RISK ASSESSMENT PROCESS
ISO 12100 & ANSI B11.0

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PARTNERED FOR SUCCESS

Pieper Automation in Partnership with Crescent Electric Supply Company

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OBJECTIVES

- Understand the motivation and necessity to complete risk assessments and the benefits to be gained from their completion
- Understand the requirements of risk assessments for machinery
- To provide a risk assessment technique that is simple to use

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TOPICS

- Risk Assessment Structure
- Primary Types of Risk Assessments
- Benefits of a Risk Assessment
- Important Notes and FAQs

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RISK ASSESSMENT STRUCTURE
RISK ASSESSMENT OVERVIEW
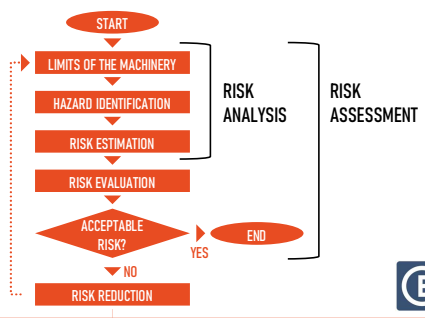
- What specifically is the process of a risk assessment?
- How is each step conducted and completed?
- Which requirements must be met for each step?

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RISK ASSESSMENT OVERVIEW
PROCESS FLOW

START → LIMITS OF THE MACHINERY → HAZARD IDENTIFICATION → RISK ESTIMATION → RISK EVALUATION → ACCEPTABLE RISK? → (YES) END / (NO) RISK REDUCTION

RISK ANALYSIS: LIMITS OF THE MACHINERY, HAZARD IDENTIFICATION, RISK ESTIMATION

RISK ASSESSMENT

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RISK ASSESSMENT OVERVIEW
STEP 1 – IDENTIFY LIMITS

LIMITS OF THE MACHINERY
HAZARD IDENTIFICATION
RISK ESTIMATION
RISK EVALUATION
ACCEPTABLE RISK? — YES
NO
RISK REDUCTION
END

Intended Use of Machine
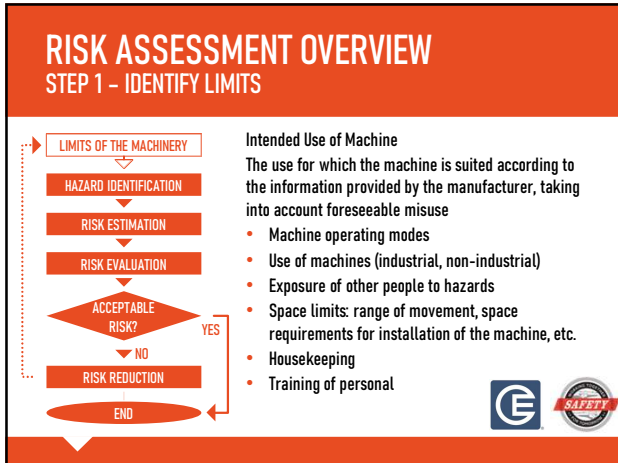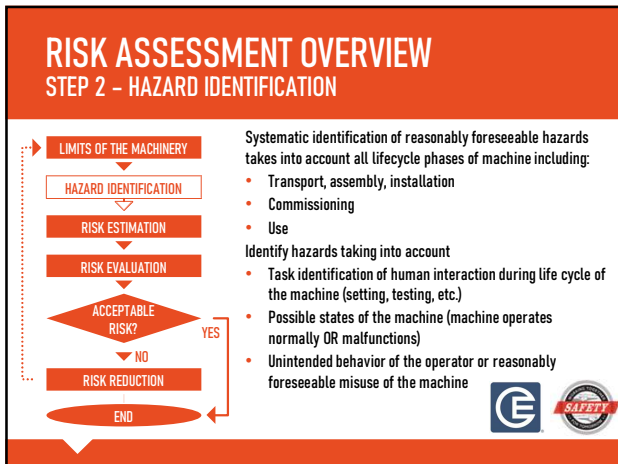The use for which the machine is suited according to the information provided by the manufacturer, taking into account foreseeable misuse
- Machine operating modes
- Use of machines (industrial, non-industrial)
- Exposure of other people to hazards
- Space limits: range of movement, space requirements for installation of the machine, etc.
- Housekeeping
- Training of personal

