



INTERNATIONAL
ROBOT SAFETY
Conference

An OSHA View on Robot Safety

Hazen Price

*Mechanical Engineer
OSHA Health Response Team*

Matt Marcinko

*Safety and Occupational Health Specialist
Region 5 Enforcement Programs*

September 2022



Outline

- OSHA's Mission
- Regulatory Activity
- Enforcement and Inspections
- OSHA Technical Manual - Robotics
- Applicable OSHA Standards
- OSHA Findings and Inspections
- Risk Reduction Methods
- Resources



OSHA Mission

OSHA was created to assure safe and healthful working conditions for workers by setting and enforcing standards and by providing training, outreach, education and assistance.

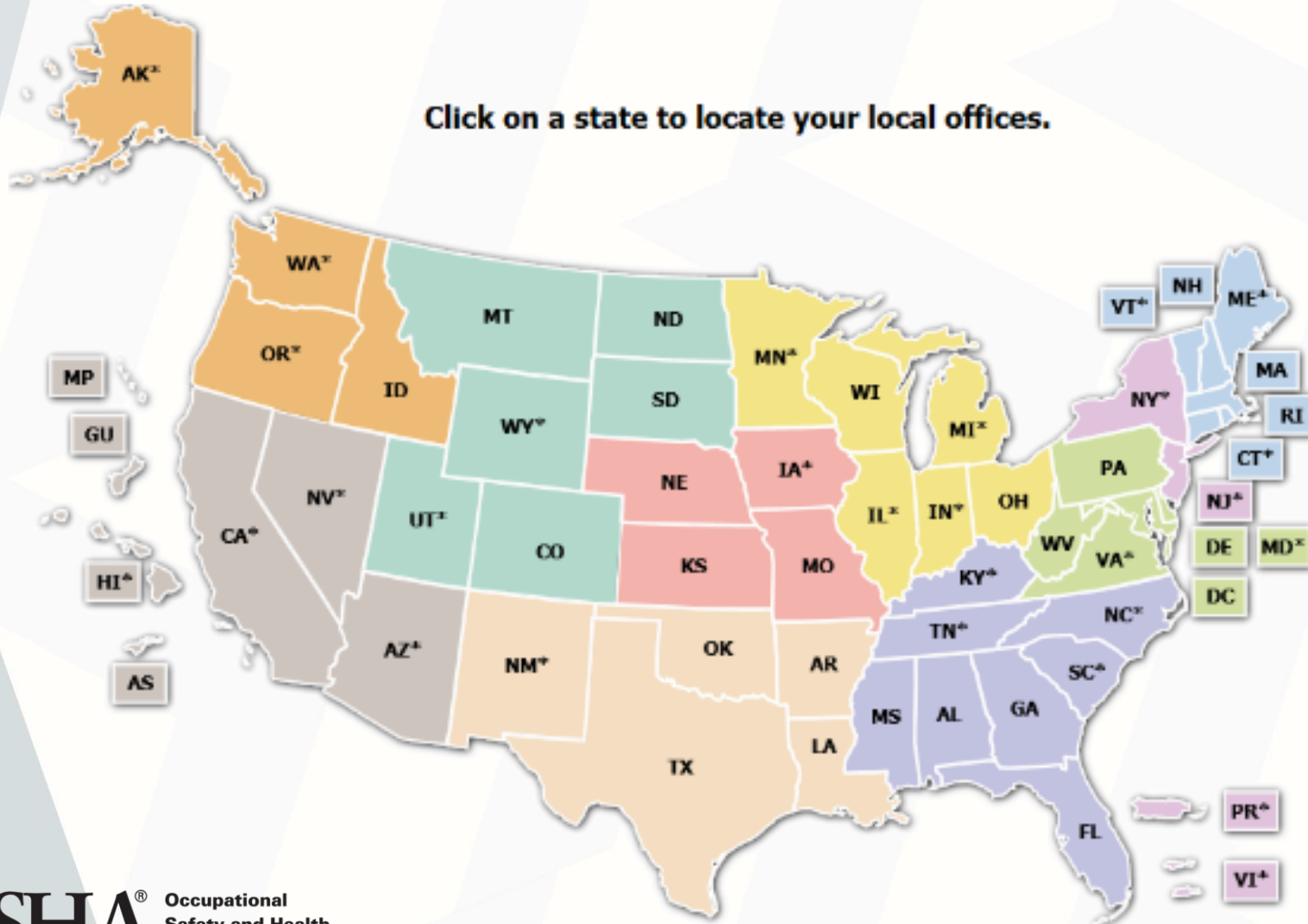
OSHA Act on Employer Responsibility

Each employer:

Shall furnish to each of its employees employment and a place of employment which are **free from recognized hazards** that **are causing or are likely to cause** death or serious physical harm to its employees;

OSHA Regions

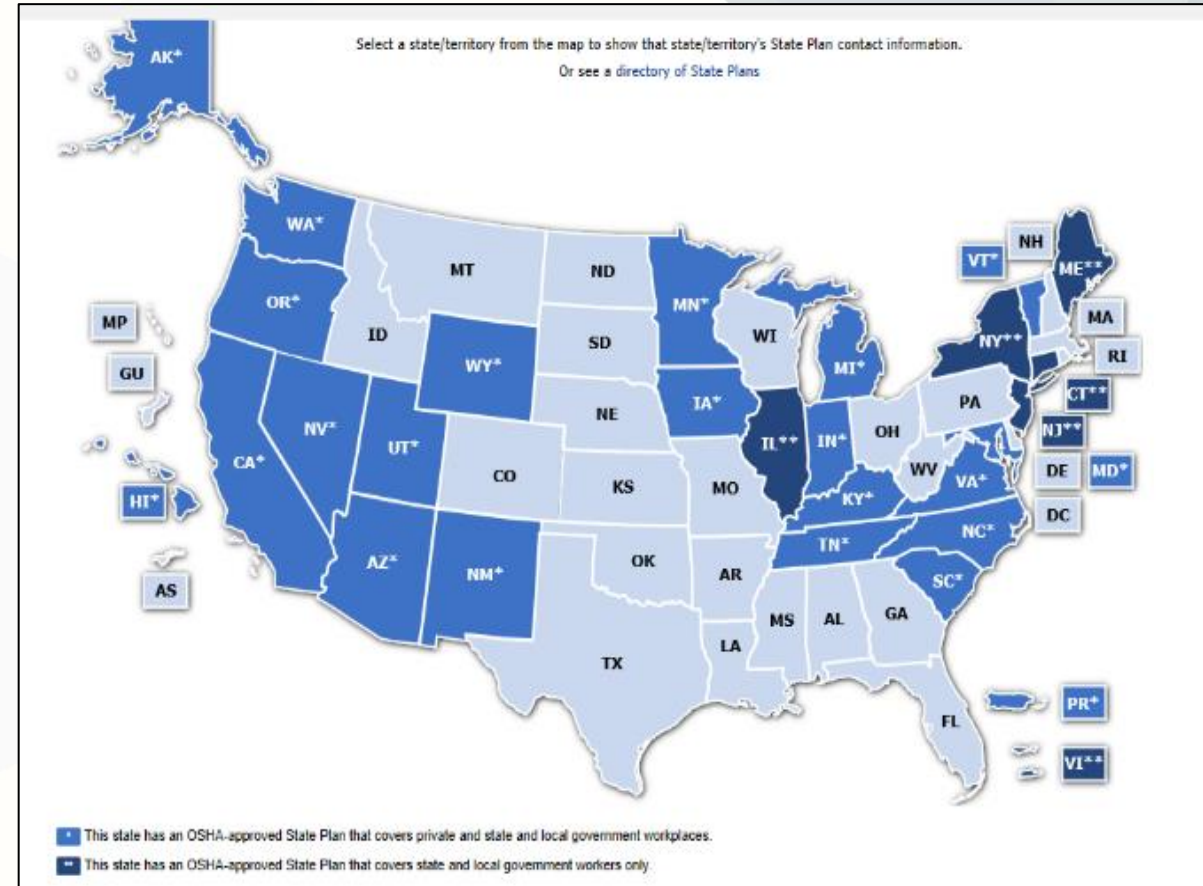
Click on a state to locate your local offices.



