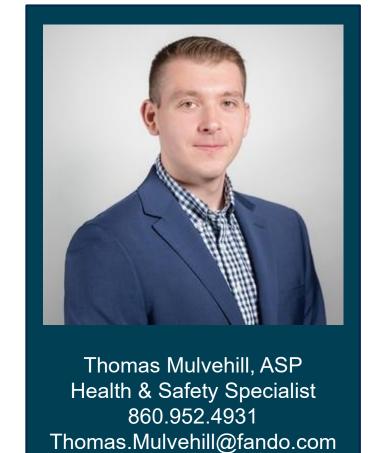


# Robotics Safety and Risk Assessment



## Introduction



## FUSS&O'NEILL Manufacturing Solutions

- Multi-disciplinary consulting services:
  - Manufacturing Equipment and Maintenance Support:
    - Maintenance Excellence
    - Total Productive Maintenance
    - Reliability Engineering
  - Health & Safety Support:
    - Machine Guarding
    - Risk Assessment
    - Supplemental EH&S Support
    - Industrial Hygiene



### What is an Industrial Robot?

"automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications"

- ANSI/RIA R15.06-2012





## Why Care About Robotic Safety?

## Further Assess Robotic System Safety:

- Occupational Health and Safety Administration Regulation
- Better understand risks within facility
- Provide a safe work environment for employees
- Comply with Industry best practices





## Standards for Industrial Robot Safety

#### Current



Photo Credit: <u>Association for</u> Advancing Automation



#### **Future**

ISO

ISO 10218-1 2006

Edition 1 2006 ISO 10218-1,2 2011

Adopted as ANSI R15.06 in the United States.

ISO 10218-1,2 2025

Expected to be adopted in the US as an updated version of ANSI R15.06 later in 2025.



Photo Credit: Inmotion Technology Distribution



### ANSI/RIA Method for Robotic Risk Assessments

#### ANSI/RIA TR R15.306-2016

- Task Based Risk Assessment
  - Severity of Injury
  - Exposure to Hazard
  - Avoidance of Hazard
- Controlled vs. Uncontrolled Risk

#### ANSI/RIA TR R15.306-2016 Method

			Potential Hazards		NSI/ 2016	'RIA 5 Me	to Safeguardir TR R15.306- ethodology Tables)	ng (Initial Risks)	Risk Reduction Measures		Verification and Valida of Risk Reduction Measures (See Tables)			
SEQ	Task	Steps			Exposure	Avoidance	Risk Level	Current Controls for existing systems (Usually N/A)			Exposure	Avoidance	Risk Level	
1	Workpiece loading	Load part on fixture	Struck by robot Hazard	SS Severity	E2	Α1	High		Interlocked enclosure	SS Severity	E0	A1	Low	
			Struck by robot Hazard	S3	E2	Α1	High		Emergency stop(s) accessible	S3	EO		Low	
			Inhalation of toxic dust hazard	S2	E2	A1	Medium		Ventilation system	S2	EO		Low	

#### Modified Method F&O Uses

		People at Risk				INITIA	AL ASSESSMI	ENT			FINAL ASSESSMENT		
			3			Severity		ISC	13849-1	Control Measure(s)	Severity		
Condition of Use (Task)	Hazard(s) / Failure Mode	Operator	Maintenance	Contractors	Any other	Frequency Likelihood Avoidance Number of Persons	Risk Level HRN	S, F, P	PL,	degree of protection the	Frequency Likelihood Avoidance Number of Persons	Risk Level (HRN)	
Machina Dawe Ha						Break major bone or major illness	Low But	S2		See control measures: 1, 2, 3	Break major bone or major illness	Negligible	
Machine Power-Up	Unexpected machine motion or the release of stored energy that could lead to personnel injury.	Х				Daily	Significant	F1			Daily		
Power up machine and			X			Probable, not surprising			С		Unlikely but could occur		
engage air and water supply.						Possible under specific conditions	40	P1			Possible	2.25	
						1-2 persons					1-2 persons		
	Unfamiliarity with	X				Break major bone or major illness	Low But	S2			Break major bone or major illness		
Turn Control Power On	machine functions or					Daily	Significant	F1		See control measures:	Daily	Negligible	
Power to robotic control	interlocks cause unexpected motion that		Х			Probable, not surprising			С		Unlikely but could occur		
system is turned on.	could lead to personnel					Possible under specific conditions	40	P1		1, 2, 4	Possible	2.25	
	injury.					1-2 persons					1-2 persons		



