A Practical Approach to Risk Assessment and Risk Reduction

Presented by
Richard Harris
Today’s Learning Objectives

• What is a risk assessment and why do I have to do it?
• Who can do a risk assessment?
• How do I do it?
• What is the difference between risk assessment and risk reduction?
• What tools are available?
What is it?

- **Risk Assessment**
  - The process by which the intended use (and reasonably foreseeable misuse) of the machine, the tasks and hazards, and the level of risk are determined

- **Risk Reduction**
  - The application of protective measures to reduce the risk to a tolerable level
Why do it?

• To create a safer working environment for employees (as required by OSHA)
• To reduce costs
• To comply with national and international consensus standards, including:
  ANSI B11.0-2010 – Safety of Machinery – General Requirements and Risk Assessment
  ANSI/RIA R15.06-1999 (R2009) – For Industrial Robots and Robot Systems – Safety Requirements
  NFPA 79-2012 – Electrical Standard for Industrial Machinery
  ANSI/PMMI B155.1-2011 – Standard for Packaging Machinery and Packaging-Related Converting Machinery – Safety Requirements for Construction, Care, and Use
  SEMI S10-0307 – Safety Guideline for Risk Assessment and Risk Evaluation Process
  CSA Z432-04 – Safeguarding of Machinery – Occupational Health and Safety
  CSA Z434-03 – Industrial Robots and Robot Systems – General Safety Requirements
  CSA Z460-05 – Control of Hazardous Energy – Lockout and Other Methods
  NOM-004-STPS-1999 – Protection Systems and Safety Devices for Machinery and Equipment Used in the Workplace
  ISO 13849-1:2006 – Safety of machinery – Safety-related parts of control systems – Part 1: General principles of design
  2006/42/EC – European Machinery Directive
How do I do it?

• Regardless of which standard you follow, the process contains 12 essential steps

• You can create your own process, as long as it’s based on industry best practices

• You can conduct the process in house, request it from your OEM, or contract an outside service provider
Identify Machine / Process

- Usually done in reaction to an accident / near miss that has already occurred

- Think Proactive!

- Can be prioritized based on common sense (more hazardous machines first)
  - Based on hazards and/or frequency of use
Collect Proper Information

- Limits of the machine
- Requirements for the lifecycle of the machine
- Design drawings, sketches, system descriptions, or other means of establishing the nature of the machine
- Information concerning energy sources
- Any accident and incident history
- Any information about damage to health
- System layout and proposed building / existing system(s) integration
- Affected personnel
- Level of training, experience, or ability of all personnel
- Exposure of other persons to the hazards associated with the machine where it can be reasonably foreseen
Gather Proper Personnel

EHS manager
Operators
Maintenance personnel
Engineers
Electricians
Production managers
Specialists

Use A-TEAM approach
Observe Machine in Use

Although many machines are similar in design, they are adapted to perform specific or different operations. The best way to understand the operation and maintenance of a machine is to see it in use. This helps ensure safety and compliance while understanding and meeting productivity needs.

“This machine is perfectly safe... As long as you never press this button.”
Identify Hazardous Areas

• Follow task/hazard approach

• Tasks include:

  - Packing and transporting
  - Unloading/unpacking
  - Systems installation
  - Start up/commissioning
  - Set up and try out
  - Operation (all modes)
  - Tool change
  - Major repair

  - Planned maintenance
  - Unplanned maintenance
  - Recovery from crash
  - Troubleshooting
  - Housekeeping
  - Decommissioning
  - Disposal
## Task / Hazard Approach

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Task</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trainees</td>
<td></td>
<td></td>
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<tr>
<td>Passers-by</td>
<td></td>
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<tr>
<td>Managers</td>
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<tr>
<td>Supervisors</td>
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<td>Programmers</td>
<td></td>
<td></td>
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<td>Engineers</td>
<td></td>
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<tr>
<td>Office Personnel</td>
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<tr>
<td>Quality Coach</td>
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<tr>
<td>Sales Personnel</td>
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<td>Contractors</td>
<td></td>
<td></td>
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<tr>
<td>Riggers</td>
<td></td>
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</table>
# Task / Hazard Approach

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Task</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
<td>Load</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Unload Part</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Unload Scrap</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Cycle</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Lube Die</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Clean Die</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Tape Die</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Power Up</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Power Down</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Clean Press</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Clean Workspace</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td>Teach Trainees</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Change Die</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>First Piece Verification</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Preventative Maintenance</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Recovery from Crash</td>
<td></td>
</tr>
</tbody>
</table>
## Task / Hazard Approach

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Task</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Shearing</td>
</tr>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Cutting or Severing</td>
</tr>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Stabbing or Puncturing</td>
</tr>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Contact with Live Parts</td>
</tr>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Reaction to Stainless Steel</td>
</tr>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Failure of the Control System</td>
</tr>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Failure of the Equipment</td>
</tr>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Slip, Trip, or Fall</td>
</tr>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Falling Objects</td>
</tr>
<tr>
<td>Operator</td>
<td>Load</td>
<td>Ejected Objects or Fluids</td>
</tr>
<tr>
<td>Operator</td>
<td>Unload Part</td>
<td>Crushing</td>
</tr>
<tr>
<td>Operator</td>
<td>Unload Part</td>
<td>Shearing</td>
</tr>
<tr>
<td>Operator</td>
<td>Unload Part</td>
<td>Cutting or Severing</td>
</tr>
<tr>
<td>Operator</td>
<td>Unload Part</td>
<td>Contact with Live Parts</td>
</tr>
<tr>
<td>Operator</td>
<td>Unload Part</td>
<td>Reaction to Stainless Steel</td>
</tr>
<tr>
<td>Operator</td>
<td>Unload Part</td>
<td>Failure of the Control System</td>
</tr>
</tbody>
</table>
Identifying Tasks & Hazards