- Region 1: Boston
- Region 2: New York
- Region 3: Philadelphia
- Region 4: Atlanta
- Region 5: Chicago
- Region 6: Dallas
- Region 7: Kansas City
- Region 8: Denver
- Region 9: San Francisco
- Region 10: Seattle

State Plans

- 22 State Plans covering private sector and state/local government workers
- 6 State Plans covering only state/local government workers
- State Plans must be at least as effective as federal OSHA



www.osha.gov/stateplans

Regulatory Activity

- Lock-Out/Tag-Out Update
 - Recent technological advancements to control hazardous energy conflict with OSHA's existing standard 1910.147 (lockout/tagout)
 - Computer based controls have become more prevalent as equipment manufactures modernize their designs
 - Request for information (RFI) completed in 2019 to understand the strengths and limitations of this new technology, as well as potential hazards to workers
 - Notice of proposed rule making (NPRM) expected March of 2023

Regulatory Activity

- Mechanical Power Press Update
 - In the pre-rule stage (before proposed rule stage)
 - OSHA's current standard 1910.217 is approximately 40 years old and does not address technological changes
 - Request for information (RFI) completed in 2021
 - Analyzing comments completed June of 2022

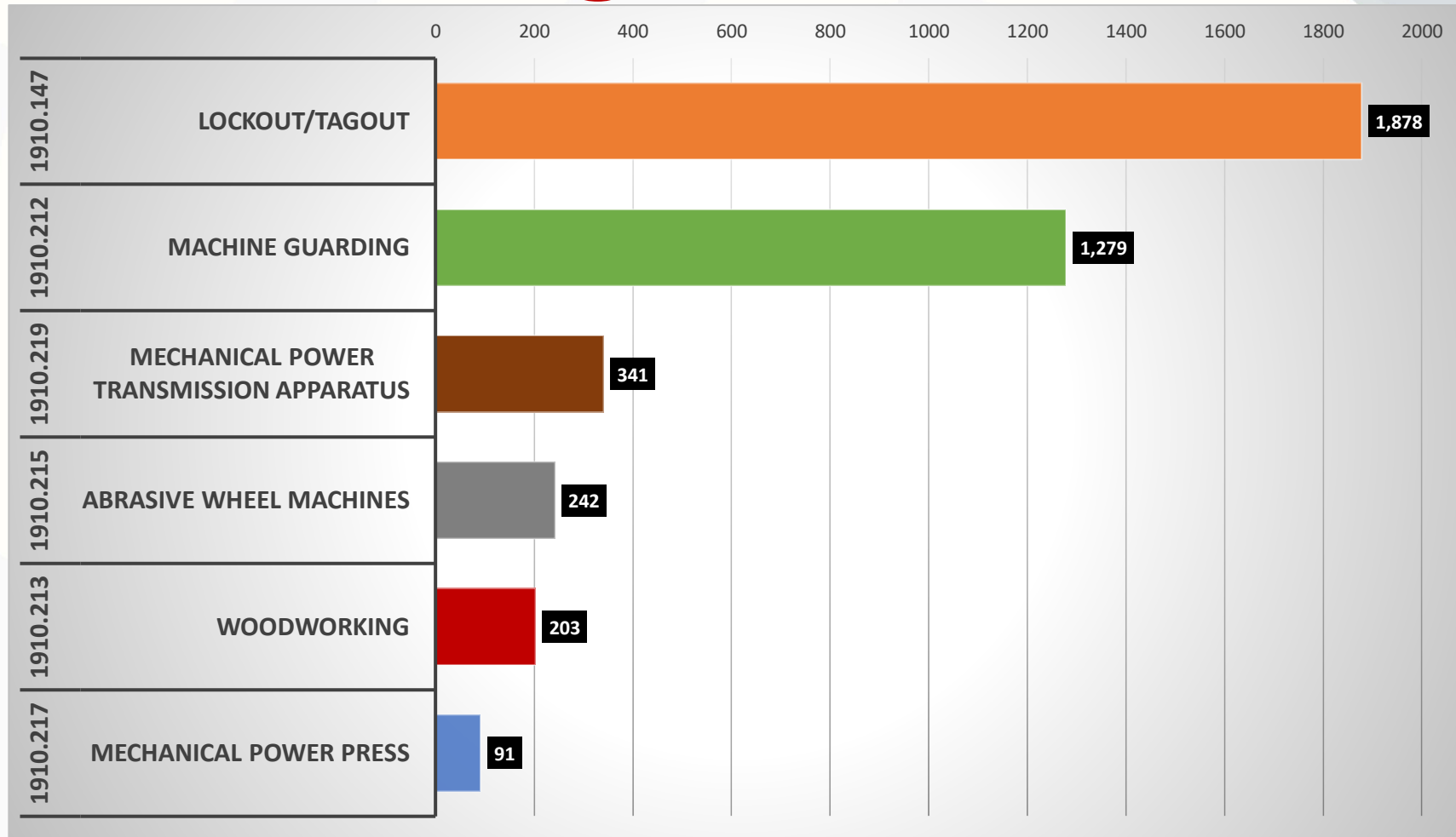
Enforcement - Inspections

- Every establishment covered by the OSH Act is subject to inspection by OSHA compliance safety and health officers (CSHO's).
- Inspections are conducted without advance notice.
- If a violation is identified, citations are issued and penalties assessed where appropriate.

