Related Classes

• SF02 ISO13849 Safety Standards
• AD01 Short Circuit Current Rating (SCCR)
• SF04 EN 14119 Guard Locking Update
• SF03 RIA R 15.06 Machine Safety Standard Update
• SF06 Machine Safety Solution Overview
• SF05 440R-CR30 Programmable Safety Relay Lab
This presentation will provide details on the concept of Safety Assessments.

We will clarify the safety assessment services offered by the Rockwell Automation machine safety services team.

Team-Based Risk Assessments, Safety Assessments, and Hazard Assessments

We will cover the risk assessment process in detail.
What is Safety? - Industry Definition

Safety is the freedom from unacceptable risk of physical injury or damage to the health of people, either directly, or indirectly as a result of damage to property or the environment.
Why Do You Implement a Safety System?

- Protect People & Equipment
- Mitigate Risk
- Comply with Standards
- Global Competitiveness

- Legal Requirements
- Insurance premiums
- Fines
- Healthcare costs
- Litigation costs
- Labor grievances

- Required for entry to markets
Develop a Safety Culture
   Must be top-down
   Make Safety Priority #1

Safety Assessments
   Implement a strategy to identify, prioritize, and mitigate risks
   Consistent procedure is imperative

Invest in Technology
   Improve productivity and safety
   Budget for technology investments
Risk Assessment

Is it safe?
Standards – Risk Assessment

Rockwell Automation’s team/task based risk assessment methodology:

ISO 13849-1 – Safety of Machinery, Safety related parts of the control system


- ISO-13849-1 and EN ISO 12100 identifies a risk assessment as the means of determining risk levels, associated risk reduction methodologies and the type of safety system performance that is to be implemented.

Risk Assessment
Fundamental Process

Machine Characteristics/Limits

Task / Hazard Identification

Risk Estimation

Risk Evaluation

Risk Tolerable

Risk Reduction
Risk Assessment Process

A Risk Assessment is a process designed to:

**Identify** hazards associated with human interaction to processes or machines

**Estimate** the risk level associated with the hazards

**Evaluate** the risk level to determine if the risk level is acceptable

With the Risk Reduction Technique applied, the task/hazard is reevaluated to **identify, estimate and evaluate** any residual risks

**Risk is too high? Apply a Risk Reduction Technique**

ISO 12100 “Safety of Machinery”
Risk Assessment Process
Identify Machine Characteristics

- Machine Characteristics/Limits
  - Task / Hazard Identification
    - Risk Estimation
      - Risk Evaluation
        - OK
        - Too High
          - Risk Reduction
            - Risk Tolerable
Evaluate the Machine!

Machine Characteristics/Limits

<table>
<thead>
<tr>
<th>Machine Make, Model Serial Number</th>
<th>Energy Sources (Elec., Hyd., Pneu., Steam)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material information</td>
<td>Finished Good information</td>
</tr>
<tr>
<td>Rates, feeds, speeds, cycle rates</td>
<td>Personnel information – Skills, Training, etc.</td>
</tr>
<tr>
<td>Environmental Limits and concerns</td>
<td>Interconnection to other equipment</td>
</tr>
<tr>
<td>Process description</td>
<td>Supporting documentation</td>
</tr>
<tr>
<td>Operations, Setup, Troubleshooting</td>
<td>Special considerations</td>
</tr>
</tbody>
</table>

We need to evaluate all modes of operation because 60 to 70% of all injuries happen in a non-production related task!
Risk Assessment Process
Task / Hazard Identification

Machine Characteristics/Limits

Task / Hazard Identification

Risk Estimation

Risk Evaluation

Risk Reduction

Risk Tolerable

OK

Too High

On the first pass, assume no safeguards are in place
Evaluate people’s interaction!

Task / Hazard Identification

Step 1
Identify Affected Personnel

Step 2
Identify Tasks

Step 3
Identify Hazards

Use Published lists, ex: (ISO14121)
Examples of Hazards on a Machine or Process

Hazards are physical objects or chemical substances that have the potential for causing harm to people, property or the environment.

