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ANSI B11.20–2017

American National Standard –

Safety Requirements for the Integration of Machinery into a System

ANSI-Accredited Standards Developer and Secretariat:

B11 Standards, Inc.
POB 690905, Houston, TX 77269
www.b11standards.org

Approved: 12 SEPTEMBER 2017

by the American National Standards Institute
Board of Standards Review

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FOREWORD (This Foreword is not part of the requirements of American National Standard B11.20-2017)

Overview

Each integrated machinery system (IMS, 1.1) can be very different in terms of size and complexity, and can incorporate different technologies that require diverse expertise and knowledge. An integrated machinery system should be considered as a whole new and different machine rather than simply the sum of its parts combined. Hazards are frequently unique to a particular IMS. The number and types of hazards are directly related to the nature of the automation process and the complexity of the installation. The risks associated with these hazards vary with the type of machinery used, their purpose, and the way in which they are installed, programmed, operated, and maintained.

As individual machines and equipment are incorporated into an IMS, new hazards arise and new risks are introduced. In particular, combining individual machines intended by the supplier to operate independently into an IMS for coordinated operation typically introduces new or additional hazards not foreseen by each OEM. This standard deals only with those safety aspects that are important for the safety-relevant interconnection of the machinery and equipment. Therefore, it is not intended to cover safety aspects of individual machines and equipment that may be covered by machine-specific "base" safety standards.

This standard relies on other standards to determine which risk reduction measures are 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 assessment of machines, the ANSI B11.19 standard on performance requirements for risk reduction measures, and any other machine-specific "base" safety standard for the given machinery incorporated into an IMS.

Designing and integrating an IMS with acceptable risk depends on the cooperation of a variety of "stakeholders" – those entities that share in a responsibility for the ultimate purpose of providing a safe working environment. Stakeholders may be identified as suppliers (see 4.1), users (see 4.2), modifiers (see 4.3), or personnel (see 4.4), but all share the common goal of an IMS with acceptable risk. The requirements in this standard may be assigned to one of the stakeholders, but overlapping responsibilities can involve multiple stakeholders in the same requirements. While using this standard, the reader is cautioned that all of the requirements identified may apply to them, even if not specifically addressed by "assigned" stakeholder tasks.

The supplier or modifier of an IMS needs the cooperation of entities who, individually, may know only a part of the whole. Where there are requirements for frequent manual interventions to parts of the IMS (e.g., inspections, maintenance, set-up, observation), it can be impractical or unnecessary to stop the whole IMS. This standard presents requirements to provide for the safety of individuals who perform these tasks. Risk reduction for these tasks relates to the concept and use of "task zones."

Objective

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

Historically, terms have been used in the B11 community to describe requirements for the safety of machinery. With the globalization of standards and the need to harmonize requirements language, the ability to translate terms has become increasingly important. In addition, some terms are commonly used but not necessarily with common meanings. As a result, this edition of B11.20 has transitioned to certain new terms, including:

Previous term	Current term
Safeguarding	Risk reduction measures / Engineering controls
Guards and safeguarding devices	Engineering controls - Guards / Engineering controls - Devices
Awareness devices	Awareness means
Complementary equipment	Term no longer used
Safeguarding methods	Part of risk reduction measures

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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.

Automation technology is continuously evolving. This standard reflects the best industry practice 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 (normative) or explanatory (informative) area of this standard, in no way infers acceptance or rejection of such technologies. This standard allows effective solutions to be developed using risk assessment as justification.

History of this American National Standard

This is the third edition of the ANSI B11.20 standard, and it is generally considered as a type-B standard (see Introduction). The original ANSI B11.20 standard was approved in 1991, reaffirmed in 1996 and revised in 2004. The second edition was reaffirmed in 2009 and again in 2015. All prior editions used the phrase “integrated *manufacturing* systems” in the title. After initial publication of the current (2017) edition, the B11 Accredited Standards Committee approved the changing of the title to one that is more accurate and ‘reflective of content’ – “**Safety Requirements for the *Integration of Machinery into a System***.”

