Rethink Your Machine Risk Strategy to Identify and Reduce Costly Risks
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AGENDA

- Top OSHA Citations 2016,

- Cost of Safety,

- Risk Assessment Process:
  - Structure of Standards,
  - Purpose,
  - Different methodologies,
  - Overview of the flow,
  - Risk Assessment,
  - Risk Reduction
  - Documentation,

- Sample of a Risk Assessment,

- Conclusion and open it up to questions
OSHA 2016 Citations

1. 1926.501 Fall Protection
2. 1910.1200 Hazard Communication
3. 1926.451 Scaffolding
4. 1910.134 Respiratory Protection
5. 1910.147 Lockout / Tagout
6. 1910.178 Powered Industrial Trucks
7. 1926.1053 Ladders
8. 1910.212 Machine Guarding
9. 1910.305 Electrical – Wiring Methods
10. 1910.303 Electrical – General Requirements

OSHA’s Top Citations for LOTO and Machine Guarding

• Lockout / Tagout

• Top 5 Cited Sections:

1. General procedures
2. Energy control program
3. Employer shall conduct periodic inspections
4. Training
5. Each authorized employee shall receive training in the recognition of applicable hazardous energy sources

• Machine Guarding

• Top 5 Cited Sections:

1. One or more methods for machine guarding shall be provided to protect the operator and other employees in the machine area from hazards
2. Point of operation
3. Anchoring fixed machines
4. General requirements
5. Exposure of blades

1. Worker’s Compensation claims,

2. OSHA Fines,

3. Machine Downtime – loss of production – loss of revenue,

4. Training cost for replacement workers,

5. Worker physical and emotional suffering,

6. Plant floor culture – negatives and bad publicity

7. Legal fees,

8. Fixing the machine safety issues,

9. others

# Type of Violation | Penalty  
---|---  
1 | Serious | $12,675.00  
2 | Failure to Abate | $12,675.00  
3 | Willful or Repeated | $126,749.00

"OSHA Penalties" 01/13/2017 https://www.osha.gov/penalties
Structure of Standards

– **Type A Standard:** Gives Basic Concepts
  – Ex: Risk assessment and Reduction
  – ANSI B11.0
  – ANSI B11.TR3

– **Type B Standard:** Generic Safety Standards:
  • Standards on Safeguards
    – ANSI B11.19
    – ANSI B11.20
    – B11.TR Standards

– **Type C Standard:** Specific Machine related Standards:
  – ANSI B11.1 Mechanical Presses
Risk Assessment

Purpose

1. Machine Risk Assessments
2. Safety Standards Training
3. Validation
4. Machine Safety Integration
5. Engineering Consulting

Risk Level

<table>
<thead>
<tr>
<th>Machine</th>
<th>Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine 1</td>
<td>10</td>
</tr>
<tr>
<td>Machine 2</td>
<td>8</td>
</tr>
<tr>
<td>Machine 3</td>
<td>6</td>
</tr>
<tr>
<td>Machine 4</td>
<td>2</td>
</tr>
</tbody>
</table>

Step 1: Plan

Step 2: Prioritize

Step 3: Execute
Risk Assessment Methods

Machine Risk Assessments
• Safety Standards Training
• Machine Safety Integration
• Validation
• Risk Assessment Methods

ANSI/PMMI B155.1

PMMI
The Association for Packaging and Processing Technologies

ANSI B11.0 – 2015
SINGLE COLUMN ("ISO style") FORMAT

American National Standard
Safety of Machinery

Secretariat and Accredited Standards Developer:
B11 Standards, Inc.
4000 N. Belt Hwy.
Houston, TX 77009, USA
Approved: 25 AUGUST 2015

by the
American National Standards Institute

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NFPA®

Robotic Industries Association
RIA TR15.306
Risk Assessment and Risk Reduction Process

