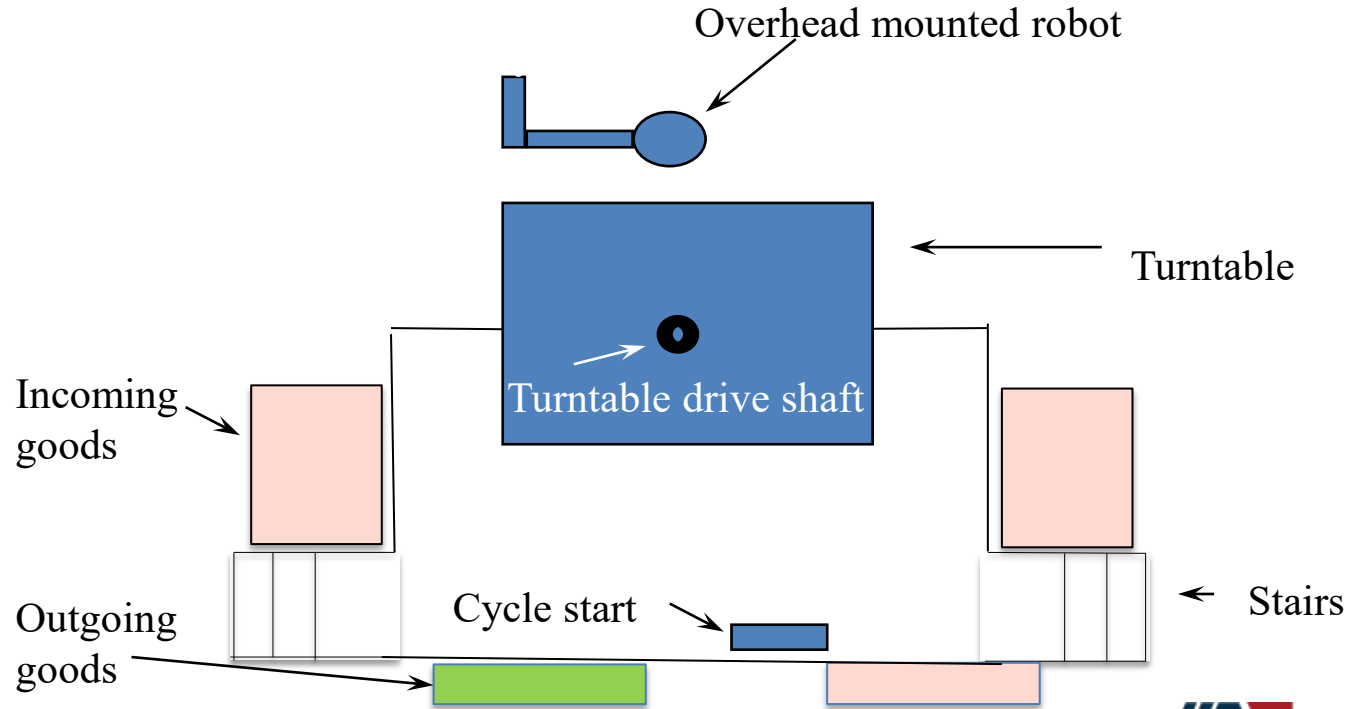




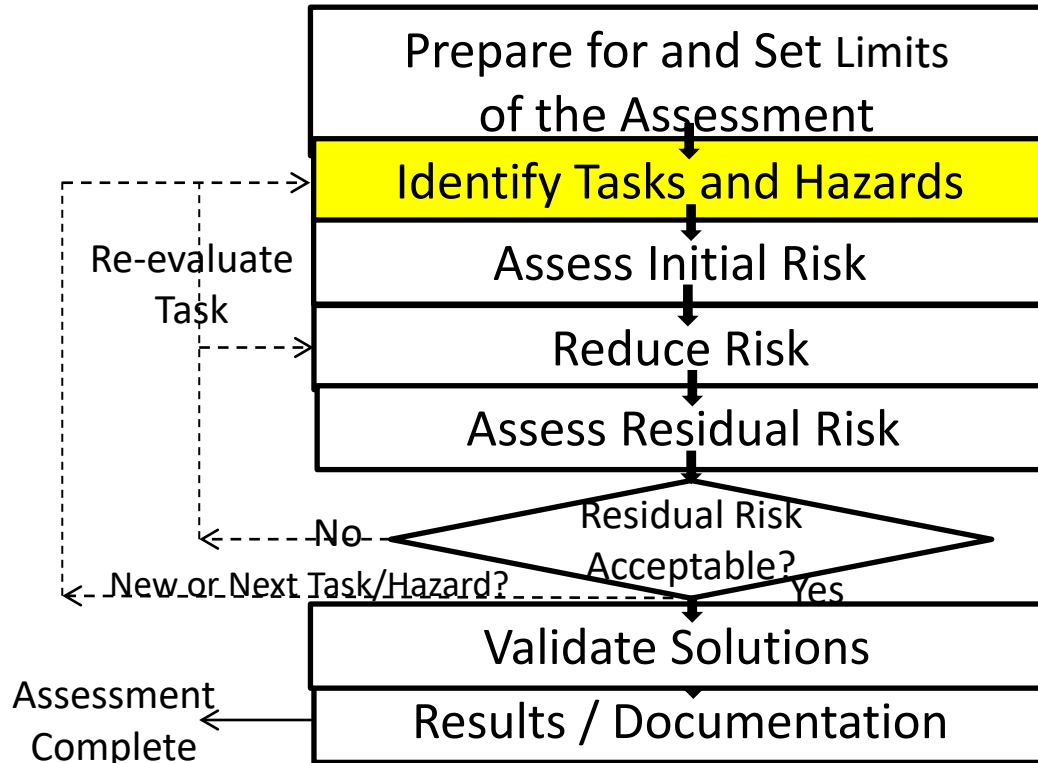
# Top View



# Top View



# TR R15.306 Process





# TASK

TASKS	HAZARDS	NOTES

# HAZARD

HAZARD	SV	EX	AV	RL





# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		

# HAZARD

HAZARD	SV	EX	AV	RL



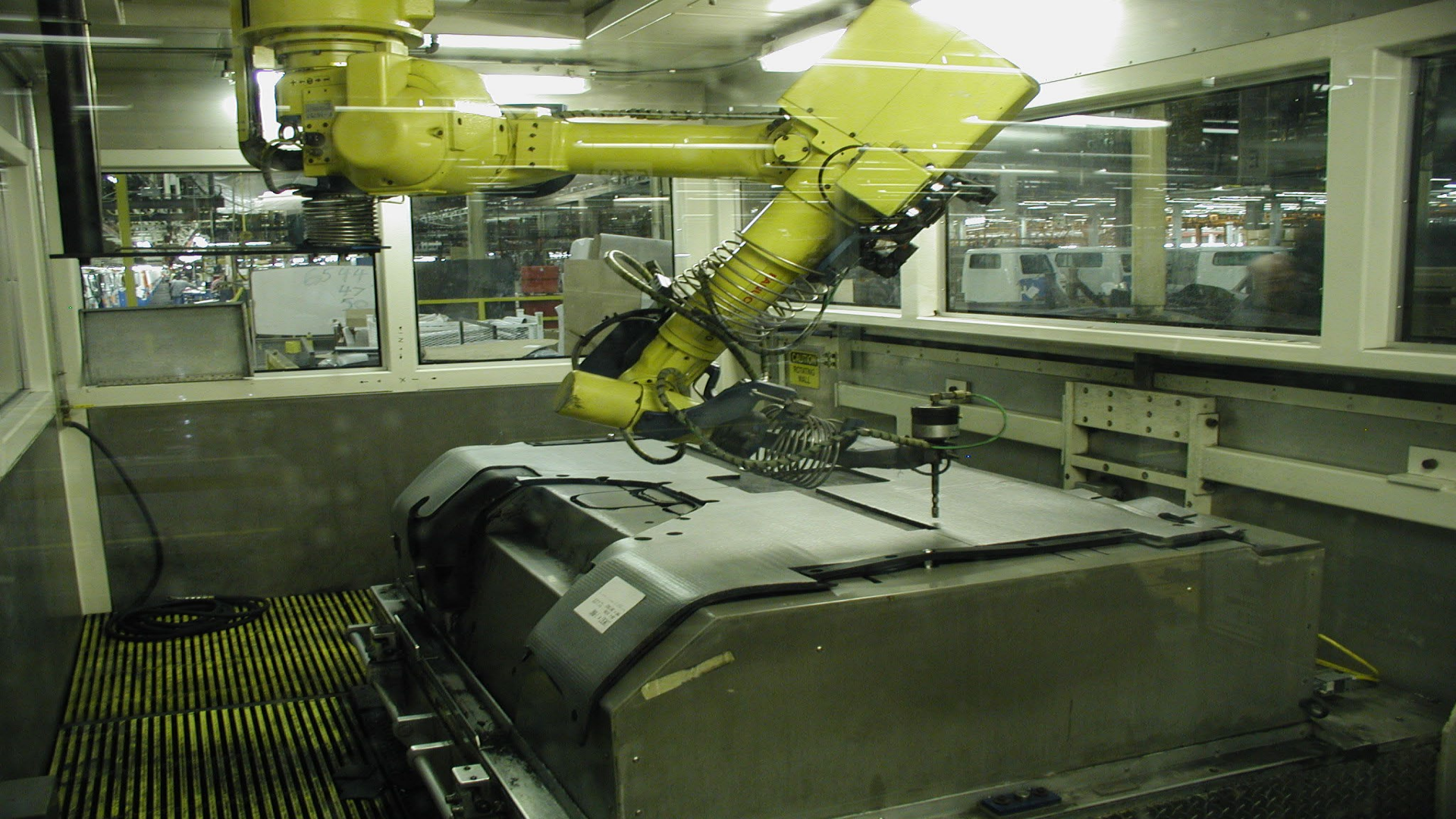


# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		

# HAZARD

HAZARD	SV	EX	AV	RL



# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

# HAZARD

HAZARD	SV	EX	AV	RL





# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT				

# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT				
SLIP/TRIP SAME LVL				



# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT				
SLIP/TRIP SAME LVL				
STRUCK BY ROBOT				

