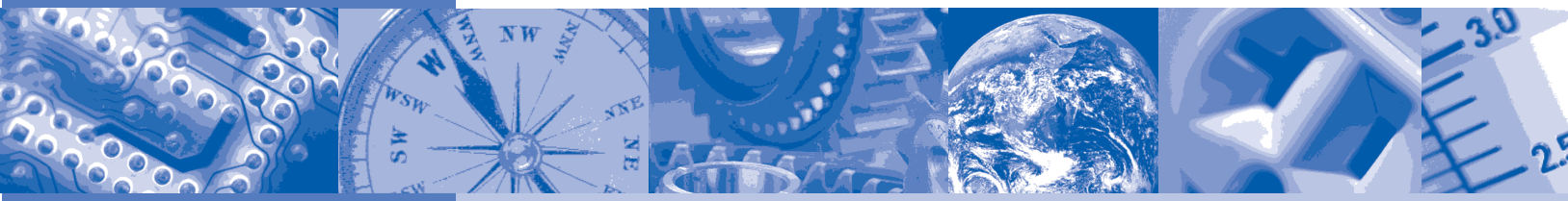
ISA-TR84.00.03 - 2002



Guidance for Testing of Process Sector Safety Instrumented Functions (SIF) Implemented as or Within Safety Instrumented Systems (SIS)

Approved 17 June 2002

ISA–The Instrumentation, Systems, and Automation Society

ISA-TR84.00.03-2002
Guidance for Testing of Process Sector Safety Instrumented Functions (SIF) Implemented as or Within Safety Instrumented Systems (SIS)

ISBN: 1-55617-801-8

ISA
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, North Carolina 27709

Preface

This preface, as well as all footnotes and annexes, is included for information purposes and is not part of ISA-TR84.00.03-2002.

This document has been prepared as part of the service of ISA—the Instrumentation, Systems, and Automation Society—toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms and asks that they be addressed to the Secretary, Standards and Practices Board; ISA; 67 Alexander Drive; P. O. Box 12277; Research Triangle Park, NC 27709; Telephone (919) 549-8411; Fax (919) 549-8288; E-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to USA users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce SI-acceptable metric units in all new and revised standards, recommended practices, and technical reports to the greatest extent possible. *Standard for Use of the International System of Units (SI): The Modern Metric System*, published by the American Society for Testing & Materials as IEEE/ASTM SI 10-97, and future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

It is the policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA standards, recommended practices, and technical reports. Participation in the ISA standards-making process by an individual in no way constitutes endorsement by the employer of that individual, of ISA, or of any of the standards, recommended practices, and technical reports that ISA develops.

CAUTION — ISA ADHERES TO THE POLICY OF THE AMERICAN NATIONAL STANDARDS INSTITUTE WITH REGARD TO PATENTS. IF ISA IS INFORMED OF AN EXISTING PATENT THAT IS REQUIRED FOR USE OF THE TECHNICAL REPORT, IT WILL REQUIRE THE OWNER OF THE PATENT TO EITHER GRANT A ROYALTY-FREE LICENSE FOR USE OF THE PATENT BY USERS COMPLYING WITH THE TECHNICAL REPORT OR A LICENSE ON REASONABLE TERMS AND CONDITIONS THAT ARE FREE FROM UNFAIR DISCRIMINATION.

EVEN IF ISA IS UNAWARE OF ANY PATENT COVERING THIS TECHNICAL REPORT, THE USER IS CAUTIONED THAT IMPLEMENTATION OF THE TECHNICAL REPORT MAY REQUIRE USE OF TECHNIQUES, PROCESSES, OR MATERIALS COVERED BY PATENT RIGHTS. ISA TAKES NO POSITION ON THE EXISTENCE OR VALIDITY OF ANY PATENT RIGHTS THAT MAY BE INVOLVED IN IMPLEMENTING THE TECHNICAL REPORT. ISA IS NOT RESPONSIBLE FOR IDENTIFYING ALL PATENTS THAT MAY REQUIRE A LICENSE BEFORE IMPLEMENTATION OF THE TECHNICAL REPORT OR FOR INVESTIGATING THE VALIDITY OR SCOPE OF ANY PATENTS BROUGHT TO ITS ATTENTION. THE USER SHOULD CAREFULLY INVESTIGATE RELEVANT PATENTS BEFORE USING THE TECHNICAL REPORT FOR THE USER'S INTENDED APPLICATION.

