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WESTINGHOUSE SETPOINT METHODOLOGY FOR PROTECTION SYSTEMS

MILLSTONE NUCLEAR POWER STATION UNIT 3

24 MONTH FUEL CYCLE EVALUATION

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FOREWORD

The Westinghouse Protection System Setpoint Study provides a basis for the Reactor Protection System, and Engineered Safety Features Actuation System values contained in the Technical Specifications. This report contains the results associated with implementation of the Technical Specifications as well as recommended Trip Setpoints.

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1.0 INTRODUCTION

In Generic Letter 91-04,[1] the NRC has noted that uncertainty calculations should be performed in a manner which results in values at a high probability and a high confidence level. The implication being a requirement for a more statistically rigorous calculation. In addition, Generic Letter 91-18[2] clarifies the NRC's definition of operability. In response to these documents, Westinghouse has modified the basic uncertainty algorithm. To address the requirements for a definitive basis for drift, explicit calculations were made to determine appropriate values for the transmitters and process racks.

The basic Westinghouse approach to an uncertainty calculation is to achieve an understanding of the plant instrumentation calibration and operability verification processes. The uncertainty algorithm resulting from this understanding can be function specific, i.e., is very likely different for two functions if their calibration or operability determination processes are different. Effort is expended in determination of what parameters are dependent statistically or functionally. Those parameters that are determined to be independent are treated accordingly. This allows the use of a Square-Root-Sum-Of-The- Squares (SRSS) summation of the various components. A direct benefit of the use of this technique is increased margin in the total allowance. For those parameters determined to be dependent, appropriate (conservative) summation techniques are utilized. An explanation of the overall approach is provided in Section 2.0.

Section 3.0 provides a description, or definition, of each of the various components, to allow a clear understanding of the methodology. Also provided is a detailed example of each setpoint margin calculation demonstrating the methodology and noting how each parameter value is utilized. In all cases, margin exists between the summation and the total allowance.

Section 4.0 provides a description of the methodology utilized in the determination of the Millstone Unit 3 Technical Specifications and an explanation of the relationship between a trip setpoint and an operability verification. An Appendix is provided noting a recommended set of Technical Specifications using the plant specific data and the revised Westinghouse approach that reflects the plant specific operability verification process.

1.1 References / Standards

[1] Generic Letter 91-04, 1991, "Changes in Technical Specification Surveillance Intervals to Accommodate a 24 Month Fuel Cycle.

[2] Generic Letter 91-18, 1991, "Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded and Nonconforming Conditions and on Operability.

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 which are statistically and functionally independent. Those uncertainties which are not independent are appropriately treated (or conservatively treated by arithmetic summation) and then systematically combined with the independent terms.

The basic methodology used is the SRSS technique which has been utilized in other Westinghouse reports. 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 noting acceptability of statistical techniques for the application requested. Also, various ANSI, American Nuclear Society, and Instrument Society of America standards approve the use of probabilistic and statistical techniques in determining safety-related setpoints[3,4]. The basic methodology used in this report is essentially the same as that noted in an ISA paper presented in 1992[5].

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

$$CSA = \{(PMA)^2 + (PEA)^2 + (SMTE + SD)^2 + (SMTE + SCA)^2 + (SPE)^2 + (STE)^2 + (SRA)^2 + (RMTE + RD)^2 + (RMTE + RCA)^2 + (RMTE + RCSA)^2 + (RTE)^2\}^{1/2} + EA + BIAS \qquad \text{(Eq. 2.1)}$$

where:

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

As can be seen in the equation, drift and calibration accuracy allowances are treated as dependent parameters with the measurement and test equipment uncertainties. The environmental allowance is not necessarily considered dependent with all other parameters, but as an additional degree of conservatism is added to the statistical sum. Bias terms are one directional with a known magnitude and are added to the statistical sum. The calibration terms are treated in the same radical based on the Generic Letter 91-04[6] requirement for general trending. Millstone Unit 3 has identified that trending will be performed. This results in a net reduction of the CSA magnitude (over that which would be determined if trending was not performed).

2.2 Sensor Allowances

Six parameters are considered to be sensor allowances: SCA, SRA, SMTE, SD, STE, and SPE (see Table 3-24). Of these parameters, three are considered to be independent (SRA, STE and SPE), and three are considered dependent with at least one other term (SCA, SMTE and SD). SRA is the manufacturer's reference accuracy that is achievable by the device. This term is introduced to address repeatability and hysteresis concerns when only performing a single pass calibration, i.e., one up and one down.[5] STE and SPE are considered to be independent due to the manner in which the instrumentation is checked; i.e., the instrumentation is calibrated and drift determined under conditions in which pressure and temperature are assumed constant. An example of this would be as follows. Assume a sensor is placed in some position in the containment during a refueling outage. After placement, an instrument technician calibrates the sensor. This calibration is performed at ambient pressure and temperature conditions. Some time later with the plant shutdown, an instrument technician checks for sensor drift. Using the same technique as for calibrating the sensor, the technician determines if the sensor has drifted. The conditions under which this determination is made are again ambient pressure and temperature. The temperature and pressure should be essentially the same at both measurements and thus should have no significant impact on the drift determination and are, therefore, independent of the drift allowance. For this evaluation, transmitter "as left / as found" data was evaluated to project a 30 month drift and process rack "as left / as found" data was evaluated for a 3 month drift for all channels noted in this document.

SCA, SMTE and SD are considered to be dependent for the same reason that STE and SPE are considered independent; i.e., due to the manner in which the instrumentation is checked. Instrumentation calibration techniques use the same process as determining instrument drift. That is, the end result of the two is the same. When calibrating a sensor, the sensor output is checked to determine if it is accurately representing the input. The same is performed for a determination of the sensor drift. The "as left / as found" data are recorded to determine whether the sensor has performed its intended function in the past and will it continue to perform this function for future cycles as specified by the manufacturer's specifications.

The transmitter "as left / as found" data were evaluated for population normality and outliers and a 30 month uncertainty determined at a 95% probability and a 95% confidence level. A similar evaluation was performed for the process racks for a 3 month uncertainty. The statistically derived calibration accuracy and drift values (for 30 months or 3 months, as appropriate) were combined with the measurement and test equipment accuracy term to form the dependent relationships. A hypothetical example of the impact of this treatment for a level transmitter is (sensor parameters only):

SCA =
SRA =
SMTE =
SPE =
STE =
SD =

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

excerpting the sensor portion of Equation 2.1 results in;

$$\{(SMTE + SCA)^2 + (SMTE + SD)^2 + (SPE)^2 + (STE)^2 + (SRA)^2\}^{1/2}$$

- or -

$$[\quad]^{+a,c} = 2.0\%$$

Assuming no dependencies for any of the parameters results in the following:

$$\{(SCA)^2 + (SMTE)^2 + (SD)^2 + (SPE)^2 + (STE)^2 + (SRA)^2\}^{1/2} \qquad (Eq.\ 2.2)$$

- or -

$$[\quad]^{+a,c} = 1.5\%$$

Thus it can be seen that the approach represented by Equation 2.1, which accounts for dependent parameters, results in a more conservative summation of the allowances.