- ANSI B11.0-2010

Identifying tasks and hazards is a critically important part of the risk assessment process because hazards not identified can create substantial unknown risks. There are many different approaches to identifying hazards. Depending on the complexity of the machinery, useful methods may include but are not limited to:

- using intuitive operational and engineering judgment;
- examining system specifications and expectations;
- reviewing codes, regulations, and consensus standards;
- interviewing current or intended system users and/or operators;
- consulting checklists;
- reviewing studies from other similar systems;
- evaluating the potential for unwanted energy releases/exposures to hazardous environments;
- reviewing historical data/industry experience, incident investigation reports (including accident or near-miss events), OSHA, Bureau of Labor Statistics and National Safety Council data, manufacturer’s literature;
- considering potential mishaps with surrounding equipment and operations;
- brainstorming.
Assumptions

• The risk assessment process includes identifying hazards regardless of the existence of risk reduction (safeguarding) measures.
• The machine should not be considered harmless as shipped and guarded.
• To assure that all hazards are included, hazard identification should be conducted with all safeguards conceptually removed.
  • This is to assure that hazards are not ignored due to an assumption that the safeguard supplied is adequate for all tasks, including reasonably foreseeable misuse.
• Existing safeguards that help meet the risk reduction objectives can be retained after evaluating their performance.
  • This decision will be confirmed during the validation/verification portion of the risk assessment.
Identify the Risk Level and Required Level of Risk Reduction

- There are several recognized methods to identify (label) risk levels
  - ANSI, RIA, CSA, EN, ISO

- Choose the method which is easiest and most practical to apply at your location

- Risks must be aligned to a risk reduction category that incorporates the selection of safeguarding devices and safety-related parts of the control system
7.2 Severity of harm
Severities of harm addresses the degree of injury or illness that could occur. The
severities are based on extent of injury or illness (from death to no injury), and
extent of treatment involved. The following is an example of severity levels:

- **Catastrophic** – death or permanently disabling injury or illness (unable to return to work)
- **Serious** – severe debilitating injury or illness (able to return to work at some point)
- **Moderate** – significant injury or illness requiring more than first aid (able to return to same job)
- **Minor** – no injury or slight injury requiring no more than first aid (little or no lost work time)

When determining risk, the worst credible severity of harm is to be selected.

7.3 Probability of occurrence of harm
Probability of occurrence of harm is estimated by taking into account the
frequency, duration and extent of exposure, training and awareness, and the
presentation of the hazard. The following is an example of probability levels:

- **Very likely** – near certain to occur
- **Likely** – may occur
- **Unlikely** – not likely to occur
- **Remote** – so unlikely as to be near zero

When estimating probability, the highest credible level of probability is to be selected.
## ANSI B11.TR3

<table>
<thead>
<tr>
<th>Probability</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>
</tr>
<tr>
<td>Likely</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Negligible</td>
</tr>
<tr>
<td>Remote</td>
<td>Low</td>
<td>Low</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
</tbody>
</table>

Table 1: Risk Determination Matrix
ANSI B11.TR3

- Safeguards providing the *highest* degree of risk reduction are:
  - **Barrier guard or protective device preventing intentional exposure** of any part of the body to the hazard, and secured with special fasteners or a lock. If moveable, such a barrier should be interlocked using system control criteria as defined in this paragraph.
  - **Control systems** having redundancy with continuous self-checking to ensure the continuance of performance.

- Safeguards providing *high / intermediate* risk reduction are:
  - **Barrier guard or protective device preventing unintended exposure** of any part of the body to the hazard, and not removable or adjustable by unauthorized persons. If moveable, such a barrier should be interlocked using system control criteria as defined in this paragraph.
  - Physical devices that do not require adjustment for use or other operator intervention.
    - **Control systems** having redundancy with self-checking upon startup to ensure the continuance of performance.

- Safeguards providing *low / intermediate* risk reduction are:
  - **Barrier guard or protective device providing simple guarding against inadvertent exposure** to the hazard. Examples are a fixed screen, chuck guard, or moveable barrier with simple interlocking using system control criteria as defined in this paragraph.
  - Physical devices that require adjustment for use.
  - **Control systems** (including associated protective devices, actuators and interfaces) having redundancy that may be manually checked to ensure the continuance of performance.

- Safeguards providing the *lowest* degree of risk reduction are:
  - **Physical barrier providing tactile or visual awareness of the hazard**, or minimal protection against inadvertent exposure. Examples are post and rope, swing-away shield, or moveable screen.
  - Electrical, electronic, hydraulic or pneumatic devices and associated **control systems** using a single-channel configuration.
Table 1 - Hazard Severity/Exposure/Avoidance Categories

<table>
<thead>
<tr>
<th>Factor</th>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td>S2</td>
<td>Serious Injury: Normally Irreversible; or fatality; or requires more than first-aid as defined in OSHA 1904.12</td>
</tr>
<tr>
<td></td>
<td>S1</td>
<td>Slight Injury: Normally reversible; or requires only first-aid as defined in OSHA 1904.12</td>
</tr>
<tr>
<td>Exposure</td>
<td>E2</td>
<td>Frequent Exposure: Typically exposure to the hazard more than once per hour.</td>
</tr>
<tr>
<td></td>
<td>E1</td>
<td>Infrequent Exposure: Typically exposure to the hazard less than once per day or shift.</td>
</tr>
<tr>
<td>Avoidance</td>
<td>A2</td>
<td>Not Likely: Cannot move out of the way; or inadequate reaction time; or robot speed greater than 250mm/sec.</td>
</tr>
<tr>
<td></td>
<td>A1</td>
<td>Likely: Can move out of the way; or sufficient warning/reaction time; or robot speed less than 250mm/sec.</td>
</tr>
</tbody>
</table>
### Table 2

