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Westinghouse Generic Setpoint Methodology

Westinghouse

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1.0 INTRODUCTION

This document provides the basic instrument uncertainty algorithms for the Reactor Trip System (RTS) trip functions, Engineered Safety Features Actuation System (ESFAS) protection functions, Emergency Operating Procedure (EOP) operator action points, control system functions assumed as initial condition assumptions in the safety analyses, and control board and computer indication of plant parameters utilized by the plant operators to confirm proper operation of the control and protection instrumentation for a Westinghouse Nuclear Steam Supply System (NSSS). These algorithms, when supported by appropriate plant procedures and equipment qualification, are believed to provide total instrument loop uncertainties, termed Channel Statistical Allowance (CSA), at a 95 % probability and 95 % confidence level; as required by U. S. NRC Regulatory Guide (RG) 1.105, Revision 3 (Reference 1). [

]^{a,c}

This document is divided into five sections. Section 2.0 identifies the current, Westinghouse generalized algorithm (Eq. 2.1) used as the basis to determine the overall instrument uncertainty for an RTS/ESFAS function. This specific algorithm evolved from a Westinghouse paper presented at an Instrument Society of America/Electric Power Research Institute (ISA/EPRI) conference in June 1992 (Reference 2). This approach is consistent with American National Standards Institute (ANSI), ANSI/ISA-67.04.01-2006 (Reference 3). The basic uncertainty algorithm is the Square-Root-Sum-of-the-Squares (SRSS) of the applicable uncertainty terms, which is endorsed by the International Society of Automation (ISA) standard. All appropriate and applicable uncertainties, as defined by a review of the plant baseline design input documentation, have been included in each RTS/ESFAS function uncertainty calculation. ISA-RP67.04.02-2010 (Reference 4) was utilized as a general guideline, but each uncertainty and its treatment is based on Westinghouse methods which are consistent or conservative with respect to this document. The latest version of NRC Regulatory Guide 1.105 (Revision 3) endorses the 1994 version of ISA S67.04, Part I. Westinghouse has evaluated this NRC document and has determined that the RTS/ESFAS function uncertainty calculations contained in this report are consistent with the guidance contained in Revision 3. It is believed that the total channel uncertainty, CSA, represents a 95/95 value as requested in Regulatory Guide 1.105. Variations of the protection function uncertainty algorithm are presented to demonstrate the Westinghouse treatment of uncertainties for control functions and parameter indication.

Section 3.0 of this report provides definitions of terms and associated acronyms used in the RTS/ESFAS function, control and indication uncertainty calculations. Appropriate references to industry standards have been provided where applicable. Included in this section are detailed descriptions of the uncertainty terms and values for a typical RTS/ESFAS, control and indication function uncertainty calculations performed by Westinghouse. Provided on each table is the function specific uncertainty algorithm which notes the appropriate combination of instrument uncertainties to determine the CSA. Included for the protection function is a listing of the Safety Analysis Limit (SAL), the Nominal Trip Setpoint (NTS), the

Total Allowance (TA) (the difference between the SAL and NTS, in % span), Margin and Operability criteria, As Left Tolerance (ALT) and As Found Tolerance (AFT), for both the sensor/transmitter and process racks.

Section 4.0 provides an overview of the Westinghouse evaluation process for calibration and drift data. It describes the basic approach utilized [

]^{a,c} This process has been used for longer than 14 years in the evaluation of surveillance data and was last described to the NRC in a Westinghouse presentation in March 2007 (Reference 27).

Section 5.0 provides a description of the Westinghouse recommendations for implementation of the Westinghouse Setpoint Methodology (WSM) in the plant Technical Specifications and the assessment of operability of sensor/transmitters and process racks.

The NRC has identified acceptance criteria and review procedures for a plant Setpoint Control Program (SCP) in BTP 7-12 Rev 5 (Reference 5). Appendix A identifies how this document addresses those acceptance criteria. Appendix B identifies how this document addresses information noted as necessary in the review procedures.

2.0 COMBINATION OF UNCERTAINTY COMPONENTS

This section describes the Westinghouse Setpoint Methodology for the combination of the uncertainty components utilized for protection, control and indication functions. The methodology used in the determination of the overall CSA is noted in Section 2.1 below. All appropriate and applicable uncertainties, as defined by a review of plant specific baseline design input documentation, are included in each protection, control or indication function CSA calculation.

2.1 Methodology

The methodology used to combine the uncertainty components for a channel is an appropriate combination of those groups which are statistically and functionally independent. Those uncertainties which are not independent are conservatively treated by arithmetic summation and then systematically combined with the independent terms.

The basic methodology used is a Square-Root-Sum-of-the-Squares (SRSS). This basic approach, or others of a similar nature, has been used for Westinghouse uncertainty calculations for many years: protection function instrument uncertainty calculations – June 1978 (Reference 6), statistical DNB calculations – WCAP-8567 (Reference 7), **AP1000**®[1] Plant protection function uncertainties – WCAP-16361-P (Reference 8). WCAP-8567 was approved by the NRC, noting acceptability of statistical techniques for the application requested, in April 1978 (Reference 7). WCAP-16361-P was approved by the NRC in August 2007 (Reference 9). Also, various ANSI, American Nuclear Society (ANS), and ISA standards approve the use of probabilistic and statistical techniques in determining safety-related setpoints (References 3 & 10).

The generalized relationship between the uncertainty components and the calculated uncertainty for a protection channel is noted in Eq. 2.1:

$$\mathrm{CSA}_{\mathrm{PROT}} = \left\{ \sqrt{\begin{array}{l} \mathrm{PMA}^2 + \mathrm{PEA}^2 + \mathrm{SRA}^2 + (\mathrm{SMTE}+\mathrm{SD})^2 + (\mathrm{SMTE}+\mathrm{SCA})^2 + \\ \mathrm{SPE}^2 + \mathrm{STE}^2 + (\mathrm{RMTE}+\mathrm{RD})^2 + (\mathrm{RMTE}+\mathrm{RCA})^2 + \mathrm{RTE}^2 \end{array}} \right\} + \mathrm{EA} + \mathrm{Bias}$$

Eq. 2.1

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The generalized relationship between the uncertainty components and the calculated uncertainty for a control channel is noted in Eq. 2.2 (subscript IND denotes indication):

a,c

Eq. 2.2

The generalized relationship between the uncertainty components and the calculated uncertainty for an indication channel is noted in Eq. 2.3 (subscript IND denotes indication – control board meter or plant process computer):

a,c

Eq. 2.3

Where:

CSA = Channel Statistical Allowance
PMA = Process Measurement Accuracy
PEA = Primary Element Accuracy
SRA = Sensor Reference Accuracy
SMTE = Sensor Measurement and Test Equipment Accuracy
SD = Sensor Drift
SCA = Sensor Calibration Accuracy
SPE = Sensor Pressure Effects
STE = Sensor Temperature Effects
RMTE = Rack Measurement and Test Equipment Accuracy
RD = Rack Drift
RCA = Rack Calibration Accuracy
RTE = Rack Temperature Effects
EA = Environmental Allowance
BIAS = One directional, known magnitude allowance

CA = Controller Accuracy
READOUT = Readout Device Accuracy
[ ]a,c

Each of the previous terms is defined in Section 3.2, Setpoint Methodology Definitions.

The equations are based on the following:

1. Sensor and rack measurement and test equipment uncertainties are treated as dependent parameters with their respective drift and calibration accuracy allowances.
2. [ ]a,c The term is arithmetically summed with the SRSS in the direction of conservatism.
3. Bias terms are one directional with known magnitudes (which may result from several sources, e.g., drift or calibration data evaluations) and are also arithmetically summed with the SRSS.
4. [ ] a,c

Consistent with the request of Regulatory Guide 1.105 (Reference 1), the CSA value from Eq. 2.1 is believed to be determined at a 95 % probability and at a 95 % confidence level (95/95). The control function CSA value from Eq. 2.2 is believed to be determined at a 95 % probability and at a 95 % confidence level (95/95), consistent with the requirements of the Westinghouse Improved Thermal Design Procedure (ITDP) (Reference 7) and the Westinghouse Revised Thermal Design Procedure (RTDP) (Reference 17). [ ]a,c

2.2 Sensor Allowances

Seven parameters are considered to be sensor allowances: SRA, SCA, SMTE, SD, STE, SPE and EA. Three of these parameters are considered to be independent, two-sided (±), unverified (by plant calibration or drift determination processes), vendor supplied terms (SRA, STE and SPE). Based on vendor supplied data, typically product data sheets and qualification reports, these parameters are treated as 95/95 values unless specified otherwise by the vendor. Three of the remaining parameters are considered dependent with at least one other term, are two-sided (±), and are the result of the plant calibration and drift determination process (SCA, SMTE and SD).

