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Letter from Thomas Coutu (NMC)

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Responses to Requests for Additional Information and Supplemental Information Regarding LAR 195

WCAP-15821-NP, Westinghouse Protection System Setpoint Methodology Kewaunee Nuclear Plant (Power Uprate to 1757 MWt-NSSS Power with Feedwater Venturis, or 1780 MWt-NSSS Power with Ultrasonic Flow Measurements, and 54F Replacement Steam Generators), October 2003, Non-Proprietary Version

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Westinghouse Protection System Setpoint Methodology Kewaunee Nuclear Plant (Power Uprate to 1757 MWt-NSSS Power with Feedwater Venturis, or 1780 MWt-NSSS Power with Ultrasonic Flow Measurements, and 54F Replacement Steam Generators)

Westinghouse

WCAP-15821-NP
Rev. 0

WESTINGHOUSE PROTECTION SYSTEM SETPOINT METHODOLOGY
KEWAUNEE NUCLEAR PLANT
(POWER UPRATE TO 1757 MWT - NSSS POWER WITH FEEDWATER VENTURIS, OR 1780 MWT - NSSS POWER WITH ULTRASONIC FLOW MEASUREMENTS, AND 54F REPLACEMENT STEAM GENERATORS)

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TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

This report has been prepared to document the instrument uncertainty calculations for specific protection system functions for power uprate to 1757 MWt-NSSS power with feedwater venturis, or 1780 MWt-NSSS power with ultrasonic flow measurements, and 54F replacement steam generators for the Kewaunee Nuclear Plant.

This document is divided into four sections. Section 2.0 identifies the general algorithm used to determine the overall instrument uncertainty for the functions that are analyzed. This approach is defined in a Westinghouse paper presented at an Instrument Society of America/Electric Power Research Institute (ISA/EPRI) conference in June, 1992[1]. This approach is consistent with ISA S67.04, Part I, 1994[2]. The uncertainty algorithm is the square-root-sum-of-the-squares (SRSS) of the applicable uncertainty terms, and is endorsed by the ISA standard. All appropriate and applicable uncertainties, as defined by a review of the plant design input documentation, have been included in each Reactor Trip (RT)/Engineered Safety Feature (ESF) function uncertainty calculation. ISA S67.04, Part II, 1994[3] was utilized as a general guideline, but each uncertainty and its treatment is based on Westinghouse methods that are consistent or conservative with respect to this document. The latest version of NRC Regulatory Guide 1.105 (Revision 3[4]) endorses the 1994 version of ISA S67.04, Part I. Westinghouse has evaluated this NRC document and has determined that the uncertainty calculations contained in this report are consistent with the guidance contained in Revision 3[4]. The total channel uncertainty (Channel Statistical Allowance or CSA) represents a 95/95 value as requested in Regulatory Guide 1.105[4].

Section 3.0 of this report provides a list of the defined terms and associated acronyms used in the uncertainty calculations. Appropriate references to industry standards have been provided where applicable. Included in this section are detailed tables of the uncertainty terms and values for each uncertainty calculation performed by Westinghouse. Provided on each table is the function specific uncertainty algorithm that notes the appropriate combination of instrument uncertainties to determine the channel statistical allowance. A summary table (Table 3-8) is provided that includes a listing of the safety analysis limit, the Technical Specification/Core Operating Limits Report (COLR) trip setpoint, the total allowance (the difference between the safety analysis limit and Technical Specification/COLR trip setpoint, in % span), and margin. In all cases, it was determined that zero or positive margin exists between the safety analysis limit and the Technical Specification/COLR trip setpoint after accounting for the instrument channel uncertainties.

Section 4.0 provides a description of the methodology that is utilized in the determination of the Technical Specifications/COLR setpoints, and an Appendix is provided with a recommended set of plant specific Technical Specification/COLR setpoints.

1.1 References / Standards

[1] 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.

[2] ISA Standard S67.04, Part I, 1994, "Setpoints for Nuclear Safety-Related Instrumentation," 1994.

[3] ISA Standard S67.04, Part II, 1994, "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation," 1994.

[4] Regulatory Guide 1.105 Revision 3, "Setpoints for Safety-Related Instrumentation," 1999.

2.0 COMBINATION OF UNCERTAINTY COMPONENTS

2.1 Methodology

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

The basic methodology is the Square-Root-Sum-of-the-Squares (SRSS) technique. This technique, or others of a similar nature, has been used in WCAP-10395[1] and WCAP-8567[2]. WCAP-8567 is approved by the NRC and notes acceptability of statistical techniques for the application requested. Also, various American National Standards Institute (ANSI), American Nuclear Society (ANS), and Instrument Society of America (ISA) standards approve the use of probabilistic and statistical techniques for determining safety-related setpoints[3,4]. The basic methodology used in this report is essentially the same as that identified in a Westinghouse paper presented at an ISA/EPRI conference in June, 1992[5]. Differences between the algorithm presented in this paper and the equations presented in Tables 3-1 through 3-7 are due to Kewaunee specific characteristics and should not be construed as differences in approach.

The relationship between the uncertainty components and the calculated uncertainty for a channel is:

$$CSA = \{(PMA)^2 + (PEA)^2 + (SMTE + SD)^2 + (SPE)^2 + (STE)^2 + (SRA)^2 + (SMTE + SCA)^2$$

$$+ (RMTE + RD)^2 + (RTE)^2 + (RMTE + RCA)^2\}^{1/2} + EA + SA + BIAS \qquad (Eq. 2.1)$$

where:

CSA	=	Channel Statistical Allowance,
PMA	=	Process Measurement Accuracy,
PEA	=	Primary Element Accuracy,
SRA	=	Sensor Reference Accuracy,
SCA	=	Sensor Calibration Accuracy,
SMTE	=	Sensor Measurement and Test Equipment,
SPE	=	Sensor Pressure Effects,
STE	=	Sensor Temperature Effects,
SD	=	Sensor Drift,

RCA = Rack Calibration Accuracy,

RMTE = Rack Measurement and Test Equipment,

RTE = Rack Temperature Effects,

RD = Rack Drift,

EA = Environmental Allowance,

SA = Seismic Allowance, and

BIAS = One-directional, known magnitude allowance.

Each of the above terms is defined in Section 3.2, Definitions for Protection System Setpoint Tolerances.

Eq. 2.1 is based on the following:

1) The sensor and rack measurement and test equipment uncertainties are treated as dependent parameters with their respective drift and calibration accuracy allowances.
2) While the environmental allowances are not considered statistically dependent with all other parameters, the equipment qualification testing generally results in large magnitude, non-random terms that are conservatively treated as limits of error and are added to the statistical summation. Westinghouse generally considers a term to be a limit of error if the term is a bias with an unknown sign. The term is added to the SRSS in the direction of conservatism.
3) Bias terms are one directional with known magnitudes (that may result from several sources, e.g., drift or calibration data evaluations) and are also added to the statistical combination.
4) The calibration terms are treated in the same square root function with the other terms based on the assumption that general trending, i.e., drift and calibration data are evaluated on a periodic and timely basis. This evaluation should confirm that the distribution function characteristics assumed as part of the treatment of the terms are still applicable.
5) Kewaunee will perform trending of the "as left" and "as found" data for the sensors and process racks on a periodic basis. This commitment results in a net reduction of the CSA magnitude (the CSA would be larger if trending was not performed). Consistent with the request of Regulatory Guide 1.105[6], the CSA value from Eq. 2.1 is at a 95 % probability and a 95 % confidence level (95/95).

It should be noted that for this document, if the effect on accuracy for a channel due to cable insulation resistance degradation in an accident environment is less than 0.1% of span, the magnitude of the impact is considered negligible and is not factored into the calculations. For those channels where this effect is identified to be in excess of 0.1% span, the uncertainty is directly added as a bias.

2.2 Sensor Allowances

Eight parameters are considered to be sensor allowances: SRA, SCA, SMTE, SD, STE, SPE, EA and seismic allowance. Three of these parameters (SRA, STE and SPE) are considered to be independent, two-sided, unverified (by plant calibration or drift determination processes), vendor supplied terms. 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 (SCA, SMTE and SD) are considered dependent with at least one other term, are two-sided, and are the result of the plant calibration and drift determination process. The SCA and SD terms are treated as 95/95 values based on the Kewaunee calibration and drift data evaluations. The SMTE term is treated as a 95/95 value based on vendor product data sheets.

The EA term is associated with the sensor exposure to adverse environmental conditions (elevated temperature and/or radiation) due to mass and energy loss from a break in the primary or secondary side piping. Where appropriate, e.g., steamline break, only the elevated temperature term may be used for this uncertainty. For sensors provided by Westinghouse, the EA term magnitudes are conservatively treated as limits of error and each individual device was verified by testing to be bounded by the EA temperature component. For sensors not provided by Westinghouse, the EA term magnitudes and characteristics (elevated temperature and radiation) were provided by vendor product data sheets.

The Seismic Allowance term is associated with adverse effects due to seismic events. For sensors provided by Westinghouse, the Seismic Allowance magnitude is conservatively treated as a limit of error and each individual device was verified by testing to be bounded by the Seismic Allowance. For sensors not provided by Westinghouse, the Seismic Allowance magnitude was provided by vendor product data sheets.

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[5].

STE and SPE are considered to be independent due to the manner that the instrumentation is checked; i.e., the instrumentation is calibrated and drift is determined when pressure and temperature are constant. For example, assume a sensor is placed in some position in the containment during a refueling outage. After placement, the instrument technician calibrates the sensor at ambient pressure and temperature conditions. Some time later with the plant shutdown, the instrument technician checks for sensor drift using the same technique as used for calibration. The conditions for drift determination are ambient pressure and temperature. The temperature and pressure should be essentially the same at both measurements. Thus, they should have no significant impact 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 that 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 and the "as left" value. It is assumed that a mechanistic cause and effect relationship between SCA and SD has not been demonstrated, and that the data evaluation determined the distribution function characteristics for both SCA and SD and confirmed that SD is random and independent of SCA.

2.3 Rack Allowances

Four parameters are considered to be rack allowances: RCA, RMTE, RTE, and RD. RTE is considered to be an independent, two-sided, unverified (by plant calibration or drift determination processes), vendor supplied term. Process racks are typically located in areas with ambient temperature control, making consistency with the rack evaluation temperature easy to achieve. Based on vendor 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 that the process racks are evaluated. The RMTE term is treated as a two-sided, 95/95 value based on vendor product data sheets. To calibrate or determine drift for a process rack module in a channel, a known input (in the form of a voltage, current or resistance) is provided and the output is either measured or the trip bistable changes state. 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 DMMs or DVMs are necessary to measure the input and the output. For the bistable output, a 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 process rack module calibration uncertainty and the channels are calibrated on a module by module basis. Drift for the process rack modules is determined using the same process used to perform the rack module 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" and the "as left" values. The RD term represents the drift for process rack modules. It is assumed that a mechanistic cause and effect relationship between RCA and RD is not demonstrated, and that any data evaluation will determine the distribution function characteristics for RCA and RD and will show that RD is random and independent of RCA.

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, calorimetric power uncertainty assumptions and fluid density changes. There may be more than one independent PMA uncertainty allowance for a channel. The PEA term typically accounts for uncertainties due to metering devices, such as elbows, venturis, and orifice plates. In this report, this type of uncertainty is limited in application to RCS flow (cold leg elbow taps), steam flow, and feedwater flow. In these specific applications, the PEA terms have 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 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 Measurement and Test Equipment Accuracy

Kewaunee procedures were reviewed to determine the measurement and test equipment used for calibration and functional testing of the transmitters and racks. Westinghouse review of Kewaunee procedures concludes that while the measurement and test equipment accuracies are reasonable, the ANSI/ISA S51.1 - 1979[7] criterion for M&TE deletion (10 to 1 ratio of calibration accuracy magnitude to measurement and test equipment accuracy magnitude) is not always satisfied. As a result, the measurement and test equipment accuracy terms for transmitters and process racks (SMTE and RMTE) may not be deleted in the uncertainty calculations. Vendor specification sheets were utilized to determine the appropriate uncertainty for each function. These M&TE uncertainties were included in the calculations, as noted on the function-specific tables included in this document.

2.6 References / Standards

[1] Grigsby, J. M., Spier, E. M., Tuley, C. R., "Statistical Evaluation of LOCA Heat Source Uncertainty," WCAP-10395 (Proprietary), WCAP-10396 (Non-Proprietary), November, 1983.

[2] Chelemer, H., Boman, L. H., and Sharp, D. R., "Improved Thermal Design Procedure," WCAP-8567 (Proprietary), WCAP-8568 (Non-Proprietary), July, 1975.

[3] ANSI/ANS Standard 58.4-1979, "Criteria for Technical Specifications for Nuclear Power Stations."

[4] ISA Standard S67.04, Part I, 1994, "Setpoints for Nuclear Safety-Related Instrumentation."

[5] 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.

[6] Regulatory Guide 1.105 Revision 3, "Setpoints for Safety Related Instrumentation", 1999.

[7] ANSI/ISA Standard S51.1, 1979 (Reaffirmed 1993), "Process Instrumentation Terminology," p.32.

3.0 PROTECTION SYSTEM SETPOINT METHODOLOGY

This section contains a list of defined terms used in the uncertainty calculations. Also included in this section are detailed tables and a summary table of the uncertainty terms and values for each calculation performed by Westinghouse. It was determined that in all cases either zero or positive margin exists between the Technical Specification/COLR trip setpoint and the safety analysis limit after accounting for uncertainties.

3.1 Margin Calculation

Tables 3-1 through 3-7 provide individual component uncertainties and explicit CSA calculations for each protection function. The values on these tables are plant-specific and are based on installed hardware, I&C calibration procedures, and measurement and test equipment. The determination of the CSA (equation 2.1) as it applies to each function is shown at the bottom of each table with plant-specific values. These equations demonstrate the treatment of independent/dependent variables, environmental and seismic allowance terms, and biases, and show the resulting CSA. Table 3-8 provides a summary of the previous tables and also includes safety analysis limits, Technical Specification/COLR trip setpoints, total allowance and margin.

The equation used to determine the margin and the acceptability of the parameter values is:

$$Margin = TA - \{(PMA)^2 + (PEA)^2 + (SMTE + SD)^2 + (SPE)^2 + (STE)^2 + (SRA)^2 + (SMTE + SCA)^2 + (RMTE + RD)^2 + (RTE)^2 + (RMTE + RCA)^2\}^{1/2} - EA - SA - BIAS \qquad (Eq.\ 3.1)$$

where:

TA = Total Allowance, and

all other parameters are as defined for equation 2.1.

Westinghouse typically reports values in these tables to one decimal place using the conventional technique of rounding down values less than 0.05 %span and rounding up values greater than or equal to 0.05 %span. Parameters reported in Tables 3-1 through 3-7 as "0.0" have been identified as having a value of ≤ 0.04 %span. Parameters reported as "0" or "---" in the tables are not applicable (i.e., have no value) for that channel.

3.2 Definitions for Protection System Setpoint Tolerances

To assure a clear understanding of the channel uncertainty values used in this report, the following definitions are noted.

- As Found

The "as found" condition is the condition that a transmitter, process rack module, or process instrument loop is found after a period of operation. For example, after one cycle of operation, a steam generator level transmitter's output at 50 % span was measured to be 12.05 mA. This would be the "as found" condition.

- As Left

The "as left" condition is the condition in which a transmitter, process rack module, or process instrument loop is left after calibration or bistable trip setpoint verification. This condition is typically better than the calibration accuracy for that piece of equipment. For example, the calibration point for a steam generator level transmitter at 50 % span is 12.0 ± 0.04 mA. A measured "as left" condition of 12.03 mA would satisfy this calibration tolerance. In this instance, if the calibration was stopped at this point (i.e., no additional efforts were made to decrease the deviation) the "as left" error would be + 0.03 mA or + 0.19 % span, assuming a 16 mA (4 to 20 mA) instrument span.

- Bias

A bias is a one directional uncertainty within a measurement, and is the difference between the true process value and the measurement. A bias has a known maximum magnitude. The instrumentation indicates higher than the actual process value for a (+) bias. The instrumentation indicates lower than the actual process value for a (-) bias. If a sign is not identified, the bias can result in either a high or low indication.

