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MAKESAFE® TOOLS

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OneBeacon TECHNOLOGY INSURANCE

A recording of this live presentation is available online at:
https://youtu.be/CQD655bIt4g

Risk Assessments

How to get started …
… and what they don't tell you in school.

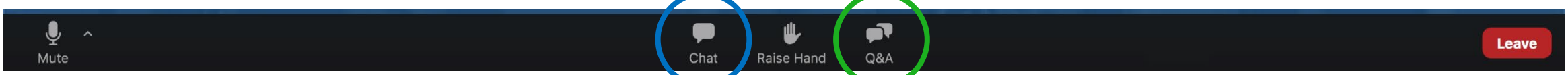
www.makesafetools.com | scott@makesafetools.com | (415) 937-1808

Zoom Webinar Participation

Use the **chat feature** to introduce yourself and chat with other attendees.

Attendee microphones are disabled by default.

Use the **Q&A** to ask the presenter questions.



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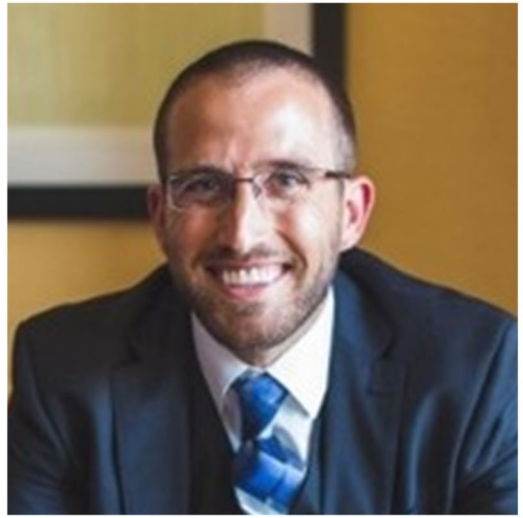
Our Speaker

- Active participant in regulatory process with the NFPA, OSHPD, NRTLs, and CAL/OSHA.
- Over a decade of experience with electrical design for hospitals, data centers, and renewable energy systems.
- Managed production and training shops across three industries.
- Carpenter, machinist, programmer, engineer.
- Has been featured in four documentary films, holds a US patent, and loves his greyhounds.



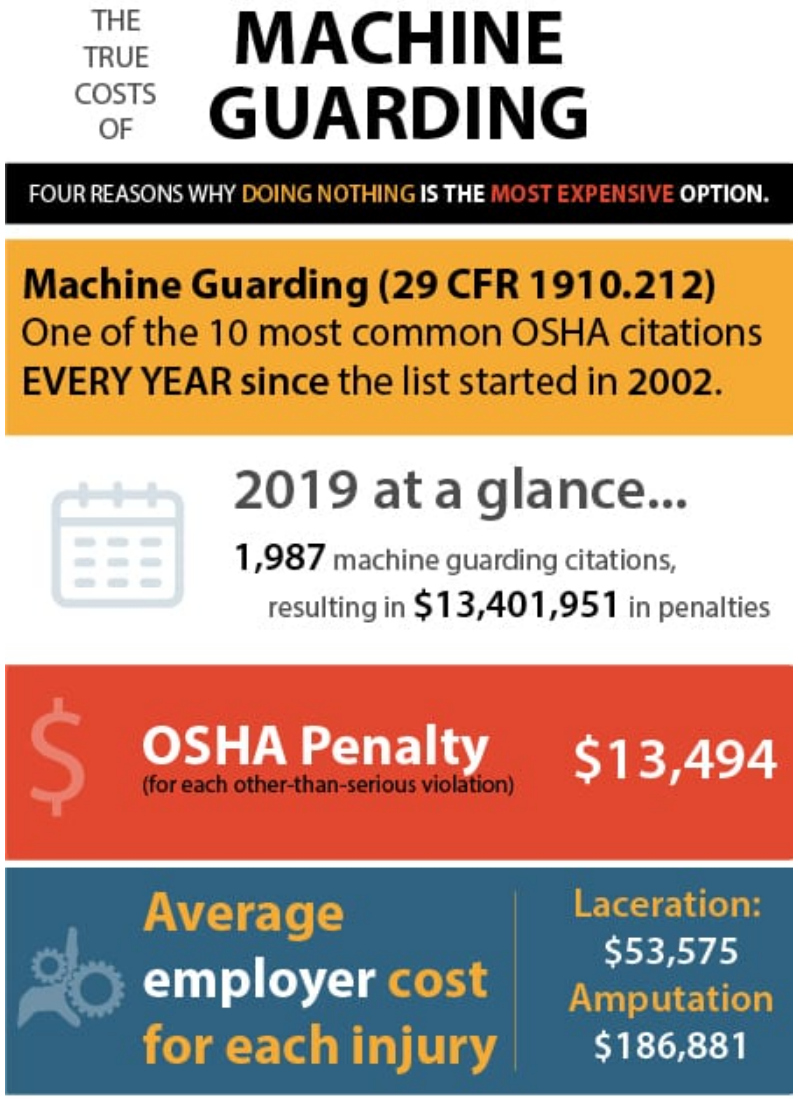
Scott Swaaley, PE

Founder and President,

MAKESafe Tools, Inc.

Why this Topic?

- Because 40,000 people each year suffer from traumatic machinery-related injuries, and it's been the same for over a decade.
- Because machine guarding has been on the top ten list of most commonly citations every year for a decade.
- And because many of these injuries and citations are easily avoidable by implementing some simple safeguards.
- Because it sometimes feels like details don't matter … until they do.



Kinds of Machinery

Everything with a Motor

Process & General Machinery

Conveyors & Infeed Rollers

Power Tools & Machine Tools

RISK ASSESSMENT

Overview

Equipment: Mold Press (Machine name) RD-437 (Machine #) BRT-NXC (SAP#)

Location: Manufacturing B (Building)

Assessment Team Members

Start Date [Date]

Accident follow up: Yes or No

Team Lead: Jannet Wells

Members: [Names here]

Contact UL for more information: www.ul.com/MachineRiskAssessment, email: FactoryServices@ul.com, 1-877-UL-HELPS

Instruction: Please follow Risk Assessment Steps below. Use Risk Assessment Flow Chart and Risk Factor Definitions.

Risk Level: 1–8 Represents Low Level 9–14 Represents Medium Level 15–20 Represents High Level

				Risk Level Estimate							Method of Reduction						Final Risk Estimate							
Task #	Task	Affected Persons	Hazard Type	Frequency of Exposure 1,2,4	Probability of Injury 1,2,4,6	Severity of Injury 1,3,6,10	Number of People Exposed	Protracted time in Danger Zone	Est. Risk Level	Tolerable?	Design	Safe-guarding	Admin. Controls	Method description	Date Final Follow-up Accessed	Owner	Frequency of Exposure 1,2,4	Probability of Injury 1,2,4,6	Severity of Injury 1,3,6,10	Number of People Exposed	Protracted time in Danger Zone	Final Risk Level	Tolerable?	Notes
	Normal Operation																							
1	Open guard to load or unload materials. Guard interlock switch not safety rated. Circuit not control reliable.	Operator / Helper	10.1 – Failure/disorder of the control system	4	4	10	1	0	18	No		X	X	Add safety rated switch and control reliable stopping circuit. Ensure all guards comply with OSHA/ANSI guard openings. E-Stop accessible.	########	J. Wells	1	1	6	1	0	8	Yes	
2	During production, operator cleans excess material off press.	Materials Handler	1.1 – Crushing hazard	4	2	6	1	0	12	No		X	X	Light curtain detects operator presence and is wired into a Control Reliable stopping circuit. Control Reliable circuit includes functional safety rated components, redundant wiring, monitoring, and redundant final switching elements. E-Stop is provided. Operator uses a tool to clean. Validated by 3rd party.	########	J. Wells	4	1	3	1	0	8	Yes	
									0	Yes												0	Yes	
	Maintenance Activities																							
3	Replace hydraulic cylinder.	Maintenance Personnel	1.9 – High pressure fluid injection or ejection hazard	1	6	10	1	1	18	No			X	Use LOTO procedures to ensure all energy is removed.	########	J. Wells	0	0	0	1	1	1	Yes	
									0	Yes												0	Yes	
	Commissioning/Other																							
4	**N/A – Machine already installed.**								0	Yes												0	Yes	
5	**Plant Visitors are not allowed close to machine. Supervisors are trained operators.**								0	Yes												0	Yes	

https://www.ul.com/resources/understanding-importance-machine-risk-assessment

RISK ASSESSMENT

Context

Equipment: [Machine Name here] [Machine # here] [Other ID here]
Machine name Machine # SAP#

