B11.TR10-2020

Functional Safety of Artificial Intelligence for Machinery Applications

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TABLE of CONTENTS

| TABLE of CONTENTS | | | | | | | | | |
|-------------------|--------------------------------|-------------------------|--|------------------|--|--|--|--|--|
| FOF | REWO | RD | | 4 | | | | | |
| | Obje | ctive | | 4 | | | | | |
| | Normative vs. Informative Text | | | | | | | | |
| | General | | | | | | | | |
| INTRODUCTION | | | | | | | | | |
| 1 | SCOPE | | | | | | | | |
| 2 | REFERENCE | | | | | | | | |
| 3 | DEFI | DEFINITIONS | | | | | | | |
| 4 | RISK | | | | | | | | |
| • | 4 1 | Data (Da | tasets) | 11 | | | | | |
| | 7.1 | 4.1.1 | Data Quantity | | | | | | |
| | | 4.1.2 | Data Quality | 11 | | | | | |
| | | 4.1.3 | Effect of Data on Safety Functions | 12 | | | | | |
| | 4.2 | Use and I | Limits | 12 | | | | | |
| | 4.3 | Analysis. | | 13 | | | | | |
| | 4.4 | Risk Red | uction | | | | | | |
| | | 4.4.1 | Methodology | 14 1 <i>4</i> | | | | | |
| | | 4.4.3 | Information Retrieval | | | | | | |
| | | 4.4.4 | Operating Conditions | 15 | | | | | |
| | | 4.4.5 | Hazardous Conditions | 15 | | | | | |
| 5 | AI SYSTEM DESIGN | | | 16 | | | | | |
| | 5.1 | General. | | 16 | | | | | |
| | | 5.1.1 | AI for Predictive Maintenance | 16 | | | | | |
| | | 5.1.2 | Al for Analytical Function(s) | 16 17 | | | | | |
| | 5.2 | Requiren | nents | | | | | | |
| | 5.3 | AI Span of Control | | | | | | | |
| | 5.4 | 4 Reward / Penalty | | | | | | | |
| | 5.5 | Classifica | ition Sets | | | | | | |
| | 5.6 | 5.6 Certainty Levels | | | | | | | |
| | 5.7 | Interface | s (communication) with Other Machines or Equipment | 21 | | | | | |
| | 5.8 | Interface | s (communication) with Humans | 21 | | | | | |
| | 5.9 | Faults Le | eading to Failures | 22 | | | | | |
| | 5.10 | .10 Faults and Failures | | | | | | | |
| 6 | AI SYSTEM TRAINING | | | 23 | | | | | |
| | 6.1 | Expertise | 2 | 23 | | | | | |
| | 6.2 | Responsi | bility | 23 | | | | | |
| | 6.3 | Training | Sets | 23 | | | | | |
| 7 | AI SYSTEM EVALUATION | | | | | | | | |
| | 7.1 | AI System | n Validation | 24 | | | | | |
| | 7.2 | AI Test S | et | 24 | | | | | |
| | 7.3 | Learning | after Test Set is Validated | 25 | | | | | |

B11 TECHNICAL REPORT

| 8 | POST MACHINE TRAINING ACTIONS | | | | | |
|---|-------------------------------|---------------------|----|--|--|--|
| | 8.1 | User Training | 25 | | | |
| | 8.2 | Maintenance | 25 | | | |
| | 8.3 | Adversarial Attacks | 26 | | | |
| | 8.4 | Traceability | 27 | | | |
| | 8.5 | Information for Use | 27 | | | |
| ANNEX A —CORRELATION OF EXISTING FUNCTIONAL SAFETY CONCEPTS TO AI SYSTEMS28 BIBLIOGRAPHY | | | | | | |

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.

Al 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.

B11 TECHNICAL REPORT

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

AHT Insurance Aluminum Extruders Council American Society of Safety Professionals Association For Manufacturing Technology The Boeing Company Bridaestone Canadian Standards Association Deere & Co. Euchner Exponent FDR Safety **General Motors Corporation** Grantek System Integration Komatsu America Industries Liberty Mutual MAG Automotive Metal Powder Industries Federation National Institute for Occupational Safety & Health Occupational Safety & Health Administration **Omron Automation** Packaging Machinery Manufacturers Institute Pilz Automation Safety, LP Plastics Industry Association Precision Metalforming Association Presence-sensing Device Manufacturers Association Robotic Industries Association Rockwell Automation Safe-T-Sense SICK, Inc. Sheet Metal & Air Conditioning Contractors Nat'l. Assn. Sub-Zero Group Toyota Motor Manufacturing North America

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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.



B11 TECHNICAL REPORT

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 <u>www.b11standards.org/current-standards</u> 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 <u>www.b11standards.org/store</u>.

|--|

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



B11.TR10 – 2020

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