SRA is the manufacturer's reference accuracy that is achievable by the device. This term is introduced to address repeatability and hysteresis effects when performing only a single pass calibration, i.e., one up and one down. If the plant performs a verification of all three aspects of the sensor reference accuracy, as defined by ISA-51.1 (Reference 12, p. 61) as part of the calibration process, the value of SRA can be set to zero. STE and SPE are considered to be independent due to the manner in which the instrumentation is checked; i.e., the instrumentation is calibrated and drift is determined under conditions in which pressure and temperature are assumed constant. For example, assume a sensor is placed in some position in the containment during a refueling outage. After placement, an instrument technician calibrates the sensor at ambient pressure and temperature conditions. Sometime later with the plant shutdown, an instrument technician checks for sensor drift using the same technique as was previously used for calibrating the sensor. The conditions under which this drift determination is made are again ambient pressure and temperature. The temperature and pressure should be essentially the same at both measurements. Thus, they should have no significant effect on the drift determination and are, therefore, independent of the drift allowance.

SCA and SD are considered to be dependent with SMTE due to the manner in which the instrumentation is evaluated. A transmitter is calibrated by providing a known process input (measured with a high accuracy gauge) and evaluating the electrical output with a digital multimeter (DMM) or digital voltmeter (DVM). The gauge and DVM accuracies form the SMTE terms. The transmitter response is known, at best, to within the accuracy of the measured input and measured output. Thus, the calibration accuracy (SCA) is functionally dependent with the measurement and test equipment (SMTE). Since the gauge and DVM are independent of each other (they operate on two different physical principles), the two SMTE terms may be combined by SRSS prior to addition with the SCA term. Transmitter drift is determined using the same process used to perform a transmitter calibration. That is, a known process input (measured with a high accuracy gauge) is provided and the subsequent electrical output is measured with a DMM or DVM. In most cases the same measurement and test equipment is used for both calibration and drift determination. Thus, the drift value (SD) is functionally dependent with the measurement and test equipment (SMTE) and is treated in the same manner as SMTE and SCA.

While the data is gathered in the same manner, SD is independent of SCA in that they are two different parameters. SCA is the difference between the As Left value and the Desired value. SD is the difference between the As Found value of the current calibration and the As Left value of the previous calibration. It is assumed that a [

]^{a,c}

Transmitters are designed and subsequently verified through qualification [

]^{a,c} to be able to withstand adverse elevated temperatures from exposure to design basis events (DBE) due to mass and energy loss from a break in the primary or secondary side piping. This is addressed in the uncertainty calculation by the inclusion of an EA temperature term. Vendor specifications typically identify the transmitter response as a "±" term, indicating that the transmitter may respond in either the indicated higher than actual direction or indicated lower than actual direction when exposed to significantly elevated temperatures. Because of this identification, this term is interpreted by many to be a random variable. [

]^{a,c} This suggests that on a plant specific basis, the more appropriate treatment of the EA temperature uncertainty term is as a limit of error, i.e., as a bias, and not as a random term.

Transmitters are designed and subsequently verified through qualification testing, to be able to withstand exposure to high doses of radiation due to mass loss from a break in the primary side piping. This is addressed in the uncertainty calculation by the inclusion of an EA radiation term. Vendor specifications typically identify the device response as a "±" term, indicating that the transmitter may respond in either the indicated higher than actual direction or indicated lower than actual direction when exposed to significant radiation. Because of this identification, this term is interpreted by many to be a random variable. [

]^{a,c} This suggests that on a plant

specific basis, the more appropriate treatment of the EA radiation uncertainty term for a pressurizer pressure transmitter is as a limit of error, i.e., as a bias, and not as a random term.

a,c

However, there are several transmitter vendors that have identified the determination of post-seismic residual effects. The vendor specifications identify the transmitter response as a "±" term, indicating that the seismic event may result in a residual effect in either the indicated higher than actual direction or the indicated lower than actual direction. Because of this identification, this term is interpreted by some to be a random variable. [

]^{a,c} This suggests that on a plant specific basis, the more appropriate treatment of the EA seismic uncertainty term is as a limit of error, i.e., as a bias, and not as a random term.

a,c

2.3 Rack Allowances

Four parameters are considered to be rack allowances: RCA, RMTE, RTE and RD. Rack Reference Accuracy (RRA) is the manufacturer's reference accuracy that is achievable by the process rack instrument string. This term is introduced to address repeatability and hysteresis effects not addressed by the performance of a single pass calibration, i.e., one up and one down. [

]^{a,c} RTE is considered to be an independent, two-sided (±), unverified (by plant calibration or drift determination processes), vendor supplied parameter. The process racks are located in an area with ambient temperature control, making consistency with the rack evaluation temperature easy to achieve. Based on Westinghouse process rack data, this parameter is treated as a 95/95 value.

RCA and RD are considered to be two-sided (±) terms dependent with RMTE. The functional dependence is due to the manner in which the process racks are evaluated. In order to calibrate or determine drift for the process rack portion of a channel, a known input (in the form of a voltage, current or resistance) is provided and the point at which the trip bistable changes state is measured. The input parameter is either measured by the use of a DMM or DVM (for a current or voltage signal) or is known to some degree of precision by use of precision equipment, e.g., a precision decade box for a resistance input. For simple channels, only a DMM or DVM is necessary to measure the input and the state change is noted by a light or similar device. For more complicated channels, multiple DVMs may be used or a DVM in conjunction with a decade box. The process rack response is known at best to within the accuracy of the measured input and indicated output. Thus the calibration accuracy (RCA) is functionally dependent with the measurement and test equipment (RMTE). In those instances where multiple pieces of measurement and test equipment are utilized, the uncertainties are combined via SRSS when appropriate.

The RCA term represents the total calibration uncertainty for the channels which are calibrated as a single string. Drift for the process racks is determined using the same process used to perform the rack calibration, and in most cases utilizes the same measurement and test equipment. Thus, the drift value (RD) is also functionally dependent with the measurement and test equipment (RMTE) and is treated in the same manner as RMTE and RCA.

While the data is gathered in the same manner, RD is independent of RCA in that they are different parameters. RCA is the difference between the As Left value and the Desired value. RD is the difference between the As Found of the current calibration and the As Left values of the previous calibration. The RD term represents the drift for all process rack modules in an instrument string, regardless of the channel complexity. For multiple instrument strings there may be multiple RD terms, e.g., Overtemperature ΔT. It is assumed that a [

]^{a,c}

a,c

2.4 Process Allowances

The PMA and PEA parameters are considered to be independent of both sensor and rack parameters. The PMA terms provide allowances for the non-instrument related effects; e.g., neutron flux distribution, calorimetric power uncertainty assumptions, temperature streaming in a pipe, process pressure effects or fluid density changes. There may be more than one independent PMA uncertainty allowance for a channel, if warranted. The PEA term typically accounts for uncertainties due to metering devices, such as elbows, venturis, and orifice plates. In this application, PEA is limited by Westinghouse to RCS Flow (Cold Leg Elbow Taps, Cold Leg Bends and Hot Leg Elbows), Steam Flow, Feedwater Flow and Steam Generator Blowdown Flow. PEA may also be used for the uncertainties associated with potential transformers for Undervoltage and Underfrequency functions. In these applications, the PEA term has been determined to be independent of the sensors and process racks. It should be noted that treatment as an independent parameter does not preclude determination that a PMA or PEA term should be treated as a bias. If that is determined to be appropriate, Eq. 2.1 would be modified such that the affected term would be treated by arithmetic summation with appropriate determination and application of the sign of the uncertainty.

2.5 Digital Functions

The treatment of digital functions varies to some extent due to the type of function. For example, indication via the plant process computer is quite simplistic in nature; add an Analog to Digital (A/D) converter to the rack allowances. [

]^{a,c} There are typically two types of digital protection functions, 1) form/fit/function replacement for an analog channel, e.g., Westinghouse **Eagle-21**™(2) protection racks, 2) complex functions that utilize multiple intermediate calculations, e.g., **AP1000** Pressurizer Level or Overtemperature ΔT. In the first instance, the process rack uncertainties associated with an analog channel (RCA, RTE, RD) are replaced with card specific equivalents for a digital channel. The digital equivalents are card specific [

]^{a,c} For simple digital protection functions, NTS is defined as a single value in voltage, current, resistance or an engineering unit (psia, psig, % span, % Rated Thermal Power, % level) [

]^{a,c}

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For complex functions, the uncertainties can be considerably different. [

]^{a,c}

a,c

3.0 PROTECTION SYSTEM SETPOINT METHODOLOGY

This section contains definitions of terms used in the instrument uncertainty calculations. Also included are detailed example tables providing representative uncertainties to demonstrate the utilization of the algorithms.