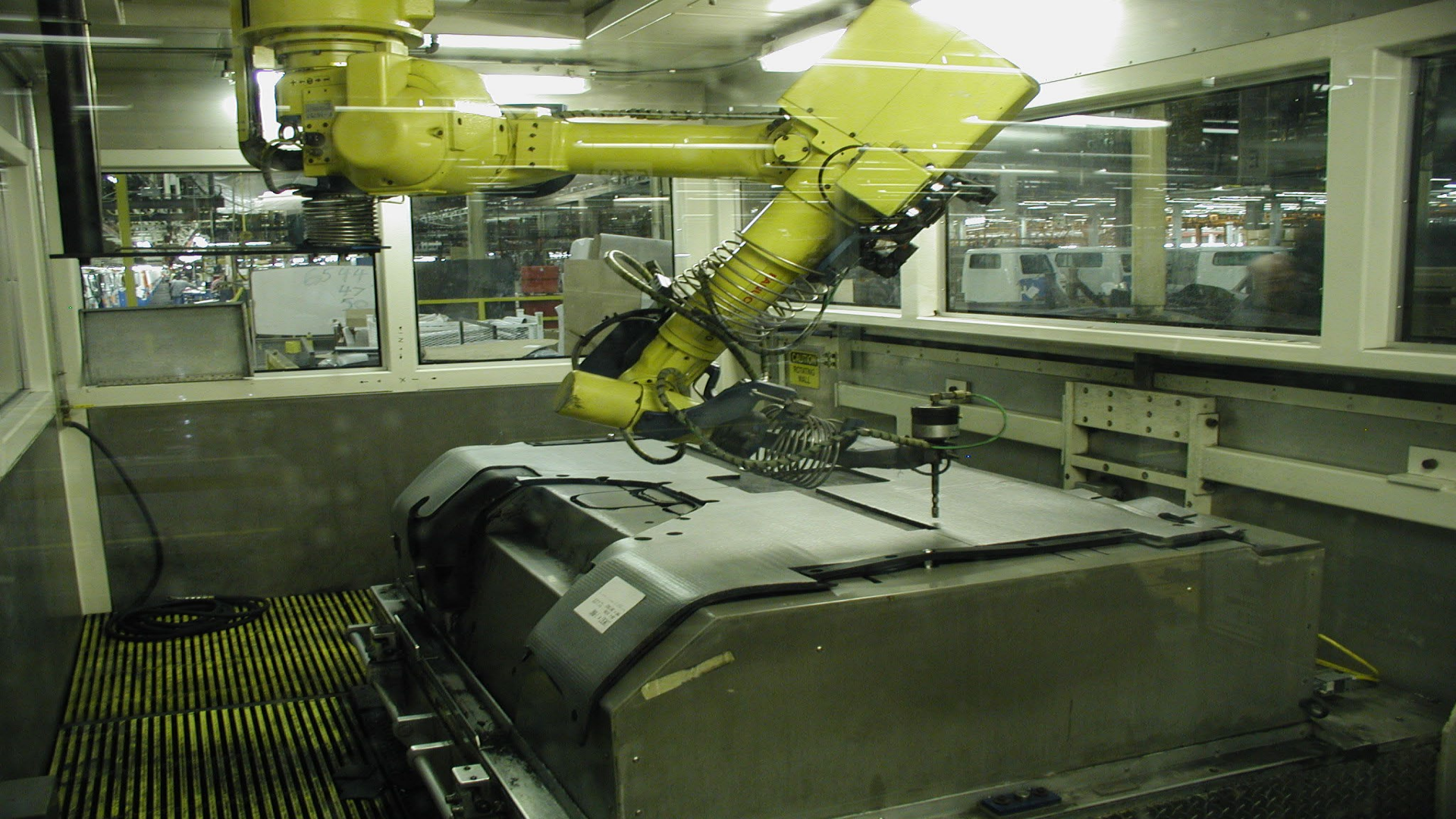


# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT				
SLIP/TRIP SAME LVL				
STRUCK BY ROBOT				
HIT HEAD ON ROBOT				



# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT				
SLIP/TRIP SAME LVL				
STRUCK BY ROBOT				
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				

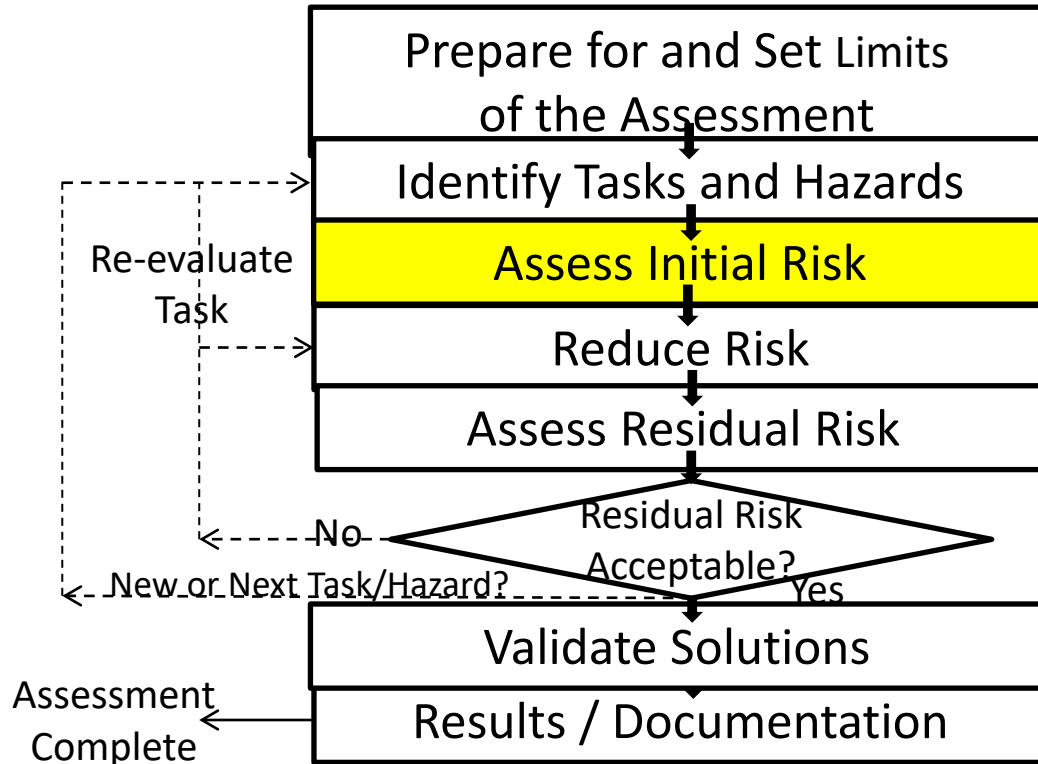
# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT				
SLIP/TRIP SAME LVL				
STRUCK BY ROBOT				
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TR R15.306 Process



# Risk Factors

Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )
Injury Severity	Serious – S3	Normally non-reversible
	Moderate – S2	Normally reversible
	Minor – S1	First aid
Exposure	Prevented – E0*	Appropriate safeguard installed (*only 2 <sup>nd</sup> time through)
	High – E2	Typically more than once per hour
	Low – E1	Typically less than once per day or shift
Avoidance	Not possible – A3	Trapping situation
	Not likely – A2	Insufficient clearance
	Likely – A1	Sufficient clearance

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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Avoidance	Not possible – A3	Trapping situation	
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	Likely – A1	Sufficient clearance	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2			
SLIP/TRIP SAME LVL				
STRUCK BY ROBOT				
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				



# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
Injury Severity	Serious – S3	Normally non-reversible	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2		
SLIP/TRIP SAME LVL				
STRUCK BY ROBOT				
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				



# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
Injury Severity	Serious – S3	Normally non-reversible	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL				
STRUCK BY ROBOT				
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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	Likely – A1	Sufficient clearance	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1			
STRUCK BY ROBOT				
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TASK

TASKS			HAZARDS	NOTES
LOAD/UNLOAD MAT				
CLEAN SCRAP INSIDE				
CHANGE TIP				
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )		
Injury Severity	Serious – S3	Normally non-reversible		
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2		
STRUCK BY ROBOT				
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT				
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TASK