<table>
<thead>
<tr>
<th>Severity of Exposure</th>
<th>Exposure</th>
<th>Avoidance</th>
<th>Risk Reduction Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S2</strong> Serious Injury</td>
<td>E2 Frequent</td>
<td>A2 Not Likely</td>
<td>R1</td>
</tr>
<tr>
<td></td>
<td>Exposure</td>
<td>A1 Likely</td>
<td>R2A</td>
</tr>
<tr>
<td>More than</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First-aid</td>
<td>E1 Infrequent</td>
<td>A2 Not Likely</td>
<td>R2B</td>
</tr>
<tr>
<td></td>
<td>Exposure</td>
<td>A1 Likely</td>
<td>R2B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>S1</strong> Slight Injury</td>
<td>E2 Frequent</td>
<td>A2 Not Likely</td>
<td>R2C</td>
</tr>
<tr>
<td></td>
<td>Exposure</td>
<td>A1 Likely</td>
<td>R3A</td>
</tr>
<tr>
<td>First-aid</td>
<td>E1 Infrequent</td>
<td>A2 Not Likely</td>
<td>R3B</td>
</tr>
<tr>
<td></td>
<td>Exposure</td>
<td>A1 Likely</td>
<td>R4</td>
</tr>
</tbody>
</table>

**Table 2 - Risk reduction decision matrix prior to safeguard selection**
Table 3 - Safeguard Selection Matrix

<table>
<thead>
<tr>
<th>Category</th>
<th>SafeGuard Performance</th>
<th>Circuit Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Hazard Elimination or hazard substitution (9.5.1)</td>
<td>Control Reliable (4.5.4)</td>
</tr>
<tr>
<td>R2A</td>
<td>Engineering controls preventing access to the hazard, or stopping the hazard (9.5.2), e.g. interlocked barrier guards, light curtains, safety mats, or other presence sensing devices (10.4)</td>
<td>Control Reliable (4.5.4)</td>
</tr>
<tr>
<td>R2B</td>
<td>Non interlocked barriers, clearance, procedures and equipment (9.5.3)</td>
<td>Single Channel with monitoring (4.5.3)</td>
</tr>
<tr>
<td>R2C</td>
<td>Awareness means (9.5.4)</td>
<td>Single Channel (4.5.2)</td>
</tr>
<tr>
<td>R3A</td>
<td>Single Channel (4.5.2)</td>
<td>Simple (4.5.2)</td>
</tr>
<tr>
<td>R3B</td>
<td>Simple (4.5.1)</td>
<td>Simple (4.5.1)</td>
</tr>
<tr>
<td>R4</td>
<td>Simple (4.5.1)</td>
<td>Simple (4.5.1)</td>
</tr>
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</table>
## Risk Reduction Measures

### Modified Table 3

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Hazard Elimination or hazard substitution</td>
<td>Control Reliable</td>
<td>(4)</td>
<td>3</td>
<td>(e) d</td>
<td>(3) 2</td>
</tr>
<tr>
<td>R2A</td>
<td>Engineering controls preventing access to the hazard, or stopping the hazard, e.g. interlocked barrier guards, light curtains, safety mats, or other presence sensing devices</td>
<td>Control Reliable</td>
<td>3</td>
<td>d</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>R2B</td>
<td>Single Channel with Monitoring</td>
<td>2</td>
<td>d / c</td>
<td>2 / 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2C</td>
<td>Single Channel</td>
<td>1</td>
<td>c</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3A</td>
<td>Non interlocked barriers, clearance, procedures and equipment</td>
<td>1</td>
<td>b</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3B</td>
<td>Simple</td>
<td>b</td>
<td>b</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td>Awareness means</td>
<td>Simple</td>
<td>b</td>
<td>a</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3 - Safeguard Selection Matrix
ANSI/RIA R15.06

• R1 Risk reduction shall be accomplished by hazard elimination or hazard substitution which does not create an equal or greater hazard. When hazard elimination or substitution is not possible, all provisions of a category R2 risk reduction shall apply and provisions of categories R3 and R4 shall be provided for safeguarding residual risk.

• R2 Safeguarding shall be by means that prevent access to the hazard, or cause the hazard to cease. Provisions of categories R3 and R4 may be used for safeguarding residual risk.

• R3 Safeguarding, at a minimum, shall be by means of non-interlocked barriers, clearance from the hazard, written procedures, and personal protective equipment if applicable. Provisions of Category R4 may also be used for safeguarding residual risk.

• R4 Safeguarding, at a minimum, shall be by administrative means, awareness means including audio/visual warnings and training.
EN 1050 / ISO 14121

S: Severity of Potential injury
   S1: Slight injury (minor cuts or bruises, requires first-aid)
   S2: Severe injury (broken bone, loss of limb or death)

F: Frequency of exposure to potential hazard
   F1: Infrequent exposure
   F2: Frequent to continuous exposure

P: Possibility of avoiding the hazard as it occurs (generally related to the speed / frequency of movement of the hazard and distance to the hazard point)
   P1: Possible
   P2: Less possible

