

ANSI B11.20–2004 (R09)

American National Standard for Machine Tools –

Safety Requirements for Integrated Manufacturing Systems

ANSI-Accredited Standards Developer and Secretariat:

AMT – The Association For Manufacturing Technology
7901 Westpark Drive
McLean, VA 22102

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AMERICAN NATIONAL STANDARDS

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FOREWORD (This Foreword is not part of the requirements of American National Standard B11.20-2004)

The primary objective of this standard is to eliminate or control hazards to personnel associated with integrated manufacturing systems by establishing requirements for the construction, operation and maintenance of these machines. To accomplish this objective, responsibilities have been assigned to the supplier (e.g., manufacturer, rebuilder, reconstructor, installer, integrator), the user, and personnel in the working environment.

The words "safe" and "safety" are not absolutes. Safety begins with good design. While the goal of this standard is to eliminate injuries, it is recognized that risk factors cannot be practically reduced to zero in any human activity. This standard is not intended to replace good judgment and personal responsibility. Operator skill, attitude, training, job monotony, fatigue and experience are safety factors that must be considered by the user.

This standard reflects the most commonly used and time-tested state of the art at the time of its approval. The inclusion or omission of language relative to any evolving technology, either in the requirements or explanatory area of this standard, in no way infers acceptance or rejection of such technologies.

Inquiries with respect to the application or the substantive requirements of this standard and suggestions for its improvement are welcomed, and should be sent to the AMT – The Association For Manufacturing Technology, 7901 Westpark Drive, McLean, Virginia 22102-4206, Attention: B11 Secretariat.

Effective Date

The following is informative guidance only, and not a normative part of this standard. This Subcommittee recognizes that some period of time after the approval date on the title page of this document is necessary for suppliers and users to develop new designs, or modify existing designs or manufacturing processes in order to incorporate the new or revised requirements of this standard into their product development or production system.

This Subcommittee recommends that suppliers complete and implement design changes for new machines within 30 months of the approval of this standard.

For existing or modified machines, this subcommittee recommends that users should confirm that the equipment / process has tolerable risk using generally recognized risk assessment methods within 30 months of the approval of this standard. If the risk assessment shows that modification(s) is necessary, refer to the requirements of this standard to implement protective measures for appropriate risk reduction.

This standard was processed and submitted for ANSI approval by the B11 Accredited Standards Committee on Safety Standards for Machine Tools. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time this document was approved as an American National Standard, the ANSI B11 Accredited Standards Committee was composed of the following member organizations:

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Explanation of the format, and ANSI B11 conventions

This ANSI B11.20 – 2004 standard is divided into parts formerly referred to as sections or chapters and now referred to as clauses in line with the current ANSI style manual. Major divisions of clauses are referred to as subclauses and, when referenced by other text in the standard, are denoted by the subclause number (e.g., see 5.1).

The standard uses a two-column format to provide supporting information for requirements. The material in the left column is confined to “Standard Requirements” only, and is so captioned. The right column, captioned “Explanatory Information” contains information that the writing Subcommittee believed would help to clarify the requirements contained in the standard. This column should not be construed as being a part of the requirements of this American National Standard.

As in all American National Standards, the term “SHALL” denotes a requirement that is to be strictly followed in order to conform to this standard; no deviation is permitted. The term “SHOULD” denotes a recommendation, a practice or condition among several alternatives, or a preferred method or course of action.

Similarly, the term “CAN” denotes a possibility, ability or capability, whether physical or causal, and the term “MAY” denotes a permissible course of action within the limits of the standard.

B11 conventions: Operating rules (safe practices) are not included in either column of this standard unless they are of such nature as to be vital safety requirements, equal in weight to other requirements, or guides to assist in compliance with the standard. The B11 standards do not use the term “and/or” but instead, the term “OR” is used as an inclusive disjunction, meaning *one or the other or both*. A distinction between the terms “*individual*” and “*personnel*” is drawn. Individual includes personnel (employees, subcontractors, consultants, or other contract workers under the indirect control of the supplier or user) but also encompasses persons who are not under the direct or indirect control of the supplier or user (e.g., visitors, vendors, etc.). Gauge refers to a measuring or testing instrument; gage refers to limiting device (e.g., backgage).