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RISK ASSESSMENT OVERVIEW
STEP 2 – HAZARD IDENTIFICATION

LIMITS OF THE MACHINERY
HAZARD IDENTIFICATION
RISK ESTIMATION
RISK EVALUATION
ACCEPTABLE RISK? — YES
NO
RISK REDUCTION
END

Systematic identification of reasonably foreseeable hazards takes into account all lifecycle phases of machine including:
- Transport, assembly, installation
- Commissioning
- Use

Identify hazards taking into account
- Task identification of human interaction during life cycle of the machine (setting, testing, etc.)
- Possible states of the machine (machine operates normally OR malfunctions)
- Unintended behavior of the operator or reasonably foreseeable misuse of the machine

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RISK ASSESSMENT OVERVIEW
STEP 2 – HAZARD IDENTIFICATION

LIMITS OF THE MACHINERY
HAZARD IDENTIFICATION
RISK ESTIMATION
RISK EVALUATION
ACCEPTABLE RISK? — YES
NO
RISK REDUCTION
END

- Always take into account the skill, awareness, and boredom factors of the exposed person. People working on repetitive jobs may not notice that equipment is deteriorating or starting to fail

- Never conduct a risk assessment without the cooperation of operators and supervisors. They may be more aware of the hazards than the assessor.
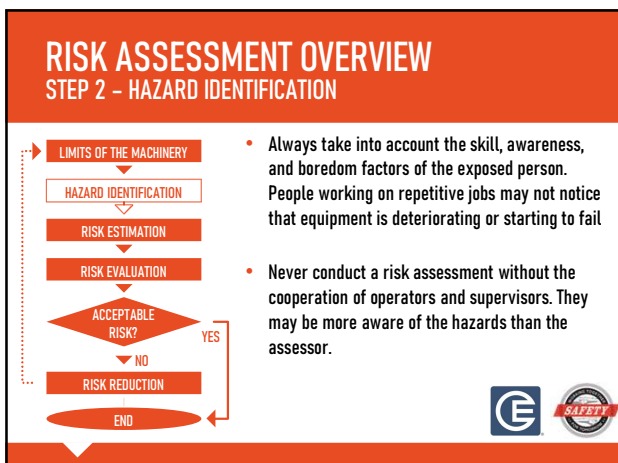
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RISK ASSESSMENT OVERVIEW
STEP 2 – HAZARD IDENTIFICATION

Mechanical Examples

- Crushing
- Shearing
- Cutting and severing
- Entanglement
- Drawing-in or trapping
- Impact
- Stabbing and puncture
- Friction and abrasion
- High-pressure fluid injection
- Ejection
- Pressure and vacuum

Non-mechanical Examples

- Electrical
- Inadequate design of control systems
- Noise
- Vibration
- Thermal – high/low temperature, fire & explosion
- Material/substance hazards – inhalation of mist, chemical agents, biological
- Radiation
- Hazards associated with the environment

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RISK ASSESSMENT OVERVIEW
STEP 3 – RISK ESTIMATION

LIMITS OF THE MACHINERY
→ HAZARD IDENTIFICATION
→ RISK ESTIMATION
→ RISK EVALUATION
→ ACCEPTABLE RISK?
→ NO
→ RISK REDUCTION
→ END
YES

