

ANSI B11.19-2010

American National Standard for Machines – Performance Criteria for Safeguarding

Secretariat and Accredited Standards Developer:

B11 Standards, Inc.,

42293 Young Lane
Leesburg, VA 20176, USA

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American National Standards Institute



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Table of Contents Page

Foreword	v
Effective Date	vi
1 Scope	8
2 References	9
2.1 Normative references	9
2.2 Informative References	9
3 Definitions	12
4 Responsibility	20
4.1 Safeguarding supplier	20
4.2 Safeguarding user	20
4.3 Personnel	21
5 Hazard control	21
6 General safeguarding requirements	22
6.1 Performance of the safety-related function(s)	22
6.2 Protective (Safety) Stop	23
6.3 Safety distance	26
6.4 Stopping performance monitor	26
6.5 Perimeter safeguarding	26
6.6 Bypassing	28
6.7 Muting	30
6.8 Presence-sensing Device Initiation (PSDI)	34
7 Guards: fixed, adjustable, and interlocked	39
7.1 Design and construction	39
7.2 Installation and operation	41
8 Safeguarding devices	44
8.1 Movable barrier devices	44
8.2 Pull Back (pull out) and restraint devices	46
8.3 Electro-optical, RF, and area scanning presence-sensing safeguarding devices	47
8.4 Two-hand operating lever, trip and control devices	53
8.5 Safety mat devices	56
8.6 Safety edge devices	59
8.7 Probe detection devices	61
8.8 Single control safeguarding devices	62
8.9 Close proximity point of operation AOPD (press brake AOPD)	64
9 Awareness barriers, signals and signs	64
9.1 Awareness barriers	64
9.2 Awareness signals	64
9.3 Awareness (safety) signs	65
10 Safeguarding methods	65
10.1 Safe-distance safeguarding method	65
10.2 Safe-holding safeguarding method	66
10.3 Safe-opening safeguarding method	66
10.4 Safe-location safeguarding method	67
10.5 Other safeguarding methods	68
11 Safe work procedures	68
12 Complementary equipment and measures	69
12.1 Safety blocks, chain locks, locking pins, limiting/blocking pins	69
12.2 Slide locks	71
12.3 Workholding equipment	71
12.4 Stopping performance monitor	71
12.5 Process malfunction, detection and monitoring equipment	72

12.6	Hand tools	73
12.7	Safety interface (safety relay) modules	73
12.8	Shields.....	73
12.9	Emergency stop devices	73
12.10	Enabling devices.....	80
12.11	Hold-to-run controls	82
12.12	Zero speed (monitoring) device.....	84
13	Inspection and maintenance of safeguarding.....	84
14	Training on the use of safeguarding.....	85
Annex A – Guidance to understand the B11 Series of Standards & Technical Reports.....		86
Annex B –Hazard List for Safeguarding.....		88
Annex C – Performance of the safety-related function(s)		89
Annex D – Safety Distance		90
Annex E – Considerations for Transparent Guards		101
Annex F – Applications and Attributes		107
Annex G – Safeguarding Flowchart		111
Annex H – Outline of Protective Measures		112
Annex I – Safety Solutions in Use		113



Foreword

(This forward is not part of the requirements of American National Standard B11.19-2010)

The primary objective of this standard is to establish the requirements for the design, construction, installation, operation and maintenance of the safeguarding (e.g., guards, safeguarding devices, awareness devices, safeguarding methods), complementary equipment and measures, and safe work procedures used to eliminate or control hazards to individuals associated with machines. This standard relies on other standards to determine which safeguarding is required or allowed to control identified hazards or hazardous situations, and is intended to be used in conjunction with the ANSI B11.0 standard on general safety requirements and risk assessments of machines, and the ANSI B11 "base" standard for a given machine. To accomplish this objective, this standard has established responsibilities for the safeguarding supplier (e.g., manufacturer, rebuilder, installer, integrator and modifier), the user, and individuals in the working environment. The overall goal is to achieve safe work practices and a safe work environment.

B11.19 was established as a B11 subcommittee in 1980 to bring together widely scattered information into one document. Mr. Barry Stockton (B11.19 Chairman 1980 - 2003) guided a diverse group of industry experts through the creation of the original standard in 1990, which was reaffirmed in 1997. The second revision, which was approved by ANSI in 2003, was a major rewrite that included updated Liberty Mutual anthropometric data and a new safety distance annex.

This current revision of B11.19 has incorporated new requirements and information including: Protective (safety) Stops, Perimeter Guarding, Muting, Bypass, Emergency Stop including rope/cable pulls, three-position Enabling Devices, Hold-to-run Control, Guard Interlocking Switches with guard locking, and Presence-sensing Device Initiation (PSDI).

The informative annexes have been expanded to include explanatory information on Transparent Guards using Plastic (e.g., Polycarbonate) Viewing Panels, Safe Distances for upper limbs for reaching over guards (e.g., fencing) that harmonizes with ISO 13857, an outline of Protective Measures that includes examples, and a cross reference of safety solutions in use at the time of release of this revision of B11.19.

A greater emphasis has been placed on risk assessment in an attempt to allow safety solutions other than those meeting requirements contained in clause 6.1 (control reliability). The intent is to maintain a high level of safety performance for safety related functions, but also allow safety solutions that can be reasonably justified through the process of a documented risk assessment that meets the required risk reduction.

The requirements that had been contained in ANSI B15.1 "Safety Standard for Mechanical Power Transmission Apparatus" have been divided and incorporated into the ANSI B11.0-2010 and ANSI B11.19-2010 standards. The safeguarding requirements have been located in a clause of the ANSI B11.0 standard entitled "Mechanical Power Transmission Apparatus" and the specific guidelines to comply with those requirements are contained within this B11.19 standard (e.g., guards, safe-distance safeguarding and safe-location safeguarding).

Throughout its history, ANSI B11.19 has not provided the requirements for the selection of the safeguarding, but only the implementation of the safeguarding once chosen. No hierarchy, no level of risk reduction, or any relationship between safeguarding options are implied within this standard.

The words "safe" and "safety" are not absolutes. Safety begins with good design. While the goal of this standard is to eliminate injuries, this standard recognizes that risk factors cannot practically be 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 factors that affect safety and that must be considered by the user.

Other industry sectors may benefit from applying this standard. Where a machine-specific standard exists, B11.19 may be used to supplement that standard.

Safeguarding and associated equipment technologies are continuously evolving. 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 American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036; (212) 642-4900. 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 date 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 Machines. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time this standard was approved as an American National Standard, the ANSI B11 Accredited Standards Committee was composed of the following member organizations:

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Metal Powder Industries Federation
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Standard Requirements

Explanatory Information

American National Standard for Machines -
Performance Criteria for Safeguarding

STANDARD REQUIREMENTS**1 Scope**

This standard provides performance requirements for the design, construction, installation, operation and maintenance of the safeguarding listed below when applied to machines.

- a) Guards (see clause 7);
- b) Safeguarding devices (see clause 8);
- c) Awareness devices (see clause 9);
- d) Safeguarding methods (see clause 10).

This standard also provides performance requirements for complementary equipment and measures (see clause 12), safe work procedures (see clause 11), and safety functions (see clause 6).

This standard does not provide the requirements for the selection of the safeguarding for a particular application.

Any deviation in conforming to a requirement of this standard shall be carefully considered and based on a documented risk assessment to achieve acceptable risk. The reasoning and information concerning any deviation shall be included in the information for operation and maintenance of the machinery.

EXPLANATORY INFORMATION

(Not part of the requirements of this American National Standard for Machines — Performance Criteria for Safeguarding ANSI B11.19–2010)

E1

The manufacturer or supplier referred to in this standard is the manufacturer or supplier of the safeguarding, not the manufacturer or supplier of the machine (see clause 3 definitions of manufacturer and supplier).

See the appropriate ANSI B11 machine-specific standard or other related machinery safety standard(s) for the requirements for the selection of safeguarding based on specific applications. Selection of the safeguarding requires task and hazard identification, and the application of documented risk assessment and risk reduction of the total production system.