In this revision, the concepts of various “zones” have been elaborated. In addition to the existing terms “zone” and “hazard zone,” the term “task zone” has been incorporated and harmonized with ISO 11161 (also a standard on integrated manufacturing/machinery systems), and the term “control zone” has been introduced. The idea of “span of control” has been updated and harmonized with ISO 11161. These terms are used to expand the concept of layout analysis as a process to determine zones and define spans of control for safety-related control devices, including minimum level of safety performance for each device. A new Annex D has been developed which details the layout analysis process.

In addition, this revision has expounded on the concept of “special mode” as any additional mode required to operate equipment when integrated into an IMS that is not necessary when the equipment is operated independently. A new Annex E has been developed to address considerations before adding a new “special mode.” This annex is an extension of the “process observation” topic addressed in both ISO 11161 and ISO 10218-2 (a standard on industrial robot systems and integration).

Furthermore, this revision incorporates the B11 Accredited Standards Committee’s (ASC) initiative to apply standardized processes and common language to the entire B11 series of ANSI standards through a stratified approach to standardization (this so-called type-A, type-B and type-C standards). Consequently, many definitions for common terms contained in the previous edition of B11.20 can now be found in the ANSI B11.0 and ANSI B11.19 standards. This initiative also significantly impacted clauses 4, 5, 7, and 9. New content to address training has been incorporated in a new clause 10 and Annex F, and a new clause 11 on the decommissioning process has been added as well. Furthermore, the concepts of layout analysis and span of control developed by the B11.20 Subcommittee have been included in the B11 ASC standardized process and common language for incorporation into the ANSI B11 Type-C standards.

The B11 standards for machines/machine tools were first approved beginning with safety requirements for power presses in 1922. Since that time, safety standards and requirements for a variety of machines have been developed and continually updated and revised to become a series of nearly 40 B11 standards and technical reports. This series contains type-A standards such as ANSI B11.0 and ANSI/ISO 12100 on broad/general safety requirements, type-B standards such as ANSI B11.19, B11.20 and all of the B11 technical reports dealing with broad safety aspects such as risk reduction measures (safeguarding), ergonomics, lean/safety integration and noise, and type-C standards addressing specific machine types or groups or like machines. This B11.20 standard is intended to be used with ANSI B11.0, ANSI B11.19, and any applicable machine-specific standards. The requirements of all standards must be met as applicable to a particular IMS.

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Effective Date

This B11.20 Subcommittee recognizes that some period of time after the approval date on the title page of this document is necessary for suppliers, integrators, modifiers 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 integrated machinery system.

This B11.20 Subcommittee recommends that suppliers complete and implement design changes for new integrated machinery systems within 30 months of the approval of this standard.

This B11.20 Subcommittee recommends that users evaluate whether existing integrated machinery systems have acceptable risk within 30 months of the approval date of this standard using generally recognized risk assessment methods. If the risk assessment shows that modification(s) is necessary, refer to the requirements of this standard to implement risk reduction measures for appropriate risk reduction.

Harmonization

The requirements of this standard have been harmonized with the international standard ISO 11161 on the same subject matter, as well as selected U.S. standards. Harmonization means that the requirements have been aligned in essence to achieve a similar level of risk reduction. Harmonization does not mean duplication of exact requirements.

Considerable effort has been made to avoid conflicting requirements, however, the task is quite challenging because the standards do not map directly in scope, requirements, approaches and revision dates. ISO safety standards tend to be very directive in nature, thus possibly limiting solutions for particular applications. In addition, ISO 11161 only applies to the suppliers of integrated manufacturing (machinery) systems and is unable to include any requirements for users. ISO 11161 also only applies to new systems and excludes existing systems. ANSI B11.20 differs from ISO 11161 in that it specifically includes requirements for suppliers, integrators, modifiers, and end users, and it also addresses both new and legacy systems.

Differences between ANSI B11.20 and ISO 11161 result from different analytical methods or approaches. However, the differences between the requirements are generally considered inconsequential to the achievement of acceptable risk or to compliance with the EU Machinery Directive 2006/42/EC, OSHA (specifically, 29 CFR 1910.212(a)(1)), or other legal requirements. As a result, using risk assessment as described by ANSI B11.0 and complying with the requirements of machine-specific "base" safety standards, ANSI B11.20 and ANSI B11.19 will enable a machine supplier to meet the essential safety and health requirements contained in Annex I of the EU Machinery Directive 2006/42/EC when used as alternate technical specifications to EU harmonized standards.