TASKS			HAZARDS	NOTES
LOAD/UNLOAD MAT				
CLEAN SCRAP INSIDE				
CHANGE TIP				
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )		
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2			
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1		
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT				
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1			
HIGH PRESSURE H <sub>2</sub> O				
NOISE				



# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1		
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O				
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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	Moderate – S2	Normally reversible	
	Minor – S1	First aid	
Exposure	Prevented – E0*	Appropriate safeguard installed (*only 2 <sup>nd</sup> time through)	
	High – E2	Typically more than once per hour	
	Low – E1	Typically less than once per day or shift	
Avoidance	Not possible – A3	Trapping situation	
	Not likely – A2	Insufficient clearance	
	Likely – A1	Sufficient clearance	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O	S3			
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
Injury Severity	Serious – S3	Normally non-reversible	
	Moderate – S2	Normally reversible	
	Minor – S1	First aid	
Exposure	Prevented – E0*	Appropriate safeguard installed (*only 2 <sup>nd</sup> time through)	
	High – E2	Typically more than once per hour	
	Low – E1	Typically less than once per day or shift	
Avoidance	Not possible – A3	Trapping situation	
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	Likely – A1	Sufficient clearance	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O	S3	E1		
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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	Moderate – S2	Normally reversible	
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Exposure	Prevented – E0*	Appropriate safeguard installed (*only 2 <sup>nd</sup> time through)	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	
NOISE				

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	
NOISE	S3			

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	
NOISE	S3	E2		

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
Injury Severity	Serious – S3	Normally non-reversible	
	Moderate – S2	Normally reversible	
	Minor – S1	First aid	
Exposure	Prevented – E0*	Appropriate safeguard installed (*only 2 <sup>nd</sup> time through)	
	High – E2	Typically more than once per hour	
	Low – E1	Typically less than once per day or shift	
Avoidance	Not possible – A3	Trapping situation	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	
NOISE	S3	E2	A3	



# Risk Level Determination

Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level
S1 – Minor	E0 - Prevented		NEGLIGIBLE
	E1 - Low	A1 - Likely	
	E2 - High	A2/A3 - Not likely/possible	
			LOW
S2 – Moderate	E0 - Prevented		MEDIUM
	E1 - Low		
	E2 - High	A1 - Likely	HIGH
		A2/A3 - Not likely/possible	
S3 – Serious	E0 - Prevented		LOW
	E1 - Low		HIGH
	E2 - High	A1/A2 - Likely/Not likely	
		A3 - Not possible	VERY HIGH

# TASK

TASKS		HAZARDS	NOTES																																								
LOAD/UNLOAD MAT																																											
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CHANGE TIP																																											
<table><tr><th>Severity of Injury</th><th>Exposure to the Hazard</th><th>Avoidance of the Hazard</th><th>Risk Level</th></tr><tr><td rowspan="3">S1 – Minor</td><td>ED - Prevented</td><td></td><td rowspan="3">NEGLECTIBLE</td></tr><tr><td>E1 - Low</td><td>A1 - Likely</td></tr><tr><td>E2 - High</td><td>A2/A3 - Not likely/possible</td></tr><tr><td rowspan="3">S2 – Moderate</td><td>ED - Prevented</td><td></td><td rowspan="3">LOW</td></tr><tr><td>E1 - Low</td><td></td></tr><tr><td>E2 - High</td><td>A1 - Likely</td></tr><tr><td rowspan="3">S3 – Serious</td><td>ED - Prevented</td><td></td><td rowspan="3">MEDIUM</td></tr><tr><td>E1 - Low</td><td></td></tr><tr><td>E2 - High</td><td>A2/A3 - Not likely/possible</td></tr><tr><td rowspan="3"></td><td>ED - Prevented</td><td></td><td rowspan="3">HIGH</td></tr><tr><td>E1 - Low</td><td></td></tr><tr><td>E2 - High</td><td>A1/A2 - Likely/Not likely</td></tr><tr><td rowspan="3"></td><td></td><td>A3 - Not possible</td><td rowspan="3">VERY HIGH</td></tr></table>				Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level	S1 – Minor	ED - Prevented		NEGLECTIBLE	E1 - Low	A1 - Likely	E2 - High	A2/A3 - Not likely/possible	S2 – Moderate	ED - Prevented		LOW	E1 - Low		E2 - High	A1 - Likely	S3 – Serious	ED - Prevented		MEDIUM	E1 - Low		E2 - High	A2/A3 - Not likely/possible		ED - Prevented		HIGH	E1 - Low		E2 - High	A1/A2 - Likely/Not likely			A3 - Not possible	VERY HIGH
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	
NOISE	S3	E2	A3	

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			

Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level
S1 – Minor	ED - Prevented		NEGLECTIBLE
	E1 - Low	A1 - Likely	
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S2 – Moderate	ED - Prevented		LOW
	E1 - Low		
	E2 - High	A1 - Likely	MEDIUM
		A2/A3 - Not likely/possible	
S3 – Serious	ED - Prevented		LOW
	E1 - Low		HIGH
	E2 - High	A1/A2 - Likely/Not likely	
		A3 - Not possible	VERY HIGH

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	
NOISE	S3	E2	A3	

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
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S3 – Serious	ED - Prevented		LOW
	E1 - Low		HIGH
	E2 - High	A1/A2 - Likely/Not likely	
		A3 - Not possible	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	
NOISE	S3	E2	A3	

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			

Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level
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	E2 - High	A1 - Likely	MEDIUM
		A2/A3 - Not likely/possible	
S3 – Serious	ED - Prevented		LOW
	E1 - Low		HIGH
	E2 - High	A1/A2 - Likely/Not likely	
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	
NOISE	S3	E2	A3	

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			

Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level	
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S2 – Moderate	ED - Prevented		MEDIUM	
	E1 - Low			
		E2 - High	A1 - Likely	HIGH
			A2/A3 - Not likely/possible	LOW
S3 – Serious	ED - Prevented		HIGH	
	E1 - Low			
		E2 - High	A1/A2 - Likely/Not likely	VERY HIGH
			A3 - Not possible	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	

# TASK

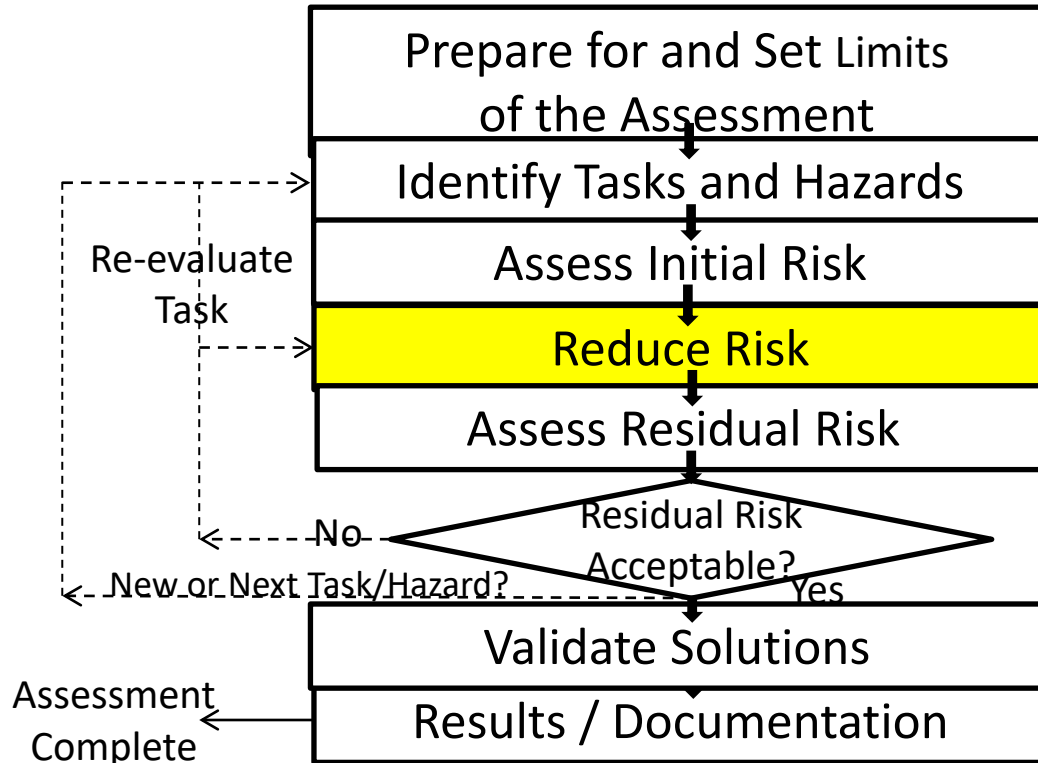
TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			

Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level	
S1 – Minor	ED - Prevented		NEGLECTIBLE	
	E1 - Low	A1 - Likely		
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S2 – Moderate	ED - Prevented		MEDIUM	
	E1 - Low			
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			A2/A3 - Not likely/possible	LOW
S3 – Serious	ED - Prevented		HIGH	
	E1 - Low			
		E2 - High	A1/A2 - Likely/Not likely	VERY HIGH
			A3 - Not possible	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH

# TR R15.306 Process






# Risk Reduction Selection

[illegible]

# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

		Risk Reduction Measure	Risk Level				
			VERY HIGH	HIGH	MEDIUM	LOW	NEGLECTIBLE
 <p>Most Preferred</p> <p>Least Preferred</p>	Elimination	One or a combination of Elimination, Substitution, and Safeguarding or SRP/CS is REQUIRED to reduce risks to an acceptable level.			One or any combination of the Risk Reduction Measures that will acceptably reduce the Risk Level may be used		
	Substitution						
	Safeguarding SRP/CS						
	Warnings and Awareness Means	Complementary Protective Measures may be used in conjunction with the above risk reduction measures but shall not be used as the primary risk reduction factor.					
	Administrative Controls						
	PPE						

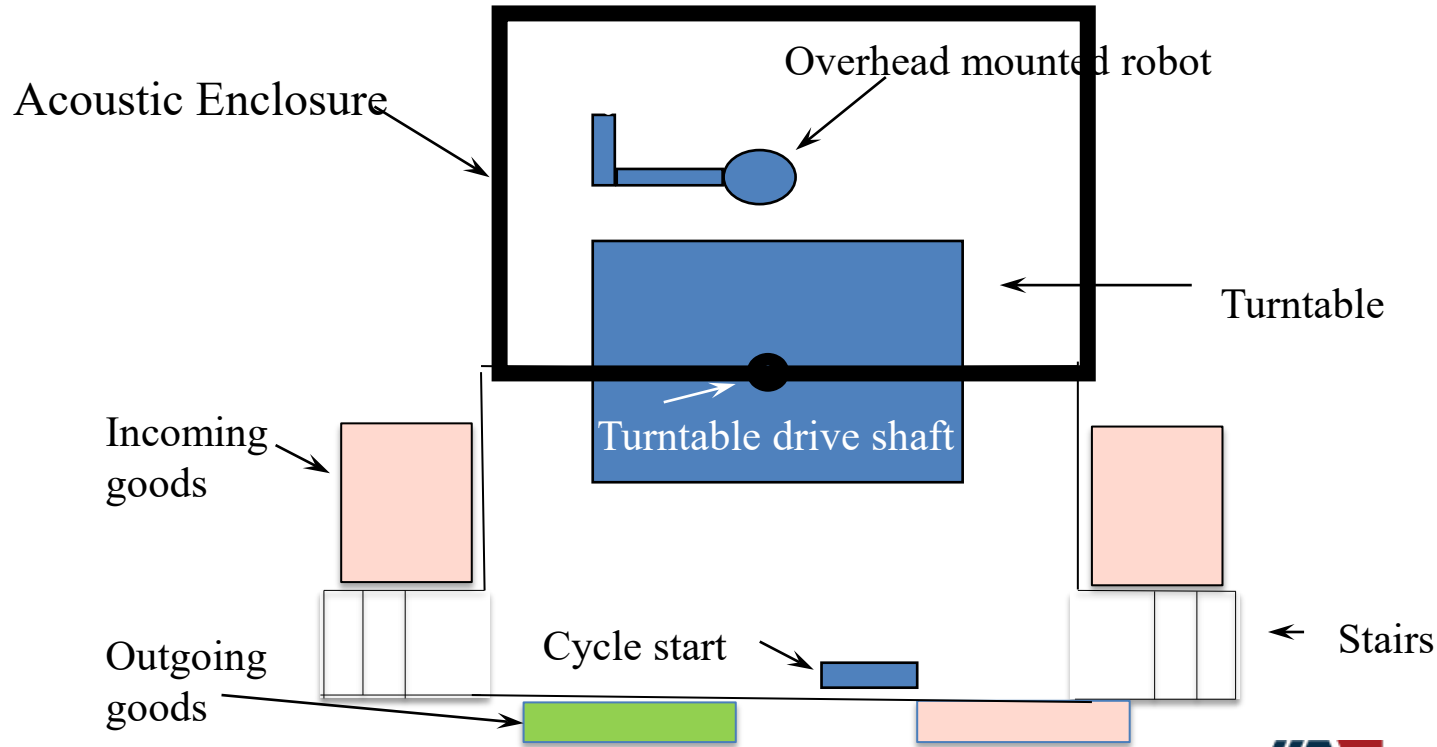
# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
<b>NOISE</b>	<b>S3</b>	<b>E2</b>	<b>A3</b>	<b>VH</b>

# Risk Reduction Selection

[illegible]

