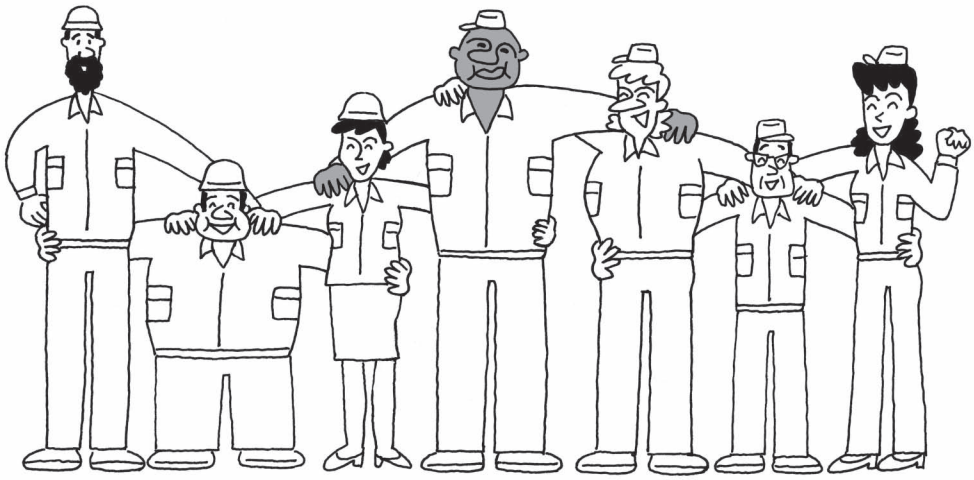
In the manufacturing industry, production consists of processing, assembling, and transporting materials. In modern times, machines use large amounts of energy to absorb the burden from workers to assist in production. This result in the wide range of development in machines that we see today. And trained workers based on experience in operating the machines create more stable quality, causing the relationship between machines and production to continue and evolve into many forms today.

1. The Social Background to Safety of Machinery

(1) Changes in People

In some countries, changes in social structure have brought changes in the people that work at production sites. For example, many experienced workers are retiring while the working population shrinks due to lower birth rates. At the same time, forms of employment continue to diversify, such as the increasing number of temporary employees and there is a continued increase in employees working overseas. Diversification also continues to increase in other ways, such as age, sex, experience, language, and social habits.

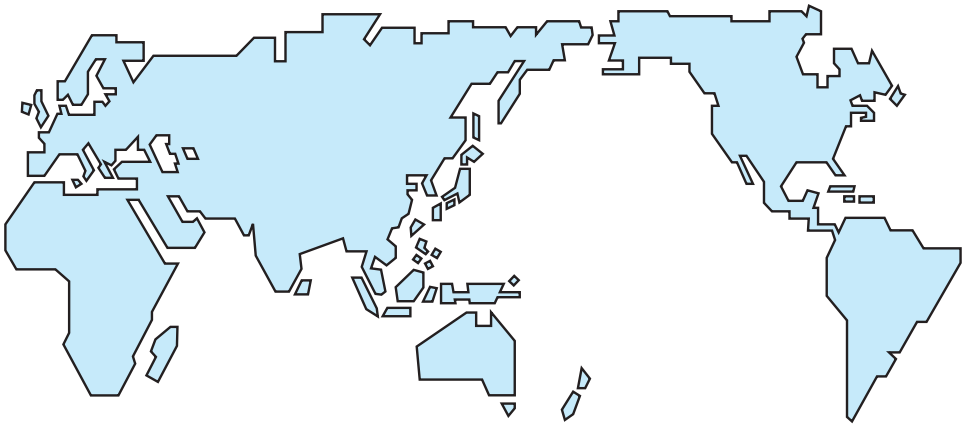


(2) Changes in Machines and Production Facilities

Today's society is facing more diversification in consumer needs driving demands for more variation in products. Production sites are required to change between many different products at relatively short intervals, resulting in frequent changes to production facilities. Machines required for production must support more functionality.
This and many other changes require that workers must master new techniques and working procedures.