Location: [Building Name here]
Building

Assessment Team Members

Start Date: [Date]

Accident follow up: Yes or No

Team Lead: [Name here]

Members: [Names here]

https://www.ul.com/resources/understanding-importance-machine-risk-assessment

RISK ASSESSMENT

Job Hazard Analysis

Task #	Task	Affected Persons	Hazard Type
	Normal Operation		
	Maintenance Activities		
	Commissioning/Other		

https://www.ul.com/resources/understanding-importance-machine-risk-assessment

RISK ASSESSMENT

Risk Estimate

Risk Level Estimate						
Frequency of Exposure 1,2,4	Probability of Injury 1,2,4,6	Severity of Injury 1,3,6,10	Number of People Exposed	Protracted time in Danger Zone	Est. Risk Level	Tolerable ?
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes

Estimated Risk Value = Frequency + Probability + Protracted Time + (Severity x # of People Exposed)

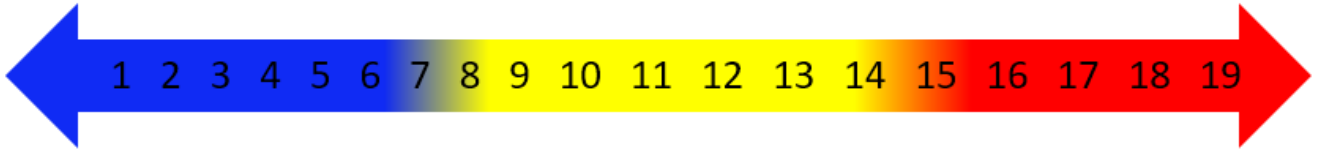
Frequency of Exposure		
Value	Factor	Definition
1	Seldom	May Possibly occur during an eight (8) hour shift
2	Occasional	Will occur during an eight (8) hour shift
4	Frequent	Will occur more than four times in an eight (8) hour shift!

Probability of Injury		
Value	Factor	Definition
1	Unlikely	When exposed to the hazard, an injury is easily avoided.
2	Possible	When exposed to the hazard, an injury can be avoided.
4	Probable	When exposed to the hazard, an injury is unlikely to be avoided.
6	Certain	When exposed to the hazard, an injury cannot be avoided.

Protracted Time		
Value	Factor	Definition
0	Short Duration	Less than 15 minutes
1	Protracted	Greater than 15 minutes

Severity		
Value	Factor	Definition
1	Minor	No/slight injury requiring no more than first aid (little or no lost work time)
3	Serious	Significant injury/illness requiring more than first aid (able to return to same job)
6	Major	Severe debilitating injury/illness (able to return to work at some point)
10	Fatal	Death or Permanently disabling injury (unable to return to work)

Risk Value Scale: 1–8 Represents Low Level, 9–14 Represents Medium Level, 15–20 Represents High Level



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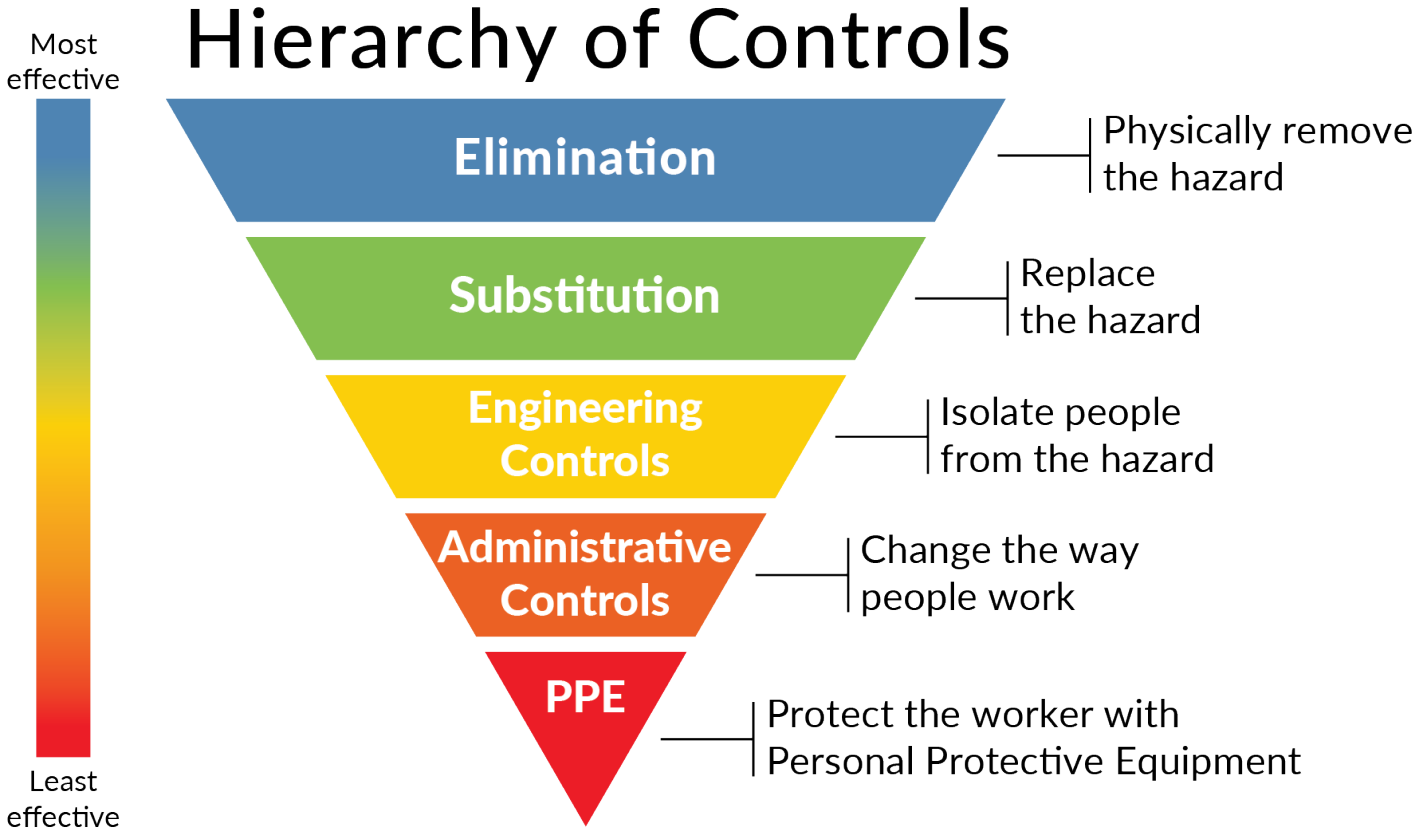
RISK ASSESSMENT

Mitigations

Method of Reduction					
Design	Safe-guarding	Admin. Controls	Method description	Date Final Follow-up Assessment	Owner
	x	x	Add safety rated switch and control reliable stopping circuit. Ensure all guards comply with OSHA/ANSI guard openings. E-Stop accessible.	########	J. Wells
	x	x	Light curtain detects operator presence and is wired into a Control Reliable stopping circuit. Control Reliable circuit includes functional safety rated components, redundant wiring, monitoring, and redundant final switching elements. E-Stop is provided. Operator uses a tool to clean. Validated by 3rd party.	########	J. Wells
		x	Use LOTO procedures to ensure all energy is removed.	########	J. Wells



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RISK ASSESSMENT

Final Risk Estimate

Final Risk Estimate						
Frequency of Exposure 1,2,4	Probability of Injury 1,2,4,6	Severity of Injury 1,3,6,10	Number of People Exposed	Protracted time in Danger Zone	Final Risk Level	Tolerable ?
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes
					0	Yes

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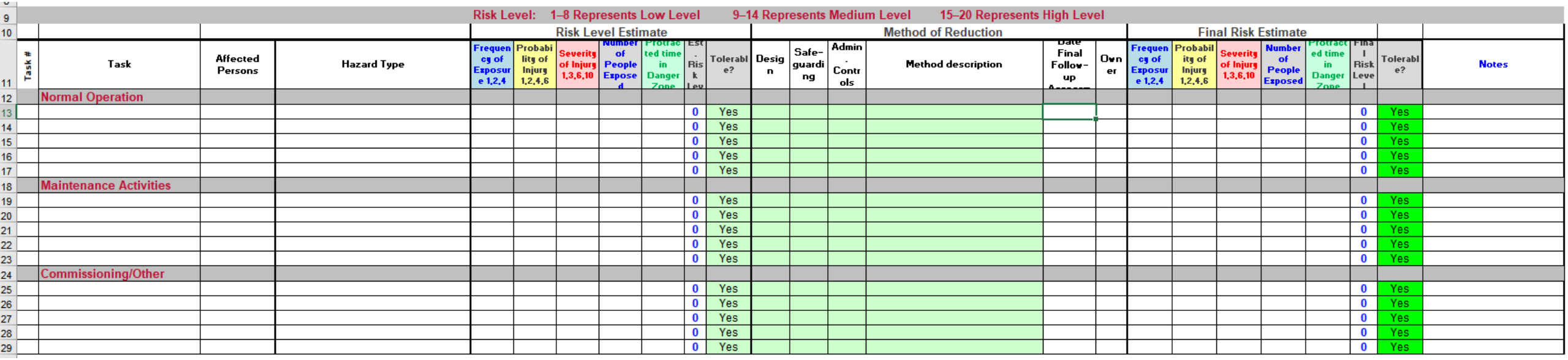
Today's Focus