Inquiries

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 B11 Standards, Inc., POB 690905, Houston Texas, 77269; Attention: B11 Secretariat or www.b11standards.org.

Development

This standard was prepared by the B11.20 Subcommittee, processed for comment/balloting by the B11 Accredited Standards Committee, and submitted for ANSI approval by the Secretariat. At the time of approval as an American National Standard, the ANSI B11 ASC was composed of the following Members:

B11 Accredited Standards Committee Leadership:
Alan Metelsky, Chairman
Barry Boggs, Vice-Chairman

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David A. Felinski, Secretary

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AMT - The Association for Manufacturing Technology	Russell Bensman	Alan Metelsky
Boeing	Don Nelson	Stephen Thomas
Bridgestone	Kenji Furukawa	Chris Buchanan
Bureau Veritas	Will Wood	David Natalizia
Canadian Standards Association	Jill Collins	Walter Veugen
FDR Safety	Michael Taubitz	Flavius Brown
General Motors Corporation	Michael Douglas	Graham Parr
Grantek Systems Integration	Jeff Winter, CSP, FS Eng	Patric Brown
John Deere	Tony Beeth	Scott Winter
Komatsu America	George Schreck	James Landowski
Liberty Mutual Insurance	Stan Brubaker, CSP	Julie Thompson
MAG Automotive	Erik Carrier	Doug Watts
Metal Powder Industries Federation	Dennis Cloutier, CSP	Teresa F. Stillman
National Institute for Occupational Safety & Health	Rick Current, PE	
Occupational Safety & Health Administration	Ken Stevanus	Jim McManus
Omron STI	Frank Webster	Tina Hull
PMMI (Assoc. for Packaging & Processing Technology)	Charles F. Hayes	Tom Egan
Pilz Automation	Doug Sten, PhD, CSP	Michael Beerman
Plastics Industry Association	Steve Petrakis	Stan Glover
Precision Metalforming Association	James Barrett, PhD, PE	William Gaskin
Presence Sensing Device Manufacturers Association	Jim Kirton	Mike Carlson
Robotic Industries Association	Carole Franklin	Jeff Fryman
Rockwell Automation	Pat Barry	Stanley Burson
Safe-T-Sense	Chris Gerges	Mark Witherspoon
Sheet Metal & Air Conditioning Contractors Natl. Assn.	Mike McCullion, CSP	Scott Lollar
SICK, Inc.	Chris Soranno, FS Exp	Mark Nehrkorn, FS Exp
Subzero/Wolf	Chad Pierce, CSP	Jim Fritz
Toyota Motor Manufacturing North America	Barry Boggs	

At the time this standard was approved, the **B11.20 Subcommittee** had the following members who participated in the development of this revision:

Name		Organization
Chris Soranno, FS Exp	**Chair**	SICK, Inc.
Chris Felinski	**Secretary**	B11 Standards, Inc.
Barry Boggs		Toyota Motor Manufacturing North America
Bronson Chevalier		John Deere
Eddie Crawford, FS Eng		Rockwell Automation
Michael Douglas		General Motors
Kenji Furukawa, FS Eng		Bridgestone
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Tina Hull, FS Eng		Omron Automation
Rex Keihl, FS Eng		Omron Automation
Heinz Knackstedt, FS Eng		C&E Sales
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Ted Sberna		White Horse Safety
Mike Taubitz		FDR Safety
Scott Whittington		Cincinnati Incorporated
Mark Witherspoon, FS Eng		Euchner
Nick Wians		Safe-T-Sense
David Felinski	**Secretariat**	B11 Standards, Inc.

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Explanation of the format, and ANSI B11 conventions

This ANSI B11.20 – 2017 standard is divided into parts or sections or chapters that are formally referred to as clauses and subclauses. Major divisions of clauses are referred to as subclauses and, when referenced by other text in the standard, are denoted by the subclause number only (e.g., “see 6.3.2”).