L: Likelihood of occurrence (in event of a failure)
   L1: Very likely
   L2: Unlikely
   L3: Highly unlikely
<table>
<thead>
<tr>
<th>Category</th>
<th>Summary of requirements</th>
<th>System behaviour</th>
<th>Principles to achieve safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>B (see 6.2.1)</td>
<td>Safety-related parts of control systems and/or their protective equipment, as well as their components, shall be designed, constructed, selected, assembled and combined in accordance with relevant standards so that they can withstand the expected influence.</td>
<td>The occurrence of a fault can lead to the loss of the safety function.</td>
<td>Mainly characterized by selection of components</td>
</tr>
<tr>
<td>1 (see 6.2.2)</td>
<td>Requirements of B shall apply. <strong>Well-tried components and well-tried safety principles</strong> shall be used.</td>
<td>The occurrence of a fault can lead to loss of the safety function, but the probability of occurrence is lower than for category B.</td>
<td></td>
</tr>
<tr>
<td>2 (see 6.2.3)</td>
<td>Requirements of B and the use of well-tried safety principles shall apply. Safety function shall be checked at suitable intervals by the machine control system.</td>
<td>- The occurrence of a fault can lead to loss of the safety function between checks. - The loss of safety function is detected with the check.</td>
<td></td>
</tr>
<tr>
<td>3 (see 6.2.4)</td>
<td>Requirements of B and the use of well-tried safety principles shall apply. Safety-related parts shall be designed so that: - a single fault in any of these parts does not lead to loss of the safety function, and - whenever reasonably practicable the single fault is detected.</td>
<td>- When a single fault occurs, the safety function is always performed. - Some but not all faults will be detected. - Accumulation of undetected faults can lead to loss of the safety function.</td>
<td>Mainly characterized by structure</td>
</tr>
<tr>
<td>4 (see 6.2.5)</td>
<td>Requirements of B and the use of well-tried safety principles shall apply. Safety-related parts shall be designed so that: - a single fault in any of these parts does not lead to loss of the safety function, and - the single fault is detected at or before the next demand upon the safety function. If this is not possible, then an accumulation of faults shall not lead to a loss of the safety function.</td>
<td>- When the faults occur the safety function is always performed. - The faults will be detected in time to prevent loss of the safety function.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 – Summary of requirements for categories

(for full requirements see clause 6)
### Risk Factor Value Definition

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Value</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity of Injury</td>
<td>S1</td>
<td>Slight (normally reversible injury)</td>
</tr>
<tr>
<td></td>
<td>S2</td>
<td>Serious (normally irreversible injury or death)</td>
</tr>
<tr>
<td>Frequency and/or Exposure to Hazard</td>
<td>F1</td>
<td>Seldom to less-often and/or exposure time is short</td>
</tr>
<tr>
<td>Exposure to Hazard</td>
<td>F2</td>
<td>Frequent to continuous and/or exposure time is long</td>
</tr>
<tr>
<td>Possibility of Avoiding Hazard of Limiting Harm</td>
<td>P1</td>
<td>Possible under specific conditions</td>
</tr>
<tr>
<td></td>
<td>P2</td>
<td>Scarcely possible</td>
</tr>
</tbody>
</table>
ISO 13849-1

Relationship between Categories, $DC_{\text{avg}}$, and MTTF$_{d}$ of Each Channel and PL
EN 954-1 vs. ISO 13849-1

EN 954-1:1996 & ISO 13849-1:1999

- Preferred categories for reference points
- Possible categories which may require additional measures
- Measures which can be over-dimensional for the relevant risk
## Comparison of Circuit Performance Requirements

<table>
<thead>
<tr>
<th>Index</th>
<th>Circuit Performance</th>
<th>Index</th>
<th>Circuit Performance</th>
<th>Category</th>
<th>PL</th>
<th>SIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Redundancy with Continuous Self-Checking</td>
<td></td>
<td>R1 Control Reliable</td>
<td>(4) 3</td>
<td>(e) d</td>
<td>(3) 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>R2A Control Reliable</td>
<td>3</td>
<td>d</td>
<td>2</td>
</tr>
<tr>
<td>High</td>
<td>Redundancy with Continuous Self-Checking</td>
<td></td>
<td>R2B Simple</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R3A Single Channel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R3B Simple</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While there are similarities between the levels of risk reduction in the various columns, an exact one-to-one comparison is virtually impossible. This chart is intended to show the comparative similarities between each standard. Where risk reduction measures depend on configurable devices, the reliability of these devices and the system should be appropriate for the level of risk.
Selecting Protective Measures Commensurate with Risk Level
Create Appropriate Risk Reduction System

- Follow hierarchy of control
  - Elimination / substitution of the hazard
  - Engineering controls
    - Safeguarding devices (interlock switches, light curtains, safety mats, etc.)
    - Electrical / pneumatic / hydraulic circuits
  - Awareness means (lights, signs, signals, etc.)
  - Training and procedures (administrative controls)
  - Personal protective equipment (PPE)
## Hierarchy of Control

<table>
<thead>
<tr>
<th>PROTECTIVE MEASURE</th>
<th>EXAMPLES</th>
<th>INFLUENCE ON RISK FACTORS</th>
<th>CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Most Effective</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elimination or Substitution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Eliminate the need for human interaction in the process</td>
<td>➢ Impact on overall risk (elimination) by affecting severity and probability of harm</td>
<td></td>
<td>Design Out</td>
</tr>
<tr>
<td>➢ Eliminate pinch points (increase clearance)</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>
<td></td>
</tr>
<tr>
<td>➢ Automated material handling (robots, conveyors, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safeguarding Technologies / Protective Devices</strong></td>
<td></td>
<td>➢ Greatest impact on the probability of harm (occurrence of hazardous events under certain circumstances)</td>
<td>Engineering Controls</td>
</tr>
<tr>
<td>➢ Barriers</td>
<td>➢ Minimal if any impact on severity of harm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Interlocks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Presence sensing devices (light curtains, safety mats, area scanners, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Two hand control and two hand trip devices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Awareness Means</strong></td>
<td></td>
<td>➢ Potential impact on the probability of harm (avoidance)</td>
<td>Administrative Controls</td>
</tr>
<tr>
<td>➢ Lights, beacons, and strobos</td>
<td>➢ No impact on severity of harm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Computer warnings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Signs and labels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Beepers, horns, and sirens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Training and Procedures</strong></td>
<td></td>
<td>➢ Potential impact on the probability of harm (avoidance and/or exposure)</td>
<td></td>
</tr>
<tr>
<td>➢ Safe work procedures</td>
<td>➢ No impact on severity of harm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Safety equipment inspections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Lockout / Tagout / Tryout</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Personal Protective Equipment (PPE)</strong></td>
<td></td>
<td>➢ Potential impact on the probability of harm (avoidance)</td>
<td></td>
</tr>
<tr>
<td>➢ Safety glasses and face shields</td>
<td>➢ No impact on severity of harm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Ear plugs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Gloves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Protective footwear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Respirators</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Effectiveness of Awareness Means

