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Westinghouse Generic Setpoint Control Program Recommendations

Westinghouse

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1 INTRODUCTION

Westinghouse Nuclear Steam Supply Systems (NSSS) and Advanced Plants (**AP1000**®[1] plant) utilize a large number of instruments for protection, control, Post-Accident Monitoring System (PAMS), indication (computer and control board), alarm and Balance Of Plant (BOP) functions. NSSS and **AP1000** protection and PAMS functions are typically listed in the plant Technical Specifications e.g., NUREG-1431 Tables 3.3.1-1, 3.3.2-1, and 3.3.3-1 (Reference 23). Chapter 7 of the NSSS Updated Final Safety Analysis Report (UFSAR) and **AP1000** Design Control Document (DCD) define typical channel functional requirements, including the channel instrument uncertainty. The channel instrument uncertainty is based upon a calculation that models defined characteristics for the function (process errors, sensor, process rack, plant computer, indication and alarm), scaling of the channel, calibration, surveillance and maintenance of the instrumentation. Two U. S. Nuclear Regulatory Commission (NRC) documents identify the acceptability of the use of an approved Setpoint Control Program (SCP):

- Final Interim Staff Guidance - 8 (ISG-08) (Reference 1) – Option 3, for Advanced Plants, and
- Technical Specification Task Force (TSTF) Traveler TSTF-493, Revision 4 (TSTF-493) (Reference 2) – Option B, for current NSSS plants.

The information contained on the following pages provides the SCP characteristics Westinghouse believes are necessary to control setpoint design input and methodology assumptions inherent in the Westinghouse Setpoint Methodology (WSM).

The WSM is defined in a plant specific WCAP, for current NSSS plants, WCAP-16361-P (Reference 3), for the **AP1000** plant and WCAP-17504-P (Reference 20) as a generic Westinghouse document directly linked to SCP requirements. Typically, a current plant specific document contains four sections:

1. a description of the basic uncertainty algorithm,
2. uncertainty term definitions,
3. tables providing function specific uncertainty calculations, and
4. a short description of the application of the methodology.

The primary purpose of a typical plant specific WSM (limited to protection functions) is to; 1) determine the Nominal Trip Setpoint (NTS) for a protection function, given a Safety Analysis Limit (SAL) defined in the plant safety analyses, documented in the plant UFSAR or DCD, or 2) demonstrate the adequacy of an existing NTS for a given SAL. This is accomplished by accounting for all appropriate instrument uncertainties, both sensor and process racks, process effects (PMA terms) and demonstrating margin between the NTS and the SAL in percent instrument span. However, the WSM is only part of the process. Inherent assumptions of the WSM are:

[1] **AP1000** is a trademark or registered trademark of Westinghouse Electric Company LLC, its affiliates and/or subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.

[ ]a,c

Proceeding through this process provides assurance, at the appropriate probability and confidence level (95/95 for protection [ ]a,c that a function will perform as designed within the modeling of the safety analyses.

The SCP noted in ISG-08 (Reference 1) is designed to meet the NRC guidance provided by BTP 7-12, Rev. 5 (Reference 4) and RG 1.105 Rev. 3 (Reference 5). The means by which the acceptance criteria of BTP 7-12 are satisfied through the Westinghouse SCP recommendations are identified in Appendix A. The means by which the information noted in BTP 7-12 review procedures are satisfied are identified in Appendix B. The WSM, in plant specific form, has been reviewed by the NRC many times, the latest being a review of WCAP-16361-P (Reference 3). The NRC's safety evaluation of this WCAP is dated August 20, 2007 (Reference 6). The methodology utilized in WCAP-16361-P (Reference 3) and WCAP-17504-P (Reference 20) is consistent with that noted in ANSI/ISA-67.04.01-2006 (Reference 7). Information contained in the International Society of Automation (ISA) recommended practice, the latest version of the document being ISA-RP67.04.02-2010 (Reference 8), was also considered in the development and evolution of the WSM.

As previously noted, the SCP and WSM specifically address the functions identified in plant Technical Specifications, e.g., NUREG-1431 Tables 3.3.1-1, 3.3.2-1 and 3.3.3-1 (Reference 23). [

]a,c Uncertainty calculations and the subsequent NTS determination for functions of a lesser significance utilize a graded approach of [ ]a,c similar to that described in ISA-TR67.04.01-2005 (Reference 9), i.e., 95/95, [ ]a,c Following the steps outlined in this SCP for the maintenance of setpoint design input control ensures that the plant remains within the design analyses through the life of the plant.

A process flow diagram is provided below for ease in visualization of the Setpoint Control Program.

