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Sent: Friday, March 25, 2011 6:26 AM
To: Starefos, Joelle
Cc: Arnholt, Brian K; Childerson, Michael T
Subject: I&C Responses to Comments
Attachments: B&W Response to NRC Questions on Instrument Setpoint Methodology_3_24_2011-1.pdf

Joelle:

Attached are detailed (draft for discussion) responses to the I&C comments on our SP Methodology Report. They address the two sets of comments wew had received as well as the comments discussed during a recent phone call. I suggest we have a call on Monday with the I&C staff if possible to run over our clarifications and to determine the best course of action for prompt resolution of comments on report content.

Chet Poslusny
B&W Licensing

B&W Review and response to NRC Questions raised during the acceptance review for the B&W Instrument Setpoint Methodology Topical Report (R0003-08-002089).

Introduction:

B&W reviewed the comments provided by the NRC during their acceptance review of the B&W Instrument Setpoint Methodology Topical Report (R0003-08-002089) and the following are discussion and responses to clear any confusion in the report. A teleconference was conducted on March 14, 2011 between representatives of B&W Nuclear Energy (B&W NE) and the NRC staff to discuss the questions submitted by the NRC. Following this teleconference, the NRC supplied additional clarifications of its concerns with the B&W Instrument Setpoint Methodology Topical Report by email dated March 17, 2011.

In addition to the initial five questions supplied, the NRC raised additional questions regarding the numerical methods used to account for and derive equations for channel uncertainty and allowable value and the relationship between these equations and a graphical representation presented as Figure 5.1 in the B&W Instrument Setpoint Methodology Topical Report. Responses to these additional questions are provided in a separate document.

Through these discussions and information provided, B&W believes that there may been some ambiguity in the relationship between equations 4.2.2, 4.2.3, and 4.2.4 including the graphical representation in Figure 5.1. In this response, a background of the equations used in the B&W Setpoint Methodology Report is presented, and comparisons are made between previously accepted methodologies submitted by other applicants and the B&W Instrument Setpoint Topical Report.

The discussion and responses that follow attempt to resolve these discrepancies and presents a proposed solution that resolves these issues.

Background:

In its acceptance review, the NRC identified concerns that the methods and equations for determination of channel uncertainty, trip setpoint and that they were not consistent with what was depicted in Figure 5.1. The concern lies with the fact that the equations used the square-root-summation-of-squares (SRSS) method to combine errors, while it was interpreted that Figure 5.1 showed the combination of the errors algebraically, inconsistent with the equations (see NRC hand-written notes). Therefore, B&W has provided the following additional discussion in response to the NRC questions, and suggestions for revisions to the report to address the NRC questions.

The equations for calculation of the total channel uncertainty (CU, equation 4.2.2), trip setpoint (NTSP, equation 4.2.3) and allowable value (AV, equation 4.2.3) are based on accepted practices outlined by Regulatory Guide 1.105, other industry standards referenced in the report and are consistent with those provided in other applicant submittals that have been reviewed and approved by the NRC.

Based on its review, the NRC identified five initial questions relating to the methods used to determine the equations 4.2.3, and 4.2.4 and Figure 5.1.

In reviewing and responding to the NRCs questions, B&W reviewed applicable industry guidance, current Instrument Setpoint Topical Reports previously submitted by other applicants were reviewed, and traceability between the B&W report and referenced industry standards was conducted.

NRC Question 1 (and supplemental information)

The methodology uses the square-root-summation-of-squares (SRSS) technique to combine instrument loop uncertainties which are statistically and functionally independent and random. Channel Uncertainty (CU) is calculated by SRSS of all instrument channel independent uncertainties from analytical limit (AL) including those uncertainties not measured during the surveillance tests. According to Equations 4.2.3 and 4.2.4, the allowable value (AV) is derived by subtracting AFT from CU. Remnant of CU between AL and AV does not provide enough allowance to protect the SL. However, in Fig. 5 of this report, the allowance between AL and AV, which accounts for those uncertainties (process uncertainties and other uncertainties) not measured during the surveillance tests, is large enough to protect the AL. The applicant is requested to provide an explanation of a discrepancy between Equations 4.2.3/4.2.4 and Fig. 5.

B&W Response:

The NRC staff indicated that their fundamental issue is related to the discussion contained in question 1 which identified a potential discrepancy between equations 4.2.3 and 4.2.4 and the illustrations in Figure 5.1.

