B11.TR10-2020

Functional Safety of Artificial Intelligence for Machinery Applications

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FOREWORD

Objective

This Technical Report was developed to incorporate the emergence of AI (Artificial Intelligence) techniques with established functional safety methodologies. Functional safety terminology used in this B11.TR10 was primarily selected to complement other ANSI B11 American National Standards. The writing subcommittee of this Technical Report realizes that AI methodologies are expected, and will continue, to evolve. The "requirements" herein were written to be robust enough to apply to future applications, with the numerous *Informative Notes* providing examples of ways it could be achieved using current methods.

Technical Reports Registered with ANSI are not consensus documents. Rather, all material contained in Technical Reports Registered with ANSI is informational in nature. Technical reports may include, for example, reports of technical research, tutorials, factual data obtained from a survey carried out among standards developers and/or national bodies, or information on the "state of the art" in relation to standards of national or international bodies on a particular subject.

The objective of the ANSI B11 series of standards and technical reports is to eliminate injuries to personnel from machinery or machinery systems by establishing requirements for the design, construction, reconstruction, modification, installation, set–up, operation and maintenance of machinery or machine systems. The guidance in this Technical Report is not intended to replace good judgment and personal responsibility. Personnel skill, attitude, training and experience are safety factors that need to be considered by the user.

Normative vs. Informative Text

Voluntary consensus standards typically denote requirements through use of the word syntax "shall" whereas the word syntax "should" denotes a recommendation and not a requirement. By definition, Technical Reports are informative guidance documents that do not contain normative requirements, however, both terms (shall / should) are used within this TR with the following distinction: The term "shall" denotes a matter with a high/strong recommendation. Following "shall" statements can improve the probability of designing an algorithm capable of achieving a more robust (higher level of) functional safety system. The term "should" denotes a topic where implementation may further improve the (functional safety) outcome.

In this sense, this technical report more resembles the form and construct of an ISO Technical Specification (a category of document that ANSI does not include). ISO Technical Specifications are used for the following:

- Preliminary publication of data which is intended to be included in a published standard after further refinement and testing;
- Represents industry best practice at the time of publication;
- Carries more weight than a Technical Report;
- Uses **shall** to indicate a normative, mandatory requirement.

General

"Safe" is the state of being protected from recognized hazards that are likely to cause physical harm. There is no such thing as being absolutely safe, that is, a complete absence of risk. In turn, there is no machine that is absolutely safe. All machinery contains hazards, and some level of residual risk. However, the risk associated with those hazards should be reduced to an acceptable level.

AI applications for machine safety systems is an emerging technology incorporating hardware and software technologies. This Technical Report reflects the best industry available knowledge/information at the time of its registration. The inclusion or omission of language relative to any evolving technology, in no way infers acceptance or rejection of such technologies.

This is the first edition of B11.TR10 and was prepared by the B11.TR10 Subcommittee, processed and submitted to the B11 Standards Development Committee (SDC) and registered by the ANSI B11 Secretariat. B11 SDC approval of this TR does not necessarily imply that all committee members voted for its approval. At the time this TR was approved as an American National Standard, the ANSI B11 SDC was composed of the following Members:

Alan Metelsky, FS Eng – Chair / Anne Mathias, PE, – Vice-Chair / David Felinski, Secretary

Organizations Represented	Name of Representative	
	Delegate	**Alternate**
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Aluminum Extruders Council	Melvin Mitchell, CSP	Bradley Wyatt, CSP
American Society of Safety Professionals	Ted Sberna, Sr.	Anne Mathias, PE
Association For Manufacturing Technology	Russell Bensman	Alan Metelsky, FS Eng
The Boeing Company	Rhiannon McPherson	Steve Thomas/Mark Ellingson
Bridgestone	Kenji Furukawa, FS Eng	Joey Hinson, FS Eng
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Occupational Safety & Health Administration	Kenneth Stevans	James McManus
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Sheet Metal & Air Conditioning Contractors Natl. Assn.	Michael McCullion	Rick Di Ioli
Sub-Zero Group		Bill Lawrie
Toyota Motor Manufacturing North America	Chip Boertlein	

At the time this Technical Report was registered, the **B11.TR10 Subcommittee** had the following members who participated in the development of this TR:

Name	Organization
Tina Hull, FS Exp; Chair	Omron Automation
Chris Felinski; Secretary	B11 Standards, Inc.
Stephen Andrew, PE	Exponent
Stan Brubaker, CSP	Liberty Mutual
Kenji Furukawa, FS Eng	Bridgestone
Elizabeth Groves, PhD	Exponent
Bruce Main, PE, CSP	design safety engineering, inc.
Laura Pahren, PhD	Procter and Gamble
Mike Poynter, FS Eng	Rockwell
Chris Soranno, FS Exp	SICK
Ernesto Staroswiecki, PhD	Exponent
Paul Thomas, PE	Procter and Gamble
Mark Witherspoon, FS Eng	IDEM Safety
David Felinski; Secretariat	B11 Standards, Inc.