- Channel

The channel includes all sensing and process equipment, i.e., transmitter to bistable output, 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 3 Steam Generator Water Level--Low-Low channels must have bistables in the tripped condition for a Reactor Trip to be initiated.

- Channel Statistical Allowance (CSA)

CSA is the result of combining the various channel uncertainties by the square-root-sum-of-the-squares (SRSS), and including appropriate biases in % instrument span. It includes both instrument (sensor and process rack) uncertainties and non-instrument related effects (Process Measurement Accuracy and Primary Element Accuracy). The CSA is compared with the total allowance for determination of instrument channel margin.

- Environmental Allowance (EA)

EA is an allowance for the change in a process signal (transmitter or process rack output) caused by adverse environmental conditions from a limiting accident condition. Typically this value is determined from a conservative set of bounding conditions, is treated as a bias, and may represent the following:

a) temperature effects on a transmitter,
b) radiation effects on a transmitter,
c) temperature effects on a level transmitter reference leg, and
d) temperature effects on signal cable insulation.

- Margin

Margin is the calculated difference in % instrument span between the total allowance and the channel statistical allowance for a given channel. Zero or positive margin must exist for a Technical Specification /COLR trip setpoint to be acceptable.

- Nominal Trip Setpoint (NTS)

The nominal trip setpoint is the bistable setpoint in plant procedures. This is the value that the bistable is set, as accurately as reasonably achievable.

- Normalization

Normalization is a process that establishes a relationship, or link, between a process parameter and an instrument channel. This approach is in contrast to a calibration process that is performed with independent known values. For example, a bistable is *calibrated* to change state when a specific voltage is reached, and the given voltage value corresponds to a process parameter magnitude (i.e., the trip setpoint) with the relationship established through the scaling process. For *normalization*, it typically involves an indirect measurement, such as the determination of loop RCS flow via the Δp drop across a section of an RCS loop. Since the flow coefficient is not known for the section of the RCS loop, a calorimetric RCS flow measurement is performed near full power, steady-state conditions using in-plant and special test instrumentation. With each loop RCS flow known through the calorimetric RCS flow measurement, the loop RCS flow is known for a measured Δp and steady-state conditions, and the loop RCS flow channel is adjusted to the calorimetric loop RCS flow measurement.

- Primary Element Accuracy (PEA)

PEA accounts for the uncertainty due to the use of a metering device, e.g., venturi, orifice, or elbow. Typically, this uncertainty is a calculated or measured accuracy for the device.

- Process Loop

The process loop (or instrument process loop) refers to all equipment associated with a single channel of a protection function.

- Process Measurement Accuracy (PMA)

Process Measurement Accuracy is an allowance that accounts for non-instrument related effects that have a direct bearing on the accuracy of an instrument channel reading. These effects are normally associated with system operating characteristics, e.g., temperature stratification in a large diameter pipe or fluid density in a pipe or vessel, and can result in either random or bias uncertainty values.

- Process Racks

For process protection systems, the process racks include all the equipment contained in the process equipment cabinets, i.e., the analog or digital modules downstream of the transmitter or sensing device, that condition a signal and/or act upon it prior to input to a voting logic system. These modules include electronic circuits such as conversion resistors, transmitter power supplies, R/Es, lead/lag, rate or lag function generators, summators, isolators and bistables for analog functions. The go/no go signal generated by the bistable is the output of the last module in the analog process rack instrument loop, and is the input to the voting logic. For this plant the process racks include the protection channels of the Nuclear Instrumentation System, and the Foxboro Process Protection System.

- R/E

R/E is the resistance (R) to voltage (E) conversion module that converts the RTD output (change in resistance as a function of temperature) to a process loop working parameter (voltage). The Foxboro Process Instrumentation System for this plant utilizes R/E converters for treatment of RTD output signals.

- Rack Calibration Accuracy (RCA)

Rack calibration accuracy is defined as the two-sided calibration tolerance of the process racks as reflected in the plant calibration procedures. It is assumed that the individual modules in a loop are calibrated to a particular tolerance. A review of the Kewaunee calibration procedures concluded that the calibration process and the identified RCA allowance is sufficient to encompass the as left deviation and the hysteresis and repeatability effects.

- Rack Drift (RD)

Rack drift is defined as the change in input-output relationship over a period of time at reference conditions, e.g., at constant temperature. A typical allowance value assumed for this parameter is [ ]$^{+a,c}$ span. For example, assume that a steam generator water level channel at 50 % span (presuming a 1 to 5 VDC span) has an "as found" value of 3.02 VDC and an "as left" value of 3.0 VDC. The magnitude of the drift would be {(3.02-3.0)(100/4)=+ 0.5 % span} in the positive direction.

- Rack Measurement & Test Equipment (RMTE)

RMTE accounts for 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 SAMA Standard PMC 20.1-1973[9] or ANSI/ISA S51.1, 1979 (reaffirmed 1993)[10] , it is considered an integral part of RCA. Uncertainties due to M&TE that are 10 times more accurate than the device being calibrated are considered insignificant and are not included in the uncertainty calculations.

- Rack Temperature Effects (RTE)

RTE provides an allowance for the change in input-output relationship for the process rack module string due to a change in the ambient environmental conditions (temperature, humidity, voltage and frequency) from the reference calibration conditions. It has been determined that temperature is the most significant of these, with the other parameters being second order effects. For the Foxboro-supplied process instrumentation, a value of [ ]$^{+a,c}$ is used for analog channel temperature effects. It is assumed that calibration is performed at a nominal ambient temperature of +70°F with an upper extreme of +120 F (+50°F ΔT) and a lower extreme of +40°F.

- Random

A random variable is a variable whose value at a particular future instant cannot be predicted exactly, but can only be estimated by a probability distribution function. The sign of the uncertainty associated with a random variable with a normal distribution is equally likely to be (+) or (-) with respect to a median value. The magnitude of the uncertainty is dependent on the probability distribution function.

- Range

The range is defined by the upper and lower limits of the operating region for a device, e.g., for a pressurizer pressure transmitter, it is 1700 to 2500 psig; for the narrow range steam generator water level, it is 0 to 100% span (corresponding to a change of approximately 144 inches of water column). This is not necessarily the calibrated span of the device, although quite often the two are close. For further information see SAMA PMC 20.1-1973(6).

- Safety Analysis Limit (SAL)

The SAL is the parameter value in a transient analysis (from the Updated Safety Analysis Report) at which a reactor trip or actuation function is assumed to be initiated.

- Seismic Allowance (SA)

Seismic allowance is an allowance to account for the change in a process signal (transmitter or process rack output) caused by a limiting seismic condition. Typically this value is determined from a conservative set of bounding conditions, and is conservatively treated as a bias.

- Sensor Calibration Accuracy (SCA)

SCA is the calibration accuracy for a sensor or transmitter as defined by the plant calibration procedures. For transmitters, this accuracy is typically [ ]$^{+a,c}$. Utilizing Westinghouse recommendations for RTD cross-calibration, this accuracy is typically [ ]$^{+a,c}$ for the hot leg and cold leg RTDs.

- Sensor Drift (SD)

Sensor Drift is the change in input-output relationship over a period of time at reference calibration conditions (e.g., at constant temperature). The transmitter drift allowance is either specified by NMC or by Westinghouse Nuclear Safety Advisory Letter NSAL-97-001. For example, assume a steam generator level transmitter at 50 % level (presuming a 4 to 20 mA span) has an "as found" value of 12.05 mA and an "as left" value of 12.01 mA. The magnitude of the drift would be {(12.05 - 12.01)(100/16) = + 0.25 % span} in the positive direction.

- Sensor Measurement & Test Equipment (SMTE)

SMTE accounts for the accuracy of the test equipment (typically a high accuracy local readout gauge and DVM) 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 S51.1, 1979 (reaffirmed 1993)[10] it is 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 are not included in the uncertainty calculations.

- Sensor Pressure Effects (SPE)

SPE accounts for either the change in input-output relationship due to a change in the static head pressure from the calibration conditions, or the accuracy to which a correction factor is introduced for the difference between calibration and operating conditions for a Δp transmitter. For Westinghouse supplied transmitters, a typical SPE value is [ ]$^{+a,c}$ with an allowance of [ ]$^{+a,c}$ variance from calibration conditions if performed at line pressure.

- Sensor Reference Accuracy (SRA)

SRA is the reference (calibration) accuracy for a sensor or transmitter as defined by SAMA Standard PMC 20.1-1973[1]. Inherent in this definition is the verification of the following under a reference set of conditions: 1) conformity[2], 2) hysteresis[3] and 3) repeatability[4]. The test procedure from which these parameters are determined is identified as part of the SAMA standard[5]. For Rosemount-supplied transmitters, this accuracy is typically [ ]$^{+a,c}$. This term is included to address repeatability concerns when performing only a one up/one down calibration, or to address repeatability and hysteresis when performing only a single pass calibration (in only one direction) over the entire instrument range.

- Sensor Temperature Effects (STE)

STE provides an allowance for the change in input-output relationship for the sensor due to a change in the ambient environmental conditions (temperature, humidity, voltage and frequency) from the reference calibration conditions. It has been determined that temperature is the most significant of these, with the other parameters being second order effects. For Westinghouse supplied transmitters, the temperature effect is typically [ ]$^{+a,c}$ with a maximum assumed change of 50°F (or an STE value of [ ]$^{+a,c}$). It is assumed that calibration is performed at a nominal ambient temperature of +70°F with an upper extreme of +120°F and a lower extreme of +40°F. For specific devices, a maximum temperature of +130°F is acceptable, which then requires a calibration temperature of greater than or equal to +80°F or an adjustment of the assumed STE.

- Span

The span is the region for which a device is calibrated and verified to be operable, e.g., for a pressurizer pressure transmitter, it is 800 psi; for the narrow range steam generator water level, it is 100% span (corresponding to approximately 144 inches of water column).

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

SRSS is the mathematical approach, as approved for use in setpoint calculations by ISA Standard S67.04-1994[7], utilized by Westinghouse to combine independent uncertainty terms and is expressed by the following:

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

- Total Allowance (TA)

Total allowance is the absolute value of the calculated difference between the safety analysis limit and the Technical Specification/COLR trip setpoint (SAL - TS) in % instrument span. Two examples of the calculation of TA are shown below.

- Steam Generator Water Level – Low-Low

SAL	0.0 % Level	
TS	10.0 % Level	
TA	| 10.0 % Level |	= 10.0 % Level

If the instrument span = 100 % Level, then

$$TA = \frac{(10.0\%\ level)*(100\%\ span)}{(100\%\ level)} = 10.0\ \%\ span$$

- Pressurizer Pressure - Low

SAL	1835 psig
TS	- 1875 psig
TA	| -40 psi | = 40 psi

If the instrument span = 800 psi, then

$$TA = \frac{(40psi)(100\%span)}{800psi} = 5.0\%span$$

- Trip Setpoint (TS)

The trip setpoint is the value that the bistable or switch can be set as accurately as reasonably achievable. The trip setpoint is found in Technical Specifications or the COLR.

3.3 Cross Reference - SAMA PMC 20.1-1973 and ANSI/ISA-S51.1-1979

SAMA Standard PMC 20.1-1973, "Process Measurement & Control Terminology" is no longer in print and thus is unavailable from SAMA. It has been replaced by ANSI/ISA S51.1-1979, "Process Instrumentation Terminology" and is available from the Instrument Society of America. Noted below is a cross reference listing of equivalent definitions between the two standards for terms used in this document. Even though the SAMA standard is no longer available, Westinghouse prefers and continues to use the SAMA definitions.

SAMA	ISA
Reference Accuracy(1)	Accuracy Rating(8)
Conformity(2)	Conformity, Independent(9)
Hysteresis(3)	Hysteresis(10)
Repeatability(4)	Repeatability(11)
Test Cycle(5)	Calibration Cycle(12)
Test Procedures(5)	Test Procedures(12)
Range(6)	Range(13)

3.4 Methodology Conclusions

The Westinghouse setpoint methodology that is used to determine plant-specific setpoint uncertainties complies with the requirements of ISA standard S67.04[7]. The results contained in this document are based on plant-specific hardware, procedures, and measurement and test equipment. Calibration and measurement and test equipment accuracies used in this analysis are consistent with (or slightly conservative with respect to) plant procedures. Process Measurement Accuracy and Primary Element Accuracy terms are also considered to be conservative values. Sensor Drift and Rack Drift must be shown to be conservative based on a qualitative assessment of plant sensor and rack drift data.

As indicated in Table 3-8 where the channel statistical allowances are compared to the total allowances, there are no negative margins for the protection channels. This demonstrates that the Technical Specification/COLR trip setpoints are satisfactory with respect to the safety analyses.

3.5 References / Standards

(1) Scientific Apparatus Makers Association Standard PMC 20.1-1973, "Process Measurement & Control Terminology", p 4, 1973.

(2) Ibid., p 5.

(3) Ibid., p 19.

(4) Ibid., p 28.

(5) Ibid., p 36.

(6) Ibid., p 27.

(7) Instrument Society of America Standard S67.04-1994, "Setpoints for Nuclear Safety-Related Instrumentation".

(8) Instrument Society of America Standard S51.1-1979, "Process Instrumentation Terminology", p 6, 1979.

(9) Ibid., p 8.

(10) Ibid., p 20.

(11) Ibid., p 27.

(12) Ibid., p 33.

(13) Ibid., p 25.

TABLE 3-1
OVERTEMPERATURE ΔT
Assumes re-normalization of ΔT_0 and T'

Parameter	Allowance*
Process Measurement Accuracy	[ ]+a,c
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Primary Element Accuracy	
Sensor Reference Accuracy	
[ ]+a,c	
[ ]+a,c	
Sensor Calibration Accuracy	
[ ]+a,c	
Sensor Measurement & Test Equipment	
[ ]+a,c	
Sensor Temperature Effects	
[ ]+a,c	
Sensor Drift	
[ ]+a,c	
Environmental Allowance	
Seismic Allowance	
[ ]+a,c	
Rack Calibration Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	

TABLE 3-1 (continued)
OVERTEMPERATURE ΔT
Assumes re-normalization of ΔT_0 and T'

Parameter	Allowance*
Rack Measurement & Test Equipment	$[\quad]^{+a,c}$
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Rack Temperature Effect	
Rack Drift	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	

* In percent ΔT span (ΔT - 150.0% RTP; Thot and Tcold: 500 - 650°F; Tavg: 520 - 620°F; Pressure: 1700 - 2500 psig; ΔI - ±60% ΔI; 90.0°F span = 150.0% RTP)
See Table 3-9 for gain and conversion calculations

Channel Statistical Allowance =

$[\quad]^{+a,c}$

\+ Number of Hot Leg RTDs used per instrument channel
++ Number of Cold Leg RTDs used per instrument channel

TABLE 3-2

OVERPOWER ΔT

Assumes re-normalization of ΔT_o and T'

Parameter	Allowance*
Process Measurement Accuracy	[ ]+a,c
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Primary Element Accuracy	
Sensor Reference Accuracy [ ]+a,c	
Sensor Calibration Accuracy	
Sensor Measurement & Test Equipment	
Sensor Temperature Effects	
Sensor Drift	
Environmental Allowance	
Seismic Allowance	
Rack Calibration Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Rack Measurement & Test Equipment	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Rack Temperature Effect	
Rack Drift	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	

TABLE 3-2 (continued)
OVERPOWER ΔT
Assumes re-normalization of ΔT_0 and T'

* In percent ΔT span (ΔT - 150.0% RTP; Thot and Tcold: 500 - 650°F; Tavg: 520 - 620°F; 90.0°F span = 150.0% RTP)
See Table 3-10 for gain and conversion calculations

Channel Statistical Allowance =

+a,c

+ Number of Hot Leg RTDs used per instrument channel
++ Number of Cold Leg RTDs used per instrument channel

TABLE 3-3
REACTOR COOLANT FLOW - LOW

Parameter	Allowance*
Process Measurement Accuracy	[ ]+a,c
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Primary Element Accuracy	
[ ]+a,c	
Sensor Reference Accuracy [ ]+a,c	
Sensor Calibration Accuracy	
[ ]+a,c	
Sensor Measurement & Test Equipment	
[ ]+a,c	
Sensor Pressure Effects	
[ ]+a,c	
Sensor Temperature Effects	
[ ]+a,c	
Sensor Drift [ ]+a,c	
Environmental Allowance	
Seismic Allowance	
Rack Calibration Accuracy [ ]+a,c	
Rack Measurement & Test Equipment [ ]+a,c	
Rack Temperature Effect [ ]+a,c	
Rack Drift [ ]+a,c	

* In percent flow span (110% Thermal Design Flow)
Percent Δp span converted to flow span via Eq.3-11.8 with Fmax = 110 and Fn = 90.0

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-4

STEAM FLOW / FEEDWATER FLOW MISMATCH

Parameter	Allowance*
Process Measurement Accuracy	[ ]+a,c
[ ]+a,c	
Primary Element Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Sensor Reference Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Sensor Calibration Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Sensor Measurement & Test Equipment	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Sensor Pressure Effects	
[ ]+a,c	
[ ]+a,c	
Sensor Temperature Effects	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Sensor Drift	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Environmental Allowance	
Seismic Allowance	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	

* In percent flow span (115.2% rated steam flow)
Percent Δp span converted to flow span via Eq.3-11.8 with Fmax = 115.2, Fn = 100.0 for steam flow and Fn = 77.6 for feedwater flow.