From its understanding of the NRCs concerns, B&W understands the NRC is concerned that while the equations (4.2.2, 4.2.3, and 4.2.4) use the SRSS method to combine errors to calculate the values for CU, NTSP and AV, respectively, it was understood by the reviewers that Figure 5.1 represented that the errors for these same terms was combined algebraically, which presents a potential inconsistency. Additionally, the NRC stated that the AFT should center around the NTSP, and not from the AV.

Figure 5.1 was intended to be a notional representation of the relationships between the NTSP, CU, and AV and represent how these are used to ensure the instrument channel setpoints are established and ensured to protect the safety limit (SL). It was not intended to illustrate the methodology for combining errors in the various components that make up the terms for CU, AV, and NTSP; the equations presented in the report show the methodology used for combining errors. This approach is consistent with the guidance contained in ISA-S67.04.01-2000 where Figure 1 is a notional representation of the relationship between instrument channel setpoints and does not attempt to show the methods for combining errors.

B&W recognizes that there may be ambiguity with Figure 5.1 that could lead the reviewers to identify an inconsistency between the equations and figures, and a proposed revision is provided for review that clearly delineates the setpoint relationships safety and design basis, and during periodic surveillance and calibration.

The following will describe in detail the basis for the methods and equations, and trace the basis for the equations to the referenced standards, regulatory guidance and make comparisons to previously accepted setpoint methodologies previously accepted by the NRC.

Basis for equation 4.2.2, Channel Uncertainty (CU):

Equation 4.2.2 calculates the total channel uncertainty (CU) using methods as documented in ISA-67.04.01-2000 as stated in the report. The calculation for CU is comprised of random uncertainties using the SRSS method to determine the uncertainty components for process measurement accuracy (PM), process element accuracy (PE), module uncertainty (e_n), and the bias uncertainty term (note, since the PM component contains both random and bias uncertainties, the random uncertainty component is treated as described above using the SRSS method, and the bias uncertainty component is included in the bias term (B) as described in section 4.1.4 of the B&W report).

This is consistent with the basis for equations 6.10a and 6.10b in ISA-RP.67.04.02-2000.

Furthermore, comparison was made to the Areva EPR Setpoint Topical Report (ANP-10275NP-A) that was reviewed and approved by the NRC. In the safety evaluation for this report, the NRC concluded the following which supports the basis for the determination of CU in equation 4.2.2.

> *The AREVA setpoint methodology combines the uncertainty of the components to determine the overall Channel Uncertainty (CU) for the functions of the RPS/ESFAS. All appropriate and applicable uncertainties have been considered for each RPS/ESFAS function. 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. It includes instrument (sensor and process rack) uncertainties and non-instrument related effects (process measurement accuracy). The methodology used the SRSS technique which is approved by the NRC. Also, ANSI/ANS and ISA approve the use of the same probabilistic and statistical techniques for the various standards in determining the setpoints.*

Additionally, the NRC concluded:

> *The CU is compared with the total allowance to determine the instrument channel safety margin. The TA is established by adding margin to the CU.*

Basis for Equation 4.2.3, Trip Setpoint (NTSP):

The trip setpoint (NTSP) is calculated following the same process and methods described in section 7.1 of ISA-RP67.04.02-2000. The NTSP is the setpoint established during normal operation for the instrument channel, and must be equal to or more conservative than the limiting trip setpoint (LTSP), in accordance with the guidance provided in RIS 2006-17.

Basis for Equation 4.2.4, Allowable Value (AV):

The equation for allowable value (equation 4.2.4) takes into account the uncertainties between the trip setpoint (NTSP) and the uncertainties due to (1) instrument calibration (M&TE and ALT terms in equation 4.2.4); (2) instrument uncertainties during normal operation (RA term), and (3) the instrument drift (DR term). These uncertainties are combined using the SRSS method and result in a term called the as-found tolerance (AFT). The AFT is compared to the NTSP to determine the allowable value in equation 4.2.4.

This is consistent with and follows the methodology described in section 4.3.2 of ISA-S67.04.01-2000 which documents the accepted basis for the determination of the allowable value for an instrument channel.

The B&W methodology determines a value for the as-found tolerance that is comprised of instrument calibration (M&TE, ALT), drift (DR), and reference accuracy (RA). It combines these terms using the SRSS method to determine a total value for the AFT during periodic surveillance testing. In comparison, the Areva report documents that the AV is compared to the Performance Acceptance Test Criteria that is referred to as the "as-found tolerance."