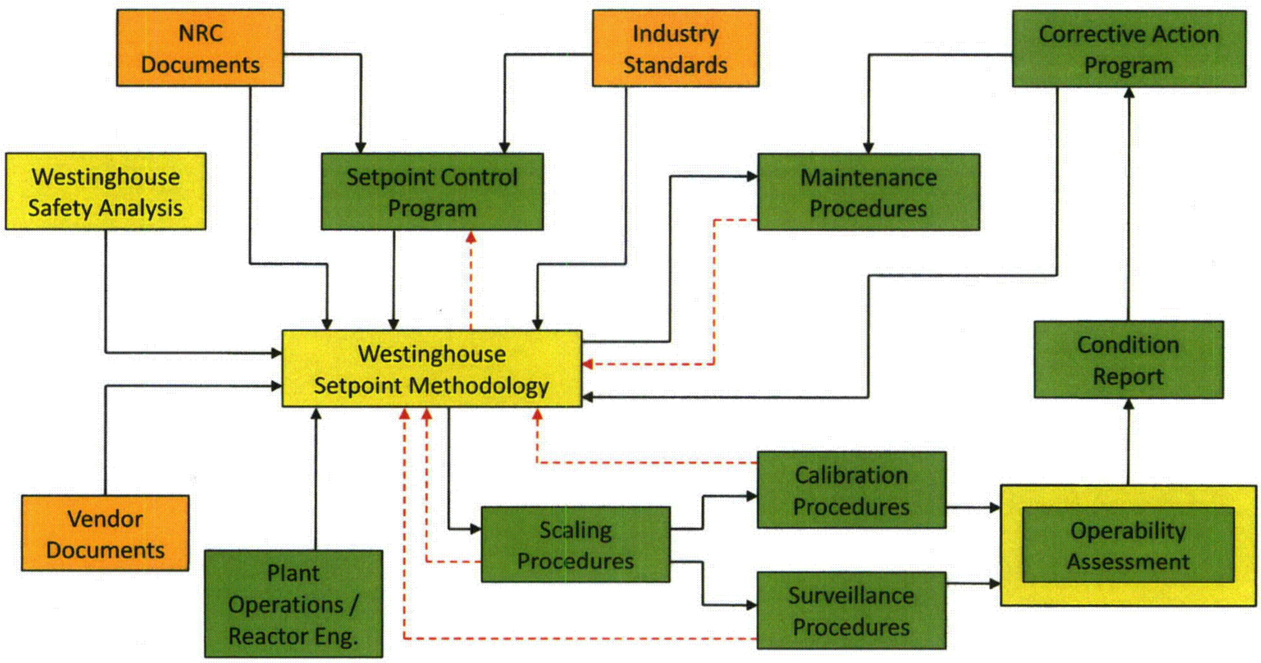

Figure 1-1 Westinghouse Setpoint Control Program Process Flow Diagram

2 PROGRAM GOALS AND OBJECTIVE

The Westinghouse SCP assures the control of critical instrumentation design input parameters, such that the plant remains within the design constraints and safety analyses assumptions during all modes of plant operation, both normal and expected transient conditions, e.g., Steam Generator and Pressurizer Level functions, and within the initial condition assumptions for abnormal events and accident conditions throughout the life of the plant. To achieve these goals, the NTS values are determined, considering process effects and instrument uncertainties, such that relevant safety features can be either automatically initiated or an operator may take appropriate action. This program is also implemented to assure compliance with applicable regulatory requirements and expectations.

To assure appropriate Instrumentation and Control (I&C) equipment operability within the assumptions of the WSM, the SCP will:

[ ] a,c

Thus, the SCP provides a means of continuous evaluation of changes to equipment, procedures and processes that provide design input to the WSM.

This document describes the scope of the SCP and provides insight to the hierarchy of the various components of the SCP.

3 SCOPE

This document defines the SCP components needed and notes the requirements of each major activity. Detailed descriptions of the various plant processes and plant administrative controls are not provided as these will be provided on a plant specific basis. However, key points and functions are identified to provide an understanding of the purpose of each component of the SCP. Further definition of each of the plant processes will be provided via the generation of reports or procedures or implementation plans that are produced on a plant specific basis. The sections that follow note the major SCP elements and subsequent descriptions for the Westinghouse SCP. Where appropriate; calibration, surveillance and operability acceptance criteria are identified.

[ ] a,c

The SCP addresses credible plant operations that are important for the safety of the plant as well as accident conditions required to be considered as a part of the nuclear power plant design. This includes:

[ ] a,c

The SCP covers the utilization of the WSM, the determination of the instrument channel uncertainty, the calculation of the 10 CFR 50.36 Limiting Safety System Setting (LSSS), NTS for the WSM, [ ]a,c

The SCP starts with the functional requirements, initially defined by Westinghouse, or required by the NRC or industry, [ ]a,c

[

][a,c] It then continues through the utilization of the WSM to determine the NTS and operability criteria for each function. The scaling program is executed to provide the correct calibration and display of a signal on qualified I&C equipment. Finally, it defines the process of maintaining the setpoints by the surveillance and maintenance of setpoints and instrumentation.

Issues that can affect the instrument uncertainty calculation for one or more protection functions or control functions, and thus, should cause uncertainty re-evaluation within the SCP are:

a,c

Specific details of the SCP, WSM, NTS determination, the scaling program, or the surveillance or maintenance procedures of setpoints and instruments are not provided in this document. These details are described in the appropriate documents, under administrative controls, that result from the SCP, such as the WSM topical report, e.g., References 3 and 20, instrument uncertainty calculation notes; calibration, surveillance and maintenance procedures, and plant corrective action program description.

4 WESTINGHOUSE SETPOINT METHODOLOGY DEFINITIONS

The WSM is explained in the generic report, Reference 20, or a plant specific topical report, e.g., Reference 3 for the **AP1000** plant. Inherent in any discussion of an SCP are setpoint methodology terms. To assure a common understanding for this discussion, the necessary terms are defined below in alphabetical order.

- **As Found** – The condition in which a transmitter, instrument process rack module, or process instrument loop is found after a period of operation.

- **As Found Tolerance** (AFT) – The As Found limit identified in the plant surveillance procedures. This defines a significant operability criterion for the instrument process rack and the transmitter. It is a sufficient condition to satisfy an operability assessment for an instrument process rack. From the WSM, the AFT for the instrument process rack is the same as (equals) the As Left Tolerance (ALT) or instrument process rack calibration accuracy (RCA) defined in the uncertainty calculations, i.e., AFT = ALT = RCA. For process racks, the AFT is a two-sided parameter (±) about the NTS. The AFT for transmitters is defined as the sensor drift (SD) magnitude indentified in the uncertainty calculations. For transmitters, the AFT is a two-sided parameter (±) about the calibration points, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span (an absolute drift parameter), or the AFT is a two-sided parameter (±) about the calibration recorded As Left points (a relative drift parameter).

a,c

- **As Left** – The condition in which a transmitter, instrument process rack module, or process instrument loop is left after calibration or trip setpoint verification. This condition is typically better than the calibration accuracy for the piece of equipment.

- **As Left Tolerance** (ALT) – The As Left limit identified in the plant calibration procedures. This defines the initial operability criterion for the instrument process rack or the transmitter. It is a necessary condition to satisfy an operability assessment for an instrument process rack or transmitter. From the WSM, the ALT is defined as the appropriate calibration accuracy in the uncertainty calculations for the sensor or associated instrument process rack string. For process racks, the ALT is a two-sided parameter (±) equal to the RCA about the NTS. The ALT for transmitters is defined as the two-sided (±) sensor calibration accuracy (SCA) magnitude indentified in the uncertainty calculations about the desired calibration points, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span.

[ ] a,c

- **Channel** – The sensing and process equipment, i.e., transmitter to bistable (analog process racks) or transmitter to trip output (digital process racks), for one input to the voting logic of a protection function.

- **Channel Statistical Allowance** (CSA) – The combination of the various channel uncertainties via Square-Root-Sum-of-the-Squares (SRSS), statistical, or algebraic techniques. It includes instrument (both sensor and process rack) uncertainties and non-instrument related effects. This parameter is compared with the Total Allowance (TA) for determination of instrument channel margin. For a protection function, the uncertainties included in, and the conservatism of, the CSA algorithm results in a CSA magnitude that is believed to be determined on a two-sided 95 % probability / 95 % confidence level (95/95) basis.