See ANSI B11.0 for additional information and guidance on risk assessment and risk reduction.

Alternate safeguarding solutions or a combination of protective measures can provide a best practical solution for a specific application. The user should evaluate the reasoning and the information concerning the deviation to ensure acceptable risk for the specific application. See ANSI B11.0.

Safeguarding and associated equipment technologies are continuously evolving. 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. See also, Annexes H and I.

Standard Requirements

Explanatory Information

2 References

2.1 Normative references

The standards below contain provisions that are referenced in this text. This standard is intended to be used in conjunction with these standards. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated.

ANSI B11.0 – 2010 Safety of Machinery; General Requirements and Risk Assessment

NFPA 79 – 2007 Electrical Standard for Industrial Machinery

ANSI Z535.1 – 2006 Safety Color Code

ANSI Z535.3 – 2007 Criteria for Safety Symbols

ANSI Z535.4 – 2007 Product Safety Signs and Labels

ANSI Z535.5 – 2007 Accident Prevention Tags and Labels

2.2 Informative References

The following documents in the right-hand column are not normative references, but contain information and guidance that may be helpful in the implementation of, or otherwise in conforming to the requirements of this standard. They are included for information only.

E2.2

29 CFR 1910.147: Control of hazardous energy ('lockout/tagout') (For more info, www.osha.gov)

29 CFR 1910.333 b(2): Selection and Use of Electrical Work Practices (For more info, www.osha.gov)

ANSI / NFPA 70 – 2008 The National Electrical Code

ANSI Z244.1–2003 Control of hazardous energy – Lockout/tagout and alternative methods

IEC 60204-1— Safety of machinery – Electrical equipment of machines – Part 1: General requirements

IEC 61496-1, 2008: Safety of machinery; Electrosensitive protective equipment- Part 1: General Requirements and tests

IEC 61496-2, 2006: Safety of machinery; Electrosensitive protective equipment- Part 2: Particular Requirements for Equipment Using Active Opto-Electronic Protective Devices (AOPDs)

IEC 61496-3, 2008: Safety of machinery; Electrosensitive protective equipment- Part 3: Particular Requirements for Active Opto-Electronic Protective devices Responsive to Diffuse Reflection (AOPDDR)

Standard Requirements

Explanatory Information

ISO 13849-1:1999: Safety of machinery; Safety-Related Parts of Control Systems – Part 1: General Principles for Design

EN/ISO 13849-1-2008: Safety of machinery; Safety-Related Parts of Control Systems – Part 1: General Principles for Design

ANSI B11.1 – 2009 Safety Requirements for Mechanical Power Presses

ANSI B11.2 – 1995 (R2005) Hydraulic Power Presses -- Safety Requirements for Construction, Care and Use

ANSI B11.3 – 2002 (R2007) Safety Requirements for Power Press Brakes

ANSI B11.4 – 2003 (R2008) Safety Requirements for Shears

ANSI B11.5 – 1988 (R2008) Iron Workers -- Safety Requirements for Construction, Care and Use

ANSI B11.6 – 2001 (R2007) Safety Requirements for Manual Turning Machines

ANSI B11.7 – 1995 (R2010) Cold Headers and Cold Formers -- Safety Requirements for Construction, Care and Use

ANSI B11.8 – 2001 (R2007) Safety Requirements for Manual Milling, Drilling, and Boring Machines

ANSI B11.9 – 2010 Safety Requirements for Grinding Machines

ANSI B11.10 – 2003 Safety Requirements for Metal Sawing Machines

ANSI B11.11 – 2001 (R2007) Safety Requirements for Gear & Spline Cutting Machines

ANSI B11.12 – 2005 (R2010) Safety Requirements for Roll Forming and Roll Bending Machines

ANSI B11.13 – 1992 (R2007) Automatic Screw/Bar and Chucking Machines -- Safety Requirements for Construction, Care and Use

ANSI B11.15 – 2001 (R2007) Safety Requirements for Pipe, Tube and Shape Bending Machines

ANSI B11.16 (MPIF #47) – 2003 (R2009) Safety Requirements for Powder/Metal Compacting Presses

ANSI B11.17 – 2004 (R2009) Safety Requirements for Horizontal Hydraulic Extrusion Presses

Standard Requirements

Explanatory Information

ANSI B11.18 – 2006 Safety Requirements for Machines Processing or Slitting Coiled or Non-coiled Metal

ANSI B11.20 – 2004 (R2009) Safety Requirements for Integrated Manufacturing Systems

ANSI B11.21 – 2006 Safety Requirements for Machine Tools Using Lasers For Processing Materials

ANSI B11.22 – 2002 (R2007) Safety Requirements for Numerically Controlled Turning Machines

ANSI B11.23 – 2002 (R2007) Safety Requirements for Machining Centers

ANSI B11.24 – 2002 (R2007) Safety Requirements for Transfer Machines

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) for Machine Tools

ANSI B11.TR5 – 2006 Sound Level Measurement Guidelines

ANSI B11.TR6 – 2010 Safety Control Systems for Machine Tools

ANSI B11.TR7 – 2007 Designing and Safety for Lean Manufacturing

ANSI Z535.6 – 2006 Product Safety Information in Product Manuals, Instructions, and other Collateral Materials

Standard Requirements

Explanatory Information

3 Definitions

For the purposes of this standard, the following definitions apply. For additional definitions, see ANSI B11.0 – Safety of Machinery: General Requirements and Risk Assessment.

E3

In the event any of these definitions differ slightly with those found ANSI B11.0 or in the C-level (base) standard, use the latter definition in context with the C-level (base) standard. These definitions have been harmonized with ANSI B11.0, but may deviate slightly in some cases to be applicable for use in this standard.

The phrase “See also” denotes not only synonyms, but also additional information and commonly confused terms.

3.1 actuating control(s): An operator control used to initiate or maintain machine motion(s) or other machine function(s).

3.2 adjustable guard: A guard with provisions for adjustment to accommodate various jobs or tooling set-ups.

3.3 antirepeat: The part of the control system designed to limit the machine tool to a single cycle if the actuating control is maintained in an operating position. Antirepeat requires release of all actuating controls before another cycle can be initiated.

E3.3 The function of antirepeat is to prevent the successive cycles that could occur if the antirepeat control did not exist.

3.4 authorized individual: Qualified personnel identified and designated by the user (employer) or supplier to perform a specified task.

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

E3.5 Also known as *safety markings* (ANSI B15.1-2000 (R2006)).

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

3.5.2 awareness sign: An awareness device that warns individuals of a potential hazard.

3.5.3 awareness signal: An awareness device that warns individuals by means of audible sound or visible light.

3.6 barrier: A device or object that provides a physical boundary to a hazard.

3.7 barrier guard: See guard.

3.8 blanking: Bypassing a portion of the sensing field of a presence-sensing safeguarding device.

3.9 brake monitor: See stopping performance monitor.

Standard Requirements

Explanatory Information

3.10 break: The term "break" when used in conjunction with PSDI operations refers to one intrusion into and subsequent withdrawal from the sensing field of the presence-sensing device.

3.11 bypass: To render ineffective any safety-related function of the control system or safeguarding device.

3.12 clutch: A mechanism that, when engaged, transmits torque to impart motion from a driving member to a driven member.

3.13 complementary equipment and measures: Devices or methods used to ensure or augment the proper operation of the safeguarding.

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

3.15 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.

3.16 control system: Sensors, manual input and mode selection elements, interlocking and decision-making circuitry and output elements to the machine actuators, operating devices and mechanisms.

3.17 cycle: A complete movement of a machine, from the initial start position back to the same start position, which may include feeding and removal of the material or workpiece.

3.18 design: To develop and plan the machine or safeguarding to meet the intended purpose and function.

3.19 device: A component, attachment or mechanism designed to serve a specific purpose or perform a specific function.