**Phase 1: Risk Assessment**

- **Step 1:** Risk Analysis
- **Step 2:** Risk Evaluation

**Phase 2: Risk Reduction**
Process Flow

1. Set Limit for the Assessment
2. Identify the Tasks & Hazards
3. Assess the Initial Risk
   - Risk Acceptable?
     - Yes: Validate Solutions
     - No: Reduce the Risk
4. Reduce the Risk
   - Residual Risk Acceptable?
     - No: Re-evaluate the Tasks
     - Yes: Validate Solutions
5. Document
Preparing for the Risk Assessment

• Assemble a diverse Team
  – A Complete Team has members that can:
    • Answer technical questions about the machine design
    • Operator Experience
    • Knowledge of the Process
    • Understand relevant standards and codes
    • Understand Ergonomics / Environment

  – Team may include:
    • EHS,
    • Operators/Maintenance / Electricians,
    • Management,
    • Controls / Mechanical Engineers,
    • Third parties, etc.
Risk Assessment
Specifying Limits of Machine

Specify the limits of the machine:

1. User Limits:
   • The different machine operating modes
   • Who is using the machine,
   • The experience of the user
   • Indirect exposure of other personnel to the hazard

2. Space Limits
   • Range of movement;
   • space requirements for persons to interact with the machine,

3. Time limits:
   • Life Time of the machine
   • Recommended service intervals

4. Other Limits:
   • Environmental
   • Housekeeping
Risk Assessment Tasks

All reasonably foreseeable operator tasks shall be documented

- Loading / Unloading
- Start-up,
- Set-up,
- Inspecting,
- Cleaning,
- Maintenance,
- Shut down / Lock Out Tag Out,
- Troubleshooting,
- Etc.
Risk Assessment
Task Identification
Risk Assessment

Task Identification - continued
Risk Assessment
Hazards

Types of Hazards to be aware of:

- Mechanical Hazards
- Energy Sources
- Unexpected Starts
- Slips and Falls
- Hot Surfaces
- Sharp Edges
- Combustible Atmosphere and Media
- Operational Hazards
- Pinch Points
- Etc.
Examples of Risk Scoring Systems

Table 1 — Example Risk Scoring System

<table>
<thead>
<tr>
<th>Probability of Occurrence of Harm</th>
<th>Severity</th>
<th>Catastrophic</th>
<th>Serious</th>
<th>Moderate</th>
<th>Minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Likely</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Likely</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Unlikely</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Negligible</td>
<td></td>
</tr>
<tr>
<td>Remote</td>
<td>Low</td>
<td>Low</td>
<td>Negligible</td>
<td>Negligible</td>
<td></td>
</tr>
</tbody>
</table>

See 6.4.2.1 and 6.4.2.2 for additional information.

Table D-1 — MILSTD 882 Two-Factor Risk Scoring System [4x5]

<table>
<thead>
<tr>
<th>Probability</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
<td>Catastrophic</td>
</tr>
<tr>
<td>Occasional</td>
<td>Critical</td>
</tr>
<tr>
<td>Remote</td>
<td>Marginal</td>
</tr>
<tr>
<td>Improbable</td>
<td>Negligible</td>
</tr>
</tbody>
</table>

Table D-2 — ANSI B11.TR3 Two-Factor Risk Model [4x4]

<table>
<thead>
<tr>
<th>Probability</th>
<th>Severity of Harm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Likely</td>
<td>Catastrophic</td>
</tr>
<tr>
<td>Likely</td>
<td>Critical</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Moderate</td>
</tr>
<tr>
<td>Remote</td>
<td>Minor</td>
</tr>
</tbody>
</table>

B11 Standards, Inc. “ANSI B11.0-2015” Table 2

B11 Standards, Inc. “ANSI B11.0-2015” Table D-1
Examples of Risk Scoring Systems - Continued

S1 – slight (normally reversible injury)
S2 – serious (normally irreversible injury or death)
F1 – seldom-to-less-often and/or exposure time is short
F2 – frequent-to-continuous and/or exposure time is long
P1 – is possible under specific conditions
P2 – is scarcely possible
Estimating the Risk

Three Steps to assess your risk level

1. Select the scoring system that you will use
2. Assess the risk using the risk factors of the scoring system selected
3. Derive a Risk Level

<table>
<thead>
<tr>
<th>Risk</th>
<th>Severity of harm</th>
<th>Probability of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Related to the considered hazard</td>
<td>That can result from the considered hazard</td>
<td>of that harm</td>
</tr>
</tbody>
</table>
Assessing the severity of harm

- What is the highest credible level of harm that can be done?