Things to watch out for

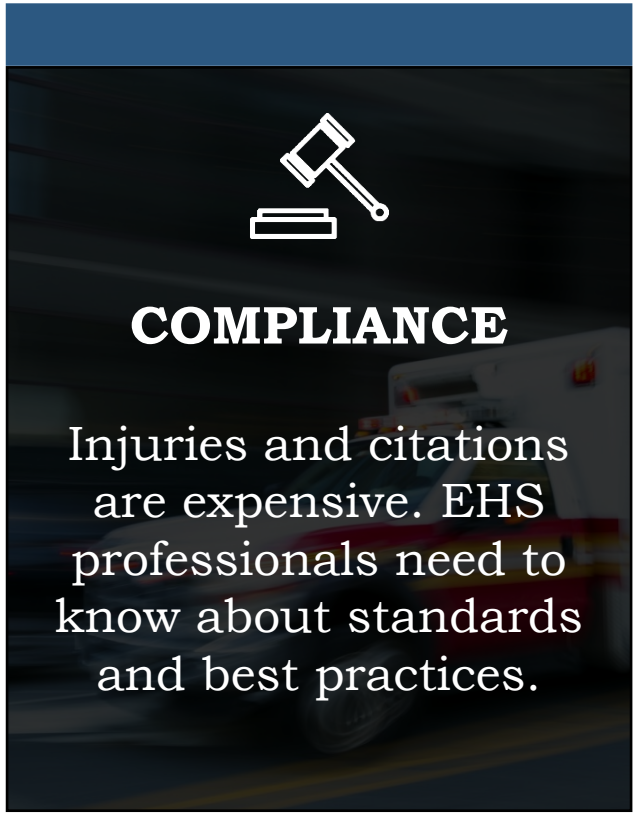
Job Hazard Analysis **Mitigations**



9				Risk Level: 1–8 Represents Low Level 9–14 Represents Medium Level 15–20 Represents High Level																				
10				Risk Level Estimate								Method of Reduction						Final Risk Estimate							
11	Task #	Task	Affected Persons	Hazard Type	Frequency of Exposure 1,2,4	Probability of Injury 1,2,4,6	Severity of Injury 1,3,6,10	Number of People Exposed	Protracted time in Danger Zone	Est. Risk Lev	Tolerable?	Design	Safe-guarding	Admin. Controls	Method description	Date Final Follow-up	Owner	Frequency of Exposure 1,2,4	Probability of Injury 1,2,4,6	Severity of Injury 1,3,6,10	Number of People Exposed	Protracted time in Danger Zone	Final Risk Level	Tolerable?	Notes
12		Normal Operation																							
13										0	Yes												0	Yes	
14										0	Yes												0	Yes	
15										0	Yes												0	Yes	
16										0	Yes												0	Yes	
17										0	Yes												0	Yes	
18		Maintenance Activities																							
19										0	Yes												0	Yes	
20										0	Yes												0	Yes	
21										0	Yes												0	Yes	
22										0	Yes												0	Yes	
23										0	Yes												0	Yes	
24		Commissioning/Other																							
25										0	Yes												0	Yes	
26										0	Yes												0	Yes	
27										0	Yes												0	Yes	
28										0	Yes												0	Yes	
29										0	Yes												0	Yes	

Hazard Analysis

Two sides of the same coin.

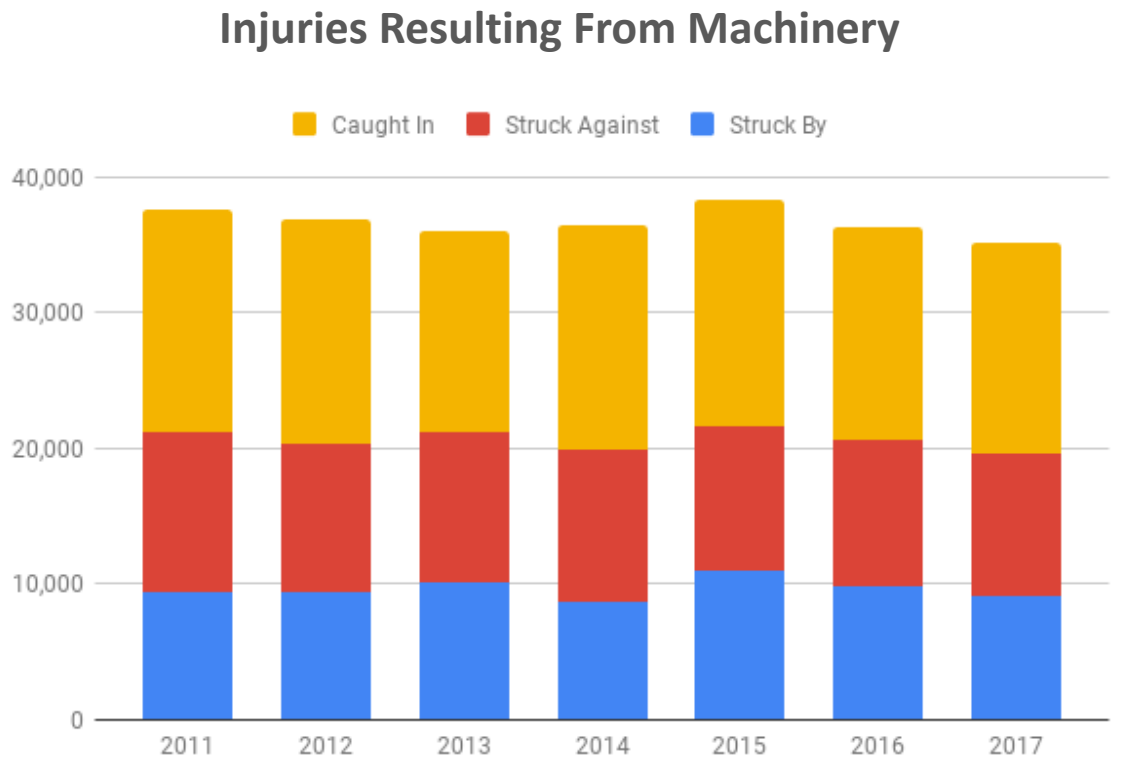


PERSONAL LIABILITY

INJURY PREVENTION

Injury Profiles

- This is only reported injuries resulting in missed days from work or medical treatment.
- By population, that means over 1,100 incidents in Los Angeles alone.



Number of nonfatal occupational injuries and illnesses involving days away from work by [all] workers, All U.S., all ownerships, 2011 – 2017.

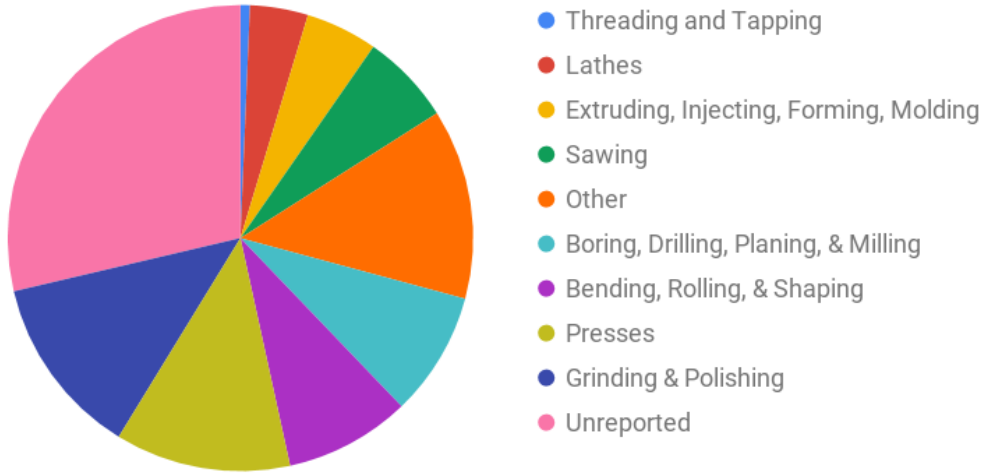
SOURCE: Bureau of Labor Statistics, U.S. Department of Labor, Jul 6, 2019

INJURY PREVENTION

Injury Profiles

- Worst Offenders
  - Grinders & Polishers
  - Presses, Benders, Rollers, Shapers
  - Drills, Mills, & Planers
  - Saws

Injuries Resulting From Machinery



Number of nonfatal occupational injuries and illnesses involving days away from work by [all] workers, All U.S., all ownerships, 2011 – 2017.