- **Environmental Allowance** (EA) - The change in a process signal (transmitter or process rack output) due to adverse environmental conditions from a limiting design basis accident condition or seismic event. Typically this value is determined from a conservative set of enveloping conditions and may represent the following:

  - Temperature effects on a transmitter
  - Radiation effects on a transmitter
  - Seismic effects on a transmitter
  - Temperature effects on a level transmitter reference leg
  - Temperature effects on signal cable, splice, terminal block or connector insulation
  - Seismic effects on process racks.

- **Margin** – The calculated difference (in % instrument span) between the TA and the CSA.

  Margin = TA – CSA

  Margin is defined to be a non-negative number, i.e., Margin ≥ 0 % span.

- **Nominal Trip Setpoint** (NTS) – The trip setpoint defined in the WSM and reflected in the plant procedures. This value is the nominal value programmed into the digital instrument process racks or the nominal value to which the bistable is set (as accurately as reasonably achievable) for analog instrument process racks. The NTS is based on engineering judgement (to arrive at a Margin ≥ 0 % span), or a historical value, that has been demonstrated over time to result in adequate operational margin. Based on the requirements of 10 CFR 50.36(c)(1)(ii)(A), Westinghouse defines the NTS as the Limiting Safety System Setting for the RTS and ESFAS functions listed in the plant Technical Specifications, e.g., Tables 3.3.1-1 and 3.3.2.-1 of, NUREG-1431 (Reference 23) or the **AP1000** plant (Reference 10).

- **Rack Calibration Accuracy** (RCA) – The two-sided (±) calibration tolerance of the process racks as reflected in the plant calibration procedures. The RCA is defined at multiple points across the calibration range of the channel, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span for input modules, and specifically at the NTS for the bistable or trip module. The RCA magnitude should be, and calibration procedure should confirm, the reference accuracy of the instrument process racks. Recording and trending of the As Left condition of the process racks (ALT = RCA) is necessary to assure conformance with the WSM basic assumptions.

  It is assumed that the individual modules in a loop are calibrated to a particular tolerance and that the process loop (as a string) is verified to be calibrated to a specific tolerance (RCA). [

  ]a,c

- **Rack Drift** (RD) – The change in input-output relationship (As Found – As Left) over a period of time at reference conditions, e.g., at constant temperature. [ ]a,c

  Recording and trending of the As Found condition of the process racks (RD) is necessary to assure conformance with the WSM basic assumptions.

- **Reference Accuracy** – "accuracy rating" as defined in ISA-51.1-1979 (R1993) (Reference 11, page 12), specifically as applied to Note 2 and Note 3 for either a process loop string or transmitter. The magnitude is typically defined in manufacturer's specification data sheets. Inherent in this definition is the verification of the following under a set of reference conditions; conformity (Reference 11, page 16), hysteresis (Reference 11, page 36) and repeatability (Reference 11, page 49).

- **Safety Analysis Limit** (SAL) – As defined in the WSM, the parameter value identified in the plant safety analyses or other plant operating limit at which a reactor trip or actuation function is assumed to be initiated. The SAL is typically defined in Chapter 15 of the UFSAR (current operating plants) or Tier 2, Chapter 15, Table 15.0-4a of the **AP1000** plant (Reference 10). Actual SAL values are determined, or confirmed, by review of the plant safety analyses.

- **Sensor Calibration Accuracy** (SCA) – The two-sided (±) calibration tolerance for a sensor or transmitter as defined in the plant calibration procedures. The SCA is defined at multiple points across the calibration range of the channel, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span. The SCA magnitude should be, and the calibration procedure should confirm, the reference accuracy of the transmitter. Recording and trending of the As Left condition of the sensor or transmitter (SCA) is necessary to assure conformance with the WSM basic assumptions.

- **Sensor Drift** (SD) – The change in input-output relationship (As Found – As Left) over a period of time at reference calibration conditions, e.g., at constant temperature. Recording and trending of the As Found condition of the sensor or transmitter (SD) is necessary to assure conformance with the WSM basic assumptions.

- **Square-Root-Sum-of-the-Squares** (SRSS) –

  $$\varepsilon = \sqrt{(a)^2 + (b)^2 + (c)^2}$$

  As approved for use in setpoint calculations by Reference 7.

- **Total Allowance** (TA) – The absolute value of the difference (in % instrument span) between the SAL and the NTS.

  $$TA = |SAL - NTS|$$

- **Trend** – The evaluation of [ ]a,c on a periodic basis utilizing As Left and As Found plant data for SCA, SD, RCA and RD for each control, protection and indication function to verify that the statistically based assumptions of the WSM are satisfied.

5 INPUTS TO THE WESTINGHOUSE SETPOINT METHODOLOGY AND THE WESTINGHOUSE SETPOINT CONTROL PROGRAM

The primary inputs to the WSM, and thus the SCP, are the instrumentation Functional Requirements documents for the protection system, control system and indication for the primary side, secondary side and safety-related equipment. These documents are the combined efforts of instrumentation engineers (sensor and process rack), analysts (cognizant of the safety analyses and transient analyses) and operations engineers. Reviews and evaluations of industry, NRC and vendor documentation are performed in conjunction with performance of engineering calculations to determine the control and protection system responses. Noted below are various documents that have bearing or influence on the determination or maintenance of protection system, control system or indication systems and their setpoints.

5.1 INDUSTRY DOCUMENTS

Noted below are industry documents Westinghouse has considered in the WSM or SCP. It should not be construed that consideration implies unqualified endorsement. There are aspects of various documents that Westinghouse does not consider appropriate for the WSM and thus, is not in literal compliance with or utilize all aspects of in the WSM or calculations. This Section and Section 5.2 discuss some of these differences.

5.1.1 ANSI/ISA-67.04.01-2006

(Reference 7)

[ ] a,c

5.1.2 ISA-RP67.04.02-2010

(Reference 8)

Westinghouse utilizes the recommended practice (RP) as a general guide only.

- As with Reference 7, the WSM does not utilize the LTSP concept described in this document. Instead, the WSM utilizes the NTS as the basis for setpoint determination.

- The WSM does not utilize the periodic test acceptance criteria (PTAC) magnitude identified in Section 8.1 of the RP. Evaluation of drift data for process racks for multiple plants and rack models, both analog and digital, has concluded that the more appropriate magnitude is the AFT as noted in; AFT = ALT = RCA. The WSM has also adopted a more conservative ALT definition than the RP, as noted in; ALT = RCA.