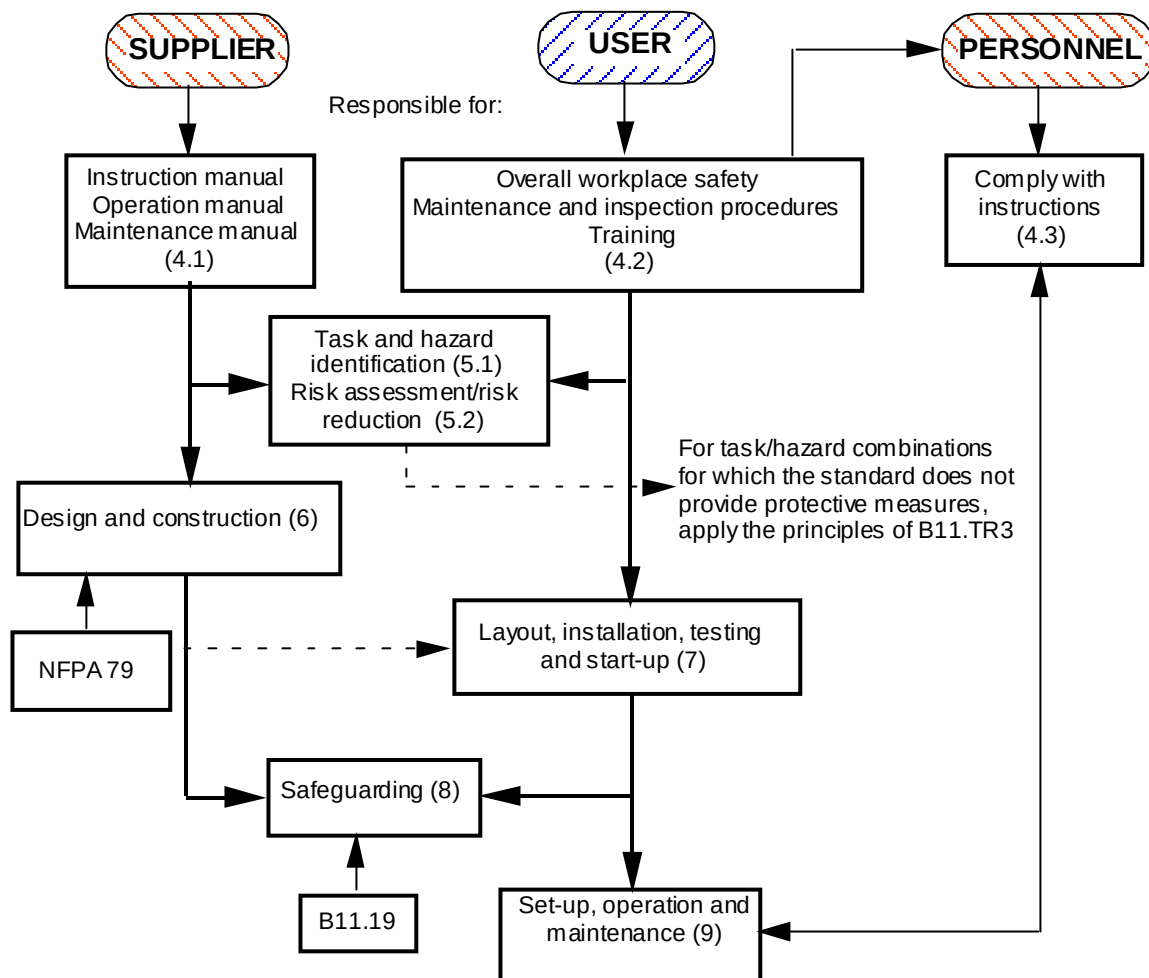
Suggestions for improvement of this standard will be welcome. They should be sent to AMT-The Association For Manufacturing Technology, 7901 Westpark Drive, McLean, VA 22102 - Attention: B11 Secretariat.