- Physical
  - Falling / Moving Objects
  - Collisions
  - Collapsing Structures
- Radiation
  - Laser
  - X-radiation
- Chemical
  - Explosion, Fire
  - Toxic Material Release
  - Wrong mix of chemicals
- Electrical
  - Flashover and Burns
  - Electrocution
  - Wrong Connection / Loose Connection
- Mechanical / Process
  - Pinch Points or Entanglement
  - Abrasion, Grinding, Cutting
  - Thermal
  - Pressure Releasing Effects (Bursting Vessels, Jets of Gas or Liquids)
  - Welding Torches, Gases, etc.

60-70% of all injuries occur during a non-production task.
Typical Causes of Machine Accidents

- Reaching in to “clear” equipment (Jam Removal)
- Safeguarding devices that were bypassed, damaged or removed
- Not using Lockout / Tagout
- Unauthorized personnel interacting with equipment
- Missing or loose machine guards
- Improperly designed safety systems
- Trying to make something right at the wrong time
Risk Assessment Worksheet

Machine: Panel Assembly Cell

<table>
<thead>
<tr>
<th>Task #1</th>
<th>Potential Incidents /Accidents #2</th>
<th>Prior to Safeguards</th>
<th>Potential Safeguards #7</th>
<th>Recommendations #8</th>
<th>With Safeguards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Severity of Injur #3</td>
<td>Exposure #4</td>
<td>Avoidance #5</td>
<td>Risk Reduction Category #6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Risk Assessment Process will guide the risk assessment team as the Risk Assessment Worksheet is filled out.
Example: Manual Loading Station

Example

Manual Loading Station to Robotic Processing Cell

When using a Task based assessment:

- Consider the affected personnel
- Identify the task
- Consider the hazards that might be present
- Consider the frequency of exposure

For each task, data collection may look like this:

Task: Loading part to fixture  Frequency: 30 times per hour

<table>
<thead>
<tr>
<th>Affected Personnel</th>
<th>Area</th>
<th>Hazard</th>
<th>Failure mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator / Supervisor / Technician / Engineering</td>
<td>“A” – Load Station #1</td>
<td>Impact / Pinch Points</td>
<td>Struck by parts picking robot while placing part in fixture</td>
</tr>
</tbody>
</table>
Risk Assessment Worksheet

Machine: Panel Assembly Cell

<table>
<thead>
<tr>
<th>Task</th>
<th>Potential Incidents /Accidents</th>
<th>Prior to Safeguards</th>
<th>Potential Safeguards</th>
<th>Recommendations</th>
<th>With Safeguards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Severity of Injury</td>
<td>Exposure</td>
<td>Avoidance</td>
<td>Sev. Risk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Risk Reduction Category</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loading 3lb. Part into Fixture, 30 times per hour</td>
<td>Impact / Pinch points due to Robot motion</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Task / Hazard Information
- The Task Column is filled in and the Potential Incident and Accident is filled in
Risk Assessment Process – Risk Estimation

Machine Characteristics/Limits

Task / Hazard Identification

Risk Estimation

Risk Evaluation

Risk Tolerable

Risk Reduction

OK

Too High
Definition of risk: “combination of the probability of occurrence of harm and the severity of that harm.”

- How Bad? (Severity)
- How Often? (Frequency)
- How Likely? (Chances)

Risk

Consequences

Frequency

Ability to Avoid
### RISK ESTIMATION
RIA TR R15.306 – 2014

<table>
<thead>
<tr>
<th>Severity of Injury</th>
<th>Exposure to the Hazard</th>
<th>Avoidance of the Hazard</th>
<th>Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E1 - Low</td>
<td>A2 - Not Likely</td>
<td>NEGLIGIBLE</td>
</tr>
<tr>
<td>S1 - Minor</td>
<td>E2 - High</td>
<td>A3 - Not Possible</td>
<td>LOW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MEDIUM</td>
</tr>
<tr>
<td>S2 - Moderate</td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A2 - Not Likely</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A3 - Not Possible</td>
<td></td>
</tr>
<tr>
<td>S3 - Serious</td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A2 - Not Likely</td>
<td>VERY HIGH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A3 - Not Possible</td>
<td></td>
</tr>
</tbody>
</table>
### RIA TR R15.306 – 2014
### INJURY SEVERITY