The allowable value (equation 4.2.4) then compares the difference between the trip setpoint (NTSP) and as-found tolerance (AFT) to determine channel operability that if this difference is less than the allowable value, the channel is operable. This is consistent with the NRC findings in RIS 2006-17 concerning channel operability.

The plant safety analysis establishes the analytical limit, and assumes the plant operates within the AL. The LTSP is the minimal setpoint that can be chosen to protect the AL (and hence the SL). The AV is based on the uncertainties during testing (AFT); therefore, if the channel actuates at or below the AV it satisfies the safety analysis and LSSS and the channel is operable. The addition of margin is based on engineering judgment and is only included to provide an additional level of conservatism provided that operating margin is not jeopardized.

Proposed Revisions

To alleviate these concerns and add clarity to address the NRC questions, B&W proposes to revise Figure 5.1 to show a distinction between the safety analysis and design bases for the limiting safety system setting (LSSS). This clarification shows that the LSSS is applied to the allowable value which ensures the safety limit is satisfied; since the AV is less than the LTSP. This is consistent with RIS 2006-17 that concludes "the LTSP protects the Safety Limit."

The proposed revision to Figure 5.1 shows two representations of how the various setpoint parameters relate to the safety analysis and design basis and the relation to periodic surveillance testing to demonstrate channel operability. The AV is the minimum acceptable as-found value for the trip setpoint (with margin applied for conservatism), in which the instrument channel is still considered operable. This ensures that the AL and safety limit are protected during periodic surveillance. In this revision, the NTSP is now shown to be determined from the AL by accounting for the total channel uncertainty and margin (if applicable).

B&W proposes to add clarity to the distinction between AL, LTSP, NTSP and AV as follows by revising section 4.2.3 clarifying that the LTSP is derived from the AL by accounting for the total channel uncertainty (CU). The LTSP is the most-limiting setting for the trip setpoint an instrument channel may have when accounting for the total channel uncertainty for the channel (consistent with RIS 2006-17 definitions for LTSP). This is illustrated in the revision to Figure 5.1 and described in the example below for an increasing process.

LTSP = AL – CU (for increasing process)

The trip setpoint used for normal plant operation (NTSP) adds margin based on engineering judgment to provide an additional level of conservatism, provided the operating margin is not jeopardized. Thus, the equation for NTSP remains:

NTSP = AL – CU – Margin (for increasing process)

NRC Question (2):

What is the criterion used to determine the Margin in Equations 4.2.3 and 4.2.4?

B&W response:

The margin used in Equation 4.2.3 and 4.2.4 is based on engineering judgment to ensure conservative calculations for the trip setpoint (4.2.3) and allowable value (4.2.4), as shown in Note 1 of Figure 5.1 This is consistent with the prior methodologies approved and accepted by the NRC.

NRC Question (3):

What specific uncertainties are taken into consideration to calculate AFT and AFT_{TOT}?

B&W response:

The total channel as-found tolerance (AFT_{TOT}) is comprised of the individual module as-found tolerances (AFT_n), using the SRSS method as described in section 4.2.4. In section 4.2.5, the AFT for module "n" is described as shown below and consists of the device reference accuracy, device drift, as-left tolerance from the previous calibration, and uncertainties from the measurement and test equipment (MTE) from the channel calibration, which is consistent with

$$AFT_n = (RA_n^2 + DR_n^2 + ALT_n^2 + MTE_n^2)^{1/2}$$

Where:

AFT	=	As-found tolerance (any typical module).
n	=	Module "n".
RA	=	Device reference accuracy.
DR	=	Device allowance for drift.
ALT	=	As-left tolerance
MTE	=	Measurement and test equipment effect

This is consistent with previously accepted Instrument Setpoint Methodologies reviewed and approved by the NRC.

In comparison, the Areva report refers to a term called "Performance and Test Acceptance Criteria" which is consistent with the as-found tolerance determined in equation 4.2.5 where ISA-RP67.04.02-2000 states that " the AV tolerance shall include those effects expected during test such as rack accuracy, instrument uncertainties during normal operation including drift, and calibration uncertainties."