TABLE 3-4 (continued)
STEAM FLOW / FEEDWATER FLOW MISMATCH

Parameter	Allowance*
Rack Calibration Accuracy	[ ]+a,c
Steam flow [ ]+a,c	
Steam flow [ ]+a,c	
Steam flow [ ]+a,c	
Feedwater flow [ ]+a,c	
Feedwater flow [ ]+a,c	
Steam pressure [ ]+a,c	
Rack Measurement & Test Equipment	
Steam flow [ ]+a,c	
Steam flow [ ]+a,c	
Steam flow [ ]+a,c	
Feedwater flow [ ]+a,c	
Feedwater flow [ ]+a,c	
Steam pressure [ ]+a,c	
Rack Temperature Effect	
Rack Drift	
Steam flow [ ]+a,c	
Steam flow [ ]+a,c	
Steam flow [ ]+a,c	
Feedwater flow [ ]+a,c	
Feedwater flow [ ]+a,c	

* In percent flow span (115.2% rated steam flow)
Percent Δp span converted to flow span via Eq.3-11.8 with Fmax = 115.2, Fn = 100.0 for steam flow and Fn = 77.6 for feedwater flow.

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-5
STEAM GENERATOR WATER LEVEL - HIGH-HIGH (54F)

Parameter	Allowance*
Process Measurement Accuracy	[ ]+a,c
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Primary Element Accuracy	
Sensor Reference Accuracy	
Sensor Calibration Accuracy	
Sensor Measurement & Test Equipment	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift	
Environmental Allowance	
Seismic Allowance [ ]+a,c	
Rack Calibration Accuracy	
Rack Measurement & Test Equipment	
Rack Temperature Effects	
Rack Drift	

* In percent span (100 percent span)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-6
STEAM FLOW - HIGH

Parameter	Allowance*
Process Measurement Accuracy [ ]+a,c	
Primary Element Accuracy [ ]+a,c [ ]+a,c [ ]+a,c	
Sensor Reference Accuracy [ ]+a,c	
Sensor Calibration Accuracy [ ]+a,c	
Sensor Measurement & Test Equipment [ ]+a,c	
Sensor Pressure Effects [ ]+a,c	
Sensor Temperature Effects [ ]+a,c	
Sensor Drift [ ]+a,c	
Environmental Allowance	
Seismic Allowance [ ]+a,c	
Rack Calibration Accuracy [ ]+a,c	
Rack Measurement & Test Equipment [ ]+a,c	
Rack Temperature Effects [ ]+a,c	
Rack Drift [ ]+a,c	

+a,c [ ]

* In percent flow span. Percent ΔP span converted to flow span via Eq. 3-11.8, where F_{max} = 115.2%, F_N = 19.2%.

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-7
Tavg - LOW-LOW

Parameter	Allowance*
	[ ]+a,c
Process Measurement Accuracy [ ]+a,c	
Primary Element Accuracy	
Sensor Reference Accuracy	
Sensor Calibration Accuracy	
Sensor Measurement & Test Equipment	
Sensor Temperature Effects	
Sensor Drift	
Environmental Allowance	
Seismic Allowance	
Rack Calibration Accuracy [ ]+a,c [ ]+a,c [ ]+a,c [ ]+a,c	
Rack Measurement & Test Equipment [ ]+a,c [ ]+a,c	
Rack Temperature Effect	
Rack Drift [ ]+a,c [ ]+a,c [ ]+a,c	

* In percent Tavg span (100 °F); Tavg: 520 - 620 °F; Thot and Tcold: 500 - 650 °F

TABLE 3-7 (continued)
Tavg - LOW-LOW

Channel Statistical Allowance* =

[ ] +a,c

* In percent Tavg span (100 °F)
+ Number of hot leg RTDs per channel
++ Number of cold leg RTDs per channel

TABLE 3-8 (Rev.0)
REACTOR TRIP / ENGINEERED SAFETY FEATURES CHANNEL UNCERTAINTY ALLOWANCES
KEWAUNEE NUCLEAR PLANT

				SENSOR								PROCESS RACK										
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	PROTECTION CHANNEL	PROCESS MEASUREMENT ACCURACY (PMA) (1)	PRIMARY ELEMENT ACCURACY (PEA) (1)	REFERENCE ACCURACY (SRA) (1)	CALIBRATION ACCURACY (SCA) (1)	MEASUREMENT & TEST EQUIPMENT (SMTE) (1)	PRESSURE EFFECTS (SPE) (1)	TEMPERATURE EFFECTS (STE) (1)	DRIFT (SD) (1)	ENVIRON-MENTAL ALLOWANCE (EA) OR BIAS (1)	SEISMIC ALLOWANCE (SA) (1)(15)	CALIBRATION ACCURACY (RCA) (1)	MEASUREMENT & TEST EQUIPMENT (RMTE) (1)	TEMPERATURE EFFECTS (RTE) (1)	DRIFT (RD) (1)	SAFETY ANALYSIS LIMIT (SAL) (2)	TECHNICAL SPECIFICATION /COLR ALLOWABLE VALUE	TECHNICAL SPECIFICATION /COLR TRIP SETPOINT (3)	TOTAL ALLOWANCE (TA) (1)	CHANNEL STATISTICAL ALLOWANCE (CSA) (1)	MARGIN (1)	
1	OVERTEMPERATURE ΔT REACTOR TRIP															+a,c						+a,c
	ΔT INPUT															FUNCTION	NA	FUNCTION	6.7			1
	TAVG INPUT																					
	PRESSURIZER PRESSURE INPUT (ROSEMOUNT TRANSMITTER)																					
	ΔI INPUT																					
2	OVERPOWER ΔT REACTOR TRIP																					
	ΔT INPUT															FUNCTION	NA	FUNCTION	4.3			2
	TAVG INPUT																					
3	REACTOR COOLANT FLOW – LOW, REACTOR TRIP (FOXBORO TRANSMITTER)															86.5% LOOP FLOW	NA	90.0% LOOP FLOW	3.2			3
4	STEAM FLOW-FEEDWATER FLOW MISMATCH, REACTOR TRIP (COINCIDENT WITH STEAM GEN. WATER LEVEL-LOW)																					4
	STEAM FLOW INPUT (ROSEMOUNT TRANSMITTER)															(14)	NA	0.87 $\times 10^6$ LB/HR	--			
	FEEDWATER FLOW INPUT (ROSEMOUNT TRANSMITTER)																					
	STEAM PRESSURE INPUT (ROSEMOUNT TRANSMITTER)																					
5	STEAM GEN. WATER LEVEL – HIGH,HIGH TURBINE TRIP (ROSEMOUNT TRANSMITTER)															94.3% SPAN	NA	78.0% SPAN	16.3			5
6	STEAM FLOW – HIGH STEAM LINE ISOLATION (COINCIDENT WITH SAFETY INJECTION AND TAVG-LOW-LOW) (ROSEMOUNT TRANSMITTER)															1.75 $\times 10^6$ LB/HR	NA	0.745 $\times 10^6$ LB/HR	22.4			6
7	TAVG - LOW-LOW INTERLOCK															535°F	NA	540°F	5.0			7

NOTES:
1. ALL VALUES IN PERCENT OF SPAN
2. AS NOTED IN CHAPTER 14.0 OF THE USAR
3. AS NOTED IN 2.3 AND TABLE 3.5-1 OF THE TECHNICAL SPECIFICATIONS OR IN THE PRECAUTIONS, LIMITATIONS & SETPOINTS DOCUMENT.
4. [ ]a,c
5. [ ]a,c
6. [ ]a,c
7. [ ]a,c
8. INCORE / EXCORE ΔI COMPARISON
9. [ ]a,c
10. [ ]a,c
11. [ ]a,c
12. [ ]a,c
13. [ ]a,c
14. NOT USED IN THE USAR
15. [ ]a,c

TABLE 3-9
OVERTEMPERATURE ΔT CALCULATIONS

■ The equation for Overtemperature ΔT

$$\Delta T \leq \Delta T_0 \{ K_1 - K_2 \frac{(1 + \tau_1 S)}{(1 + \tau_2 S)} [T - T'] + K_3 (P - P') - f_1(\Delta I) \}$$

K_1 (nominal)	= 1.20 COLR value
K_1 (max)	= [ ]+a,c
K_2	= 0.015/°F
K_3	= 0.00072/psi
Vessel ΔT	= 60.0 °F
ΔI gain	= 0.96% /% ΔI (ΔI ≥ +12%)

■ Full power ΔT calculation

ΔT span = [ ]+a,c

■ Process Measurement Accuracy Calculations

[ ]+a,c

[ ]+a,c

[ ]+a,c

[ ]+a,c

[ ]+a,c

* Presumes normalization of ΔT_0 to as found full power indicated value, and presumes normalization of T' to Tref.

TABLE 3-9 (continued)
OVERTEMPERATURE ΔT CALCULATIONS

ΔI - Incore / Excore Mismatch

+a,c

=

ΔI - Incore Map Delta-I

+a,c

=

■ Pressure Channel Uncertainties

+a,c

Gain =

+a,c

SRA =

SCA =

SMTE =

STE =

SD =

BIAS =

+a,c

RCA =

RMTE =

RD =

TABLE 3-9 (continued)
OVERTEMPERATURE ΔT CALCULATIONS

■ Tavg Channel Uncertainties

+a,c

Gain =

+a,c

RCA =
RCA =
RCA =

RMTE =

RD =
RD =
RD =

■ ΔI Channel Uncertainties

+a,c

Gain =

+a,c

RCA =
RCA =
RCA =
RCA =

RMTE =

RD =
RD =
RD =
RD =

■ Total Allowance

+a,c

TA =

=

=

TABLE 3-10
OVERPOWER ΔT CALCULATIONS

■ The equation for Overpower ΔT

$$\Delta T \leq \Delta T_0 \{ K_4 - K_5 \frac{(\tau_3 S)}{(1 + \tau_3 S)} T - K_6 [T - T'] - f_2(\Delta I) \}$$

K_4 (nominal)	= 1.095 COLR value
K_4 (max)	= [ ]+a,c
K_5	= 0.0 for decreasing average temperature
K_5	= 0.0275/°F for increasing average temperature
K_6	= 0.00103/°F
Vessel ΔT	= 60.0 °F
f(ΔI)	= 0 for all ΔI

■ Full power ΔT calculation

ΔT span = [ ]+a,c

■ Process Measurement Accuracy Calculations

[ ]+a,c

[ ]+a,c

[ ]+a,c

[ ]+a,c

[ ]+a,c

* Presumes normalization of ΔT_0 to as found full power indicated value, and presumes normalization of T' to Tref.

TABLE 3-10 (Continued)
OVERPOWER ΔT CALCULATIONS

■ Tavg Channel Uncertainties

Gain = [ ] +a,c

RCA =
RCA =
RCA =
RCA =

RMTE =

RD =
RD =
RD =
RD =

[ ] +a,c

■ Total Allowance

TA =
=
=

[ ] +a,c

TABLE 3-11
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:

$$(F_N)^2 = \Delta P_N \qquad \text{where N = Nominal Flow}$$

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

$$\text{thus } \partial F_N = \frac{\partial \Delta P_N}{2F_N} \qquad \text{Eq. 3-11.1}$$

Error at a point (not in percent) is:

$$\frac{\partial F_N}{F_N} = \frac{\partial \Delta P_N}{2(F_N)^2} = \frac{\partial \Delta P_N}{2\Delta P_N} \qquad \text{Eq. 3-11.2}$$

and

$$\frac{\Delta P_N}{\Delta P_{max}} = \frac{(F_N)^2}{(F_{max})^2} \quad \text{where max = maximum flow} \qquad \text{Eq. 3-11.3}$$

and the transmitter ΔP error is:

$$\frac{\partial \Delta P_N}{\Delta P_{max}}(100) = \text{percent error in Full Scale } \Delta P \ (\%\varepsilon \ (FS\ \Delta P)) \qquad \text{Eq. 3-11.4}$$

therefore:

$$\frac{\partial F_N}{F_N} = \frac{\Delta P_{max}\left[\frac{\%\,\varepsilon\,(FS\ \Delta P)}{100}\right]}{2\Delta P_{max}\left[\frac{F_N}{F_{max}}\right]^2} = \left[\frac{\%\,\varepsilon(FS\ \Delta P)}{(2)(100)}\right]\left[\frac{F_{max}}{F_N}\right]^2 \qquad \text{Eq. 3-11.5}$$

TABLE 3-11 (Continued)
ΔP MEASUREMENTS EXPRESSED IN FLOW UNITS

Error in flow units is:

$$\partial F_N = F_N \left[\frac{\%\,\varepsilon\,(FS\,\Delta P)}{(2)(100)}\right]\left[\frac{F_{max}}{F_N}\right]^2 \qquad \text{Eq. 3-11.6}$$

Error in percent nominal flow is:

$$\frac{\partial F_N}{F_N}(100) = \left[\frac{\%\,\varepsilon\,(FS\,\Delta P)}{2}\right]\left[\frac{F_{max}}{F_N}\right]^2 \qquad \text{Eq. 3-11.7}$$

Error in percent full span is:

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

$$= \left[\frac{\%\,\varepsilon\,(FS\,\Delta P)}{2}\right]\left[\frac{F_{max}}{F_N}\right] \qquad \text{Eq. 3-11.8}$$

Equation 3-11.8 is used to express errors in percent full span in this document.

4.0 APPLICATION OF THE SETPOINT METHODOLOGY

4.1 Uncertainty Calculation Basic Assumptions/Premises

The equations noted in Sections 2 and 3 have several basic premises related to the calibration and drift determination procedures utilized at the plant and statistical evaluations of "as left" and "as found" data for the RT/ESF functions noted in Tables 3-1 through 3-7 of this document:

1) the instrument technicians make reasonable attempts to achieve the nominal trip setpoint as an "as left" condition at the start of each process rack channel's surveillance interval,

2) the instrument technicians make reasonable attempts to achieve a nominal "as left" condition at the start of each sensor/transmitter's surveillance interval,

3) the drift for the process rack modules is evaluated (probability distribution function characteristics and drift magnitude) over multiple surveillance intervals,

4) the sensor/transmitter drift is trended over the fuel cycle and evaluated (probability distribution function characteristics and drift magnitude) over multiple fuel cycles,

5) the calibration accuracy for the process rack modules is evaluated (probability distribution function characteristics and calibration magnitude) over multiple surveillance intervals,

6) the sensor/transmitter calibration accuracy is evaluated (probability distribution function characteristics and calibration magnitude) over multiple surveillance intervals,

7) the process rack modules (including the bistables) are calibrated using a one up (or one down) pass utilizing multiple calibration points (minimum 4 points and for many functions - 5 points, as recommended by ISA S51.1[11]), and

8) the sensor/transmitters are calibrated using a one up (or one down) pass utilizing multiple calibration points (minimum 4 points and for many functions - 5 points, as recommended by ISA S51.1[11]).