- [ ]a,c

5.1.3 ISA-TR67.04.09-2005

(Reference 9)

Westinghouse endorses the concept of a Graded Approach. With respect to WSM uncertainty calculations, the following are utilized:

1. Two-sided 95/95 calculations for all RTS/ESFAS protection functions identified in the Technical Specifications, e.g., Tables 3.3.1-1 and 3.3.2-1 of NUREG-1431 (Reference 23) and the **AP1000** plant (Reference 10), [ ]a,c

2. [ ]a,c

3. [ ]a,c

5.1.4 ISA 51.1-1979 (R1993)

(Reference 11)

The WSM utilizes this standard for definition of instrumentation parameter terms.

5.1.5 ISA 67.06.01-2002

(Reference 12)

Westinghouse considers this standard, recognizing that specific methods between the annexes and the WSM may differ. Westinghouse suggests Annex G, Online Monitoring, requires additional development prior to utilization to justify increased surveillance intervals for transmitters.

5.1.6 IEEE-279-1971

(Reference 28)

Westinghouse protection systems are designed to be in conformance with this standard. The WSM identifies the levels at which protective action is required, i.e., the Nominal Trip Setpoint.

5.1.7 IEEE-338-2006

(Reference 13)

Westinghouse protection systems are designed to be in conformance with this standard. The identified testing requirements are considered in the WSM, e.g., functional tests, channel calibration tests and test methods.

5.1.8 IEEE-498-1990

(Reference 29)

Westinghouse agrees with the requirements of this standard. Specifically, Westinghouse concurs with the requirement that the accuracy of the working standard should be four times better than the accuracy of the Measurement and Test Equipment (M&TE) (Figure 1 of the standard).

5.1.9 IEEE-603-2009

(Reference 14)

Westinghouse protection systems are designed to be in conformance with this standard. The protection system process racks are designed to allow periodic testing and calibration of channels via the introduction of known inputs. The WSM reflects the most common periodic testing methods utilized in the plant. The WSM documents the methodology that provides the basis for the Total Allowance and identifies the basis for the utilized Safety Analysis Limits.

5.1.10 Technical Specifications Task Force Traveler TSTF-493, Rev. 4

(Reference 2)

The proposed Westinghouse generic SCP is in conformance with TSTF-493, Rev. 4, Option B. Based on the WSM, the SCP does not utilize the concepts of LTSP and Allowable Value (AV), but rather defines an operable channel based on the AFT and ALT about the NTS. The NTS, AFT and ALT are defined, and controlled, for each protection function process rack channel as part of the SCP. The AFT and ALT for transmitters are also defined, and controlled, for each protection function as part of the SCP.

5.1.11 Emergency Response Guidelines

The Emergency Response Guidelines (ERGs) specify operator action points where specific operations are performed to stabilize the plant and limit the consequences of an event. These action points may be determined utilizing the WSM and accounting for the environmental and process conditions that exist at that time. The determination, control and maintenance of these operator action points would be contained within the SCP.

5.2 NRC DOCUMENTS

Noted below are NRC documents Westinghouse has considered in the WSM or SCP.

5.2.1 RG 1.105 Rev 3

(Reference 5)

The WSM is in general compliance with the requirements of this RG. However, Westinghouse does take exception to the definition of the LSSS as the Allowable Value. As noted previously, the WSM defines the NTS as the LSSS. The NRC Staff concerns identified in the "Discussion" section of the RG are addressed in the following manner:

1. Limited drift data evaluated – Reference 20 notes the number of calibration/drift intervals utilized in the Westinghouse calibration/drift evaluation process.

2. Drift data accounts for all data points – [

   ]a,c

3. Large number of data points for limited number of channels – Reference 20 provides support for the claim that the Westinghouse calibration/drift evaluation process is appropriate. [

   ]a,c

4. Flawed outlier analysis – Reference 20 provides the Westinghouse outlier evaluation process, [

   ]a,c

5. Time dependency found to be negligible – [

   ]a,c Rather, Reference 20 provides the process Westinghouse follows to establish the absence/presence of a significant time dependent drift characteristic and follows this process for plant specific drift evaluations.

6. Assumption of Normal distribution – Reference 20 identifies the process Westinghouse follows with regards to normality. [

   ]a,c

7. Drift evaluations utilize incomplete data sets – [

   ]a,c

8. Drift projections do not include appropriate projection penalties – Reference 20 describes the Westinghouse drift evaluation process, [ ][a,c]

9. Process or installation variables not addressed – [ ][a,c]

10. Assumptions for instrumentation or process effects not verified or surveillance performed – [ ][a,c]

11. Pooling of generic drift data with plant specific data – [ ][a,c]

12. All applicable data not utilized – see (7) above.

5.2.2 RG 1.97

(Reference 24)

The WSM is appropriate and applicable for instrumentation uncertainty determination for monitoring instrumentation required by RG 1.97, whichever revision is the licensing basis for the plant.

5.2.3 BTP 7-12 Rev 5

(Reference 4)

BTP 7-12 Rev. 5 provides guidance on the establishment and maintenance of setpoints. The means by which the acceptance criteria of BTP 7-12 are satisfied by the Westinghouse SCP are provided in this document and are identified in Appendix A.

5.2.4 ISG-08

(Reference 1)

With respect to the **AP1000** plant, ISG-08 requires one of three options be met for information contained in the plant technical specifications prior to issuance of the Combined License (COL):

1) Provide a plant specific value.

2) *Provide a value that bounds the plant-specific value, but by which the plant may be safely operated (i.e., a usable bounding value).*

3) *Establish a PTS Section 5.5 or 5.6 administrative controls program or report.*

Such an administrative controls technical specification as described in option (3) shall require (a) use of an NRC-reviewed and -approved methodology for determining the plant-specific value, (b) establishment of an associated document, outside the PTS, in which the relocated plant-specific value shall be recorded and maintained, and (c) any other information or restrictions the NRC staff deems necessary and appropriate to satisfy 10 CFR 50.36. For example, some COL applicants have proposed an administrative controls technical specification for a set point control program to satisfy 10 CFR 50.36(c)(1)(ii)(A) in lieu of specifying explicit values for the limiting safety system settings in the PTS.

Options (2) and (3) should allow an applicant to provide the necessary information without relying on information that is impractical to obtain before the time of COL issuance (i.e., information such as design detail, equipment selection, as-built system configuration, and system test results). Option (2) may be the most time-efficient approach to provide to the NRC staff for review.

As transmitter and process rack uncertainties had not been determined at a level sufficient to satisfy Option 1 and Option 2 was determined to be a burden to the plant, Option 3 was selected. This was reflected in Chapter 16, Specification 5.5.14 of Reference 10.