3.20 enabling device: A manually operated control device, when continuously activated and used in conjunction with a separate actuating control, will allow the machine to function.

3.21 ensure: To design, construct, and apply by the user or supplier or to establish, maintain, or monitor an effective program, procedure, or system to implement the safeguarding or system requirements of this standard.

3.22 foot control: A foot-operated mechanism or device used as an actuating control.

E3.10 Single break and double break refer to either one intrusion and withdrawal from the sensing field or two intrusions and withdrawals after which a cycle is initiated. See also, **Presence-Sensing Device Initiation**.

E3.11 Bypassing the safety device or function is done manually and typically requires additional protective measures. Not to be confused with **muting**.

E3.13 See also, clause 12.

E3.15 See 6.1. See also, **safety-related function**.

E3.21 It should be noted that usage of this word is not meant to be an absolute and is different than common usage.

E3.22 Also referred to as *foot pedal*; *foot treadle*; *foot treadle bar*; *pedal*; *switch*; or *valve*.

Standard Requirements

Explanatory Information

3.23 guard: A barrier that prevents exposure to a hazard.

E3.23 Sometimes referred to as *barrier guard*.

3.24 hand control: A hand-operated mechanism or device used as an actuating control.

E3.24 Also referred to as *actuating control*; *two-hand control*; or *two-hand trip*.

3.25 hand tool: Any device used for manual feeding, or for freeing a stuck workpiece or scrap.

3.26 hazard: A potential source of harm.

3.27 hazard area: See hazard zone.

3.28 hazard zone: Any space within and/or around a machine in which a person can be exposed to a hazard.

E3.28 Also referred to as *hazard area* or *hazard space*.

3.29 hazardous situation: A circumstance in which a person is exposed to a hazard(s).

E3.29 A hazardous situation is also referred to as a *task/hazard pair (combination)*.

3.30 hold-to-run control: Control device which initiates and maintains hazardous machine functions only as long as the manual control is actuated.

E3.30 See also, ANSI / ISO 12100.

3.31 interlock blocking device: A personal control device used to prevent energizing of interlocked guard circuit(s).

E3.31 This may be a padlock or other lockable device.

3.32 individual: A person, including personnel, who may or may not be under the direct control of the supplier or user. See also, **personnel**.

E3.32 For the purposes of this standard, a distinction between individual and personnel is drawn. The term “individual” includes personnel but encompasses persons who are not under direct or indirect control of the supplier or user (e.g., visitors, vendors, etc.). See also, personnel.

3.33 installer: An individual, partnership or corporation responsible for placement and preparation for use of a machine.

E3.33 Responsibility for installation of the machine usually depends on the terms of the purchase agreement. See also, **supplier**.

3.34 integrator: An entity that designs, provides, manufactures or assembles a machine, its associated machines or equipment, the safeguarding, control interfaces, interconnections or the control system into a machine tool system.

E3.34 See also, **supplier**.

3.35 interlock: Mechanical, electrical, fluid power or other type of device or means to prevent a hazardous situation(s) under specified conditions.

3.36 interlocked guard: A barrier, or section of a barrier, interfaced with the machine control system in such a manner so as to prevent inadvertent access to the hazard.

3.37 limiting/blocking pin: A mechanical device which limits the range of motion.

E3.37 A limiting/blocking pin can incorporate a locking pin function. Also known as *over-travel*; *end-stop*; or *end-of-travel stop*.

3.38 locking pin: An energy-isolating device that is engaged either manually or by the control system to prevent motion.

E3.38 A locking pin is used to prevent motion once the machine is stopped. The locking pin may be designed to prevent motion resulting only from gravity or prevent motion from the additional force of the drive system.

Standard Requirements

Explanatory Information

3.39 maintenance personnel: Qualified personnel trained and authorized to maintain the machine, including the safeguarding.

E3.39 When maintenance personnel perform installation, integration or modification activities, they are considered installers, integrators or modifiers, respectively. See also, the clause 3 definitions of these terms, and 4.1.

3.40 manufacturer: See *supplier*.

3.41 mode: The operation of a machine or machine system as determined by the state or condition of the control system.

E3.41 Modes can include automatic, continuous, jog/inch, manual, normal, run, semi-automatic. See also, ANSI B11.

3.42 modification: Change to the machine or machine system that alters its original purpose, function, capacity, operation or safeguarding requirements.

3.43 modifier: Any entity that changes the original purpose, function or capacity of the machine or machine system by design or construction.

E3.43 See also, *supplier, modification*.

3.44 monitoring: The checking of system components to detect a failure of a component, subassembly or module that affects the performance of the safety-related functions.

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

E3.45 There are two types of movable barrier devices:

- Type A, which encloses the hazard zone during the complete machine cycle;
- Type B, which encloses the hazard zone during the hazardous portion of the machine cycle.

3.46 muting: The temporary automatic suspension of a safety-related function(s).

E3.46 Not to be confused with *bypassing*.

3.47 operator: An individual who performs production work or controls a machine.

3.48 operator controls: A pushbutton, switch, lever, hand wheel, or other device actuated by the operator that initiates, cycles, controls or stops the motion of a machine.

E3.48 See also, *actuating control*.

3.49 perimeter guarding: A guard or safeguard designed to limit or detect an individual(s) entering a hazardous area after which the individual(s) is not continuously being detected.

E3.49 Also known as *pass through guarding* or *full body access*.

3.50 personnel: Individuals who are employed by or on behalf of the user or supplier.

E3.50 Personnel includes subcontractors, consultants, or other contract workers under the indirect control of the supplier or user.

3.51 point of operation: The location in the machine where the material or workpiece is positioned and work is performed.

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

E3.52 For the purpose of this standard, a presence-sensing device is an electro-optical, radio frequency or area scanning device. See also *safety mats* and *safety edges* for information on pressure sensitive devices.

Standard Requirements

Explanatory Information

3.53 Presence–Sensing Device Initiation (PSDI): Operating mode of indirect manual initiation of a single cycle by a presence–sensing device when it senses that work motions of the operator related to feeding or removing parts are completed and all parts of the operator's body are withdrawn from the sensing field of the device.

3.54 probe detection device: A device used to detect the presence or absence of the individual's hand by encircling all or part of the hazard zone with a two- or three-dimensional object prior to actuating the machine cycle.

3.55 protective measure (risk reduction measure): Any action or means used to eliminate or control access to hazards hazards and/or reduce risks.

3.56 pull back (pull out) device: A device that is attached to the operator's hands and wrists and is connected to the ram, slide, upper die, or other moving portion of the machine, so that when properly adjusted, the device will prevent the operator from reaching into the hazard zone, or withdraw the operator's hands from the hazard zone during hazardous motion.

3.57 qualified personnel: An individual who, as a result of training and experience, understands and demonstrates competence with the design, construction, operation or maintenance of the machine and the associated hazards.

3.58 rebuilder (reconstructor): An entity who rebuilds or reconstructs a machine tool or machine tool system.

3.59 redundancy: The use of multiple means to perform the same function.

3.60 repeat: An unintended or unexpected successive cycle of the machine.

3.61 restraint device: A safeguarding device with attachments for the operator's hands and wrists that prevents the operator from reaching into the hazard zone.

3.62 safe-holding (workpiece) safeguarding method: A method of safeguarding in which the operator's hands are maintained away from the hazardous portion of the machine cycle by requiring that both hands are used to hold or support the workpiece, or by requiring that one hand holds the workpiece while the other hand operates the machine.

E3.53 This operating mode is also known as “ESPE used as a machine reinitiation device” (IEC 61496-1) and “sensitive protective equipment when used for cycle initiation” (ISO 12100).

See also, *break*.

E3.55 Protective measures can include but are not limited to: inherently safe design; guards; safeguarding devices; complementary equipment and measures; awareness devices including warnings; safe work practices / procedures, training or other administrative controls, and personal protective equipment (PPE).

E3.58 See also, *supplier*. For definition of *rebuilding*, see ANSI B11.0.

E3.60 Typically results from, or in conjunction with, a malfunction.

