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Industrial automation systems — Safety of integrated manufacturing systems — Basic requirements

Systèmes d'automatisation industrielle — Sécurité des systèmes de fabrication intégrés — Prescriptions fondamentales

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Contents

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Annex

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11161 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*.

Annex A of this International Standard is for information only.

Introduction

0.1 This International Standard is part of a series of standards dealing with safety of industrial machines. It has been harmonized with other relevant International Standards dealing with safety issues of industrial equipment.

The intent of this International Standard is to provide safety requirements and guidelines for the design, construction, installation, programming, operation, use, and maintenance of integrated manufacturing systems. It describes basic types of hazards associated with these systems and steps to be taken to assess the risks associated with these hazards and to eliminate or reduce the hazards to an acceptable level.

Where specific points in this International Standard are considered to be in conflict with the requirements of other international standards (now or in the future), these requirements will be analysed to determine if they are to be included or deleted as system safety requirements.

0.2 This International Standard has been created in recognition of the particular hazards which exist in integrated manufacturing systems incorporating industrial machines and associated equipment.

The risks associated with these hazards vary with the types of industrial machines incorporated in integrated manufacturing system and the application of such a system as to how it is installed, programmed, operated, maintained and repaired.

The requirements of this International Standard are aimed at minimizing the possibilities of injuries to personnel while working on or adjacent to an integrated manufacturing system. This International Standard contains definitions, measures or procedures, and devices which are not specific to systems but can also apply to safety requirements for individual machines and equipment. They are included in this International Standard to make it more understandable or because no relevant international standards exist.

Figure 0.1 shows a typical system with the assumption that all of the hazards presented by the system are contained within the work zone. These hazards are suitably protected by safeguarding means determined by the risk assessment (see clause 4) and described in clauses 5 to 8 of this International Standard.

Where hazards are presented by equipment outside the work zone (e.g. electrical shock), it is intended that these hazards be suitably protected by means described in relevant International Standards (e.g. IEC 204-1)

which can be integrated by the procedures developed by the system supplier or user.

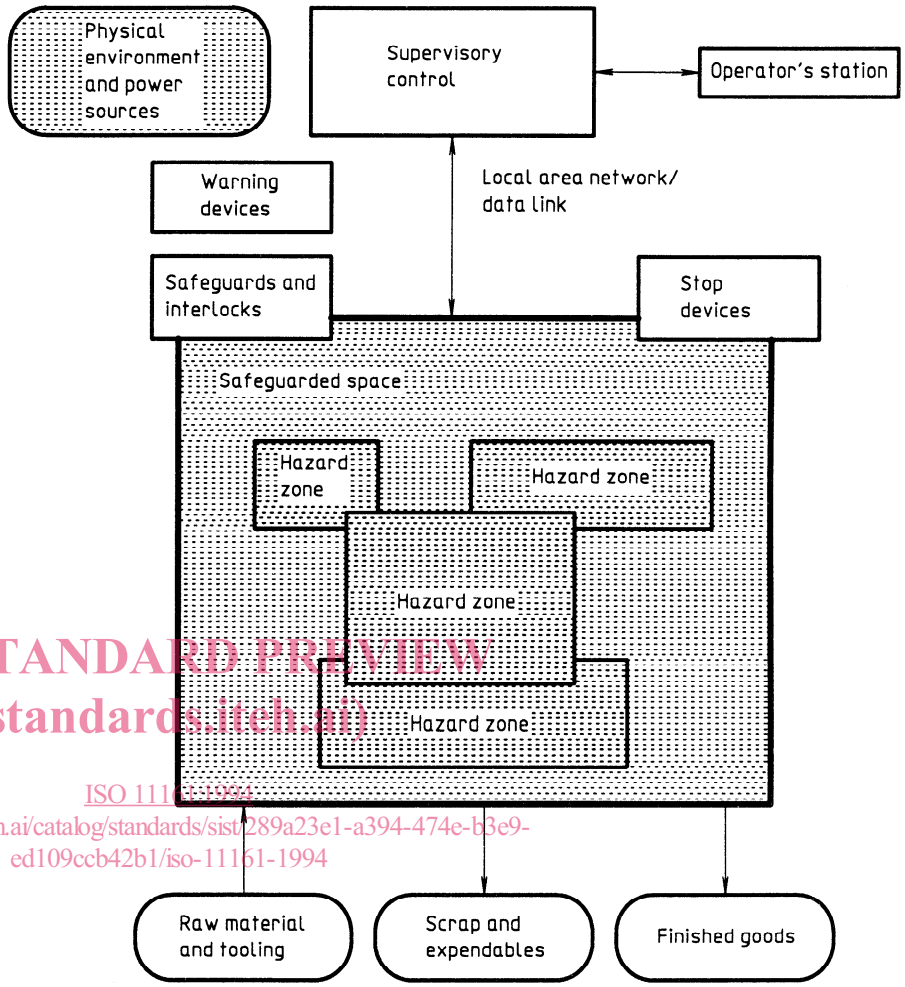

Figure 0.1 — Basic integrated manufacturing system

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Industrial automation systems — Safety of integrated manufacturing systems — Basic requirements

1 Scope

This International Standard specifies the safety requirements for integrated manufacturing systems that incorporate two or more industrial machines interconnected with and operated by a controller(s) capable of being reprogrammed for the manufacturing of discrete parts or assemblies. It describes the requirements and recommendations for the safe installation, programming, operation, maintenance, or repair of such systems (see figure 0.1 for the basic configuration of an integrated manufacturing system).