5.2.5 GL 91-04

(Reference 15)

The Westinghouse calibration and drift data evaluation process has been reviewed and found acceptable by the NRC for several 24 month surveillance cycle extensions. Reference 20 is the most definitive documentation of the Westinghouse calibration and drift evaluation process. The Westinghouse SCP requirements for evaluation of As Left and As Found data are consistent with the requirements of GL 91-04.

5.2.6 RIS 2006-17

(Reference 21)

With respect to this document, the parameters; LTSP and AV have no equivalent in the WSM and are not utilized. Operability of the process racks and the transmitters are as defined in Section 5.6.3.

The LSSS is defined as the NTS in the WSM. With respect to the NRC guidance provided on test acceptance criteria about the NTS, Westinghouse utilizes the process rack reference accuracy (defined as RCA) only in the determination of the ALT and AFT, i.e., AFT = ALT = RCA for process racks.

5.3 VENDOR DOCUMENTS – TYPICAL

Noted below are typical industry equipment vendor documents Westinghouse considers in the WSM or SCP, depending on the transmitters installed. It should not be construed that consideration implies unqualified endorsement. There are aspects of various documents that Westinghouse does not consider appropriate for the WSM and thus does not comply with or utilize in the Westinghouse methodology or calculations.

- Cameron/Barton®[2] Model 764 Differential Pressure Transmitter User Manual (Reference 16).
- Ultra/Weed Product Specifications Series N-E11 and N-E13 Electronic Pressure Transmitters (Reference 17).
- Rosemount 1154 Series H Alphaline®[3] Nuclear Pressure Transmitter (Reference 18).
- Ultra/Weed Product Specifications Model DTN2010 Pressure Transmitters (Reference 19).
- Fluke 8845A/8846A®[4] Digital Multimeter User's Manual (Reference 25).
- Keithley Model 2002®[5] Multimeter User's Manual (Reference 26).
- Heise®[6] 901A/901B Digital Pressure Indicator Installation and Operation Manual (Reference 27).

5.4 PLANT DOCUMENTS

5.4.1 Scaling procedures/calculations

The WSM receives input from the Scaling procedures or calculations. Examples of scaling corrections are:

[ ] a,c

[2] Barton® is a registered trademark of Cameron International Corporation ("Cameron")

[3] Alphaline, Rosemount and the Rosemount logotype are registered trademarks of Rosemount Inc.

[4] Fluke is a registered trademark of the Fluke Corporation

[5] All Keithley product names are trademarks or registered trademarks of Keithley Instruments, Inc.

[6] Heise is a registered trademark of Dresser, Inc., Dresser Measurement

The As Left (calibration) and As Found (drift determination) limits are typically provided in the calibration and surveillance procedures but calculated via scaling calculations. The values from these procedures are input to the uncertainty calculations for an operating plant and thus the magnitudes can have an effect in the determination or acceptability evaluation of the NTS.

Therefore, the plant scaling calculations and procedures should not be modified without an evaluation of the potential effects on the associated function uncertainty calculation. The SCP shall assure that a formal hierarchy of review is established via the plant scaling procedures to confirm the potential effects are addressed. The procedures necessary to achieve this hierarchy are contained in the plant SCP.

5.4.2 Calibration Procedures

The WSM assumes that the plant calibration procedures confirm device operability via verification that the instrument string or sensor can be calibrated to within the device reference accuracy on a periodic basis. The WSM assumes that the more complex instrument process racks are string calibrated, or string verified if individual module calibration is performed. The WSM assumes the calibration is performed at multiple points across the instrument span. An instrument string or sensor that cannot be calibrated to within the ALT is declared inoperable and repair or replacement action is initiated. The assumptions of the WSM are confirmed as part of the uncertainty determination process. The SCA and RCA characteristics of the WSM are confirmed on a periodic basis via the trend program evaluation process of the ALT recorded values.

Operating plant calibration procedures typically identify M&TE by make and model or equivalent accuracy that must be used in the performance of the procedure. The WSM reflects the accuracy of operating plant worst case M&TE or makes recommendations with regards to new plant M&TE, e.g., Digital Multimeter (DMM), digital pressure gauge, decade resistance box, for a given calibration procedure. The SCP shall assure that a formal hierarchy of review is established via the plant calibration procedures to address changes to M&TE used in the plant. The procedures necessary to achieve this hierarchy are contained in the plant SCP.

5.4.3 Surveillance Procedures

The WSM assumes that the plant surveillance procedures confirm device operability via verification that the instrument channel or sensor maintains operation within the AFT on a periodic basis. The WSM assumes that the As Found condition of the more complex instrument channels is determined on a string basis. The WSM assumes the surveillance is performed at multiple points across the instrument span. The assumptions of the WSM are confirmed as part of the uncertainty determination process. The SD and RD characteristics of the WSM are confirmed on a periodic basis via the trend program evaluation process of the recorded AFT and ALT values (AFT – ALT).

An instrument channel that is found:

1. Within the ALT = AFT = RCA is considered OPERABLE,

2. Outside the ALT = AFT = RCA and can be recalibrated to within the ALT is considered OPERABLE, but Suspect and should be observed closely via trending, for indications of additional drift outside tolerance. Such drift should result in the generation of a Condition Report and frequent drift should result in repair or replacement. Multiple instrument channels for a given function drifting in this manner should result in an evaluation of the drift characteristics of the RD term of the WSM.

3. Outside the ALT = AFT = RCA and cannot be recalibrated to within the ALT is considered INOPERABLE. A Condition Report should be generated and the instrument channel should be repaired or the failed component replaced to return the instrument channel to an OPERABLE condition.

A sensor that is found:

1. Within the ALT is considered OPERABLE,

2. Within the AFT, but outside the ALT, is considered OPERABLE and must be recalibrated to within the ALT,

3. Outside the AFT, but can be recalibrated to within the ALT, is considered OPERABLE, but Suspect and should be observed closely via trending, for indications of additional drift outside tolerance. Such drift should result in generation of a Condition Report and frequent drift should result in repair or replacement. Multiple sensors for a given function drifting in this manner should result in an evaluation of the drift characteristics of the SD term of the WSM.

Operating plant surveillance procedures typically identify M&TE by make and model or equivalent accuracy that must be used in the performance of the procedure. The WSM reflects the accuracy of operating plant worst case M&TE or makes recommendations with regards to new plant M&TE, e.g., DMM, digital pressure gauge, decade resistance box, for a given surveillance procedure. The SCP shall assure that a formal hierarchy of review is established via the plant surveillance procedures to address changes to M&TE used in the plant. The procedures necessary to achieve this hierarchy are contained in the plant SCP.