HOWEVER, ISA ASKS THAT ANYONE REVIEWING THIS TECHNICAL REPORT WHO IS AWARE OF ANY PATENTS THAT MAY IMPACT IMPLEMENTATION OF THE TECHNICAL REPORT NOTIFY THE ISA STANDARDS AND PRACTICES DEPARTMENT OF THE PATENT AND ITS OWNER.

ADDITIONALLY, THE USE OF THIS TECHNICAL REPORT MAY INVOLVE HAZARDOUS MATERIALS, OPERATIONS OR EQUIPMENT. THE TECHNICAL REPORT CANNOT ANTICIPATE ALL POSSIBLE APPLICATIONS OR ADDRESS ALL POSSIBLE SAFETY ISSUES ASSOCIATED

WITH USE IN HAZARDOUS CONDITIONS. THE USER OF THIS TECHNICAL REPORT MUST EXERCISE SOUND PROFESSIONAL JUDGMENT CONCERNING ITS USE AND APPLICABILITY UNDER THE USER'S PARTICULAR CIRCUMSTANCES. THE USER MUST ALSO CONSIDER THE APPLICABILITY OF ANY GOVERNMENTAL REGULATORY LIMITATIONS AND ESTABLISHED SAFETY AND HEALTH PRACTICES BEFORE IMPLEMENTING THIS TECHNICAL REPORT.

THE USER OF THIS DOCUMENT SHOULD BE AWARE THAT THIS DOCUMENT MAY BE IMPACTED BY ELECTRONIC SECURITY ISSUES. THE COMMITTEE HAS NOT YET ADDRESSED THE POTENTIAL ISSUES IN THIS VERSION.

The following people served as members of ISA Committee SP84:

NAME	COMPANY
V. Maggioli, Chair	Feltronics Corporation
R. Webb, Managing Director	POWER Engineers
C. Ackerman	Air Products & Chemicals Inc.
R. Adamski	Invensys
C. Adler	Moore Industries International Inc.
R. Bailliet	Syscon International Inc.
N. Battikha	Bergo Tech Inc.
L. Beckman	HIMA Americas Inc.
K. Bond	Shell Global Solutions
S. Brown	DuPont Company
J. Carew	Consultant
K. Dejmek	Baker Engineering & Lisk Consulting
R. Dunn	DuPont Engineering
P. Early	ABB Industrial Systems Inc.
A. Frederickson	Triconex Corporation
K. Gandhi	Kellogg Brown & Root
J. Gilman	Consultant
W. Goble	exida.com LLC
D. Green	Rohm & Haas Company
P. Gruhn	Siemens
C. Hardin	CDH Consulting Inc.
J. Harris	UOP LLC
J. Jamison	Bantrel Inc.
W. Johnson	E I du Pont
L. Laskowski	Solutia Inc.
T. Layer	Emerson Process Management
N. McLeod	Atofina
G. Ramachandran	Cytec Industries Inc.
K. Schilowsky	Marathon Ashland Petroleum Company LLC
D. Sniezek	Lockheed Martin Federal Services
C. Sossman	WG-W Safety Management Solutions
R. Spiker	Yokogawa Industrial Safety Systems BV
P. Stavrianidis	Factory Mutual Research Corporation
H. Storey	Equilon Enterprises LLC
A. Summers	SIS-TECH Solutions LLC
L. Suttinger	Westinghouse Savannah River Company
R. Szanyi	ExxonMobil Research Engineering
R. Taubert	BASF Corporation
H. Tausch	Honeywell Inc.
T. Walczak	GE FANUC Automation
M. Weber	System Safety Inc.

This standard was approved for publication by the ISA Standards and Practices Board on 17 June 2002.

