



Breakers and Switches

Machinery Directive EN60204

Health and safety requirements in machine design and manufacture

Health and safety requirements in machine design and manufacturing

Machine design and manufacturing is an important part of industry. Many of the accidents directly related to the use of machines can be reduced by proper engineering, manufacture, installation and maintenance.

The Directive 2006/42/EC of the European Parliament and the Council (Machinery Directive EN60204) harmonizes the legislation of member countries in new formulation and takes account of the following:

- Member countries are responsible for reducing risks for employees, consumers and pets (if deemed necessary) and goods that arise from the use of machines in question.
- To ensure legal certainty, the scope and applicability of the Directive should be accurately specified.
- To assure machine-related safety, the necessary health and safety requirements should be taken into account already during manufacture, paying attention at the same time to current technical and economic conditions.

The Machine Directive EN60204 applies to machines, replaceable devices, safety elements, lift devices, chains, ropes and cables, removable power transmission mechanisms and partially-built machines. This directive uses two important terms:

Machine: an assembly consisting of multiple parts or components where at least one of them is moving. It is or it should be equipped with a gear system that is not powered by a man or an animal. It is designed for a specific purpose.

Manufacturer: an individual or a legal entity who designs and manufactures a machine for personal use or sale under his name or trademark that is governed by the directive in question. In case the manufacturer is not known, an individual or legal entity who is selling or making use of the machine governed by this directive, whether fully assembled or not, should be considered the manufacturer.



Important health and safety requirements

The manufacturer or its authorized representative should make sure that preliminary risk assessment takes place. It is needed in order to determine the applicable health and safety requirements that should be considered during the design and manufacture processes.

The risk assessment is the basis to decide whether the safety measures in the machinery directive are sufficient to eliminate the possible hazards or to ensure minimal risks.

During the risk assessment and reduction phase, the manufacturer or its authorized representative and, if possible, the intended user:

- Determine the machine's intended use and restrictions, but also every possibility of misuse, including justified misuse.
- Determine all the machine related safety hazards and associated escalating situations.
- Assess the risks and consider the severity of all possible injuries and accidents, taking into account their probability.

The machine must be designed and constructed in such a way that it is acceptable to use for its intended purpose and can be operated, configured and serviced without putting anyone at risk, provided that the mentioned operations are performed according to the instructions and taking into account the possibilities for foreseeable misuse.

The following list includes important terms related to machine operation and safety:

- a) Hazard.- Source of possible injuries or health risks.
- b) Hazard area.- Area inside the machine and/or around it where the operator or other individuals are at risk.
- c) Endangered person.- Everyone who is entirely or partially within the hazard area.
- d) Operator.- Person who installs, operates, configures, maintains, cleans, services or moves a machine.
- e) Risk.- The combination of the likelihood of an injury or a trauma and its degree of severity.
- f) Protective guard.- A part of a machine that is used as a physical barrier to ensure safety.

- g) Protective device.- A device (not a protective guard) that minimizes danger, either alone or with a protective guard.
- h) Intended use.- Use of a machine according to its instruction manual
- i) Foreseeable misuse.- Use of a machine in a way that is not recommended by the manual, but can be predicted due to human behavior.

Safety and reliability of control systems

All control systems must be designed and constructed so that they are safe:

- They should withstand their intended workload and environmental conditions.
- The hardware and software of a control system should be safe.
- All possible logic errors in a control system should not escalate to a hazard situation.
- All foreseeable human errors should not escalate to a hazard situation.

In addition, the following requirements must be met:

- A machine must not start unexpectedly.
- It must not be possible to change a machine's parameters without supervision if it can possess a safety risk.
- Stopping of a machine must not be blocked if the power has been switched off.
- None of the moving or transportable parts must come off or fall down when a machine is switched off.
- Automatic or manual stopping of all moving parts must not be blocked.
- The protective devices used must perform as expected or transmit a stop signal.
- The devices connected with the control system must, if deemed necessary, apply to the entire assembly or a part of it (depending on the technological process).
- In case of a wireless control, the machine must stop automatically if there is no correct signal or data transmission.