It should be noted for (1) and (2) that it is not necessary for the instrument technician to recalibrate a device or process rack channel if the "as left" condition is not exactly at the nominal condition but is within the plus or minus of the nominal "as left" procedural tolerance. As noted above, the uncertainty calculations assume that the "as left" tolerance (conservative and non-conservative direction) is satisfied on a reasonable basis, not that the nominal condition is satisfied exactly. It is recommended that the "as left" condition for the RT/ESF process rack channels and sensor/transmitters be evaluated over multiple calibration cycles. This evaluation will verify that the SCA and RCA parameter values noted in Tables 3-1 through 3-7 are satisfied on a 95% probability / 95% confidence level basis. For those instances where non-conservative biases in calibration are noted, the biases must be factored into the uncertainty calculation. Calibration biases for sensor/transmitters are considered as non-conservative since sensor/transmitter signals are used for both control and protection, and could be considered significant for control purposes. It is therefore necessary to periodically re-verify the continued validity of these results. This prevents the institution of non-conservative biases due to a procedural basis without the plant staff's knowledge and appropriate treatment.

Conservative drift values ("as found" - "as left") for the sensor/transmitters and the process rack modules have been used for this effort. Multiple surveillance intervals have been evaluated by NMC to verify that the drift values for a surveillance interval of 125% of 18 months (for sensor/transmitters) and 125% of either monthly or quarterly (for analog process rack channels) are consistent with the SD and RD parameter values noted in Tables 3-1 through 3-7. The equations used in Sections 2 and 3 assume that drift data are evaluated for continuation of the validity of the basic characteristics used by the uncertainty calculations. This assumption has a significant beneficial effect on the basic uncertainty equation, i.e., it results in a reduction in the CSA magnitude.

In summary, a process rack channel is considered to be "calibrated" when the two-sided "as left" calibration procedural tolerances are satisfied. An instrument technician may determine to recalibrate if near the extremes of the "as left" procedural tolerance, but it is not required. Re-calibration is explicitly required any time the "as found" condition of the device or module is outside of the "as left" procedural tolerance. A device or module may not be left outside the "as left" tolerance without declaring the channel "inoperable" and appropriate action taken. Thus an "as left" tolerance may be considered as an outer limit for the purposes of calibration and instrument uncertainty calculations.

4.2 Application to the Technical Specifications/COLR

Section 4.1 is basically consistent with the recommendations of the Westinghouse paper presented at the June 1994, ISA/EPRI conference in Orlando, FL[2]. Therefore, consistent with the paper, Westinghouse recommends revision of Technical Specification 2.3 "Limiting Safety System Settings, Protective Instrumentation", Technical Specification 3.5, "Instrumentation System" and the COLR based on this uncertainty analysis. Appendix A provides the Westinghouse recommendations for the Technical Specification/COLR setpoints. Table 3-8 (Column 17) provides the recommended Technical Specification/COLR trip setpoint for each RT/ESF protection function that was determined in the Westinghouse uncertainty calculations to be acceptable for use.

4.3 References/Standards

[1] Instrument Society of America Standard S51.1 - 1979, "Process Instrumentation Terminology", p 33, 1979.

[2] 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.

Appendix A

Reactor Trip and Engineered Safety Features Setpoints

REACTOR TRIP SETPOINTS

Reactor trip setpoints are as follows:

Functional Unit	Trip Setpoint
Overtemperature ΔT	See Note 1
Overpower ΔT	See Note 2
Reactor Coolant Flow - Low	$\geq$ 90 % of normal indicated flow as measured by elbow taps
Steam/Feedwater Flow Mismatch (coincident with Steam Generator Water Level-Low)	$\leq 0.87 \times 10^6$ lb/hr

NOTE 1: OVERTEMPERATURE ΔT REACTOR TRIP SETPOINT

$$\Delta T \leq \Delta T_0 \{ K_1 - K_2 \frac{(1 + \tau_1 S)}{(1 + \tau_2 S)} (T - T') + K_3 (P - P') - f_1(\Delta I) \}$$

Where:	ΔT	= loop-specific indicated Reactor Coolant System ΔT, % Rated Power;
	ΔT_o	= loop-specific indicated Reactor Coolant System ΔT at RATED POWER, % Rated Power;
	T	= Average temperature, °F;
	T'	= Reference T_{avg} at RATED POWER, ≤ 573.0°F;
	P	= Pressurizer pressure, psig;
	P'	= 2235 psig;
	K_1	≤ 1.20;
	K_2	= 0.015/°F;
	K_3	= 0.00072/psig;
	$\frac{1 + \tau_1 S}{1 + \tau_2 S}$	= The function generated by the lead-lag compensator for T_{avg} dynamic compensation;
	τ_1	≥ 30 sec;
	τ_2	≤ 4 sec;
	S	= Laplace transform operator, sec^{-1}; and

$f_1(\Delta I)$ = a function of the indicated difference between top and bottom detectors of the power range neutron ion chambers. Selected gains are based on measured instrument response during plant startup tests, where q_t and q_b are percent of RATED POWER in the top and bottom halves of the core respectively, and $q_t + q_b$ is the total core power in percent of RATED POWER, such that:

(a) For $q_t - q_b$ within -22.0 % and +12.0 %, $f_1(\Delta I) = 0$;

(b) For each percent that the magnitude of $q_t - q_b$ exceeds +12.0 %, the ΔT trip setpoint shall be automatically reduced by an equivalent of 0.96 % of RATED POWER; and

(c) For each percent that the magnitude of $q_t - q_b$ exceeds -22.0 %, the ΔT trip setpoint shall be automatically reduced by an equivalent of 0.86 % of RATED POWER.

NOTE 2: OVERPOWER ΔT REACTOR TRIP SETPOINT

$$\Delta T \leq \Delta T_0 \{ K_4 - K_5 (\frac{\tau_3 S}{1 + \tau_3 S}) T - K_6 (T - T') - f_2(\Delta I) \}$$

Where:

Where:	ΔT	= As defined in Note 1;
	ΔT_o	= As defined in Note 1;
	T	= As defined in Note 1;
	T'	= As defined in Note 1;
	K_4	$\leq$ 1.095;
	K_5	$\geq$ 0.0275/°F for increasing T and 0 for decreasing T;
	K_6	$\geq$ 0.00103/°F when T > T' and 0/°F when T $\leq$ T';
	$\frac{\tau_3 S}{1 + \tau_3 S}$	= The function generated by the rate-lag compensator for T_{avg} dynamic compensation;
	τ_3	$\geq$ 10 sec;
	S	= As defined in Note 1, and
	$f_2(\Delta I)$	= 0 for all ΔI.

BASES

The trip setpoints are the nominal values at which the reactor trip bistables may be set for each functional unit. They have been selected to ensure that the core and Reactor Coolant System are prevented from exceeding their safety limits during normal operation and during design basis anticipated operational occurrences. They also assist the Engineered Safety Features system in mitigating the consequences of accidents. The setpoint is considered to be consistent with the trip setpoint value when the measured "as left" setpoint is within the administratively controlled (±) process rack calibration tolerance identified in plant procedures. Additionally, the setpoints may be adjusted in the conservative direction.

Maintenance and Test Equipment accuracy is administratively controlled by plant procedures and is included in the plant uncertainty calculations as defined in WCAP-15821. Maintenance and Test Equipment that conforms to the accuracy used in the plant uncertainty calculations should be consistent with the requirements of ANSI / ISA 51.1-1979 or the most accurate practicable.

The methodology, as defined in WCAP-15821 to derive the trip setpoints, is based upon combining all of the uncertainties in the channels. The magnitudes of these channel uncertainties are inherent in the determination of the trip setpoints. Sensors and other instrumentation utilized in these channels must be capable of operating within the allowances of these uncertainty magnitudes. Occasional drift in excess of the allowance may be determined to be acceptable based on other device performance characteristics. Device drift in excess of the allowance that is more than occasional, may be indicative of more serious problems and warrant further investigation.

The OPERABILITY of the reactor trip system instrumentation and interlocks ensures that: (1) the Reactor Trip will be initiated when the parameter monitored by each channel or combination thereof reaches its setpoint, (2) the specified coincidence logic is maintained, and (3) sufficient redundancy is maintained to permit a channel to be out of service for testing or maintenance.

The OPERABILITY of this system is required to provide the overall reliability, redundancy, and diversity assumed available in the facility design for the protection and mitigation of accident and transient conditions. The operation of this system is consistent with the assumptions used in the safety analyses. The Surveillance Requirements specified for this system ensure that the overall system functional capability is maintained comparable to the original design standards. The periodic surveillance tests performed at the minimum frequencies are sufficient to demonstrate this capability.

ENGINEERED SAFETY FEATURES SETPOINTS

The Engineered Safety Features setpoints are as follows:

Functional Unit	Trip Setpoint
Steam line isolation of affected line: High steam flow in a steam line	$\leq$ d/p corresponding to 0.745 x 10^6 lb/hr at 1005 psig
coincident with	
Safety Injection and	
Low-Low Tavg	$\geq$ 540 °F
Turbine Trip: Steam Generator Water Level - High-High	$\leq$ 78 % of narrow range instrument span

ENGINEERED SAFETY FEATURES SETPOINTS

BASES

The Engineered Safety Features trip setpoints are the nominal values at which the protection system bistables may be set for each functional unit. The setpoint is considered to be consistent with the trip setpoint value when the measured "as left" setpoint is within the administratively controlled (±) process rack calibration tolerance identified in plant procedures. Additionally, the setpoints may be adjusted in the conservative direction.

Maintenance and Test Equipment accuracy is administratively controlled by plant procedures and is included in the plant uncertainty calculations as defined in WCAP-15821. Maintenance and Test Equipment that conforms with the accuracy used in the plant uncertainty calculations should be consistent with the requirements of ANSI / ISA 51.1-1979 or the most accurate practicable.

The methodology, as defined in WCAP-15821 to derive the trip setpoints, is based upon combining all of the uncertainties in the channels. The magnitudes of these channel uncertainties are inherent in the determination of the trip setpoints. Sensors and other instrumentation utilized in these channels must be capable of operating within the allowances of these uncertainty magnitudes. Occasional drift in excess of the allowance may be determined to be acceptable based on other device performance characteristics. Device drift in excess of the allowance that is more than occasional, may be indicative of more serious problems and warrant further investigation.

The OPERABILITY of the Engineered Safety Features instrumentation and interlocks ensures that: (1) the associated action and/or Reactor Trip will be initiated when the parameter monitored by each channel or combination thereof reaches its setpoint, (2) the specified coincidence logic is maintained, and (3) sufficient redundancy is maintained to permit a channel to be out of service for testing or maintenance.

The OPERABILITY of these systems is required to provide the overall reliability, redundancy, and diversity assumed available in the facility design for the protection and mitigation of accident and transient conditions. The integrated operation of each of these systems is consistent with the assumptions used in the safety analyses. The Surveillance Requirements specified for these systems ensure that the overall system functional capability is maintained comparable to the original design standards. The periodic surveillance tests performed at the minimum frequencies are sufficient to demonstrate this capability.

ENCLOSURE G

NUCLEAR MANAGEMENT COMPANY, LLC
KEWAUNEE NUCLEAR PLANT
DOCKET 50-305

November 5, 2003

Letter from Thomas Coutu (NMC)

To

Document Control Desk (NRC)

Responses to Requests for Additional Information and Supplemental Information Regarding LAR 195

Kewaunee Procedure GNP-04.06.01, Revision E (December 19, 2002), Plant Setpoint Accuracy Calculation Procedure

Prepared By Victor Myers	Approved By Kelly Holt
Reviewed By Todd Otradovec	

Nuclear Safety Related	☑ Yes ☐ No	PORC Review Required	☑ Yes ☐ No	SRO Approval Of Temporary Changes Required	☑ Yes ☐ No

1.0 Purpose

1.1 This procedure provides guidance for outlining the process for initiating and performing Plant Setpoint Accuracy Calculations and Instrument Loop Accuracy Calculations.

2.0 General Notes

2.1 This procedure is applicable to all nuclear staff and plant personnel initiating, calculating, and reviewing Plant Setpoint Accuracy Calculations or Instrument Loop Accuracy Calculations.

2.2 **Setpoint Accuracy Calculations** determine the overall instrument loop performance characteristics up to the end setpoint device which initiates a protective action (i.e., reactor trips, alarms, status lights, automatic actuation, etc.).

2.3 **Instrument Loop Accuracy Calculations** determine the overall instrument loop performance characteristics up to the end device which does NOT incorporate a setpoint (i.e., Control Room indicators, ICCMS inputs, computer inputs, control circuits, etc.). These types of calculations are particularly useful for determining the accuracy of an indication during normal conditions, post accident (Reg. Guide 1.97 circuits), or during Adverse Containment (EOP action levels).

2.4 Complete an Action Request (AR) form for nonconforming conditions as required by NMC FP-PA-ARP-01, "Action Request Process."

3.0 Definitions

3.1 Reference NAD-04.06, "Plant Setpoint Accuracy," definitions.

3.2 Plant Setting - A predetermined trip setpoint value at which the device is actually set in order to initiate a protective action (i.e., reactor trips, alarms, automatic actuation, control logic, etc.). The actual plant setpoint may be the Nominal Trip Setpoint or include additional margin as specified in the setpoint calculation.

3.3 Safety Margin - The margin between the plant setting and the Analytical Limit, established in the safety analysis, in order to protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity. A trip setpoint with insufficient safety margin could exceed the Analytical Limit due to loop inaccuracies. A trip setpoint may also have insufficient margin and exceed the Technical Specification limit due to loop inaccuracies. The difference between the Technical Specification value and the Analytical Limit is additional margin of safety established for a particular setpoint instrument loop.

3.4 Operational Margin - The margin between the plant setting and the nominal operating value. A setpoint too close to the nominal operating parameters could cause spurious actuations and alarms due to system inaccuracies.

4.0 Precautions and Limitations

4.1 None

5.0 Initial Conditions

5.1 None

6.0 Procedure

6.1 Initiation of Setpoint Accuracy Calculation Request (SACR)

6.1.1 The Initiator shall complete the information on the SACR Form, Form GNP-04.06.01-1, Section I, Steps 1 through 7, and forward it to the Setpoint Program Owner.

6.1.1.1 Determine if the Setpoint Accuracy affects safety related components.

6.1.1.2 Assign a priority to the SACRs using the criteria of NMC FP-PA-ARP-01.

6.1.2 The Setpoint Program Owner shall perform the following (finish completing Section I of Form GNP-04.06.01-1):

6.1.2.1 Review the SACR to ensure the necessity of the calculation request and the priority assigned. IF there are activities in progress or planned which warrant no work on this new request, THEN return the SACR to the initiator along with justification.

6.1.2.2 Assign an SACR number per GNP-04.03.04, "Calculation - Preparation, Review, and Approval."

6.1.2.3 A particular field transmitter (pressure, temperature, flow, etc.) may have multiple instrument loops. The loop accuracy calculation software is designed to perform multiple calculations utilizing common field devices. These calculations will utilize a common base calculation number (e.g., C10835) followed by the various loop configurations established (e.g., C10835-1, C10835-2, etc.).

6.1.2.4 Obtain a competent person or team to perform the Setpoint Calculation Request. A Responsible Person (RP) will be designated.

6.1.2.5 Enter the new SACR into the Setpoint Tracking Log with description, Responsible Person, and all other relevant information (Form NAD-04.06-4).

6.2 Setpoint Accuracy Calculation Review

6.2.1 IF performing a Setpoint Accuracy Calculation, THEN the Responsible Person shall perform the following steps of Section 6.2. IF performing an Instrument Loop Accuracy Calculation, THEN go to Section 6.3.

6.2.1.1 Document the criteria, analyses, assumptions, and other design input required to perform the Plant Setpoint Accuracy Calculation. Per Reference 8.11, address the temperature effect on M&TE equipment identified in the calculation.

Note

This Setpoint Methodology is very rigorous and may NOT be applicable to simple instrument loops, electromechanical applications (i.e., time delay relays, protective relays, thermostats, etc.), motor operated valve torque switches, spring cans, snubbers, process actuated safety relief valves, etc. The Setpoint Program Owner can accept or reject requests per these associated GNPs. IF a request is rejected, THEN the Program Owner will provide justification and may recommend the use of alternate programs (i.e., Calculation Control, Plant Modification Control, etc.).