Gather Team

Develop
Task /
Hazard List

Assess
Uncontrolled
Risk

Review
Controls

Review
Controls

Risk

Assess
Controlled
Risk

Action Plan





**Gather Team** 

Develop Task / Hazard List Assess Uncontrolled Risk

Review Controls

Assess Controlled Risk

		Pe	ople	at R	lisk	INIT <i>IA</i>	L ASSESSM	ENT			FINAL ASSESSMENT		
		Г	<	0		Severity		ISC	13849-1	Control Measure(s)	Severity		
Condition of Use (Task)	Hazard(s) / Failure Mode	Operator	Maintenance	Contractors	Any other	Frequency Likelihood Avoidance Number of Persons	Risk Level HRN	S, F, P	$PL_r$	You cannot use risk assessment to lower the degree of protection the standards require!	Frequency Likelihood Avoidance Number of Persons	Risk Level (HRN)	
Machine Power-Up						Break major bone or major illness	Low But	S2		See control measures:	Break major bone or major illness		
Machine Power-Up	Unexpected machine					Daily	Significant	F1			Daily	Negligible	
Power up machine and	motion or the release of stored energy that could	Х	X			Probable, not surprising			С		Unlikely but could occur		
engage air and water supply.	lead to personnel injury.					Possible under specific conditions	40	P1			Possible	2.25	
						1-2 persons					1-2 persons		
	Unfamiliarity with machine functions or interlocks cause unexpected motion that could lead to personnel injury.		Х			Break major bone or major illness	Low But	S2		See control measures:	Break major bone or major illness		
Turn Control Power On						Daily	Significant	F1			Daily	Negligible	
Power to robotic control		Х				Probable, not surprising			С	4.0.4	Unlikely but could occur		
system is turned on.						Possible under specific conditions	40	P1		1, 2, 4	Possible	2.25	
				╙		1-2 persons					1-2 persons		
Set-up	Contact with the					Loss of two limbs, eyes (permanent)		S2	_	See control measures: 13, 16, 67, 86, 87, 93,100	Break major bone or major illness		
· ·	movement of the robotic manipulator or contact					Hourly	High	F2			Daily	Negligible	
Operator installs appropriate fixtures for	with high pressure water	Х				Probable, not surprising			d		Unlikely but could occur		
part drop off/ pick-up area.	leading to injury. Contact with door movement					Possible under specific conditions	160	P1			Possible	2.25	
alea.	resulting in injury.					1-2 persons	100				1-2 persons		
	Contact with the	Г				Loss of two limbs, eyes (permanent)		S2			Break major bone or major illness		
Loading Part	movement of the robotic					Hourly	High	F2	d	See control measures: 13, 16, 67, 86, 87, 93,100	Hourly	Negligible	
Place part in designated	manipulator or contact with high pressure water	Х				Probable, not surprising					Unlikely but could occur		
area and close the load door.	leading to injury. Contact with door movement					Possible under specific conditions	160	P1			Possible	3.6	
	resulting in injury.					1-2 persons	100				1-2 persons	3.6	