# Install Enclosure

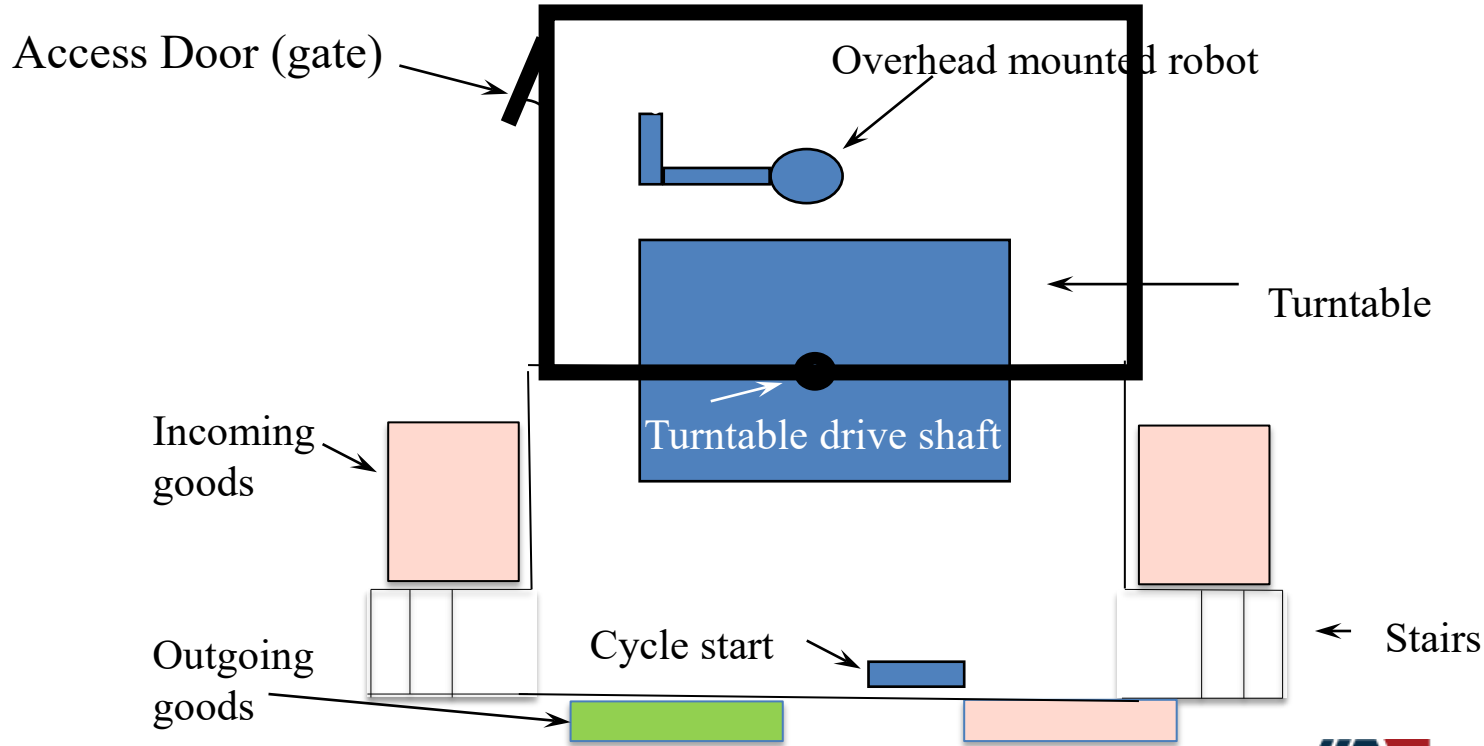


# Functional Safety

# SRP/CS

**Safety Related Part  
of the Control System**

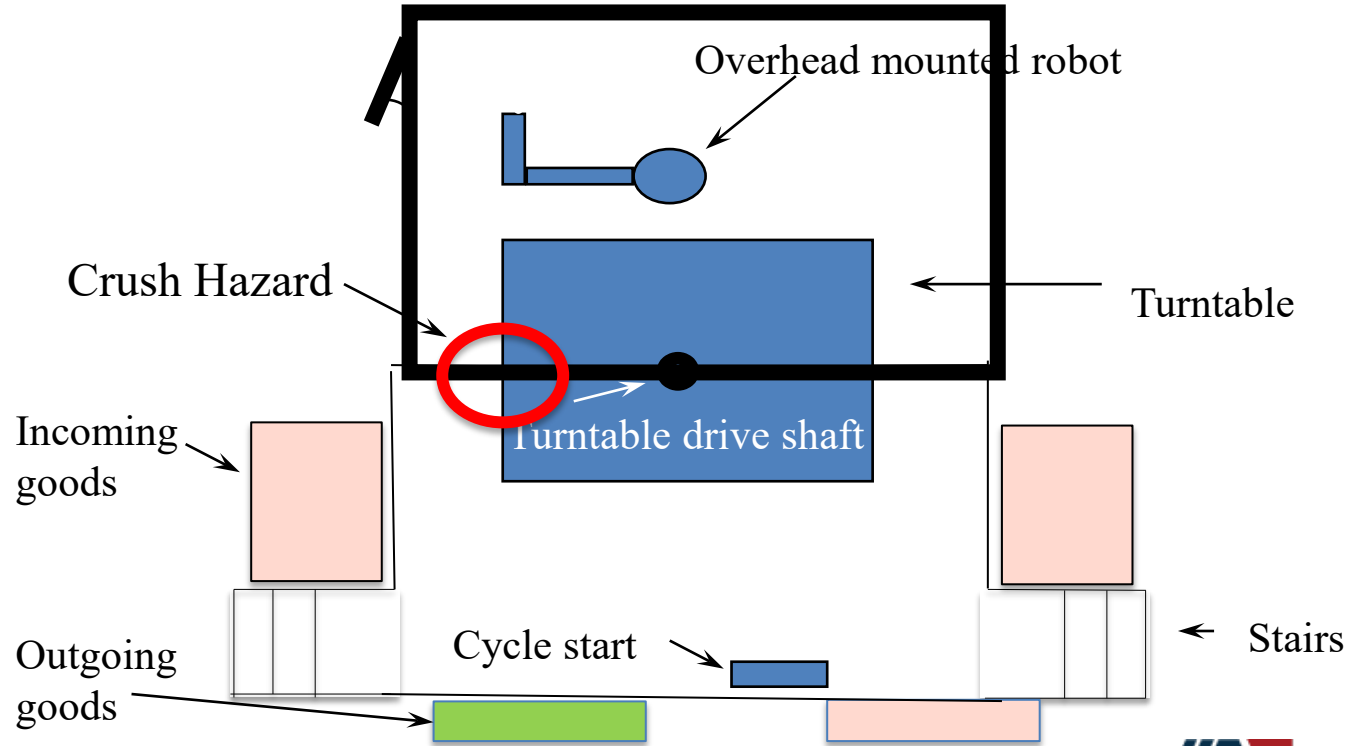
# Access to Enclosure



# Functional Safety

Risk Level	Minimum SRP/CS requirements	
	$PL_r$	Structure Category
<b>NEGLIGIBLE</b> (see 6.5.3.1)	<b>b</b>	-
<b>LOW</b>	<b>c</b>	<b>2</b>
<b>MEDIUM</b>	<b>d</b>	<b>2</b>
<b>HIGH</b>	<b>d</b>	<b>3</b>
<b>VERY HIGH</b> (see 6.5.3.2)	<b>e</b>	<b>4</b>

# New Hazard?





# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )	
Injury Severity	Serious – S3	Normally non-reversible	
	Moderate – S2	Normally reversible	
	Minor – S1	First aid	
Exposure	Prevented – E0*	Appropriate safeguard installed (*only 2 <sup>nd</sup> time through)	
	High – E2	Typically more than once per hour	
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# HAZARD

HAZARD	SV	EX	AV	RL
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STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT				

# TASK

TASKS			HAZARDS	NOTES
LOAD/UNLOAD MAT				
CLEAN SCRAP INSIDE				
CHANGE TIP				
Factor	Rating	Criteria (Examples – choose most likely <i>Read criteria from the top for each factor</i> )		
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	Minor – S1	First aid		
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
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STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3			

# TASK

TASKS			HAZARDS	NOTES
LOAD/UNLOAD MAT				
CLEAN SCRAP INSIDE				
CHANGE TIP				
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
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HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2		

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
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NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	

# TASK


TASKS		HAZARDS	NOTES	
LOAD/UNLOAD MAT				
CLEAN SCRAP INSIDE				
CHANGE TIP				
Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level	
S1 – Minor	ED - Prevented		NEGLECTIBLE	
	E1 - Low	A1 - Likely		
	E2 - High	A2/A3 - Not likely/possible		
S2 – Moderate	ED - Prevented		LOW	
	E1 - Low		MEDIUM	
	E2 - High	A1 - Likely		
			A2/A3 - Not likely/possible	HIGH
S3 – Serious	ED - Prevented		LOW	
	E1 - Low		HIGH	
	E2 - High	A1/A2 - Likely/Not likely		
			A3 - Not possible	VERY HIGH

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
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CRUSH BY TT	S3	E2	A3	H

# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		


		Risk Reduction Measure	Risk Level				
			VERY HIGH	HIGH	MEDIUM	LOW	NEGLECTIBLE
 <p>Most Preferred</p> <p>Least Preferred</p>	Elimination	One or a combination of Elimination, Substitution, and Safeguarding or SRP/CS is REQUIRED to reduce risks to an acceptable level.			One or any combination of the Risk Reduction Measures that will acceptably reduce the Risk Level may be used		
	Substitution						
	Safeguarding SRP/CS						
	Warnings and Awareness Means	Complementary Protective Measures may be used in conjunction with the above risk reduction measures but shall not be used as the primary risk reduction factor.					
	Administrative Controls						
	PPE						

# HAZARD

HAZARD	SV	EX	AV	RL
<b>STRUCK BY TT</b>	<b>S2</b>	<b>E2</b>	<b>A2</b>	<b>H</b>
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
<b>HIGH PRESSURE H<sub>2</sub>O</b>	<b>S3</b>	<b>E1</b>	<b>A2</b>	<b>H</b>
NOISE	S3	E2	A3	VH
<b>CRUSH BY TT</b>	<b>S3</b>	<b>E2</b>	<b>A2</b>	<b>H</b>

# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

		Risk Reduction Measure	Risk Level				
			VERY HIGH	HIGH	MEDIUM	LOW	NEGLECTIBLE
 <p>Most Preferred</p> <p>Least Preferred</p>	Elimination	One or a combination of Elimination, Substitution, and Safeguarding or SRP/CS is REQUIRED to reduce risks to an acceptable level.			One or any combination of the Risk Reduction Measures that will acceptably reduce the Risk Level may be used		
	Substitution						
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	Warnings and Awareness Means	Complementary Protective Measures may be used in conjunction with the above risk reduction measures but shall not be used as the primary risk reduction factor.					
	Administrative Controls						
	PPE						

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Risk Level	Minimum SRP/CS requirements		
	PL <sub>r</sub>	Structure Category	
NEGLIGIBLE (see 6.5.3.1)	b	-	
LOW	c	2	
MEDIUM	d	2	
HIGH	d	3	
VERY HIGH (see 6.5.3.2)	e	4	


# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H



# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
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		Risk Reduction Measure	Risk Level				
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<b>HIGH PRESSURE H<sub>2</sub>O</b>	<b>S3</b>	<b>E1</b>	<b>A2</b>	<b>H</b>
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H

# TASK


TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Risk Level	Minimum SRP/CS requirements		
	PL <sub>r</sub>	Structure Category	
<b>NEGLECTIBLE</b> (see 6.5.3.1)	<b>b</b>	-	
<b>LOW</b>	<b>c</b>	<b>2</b>	
<b>MEDIUM</b>	<b>d</b>	<b>2</b>	
<b>HIGH</b>	<b>d</b>	<b>3</b>	
<b>VERY HIGH</b> (see 6.5.3.2)	<b>e</b>	<b>4</b>	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
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HIGH PRESSURE H <sub>2</sub> O	<b>S3</b>	<b>E1</b>	<b>A2</b>	<b>H</b>
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H

# TASK

TASKS	HAZARDS	NOTES
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<b>STRUCK BY ROBOT</b>	<b>S2</b>	<b>E1</b>	<b>A2</b>	<b>M</b>
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HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H

# TASK


TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Risk Level	Minimum SRP/CS requirements		
	PL <sub>r</sub>	Structure Category	
NEGLIGIBLE (see 6.5.3.1)	b	-	
LOW	c	2	
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HIGH	d	3	
VERY HIGH (see 6.5.3.2)	e	4	

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<b>STRUCK BY ROBOT</b>	<b>S2</b>	<b>E1</b>	<b>A2</b>	<b>M</b>
HIT HEAD ON ROBOT	S1	E1	A1	N
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# TASK

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STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H

# TASK


TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Risk Level	Minimum SRP/CS requirements		
	PL <sub>r</sub>	Structure Category	
<b>NEGLECTIBLE</b> (see 6.5.3.1)	<b>b</b>	-	
<b>LOW</b>	<b>c</b>	<b>2</b>	
<b>MEDIUM</b>	<b>d</b>	<b>2</b>	
<b>HIGH</b>	<b>d</b>	<b>3</b>	
<b>VERY HIGH</b> (see 6.5.3.2)	<b>e</b>	<b>4</b>	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H

# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

		Risk Reduction Measure	Risk Level				
			VERY HIGH	HIGH	MEDIUM	LOW	NEGLECTIBLE
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	PPE						

# HAZARD

HAZARD	SV	EX	AV	RL
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HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H