6.2.1.2 Perform a setpoint calculation in accordance with the computer based Instrument Loop Uncertainty Program Software (ILUP). The computer based program is the preferred method of performing the calculation, but comparable hand calculations can be utilized in cases where rigorous calculations are NOT required. In either case, utilize the Setpoint Methodology which is per the ISA standards.

6.2.1.3 IF the calculation is safety related, THEN ensure that a Design Verification is performed per GNP-04.03.06, "Design Verification."

6.2.1.4 Based on the Setpoint Accuracy Calculation, determine if sufficient Safety Margin exists between the plant setting and the Analytical Limit to justify continued use of the current setting. Also, determine if sufficient margin exists between the plant setting and the Technical Specifications value. IF the Responsible Person determines that sufficient margin exists, THEN complete the information required under this section. IF the calculation shows that insufficient margin exists, THEN re-evaluate all the input criteria to the calculation in order to determine available margin, otherwise, proceed to Step 6.2.2. Complete Form GNP-04.06.01-1, Section II, Steps 13 and 14.

6.2.1.5 Compile a Setpoint Accuracy Calculation Package (SACP) containing the information shown on the "Setpoint Accuracy Calculation Package Review Form," Form GNP-04.06.01-2.

6.2.1.6 Proceed to Step 6.4 for documentation close out.

6.2.2 IF the Responsible Person determines that insufficient Safety Margin exists in the existing plant setting, or if there is NOT sufficient margin between the plant setting and the Technical Specifications value, THEN the Responsible Person shall perform the following:

6.2.2.1 Initiate an AR and perform an operability determination on the associated component/system. Step 15 of Section II.

6.2.2.2 Determine if there is sufficient Operational Margin to change the plant setting, Step 16 of Section II.

6.2.2.3 IF the Responsible Person determines that sufficient Operational Margin exists to change the setpoint, THEN complete Steps 17 and 18 of Section II. Initiate a Temporary Change and/or transition to GNP-04.06.02, "Plant Setpoint Change Request Procedure," while completing this calculation package. IF insufficient Operational Margin exists in order to change the setpoint, THEN attempt to resolve the discrepancy through some other method (i.e., component changes, plant modifications, Technical Specification change, etc.).

6.2.2.4 Compile a Setpoint Accuracy Calculation Package (SACP) containing the information shown on the Setpoint Accuracy Calculation Package Review Form, Form GNP-04.06.01-2.

6.2.2.5 Complete the documentation as indicated in Step 6.4.

6.3 Instrument Loop Accuracy Calculation Review

6.3.1 IF performing an Instrument Loop Accuracy Calculation, THEN the Responsible Person shall perform the following:

6.3.1.1 Document the criteria, analyses, assumptions, and other design input required to perform the Instrument Loop Accuracy Calculation. Per Reference 8.11, address the temperature effect on M&TE equipment identified in the calculation.

Note

This Setpoint Methodology is very rigorous and may <u>NOT</u> be applicable to simple instrument loops, electromechanical applications (i.e., time delay relays, protective relays, thermostats, etc.), motor operated valve torque switches, spring cans, snubbers, process actuated safety relief valves, etc. The Setpoint Program Owner can accept or reject requests per these associated GNPs. <u>IF</u> a request is rejected, <u>THEN</u> the Program Owner will provide justification and may recommend the use of alternate programs (i.e., Calculation Control, Plant Modification Control, etc.).

6.3.1.2 Perform an Instrument Loop Accuracy Calculation in accordance with the computer based Instrument Loop Uncertainty Program Software (ILUP). The computer based program is the preferred method of performing the calculation, but comparable hand calculations can be utilized in cases where rigorous calculations are <u>NOT</u> required. In either case, utilize the Setpoint Methodology which is per the ISA standards.

6.3.1.3 <u>IF</u> the calculation is safety related, <u>THEN</u> ensure that a Design Verification is performed per GNP-04.03.06, "Design Verification."

6.3.1.4 Compile a Setpoint Accuracy Calculation Package (SACP) containing the information shown on the Setpoint Accuracy Calculation Package Review Form, Form GNP-04.06.01-2.

6.3.1.5 Proceed to Step 6.4 for documentation close out.

6.3.1.6 Complete Steps 11 and 12 of Section II, Form GNP-04.06.01-1. The remaining steps of Section II would be N/A.

6.4 <u>Documentation Update - Setpoint Accuracy Calculation Package Close Out</u>

6.4.1 The Responsible Person shall review the Setpoint Accuracy Calculation Package and verify that all work has been performed then sign Step 19 of Section III, Form GNP-04.06.01-1.

6.4.2 The Responsible Person shall sign Step 20 of Section III, Form GNP-04.06.01-1, then forward a copy of the completed Form GNP-04.06.01-1 to the initiator.

6.4.3 The Responsible Person shall forward the complete Setpoint Accuracy Calculation Package to the Setpoint Program Owner for final review. The Setpoint Program Owner signs off Step 22 of Section III.

6.4.4 The Setpoint Program Owner then forwards the original SACP to the Nuclear Records Management for long term storage and control. Enter the Setpoint Accuracy Calculation completion into the Setpoint Tracking Log.

7.0 Final Conditions

7.1 None

8.0 References

8.1 NAD-04.06, Plant Setpoint Accuracy

8.2 NAD-05.01, Drawing Control

8.3 NAD-11.08, Action Request Process

8.4 GNP-04.03.04, Calculation - Preparation, Review, and Approval

8.5 GNP-04.03.06, Design Verification

8.6 GNP-04.06.02, Plant Setpoint Change Request Procedure

8.7 NMC FP-PA-ARP-01, Action Request Process

8.8 NAD-05.14, Revision and Control of the KNPP Technical Specifications and Operating License

8.9 ANSI/ISA-67.04.01-2000, Setpoints for Nuclear Safety-Related Instrumentation

8.10 ISA-RP67.04.02-2000, Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation

8.11 Operating Experience Assessment, OEA No.: 96-041, NRC Information Notice 1996-022 for Improper Equipment Settings Due to the Use of Non-Temperature Compensated Test Equipment

8.12 NRC Generic Letter 91-18, dated Nov. 7, 1991, discussing "Operability Determination"

9.0 Records

9.1 The following QA records and non-QA records are identified in this directive/procedure and are listed on the KNPP Records Retention Schedule. These records shall be maintained according to the KNPP Records Management Program.

9.1.1 QA Records

- Setpoint Accuracy Calculation Request Form (or Instrument Loop Accuracy Calculation Request), Form GNP-04.06.01-1
- Setpoint Accuracy Calculation Package Review Form, Form GNP-04.06.01-2

9.1.2 Non-QA Records

None

SETPOINT ACCURACY CALCULATION REQUEST FORM
(OR INSTRUMENT LOOP ACCURACY CALCULATION REQUEST)

ACCURACY CALCULATION NUMBER: ____________________

I. INITIATION (Completed by Initiator)

1. Component/Loop ID # ______________

2. System(s) # ____________________

3. Component/Loop Description ____

____

____

____

4. Safety Related? (Circle one) YES NO

5. Reason for calculation request: ____

____

____

____

____

6. Accuracy Calculation Request Priority Number (NMC FP-PA-ARP-01): ____________

7. Requested by: ______________________________ Date: ______________
(Name)

(Completed by Setpoint Program Owner)

8. Accept Accuracy Calculation Request: YES NO*

* IF NO, THEN return a copy to originator with justification.

9. Obtain an Accuracy Calculation Number: ______________
Place calculation number at top of the pages of this form.

______________________ Date: ____________
Setpoint Program Owner

10. Calculation assigned to: ________________________ Date: ______________
(Responsible Person)

SETPOINT ACCURACY CALCULATION REQUEST FORM (OR INSTRUMENT LOOP ACCURACY CALCULATION REQUEST) continued

ACCURACY CALCULATION NUMBER: ____________________

II. ACCURACY CALCULATION: (Completed by Responsible Person)

11. Responsible Person performs the Accuracy Calculation.

    Responsible Person: ______________________________ Date: ______________

12. Design Verification of calculation per GNP-04.03.06, if required.

    Review Person: ______________________________ Date: ______________

13. Does sufficient Safety Margin exist? (Circle one) YES NO N/A ______/______ (RP Initials/Date)

14. Does sufficient Margin exist to the Tech. Specs. value? (Circle one) YES NO N/A

    ______/______ (RP Initials/Date)

    <u>IF</u> YES or N/A for the above two questions, <u>THEN</u> mark N/A in the remaining portions of Section II. N/A would apply to Instrument Loop Accuracy Calculations which have no setpoint.

    <u>IF</u> NO for either of the above two questions, <u>THEN</u> continue with this Section.

15. <u>IF</u> sufficient Margin does <u>NOT</u> exist, <u>THEN</u> re-evaluate all the input criteria to the calculation in order to determine available margin, otherwise, issue an AR and investigate the various alternatives for gaining more margin (i.e., setpoint change, component change, plant modification, Tech. Spec. change, etc.).

    AR Number ______________

16. Does sufficient Operational Margin exist to change the plant setting? YES NO

17. <u>IF</u> sufficient Operational Margin, <u>THEN</u> Proposed Setpoint Value: ______/______
    (Justification for this value attached) (RP Initials/Date)

18. <u>IF</u> the field setting is to be changed, per the AR, <u>THEN</u> utilize the Temporary Change Program or Setpoint Change Procedure, GNP-04.06.02.

    TCR# and/or PSCR# ______________

SETPOINT ACCURACY CALCULATION REQUEST FORM
(OR INSTRUMENT LOOP ACCURACY CALCULATION REQUEST) continued

ACCURACY CALCULATION NUMBER: ____________________

III. DOCUMENTATION PACKAGE CLOSEOUT

19. Documentation Review complete, including those items on Form GNP-04.06.01-2.

    Responsible Person: ______________________ Date: ______________

20. Copy of Form GNP-04.06.01-1 routed to initiator.

    Responsible Person: ______________________ Date: ______________

21. Package forwarded to the Setpoint Program Owner.

22. Accuracy Calculation Package is complete. Package forwarded to the KNPP QA Vault.

    Setpoint Program Owner: ____________________ Date: ______________

SETPOINT ACCURACY CALCULATION PACKAGE REVIEW FORM

ACCURACY CALCULATION NUMBER: ____________________

Verify that the following items are present:	RP Initials
Setpoint Accuracy Calculation Request Form, Form GNP-04.06.01-1	______
Setpoint or Instrument Loop Accuracy Calculation	______
Per Reference 8.11, the temperature effect of M&TE equipment used is addressed	______
Calculation Cover Sheet, Figure 1 of GNP-04.03.04	______
Plant Setpoint Control Document, Form NAD-04.06-1	______
Design Verification (if required), Form GNP-04.03.06-1	______
DBDB Load Form, Form GNP-05.27.07-1	______
Equipment Database New/Revised/Deleted submittals (if required) (could use the worksheet under Physchg\forms\pcws007.doc)	______

Other forms or submittals as needed:

______________________________	______
______________________________	______
______________________________	______
______________________________	______

ENCLOSURE H

NUCLEAR MANAGEMENT COMPANY, LLC
KEWAUNEE NUCLEAR PLANT
DOCKET 50-305

November 5, 2003

Letter from Thomas Coutu (NMC)

To

Document Control Desk (NRC)

Responses to Requests for Additional Information and Supplemental Information Regarding LAR 195

Excerpt, Generic Section of Kewaunee I&C Calculations, Methodology

METHODOLOGY

This methodology is based on ISA Standard ANSI/ISA-67.04.01-2000, Setpoints for Nuclear Safety-Related Instrumentation Used in Nuclear Power Plants and ISA-RP67.04.02-2000, Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation. The elements of the expressions used within this methodology may not exactly match those of the ISA standard.

Calculation of Total Loop Error (TLE)

Total Loop Error (TLE) = The Square Root of the Sum of the Squares (SRSS) of the Random terms ± the sum of the Bias terms or, symbolically:

$$TLE_{pos} = +SRSS + Bias_{pos}$$

and

$$TLE_{neg} = -SRSS - Bias_{neg}$$

For normal conditions:

$$SRSS = (A + D_R + M + T_{NR} + H_{NR} + OPE_R + SPEZ_R + SPES_R + P_R + R_{NR} + READ + DPC_{NR} + PMA_{NR} + PEA_{NR} + PC_{NR})^{1/2}$$

$$Bias_{pos} = D_{Bp} + T_{NBp} + H_{NBp} + OPE_{Bp} + SPEZ_{Bp} + SPES_{Bp} + P_{Bp} + R_{NBp} + DPC_{NBp} + PMA_{NBp} + PEA_{NBp} + PC_{NBp}$$

$$Bias_{neg} = D_{Bn} + T_{NBn} + H_{NBn} + OPE_{Bn} + SPEZ_{Bn} + SPES_{Bn} + P_{Bn} + R_{NBn} + DPC_{NBn} + PMA_{NBn} + PEA_{NBn} + PC_{NBn}$$

For accident conditions:

$$SRSS = (A + D_R + M + T_{AR} + H_{AR} + OPE_R + SPEZ_R + SPES_R + P_R + R_{ANR} + SPT_R + READ + DPC_{AR} + PMA_{AR} + PEA_{AR} + PC_{AR})^{1/2}$$

$$Bias_{pos} = D_{Bp} + T_{ABp} + H_{ABp} + OPE_{Bp} + SPEZ_{Bp} + SPES_{Bp} + P_{Bp} + R_{ANBp} + SPT_{Bp} + DPC_{ABp} + PMA_{ABp} + PEA_{ABp} + IR_{Bp} + PC_{ABp}$$

$$Bias_{neg} = D_{Bn} + T_{ABn} + H_{ABn} + OPE_{Bn} + SPEZ_{Bn} + SPES_{Bn} + P_{Bn} + R_{ANBn} + SPT_{Bn} + DPC_{ABn} + PMA_{ABn} + PEA_{ABn} + IR_{Bn} + PC_{Abn}$$

For loss of non-seismic HVAC due to a seismic event:

SRSS = $(A + D_R + M + T_{NSR} + H_{NSR} + OPE_R + SPEZ_R + SPES_R + P_R + S_R + R_{NR} + READ + DPC_{NR} + PMA_{NR} + PEA_{NR} + PC_{NR})^{1/2}$

$Bias_{pos}$ = $D_{Bp} + T_{NSBp} + H_{NSBp} + OPE_{Bp} + SPEZ_{Bp} + SPES_{Bp} + P_{Bp} + S_{Bp} + R_{NBp} + DPC_{NBp} + PMA_{NBp} + PEA_{NBp} + PC_{NBp}$

$Bias_{neg}$ = $D_{Bn} + T_{NSBn} + H_{NSBn} + OPE_{Bn} + SPEZ_{Bn} + SPES_{Bn} + P_{Bn} + S_{Bn} + R_{NBn} + DPC_{NBn} + PMA_{NBn} + PEA_{NBn} + PC_{NBn}$

- For Post Accident conditions:

SRSS = $(A + D_R + M + T_{NR} + H_{NR} + OPE_R + SPEZ_R + SPES_R + P_R + R_{NR} + PDBE_R + READ + DPC_{NR} + PMA_{NR} + PEA_{NR} + PC_{NR})^{1/2}$

$Bias_{pos}$ = $D_{Bp} + T_{NBp} + H_{NBp} + OPE_{Bp} + SPEZ_{Bp} + SPES_{Bp} + P_{Bp} + R_{NBp} + PDBE_{Bp} + DPC_{NBp} + PMA_{NBp} + PEA_{NBp} + PC_{NBp}$

$Bias_{neg}$ = $D_{Bn} + T_{NBn} + H_{NBn} + OPE_{Bn} + SPEZ_{Bn} + SPES_{Bn} + P_{Bn} + R_{NBn} + PDBE_{Bn} + DPC_{NBn} + PMA_{NBn} + PEA_{NBn} + PC_{NBn}$

Where:

A = The sum of the squares of all of the random device accuracy's (a).

CS = Calibrated Span (Use in Vendor expression for "S")

CSP = Calibration Static Pressure

D = The sum of the squares of all of the random device drift effects (d).

DPC = The sum of the squares of all the random device dependent process considerations (DPC).

H = The sum of the squares of all of the random device humidity effects (h).

IR = The error introduced by insulation resistance.