<table>
<thead>
<tr>
<th>Injury Severity</th>
<th>Rating</th>
<th>Criteria (Examples) – choose most likely Read criteria from the top for each factor</th>
</tr>
</thead>
</table>
| **Serious**     | S3     | Normally non-reversible:  
  – fatality
  – limb amputation
  – long term disability
  – chronic illness
  – permanent health change
  If any of the above are applicable, the rating is SERIOUS |
| **Moderate**    | S2     | Normally reversible:  
  – broken bones
  – severe laceration
  – short hospitalization
  – short term disability
  – loss time (multi-day)
  – fingertip amputation (not thumb)
  If any of the above are applicable, the rating is MODERATE |
| **Minor**       | S1     | First aid:  
  – bruising
  – small cuts
  – no loss time (multi-day)
  – does not require attention by a medical doctor
  If any of the above are applicable, the rating is MINOR |
## Exposure

<table>
<thead>
<tr>
<th>Factor</th>
<th>Rating</th>
<th>Criteria (Examples) – choose most likely Read criteria from the top for each factor</th>
</tr>
</thead>
</table>
| Exposure | High E2 | - Typically more than once per hour  
- Frequent or multiple short duration  
- Durations/situations which could lead to task creep and does not include teach  
If any of the above are applicable, the rating is HIGH |
| Exposure | Low E1  | - Typically less than or once per day or shift  
- Occasional short durations  
If either of the above are applicable, the rating is LOW |
# AVOIDANCE

| Factor      | Rating   | Criteria (Examples) – choose most likely
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Read criteria from the top for each factor</td>
</tr>
<tr>
<td></td>
<td>Not Possible</td>
<td>– Insufficient clearance to move out of the way and safety-rated speed control is not used</td>
</tr>
<tr>
<td></td>
<td>A3</td>
<td>– The robot system layout causes the operator to be trapped, with the escape route toward the hazard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Process observation is required, but a safe location for process observation is not available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Safeguarding does not offer protection from the hazard (e.g. explosion or eruption hazard)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If any of the above are applicable, the rating is NOT POSSIBLE</td>
</tr>
<tr>
<td>Avoidance</td>
<td>Not Likely</td>
<td>– insufficient clearance to move out of the way but safety-rated speed control is used</td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>– obstructed path to move to safe area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– inadequate warning/reaction time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– hazard is moving faster than reduced speed (250 mm/sec)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– may not perceive the hazard exists</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If any of the above are applicable, the rating is NOT LIKELY</td>
</tr>
<tr>
<td></td>
<td>Likely</td>
<td>– sufficient clearance to move out of the way</td>
</tr>
<tr>
<td></td>
<td>A1</td>
<td>– adequate warning/reaction time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– positioned in a safe location away from the hazard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– hazard is moving at or less than reduced speed (250 mm/sec)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If any of the above are applicable, the rating is LIKELY</td>
</tr>
<tr>
<td>Severity of Injury</td>
<td>Exposure to the Hazard</td>
<td>Avoidance of the Hazard</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A1 - Likely</td>
</tr>
<tr>
<td>S1 - Minor</td>
<td>E1 - Low</td>
<td>A2 - Not Likely</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A3 - Not Possible</td>
</tr>
<tr>
<td>S2 - Moderate</td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A2 - Not Likely</td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A3 - Not Possible</td>
</tr>
<tr>
<td>S3 - Serious</td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A2 - Not Likely</td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A3 - Not Possible</td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severity of Injury</td>
<td>Exposure to the Hazard</td>
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</tr>
<tr>
<td>--------------------</td>
<td>------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>S1 - Minor</td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A2 - Not Likely</td>
</tr>
<tr>
<td>S2 - Moderate</td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A2 - Not Likely</td>
</tr>
<tr>
<td></td>
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<td>A3 - Not Possible</td>
</tr>
<tr>
<td>S3 - Serious</td>
<td>E2 - High</td>
<td>A2 - Not Likely</td>
</tr>
<tr>
<td></td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A2 - Not Likely</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A3 - Not Possible</td>
</tr>
</tbody>
</table>