3.1 Instrument Channel Uncertainty Calculations

Tables 3-1 through 3-3 provide individual component uncertainties and CSA calculations for an example set of uncertainty calculations. Table 3-1 is for a protection function. Table 3-2 is for a control function. Table 3-3 is for an indication function. The tables list the applicable terms for the representative uncertainty calculation, e.g., Safety Analysis Limit, Nominal Trip Setpoint, (in engineering units), and Channel Statistical Allowance, Margin, Total Allowance, As Left Tolerance, As Found Tolerance, and uncertainty terms (in % span). Westinghouse reports uncertainty values, as demonstrated in Tables 3-1, 3-2 and 3-3, to one decimal place using the technique of rounding down values less than 0.05 % span and rounding up values greater than or equal to 0.05 % span. Parameters reported as "0.0" have been identified as having a value of ≤ 0.04 % span. Parameters reported as "0" are not applicable (i.e., have no value) for that channel. These have been the Westinghouse practice for rounding and reporting values since the first uncertainty report for D. C. Cook Unit 2 (Reference 6). Table 3-4 provides the derivation of the translation of differential pressure span to % nominal flow and % flow span for flow functions.

3.2 Setpoint Methodology Definitions

For the channel uncertainty values used in this report, the following definitions are provided, in alphabetical order:

- **Analog to Digital Convertor** (A/D)

  An electronic circuit module that converts a continuously variable analog signal to a discrete digital signal via a prescriptive algorithm.

- **As Found**

  The condition in which a transmitter, 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. The AFT for the instrument process rack is the same as (equals) the As Left Tolerance or instrument process rack calibration accuracy, i.e., AFT = ALT = RCA, see Figure 3-1. For process racks, the AFT is a two-sided parameter (±) about the Nominal Trip Setpoint. The AFT for transmitters is defined as the sensor drift magnitude identified 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 that 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 (see Figure 3-1) or the transmitter. It is a necessary condition to satisfy an operability assessment for an instrument process rack or transmitter. 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, see Figure 3-1. The ALT for transmitters is defined as the two-sided (±) sensor calibration accuracy magnitude indentified in the uncertainty calculations about the desired calibration points, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span.

a,c

- **Bias**

  - A parameter with a known consistent arithmetic sign, e.g., heatup effect on a level channel Reference Leg.
  - A parameter that is treated as a limit of error, e.g., transmitter heatup in a Steambreak elevated temperature environment.

- **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. Westinghouse designs protection functions with voting logic made up of multiple channels, e.g. 2 out of 4 Steam Generator Level - Low-Low channels for one steam generator must have their bistables in the tripped condition for a Reactor Trip to be initiated. For control functions, a channel is the sensing and process equipment through the controller module. For indication functions, a channel is the sensing and process equipment through the indicator (control board or Plant Process Computer).

- **Channel Statistical Allowance** (CSA)

  The combination of the various channel uncertainties via SRSS, statistical, or algebraic techniques. It includes instrument (both sensor and process rack) uncertainties and non-instrument related effects, e.g., Process Measurement Accuracy, see Eq.(s) 2.1, 2.2 and 2.3. This parameter is compared with the Total Allowance for determination of instrument channel margin, see Figure 3-1. 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.

- **Controller Accuracy** (CA)

  Allowance for the accuracy of the controller rack module(s) that performs the comparison and calculates the difference between the controlled parameter and the reference signal.

- **Digital to Analog Convertor** (D/A)

  An electronic circuit module that converts a discrete digital signal to a continuously variable analog signal via a prescriptive algorithm.

- **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 TA and CSA.

  Margin = TA – CSA

Margin is defined to be a non-negative number i.e., Margin ≥ 0 % span, see Figure 3-1. [

]^{a,c}

- **Nominal Trip Setpoint** (NTS)

  The trip setpoint defined in the uncertainty calculation 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, see Figure 3-1. Based on the requirements of 10 CFR 50.36(c)(1)(ii)(A), Westinghouse defines the NTS as the Limiting Safety System Setting (LSSS) 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 13) or the **AP1000** plant (Reference 14).

- **Normalization**

  The process of establishing a relationship, or link, between a process parameter and an instrument channel. This is in contrast with a calibration process. A calibration process is performed with independent known values, i.e., a bistable is calibrated to change state when a specific voltage is reached. This voltage corresponds to a process parameter magnitude with the relationship established through the scaling process. A normalization process typically involves an indirect measurement, [

  ]^{a,c}

- **Primary Element Accuracy** (PEA)

  Uncertainty due to the use of a metering device. In Westinghouse RTS/ESFAS calculations, this parameter is limited to use on a venturi, orifice, elbow or potential transformer. Typically, this is a calculated or measured accuracy for the device. PEA may also be used for the uncertainties associated with potential transformers for Undervoltage and Underfrequency functions.

- **Process Loop** or **Instrument Process Loop**

  The process equipment for a single channel of a protection, control or indication function.

- **Process Measurement Accuracy** (PMA)

  An allowance for non-instrument related effects which have a direct bearing on the accuracy of an instrument channel's reading, e.g., neutron flux distribution, calorimetric power uncertainty assumptions, temperature streaming/stratification in a large diameter pipe, process pressure effects or fluid density changes in a pipe or vessel.

- **Process Racks**

  The modules downstream of the transmitter or sensing device, which condition a signal and act upon it prior to input to a voting logic system. For analog process systems, this includes all the equipment contained in the process equipment cabinets, e.g., conversion (dropping) resistor, loop power supply, lead/lag, rate, lag functions, function generator, summator, control/protection isolator, and bistable (protection function), controller module (control function), meter (control board indication) or Analog to Digital (A/D) conversion module (process computer). For digital process systems, this again includes all the equipment contained in the process equipment cabinets, e.g., conversion (dropping) resistor, A/D signal conditioning module, processor module and trip module (protection function), D/A output module and controller module (analog control function), D/A output module and meter (analog control board indication) and D/A output module and A/D conversion module (process computer). The go/no go signal generated by the bistable (analog) or the trip module (digital) is the output of the last module in the protection function process rack instrument loop and is the input to the voting logic.

- **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, see Figure 3-1. 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 uncertainty calculation 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 uncertainty calculation basic assumptions.

- **Rack Measurement & Test Equipment Accuracy** (RMTE)

  The accuracy of the test equipment (typically a transmitter simulator, voltage or current power supply, and DVM) used to calibrate a process loop in the racks. When the magnitude of RMTE meets the requirements of ANSI/ISA-51.1-1979 (R1993) (Reference 12, p. 61) it may be considered an integral part of RCA or RD. Uncertainties due to M&TE that are 10 times more accurate than the device being calibrated are considered insignificant and may not be included in the uncertainty calculations.

- **Rack Reference Accuracy** (RRA)

  Rack Reference Accuracy is the "accuracy rating" as defined in ISA-51.1-1979 (R1993) (Reference 12, page 12), specifically as applied to Note 2 and Note 3 for a process loop string. 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 12, page 16), hysteresis (Reference 12, page 36) and repeatability (Reference 12, page 49).

[ ] a,c

- **Rack Temperature Effects** (RTE)

  Change in input-output relationship for the process rack module string due to a change in the ambient environmental conditions (temperature, humidity), and voltage and frequency from the reference calibration conditions. It has been determined that temperature is the most significant, with the other parameters being second order effects. For process instrumentation, a typical value of [ ]^{a,c} is used for the analog channel RTE which, based on design testing, allows for an ambient temperature deviation of ± 50 °F. [ ]^{a,c}

- **Range**

  The upper and lower limits of the operating region for a device, e.g., 0 to 1400 psig for a Steamline Pressure transmitter. This is not necessarily the calibrated span of the device, although quite often the two are close. For further information see ANSI/ISA-51.1-1979 (R1993) (Reference 12).