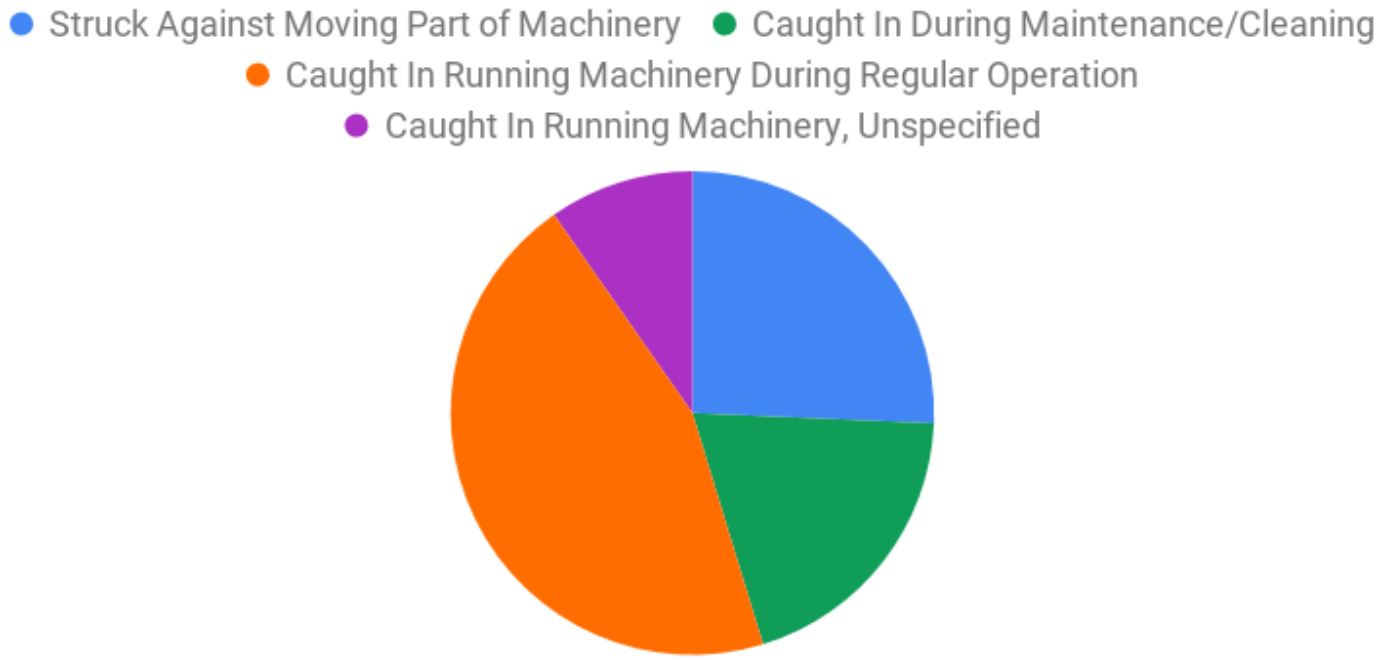
SOURCE: Bureau of Labor Statistics, U.S. Department of Labor, Jul 6, 2019

INJURY PREVENTION

Injury Profiles

- More than 50% of the injuries are not a result of “regular operation”.
- So when and how do these injuries occur?

Injuries Resulting From Machinery



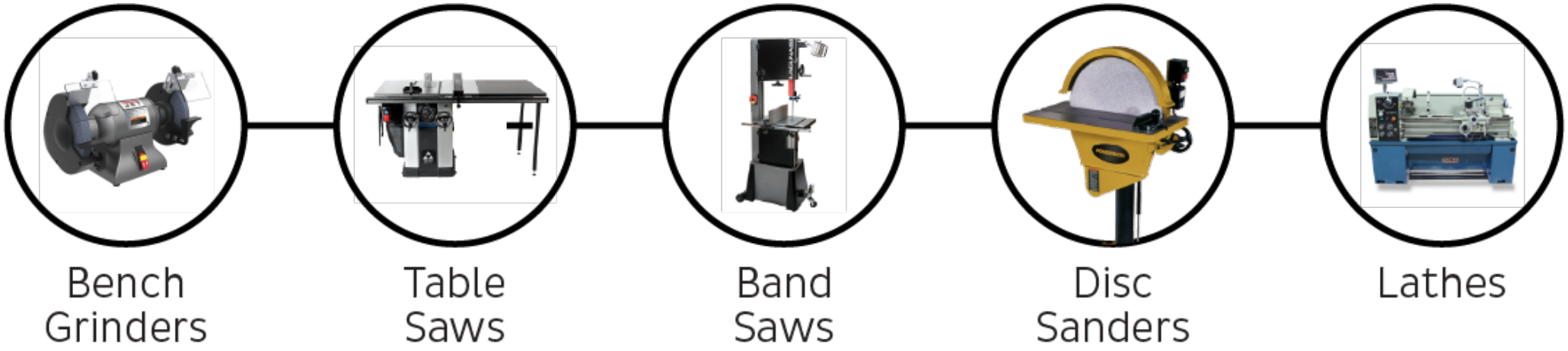
Number of nonfatal occupational injuries and illnesses involving days away from work by [all] workers, All U.S., all ownerships, 2011 – 2017.

SOURCE: Bureau of Labor Statistics, U.S. Department of Labor, Jul 6, 2019

INJURY PREVENTION

Injury Profiles

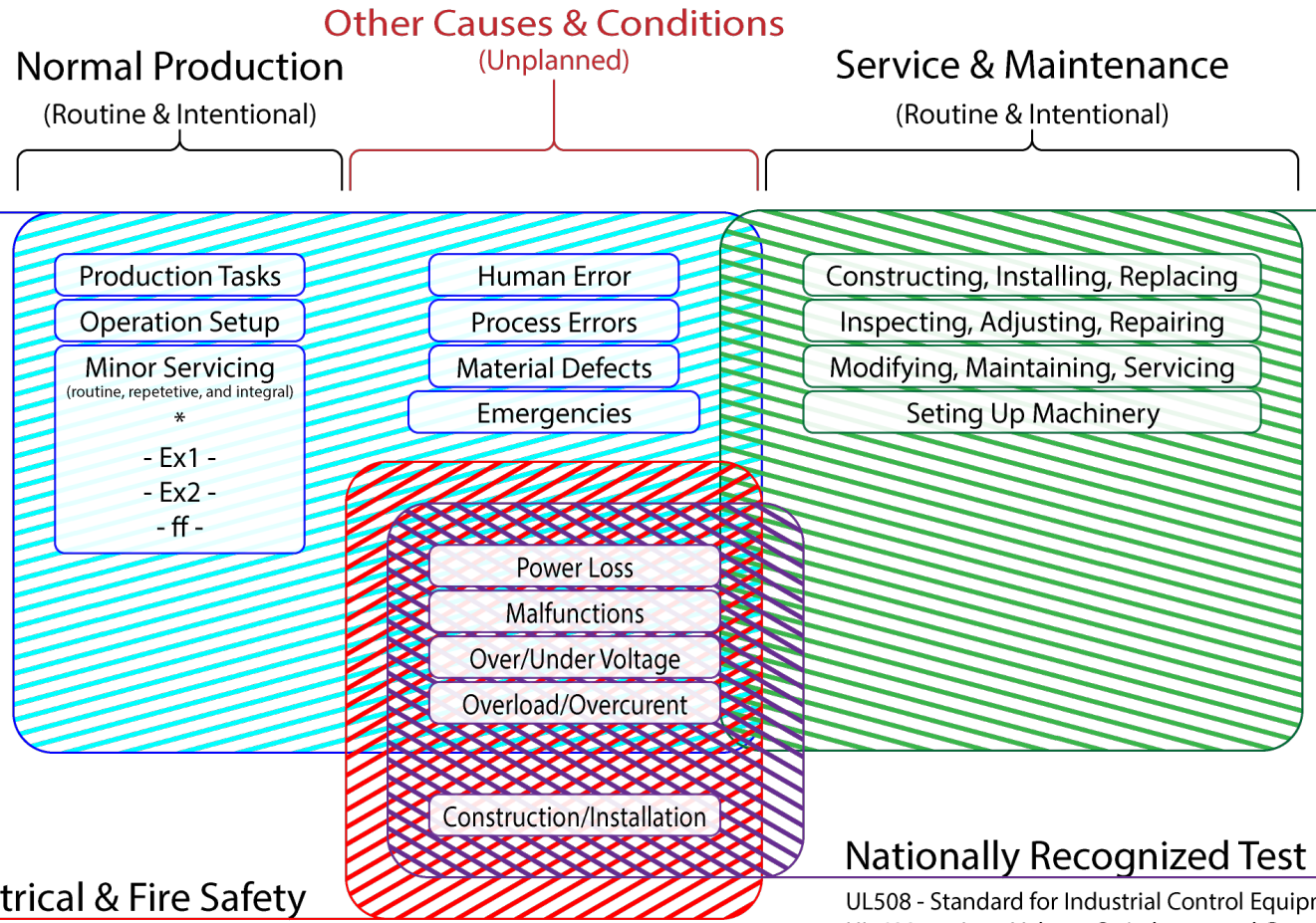
- The Control of Hazardous Energy (Lockout Tagout)
- Accidental Restart
- Coasting
- Emergency Situations & E-Stop
- And more …