Introduction

The primary purpose of every machine tool is to process parts. During production, maintenance, commissioning and de-commissioning, hazards exist that may result in injury.

The primary purpose of the ANSI B11 series of machine tool safety standards is to devise and propose ways to minimize risks of the potential hazards. This can be accomplished either by an appropriate machine design, by restricting personnel or other individuals' access to hazard areas, and by devising work procedures to minimize personnel exposure to hazardous situations.

The responsibility for the alleviation of these risks is divided between the equipment supplier, the equipment user and its operating personnel, as follows (numbers in parentheses refer to the clause numbers in these standards which address that responsibility):



American National Standard for Machine Tools – Safety Requirements for Integrated Manufacturing Systems

STANDARDS REQUIREMENTS

1 Scope

1.1 General

This American National Standard specifies the safety requirements for the design, construction, set-up, operation and maintenance (including installation, dismantling and transport) of integrated manufacturing systems.

An integrated manufacturing system:

- a) incorporates two or more industrial machines, at least one of which is a machine tool;
- b) is linked by a material handling system;
- c) is interconnected with and coordinated by a control system;
- d) is capable of being re-programmed, re-configured or re-sequenced for the manufacturing of a variety of discrete parts or assemblies.

An integrated manufacturing system shall be designed and safeguarded to ensure proper and safe operation and maintenance in accordance with the risk assessment (see Clause 5).

1.2 Exclusions

This standard does not cover:

- a) safety aspects of individual machines and equipment that may be covered by standards specific to those machines and equipment (B11 "base" standard);
NOTE: See inside cover of this standard for a list of the B11 "base" standards.
- b) transfer machines or transfer lines;
- c) continuous flow processes.

EXPLANATORY INFORMATION

(Not part of the requirements of this American National Standard for Machine Tools – *Safety requirements for Integrated Manufacturing Systems.*)

E1.1

The terms "integrated manufacturing system," and "integrated manufacturing cell" should be considered as synonymous. This may also be known as a "flexible manufacturing system."

Integrated manufacturing systems may be comprised of two or more zones, each with their own individual controls.

Zones segment the integrated manufacturing system into manageable sections with defined purposes. See also, Annex D.

See Annex A for examples of integrated manufacturing systems.

E1.2

- a) Where machines and equipment of an integrated manufacturing system are operated separately or individually, the relevant B11 safety standards for these specific machines and related equipment should apply.
- b) See ANSI B11.24.
- c) Examples of continuous flow processes include but are not limited to:
 - petrochemical;
 - food/beverage processing;
 - textiles;
 - rubber;
 - pulp and paper;
 - metal refining;
 - printing.

STANDARD REQUIREMENTS

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All documents in this clause are subject to revision, and parties to agreements subject to this American National Standard should apply the most recent editions of the documents listed below, unless a revision of a normative reference below published after the approval date of this standard contradicts what is required in this standard.

ANSI / ASSE Z244.1-2003, *Control of Hazardous Energy - Lockout/Tagout and Alternative Methods*

ANSI / NFPA 79-2002, *Electrical Standard for Industrial Machinery*

ANSI / NFPA 70-2002, *The National Electrical Code*

ANSI / NFPA-70E-2000, *Electrical Safety Requirements for Employee Workplaces*

ANSI / ASME B15.1-2000, *Mechanical Power Transmission Apparatus*

ANSI / IES-RP-7-1991, *Industrial Lighting*

ANSI A14.3-2002, *Safety requirements for fixed ladders*

ANSI A1264.1-2002, *Safety requirements for industrial fixed stairs; floor and wall openings, and industrial railings and toe boards*

ANSI B11.19-2003, *Performance Criteria for Safeguarding*

EXPLANATORY INFORMATION

E2 Informative References

The documents listed below contain information and guidance for implementation of the requirements of this standard. They are included for information only.