- **Readout Device Accuracy** (READOUT)

  - The measurement accuracy of a special test, high accuracy, local gauge, digital voltmeter, or multimeter on its most accurate, applicable range for the parameter measured.
  - ½ the smallest increment of an indicator, e.g., control board meter, i.e., readability.

- **Safety Analysis Limit** (SAL)

  The parameter value identified in the plant safety analysis 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 Reference 14 (**AP1000** plant). Actual SAL values are determined, or confirmed, by review of the plant safety analyses. The SAL is the starting point for determination of the acceptability of the CSA, see Figure 3-1.

- **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 device. Recording and trending of the As Left condition of the sensor or transmitter (SCA) is necessary to assure conformance with the uncertainty calculation basic assumptions. Based on Westinghouse recommendations for Resistance Temperature Detector (RTD) cross-calibration, this accuracy is typically[ ]^{a,c} for the Hot and Cold Leg RTDs.

- **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 uncertainty calculation basic assumptions.

- **Sensor Measurement & Test Equipment Accuracy** (SMTE)

  The accuracy of the test equipment (typically a high accuracy local readout gauge and DMM) used to calibrate a sensor or transmitter in the field or in a calibration laboratory. When the magnitude of SMTE meets the requirements of ANSI/ISA-51.1-1979 (R1993) (Reference 12, p. 61) it may be considered an integral part of SCA. Uncertainties due to M&TE that are 10 times more accurate than the device being calibrated are considered insignificant and may not be included in the uncertainty calculations.

- **Sensor Pressure Effects** (SPE)

  - The change in input-output relationship due to a change in the static head pressure from the calibration conditions.
  - The accuracy to which a correction factor is introduced for the difference between calibration and operating conditions for a Δp transmitter.

- **Sensor Reference Accuracy** (SRA)

  The reference accuracy is the "accuracy rating" as defined in ISA-51.1-1979 (R1993) (Reference 12, page 12), specifically as applied to Note 2 and Note 3 for a sensor 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 12, page 16), hysteresis (Reference 12, page 36) and repeatability (Reference 12, page 49).

- **Sensor Temperature Effects** (STE)

  The change in input-output relationship due to a change in the ambient environmental conditions (temperature, humidity), and voltage and frequency from the reference calibration conditions. It has been determined that temperature is the most significant, with the other parameters being second order effects. This term is typically limited to the effect due to temperature swings that occur at less than 130 °F.

- **Span**

  The region for which a device is calibrated and verified to be operable, e.g., for a Steamline Pressure transmitter, 1400 psi.

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

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

  As approved for use in setpoint calculations by ANSI/ISA-67.04.01-2006 (Reference 3).

- **Total Allowance** (TA)

  The absolute value of the difference (in % instrument span) between the SAL and the NTS.

  $$\mathrm{TA} = |\mathrm{SAL} - \mathrm{NTS}|$$

  An example of the calculation of TA is:

  Pressurizer Pressure - Low (Safety Injection)

SAL	1740.0 psig
NTS	-1850.0 psig
TA	|-110.0 psi| = 110.0 psi

  The instrument span = 1700 – 2500 psig = 800 psi, therefore,

  $$TA = \frac{(110.0\ psi) * (100\%\ span)}{(800\ psi)} = 13.8\ \%\ span$$

- **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 uncertainty calculations are satisfied.

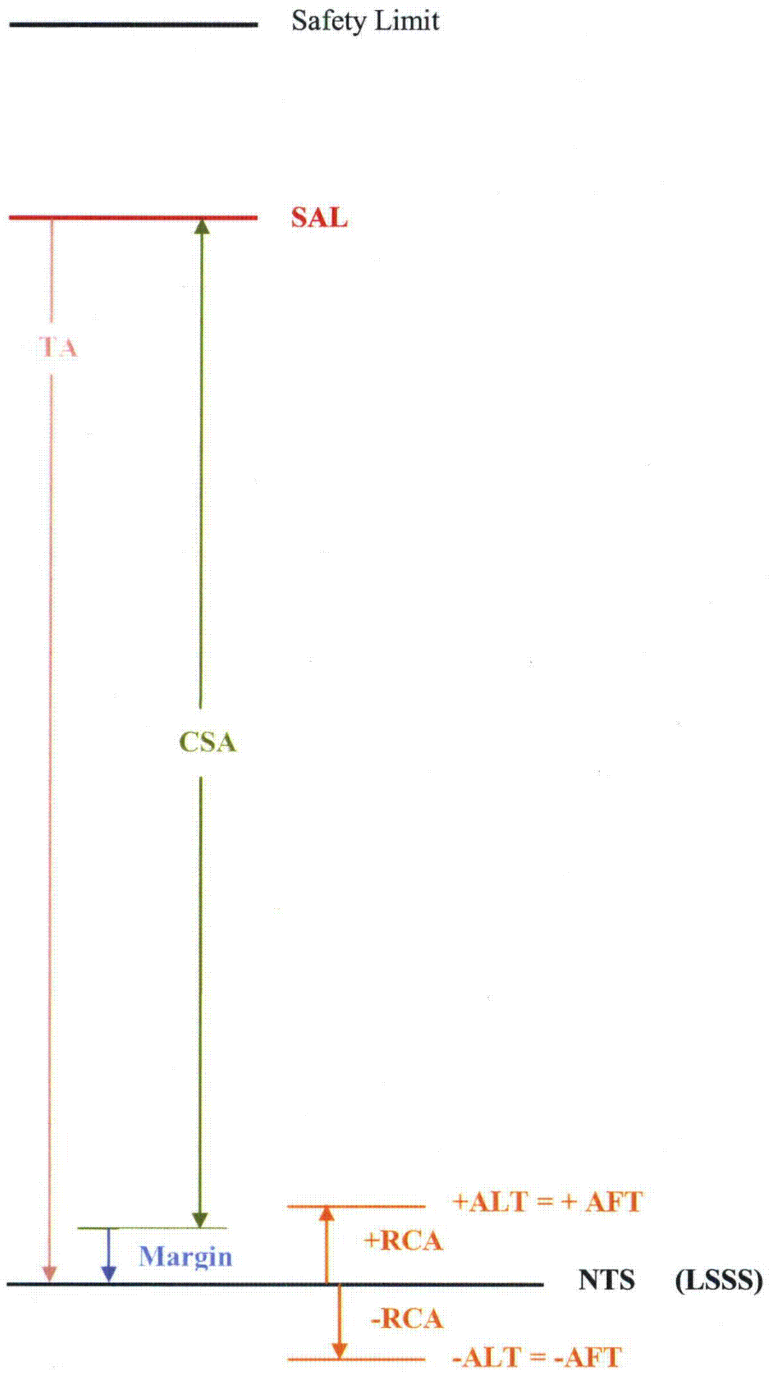

Figure 3-1 Westinghouse Setpoint Parameter Relationship Diagram (Increasing Function)

Table 3-1
Protection Function Example - Pressurizer Pressure – Low (Safety Injection)
Barton 763A Transmitter, Westinghouse 7300 Process Racks

Parameter	Allowance*
Process Measurement Accuracy (PMA)	[ ]^{a,c}
Primary Element Accuracy (PEA)	
Sensor Reference Accuracy (SRA)	
Sensor Calibration Accuracy (SCA)	
Sensor Measurement & Test Equipment Accuracy (SMTE) [ ]^{a,c}	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE)	
Sensor Drift (SD)	
Environmental Allowance (EA) [ ]^{a,c}	
Bias [ ]^{a,c}	
Rack Calibration Accuracy (RCA)	
Rack Measurement & Test Equipment Accuracy (RMTE) [ ]^{a,c}	
Rack Temperature Effect (RTE)	
Rack Drift (RD)	

---

* In percent span (800 psi)

Table 3-1 (continued)
Protection Function Example

Channel Statistical Allowance =

$$\left\{\sqrt{\begin{array}{l}PMA^2+PEA^2+SRA^2+(SMTE+SD)^2+(SMTE+SCA)^2+SPE^2+STE^2+\\(RMTE+RD)^2+(RMTE+RCA)^2+RTE^2\end{array}}\right\}+$$
$$EA_T+EA_R+EA_{IR}+Bias$$

[ ] a,c

SAL = 1740 psig
NTS = 1850 psig
Instrument span = 1700 – 2500 psig = 800 psi / 4-20 mA = 16 mA / 0 – 10 VDC = 10 VDC
TA = |(1740 – 1850)*(100/800)| = 13.8 % span

[ ] a,c

Transmitter +ALT =
Transmitter –ALT =
Transmitter +AFT =
Transmitter –AFT =
[ ] a,c