Note: The table represents a risk estimation matrix where the severity of injury, exposure to the hazard, and avoidance of the hazard are evaluated to determine the risk level. The risk levels are NEGLIGIBLE, LOW, MEDIUM, HIGH, and VERY HIGH.
Risk Estimation - Example

Example

<table>
<thead>
<tr>
<th>Affected Personnel</th>
<th>Area</th>
<th>Hazard</th>
<th>Failure mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator / Supervisor / Technician / Engineering</td>
<td>“A” – Load Station #1</td>
<td>Impact / pinch points</td>
<td>Struck by parts picking robot</td>
</tr>
</tbody>
</table>

Task: Loading part to fixture
Frequency: 30 times per hour

Estimate the Risk Level

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Failure mode</th>
<th>Severity</th>
<th>Exposure</th>
<th>Avoidance</th>
<th>Initial Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact</td>
<td>Struck by parts picking robot</td>
<td>S2</td>
<td>E2</td>
<td>A2</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

On the first pass, assume no safeguards are in place
• Risk Estimation
  • The Rating Columns are filled in and the Risk Reduction Category is filled in

Risk Assessment Worksheet
Machine: Panel Assembly Cell

<table>
<thead>
<tr>
<th>Task</th>
<th>Potential Incidents / Accidents</th>
<th>Prior to Safeguards</th>
<th>Potential Safeguards</th>
<th>Recommendation -</th>
<th>With Safeguards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading 3lb. Part into Fixture, 30 times per hour</td>
<td>Impact / Pinch points due to Robot motion</td>
<td>S2 E2 A2 HIGH</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Risk Assessment Process
Risk Evaluation

Now that we identified the risks and calculated their severity we need to evaluate them!

Machine Characteristics/Limits

Task / Hazard Identification

Risk Estimation

Risk Evaluation

Risk Tolerable

Risk Level here dictates Safety Control Circuit / Device requirements

Risk Reduction

OK

Too High
# Table 3 – Hierarchy of risk reduction measures

<table>
<thead>
<tr>
<th>Most Effective</th>
<th>Elimination</th>
<th>Substitution</th>
<th>Safeguarding and Safety Related Parts of the Control System (SRP/CS)</th>
<th>Warnings and Awareness Means</th>
<th>Administrative Controls</th>
<th>Personal Protective Equipment</th>
</tr>
</thead>
</table>
| Elimination    | - Process design, redesign or modification including changing layout to eliminate hazards such as falls, hazardous materials, noise, confined spaces, pinch points (increase clearances) & manual handling  
- Eliminate or reduce human interaction in the process  
- Automate tasks, material handling systems (e.g. lift tables, conveyors, balancers), automated ventilation systems | - Substitute for less hazardous material  
- Intrinsically safe (energy containment)  
- Reduce energy (e.g. lower speed, force, amperage, pressure, temperature, and noise) | - Guarding  
- Acoustic enclosures (typically interlocked)  
- Circuit breakers  
- Platforms and guard railing  
- Interlocks / interlocking  
- Sensitive protective equipment  
- Two-hand controls  
- Enabling devices  
- Safety controls / safety logic / safety systems (&integration of interlocking, safety parameters, & safeguarding)  
- Safety-rated speed, position, location limits | - Emergency stop devices and systems [1] Emergency stop devices are complementary protective measures, NOT safeguards  
- Lights, beacons and strobes  
- Backup alarms, beepers, horns, sirens, other visual and audible means, Computer warnings  
- Signs, labels | - Training and safe job procedures  
- Safety equipment inspections  
- Rotation of workers  
- Changing work schedule  
- Lockout  
- Hazard communications  
- Confined space entry | - Safety glasses, face shields, Respirators  
- Hearing protection  
- Safety harness and lanyards  
- Gloves, Hard hats  
- Clothing & footwear for specific safety purposes (e.g. Kevlar sleeves, metatarsal shoes) |
| Substitution    | - Substitute for less hazardous material  
- Intrinsically safe (energy containment)  
- Reduce energy (e.g. lower speed, force, amperage, pressure, temperature, and noise) | - Substitute for less hazardous material  
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| Safeguarding    | - Guarding  
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- Hearing protection  
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- Gloves, Hard hats  
- Clothing & footwear for specific safety purposes (e.g. Kevlar sleeves, metatarsal shoes) |
| Complementary Protective Measures | - Guarding  
- Acoustic enclosures (typically interlocked)  
- Circuit breakers  
- Platforms and guard railing  
- Interlocks / interlocking  
- Sensitive protective equipment  
- Two-hand controls  
- Enabling devices  
- Safety controls / safety logic / safety systems (&integration of interlocking, safety parameters, & safeguarding)  
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- Gloves, Hard hats  
- Clothing & footwear for specific safety purposes (e.g. Kevlar sleeves, metatarsal shoes) |
### Table 5 – Minimum functional safety for the risk level

