Machine Safeguarding Risk Assessment: Achieving Acceptable Risk
- Recognizing Machine Hazards
- Introduction
  - Why Risk Assessment?
  - ANSI B11 Consensus Standard
- Risk Assessment
  - ANSI B11-TR3
  - ANSI B11-2008
Understanding Risk

- **Hazard**
  - Potential source of harm

- **Risk**
  - Combination of severity of harm & probability of occurrence of harm

Risk = Severity of Harm $\times$ Likelihood
Why Risk Assessment

- **Job Hazard Analysis (JHA)**
  - Generally lists the sequence of basic job steps, potential hazards, and recommended hazard controls

- **Risk Assessment**
  - Similar to JHA but contains additional assessment of risk to determine if hazard controls will reduce the risk of potential harm to an acceptable level
Why Risk Assessment

- A structured process that can discover the cause for the vast majority of workplace injuries.
- Focuses on the relationship between the worker, the task, the tools and the work environment.
Why Risk Assessment?

- Through the use of a Risk Evaluation Form you look at equipment to identify potential problems.
- ANSI B11 assists in identification of machine hazards & uses a quantitative approach for identification & prioritization.
Why Risk Assessment?

ANSI Series of Standards


The term that focuses on the relationship between the worker, the task, the tools and the work environment.

A. Risk Assessment
B. Job Hazard Analysis
C. Safety Assessment
D. Height Assessment
• A numeric risk score is generated for each hazard analyzed.
• The Machine Safeguarding Risk Assessment sequence adds a third variable, a guarding factor to identify the potential for contact with the machine hazard.
• Scores range from:
  ◦ $5 = \text{Low Risk}$
  ◦ $160 = \text{High Risk}$

Acceptable

Unacceptable
• Evaluations can be averaged to even out slight differences between observers
• When complete management will have a better picture of which areas need guarding attention
1. Opening Instruction Information
   - Machine
   - Location
   - Department Name
2. Observe & understand how machine operates
   - Watch operators at work paying attention to what they do and how they move
   - Ask questions of operators and crew members
   - Video tape/photograph machine hazards
3. Determine which moving parts should be evaluated
   ◦ Assume that if something on a machine moves, it should be evaluated
   ◦ Do not eliminate moving parts because they do not seem dangerous
4. Do not skip moving parts because they are already guarded
   ◦ Evaluate how well those guards work
5. Assign a hazard type
   - Type of machine motion
   - Point of operation hazards
   - Miscellaneous hazards

6. Location of evaluation
   - Sketch the location
   - Photographs

Point of operations on a table saw
- Probability of Contact (P)
  - \(2\)=Lesser (likelihood of injury low)
  - \(4\)=Greater (likelihood of injury high)
- Consider
  - Do people pass by it frequently?
  - When they go near it, is it at close range?
  - Watch operators as they work and ask questions about their contact with the hazard.
  - If you have any doubts about which probability level to choose, pick the greater probability score.
Operator’s position at the operator control and lack of guarding puts him at close range to the point of operation. He has reason to access therefore \( P \) could be evaluated at 4.
Operator’s position at the operator control does not put him at close range to the point of operation during normal operations. He has little/no reason to access therefore $P$ could be evaluated at 2.
Risk Assessment

- **Severity (S)**
  - **High=4:** Involves death from injury or injuries involving permanent disability.
  - **Medium=3:**
    - Involves injuries resulting in hospitalization or variable but limited period of disability.
    - OSHA recordable injury not resulting in fatality or permanent disability.
  - **Low=2:**
    - Involves injuries not resulting in hospitalization and requiring only minor supportive treatment.

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Machine Safeguarding Risk Assessment Evaluation Form

1. Opening Information. Complete the following:
   - Machine Name:
   - Machine Location:
   - Department:
   - Serial number or asset identification:

2. Observation. Summarize a narrative observation of process. Include videos and/or photographs of process.

3. Hazard Types:
   - Point of Operation
   - Power Transmission
   - Other Moving Parts

4. Risk Evaluation
   Instructions: check appropriate variable for S, P, and I. Estimate overall risk assessment with each variable.
   - Probability of Contact (P)
     - Create 2:
     - Lessen 2:
   - Severity of Injury if Contact with Hazard (S)
     - High=4:
     - Medium=3:
     - Low=2:

Insert as applicable, photos or additional information.
Risk Assessment

- **Guarding Factor (G)**
  - *Contact with the hazard is not expected* = **0.9**
    - Complete guarding in place, little chance of operator removal of guards during normal operation; little chance of guards being over-ridden during operation.
  - *Contact with hazard is unlikely but conceivable* = **0.6**
    - Guards permit slight chance of contact; slight chance of operator removal of guards during normal operations; slight chance of guards being over-ridden during operation.