NAME	COMPANY
M. Zielinski	Emerson Process Management
D. Bishop	David N Bishop, Consultant
D. Bouchard	Paprican
M. Cohen	Consultant
M. Coppler	Ametek, Inc.
B. Dumortier	Schneider Electric
W. Holland	Southern Company
E. Icayan	ACES Inc
A. Iverson	Ivy Optiks
R. Jones	Dow Chemical Company
V. Maggioli	Feltronics Corporation
T. McAvinew	ForeRunner Corporation
A. McCauley, Jr.	Chagrin Valley Controls, Inc.
G. McFarland	Westinghouse Process Control Inc.
R. Reimer	Rockwell Automation
J. Rennie	Factory Mutual Research Corporation
H. Sasajima	Yamatake Corporation
I. Verhappen	Syncrude Canada Ltd.
R. Webb	POWER Engineers
W. Weidman	Parsons Energy & Chemicals Group
J. Weiss	KEMA Consulting
M. Widmeyer	Stanford Linear Accelerator Center
C. Williams	Eastman Kodak Company
G. Wood	Graeme Wood Consulting

This page intentionally left blank.

Contents

Tables

1 Introduction

The best test of the Safety Instrumented Function (SIF) is the full functional test. Because SIF are designed to act upon an abnormal condition being measured and a corrective action taking place, any test must examine the measurement, logic and final control element activity to be considered a full functional test. This should involve creating an abnormal condition of the measured variable such that the input variable first reaches the alarm state and secondly moves to the interlock point making observations that the rest of the system responds as expected. Any less complete test is necessarily a compromise. Understanding what techniques should be used to ensure that this full functional test is complete is vital.

The sense of well being resulting from this successful test unfortunately deteriorates with time. Therefore, determining when subsequent testing is required to maintain this feeling of comfort is critical. The relative value of the functional test versus the cost of running the test can impact this decision. It is necessary to consider the degree of safety risk caused by a Safety Instrumented Function (SIF) initiated nuisance shutdown and at the same time the safety risk associated with an event not stopped due to a dangerous unrevealed fault in the SIF. Real processes are not ideal. Many systems are at maximum expected risk during startup and shutdown conditions.

NOTE 1 In this document the acronyms SIF and SIS will be used for both singular and plural usage of the term.

NOTE 2 The techniques for testing SIF or SIS described in this document apply to demand mode systems only. Continuous mode systems, which are rare in the process industry, require testing considerations beyond the scope of this document.

SIF applications are normally in a standby mode waiting for an indication of some potentially unsafe condition to occur before taking action. Faults may not become visible until the SIF fails to respond to an unsafe condition in the process. In basic process control loops the sensors and valves are exercised continuously during the Distributed Control System (DCS) and Programmable Logic Controller (PLC) cycles making process or equipment faults visible quickly and rendering them hard to ignore. It is vital that some program of testing and observation of each SIF in the SIS be in place. Any testing scheme, though which is burdensome or difficult has the very real probability of being ignored or bypassed. Where on-line testing techniques are implemented, they should not unnecessarily compromise the process safety integrity during the test. The test equipment and procedure must be carefully evaluated to determine whether the danger of causing an incident due to performing the on-line test is greater than the danger of not discovering the failure. Ill-advised maintenance or troubleshooting might actually increase the process risk.

Effective safety testing is strongly affected by local situations. Hazards differ, resources differ, and even the site conditions differ widely. Rapidly changing technology and ever increasing citizen expectations also impact decisions. Safety incidents can have the political result of closing down entire businesses if the local citizens are sufficiently offended. International competition has put tremendous pressure on manufacturing operations to reduce personnel and costs. Whatever testing schemes are used, they need to be very practical and should minimize maintenance and operating costs while ensuring the integrity of the SIF. The techniques suggested in this document are intended to provide guidance in the development of effective and efficient methods to plan and to manage testing and maintenance of SIF. Users of this document should have a good understanding of the applicable standards or guidelines which apply to SIF and SIS such as ANSI/ISA-84.01-1996, ISA-TR84.00.02-2002, OSHA 1910.119, dIEC 61511, and others.

The records resulting from the testing program should be equally valuable to planned and preventive maintenance and address the requirements of all regulations, as well as quality control and mandated standards.

Another important part of process safety in an operating unit is the knowledge and motivation of the operators and maintenance personnel. It is the responsibility of management to provide training and motivation. Any plan, formula, procedure, or even a standard, which attempts to, or claims to substitute