(3) Changes in Production Locations

Market globalization has taken production sites from fixed sites across national borders. Domestic production is faced with the need for more competitive products and new markets combined with demand for production sites in newly industrialized countries, such as BRICs. Offshore production means dealing with different laws, infrastructures, cultures, and values. The machines and production facilities resulting from the accumulated knowhow of industry domestically must now be used in different human environments.



(4) Changes in Social Consciousness

In mature civil societies, companies must take social responsibility for their activities. For example, they must assume product liability for the products that they produce. Although conditions vary by country, all countries now have laws requiring product safety to protect the consumer. (For example, Japan and the USA have product liability laws and the EU has the EC directives.) It is not necessary to provide examples of product accidents to realize the very strict monitoring of manufacturing liability for safety and ease of mind in societies that share a common ideal of respect for human beings. And based on these ideals, the responsibility of companies for the safety of workers on production sites is also strictly monitored. (For example, OSHA in the USA, the Revised Industrial Safety and Health Law in Japan, and EC directives in the EU.) Companies face not only criminal, civil, and damage liability for any accidents that might occur, but their corporate image is greatly hurt as a result. The social liability of companies for the safety of their workers has skyrocketed in recent years.

The relationship between workers and machines and the environment in which they operate has thus changed on a global scale. And yet, manufacturing is not possible until a worker operates a machine. Across changes in the operating environment, society demands that machines and production facilities can be used safely regardless of where they are used or who uses them. This is required not only in the workers, but also in the machines and hardware technology. As a result, global standards for safety are required for today's production sites. This is the concept of Safety of Machinery.

2. Safety of Machinery

Security assurance which was not enough by the human scheme is intended to be secured against the machines themselves by the engineering means for a higher level of assurance. Safety standards define the requirements for the safety of machinery.
ISO 12100 was officially issued in November 2003 as an international safety standard.
Publication of ISO 12100: 2010 was followed by the integration of ISO 12100-1, ISO 12100-2 and ISO 14121 into "General principles for design - Risk assessment and risk reduction."
Typical standard for the safety of machinery is an European Standard (EN).
EN standard is established as the engineering criteria for meeting the basic safety requirements defined in the machinery directive within the European Union and the conformity with the EN standard is a prerequisite for the EC Declaration of Conformity which is mandatory for the distribution within the EU.
Thus, conformity with the directives or standards is performed as part of the mechanical design or engineering and some technical files are treated as a complete set of documents for machinery.

(1) Strategies for Selecting Safety Measures

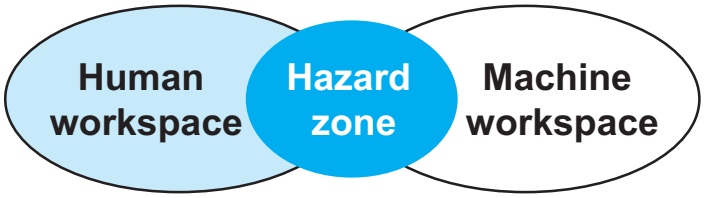
1) Separation between human and machinery

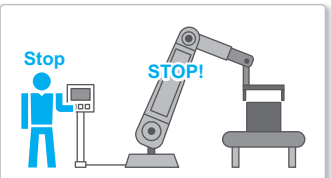
Machinery hazards occur in hazard areas, where the human workspace overlaps the machine workspace.
Preventing machinery hazards begins by eliminating mechanisms that facilitate hazardous conditions.
The following strategies are generally used to achieve this goal.

1. Spatial separation between human and machine workspaces (Isolation principle: Safeguarding with guards)

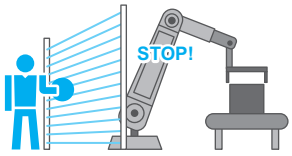
2. Temporal separation (Stoppage principle: Safeguarding with interlocking devices *)

* An interlocking device refers to a mechanical or electrical device that was designed to prevent machines from operating unless certain conditions are met, such as closing a guard for example. (ISO 14119)

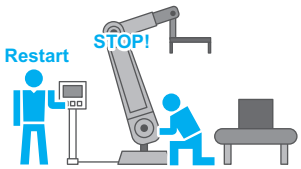




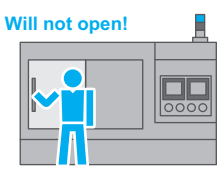
Emergency stop ensures termination of the power source.