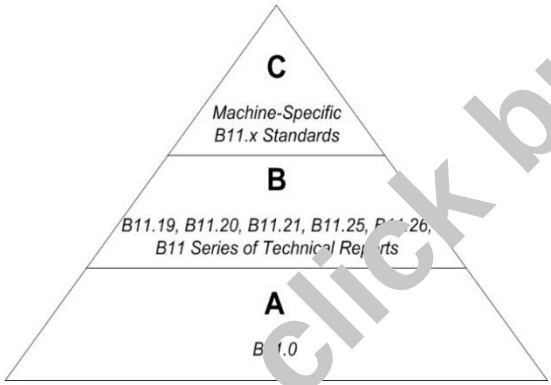
Introduction

Organization and Application of B11 Documents

The B11 standards and technical reports can be associated with the “type A-B-C” structure, originally developed within ISO/TC199 but broadly adopted and used globally in machinery safety standards.

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

This B11.TR10 Technical Report is considered a “type-B” document.



Organization of the B11 Series of Documents

As of the date of approval of this Technical Report, 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 www.b11standards.org/current-standards or a licensed reseller such as ANSI (www.ansi.org) for the current versions of any of these documents. All archival / historical versions of the B11 series of documents are available at www.b11standards.org/store.

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

#	SHORT TITLE / TOPIC	YEAR	TYPE
B11.0	Safety of Machinery	2020	A
B11.1	Mechanical Power Presses	2009 (R20)	C
B11.2	Hydraulic & Pneumatic Power Presses	2013	C
B11.3	Power Press Brakes	2012	C
B11.4	Shears	2003 (R2	C
B11.5	Ironworkers	1988 (R	C
B11.6	Manual Turning Machines w/ or without Auto Control	2001 (R2	C
B11.7	Cold Headers and Cold Formers	1995 (R	C
B11.8	Manual Milling, Drilling, & Boring Machines	2001 (R20)	C
B11.9	Grinding Machines	2010 (R20)	C
B11.10	Sawing Machines	2003 (R20)	C
B11.11	*Withdrawn* (Gear and Spline Cutting Machines)	2001 (R12)	C
B11.12	Roll Forming and Roll Bending Machines	2005 (R20)	C
B11.13	Single & Multiple-Spindle Automatic Bar and Chucking Machine	1992 (R20)	C
B11.14	*Withdrawn* (Coil Slitting Machines; combined into B11.18)	(1996)	C
B11.15	Pipe, Tube and Shape Bending Machines	2001 (R20)	C
B11.16	Powder / Metal Compacting Presses	2014 (R20)	C
B11.17	Horizontal Hydraulic Extrusion Presses	2004 (R20)	C
B11.18	Machines Processing or Slitting Coiled or Non-Coiled Meta	2006 (R20)	C
B11.19	Performance Requirements for Risk Reduction Measures (Safeguarding)	2019	B
B11.20	Integration of Machinery into a System	2017	B
B11.21	Machine Tools Using Lasers for Processing Materials	2006 (R20)	B
B11.22	Turning Centers and Automatic Numerically Controlled Turning Machines	2002 (R20)	C
B11.23	Machining Centers & CNC Milling, Drilling & Boring Machines	2002 (R20)	C
B11.24	Transfer Machines	2002 (R20)	C
B11.25	Large Machines	2015 (R20)	B
B11.26	Functional Safety for Equipment / Machine Control Systems	2018	B
B11.27	Electro-Discharge Machines	2020	C
B15.1	*Withdrawn* (Mechanical Power Transmission Apparatus)	2000 (R08)	B
B11.TR1	Ergonomics	2016	B
B11.TR2	Metal Working Fluids	1997 (R16)	B
B11.TR3	*Withdrawn* (Risk Assessment / Risk Reduction Guide)	(2000 R15)	B
B11.TR4	Selection of Programmable Electronic Systems (PES/PLC)	2004 (R15)	B
B11.TR5	Noise Measurement	2006 (R17)	B
B11.TR6	*Withdrawn* (Safety Control Systems for Machines)	(2010)	B
B11.TR7	Integration of Lean and Safety	2007 (R17)	B
B11.TR8	Sustainable Safety Systems Through Inspection of Risk Reduction Measures	202x	B
B11.TR9	Cybersecurity	2019	B
B11.TR10	Guidance on Artificial Intelligence into Machinery Safety Applications	2020	B
ANSI/ISO 12100	Safety of machinery (national adoption of ISO 12100-2010)	2012	A

Functional Safety of Artificial Intelligence for Machinery Applications

1 Scope

This Technical Report provides guidance for the:

- implementation of functional safety principles in artificial intelligence (AI) programming when used as a means for machinery safety applications;
- effective communication between functional safety personnel (who provide the primary technical knowledge of machine(s) system hazards and the application of risk reduction measures) and data scientists / programmers with no or limited machine system knowledge, but who understand the capabilities and limitations of the AI system.

These principles may include internal diagnostics such as component/system integrity during operation and external diagnostics such as environmental effects and communication networks.

This Technical Report is not a replacement for embedded and application functional safety software requirements. Examples and topics used in this Technical Report are non-inclusive of all possible situation / scenarios / applications.

2 Reference

The following standard contains provisions which may augment the use of this Technical Report. At the time of registration / publication of B11.TR10, the edition below was valid.

ANSI B11.0—2020 *Safety of Machinery*