![Image of caution sign and railroad crossing sign](image)
Effectiveness of Administrative Controls

---

The cartoon titled "Grantland" humorously illustrates the effectiveness of administrative controls in workplace safety. The comic strip shows a dialogue where one character says, " Okay, let's get started on this rewiring - rate, I forgot to lock out that panel."

The other character responds, "I'm not going all the way back there, I don't have time."

The first character continues, "Besides, no one ever goes near that box."

The last panel shows a character saying, "Hey, I just noticed that switch was off so I turned it on for you."

---

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Effectiveness of PPE

Face Shield

Dust Mask

Hard Hat
Effectiveness of PPE

TO PROTECT YOUR HEARING, THE SECOND MOST IMPORTANT THING YOU CAN DO IS TO SELECT THE RIGHT TYPE OF HEARING PROTECTION -- EAR PLUGS, EAR MUFFS, OR BOTH.

WHAT'S THE MOST IMPORTANT THING YOU NEED TO DO?

WEAR THEM.
Present Risk Reduction System

• The proposed system should be reviewed with the stakeholders involved before dedicating time, money and resources to the installation process.

• If the safety system installed is improperly selected or applied for the application, the safeguards will be bypassed and the system will be ineffective.
Accurately Estimate Implementation of the Proposed System

- It is important that the entire system be considered
  - Devices (interlock switches, light curtains, etc.)
  - Hardware (gates, posts, etc.)
  - Control system (safety monitoring relays, safety PLC, positive guided relays)
  - Wiring (conduit, etc.)
Proper Installation

Proper installation is key to the reliability of the entire system. Use tried and true methods set forth by:

- Applicable national, regional, and local regulations
- Consensus standards
- Customer specifications
- Device and machine manufacturer’s recommendations

Use devices rated for human safety (safety-rated)
Guidelines for the Selection and Application of Protective Devices According to ISO Standards
Set Back Distance of Barrier Guards

From ANSI B11.19-2003, Annex D
Barrier Height and Distance vs. Height of Hazard

Reference plane

Hazard zone

Protective structure

Guard height to protect against reach over

a – height of hazard zone
b – height of protective structure
c – horizontal safety distance to hazard zone
Safe Mounting Distance

\[ D_s = K(T) + D_{PF} \]

Example of guarding with various object sensitivities

Safety Distance \((D_s)\) for devices with a larger value for object sensitivity must be placed farther from the hazard than a device with higher resolution.
Ensure Tolerable Risk is Achieved

• It is important to conduct a documented risk assessment both before and after safeguarding the machine / process

• If the residual risk is not tolerable after applying safeguards, conduct the process again
Zero Risk vs. Tolerable Risk

Many standards recognize that zero risk does not exist and cannot be attained.

However, a good faith approach to risk assessment and risk reduction should achieve a tolerable risk level.

FYI: One of every 2 million deaths are caused by falling out of bed.
What is ‘Tolerable Risk’?

Example: A moving chain in close proximity to hands

Chain speed is 3,300 ft/min (1,007 m/min)

- 45 mph (72 km/h)
- 66 ft/sec (20 m/sec)

Is this tolerable?

If this risk is not tolerable, no chainsaw could ever be used.
Measuring Tolerable Risk

YES  NO  Can all of the following questions be answered with a YES?

☐  ☐  Have all operating conditions and all intervention procedures been taken into account?

☐  ☐  Has the method of hierarchy of control been applied?

☐  ☐  Have hazards been eliminated or risks from hazards been reduced to the lowest practical level?

☐  ☐  Is it certain that the measures taken do not generate new hazards?

☐  ☐  Are the users sufficiently informed and warned about the residual risks?

☐  ☐  Is it certain that the operator's working conditions are not jeopardized by the protective measures taken?

☐  ☐  Are the protective measures taken compatible with each other?

☐  ☐  Has sufficient consideration been given to the consequences that can arise from the use of a machine designed for professional / industrial use when it is used in a non-professional / non-industrial context?

☐  ☐  Is it certain that the measures taken do not excessively reduce the ability of the machine to perform its function?
Measuring Tolerable Risk

- ANSI B11.0-2010, Clause 6.7

Achieve acceptable risk

Once the residual risk has been established for each hazard, a decision shall be made to accept the residual risk, or to further reduce it.

Risk reduction is complete when risk reduction measures are applied and acceptable risk has been achieved for the identified hazards. Achieving acceptable risk shall include reducing the likelihood of injury to a minimum. Additionally, achieving acceptable risk shall include, at a minimum, complying with local, regional, and national regulations.