2.3 Rack Allowances

Five parameters, as noted by Table 3-24, are considered to be rack allowances: RCA, RMTE, RCSA, RTE, and RD. Three of these parameters (RCA, RMTE, and RD) are considered to be dependent for much the same reason outlined for sensors in Section 2.2. When calibrating or determining drift in the racks for a specific channel, the processes are performed at essentially constant temperature; i.e., ambient temperature (which is reasonably controlled). Because of this, the RTE parameter is considered to be independent of any factors for calibration or drift. However, the same cannot be said for the other rack parameters. As noted in Section 2.2, when calibrating or determining drift for a channel, the same end result is desired; that is, the point at which the bistable changes state. For this evaluation, "as left / as found" data was evaluated to project a calibration uncertainty, rack drift and a comparator setting accuracy based on the 3 month surveillance interval requirement for each channel. Based on this logic, these factors have been conservatively summed to form several independent groupings (see Equation 2.1). The impact of this approach (formation of independent groups based on dependent components) is significant. For the hypothetical example of a level transmitter channel, using the same approach outlined in Equations 2.1 and 2.2 results in the following:

RCA =
RMTE =
RCSA =
RTE =
RD =

[ ] +a,c

excerpting the rack portion of Equation 2.1 results in;

$$\{(RMTE + RCA)^2 + (RMTE + RCSA)^2 + (RMTE + RD)^2 + (RTE)^2\}^{1/2}$$

- or -

$$[\qquad]^{+a,c} = 1.5\%$$

Assuming no dependencies for any of the parameters yields the following less conservative results;

$$\{(RCA)^2 + (RMTE)^2 + (RCSA)^2 + (RD)^2 + (RTE)^2\}^{1/2} \qquad (Eq.\ 2.3)$$

- or -

$$[\qquad]^{+a,c} = 1.3\%$$

Thus, the use of Equation 2.1 is conservative for rack effects and for sensor effects. Therefore, accounting for dependencies in the treatment of these allowances provides a conservative result.

2.4 Process Allowances

Finally, the PMA and PEA parameters are considered to be independent of both sensor and rack parameters. PMA provides allowances for the non-instrument related effects; e.g., neutron flux, calorimetric power uncertainty assumptions, fluid density changes, and temperature stratification assumptions. PMA may consist of more than one independent uncertainty allowance. PEA accounts for uncertainties due to metering devices, such as elbows, venturis, and orifice plates. Thus, these parameters have been factored into Equation 2.1 as independent quantities. 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, Equation 2.1 would be modified such that the affected term would be treated by arithmetic summation as deemed necessary.

2.5 Measurement and Test Equipment Accuracy

Based on information from Northeast Nuclear Energy Company (NNECO), it was concluded that the equipment used for calibration and functional testing of the transmitters and racks does not meet SAMA Standard PMC 20.1-1973[7] with regards to allowed exclusion from the calculation. This implies that test equipment without an accuracy of 10% or less of the calibration accuracy is required to be included in the uncertainty calculations of Equations 2.1, and 3.1. NNECO procedures were reviewed to determine the appropriate uncertainty for each function evaluated. These M&TE uncertainties were included in the calculations, as seen on the tables included in this report.

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, 1994, "Setpoints for Nuclear Safety-Related Instrumentation Used in Nuclear Power Plants."

[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] Generic Letter 91-04, 1991, "Changes in Technical Specification Surveillance Intervals to Accommodate a 24 Month Fuel Cycle."

[7] Scientific Apparatus Manufacturers Association, Standard PMC 20.1-1973. "Process Measurement and Control Terminology."

3.0 PROTECTION SYSTEM SETPOINT METHODOLOGY

3.1 Margin Calculation

As noted in Section 2.0, Westinghouse utilizes the square root of the sum of the squares for summation of the various components of the channel uncertainty. This approach is valid where no dependency is present. Arithmetic summation is a conservative treatment when a dependency between two or more parameters exists. The equation used to determine the margin, and thus the acceptability of the parameter values used, is:

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

where:

TA = Total Allowance (which is defined as) Safety Analysis Limit - Nominal Trip Setpoint, and all other parameters are as defined for Equation 2.1.

This equation is appropriate when trending of transmitter calibration and drift and process rack calibration and drift values is taking place. Using Equation 2.1, Equation 3.1 may be simplified to:

$$Margin = TA - CSA \qquad \text{(Eq. 3.2)}$$

Tables 3-1 through 3-23 provide individual component uncertainties and CSA calculations for the protection functions noted in Tables 2.2-1 and 3.3-4 of the Millstone Unit 3 Technical Specifications. Table 3-24 provides a summary of the Reactor Protection System / Engineered Safety Features Actuation System Channel Uncertainty Allowances for Millstone Unit 3 and includes Safety Analysis and Technical Specification values, Total Allowance and

Margin. Westinghouse typically reports values in these tables to one decimal place using the conventional technique of rounding down values less than 0.05 and rounding up values greater than or equal to 0.05. Parameters reported in Tables 3-1 through 3-24 as "0.0" have been identified as having a value of $\leq$ 0.04. 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 insure a clear understanding of the channel uncertainty values used in this report, the following definitions are noted:

- As Found

  The condition in which a transmitter, process rack module or process instrument loop is found after a period of operation. For example, after a period of operation, a transmitter was found to deviate from the ideal condition by -0.5% span. This would be the "as found" condition.

- As Left

  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 permitted calibration accuracy for a transmitter is ±0.5% of span, while the worst measured deviation from the ideal condition after calibration is +0.1% span. 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 +0.1% span.

- Channel

  The sensing and process equipment, i.e., transmitter to bistable, 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. 2/4 Steam Generator Level - Low-Low channels must have two bistables in the tripped condition for a Reactor Trip to be initiated.

- Channel Statistical Allowance (CSA)

  The combination of the various channel uncertainties via SRSS. It includes both instrument (sensor and process rack) uncertainties and non-instrument related effects (Process Measurement Accuracy). This parameter is compared with the Total Allowance for determination of instrument channel margin.

- Environmental Allowance (EA)

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

  a) temperature effects on a transmitter,
  b) radiation effects on a transmitter,
  c) seismic effects on a transmitter,
  d) temperature effects on a level transmitter reference leg,
  e) temperature effects on signal cable insulation, and
  f) seismic effects on process racks.

- Margin

  The calculated difference (in % instrument span) between the Total Allowance and the Channel Statistical Allowance.

- Nominal Trip Setpoint (NTS)

  A bistable trip setpoint in plant Technical Specifications or plant administrative procedures. This value is the nominal value to which the bistable is set, as accurately as reasonably achievable.

- Normalization

  The process of establishing a relationship, or link, between a process parameter and an instrument channel. This is in contrast with a calibration process. A calibration process is performed with independent known values, i.e., a bistable is calibrated to change state when a specific voltage is reached. This voltage corresponds to a process parameter magnitude with the relationship established through the scaling process. A normalization process typically involves an indirect measurement, e.g., determination of Steam Flow via the Δp drop across a flow restrictor. The flow coefficient is not known for this condition, effectively an orifice, therefore a mass balance between Feedwater Flow and Steam Flow can be made. With the Feedwater Flow known through measurement via the venturi, the Steam Flow is normalized.

- Process Loop (Instrument Process Loop)

  The process equipment for a single channel of a protection function.

- Process Measurement Accuracy (PMA)

  Allowance for non-instrument related effects which have a direct bearing on the accuracy of an instrument channel's reading, e.g., temperature stratification in a large diameter pipe, fluid density in a pipe or vessel.

- Primary Element Accuracy (PEA)

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

- Process Racks

  The analog modules downstream of the transmitter or sensing device, which condition a signal and act upon it prior to input to a voting logic system. For Westinghouse process systems, this includes all the equipment contained in the process equipment cabinets, e.g., conversion resistor, transmitter power supply, R/E, lead/lag, rate, lag functions, function generator, summator, control/protection isolator, and bistable 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.

- R/E

  Resistance (R) to voltage (E) conversion module. The RTD output (change in resistance as a function of temperature) is converted to a process loop working parameter (voltage) by this analog module.

■ Rack Calibration Accuracy (RCA)

The reference (calibration) accuracy, as defined by SAMA Standard PMC 20.1-1973[1] for a process loop string. 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 Westinghouse definition of a process loop includes all modules in a specific channel. Also it is assumed that the individual modules are calibrated to a particular tolerance and that the process loop as a string is verified to be calibrated to a specific tolerance. The tolerance for the string is typically less than the arithmetic sum or SRSS of the individual module tolerances. This forces calibration of the process loop without a systematic bias in the individual module calibrations, i.e., as left values for individual modules must be compensating in sign and magnitude.

