SAFEGUARDING 101

What needs to be guarded, to what degree, and with what type of device

Numerous governing bodies and agencies as well as standards, regulations and policies have been established globally, specifically with the goal of machine safety. Stringent safety standards mean that today's machines are designed with greater safeguards for both the operator and process. However, the actual process of safeguarding may still raise the same questions to some as they had 20 years ago - what needs to be guarded, to what degree and with what type of device?

The Occupational Safety & Health Administration (OSHA) under the United States Department of Labor is responsible for setting forth polices to ensure safe working conditions which include machine safety as described in 1910 Subpart O - *Machinery and Machine Guarding*. The General Duty clause issued under the OSHA Act of 1970 states that each employer is responsible for supplying a workplace which is "*free from hazards that are causing or are likely to cause death or serious physical harm*". The options to provide such a workplace are endless and knowing where to begin the process can be overwhelming.

There are a few OSHA regulations that call out requirements for specific machinery such as 1910.213 for woodworking machinery or 1910.217 for mechanical power presses, but like most these requirements are a bit abstract and leave room for interpretation.

Since the process to change or update regulations to a more current and clear set of documents can be long and arduous, OSHA suggests the use of the most current and relevant industry consensus standards be followed when needed in an effort to be sure employers are well informed when working to provide a safe workplace. For example, ANSI/A3 R15.06 is a current and relevant industry standard which is used to safeguard robot and robotic cell application. Another example is NFPA 79 which is used to ensure proper wiring practices are used.

It may be clear that it is a requirement by law to provide a safe working environment. However, to provide safe working conditions we first need to know what needs to be safeguarded, thus the first step in safeguarding is to identify the hazards and the risks associated with the machine. Identifying these hazards is also one of the first steps in the risk analysis process. These risks include, but are not limited to: mechanical hazards such as rotating or sharp parts; electrical hazards such as live parts; radiation; ergonomic, etc. ANSI B11.0 – *Safety of Machinery* and ISO 12100 *Safety of Machinery — Risk Assessment* are current and relevant industry consensus standard which can be used as a guide to help identify machine hazards.

Once the risks have been identified they can then be evaluated to determine the degree they should be guarded to. For example, a crushing hazard on a capping process has been determined as shown in figure 1.