RISK
RELATED TO THE CONSIDERED HAZARD
IS A FUNCTION OF
SEVERITY
OF THE POSSIBLE HARM THAT CAN RESULT FROM THE CONSIDERED HAZARD
AND
PROBABILITY OF OCCURENCE
FREQUENCY AND DURATION OF EXPOSURE
PROBABILITY OF OCCURRENCE OF THE EVENT
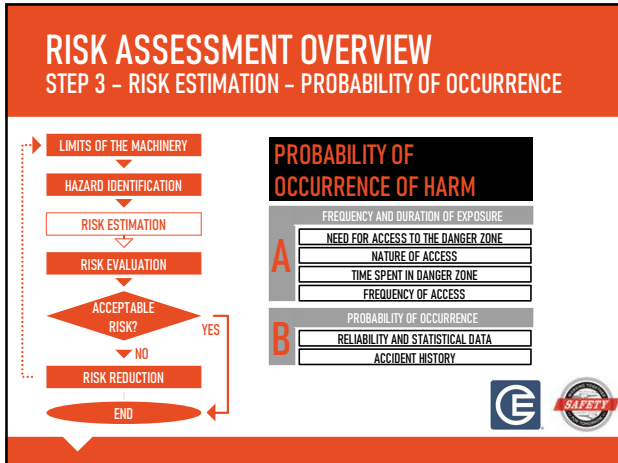POSSIBILITY TO AVOID OR LIMIT
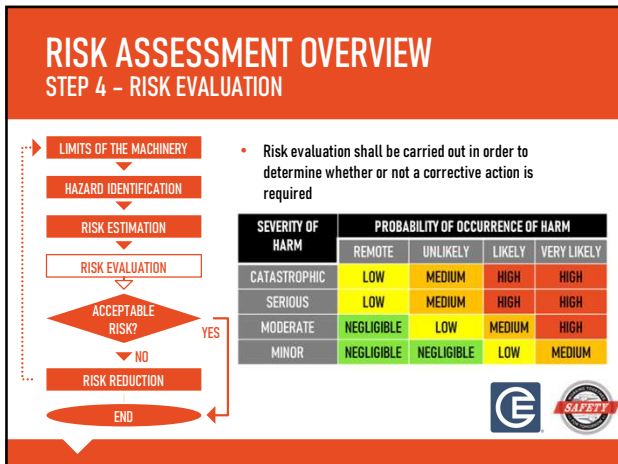
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RISK ASSESSMENT OVERVIEW
STEP 3 – RISK ESTIMATION - SEVERITY

LIMITS OF THE MACHINERY
→ HAZARD IDENTIFICATION
→ RISK ESTIMATION
→ RISK EVALUATION
→ ACCEPTABLE RISK?
→ NO
→ RISK REDUCTION
→ END
YES

