



Safety of machinery

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Why safety is an important consideration when designing machines:

When designing machinery, it is necessary to observe the legal requirements that require the necessary safety of machines. These requirements have a moral and significant economic reason. Machine safety must be ensured throughout the life cycle of the machine. We must therefore take into account the **design, manufacture, installation, operation, adjustment, maintenance and disposal.**

<https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1998L0037:19981207:CS:PDF>



DIRECTIVE 98/37 / EC OF THE EUROPEAN PARLIAMENT:

of 22 June 1998

The minimum level of machine safety is given by Directive **98/37/EC**. Before placing the machine on the market, the manufacturer must ensure that the machine complies with the applicable regulations.

<https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1998L0037:19981207:CS:PDF>



DIRECTIVE 2009/104 / EC OF THE EUROPEAN PARLIAMENT:

of 16 September 2009

The Directive defines minimum safety and health requirements for the use of work equipment by workers at work. It requires all equipment to be operational and to be checked by regular inspections and maintenance.

<https://eur-lex.europa.eu/legal-content/CS/TXT/PDF/?uri=CELEX:32009L0104&from=EN>

List of standards:

Type A – basic safety standards
Type B – general safety standards
Type C – safety standards of machinery

Standard	Type of norm	Name
EN/ISO 12100	A	Principles for the manufacture of safe machinery
EN 574	B	Safety of machinery. Two-hand control devices. Functional aspects. Principles for design
EN/ISO 13850	B	Safety of machinery - Emergency stop function - Principles for design
EN/IEC 62061	B	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN/ISO 13849-1	B	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN 349	B	Safety of machinery. Minimum gaps to avoid crushing of parts of the human body
EN/ISO 13857	B	Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs
EN/IEC 60204-1	B	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN 999/ISO 13855	B	Safety of machinery – Positioning of safeguards with respect to the approach speeds of parts of the human bod
EN 1088/ISO 14119	B	Safety of machinery – Interlocking devices associated with guards – Principles for design and selection
EN/IEC 61496-1	B	Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests
EN/IEC 60947-5-5	B	Low-voltage switchgear and controlgear - Part 5-5: Control circuit devices and switching elements - Electrical emergency stop device with mechanical latching function
EN 842	B	Safety of machinery - Visual danger signals - General requirements, design and testing
EN 1037	B	Safety of machinery - Prevention of unexpected start-up
EN 953	B	Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards
EN 201	C	Rubber and plastics machines - Injection moulding machines - Safety requirements
EN 692	C	Mechanical presses - Safety
EN 693	C	Machine tools - Safety - Hydraulic presses
EN 289	C	Plastics and rubber machines – Presses – Safety requirements
EN 422	C	Rubber and plastics machines - Safety - Blow moulding machines intended for the production of hollow articles - Requirements for the design and construction
EN/ISO 10218-1	C	Robots for industrial environments - Safety requirements - Part 1: Robot
EN 415-4	C	Safety of packaging machines - Part 4: Palletisers and depalletisers
EN 619	C	Continuous handling equipment and systems - Safety and EMC requirements for equipment for mechanical handling of unit loads
EN 620	C	Continuous handling equipment and systems - Safety and EMC requirements for fixed belt conveyors for bulk materials



Responsibility of the manufacturer:

Manufacturers who place their machines on the European Union market must comply with the Machinery Directive. The term „**placing on the market**“ also includes cases where a company delivers a machine to itself - that is, produces or modifies a machine for its purposes, and cases where a company exports the machine to the EU.



User responsibility:

- The user must ensure that newly purchased machines bear the **CE** marking and that they have a „**Declaration of conformity**“ with the requirements of the Machinery Directive. The machines must be used in **accordance with the manufacturer's instructions**.
- **Modifications of machines** (including those made for own purposes) can be considered as **production of new machines**. The company modifying the machine must be aware that it may need to issue a **new „Declaration of conformity“** and **CE** marking.

Risk assessment:

For the machine to be safe, the risks arising from its use must be assessed. The standards set out general principles. The risk assessment cannot be unambiguously defined as it depends on the conditions in the company.

Delimitation of machine boundaries:

- boundaries of use,
- spatial borders,
- time limits.