Process Racks +ALT =
Process Racks –ALT =
Process Racks +AFT =
Process Racks –AFT =
[ ] a,c

Table 3-1 (continued)
Protection Function Example

Example Scaling Information at Calibration Points

Calibration Point	Span	psig	Xmtr mA	Rack VDC

a,c

Table 3-2
Control Function Example - Pressurizer Pressure – Control
Barton 763A Transmitter, Westinghouse 7300 Process Racks

Parameter	Allowance*
Process Measurement Accuracy (PMA) Thermal Inertia Allowance (treated as a bias)	a,c
Primary Element Accuracy (PEA)	
Sensor Reference Accuracy (SRA)	
Sensor Calibration Accuracy (SCA)	
Sensor Measurement & Test Equipment Accuracy (SMTE) a,c	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE)	
Sensor Drift (SD)	
Environmental Allowance (EA)	
Bias a,c	
Rack Calibration Accuracy (RCA_{IND}) Control Board meter	
Rack Measurement & Test Equipment Accuracy ($RMTE_{IND}$) a,c	
Rack Temperature Effect (RTE)	
Rack Drift (RD_{IND}) Control Board meter	
Controller Accuracy (CA)	
Indication (READOUT) Control Board meter readability	

---

* In percent span (800 psi)

Table 3-2 (continued)
Control Function Example

Channel Statistical Allowance [$]^{a,c}$ (indicated higher than actual) =

a,c

a,c

Channel Statistical Allowance [$]^{a,c}$ (indicated lower than actual) =

a,c

Table 3-2 (continued)
Control Function Example

Nominal Control Setpoint (NCS) = 2235 psig
Instrument span = 1700 – 2500 psig = 800 psi / 4 – 20 mA = 16 mA / 0 – 10 VDC = 10 VDC

Safety Analysis Initial Condition (indicated lower than actual) = 2275 psig
TA (indicated lower than actual) = |(2275 – 2235)*100/800| = 5.0 % span

[ ] a,c

Safety Analysis Initial Condition (indicated higher than actual) = 2195 psig
TA (indicated higher than actual) = |(2195 – 2235)*100/800| = 5.0 % span

[ ] a,c

Transmitter +ALT =
Transmitter –ALT =
Transmitter +AFT =
Transmitter –AFT =
[ ] a,c

Process Racks (controller) +ALT =
Process Racks (controller) –ALT =
Process Racks (controller) +AFT =
Process Racks (controller) –AFT =
[ ] a,c

Process Racks (control board meter) +ALT =
Process Racks (control board meter) –ALT =
Process Racks (control board meter) +AFT =
Process Racks (control board meter) –AFT =
[ ] a,c

Table 3-2 (continued)
Control Function Example

Example Scaling Information at Calibration Points

Calibration Point	Span	Meter psig	Xmtr mA	Controller VDC

a,c

Table 3-2 (continued)
Control Function Example

Calibration Point	Span	Meter psig	Xmtr mA	Controller VDC

a,c

Table 3-3
Indication Function Example - Pressurizer Pressure
Barton 763A Transmitter, Westinghouse 7300 Process Racks, VX-252 Meter

Parameter	Allowance*
Process Measurement Accuracy (PMA)	a,c
Primary Element Accuracy (PEA)	
Sensor Reference Accuracy (SRA)	
Sensor Calibration Accuracy (SCA)	
Sensor Measurement & Test Equipment Accuracy (SMTE) a,c	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE)	
Sensor Drift (SD)	
Environmental Allowance (EA)	
Bias a,c	
Rack Calibration Accuracy (RCA_{IND}) Control Board meter	
Rack Measurement & Test Equipment Accuracy ($RMTE_{IND}$) a,c	
Rack Temperature Effect (RTE)	
Rack Drift (RD_{IND}) Control Board meter Drift	
Indication (READOUT) Control Board meter readability	

---

* In percent span (800 psi)

Table 3-3 (continued)
Indication Function Example

Channel Statistical Allowance [ ]^{a,c} (indicated higher than actual) =

[ ]^{a,c}

[ ]^{a,c}

Channel Statistical Allowance [ ]^{a,c} (indicated lower than actual) =

[ ]^{a,c}

Table 3-3 (continued)
Indication Function Example

Instrument span = 1700 – 2500 psig = 800 psi / 4 – 20 mA = 16 mA / 0 – 10 VDC = 10 VDC

a,c

Transmitter +ALT =
Transmitter –ALT =
Transmitter +AFT =
Transmitter –AFT =

a,c

Process Racks (control board meter) +ALT =
Process Racks (control board meter) –ALT =
Process Racks (control board meter) +AFT =
Process Racks (control board meter) –AFT =

a,c

Example Scaling Information at Calibration Points

Calibration Point	Span	Digital* Meter psig	Xmtr mA

a,c

a,c

Table 3-3 (continued)
Indication Function Example

Calibration Point	Span	Digital* Meter psig	Xmtr mA

a,c

a,c

Table 3-4

ΔP Measurements Expressed in Flow Units

The ΔP accuracy expressed as percent of span of the transmitter applies throughout the measured span, i.e., ± 1.5 % of 100 inches ΔP = ± 1.5 inches anywhere in the span. Because $F^2 = f(\Delta P)$ the same cannot be said for flow accuracies. When it is more convenient to express the accuracy of a transmitter in flow terms, the following method is used:

$$(F_N)^2 = \Delta P_N$$

Where: N = Nominal Flow

$$2F_N \partial F_N = \partial \Delta P_N$$

Thus,

$$\partial F_N = \frac{\partial \Delta P_N}{2F_N} \tag*{Eq. 3-4.1}$$

Error at a point (not in percent) is:

$$\frac{\partial F_N}{F_N} = \frac{\partial \Delta P_N}{2(F_N)^2} = \frac{\partial \Delta P_N}{2\Delta P_N} \tag*{Eq. 3-4.2}$$

and

$$\frac{\Delta P_N}{\Delta P_{\max}} = \frac{(F_N)^2}{(F_{\max})^2} \tag*{Eq. 3-4.3}$$

Where: max = maximum flow and the transmitter ΔP error is:

$$\frac{\partial \Delta P_N}{\Delta P_{\max}}(100) = \text{percent error in Full Scale } \Delta P \ (\% \ \varepsilon \ \text{FS} \ \Delta P) \tag*{Eq. 3-4.4}$$

Table 3-4 (continued)
ΔP Measurements Expressed in Flow Units

Therefore,

$$\frac{\partial F_N}{F_N} = \frac{\Delta P_{\max}\left[\frac{\% \varepsilon\ FS\ \Delta P}{100}\right]}{2\Delta P_{\max}\left[\frac{F_N}{F_{\max}}\right]^2} = \left[\frac{\% \varepsilon\ FS\ \Delta P}{(2)(100)}\right]\left[\frac{F_{\max}}{F_N}\right]^2 \qquad \text{Eq. 3-4.5}$$

Error in flow units is:

$$\partial F_N = F_N\left[\frac{\% \varepsilon\ FS\ \Delta P}{(2)(100)}\right]\left[\frac{F_{\max}}{F_N}\right]^2 \qquad \text{Eq. 3-4.6}$$

Error in percent nominal flow is:

$$\frac{\partial F_N}{F_N}(100) = \left[\frac{\% \varepsilon\ FS\ \Delta P}{2}\right]\left[\frac{F_{\max}}{F_N}\right]^2 \qquad \text{Eq. 3-4.7}$$

Error in percent full span is:

$$\frac{\partial F_N}{F_{\max}}(100) = \left[\frac{F_N}{F_{\max}}\right]\left[\frac{\% \varepsilon\ FS\ \Delta P}{(2)(100)}\right]\left[\frac{F_{\max}}{F_N}\right]^2(100)$$

$$= \left[\frac{\% \varepsilon\ FS\ \Delta P}{2}\right]\left[\frac{F_{\max}}{F_N}\right] \qquad \text{Eq. 3-4.8}$$

Equation 3-4.8 is typically used to express errors in percent full span in Westinghouse uncertainty calculations.