For an analog channel, an individual module is typically calibrated to within [ ]$^{+a,c}$, with the entire process loop typically calibrated to within [ ]$^{+a,c}$.

■ Rack Comparator Setting Accuracy (RCSA)

The reference (calibration) accuracy, as defined by SAMA Standard PMC 20.1-1973[1], of the instrument loop comparator (bistable). Inherent in this definition is the verification of repeatability[4] under a reference set of conditions. For a single input bistable (fixed setpoint) the typical calibration tolerance is [ ]$^{+a,c}$. This assumes that comparator nonlinearities are compensated by the setpoint. For a dual input bistable (floating setpoint) the typical calibration tolerance is [ ]$^{+a,c}$. This allows for nonlinearities between the two inputs. In many plants calibration of the bistable is included as an integral part of the rack calibration, i.e., string calibration.

■ Rack Drift (RD)

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 $\pm1.0\%$ span for analog channels. An example of RD is: for an "as found" value of -0.5% span and an "as left" value of +0.1% span, the magnitude of the drift would be $\{(-0.5) - (+0.1) = -0.6\%$ span$\}$ in the negative direction. For this evaluation, a maximum surveillance interval of 3 months was assumed when projecting drift allowance, as noted in the uncertainty tables.

■ Rack Measurement & Test Equipment Accuracy (RMTE)

The accuracy of the test equipment (typically a transmitter simulator, voltage or current power supply, and DVM) used to calibrate a process loop in the racks. When the magnitude of RMTE meets the requirements of SAMA PMC 20.1-1973[5] it is considered an integral part of RCA. Magnitudes in excess of the 10:1 limit are explicitly included in Westinghouse calculations.

■ Rack Temperature Effects (RTE)

Change in input-output relationship for the process rack module string due to a change in the ambient environmental conditions (temperature, humidity, voltage and frequency) from the reference calibration conditions. It has been determined that temperature is the most significant, with the other parameters being second order effects. For process instrumentation, a 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.

- Range

The upper and lower limits of the operating region for a device, e.g., for a Pressurizer Pressure transmitter, 1700 to 2500 psig, for Steam Generator Level, approximately 120.8 to 31.5 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 parameter value assumed in a transient analysis or other plant operating limit at which a reactor trip or actuation function is initiated.

- Sensor Calibration Accuracy (SCA)

The calibration accuracy for a Sensor or transmitter as defined by the Millstone Unit 3 calibration procedures. For transmitters, this accuracy is typically [ ]+a,c as defined by NNECO Procedures. Utilizing Westinghouse recommendations for RTD cross-calibration, this accuracy is typically [ ]+a,c for the Hot and Cold Leg RTDs.

- Sensor Drift (SD)

The change in input-output relationship over a period of time at reference calibration conditions, e.g., at constant temperature. An example of SD is: for an "as found" value of +0.5% span and an "as left" value of +0.1% span, the magnitude of the drift would be {(+0.5) − (+0.1) = +0.4% span} in the positive direction. For this evaluation, a maximum surveillance interval of 30 months was assumed when projecting drift allowance with exceptions as noted in the uncertainty tables.

- Sensor Measurement & Test Equipment Accuracy (SMTE)

  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 SAMA PMC 20.1-1973[5] it is considered an integral part of SCA. Magnitudes in excess of the 10:1 limit are explicitly included in Westinghouse calculations.

- Sensor Pressure Effects (SPE)

  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.

- Sensor Temperature Effects (STE)

  The change in input-output relationship 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, with the other parameters being second order effects. 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.

- Sensor Reference Accuracy

  The reference accuracy that is achievable by the device as specified in the manufacturers specification sheets. 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]. This term is introduced into the uncertainty calculation to address repeatability concerns when only performing a calibration, i.e., one up and one down or repeatability and hysteresis when performing a single pass calibration in only one direction.

- Span

The region for which a device is calibrated and verified to be operable, e.g., for a Pressurizer Pressure transmitter, 800 psi, for Steam Generator Level, approximately 89.3 inches of water column. For Pressurizer Pressure, considerable suppression of the zero is exhibited.

- SRSS

Square root of the sum of the squares, i.e.,

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

as approved for use in setpoint calculations by ISA Standard S67.04-1994[7].

- Total Allowance (TA)

The calculated difference between the Safety Analysis Limit and the Nominal Trip Setpoint (SAL - NTS) in % instrument span. Two examples of the calculation of TA are:

■ *Steam Generator Level - Low-Low*

SAL	0% LVL
NTS	- 18% LVL
TA	18% LVL

If the instrument span = 100% LVL, then

$$TA = \frac{(18\%\ level) * (100\%\ span)}{(100\%\ level)} = 18.0\%\ span$$

■ *Pressurizer Pressure - Low Trip*

SAL	1860 psia
NTS	- 1900 psia
TA	40 psia

If the instrument span = 800 psi, then

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

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 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", p 18, 1994.

[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
POWER RANGE, NEUTRON FLUX - LOW & HIGH

Parameter	Allowance*
Process Measurement Accuracy [ ]+a,c [ ]+a,c	[ ]+a,c
Primary Element Accuracy	
Sensor Calibration Accuracy [ ]+a,c	
Measurement & Test Equipment Accuracy [ ]+a,c	
Sensor Pressure Effects	
Sensor Temperature Effects [ ]+a,c	
Sensor Drift [ ]+a,c	
Environmental Allowance	
Bias	
Rack Calibration Rack Accuracy Measurement & Test Equipmen+ Accuracy	
Comparator	
Rack Temperature Effect	
Rack Drift	
Tag No.'s - N41, N42, N43, N44	

* In percent span (120% RTP)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-2
POWER RANGE, NEUTRON FLUX - HIGH N-1 LOOP OPERATION

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

Tag No.'s - N41, N42, N3, N44

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* In percent span (120% RTP)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-3
POWER RANGE, NEUTRON FLUX HIGH POSITIVE AND NEGATIVE RATE

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

Tag No.'s - N41, N42, N43, N44

* In percent span (120% RTP)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-4
INTERMEDIATE RANGE NEUTRON FLUX

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

Tag No.'s - N35, N36

* In percent span (120% RTP)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-5
SOURCE RANGE NEUTRON FLUX

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

Tag No.'s - N31, N32

* In percent span (10^6 cps)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-6
OVERTEMPERATURE ΔT (CORE BURNDOWN EFFECTS) (N LOOP)
(Rosemount Model 1154 transmitter for Pressurizer Pressure)
Assumes re-normalization of ΔT_o, T", and T'

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

TABLE 3-6 (continued)
OVERTEMPERATURE ΔT (CORE BURNDOWN EFFECTS) (N LOOP)
(Rosemount Model 1154 transmitter for Pressurizer Pressure)
Assumes re-normalization of ΔT_o, T", and T'

Parameter	**Allowance***
Measurement & Test Equipment Accuracy	[ ]+a,c
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Comparator (Included in string calibration)	
Rack Temperature Effect	
Rack Drift	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	

Tag Numbers - TE411A, TE411B, PT455, N41
TE421A, TE421B, PT456, N42

* In percent ΔT span (ΔT - 90.3°F; Tavg - 100°F; Pressure - 800 psi; Power - 150% RTP; ΔI - ±60% ΔI; 90.3°F span = 150% power)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-7
OVERPOWER ΔT (CORE BURNDOWN EFFECTS) (N LOOP)
Assumes re-normalization of ΔT_o, T", and T'

Parameter	Allowance*
	[ ]+a,c
Process Measurement Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Primary Element Accuracy	
Sensor Calibration Accuracy	
[ ]+a,c	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift	
[ ]+a,c	
Environmental Allowance	
[ ]+a,c	
Rack Calibration Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Measurement & Test Equipment Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Comparator (Included in string calibration)	
Rack Temperature Effect	
Rack Drift	
[ ]+a,c	
[ ]+a,c	