INJURY PREVENTION

COMPLIANCE

According To …



Machine Guarding

OSHA 29 CFR 1910 Subpart O - Machinery and Machine Guarding
ANSI B11.19 - Performance Criteria for Safeguarding

Hazardous Energy Control

OSHA 1910.147 - The control of hazardous energy (lockout/tagout)
ANSI Z244.1 - The Control of Hazardous Energy Lockout, Tagout and Alternative Methods

Electrical & Fire Safety

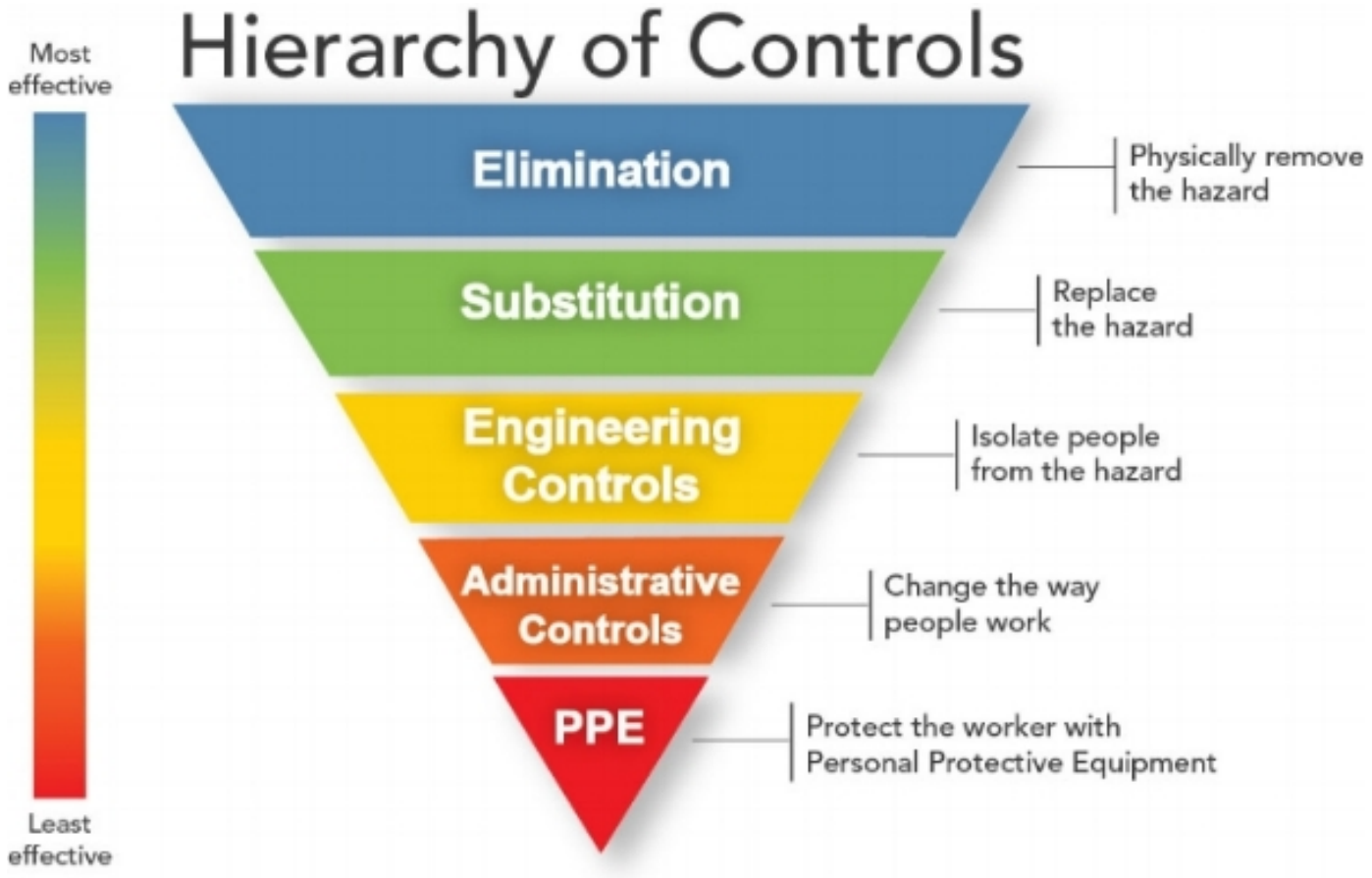
NFPA 70 - National Electric Code
NFPA 79 - Electrical Standard for Indusrial Machinery
OSHA 29 CFR 1910 Subpart S - Electrical

Nationally Recognized Test Labs

UL508 - Standard for Industrial Control Equipment
UL 60947 - Low-Voltage Switchgear and Controlgear

INJURY PREVENTION

COMPLIANCE



INJURY PREVENTION

COMPLIANCE

OSHA 1910.212 - General Requirements for all Machines

OSHA 1910.212(a)(1)

"Types of guarding. One or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area from hazards such as those created by point of operation, ingoing nip points, rotating parts, flying chips and sparks. Examples of guarding methods are-barrier guards, two-hand tripping devices, electronic safety devices, etc."

1910.212(a)(3)(ii)

"The point of operation of machines whose operation exposes an employee to injury, shall be guarded. **The guarding device shall be in conformity with any appropriate standards therefor, or, in the absence of applicable specific standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operating cycle."**

INJURY PREVENTION

COMPLIANCE

- What is the “operating cycle”?
- The Operating Cycle = Normal Operation + Other Conditions Likely to Occur.
- “ … and other employees … ”
- Examples include:
  - Before Operation (Setup)
  - After Operation (Cleanup/Shutdown)
  - Jams, Cutoffs, Malfunctions
  - Power Loss (1910.213(b)(3))
  - Emergencies (1910.213(b)(1))
  - Maintenance and Cleaning

*“The guarding device …shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone **during the operating cycle**.” (1910.212(a)(3)(ii))*

*“One or more methods of machine guarding shall be provided to protect the operator **and other employees** in the machine area from hazards …”*

OSHA 1910.212(a)(1)

INJURY PREVENTION

COMPLIANCE

PRODUCTION

Other P-P-P Pressures

People

- Can't get in the way.
- Can't be bypassed.
- Can't cause additional hazards.
- Can't be "too hard".

Production

- Can't slow people down.
- Can't impact workflow.

Profit

- Can't be expensive to implement or use.
- Can't require significant training.

Means of Mitigation

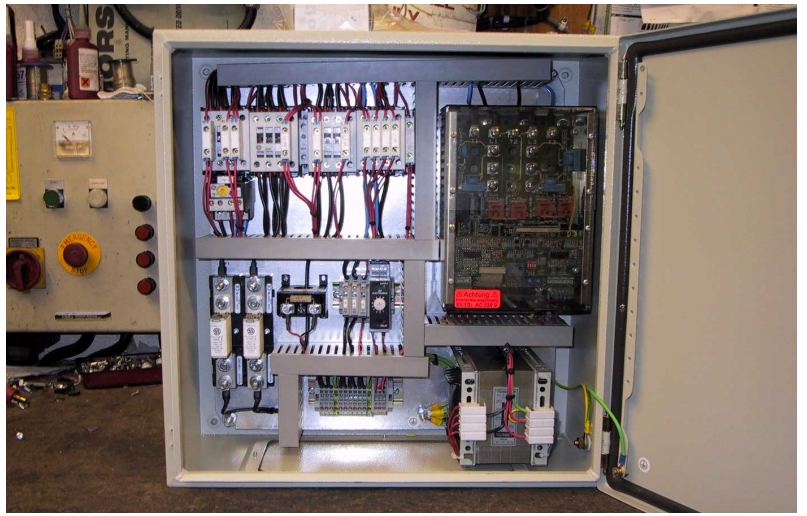
- A look at your options for how to prevent injury and comply.