Safety and reliability of control systems

Start and stop

Requirements for control devices

All control devices must be:

- Visible and recognizable and, if necessary, with proper pictographs and text.
- Installed in a way that their use is understandable, safe, quick and does not cause any mistakes.
- Designed so that the movement of a control device matches its function.
- Placed outside the hazard area, if possible. For example, an emergency stop button or a local control device.
- Installed so that their use does not introduce any additional risks caused by the environment. For instance, the device must be splash-proof, water-resistant, flame- and temperature-proof.
- Designed so that a risky procedure cannot be performed, unless it is the user's intention.
- Constructed for their intended use at rated load or overload if switching an emergency stop device or disconnecting from a power supply can introduce an additional load.
- All control devices must be positioned so that their layout, movement and counter-effect to movement are in accordance with the performed actions, at the same time considering the fundamentals of ergonomics.
- If a control device is designed and constructed for executing several different commands, the selected function must be visible and, if necessary, be confirmed by an operator. For safe use, the machine must be equipped with indicators, which the operator can use to read data.

The operator should be able to make sure easily that all hazard areas are free of bystanders. Otherwise, the control system must be designed and built so that starting is not possible, unless the hazard area is empty. If neither of these is possible, an audible and/or visual warning should be used before start-up. Then, the person in danger should have enough time to leave the area or stop the process.

If necessary, there should be remote-control devices in one or multiple predetermined areas (for example, near a hazard zone) If more than one control zone exists, the control system must be built so that if one of them is being used, the others become disabled, except switch off and emergency stop features. In case there are two or more control zones, they all must be



Example of an operating area next to a hazard area

equipped with all the necessary control devices and means that prevent errors and dangerous situations.

Start-up requirements

A machine should start only when its control device is moved intentionally. When it needs to be restarted after it stopped for some reason or when there is a significant change in working conditions.

A machine can be restarted or configured using other devices than control elements only if it does not create a hazardous situation. Starting, restarting and changing work conditions of automatically operated machines can take place without intervention.

If a machine has multiple start switches and operators that might jeopardize each other, an additional element must be installed to eliminate the risk.

If it is required for safety reasons that starting and/or stopping a machine must follow a certain sequence, appropriate devices must be fitted.

Stop requirements

All machines or machine parts in a system should be designed and constructed so that the stopping devices, including the emergency switch-off devices, stop the relevant machine and any other connected machine if their ongoing operation might be dangerous.

Standard stop procedure

Each machine must have a control device that enables safe and complete shut down. All operating areas must include a stopping device to switch off the entire machine or its moving parts, depending on the nature of the hazard, so that this machine is safe.

The machine stopping function must take priority over start-up. If a machine and its moving parts and drives have stopped, it must be possible to switch off its power supply.

Stopping during start-up

In case it was necessary to switch off a machine during its start-up and the entire power supply cannot be disconnected, then the stopping process must be observable.

Emergency stop

All machines must be equipped with at least one emergency stop device for immediate switch-off to prevent a direct or a possible hazard. The exceptions are:

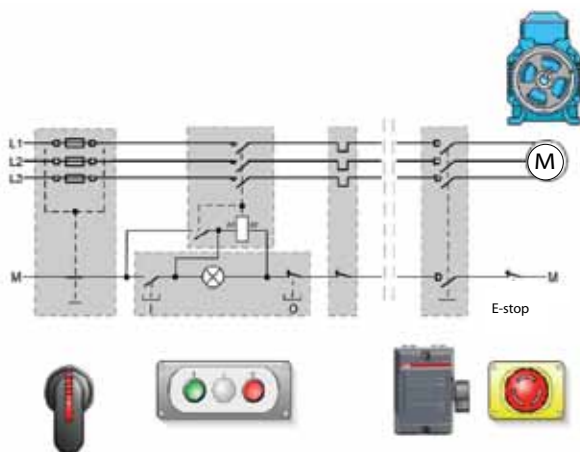
- If an emergency stop button does not reduce the risk due to long stopping time or it would not enable to use other necessary procedures to eliminate the hazard.
- Portable machines and/or manual machines.

