

**B11.TR4 – 2004 (R2015)**

**ANSI Technical Report for Machines –  
Selection of Programmable Electronic  
Systems (PES/PLC)  
for Machine Tools**

Registered by ANSI: **JUNE 20, 2004**  
Reaffirmed: **18 JANUARY 2015**

Secretariat and Standards Developing Organization:

**B11 Standards, Inc.**  
**POB 690905**  
**Houston, TX 77269**

**Copyright; All rights reserved**

a) No part of this document may be reproduced in any form, in an electronic retrieval system or otherwise, without prior written permission of the publisher.

Printed in the United States of America

## AMERICAN NATIONAL STANDARDS / TECHNICAL REPORTS

By registering this ANSI Technical Report, the ANSI Board of Standards Review confirms that the requirements for due process, consensus, balance and openness have been met by B11 Standards, Inc. (the ANSI-accredited standards developing organization).

American National Standards and Technical Reports are developed through a consensus process. Consensus is established when substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward resolution. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While B11 Standards, Inc. administers the process and establishes procedures to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards or guidelines.

American National Standards and Technical Reports are promulgated through ANSI for voluntary use; their existence does not in any respect preclude anyone, whether they have approved the standards/technical reports or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to these documents. However, users, distributors, regulatory bodies, certification agencies and others concerned may apply American National Standards or Technical Reports as mandatory requirements in commerce and industry.

The American National Standards Institute does not develop standards or technical reports and will in no circumstances give an interpretation of an American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the Secretariat (B11 Standards, Inc.).

B11 STANDARDS, INC., MAKES NO WARRANTY, EITHER EXPRESSED OR IMPLIED AS TO THE FITNESS OF MERCHANTABILITY OR ACCURACY OF THE INFORMATION CONTAINED WITHIN THIS TECHNICAL REPORT, AND DISCLAIMS AND MAKES NO WARRANTY THAT THE INFORMATION IN THIS DOCUMENT WILL FULFILL ANY OF YOUR PARTICULAR PURPOSES OR NEEDS. B11 Standards, Inc. disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, application or reliance on this document. B11 Standards, Inc. does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this technical report, nor does it take any position with respect to the validity of any patent rights asserted in connection with the items which are mentioned in or are the subject of this document, and B11 Standards, Inc. disclaims liability for the infringement of any patent resulting from the use of or reliance on this document. Users of this document are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

In publishing or making this document available, B11 Standards, Inc. is not undertaking to render professional or other services for or on behalf of any person or entity, nor is B11 Standards, Inc. undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment, or as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

B11 Standards, Inc. has no power, nor does it undertake to police or enforce conformance to the requirements of this document. B11 Standards, Inc. does not certify, test or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of conformance to any health or safety-related information in this document shall not be attributable to B11 Standards, Inc. and is solely the responsibility of the certifier or maker of the statement.

**NOTICE:** This ANSI Technical Report may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this technical report. You may contact the Secretariat for current status information on this, or other B11 documents. Individuals interested in obtaining up-to-date information on standards can access this information at <http://www.nssn.org> (or by contacting ANSI). NSSN - A National Resource for Global Standards, provides a central point to search for standards information from worldwide sources and can connect those who seek standards to those who supply them.

Published by: B11 Standards, Inc.  
POB 690905, Houston, TX 77269, USA

**Copyright © 2015** by B11 Standards, Inc.  
**All rights reserved.** Printed in the United States of America

**No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.**

# CONTENTS

# PAGE

<b>FOREWORD</b> .....	<b>IV</b>
<b>INTRODUCTION</b> .....	<b>VI</b>
<b>1 SCOPE AND PURPOSE</b> .....	<b>1</b>
1.1 SCOPE.....	1
1.2 PURPOSE.....	1
<b>2 REFERENCES</b> .....	<b>1</b>
<b>3 DEFINITIONS</b> .....	<b>2</b>
<b>4 GENERAL CONSIDERATIONS</b> .....	<b>3</b>
4.1 SAFETY PROGRAMMABLE ELECTRONIC SYSTEM (SPES).....	6
<b>5 DESIGN CONSIDERATIONS FOR A SPES</b> .....	<b>9</b>
5.1 SPES PERFORMANCE LEVEL.....	9
5.2 SELECTION OF CONFIGURATION.....	9
5.3 FAILURE MODES.....	9
<b>6 SAFETY PROGRAMMABLE ELECTRONIC DEVICE</b> .....	<b>9</b>
6.1 SELECT OR DESIGN THE SPED FOR THE GIVEN SAFETY RELATED FUNCTION(S).....	10
6.2 APPLICATION SOFTWARE.....	11
6.3 SECURITY METHODS.....	11
6.4 DOCUMENTATION.....	11
<b>7 VALIDATION OF THE PES</b> .....	<b>12</b>
<b>ANNEX A – PERFORMANCE OF THE SAFETY-RELATED FUNCTION(S)</b> .....	<b>13</b>
<b>ANNEX B – IDENTIFICATION AND ANALYSIS OF FAILURES</b> .....	<b>14</b>
<b>ANNEX C – SAFETY RELATED PERFORMANCE LEVELS</b> .....	<b>16</b>

This document is copyright protected and may not be reproduced or distributed to any other party.