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Minimum SRP/CS requirements</th>
<th>PL&lt;sub&gt;r&lt;/sub&gt;</th>
<th>Structure Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEGLIGIBLE (see 5.6.1)</td>
<td>c</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>LOW</td>
<td>c</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>d</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>HIGH</td>
<td>d</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>VERY HIGH (see 5.6.2)</td>
<td>e</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

Robot Safety Standard (ANSI, CSA, ISO, EN) require PL<sub>d</sub>, Cat 3 unless a risk assessment determines another PL and Cat would be appropriate. However a higher requirement is not expected due to hazards associated with a robot system. PL<sub>d</sub>, Cat 3 is equivalent to Control Reliable!

NOTE – Applications that cause risk levels to be deemed “VERY HIGH” are likely to have hazards addressed in other specific safety standards, e.g. hazardous locations, hand fed presses.
Hazard ID & Risk Assessment
RIA TR R15.306 Tables 2 and 5

<table>
<thead>
<tr>
<th>Severity of Injury</th>
<th>Exposure to the Hazard</th>
<th>Avoidance of the Hazard</th>
<th>Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 - Minor</td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
<td>NEGLIGIBLE</td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A2 - Not Likely</td>
<td>LOW</td>
</tr>
<tr>
<td></td>
<td>E3 - High</td>
<td>A3 - Not Possible</td>
<td>HIGH</td>
</tr>
<tr>
<td>S2 - Moderate</td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
<td>MEDIUM</td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A2 - Not Likely</td>
<td>MEDIUM</td>
</tr>
<tr>
<td></td>
<td>E3 - High</td>
<td>A3 - Not Possible</td>
<td>HIGH</td>
</tr>
<tr>
<td>S3 - Serious</td>
<td>E1 - Low</td>
<td>A1 - Likely</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>E2 - High</td>
<td>A2 - Not Likely</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>E3 - High</td>
<td>A3 - Not Possible</td>
<td>VERY HIGH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Min SRP/CS requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEGLIGIBLE</td>
<td>c</td>
</tr>
<tr>
<td>LOW</td>
<td>c</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>d</td>
</tr>
<tr>
<td>HIGH</td>
<td>d</td>
</tr>
<tr>
<td>VERY HIGH</td>
<td>e</td>
</tr>
</tbody>
</table>

Table 2 – TR 15.306

Table 5 – TR 15.306
Potential Risk Reduction Techniques

Example

**Task:** Loading part to fixture  
**Frequency:** 30 times per hour

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>Potential Risk Reduction techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Struck by Robot</td>
<td>Redesign: Automate loading</td>
</tr>
<tr>
<td></td>
<td>Interlocked Hard Guarding (manual or automatic safety gate)</td>
</tr>
<tr>
<td></td>
<td>Light Curtain / Area Scanner</td>
</tr>
<tr>
<td></td>
<td>Floor mat</td>
</tr>
</tbody>
</table>

![Diagram of Load Station #1 with C Robot and Load Fixture]
## Risk Assessment Worksheet

**Machine:** Panel Assembly Cell  
**Sheet #:**  
**Date:**

<table>
<thead>
<tr>
<th>Task</th>
<th>Potential Incidents /Accidents</th>
<th>Prior to Safeguards</th>
<th>Potential Safeguards</th>
<th>Recommendations</th>
<th>With Safeguards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Severity Exposure</td>
<td>Avoidance Risk Reduction Category</td>
<td>Redesign: Automate Part Loading Guarding: Light Curtains, Floor Mat, Interlocked Gate, Automated Gate</td>
<td>Short Term: Add Floor Mat Guarding solution.</td>
</tr>
<tr>
<td>Loading 3lb. Part into Fixture, 30 times per hour</td>
<td>Impact / Pinch points due to Robot motion</td>
<td>S2 E2 A2 HIGH</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Residual Risk