LD = Loop Drift

M = The sum of the squares of all of the random device M&TE effects (m).

OPE = The sum of the squares of all of the random device over pressure effects (ope)

P = the sum of the squares of all the random device power supply effects (p).

PC = The sum of all of the independent process considerations.

PDBE = The sum of the squares of all of the random device post design basis event effects (pdbe).

PEA = The primary element accuracy.

PMA = The process measurement accuracy.

PMOP = Process Maximum Operating Pressure

PS = Process Span

PSS = Power Supply Stability

R = The sum of the squares of all of the random device radiation effects (r). (The "R" in vendor expressions is Reading or Range)

RD = Rack Drift

READ = The square of the indicator readability term (read).

S = The sum of the squares of all of the random device seismic effects (s).

SPEZ = The sum of the squares of all of the random device static pressure zero effects (spez).

SPES = The sum of the squares of all of the random device static pressure span effects (spes).

T = The sum of the squares of all of the random device temperature effects (t).

The subscripts are defined as follows:

A For accident conditions only.

AN For cumulative accident and normal conditions.

Bp A Bias positive term.

Bn A Bias Negative term.

N For normal conditions only.

NS For loss of non-seismic HVAC conditions only.

R A Random term.

Notes:

1. Throughout the methodology, mathematical expressions adhere to the following convention: Elements of device uncertainty are represented by lower case variable names. Elements of loop uncertainty are represented by uppercase variable names.

2. When a device's setting tolerance is greater than its accuracy, then the setting tolerance is used in place of that device's accuracy. The "S" in vendor expressions is Calibrated Span for that component, "R" is the Reading (Range) of that component.

3. When accident conditions are being evaluated and a Steam Pressure/Temperature (SPT) effect is given on the vendor screen, the SPT effect will automatically be substituted for T_A and H_A.

4. During all conditions, when Plant Specific Drift is entered on the vendor screen, accuracy, M&TE effect, normal temperature effect, normal radiation effect, and normal humidity effect for that device default to zero since they are all considered to be included in the Plant Specific Drift value. During the calculation, the option to override the default for each effect is given.

<u>Calculation of the Nominal Trip Setpoint (NTSP) for Safety Related calculations</u>

For an increasing process: $NTSP = AL - TLE_{neg}$

For a decreasing process: $NTSP = AL + TLE_{pos}$

Where:

AL = Analytical Limit

<u>Calculation of the Nominal Trip Setpoint (NTSP) for non-Safety Related calculations</u>

For an increasing process: $NTSP = PL - TLE_{neg}$

For a decreasing process: $NTSP = PL + TLE_{pos}$

Where:

PL = Process Limit

Calculation of Allowable Value (AV)

Defines the maximum allowed departure of a setpoint from the Nominal Trip Setpoint value during the period between calibrations. Per the Two Loop Group Setpoint Methodology, the term AV applies to safety related calculations only. In practice, the term AV is also an output of non-Safety Related calculations.

For an increasing process:

$$AV = NTSP + LD + LD_{Bp}$$

For a decreasing process:

$$AV = NTSP - LD - LD_{Bn}$$

Where:

$$LD \text{ (Loop Drift)} = (A + D_R + M + R_{NR})^{1/2}$$

$$LD_{Bp} = D_{Bp} + R_{Bp}$$

$$LD_{Bn} = D_{Bn} + R_{Bn}$$

Calculation of Rack Allowance (RA)

The rack allowable is the maximum value for the loop when the transmitter is not considered in the functional check. The term RA applies to safety related calculations only. There is no equivalent term for non-safety related calculations.

For an increasing process:

$$RA = NTSP + RD + RD_{Bp}$$

For a decreasing process:

$$RA = NTSP - RD - RD_{Bn}$$

Where:

$$RD \text{(Rack Drift)} = (A + D_R + M + R_{NR})^{1/2}$$

$$RD_{Bp} = D_{Bp} + R_{Bp}$$

$$RD_{Bn} = D_{Bn} + R_{Bn}$$

Note:

5. Rack Drift includes the effects from all loop devices except the sensor.

Calculation of Instrument Uncertainties

Instrument Accuracy (a_n)

$a_n = (va_n)(PS/CS_n)$

Where:

n = the number of the loop device
va = vendor's accuracy expression

** reference note #2

Instrument Drift (d_n)

$d = (CI/DT)^{1/2}(vd)(PS/CS)$

Where:

CI = Calibration Interval

DT = Drift Time

vd = vendor's drift expression

Note:

6. The factor $(CI/DT)^{1/2}$ is included in the above equation if Drift is non-linear over time. If Drift is linear over time, the factor is replaced by:

(CI/DT)

Instrument Measurement and Test Equipment Allowance (m_n)

$$mte_x = [(mtea_x + mtestd_x)^2 + (mtet_x)^2 + (meteread_x)^2]^{1/2}$$

$$m_n = [(mte_1/mtecs_1)^2 + (mte_2/mtecs_2)^2 + (mte_3/mtecs_3)^2 + (mte_4/mtecs_4)^2 + (mte_5/mtecs_5)^2]^{1/2} * PS$$

Where:

mte_x = the Measurement and Test Equipment allowance for one M&TE device.

$mtea_x$ = the accuracy of the M&TE device.

$mtet_x$ = the temperature effect of the M&TE device. (Not addressed in ISA67.04)

$mteread_x$ = the readability of the M&TE device.

$mtestd_x$ = the accuracy of the standard used to calibrate the M&TE device.

m_n = the Measurement and Test Equipment allowance for one loop device.

mtecs = the calibrated span of the M&TE device. Mtecs = cs for Input devices or Mtecs = os for Output devices.

Instrument Temperature Effect (t_N, t_A & t_{NS})

Normal:

$$t_N = (NTMAX - NTMIN)(vte)(PS/CS)$$

Accident (Reference Note #3)

$$t_A = [(AT - NTMIN)(vte)(PS/CS)] - t_N$$

Loss of non-seismic HVAC during a seismic event:

$$t_{NS} = [(NST - NTMIN)(vte)(PS/CS)] - t_N$$

Where:

vte = vendor's temperature effect expression

Notes:

7. The factors (NTMAX - NTMIN), (AT - NTMIN) and (NST - NTMIN) are included in the equations shown above only if the Vendor's Temperature Effect (vte) for a specific device is expressed per degree. This is indicated by the character "/" in the Vendor's Temperature Effect equation shown on the Vendor data sheet.

8. If the Vendor's Temperature Effect equation is expressed as a step function, then the values of NTMAX, AT and NST will be used to determine the value of "X" in the step function.

Instrument Humidity Effect (h_N, h_A & h_{NS})

Normal:

h_N = (NHMAX - NHMIN)(vhe)(PS/CS)

Accident: (Reference Note #3)

h_A = [(AH - NHMIN)(vhe)(PS/CS)] - h_N

Loss of non-seismic HVAC during a seismic event:

h_{NS} = [(NSH - NHMIN)(vhe)(PS/CS)] - h_N

Where:

vhe = vendor's humidity effect expression

Notes:

9. The factors (NHMAX - NHMIN), (AH - NHMIN) and (NSH - NHMIN) are included in the equations shown above only if the Vendor's Humidity Effect (vhe) for a specific device is expressed per degree. This is indicated by the character "/" in the Vendor's Humidity Effect equation shown on the Vendor data sheet

10. If the Vendor's Humidity Effect equation is expressed as a step function, then the values of NHMAX, AH and NSH will be used to determine the value of "X" in the step function.

Instrument Over Pressure Effect (ope)

ope = (PMOP - DP)(vope)(PS/CS)

Where:

PMOP = Process Maximum Operating Pressure, entered on the Process/Setpoint screen

DP = Design Pressure, entered on the Vendor screen

vope = vendor's over pressure effect expression

Notes:

11. The factor (PMOP -DP) is included in the equation shown above only if the Vendor's Over Pressure Effect (vope) for a specific device is expressed per PSI. This is indicated by the character "/" in the Vendor's Over Pressure Effect equation shown on the Vendor data sheet.

12. If the Design Pressure for a specific device (DP) is greater than or equal to the Process Maximum Operating Pressure (PMOP), then the Over Pressure Effect (ope) is equal to zero.

Instrument Static Pressure Effect Zero (spez)

spez = (PMOP - CSP)(vspez)(PS/CS)

Where:

PMOP = Process Maximum Operating Pressure, entered on the Process/Setpoint screen

CSP = Calibration Static Pressure, entered on the Loop Dependence screen

vspez = vendor's static pressure zero effect expression

Note:

13. The factor (PMOP - CSP) is included in the equation shown above only if the Vendor's Static Pressure Effect Zero (vspez) for a specific device is linear for the given pressure change defined. This is indicated by the character " / " in the Vendor's Static Pressure Effect Zero equation shown on the Vendor data sheet. The Calibration Static Pressure (CSP) values are expressed as decimal percent of span. Static pressure effects need only be considered for differential pressure devices in direct contact with the process. If the static pressure is compensated for in the calibration of the device, the effect may be ignored in the setpoint calculation.

Instrument Static Pressure Effect Span (spes)

spes = (PMOP - CSP)(vspes)(PS/CS)

Where:

PMOP = Process Maximum Operating Pressure, entered on the Process/Setpoint screen

CSP = Calibration Static Pressure, entered on the Loop Dependence screen

vspes = vendor's static pressure span effect expression

Note:

14. The factor (PMOP - CSP) is included in the equation shown above only if the Vendor's Static Pressure Effect Span (vspes) for a specific device is linear for the given pressure change defined. This is indicated by the character " / " in the Vendor's Static Pressure Effect Span equation shown on the Vendor data sheet. The Calibration Static Pressure (CSP) values are expressed as decimal percent of span. Static pressure effects need only be considered for differential pressure devices in direct contact with the process. If the static pressure is compensated for in the calibration of the device, the effect may be ignored in the setpoint calculation.

Instrument Power Supply Effect (p)

p = (PSS)(vp)(PS/CS)

Where:

vp = vendor's power supply effect expression

Note:

15. The Power Supply Stability (PSS) denotes the value, in volts, that the device's power supply voltage may vary. The factor (PSS) is included in the equation shown above only if the Vendor's Power Supply Effect (vp) for a specific device is expressed as per volt. This is indicated by the character " / " in the Vendor's Power Supply Effect equation shown on the Vendor data sheet.

Instrument Seismic Effect (s)

s = (vse)(PS/CS)

Where:

vse = vendor's seismic effect expression

Instrument Radiation Effect (r_N, r_A & r_{AN})

Normal:

r_N = (NTID)(vre)(PS/CS)

Accident:

r_A = (ATID)(vre)(PS/CS)

r_{AN} = (ANTID)(vre)(PS/CS)

Where:

vre = vendor's radiation effect expression

NTID = total integrated dose for normal conditions
=744 x CI x NR, 744 = 24 hours/day x 31 days/month
CI = calibration interval in months
NR = normal radiation in Rads/hour

ATID = total integrated dose for accident conditions
=744 x CI x AR, 744 = 24 hours/day x 31 days/month
CI = calibration interval in months
AR = Accident radiation in Rads/hour

ANTID = total integrated dose for accident plus normal conditions

Notes:

16. The factors (NTID)(ATID) and (ANTID) are included in the equations only if the Vendor Radiation Effect (vre) for a specific device is expressed per Rad. This is indicated by the character " / " in the Radiation Effect equation shown on the Vendor screen.

17. If the Radiation Effect equation is expressed as a step function, then the values NTID, ATID and ANTID will be used to determine the value of "X" in the step function.

18. If plant specific drift is entered for a loop device that is subject to accident radiation, r_A is used in place of r_{AN} if the user does not change the plant specific drift default value of 0 for the normal radiation effect.

19. The Radiation value (Rads/Hour) on the Location screen is obtained from the EQ Manual for that particular EQ Zone. Since the EQ Manual gives a Total Integrated Dose value the following conversion applies:
R(Location Screen Rads/Hour value) = R(EQ Manual TID value)/40yrs/365days/24hours

Instrument Steam Pressure/Temperature Effect (spt)

spt = (vspt)(PS/CS)

Where:

vspt = vendor's steam pressure/temperature effect expression

** Reference note: #3

Instrument Post-DBE Effect (pdbe)

pdbe = (vpdbe)(PS/CS)

Where:

vpdbe = vendor's Post-DBE effect expression

Instrument Readability (Read)

Readability is a random term only, and is entered on the MCDS screen for an Indicator if applicable.

Read = Value * PS / OS

Where:

Value = the numeric value of Readability in OS Units as specified on the MCDS Screen

Instrument Allowable Value (IAV)

IAV is included in the calculation as an aid to making instrument operability determinations, and defines the maximum allowed departure from an instrument calibration desired output, beyond which additional evaluations may be required. The IAV is calculated in the same manner as the Loop AV using the same instrument uncertainties. The Instrument AV is inherently a component of the Loop AV and therefore not considered separately under the combined effects calculation. The IAV is applied to the Instrument Calibration desired output.

Increasing:

$IAV = Desired + ID_R + ID_{Bp}$

Decreasing:

$IAV = Desired - ID_R - ID_{Bn}$

Where:

ID = Instrument Drift

$ID_R = (a^2 + d_R^2 + m^2 + r_R^2)^{1/2}$

$ID_{Bp} = d_{Bp} + r_{Bp}$

$ID_{Bn} = d_{Bn} + r_{Bn}$

Notes:

20. The IAV is in terms of Process Units and may need to be converted to the instrument OS units for use in Calibration Procedures and / or other plant documents.

21. The uncertainty value's used to calculate the IAV are not affected by the Math or Square root modules. They are calculated using the Vendor effect (Ve) as specified on the vendor data sheet and converted to PS units.

22. Where an uncertainty is flagged as included in plant specific drift it will not be included in the IAV. Reference the Plant Specific Screen.

Dependent Process Considerations (dpc)

Process Considerations not included in any other parameter associated with an instrument or device. DPC's can be Random(R), Bias Positive(Bp), or Bias Negative(Bn) and designated as occurring under Normal, Accident or Both conditions. DPC's are specified on the Process Considerations Screen.

Normal:

dpc_{NR} = Value * PS

dpc_{NBp} = Value * PS

dpc_{NBn} = Value * PS

Accident:

dpc_{AR} = Value * PS

dpc_{ABp} = Value * PS

dpc_{ABn} = Value * PS

Where:

Value = The Magnitude in decimal percent of PS as specified on the Process Considerations Screen.

PS = Process Span as specified on the Process / Setpoint screen

Temperature Dependent Process Considerations (dpctx)
Dependent Process Considerations specified as Temperature Dependent and not included in the temperature uncertainty effects specified on the Vendor Data Sheet for an instrument or device.

Normal:

$dpctx_{NR}$ = Value * PS

$dpctx_{NBp}$ = Value * PS

$dpctx_{NBn}$ = Value * PS

Accident:

$dpctx_{AR}$ = Value * PS

$dpctx_{ABp}$ = Value * PS

$dpctx_{ABn}$ = Value * PS

Where:

Value = The Magnitude in decimal percent of PS as specified on the Process Considerations Screen.
PS = Process Span as specified on the Process / Setpoint screen

Calculation of Propagation of Uncertainties through functional Modules

Square Root Extractor (Flow)
ILUP will calculate the propagation of all uncertainties for an instrument flagged for Flow propagation on the Loop Dependency Screen.

$$\text{Uncertainty (E)} = [(POI) - (POI^2 - e)^{1/2}] * PS$$

Where:

E = Uncertainty after propagation through module, replaces original uncertainty for the instrument or device.
POI = Point of Interest as specified on the Calc General Information Screen
e = Magnitude of uncertainty (Input) as a decimal percent of PS.
(i.e. e = "a" for propagation of the Accuracy Uncertainty
e = "d" for the propagation of the Drift Uncertainty)

Math Module (Math) (i.e. Multiplier / Divider)

ILUP will calculate the propagation of all uncertainties for an instrument flagged for Math propagation on the Loop Dependency Screen. The Amplification factor (K_f) is determined separately from ILUP and entered on the Loop Dependency Screen for each input signal.

$$\text{Uncertainty (E)} = e * K_f$$

Where:

E = Uncertainty after propagation through the module, replaces uncertainty for device.
K_f = Amplification Factor as specified on the Process Consideration Screen.

e = Magnitude of uncertainty (Input) in PS as defined in the Methodology. This value is normally calculated as e = Ve * PS/CS where Ve is the vendor effect from the Vendor data screen for an uncertainty.