  - **Catastrophic**
    - Death or Permanent Disability
    - (Unable to return to work)

  - **Serious**
    - Severe debilitating injury
    - (Able to return to work at some point)

  - **Moderate**
    - Significant injury requiring more than first aid
    - (Able to return to same job)

  - **Minor**
    - Injury requiring first aid or less
    - (Little or no lost work time)
Assessing the Probability of Occurrence

Probability is subjective

Factors to consider:
- How frequently are personnel exposed
- How long some one is exposed
- How much of their body is exposed
- Movement and Speed of occurrence
- Human deviations and errors
- Training of operators

Assessing the Probability of Occurrence

- Very Likely – Near certain to occur
- Likely – May occur
- Unlikely – Not likely to occur
- Remote – So unlikely as to be near zero
After listing all the tasks, hazards, and estimating the risk on each one of these hazards, we get now to the point where we would need to evaluate the risk for each of the hazards.

Once the risk is evaluated, we can determine whether the risk reduction is required in that case or not.
### Table 3 — The Hazard Control Hierarchy

<table>
<thead>
<tr>
<th>Protective Measure</th>
<th>Examples</th>
<th>Influence on Risk Factors</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elimination or Substitution</td>
<td>• Eliminate pinch points (increase clearance)</td>
<td>• Impact on overall risk (elimination) by affecting severity and probability of harm</td>
<td>Design Out</td>
</tr>
<tr>
<td></td>
<td>• Intrinsically safe (energy containment)</td>
<td>• May affect severity of harm, frequency of exposure to the hazard under consideration, and/or the possibility of avoiding or limiting harm depending on which method of substitution is applied.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Automated material handling (robots, conveyors, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Redesign the process to eliminate or reduce human interaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reduced energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Substitute less hazardous chemicals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guards and Safeguarding Devices</td>
<td>• Barriers</td>
<td>• Greatest impact on the probability of harm (Occurrence of hazardous events under certain circumstance)</td>
<td>Engineering Controls</td>
</tr>
<tr>
<td></td>
<td>• Interlocks</td>
<td>• Minimal if any impact on severity of harm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Presence sensing devices (light curtains, safety mats, area scanners, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Two hand control and two-hand trip devices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness Devices</td>
<td>• Lights, beacons, and strobes</td>
<td>• Potential impact on the probability of harm (avoidance)</td>
<td>Administrative Controls</td>
</tr>
<tr>
<td></td>
<td>• Computer warnings</td>
<td>• No impact on severity of harm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Signs and labels</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Bleepers, horns, and sirens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training and Procedures</td>
<td>• Safe work procedures</td>
<td>• Potential impact on the probability of harm (avoidance and/or exposure)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safety equipment inspections</td>
<td>• No impact on severity of harm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Lockout / Tagout / Tryout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Protective Equipment (PPE)</td>
<td>• Safety glasses and face shields</td>
<td>• Potential impact on the probability of harm (avoidance)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ear plugs</td>
<td>• No impact on severity of harm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Protective footwear</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Respirators</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B11 Standards, Inc. “ANSI B11.0-2010” Table 3
Elimination / Substitution

• Inherently safe design measures is the most important step in a risk assessment.
  — Since they are the most likely to remain effective since they are inherent to the design of the machine, whereas safeguarding measures are more likely to be violated over time.

• What considerations can be taken into account:
  
  — Physical Dimensions of the machine:
    • Direct visibility of the hazard zone from the control position
    • Limiting blind spots
    • Choosing means of indirect vision where necessary
    • The form and relative location of the mechanical components part
    • Avoiding sharp edges and corners.