OSHA Field Staff (CSHOs)

- Usually arrive in response to injury report or complaint
- Trained to identify hazards in the workplace
- Conduct various interviews
- Have varying knowledge of robot safety standards
- Reference all applicable industry standards
- Have access to industry experts and industry and trade partners
- Contact OEM for technical support

Frequently Cited Machine Guarding and Lockout/Tagout Standards FY21



General Duty Clause Citations 5(a)(1)

Citations referencing robotic industry standards:

- From 2020-2022 two citations reference industry standards
 - Both were fatalities
- Struck by hazard, working in an automated travel path
- Caught in between, Robot completed an automated cycle that pinned an employee between the robot and guardrail

OSHA Technical Manual (OTM) – For OSHA and S&H Professionals

- Provides technical information about workplace hazards and controls
- Content is based on currently available research publications, OSHA standards, and consensus standards
- Available to the public for use by other S&H professionals, employers to develop or implement an effective workplace safety and health programs

<https://www.osha.gov/otm> & <https://www.osha.gov/otm/section-4-safety-hazards/chapter-4>

OTM – Section IV: Chapter 4

Industrial Robot Systems and Industrial Robot System Safety

- OSHA/NIOSH/A3 Alliance provided industry expert advice
- Basic components of robots and the associated structure
- Collaborative, non-collaborative, and industrial mobile robots
- Hazards associated with industrial robot systems
- Safety Considerations for Employers and Workers
- Risk Assessments / Risk Reduction Measures
- Applicable OSHA and Industry Standards Regarding Industrial Robot System Safety
- Considerations for Evaluating Robotic Safety Systems
- Provides CSHOs with additional inspection guidance

Guidance For OSHA and S&H Professionals

Considerations for Evaluating Robotic Safety Systems

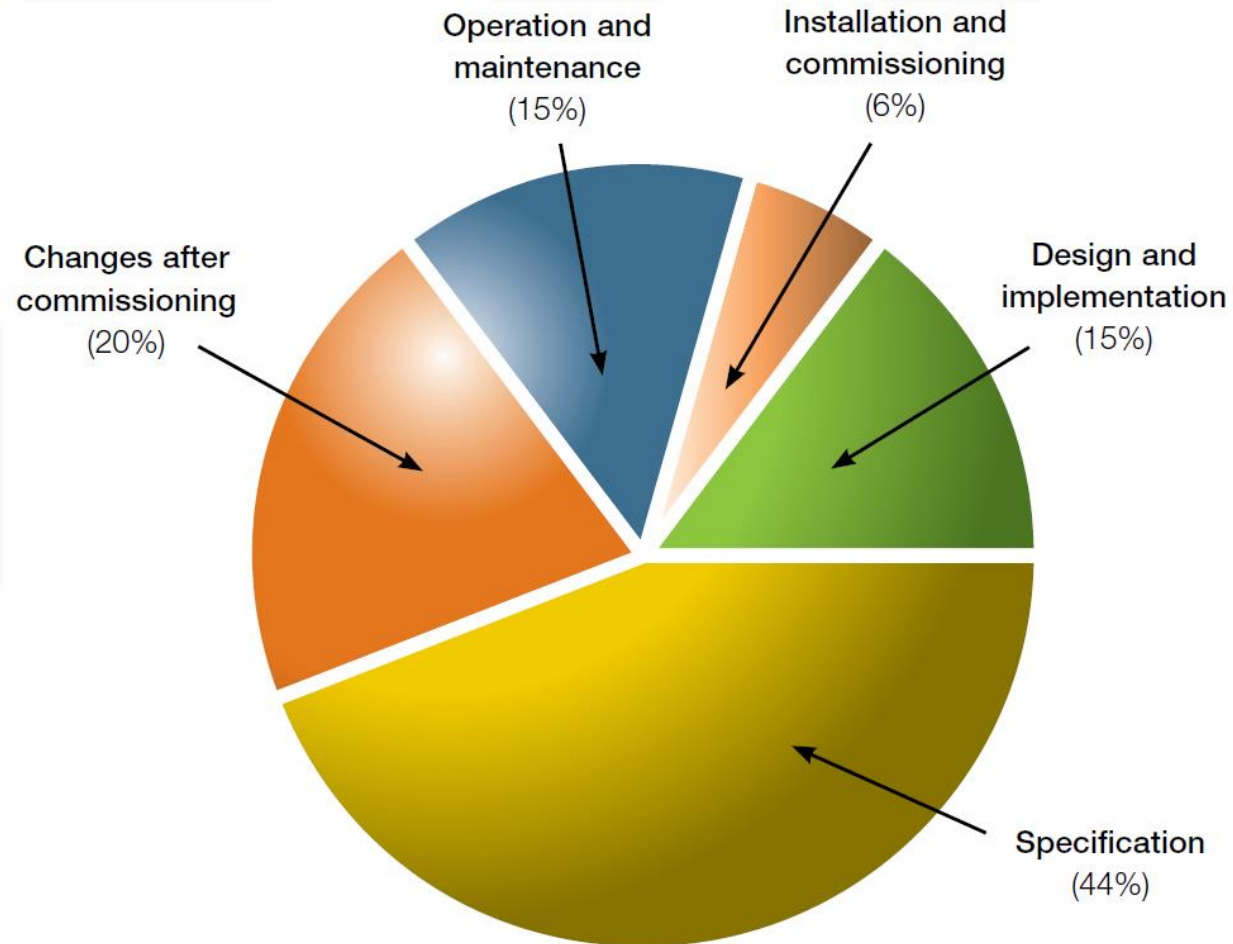
- Summary of 22 topics found in the OTM chapter
 - Review for lists of common hazards found in each process
 - Obtain and review the risk assessments
 - Review and evaluate relevant OSHA standards and applicable industry standards
 - Evaluate that all robot systems meet safe operating requirements
 - Review testing procedures
 - Review the temporary risk reduction measures
 - Review safe operating practices, and robot installation
 - Review all hazards have been properly identified
 - Review safeguards and controls are functioning
 - Review employee training to understand the hazards, risks, and risk reductions
 - Review that the software was designed, written, and tested to industry standards

Machine Safety Statistics: Incident by Task

Tasks		Number of accidents	%
Set-up	Verifying quality, sampling removing defects, optimizing	13	12.3
Production	Feeding material manually (loading)	15	14.2
	Operating	3	2.8
	Removing finished product manually (unloading)	3	2.8
Maintenance	Sharpening blades	2	1.9
	Lubricating	3	2.8
	Adjusting	5	4.7
	Installing guards	3	2.8
	Repairing or troubleshooting	14	13.2
Handling production disturbances	Cleaning	10	9.4
	Unjamming	21	19.8
	Removing excess material	3	2.8
	Picking up material following incident	4	3.8
Access	Adjusting and repositioning material	5	4.7
	Circulating	2	1.9
Total		106	