## Foreword

Recognizing the need for a guidance document on the subject matter, the ANSI-B11 Accredited Standards Committee for Machine Tool Safety formed a subcommittee consisting of professionals that are involved in manufacturing, safety, design and controls to develop a technical report giving guidelines for the selection of programmable electronic systems when applied to machine tools covered by the ANSI B11 series of safety standards. This Subcommittee began work on this Technical Report in October 1997. After a hiatus beginning August 2000, the Subcommittee resumed its work in June 2003, taking a very different direction and finally producing the work you are reading in early 2004. This Technical Report was reaffirmed and registered by ANSI on 18 January 2015.

There are annexes at the end of this technical report dealing specifically with the performance of safety related functions (control reliability), identification and analysis of failures, and safety related performance levels.

Publication of this Technical Report has been approved by the Accredited Standards Developer – AMT- The Association For Manufacturing Technology (now B11 Standards, Inc.). This document is registered as a Technical Report according to the Procedures for the Registration of Technical Reports with ANSI. This document is not an American National Standard and the material contained herein is not normative in nature.

While standards generally use the term **shall** to denote a requirement and the word **should** to denote a recommendation, this document is written using those terms consistent with how they are used in a standard (normative requirement vs. an informative recommendation). Nonetheless, the preceding paragraph remains true; nothing in this document is normative.

Suggestions for improvement or comments on the technical content of this technical report are welcomed. They should be sent to: B11 Standards, Inc., POB 690905, Houston, Texas. Attention: B11 Secretariat.

### ANSI B11 Accredited Standards Committee:

John W. Russell, PE, CSP Chairman  
 Gary D. Kopps, Vice-Chairman  
 David A. Felinski, Secretary

### Organizations Represented

	Name of Representative	
	Delegate	Alternate
Aerospace Industries Association of America	Willard J. Wood	Robert J. Eaker, PE, CSP
Alliance of American Insurers	John Russell, PE, CSP	Keith Lessner
American Institute for Steel Construction	Thomas Schlafly	
American Society of Safety Engineers	Bruce Main, PE, CSP	George Karosas, PE, CSP
AMT- The Association For Manufacturing Technology	Russell Bensman	
Automotive Industry Action Group	Ron Tillinger	
Boeing	Robert J. Eaker, PE, CSP	Willard J. Wood
Can Manufacturers Institute	Geoffrey Cullen	
General Motors Corporation	Michael Taubitz	
John Deere	Gary Kopps	Ellen K. Blanshan
Metal Building Manufacturers Association	Charles M. Stockinger	Charles E. Praeger
Metal Powder Industries Federation	Dennis Cloutier, CSP	Teresa F. Stillman
Natl. Inst. for Occupational Safety & Health	John Etherton, PhD, PE	
Occupational Safety & Health Administration	Ken Stevanus	
Packaging Machinery Manufacturers Institute	Charles F. Hayes	
Precision Metalforming Association	William Gaskin	Christie Carmigiano
Presence Sensing Device Manufact. Assn.	Jim Kirton	Mike Carlson
Robotic Industries Association	Jeff Fryman	
Scientific Technologies, Inc.	Frank Webster	Chris Soranno
Sheet Metal & Air Conditioning Contractors' Natl. Assn.	Mike McCullion, CSP	

Tooling and Manufacturing Association  
Toyota Motor Manufacturing North America

Daniel Kiraly  
Barry Boggs

Allan Te Ronde  
Tom Huff

The B11 Subcommittee on the Selection of Programmable Electronic Systems which developed this technical report had the following members:

Sam Boytor, Chairman  
Barry Stockton (Chairman, 10/1997-1/2003)  
David Felinski, Secretary  
Jim Barrett  
Barry Boggs  
Mike Crampton  
Mike Douglas  
Mat Einecker  
Dave Fisher  
Jim Kirton  
Heinz Knackstedt  
Don Lawson  
Morris Lint  
Mark Nehr Korn  
Art Pietrzyk  
Thomas Pilz  
Ashok Shah  
Chris Soranno  
J.B. Titus  
Frank Webster

Fox Controls  
High Tech Consulting  
AMT  
Link Systems  
Toyota  
General Motors  
General Motors  
Control Reliability Engineering  
Rockwell  
ISB Services  
C & E Sales  
SICK, Inc.  
National Machinery  
STI Machine Services  
Rockwell  
Pilz  
Lockformer  
STI Machine Services  
Siemens  
Scientific Technologies Inc.

The B11.TR4 Subcommittee and the  
ANSI B11 Accredited Standards Committee  
would like to dedicate this work to Mr. Barry Stockton  
who passed away on November 28, 2003.