The Areva report states that the AF acceptance criteria (tolerance) will use no more than the SRSS of RA, M&TE, DR, and the following calculation illustrates the determination for AV:

AV = NSTP + PTAC (for increasing setpoint)

Where PTAC is defined as: $(RA^2 + M\&TE^2 + DR^2 + \ldots)^{1/2}$

Similarly, the B&W equation for AV = NTSP + (AFT_{TOT} + Margin)

Where $AFT_{TOT} = (RA^2 + M\&TE^2 + DR^2 + ALT^2)$

NRC Question (4):

Explain why this setpoint methodology does not consider the calibration uncertainty, which is called as as-left tolerance or calibration tolerance.

B&W Response:

B&W maintains that the methodology described in the report does account for calibration uncertainty. The calibration uncertainty is considered as part of the as-found tolerance in equation 4.2.5, which follows the review guidance contained in BTP 7-12 (Section 3.A). It is stated explicitly in section 4.2.5 that the as-found tolerance is part of the channel calibration uncertainty, as excerpted below.

"This is the module uncertainty as discovered during module calibration. Therefore, it does not include uncertainties due to harsh environment or process measurement, and does not include primary element uncertainty. AFT includes consideration of reference accuracy (RA), drift (DR), and as-left tolerance (ALT) uncertainties."

Additionally, in accordance with section 6.2.6.3 of ISA-RP67.04.02-2000, the difference between the as-found of the current calibration and the as-left of the previous calibration represents the net effect of several uncertainties including RA, DR, MTE, and TE(if applicable).

NRC Question (5):

Consider including typical calculations in appendix to the report for staff review. This would be consistent with previous setpoint methodology documents the NRC staff has evaluated.

B&W response:

B&W followed the guidance in BTP 7-12, and this report only addresses some of the many items required for documentation submittals to the NRC for review. It is recognized there are several additional required submittals to meet the required for the NRC review acceptance criteria such as Technical Specification setpoints for limiting safety system settings, setpoint control program, etc.

B&W can consider providing an example calculation. BTP 7-12 of the SRP was consulted and, Section B.3 listed the documentation to be provided by applicants to meet the NRC acceptance criteria. The Topical Report supplied by B&W meets many of these criteria, and B&W recognizes additional submittal information will be required in due course to meet the complete list of required document submittals required by BTP 7-12.

- Discrepancy between Figure 5.1 versus Equations (methodology) in 4.2.2-4.2.4

The methodology uses square-root-summation-of-squares (SRSS) technique to combine instrument loop uncertainties which are statistically and functionally independent and random. Channel Uncertainty (CU) is calculated by SRSS of all instrument channel independent uncertainties from analytical limit (AL) including those uncertainties not measured during the surveillance tests. Methodology and figure should have same expressions/equations for each section identified. For example, AFT should be around NTSP not from AV. In addition, ALT should be included in the figure.

For an illustration, see the attached scanned file.

[B&W response: see discussion in separate document]

- Margins in 4.2.3 and 4.2.4 and in Figure 5.1

What are the specific criteria for determination of Margin of the equations 4.2.3 and 4.2.4?

[B&W response: see answer to question 2]

In Figure 5.1, Margin (Note 1) and Margin (Note 2) appear to be the same. Are they always the same? It is not clear how they are determined.

[B&W response: See clarification to Figure 5.1]

- Identification of LSSS

LSSS should be clearly identified in both methodology and Figure 5.1.

[B&W response: See clarification to Figure 5.1]

- Use of ETC in Figure 5.1

Specific factors should be identified instead of using ETC or etc.

[B&W response: See clarification to Figure 5.1]

- Seismic effect and Accident

Does methodology use seismic effect and accident together?

[B&W response: The seismic effect and accident effect are treated separately as described in Section 4.1.3.1, and equation 4.1 for module uncertainty in the terms for seismic effect

(SE), and temperature and radiation effects due to accident conditions (TEA and REA, respectively).]