This International Standard is not intended to cover safety aspects of individual machines and equipment which may be covered by standards specific to those machines and equipment. Where machines and equipment of an integrated manufacturing system are operated separately or individually and while the protective effects of the safeguards provided for automatic mode are muted or suspended, the relevant safety standards for these machines and equipment shall apply.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3864:1984, *Safety colours and safety signs.*

ISO 6385:1981, *Ergonomic principles in the design of work systems.*

ISO/TR 8373:1988, *Manipulating industrial robots — Vocabulary.*

ISO 10218:1992, *Manipulating industrial robots — Safety.*

CEI 204-1:1992, *Electrical equipment of industrial machines — Part 1: General requirements.*

EN 418:1992, *Safety of machinery — Emergency stop equipment, Functional aspects — Principles for design.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 awareness barrier: Attachment or obstacle that by physical contact warns of an approaching or present hazard.

3.2 barrier: Physical boundary to a hazard.

3.3 controlled stop: The stopping of machine motion by reducing the command signal to 0 once the signal has been recognized by the control but retaining power to the machine actuators during the stopping process. [IEC 204-1:1992, 3.12]

3.4 enabling device: Manually-operated device which, when continuously activated in one position only, allows hazardous functions but does not initiate them. In any other position, hazardous functions are stopped safely.

3.5 guard: Machine element specifically used to provide protection by means of a physical barrier. Depending on its construction, a guard may be called casing, cover, screen, door, enclosing guard, etc.

3.6 hazard: Source of possible injury or damage to health.

3.7 hazard zone [area] [space]: Any zone within and/or around machinery in which a person is exposed to risk of injury or damage to health.

3.8 hazardous situation [condition] [motion]: Any situation in which a person is exposed to a hazard or hazards.

3.9 hold-to-run control device: Manually-actuated start and stop control device which initiates and maintains operation of machine elements only as long as the control is actuated in a set position. The control automatically returns to the stop position when released.

3.10 industrial machine; machine: Individual component machine and associated equipment of an integrated manufacturing system.

3.11 integrated manufacturing system; system: Group of two or more industrial machines working together in a coordinated manner normally interconnected with and operated by a supervisory controller or controllers capable of being reprogrammed for the manufacturing of discrete parts or assemblies.

3.12 interlocking device (as used with a guard): Mechanical, electrical, or other type of device, the purpose of which is to prevent the operation of system elements under specified conditions (generally as long as the guard is not closed).

3.13 limiting device: Device which prevents a system or system elements from exceeding a design limit.

3.14 local control: State of the system or portions of the system in which the system is operated from the control panel or pendant of the individual machines only.

3.15 lockout: Placement of a lock on the energy isolating device (e.g. disconnecting means) in the "OFF" or "OPEN" position indicating that the energy isolating device or the equipment being controlled shall not be operated until the removal of the lock.

3.16 muting: Temporary automatic suspension of the protective function of a safeguarding device during normal operation.

3.17 operational stop: Stop which stops the production process at a natural point in the working process as soon as possible after its activation.

3.18 pendant: Unit linked to the control system with which the system or portions of the system can be programmed (or moved).

3.19 person: Any individual.

3.20 personnel: Persons specifically employed and trained in the use and care of a machine or manufacturing system.

3.21 protective device: Device (other than a guard) which reduces risk, alone or associated with a guard.

3.22 risk: Combination of the probability of injury occurring and the degree of the injury or damage to health in a definite hazardous situation.

3.23 safeguard: Guard or protective device used in a safety function to protect persons from a present or impending hazard.

3.24 safeguarded space: Space determined by the safeguards.

3.25 safeguarding: Those safety measures consisting of the use of safeguards to protect persons from the hazards which cannot reasonably be removed or sufficiently eliminated by design.

3.26 safe working procedure: Specified procedure intended to reduce the possibility of injury while performing an assigned task.

3.27 supplier: Entity (e.g. designer, manufacturer, contractor, installer, integrator) who provides equipment or services associated with the manufacturing system or portion of the system.

NOTE 1 The user may also act in the capacity of a supplier to himself.

3.28 task program: Set of motion and auxiliary functions instructions which define the specific intended task of the manufacturing system.

NOTE 2 This type of program is normally generated by the user.

3.29 trip device: Device which causes a system or system element to stop when a person or a part of his or her body goes beyond a safe limit.