They must be taken into account:

- all existence phases of the machine,
- consequences of improper use of the machine or failure of machine functions,
- user characteristics (gender, age, intellectual level of attendant),
- endangering other persons,
- machine application area.

Identify of danger:

The following aspects should be considered when identifying potential hazards:

- operator interventions in all exist phases of life of the machine,
- machine operating states (machine works/not works),
- predictable possibilities machine misuse.



Examples of typical risks:

- puncture, abrasion, chopping, cutting,
- capture, tangl up, pulling in,
- crash,
- crush,
- death / injury el. current,
- leakage of dangerous substances,
- burns.



Sorting risks by severity:

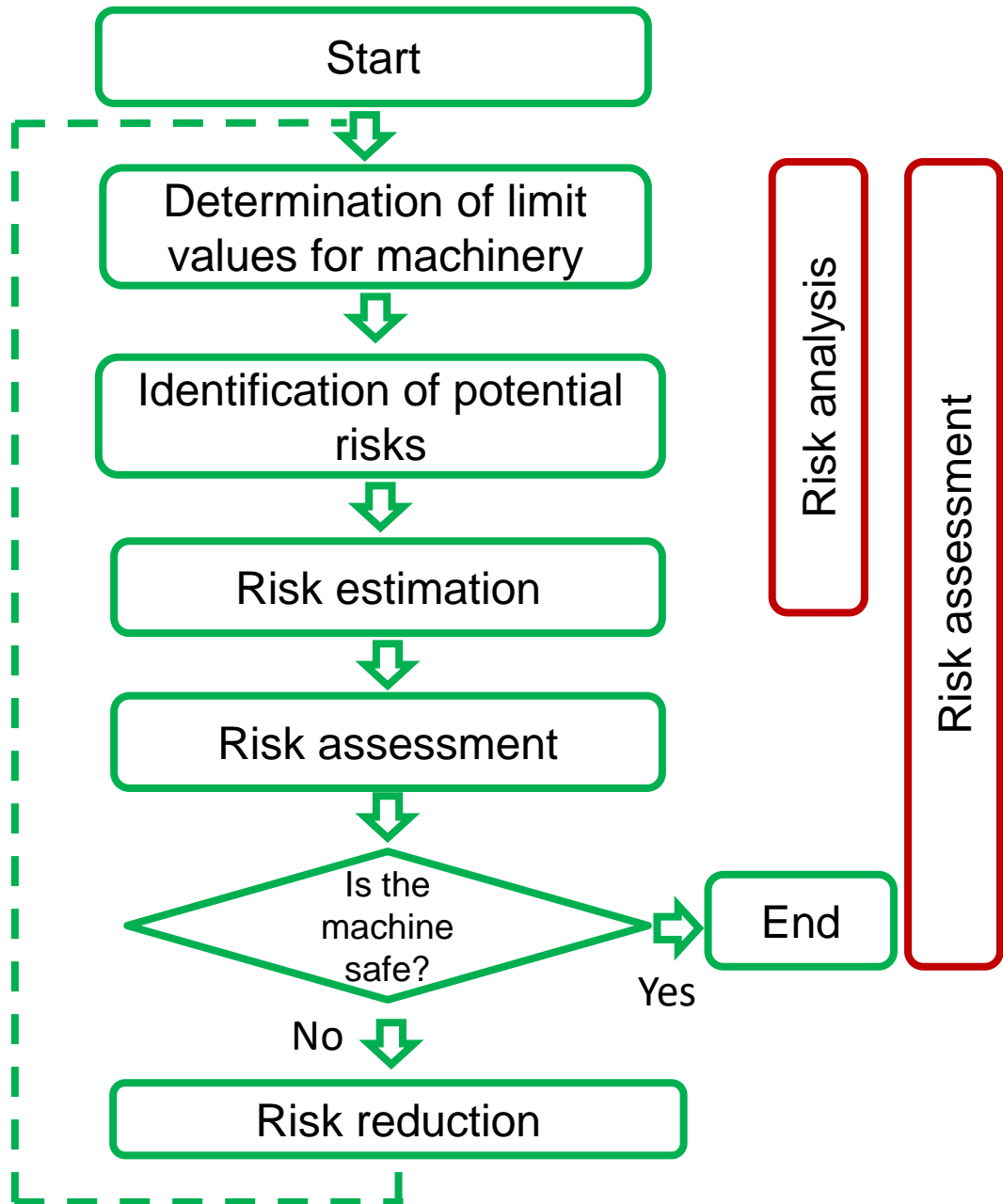
The risk assessment process should result in a table of the various risks associated with the machine, indicating the severity of each risk. The machine is difficult to determine the classification unit or its categorization. Each risk needs to be individually considered. It is important to say that the severity can only be estimated - risk assessment is not an accurate or final process. The purpose of the risk assessment is to provide guidance on how to reduce/eliminate them.