29 CFR 1910.147, *Control of hazardous energy (Lockout/Tagout)*. For more information, go to www.osha.gov

29 CFR 1910.333 (b), *Selection and Use of Electrical Work Practices*. For more information, go to www.osha.gov

ANSI B11.TR1-2004 *Ergonomic Guidelines for the Design, Installation and Use of Machine Tools*

ANSI B11.TR2-1997 *Mist Control Considerations for the Design, Installation and Use of Machine Tools Using Metalworking Fluids*

ANSI B11.TR3-2000 *Risk Assessment and Risk Reduction – A Guide to Estimate, Evaluate and Reduce Risks Associated with Machine Tools*

ANSI B11.TR4-2004 *Selection of Programmable Electronic Systems (PES/PLC) When Applied to Machine Tools*

ANSI / ASME B56.5-1993, *Safety Standard for Guided Industrial Vehicles and Automation Functions of Manned Industrial Vehicles*

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EXPLANATORY INFORMATION

ANSI / ASME B20.1-2000, Safety Standard for Conveyors and Related Equipment
<Revision currently out for vote –ends 8/4/03>

ANSI / ASME B30.13c-1999, Safety standard for automatic storage / retrieval machines and associated equipment

ANSI / RIA R15.06-1999, *Industrial Robots and Robot Systems -- Safety Requirements*

ISO 11161-1994: *Safety of machinery – Integrated manufacturing systems – Basic requirements*

NOTE – A substantive revision of this standard was at the DIS stage at the time of B11.20 approval. A final ISO standard is expected sometime late 2005 or early 2006.

ANSI / IEEE 518-1982, *IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources*

ANSI Z535.1 – 2002 *Safety Color Code*

ANSI Z535.3 – 2002 *Criteria for Safety Symbols*

ANSI Z535.4 – 2002 *Product Safety Signs and Labels*

NMTBA (AMT) Noise Measurement Techniques – 1976. NOTE: At the time of approval of B11.20-2003, this voluntary industry standard was being updated and revised as B11.TR5. Expected ANSI registration as a new Technical Report is late 2005.

Organization Resources Counselors (ORC) *Management of the Metal Removal Fluid Environment: A Guide to the Safe and Efficient Use of Metal Removal Fluids* (www.orc-dc.org)

Metalworking Fluids: Safety and Health Best Practices Manual. OSHA (www.osha-slc.gov/SLTC/metalworkingfluids).

Main, B.; *Risk Assessment: basics and benchmarks*; dse, 2004 (www.designsafe.com).

3 Definitions

For the purposes of this standard, the following definitions apply.

3.1 awareness barrier: An awareness device that warns individuals by means of physical contact.

3.2 awareness device: A barrier, signal or sign that warns individuals of an impending, approaching or present hazard.

3.3 barrier: A physical boundary to a hazard.

3.4 bypass: The suspension of a safety-related function of the control system or safeguarding device.

E3.2 See also, ANSI Z535.1, Z535.3 and Z535.4.

E3.4 For the purposes of this standard, a bypass refers to the safety-related functions and not to process-oriented operating modes.

STANDARD REQUIREMENTS

EXPLANATORY INFORMATION

3.5 complementary equipment: Devices used to ensure or augment the proper operation of the safeguarding.

E3.5 Examples include devices such as safety blocks, stopping performance monitors, and hand tools. For more information, see clause 12 of ANSI B11.19.

3.6 concurrent: Acting in conjunction; used to describe a situation where two or more controls exist in an operated condition at the same time but not necessarily simultaneously.

3.7 control reliability: The capability of the machine control system, the safeguarding, other control components and related interfacing to achieve a safe state in the event of a failure within their safety-related functions.

E3.7 See also, *safety-related function*.

3.8 control system: Sensors, manual input and mode selection elements, interlocked and decision making circuitry, and output elements to the operating devices or mechanisms.

3.9 cycle: A complete movement from an initial start position back to the same start position of the industrial machine or system; the movement may include loading and unloading.

3.10 discrete parts or assemblies: Separate or distinct units or elements which are considered as the output or work in process of an industrial machine or system.

3.11 emergency stop: A control that, when actuated, initiates immediate or controlled stopping action of hazardous motion of the system or zone.