**Example**

**Task:** Loading parts into fixture

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Failure mode</th>
<th>Severity</th>
<th>Exposure</th>
<th>Avoidance</th>
<th>Initial Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact / Pinch point</td>
<td>Struck by parts picking robot</td>
<td>S2</td>
<td>E2</td>
<td>A2</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

**Risk Reduction technique**

- Floor mat at point of operation

**Residual Risk**

<table>
<thead>
<tr>
<th>Final Rating</th>
<th>Exposure</th>
<th>Avoidance</th>
<th>Severity</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>A1</td>
<td>S1</td>
<td></td>
<td>NEGLIBLE</td>
</tr>
</tbody>
</table>

Circuit Design to be per High Safeguarding requirements
Risk Assessment Work Sheet

- Evaluate the residual risk with the risk reduction technique applied properly.
- Additional risk reduction or safeguards may need to be applied such as procedures, training and administration. Just adding a floor mat without proper maintenance and testing may result in a system failure that could cause exposure to a hazard.

### Risk Assessment Worksheet

**Machine:** Panel Assembly Cell

<table>
<thead>
<tr>
<th>Task</th>
<th>Potential Incidents /Accidents</th>
<th>Prior to Safeguards</th>
<th>Potential Safeguards</th>
<th>Recommendation</th>
<th>With Safeguards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Impact / Pinch points due to Robot motion</td>
<td>S2 E2 A2</td>
<td>HIGH</td>
<td>Redesign: Automate Part Loading Guarding: Light Curtains, Floor Mat, Interlocked Gate, Automated Gate</td>
<td>Short Term: Add Floor Mat Guarding solution.</td>
</tr>
</tbody>
</table>

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**Sheet #: Date:**
## Risk Assessment Models Comparison

<table>
<thead>
<tr>
<th>Severity</th>
<th>Exposure</th>
<th>Avoidability</th>
<th>Risk Reduction Index</th>
<th>Circuitry Description (if risk reduction includes a control system)</th>
<th>Min Equivalency to EN 954 per R15.206</th>
<th>Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 Slight</td>
<td>E1 A1</td>
<td>A1</td>
<td>R4</td>
<td>Simple</td>
<td>B</td>
<td>Negligible c 1 SIL 1</td>
</tr>
<tr>
<td>E1 A2</td>
<td>R3B</td>
<td>B</td>
<td>E1 A1 A2</td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
</tr>
<tr>
<td>E2 A1 A2</td>
<td>R3A R2C</td>
<td>1</td>
<td>1</td>
<td>A2</td>
<td>R2B</td>
<td>Single Ch w/monitoring</td>
</tr>
<tr>
<td>E1 A2</td>
<td>R2B (R15.06) R2A (CSA Z434:03)</td>
<td>2</td>
<td>Single Ch w/mon Control Reliable (CSA)</td>
<td>3 (Z434-03)</td>
<td>A1 A2 A3</td>
<td>A1 A2</td>
</tr>
<tr>
<td>A1</td>
<td>R2A</td>
<td>A3</td>
<td>A1 A2</td>
<td>A3</td>
<td>Very High e 4 SIL 3</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>R1</td>
<td>3</td>
<td>3</td>
<td>A3</td>
<td>Very High e 4 SIL 3</td>
<td></td>
</tr>
</tbody>
</table>
Machine Safety Services

Rockwell Automation Machine Safety Services include the following Assessments:

- Team-Based Risk Assessments
- Safety Assessments
- Hazard Assessments
- Arc Flash Analysis
The Safety Life Cycle provides a roadmap to the implementation of Safety.

