Machine Safety Fundamentals

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Standards, Methods, and Technologies for a Safe Machine

In the machine-intensive manufacturing industry, employees must be protected against machine-related injuries that could result in disfigurement, amputation, or death. Safeguarding is one way to protect against occupational hazards. This white paper provides a brief overview of national and international safety standards, important steps to take to ensure compliance with these standards, and several key technologies used to protect people who operate or come in contact with dangerous machines in the industrial environment.

Why Safety Matters

Safeguarding benefits workers, manufacturers, and employers by reducing lost work days due to injury, increasing productivity and worker morale, reducing liability for employers, and demonstrating employer's compliance with safety standards to appropriate regulatory agencies. Additionally, OEMs who integrate safeguarding into their machines enjoy a ready market for their easy-to-use, pre-integrated machines.

Occupational hazards can be either mechanical or non-mechanical. Mechanical hazards are any machine part, function or process which may cause harm. Mechanical hazards typically occur in three areas:

- **Point of operation:** point where work is performed on the material
- **Power transmission:** parts of the machine that transmit power to the parts doing the work
- **Other moving parts:** all parts of the machine which move when the machine is working

Non-mechanical hazards include electrical power sources, noise, ergonomic hazards and hazardous or toxic substances. This white paper addresses only mechanical hazards.

Machine Safety Standards in a Global Perspective

National and international safety standards exist regarding both products and workplace safety. The use of standards assures consistency, compatibility and quality in products, services or systems. Machine safety standards are part of a larger body of requirements, either legally mandated or voluntary, depending on your region and industry.

A standard is a specification, usually representing what is considered to be best practices at the time. Standards either recommend or mandate corrective measures that are intended to establish a **minimum** level of safety for product and machine design. Machine safety standard fall into three categories:

- **Workplace** safety, which defines how employees are protected from occupational hazards,
- **Application** standards, which deal with applying safety devices to machines or potential hazards, and
- **Product-specific** standards, which define how safety devices themselves must perform.

Differences between US and EU Standards

In the United States, standards development and enforcement is a combined effort of governmental agencies, industry, and interest groups. In the US, ensuring compliance falls to the employer, installer, or the OEM. Compliance can be ensured by following all applicable regulations, both national and international.

The European community has created a harmonized regional standards system in support of its unification efforts and to reduce trade barriers between member states. Two organizations are primarily responsible for machine safeguarding standard development: CENELEC and CEN. CENELEC and CEN develop standards that, once ratified, become European Standards (EN).

EU standards are primarily directed towards machine manufacturers, while US standards are primarily directed towards users. For safety products, 3rd party certification is mandated in the EU. While 3rd party certification is not mandated in the US, certification is demanded by market forces. The EU's Machinery Directive is legislation that requires machines and safeguarding devices shipped to the EU countries to meet essential health and safety standards. Compliance is mandated by the EU.

In the US, certification of machines and safeguarding devices is typically market-driven. While OSHA is a federal agency that can enforce its regulations through penalties and fines, it does so on an individual basis, in many cases after there has been an incident. Compliance is the responsibility of the employer.

International Safety Standards

While each country may have its own national and regional standards and standard development organization, the European Standards prevail over any national deviation. EU countries must remove any national standard that conflicts with the EN.

Internationally, two entities play a significant part in machine safety: the International Electrotechnical Committee (IEC) and the International Standards Organization (ISO). The IEC is globally recognized as providing standards in the electrotechnical field and is made up of nations with National Electrotechnical Committees. The ISO is a global federation of National Standardization Bodies that each represent a single country.

ISO and IEC can influence international standards through formal relationships. For the US, the American National Standards Institute (ANSI) through its Technical Advisory Groups (TAG) coordinates with ISO and IEC. For the EU, CENELEC and CEN closely cooperate with these two international entities.

Ensuring Compliance with Safety Regulations

A critical step to ensuring a safe machine is to conduct a risk assessment. A risk assessment is an established process which can be used to evaluate the operation of the machine and the tasks the operators must perform as well as associated hazards. For machine safety, risk assessment is used to identify, document and eliminate or reduce hazards in particular machine or processes.

