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Machine Safeguarding Risk Assessment: Achieving Acceptable Risk

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Introduction

Worker injuries resulting from inadequate machine safety controls can be debilitating and even fatal. It is the OEHS professional's responsibility to recognize machine hazards, assess risk factors and suggest methods of control. The ANSI B11 machine safeguarding risk assessment series consensus standard have always been the gold standard in risk assessment to machine hazards. They provide guidance on the intermediate step of recognition, evaluation, and control.

Understanding Risk

In order to properly evaluate machine hazards and ultimately perform a risk assessment, it is important to understand the terms hazard and risk.

Hazard vs. Risk

Hazard is the potential source of harm. This is typically identified as the point of operation (point at which, for example, cutting, shaping, boring, or forming is accomplished upon the stock) or other moving machine part which may cause injury to the worker. It is one variable used in the risk assessment process.

Risk is the combination of severity of harm and the probability of the occurrence of harm. *Severity of harm* can be used interchangeably with injury severity, which ranges from a minor cut to amputation to a fatality as a result of worker contact with a moving machine part. Probability of occurrence or *likelihood* is defined as how likely injury is to occur. This ranges from injury not likely to occur to imminent injury. Risk can be quantified as follows:

Risk=Severity of Harm X Likelihood

The Machine Safeguarding Risk Assessment sequence adds a third variable, a *guarding factor* to identify the potential for contact with the machine hazard.

Job Hazard Analysis vs. Risk Assessment

Job Hazard Analysis (JHA) lists the sequence of basic job steps, potential hazards, and recommended hazard controls. A JHA will list a task associated with a job activity then list the protective equipment associated with that task.

Risk Assessment is similar to JHA but contains an additional assessment of *Risk* to determine if hazard controls will reduce the risk of potential harm to an acceptable level. Risk Assessment is the focus of this document as it relates to machine hazards.

The Machine Safeguarding Risk Assessment encompasses the following features:

- Focuses on the relationship between the worker, the task, the machinery and the work environment;
- Identifies potential problems with equipment through the use of a Risk Evaluation Form; and
- Provides a quantitative approach for identifying machine hazards and assists in establishing a priority for addressing these hazards.

Risk Assessment Standards

Several consensus standards exist for machine safeguarding risk assessment guidance. Both ANSI B11.0 and ANSI Z10, for example, use a qualitative risk scoring system that is based on severity of harm and probability of occurrence of harm. ANSI B11.19 recommends a process that incorporates a series of steps of hazard identification, risk assessment, and risk reduction strategies.

This method combines the concepts of these standards and utilizes a quantitative scoring method to assess risk. Through the use of three variables- (1) probability of contact, (2) injury severity and (3) guarding factor- risk evaluators are able to quantitatively determine an overall risk probability.

Assessing Quantitative Risk

When Machine Safeguarding Risk Assessment is used, an overall numeric risk score is generated for each piece of equipment analyzed. This overall score results from three variables; observed injury severity, probability of contact, and a guarding factor. Noting that zero risk does not conceivably exist, possible scores ranging from 4 (low risk) to 160 (high risk) can be used to prioritize equipment evaluated. Acceptable risk can be judged as a result of the final assessment score. When complete, the final score will give the evaluator a better picture of which areas are most in need of guarding attention.

Risk Assessment Sequence

Use the Risk Evaluation Form to look at equipment and identify potential problems and to assign risk assessment scores. The following sequence outlines steps to be taken in performing the risk assessment.

Observations

The following outlines initial observations necessary to provide a background for assigning quantitative scores.

1. Opening Information: Record the following:
   a. Machine Name
   b Machine Location
   c. Department
   d. Serial number or asset identification
   e. Number of operators potentially exposed to the machine
2. Observation
   a. Watch operators at work, paying attention to what they do and how they move.
   b. Ask questions of operators and crew members with regard to their interaction with the machine, and any perceived or experienced hazards associated with it's use.
   c. Video tape/photograph machine hazards.
   d. Ask operators what can go wrong in unusual or upset conditions
   e. Find out if previous injuries have occurred during use of the machine.
   f. Determine which moving parts should be evaluated
   (1) Assume that if something on a machine moves, it should be evaluated.
   (2) Do not eliminate moving parts because they do not seem dangerous.
   (3) Evaluate each moving part as a separate risk assessment. This includes moving machine parts which have access not only by the operator, but by other employees in the area of the machine hazard.
3. Assign a hazard type
   a. Point of operation. This is the location where a machine performs its work and an operator may come into contact with the machine. Examples could be the blade on a band saw or a drill spindle.
   b. Power Transmission. Transmits energy to the part of the machine performing the work. Examples include flywheels and belts.
   c. Other Moving Parts. All other parts of the machine which move while the machine is in operation. Examples include reciprocating (back and forth movement) machines, feed mechanisms, robots and auxiliary parts of a machine.