The standard uses a two-column format to provide supporting information for requirements. The material in the left column is under the heading of “Standard Requirements” and the text there is considered as ***normative***. 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” typically denotes a possibility, ability or capability, whether physical or causal, and the term “MAY” typically 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. When B11 standards normatively reference either an external standard or an internal (intra-document) reference, they will use: “See X.” When B11 standards informatively reference either an external or internal (intra-document) reference, they will use: “See ***also***, X.” The B11 standards generally use the term “OR” as an inclusive disjunction, meaning *one or the other or both*. When the term “and/or” is used, it means the same as the inclusive disjunctive “or” but is used by the writing subcommittee merely to emphasize the fact it is one ***or*** the other ***or*** both. B11 standards also draw a distinction between the terms “*individual*” and “*personnel.*” The term “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.).

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Introduction

The main purpose of every machine is to process materials. Inadvertent interference with, or accidental misdirection of released energy during production, maintenance, commissioning and de-commissioning can result in injury.

The purpose of the ANSI B11 series of machinery safety standards is to devise and propose ways to eliminate or minimize risks of the potential hazards associated with the required tasks. This can be accomplished either by an appropriate machine design or by restricting personnel or other individuals' access to hazard zones, and by devising work procedures to minimize personnel exposure to hazardous situations. This is the essence of the ANSI B11 series of safety standards. This standard recognizes that zero risk does not exist and cannot be attained. However, a good faith approach to risk assessment and risk reduction should achieve an acceptable risk level.

Organization and Application of B11 Documents

The B11 standards and technical reports can be associated with the ISO "Type A-B-C" structure as described immediately below, and as shown in Figure 1.

- **Type-A standards** (basis standards) give basic concepts, principles for design, and general aspects that can be applied to machinery;
- **Type-B standards** (generic safety standards) deal with one or more safety aspects or one or more types of engineering controls that can be used across a wide range of machinery:
- **Type-C standards** (machinery safety standards) deal with detailed safety requirements for a particular machine or group of machines**.**

The B11.0 standard on general safety requirements common to ANSI B11 machines is primarily a "Type - A" standard in that it applies to a broad array of machines and contains very general requirements. However, in many areas it also contains very specific requirements. B11.19, B11.20, B11.21, B11.25, B11.26, as well as the entire B11 series of Technical Reports are all typical "Type-B" documents addressing general safety elements that can be used across a wide range of machinery (such as B11.19 and B11.26) or as a standard when combining machines (B11.20). The B11 series of Technical Reports are informative documents that may be generally applied to many different machines, and as such would fall into the "Type-B" category. The machine-specific ("Type-C") B11 standards contain detailed safety requirements for a particular machine or group of machines. The type-A B11.0 and the type-C (machine-specific) B11 standards are intended to be used concurrently by the supplier and user of machines.

When a type-C standard deviates from one or more provisions dealt with by this standard or by a type-B standard, the type-C standard requirement generally takes precedence. Any deviation in conforming to a requirement of any standard should be carefully evaluated and based on a documented risk assessment.

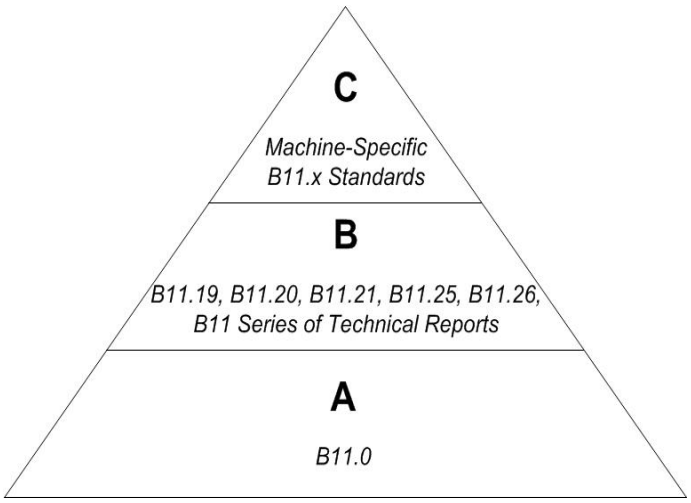

Figure 1 – Organization of the B11 series of documents

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The responsibility for reducing these risks to an acceptable level is divided between the equipment supplier, the equipment modifier, the equipment user and it its operating personnel, as addressed in Figure 2.