Step 1: Identify the task and the associated hazard.

You will need to identify all the tasks associated with the machine in the workplace, the hazards associated with those tasks and who may be affected by the machine-related hazards. What you identify will be known as a "Hazardous Situation" or a "Task/Hazard Pair." To identify the task/hazard pairs, you must first:

- Understand all the tasks related to the machine, including but not limited to setup, operation and maintenance.
- Consider which employees will be affected.
- Review any existing information about the machine's accident history.
- Determine the limits of the machine or system

Step 2: Assess the potential to cause injury and the severity of injury.

Now that you know what the tasks are and where an operator might encounter a hazard, you can determine:

- Severity of harm
- Probability of occurrence
- Frequency of exposure to hazard

Assessing the risk weighs such factors as the anticipated task performed by all personnel; their knowledge, training and experience, and the possibility that they can defeat safety measures or ignore safety procedures.

Step 3: Reduce the risk.

Once problem areas are identified, safety measures can be proposed, such as the following:

- Elimination of risk through machine design
- Installation of safeguards and complementary protective equipment
- Implementation of procedures to deal with hazards
- Training employees who use the machine
- Placement of visible warnings near and on the machine

The chosen solution must be evaluated to determine whether the risk has been eliminated or reduced to an acceptable level. If the hazard's risk level is high, the reliability and performance integrity of the safety system and all its components (devices, wiring and actuators) should be evaluated.

Machine Safeguarding Solutions

The best way to make a machine safe is by designing it with safety in mind. However, you can also add safeguards to existing machines; in fact, retrofitting modern safety equipment onto older machines is a common practice and often essential. Safeguarding solutions include guards, awareness devices, and optical systems.

Guards

Guards are physical barriers that prevent exposure to an identified hazard. These include fixed or hard guards, adjustable and interlocked guards. Interlock switches can be added to moveable guards in order to detect whether they are opened or closed.

Awareness Devices

Awareness devices warn individuals of impending, approaching or present hazards through the use of barriers, signals or signs. These include awareness barriers, safety signs and awareness signals. Additional safeguarding devices include moveable barriers, pull-backs or restraints, two-hand control devices, safety mats, safety edges, probe detection and single control.

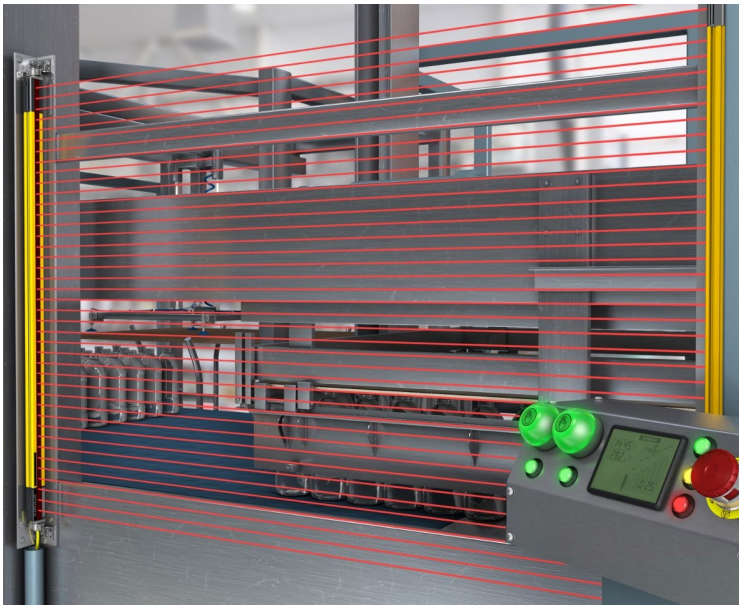
Optical Devices

Optoelectronic safety devices use optics to actively monitor for objects approaching a hazard. Safety light curtains and safety laser scanners are two common optoelectronic safety devices that can both be used in a variety of safety applications, including point-of-operation guarding, area guarding, and perimeter protection.