E3.61 Also sometimes referred to as a *hold out device*.

Standard Requirements

Explanatory Information

3.63 safe-opening safeguarding method: A method of safeguarding that limits access to the hazard zone by the size of openings or by closing off access when the workpiece is in place in the machine.

3.64 safe-work procedure(s): Formal written documentation developed by the user that describes steps that are to be taken to safely complete tasks where hazardous situations may be present or hazardous events are likely to occur.

3.65 safeguarding: Protection of personnel from hazards by the use of guards, safeguarding devices, awareness devices, or safeguarding methods.

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

E3.65 See also, *protective measure*.

E3.66 For a device to be used for safeguarding purposes, it must comply with clauses 6 and 8 (at a minimum).

The scope of, and the devices that are included within, the classification of “Safeguarding Device” as defined by this standard is not as broad as the classification of “Protective Device” as defined by ISO 12100. Some of the devices that are considered “Protective Devices” do not meet the B11.0 definition of “Safeguarding Device” and are considered “Complementary Equipment” by this standard (see clause 12).

3.67 safeguarding method: Safeguarding implemented to protect individuals from hazards by the physical arrangement of distance, holding, openings, or positioning of the machine or machine system to ensure that a hazard cannot be reached.

E3.67 The phrase “safeguarding by location” is often used to describe these methods.

3.68 safety block: A prop that is inserted between opposing tooling or machine members to prevent closing of machine members or tooling components.

E3.68 Also referred to as *die block*.

3.69 safety distance: The distance a safeguard is installed from a hazard such that individuals are not exposed to the hazard.

E3.69 See also, Annex D.

3.70 safe-distance safeguarding method: A method of safeguarding in which a minimum distance is determined and awareness to the hazard is identified so it can be avoided.

3.71 safe-location safeguarding method: A method of safeguarding by physically locating either the hazard or the individual such that the hazard is not accessible.

3.72 safety edge device: A device, consisting of a sensing edge and its control, that detects an individual(s) when in contact with its sensing edge.

3.73 safety interface module: A device designed to ensure the performance of the safety-related function(s).

E3.73 Safety interface modules are also commonly referred to as *safety relay modules*.

3.74 safety markings: See awareness device.

Standard Requirements

Explanatory Information

3.75 safety mat device: A device, consisting of a sensing surface and control, which detects the presence of an individual(s) on its surface.

3.76 safety-related function(s): That portion of the control system or safeguarding device that controls (limits) exposure to a hazardous situation or reduces risk to an acceptable level.

3.77 sensing angle: The angle defining the sensing surface at which the individual will always be detected by the sensing edge.

3.78 set-up: The process of changing over or adjusting the machine work holding device(s), tooling and safeguarding and ensuring proper and safe operation of the machine or machine system.

3.79 shield: A barrier used to either keep chips or coolant within the confines of the machine, or to reduce the potential of tooling parts or workpieces from being ejected from the machine.

3.80 single control safeguarding device: A single actuating control used to initiate or maintain machine motion, located at a safe distance from the hazard.

3.81 single cycle (stroke): One complete cycle of the machine from the initial (open) position through the closing or work performing position and a return to the initial position.

3.82 slide lock: An energy-isolating device intended to address gravity hazards associated with a slide.

3.83 stop: Immediate or controlled cessation of machine motion or other hazardous situations. There are many terms used to describe the different kinds of stops, including user- or supplier-specific terms, the operation and function of which is determined by the individual design. Definitions of some of the more commonly used “stop” terminology include:

3.83.1 controlled stop: The stopping of machine motion while retaining power to the machine actuators during the stopping process. Also referred to as Category 1 or 2 stop.

3.83.2 emergency stop: The stopping of a machine, manually initiated, for emergency purposes;

3.83.3 normal stop: The stopping of a machine, initiated by the control system, at the completion of a cycle;

3.83.4 protective stop: The stopping of a machine initiated by safeguarding for safeguarding purposes;

E3.78 Also referred to as *tryout*.

3.82 A slide lock is not intended to prevent motion by the drive system. A slide is also called a *ram*, *plunger*, or *platen*.

3.83 See also, NFPA 79.

E3.83.4 This type of stop allows the orderly cessation of motion or the hazardous situation and allows for the retention of program logic to facilitate restarting of the machine. This type of stop includes stop Categories 0, 1 and 2 as defined in NFPA 79. Also known as *safety stop*.

Standard Requirements

Explanatory Information

3.83.5 uncontrolled stop: The stopping of machine motion by removing power to the machine actuators, all brakes or other mechanical stopping devices being activated. Also referred to as a Category 0 stop.

E3.83.5 See also, NFPA 79.

3.84 stop command: An action to cause cessation of machine motion either automatically or through human intervention. The stop command can be immediate or normal. See also, immediate stop command, normal stop command.

3.84.1 immediate stop [stopping] command: Initiation of a stopping command to the machine control or actuators at any point in the machine cycle.

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

3.85 stop control: A control that when actuated, initiates immediate or controlled stopping action of the hazardous motion of the machine;

3.86 stopping performance monitor: A sensor, system, or device used to monitor the stopping performance of the machine.

E3.86 A stopping performance monitor is sometimes referred to as a *brake monitor*.

3.87 supplier: An individual, corporation, partnership or other legal entity or form of business who provides equipment or services.

E3.87 A supplier can be the manufacturer, manufacturer's agent, representative or distributor, reseller, installer, modifier, rebuilder or integrator who provides equipment or services for the safeguarding associated with the machine.

For the purpose of this standard, a supplier provides, or makes available for use, all or part of the safeguarding associated with the machine. When the user provides any of the above services, the user is considered the supplier.

3.88 synchronous (actuation): Concurrent actuation where the time lag between the start of one input signal and the start of the other is less than or equal to a predetermined time.

E3.88 For a two hand trip and control device(s) the time lag is less than or equal to 500 milliseconds.

3.89 transparent guard: a guard that enables viewing the work area / operation(s) through the guard.

E3.89 This is not intended to include standalone metal mesh guarding.

3.90 trip [tripping]: The initiation of a machine cycle.

E3.90 The initiation of a machine cycle may be by manual operator controls or by signal(s) from automation.

3.91 two-hand control device: An actuating control that requires the synchronous use of both the operator's hands to initiate a machine cycle and concurrent use during the hazardous portion of the machine cycle.

E3.90 Two-hand control devices are sometimes referred to as *hostage controls*.

Standard Requirements

Explanatory Information

3.92 two-hand trip device: An actuating control that requires the synchronous use of both of the operator's hands to initiate a machine cycle.

3.93 user: An individual, corporation, partnership or other legal entity or form of business that utilizes a machine, machine production system or related equipment.

3.94 workpiece: Any piece of material placed into the machine for the purpose of having work performed upon it.

E3.92 Two-hand trip devices typically cause a full machine cycle and do not issue a stop command if either or both the operator controls are released.

E3.93 The user is typically regarded as the entity that employs the operator of the machine and/or supervises the operation of the machine, including production and maintenance. Under certain circumstances (i.e., acting as a builder, modifier, integrator), the user is a supplier.

4 Responsibility

4.1 Safeguarding supplier

4.1.1 Within the scope of its work activity, the safeguarding supplier shall ensure that safeguarding meets the design, construction, integration and installation requirements of this standard.

4.1.2 The safeguarding supplier shall furnish documentation as required for the safeguarding, including installation requirements, operating instructions, and maintenance requirements.

E4.1.1 See also, 3.91. If more than one entity is involved in the design, construction, integration or installation, each entity is responsible for the scope of its work activity.

E4.1.2 The documentation should include the following, where applicable:

- performance specifications;
- electrical or pneumatic schematics and diagrams;
- physical environment for which the device was designed;
- function and location of the operator controls, indicators, and displays;
- schedules for periodic maintenance, lubrication and inspection;
- signs and warnings.

See also ANSI B11.0 - Annexes I and J, and ANSI Z535.6 for additional guidance.