# TASK

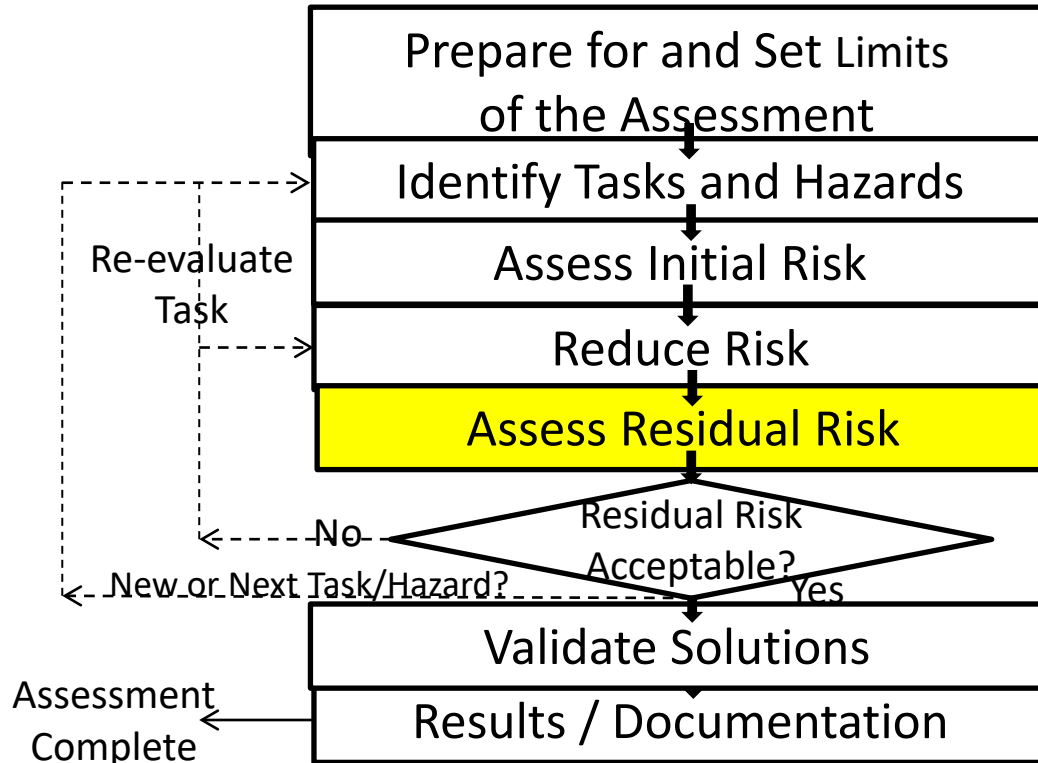
TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Risk Level	Minimum SRP/CS requirements		
	PL <sub>r</sub>	Structure Category	
NEGLIGIBLE (see 6.5.3.1)	b	-	
LOW	c	2	
MEDIUM	d	2	
HIGH	d	3	
VERY HIGH (see 6.5.3.2)	e	4	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
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HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H



# TR R15.306 Process



# Risk Level Determination

Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level
E0 - Prevented	A1 - Likely	A2/A3 - Not likely/possible	NEGLIGIBLE
		A2/A3 - Not likely/possible	LOW
E1 - Low	A1 - Likely	A2/A3 - Not likely/possible	MEDIUM
		A2/A3 - Not likely/possible	HIGH
E2 - High	A1/A2 - Likely/Not likely	A3 - Not possible	LOW
		A3 - Not possible	HIGH
			VERY HIGH

The second time through the table E0 may be used if the risk reduction measure did in fact limit exposure to the identified hazard

# TASK


TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		
Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard
S1 - Minor	ED - Prevented	
	E1 - Low	A1 - Likely
	E2 - High	A2/A3 - Not likely/possible
S2 - Moderate	ED - Prevented	
	E1 - Low	
	E2 - High	A1 - Likely
S3 - Serious	ED - Prevented	
	E1 - Low	
	E2 - High	A1/A2 - Likely/Not likely
		A3 - Not possible

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E1	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E2	A3	VH
CRUSH BY TT	S3	E2	A2	H

# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

		Risk Reduction Measure	Risk Level				
			VERY HIGH	HIGH	MEDIUM	LOW	NEGLECTIBLE
 <p>Most Preferred</p> <p>Least Preferred</p>	Elimination	One or a combination of Elimination, Substitution, and Safeguarding or SRP/CS is REQUIRED to reduce risks to an acceptable level.			One or any combination of the Risk Reduction Measures that will acceptably reduce the Risk Level may be used		
	Substitution						
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	Warnings and Awareness Means	Complementary Protective Measures may be used in conjunction with the above risk reduction measures but shall not be used as the primary risk reduction factor.					
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# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
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NOISE	S3	E0	A3	VH
CRUSH BY TT	S3	E2	A2	H

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Risk Level	Minimum SRP/CS requirements		
	PL <sub>r</sub>	Structure Category	
<b>NEGLECTIBLE</b> (see 6.5.3.1)	<b>b</b>	-	
<b>LOW</b>	<b>c</b>	<b>2</b>	
<b>MEDIUM</b>	<b>d</b>	<b>2</b>	
<b>HIGH</b>	<b>d</b>	<b>3</b>	
<b>VERY HIGH</b> (see 6.5.3.2)	<b>e</b>	<b>4</b>	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
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HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E1	A2	H
NOISE	S3	E0	A3	L
CRUSH BY TT	S3	E2	A2	H

# TASK


TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level
S1 – Minor	ED - Prevented		NEGLECTIBLE
	E1 - Low	A1 - Likely	
	E2 - High	A2/A3 - Not likely/possible	
S2 – Moderate	ED - Prevented		LOW
	E1 - Low		MEDIUM
	E2 - High	A1 - Likely	
		A2/A3 - Not likely/possible	
S3 – Serious	ED - Prevented		HIGH
	E1 - Low		LOW
	E2 - High	A1/A2 - Likely/Not likely	HIGH
		A3 - Not possible	VERY HIGH

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E2	A2	H
SLIP/TRIP SAME LVL	S1	E2	A1	L
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# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

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HAZARD	SV	EX	AV	RL
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NOISE	S3	E0	A3	L
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# TASK

TASKS		HAZARDS	NOTES
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	PL <sub>r</sub>	Structure Category	
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# TASK


TASKS	HAZARDS	NOTES
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Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard
S1 - Minor	ED - Prevented	
	E1 - Low	A1 - Likely
	E2 - High	A2/A3 - Not likely/possible
S2 - Moderate	ED - Prevented	
	E1 - Low	
	E2 - High	A1 - Likely
S3 - Serious	ED - Prevented	
	E1 - Low	
	E2 - High	A1/A2 - Likely/Not likely
		A3 - Not possible

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
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Risk Level	Minimum SRP/CS requirements		
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<b>NEGLECTIBLE</b> (see 6.5.3.1)	<b>b</b>	-	
<b>LOW</b>	<b>c</b>	<b>2</b>	
<b>MEDIUM</b>	<b>d</b>	<b>2</b>	
<b>HIGH</b>	<b>d</b>	<b>3</b>	
<b>VERY HIGH</b> (see 6.5.3.2)	<b>e</b>	<b>4</b>	

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# TASK


TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		
Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard
S1 - Minor	ED - Prevented	
	E1 - Low	A1 - Likely
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S2 - Moderate	ED - Prevented	
	E1 - Low	
	E2 - High	A1 - Likely
S3 - Serious	ED - Prevented	
	E1 - Low	
	E2 - High	A1/A2 - Likely/Not likely
		A3 - Not possible

# HAZARD

HAZARD	SV	EX	AV	RL
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# TASK

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CHANGE TIP		

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HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E0	A2	M
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A3	L
CRUSH BY TT	S3	E0	A2	L

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Risk Level	Minimum SRP/CS requirements		
	PL <sub>r</sub>	Structure Category	
<b>NEGLECTIBLE</b> (see 6.5.3.1)	<b>b</b>	-	
<b>LOW</b>	<b>c</b>	<b>2</b>	
<b>MEDIUM</b>	<b>d</b>	<b>2</b>	
<b>HIGH</b>	<b>d</b>	<b>3</b>	
<b>VERY HIGH</b> (see 6.5.3.2)	<b>e</b>	<b>4</b>	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E0	A2	L
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A3	L
CRUSH BY TT	S3	E0	A2	L

# TASK


TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		
Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard
S1 - Minor	ED - Prevented	
	E1 - Low	A1 - Likely
	E2 - High	A2/A3 - Not likely/possible
S2 - Moderate	ED - Prevented	
	E1 - Low	
	E2 - High	A1 - Likely
S3 - Serious	ED - Prevented	
	E1 - Low	
	E2 - High	A1/A2 - Likely/Not likely
		A3 - Not possible

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E2	A1	L
STRUCK BY ROBOT	S2	E0	A2	L
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A3	L
CRUSH BY TT	S3	E0	A3	L

# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

		Risk Reduction Measure	Risk Level				
			VERY HIGH	HIGH	MEDIUM	LOW	NEGUGIBLE
 <p>Most Preferred</p> <p>Least Preferred</p>	Elimination	One or a combination of Elimination, Substitution, and Safeguarding or SRP/CS is REQUIRED to reduce risks to an acceptable level.			One or any combination of the Risk Reduction Measures that will acceptably reduce the Risk Level may be used		
	Substitution						
	Safeguarding SRP/CS						
	Warnings and Awareness Means	Complementary Protective Measures may be used in conjunction with the above risk reduction measures but shall not be used as the primary risk reduction factor.					
	Administrative Controls						
	PPE						

