EXECUTIVE SUMMARY

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Engineering Safety Control Measures — Best Practices for a Safer Workplace

Presenter:
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KEY TAKEAWAYS

- The hierarchy of risk control measures.
- Safety design considerations for fixed guarding.
- Safety design considerations for the monitoring of moveable guards.
- Presence sensing devices and their proper placement.

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OVERVIEW

Effective engineering controls play a vital role in workplace safety by minimizing risks and protecting workers from hazards. A range of essential safety control measures is used across industries, including fixed guarding, guard door interlocks, and presence sensing devices. These devices, along with best practices for implementation and compliance with key local and international safety standards, contribute to safer work environments.

The Schmersal Group develops and produces systems and solutions for its customers worldwide to help boost machine safety and occupational health and safety.

The specialists in tec.nicum, the department for services relating to machine and industrial safety, offer machine manufacturers and operators competent, product- and manufacturer-neutral advice on all current legal regulations, support in the safe design of machines and workplaces, and design and implement safety solutions across all life cycle phases of machines and plants.

CONTEXT

Devin Murray explained how to apply engineering safety controls according to relevant ISO and ANSI standards.

KEY TAKEAWAYS

The hierarchy of risk control measures.

The process of implementing engineering control measures assumes that one crucial element—a risk assessment—has been completed. A risk assessment consists of:

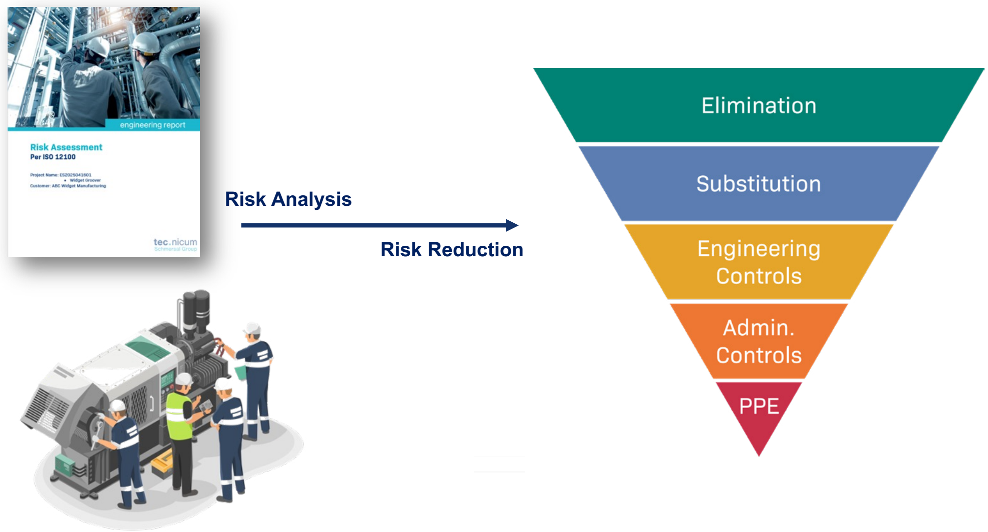
1. A **risk analysis**, in which the machine is evaluated to determine its limits and identify associated hazards and risks.
2. **Risk reduction**, in which the Hierarchy of Controls is applied to identified risks.

The **Hierarchy of Controls** comprises five categories (in decreasing order of effectiveness):

- Elimination through design.
- Substitution of the hazard for a lower-risk option.
- Engineering controls that reduce risk to personnel.
- Administrative controls.
- Personal protective equipment.

Typically, a combination of more than one category will be applied to a machine to decrease risk.

Figure 1: The Hierarchy of Controls is applied following a risk assessment



Understanding Engineering Controls: Separating and non-separating guarding

There are two main categories within engineering controls: separating guarding and non-separating guarding.

Separating guarding provides a physical barrier between the worker and the hazard. Separating guarding can be fixed or movable. International safety standard ISO 14120 proposes to prevent or reduce access to the danger zone and/or reduce exposure to hazards.

Non-separating guarding does not provide a physical barrier between the worker and the hazard. Non-separating guarding includes presence-sensing devices such as light barriers, safety sensors, and emergency stop buttons.

Safety design considerations for fixed guarding.

Any time a control measure is introduced, it is critical to ensure no additional hazards are introduced. To ensure separating guarding is correctly and safely applied, there are several **key implementation considerations**:

Ergonomic attributes	Guarding should not place personnel in physical discomfort to maneuver
Required access points	Understand who is using the machine and how to accommodate easy access points for maintenance.
Guard rigidity	The guard must be able to withstand the impact of the product, including the machine itself (e.g., a robot).
Visibility	Visibility of the machine should be a consideration when choosing a guard. For example, of the two main colors of safety mesh (yellow and black), yellow is often used to make the mesh itself visible, but black mesh can be a better choice to enable better viewing of the machine.
Mounting	ISO 14120 (see box below) refers to the use of tools to remove the guard. Typically, the mounting used to fix the guard in place will require a special tool for removal, usually available only to the maintenance team.