**Gather Team** 

Develop Task / Hazard List Assess Uncontrolled Risk

Review Controls

Assess Controlled Risk

		Pe	ople	at F	Risk	INITIA	L ASSESSM	ENT			FINAL ASSESS	MENT	
		Operator	3	٥		Severity		ISO	13849-1	Control Measure(s)	Severity		
Condition of Use (Task)	Hazard(s) / Failure Mode		Maintenance	Contractors	Any other	Frequency Likelihood Avoidance Number of Persons	Risk Level HRN S, F, P PL <sub>r</sub>			Errequency Likelihood Avoidance Number of Persons	Risk Level (HRN)		
Mashina Dawan Un						Break major bone or major illness	Low But	S2			Break major bone or major illness		
Machine Power-Up	Unexpected machine					Daily	Significant	F1		See control measures:	Daily	Negligible	
Power up machine and	motion or the release of stored energy that could	Х	Х			Probable, not surprising			С		Unlikely but could occur		
engage air and water supply.	lead to personnel injury.					Possible under specific conditions	40	P1			Possible	2.25	
						1-2 persons					1-2 persons		
	Unfamiliarity with machine functions or interlocks cause unexpected motion that could lead to personnel injury.					Break major bone or major illness	Low But Significant	S2			Break major bone or major illness		
Turn Control Power On			х			Daily		F1		See control measures:	Daily	Negligible	
Power to robotic control		Х				Probable, not surprising			С		Unlikely but could occur		
system is turned on.						Possible under specific conditions	40	P1		1, 2, 4	Possible	2.25	
						1-2 persons					1-2 persons		
Set-up	Contact with the					Loss of two limbs, eyes (permanent)	High	S2		See control measures: 13, 16, 67, 86, 87, 93,100	Break major bone or major illness		
,	movement of the robotic manipulator or contact					Hourly		F2			Daily	Negligible	
Operator installs appropriate fixtures for	with high pressure water	Х				Probable, not surprising			d		Unlikely but could occur		
part drop off/ pick-up area.	leading to injury. Contact with door movement					Possible under specific conditions	160	P1			Possible		
alea.	resulting in injury.					1-2 persons	100				1-2 persons	2.20	
	Contact with the					Loss of two limbs, eyes (permanent)		S2			Break major bone or major illness		
Loading Part	movement of the robotic manipulator or contact					Hourly	High	F2		See control measures: 13, 16, 67, 86, 87, 93,100	Hourly	Negligible	
Place part in designated	with high pressure water	Χ				Probable, not surprising			d		Unlikely but could occur		
area and close the load door.	leading to injury. Contact with door movement					Possible under specific conditions	160	P1			Possible	2.6	
	resulting in injury.					1-2 persons	100				1-2 persons	3.6	



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Develop Task / Hazard List Assess Uncontrolled Risk

Review Controls

Assess Controlled Risk

		Pe	ople	at R	isk	INITIA	L ASSESSM	ENT			FINAL ASSESSMENT		
Condition of Use (Task)	Hazard(s) / Failure Mode	Operator	Maintenance	Any other Contractors Maintenance		Severity Frequency Likelihood Avoidance Number of Persons	Risk Level HRN	ISC S, F, P	9 13849-1 PL <sub>r</sub>	You cannot use risk assessment to lower the degree of protection the standards require!	Severity Frequency Likelihood Avoidance Number of Persons	Risk Level (HRN)	
Maskins Davisa Ha						Break major bone or major illness	Low But Significant	S2		See control measures:	Break major bone or major illness		
Machine Power-Up	Unexpected machine		}			Daily		F1			Daily	Negligible	
Power up machine and	motion or the release of stored energy that could	Х	Х			Probable, not surprising			С		Unlikely but could occur		
engage air and water supply.	lead to personnel injury.					Possible under specific conditions	40	P1			Possible	2.25	
						1-2 persons					1-2 persons		
	Unfamiliarity with machine functions or interlocks					Break major bone or major illness	Low But	S2		See control measures:	Break major bone or major illness		
Turn Control Power On						Daily	Significant	F1			Daily	Negligible	
Power to robotic control	cause unexpected motion	Х	Х			Probable, not surprising			С	4.0.4	Unlikely but could occur		
system is turned on.	that could lead to personnel injury.					Possible under specific conditions	40	P1		1, 2, 4	Possible	2.25	
						1-2 persons					1-2 persons	_	
Set-up	Contact with the movement of the robotic manipulator or contact					Loss of two limbs, eyes (permanent)		S2		See control measures:	Break major bone or major illness	Negligible - 2.25	
'						Hourly	High	F2			Daily		
Operator installs appropriate fixtures for	with high pressure water	Х				Probable, not surprising			d		Unlikely but could occur		
part drop off/ pick-up	leading to injury. Contact with door movement					Possible under specific conditions	160	P1		13, 16, 67, 86, 87, 93,100	Possible		
area.	resulting in injury.					1-2 persons	100				1-2 persons		
	Contact with the					Loss of two limbs, eyes (permanent)		S2			Break major bone or major illness		
Loading Part	movement of the robotic manipulator or contact					Hourly	High	F2		See control measures: 13, 16, 67, 86, 87, 93,100	Hourly	Negligible	
Place part in designated	with high pressure water	Х				Probable, not surprising			d		Unlikely but could occur		
area and close the load door.	leading to injury. Contact with door movement					Possible under specific conditions	160	P1			Possible	3.6	
	resulting in injury.					1-2 persons	100				1-2 persons		