5.4.4 Corrective Action Program

The generation of a Condition Report should result in entering the Correction Action Program (CAP). The inability to satisfy the ALT or AFT for a given function should be trended within the CAP for feedback to the Maintenance Procedures and to the WSM. The inability to satisfy the ALT and AFT for a given function should result in evaluation of the adequacy of the RD and SD term characteristics and the subsequent impact on the uncertainty calculation, NTS and SAL.

5.4.5 Maintenance Procedures

The maintenance procedures provide input to the WSM via the performance of the sensor/transmitters and process racks. Confirmation that the hardware performs as designed and modeled in the uncertainty calculations, would result in no changes to the NTS or surveillance/calibration process. If it is found that abnormally high maintenance is necessary to keep equipment within specification, this could call into question the appropriateness of the various equipment uncertainty terms. The uncertainty term magnitudes are based on equipment design specifications and the inability to meet these magnitudes could call into question other uncertainty assumptions and equipment operability. Thus, feedback from the instrumentation maintenance program on these assumptions and how the equipment is operating is required. If new or different equipment, e.g., transmitter, process rack modules, measurement and test equipment, is installed or utilized, or significantly revised calibration or surveillance procedures are utilized, it is then necessary to evaluate the effects of such changes on the uncertainty calculation assumptions and results, and potentially the adequacy of the NTS, ALT and AFT values. Such changes should also be evaluated to determine potential effects on scaling procedures/calculations.

The opposite would be the fact that little or no recalibration is required to meet ALT/AFT values. This could suggest that the ALT/AFT values are not representative of expected equipment performance by being too large in magnitude. A 95/95 parameter is expected to be challenged on an occasional basis. If an AFT is never challenged, that is indicative of using a conservatively high magnitude in the uncertainty calculation but a non-conservatively high magnitude for a performance based operability criterion.

5.4.6 Plant Operations/Reactor Engineering

The WSM receives input, or feedback, from Plant Operations through the confirmation of acceptable AFT values. Indirectly this occurs through the channel check process performed by the Operators. If a channel deviates from its associated channels frequently, without equipment failure, this could be an indication that the AFT is not representative of the equipment performance, i.e., is too large in magnitude. Reactor Engineering would confirm that the allowed Incore/Excore ΔI mismatch magnitude is sufficient. This is influenced by the surveillance interval, i.e., the expected shift in ΔI as a function of core burnup.

5.4.7 Change Control Process

In order to maintain the uncertainty calculations of the WSM current during plant operation, the Change Control Process must determine and evaluate the effects of changes to: instrumentation (transmitters, process racks, M&TE, control system design/approach), plant operating parameters (Thot, Tcold, flow rates, pressures), plant design (tap relocation, replacement steam generators, flow measurement methods, steam generator or vessel internals), operating philosophy (surveillance intervals, surveillance methods, calibration methods) and analyses (SAL, NTS, thermal design methodology). This evaluation process must require formal review of potential effects of plant changes and processes on the assumptions and values of the WSM. The SCP shall provide the formalization and linkage of the Change Control Process to the WSM calculations.

5.4.8 Administrative Controls

To assure interlocking of the various plant procedures and processes, an Administrative Controls program, with appropriate oversight and auditing must be present. This would typically be performed via a Quality program.

5.5 PLANT SAFETY ANALYSES

Safety Analysis Limits are initially gathered from Chapter 15 of the plant UFSAR or DCD, e.g., Reference 10, and confirmed with the holder of the Analysis of Record (AOR). (In some older plants, the SALs are defined in Chapter 14.) [ ]^{a,c} [ ]^{a,c} This information is utilized by the WSM in the form of SAL values [ ]^{a,c}

5.6 INSTRUMENTATION TESTING

5.6.1 Instrumentation Qualification Testing

Design aspects of transmitter, process rack or other equipment, e.g., solid state relays, behavior are confirmed for Design Basis Event conditions via qualification testing. This type of testing is typically limited in the number of devices tested and scope. [ ]^{a,c} The results of the qualification testing are utilized in the WSM. The SCP shall provide the controls necessary to assure that replacement equipment meets or exceeds the same criteria. The areas covered in Westinghouse design basis qualification testing are:

1. Environmental

    a. Temperature – [ ]^{a,c} This testing includes a bounding temperature for the maximum temperature expected for a high energy line break, typically a large steam line break.

    b. Radiation – the device design accuracy is confirmed for radiation exposure [ ]^{a,c}

    c. Submergence/high humidity – device survivability is confirmed for those transmitters that are required to operate in a high humidity environment and potential submergence.

2. Drift – [ ]^{a,c}

3. Seismic – survivability and design maximum error during bounding seismic acceleration testing is confirmed. [ ]a,c

1.a, 1.b, and 3 result in the definition of Environmental Allowance terms in the WSM. 2 results in the definition of [ ]a,c

5.6.2 [ ]a,c

a,c

5.6.3 Calibration and Surveillance Testing

1. As Left Condition - Calibration Accuracy - Reference Accuracy verification – On a periodic basis the transmitter or process rack channel is calibrated. This calibration should verify the device reference accuracy characteristics and establish the As Left condition at multiple calibration points within the instrument calibration span, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span, for the next surveillance interval. When combined with previous As Left values, the trend characteristics of that device and function can be determined. Such trend data for an instrument channel (transmitter or process racks) [ ]a,c of the calibration process and thus, confirm the WSM uncertainty calculation assumption. The ability to calibrate is the first step in establishing the operability condition of the device or instrument channel.

2. As Found Condition – Drift – On a periodic basis the transmitter's or process rack channel's As Found condition should be determined at multiple calibration points within the instrument calibration span, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span. The recording of the first pass values in the increasing and decreasing span directions across the instrument span, when compared to the As Left values at the same points determines the instrument drift. When combined with previous drift data for that device or instrument channel, the trend characteristics of drift for that device or instrument channel can be determined. The device characteristics establish the performance of that single device or channel. [ ]^{a,c} the WSM uncertainty calculation assumption of drift for the transmitter and/or process racks is confirmed. The magnitude of drift for a device is the second indication of the operability condition of the device or instrument channel.