Tag Numbers - TE411A, TE411B, TE431A, TE431B, TE421A, TE421B, TE441A, TE441B

* In percent ΔT span (ΔT - 90.3°F; Tavg - 100°F; Power - 150% RTP; 90.3°F span = 150% power)

TABLE 3-7 (continued)
OVERPOWER ΔT (CORE BURNDOWN EFFECTS) (N LOOP)
Assumes re-normalization of ΔT_o, T", and T'

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-8

OVERTEMPERATURE ΔT (CORE BURNDOWN EFFECTS) (N-1 LOOP)

(Rosemount Model 1154 transmitter for Pressurizer Pressure)

Assumes re-normalization of ΔT_o, T", 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 Calibration Accuracy	
[ ]+a,c	
[ ]+a,c	
Sensor Reference Accuracy	
[ ]+a,c	
Measurement & Test Equipment Accuracy	
[ ]+a,c	
Sensor Pressure Effects	
Sensor Temperature Effects	
[ ]+a,c	
Sensor Drift	
[ ]+a,c	
[ ]+a,c	
Environmental Allowance	
[ ]+a,c	
[ ]+a,c	
Rack Calibration Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	

TABLE 3-8 (continued)
OVERTEMPERATURE ΔT (CORE BURNDOWN EFFECTS) (N-1 LOOP)
(Rosemount Model 1154 transmitter for Pressurizer Pressure)
Assumes re-normalization of ΔT_o, T", and T'

Parameter	Allowance*
Measurement & Test Equipment Accuracy	[ ]+a,c
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Comparator (Included in string calibration)	
Rack Temperature Effect	
Rack Drift	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	

Tag Numbers - TE411A, TE411B, PT455, N41
TE421A, TE421B, PT456, N42

* In percent ΔT span (ΔT - 87.0°F; Tavg - 100°F; Pressure - 800 psi; Power - 150% RTP; ΔI - ±60% ΔI; 87.0°F span = 150% power)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-9
OVERPOWER ΔT (CORE BURNDOWN EFFECTS) (N-1 LOOP)
Assumes re-normalization of ΔT_o, T", 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 Calibration Accuracy	
[ ]+a,c	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift	
[ ]+a,c	
Environmental Allowance	
[ ]+a,c	
Rack Calibration Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Measurement & Test Equipment Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Comparator (Included in string calibration)	
Rack Temperature Effect	
Rack Drift	
[ ]+a,c	
[ ]+a,c	

Tag Numbers - TE411A, TE411B, TE431A, TE431B, TE421A, TE421B, TE441A, TE441B

* In percent ΔT span (ΔT - 87.0°F; Tavg - 100°F; Power - 150% RTP; 87.0°F span = 150% power)

TABLE 3-9 (continued)
OVERPOWER ΔT (Core Burndown Effects) (N-1 LOOP)
Assumes re-normalization of ΔT_o, T", and T'

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-10
PRESSURIZER PRESSURE - LOW & HIGH
(ROSEMOUNT 1154 TRANSMITTER)

Parameter	**Allowance***
	[ ]+a,c
Process Measurement Accuracy	
Primary Element Accuracy	
Sensor Calibration Accuracy	
Sensor Reference Accuracy	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift (30 months)	
Environmental Allowance	
Bias	
[ ]+a,c	
Rack Calibration	
Rack Accuracy	
Measurement & Test Equipment Accuracy	
Comparator	
String Calibrated	
Rack Temperature Effect	
Rack Drift	

Tag No.'s - PT457, PT458

* In percent span (800 psia)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-11
PRESSURIZER PRESSURE - SI
(ROSEMOUNT 1154 TRANSMITTER)

Parameter	Allowance*
Process Measurement Accuracy	[ ]+a,c
Primary Element Accuracy	
Sensor Calibration Accuracy Sensor Reference Accuracy	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects Included in EA term	
Sensor Drift (30 months)	
Environmental Allowance [ ]+a,c [ ]+a,c	
Bias [ ]+a,c	
Rack Calibration Rack Accuracy Measurement & Test Equipment Accuracy	
Comparator String Calibrated	
Rack Temperature Effect	
Rack Drift	

Tag No.'s - PT457, PT458

* In percent span (800 psia)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-12
PRESSURIZER WATER LEVEL - HIGH (VERITRAK TRANSMITTER)

Parameter	Allowance*
Process Measurement Accuracy [ ]+a,c [ ]+a,c	[ ]+a,c
Primary Element Accuracy	
Sensor Calibration Accuracy	
Sensor Reference Accuracy	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift (30 months)	
Environmental Allowance	
Bias [ ]+a,c [ ]+a,c	
Rack Calibration Rack Accuracy Measurement & Test Equipment Accuracy	
Comparator String Calibrated	
Rack Temperature Effect	
Rack Drift	

Tag No.'s - LT-459

* In percent span (100%)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-13
PRESSURIZER WATER LEVEL - HIGH (ROSEMOUNT TRANSMITTER)

Parameter	Allowance*
Process Measurement Accuracy [ ]+a,c [ ]+a,c	[ ]+a,c
Primary Element Accuracy	
Sensor Calibration Accuracy Sensor Reference Accuracy	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift (30 months)	
Environmental Allowance	
Bias [ ]+a,c [ ]+a,c	
Rack Calibration Rack Accuracy Measurement & Test Equipment Accuracy	
Comparator String Calibrated	
Rack Temperature Effect	
Rack Drift	

Tag No.'s - LT-460, LT-461

* In percent span (100%)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-14
STEAM GENERATOR WATER LEVEL - LOW-LOW (FLB)
(ROSEMOUNT 1154 TRANSMITTER ANALYZED FOR FUTURE OPERATIONS)

Parameter — **Allowance***

[ ] +a,c

Process Measurement Accuracy
[ ] +a,c
[ ] +a,c
[ ] +a,c
[ ] +a,c

Primary Element Accuracy

Sensor Calibration Accuracy
Sensor Reference Accuracy

Measurement & Test Equipment Accuracy

Sensor Pressure Effects

Sensor Temperature Effects
Included in EA term

Sensor Drift (30 months)

Environmental Allowance
[ ] +a,c
[ ] +a,c
[ ] +a,c

Bias
[ ] +a,c

Rack Calibration
Rack Accuracy
Measurement & Test Equipment Accuracy

Comparator
String Calibrated

Rack Temperature Effect

Rack Drift

Tag No.'s - LT517, LT518, LT519
LT527, LT528, LT529
LT537, LT538, LT539
LT547, LT548, LT549
LT551, LT552, LT553
LT554

---
* In percent span (100%)

TABLE 3-14 (continued)
STEAM GENERATOR WATER LEVEL LOW-LOW (FLB)
(ROSEMOUNT 1154 TRANSMITTER ANALYZED FOR FUTURE OPERATIONS)

Channel Statistical Allowance =

[ ] +a,c

TABLE 3-15
STEAM GENERATOR WATER LEVEL - LOW-LOW (LONF)
(ROSEMOUNT 1154 TRANSMITTER ANALYZED FOR FUTURE OPERATIONS)

Parameter	**Allowance***
Process Measurement Accuracy	[ ]+a,c
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Primary Element Accuracy	
Sensor Calibration Accuracy	
Sensor Reference Accuracy	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift (30 months)	
Environmental Allowance	
Bias	
[ ]+a,c	
Rack Calibration	
Rack Accuracy	
Measurement & Test Equipment Accuracy	
Comparator	
String Calibrated	
Rack Temperature Effect	
Rack Drift	

Tag No.'s - LT517, LT518, LT519
LT527, LT528, LT529
LT537, LT538, LT539
LT547, LT548, LT549
LT551, LT552, LT553
LT554

---

* In percent span (100%)

TABLE 3-15 (continued)
STEAM GENERATOR WATER LEVEL LOW-LOW (LONF)
(ROSEMOUNT 1154 TRANSMITTER ANALYZED FOR FUTURE OPERATIONS)