At what point in the Safety Life Cycle does the Risk, Safety, or Hazard Assessment occur?
Scalable Assessment Solutions

<table>
<thead>
<tr>
<th>Conformity Audits &amp; Use of Work Audits</th>
<th>Hazard Assessment</th>
<th>Safety Assessment</th>
<th>Team-Based Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Machines / Plant Wide Machine Assessment</td>
<td>Identifies Primary Hazards</td>
<td>Assessment / Evaluation</td>
<td>Detailed Risk Assessment</td>
</tr>
<tr>
<td></td>
<td>Used with simple machines</td>
<td>Multiple Machines, Multiple Sites Used with semi-complex machines</td>
<td>Used with complex machines</td>
</tr>
<tr>
<td>Provides a scalable solution to help save $ Per Machine</td>
<td>Identifies guarding/ hazards for immediate plant actions</td>
<td>Most common – provides report &amp; provides remediation recommendations</td>
<td>In-depth analysis required for critical or special machines</td>
</tr>
</tbody>
</table>

- Provides customers with a method of categorizing & prioritizing machines
- Conformity audits that analyze guarding, LOTO, e-stops and circuit review and provides a list of complying & non-complying machines to be assessed
- Use of work that provides mitigation solutions for simple machines
- Provides a rapid approach to identifying point-of-operation and power transmission hazards, and identifying appropriate and effective safeguarding measures for reducing risk and exposure

**Report Identifying**
- Hazard exposure
- Estimated risk parameters and risk reduction
- Category / Performance level per standards
- Potential safeguard or risk mitigation solution

- Assessment led by RA Consultant, limited customer involvement. Typically operations / maintenance
- Report per standard
  - Identification of primary hazards/tasks
  - List non-compliance issues
  - Risk In / Risk Out Rating
  - Mitigation Guarding and Controls recommendations
  - Prioritized recommendations for safety improvements
  - Photograph of critical identified hazards (based on customer approval)

- Team-based assessment led by RA, team typically consists of operations, maintenance, engineering, technicians, set up personnel, etc.
- Report per standards
  - Identification of primary hazards/tasks
  - List non-compliance issues
  - Risk In / Risk Out Rating
  - Mitigation Guarding and Controls recommendations
  - Prioritized recommendations for safety improvements
  - Photograph of critical identified hazards (based on customer approval)

- Mitigation Drawing
- Consult for all machine life phases – start up, normal / abnormal operation, set up, maintenance, product changeover, ergonomic review, etc.
The Conformity Audit & Use of Work Audits are quick check processes to identify non-conforming machines!

<table>
<thead>
<tr>
<th>Machine Identification</th>
<th>Guarding</th>
<th>Lock-out &amp; Tag-out</th>
<th>Emergency Stops</th>
<th>Circuit Analysis</th>
<th>Modes of Interaction</th>
<th>Action Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine Name</td>
<td>Machine #</td>
<td>Location</td>
<td>Existing</td>
<td>Type</td>
<td>Reach</td>
<td>Over/Under</td>
<td>Interlocked</td>
</tr>
<tr>
<td>Note area that can be used to identify duplicate machines and any urgent issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Conformity Audit process is used to analyze large numbers of machines in a cost effective manner. The audit includes:

- Guarding Evaluation
- Lock-out & Tag-out methods, procedures and hardware
- Emergency stop evaluation
- Basic circuit analysis
- Identification of conforming & non-conforming machinery

The Use of Work Audit has the same content as the Conformity Audit but adds additional recommendations for remediation for simple machine solutions.
As a minimum a LOTO program must include:

- LOTO procedures
- LOTO training
- LOTO audits
- Locks and devices
- LOTO policy
Hazard Assessment – The Beginning

Provides an Exception Based Assessment

Machine or Work Cell

- Operation
- Power
- Energy
- Guarding
What’s the difference between a Team Based Risk Assessment, a Hazard Assessment, and a Safety Assessment?