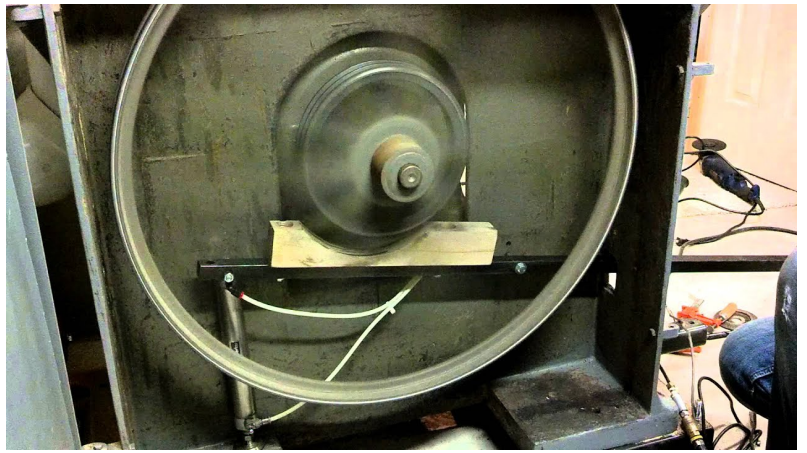
Lock Out Tag Out

- Lots of information online
- Lots of product options

Braking Systems

- Braking Systems
  - OEM vs. Retrofit
  - Mechanical Braking
  - Electrical (Motor) Braking



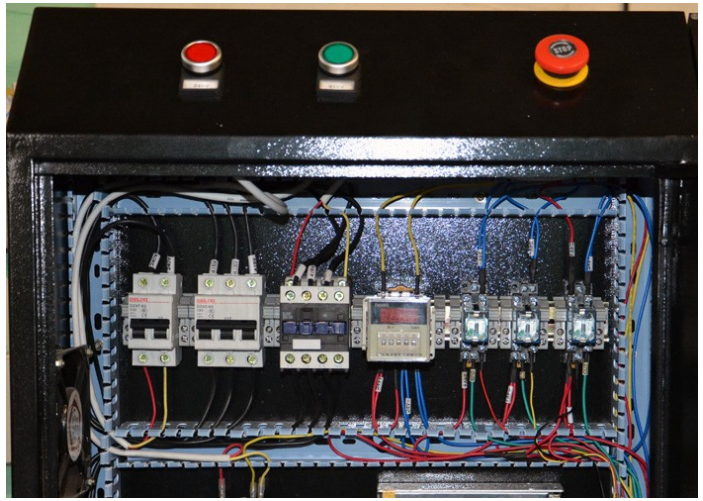


Restart Prevention

- Lots of Names:
  - “Safe Start”
  - “Accidental Restart Protection”
  - “Anti-Automatic Restart Protection”
  - “Low Voltage Dropout”
- Beware … there is a reason they’re low cost.

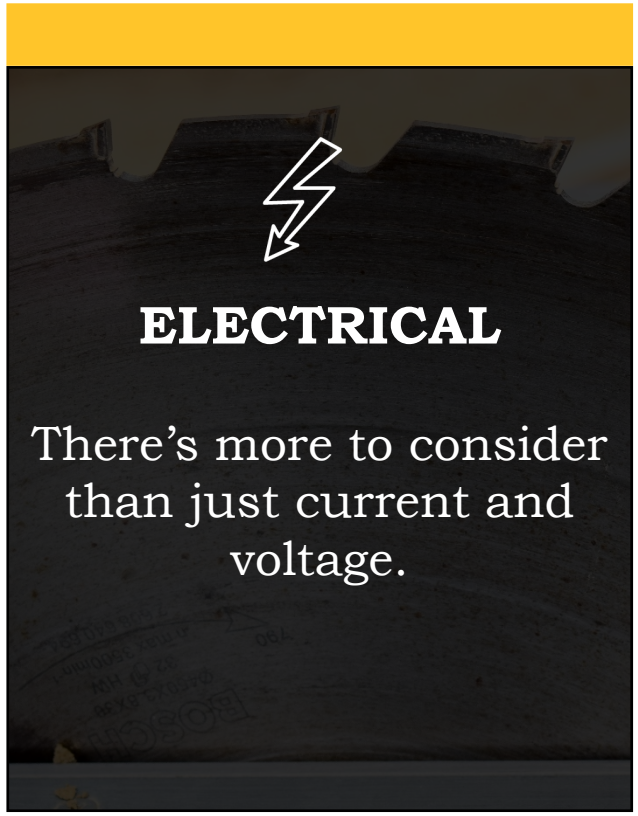
Emergency Stop

- E-Stop Categories
- ANSI Requirements



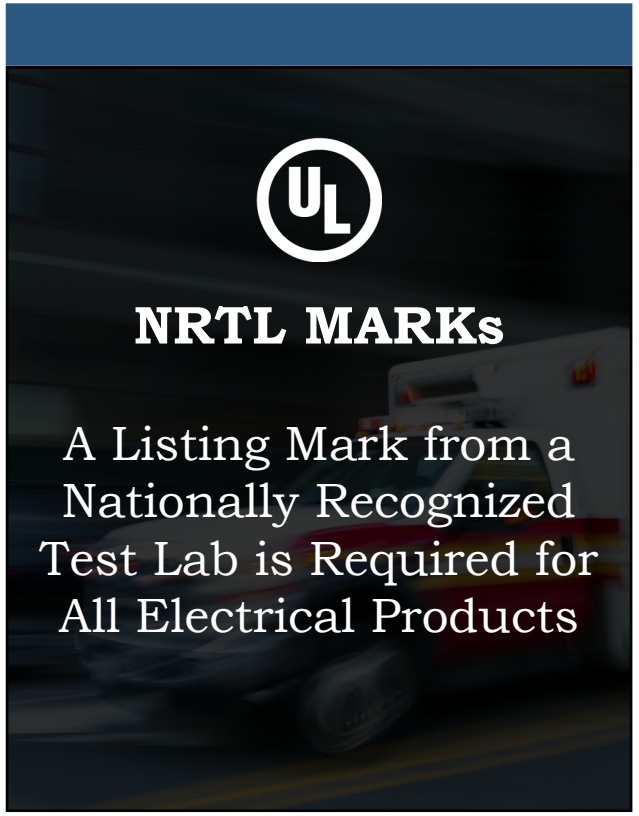
Specifications

Considerations when purchasing and specifying electrical safeguards.



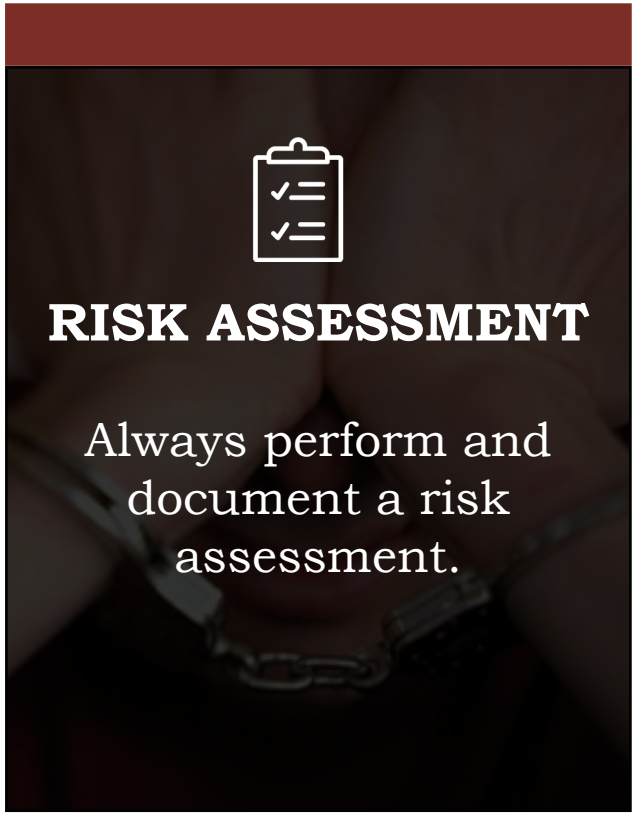
ELECTRICAL

There's more to consider than just current and voltage.