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E0	A1	L
STRUCK BY ROBOT	S2	E0	A2	L
HIT HEAD ON ROBOT	S1	E1	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A3	L
CRUSH BY TT	S3	E0	A2	L



# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Risk Level	Minimum SRP/CS requirements		
	PL <sub>r</sub>	Structure Category	
<b>NEGLECTIBLE</b> (see 6.5.3.1)	<b>b</b>	-	
<b>LOW</b>	<b>c</b>	<b>2</b>	
<b>MEDIUM</b>	<b>d</b>	<b>2</b>	
<b>HIGH</b>	<b>d</b>	<b>3</b>	
<b>VERY HIGH</b> (see 6.5.3.2)	<b>e</b>	<b>4</b>	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E0	A1	N
STRUCK BY ROBOT	S2	E0	A2	L
HIT HEAD ON ROBOT	S1	E0	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A3	L
CRUSH BY TT	S3	E0	A2	L

# TASK


TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level
S1 – Minor	ED - Prevented		NEGLECTIBLE
	E1 - Low	A1 - Likely	
	E2 - High	A2/A3 - Not likely/possible	
S2 – Moderate	ED - Prevented		LOW
	E1 - Low		
	E2 - High	A1 - Likely	
S2 – Moderate	E2 - High	A2/A3 - Not likely/possible	MEDIUM
	ED - Prevented		
	E1 - Low		
S3 – Serious	ED - Prevented		HIGH
	E1 - Low		
	E2 - High	A1/A2 - Likely/Not likely	
S3 – Serious	E2 - High	A3 - Not possible	VERY HIGH
	ED - Prevented		
	E1 - Low		

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E0	A1	N
STRUCK BY ROBOT	S2	E0	A2	L
HIT HEAD ON ROBOT	S1	E1	A1	<b>N</b>
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A3	L
CRUSH BY TT	S3	E0	A3	L

# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

		Risk Reduction Measure	Risk Level				
			VERY HIGH	HIGH	MEDIUM	LOW	NEGLECTIBLE
 <p>Most Preferred</p> <p>Least Preferred</p>	Elimination	One or a combination of Elimination, Substitution, and Safeguarding or SRP/CS is REQUIRED to reduce risks to an acceptable level.			One or any combination of the Risk Reduction Measures that will acceptably reduce the Risk Level may be used		
	Substitution						
	Safeguarding SRP/CS						
	Warnings and Awareness Means	Complementary Protective Measures may be used in conjunction with the above risk reduction measures but shall not be used as the primary risk reduction factor.					
	Administrative Controls						
	PPE						

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E0	A1	N
STRUCK BY ROBOT	S2	E0	A2	L
HIT HEAD ON ROBOT	S1	E0	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A3	L
CRUSH BY TT	S3	E0	A2	L

# TASK

TASKS		HAZARDS	NOTES
LOAD/UNLOAD MAT			
CLEAN SCRAP INSIDE			
CHANGE TIP			
Risk Level	Minimum SRP/CS requirements		
	PL <sub>r</sub>	Structure Category	
<b>NEGLECTIBLE</b> (see 6.5.3.1)	<b>b</b>	-	
<b>LOW</b>	<b>c</b>	<b>2</b>	
<b>MEDIUM</b>	<b>d</b>	<b>2</b>	
<b>HIGH</b>	<b>d</b>	<b>3</b>	
<b>VERY HIGH</b> (see 6.5.3.2)	<b>e</b>	<b>4</b>	

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E0	A1	N
STRUCK BY ROBOT	S2	E0	A2	L
HIT HEAD ON ROBOT	S1	E0	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A3	L
CRUSH BY TT	S3	E0	A2	L

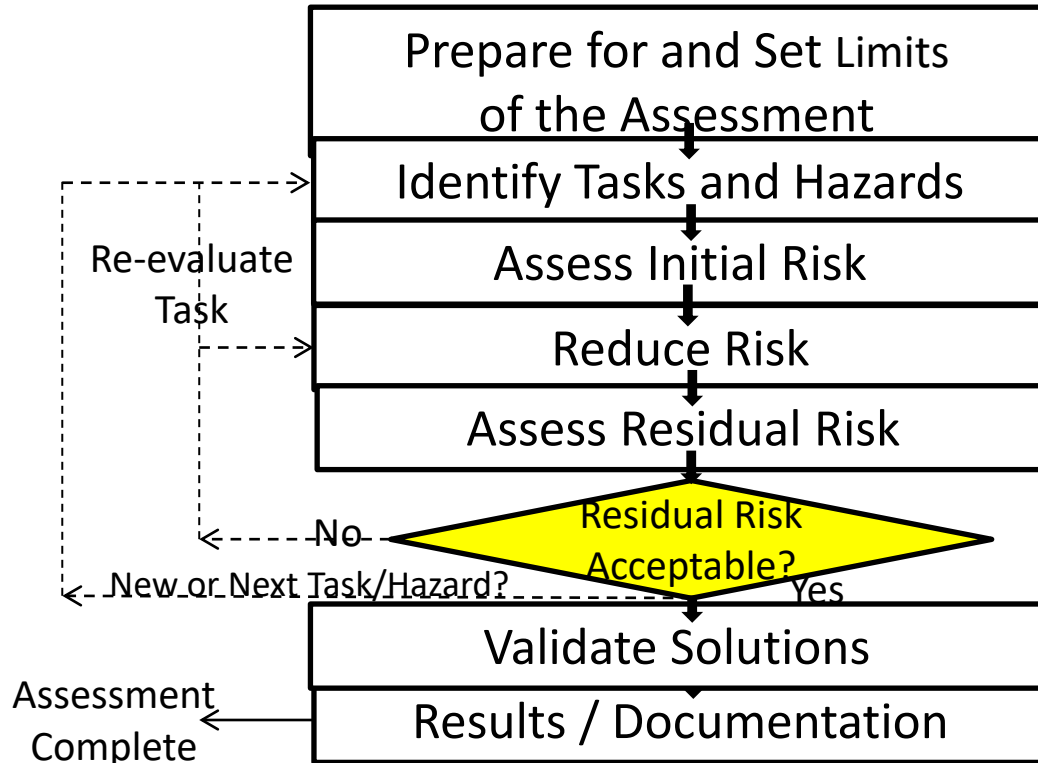
# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E0	A1	N
STRUCK BY ROBOT	S2	E0	A2	L
HIT HEAD ON ROBOT	S1	E0	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A2	L
CRUSH BY TT	S3	E0	A2	L

# TR R15.306 Process



# Residual Risk Defined

- Residual Risk is the level of risk remaining after controls have been implemented. Controls are altered until the residual risk is at an acceptable level or until it cannot practically be further reduced.

# Acceptable Residual Risk

- RIA TR R15.306 says risk is acceptable when a **low** or **negligible** risk level is reached the second time through the decision matrix.