**Informative Note:** In all machinery applications, some level of residual risk exists.
Measuring Tolerable Risk

- ANSI B11.0-2010, Clause 6.7 (continued)

Achieving acceptable risk will depend on:
- the application of the hierarchy of controls (6.5.1.1 through 6.5.1.6);
- the feasibility of the selected risk reduction measure(s).

Informative Note 1: Risk assessment should facilitate a consistent decision making process. Qualified personnel are particularly important in decision making about acceptable risk.

Informative Note 2: Acceptable risk is fundamentally a decision made by each supplier or user in the context of their own unique circumstances. The following structure is one example of a practical application of acceptable residual risk to relevant stakeholders:

High residual risk – only acceptable when all reasonable alternatives/options (risk reduction measures) have been reviewed and formally deemed impracticable or infeasible. It is recommended that the group performing the risk assessment seek advice from additional safety or subject matter experts.

Medium residual risk – undesirable but permissible only when all reasonable alternatives/options (risk reduction measures) have been formally deemed infeasible.

Low residual risk – usually acceptable.

Negligible residual risk – acceptable.

Informative Note 3: See also, Annex F for additional information on achieving acceptable risk.
Close-out / Sign-off

• Conduct the following before releasing the machine for production:
  • Identify and document residual risk
  • Test for functionality
  • Document safe work procedures
  • Train personnel
  • Complete machine sign-off
Review

Figure 1 - Risk assessment and risk reduction process

Image from ANSI B11.TR3-2000

Image from ANSI B11.0-2010
The Omron STI Point System

1. THE SEVERITY OF POTENTIAL INJURY.

   For this consideration we are presuming that the accident or incident has happened. Careful study of the hazard will reveal the most severe injury that can be reasonably conceived.

   The severity of injury should be assessed as:
   - FATAL
   - MAJOR - (Normally irreversible)
     Permanent disability, loss of sight, limb amputation, respiratory damage etc.
   - SERIOUS - (Normally reversible) Loss of consciousness, burns, breakages etc.
   - MINOR - Bruising, cuts, light abrasions etc.

2. FREQUENCY OF EXPOSURE

   The frequency of exposure to hazard can be classed as:
   - FREQUENT - Several times per day.
   - OCCASIONAL - Daily.
   - SELDOM - Weekly or less.

3. PROBABILITY OF INJURY

   You should assume that the operator is exposed to the hazardous motion or process. By considering the manner in which the operator is involved with the machine and other factors such as speed of start up etc., the probability of injury can be classed as:
   - CERTAIN
   - PROBABLE
   - POSSIBLE
   - UNLIKELY

<table>
<thead>
<tr>
<th>Additional Factor</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than one person</td>
<td>Multiply the severity factor by the number of people.</td>
</tr>
<tr>
<td>exposed to the hazard</td>
<td></td>
</tr>
<tr>
<td>Protracted time in the</td>
<td>If time spent per access is more than 15 minutes, add 1 point to the frequency factor.</td>
</tr>
<tr>
<td>danger zone without</td>
<td></td>
</tr>
<tr>
<td>complete power isolation.</td>
<td></td>
</tr>
<tr>
<td>Operator is unskilled or</td>
<td>Add 2 points to the total</td>
</tr>
<tr>
<td>untrained.</td>
<td></td>
</tr>
</tbody>
</table>
Level of Risk

Add up to determine level of risk

High
- Cat 3-4, Control Reliable

Medium or Intermediate
- Cat 2, Single Channel with Monitoring

Low
- Cat 1, ANSI Single Channel

Helps Determine Guarding Technology
## Risk Reduction Requirements

<table>
<thead>
<tr>
<th>Identified Risk Level</th>
<th>Required Safeguard Performance</th>
<th>Required Circuit Performance Definitions for ANSI/RIA R15.06-1999 (R2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High (12+)</strong></td>
<td>Barrier guard or safety-rated protective device (e.g. interlocked barrier guards, light curtains, safety mats, laser area scanners, or other presence sensing devices) preventing intentional exposure of any part of the body to the hazard by preventing access to the hazard or stopping the hazard. The guard or device shall be secured with special fasteners or a lock.</td>
<td><strong>Control Reliable</strong>&lt;br&gt;Control reliable safety circuitry shall be designed, constructed and applied such that any single component failure shall not prevent the stopping action of the equipment. These circuits shall include automatic monitoring at the system level.&lt;br&gt;1) The monitoring shall generate a stop signal if a fault is detected. A warning shall be provided if a hazard remains after cessation of motion;&lt;br&gt;2) Following detection of a fault, a safe state shall be maintained until the fault is cleared;&lt;br&gt;3) Common mode failures shall be taken into account when the probability of such a failure occurring is significant;&lt;br&gt;4) The single fault should be detected at time of failure. If not practicable, the failure shall be detected at the next demand upon the safety function.</td>
</tr>
<tr>
<td><strong>Medium (7-11)</strong></td>
<td>Barrier guard or safety-rated protective device (e.g. interlocked barrier guards, light curtains, safety mats, laser area scanners, or other presence sensing devices) preventing unintended exposure of any part of the body to the hazard by preventing access to the hazard or stopping the hazard. The guard or device shall not be removable or adjustable by unauthorized persons. This may also include physical devices that do not require adjustment or other operator intervention for use.</td>
<td><strong>Single Channel with Monitoring</strong>&lt;br&gt;Single channel with monitoring safety circuits shall include the requirements for single channel and be checked (preferably automatically) at suitable intervals.&lt;br&gt;1) The check of the safety function's) shall be performed:&lt;br&gt;   a) At machine start-up, and&lt;br&gt;   b) Periodically during operation;&lt;br&gt;2) The check shall either:&lt;br&gt;   a) Allow operation if no faults have been detected, or&lt;br&gt;   b) Generate a stop signal if a fault is detected. A warning shall be provided if a hazard remains after cessation of motion;&lt;br&gt;3) The check itself shall not cause a hazardous situation;&lt;br&gt;4) Following detection of a fault, a safe state shall be maintained until the fault is cleared.</td>
</tr>
<tr>
<td><strong>Low (1-6)</strong></td>
<td>Barrier guard or safety-rated protective device (e.g. interlocked barrier guards, light curtains, safety mats, laser area scanners, or other presence sensing devices) providing simple guarding against inadvertent exposure to the hazard. Examples include a fixed screen, chuck guard, or moveable barrier. This may include physical devices that require adjustment for use.</td>
<td><strong>Single Channel</strong>&lt;br&gt;Single channel safety circuits shall:&lt;br&gt;1) Include components which are safety-rated;&lt;br&gt;2) Be used in compliance with the manufacturers’ recommendations and proven circuit designs (e.g. a single channel electromechanical positive break device which signals a stop in a de-energized state.)</td>
</tr>
</tbody>
</table>
Key elements of a useful safeguarding assessment and risk reduction report
## Sample Assessment Report With Usable Information