3.13 enabling device: A manually operated device which when continuously activated, permits motion.

3.14 ensure: To establish, maintain, and monitor an effective program, procedure or system to implement the requirements of this standard

3.15 external [remote] control: A control mode where the system or its machines and related equipment are controlled from a location usually external to the system.

3.16 fixed barrier guard: A guard affixed to a fixed surface in such a manner so as to enclose all or part of the hazard area.

3.17 fixture: A means used to locate or support material or workpieces or tools [tooling] during operation.

E3.17 Examples of fixtures are universal tables, angle plates, trunnions, rotating tables, and other removable workholding equipment.

3.18 guard: A barrier that is designed and installed to prevent entry into a hazard area.

3.19 harm: Physical injury or damage to health of individuals.

E3.19 Harm may be a result of direct interaction with the integrated manufacturing system or indirectly as a result of damage to property or to the environment.

3.20 hazard: A potential source of harm.

STANDARD REQUIREMENTS	EXPLANATORY INFORMATION
3.21 hazard zone (area): Space in which an immediate or impending hazard exists.	
3.22 hazardous motion: Motion of equipment or release of energy that can present a hazard.	
3.23 hazardous situation: A circumstance in which an individual is exposed to a hazard(s).	E3.23 A hazardous situation is also referred to as a task/hazard pair (combination). The exposure can result in harm immediately or over a period of time.
3.24 immediate stop command: A command that initiates an action(s) to stop a hazardous motion (or situation) at any point in the system cycle.	
3.25 individual: A particular human being.	E3.25 For the purposes of this standard, a distinction between <i>individual</i> and <i>personnel</i> is drawn. Individual includes personnel but also encompasses persons who are not under direct or indirect control of the supplier or user (e.g., visitors, vendors, etc.). See also, <i>personnel</i> .
3.26 installer: A supplier who installs the safeguarding.	E3.26 See also, <i>supplier</i> .
3.27 integrated manufacturing system: See 1.1.	
3.28 integrator: A supplier who applies or installs safeguarding, safety-related control interfaces, interconnections or the safety-related functions of the control system into a machine production system.	E3.28 See also, <i>supplier</i> .
3.29 interlock: A means to permit or prevent hazardous motion or conditions.	
3.30 interlocked barrier guard: A fixed or movable barrier or section of a barrier provided with an interlock arranged to prevent entry into the hazard area [zone] when the barrier or the section of the barrier is in the closed position.	
3.31 local control: A means that provides the operator with direct and exclusive control of a specific piece of equipment or zone.	
3.32 lockout/tagout: The placement of a lock, tag or both on the energy isolating device (e.g. disconnecting means) in the de-energized condition indicating that the energy isolating device or the equipment being controlled shall not be operated until the removal of the lock/tag.	
3.33 manufacturer: A supplier that designs, manufactures or assembles machines or systems.	E3.33 See also, <i>supplier</i> .
3.34 material handling system: A system which will take parts from the load/unload area, deliver them to the proper work station for processing and return them to a load/unload area without human intervention.	
3.35 mode: The state or condition of the control system that allows specific operation of the system.	

STANDARD REQUIREMENTS

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3.36 movable barrier device: A safeguarding device arranged to enclose the hazard area before machine motion can be initiated.

3.37 muting: The automatic temporary suspension of any safety-related function(s) of the control system or safeguarding device.

3.38 normal stop command: A command that initiates an action(s) to stop motion(s) or situation(s) at the end of a cycle or at other points required by the system functions.

3.39 operator: An individual who performs production work and who controls the machine.

3.40 operator's [control] station: The complement of controls used by the operator to operate the system or zone.

3.41 personnel: An individual or individuals who are employed by the user and trained for a specific task(s).

3.42 presence sensing device: A device that creates a sensing field, area or plane to detect the presence of an individual or object.

3.43 protective measures: Any action or means used to eliminate hazards or reduce risks.

3.44 readily accessible: Having the capability of being reached quickly, without having to remove obstacles or obstructions.