In addition to improving safety by initiating a machine stop function when a worker gets too close to a pinch point or other hazardous area, optical safety devices can also provide many benefits, including saving floor space and increasing productivity by improving workstation ergonomics.

Safety Light Curtains

The most common optical safety system today is the safety light curtain. A safety light curtain contains an emitter array and corresponding receivers that together create a sensing field with a specified resolution. A safety light curtain offers greater flexibility than other guarding methods such as hard guards, interlocked gates, pull-backs and restraints, and can simplify tasks such as setup, maintenance and repair.



Safety light curtains help protect personnel from machine pinch points

Like an opposed-mode photoelectric sensor, a safety light curtain detects when the presence of an opaque object interrupts its light beam. Light curtains must be installed between the machine hazard and all personnel, in accordance with requirements specified in accepted standards.

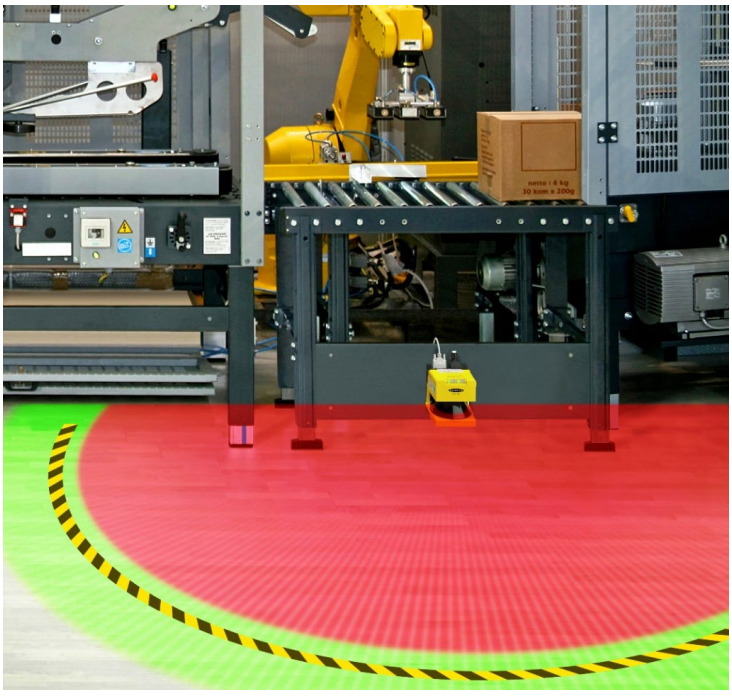
When compared to hard guarding, light screens generally cost less for installation and maintenance and can help improve productivity by allowing frequent access to the machine. In addition, light curtains can be placed close to the hazard, saving valuable floor space.

Safety light curtains are often used in applications where operators need frequent access to a hazard and where the hazardous machine motion can be stopped relatively quickly. You would typically use a safety light curtain in applications like mechanical and hydraulic power presses, molding presses, stamping, forming, and automated assembly machinery.

However, a safety light curtain may not be appropriate for all applications. For example, applications with hazards such as high heat, ejected material, or machines that cannot be stopped quickly are not good candidates for light curtain protection.

Safety Laser Scanners

Another type of optoelectronic safety device is a safety laser scanner, which uses time-of-flight technology similar to many laser-based sensors. This means that the safety laser scanner emits a pulse of light that is then reflected by a target and returns to the scanner. A safety laser scanner uses this technology to scan a defined safeguarding area and identify when an object has entered.



Safety laser scanner provides access protection for robot cell

Safety laser scanner offer many important advantages including flexible and discrete mounting due to freely defined fields as well as the ability to set warning fields to indicate when a person or other object is approaching the hazardous area. Common applications for safety laser scanners include area guarding and access protection for robotic cells as well as safe navigation for mobile systems.

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This article is for educational purposes only and is accurate as of the date of publication. Banner recommends consulting a safety professional about your specific application before implementing safety measures.

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