Note:

23. ILUP is currently setup to process a Math propagation first and then Flow where both are used. A method for verifying calculation process with math and square root modules is to run a "What - If" calculation scenario with these options disabled in order to get the initial calculated values.

Calculation of Process Considerations

Process Measurement Accuracy (PMA)

Uncertainty associated with the Process Measurement not included as part of any uncertainty associated with an instrument or device (i.e. temperature stratification in a pipe). PMA can be Random (R), Bias Positive(Bp), or Bias Negative(Bn) and specified as occuring under Normal, Accident or Both conditions. PMA is specified on the Process Considerations Screen as a decimal percent of span.

Normal:

$$PMA_{NR} = \text{Value} * PS$$

$$PMA_{NBp} = \text{Value} * PS$$

$$PMA_{NBn} = \text{Value} * PS$$

Accident:

$$PMA_{AR} = \text{Value} * PS$$

$$PMA_{ABp} = \text{Value} * PS$$

$$PMA_{ABn} = \text{Value} * PS$$

Where:

Value = The Magnitude in decimal percent of PS as specified on the Process Considerations Screen.

PS = Process Span as specified on the Process / Setpoint screen

Primary Element Accuracy (PEA)

The accuracy of the device between the process variable being measured and the loop sensor input, which must be converted to process span units for combination with other loop errors.
PEA can be Random (R), Bias Positive(Bp), or Bias Negative(Bn) and specified as occuring under Normal, Accident or Both conditions. The PEA is specified on the Process Considerations Screen as a decimal percent of span.

Normal:

PEA_{NR} = Value * PS

PEA_{NBp} = Value * PS

PEA_{NBn} = Value * PS

Accident:

PEA_{AR} = Value * PS

PEA_{ABp} = Value * PS

PEA_{ABn} = Value * PS

Where:

Value = The Magnitude in decimal percent of PS as specified on the Process Considerations Screen.

PS = Process Span as specified on the Process / Setpoint screen

Insulation Resistance Effects (IR)

The Insulation Resistance (IR) uncertainty is the leakage resistance of an instrument loop caused by specified accident effects for a specified area. IR is only considered for specified Accident calculations (i.e. LOCA, HELB) and can be Bias Positive(Bp), or Bias Negative(Bn). The IR error is specified on the Process Considerations Screen as a decimal percent of span. The IR error is normally assumed to be Bias Positive.

IR_{Bp} = Value * PS

IR_{Bn} = Value * PS

Where:

Value = The Magnitude in decimal percent of PS as specified on the Process Considerations Screen.

PS = Process Span as specified on the Process / Setpoint screen

Other Process Considerations (PC) (Independent)

Process Considerations not included in any other parameter and not associated with an instrument or device. A PC can be Random (R), Bias Positive(Bp), or Bias Negative(Bn) and designated as occurring under Normal, Accident or Both conditions. PC's are specified on the Process Considerations Screen, there can be up to 6 independent PC's per loop.

Normal:

PC_{NR} = Value * PS

PC_{NBp} = Value * PS

PC_{NBn} = Value * PS

Accident:

PC_{AR} = Value * PS

PC_{ABp} = Value * PS

PC_{ABn} = Value * PS

Where:

Value = The Magnitude in decimal percent of PS as specified on the Process Considerations Screen.

PS = Process Span as specified on the Process / Setpoint screen

Calculation of Combined Loop Effects

Loop Accuracy (A)
Accuracy contains only random terms. Since the individual device accuracies are considered independent, they may be combined as follows:

$$A = (a_1)^2 + (a_2)^2 + ... + (a_n)^2$$

Loop Drift (D)
Drift may contain random and bias terms. The individual device drifts which are random are combined according to device calibration dependency groups.

For example, consider a loop which contains devices 1, 2, and 3 which each have random, bias positive, and bias negative terms. If device 1 is calibrated alone (e.g. Calibration Group "A") and devices 2 and 3 are calibrated together (e.g. Calibration Group "B") then:

$$D_R = (d_{1R})^2 + (d_{2R} + d_{3R})^2$$

$$D_{Bp} = (d_{1Bp} + d_{2Bp} + d_{3Bp})$$

$$D_{Bn} = (d_{1Bn} + d_{2Bn} + d_{3Bn})$$

Loop Measurement & Test Equipment Allowance (M)
The M&TE Allowance contains a random term only. The individual device M&TE Allowances are combined according to device calibration dependency groups.

For example, consider a loop which contains devices 1, 2, and 3. If device 1 is calibrated alone (e.g. Calibration Group "A") and devices 2 and 3 are calibrated together (e.g. Calibration Group "B") then:

$$M = (m_1)^2 + (m_2 + m_3)^2$$

Loop Temperature Effect (T_N, T_A and T_{NS})

The Temperature Effect (Normal, Accident and Loss of non-seismic HVAC during a seismic event) contains a random term and bias terms. The individual device Temperature Effects which are random are combined according to device temperature dependency groups. Process Considerations that are considered to be temperature-related are also combined with the associated device Temperature Effect.

For example, consider a loop which contains devices 1, 2, and 3 which each have a random, bias positive, and bias negative terms. The devices also have the following temperature-related Dependent process considerations (dpctx):

$dpctx_{A1R}$ = Device 1 Accident Random Temperature Related Dependent PC

$dpctx_{N1R}$ = Device 1 Normal Random Temperature Related Dependent PC

$dpctx_{A2Bp}$ = Device 2 Accident Temperature Related Dependent Bias Positive PC

$dpctx_{N3Bn}$ = Device 3 Normal Temperature Related Dependent Bias Negative PC

If device 1 is located in one temperature environment (e.g. Temperature Group "A") and devices 2 and 3 are located in another temperature environment (e.g. Temperature Group "B") then:

Normal:

$$T_{NR} = (t_{N1R} + dpctx_{N1R})^2 + (t_{N2R} + t_{N3R})^2$$

$$T_{NBp} = (t_{N1Bp} + t_{N2Bp} + t_{N3Bp})$$

$$T_{NBn} = (t_{N1Bn} + t_{N2Bn} + t_{N3Bn} + dpctx_{N3Bn})$$

Accident:

$$T_{AR} = (t_{N1R} + t_{A1R} + dpctx_{A1R})^2 + (t_{N2R} + t_{A2R} + t_{A3R} + t_{N3R})^2$$

$$T_{ABp} = (t_{N1Bp} + t_{A1Bp} + t_{N2Bp} + t_{A2Bp} + dpctx_{A2Bp} + t_{N3Bp} + t_{A3Bp})$$

$$T_{ABn} = (t_{N1Bn} + t_{A1Bn} + t_{N2Bn} + t_{A2Bn} + t_{N3Bn} + t_{A3Bn} + dpctx_{N3Bn})$$

Loss of non-seismic HVAC during a seismic event:

$$T_{NSR} = (t_{N1R} + t_{NS1R} + dpctx_{A1R})^2 + (t_{N2R} + t_{NS2R} + t_{N3R} + t_{NS3R})^2$$

$$T_{NSBp} = (t_{N1Bp} + t_{NS1Bp} + t_{N2Bp} + t_{NS2Bp} + dpctx_{A2Bp} + t_{N3Bp} + t_{NS3Bp})$$

$$T_{NSBn} = (t_{N1Bn} + t_{NS1Bn} + t_{N2Bn} + t_{NS2Bn} + t_{N3Bn} + t_{NS3Bn} + dpctx_{N3Bn})$$

Loop Humidity Effect (H_N, H_A and H_{NS})

The Humidity Effect (Normal, Accident and Loss of non-seismic HVAC during a seismic event) contains a random term and bias terms. The individual device Humidity Effects which are random are combined according to device humidity dependency groups.

If device 1 is located in one humidity environment (e.g. Humidity Group "A") and devices 2 and 3 are located in another humidity environment (e.g. Humidity Group "B") then:

Normal:

$$H_{NR} = (h_{N1R})^2 + (h_{N2R} + h_{N3R})^2$$

$$H_{NBp} = (h_{N1Bp} + h_{N2Bp} + h_{N3Bp})$$

$$H_{NBn} = (h_{N1Bn} + h_{N2Bn} + h_{N3Bn})$$

Accident:

$$H_{AR} = (h_{N1R} + h_{A1R})^2 + (h_{N2R} + h_{A2R} + h_{N3R} + h_{A3R})^2$$

$$H_{ABp} = (h_{N1Bp} + h_{A1Bp} + h_{N2Bp} + h_{A2Bp} + h_{N3Bp} + h_{A3Bp})$$

$$H_{ABn} = (h_{N1Bn} + h_{A1Bn} + h_{N2Bn} + h_{A2Bn} + h_{N3Bn} + h_{A3Bn})$$

Loss of non-seismic HVAC during a seismic event:

$$H_{NSR} = (h_{N1R} + h_{NS1R})^2 + (h_{N2R} + h_{NS2R} + h_{N3R} + h_{NS3R})^2$$

$$H_{NSBp} = (h_{N1Bp} + h_{NS1Bp} + h_{N2Bp} + h_{NS2Bp} + h_{N3Bp} + h_{NS3Bp})$$

$$H_{NSBn} = (h_{N1Bn} + h_{NS1Bn} + h_{N2Bn} + h_{NS2Bn} + h_{N3Bn} + h_{NS3Bn})$$

Loop Over Pressure Effect (OPE)

The Over Pressure Effect contains a random term and bias terms. Since the individual device Over Pressure Effects are considered independent, the random terms may be combined by the sum of the squares. The random and bias terms will combined as follows:

$$OPE_R = (ope_{1R})^2 + (ope_{2R})^2 + ... + (ope_{nR})^2$$

$$OPE_{Bp} = (ope_{1Bp} + ope_{2Bp} + ... + ope_{nBp})$$

$$OPE_{Bn} = (ope_{1Bn} + ope_{2Bn} + ... + ope_{nBn})$$

Loop Static Pressure Effect Zero (SPEZ)

The Static Pressure Zero Effect contains a random term and bias terms. Since the individual device Static Pressure Zero Effects are considered independent, the random terms may be combined by the sum of the squares. The random and bias terms will be combined as follows:

$$SPEZ_R = (spez_{1R})^2 + (spez_{2R})^2 + ... + (spez_{nR})^2$$

$$SPEZ_{Bp} = (spez_{1Bp} + spez_{2Bp} + ... + spez_{nBp})$$

$$SPEZ_{Bn} = (spez_{1Bn} + spez_{2Bn} + ... + spez_{nBn})$$

Loop Static Pressure Effect Span (SPES)

The Static Pressure Span Effect contains a random term and bias terms. Since the individual device Static Pressure Span Effects are considered independent, the random terms may be combined by the sum of the squares. The random and bias terms will be combined as follows:

$$SPES_R = (spes_{1R})^2 + (spes_{2R})^2 + ... + (spes_{nR})^2$$

$$SPES_{Bp} = (spes_{1Bp} + spes_{2Bp} + ... + spes_{nBp})$$

$$SPES_{Bn} = (spes_{1Bn} + spes_{2Bn} + ... + spes_{nBn})$$

Loop Power Supply Effect (P)

The Power Supply Effect contains a random term and bias terms. The individual device Power Supply Effects which are random are combined according to device power dependency groups.

For example, consider a loop which contains devices 1, 2, and 3 which each have random, bias positive, and bias negative terms. If device 1 is powered by one power supply (e.g. Power Supply Group "A") and devices 2 and 3 are powered by another Power Supply (e.g. Power Supply Group "B") then:

$$P_R = (p_{1R})^2 + (p_{2R} + p_{3R})^2$$

$$P_{Bp} = (p_{1Bp} + p_{2Bp} + p_{3Bp})$$

$$P_{Bn} = (p_{1Bn} + p_{2Bn} + p_{3Bn})$$

Loop Seismic Effect (S)

The Seismic Effect contains a random term and bias terms. The individual device Seismic Effects which are random are combined according to device seismic dependency groups.

For example, consider a loop which contains devices 1, 2, and 3 which each have random, bias positive, and bias negative terms. If device 1 is located in one seismic environment (e.g. Seismic Group "A") and devices 2 and 3 are located in another seismic environment (e.g. Seismic Group "B") then:

$$S_R = (s_{1R})^2 + (s_{2R} + s_{3R})^2$$

$$S_{Bp} = (s_{1Bp} + s_{2Bp} + s_{3Bp})$$

$$S_{Bn} = (s_{1Bn} + s_{2Bn} + s_{3Bn})$$

Loop Radiation Effect (R_N & R_{AN})

The Radiation Effect contains a random term and bias terms. The individual device Radiation Effects which are random are combined according to device radiation dependency groups.

For example, consider a loop which contains devices 1, 2, and 3 which each have random, bias positive, and bias negative terms. If device 1 is located in one radiation environment (e.g. Radiation Group "A") and devices 2 and 3 are located in another radiation environment (e.g. Radiation Group "B") then:

Normal:

$$R_{NR} = (r_{N1R})^2 + (r_{N2R} + r_{N3R})^2$$

$$R_{NBp} = (r_{N1Bp} + r_{N2Bp} + r_{N3Bp})$$

$$R_{NBn} = (r_{N1Bn} + r_{N2Bn} + r_{N3Bn})$$

Accident:

$$R_{ANR} = (r_{AN1R})^2 + (r_{AN2R} + r_{AN3R})^2$$

$$R_{ANBp} = (r_{AN1Bp} + r_{AN2Bp} + r_{AN3Bp})$$

$$R_{ANBn} = (r_{AN1Bn} + r_{AN2Bn} + r_{AN3Bn})$$

Loop Steam Pressure/Temperature Effect (SPT)

The Steam Pressure/Temperature Effect contains a random term and bias terms. Since the individual device Steam Pressure/Temperature Effects are considered independent, the random terms may be combined by the sum of the squares. The random and bias terms will be combined as follows:

$$SPT_R = (spt_{1R})^2 + (spt_{2R})^2 + ... + (spt_{nR})^2$$

$$SPT_{Bp} = (spt_{1Bp} + spt_{2Bp} + ... + spt_{nBp})$$

$$SPT_{Bn} = (spt_{1Bn} + spt_{2Bn} + ... + spt_{nBn})$$

Loop Post-DBE Effect (PDBE)

The Post-DBE Effect contains a random term and bias terms. Since the individual device Post-DBE Effects are considered independent, the random terms may be combined by the sum of the squares. The random and bias terms will be combined as follows:

$$PDBE_R = (pdbe_{1R})^2 + (pdbe_{2R})^2 + ... + (pdbe_{nR})^2$$

$$PDBE_{Bp} = (pdbe_{1Bp} + pdbe_{2Bp} + ... + pdbe_{nBp})$$

$$PDBE_{Bn} = (pdbe_{1Bn} + pdbe_{2Bn} + ... + pdbe_{nBn})$$

Loop Readability Effect (READ)

The Readability Effect contains a random term only and is the square of the Readability term given on the MCDS table for the loop's indicator, if applicable. The Readability effect is determined as follows:

$$READ_R = (read_{nR})^2$$

Dependent Process Considerations (DPC)

The Dependent Process Considerations can contain random and bias terms. Since the individual device DPC Effects are considered independent, the random terms may be combined by the sum of the squares. The random and bias terms will be combined as follows:

Normal:

$$DPC_{NR} = (dpc_{N1R})^2 + (dpc_{N2R})^2 + ... + (dpc_{N\,nR})^2$$

$$DPC_{NBp} = (dpc_{N1Bp} + dpc_{N2Bp} + ... + dpc_{NnBp})$$

$$DPC_{NBp} = (dpc_{N1Bn} + dpc_{N2Bn} + ... + dpc_{NnBn})$$

Accident:

$$DPC_{AR} = (dpc_{A1R})^2 + (dpc_{A2R})^2 + ... + (dpc_{AnR})^2$$

$$DPC_{ABp} = (dpc_{A1Bp} + dpc_{A2Bp} + ... + dpc_{AnBp})$$

$$DPC_{ABn} = (dpc_{A1Bn} + dpc_{A2Bn} + ... + dpc_{AnBn})$$

Process Measurement Accuracy (PMA)