Safety Science 75 (2015) 163-173

Machine Safety Statistics: Control System Failures



HSE: Out of Control 978 0 7176 2192 7

History of Machine Safeguarding Technology

1970

1980

1990

2000

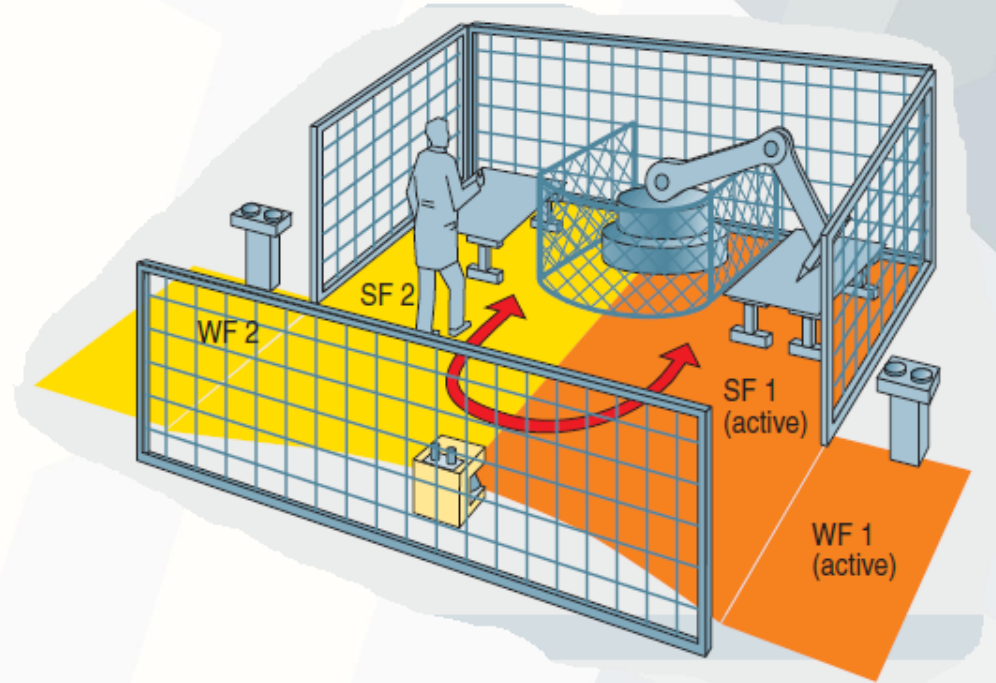
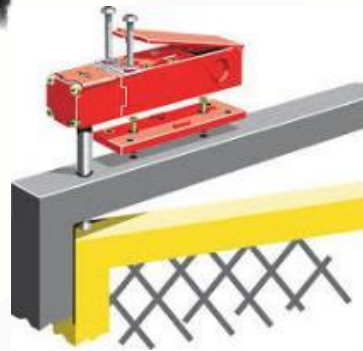
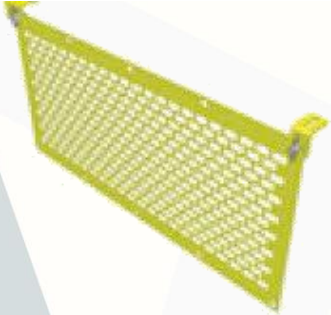
2010

2022+

Prevent Access

Detect Access

Control Access



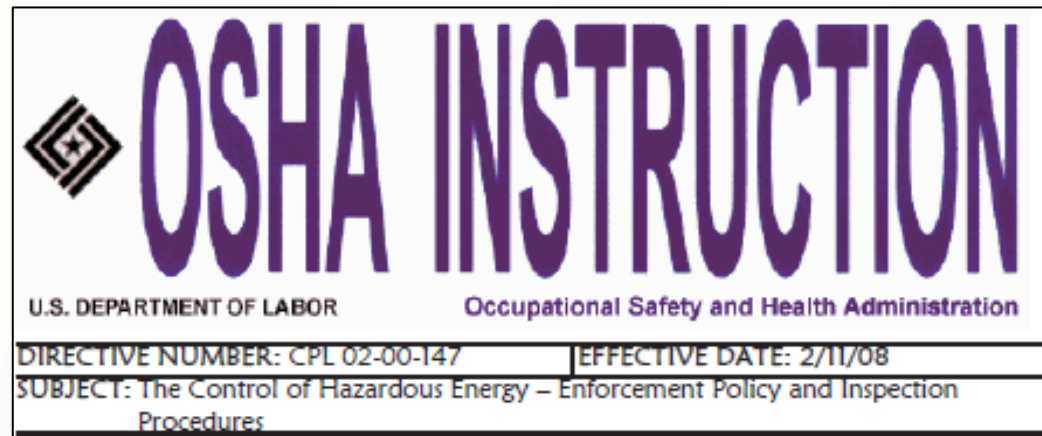
Applicable OSHA Standards

- 29 CFR 1910.147 – The Control of Hazardous Energy
- Lock Out Tag Out
- Servicing and/or maintenance where employees may be exposed to unexpected start-up or release of hazardous energy:
 - Constructing
 - Installing and setting up
 - Adjusting, inspecting, modifying
 - Lubricating, cleaning or un-jamming
 - Tool changes

Note: LOTO applies to all workers performing these tasks, regardless of their job titles.

Hazardous Energy Control Directive

- Issued in 2008 (CPL 02-00-147)
- Position on machine safeguard and 'device' integration to meet the exemption in 1910.147(a)(2)(ii) A.K.A Minor Servicing Exemption:
- Risk Assessment
- B11.19 reference
- NFPA 79 reference



The Purpose of LOTO

- Prevent **unexpected energizing** or **release of stored energy**
- Establish a program of **procedures** and **periodic inspections**
- Reduce the number of fatalities & injuries
- Control/isolate hazardous energy



LOTO Definitions

- **Set-up** - Work to prepare a machine to perform its normal production operation
- **Lockout** – Placement of lockout device on an energy isolating device
- **Lockout device** – Device that uses a physical means to prevent energizing of a machine or equipment

LOTO Definitions (continued)

Energy Isolation Devices:

A mechanical device that physically prevents the transmission or release of energy, including but not limited to the following:

- A manually operated electrical circuit breaker;
- A disconnect switch;
- A manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors



29 CFR 1910.147(b)

Power Circuits and Control Circuits

- The **power circuit** is what actually distributes power from the source to the connected load (motor).
- The **control circuit** is used to “control” the distribution of power.
 - **Push buttons, selector switches, etc. are part of the control circuit, and they only interrupt the circuit. The power circuit is not isolated.**

Energy Isolation Devices *(CPL:Pg 1-5)*



Push-buttons, selector switches, safety interlocks and other control circuit type devices are NOT energy isolating devices.