5.7 CALIBRATION AND DRIFT DATA EVALUATION

The WSM (Reference 20) assumes that the SCA, RCA, SD and RD terms can be described as two-sided, random probability distribution functions. In the simplistic sense, the SRSS presumes that the distribution functions can be described as Normal. [ ]^{a,c} However, changes in hardware (transmitters, process racks, M&TE), surveillance intervals or procedures can invalidate previous uncertainty calculation assumptions, depending on the degree of conservatism of said assumptions. Therefore, to maintain the 95/95 calculation basis, periodic evaluation of transmitter and process rack calibration (recorded As Left condition) and drift (recorded As Found condition - recorded As Left condition) data is required. It is suggested that the evaluation for a function should take place any time the hardware or surveillance interval is changed [ ]^{a,c}

Reference 20 describes the Westinghouse data evaluation process in detail. In the simplistic sense, it should be noted that the process includes the following:

[ ]^{a,c}

5.8 INSTRUMENT OPERABILITY CRITERIA

Instrument operability is determined based on several criteria. On a continuous basis, channel checks, i.e., comparison of redundant channels, are performed by the plant process computer. The Setpoint Control Program shall determine and document the appropriate channel check acceptance criteria. These acceptance criteria should be representative of normal operation and expected differences between like channels. [

]a,c On a longer term basis (refueling), instrument performance is determined by the surveillance procedure, i.e., the gathering of As Found data for multiple points across the instrument span. If during the surveillance process, a device is found outside of the ALT, the device is recalibrated utilizing the appropriate calibration procedure. The ability to calibrate a device is a major indication of the expected performance of the instrument and once a device can be recalibrated to within the ALT it is again considered operable.

If a device is found outside of the AFT, it is identified (via entry into the plant corrective action program) for further evaluation, as this is an indication of drift greater than that assumed in the WSM uncertainty calculation. It may be concluded that the device is not operating within design and must be investigated for repair or replacement. It may be concluded that the surveillance interval is too long and should be decreased. It may be concluded that the drift magnitude is characteristic of the device, found to be consistent with design, and that the uncertainty calculation should be revised.

The SCP shall assure that a formal hierarchy of review is established via plant maintenance procedures to address instrument operability assessment – surveillance procedure review, initialization of a condition report to note operation outside of design, entry into a corrective action program for repair or replacement as necessary. The procedures necessary to achieve this hierarchy are contained in the plant SCP.

5.8.1 Procedures for Detecting Instrument Abnormal Conditions

The WSM instrument uncertainty calculations account for protection function actuation and post event indication when the transmitter experiences harsh environment conditions within the instrumentation qualification envelope. [

]a,c

5.8.2 Instrument Process Rack

The WSM assumes that an instrument process rack string begins each surveillance interval within the two-sided tolerances of the RCA (ALT) term in order to satisfy the requirements of the calibration process. This is the first definition of an operable instrument channel. While the response time of the process rack is not explicitly measured as part of the calibration process, it is expected that the instrument technician performs a qualitative evaluation, i.e., the channel is not slow in responding. This is a second order definition of operability. In order to satisfy the randomness requirement, minimize the possibility of introducing an uncertainty bias over time [ ]^{a,c} and withstand the application of tolerance factors in a statistical trend evaluation; it is suggested that whenever an instrument channel is adjusted, the instrument technician should drive the calibration error to zero, i.e., minimize the calibration error. When a "leave alone zone" concept is incorporated into the calibration process, it is incumbent upon the plant staff to verify through the calibration trend evaluation process that a calibration bias is not introduced. An instrument channel must be left within the ALT at each calibration point as part of the calibration process. Westinghouse [ ]^{a,c} therefore, it should be found within the ALT; thus, the Westinghouse definition for operability of the process racks: AFT = ALT = RCA. If an instrument process rack string is found outside of the AFT, the instrument string must be recalibrated and left within the ALT.

5.8.3 Sensor/Transmitter

The WSM assumes that a sensor or transmitter begins each surveillance interval within the two-sided tolerances of the SCA term in order to satisfy the requirements of the calibration process. This is the first definition of an operable transmitter. The second definition of an operable sensor or transmitter is that at the end of the surveillance interval, the device should be found within its AFT, i.e., for relative drift determinations, {(As Found value – As Left value) ≤ AFT}; for absolute drift determinations, {As Found value ≤ AFT}. While the response time of the transmitter is not explicitly measured as part of the calibration process, it is expected that the instrument technician performs a qualitative evaluation, i.e., the device is not slow in responding. This is a second order definition of operability. In order to satisfy the randomness requirement, minimize the possibility of introducing an uncertainty bias over time [ ]^{a,c} and withstand the application of tolerance factors in a statistical trend evaluation; it is suggested that whenever a transmitter is adjusted, the instrument technician should drive the calibration error to zero, i.e., minimize the calibration error. When a "leave alone zone" concept is incorporated into the calibration process, it is incumbent upon the plant staff to verify through the calibration trend evaluation process that a calibration bias is not introduced. A sensor or transmitter must be left within the ALT at each calibration point as part of the calibration process. If a sensor or transmitter is found outside of the ALT, it must be recalibrated and left within the ALT.

6 OUTPUTS OF THE WESTINGHOUSE SETPOINT METHODOLOGY

6.1 SCALING PROCEDURES/CALCULATIONS

The WSM works in the unit of % span. Utilization of % span, instead of the engineering unit (psia, psig, % RTP, etc.), results in fewer errors in the determination of the instrument uncertainty. However, this is not acceptable for the instrument technician to use in the field. The channel must be scaled into a unit that can be read in the field, millamp (mA), or voltage (V) if measured across a dropping resistor, for transmitters, and voltage for process rack modules (signal condition, bistables and analog to digital (A/D) converters). In addition, it is in the scaling process that static head corrections, systematic calibration offsets, gain factors, fluid density effects, elevated temperature corrections and elevated zero corrections are introduced. Thus, the WSM provides input to the plant instrumentation Scaling procedures or calculations. [

]^{a,c}

6.2 CALIBRATION AND SURVEILLANCE PROCEDURES

The surveillance program, which includes the recalibration of the channels, will assess operability of the equipment, transmitter or process rack modules. As a result, instrumentation that is out of calibration or determined inoperable will be identified, recalibrated, repaired or replaced. When an instrument is replaced with a different make or model, criteria must be developed to define the acceptability of the new instrumentation. These criteria may include recalculation of the setpoint to re-establish margin (analysis or operational margin as required). If necessary, the plant Technical Specifications, licensing and or design basis documentation will be appropriately revised.