The machine stops safely even if a failure occurs on light curtains.



Unauthorized personnel intrusion disables the restart.



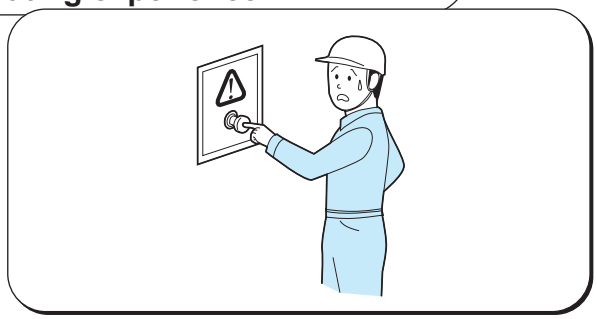
A door will not open until a machine stops.

2) Safety Measure Strategy

All machines fail and everyone makes mistakes.
Therefore, basic designs that take every precaution to ensure the safety of operators is required in the event of a fault.

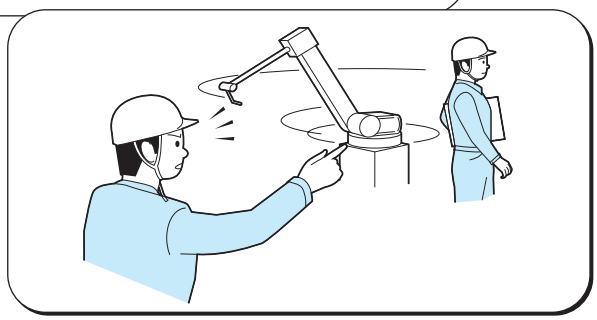
Humans make mistakes.

Ensuring safety irrespective of operating experience



Machines fail.

Ensuring safety during machine setup and maintenance



3) Safety secured by de-energizing

Isolating the human and machine states of operation with respect to time by controlling the interlocking devices can be achieved in principle by shutting down the machine power source and thus reducing the risk derived from the motion of the machine.

Note: If, however, de-energizing increases another risk (such as fall, scatter or overturn due to the loss of retention power), this does not apply.

IEC 60204-1 defines how the power is shut off with the stop categories of 0 to 2 depending on the behavior from the request of emergency stop to the machine operation termination. Take the optimum scheme for shutting down the energy from the selected risk reduction measures.

Note: Depending on the risk reduction measures, there are some cases where the stop categories are specified by the standard's requirement.

Type of Stop Functions

Stop Category 0

Stop category 0 is an uncontrolled stop that is achieved by immediately removing power to the machine actuators (e.g., directly cutting off the power supply).

Stop Category 1

Stop category 1 is a controlled stop that is achieved by sending a stop command from the control circuit to stop (e.g., brake) the machine actuators and then removing power to the actuators (e.g., cutting off control circuit power) after the stop is achieved.