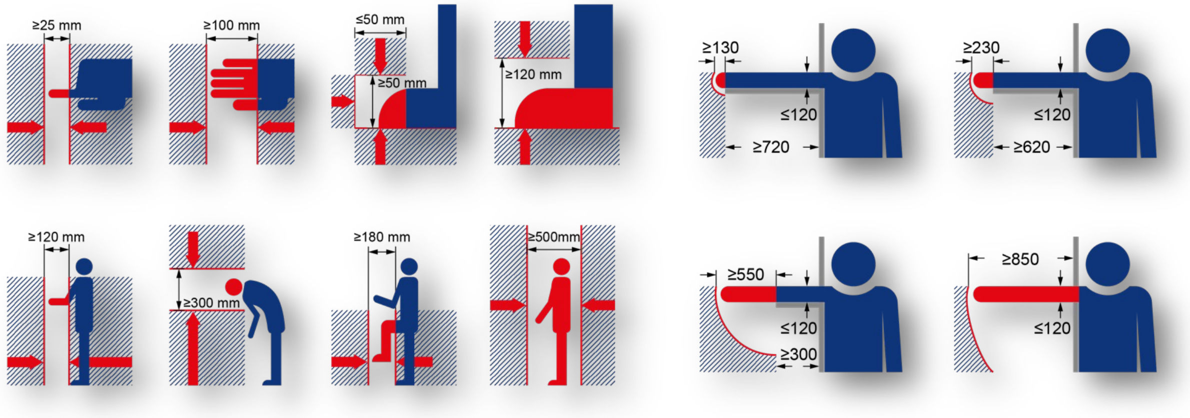
ISO 14120, General Requirements for the Design and Construction of Fixed and Movable Guards

A fixed guard is a guard affixed in such a manner (for example, by screws, nuts, and welding) that **can only be opened or removed** by the use of tools or by destruction of the means by which the guard is affixed.

> "Maintenance personnel will probably have the most dangerous exposure because they're doing tasks that call upon them to maybe remove or even bypass the guards while the machine is running."
>
> *Devin Murray, Schmersal USA*

Figure 2: Key considerations in fixed guarding

Figure 3: ISO 13857 provides safety distances for guard placement



ISO 13857 provides easily referenceable tables to determine the distance at which to place hard guards to prevent hazard zones from being reached by upper and lower limbs. Prescribed distances are based on a set of parameters that describe the opening that needs to be guarded, as well as the height of the hazard and height of the guard.

Safety design considerations for the monitoring of moveable guards.

There are several key statements that guide the choice and installation of movable guards when implementing engineering controls.

From ISO 14120:	• The opening of movable guards shall require **deliberate action**. • Where possible, movable guards shall be attached to the machine or adjacent fixed elements so that they are retained, for example by **hinges or slides**, even when open.
These requirements are intended to prevent or reduce access to the danger zone and/or reduce exposure to hazards, while allowing access to parts of the machine for certain tasks such as normal routine operations	

From ISO 14119:	• Movable guards shall be associated with an **interlock** or an **interlock with guard locking**.
This statement means that when a movable guard is opened, the system must know that the guard door is open. This requires a signal to be sent to the system to trigger a safe stop/safe condition. An interlock with guard locking takes this guidance a step further, locking the door until a safe state is reached.	

There are many types of interlock devices, most of which are either electrical mechanical (electromechanical) or electronic. Electromechanical devices tend to be more "simple," such as a door key and frame switch, while electronic devices are typically more complex, with built-in diagnostics and monitoring. However, both electromechanical and electronic devices can be used in the highest safety circuit allowable (Performance Level E with Category 4).

When installing an interlock device, it is critical that the machine is in a safe condition when the guard doors are open and/or the machine fails. **ISO 13849** outlines proper circuit design principles to prevent the machine from failing in an unsafe state and safety circuit validation to ensure the design is properly implemented. **ISO 14119** provides additional measures to prevent bypassing.

Figure 4: Interlock devices

Presence sensing devices and their proper placement.

Non-separating guarding (presence sensing devices) does not provide a physical barrier between personnel and hazards but does initiate and/or maintain a safe condition if the non-separating guarding device is being triggered.

Because there is no physical barrier in non-separating guarding, it is important to ensure the presence sensing devices are installed at the appropriate distance. ISO 13855 provides guidance on the correct positioning of presence sending devices with respect to the approach of the human body. Proper application of the formulas used by **ISO 13855** requires a stop time analysis, the results of which are used to determine the safe minimum distance for placement of a safeguard.

> "We have good intentions. . . We want to make this machine safe. But let's dig deeper . . . to make sure that we're implementing this correctly."
>
> *Devin Murray, Schmersal USA*

Figure 5: Example presence sensing devices

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BIOGRAPHY

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Devin Murray is the tec.nicum Services Manager at Schmersal, with over 15 years of experience in machine safety. A TÜV-certified Functional Safety Engineer and Functional Safety Trainer, he has developed training programs, conducted risk assessments, and authored whitepapers on machine safety. Devin holds a BSEE and MBA from Alfred University.