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5. Conclusions

<table>
<thead>
<tr>
<th>Factor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of Contact (P)</td>
<td></td>
</tr>
<tr>
<td>Severity of Injury if Contact with Hazard (S)</td>
<td></td>
</tr>
<tr>
<td>Guarding Factor (G)</td>
<td></td>
</tr>
<tr>
<td>Risk = P x S x G</td>
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</tbody>
</table>

Risk classified as:
- Unacceptable. Remove machine from operation until further safeguards are implemented. (Score of 40 to 160)
- Implement additional control measures. (Score of 20 to 26)
- Risk is Acceptable. (Score of 4 to 18)

<table>
<thead>
<tr>
<th>Score</th>
<th>Guarding Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>0.1 0.3 0.5 0.6 0.9</td>
</tr>
<tr>
<td>12</td>
<td>0.1 0.3 0.5 0.6 0.9</td>
</tr>
<tr>
<td>8</td>
<td>0.1 0.3 0.5 0.6 0.9</td>
</tr>
<tr>
<td>6</td>
<td>0.1 0.3 0.5 0.6 0.9</td>
</tr>
<tr>
<td>4</td>
<td>0.1 0.3 0.5 0.6 0.9</td>
</tr>
</tbody>
</table>

Recommended Controls
- One of the following MUST be checked:
  - Process elimination
  - Engineering control

At least two of the following MUST be checked:
- Awareness Devices
- Personal Protective Equipment
- Procedures & training
Compete enclosure of process & operator controls outside the point of operation making inaccessible. Therefore $G$ could be evaluated at $0.9$. 
Enclosure of process & safety interlock guard. Operator has slight chance of accessing point of operation if he left operator control because of lack of guarding on sides. Therefore $G$ could be evaluated at 0.6.
Risk Assessment

- Guarding Factor (G)
  - *Contact with hazard is possible* = 0.3
    - Can/are safeguards missing or be overridden?
    - Can operator contact point of operation?
  - *Contact with hazard is imminent* = 0.1
    - Has there been an injury?
    - Are safeguards properly used/adjusted properly?
Operator needs access to piston periodically throughout the shift. Guarding over piston is interlocks, however the interlock is a limit switch which can be easily overridden. Therefore $G$ could be evaluated at $0.3$. 
Lack of guarding and operational controls puts operator at risk of contact with in-running nip point since he has to access the point of operation with a tool at close range. Therefore $G$ could be evaluated at 0.1.
- Probability (P)
- Severity (S)
- Guarding Factor (G)
- Risk = \( \frac{P \times S}{G} \)
  - Scores range from:
    - 5 = Low Risk
    - 160 = High Risk
### Quantitative Risk Assessment Scoring Summary

<table>
<thead>
<tr>
<th>PXS</th>
<th>Guarding Factor</th>
<th>0.1</th>
<th>0.3</th>
<th>0.6</th>
<th>0.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td></td>
<td>160</td>
<td>53</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>120</td>
<td>40</td>
<td>20</td>
<td>13</td>
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<tr>
<td>8</td>
<td></td>
<td>80</td>
<td>26</td>
<td>13</td>
<td>9</td>
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<tr>
<td>6</td>
<td></td>
<td>60</td>
<td>20</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>40</td>
<td>13</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

- **Risk Unacceptable. Remove machine from operation until further safeguards are implemented.**
- **Implement Additional Controls**
- **Risk Acceptable**
Risk Assessment

Equipment Hazard Ranking

- Equipment #6
- Equipment #5
- Equipment #4
- Band Saw
- ML12
- ML06
- ML03
- MP06
- ML11
- Milling Machines
- Lathe Machines
- Drill Press
- Equipment #3
- Equipment #2
- Equipment #1
Question 2

Overall risk that would result in score that would necessitate taking the machine out of service.