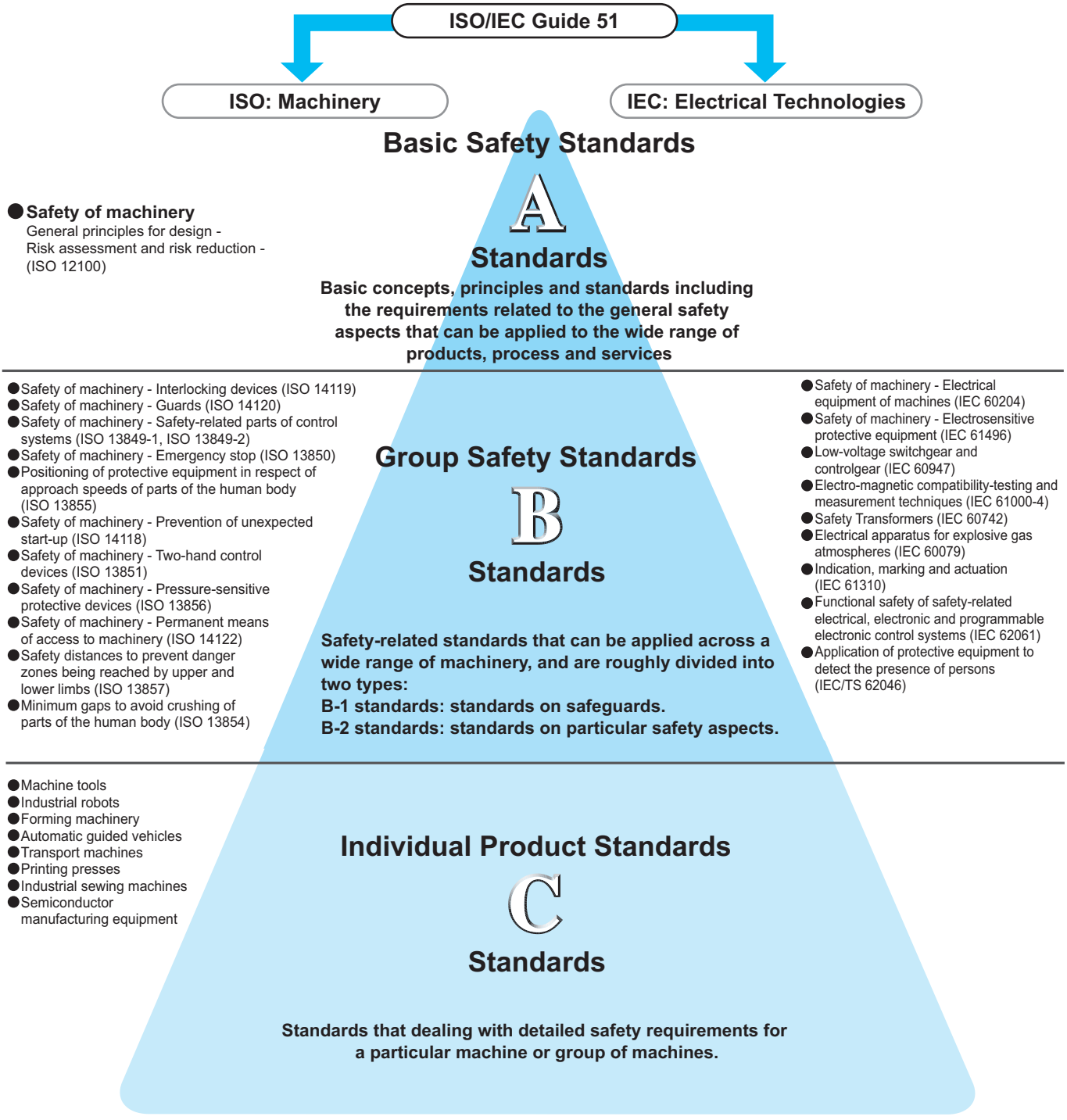
Stop Category 2

Stop category 2 stops machine actuators without cutting off the power.