4.2 Safeguarding user

4.2.1 The user shall be responsible for ensuring that safeguarding is provided, integrated, installed, maintained, and used in accordance with the requirements of this standard.

E4.2.1 The user should consider the safeguarding supplier's performance specifications, schematics, and diagrams, operating and maintenance instructions and warnings when installing, operating, and maintaining the safeguarding.

When machines are ordered/purchased without safeguards, the user shall provide safeguarding as determined by this standard, the base B11 standard and shall be based on a risk assessment. See ANSI B11.0.

When the user designs, constructs, installs, modifies or reconstructs the safeguarding, the user is considered to be the supplier. See also, 4.1.

Standard Requirements

4.2.2 The user shall be responsible for ensuring that supervisors, operators, maintenance, and service personnel are trained in the proper installation, adjustment, operation and maintenance of the safeguarding, within the scope of their work activity.

4.2.3 The user shall ensure that when any change of the tooling, process or procedures occurs, the safeguarding continues to meet the requirements of this standard and the ANSI B11 'base' standard (the B11 standard dealing with the specific machine). See ANSI B11.0

4.3 Personnel

Personnel involved with the installation, operation, or maintenance of the safeguarding shall be responsible for following the training and safety procedures provided by the user in the operation and maintenance of the safeguarding.

5 Hazard control

Hazards (residual risk) associated with the use of the safeguarding shall be identified and controlled as part of the overall risk reduction strategy.

Explanatory Information

E4.2.2 The user should direct operators and service personnel to immediately report to supervision, any apparent malfunction or improper operation of the safeguarding systems.

The user should consider the safeguarding supplier's performance specifications, schematics and diagrams, operating and maintenance instructions, and warnings when developing installation and operation procedures or instructions.

E4.2.3 Changes in the production system that may affect the safeguarding include, but are not limited to:

- tooling changes;
- addition or removal of auxiliary equipment;
- modification of the machine;
- modification of machine systems;
- operating method (program);
- change in operating personnel;
- adjustment location of safeguarding;
- part configuration.

Adjustments to the safeguarding or supplemental safeguarding may be necessary.

E4.3

The Occupational Safety and Health Act of 1970 – Public Law 91-596, states in Section 5(b) "Each employee shall comply with occupational safety and health standards and all rules, regulations and orders issued pursuant to this Act which are applicable to his own actions and conduct."

Personnel have a responsibility to avoid the hazards that are identified or known to them, and not intentionally attempt to circumvent the safeguarding.

E5

The overall hazard identification and risk reduction strategy is identified in each ANSI B11 'base' standard or in ANSI B11.0 (B11.TR3). These documents are used to select safeguarding appropriate to the reasonably foreseeable tasks and identified hazards.

With the application of safeguarding, additional (new) hazards may occur that are not due to the safeguarding, but occur with the implementation.

Refer to Annex B for additional information on the hazards associated with safeguarding.

Standard Requirements

Explanatory Information

6 General safeguarding requirements

Guards, safeguarding devices, awareness devices, safeguarding methods, safe work procedures, and complementary equipment and measures shall meet the requirements of this clause and clauses 7, 8, 9, 10, 11 and 12.

6.1 Performance of the safety-related function(s)

This subclause shall apply when referenced by other parts of this standard.

When a component, module, device or system failure occurs, such that it or a subsequent failure of another component, module, device or system would lead to the inability of the safety-related function(s) to respond to a normal stop command or an immediate stop command, the safety-related function shall:

- prevent initiation of hazardous machine motion (or situation) until the failure is corrected or until the control system is manually reset; or
- initiate an immediate stop command and prevent re-initiation of hazardous machine motion (or situation) until the failure is corrected or until the control system is manually reset; or
- prevent re-initiation of hazardous machine motion (or situation) at the next normal stop command until the failure is corrected or until the control system is manually reset.

In the presence of a failure, the user shall be responsible to ensure that repetitive manual reset of the system or device is not used for production operation.

Because some failures cannot be detected until the completion of a cycle or a portion of the cycle, loss of safety functions may occur for a portion of the machine cycle.

Other failures cannot be detected until a demand is made on the safety-related function. An example of such a safety-related function may be the use of a safeguard that is actuated infrequently (e.g., an interlocked guard for maintenance) that must be cycled (guard opened) to detect a failure. When a failure is detected, the safety-related function should meet the requirements of this subclause.

The intention of a manual reset is to encourage the diagnosis of a failed component, subassembly, device or module. A second failure may occur during the diagnostic or troubleshooting process, negating the safety-related function(s). Additional safeguarding should be used to protect individuals during this process.

Control reliability:

- is one of the design strategies that may be used to meet these requirements;
- cannot prevent a repeat cycle in the event of a major mechanical failure or in the presence of multiple simultaneous component failures;
- is not provided by simple redundancy. There must be monitoring to ensure that redundancy is maintained.

Standard Requirements

Explanatory Information

While the requirements of control reliability are not directly comparable to the requirements of ISO 13849-1 (1999) or EN/ISO 13849-1 (2008), for the purposes of this standard, complying with Category 3 or 4 and/or Performance Level “d” or “e”, at a minimum, will satisfy the requirements of control reliability.

Other Categories and Performance Levels per EN/ISO 13849-1, and Safety Integrity Levels (SILs) per IEC 61508 and IEC 62061 can also satisfy the requirements of this subclause depending on the design, construction, fault exclusions, installation, and maintenance of the safety-related function and a documented risk assessment. For further information on the performance of safety-related functions, see Annex C.

6.2 Protective (Safety) Stop

When required by the risk assessment, the machine shall have one or more protective stop circuits designed for the connection of interlocked guards, safeguarding (protective) devices and where applicable, complementary equipment and measures.

E6.2

The protective stop command can be activated either automatically (e.g., interrupting safety light curtain) or manually (e.g., opening interlocked guard).

The reset of the protective stop command can be accomplished either manually or automatically. This reset is not considered starting or restarting machine operation.

A protective stop is typically an immediate stop command that is initiated by the safety-related part of the control system for safeguarding purposes, which can allow an orderly cessation of the hazard or hazardous situation.

This stop can retain the program logic to facilitate troubleshooting, the stop function, or to facilitate a restart. This can include but is not limited to PES/PLC and drive logic.

The cessation or reset of a protective stop command shall not initiate hazardous motion(s) or situation(s) except under specifically controlled design conditions.

Examples of a specifically controlled design condition are presence-sensing device initiation (PSDI) and Type A/B movable barrier devices. When used, these control design conditions are considered the normal machine initiation means. See 6.8 and 8.1.

Once the stop condition is removed, the use of normal machine initiation means (e.g., operator controls) to start or initiate a hazardous motion or situations shall be required.

The intent is to require a minimum of two actions to initiate a machine cycle. One action is to clear the stop command (e.g., re-arming an emergency stop device) and the second action is the normal machine initiation.

6.2.1 The protective stop circuit shall conform to the requirements of 6.1, or shall be designed and constructed to meet the safety performance level (risk reduction) as determined by a risk assessment.

E6.2.1 See also, clause 5 and ANSI B11.0 (B11.TR3).

Standard Requirements

6.2.1.1 The protective stop circuit shall control the safeguarded hazard by causing an immediate stop command of hazardous machine motion(s) or situation(s).

When protective stop circuits are combined with a circuit of a lower safety performance level, the performance of the protective stop circuits shall not be reduced.

6.2.2 The components of the protective stop circuit shall be designed, selected, constructed and interconnected in such a manner so as to withstand the anticipated operational and environmental operating conditions.

Explanatory Information

The protective stop is typically a separate function from the emergency stop function.

This separation of functions allows for different safety performance levels (risk reduction) as determined by a risk assessment for the different circuits. As an example, this may allow a single channel emergency stop circuit, and a separate dual channel with monitoring circuit for a safety light curtain.

This does not preclude combining emergency stop functions and protective stop functions within one circuit. The interfacing of an emergency stop command should not reduce the safety performance of safeguarding devices and their circuits. See 12.9.1.1(g).

