Branch Technical Position HICB-12

Guidance on Establishing and Maintaining Instrument Setpoints

A. Background

This branch technical position (BTP) provides guidelines for reviewing the process an applicant/licensee follows to establish and maintain instrument setpoints. These guidelines are based on reviews of applicant/licensee submittals and vendor topical submittals describing setpoint assumptions, terminology, and methodology and experience gained from NRC inspections of operating plants.

1. Regulatory Basis

10 CFR 50.55a(h), "Protection Systems," requires in part that protection systems satisfy the criteria of ANSI/IEEE Std 279, "Criteria for Protection Systems for Nuclear Power Generating Stations." Section 3(6) requires identification of the levels that, when reached, will require protective action.

10 CFR 50 Appendix B, Criterion XI, "Test Control," and XII, "Control of Measuring and Test Equipment," provide requirements for tests and test equipment used in maintaining instrument setpoints.

10 CFR 50 Appendix A, General Design Criterion (GDC) 13, "Instrumentation and Control," requires in part that instrumentation be provided to monitor variables and systems, and that controls be provided to maintain these variables and systems within prescribed operating ranges.

10 CFR 50 Appendix A, GDC 20, "Protection System Functions," requires in part that the protection system be designed to initiate operation of appropriate systems to ensure that specified acceptable fuel design limits are not exceeded.

10 CFR 50.36(c)(1)(ii)(A), "Technical Specifications," requires that, where a limiting safety system setting is specified for a variable on which a safety limit has been placed, the setting be so chosen that automatic protective action will correct the most severe abnormal situation anticipated without exceeding a safety limit. Limiting safety system settings are settings for automatic protective devices related to those variables having significant safety functions. Setpoints found to exceed technical specification limits are considered a malfunction of an automatic safety system. Such an occurrence could challenge the integrity of the reactor core, reactor coolant pressure boundary, containment, and associated systems.

2. Relevant Guidance

Draft Reg. Guide DG-1045, proposed revision 3 to Reg. Guide 1.105, "Instrument Setpoints for Safety Systems," provides guidance for ensuring that instrument setpoints are initially within and remain within the technical specification limits. The guidance of this Reg. Guide is referenced to ISA-S67.04 Part I, "Setpoints for Nuclear Safety-Related Instrumentation Used in Nuclear Power Plants."

ISA-S67.04, Part II, provides additional background information.

Regulatory Guide 1.153, "Criteria for Power, Instrumentation, and Control Portions of Safety Systems," endorses IEEE Std 603, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations," as an alternative to ANSI/IEEE Std 279. Section 4.4 requires the identification of functional requirements pertinent to establishing instrument setpoints. Section 6.8 requires that setpoints be determined using a documented methodology, such as that described in ISA-S67.04. While IEEE Std 603 references ISA-S67.04-1988 for setpoint methodology, the Staff has not endorsed this version of the standard. The Staff is endorsing ISA-S67.04, Part I, via revision 3 of Reg. Guide 1.105. Draft Reg. Guide DG-1045 contains this proposed revision.

IEEE Std 498 (Withdrawn), "IEEE Standard Supplementary Requirements for the Calibration and Control of Measurement and Test Equipment Used in the Construction and Maintenance of Nuclear Power Generating Stations," and ANSI/NCSL Std Z540, "General Requirements for Calibration Laboratories and Measuring and Test Equipment," provide guidance for the calibration and control of measuring and test equipment used in the maintenance of instrument setpoints.

Generic letter 91-04, "Guidance on Preparation of a Licensee Amendment Request for Changes in Surveillance Intervals to Accommodate a 24-Month Fuel Cycle," provides guidance on issues that should be addressed by the setpoint analysis when calibration intervals are extended from 18 months to 24 months.

The Staff has reviewed setpoint methodologies submitted as either topical reports or as support for amendments to technical specifications, and found that they met the requirements of the above regulations.

3. Definitions

Section 3 and Figure 1 of ISA-S67.04, Part I, provide acceptable definitions (except as noted by Draft Reg. Guide DG-1045) of setpoint terminology and relationships between trip setpoint, allowable value, analytical limit, limiting safety system setting (LSSS) and safety limit.