  — Physical Aspects
    • Limiting the force applied on a mechanical part
    • Limit the speed/movement
    • Limiting the emissions (Noise, vibration, dust, radiation)
Administrative Controls

Stack Lights

Awareness Barrier

PA Horn
Residual Risk

• After safeguarding is implemented, reassess the risk to find the Residual Risk Level

• Residual Risk is used to verify the degree of training, PPE and other protective measures

• When evaluating Residual Risk, Incentive to Defeat Safeguarding Measures must be considered

• Collectively as a team the Acceptable Risk level should be agreed upon

• After the residual risk is determined, the team shall determine if it is acceptable or if more safeguarding is needed
Risk Assessment documentation:

- Machine Name,
- Machine Description / Pictures
- Date of the assessment
- Risk Assessment Team,
- Energy Sources for the equipment,
- Any assumptions that were made,
- Tasks and Hazards that were identified
- Initial risk before safeguarding measures
- Risk Reduction measures that were implemented
- Residual Risks
- Validation of the risk reduction measures
- Supplier recommendations of additional risk reduction measures
Risk Assessment Example
<table>
<thead>
<tr>
<th>Machine Name</th>
<th>Filling Line 1</th>
<th>Date of Assessment</th>
<th>Hazard</th>
<th>Hazardous Energy Source</th>
<th>Frequency</th>
<th>Severity</th>
<th>Risk Level</th>
<th>Risk Level Before</th>
<th>Solution</th>
<th>Risk Level After</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Draw in from cup belt conveyor.</td>
<td>11/16/2016</td>
<td>Electrical</td>
<td>S2</td>
<td>F2</td>
<td>P1</td>
<td>Medium</td>
<td>Low</td>
<td>Currently there exists a fixture on this machine which allows for a stack of cups to be loaded into the cup dispenser. The cups need to constantly be loaded and replaced within the dispenser so there will be a container in which the product will be able to fall into. If personnel are not loading cups, the process continues and the operators are exposed to the hazardous pinch points on the cup dispenser. In addition to the hazard the fillers begin emptying out onto the conveyors, thus causing a mess which will need to be addressed which contributes to extra downtime which can be avoided. Proposed solution would be to install a one-way door at the end of cups and installation of warning signs to identify the hazardous pinch point if cups are removed. The one-way door will close automatically when no cups are present to restrict the access to the pinch points and draw-in hazards. Each cup opening will require a one-way door. The diameter of the guard will be approximately 4 inches wide to fill the opening (qty 4).</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Front of Filler (Zone 1)</td>
<td></td>
<td>Pneumatic</td>
<td>S1</td>
<td>F2</td>
<td>P1</td>
<td>Low</td>
<td>Negligible</td>
<td>d S2 F1 P1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Draw in from spacer bars.</td>
<td></td>
<td>Electrical</td>
<td>S2</td>
<td>F2</td>
<td>P1</td>
<td>Medium</td>
<td>Low</td>
<td>Currently nothing prevents personnel from reaching into the end of the filler into the space bar area. Existing guard in place only stops dangerous motion only if the guard above the conveyor is opened, but not if reached through. To ensure this exposure to hazard is reduced, the proposed solution would be to install a 32 mm wide x 10.5 mm high x 16 mm deep hinged and interlocked tunnel guard at end of filler. The interlock will be guard locking and require the entire line to be stopped due to process reasons. The extended guard from the exit will allow for a product to pass through and the operators will be restricted from accessing the hazardous motion due to the 36 inches depth of the guard. In addition to the tunnel guard top and sides, install a fixed portion at the base to restrict reaching under the guard and accessing the hazardous motion. The fixed guard will be approximately 4 inches wide by 33 inches long.</td>
<td>d S2 F1 P1</td>
</tr>
<tr>
<td>8</td>
<td>End of Filler (Zone 4)</td>
<td></td>
<td>Electrical</td>
<td>S2</td>
<td>F2</td>
<td>P1</td>
<td>Medium</td>
<td>Low</td>
<td>d S2 F1 P1</td>
<td></td>
</tr>
</tbody>
</table>
Thank you for attending

Questions?

Future Presentations:

1. SIEMENS Summit
   - Date: June 2016
   - Topic: Functional Safety Controls

2. SIEMENS WebEx:
   - Date: August 2016
   - Topic: Safety Controls Validation

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