### Summary Spreadsheet for ABC Company - Somewhere, CA

<table>
<thead>
<tr>
<th>Pg #</th>
<th>Asset Number</th>
<th>Manufacturer</th>
<th>Machine Type</th>
<th>Model Number</th>
<th>Serial Number</th>
<th>Location / Dept.</th>
<th>Highest Risk Score Before Guarding*</th>
<th>Highest PLy**</th>
<th>Appears Compliant</th>
<th>Risk Level After Guarding***</th>
<th>Highest Prioritization Score to Establish Corrective Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>EEE / FFF / GGG / HHH</td>
<td>Balance Tech. Inc. / XY Tool &amp; Die</td>
<td>Widget Assembly Line (Balancer)</td>
<td>EEE / FFF / GGG / HHH</td>
<td>EEE / FFF / GGG / HHH</td>
<td>Assembly</td>
<td>42</td>
<td>d</td>
<td>No</td>
<td>A</td>
<td>27.3</td>
</tr>
<tr>
<td>42</td>
<td>CCC / DDD</td>
<td>Fanuc / Federal / Kingsbury</td>
<td>Robot Cell (Press, Robots, Assembly)</td>
<td>CCC / DDD</td>
<td>CCC / DDD</td>
<td>Assembly</td>
<td>25</td>
<td>d</td>
<td>No</td>
<td>A</td>
<td>23</td>
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<tr>
<td>56</td>
<td>BBB</td>
<td>Bliss</td>
<td>Punch Press</td>
<td>BBB</td>
<td>BBB</td>
<td>Forming</td>
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<td>62</td>
<td>AAA</td>
<td>HEM Inc.</td>
<td>Horizontal Band Saw</td>
<td>AAA</td>
<td>AAA</td>
<td>Machining</td>
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<td>67</td>
<td>JJJ</td>
<td>Weld Wire</td>
<td>Welding Position Table</td>
<td>JJJ</td>
<td>JJJ</td>
<td>Welding</td>
<td>9</td>
<td>b</td>
<td>Yes</td>
<td>A</td>
<td>0.9</td>
</tr>
</tbody>
</table>

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Executive Summary for ABC Company - Somewhere, CA

**Assessment Results**
In summary, Omron STI reviewed machines to determine if they meet the minimum requirements for machine safeguarding. Of these 5 machines, 1 appears to be adequately guarded in accordance with our interpretation of the applicable equipment safeguarding requirements, but may require additional engineering review.

---

**Highest Classification by Initial Risk Levels**
- (4) HIGH risk machines (score of 12 or higher)
- (1) MEDIUM risk machines (score of 7-11)
- (6) LOW risk machines (score of 5 or lower)

---

**Classification by Potential Residual Risk Levels**

*(5) Level A – Reduced Risk and Compliance Achieved*
The residual risk level will be Low/Negligible and compliance with the appropriate standards will be achieved if the recommended risk reduction measures listed below are correctly implemented in accordance with the applicable requirements. The customer is responsible for ensuring that adequate training, supervision, and administrative controls are implemented and executed as necessary. This is based on Omron STI's experience and interpretation of the relevant safety standards.

*(6) Level B – Reduced Risk but not Fully Compliant*
The residual risk level will be Low/Negligible if the recommended risk reduction measures listed below are correctly implemented in accordance with the applicable requirements. However, the equipment will not meet full compliance with the appropriate standards due to the unique nature and special use of the equipment. The customer is responsible for ensuring that adequate training, supervision, and administrative controls are implemented and executed as necessary. This is based on Omron STI's experience and interpretation of the relevant safety standards.

*(9) Level C – Lower Risk but not Fully Compliant*
The residual risk cannot achieve a Low/Negligible level due to the unique nature and special use of the equipment, but it can be significantly reduced and compliance with the appropriate standards will be achieved if the recommended risk reduction measures listed below are correctly implemented in accordance with the applicable requirements. The customer must determine if the residual risk(s) still present is tolerable for the identified hazard(s) associated with the task(s) required by the customer to operate the equipment. The customer is responsible for ensuring that adequate training, supervision, and administrative controls are implemented and executed as necessary. This is based on Omron STI's experience and interpretation of the relevant safety standards.

*(8) Level D – Lower Risk but not Fully Compliant*
The equipment will not meet full compliance with the appropriate standards and the residual risk cannot achieve a Low/Negligible level due to the unique nature and special use of the equipment, but the residual risk can be significantly reduced if the recommended risk reduction measures listed below are correctly implemented in accordance with the applicable requirements. The customer must determine if the residual risk(s) still present is tolerable for the identified hazard(s) associated with the task(s) required by the customer to operate the equipment. The customer is responsible for ensuring that adequate training, supervision, and administrative controls are implemented and executed as necessary. This is based on Omron STI's experience and interpretation of the relevant safety standards.