3. Safety Requirements

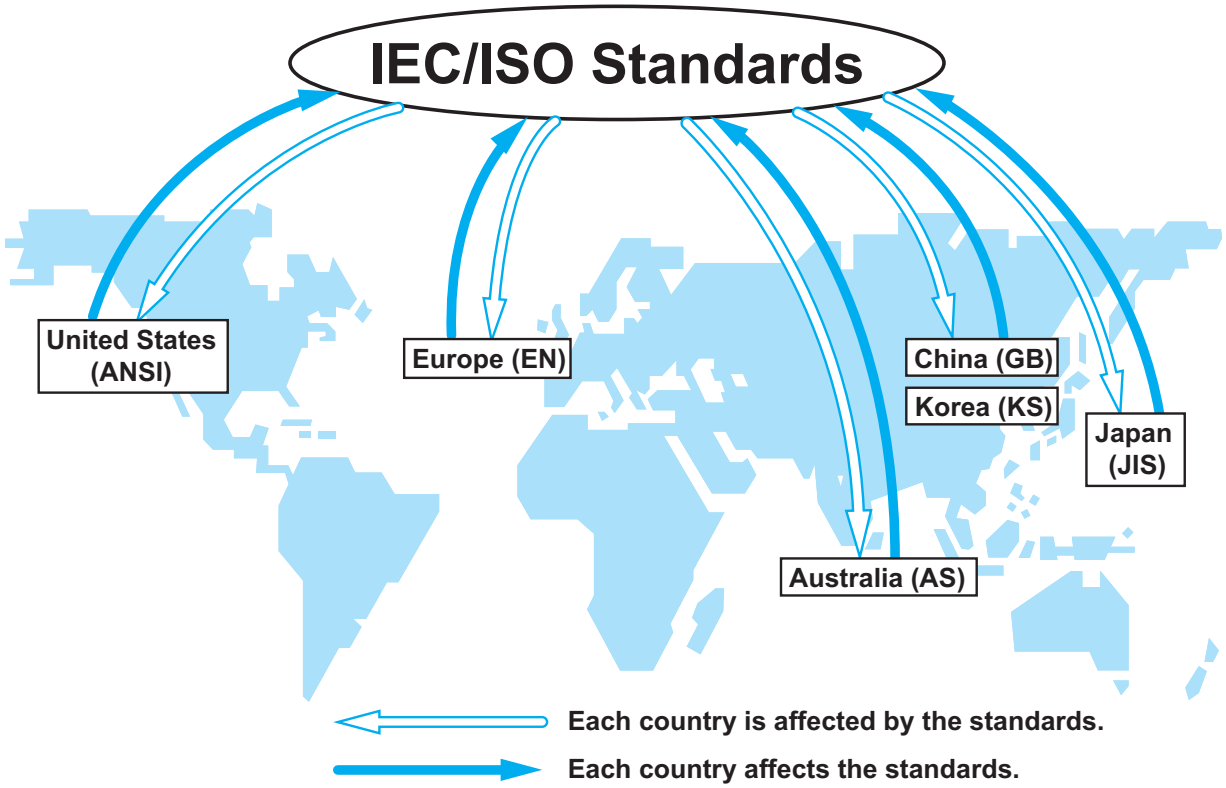
(1) System of Standards for Safety of Machinery

The International Electrotechnical Commission (IEC) prepares international standards for all electrical, electronic and related technologies, and the International Organization for Standardization (ISO) prepares international standards for all technologies other than electrical and electronic technologies (machinery and management). European countries often take the initiative in proposing the standards and establishing them as ISO/IEC international standards. The standards referred to here are related to the safety aspects and they are classified into three tiers of standards of A, B and C as shown below for coverage of wide variety of machinery as well as fulfilling the specific purposes.



Accelerated international harmonisation of safety standards

The international standards which have been created by each country in its own way are now geared to the harmonisation with the ISO/IEC international standards by the WTO Standards Alliance.
It is mandatory for WTO members to adopt its policy into their safety regulations of each country. With the technological advancement, the international standards are actively greeted with new proposals and amendments by years and the way to the integrated standards is now under way throughout the world.

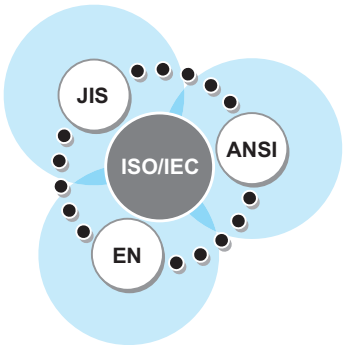


International Standards and Design of Machines and Devices

Responding to Machine and Device Design Standards Today

International standards

(1) The newest information on international standards and industry standards must be collected, and the contents of new and revised standards must be understood.



(2) The differences between EN, UL, JIS, and other standards must be understood.

(3) Global designs must be created that taking into account the differences.