**Team-Based Risk Assessment provides more details**
- The customer is fully involved in the process, and therefore learns the process
- Identifies the risks inherent to the machine and in the process
- Recommends specific risk reduction techniques
- Includes full documentation of hazards and associated risks – required for standards conformance

**Hazard Assessment provides a starting point at a lower cost**
- RA Safety Consultant observes machine operation and interviews the operators in order to provide guidance on potential risks and recommended risk reduction techniques
- Customer is NOT trained on the process – future assessments will require hiring a consultant
- Competitive safety component suppliers that provide “Risk Assessments” are typically at most similar to RA Hazard Assessments (and frequently even less detailed)

**Safety Assessment: between Team-Based Risk Assessment and Hazard Assessment**
- Similar process to Team-Based Risk Assessment but executed by the RA Safety Consultant with less involvement from customer employees
Risk Assessment Benefits

End-User Benefits
- Proof of due diligence
- Promotes consistent risk reduction across multiple plants
- Identifies risk reduction techniques for new & upgraded equipment
- Produces a more complete machine safeguarding solution

OEM Benefits
- Meets end-user equipment purchase requirements
- Provides OEMs with evidence of due diligence, potentially reducing litigation after the equipment ships
- Helps define safety solutions that improve productivity
- Provides competitive differentiation
4.0 Machine Summary

The Machine or Project Name can be separated into several sections. These sections are listed below and details are provided on each section.

4.1 Depalletizer

A pallet loaded with cases of empty bottles is loaded onto the Depalletizer conveyor. The pallet advances to the elevator. At the final stopping position before entering the elevator, a worker removes the strap around the top stack of the cases. The pallet advances into the elevator where the top layer is pushed onto a platform. The cases then move to a conveyor where they travel single file to the Decaser.

5.0 Risk Review and Mitigation Strategies

5.1 Depalletizer

5.1.1 Exposed Chain Conveyor

Hazard.
The Depalletizer chain conveyor is exposed while running. Fingers could get caught in the chain or pulley mechanisms. Hair or loose clothing could get entangled in the pulley mechanism, dragging a person into the machinery.

Consequences
• Digit amputation
• Entanglement

Risk Parameters

<table>
<thead>
<tr>
<th>Severity Of Injury</th>
<th>Frequency</th>
<th>Possibility of Avoidance</th>
<th>Per Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 Slight Injury</td>
<td>F1 Seldom</td>
<td>P1 Possible</td>
<td>a</td>
</tr>
<tr>
<td>S2 Serious Injury</td>
<td>F2 Frequent</td>
<td>P2 Scarce</td>
<td>b</td>
</tr>
</tbody>
</table>

Mitigation Strategies
• Place Presence Sensing Devices around this area to create a Restricted Space.
• This Restricted Space would consist of 3 small size Light Curtains around the perimeter of the chain conveyor.
• Provide electrical gap isolation to motors when a Restricted Space Violation occurs.
• Provide awareness (stack lights) of Restricted Space Violation and reset capabilities (reset push buttons). Reset capabilities for lift operator may consist of pull cord. Modified Conveyorized muting may be used for full pallets entering this conveyor.

Overview 1: Depalletizer

Picture 20: 094136
RA Safety Product Portfolio

All safety automation solutions require input, logic and output elements with the correct connectivity to complete a compliant “safety function”

The industry’s broadest safety portfolio!
Review of the Fundamental Process

Risk Reduction

Identify / Estimate / Evaluate

1\textsuperscript{st} pass of analysis – Estimate the risk assuming \textit{no safeguards} are in place, and the machine starts unexpectedly.

Determine Risk category
Mitigate Risk (risk reduction)

2\textsuperscript{nd} pass of analysis – with safeguard in place and hazard that was controlled not present or reduced, evaluate if other hazards might be present and then re-evaluate risk level.

Continue until an acceptable level of risk is achieved.
Conclusion

Applying modern safety practices will enable you to deploy safer machine designs and improve overall machine and plant productivity.

Rockwell Automation is the world leader in safety solutions with the broadest offering of:

- Safety products
- Safety Services
- Integrated solutions
- Global sales and support
- Application knowledge

Together we can meet your safety & productivity goals.
Where can I find out more?

Tech Sessions
- SF02 ISO13849 Safety Standards
- AD01 Short Circuit Current Rating (SCCR)
- SF04 EN 14119 Guard Locking Update
- SF03 RIA R 15.06 Machine Safety Standard Update
- SF06 Machine Safety Solution Overview
- SF05 440R-CR30 Programmable Safety Relay Lab

Tradeshow
- Connected Enterprise Solution Area
Thank You!