An emergency stop device must be:

- Equipped with identifiable, visible and easy-to-use controls.
- Able to stop and end dangerous processes as quickly as possible without introducing additional risks.
- The emergency switch-off device must be capable of executing or allowing the use of additional safety features, such as emergency lights or sound alarms.

When an emergency switch-off device is activated, the command and the switch-off device have to stay active until the machine is reset. In case the switch-off device is activated, the system must sense that the stopping procedure was initiated. The emergency switch-off device should reset the system only when the appropriate procedure is used. Returning the switch-off device to its original position should not restart the machine, but make it possible.

The emergency stop function should always be usable and accessible, irrespective of the operating mode. The emergency switch-off device must complement other safety features, not replace them.



Starting, standard and emergency switch-off functions in a control system



Switches disconnect machines from the electricity supply

Safety and reliability of control systems

Selecting control modes

The selected control or working mode must take priority over any other control or working mode, except for emergency stopping.

In case a machine is designed to offer several control or operating modes and they require different protective measures and/or operating procedures, then this machine should be equipped with a working mode selection switch that can be locked in certain position. Each position of the switch must correspond to one control or working mode.

The selection switch can be replaced with another selection device which enables the use of specific functions only for certain operator groups.

If a procedure requires moving or taking off a protective guard and/or disabling a safety device, then the control or working mode selection switch must:

- Disable all other control or working modes.
- Allow the operation of dangerous moving parts only when a hold-to-run control is used.
- Enable the operation of dangerous moving parts only at reduced risk, at the same time avoiding hazards that might be caused by interconnected operating phases.
- Prevent the use of all dangerous moving machine-parts,

which might cause a hazard, by affecting sensors either intentionally or not.

If the aforementioned four conditions cannot be met at the same time, then the control and working mode selection switch must activate other protective measures, which are designed and constructed to ensure safe work area. Furthermore, the operator should be able to control the components in use.

Disconnecting the machine from power source

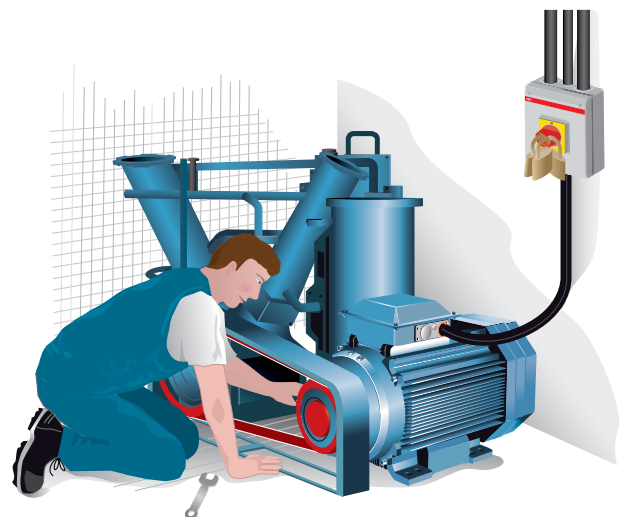
The machine must have devices to disconnect it from all power sources. Such devices should be easy to identify and they need to be lockable if restoring the power can cause a hazard.

The operator should be able to lock the power disconnect switch if he is away from the power control box and cannot be certain that someone does not touch the switch. The safety switches or other power switches used in the control box must meet the requirements of IEC 60947-3.

If a machine is plugged to a power outlet, it is sufficient to unplug it, provided that the operator can be sure that someone does not plug it in unexpectedly. After disconnecting the power, it should be possible to eliminate any remaining charge in the machine's electrical circuits so that there is no risk of electrical shock.