The Process Measurement Accuracy can contain random and bias terms. Since the PMA is a single uncertainty per loop and the effects considered independent, the random term is squared and the Bias terms simply carried forward. The random and bias terms will be combined as follows:

Normal:

$$PMA_{NR} = (PMA_{NR})^2$$

$$PMA_{NBp} = (PMA_{NBp})$$

$$PMA_{NBn} = (PMA_{NBn})$$

Accident:

$$PMA_{AR} = (PMA_{AR})^2$$

$$PMA_{ABp} = (PMA_{ABp})$$

$$PMA_{ABn} = (PMA_{ABn})$$

Primary Element Accuracy (PEA)

The Primary Element Accuracy can contain a random or bias term. Since the PEA is a single uncertainty per loop and the effect considered independent, the random term is squared and combined with the other loop random terms. A bias term is simply carried forward and combined with any other loop bias terms

Normal:

$$PEA_{NR} = (PEA_{NR})^2$$

$$PEA_{NBp} = (PEA_{NBp})$$

$$PEA_{NBn} = (PEA_{NBn})$$

Accident:

$$PEA_{AR} = (PEA_{AR})^2$$

$$PEA_{ABp} = (PEA_{ABp})$$

$$PEA_{ABn} = (PEA_{ABn})$$

Insulation Resistance effect (IR)

The Insulation Resistance Effect is considered to be a bias term only. Since the IR is a single uncertainty per loop it is simply carried forward and combined with any other loop bias terms.

$$IR_{Bp} = IR_{Bp}$$

$$IR_{Bn} = IR_{Bn}$$

Other Process Considerations (PC) (Independent)

Other Process Considerations can contain a random and bias term. Since the PC Effects are considered independent, the random terms may be combined by the sum of the squares. The random and bias terms will be combined as follows:

Normal:

$$PC_{NR} = PC_{N1R}^2 + PC_{N2R}^2 + \ldots\ldots\ldots\ldots PC_{NnR}^2$$

$$PC_{NBp} = PC_{N1Bp} + PC_{N2Bp} + \ldots\ldots\ldots\ldots PC_{NnBp}$$

$$PC_{NBn} = PC_{N1Bn} + PC_{N2Bn} + \ldots\ldots\ldots\ldots PC_{NnBn}$$

Accident:

$$PC_{AR} = PC_{A1R}^2 + PC_{A2R}^2 + \ldots\ldots\ldots\ldots PC_{AnR}^2$$

$$PC_{ABp} = PC_{A1Bp} + PC_{A2Bp} + \ldots\ldots\ldots\ldots PC_{AnBp}$$

$$PC_{ABn} = PC_{A1Bn} + PC_{A2Bn} + \ldots\ldots\ldots\ldots PC_{AnBn}$$

ENCLOSURE I

NUCLEAR MANAGEMENT COMPANY, LLC
KEWAUNEE NUCLEAR PLANT
DOCKET 50-305

November 5, 2003

Letter from Thomas Coutu (NMC)

To

Document Control Desk (NRC)

Responses to Requests for Additional Information and Supplemental Information Regarding LAR 195

KNPP Concern No. 92006-02 (4/9/92), documenting a question of the fault ratings on 4.16KV buses, and the subsequent resolution

CONCERN NO. 92006-02

INSPECTOR: HALLER DATE: 04/09/92

CONCERN TITLE:

DESCRIPTION OF CONCERN:

CALC 8632-12-EPED-1, REV. 1, DATED NOVEMBER. 11, 1991, INDICATED THAT THE POTENTIAL FAULT DUTIES ON BOTH SAFETY-RELATED AND NON-SAFETY-RELATED 4.16KV SWITCHGEAR BUSES COULD EXCEED THE EQUIPMENTS RATING. THUS, ISOLATION OF A FAULT IN THE 4.16KV SYSTEM WITHOUT IMPACTING THE UNFAULTED SAFETY-RELATED PORTION OF THE SYSTEM COULD NOT BE ASSURED.

REFERENCE QUESTION 225 AND CONCERN #2. THE CALC CONSIDERED 1.0/UNIT VOLTAGE AS THE PRE-FAULT CONDITION AT EVERY BUS TO ARRIVE AT THE FAULT DUTIES. THIS ASSUMPTION RESULTED IN LESS CONSERVATIVE VALUES OF FAULT CURRENT THAN WOULD HAVE RESULTED HAD THE MAX ANTICIPATED PRE-FAULT DUTY BEEN CONSIDERED.

REFERENCES: USAR 8.2-9.

KEWAUNEE NUCLEAR POWER PLANT

ASSIGNED TO: Duane Schwartz/Dan Cole SEQUENTIAL NUMBER: C-2

DATE: 4/29/92

CLOSED BY: DFS

DATE: 4/30/92

COMMENTS:

This concern states that a fault within the 4.16kV system cannot be assured to not impact the safety-related portion of the system. Kewaunee is designed to IEEE-308(-1970), as referenced in the USAEC Safety Evaluation, section 8.0, "Electric Power".

Section 5.2.1 of IEEE-308 requires that for Class 1E Alternating-Current Power Systems, "Sufficient physical separation, electrical isolation, and redundancy shall be provided to prevent the occurrence of common failure mode in the Class 1E systems". Section 5.2.2 requires that "3) Independence: Distribution circuits to redundant equipment shall be physically and electrically independent of each other." Section 5.2.6 requires that "Protective devices shall be provided to isolate failed equipment automatically."

The normal operating bus line-up for 1E buses 1-5 and 1-6 per procedure N-EHV-39 is 1-5 to the Tertiary Auxiliary Transformer and 1-6 to the Reserve Auxiliary Transformer. Failure of either the TAT or the RAT will result in both buses 1-5 and 1-6 connected to the same transformer; this will also initiate a seven (7) day Limiting Condition of Operation for plant shutdown per Technical Specification 3.7.b.1.

I. <u>Fault Within the non-1E Portion of the 4.16kV Distribution System</u>

An electrical fault anywhere within the non-1E 4.16kV A-C distribution system for any plant operating or DBA condition results in a total current from all the contributing sources to the fault location. The predominance of the total fault current is provided from the Off-site power supply, and the balance from the operating motors. If all non-1E buses and both 1E buses 1-5 and 1-6 are connected to the same off-site transformer during the 7 day L.C.O. period;

a. The fault contribution from the operating motors on buses 1-5 and 1-6 to the non-1E fault location are the currents to which the respective Class 1E distribution bus and its circuit breakers are required to be braced for and capable of carrying and interrupting. These operating motor fault contribution currents are significantly less than the design and tested ratings of the bus 1-5 and 1-6 switchgear. The external fault does not create a common failure mode to the Class 1E portion of the distribution system due to 1E equipment ratings.

b. The occurrence of a fault within the non-1E distribution system will cause a power supply voltage collapse as delivered to the 1E 4.16kV distribution buses. This will cause the independent bus undervoltage relays of buses 1-5 and 1-6 to search for and connect to a source of sufficient power, thereby isolating the failed equipment automatically. The external fault does not create a common failure mode to the Class 1E portion of the distribution system due to failure of automatic isolation.

During normal plant bus configurations, with bus 1-5 connected to the TAT and 1-6 connected to the RAT, only bus 1-6 is subjected to the above demand.

Therefore, there is assurance that a fault within the non-1E portion of the 4.16kV distribution system will not create loss of the redundant Class 1E portions of the system.

II. Fault Within the 1E Portion of the 4.16kV Distribution System

The redundant Class 1E portions of the 4.16kV distribution system power only Class 1E electrical loads; ie, there are no non-1E electrical loads connected to either Class 1E 4.16kV bus that are non-seismic or non-environmentally qualified. A single electrical fault within either of the redundant Class 1E 4.16kV buses is a single failure to which the plant is designed. As with a fault anywhere within the non-1E 4.16kV distribution system, the total fault current comes from all contributing sources to the fault location. If all non-1E buses and both 1E buses 1-5 and 1-6 are connected to the same off-site transformer during the 7 day L.C.O. period;

a. The fault contribution from the operating motors of the non-faulted redundant Class 1E 4.16kV bus is the current to which the non-faulted bus and its circuit breakers are required to be braced for and capable of carrying and interrupting. This current again is significantly less than the design and tested ratings of the redundant Class 1E 4.16kV buses. The fault within one of the redundant Class 1E 4.16kV buses does not create a common failure mode to the redundant 4.16kV Class 1E bus due to 1E equipment ratings.

b. The occurrence of a fault within one of the redundant Class 1E 4.16kV distribution buses will cause a power supply collapse as delivered to the redundant Class 1E 4.16kV bus. This will cause the redundant bus's undervoltage relays to search for and connect to a source of sufficient power, thereby isolating the failed equipment automatically. The occurrence of a fault within either of the redundant Class 1E 4.16kV distribution buses does not create a common failure mode to the redundant Class 1E bus due to failure of automatic isolation.

During normal plant bus configurations, with bus 1-5 connected to the TAT and 1-6 connected to the RAT, the above scenario does not apply.

Therefore, there is also assurance that a single fault within either of the redundant Class 1E 4.16kV buses will not create a common failure mode for the redundant bus.

III. Fault Duty Ratings of 4.16KV System Switchgear

The calculated fault currents from Fluor calculation No. 237127-E1 (ANSI method) and DAPPER (ohms law) were compared to the switchgear manufacture's (McGraw Edison) interrupting ratings and test results to assess the ability of the 4.16KV system switchgear to interrupt the available fault.

The attached Table 1-1 provides, from DAPPER, the anticipated fault currents at the worst case breakers for buses 1 through 6 (assuming a substation voltage of 1.05 p.u.), as well as summarizes the McGraw Edison switchgear ratings and test results.

In the original KNPP switchgear test report No. TC-8456-A from McGraw Edison entitled, "Short Time and Close Latch Test, Type PSD, 4.16KV, 250MVA Magnetic Air Circuit Breaker" dated 3/16/70, switchgear ratings are shown to be established in accordance with ANSI C37.06-1966. The method of short circuit calculation used in the Fluor calculation mentioned above is based on this ANSI standard. Therefore, the results of this short circuit calculation and the McGraw Edison Switchgear Ratings for the KNPP 4.16KV switchgear can be more directly compared than OHMs law results. The results of the ohms law method that DAPPER uses to calculate short circuit currents can be compared to the test results contained in the McGraw Edison test report referenced above. A summary of the Fluor Daniel and DAPPER calculated short circuit currents and their comparison to the test report and rated interrupting currents are shown in Table 1-2.

For safeguards bus 6, the interrupting rating of the switchgear is greater than the maximum anticipated fault current as calculated in both the Flour calculation (ANSI method) and DAPPER (ohms law). For the safeguards bus 5, the asymmetrical fault calculated by DAPPER (using ohms law) is within the asymmetrical switchgear interrupting rating of the switchgear as provided by McGraw Edison. However, the symmetrical fault current for bus 5 as calculated by Fluor (using ANSI) is marginally lower (1.2%) than the symmetrical switchgear rating provided by McGraw Edison. For buses 5 and 6, the interrupting ratings as calculated by both DAPPER and Fluor are well within the tested switchgear interrupting currents found in the McGraw Edison Test Report TC-8456-A.

For buses 3 and 4 both the asymmetrical and symmetrical fault currents exceed the rated interrupting currents provided by McGraw Edison. The possibility of a fault of the magnitude resulting in the calculated interrupting currents is felt to be highly unlikely and not of nuclear safety significance.

Buses 1 and 2 are shown in both the Fluor and DAPPER calculation to have fault currents in excess of both the switchgear interrupting ratings. However, these fault currents are within the tested switchgear interrupting currents found in the McGraw Edison Test Report TC-8456-A. American Switchgear has provided, via a telephone conversation, to WPS the following information relative to the actual capability of the KNPP switchgear to interrupt fault currents in excess of the rated and tested values:

- The McGraw Edison switchgear is a very rugged gear and would exceed the ANSI standard if tested to higher values.

- Circuit breakers can take significant faults over their rating and still interrupt the fault. However, some damage may be experienced such as burned contacts, arc chute damage, or insulation damage depending on the fault magnitude.

- In their experience 3Ø bolted faults only occur when a breaker is closed on a bus that has been shorted for personnel protection during maintenance actions.

- The damage caused by faults grossly exceeding the switchgear rating is contained within the switchgear cabinetry.

The likelihood of buses 1 and 2 experiencing a fault of this magnitude that would generate fault currents of the magnitude shown in Tables 1-1 and 1-2, is extremely remote. Fault currents of this magnitude would only be available during full power operation when buses 1 and 2 are fed from the main aux transformer. As stated by American Switchgear, it is reasonable to assume that a 3Ø bolted fault can realistically only occur during a maintenance activity where the bus is purposely grounded for personnel protection and the breaker is accidently closed in on the fault. Such an event is not possible during full power operation since no such maintenance activities would be performed during this mode of operation and the plant cannot operate with one RCP. Maintenance activities such as those described above are possible during plant shutdown; however, buses 1 and 2 would be supplied from the reserve aux transformer where available fault currents are much lower. A fault due to an insulation failure is a credible failure. This type of failure would result in an arcing fault of a significantly lower magnitude.

In any event, a failure of the switchgear for buses 1 and 2 to interrupt a fault of the magnitudes shown in Table 1-1 and 1-2 is not considered to be credible, and is not a nuclear safety related concern but plant a reliability/economic concern.

TABLE 1-1

	BKR 1-102	BKR 1-202	BKR 1-308	BKR 1-402	BKR 1-506	BKR 1-605
OC Relay	GE1AC66	GE1AC66	W CO-8	W CO-8	GE1AC66	GE1AC66
OC Relay Time Delay	0.01s	0.01s	0.01s	0.01s	0.01s	0.01s
Lock Out Relay (MG-6)	1 cycle	1 cycle	N/A	N/A	1 cycle	1 cycle
BKR Opening Time Delay	3 cycle	3 cycle	3 cycle	3 cycle	3 cycle	3 cycle
Total Delay	4.6 cycle	4.6 cycle	3.6 cycle	3.6 cycle	4.6 cycle	4.6 cycle
DAPPER Current @ Total Delay Cycles	45.3KA	45.3KA	37.7KA	37.7KA	34.5KA	34.5KA
DAPPER Bus Voltage (Substation Voltage p.u.)	0.973(1.033)	0.973(1.033)	0.990(1.033)	0.990(1.033)	1.000(1.0291)	1.000(1.05)
Estimated DAPPER Bus Voltage w/Sub. @ 1.05(p.u.)	0.991	0.991	1.008	1.008	1.020	0.999
Estimated DAPPER Current @ 1.05 p.u. Sub. Voltage	44.9KA	44.9KA	38.0KA	38.0KA	35.2KA	34.5KA
BKR Asymmetrical Rating @ Est. Bus Voltage	36.8KA	36.8KA	36.2KA	36.2KA	35.8KA	36.5KA
BKR Test Value @ Est. Bus Voltage	46.3KA	46.3KA	45.5KA	45.5KA	45.0KA	45.9KA

TABLE 1-2

BUS	PLANT STATUS	ASYMMETRICAL SWITCHGEAR I_{SC} BY RATING	ASYMMETRICAL FAULT I_{SC} BY OHMS LAW	SYMMETRICAL SWITCHGEAR I_{SC} BY RATING	SYMMETRICAL FAULT I_{SC} BY ANSI	SWITCHGEAR I_{SC} BY TEST
1-1	Normal OP	36.8 KA	44.9 KA	33.5 KA	43.7 KA	46.3 KA
1-2	Normal OP	36.8 KA	44.9 KA	33.5 KA	43.7 KA	46.3 KA
1-3	Normal OP	36.2 KA	38.0 KA	32.9 KA	35.3 KA	45.5 KA
1-4	Normal OP	36.2 KA	38.0 KA	32.9 KA	35.3 KA	45.5 KA
1-5	Safety Injection	35.8 KA	35.2 KA	32.5 KA	32.9 KA	45.0 KA
1-6	Safety Injection	36.5 KA	34.5 KA	33.2 KA	32.3 KA	45.9 KA

NOTE: All values of fault current and interrupting are corrected to an estimated bus voltage, that bus voltage corresponds with a substation @ 1.05 p.u. (see Table 1-1).