4. Purpose

The purpose of this BTP is to provide guidance for NRC staff to verify conformance with the previously cited regulatory bases and standards for instrument setpoints. This BTP has three objectives:

- To verify that setpoint calculation methods are adequate to ensure that protective actions are initiated before the associated plant process parameters exceed their analytical limits.

- To verify that setpoint calculation methods are adequate to ensure that control and monitoring setpoints are consistent with their requirements.

- To confirm that calibration intervals and methods established are consistent with safety analysis assumptions.

B. Branch Technical Position

1. Introduction

Instrumentation and control (I&C) safety systems control plant parameters to ensure that safety limits will not be exceeded under the most severe design basis accident or transients. Instrument setpoints and allowable

values for these I&C safety system functions are chosen so that potentially unsafe or damaging process excursions (transients) can be avoided and/or terminated before plant conditions exceed safety limits. Accident analyses establish the limits for critical process parameters. These analytical limits, as established by accident analyses, do not normally include considerations for the accuracy (uncertainty) of installed instrumentation. Additional analyses and procedures are necessary to ensure that the actual trip setpoint of each safety control function is appropriate.

Instrument channel uncertainties in these analyses are based upon the characteristics of installed instrumentation, the environmental conditions present at the instruments' installed locations, and process conditions. A properly established setpoint will initiate a plant protective action before the process parameter exceeds its analytical limit. This, in turn, ensures that the transient will be avoided and/or terminated before the process parameters exceed the established safety limits.

Similar calculations and reviews are performed as necessary to verify the setpoints for non-safety systems or procedural action points for safety and non-safety systems.

2. Information to be Reviewed

The information to be reviewed consists of (1) a description of the setpoint program, procedures, and analytical results, (2) engineering information for the installed instrumentation, (3) supporting analyses, and (4) requirements and operating history for the instrument maintenance and calibration program.

3. Acceptance Criteria

Setpoint Documentation

The following information on the licensee/applicant's setpoint program should be provided for review:

- The facility setpoint list identifying safety and non-safety setpoints.
- A description of the setpoint methodology and procedures used in determining setpoints, including information sources, scope, assumptions, interface reviews, and statistical methods used.
- Terminology used to describe limits, allowances, tolerances, and environmental or other effects used to support setpoint calculations.
- The technical specifications and the basis for limiting safety system settings (LSSS).
- The basis for calibration intervals.
- The basis for assumptions regarding instrument uncertainties and a discussion of the method used to determine uncertainty values.
- A description of the provisions for control of measuring and test equipment used for calibration of the instrument.
- A description of the program and methodology used to monitor and manage instrument uncertainties, including drift.

A documented basis for safety system setpoint should be available for Staff review. Documentation should conform with the guidance of Draft Reg. Guide DG-1045.

The description of the instrument channel required by ISA-S67.04 Part I should include:

- A description of the functional and performance requirements for the initiation and execution of the safety functions initiated at the setpoints.

- Instrument specifications, including range, accuracy, repeatability, hysteresis, dynamic response, environmental qualification, calibration reference, and calibration intervals should be listed for each instrument type.

- Instrument loop diagrams showing all hardware elements of the instrument loop(s).

- Instrument and tubing layout drawings and installation details showing locations and elevations of instruments and tubing relative to a reference datum, as well as the points where the instrument interfaces with the monitored process.

- For digital instrumentation, the configuration database for the instrumentation functions, and identification of digital elements (hardware and software) where error could be introduced in the measurement. (For example, errors that could result from analog-to-digital or digital-to-analog conversion or from numerical methods used in the software (e.g., curve fitting).)

The description of assumptions required by ISA-S67.04 Part I should include the environmental allowances (temperature, pressure, humidity, radiation, vibration, seismic, and electrical) for the instruments.

Analysis Supporting Establishment of Setpoints and Instrumentation Tolerances

The applicant/licensee should document the bases and the calculations of measurement uncertainties. The methods by which setpoints are calculated should conform to the guidance of Draft Reg. Guide DG-1045.