An overview of each clause of this standard is provided below (clauses 1 through 3 are not shown in Figure 2, for clarity).

1) Scope – Provides the boundaries or limits of the standard (i.e., what is/is not included).
2) Normative references – Other standards which in whole or in part provide additional requirements when referenced in the normative text (i.e., left-hand column of clauses 4 – 9) of this standard.
3) Definitions – Terms used in this standard, together with their definitions (terms used in the same context as are generally understood and commonly used in everyday English are not defined).
4) Responsibility – The general responsibilities of the supplier (builder), user, modifier and the user personnel are listed in clause 4 together with the remaining clauses for which they have primary responsibility.
5) Risk assessment process – Clause 5 presents the general approach to risk assessment (see ANSI B11.0 for further explanation of hazard/task identification and risk assessment/risk reduction).
6) Design and construction – It is assumed that the supplier of new equipment to the user will be responsible for the requirements of clause 6, understanding that the user may add to or modify these requirements through the purchase agreement. For existing machinery, the user is generally responsible for the requirements of clause 6.
7) Layout, installation, testing and start-up – Although the requirements of clause 7 are predominantly the responsibility of the user, the supplier will normally provide assistance either directly (providing personnel) or indirectly (instruction materials).
8) Risk reduction measures – This is normally a shared responsibility but often, either the supplier or the user will provide and/or meet the requirements of clause 8.
9) Set-up, operation and maintenance – The user is normally responsible for the requirements of clause 9 with possible assistance from the supplier for training.
10) Training – The user is normally responsible for the requirements of clause 10 with possible assistance from the supplier for materials or the training itself.
11) Decommissioning – This is primarily a user responsibility, however, the supplier shares responsibility for taking the aspects of clause 11 into consideration during the design.

Notes for Column Headings in Figure 2:
SUPPLIER: The early stages of a project present the greatest opportunity to determine project requirements and to anticipate and eliminate hazards and hazardous situations.
MODIFIER: The entity (OEM, Supplier, or the expert) in that discipline responsible for creating or modifying the system, machinery or equipment, shall have all relevant design standards documentation. The entity shall begin by working with the end user to list all tasks to achieve an appropriate comprehensive task list base of the “context of use” for the system, machine or equipment.
USER: The company representatives (who can be from many disciplines) where the system, machinery or equipment will reside during its productive life. They should engage in participating or reviewing the risk assessment and what will be necessary for a final safety buy-off at the final location.
PERSONNEL: The group “at risk” from any hazards or hazardous situation presented by the system, machinery, or equipment while performing their tasks to achieve the company’s desired productive life. This would include at a minimum, operators, maintenance personnel for both planned and unplanned maintenance, housekeeping and safety representatives. This group would evaluate the engineering controls and administrative controls (see ANSI B11.19).

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Figure 2 provides an overview of this standard and in particular the responsibilities of and requirements for the supplier, modifier, user, and the user personnel. Numbers in parentheses denote the particular clause or subclause of the standard.