SEVERITY (DEGREE OF POSSIBLE HARM)
CAN BE ESTIMATED BY TAKING INTO ACCOUNT

THE NATURE OF WHAT IS TO BE PROTECTED
A
- PERSONS
- EQUIPMENT
- ENVIRONMENT

THE SEVERITY OF INJURIES OR DAMAGE TO HEALTH
B
- SLIGHT (NORMALLY REVERSIBLE)
- SERIOUS (NORMALLY IRREVERSIBLE)
- DEATH

THE EXTENT OF HARM (FOR EACH MACHINE)
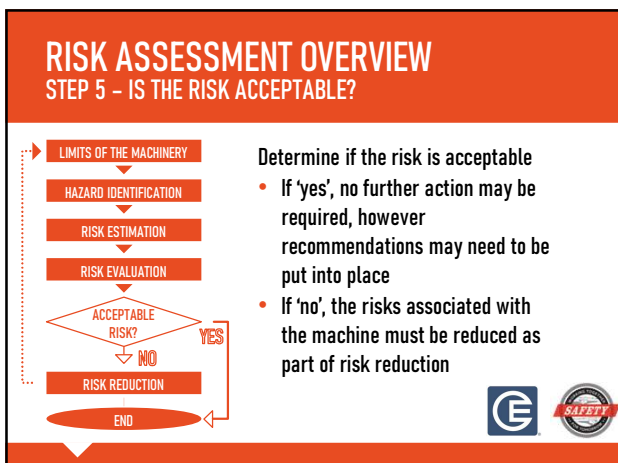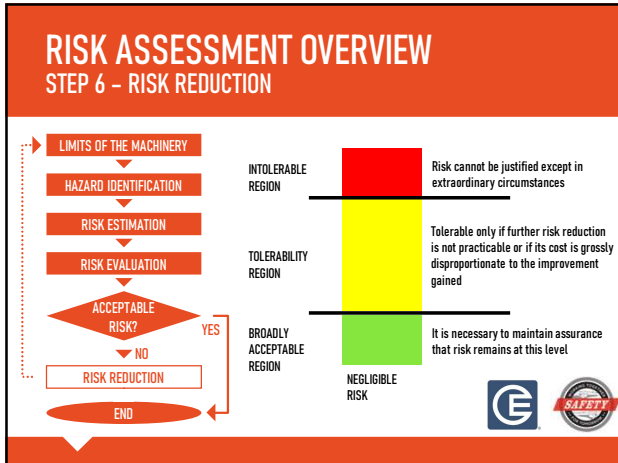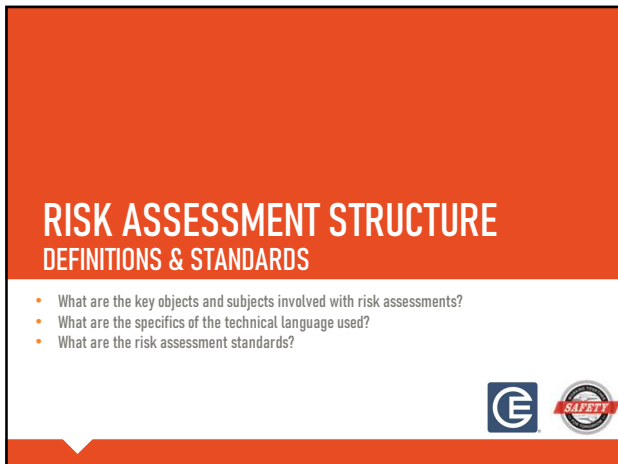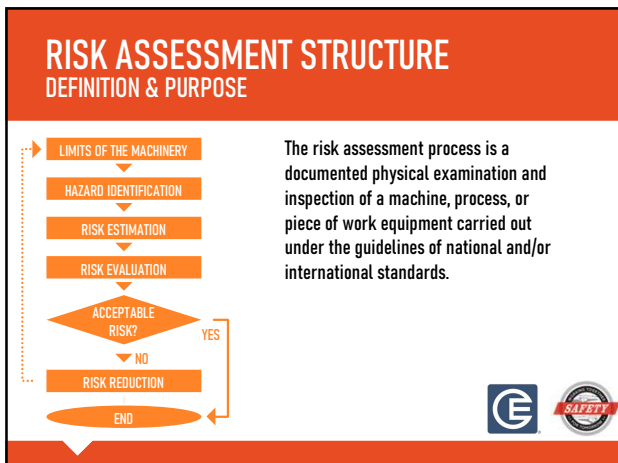**C**
- ONE PERSON
- SEVERAL PERSONS
- PRODUCT
- MACHINERY

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RISK ASSESSMENT OVERVIEW
STEP 3 – RISK ESTIMATION – PROBABILITY OF OCCURRENCE

LIMITS OF THE MACHINERY
HAZARD IDENTIFICATION
RISK ESTIMATION
RISK EVALUATION
ACCEPTABLE RISK?
YES
NO
RISK REDUCTION
END

PROBABILITY OF OCCURRENCE OF HARM

FREQUENCY AND DURATION OF EXPOSURE

A
- NEED FOR ACCESS TO THE DANGER ZONE
- NATURE OF ACCESS
- TIME SPENT IN DANGER ZONE
- FREQUENCY OF ACCESS

PROBABILITY OF OCCURRENCE

B
- RELIABILITY AND STATISTICAL DATA
- ACCIDENT HISTORY

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RISK ASSESSMENT OVERVIEW
STEP 4 – RISK EVALUATION

LIMITS OF THE MACHINERY
HAZARD IDENTIFICATION
RISK ESTIMATION
RISK EVALUATION
ACCEPTABLE RISK?
YES
NO
RISK REDUCTION
END

- Risk evaluation shall be carried out in order to determine whether or not a corrective action is required

SEVERITY OF HARM	PROBABILITY OF OCCURRENCE OF HARM			
	REMOTE	UNLIKELY	LIKELY	VERY LIKELY
CATASTROPHIC	LOW	MEDIUM	HIGH	HIGH
SERIOUS	LOW	MEDIUM	HIGH	HIGH
MODERATE	NEGLIGIBLE	LOW	MEDIUM	HIGH
MINOR	NEGLIGIBLE	NEGLIGIBLE	LOW	MEDIUM

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RISK ASSESSMENT OVERVIEW
STEP 5 – IS THE RISK ACCEPTABLE?