Statistical Guidelines for Instrument Uncertainty

In the review of uncertainties in determining a trip setpoint and its allowable values, the NRC staff typically uses 95/95 tolerance limits as an acceptable criterion. That is, there is a 95% probability that the constructed limits contain 95% of the population of interest for the surveillance interval selected.

Guidelines for Graded Approach

Section 4 of ISA-S67.04 Part I states that the safety significance of various types of setpoints important to safety may differ, and thus one may apply a less rigorous setpoint determination method for certain functional units and limiting conditions of operation. The use of a graded approach allows a less-rigorous setpoint determination method based on the safety significance of the instrument function. However, the grading technique chosen by the applicant/licensee should be consistent with the standard and should consider all known applicable uncertainties regardless of setpoint application. Additionally, the application of the standard, using a "graded" approach, is also appropriate for non-safety system instrumentation maintaining design limits in the technical specifications.

Basis for Instrument Calibration Intervals

The applicant/licensee should evaluate the effects of extended calibration intervals on instrument uncertainties, equipment qualification, and vendor maintenance requirements to ensure that an extended surveillance interval does not result in exceeding the assumptions stated in the safety analysis. Generic Letter 91-04 Enclosure 2, "Guidance for Addressing the Effect of Increased Surveillance Intervals on Instrument Drift and Safety Analysis Assumptions," provides acceptable guidance for justifying extended calibration intervals through the use of data analysis, monitoring and assessment.

4. Review Procedures

The setpoint analysis methodology and assumptions should be reviewed to confirm that an acceptable analysis method is used and that the analysis parameters and assumptions are consistent with the safety analysis, system design basis, technical specifications, plant design, and expected maintenance practices. The following factors should be emphasized in the review:

- The relationships between the safety limit, analytical limit, the allowable value, the setpoint, the as-found limit and the as-left limit.
- The basis for selection of the trip setpoint.
- The uncertainty terms that are addressed.
- The method used to combine uncertainty terms.
- Justification of statistical combination.
- The relationship between instrument and process measurement units.
- Data used to select the trip setpoint, including the source of the data.
- Assumptions used to select the trip setpoint (e.g., ambient temperature limits for equipment calibration and operation, potential for harsh accident environment).
- Instrument installation details and bias values that could affect the setpoint.
- Correction factors used to determine the setpoint, e.g., pressure compensation to account for elevation difference between the trip measurement point and the sensor physical location.
- Instrument test, calibration or vendor data, as-found and as-left; each instrument should be demonstrated to have random drift by empirical and field data. Evaluation results should be reflected appropriately in the uncertainty terms, including the setpoint methodology.

The design, installation, calibration procedures, and calibration activities for specific channels may be inspected to gain further confidence that setpoint calculations are consistent with plant equipment and calibration procedures. NRC Inspection Manual Chapter 93807, "Systems Based Instrumentation and Control Inspection," provides guidance for such inspections.

C. References

ANSI/IEEE Std 279-1971. "Criteria for Protection Systems for Nuclear Power Generating Stations."

ANSI/NCSL Std Z540-1-1994. "Calibration Laboratories and Measuring and Test Equipment - General Requirements."

Draft Regulatory Guide DG-1045. Proposed Revision 3 to Regulatory Guide 1.105, "Instrument Setpoints for Safety Systems." Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, 1997.

Generic Letter 91-04. "Guidance on Preparation of a Licensee Amendment Request for Changes in Surveillance Intervals to Accommodate a 24-Month Fuel Cycle." April 2, 1991.

IEEE Std 498. "IEEE Standard Supplementary Requirements for the Calibration and Control of Measurement and Test Equipment Used in the Construction and Maintenance of Nuclear Power Generating Stations."

IEEE Std 603-1991. "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations."

ISA-S67.04-1994, Parts I and II. "Setpoints for Nuclear Safety-Related Instrumentation Used in Nuclear Power Plants."

NRC Inspection Manual, Chapter 93807. "Systems Based Instrumentation and Control Inspection." May 31, 1994.

Regulatory Guide 1.153. "Criteria for Power, Instrumentation, and Control Portions of Safety Systems." Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, 1996.