A protective stop can be a stop category 0, 1 or 2 as described by NFPA 79. If the protective stop is stop category 2, then the emergency stop cannot be combined in the same circuit. See 12.9.1.1(d).

E6.2.2 Consideration should be given to:

- frequency of operation;
- need for periodic testing (especially where operation is infrequent);
- vibration, shock, temperature, dust, foreign or corrosive materials, fluids, etc.

As a good practice, provision should be provided for the capability of expanding or connecting additional interlocked guards, safeguarding (protective) devices, or complementary equipment.

Standard Requirements

Explanatory Information

Table 1 – Comparison of Stop, Emergency Stop and Protective Stops

This table offers an explanatory comparison of the different functions. See NFPA 79 for stop requirements, see clause 12 for emergency stop requirements and see clause 6.2 for protective stop requirements.

	Stop	Emergency Stop	Protective (Safety) Stop
Location	Personnel have quick, unobstructed access. Stop Category 0 required on every machine (other categories may be used as determined by a risk assessment). Required on all operator stations	Personnel have quick, unobstructed access. Required on all operator stations and other locations as determined by a risk assessment	Located such that an individual cannot access the hazard. Determined by the safety distance formula
Initiation of stop signal	Manual or automatic	Manual only	Manual or automatic
Stop category**	0, 1 or 2	0 or 1 only	0, 1, or 2
Circuit performance	As determined by a documented risk assessment		
	Typically single channel (non safety rated)	Minimum single channel safety rated controls. Greater performance may be required when interfaced with a safeguarding device(s).	Typically control reliable
Circuit reset	Manual only	Manual only	Manual or automatic (hardware or software)
Bypass and mute	Allowed (for cycle completion, etc.)	Not allowed	Allowed (for muting, modes of operation, set up, etc.)
Use frequency	Variable; frequent (every cycle) to infrequent	Infrequently; only in emergency or for other immediate stop purposes	Variable; frequent (every cycle) to infrequent
Effect	De-energize the relevant circuit and override related start functions	Remove all energy sources to hazards and override all other functions and operations in all modes	Remove or control energy sources to the safeguarded hazard and override all other functions and operations in all modes associated with the safeguarded hazard
Final removal of power	Electromechanical or solid-state components	Electromechanical components or solid state output devices (drives) designed for safety related functions	Electromechanical or solid state components designed for safety related functions

**See NFPA 79 clause 9.2.2 Stop Functions. The three categories of stop functions shall be as follows:

- (1) Category 0 is an uncontrolled stop by immediately removing power to the machine actuators.
- (2) Category 1 is a controlled stop with power to the machine actuators available to achieve the stop then remove power when the stop is achieved.
- (3) Category 2 is a controlled stop with power left available to the machine actuators.

Standard Requirements

Explanatory Information

6.3 Safety distance

When required by this standard, the guard or safeguarding device shall be located at a distance from its associated hazard such that individuals cannot reach the hazard before cessation of hazardous motion (or situation).

6.4 Stopping performance monitor

When the stopping time of the machine can increase to a value where the calculated safety distance used in locating the safeguarding is no longer met, a stopping performance monitor shall be provided in accordance with 12.4 of this standard.

See the 'base' B11 machine safety standard for specific requirements.

6.5 Perimeter safeguarding**6.5.1 Perimeter-guarding**

Perimeter-guarding is utilized where areas containing single or multiple hazards are not individually safeguarded.

6.5.1.1 Perimeter-guarding applications shall be designed to stop hazardous motion and prevent the initiation of hazardous motion while an individual is in the safeguarded area.

6.5.2 When an individual(s) can pass through the safeguard into the safeguarded area and is no longer detected by the safeguard or other supplemental safeguarding:

E6.3

See Annex D for further explanation and an example method to calculate the safety distance. Additional methods might be used as determined by the supporting risk assessment documentation.

E6.4

A stopping performance monitor is used to detect when stopping time increases to a value that the safety distance calculated as required by 6.3 no longer protects the safeguarded individual(s).

Driven machines having no clutch in their power-trains and use of servo drives, ac or dc drives, or variable speed drives having closed loop control may not require a stopping performance monitor. Failure of these drives is usually catastrophic.

The operating mechanisms (cylinders, valves, hydraulic/pneumatic motors) of hydraulic and pneumatic operated machines may become sticky, sluggish or may wear, affecting the stopping distance. The use of a stopping performance monitor should be evaluated based on the risk assessment.

E 6.5.1

Perimeter-guarding applications are designed to detect an individual entering a hazardous area (e.g., interlocked gate or door on fencing, electro-optical presence-sensing safeguarding devices, electro-mechanical switches, etc.).

This is not intended to replace lockout/tagout or alternatives to safe energy control (see also, ANSI Z 244.1)

E6.5.1.1 This type of situation is often referred to as a *pass-through*. A pass-through hazard occurs when an individual crosses the safeguard, which issues a stop command to remove the hazard. Subsequently, the individual may cross into the hazardous area but their presence is no longer detected. A hazard arises if the machine motion resumes while personnel are within the safeguarded area.

E6.5.2

Standard Requirements

Explanatory Information

- a) additional protective measures shall be used in conjunction with the perimeter guarding to prevent the individual from exposure to the hazard; or
- b) the perimeter guarding system shall require manual reset before hazardous motion can occur. The sole action of closing a guard or clearing the sensing field of a presence-sensing device shall not reset the perimeter safeguarding circuit or function.

- b) in perimeter guarding applications, the individual is not continuously being detected (e.g., continuously interrupting the sensing field of a presence-sensing device).

6.5.3 When used or required by 6.5.2 (b), the manual reset device shall be located outside of the safeguarded area such that the perimeter guarding cannot be reset from within the hazardous area.

E6.5.3 Means of manual reset can include but are not limited to:

- pushbuttons;
- slide bolts;
- trapped key systems;
- manually actuated safety switches, or
- other means of providing additional intentional action(s) to reset the perimeter guarding.

An additional means can be a key-actuated switch that can provide some operator supervisory control, as the key can be removed from the switch and kept in the possession of an individual. This does not prevent unauthorized or inadvertent resets due to spare keys in the possession of others, or additional personnel entering the guarded area unnoticed.

6.5.4 Reset of the perimeter safeguarding shall only be performed after the hazard zone is clear of all individuals.

E6.5.4 One means of meeting the requirements of this subclause when multiple individuals are in the hazard zone is to provide each individual with their own means of control.

6.5.4.1 If the entire safeguarded area is not visible from the single reset device location, then a method for detecting personnel or by providing an “inhibit” to the reset function at the non-observable location(s) shall be used.

E6.5.4.1 Means for inhibiting the reset function may be a detented operator (e.g., emergency stop device) located in the non-observable location(s).

If a means or method for detecting personnel is not reasonably practicable, the following requirements shall apply:

- a) visual or audible warning device(s) shall be used;
- b) operation of the reset function shall immediately activate the warning device;
- c) the warning device shall be continuously activated until the predetermined warning period has elapsed;
- d) the restart function shall be inhibited during the warning period;
- e) the restart shall require the use of the normal initiating means;
- a) color blindness and background noise should be considered. See clause 9.
- c) the safeguarding circuit(s) should not be reset until the warning period has elapsed.

Standard Requirements

- f) if the restart of the machine or other hazard(s) can occur unexpectedly or unintentionally, the safeguarded circuit shall not be capable of being reset until the warning period has elapsed; and
- g) a means of preventing reset or restart shall be provided inside the safeguarded area. Operation of this means shall override all safeguarding device resets and start/restart functions.

6.5.5 Reset of the perimeter safeguarding system shall not, in or of itself:

- restart the machine or equipment;
- cause a hazardous situation.

6.5.6 The reset function and its interface shall conform to the requirements of 6.1, or shall be designed and constructed to meet the safety performance level (risk reduction) as determined by a risk assessment.