LOTO Definitions (continued)

Energized - Connected to an energy source, or containing residual or stored energy

29 CFR 1910.147(b)



LOTO Applies When

Service and maintenance takes place during normal production, if an employee:

- Must remove or bypass a guard or safety device; or
- Must place **any part of their body** into the danger zone

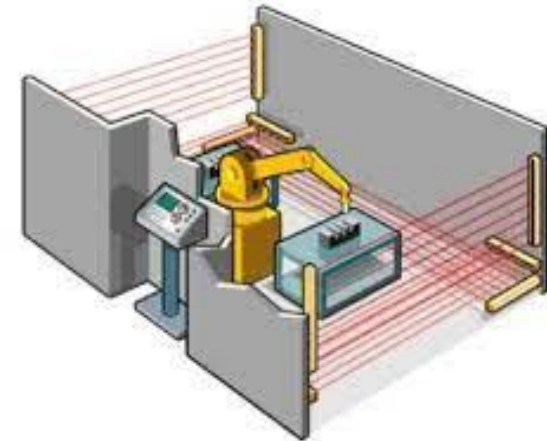


29 CFR 1910.212(a)(1) General Machine Guarding

“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.”

29 CFR 1910.212(a)(1) General Machine Guarding (cont.)

“Examples of guarding methods are: Barrier guards, two-hand tripping devices, electronic safety devices, etc.”



U.S. Machine Safety Standards

OSHA 29 CFR, Part 1910 - General Industry

- Subpart O – Machinery and Machine Guarding
- Subpart P – Hand and Portable Powered Tools and Other Hand-Held Equipment
- Subpart Q – Welding, Cutting and Brazing
- Subpart R – Special Industries

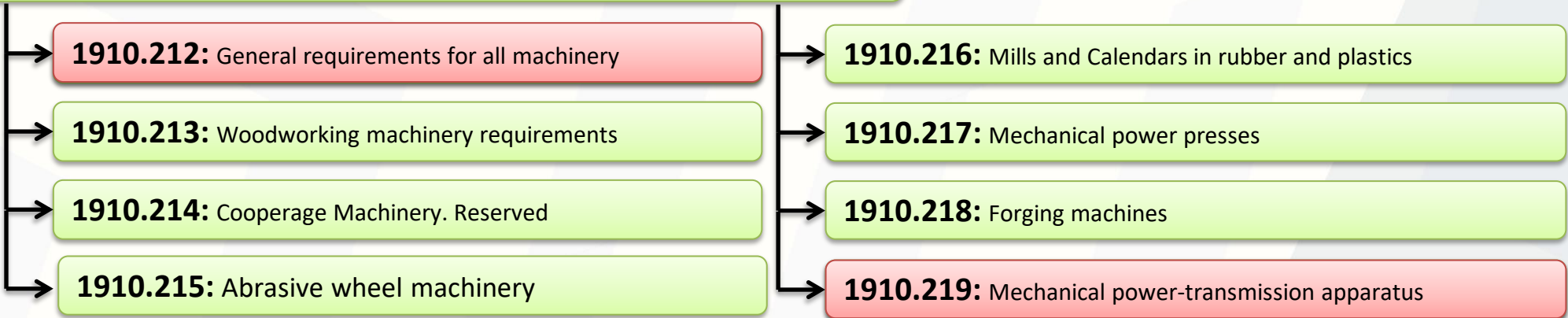
www.osha.gov

Part 1910 Subpart O – Machinery and Machine Guarding



Part 1910: Occupational Safety and Health Standards

Subpart O: Machinery & Machine Guarding



OSH Review Commission

The guarding required must be provided by a “device” that **does not allow reliance upon the skill or attentiveness** of employees. It is “intended to **eliminate danger from unsafe operating procedures, poor training or employee inadvertence.**”

Cincinnati Incorporated, OSHRC Docket No. 00-0955, Final Order

U.S. Consensus Standards

- ANSI/RIA R15.06 - Industrial Robots and Robot Systems - Safety Requirements
- RIA TR R15.306, *Task-Based RA Methodology*
- RIA TR R15.506, *Applicability of R15.06-2012 for Existing Industrial Robot Applications*
- RIA TR R15.606, *Collaborative Robot Safety*
- RIA TR R15.706, *User Responsibilities*
- RIA TR R15.806, *Testing Methods for Power & Force Limited Collaborative Applications*

U.S. Consensus Standards

- ANSI B11.1 Mechanical Power Presses
- ANSI B11.2 Hydraulic Power Presses
- ANSI B11.3 Power Press Brakes
- ANSI B11.4 Shears
- ANSI B11.17 Horizontal Hydraulic Extrusion Presses
- ANSI B11.18 Machines for Processing Strip, Sheet, or Plate from Coiled Configuration
- ANSI B11.19 Performance Criteria for Safeguarding
- ANSI B11.20 Manufacturing Systems/Cells
- ANSI/ASME B20.1 Conveyors and Related Equipment

U.S. Consensus Standards

ANSI/RIA R15.06 - Industrial Robots and Robot Systems - Safety Requirements

- Requirements for industrial robot manufacture, remanufacture and rebuild; robot system integration/installation; and methods of safeguarding to enhance the safety of personnel associated with the use of robots and robot systems.

Risk Assessments

- ANSI/RIA R15.06 requires robot system integrators and users (employers) to complete RAs, and to implement the requisite risk reduction measures/safeguards.
- Requires affected workers to be trained to understand the hazards and the associated risk reduction measures/safeguards that must be implemented.

Safeguarding and Guarding Devices

- The **Safety-Related Function**:
 - Cannot lose safety function.
 - Includes all safety devices, components and wiring (light curtains, interlocks, safety controllers, relays) throughout the system.
- The design and performance of the safety-related parts of the control system (SRP/CS) is related to the risk to the employee. (ANSI B11.0 – ***Safety of Machinery – General Requirements and Risk Assessment***)

Design of the SRP/CS

- One strategy used to meet these requirements is to design the system with;
 - Redundancy, and
 - Monitoring to ensure that redundancy is maintained.
- OSHA recognizes the design strategy as “Control Reliability” and it is used to describe adequate integrity of the safety rated control system.

