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Performance Monitoring for Nuclear Safety-Related Instrument Channels in Nuclear Power Plants

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Preface

This preface, as well as all annexes and footnotes, is included for information purposes and is not a part of ANSI/ISA-67.06.01-2002.

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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.

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The subcommittee has determined that the terms "sensor" and "transducer" will be interchangeable throughout this standard. The term "sensor" is preferred due to its wider application. A "sensor" is considered to be the device that transforms the monitored variable into an intelligible signal.

This standard’s purpose, when it was originally approved on 21 October 1980, was to provide guidance to the nuclear power industry in demonstrating compliance with Technical Specifications response time requirements for various Reactor Trip System and Engineered Safety Features Actuation System functions. At the time of its approval, little information was available regarding the reliability/validity of various response time testing methods. Also, very little data existed regarding the possible degradation of the response times of the protection system sensors and modules.

Utility experience and industry research has demonstrated the adequacy of instrument response times testing methods. Utility experience, based on historic response time test data, has also shown minimal changes in protection channel response times between tests. Industry research, based on failure modes and effects analysis (FMEAs) and component testing, has identified few degradation mechanisms that can affect some pressure sensor and rack module response times. Such research has resulted in the reduction of “periodic” response time testing to demonstrate acceptable performance for certain pressure sensors, rack modules, logic circuits, and actuation relays. Specific instrumentation excluded from the

Technical Specifications response time testing requirements is defined in Owners Group topical reports approved by NRC Safety Evaluations. Note that similar research also confirmed that other protection system instrumentation must be response time tested periodically, e.g., RTDs.

Given the objectives of increased safety and reliability and reduced maintenance costs, the industry has developed on-line instrument performance monitoring techniques to demonstrate acceptable channel/sensor calibration. Such techniques are defined in an industry topical report approved by an NRC safety evaluation. (The general requirements for an on-line monitoring system are provided in this standard's Annex G.)

As the emphasis on nuclear safety grew, this subcommittee recognized the need to balance the surveillance requirements for channel calibration, channel checks, functional tests, and response time tests by preparing a standard for performance monitoring of nuclear safety-related instrumentation. It was determined that the existing response time testing standard would be the most suitable for inclusion of other performance monitoring techniques, i.e., surveillance test methods such as channel calibration. The subcommittee also recognized the need to supplement other instrumentation testing requirements and methods delineated in IEEE Standard 338-1987, "IEEE Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems."

In 1990, SP67.06 was reconvened with the objective of providing guidance to the nuclear power industry in demonstrating acceptable performance of safety-related instrument channels. The subcommittee initially added other performance monitoring techniques and attributes without curtailing the original emphasis on response time testing. However, as the deliberations continued, the presence of the performance related issues became more balanced and the details of response time monitoring found a home in the annex. The subcommittee was careful to ensure that all performance related issues received appropriate emphasis.

This revision of ISA-67.06-1984 is not intended to impose new testing or monitoring requirements on the nuclear power industry; rather, in addition to providing guidance in response time testing techniques, it is intended to describe methods that could be useful to monitor the performance of protection as well as process instrumentation systems. The standard does not intend to describe a testing program or techniques that can be implemented by themselves, but rather to provide information on methods that could be useful in developing an effective monitoring program. This standard is considered to be complementary to IEEE 338-1987.

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Contents

1 Scope

This standard provides the nuclear power industry methods for assuring that nuclear safety-related instrument channels satisfy acceptable calibration, response time, and other factors affecting the performance of the instrument channel. This standard applies only to those instrument channels whose primary sensors measure pressure, differential pressure, temperature, or neutron flux. Primary flow elements are addressed by other standards.

2 Purpose

The purpose of this standard is to provide guidance to the nuclear power industry in demonstrating acceptable performance of safety-related instrument channels.

3 Definitions and terminology

For the purposes of this standard, the following definitions apply:

3.1 accuracy:
the conformance of an instrument signal to an accepted value of the variable being measured; it is often expressed as inaccuracy.

3.2 calibration:
a process of achieving an input/output relationship for an instrument channel so it conforms within specified requirements to the desired relationship.

3.3 channel check:
a qualitative comparison of the readings of two or more instrument channels to determine the operability of the channel that may be (1) the comparison of redundant channels that monitor the same process parameter, (2) the comparison of instruments that cover different process variable ranges at a common point on their scales, or (3) the comparison of diverse channels whose inputs have a known relationship to each other, such as steam pressure and temperature.

3.4 cross calibration:
a procedure of intercomparison of the indications among similar channels under conditions where the process variables are expected to indicate the same value, such as temperature and/or pressure, or to have a known relationship to each other.

3.5 design basis:
information that identifies the specific functions to be performed by a structure, system, component, or a facility, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be either (1) restraints derived from generally accepted "state-of-the-art" practices for achieving functional goals, or (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated event for which a structure, system, or component must meet its functional goals.

3.6 direct test method:
a test method that substitutes a controlled parameter for the monitored process parameter and can be modulated to demonstrate the performance of the instrument channel.

3.7 diverse parameter:
instruments that use different measurement principles to obtain the value of a given monitored process variable as distinct from redundant instruments.