NRTL MARKs

A Listing Mark from a Nationally Recognized Test Lab is Required for All Electrical Products

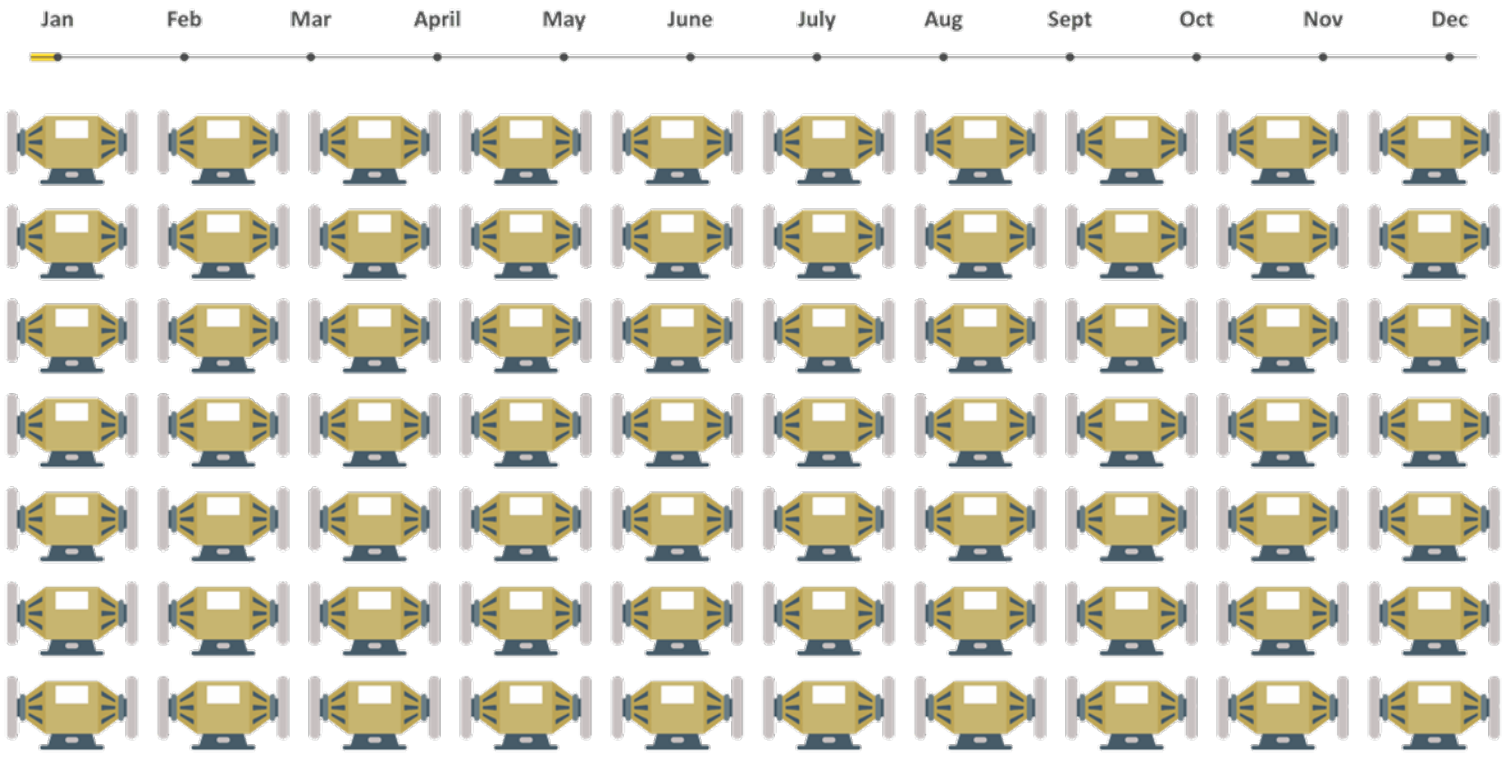


RISK ASSESSMENT

Always perform and document a risk assessment.

Misleading Products

- Customer: Aerospace parts manufacturer
- Intent: Protect operators and comply w/ anti-restart regulation.
- Context: Customer has a pedestal bench grinder at each CNC operator station, used for tool sharpening.
- Project Scope: Install commercially available anti-restart devices on 70 bench grinders.
- Result: Based on monthly testing, between one and three devices failed each month.



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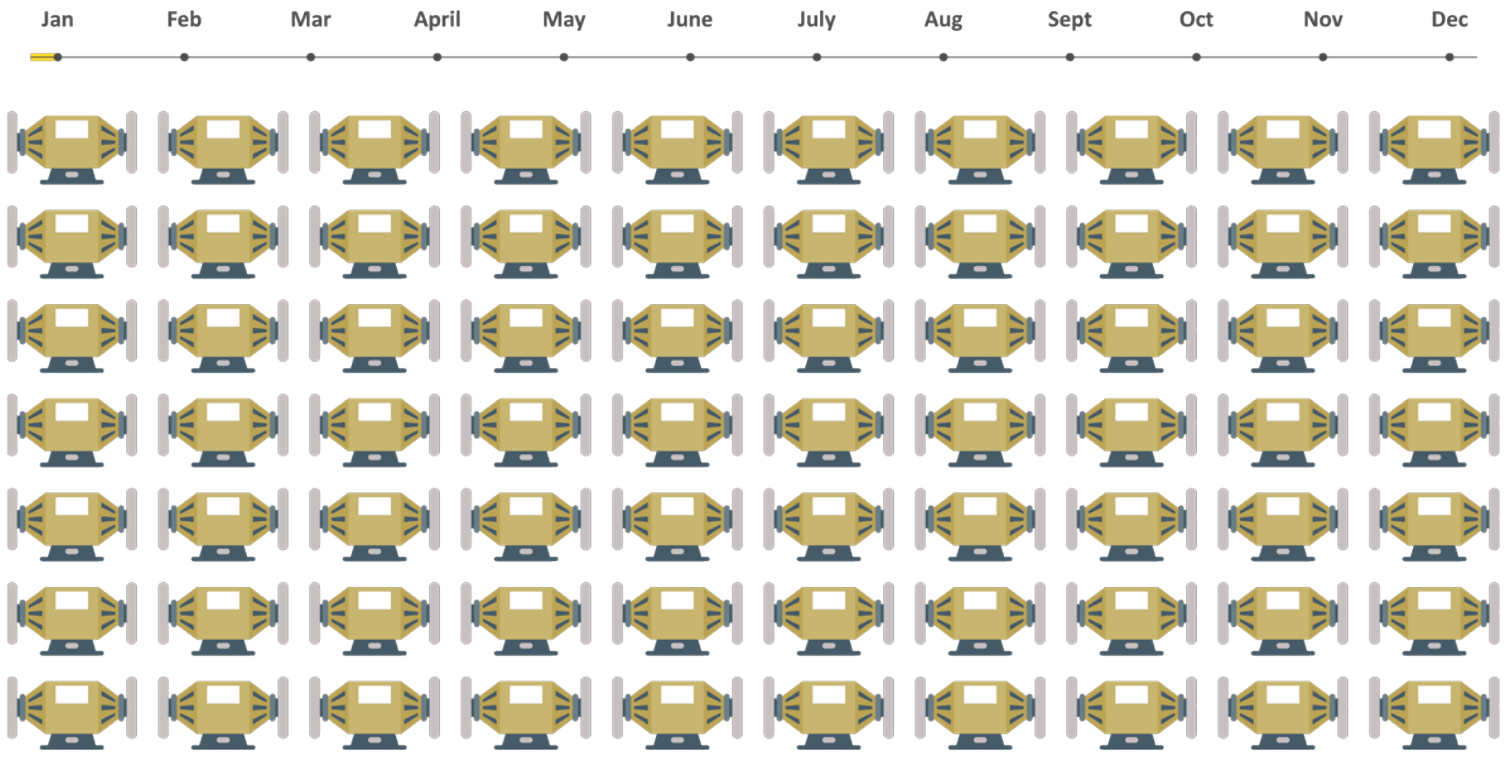


Why they fail (Electrically)