Channel Statistical Allowance =

[ ] +a,c

TABLE 3-16
STEAM GENERATOR WATER LEVEL - HIGH-HIGH
(ROSEMOUNT 1154 TRANSMITTER ANALYZED FOR FUTURE OPERATIONS)

Parameter	**Allowance***
	[ ]+a,c
Process Measurement Accuracy	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
[ ]+a,c	
Primary Element Accuracy	
Sensor Calibration Accuracy	
Sensor Reference Accuracy	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift (30 months)	
Environmental Allowance	
Bias	
[ ]+a,c	
Rack Calibration	
Rack Accuracy	
Measurement & Test Equipment Accuracy	
Comparator	
String Calibrated	
Rack Temperature Effect	
Rack Drift	

Tag No.'s - LT517, LT518, LT519
LT527, LT528, LT529
LT537, LT538, LT539
LT547, LT548, LT549
LT551, LT552, LT553
LT554

* In percent span (100%)

TABLE 3-16 (continued)
STEAM GENERATOR WATER LEVEL HIGH-HIGH
(ROSEMOUNT 1154 TRANSMITTER ANALYZED FOR FUTURE OPERATIONS)

Channel Statistical Allowance =

[ ] +a,c

TABLE 3-17
REACTOR COOLANT PUMP UNDERSPEED

Parameter	Allowance*
	[ ]+a,c
Process Measurement Accuracy	
Primary Element Accuracy	
Sensor Calibration Accuracy	
Sensor Reference Accuracy	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift (30 months)	
Environmental Allowance	
Bias	
Rack Calibration	
Rack Accuracy	
Measurement & Test Equipment Accuracy	
Comparator	
String Calibrated	
Rack Temperature Effect	
Rack Drift	
Tag No.'s - SE495, SE496, SE497, SE498	

* In percent span (81.013 - 106.329% RNS)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-18
CONTAINMENT PRESSURE - HIGH 1, HIGH 2, HIGH 3 (ROSEMOUNT TRANSMITTER)

Parameter	Allowance*
	[ ]+a,c
Process Measurement Accuracy	
Primary Element Accuracy	
Sensor Calibration Accuracy	
Sensor Reference Accuracy	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift (30 months)	
Environmental Allowance	
Bias	
[ ]+a,c	
Rack Calibration	
Rack Accuracy	
Measurement & Test Equipment Accuracy	
Comparator	
String Calibrated	
Rack Temperature Effect	
Rack Drift	

Tag No.'s - PT934, PT935, PT936, PT937

* In percent span (60 psia)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-19
STEAMLINE PRESSURE - LOW SI (ROSEMOUNT TRANSMITTER)

Parameter	Allowance*
	[ ]+a,c
Process Measurement Accuracy	
Primary Element Accuracy	
Sensor Calibration Accuracy	
Sensor Reference Accuracy	
Measurement & Test Equipment Accuracy	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift (30 months)	
Environmental Allowance	
Bias [ ]+a,c [ ]+a,c	
Rack Calibration Rack Accuracy Measurement & Test Equipment Accuracy	
Comparator String Calibrated	
Rack Temperature Effect	
Rack Drift	

Tag No.'s - PT514, PT515, PT516
PT524, PT525, PT526
PT534, PT535, PT536
PT544, PT545, PT546

* In percent span (1300 psig)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-20
NEGATIVE STEAM PRESSURE RATE - HIGH

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

Tag No.'s - PT514, PT515, PT516
PT524, PT525, PT526
PT534, PT535, PT536
PT544, PT545, PT546

* In percent span (1300 PSIG)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-21
RCS LOW FLOW (N LOOP) (ROSEMOUNT TRANSMITTER)

Parameter	Allowance*
Process Measurement Accuracy	[ ]+a,c
[ ]+a,c	
[ ]+a,c	
Primary Element Accuracy	
[ ]+a,c	
Sensor Calibration Accuracy	
[ ]+a,c	
Sensor Reference Accuracy [ ]+a,c	
Measurement & Test Equipment Accuracy	
[ ]+a,c	
Sensor Pressure Effects	
[ ]+a,c	
Sensor Temperature Effects	
[ ]+a,c	
Sensor Drift (30 months)[ ]+a,c	
Environmental Allowance	
Bias [ ]+a,c	
Rack Calibration	
Rack Accuracy [ ]+a,c	
Measurement & Test Equipment Accuracy [ ]+a,c	
Comparator	
String Calibrated	
Rack Temperature Effect [ ]+a,c	
Rack Drift [ ]+a,c	

Tag No.'s - FT414, FT415, FT416, FT424, FT425, FT426
FT434, FT435, FT436, FT444, FT445, FT446

* In percent span (120% flow)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-22
RCS LOW FLOW (N-1 LOOP) (ROSEMOUNT TRANSMITTER)

Parameter	Allowance*
Process Measurement Accuracy	[ ]+a,c
[ ]+a,c	
[ ]+a,c	
Primary Element Accuracy	
[ ]+a,c	
Sensor Calibration Accuracy	
[ ]+a,c	
Sensor Reference Accuracy [ ]+a,c	
Measurement & Test Equipment Accuracy	
[ ]+a,c	
Sensor Pressure Effects	
[ ]+a,c	
Sensor Temperature Effects	
[ ]+a,c	
Sensor Drift (30 months)[ ]+a,c	
Environmental Allowance	
Bias [ ]+a,c	
Rack Calibration	
Rack Accuracy [ ]+a,c	
Measurement & Test Equipment Accuracy [ ]+a,c	
Comparator	
String Calibrated	
Rack Temperature Effect [ ]+a,c	
Rack Drift [ ]+a,c	

Tag No.'s - FT414, FT415, FT416, FT424, FT425, FT426
FT434, FT435, FT436, FT444, FT445, FT446

---

* In percent span (120% flow)

Channel Statistical Allowance =

[ ]+a,c

TABLE 3-23
TAVG, LOW AND LOW-LOW

Parameter	Allowance*
Process Measurement Accuracy (hot leg streaming)(pmaTh)	[ ]+a,c
Beta (hot leg streaming stability-introduced on the loss of a hot leg RTD)	
Primary Element Accuracy	
Sensor Calibration Accuracy (scartd)	
Sensor Reference Accuracy (srartd)	
Measurement & Test Equipment Accuracy (smte)	
Sensor Pressure Effects	
Sensor Temperature Effects	
Sensor Drift (30 months) (sdrtd)	
Environmental Allowance	
Bias	
[ ]+a,c	
Rack Calibration Accuracy	
Tavg (tcal)	
R/I (rical)	
Alpha (accuracy of hot leg streaming bias on the loss of a hot leg RTD)	
Measurement & Test Equipment Accuracy	
Tavg (tmte)	
R/I (rimte)	
Comparator	
String Calibrated	
Rack Temperature Effect (trte)	
Rack Drift (trd)	