4.0 WESTINGHOUSE CALIBRATION AND DRIFT EVALUATION PROCESS

a,c

a,c

a,c

a,c

a,c

a,c

a,c

a,c

Figure 4-1 Westinghouse Calibration and Drift Data Evaluation Process Diagram

5.0 APPLICATION OF THE WESTINGHOUSE SETPOINT METHODOLOGY

5.1 Uncertainty Calculation Basic Assumptions / Premises

The equations noted in Sections 2 and 3 are based on the following premises:

1. The instrument technicians make reasonable attempts to achieve the NTS as an As Left condition at the start of each process rack's surveillance interval, i.e., the calibration error is driven towards 0.0 % span.
2. The process rack calibration accuracy (As Left values) will be evaluated [ ]^{a,c} When combined with previous As Left values, the trend characteristics of that instrument channel can be determined. [ ]^{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 instrument channel. 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.
3. The process rack drift will be evaluated [ ]^{a,c} Process rack drift is defined as the arithmetic difference between current As Found and previous As Left values. 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 instrument channel, the trend characteristics of drift for that channel can be determined. The instrument channel characteristics establish the performance of that channel. [ ]^{a,c} The magnitude of drift for an instrument channel is the second indication of the operability condition of the channel.
4. The process racks, including the bistables for analog racks, are verified/functionally tested in a string or loop process.
5. The instrument technicians make reasonable attempts to achieve a small calibration error as an As Left condition at the start of each transmitter's surveillance interval, i.e., the calibration error is driven towards 0.0 % span.
6. The transmitter calibration accuracy (As Left values) will be evaluated [ ]^{a,c} When combined with previous As Left values, the trend characteristics of that device can be determined. [ ]^{a,c}

[

]^{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. 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.

7. The transmitter drift will be evaluated [

   ]^{a,c} Transmitter drift is defined as the arithmetic difference between current As Found and previous As Left values. 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 transmitter drift. When combined with previous drift data for that device, the trend characteristics of drift for that device can be determined. The transmitter characteristics establish the performance of that transmitter. [

   ]^{a,c} The magnitude of drift for a transmitter is the second indication of the operability condition of the device.

It should be noted for (1) and (5) above that it is not necessary for the instrument technician to recalibrate a device or channel if the As Found condition is not exactly at the nominal condition, but is within the two-sided (±) ALT. As noted above, the uncertainty calculations assume that the ALT (conservative and non-conservative direction) is satisfied on a reasonable, statistical basis, not that the nominal condition is satisfied exactly. The evaluations above assume that the SCA, SD, RCA and RD parameter values noted in Tables 3-1 and 3-2 are satisfied on at least a two-sided (±) 95 % probability / 95 % confidence level basis. Therefore, it is necessary for the plant to periodically re-verify the continued validity of these assumptions. Westinghouse recommends that this verification be performed [

]^{a,c} This prevents the institution of non-conservative biases due to a procedural (or unwritten cultural) basis without the plant staff's knowledge and appropriate treatment.

In summary, a sensor/transmitter or process rack channel is considered to be "calibrated" when the two-sided (±) ALT is satisfied. An instrument technician may determine to recalibrate if near the extremes of the ALT, but it is not required. Recalibration is explicitly required any time the As Found condition of the device or channel is outside of the ALT. A device or channel may not be left outside the ALT without declaring the device or channel "inoperable" and appropriate action taken. Thus, an ALT may be considered as an outer limit for the purposes of calibration and instrument uncertainty calculations.

Note that the above discussion is limited to the ALT. Nothing was said with respect to the AFT. That is because, for process racks, [

]^{a,c} Thus, Westinghouse has

concluded, that for operable process racks, AFT = ALT = RCA. With respect to sensor/transmitters, the AFT = SD, based initially on the vendor specification data and subsequently on the periodic evaluation of SD data (As Found – As Left).

The above results in the WSM's reliance on the NTS, and not the Limiting Trip Setpoint (LTSP) as defined in ISA-67.04.01-2006 (Reference 3) or the Limiting Setpoint (LSP) as defined in RIS 2006-17 (Reference 15). Specific to Reference 15, the LSP is noted as: "... *the limiting setting for the channel trip setpoint (TSP) considering all credible instrument errors associated with the instrument channel. The LSP is the limiting value to which the channel must be reset at the conclusion of periodic testing to ensure the safety limit (SL) will not be exceeded if a design basis event occurs before the next periodic surveillance or calibration.*" As noted on the previous page, with respect to the WSM, operability of the process racks is defined as the ability to be calibrated about the NTS (ALT about the NTS) and subsequent surveillance should find the channel within the AFT = ALT about the NTS. On those rare occasions that the channel is found outside of the AFT = ALT, operability requirements would be initially satisfied via recalibration, or reset, about the NTS. Operability defined as conservative with respect to a zero margin LSP is a concept that is insufficient for the WSM, and is inconsistent with its basic assumption of the AFT = ALT = RCA definition. In order to have confidence (statistical or otherwise) of appropriate operation of the process racks, it is necessary that the process racks operate within the two-sided (±) limits defined about the NTS. This is particularly true for protection functions that have historical NTS values that generate large margins. From a WSM perspective, systematic allowance of large drift magnitudes in excess of equipment design – either by large magnitude RD or RMTE terms or utilization of an LSP, generates a false sense of security which is inappropriate for future operation consideration, and which erodes the concept of performance based specifications and limits.

5.2 Process Rack Operability Assessment Program and Criteria

The parameter of most interest as an indication of process rack operability is relative drift (As Found – As Left) found to be within RD, where RD is the two-sided (±) 95/95 drift value assumed for that channel. However, this would require the instrument technician to record and have available in the field both the current As Found and the previous As Left condition data to perform a calculation in the field. Generally, plants are reluctant to perform this field calculation due to the requirements of having the previous As Left value for that channel at the time of the drift determination and the need for independent calculation verification. Few plants require that the previous As Left condition be ascertained prior to performance of a surveillance test or are set up for independent verification of calculations in the field.

An alternative for the process racks is the Westinghouse method for use of a fixed magnitude, two-sided (±) AFT about the NTS. It would be reasonable for this AFT to be RMTE + RD, where RD is the actual statistically determined 95/95 drift value and RMTE is defined in the plant procedures. However, comparison of this value with the RCA tolerance utilized in the Westinghouse uncertainty calculations would yield a value where the AFT is less than the RCA tolerance (ALT). [ ]^{a,c}

[

]^{a,c} Therefore, a more reasonable approach for the plant staff to follow was determined. An AFT criterion based on an absolute magnitude that is the same as the RCA criterion, i.e., the allowed deviation from the NTS on an absolute indication basis is plus or minus (±) the RCA tolerance (ALT). A channel found inside the RCA tolerance (ALT) on an indicated basis is considered to be operable. A channel found outside the RCA tolerance (ALT) is evaluated and recalibrated. The channel must be returned to within the ALT for the channel to be considered operable. This criterion is incorporated into plant, function specific calibration and drift procedures as the defined ALT about the NTS. [

]^{a,c} A channel found to exceed this criterion multiple times should trigger a more comprehensive evaluation of the operability of the channel. Thus, more elaborate evaluation and monitoring may be included, as necessary, if the drift is found to be excessive or the channel is difficult to calibrate.

5.3 Application of Process Rack Operability Assessment to the Plant Technical Specifications

The drift operability criteria described for the process racks in Section 5.2 are based on a statistical evaluation of the performance of the installed hardware. Thus, these criteria [

]^{a,c}

Sections 5.1 and 5.2 are consistent with the recommendations of the Westinghouse paper presented at the June 1994, ISA/EPRI conference in Orlando, FL (Reference 16). In addition, the plant operability assessment processes described in Sections 5.2 and 5.3 are consistent with the basic intent of ISA-67.04.01 (Reference 3). Therefore, the ALT and AFT magnitudes are "performance based" and are determined by adding (subtracting) the calibration accuracy (RCA=ALT=AFT) of the device tested during the Channel Operational Test to the NTS.

An example of the ALT and AFT calculations for the process racks is:

Pressurizer Pressure – Low (Safety Injection)

ALT/AFT Determination
NTS = 1850 psig
SPAN = 800 psi
RCA = [$]^{a,c}$

ALT = NTS ± RCA
(+) ALT = [$]^{a,c}$
(-) ALT =

AFT = NTS ± RCA
(+) AFT = [$]^{a,c}$
(-) AFT =

Those plants that opt for Option A of TSTF-493 Revision 4 (Reference 18) will have one of several parameter lists in the Technical Specifications for RTS/ESFAS functions. These options and the Westinghouse recommendations that address them are noted below.