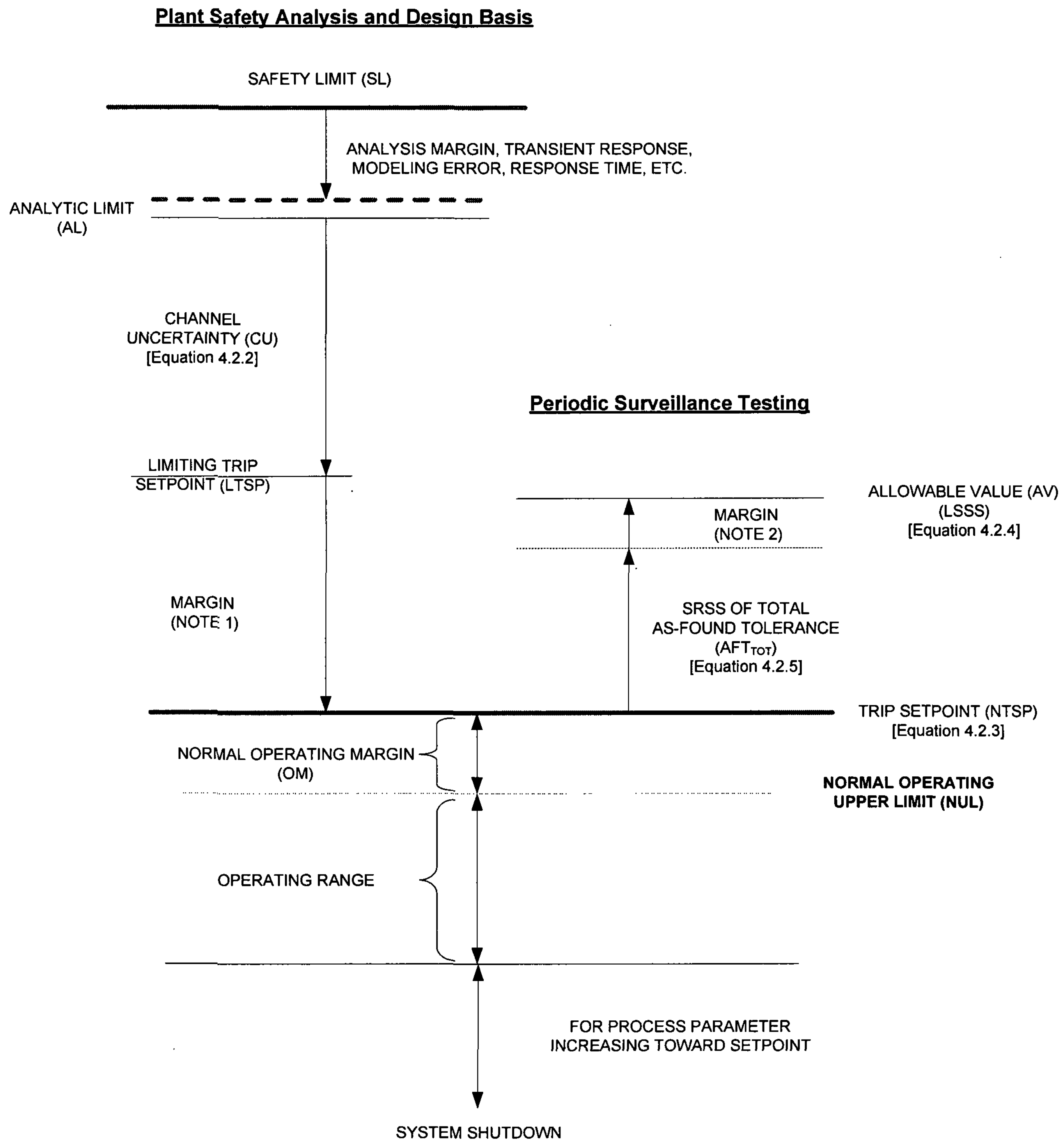
- AFT/AFT_{tot}

Does module uncertainty in 4.2.1 include sensors?

[B&W response: Yes, equation 4.2.1 contains several terms that include sensors such as the drift term (DR), reference accuracy (RA), as shown in the descriptions for the various terms that comprise this equation.]

UNVERIFIED DRAFT

Proposed revision to Figure 5.1 in B&W Instrument Setpoint Topical Report



NOTES:

1. THERE IS NO SET VALUE FOR MARGIN. IT IS A DISCRETIONARY VALUE BASED ON ENGINEERING JUDGEMENT TO ADD CONSERVATISM TO THE CU, TO ENSURE THE TRIP SETPOINT PROTECTS THE ANALYTIC LIMIT.

2. DURING SURVEILLANCE TESTING, IF MARGIN IS ADDED BETWEEN THE TRIP SETPOINT AND AV, THE AS-FOUND TOLERANCE IS TO BE USED TO IDENTIFY IF THE INSTRUMENT IS DEGRADED.

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