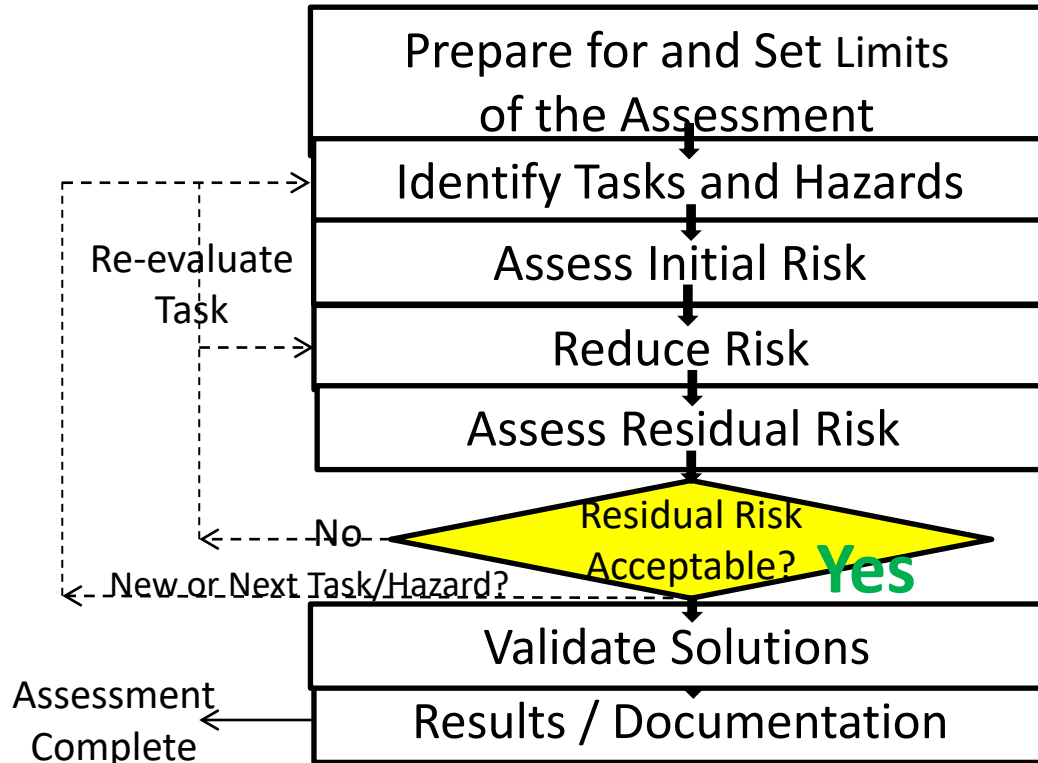
# TASK

TASKS	HAZARDS	NOTES
LOAD/UNLOAD MAT		
CLEAN SCRAP INSIDE		
CHANGE TIP		

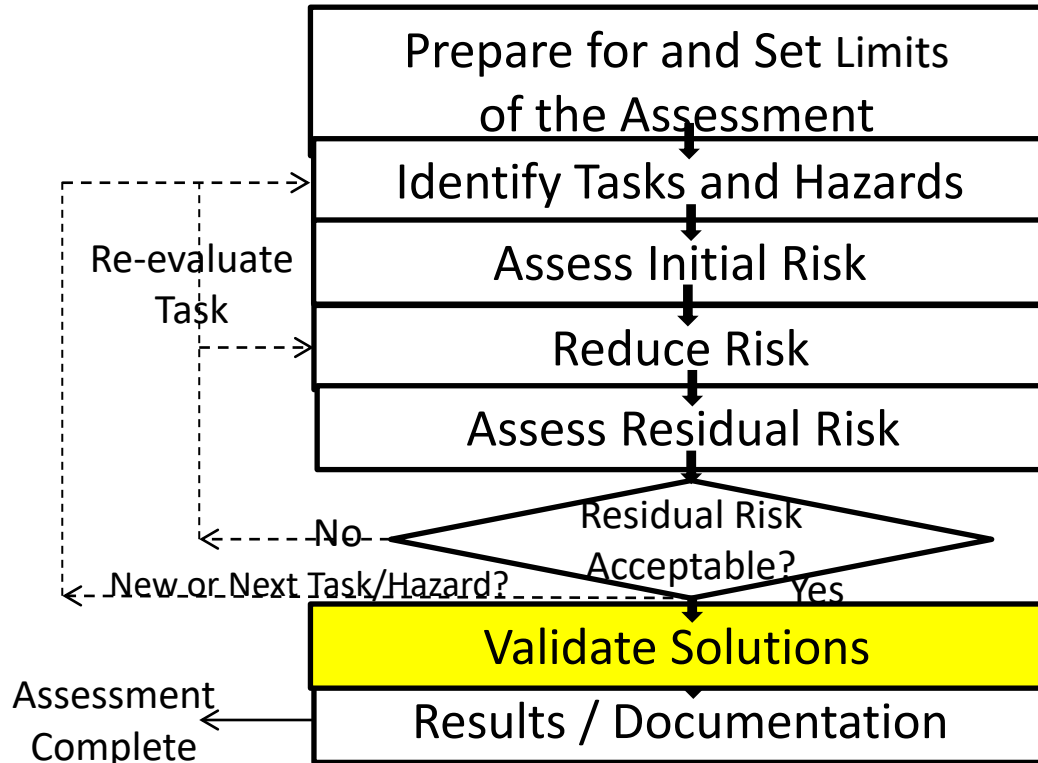
# HAZARD

HAZARD	SV	EX	AV	RL
STRUCK BY TT	S2	E0	A2	L
SLIP/TRIP SAME LVL	S1	E0	A1	N
STRUCK BY ROBOT	S2	E0	A2	L
HIT HEAD ON ROBOT	S1	E0	A1	N
HIGH PRESSURE H <sub>2</sub> O	S3	E0	A2	L
NOISE	S3	E0	A2	L
CRUSH BY TT	S3	E0	A2	L

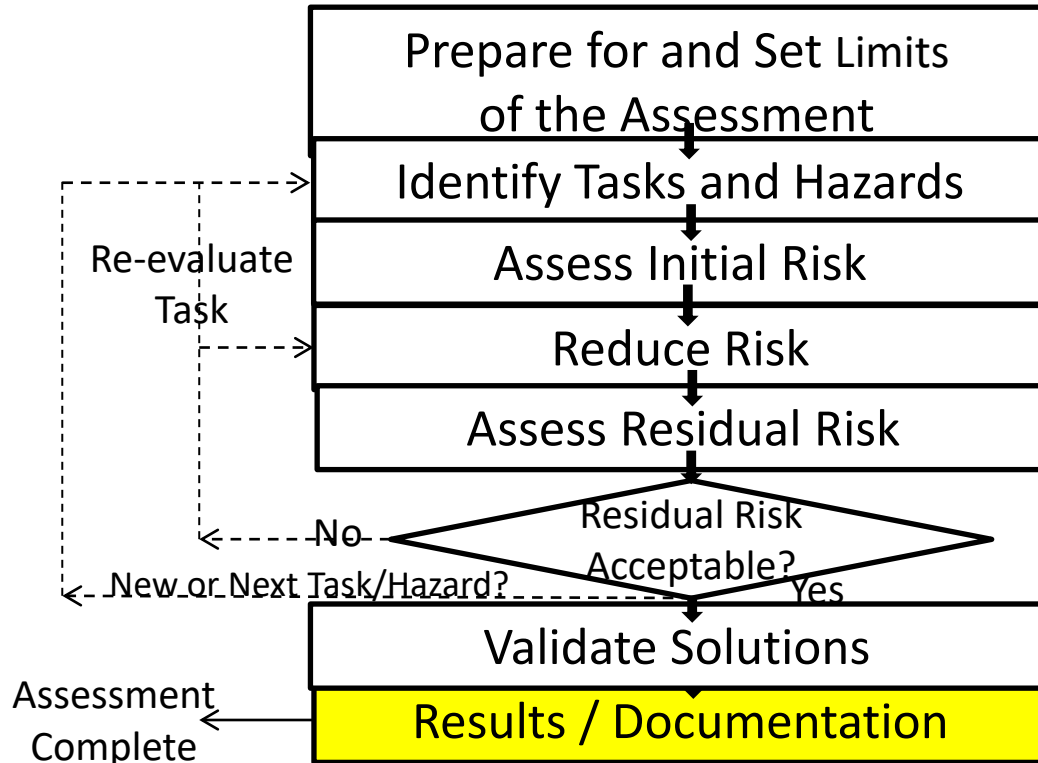
# TR R15.306 Process



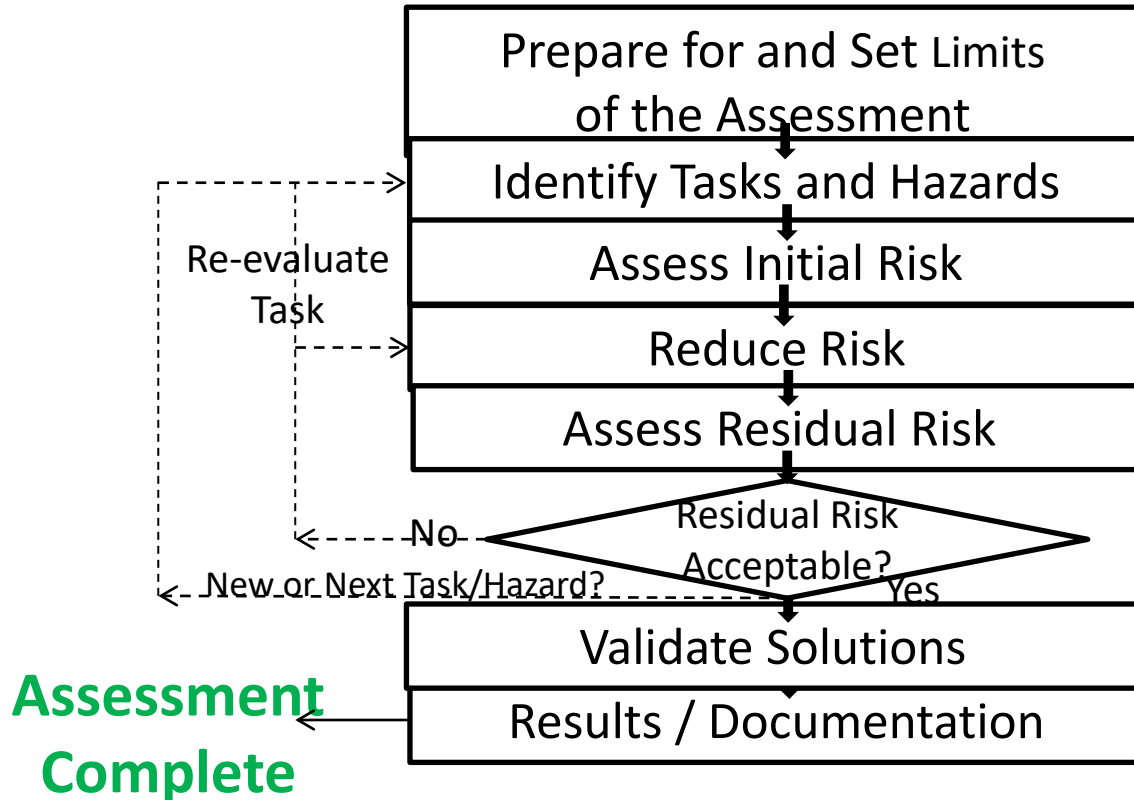
# TR R15.306 Process



# TR R15.306 Process



# TR R15.306 Process



THANK YOU!