Robotic Systems and LOTO

- Reasons heard for not locking out robotic cells
 - Long start-up
 - Loss of programming
- Simple Solutions (limited application)
 - A well designed system should be capable of being restarted from a power down situation in a relatively short time
 - Maintain the memory back up batteries
 - PLC powered by on a dedicated circuit with UPS

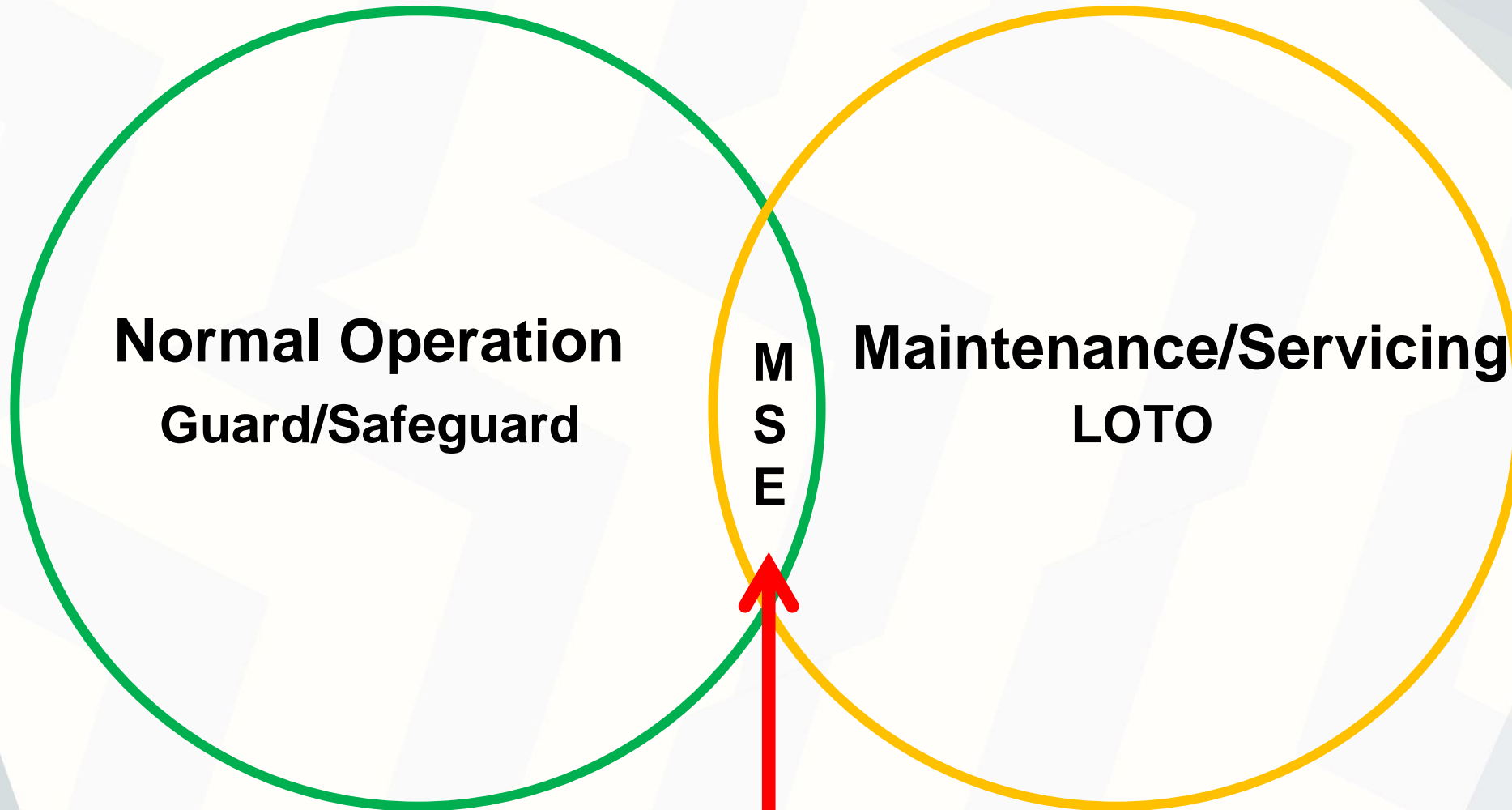
Minor Servicing Exemption (MSE)

During Normal Production Operations

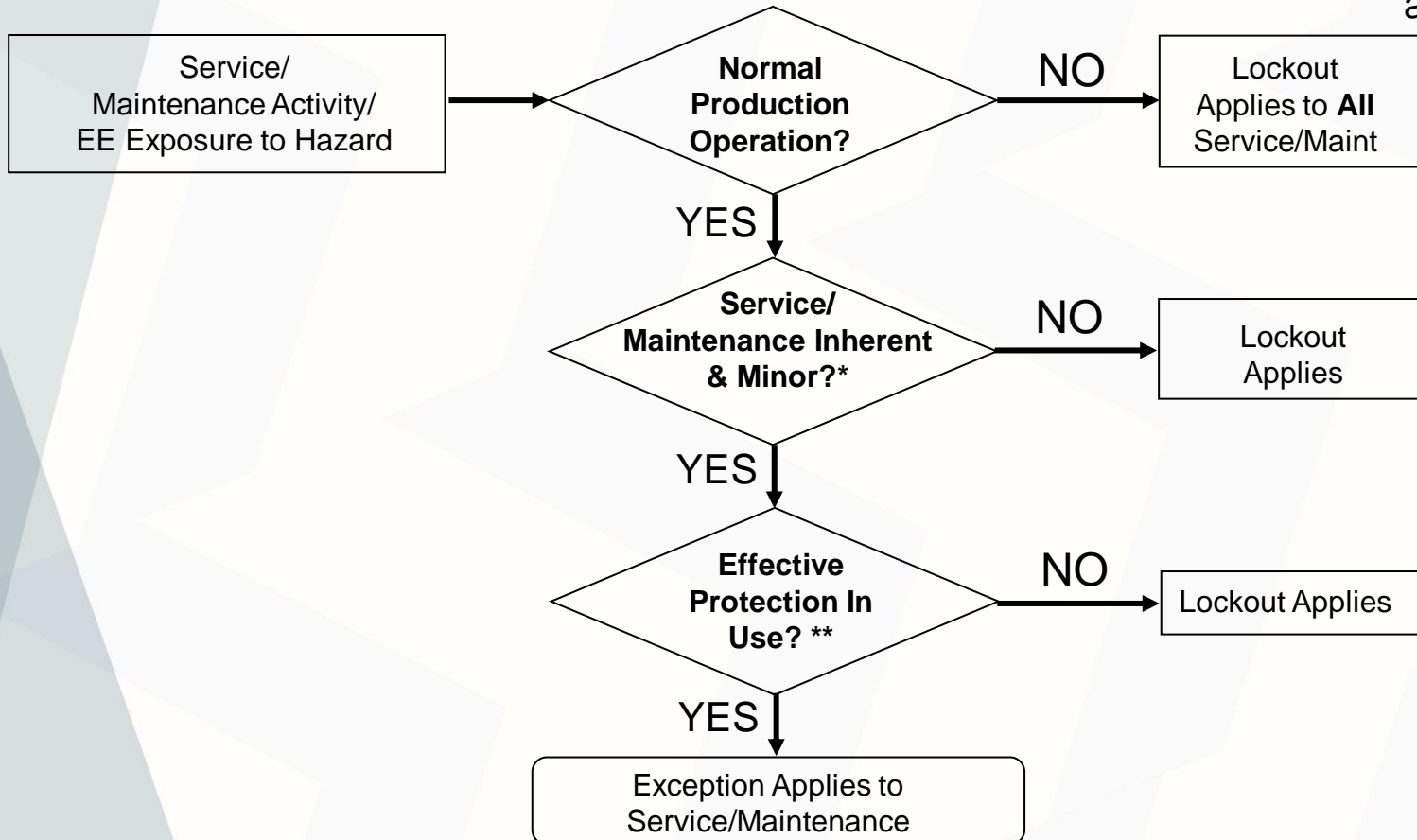
The activity must use alternative measures that **provide effective protection** and must be:

- **Routine:** The activity must be a regular course of procedure and be in accordance with established practices.
- **Repetitive:** The activity must be repeated as part of the production process or cycle.
- **Integral:** The activity must be inherent to the production process.