Tag No.'s - TE411, TE421, TE431, TE441

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

TABLE 3-23 (continued)
TAVG, LOW AND LOW,LOW

$$srtd = (smtertd + sdrtd)^2 + (scartd + smtertd)^2 + srartd^2 = 0.9$$

$$ri = (rimte + rird)^2 + (rical + rimte)^2 = 0.2$$

$$track = (tmte + trd)^2 + trte^2 + (tcal + tmte)^2 + alpha^2 = 1.0$$

Channel Statistical Allowance =

$$\left[\qquad \right]^{+a,c}$$

TAB
REACTOR PROTECTION SYSTE
ACTUATION SYSTEM (HA
MILLSTO

	PROTECTION CHANNEL		1 PROCESS MEASUREMENT ACCURACY (1)	2 PRIMARY ELEMENT ACCURACY (1)	SENSOR: 3 CALIBRATION ACCURACY (1)	4 REFERENCE ACCURACY (1)	5 MEASUREMENT & TEST EQUIPMENT ACCURACY (1)	6 PRESSURE EFFECTS (1)	TEMPE EFF
1	POWER RANGE, NEUTRON FLUX - HIGH SETPOINT		[						
2	POWER RANGE, NEUTRON FLUX - LOW SETPOINT								
3	POWER RANGE, NEUTRON FLUX - HIGH SETPOINT (N-1 LOOP)								
4	POWER RANGE, NEUTRON FLUX - HIGH POSITIVE & NEGATIVE RATE								
5	INTERMEDIATE RANGE, NEUTRON FLUX								
6	SOURCE RANGE, NEUTRON FLUX								
7	OVERTEMPERATURE ΔT (N-LOOP)	ΔT CHANNEL							
		TAVG CHANNEL							
		PRESSURIZER PRESSURE CHANNEL							
		f(ΔI) CHANNEL							
8	OVERPOWER ΔT (N-LOOP)	ΔT CHANNEL							
		Tavg CHANNEL							
9	OVERTEMPERATURE ΔT (N-1 LOOP)								
10	OVERPOWER ΔT (N-1 LOOP)								
11	PRESSURIZER PRESSURE - LOW, REACTOR TRIP	(ROSEMOUNT 1154 XMITTER)							
12	PRESSURIZER PRESSURE - HIGH, REACTOR TRIP	(ROSEMOUNT 1154 XMITTER)							
13	PRESSURIZER WATER LEVEL - HIGH	(VERITRAK XMITTER)							
14	PRESSURIZER WATER LEVEL - HIGH	(ROSEMOUNT XMITTER)							
15	LOSS OF FLOW (N LOOP)	(ROSEMOUNT XMITTER)							
16	LOSS OF FLOW (N-1 LOOP)	(ROSEMOUNT XMITTER)							
17	STEAM GENERATOR WATER LEVEL - LOW-LOW for FLB	(ROSEMOUNT 1154 XMITTER)							
18	STEAM GENERATOR WATER LEVEL - LOW-LOW for LONF	(ROSEMOUNT 1154 XMITTER)							
19	REACTOR COOLANT PUMP UNDERSPEED								
20	PRESSURIZER PRESSURE LOW - SI	(ROSEMOUNT 1154 XMITTER)							
21	STEAMLINE PRESSURE - LOW	(ROSEMOUNT XMITTER)							
22	CONTAINMENT PRESSURE HIGH 1	(ROSEMOUNT XMITTER)							
23	CONTAINMENT PRESSURE HIGH 2	(ROSEMOUNT XMITTER)							
24	CONTAINMENT PRESSURE HIGH 3	(ROSEMOUNT XMITTER)							
25	NEGATIVE STEAM PRESSURE RATE - HIGH								
26	STEAM GENERATOR WATER LEVEL - HIGH-HIGH	(ROSEMOUNT 1154 XMITTER)							
27	TAVG LOW & LOW-LOW		[						

NOTES:

1. ALL VALUES IN PERCENT OF SPAN.
2. AS NOTED IN TABLE 15.0-4 OF THE FSAR.
3. AS NOTED IN TABLES 2.2-1 AND 3.3-4 OF THE PLANT TECHNICAL SPECIFICATIONS.
4. [ ]a,c
5. NOT USED IN SAFETY ANALYSIS.
6. AS NOTED IN FIGURE 15.0-1 & 15.0-1A OF THE FSAR.
7. AS NOTED IN TABLE 2.2-1, NOTE 1 OF THE PLANT TECHNICAL SPECIFICATIONS.
8. AS NOTED IN TABLE 2.2-1, NOTE 2 OF THE PLANT TECHNICAL SPECIFICATIONS.
9. [ ]a,c
10. [ ]a,c
11. [ ]a,c
12. [ ]a,c
13. [ ]a,c
14. [ ]a,c
15. [ ]a,c
16. INCORE / EXCORE f(ΔI) COMPARISON AS NOTED IN TABLE 4.3-1 OF THE PLANT TECHNICAL SPECIFICATIONS.
17.
18.
19.
20.
21.
22.

LE 3-24
M/ENGINEERED SAFETY FEATURES
ANNEL ERROR ALLOWANCES
ONE UNIT 3

7	8	9	10	11	12	13	14	15	16	17	18	19	
			INSTRUMENT RACK										
RATURE ECTS (1)	DRIFT (1)	ENVIRON-MENTAL ALLOWANCE (1)	CALIBRATION ACCURACY (1)	MEASUREMENT & TEST EQUIPMENT ACCURACY (1)	COMPARATOR SETTING ACCURACY (1)	TEMPERATURE EFFECTS (1)	DRIFT (1)	SAFETY ANALYSIS LIMIT (2)	NOMINAL TRIP SETPOINT (3)	TOTAL ALLOWANCE (1)	CHANNEL STATISTICAL ALLOWANCE (1)	MARGIN (1)	
							]	118% RTP	109% RTP	7.5	[	]	1
								35% RTP	25% RTP	8.3			2
								89% RTP	80% RTP	7.5			3
								(5)	5.0% RTP	—			4
								(5)	25% RTP	—			5
								(5)	1.0E+05 CPS	—			6
								FUNCTION(6)	FUNCTION(7)	10.0			7
								FUNCTION(6)	FUNCTION(8)	4.8			8
								FUNCTION(6)	FUNCTION(7)	10.0			9
								FUNCTION(6)	FUNCTION(8)	4.8			10
								1860 PSIA	1900 PSIA	5.0			11
								2425 PSIA	2385 PSIA	5.0			12
								(5)	89% SPAN	—			13
								(5)	89% SPAN	—			14
								85% DESIGN	90% DESIGN	4.2			15
								85% DESIGN	90% DESIGN	4.2			16
								0% SPAN	18.1% SPAN	18.1			17
								10% SPAN	18.1% SPAN	8.1			18
								43.4% SPAN	45.1% SPAN	1.7			19
								1700 PSIA	1892.3 PSIA	24.0			20
								420 PSIG	658.6 PSIG	18.4			21
								19.7 PSIA	17.7 PSIA	3.3			22
								19.7 PSIA	17.7 PSIA	3.3			23
								24.1 PSIA	22.7 PSIA	3.3			24
								(5)	100 PSIG	—			25
								96% SPAN	80.5% SPAN	15.6			26
							]	(5)	564° F / 553° F	—	[	]	27

]
]
]
]
]
]

23. [ ]
24. [ ]
25. [ ]
26. INSULATION RESISTANCE DEGRADATION - TREATED AS A BIAS
27. [ ]
28. [ ]
29. [ ]
30. [ ]
31. [ ]

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TABLE 3-25
OVERTEMPERATURE ΔT CALCULATIONS
(Rosemount 1154 Transmitter for Pressurizer Pressure)

- The equation for Overtemperature ΔT:

$$\Delta T \frac{(1 + \tau_1 S)}{(1 + \tau_2 S)} \left(\frac{1}{1 + \tau_3 S}\right) \leq \Delta T_0 \{K_1 - K_2 \frac{(1 + \tau_4 S)}{(1 + \tau_5 S)} \left(T \left(\frac{1}{1 + \tau_6 S}\right) - T'\right) + K_3 (P - P') - f_1 (\Delta I)\}$$

K_1 (nominal)	=	1.20 Technical Specification value
K_1 (max)	=	[ ]+a,c
K_2	=	0.02456/°F
K_3	=	0.001311/psi
Vessel ΔT	=	60.2 °F (N Loop)
Vessel ΔT	=	58.0 °F (N-1 Loop)
ΔI gain	=	1.98% RTP/% ΔI

- Full power ΔT calculation:

ΔT span = [ ]+a,c
ΔT span = [ ]+a,c

- Process Measurement Accuracy Calculations:

[ ]+a,c

[ ]+a,c

[ ]+a,c

[ ]+a,c

* Presumes normalization of ΔT_0 and T' to as found full power indicated values.