3.30 troubleshooting; fault finding: Act of methodically determining the reason that the system or portions of the system has failed to perform the task or function as intended.

3.31 uncontrolled stop: Stopping of machine motion by removing power to the machine actuators which cause hazardous conditions, all brakes or other mechanical stopping devices being activated (see IEC 204-1).

3.32 user: Entity who utilizes and maintains the manufacturing system.

4 Safety strategy

4.1 General

This clause deals with the overall strategy of determining the safety requirements for a system. This overall strategy is a combination of the measures incorporated at the design stage and those measures required to be implemented by the user.

The design of the system shall be the first consideration while still maintaining an acceptable level of performance. This phase of the safety strategy should:

— specify the limits or parameters of the system (see 4.2);

— apply a safety strategy (4.3);

— identify the hazards (4.4);

— assess the associated risks (4.5);

— remove the hazards or limit the risks as much as practicable.

Where it is not possible to reduce the risks to an acceptable level by the above measures, provisions for safeguarding in the design phase shall be considered in such a manner that the flexibility of the system in its application is retained without impairing its safety.

In addition, information (e.g. written instructions, warning signs) concerning hazards which are difficult to recognize shall be provided.

4.2 System specification

A system concept shall define the system specification. This includes or takes into account:

— description of functions;

— layout and/or model;

— survey about the interaction of different working processes and manual activities;

— analysis of process sequences including manual interaction;

— description of the interfaces with conveyer or transport lines;

— process flow charts;

— foundation plans;

— plans for supply and disposal devices;

— determination of the space required for supply and disposal of material;

— available accident records;

— study of similar system installations.

The designer shall have a specific and documented idea of the probable human activities on the site, and in particular:

— visits (presence of third parties not directly concerned by the operation);

— process control and monitoring;

— workpiece loading;

— takeover of manual control by operator;

— brief interventions not requiring disassembly;

— setting;

— troubleshooting;

— maintenance.

This information will enable the designer to work out a coherent, purposeful programme of action based on the following elements:

— analysis of reference situations (old or more recent on other sites);

— allowance for effects of industrial variability (equipment wear, dimensional variations of product, etc.);

— participation of personnel having to work on the system in the future.

4.2.1 System design criteria

Besides the description of functions, all necessary requirements to ensure safe operation should be considered in the design criteria list. This includes all protective measures to effectively reduce the hazards listed in 4.4 where they exist.

Such a design implies a coherent procedure which minimizes the effects of project fragmentation. This requires:

— integration of the man-machine interface;

— early definition of the position of those working on the system (in time and space);

— early consideration of ways of cutting down on isolated work;

— consideration of environmental aspects (e.g. quality of air, lighting conditions, noise).

A system shall not be designed exclusively in terms of its working functions; it shall also be considered from the viewpoints of its use and operation.

4.2.2 Project organization

During planning, design and construction of a manufacturing system, safety measures especially those related to the interactions between individual machines shall be coordinated. This applies also where a system consists of a combination of sections and/or single units from different suppliers.

The coordination of activities include, for example:

— planning;

— procurement;

— delivery and assembly;

— installation procedure and stage of testing;

— partial acceptance/acceptance;

— delivery of the system in final working order;

— system verification (runoff) including correction of any faults or failures found;

— maintainability;

— ergonomic factors.

4.3 Application of a safety strategy

An integrated manufacturing system shall be designed and safeguarded to ensure orderly transport and installation as well as proper and safe use and maintenance in accordance with the risk assessment (see 4.5). To achieve these objectives the relationship between human factors, the work being carried out, the hazards arising and the production process should be taken into account.

The factors of noise, hazardous materials, heat, low temperature, radiation and similar influences of the physical operating environment shall be considered so as not to create health hazards.

The supplier(s) of the system (or parts of the system) shall state the expected conditions of the physical environment and the requirements of the external powers sources and how they are to be connected to ensure proper operation. The user shall ensure that either these conditions are met or that alternative means are provided and that the system operates under these conditions according to the specification.

4.3.1 Design and development

All available knowledge concerning safety should be considered during the development of single units, sections of system and complete systems so that, through its application, accident and health hazards shall be prevented or reduced to an acceptable level. This includes the clarity of the complete system, the sections of system and the single units. Particularly, the normal operating positions of personnel shall grant sufficient vision of the flow of production and the machining operations which may require additional measures (e.g. video monitoring).

Normal positions for operating and maintenance personnel shall be easily accessible and located outside hazardous areas. Elements requiring routine maintenance (e.g. points of lubrication, setting mechanisms) shall be arranged, where practicable, outside the hazardous areas. It is preferable to achieve the desired levels of safety by the use of nonhazardous elements to remove or reduce hazards. Secondly, alternative process sequences or working processes giving a lower level of risk may be used.

Manually-operated start and stop controls shall be located in such a way that the hazard zone which is associated with that control facility is clearly identified.