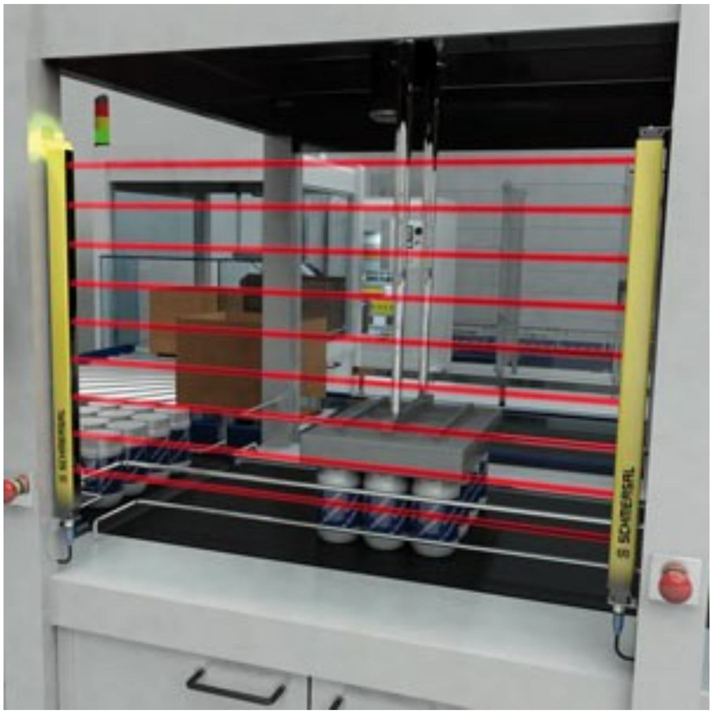

Figure 1: a capping process with a crushing hazard

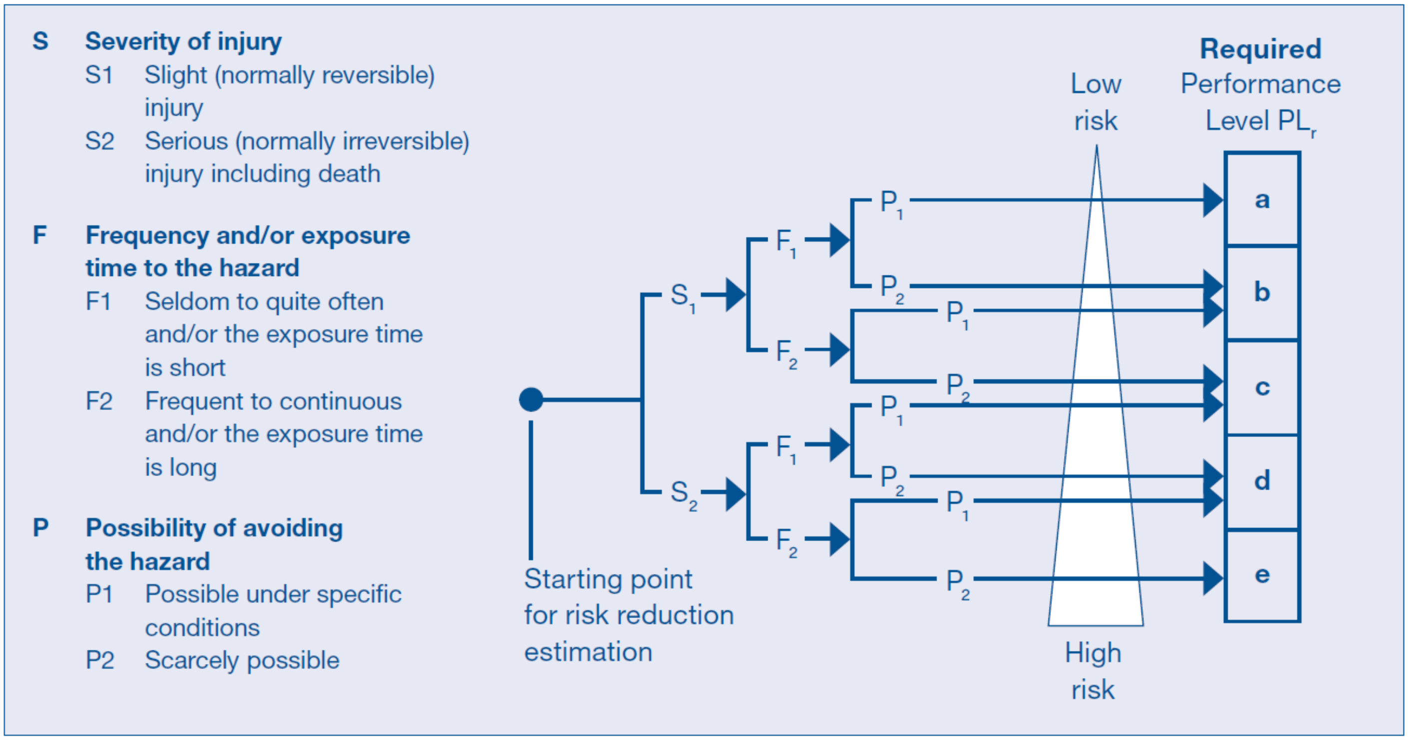

Figure 2: the risk assessment decision tree from ISO 13849-1

To determine what level of safety our safety function needs to be for this risk we can use ISO 13849 - *Safety-related parts of control systems*. This standard will utilize 3 parameters to determine a required Performance Level (PLr) for the safety function, with PLa being the least stringent and PLe needing to meet the most stringent requirements. The first parameter is the Severity of the injury that the risk poses. **S1** represents a slight injury such as bruising and/or lacerations without complications while **S2** is more severe such as amputation up to the possibility of death. The next parameter is the frequency of being exposed to the risk. **F1** represents seldom exposure while **F2** is more frequent or 15 minute accumulation per shift. The last parameter is the ability to avoid the risk if exposed to it. **P1** represents a risk where there is a realistic chance of avoiding an accident where **P2** should be selected if there is almost no chance of avoiding the hazard such as hazards which are faster than 250mm/s. The decision tree using these parameters is seen in figure 2.

Now that we have assessed the identified risks of the machine the next question to answer is what safety solution to select. The first distinction which needs to be answered is whether the safeguard is considered separating, such that there is a physical separation between the operator and the hazard, or non-separating where there is no physical separation. Safety devices for non-separating applications include safety light curtains, safety rated pressure maps, laser scanners, etc. Separating guards can include hinged doors, sliding doors, removable lids, etc. These access doors will require a safety monitoring device which will interlock the machine while the guard is not in place. These safety monitoring devices can include non-contact reed switches, keyed interlock switches, electronic sensors, etc.

The next questions which will dictate which type of device can be used are:

- What type of environment will the devices be operating in?
- Are there reflective surfaces or optical interference that will disrupt a laser scanner or light curtain?
- Is there any debris that can enter key entry slots of a keyed switch?
- Is there material present that will cause interference with the magnetic field of a reed sensor?

The answer to these questions can help lead you in the correct direction in selecting the proper safety device as some may function better than others within certain environments. Another question which can be asked is how often will the safety device be called upon to perform its safety function? If an application calls for an operator to place a product every few seconds, installing an access door with an electrical mechanical keyed interlock may not be the best option due to the mechanical stresses which can accumulate on the switch. A light curtain may be more feasible, if there are no risks of part or material ejection from the process which can be answered with the previous question raised.

The safety standard ISO 14119 *Safety of machinery - Interlocking devices associated with guards - Principles for design and selection* may be of use in the selection and implementation of interlocking devices. This standard provides information pertaining to the different operating principles of the various interlocking device types within the industry, what to consider for their use in an application and even provides measures to help deter bypassing of the device.

There are numerous ways in which a safe workplace can be achieved. Manufacturers of safety components offer wide ranges of devices which aim to protect the operator and processes from hazards. Two applications of similar process may require two different ways to safeguard depending on the relevant machine standards (if applicable), the environment and the actual operator interactions with the specific machine as different interactions can pose different types of hazards. The first step in reaching a safe workplace is conducting a proper risk analysis to determine exactly what the hazards are.

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Image credits:
Figure 1: K.A. Schmersal GmbH & Co. KG © 2025

For more information on standards referenced:

OSHA 29 CFR 1910.212
General requirements for all machines.

ANSI B11.0-2023
Safety of Machinery

ANSI/A3 R15.06-2025
American National Standard for Industrial Robots and Robot Systems – Safety Requirements

ISO 12100:2010
Safety of machinery — General principles for design — Risk assessment and risk reduction

ISO 13849-1:2023
Safety of machinery — Safety-related parts of control systems Part 1: General principles for design

ISO 14119:2024
Safety of machinery — Interlocking devices associated with guards — Principles for design and selection