TABLE 3-25 (continued)
OVERTEMPERATURE ΔT CALCULATIONS
(Rosemount 1154 Transmitter for Pressurizer Pressure)

ΔI - Incore / Excore Mismatch

[ ]+a,c

ΔI - Incore Map Delta-I

[ ]+a,c

- Pressure Channel Uncertainties

Gain = [ ]+a,c

SCA =
SRA =
SMTE =
STE =
SD =
[ ]+a,c

RCA =
RMTE =
RD =
[ ]+a,c

TABLE 3-25 (continued)
OVERTEMPERATURE ΔT CALCULATIONS
(Rosemount 1154 Transmitter for Pressurizer Pressure)

- ΔI Channel Uncertainties

Gain = [ ] +a,c

RCA = [ ] +a,c

RMTE =

RD =

- Total Allowance

[ ] +a,c

* Same result for N-1 Loop

TABLE 3-26
OVERPOWER ΔT CALCULATIONS

- The equation for Overpower ΔT:

$$\Delta T \frac{(1 + \tau_1 S)}{(1 + \tau_2 S)} \left(\frac{1}{1 + \tau_3 S}\right) \le \Delta T_0 \{K_4 - K_5\left(\frac{\tau_7 S}{(1 + \tau_7 S)}\right)\left(\frac{1}{1 + \tau_6 S}\right)T - K_6[T\left(\frac{1}{1 + \tau_6 S}\right) - T''] - f_2(\Delta I)\}$$

K_4 (nominal)	=	1.09 Technical Specification value
K_4 (max)	=	[ ]$^{+a,c}$
K_5	=	0.0 for decreasing average temperature
K_5	=	0.02 for increasing average temperature (sec/°F)
K_6	=	0.0018/°F
Vessel ΔT	=	60.2 °F (N Loop)
Vessel ΔT	=	58.0 °F (N-1 Loop)

- Full power ΔT calculation:

ΔT span = [ ]$^{+a,c}$
ΔT span = [ ]$^{+a,c}$

- Process Measurement Accuracy Calculations:

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

* Presumes normalization of ΔT_0 and T" to as found full power indicated values.

TABLE 3-26 (Continued)
OVERPOWER ΔT CALCULATIONS

- Total Allowance

[ ]+a,c

** Same results for N-1 Loop

TABLE 3-27
ΔP MEASUREMENTS EXPRESSED IN FLOW UNITS

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

$(F_N)^2 = \Delta P_N$ where N = Nominal Flow

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

thus $\partial F_N = \dfrac{\partial \Delta P_N}{2F_N}$ Eq. 3-27.1

Error at a point (not in percent) is:

$$\frac{\partial F_N}{F_N} = \frac{\partial \Delta P_N}{2(F_N)^2} = \frac{\partial \Delta P_N}{2\Delta P_N} \quad \text{Eq. 3-27.2}$$

and

$$\frac{\Delta P_N}{\Delta P_{max}} = \frac{(F_N)^2}{(F_{max})^2} \quad \text{Eq. 3-27.3}$$

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

$\dfrac{\partial \Delta P_N}{\Delta P_{max}}(100)$ = percent error in Full Scale ΔP (% ε FS ΔP) Eq. 3-27.4

therefore:

$$\frac{\partial F_N}{F_N} = \frac{\Delta P_{max}\left[\frac{\%\ \epsilon\ FS\ \Delta P}{100}\right]}{2\Delta P_{max}\left[\frac{F_N}{F_{max}}\right]^2} = \left[\frac{\%\ \epsilon\ FS\ \Delta P}{(2)(100)}\right]\left[\frac{F_{max}}{F_N}\right]^2 \qquad \text{Eq. 3-27.5}$$

Error in flow units is:

$$\partial F_N = F_N\left[\frac{\%\ \epsilon\ FS\ \Delta P}{(2)(100)}\right]\left[\frac{F_{max}}{F_N}\right]^2 \qquad \text{Eq. 3-27.6}$$

Error in percent nominal flow is:

$$\frac{\partial F_N}{F_N}(100) = \left[\frac{\%\ \epsilon\ FS\ \Delta P}{2}\right]\left[\frac{F_{max}}{F_N}\right]^2 \qquad \text{Eq. 3-27.7}$$

Error in percent full span is:

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

$$= \left[\frac{\%\ \epsilon\ FS\ \Delta P}{2}\right]\left[\frac{F_{max}}{F_N}\right] \qquad \text{Eq. 3-27.8}$$

Equation 3-27.8 is used to express errors in percent full span in this document.

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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 which were determined by a systematic review of the calibration and drift determination procedures utilized at Millstone Unit 3 and statistical evaluations of "as left" and "as found" data for the RPS/ESFAS functions noted in Tables 3-1 through 3-24:

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'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 process rack drift 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 process rack calibration accuracy is evaluated (probability distribution function characteristics and drift magnitude) over multiple surveillance intervals,

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

7) the process racks (with the exception of 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 ISA51.1[1]).

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 ISA51.1[2]).

It should be noted for (1) and (2) that it is not necessary for the instrument technician to recalibrate a device or channel if the "as left" condition is not exactly at the nominal condition but is within the plus or minus of 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, statistical basis, not that the nominal condition is satisfied exactly. Westinghouse has statistically evaluated the "as left" condition for the RPS/ESFAS process rack channels and sensor/transmitters for Millstone Unit 3 over multiple calibration cycles. This evaluation determined that the SCA and RCA parameter values noted in Tables 3-1 through 3-24 were satisfied on at least a 95 % probability / 95 % confidence level basis. For those instances where non-conservative biases in calibration were noted, the biases were factored into the uncertainty calculations. Calibration biases for sensor/transmitters were 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 for the plant to periodically reverify 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.

In summary, a sensor/transmitter or a process rack channel is considered to be "calibrated" when the two-sided "as left" calibration procedural tolerance is satisfied. An instrument technician may determine to recalibrate if near the extremes of the "as left" procedural tolerance, but it is not required. Recalibration is explicitly required any time the "as found" condition of the device or channel is outside of the "as left" procedural tolerance. A device or channel 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.

As part of this effort, drift data ("as found" - "as left") for the sensor/transmitters and the process racks were evaluated. Multiple surveillance intervals were evaluated to determine the appropriate values for drift for a surveillance interval of 30 months (for sensor/transmitters) and 3 months (for analog process rack modules). This evaluation determined that the SD and RD parameter values noted in Tables 3-1 through 3-24 were satisfied on a 95 % probability / 95 % confidence level basis for the projected surveillance intervals. Generic Letter 91-04[3] requires that drift be tracked or trended on a periodic basis. The equations used in Sections 2 and 3, assume that drift data is evaluated for continuation of the validity of the basic characteristics determined by the Westinghouse evaluation. This assumption has a significant beneficial effect on the basic uncertainty equations utilized, i.e., it results in a reduction in the CSA magnitude.

4.2 Sensor/Transmitter Operability Determination Program and Criteria

As a result of the review of the plant procedures, the equations noted in Sections 2 and 3 are significantly different from those used in previous Westinghouse uncertainty calculations. One aspect of the equations easily noted is the significance of the calibration process, i.e., it is treated as statistically independent of the drift determination. Another aspect is that if drift and calibration are independent processes, then the determination of equipment operability is changed, i.e., it is not the arithmetic sum of the two uncertainties. Millstone Unit 3 and Westinghouse have agreed upon a set of criteria that may be used for equipment operability determination which are controlled by plant procedures and processes, as opposed to the plant Technical Specifications. The principle criterion for sensor/transmitter operability, as a first pass parameter, is drift ("as found" - "as left") determined to be within SD, where SD is the 95/95 drift value determined for that specific device, e.g., a Pressurizer Pressure transmitter. This would require the instrument technician to record both the "as left" and "as found" conditions and perform a calculation in the field. This field calculation has been determined to be impracticable at this time since it would require having the "as left" value for that device at the time of drift determination and becomes a records availability/control problem. An alternative is the use of a fixed magnitude, two-sided "as found" tolerance about the nominal value. It was agreed that a reasonable value for this tolerance is SMTE + SD, where SD is again the 95/95 drift value and SMTE is as defined in the uncertainty calculations and identified in the Millstone Unit 3 procedures reviewed by Westinghouse. The value of this sum is explicitly noted for each RPS/ESFAS function in Table 4-1 of this document. This criterion can then be incorporated into plant, function specific calibration and drift procedures as the defined "as found" tolerance about the desired, nominal value.