---

**Optional Stop Time Measurement**
Of the 5 machines assessed, require a stop time measurement to determine the adequate safe mounting distance of presence sensing devices. This proposal includes Omron STI performing this service at our standard labor rate. However, a Stop Time Measurement device can be purchased to allow your facility to conduct the periodic measurements required for compliance with appropriate regulations. Please contact John Peabody at 714-659-0197 to obtain a quotation for this device.
Machine Detail

Plant Name: ABC Company
Location: Somewhere, CA
Machine Manufacturer: Balance Tech. Inc. / XY Tool & Die
Machine Type: Widget Assembly Line (Balancer / Rivet
Machine Model:
EEF / FFF / GGG / HHH
Machine Serial Number:
EEE / FFF / GGG / HHH
Machine Asset Number:
EEE / FFF / GGG / HHH
Machine Location/Dept: Assembly

Applicable Vertical (Machine Specific) Standards [See page 6 for additional information]:
ANSI B11.20
ANSI/ASME B20.1

Emergency Stop Recommendations
Category (per NFPA 79): 1 - Controlled stop with power to the machine actuators available to achieve the stop then remove power when the stop is achieved
Circuit Performance: Single Channel with Monitoring

Estimated Residual Risk Level
Level A – Reduced Risk and Compliance Achieved
The residual risk level will be Low/ Negligible and compliance with the appropriate standards will be achieved if the recommended risk reduction measures listed below are correctly implemented in accordance with the applicable requirements. The customer is responsible for ensuring that adequate training, supervision, and administrative controls are implemented and executed as necessary. This is based on Omron STI's experience and interpretation of the relevant safety standards.
### Machine Detail – Hazard Zones

**Plant Name:** ABC Company  
**Location:** Somewhere, CA

**Machine Model**: EEE / FFF / GGG / HHH  
**Machine Type**: Widget Assembly Line (Balancer)

#### Safety Function / Zone(s): Cell Interior

**Risk Evaluation**

- **Description of Task(s) Evaluated:** Restarting the machine after stopping / interruption  
- **Hazard:** Mechanical - Crushing  
- **Description of Hazard(s):** There are crushing hazards at various points of operation within the assembly line.

**Risk Level:** HIGH

**Initial Risk Score and Level per Omron STI Methodology**

- **Severity:** Major  
- **Frequency:** 2  
- **Probability:** Probable  
- **Other Factors:**  

<table>
<thead>
<tr>
<th>Severity</th>
<th>No. of People Exposed</th>
<th>X</th>
<th>=</th>
<th>Risk Score Before Guarding</th>
<th>Risk Level</th>
<th>See Table 5 of Assessment Process for safeguard and circuit performance requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>2</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Required Performance Level (RPL) per EN ISO 13849-1:2006:** PLd

---

### Prioritization Score to Establish Corrective Actions

The prioritization score for this machine is 27.36 and is provided to present further information to help determine a corrective action plan. This value is based on the following common safeguarding categories evaluated for compliance at the time of our assessment.

#### Basic Safeguarding Categories Evaluated for Compliance

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>COMPLIANCE ACHIEVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point of Operation / Perimeter Guards</td>
<td>Yes</td>
</tr>
<tr>
<td>Safety Control System</td>
<td>No</td>
</tr>
<tr>
<td>Safety-Rated Devices</td>
<td>Yes</td>
</tr>
<tr>
<td>Emergency Stop Devices</td>
<td>No</td>
</tr>
</tbody>
</table>

**Mechanical Power Transmission Guards**

- All mechanical power transmission apparatuses below 8' have guards which appear to be compliant at this time.

**Energy Isolation Devices**

- All required energy isolation devices appear to be compliant at this time.

**Electrical Drop-Out Protection**

- The electrical control system has been tested for the required drop-out protection.
Risk Reduction (Safeguarding) Recommendations

Install yellow legend plates on the existing emergency stop pushbutton devices for compliance. Replace the existing light curtains at the load/unload stations with safety-rated devices and install covers on the existing optical two hand control devices to prevent unintentional actuation. The perimeter barrier guards will be augmented to prevent contact with the hazardous moving equipment by reaching around, under, through, or over the guards. A hinged interlocked guard will be installed at the conveyor and a fixed tunnel guard will be installed at the out feed conveyor to prevent access to the part transfer equipment. The existing pushbutton station at the out feed conveyor will be rotated to prevent intentional bypassing by personnel. All safety-rated devices will be integrated to a safety interface control.

See plan view drawing for location of guards and controls.
Commercially Available Risk Assessment Software Packages

- CIRLSMA™ (Corporate Industrial Risk and Safety Management Application) by *Industrial Safety Integration*  
  www.cirsma.com
- Designsafe® by *design safety engineering*  
  www.designsafe.com
- RiskSafe by *Dyadem*  
  www.dyadem.com
Let’s review

• What is a risk assessment and why do I have to do it?
  • A comprehensive evaluation of the hazards associated with a machine.
    • It must be repeatable and documented
  • Do it to insure compliant risk reduction

• Who can do a risk assessment?
  • A qualified vendor or in-house resources

• How do I do it?
  • Follow the 12 step process
Let’s Review

• What is the difference between risk assessment and risk reduction?
  • Risk Assessment identifies the hazards and exposure
  • Risk Reduction applied safeguards and processes to mitigate the risks identified

• What tools are available?
  • There are a wealth of third party software products
  • None do the job for you, you must have expertise
Questions?