3.45 risk: A combination of the probability of occurrence of harm and the severity of that harm.

3.46 safeguarded space: The three-dimensional volume defined by the safeguarding.

3.47 safeguarding: Protection of personnel from hazards by the use of guards, safeguarding devices, awareness devices, safeguarding methods, or safe work procedures.

3.48 safeguarding device: A device that detects or prevents inadvertent access to a hazard.

E3.41 Personnel includes subcontractors, consultants, or other contract workers under the direct or indirect control of the supplier or user. Does not include other individuals such as visitors, vendors, etc. See *individual*.

E3.42 See E8.4.

E3.43 Protective measures can include but not be limited to:

- inherent design;
- guards;
- safeguarding devices and complementary equipment;
- awareness devices;
- safeguarding methods;
- safe work practices / procedures, training, personal protective equipment or other administrative controls;
- warnings.

E3.48 See clause 8.

STANDARD REQUIREMENTS

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3.49 safety-related function(s): That portion of the control system or safeguarding device that eliminates exposure to a hazardous situation or reduces risk to a tolerable level.

3.50 safe work procedure: Documented instructions that describe how a task is to be performed.

3.51 set-up: The process of changing, replacing or adjusting the integrated manufacturing system components to perform the desired task(s)/function(s).

3.52 shield: A barrier used to keep chips or coolant(s) within the system, or used to reduce the potential of tooling parts or workpieces from being ejected from the system.

3.53 span of control: That predetermined portion of an integrated manufacturing system under coordinated control.

3.54 supervised: A means or method whereby the user exercises control of the operation of the system.

3.55 supplier: An entity that provides the entire IMS, one or more machines, components, equipment, or services for the safeguarding associated with the IMS.

E3.53 The span of control is a term used to conveniently describe that portion of the IMS controlled by safeguarding devices, emergency stops, enabling devices, or other similar devices.

E3.55 A supplier can be the manufacturer, manufacturer's agent, representative or distributor, reseller, installer, modifier, rebuilder or integrator.

NOTE - The user is considered a supplier when the user provides part or all of the products or services (e.g., design, system integration, maintenance).

3.57 tolerable risk: Risk that is accepted for a given task and hazard combination [hazardous situation]. The risk reduction process is complete when protective tolerable risk has been achieved for the identified task/hazard combinations and the machine as a whole.

E3.57 Although not used in this standard, the phrase "acceptable risk" is considered virtually synonymous with the phrase "tolerable risk." See also, discussion at p.31 in *Risk Assessment: basics and benchmarks*; dse, 2004.

3.56 user: An entity that utilizes machines, systems, and related equipment.

E3.56 When the user manufactures, installs, modifies, rebuilds or integrates the safeguarding, the user is considered the supplier.

3.57 zone: A segmented space within the integrated manufacturing system.

E3.57 Zones are created to segment the integrated manufacturing system into manageable sections with defined purposes.

4 Responsibility

4.1 Supplier's responsibility

The supplier shall be responsible for the design and construction of those elements of the IMS that they provide.

4.1.1 The supplier shall design and construct those parts/portions of the IMS that they supply, in accordance with clauses 5, 6, and 8 of this standard.

E4.1

Contractual agreements should provide a clear delineation of the specific goods and services provided when multiple suppliers are involved.

E4.1.1 The supplier should refer to clause 2 for applicable standards relative to the product or service provided by that supplier. When safety standards are not provided, safeguarding techniques used on similar equipment should be applied to this type of equipment, where applicable.

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The supplier shall identify the sources of hazards (see 5.1).

The supplier should work in conjunction with the user to identify the task/hazard combinations (see ANSI B11.TR3).

4.1.2 The supplier shall eliminate or provide the means for controlling the identified hazards by implementing a hazard control strategy (see clause 5).

4.1.3 The supplier shall provide instructional material for installation, testing, set-up, operation, safeguarding, and maintenance of the system.