Employee Protection and MSE



Region V Minor Servicing Decision Flow Chart



* **Inherent & Minor** - Activities must be necessary to allow production to proceed and be:

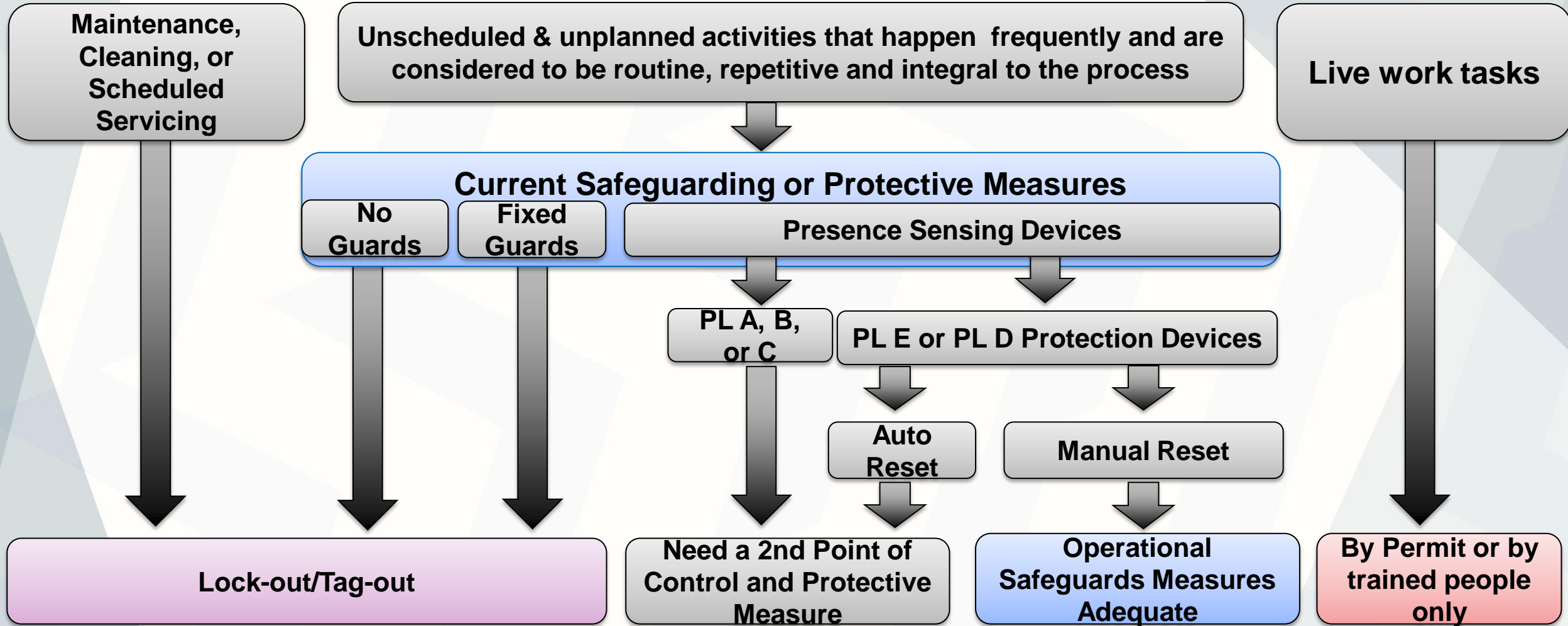
Routine: The activity must be performed as part of a regular and prescribed course of procedure and be performed in accordance with established practices.

Repetitive: The activity must be repeated regularly as part of the production process or cycle.

Integral: The activity must be inherent to the production process.

** Employer must demonstrate that the alternative measures provide effective protection from the hazardous energy.
(Subpart O; ANSI B11.19-2003; etc.)

Example Approach for applying a method



Analog Problems

- Sticking/pitted contacts
- “Runaway” machine operations
- “Ghost Cycles” not investigated
- Investigations resulting in “Could Not Duplicate”
- Intermittent safety functionality
- Limited reliability upon failure

Digital Solutions

- Functional Safety (SF)
- Rated Equipment
 - ISO 26262 (and IEC 61508)
 - ISO 13849 (and IEC 62061)
- Risk Assessments
- Task-based analysis
 - ANSI B11.0
- Integration by certified FS personnel

What Can You Do?

- **Identify more and more non-routine tasks**
- Periodic review of JHA's and LOTO procedures
- Follow Recognized Industry Standards
 - Evaluate effectiveness of Risk Assessments
 - Evaluate safeguarding methods
 - ✓ Is it effective? (Minor Servicing)

Take-Aways:

- Lockout is the most effective protective method when done right
- Lockout is required for all maintenance
- Safeguarding solutions are available and feasible for many minor servicing tasks
- Safeguards used for minor servicing must meet control reliability requirements
- Effective, reliable safeguarding is time efficient
- A risk assessment is an important step in safeguard selection

And More Take-Aways:

- There are lots of different ways to safeguard a machine
- Safeguarding solutions should not be impeding productivity
- Don't confuse "Categories" with "Safety"
- Make sure your employees, your contractors, and your OEMs are qualified to assess risk and design safety systems
- Embrace the future of Machine Safeguarding!

RESOURCES

- Your local area OSHA office
 - Compliance Assistance Specialists (CAS)
- OSHA Onsite Consultation
 - Available in each state, at no cost
 - Primarily targeted for smaller, high-hazard businesses
 - Help identify and address hazards and compliance

Compliance Assistance Specialists in Action



OSHA's Compliance Assistance Specialists and other field staff conducted more than 5,000 outreach activities reaching millions of workers in 2020.

Home / On-Site Consultation

On-Site Consultation



OSHA's On-Site Consultation Program offers no-cost and confidential occupational safety and health services to small- and medium-sized businesses in all 50 states, the District of Columbia, and several U.S. territories, with priority given to high-hazard worksites. On-Site Consultation services are separate from enforcement and do not result in penalties or citations. Consultants from state agencies or universities work with employers to identify workplace hazards, provide advice for compliance with OSHA standards, and assist in establishing and improving safety and health programs.