6.6 Bypassing

6.6.1 Bypassing of the interlocked guard or a safeguarding device shall be permitted in accordance with clauses 7 and 8.

6.6.2 When the safety-related function is bypassed, other protective measures shall be provided and used.

Explanatory Information

- f) unexpected or unintended machine motion or other hazard(s) can occur such as:
- if the restart function fails such that the machine cycle occurs as soon as the safeguard is reset; or
 - if fluid power system contains trapped energy that can cause hazardous motion.
- g) a method of accomplishing this function is through use of an easily accessible control to issue an immediate stop command (e.g., emergency stop device or rope/cable pull) inside the safeguarded area.

E6.5.5 The user should evaluate the installation and perform a risk assessment to determine the appropriate elements needed for an effective reset procedure. These elements may include pre-determined time, sequence, location, or position.

When a specific reset sequence is required, the control circuitry should force this reset sequence and the control system should have the ability to prompt for it.

E6.5.6 One method of complying with this clause is to require an open-closed-open action within a specific time frame for a valid reset. This prevents a shorted or failed ON switch from creating an automatic reset of the safeguarding system.

See also, clause 5 and ANSI B11.0 (B11.TR3).

E6.6.1 Bypassing renders ineffective one or more safety-related function(s) of the control system or safeguarding device(s).

Bypassing is typically a manually actuated or selected function. This function is sometimes known as overriding.

E6.6.2 Other protective measures include, but are not limited to, the following measures:
Alternate or supplemental safeguarding devices (clause 8);

- Initiation of motion by a hold-to-run or other control device;
- A portable control station (e.g., pendant) with an emergency stop device, and where used, an enabling device. Where a portable station is used, motion shall only be initiated from that station;
- Limiting the speed or the power of motion;
- Limiting the range of motion.

Standard Requirements

Explanatory Information

6.6.3 Emergency stop functions shall remain active at all times.

E6.6.3 As an example, if the safeguarding device to be bypassed is a two-hand control operator station with an emergency stop device, bypassing the safety-related (two-hand control) function cannot render the emergency stop function ineffective. If the operator station can be disconnected or is cableless, see NFPA 79.

6.6.4 The bypassing function, including its components, shall conform to the requirements of 6.1, or shall be designed and constructed to meet the safety performance level (risk reduction) as determined by a risk assessment but at a minimum shall be equal to that required of the safety function being bypassed.

E6.6.4 As an example, a simple key-operated switch wired in parallel with the device's output is inadequate, as its failure can remain undetected.

See Annex C for further information. See also, clause 5 and ANSI B11.0 (B11.TR3).

When conforming to the requirements of 6.1, a single failure shall not cause or extend a bypassed condition such that individual(s) are exposed to a hazard.

6.6.5 The means of selecting or enabling bypassing shall be capable of being supervised.

E6.6.5 Methods of meeting this requirement include, but are not limited to, the use of key operated controls, controls located under lockable covers, or controls that requires a tool or password to access. Adjustment or configuration should only be performed by authorized individuals.

6.6.6 It shall not be possible for common cause failures or environmental conditions to initiate a bypassed condition.

E6.6.6 Common cause failures are dependent on the sensing technology of the devices or the means to initiate a bypass. Examples include, but are not limited to:

- power supply failures;
- airborne contamination (e.g., dust);
- weld flash/slag;
- humidity.

Diverse technologies can eliminate or greatly reduce the possibility of common cause failures, such as complementary signals (one ON and one OFF, or one PNP and one NPN).

Interruption of power to the means of bypassing should not allow a bypass condition to be initiated or be continued.

The risk assessment should address the issue of interruption and restoration of power to the system.

Standard Requirements

6.6.7 Indication that the bypass is active shall be provided and shall be readily observable by individuals protected by the safeguarding device or the safety-related function.

6.7 Muting

6.7.1 Muting of the interlocked guard or a safeguarding device shall be permitted in accordance with clause 7 and 8, and when:

- individuals are not exposed to the hazard, or during the non-hazardous portion of the machine cycle;
- the hazard cannot be accessed or is otherwise safeguarded.

Explanatory Information

E6.6.7 This indication warns that the protective function is suspended.

An amber indicator lamp or other means may be used to meet this requirement. Due to the prevalence of color blindness (10% in males for red/green), methods such as unambiguous positioning, patterning, labeling or flashing of the indicators may be effective in providing the indication required.

Care should be taken to ensure that the operators and other individuals are aware that the device has been bypassed so that individuals do not assume that the device is active and that they are safeguarded when in fact, the device is bypassed.

This indication is to be readily observable from the location of the bypassed safeguard.

Operation of the indication should be verified at suitable intervals.

E6.7.1 Muting is the temporary, automatic suspension of the safeguarding function during a non-hazardous portion of the machine cycle without human interaction. This allows for material to be fed into a machine or process without issuing a stop command. Examples include but are not limited to:

- loading of a part;
- unloading of a part;
- material movement during the process;
- repositioning the workpiece or part.

The muting function typically is provided by either the machine control, the means that monitors the interlocked guard, the safeguarding device itself, or other safety related logic device.

Muting should not be confused with “bypassing” or “overriding,” which is initiated by an individual manually suspending the normal function of a safeguard. Another term commonly confused with muting is “blanking,” which desensitizes or disables a portion of the sensing field of a Presence-sensing Safeguarding Device such that a specific interruption is ignored.

Standard Requirements

Explanatory Information

6.7.1.1 Emergency Stop functions shall remain active at all times.

6.7.2 Muting shall conform to the requirements of 6.1, or shall be designed and constructed to meet the safety performance level (risk reduction) as determined by a risk assessment but at a minimum shall be equal to that required of the safety function being muted.

6.7.2.1 When complying with the requirements of 6.1:

- a single source that initiates or continues a muted condition shall comply with the requirements of 6.1, or

- the mute condition shall be initiated and continued by a minimum of two independent sources that function with a concurrent action.

To mute a safeguard appropriately, the design of a muting system should include, but is not limited to:

- the ability to identify the non-hazardous portion of the machine cycle,
- the selection of the proper means (e.g., devices) that signal a mute cycle for the expected environmental and application conditions,
- proper mounting and installation of the muting means (e.g., devices).

E6.7.2 As an example, a single unmonitored cam-operated limit switch wired in parallel with the device's output is inadequate, as its failure can remain undetected.

A single failure should not extend a muted condition such that individual(s) are exposed to a hazard.

See Annex C for further information. See also, clause 5 and ANSI B11.0 (B11.TR3).

E6.7.2.1

A safeguarding device that complies with clause 8 can be used as a source.

A source can also be a device or system that is tested, verified or monitored for proper operation that meets the requirements of 6.1.

Typically monitored single source devices are used in short machine cycles where the monitoring is performed at a minimum of once a cycle.

It is not acceptable to use a single standalone switch, device, or relay for the mute source that is not monitored. This single device may fail so that a mute condition occurs at an inappropriate time.

These signal sources are typically hardwired and function within prescribed time of each other. Two dissimilar devices such as encoders and resolvers may also be used.

Only one of these sources should pass through, or be affected by, a non safety rated programmable logic controller or similar device (e.g., PES).

Annex A.7 of IEC 61496-1 requires at least two independent hard-wired muting signal sources to initiate the function.

Standard Requirements

Explanatory Information

6.7.3 If the muting function is capable of adjustment or configuration, the means shall be capable of being supervised.

6.7.4 If the machine has reversing capability or alternate motion paths where a hazard is possible, the control system shall include an automatic means so muting is only permitted in the non-hazardous direction or path.

6.7.5 It shall not be possible to initiate the mute condition when the interlocked guard or safeguarding device:

- safety outputs are in the open state, the OFF-state, or the non-conducting state; or
- is in the lock-out condition.

6.7.6 Muting shall not be used if an individual can enter the hazard zone by passing through the safeguard sensing field unless:

- detected by supplemental safeguarding that would initiate an immediate stop command or otherwise prevent access to the hazard; or
- a manual reset of the safeguard is required. See 6.5.