1. **Allowable Value** only – the Allowable Value is defined as the "+" or "-" ALT for the process rack, depending on the direction of conservatism. Since the process rack ALT is two-sided, Westinghouse suggests that the opposite sign ALT value, the ±AFT values and the NTS should be defined in administratively controlled documents, e.g., calibration and surveillance procedures.
2. **Nominal Trip Setpoint** only – the process rack ±ALT and ±AFT values should be defined in administratively controlled documents, e.g., calibration and surveillance procedures.
3. **Nominal Trip Setpoint** and **Allowable Value** – the Allowable Value is defined as the "+" or "-" ALT for the process rack, depending on the direction of conservatism. Again, Westinghouse suggests that the opposite sign ALT value and the ±AFT values should be defined in administratively controlled documents, e.g., calibration and surveillance procedures.

Of the three approaches, Westinghouse recommends the Technical Specifications include the NTS only (2) as that places control on the parameter of primary interest, the NTS.

Those plants that opt for Option B of TSTF-493 Revision 4 (Reference 18) will remove the RTS/ESFAS trip setpoints from the Technical Specifications and utilize a Setpoint Control Program (SCP). The Westinghouse recommendations for an SCP based on the WSM are identified in WCAP-17503-P (Reference 19). In this instance, the process rack ±ALT and ±AFT values and the NTS for each protection function are defined in an administratively controlled document. If the protection function uncertainty calculations are performed by Westinghouse, this document would be a plant specific WCAP providing a summary of the uncertainty calculations with tables identifying the NTS, process rack ALT and AFT values.

5.4 Sensor/Transmitter Operability Assessment Program and Criteria

The parameter of most interest for indication of transmitter operability is relative drift (As Found – As Left) found to be within SD, where SD is the two-sided (±) 95/95 drift value assumed for that device. However, this would require the instrument technician to record and have available in the field both the current As Found and the previous As Left condition data to perform calculations in the field. Generally, plants are reluctant to perform these field calculations due to the requirements of having the previous As Left values for that device at the time of the drift determination and the need for independent calculation verification. Few plants require that the previous As Left condition be ascertained prior to performance of a surveillance test or are set up for independent verification of calculations in the field.

An alternative for the transmitters is the very common method of use of a fixed magnitude, two-sided (±) AFT about each of the nominal calibration points, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span. Based on the As Found condition, operability of the device is determined as follows.

1. A transmitter found inside the SCA tolerance (ALT) about all calibration points, on an indicated basis, is considered to be operable and may be recalibrated.
2. A transmitter found outside the SCA tolerance (ALT) about one or more calibration point(s) but within the SD (AFT) at all of the calibration points is considered operable and must be recalibrated.
3. A transmitter found outside the SD (AFT) at three or more calibration point(s) is considered inoperable. A condition report should be initiated and the device must be recalibrated to demonstrate a return to an operable condition.

In all cases, for the device to be considered operable, the transmitter must be returned to within the ALT about all desired calibration points. This criterion is incorporated into plant, function specific calibration and drift procedures as the defined ALT about the desired calibration points. At a later date, once the As Found data is compiled, the relative drift (As Found – As Left) can be calculated and compared against the SD value. This comparison can then be utilized to ensure consistency with the assumptions of the uncertainty calculations documented in Tables 3-1 through 3-3, see Assumption 7. A transmitter found to exceed this criterion multiple times should trigger a more comprehensive evaluation of the operability of the device. Thus, more elaborate evaluation and monitoring may be included, as necessary, if the drift is found to be excessive or the transmitter is difficult to calibrate.

5.5 Application of the Sensor/Transmitter Operability Assessment

The drift operability criteria described for transmitters in Section 5.4 are based on a statistical evaluation of the performance of the installed hardware. Thus, these criteria [

]^{a,c}

[

]^{a,c}

Utilizing the approach of Section 5.4, ALT and AFT values for the transmitter would be defined at the multiple calibration points, as noted in Table 3-1. An example is provided below.

Pressurizer Pressure - Low (Safety Injection)

<u>ALT/AFT Determination</u>
SPAN = 800 psi / 16 mA
[ ]^{a,c}
Calibration Points = 0 %, 25 %, 50 %, 75 %, 100 % span
Calibration zero = 1700 psig
Calibration Points = 1700, 1900, 2100, 2300, 2500 psig

ALT = Calibration Point ± SCA

		^{a,c}		^{a,c}
0 % span:	(+) ALT =		(-) ALT =	
25 % span:	(+) ALT =		(-) ALT =	
50 % span:	(+) ALT =		(-) ALT =	
75 % span:	(+) ALT =		(-) ALT =	
100 % span:	(+) ALT =		(-) ALT =	

The above ALT values would be found in the calibration procedure.

AFT = Calibration Points ± SD

		^{a,c}		^{a,c}
0 % span:	(+) AFT =		(-) AFT =	
25 % span:	(+) AFT =		(-) AFT =	
50 % span:	(+) AFT =		(-) AFT =	
75 % span:	(+) AFT =		(-) AFT =	
100 % span:	(+) AFT =		(-) AFT =	

The above AFT values would be found in the surveillance procedure.

6.0 Summary of Important Points

Noted below is a summary of important points or assumptions with regards to the Westinghouse Setpoint Methodology.

1. The basic algorithm is an SRSS, accounting for M&TE dependency with the calibration or drift parameter.
2. Protection function uncertainty calculations are based on a single channel.
3. [$]^{a,c}$
4. Westinghouse instrument uncertainties are two-sided.
5. EA terms are not considered statistically dependent with all other parameters, however, the EA terms are generally large magnitude, non-random terms that are conservatively treated as limits of error.
6. [$]^{a,c}$
7. PMA terms provide allowances for the non-instrument related effects.
8. PEA term accounts for uncertainties due to metering devices, such as elbows, venturis, and orifice plates. In RTS/ESFAS uncertainty calculations, these are limited in application to flow measurements, e.g., RCS Flow (Cold Leg Elbow Taps, Cold Leg Bends, Hot Leg Elbows), Steam Flow, Feedwater Flow and Steam Generator Blowdown Flow.
9. The PEA term may be used for potential transformer characteristics for Undervoltage and Underfrequency applications.
10. The protection function CSA value is believed to be a two-sided 95 % probability at a 95 % confidence level (95/95) result.
11. The control function CSA value is believed to be a two-sided 95 % probability at a 95 % confidence level (95/95) result.
12. [$]^{a,c}$
13. There are typically two types of digital protection functions, 1) form/fit/function replacement for an analog channel and, 2) complex functions that utilize multiple intermediate calculations.
14. [$]^{a,c}$
15. [$]^{a,c}$

16. Westinghouse reports CSA values to one decimal place using the technique of rounding down values less than 0.05 % span and rounding up values greater than or equal to 0.05 % span.

17. For process racks, AFT = ALT = RCA, i.e., the AFT is a two-sided parameter (±) about the NTS.

18. For transmitters, the AFT is a two-sided parameter (±) about the calibration points (absolute drift), or the AFT is a two-sided parameter (±) about the calibration recorded As Left points (relative drift).

19. For process racks, the ALT is a two-sided parameter (±) equal to the RCA about the NTS.

20. For transmitters, the ALT is defined as the two-sided (±) SCA magnitude about the desired calibration points.

21. Margin is defined to be a non-negative number.

22. Westinghouse defines the NTS as the LSSS for the RTS and ESFAS functions listed in the plant Technical Specifications.

23. RCA is the two-sided (±) calibration tolerance of the process racks as reflected in the plant calibration procedures.

24. RCA is defined at multiple points across the calibration range of the channel, and specifically at the NTS for the bistable or trip module.

25. The RCA magnitude should be, and calibration procedure should confirm, the reference accuracy of the instrument process racks.

26. Recording and trending of the As Left condition of the process racks (ALT = RCA) is necessary to assure conformance with the uncertainty calculation basic assumptions.

27. It is assumed that 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 the RCA. [

]^{a,c}

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

29. Actual SAL values are determined, or confirmed, by review of the plant safety analyses.

30. The SAL is the starting point for determination of the acceptability of the CSA.

31. The two-sided (±) calibration tolerance for a sensor or transmitter (ALT) is defined in the plant calibration procedures.

32. The SCA is defined at multiple points across the calibration range of the channel.

33. The SCA magnitude should be, and the calibration procedure should confirm, the reference accuracy of the device.

34. Recording and trending of the As Left condition of the sensor or transmitter (SCA) is necessary to assure conformance with the uncertainty calculation basic assumptions.

35. Recording and trending of the As Found condition of the sensor or transmitter (SD) is necessary to assure conformance with the uncertainty calculation basic assumptions.