E4.1.3 The system documentation should contain the following:

- a) A clear, comprehensive description of the system and its installation including:
 - foundation requirements (e.g., space allocation, dynamic loading);
 - power consumption requirements;
 - equipment layout;
 - major component weights;
 - work area safeguarding;
 - preparation prior to start-up;
 - energy sources;
 - dynamic (power on) set-up methods;
 - procedures for transporting and lifting, erection, commissioning and decommissioning;
- b) The system performance specifications;
- c) Physical environment requirements (e.g., lighting, vibration, noise levels, airborne contaminants);
- d) Information on the:
 - programming;
 - operation;
 - frequency of inspection.
- e) Frequency and method of functional testing;
- f) Guidance on the repair and maintenance of the system and its safeguards.

4.1.4 Each supplier shall provide documentation for the equipment they provide. The system integrator shall ensure that the documentation provided is coordinated and relevant to the entire system (see 6.23).

4.1.5 The supplier(s) shall be responsible for providing means of isolating or dissipating stored energy associated with the system.

4.2 User's Responsibility

4.2.1 The user shall be responsible for the overall workplace safety of personnel. The user shall review the system and its associated equipment including installation and set-up and any modifications as provided by the supplier(s) to ensure their compliance with clauses 5, 7, 8 and 9 of this standard.

E4.2.1 Users should consult the supplier's instructional material regarding the unpacking, handling, installation, operation and maintenance including safeguarding of the system.

The user should provide, or require others to provide, the necessary safeguarding.

4.2.2 The user shall ensure that:

- a) Hazards are identified for the tasks to be performed on the system (see 5.1);
- b) The protective measures required for the tasks identified in 4.2.1 (a) are provided and used in accordance with clause 8 (see 5.2);

E4.2.2

- a) One method that may be used to identify hazards and establish a hazard control strategy is to form a team of individuals from the various disciplines involved with the design, construction, set-up, operation and maintenance of the system.

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- c) The safeguarding required to eliminate or control the identified hazards is used and maintained in accordance with clause 8 of this standard (see 5.2);
- d) A procedure for the inspection and maintenance of the system is established to ensure that the system safeguarding and all other protective devices are in safe operating condition and adjustment;
- e) Correct and safe work procedures are followed.

4.2.3 The user shall provide parameters to the supplier such as production rate, quality and inspection requirements, human interactions for maintenance and operation, system efficiency requirements, available physical space for the system, machine/system reconfiguration requirements, services (e.g., power, water, air, etc.) available, access locations, and noise level targets.

4.2.4 The user shall ensure that personnel who operate, maintain, clean or perform other tasks associated with the system follow the instructions and directions to meet the requirements of this standard.

4.2.5 The user shall ensure that all set-up and maintenance personnel and operators are trained to perform the functions for which they are responsible. The training shall include the portions of this standard related to their work (see clause 9).

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E4.2.4 Some typical examples of instructions for system personnel might include, but not be limited to the following.

Personnel should:

- Follow all safety practices and procedures derived by conformance to this standard that apply to their actions and conduct;
- Notify the supervisor when they observe an unsafe practice or condition;
- Properly use all personal protective equipment as specified by their user;
- Install, position, or adjust safety devices as instructed by the user under the provisions of this standard;
- Maintain an orderly work area. Particular attention should be given to the storage of tools or parts that could be dislodged and fall, or roll;
- Make a visual safety check of the set-up during each shift. Severe operating conditions should require more frequent checking;
- Clean spillage of coolants or other industrial fluids in work areas to prevent slipping hazards.

Personnel should not:

- Alter, remove, or disable any safety equipment without the approval of the user;
- Wear clothing or jewelry that will present a hazard to their personal safety;
- Slow or stop moving parts (e.g., spindle or workpiece) by hand-gripping of the work-holding device or the workpiece;
- Improvise a braking device (e.g., pry bar, piece of wood, etc.).

E4.2.5 The following should be considered as examples of training elements and should be expanded as they apply to a particular condition:

- the function, location and use of all controls;
- a safe method for installing, removing, and adjusting tooling;
- the location and method for installation and adjustment of all protective devices and guards, and the use of safe work procedures;