OSHA Website

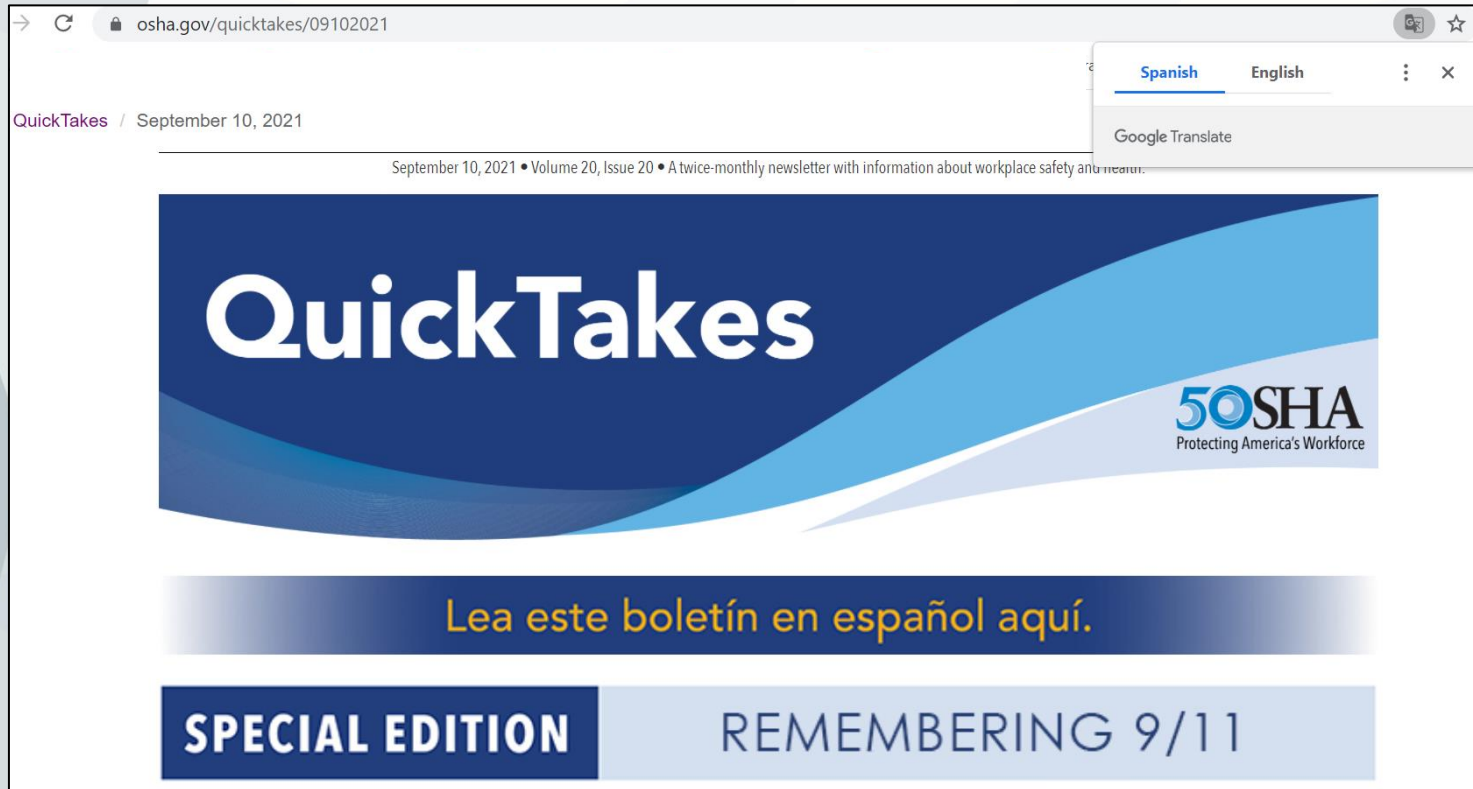
The screenshot displays the OSHA website interface. At the top left, there is a 'WORKPLACE SAFETY REMINDER' banner with the text 'Don't wait, plan ahead for extreme weather events.' Below this are links for 'Subscribe', 'More Reminders', and a 'Español' button. To the right is a 'Prevent Heat Illness at Work' section with a sun icon and the text 'Outdoor and indoor heat exposure can be dangerous.' Further right is a 'OSHA is Hiring! Apply Here' section with a 'TAKE ACTION' heading and links for 'File a Complaint', 'Report a Fatality or Severe Injury', and 'Submit 2020 Injury and Illness Data'. At the bottom left is a 'Find COVID-19 Vaccines Near You' button. To its right is a 'QuickTakes' section with the OSHA logo. At the bottom right is a 'News' section with a date 'September 14, 2021' and a snippet of text: 'US Department of Labor cites Foundation Food Group Inc. for exposing workers to'.

Free fact sheets, guidance documents, pocket guides and hundreds of other publications.

Industry and hazard specific information.

www.osha.gov

QuickTakes



Twice monthly newsletter helps you track the latest trends and learn about new safety and health tools and services

<https://www.osha.gov/quicktakes>

OSHA QuickStart



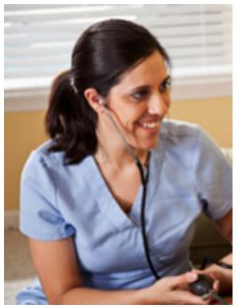
General Industry

This module applies to workplaces that are subject to OSHA's general industry standards, including manufacturing, wholesale, and retail establishments. OSHA's general industry standards also may apply to any industry to the extent that they supplement specific standards for an industry.



Construction Industry

This module applies to employers and workers engaged in construction work, which OSHA defines as construction, alteration, and/or repair, including painting and decorating (29 CFR 1910.12(b)).



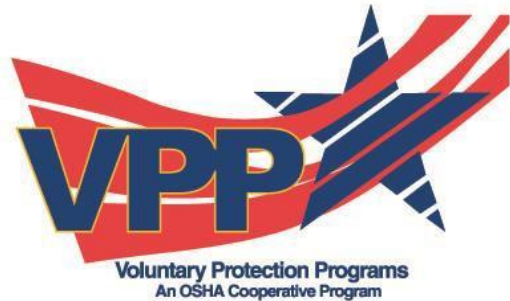
Health Care

This module applies to employers and workers in the health care field.

Step-by-step guide to help identify major OSHA requirements for your business

<https://www.osha.gov/complianceassistance/quickstarts>

Cooperative Programs



Safe + Sound Campaign

- EVERY workplace should have a safety and health program that includes:
 - Management Leadership
 - Worker Participation
 - Systematic Approach to Find and Fix Hazards
- Wherever you are, take a step in the right direction.



WWW.OSHA.GOV/SAFEANDSOUND

SAFE + SOUND 

OSHA[®] Occupational
Safety and Health
Administration

IA3
ROBOTICS | INTERNATIONAL
ROBOT SAFETY
Conference

Hazen Price

Mechanical Engineer
OSHA Health Response Team

Price.hazen.s@dol.gov

Matt Marcinko

Safety and Occupational Health Specialist
OSHA Region 5 Enforcement Programs

Marcinko.matthew@dol.gov