LIMITS OF THE MACHINERY
HAZARD IDENTIFICATION
RISK ESTIMATION
RISK EVALUATION
ACCEPTABLE RISK?
YES
NO
RISK REDUCTION
END

Determine if the risk is acceptable
- If 'yes', no further action may be required, however recommendations may need to be put into place
- If 'no', the risks associated with the machine must be reduced as part of risk reduction

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RISK ASSESSMENT OVERVIEW
STEP 6 – RISK REDUCTION

LIMITS OF THE MACHINERY
HAZARD IDENTIFICATION
RISK ESTIMATION
RISK EVALUATION
ACCEPTABLE RISK? — YES
NO
RISK REDUCTION
END

INTOLERABLE REGION — Risk cannot be justified except in extraordinary circumstances

TOLERABILITY REGION — Tolerable only if further risk reduction is not practicable or if its cost is grossly disproportionate to the improvement gained

BROADLY ACCEPTABLE REGION — It is necessary to maintain assurance that risk remains at this level

NEGLIGIBLE RISK

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RISK ASSESSMENT STRUCTURE
DEFINITIONS & STANDARDS

- What are the key objects and subjects involved with risk assessments?
- What are the specifics of the technical language used?
- What are the risk assessment standards?

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RISK ASSESSMENT STRUCTURE
DEFINITION & PURPOSE

LIMITS OF THE MACHINERY
HAZARD IDENTIFICATION
RISK ESTIMATION
RISK EVALUATION
ACCEPTABLE RISK? — YES
NO
RISK REDUCTION
END

The risk assessment process is a documented physical examination and inspection of a machine, process, or piece of work equipment carried out under the guidelines of national and/or international standards.

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RISK ASSESSMENT STRUCTURE
DEFINITION & PURPOSE

LIMITS OF THE MACHINERY

HAZARD IDENTIFICATION

RISK ESTIMATION

RISK EVALUATION

ACCEPTABLE RISK? — YES

NO

RISK REDUCTION

END

The purpose of the risk assessment is to:
- Identify any hazards associated with the equipment
- Estimate and evaluate risk
- Determine how risk reduction can be achieved in accordance with applicable legislation, standards, and industry best practices

Risk assessments must be dynamic. If the work or work equipment itself changes; the risks must be re-assessed.

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RISK ASSESSMENT STRUCTURE
ISO 12100 RISK ASSESSMENT STANDARD

ISO 12100: Safety of Machinery – General principles for design – risk assessment and risk reduction
- Type A standard
- Clarifies the interpretation of the essential safety requirements to achieve conformity with European legislation on machinery safety
- Defines basic terminology and specifies general design methods to achieve safety
- Describes general procedures and principles for identifying hazards and assessing risks in all phases of the life of machinery
- Defines documentation required to verify the assessment carried out
- The standard does not define any method for analyzing hazards and estimating risks

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RISK ASSESSMENT STRUCTURE
ANSI B11.0 RISK ASSESSMENT STANDARD

ANSI B11.0: Safety of Machinery
- Type A standard
- This standard reflects industry best practice
- Clarifies the interpretation of the essential safety requirements
- Defines basic terminology and specifies general design methods to achieve safety
- Describes general procedures and principles for identifying hazards and assessing risks in all phases of the life of machinery
- Defines documentation required to verify the assessment carried out

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TOPICS

- Risk Assessment Structure
- Primary Types of Risk Assessments
- Benefits of a Risk Assessment
- Important Notes and FAQs

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METHODOLOGY

- How are risk assessments made?
- What tools and processes can we follow to carry out an assessment?
- How are different combinations and components of risk categorized?