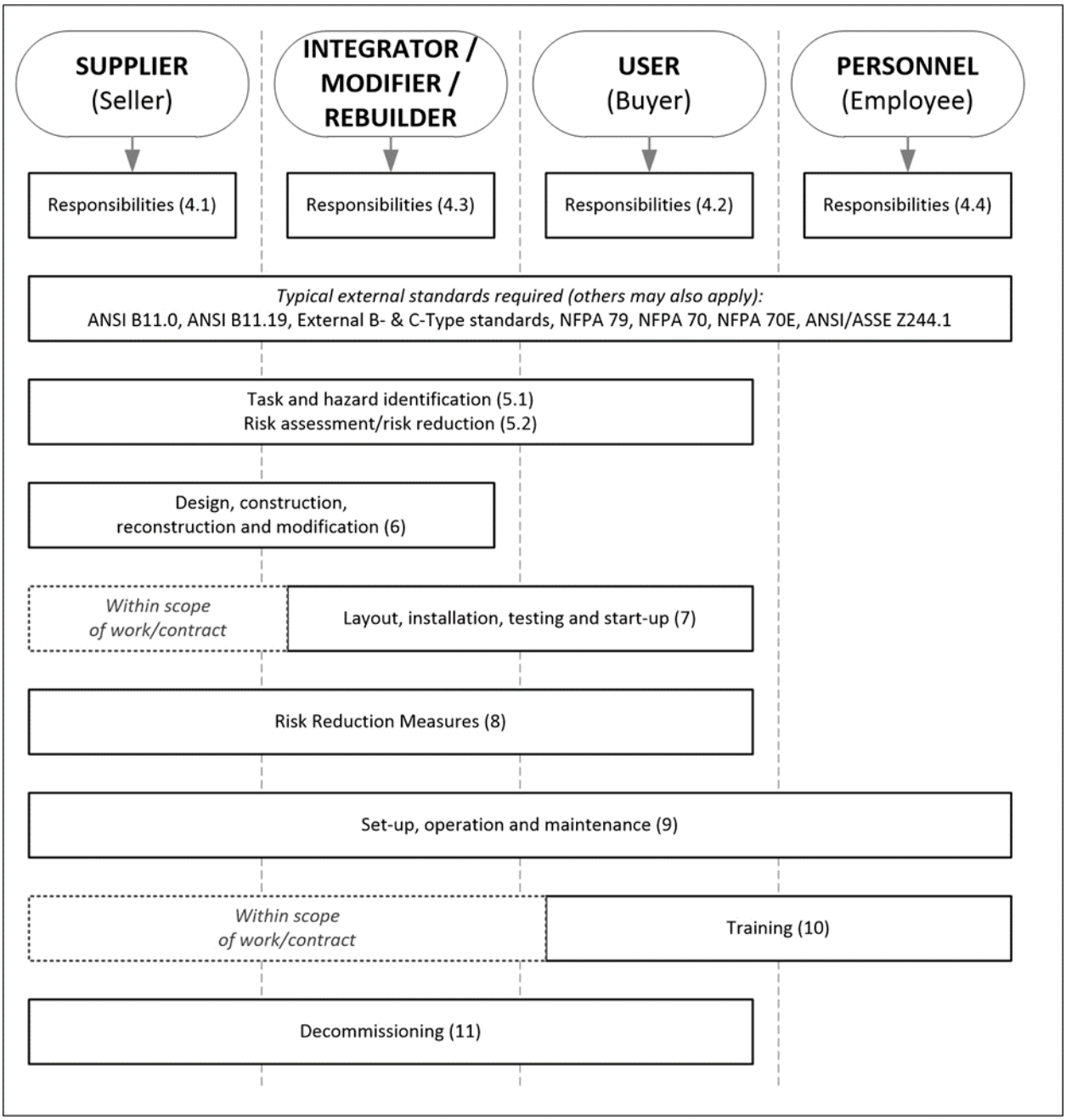

Figure 2 – Typical clause layout of B11 base standards showing the various responsibilities

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As of the date of approval of this standard, the ANSI B11 series of American National Standards and Technical Reports on machinery safety consisted of the following documents shown in the list below. The user should check a licensed reseller such as ANSI (www.ansi.org) for the current versions of any of these documents. All archival / historical versions of the documents are available at www.b11standards.org.