Assigning Scores

Once the initial observations are complete, the observer(s) should assign scores based on Probability of Contact (P), Injury Severity (**S**) and Guarding Factor (**G**). The following summarizes variable scoring for each category.

1. Assign Probability of Contact (P)

a. Assign P=4 if operator is able to reach into the point of operation or other moving machine part while machine is in motion If an operator is able to reach around, under or through an existing guard and reach the point of operation while standing in his/her normal work position, assign a P=4.

b. Assign P=2 if safeguarding is in place and does not allow operator access to the point of operation while standing at his/her position at the operator control.

2. Assign Injury Severity (**S**). Remember that you are assigning injury severity regardless of the safeguards that are in place and injury that could result if the operator came into contact with the moving machine part. For example, a properly guarded band saw that could result in amputation to a worker's fingers as if safeguards were not in place should be assigned an S=4.

a. Assign S=4 (high) if injury may result in death or disabling injury. An example of disabling injury would include amputation.

b. Assign S=3 (Medium) if injury may result in hospitalization but limited period of disability. Injuries that would not result in fatality or permanent disability would be included in this category. An example of this category would be an injury resulting in stitches or a bone fracture not resulting in permanent disability.

c. Assign S=3 (Low) if injury would not result in hospitalization and would require only minor supportive treatment. Examples would include injury resulting in first aid treatment.

3. Assign Guarding Factor (**G**)

a. Assign G=0.9 (Contact with the hazard is not expected) when complete guarding is in place; there is little chance of the operator removing guards during normal operation; and there is little chance of guards being over-ridden during operation. Example would include complete enclosure of point of operation hazard only accessible through a properly functioning interlocked guard.

b. Assign G=0.6 (Contact with the hazard is unlikely but conceivable) when guards permit a slight chance of contact; there is a slight chance of operator removal of guards during normal operations; and/or slight chance of guards being over-ridden during operation. Example would be when operator can access the point of operation, but it is relatively inaccessible to the operator, or the operator would have to exert great effort in order to access the machine hazard (i.e. move from his/her position at operator controls in order to access).

c. Assign G=0.3 (Contact with hazard is possible) when safeguards are missing or can be overridden and/or the operator can access machine hazard (i.e. operator can access machine hazard without moving from his/her position at operator control due to inadequate guarding).

d. Assign G=0.1 (Contact with hazard is imminent) when a hazard exists and available safeguards are not properly used or an injury has occurred

Determining Overall Risk

Overall risk is calculated by multiplying the Probability of Contact (P) by the Injury Severity (S), and then dividing the resulting product by the Guarding Factor (G) as follows:

$$\text{Overall Risk} = \frac{P \times S}{G}$$

The resulting overall score will range from 4 to 160. The following summarizes resulting scores:

1. If overall risk score ranges from 4-13, risk is acceptable and no further action is necessary.
2. If overall risk score ranges from 20-26, additional controls should be considered in addition to controls in place. The Hazard Control Hierarchy should be considered along with applicable machine safeguarding standard (such as ANSI- B.11) to bring the machine risks into the acceptable range.
3. If overall risk score ranges from 40-160, risk is unacceptable and safeguards need to be engineered in place to bring the machine risks into the acceptable range.

		Guarding Factor			
		0.1	0.3	0.6	0.9
PXS	16	160	53	26	18
	12	120	40	20	13
	8	80	26	13	9
	6	60	20	10	6
	4	40	13	6	4

Risk Unacceptable. Remove machine from operation until safeguards are implemented.
Implement Additional Controls
Risk Acceptable

Table 1. Quantitative Risk Assessment Scoring Summary

Achieving Acceptable Risk

Acceptable risk refers to the level at which further risk actions will not result in significant reduction in risk, or where additional expenditure of resources will not result in significant advances towards increased safety. Risk reduction is considered complete when protective measures are applied and acceptable risk had been achieved for the identified hazards. There is a hierarchy of controls in machine safeguarding that should be used when considering control methods. Machine safeguarding engineering controls coupled with administrative controls must be implemented in order to assist in achieving acceptable risk for machine hazards.

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