Safety switches can be padlocked in OFF position



Safety switches protect the operator from unexpected start-up

The aforementioned conditions do not apply to circuits used for holding components, protecting data, internal lights, etc meaning that they are active. In this case, special measures must be used to ensure the operator's safety.

EMC – Electromagnetic Compatibility

The operation of different electric drives, control and start devices may cause electromagnetic radiation, which could have a negative effect on human health. In addition, the electromagnetic emission can also affect control devices, thus making it impossible to operate or stop a machine.

The acronym EMC (Electromagnetic Compatibility) refers to electric devices that can operate together without causing harmful interference. It is assumed that stationary machines, devices and assembly parts are tested to ensure their compliance with EN50081-2.

The devices should be chosen and constructed so that they are immune to external radiation and signals, whereas the level of their electromagnetic emission cannot exceed the limits.

The interoperability of all devices must meet the requirements of IEC 6100-6-3/4. The parts or the machine itself must have CE certification.



The devices must be chosen carefully to prevent any interferences

Risks from moving parts

All moving parts must be designed and constructed so that they are safe and cannot cause injuries. If such risks cannot be reduced, the machines in question should be equipped with protective guards or safety devices.

The safety guards or devices protecting against transmission system related injuries should be selected according to risk type:

- The affixed protective guards must be secured so that they can be opened or removed only by using a tool.
- The protective guards that can be opened should stay connected to a machine. If possible they should be designed and constructed in such a way that they can only be modified intentionally.
- All adjustable protective guards that provide access to areas near moving parts which are absolutely necessary for specific operations should be automatically or manually adjustable without any tools.

Movable guards must be connected to a blocking device which:

- Prevents a dangerous operation, unless the guard is in its original position.
- Stops the machine if a protective guard is moved.
- Prevents the machine from starting until the protective guard is back in its original position and locked;
- Holds a protective guard in closed and blocked position until a dangerous operation is over.

Movable protective devices should be used if operators need frequent access to guarded component. Special safety devices and their usage is explained in the user's manual and if possible on one of the machine's information labels.

References

1. Directive 2006/42EC of the European Parliament and of the Council of 17 May 2006 (Official Journal of the European Union)
2. Directive 2004/108EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC (Official Journal of the EU 31.12.2004)

Safety and reliability of control systems

ABB's Safety Switches



ABB's range includes side and front operated safety switches from 16 to 1250 Amperes, with power ratings from 7.5 to 1200 kW, up to 690 V. All the products in this range fulfill the requirements of the Machinery Directive EN60204.

- **ABB's safety switches are designed to isolate the motor or machine from the main power source**, ensuring safe maintenance work.
- **ABB's safety switches prevent unintentional operation.** They include an auxiliary contact used as electrical interlock, by connecting the safety switch to starter or other motor control device. The handle can be padlocked in OFF position and the cover cannot be opened while the switch is in ON position.
- **The safety switches can be identified easily.** A label is included on the cover.
- **The switch position indication is always reliable.** The switches have been designed so that the handle does not reach the OFF position unless all the contacts are open.

The position indication is also shown reliably on the switch body in case that the cover is open. OFF position cannot be indicated if one of the contacts has been welded together.

- **ABB's safety switches have been tested according to IEC 60947-3.** One of the most significant is the arc proof short-circuit durability test, where they have had an outstanding performance.
- **ABB offers the appropriate switch even for the most demanding environments.** The enclosures are available in strong, high quality materials: plastic, aluminum, steel sheet, stainless steel sheet and acid-proof material. To ensure corrosion resistance in difficult operating conditions, all the switches starting from 200 A have extra thick silver plated contacts. It is also possible to request gold plated auxiliary contacts for demanding conditions.
- **ABB's offering includes safety switches especially designed for environments with electromagnetic disturbances (EMC).** The safety switches comply with IEC61000-6-3/4 according to the EU directive 2004/108/EC.



ABB's safety switches comply with the health and safety requirements stated in the Machinery Directive EN60204. All our safety switches are designed to protect people and equipment, even in the most demanding environments.

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OT22GB 12-10 1SCC340006K0201