List of the ANSI B11 Series of Safety Standards and Technical Reports

#	SHORT TITLE / TOPIC	YEAR	TYPE
B11.0	Safety of Machines	2015	A
B11.1	Mechanical Power Presses	2009 (R14)	C
B11.2	Hydraulic & Pneumatic Power Presses	2013	C
B11.3	Power Press Brakes	2012	C
B11.4	Shears	2003 (R13)	C
B11.5	Ironworkers	1988 (R13)	C
B11.6	Manual Turning Machines w/ or without Auto Control	2001 (R12)	C
B11.7	Cold Headers and Cold Formers	1995 (R15)	C
B11.8	Manual Milling, Drilling, & Boring Machines	2001 (R12)	C
B11.9	Grinding Machines	2010 (R15)	C
B11.10	Sawing Machines	2003 (R15)	C
B11.11	Gear and Spline Cutting Machines	2001 (R12)	C
B11.12	Roll Forming and Roll Bending Machines	2005 (R15)	C
B11.13	Single & Multiple-Spindle Automatic Bar and Chucking Machines	1992 (R12)	C
B11.14	*Withdrawn* (Coil Slitting Machines; combined into B11.18)		---
B11.15	Pipe, Tube and Shape Bending Machines	2001 (R12)	C
B11.16	Powder / Metal Compacting Presses	2014	C
B11.17	Horizontal Hydraulic Extrusion Presses	2004 (R15)	C
B11.18	Machines Processing or Slitting Coiled or Non-Coiled Metal	2006 (R12)	C
B11.19	Performance Requirements for Risk Reduction Measures (Safeguarding)	2010	B
B11.20	Integrated Machinery Systems	2017	B
B11.21	Machine Tools Using Lasers for Processing Materials	2006 (R12)	B
B11.22	Turning Centers and Automatic Numerically Controlled Turning Machines	2002 (R12)	C
B11.23	Machining Centers & CNC Milling, Drilling & Boring Machines	2002 (R12)	C
B11.24	Transfer Machines	2002 (R12)	C
B11.25	Large Machines	2015	B
B11.26	Functional Safety for Equipment / Machine Control Systems	201x	B
B11.27	Electro-Discharge Machines	201x	C
B11.TR1	Ergonomics	2016	B
B11.TR2	Metal Working Fluids	1997	B
B11.TR3	Risk Assessment / Risk Reduction	2000 (R15)	B
B11.TR4	Selection of Programmable Electronic Systems (PES/PLC)	2004 (R15)	B
B11.TR5	Noise Measurement	2006	B
B11.TR6	Safety Control Systems for Machines	2010	B
B11.TR7	Integration of Lean and Safety	2007 (R17)	B
B11.TR8	Maintenance of Safety-Related Components for Machines	201x	B
ANSI/ISO 12100	Safety of machinery (identical adoption of ISO 12100-2010)	2012	A

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STANDARD REQUIREMENTS | EXPLANATORY INFORMATION

American National Standard –
Safety Requirements for Integration of Machinery into a System

STANDARDS REQUIREMENTS

EXPLANATORY INFORMATION

(Not part of the requirements of this American National Standard – ANSI B11.20-2017, *Safety requirements for Integration of Machinery into a System*.)

1 Scope

1.1 General

This American National Standard specifies the safety requirements for the design, construction, installation, set-up, operation, maintenance, modification and decommissioning of integrated machinery systems.

An integrated machinery system (IMS):

a) incorporates two or more industrial machines which:
   - can operate independently of each other; and
   - are intended for the purposes of manufacturing, treatment, movement or packaging of discrete parts or assemblies;
b) is linked by a material handling system; and
c) is interconnected by a control system(s) for coordinated operation.

An IMS shall meet the requirements of this standard.

Proper application of this standard requires compliance with ANSI B11.0 and ANSI B11.19.

E1.1

The terms "*integrated machinery (manufacturing) system*," "*integrated machinery (manufacturing) cell*" and "*IMS*" should all be considered as synonymous. These may also be known as a "flexible machinery (manufacturing) system."

This standard addresses only those safety aspects that are important for the safety-relevant interconnection of the machinery and equipment. Therefore, it is not intended to cover safety aspects of individual machines and equipment that may be covered by machine-specific "base" safety standards.

See also, Annex A for examples of integrated machinery systems.

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 (machine-specific "base" safety standard);

b) transfer machines or transfer lines (see also, ANSI B11.24);

E1.2

a) Where machines and equipment of an IMS are operated separately or individually, the relevant machine-specific "base" safety standard for these machines and related equipment should apply.

b) Transfer machines have more than one station and one or more workpiece transport systems (e.g., transfer bar) designed to process (e.g., machine, assemble) only a pre-specified workpiece or a limited family of workpieces by means of a predetermined sequence of operations and process parameters.