36. [ ]^{a,c}

37. [ ]^{a,c}

38. [ ]^{a,c}

39. [ ]^{a,c}

40. [ ]^{a,c}

41. [ ]^{a,c}

42. Westinghouse will not pool data from multiple sites or different vendor hardware.

43. [ ]^{a,c}

44. [ ]^{a,c}

45. [ ]^{a,c}

46. [ ]^{a,c}

47. [ ]^{a,c}

48. [ ]^{a,c}

49. The instrument technicians make reasonable attempts to achieve the NTS as an As Left condition at the start of each process rack's surveillance interval, i.e., the calibration error is driven towards 0.0 % span.

50. The process rack calibration accuracy (As Left values) will be evaluated [

    ]^{a,c}

51. The ability to calibrate is the first step in establishing the operability condition of the instrument channel.

52. 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.

53. [

    ]^{a,c}

54. 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. The magnitude of drift for an instrument channel/rack is the second indication of the operability condition of the instrument channel/rack.

55. The process racks, including the bistables, are verified/functionally tested in a string or loop process.

56. The instrument technicians make reasonable attempts to achieve a small calibration error as an As Left condition at the start of each transmitter's surveillance interval, i.e., the calibration error is driven towards 0.0 % span.

57. The transmitter calibration accuracy (As Left values) will be evaluated [

    ]^{a,c}

58. The ability to calibrate is the first step in establishing the operability condition of the device.

59. The transmitter drift will be evaluated [

    ]^{a,c}

60. The transmitter characteristics establish the performance of that transmitter. The magnitude of drift for a transmitter is the second indication of the operability condition of the device.

61. The operability evaluations assume that the SCA, SD, RCA and RD parameter values are satisfied on at least a two-sided (±) 95 % probability / 95 % confidence level basis. Therefore, it is necessary to periodically re-verify the continued validity of these assumptions. Westinghouse recommends verification [ ]^{a,c}

62. The Westinghouse Setpoint Methodology relies on the NTS as the initial condition for process rack operability evaluations.

63. [ ] a,c

64. Process rack ALT and AFT magnitudes are "performance based" and are determined by adding (subtracting) the calibration accuracy (RCA=ALT=AFT) of the device tested during the Channel Operational Test to the NTS.

65. With regards to TSTF-493 Rev. 4, Option A, Westinghouse has three recommendations based on the parameter(s) noted in the plant Technical Specifications RTS/ESFAS setpoint tables.

66. With regards to TSTF-493 Rev. 4, Option B, Westinghouse recommendations are identified in WCAP-17503-P.

67. Westinghouse has defined a three step transmitter operability evaluation process based on drift.

    a. If found inside the SCA tolerance (ALT) about all calibration points – the transmitter is considered to be operable and may be recalibrated.
    b. If found outside the SCA tolerance (ALT) about one or more calibration point(s) but within the SD (AFT) at all of the calibration points – the transmitter is considered operable and must be recalibrated.
    c. If found outside the SD (AFT) at three or more calibration point(s) – the transmitter is considered inoperable. A condition report should be initiated and the device must be recalibrated to demonstrate a return to an operable condition.

    In all cases, for the device to be considered operable, the transmitter must be returned to within the ALT about all desired calibration points.

7.0 References

1. Regulatory Guide 1.105, Revision 3, "Setpoints for Safety-Related Instrumentation," Nuclear Regulatory Commission, December 1999.
2. Tuley, C. R., Williams, T. P., "The Significance of Verifying the SAMA PMC 20.1-1973 Defined Reference Accuracy for the Westinghouse Setpoint Methodology," Instrumentation, Controls and Automation in the Power Industry, Vol. 35, Proceedings of the Thirty-Fifth Power Instrumentation Symposium (2nd Annual ISA/EPRI Joint Controls and Automation Conference), Kansas City, Mo., June 1992, p. 497.
3. ANSI/ISA-67.04.01-2006, "Setpoints for Nuclear Safety-Related Instrumentation," International Society of Automation, May 2006.
4. ISA-RP67.04.02-2010, "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation," International Society of Automation, December 2010.
5. Branch Technical Position 7-12, Rev. 5 "Guidance on Establishing and Maintaining Instrument Setpoints," Nuclear Regulatory Commission, March 2007.
6. Westinghouse letter NS-TMA-1835, "American Electric Power Project, Donald C. Cook Unit 2 (Docket 50-316), Westinghouse Reactor Protection System/Engineered Safety Features Actuation System Setpoint Methodology," Westinghouse Electric Company LLC, June 1978.
7. WCAP-8567-P-A, "Improved Thermal Design Procedure," Westinghouse Electric Company LLC, July 1975.
8. WCAP-16361-P Rev. 0, "Westinghouse Setpoint Methodology for Protection Systems – **AP1000**," Westinghouse Electric Company LLC, May 2006.
9. NRC letter "Safety Evaluation by the Office of New Reactors, Westinghouse Electric Company, WCAP-16361-P Revision 0, (Technical Report 28) Westinghouse Setpoint Methodology for Protection Systems – **AP1000**," Nuclear Regulatory Commission, August 2007 .
10. ANSI/ANS Standard 58.4-1979, "Criteria for Technical Specifications for Nuclear Power Stations," American Nuclear Society, January 1979.
11. ISA-TR67.04.09-2005, "Graded Approaches to Setpoint Determination," International Society of Automation, October 2005.
12. ANSI/ISA-51.1-1979 (R1993), "Process Instrumentation Terminology," International Society of Automation, Reaffirmed May 1995.
13. NUREG-1431, Volume 1, Rev. 3, "Standard Technical Specifications Westinghouse Plants," Nuclear Regulatory Commission, March 2004.
14. APP-GW-GL-700, Rev. 19, "**AP1000** Design Control Document," Tier 2, Chapter 16, Westinghouse Electric Company LLC, June 2011.
15. NRC Regulatory Issue Summary 2006-17, "NRC Staff Position on the Requirements of 10 CFR 50.36, 'Technical Specifications,' Regarding Limiting Safety System Settings During Periodic Testing and Calibration of Instrument Channels," Nuclear Regulatory Commission, August 2006.

16. Tuley, C. R., Williams, T. P., "The Allowable Value in the Westinghouse Setpoint Methodology – Fact or Fiction?" presented at the Thirty-Seventh Power Instrumentation Symposium (4th Annual ISA/EPRI Joint Controls and Automation Conference), Orlando, FL, June 1994.
17. WCAP-11397-P-A, "Revised Thermal Design Procedure," Westinghouse Electric Company LLC, February 1987.
18. Technical Specifications Task Force Traveler TSTF-493, Rev. 4, "Clarify Application of Setpoint Methodology for LSSS Functions," PWR Owners Group/BWR Owners' Group, April 2010.
19. WCAP-17503-P, "Westinghouse Generic Setpoint Control Program Recommendations," Westinghouse Electric Company LLC, February 2012.
20. [ ]^{a,c}
21. Walpole, R. E. and Myers, R. H., "Probability and Statistics for Engineers and Scientists," 7th Edition, Macmillan Publishing Company, New York, NY, 2002.
22. Law, A. M. and Kelton, W. D., "Simulation Modeling and Analysis," 2nd Edition, McGraw-Hill, New York, NY, 1991.
23. ASTM E 178-80, Reapproved 1989, "Standard Practice for Dealing with Outlying Observations," American Society for Testing and Materials, July 1989.
24. Regulatory Guide 5.36, "Recommended Practice for Dealing with Outlying Observations," Nuclear Regulatory Commission, June 1974.
25. ASTM E 178-02, "Standard Practice for Dealing with Outlying Observations," American Society for Testing and Materials, July 2002.
26. [
]^{a,c}
27. Westinghouse letter LTR-NRC-07-14, "Westinghouse Presentation to the NRC, 'Westinghouse Transmitter and Process Rack Surveillance Extension Program,'" Westinghouse Electric Company LLC, March 2007.
28. Generic Letter 91-04, "Changes in Technical Specification Surveillance Intervals to Accommodate a 24-Month Fuel Cycle," Nuclear Regulatory Commission, April 1991.
29. Microsoft® Office Excel®(3) 2007 (12.0.6557.5000) SP2 MSO (12.0.6554.5001), © 2006 Microsoft Corporation.
30. APP-GW-GLR-137, Rev. 1, "Bases of Digital Overpower and Overtemperature Delta-T (OPΔT/OTΔT) Reactor Trips," Westinghouse Electric Company LLC, February 2011.

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[3] Microsoft and Excel are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries

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}