Risk reduction:

The description of the risk reduction process is defined in EN / ISO 12100.

Risk reduction is defined here in terms of **risk elimination**: The objective of the measures taken must be to eliminate all risks of the machinery, including transport, assembly, dismantling, decommissioning and disposal. If any risk can be reduced, it **must be reduced**. It is important to identify whether risk reduction has been proportionate to an acceptable level in the context of economic reality.

Risk reduction block diagram:



Safe construction:

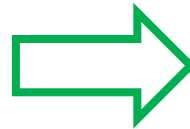
The security measures themselves can be divided into two basic sets:

- design arrangement,
- use of safety features and additional measures.

Design measures include structural modifications to parts, subassemblies of the machine itself to eliminate possible risk of injury. For example, by eliminating hollow spaces between moving parts.

Safe construction:

By supplementary measures we mean covering of dangerous parts of the machine either by fixed or movable covers. The movable covers can be electrically controlled or with manual manipulation and with the electronic interlock.



Safe construction:

By protective devices we mean additional attachments to increase machine safety. The basic distribution is as follows:

- interlock safety switches,
- safety light curtains,
- pressure-sensitive safety mat ,
- electromagnetic locking device,
- two-hand control devices and foot switches,
- confirm switches,
- monitoring of safety signals,
- emergency stop.

Examples of security features:



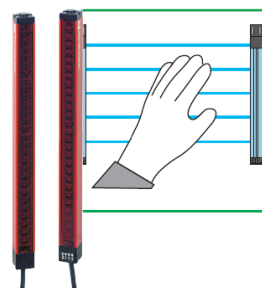
ePac & Safety PLC



foot switch



safety switches



Safety light curtains



Examples of security features:

SICK
Sensor Intelligence.



Safety light curtains



Non-contact safety switches



Safety laser scanners
outdoorScan3



Non-contact safety switches



Electro-mechanical safety switches



Safe Robotics Area Protection Solutions

<https://www.sick.com/cz/en/safety-switches/non-contact-safety-switches/str1/c/g353451>

Conclusion

Machine safety is an important aspect in machine design. The level of hazard is determined mainly by the function of the machine. Possible injuries can result in permanent health consequences or, in extreme cases, death. This can also mean considerable financial losses for the company as well as a loss of reputation.

Questions:

- Write down examples of typical risks.
- Why safety is an important aspect in machine design.
- Name typical protective devices to increase machine safety.

Used literature and sources of information:

Bezpečnostní příručka pro strojní zařízení - Schneider

Evropská směrnice o strojních zařízeních 2006/42/ES (NV 176/2008 Sb.)

EN/ISO 12100: Bezpečnost strojních zařízení – Zásady pro posouzení a snížení rizika

PD 5304:2005: Pokyny pro bezpečné používání strojních zařízení

EN/IEC 60204: Bezpečnost strojních zařízení – Elektrická zařízení strojů – Všeobecné požadavky

EN/IEC 13850: Bezpečnost strojních zařízení – Nouzové zastavení – Zásady pro konstrukci

EN/IEC 62061: Bezpečnost strojních zařízení – Funkční bezpečnost elektrických, elektronických a programovatelných řídicích systémů souvisejících s bezpečností

EN/IEC 61508: Funkční bezpečnost elektrických/elektronických/programovatelných řídicích systémů souvisejících s bezpečností

EN/ISO 13849-1: Bezpečnost strojních zařízení – Bezpečnostní části ovládacích systémů – Část 1: Všeobecné zásady pro