Calibration and surveillance of the transmitters and process racks is performed on a periodic basis, as required by the plant Technical Specifications. Transmitters and process rack modules are checked on a continuous basis via the plant process computer and periodically by the Operators via the control board indication, i.e., comparisons between channels (channel checks). Transmitters are checked utilizing known inputs on a refueling basis (nominal 18 months, maximum 22.5 months or nominal 24 months, maximum 30 months) to determine the As Found condition. Process rack modules are checked utilizing known inputs on a more frequent basis, as short as monthly, as long as semi-annually. The surveillance procedures confirm that the hardware is performing as designed and if not found within the ALT, are recalibrated utilizing the appropriate calibration procedure. These checks and calibrations provide the data necessary to determine the drift magnitudes and establish the initial condition for the next operating or surveillance interval. Device As Left and As Found data is recorded and managed. The data is utilized to confirm device operation within design and the assumptions of the uncertainty calculations. The As Left data are evaluated to confirm that calibration biases are not instituted through the calibration process.

As Left and As Found data are evaluated to confirm that the device drift magnitude is within limits and that no biases become evident. The As Left and As Found data form the basis for future re-evaluation of the calibration and drift magnitudes utilized in the uncertainty calculations and NTS determination. The WSM provides as an output, the definition of the design ALT/AFT, through the SCA and SD term magnitudes for the sensor/transmitter and the RCA and RD term magnitudes for the process racks. These magnitudes are reflected as two-sided calibration accuracies at the calibration points in the transmitter and process rack calibration procedures; and as two-sided As Found tolerances at the calibration points in the transmitter and process rack surveillance procedures.

Measurement and Test Equipment (M&TE) utilized to perform the instrument calibration and surveillance should be as accurate as reasonably achievable. Utilization of currently available, high accuracy DMM and digital pressure gauges, examples of which are provided in Section 5.3, results in easily accomplished accuracy ratios of 10:1 (SCA:M&TE, SD:MT&E, RCA:M&TE, RD:M&TE). This minimizes the effect of M&TE on the As Left and As Found condition of the instrumentation. Surprisingly, older DMMs (0.05 % span for a Fluke 8600A) can achieve better accuracies than more modern DMMs (0.09 % span for a Fluke 8050A and 0.08 % span for a Fluke 45) on a worst case basis, i.e., 5 VDC reading on a 1 – 5 VDC instrument span. However, this suggests that while the desired 10:1 ratio is not satisfied with some DMMs, a 5:1 ratio is satisfied. The effects of a 5:1 ratio M&TE are still acceptable as the DMM uncertainty is a specification and may not represent the actual uncertainty with careful calibration and use under controlled conditions.

[ ] a,c

[ ]a,c The Westinghouse evaluation process identified in Reference 20 addresses all of these aspects and concerns. Once the surveillance interval is extended, confirmation of continued equipment operability will be achieved [ ]a,c

6.3 MAINTENANCE PROCEDURES

The plant SCP shall identify that the instrument maintenance program provides directions to repair instrumentation to within design specifications. The maintenance program shall track and assess ALT/AFT data to determine the performance of the instrument throughout the life of the device. Replacement instrumentation shall be confirmed to meet or exceed the design specifications of the instrument uncertainty calculations. If the replacement instrumentation does not meet the design specifications of the instrument uncertainty calculations; the instrument uncertainty calculations shall be re-evaluated and revised as necessary. If the replacement instrumentation exceeds the design specifications of the instrument uncertainty calculations, the ALT/AFT shall be evaluated for revision to reflect the appropriate criteria. If the ALT/AFT criteria are revised, appropriate changes must be reflected in all affected downstream calculations and documentation, e.g., scaling procedures/calculations, calibration procedures, surveillance procedures, etc.

7 REFERENCES

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APPENDIX A: NRC BTP 7-12 ACCEPTANCE CRITERIA

1. *Facility setpoint list identifying safety setpoints and non-safety setpoints for functions providing protective functions important to safety or that are relevant to compliance with technical specification limiting conditions for operation.*

[ ]a,c

2. *Identification of safety setpoints that are not safety-limit-related LSSS and the basis for this determination.*

[ ]a,c

3. *Identification of setpoints that trigger procedural actions that are important to safety.*

[ ]a,c

4. *Description of the setpoint methodology and procedures used in determining setpoints, including information sources, scope, assumptions, interface reviews, and statistical methods.*

[ ]a,c

5. *Terminology used to describe limits, allowances, and tolerances, and environmental or other effects used to support setpoint calculations.*

[ ]a,c

6. *Technical specifications and basis for LSSSs.*

[ ]a,c

7. *Basis for acceptable as-found band and acceptable as-left band and determination of the instrument operability based on acceptable as-found band and acceptable as-left band.*

[ ]a,c

8. Basis for calibration intervals.

[ ]a,c

9. Basis for assumptions regarding instrument uncertainties and discussion of the method used to determine uncertainty values.

[ ]a,c

10. Description of the provisions for control of measuring and test equipment used for calibration of the instrument.

[ ]a,c

11. Description of the program and methodology used to monitor and manage instrument uncertainties, including drift.

[ ]a,c

12. Description of the functional and performance criteria for the initiation and execution of the safety functions at the setpoints.

[ ]a,c

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

[ ]a,c

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

[ ]a,c

15. *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.*

[

]^{a,c}

16. *For digital instrumentation, the configuration database for the instrumentation functions, and identification of digital elements (hardware and software) where error could be introduced into 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).*

[ ]^{a,c}

17. *The description of assumptions in accordance with ISA-S67.04, should include the environmental allowances (temperature, pressure, humidity, radiation, vibration, seismic, and electrical) for the instruments.*

[ ]^{a,c}

APPENDIX B: NRC BTP 7-12 REVIEW PROCEDURES

1. *Relationships between the safety limit, analytical limit, limiting trip setpoint, the allowable value, the setpoint, the acceptable as-found band, the acceptable as-left band, and the setting tolerance.*

[ ]a,c

2. *The reviewer should assure that the setpoint technical specifications meet the requirements of 10 CFR 50.36. Additional information related to setpoint technical specifications is provided in RIS 2006-17.*

[ ]a,c

3. *Basis for selection of the trip setpoint.*

[ ]a,c

4. *Uncertainty terms that are addressed.*

[ ]a,c

5. *Method used to combine uncertainty terms.*

[ ]a,c

6. *Justification of statistical combination.*

[ ]a,c

7. *Relationship between instrument and process measurements units.*

[ ]a,c

8. Data used to select the trip setpoint, including the source of the data.

[

]a,c

9. Assumptions used to select the trip setpoint (e.g., ambient temperature limits for equipment calibration and operation, potential for harsh accident environment).

[

]a,c

10. Instrument installation details and bias values that could affect the setpoint.

[

]a,c

11. 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).

[

]a,c

12. 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.

[

]a,c