The Machine

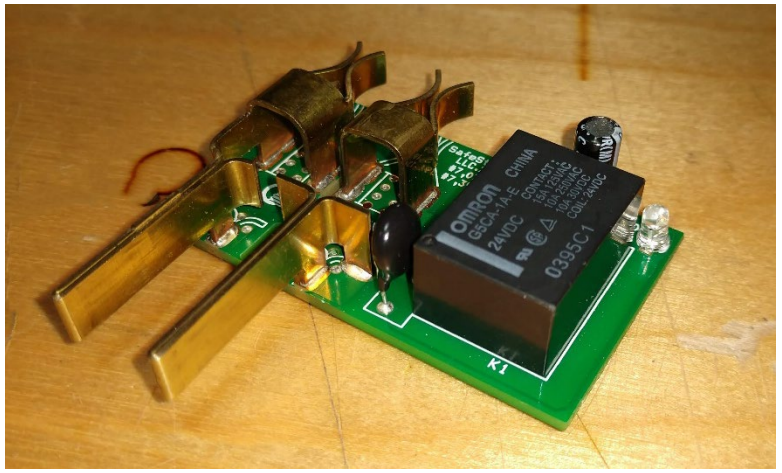
8” Bench Grinder

1HP

120V, 60Hz

8A

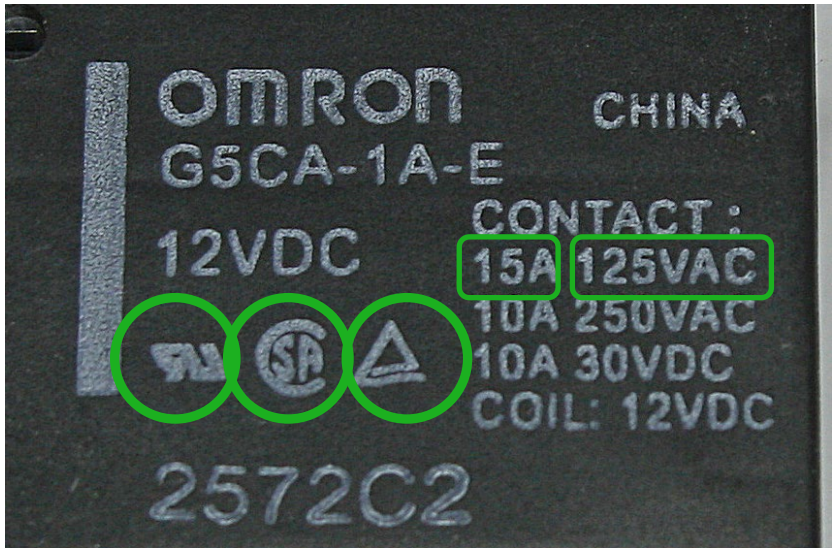
The Failed Device



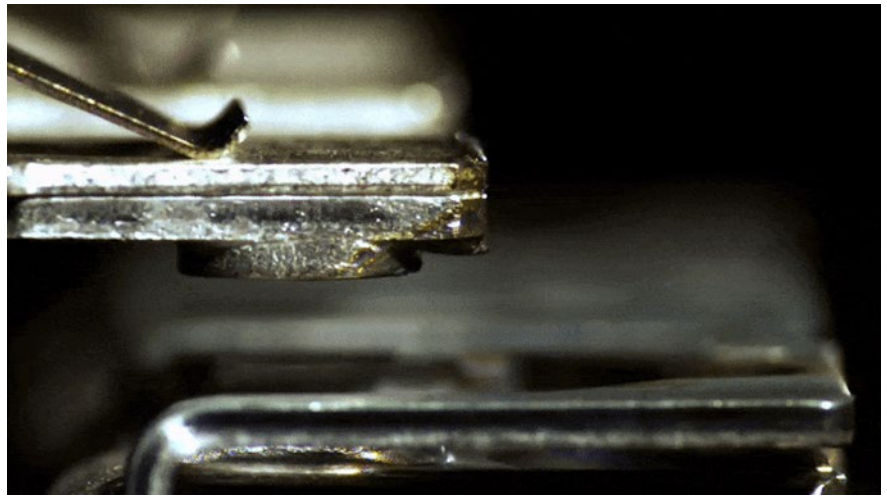
Just One of Many

The product shown here is just one of many anti-restart devices that suffer from the same shortcomings.

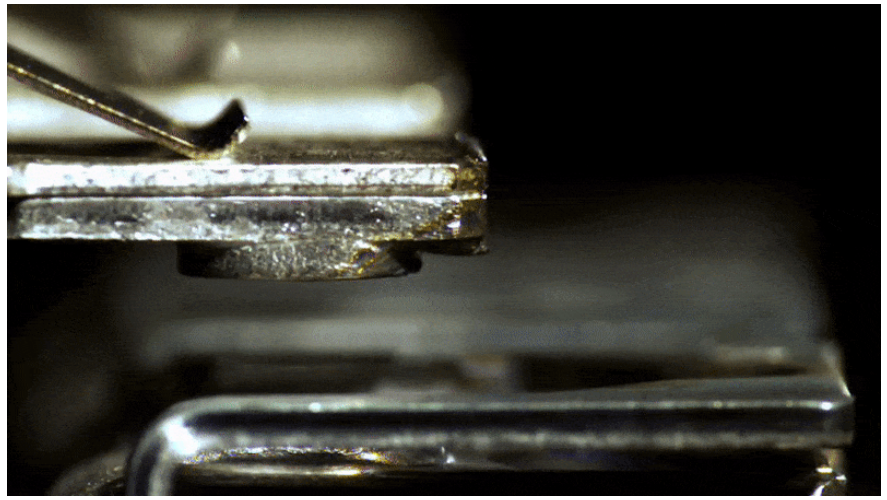
The Relay Inside



Why they fail (Electrically)



Why they fail (Electrically)



Why they fail (NRTLs)

UL 246A - Appliance Controls

"This category covers controllers … [with] one or more output switching components to directly control … household-type appliances, such as portable luminaires, audio/video equipment, etc."

"They are not intended for controlling motor-operated appliances"

UL 508 - Industrial Control Equipment

"These requirements cover industrial control devices, and devices accessory thereto, for starting, stopping, regulating, controlling, or protecting electric motors. "

Two relays with similar current ratings under each standard

(to scale)

Alternatives

* In some cases, OSHA considers momentary foot switches to meet basic anti-restart and e-stop requirements.

Features & Protection

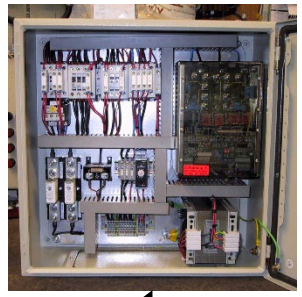
Magnetic Switches
(anti-restart only)

In-Line Protection Devices
(anti-restart only)

Momentary Foot Switches
(anti-restart & e-stop*)

UL508A Control Boxes
(anti-restart + e-stop)

MAKESafe One-Stop
(anti-restart + e-stop + motor braking)



Custom Control Cabinets
(anything you want …)

Cost

$20 — $40-$150 — $400-$1,000 — $3000+

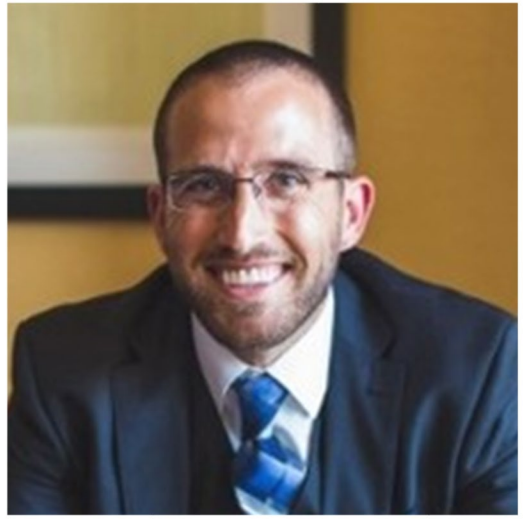
Bandsaw Demo

In Summary – Client Resources

- Risk assessments:
  - Simple Version: MAKESafe Tools Risk Assessment Workshop
  - Technical Version: https://www.ul.com/resources/understanding-importance-machine-risk-assessment
- Easy-to-install mitigations exist.
  - Practical Implications: MAKESafe Webinar
  - More about NRTLs: https://www.osha.gov/dts/otpca/nrtl/
- Make sure to check your mitigation specs
  - Look for HP ratings!
- Go evaluate your machinery!
  - Low hanging fruit!
- Search Terms:
  - “restart prevention”, “category 1 emergency stop”, “make safe tools”, “motor braking”

I’m here to help!

- scott@makesafetools.com
- (415) 937-1808



Scott Swaaley, PE

Founder and President,

MAKESafe Tools, Inc.