6.7.7 The risk assessment shall identify the need for consideration if an individual can enter the hazard zone by passing through the safeguard sensing field with the material.

6.7.8 It shall not be possible for common cause failures or environmental conditions to initiate a mute condition.

If the two sources disagree or conflict, the mute condition ends or does not occur. Incorrect signals, sequence, or timing of the muting sensors or signals do not allow a mute condition. This is to ensure that a single fault cannot cause (start) a muted condition.

E6.7.3 Methods of meeting this requirement include, but are not limited to, the use of key operated controls, controls located under lockable covers, or controls that requires a tool or password to access. Adjustment or configuration should only be performed by authorized individuals.

E6.7.4 As an example, one method of meeting this requirement is by the use of a control circuit interlock on the drive motor starter (forward direction contact) to allow "muting" only in the forward direction, when the starter is energized.

Another method is to incorporate a Mute Enable function such that a mute condition cannot begin if the Mute Enable signal is not present.

E6.7.6 A hazardous situation can occur if devices that are safeguarding multiple areas, such as safety light curtains using mirrors or that have multiple sensing fields, are muted and an individual can enter the hazard zone without being detected.

This requirement is not intended to detect deliberate acts to bypass or circumvent safeguards such as riding within material in order to avoid detection. See 4.3 on circumvention of safeguards.

E6.7.7 Consideration includes but is not limited to:

- distinguishing a person from the material that is allowed to pass through the sensing field;
- detecting the load being conveyed, but not the pallet or transport;
- reducing the possibility of personnel entering the hazard zone immediately preceding or following the material or alongside;
- reducing the possibility of entrapment by the material, the pallet or the transport.

E6.7.8 Common cause failures are dependent on the sensing technology of the devices or the means to initiate a mute.

Standard Requirements

Explanatory Information

Examples include, but are not limited to:

- power supply failures;
- airborne contamination (e.g., dust);
- weld flash/slag;
- humidity.

Diverse technologies can eliminate or greatly reduce the possibility of common cause failures, such as:

- one photoelectric sensor and one inductive proximity sensor;
- complementary signals (one ON and one OFF, or one PNP and one NPN);
- different sensing means (one diffuse and one through-beam photoelectric sensor).

Interruption of power to the means of muting should not allow a mute condition to be initiated or be continued. The restoration of the power to the means of muting may not initiate muting unless:

- the safety outputs are in the closed state, the ON-state, or the conducting state before the mute is initiated;
- the muting means or devices are signaling a mute condition;
- the Mute Enable command, when used, is active.

The risk assessment should address the issue of interruption and restoration of power to the system.

6.7.8.1 The mute means or devices shall be installed to prevent maladjustment or misalignment that results in an unintended or inappropriate mute condition, or means shall be provided to limit the duration of the mute condition.

E6.7.8.1 As an example, physical damage to the mounting surface could cause the muting devices to be knocked out of alignment, resulting in false muting input signals.

Examples to reduce the possibility of failure due to mounting include but are not limited to:

- secure (robust) mounting or mechanical guarding of the mute device(s);
- a time limit after which the muted condition ends automatically when exceeded and can detect the unintended or inappropriate mute condition;
- directional or sequence monitoring of the mute devices;
- concurrent monitoring of the mute devices.

6.7.9 The devices or the means to initiate a mute condition shall be selected and installed such that they cannot be easily defeated, bypassed, or otherwise actuated by a single individual.

6.7.10 The devices or the means to initiate a mute condition shall not use a delay or other timing functions if a single fault could extend the time of the mute condition and create a hazardous situation.

Standard Requirements

Explanatory Information

6.7.11 When required by a risk assessment, an indicator shall be provided to identify the muting condition.

E6.7.11 This indicator warns that the protective function is suspended.

It is not a requirement of this standard to provide indication of the mute cycle, but other standards may require this function.

This indicator is to be readily observable from the location of the muted safeguard.

Operation of the indicator should be verified at suitable intervals.

6.8 Presence-sensing Device Initiation (PSDI)

When a presence-sensing device is used to perform both the safeguarding function and to initiate the machine cycle, the presence-sensing device, PSDI control logic, and the operator station shall be designed and installed to meet this clause.

E6.8

Typically, an electro-optical presence-sensing device is used for PSDI and is commonly known as a safety light curtain (screen) as described in IEC 61496-1/-2.

Although safety light curtains are typically used, alternatives may be used for PSDI when the user can demonstrate, through tests and analysis by the user or supplier, that the alternative device:

- a) is as reliable as the safety light curtain;
- b) meets the conditions of this clause;
- c) has the same long term reliability as safety light curtains; and
- d) can be integrated into the entire safety system.

Initiating a machine cycle by simply clearing an interruption of a presence-sensing device sensing field that has created a protective stop is not allowed, see 6.2.

6.8.1 PSDI shall be used only on machines which can be stopped anywhere in their cycle.

E6.8.1 Specific machine standards may have additional requirements.

6.8.1.1 When a stopping performance monitor is used, it shall be in accordance with 6.4.

E6.8.1.1 A stopping performance monitor is required when the stopping time of the machine can increase to a value where the calculated safety distance used in locating the safeguarding is no longer met.

6.8.2 PSDI shall be used to initiate a single machine cycle for normal production operation only.

E6.8.2 PSDI operating mode is not to be used for set-up or maintenance.

6.8.3 The presence-sensing device and the protective stop circuit (see 6.2) used for PSDI shall conform to the requirements of 6.1, or shall be designed and constructed to meet the safety performance level (risk reduction) as determined by a risk assessment.

E6.8.3 This clause does not apply to the PSDI control logic of 6.8.9 unless required by a risk assessment.

Standard Requirements

Explanatory Information

6.8.3.1 The PSDI control logic shall not override the protective stop circuit (function).

6.8.4 The presence-sensing device used in the PSDI system shall conform to the applicable clauses in 8.3.

6.8.4.1 In addition to clause 8.3, the following shall apply:

- a) the minimum object sensitivity shall be no greater than 32 mm (1.25");
- b) Individual sensing fields of presence-sensing devices used to initiate cycles in the PSDI operating mode shall cover only one side or opening of the machine. Mirrors shall not be used with presence-sensing devices used in PSDI applications;
- c) The sensing field shall be located at a minimum safety distance per 6.3;
 - it shall not be possible for an individual to enter, pass through, and become clear of the presence-sensing device sensing field;

- the entire area of the sensing field of a presence-sensing device used to initiate cycles in the PSDI operating mode shall be in clear view of the operator from the normal operating position.

6.8.5 The PSDI system shall discriminate between an intended break and rapid unintended interruptions of the presence-sensing device sensing field.

E6.8.4.1 Blanking of the sensing field is permitted, provided the minimum object sensitivity is no greater than 32 mm (1.25").

If fixed blanking is used and the minimum object sensitivity exceeds 32 mm (1.25"), then it is required that the blanked area is completely obstructed (see 8.3.2.5).

This does not preclude the use of segmented sensing fields used to create "L" shaped sensing fields.

Examples to meet this requirement can include, but are not limited to:

- a) mechanical barriers;
- b) extended sensing field(s) of the presence-sensing device such as horizontal sensing segments; or
- c) supplemental safeguarding.

A common cause of injury when using PSDI results from improper placement of the sensing field allowing reaching around, over, under, or passing through the sensing field and creating an unintended break.

The operator should be able to view the entire area of the sensing field so that the operator can warn others not to intrude into the sensing field, which could cause an unintended cycle.

E6.8.5 Rapid changes of the presence-sensing device output may occur as a result of fingers or parts intermittently interrupting individual beams of the sensing field or minor misalignments between the transmitter and receiver. The effect would be to start a cycle, but then immediately stop since the sensing field is interrupted, and thus reduce the efficiency of the PSDI system.

One method to meet this requirement is to establish a minimum time between presence-sensing field interruption and clear signals within the presence-sensing device. Another means is to have the PSDI control logic input(s) ignore rapid changes in state of the outputs of the presence-sensing device.