A. 80
B. 26
C. 13
D. 9
Risk Assessment Exercise
Question 3

The risk assessment analyzed resulting in a Probability of Risk (P) of:

A. 2
B. 4
Question 4

The risk assessment analyzed resulting in a Severity of Injury (S) of:

A. 4  
B. 3  
C. 2
The risk assessment analyzed resulting in a Guarding Factor \((G)\) of:

A. 0.9  
B. 0.6  
C. 0.3  
D. 0.1
As a result of this risk assessment, equipment should be:

A. Removed from service  
B. Additional controls implemented  
C. Risk is acceptable
### Guarding Requirements

<table>
<thead>
<tr>
<th>Protective Measure</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elimination or Substitution</strong></td>
<td>• Eliminate human interaction in the process</td>
</tr>
<tr>
<td></td>
<td>• Eliminate pinch points (increase clearance)</td>
</tr>
<tr>
<td></td>
<td>• Automated material handling (robots, conveyors, etc.)</td>
</tr>
<tr>
<td><strong>Engineering Controls</strong></td>
<td>• Barriers</td>
</tr>
<tr>
<td>(Safeguarding Technology/Protective Devices)</td>
<td>• Interlocks</td>
</tr>
<tr>
<td></td>
<td>• Presence sensing devices (light curtains, safety mats, area scanners, etc.)</td>
</tr>
<tr>
<td></td>
<td>• Two hand control and two hand trip devices</td>
</tr>
<tr>
<td><strong>Awareness Means</strong></td>
<td>• Lights, beacons, and strobes</td>
</tr>
<tr>
<td></td>
<td>• Computer warnings</td>
</tr>
<tr>
<td></td>
<td>• Signs and labels</td>
</tr>
<tr>
<td></td>
<td>• Beepers, horns, and sirens</td>
</tr>
<tr>
<td><strong>Training and Procedures</strong></td>
<td>• Safe work procedures</td>
</tr>
<tr>
<td>(Administrative Controls)</td>
<td>• Safety equipment inspections</td>
</tr>
<tr>
<td></td>
<td>• Training</td>
</tr>
<tr>
<td></td>
<td>• Lockout/Tagout/Tryout</td>
</tr>
<tr>
<td><strong>Personal Protective Equipment</strong> (PPE)</td>
<td>• Safety glasses and face shields</td>
</tr>
<tr>
<td></td>
<td>• Ear plugs</td>
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<tr>
<td></td>
<td>• Gloves</td>
</tr>
<tr>
<td></td>
<td>• Protective footwear</td>
</tr>
<tr>
<td></td>
<td>• Respirators</td>
</tr>
</tbody>
</table>
Risk Assessment

- Suggested Engineering Controls
  - Two Hand Control
  - Light Curtain
  - Adjustable Guard
  - Robot
Acceptable Risk
- Refers to the level at which further risk reduction will not result in significant reduction in risk
- Risk reduction is considered complete when protective measures are applied and acceptable risk had been achieved for the identified hazards
Achieving **Acceptable Risk**
- Use the hazard control hierarchy.
- Use of engineering controls (guards/devices) mandatory but not sufficient in reducing risk to an acceptable level.
Risk Assessment

Required element to achieve **Acceptable Risk**.

<table>
<thead>
<tr>
<th>More Effective</th>
<th>1. Eliminate by design</th>
<th>Engineering Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Guards and Safeguarding Devices</td>
<td>3. Awareness Devices</td>
<td>Administrative Controls</td>
</tr>
<tr>
<td>4. Procedures and Training</td>
<td>5. Personal Protective Equipment</td>
<td></td>
</tr>
<tr>
<td>Less Effective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Need culture driven combination to balance to achieve **Acceptable Risk**. Requires at least a combination of two or more administrative controls in addition to engineering controls.
Required Balance to achieve **Acceptable Risk**.

- Engineering Control
- Administrative Control
- Administrative Control

Can contain more than two administrative controls!!
Suggested for achieving acceptable risk after engineering controls are in place:

- Signage
- Training of proper use of equipment
- Energy control procedures
- PPE