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PRIMARY TYPES OF RISK ASSESSMENT
APPROACHES

INDUCTIVE METHOD	DEDUCTIVE METHOD
EXAMINES ALL THE HAZARDS AND CONSIDERS THE POSSIBLE WAYS THAT SOMETHING CAN GO WRONG IN A HAZARDOUS SITUATION AND HOW THIS CAN LEAD TO HARM (BOTTOM-UP APPROACH)	BEGINS WITH A CHECKLSIT OF POTENTIAL CONSEQUENCES (HARM) AND ESTABLISHES WHAT HAZARDS COULD CAUSE THEM (TOP-DOWN APPROACH)
PRELIMINARY HAZARD ANALYSIS	FAULT TREE ANALYSIS
RISK ESTIMATION TOOLS	
RISK MATRIX	
RISK GRAPH	
HAZARD RATING NUMBER (HRN)	

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PRIMARY TYPES OF RISK ASSESSMENT
FAULT TREE ANALYSIS

Fault tree analysis utilizes logic diagrams (gates) that display the state of a system (top event) in terms of the states of its components (basic events).

SITE BLACKOUT

1 2   3 4 5   6

7 8

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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION TOOLS – RISK ASSESSMENT MATRIX

This method is based on the definition of risk (a combination of the probability and the severity of harm)

Risk = Probability * Severity of Harm

INCREASING RISK

R3

SEVERITY

R2

R1

ISO RISK CONTOUR

0

R1 < R2 < R3

NEVER   PROBABILITY

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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION TOOLS – RISK ASSESSMENT MATRIX

UNACCEPTABLE

SEVERITY

PROVISIONALLY ACCEPTABLE

ACCEPTABLE

0

NEVER   PROBABILITY

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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION TOOLS – RISK ASSESSMENT MATRIX

SEVERITY OF HARM	
DESCRIPTION	DEFINITION
CATASTROPHIC	DEATH OR PERMANENT 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 TIME)

PROBABILITY OF OCCURRENCE OF HARM	
DESCRIPTION	DEFINITION
VERY LIKELY	NEAR CERTAIN TO OCCUR
LIKELY	CAN OCCUR
UNLIKELY	NOT LIKELY TO OCCUR
REMOTE	SO UNLIKELY AS TO BE NEAR ZERO

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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION TOOLS – RISK ASSESSMENT MATRIX

SEVERITY OF HARM	PROBABILITY OF OCCURRENCE OF HARM			
	REMOTE	UNLIKELY	LIKELY	VERY LIKELY
CATASTROPHIC	LOW	MEDIUM	HIGH	HIGH
SERIOUS	LOW	MEDIUM	HIGH	HIGH
MODERATE	NEGLIGIBLE	LOW	MEDIUM	HIGH
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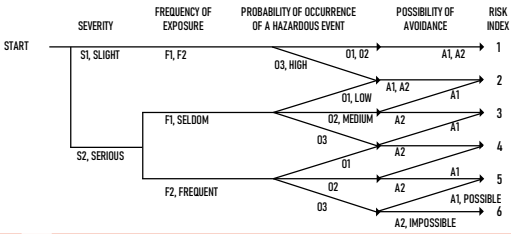
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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION TOOLS – RISK GRAPH

A risk graph is a method where parameters are given a number of possible levels. The path along the graph is traced by evaluation of the parameters to reach a risk level.

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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION – HAZARD RATING NUMBER SYSTEM (HRN)

Numerical values are assigned to these factors in order to evaluate the risk related with a hazard:
- The likelihood of occurrence (LO)
- The frequency of exposure (FE)
- The degree of possible harm (DPH)

Multiplication of the factors yields the HRN;

$$HRN = LO * FE * DPH$$

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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION – HAZARD RATING NUMBER SYSTEM (HRN)

Likelihood of occurrence (LO)

0.033	Almost impossible	Cannot happen under almost any circumstance
1	Highly unlikely	Conceivable
2	Possible	Unusual
5	Even chance	Could happen
8	Probable	Not surprised
10	Likely	Only to be expected
15	Certain	No doubt

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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION – HAZARD RATING NUMBER SYSTEM (HRN)

Frequency of exposure (FE)

0.5	Annually
1	Monthly
1.5	Weekly
2.5	Daily
4	Hourly
5	Constantly

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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION – HAZARD RATING NUMBER SYSTEM (HRN)