**Gather Team** 

Develop Task / Hazard List Assess Uncontrolled Risk

Review Controls

Assess Controlled Risk





**Gather Team** 

Develop Task / Hazard List Assess Uncontrolled Risk

Review Controls

Assess Controlled Risk

		Pe	ople	at R	lisk	INITIA	L ASSESSM	ENT			FINAL ASSESSMENT		
Candition of Han	Hanard(a) / Failura	0	Ма	င္ပ	Þ	Severity		ISC	) 13849-1 I	Vou connet use riek	Severity		
Condition of Use (Task)	Hazard(s) / Failure Mode	Operator	Maintenance	Contractors	Any other	Frequency Likelihood Avoidance Number of Persons	Risk Level HRN	S, F, P	PL <sub>r</sub>	assessment to lower the degree of protection the standards require!	Frequency Likelihood Avoidance Number of Persons	Risk Level (HRN)	
Machine Power-Up						Break major bone or major illness	Low But	Low But S2			Break major bone or major illness		
Macrime Power-op	Unexpected machine					Daily	Significant	F1	1	See control measures:	Daily	Negligible	
Power up machine and	motion or the release of stored energy that could	Х	Х			Probable, not surprising			С	1, 2, 3	Unlikely but could occur		
engage air and water supply.	lead to personnel injury.					Possible under specific conditions	40	P1			Possible	2.25	
						1-2 persons					1-2 persons		
	Unfamiliarity with machine functions or interlocks cause unexpected motion that could lead to personnel injury.					Break major bone or major illness	Low But	S2	С	See control measures:	Break major bone or major illness		
Turn Control Power On						Daily	Significant	F1			Daily	Negligible	
Power to robotic control		X	Х			Probable, not surprising				4.0.4	Unlikely but could occur		
system is turned on.						Possible under specific conditions	40	P1		1, 2, 4	Possible	2.25	
						1-2 persons					1-2 persons		
Set-up	Contact with the	x				Loss of two limbs, eyes (permanent)		S2		See control measures: 13, 16, 67, 86, 87, 93,100	Break major bone or major illness	Negligible	
,	movement of the robotic manipulator or contact					Hourly	High	F2			Daily		
Operator installs appropriate fixtures for	with high pressure water leading to injury. Contact					Probable, not surprising			d		Unlikely but could occur		
part drop off/ pick-up	with door movement					Possible under specific conditions	160	P1			Possible		
area.	resulting in injury.					1-2 persons	100				1-2 persons		
	Contact with the					Loss of two limbs, eyes (permanent)		S2			Break major bone or major illness		
Loading Part	movement of the robotic manipulator or contact					Hourly	High	F2		See control measures:	Hourly	Negligible	
Place part in designated	with high pressure water	Х				Probable, not surprising			d		Unlikely but could occur		
area and close the load door.	leading to injury. Contact with door movement					Possible under specific conditions	160	P1		13, 16, 67, 86, 87, 93,100	Possible	3.6	
	resulting in injury.					1-2 persons					1-2 persons	0.0	



> Gather Team

Develop Task / Hazard List Assess Uncontrolled Risk

Review Controls

Assess Controlled Risk

Develop Corrective Action Plan

Employee may become trapped inside of the robotic cell.

· Install emergency door releases inside of cell.

Employee may remain in cell with robotic system running in auto mode.

Install an area scanner inside of the cell.

Two employees may be involved in the robotic teaching process, however only one pendant is available for use.

• Install a secondary non-teach pendant equipped with an emergency stop and 3-position switch.

Teach pendant is equipped with a 2-position switch.

• Upgrade to a new teach pendant equipped with a 3-position switch.

Interior of robotic cell is not equipped with means to stop robotic operation.

• Install emergency stops inside of the cell.



## Questions

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Solve better. Go further.