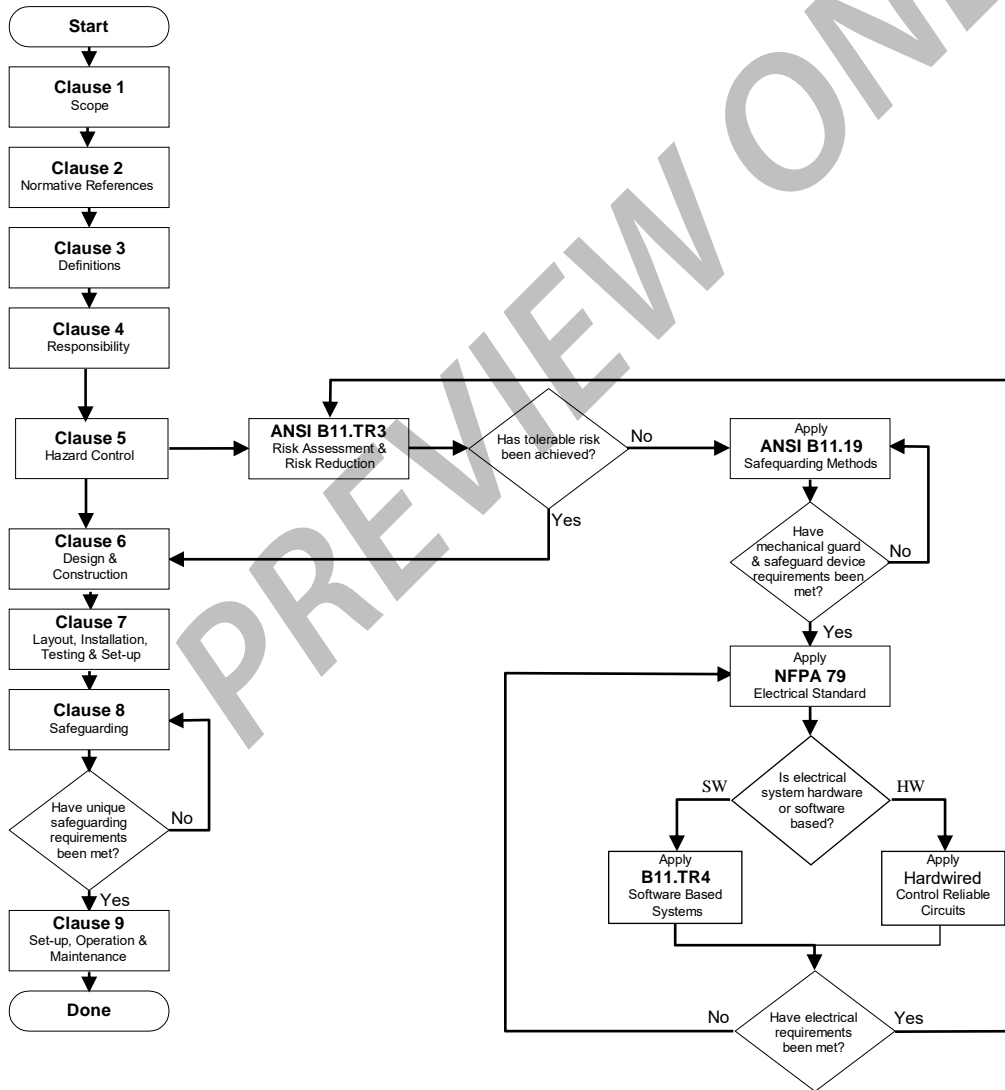
Barry served as Chairman of this Subcommittee  
during the majority of its development.

His contributions here, and to the ANSI B11  
series of safety standards in general,  
will be long remembered.

This document is copyright protected and may not be reproduced or distributed to any other party.

# Introduction

General overview of the interaction between a typical ANSI B11 American National Standard and other standards / technical reports



# Selection of Programmable Electronic Systems (PES/PLC) for Machine Tools

## 1 Scope and purpose

### 1.1 Scope

This Technical Report covers the safety related aspects of programmable electronic systems (PESs) for machine tools covered by the B11 series of safety standards (see inside cover for a listing).

### 1.2 Purpose

The purpose of this Technical Report is to provide guidance for the selection, design, construction, integration, and validation of PESs for the safety related functions of a machine production system. The terminology used in this document may not be used consistently throughout the industry, but this document does represent the concepts which are important when using and designing safety-related control systems.

NOTE: Usage of [machine] in the following text means any of the specific machine tools covered by the ANSI B11 'base' series of safety standards.

## 2 References

ANSI / NFPA 79 – 2002 *Electrical Standard for Industrial Machinery*

ANSI B11.19 – 2003 *Performance Criteria for Safeguarding*

ANSI B11.TR3 – 2000 *Risk Assessment and Risk Reduction – A guide to estimate, evaluate and reduce risks associated with machine tools*

ANSI / U.L. 1998 – 2000 *Software and programmable systems*

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

CSA Z434-03 – *Industrial Robots and Robot Systems – General Safety Requirements*

CSA Z432-04 – *Safeguarding of machinery*

EN 954-1:1996 (ISO/DIS 13849-1:2004) *Safety of machinery – Safety related parts of control systems – Part 1: General Principles for Design*

IEC 60204-1 – *Safety of electrical equipment of machinery used for general electrical safety aspects*

IEC 61508 Parts 1-7 – *Functional safety of E/E/PE safety-related systems used for the design of complex subsystems*

IEC 62061 - *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*