The degree of possible harm (DPH)

0.1	Scratch / bruise
0.5	Laceration / mild ill health effect
1	Break – minor bone or minor illness (temporary)
2	Break – major bone or minor illness (permanent)
4	Loss of 1 limb/eye or major illness (permanent)
8	Loss of 2 limbs/eyes or major illness (permanent)
15	Fatality

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PRIMARY TYPES OF RISK ASSESSMENT
RISK ESTIMATION – HAZARD RATING NUMBER SYSTEM (HRN)

HRN = LO * FE * DPH

HRN	Risk
0–1	Negligible
2–5	Very low
6–10	Low
11–50	Significant
51–100	High
101–500	Very high
501–1000	Extreme
Over 1000	Unacceptable

$$\text{RISK REDUCTION \%} = \frac{\text{ORIGINAL HRN} - \text{NEW HRN}}{\text{ORIGINAL HRN}} * 100$$

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TOPICS

- Risk Assessment Structure
- Primary Types of Risk Assessments
- Benefits of a Risk Assessment
- Important Notes and FAQs

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BENEFITS OF A RISK ASSESSMENT

- Understanding the machine
- Greater team involvement
- Team Buy-In

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BENEFITS OF A RISK ASSESSMENT
UNDERSTANDING YOUR MACHINE

- Identify necessary safety procedures more readily
- Identification of specific and infrequent tasks that pose special hazards
- Risk assessments are not static; they encourage a culture of continuous improvement. Regular reviews and updates to assessments allow organizations to adapt to changes in machinery, technology, or work processes
- Performing machine risk assessments ensures compliance with relevant safety regulations and standards. Adhering to these guidelines not only keeps the workplace safe but also helps organizations avoid legal and regulatory penalties.

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BENEFITS OF A RISK ASSESSMENT
GREATER TEAM INVOLVEMENT

- Performing a risk assessment will build repour and familiarity with your team
- Involving more people brings different perspectives
- Involving members of the team often increases the safety culture
- Providing a safe working environment fosters a positive workplace culture and boosts employee morale. When employees feel secure in their work environment, it enhances job satisfaction and overall well-being.

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BENEFITS OF A RISK ASSESSMENT
TEAM BUY-IN

- When members on the team share responsibility for assessment and mitigation they will work harder to find the right solution
- Exposes team members to hazards they may not have known about
- Demonstrating a commitment to safety through thorough risk assessments contributes to a positive organizational reputation. This can be beneficial for attracting and retaining talent, as well as fostering positive relationships with clients and partners.

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TOPICS

- Risk Assessment Structure
- Primary Types of Risk Assessments
- Benefits of a Risk Assessment
- Important Notes and FAQs

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IMPORTANT NOTES AND FAQs

- In accordance with legislative requirements including OSHA, it is necessary to conduct a risk assessment
- Standards for risk assessment are ISO 12100 and ANSI B11.0
- If the assessment shows that training is a significant measure, this must be structured accordingly and continuously assessed
- When performing a risk assessment, it is essential to select the highest **credible** values of severity and risk

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IMPORTANT NOTES AND FAQs

My colleague and I performed a risk assessment on the same machine. Why are the risk estimation levels completely different?

- "Risk assessment relies on judgmental decisions"
- Having a methodology in place helps consistency

Why did this happen?

- Different criteria and different levels of risk perception

What can we do?

- Unify criteria
- Create example cases together
- Apply the worst case scenario

Do I need to fully understand the machine?

- Yes, from installation to normal operation to cleaning, etc.

NOTE: minor differences can happen – however, if there are major differences in estimated risk steps must be taken (e.g. review methodology, train personnel, etc.)

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IMPORTANT NOTES AND FAQs

I don't have an electrical or mechanical background. Can I perform a risk assessment?

- Yes, but you need an expert in those aspects in order to define the risk reduction measures.

A new machine has arrived at my company. I don't understand how it works or the risks involved with it. What can I do?

- Check the manufacturer's manuals.
- Call an expert. Safety is not "trying to do things safely". It IS "doing things safely".

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"No matter how remote the probability of occurrence exists for hazard, if it's possible, it will happen."

Murphy's Law

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