A second criterion is the ability to calibrate the sensor/transmitter within the two-sided "as left" tolerance. If the device drift is found outside the SMTE + SD (or "as found") criterion, the drift characteristics may be evaluated incorporating the previous experience for that specific device. The response time characteristics may also be evaluated on a qualitative and if necessary, a quantitative basis. It has also been agreed by Millstone Unit 3 and Westinghouse that monitoring the sensor/transmitter response with the average of it's peer devices, utilizing data available online, periodically over the entire cycle is an additional check on operability. This additional check provides a reasonable substitute for the use of a relative SD term (as recommended in the Westinghouse paper presented at the ISA/EPRI conference of June, 1994[4]). When an appropriate acceptance criterion is utilized, it then allows the use of SMTE + SD as a first pass operability criterion. The acceptance criterion agreed upon between Westinghouse and Millstone Unit 3 is a relative deviation of ±0.5% span from the beginning of cycle difference value. A relative shift of this magnitude has been determined to be an appropriate indication of device drift warranting further investigation..

It is believed that the Millstone Unit 3 systematic sensor/transmitter program of drift and calibration review is acceptable as a set of first pass criteria. More elaborate evaluation and more frequent online monitoring may be included, as necessary, if the drift is found to be excessive or the device is found difficult to calibrate. To provide additional confidence in the evaluation process, Millstone Unit 3 has agreed to utilize a function indication match criterion at the beginning of each cycle to determine the acceptability of the calibration process for the transmitter and that portion of the channel encompassed through the indicator. Based on the above, it is believed that the total program proposed for Millstone Unit 3 will provide a more comprehensive evaluation of operability than a simple determination of an acceptable "as found".

4.3 Process Rack Operability Determination Program and Criteria

A similar program to that described for sensor/transmitters has been determined for the process racks. However, since the surveillance interval for the process racks is significantly shorter than the sensor/transmitter (3 months vs 30 months) and the process racks are accessible at power, the program does not have to be as comprehensive. The parameter of most interest as a first pass operability criterion is drift ("as found" - "as left") found to be within RD, where RD is the 95/95 drift value determined for that channel. However, this has the same difficulties as the drift determination for a sensor/transmitter, i.e., records of the "as left" condition must be available for field use in a calculation with the same records availability/control problems. A similar alternative may be used for the process racks as was agreed upon for the sensor/transmitter; a fixed magnitude, two-sided "as found" tolerance about the nominal trip setpoint. It was agreed that a reasonable value for this tolerance is RMTE + RD, where RD is the 95/95 drift value and RMTE is as defined in the uncertainty calculations and identified in the Millstone Unit 3 procedures reviewed by Westinghouse. This is explicitly noted for each RPS/ESFAS function in Table 4-1 of this document. This criterion can then be incorporated into plant, function specific calibration and drift procedures as the defined "as found" tolerance about the Nominal Trip Setpoint.

A second criterion is the ability to calibrate the process rack channel within the two-sided "as left" tolerance. If the channel drift is found outside the RMTE + RD (or "as found") criterion, the drift characteristics may be evaluated incorporating the previous experience for that specific channel. The response time characteristics for the channel (or individual process rack module) may also be evaluated on a qualitative and if necessary, a quantitative basis. There is not as much information to be gained by evaluating channel to average of peer channels utilizing control board or process computer indication due to the difference in uncertainty significance, i.e., the uncertainty associated with a control board indicator is significantly larger than the uncertainty associated with a trip bistable. Therefore channel to channel or average of channels comparison is not expected to provide significant indication of operability of the process racks in any way other than in a gross manner. Thus no recommendations have been made in performing this process for the racks. (It should be noted that this type of comparison is considered beneficial for transmitters and is included for that purpose in Section 4.2 by Millstone Unit 3 and Westinghouse).

It is believed that the Millstone Unit 3 systematic program of drift and calibration review proposed for the process racks is acceptable as a set of first pass criteria. More elaborate evaluation and monitoring may be included, as necessary, if the drift is found to be excessive or the channel is found difficult to calibrate. Based on the above, it is believed that the total process rack program proposed for Millstone Unit 3 will provide a more comprehensive evaluation of operability than a simple determination of an acceptable "as found".

4.4 Application to the Plant Technical Specifications

The first pass operability criteria noted for the process racks in Section 4.3 are based on a statistical evaluation of the performance of the installed hardware. Thus the values can change if the Measurement and Test Equipment is changed, or the procedures used in the surveillance process are changed significantly and particularly if the process rack modules themselves are changed, e.g., from pure analog to a mixture of analog and ASIC (Application Specific Integrated Circuit) modules. Therefore, the operability criteria are not expected to be static. In fact they are expected to change as the characteristics of the equipment change. This does not imply that the criteria can increase due to increasingly poor performance of the equipment over time. But rather just the opposite, as new and better equipment and processes are instituted, the operability criteria magnitudes would be expected to decrease to reflect the increased capabilities of the replacement equipment.

Sections 4.2 and 4.3 are basically consistent with the recommendations of the Westinghouse paper presented at the June, 1994, ISA/EPRI conference in Orlando, Fl[5]. Therefore, consistent with this paper, Westinghouse recommends revision of Specification 2.2.1, Limiting Safety System Settings - Reactor Trip System Instrumentation Setpoints", Specification 3.3.2, "Engineered Safety Features Actuation System Instrumentation - Limiting Condition for Operation", Table 2.2-1 "Reactor Trip System Instrumentation Setpoints" and Table 3.3-4, "Engineered Safety Features Actuation System Instrumentation Trip Setpoints". Appendix A provides the Westinghouse recommendations for revision of these two specifications and tables. Table 3-24 (Column 16) and Table 4-1 of this document provide the recommended Nominal Trip Setpoint for each RPS/ESFAS protection function, which was utilized in the Westinghouse uncertainty calculations and determined to be acceptable for use. Table 4-1 also notes the first pass operability criteria for each RPS/ESFAS protection function sensor/transmitter and process rack channel, specific to each input for multiple input functions, which should be placed in the plant procedures and maintained under plant administrative control. This is consistent with the bases sections for the two specifications provided in Appendix A. In addition, the plant operability determination processes described in Sections 4.2 and 4.3 are consistent with the ISA paper[6] and the bases sections for the two specifications provided in Appendix A.

4.5 References/Standards

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

[2] Ibid

[3] Generic Letter 91-04, 1991, "Changes in Technical Specification Surveillance Intervals to Accommodate a 24 month Fuel Cycle."

[4] 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.

[5] Ibid

[6] Ibid

TABLE 4-1
WESTINGHOUSE PROTECTION SYSTEM STS SETPOINT INPUTS
MILLSTONE UNIT 3

	PROTECTION CHANNEL		SENSOR OPERABILITY (1,8)	RACK OPERABILITY (1,9)	INSTRUMENT SPAN	NOMINAL TRIP SETPOINT	
1	POWER RANGE, NEUTRON FLUX - HIGH SETPOINT		—	0.4% SPAN	120% RTP	109% RTP	1
2	POWER RANGE, NEUTRON FLUX - LOW SETPOINT		—	0.4% SPAN	120% RTP	25% RTP	2
3	POWER RANGE, NEUTRON FLUX - HIGH SETPOINT (N-1 LOOP)		—	0.4% SPAN	120% RTP	80% RTP	3
4	POWER RANGE, NEUTRON FLUX - HIGH POSITIVE & NEGATIVE RATE		—	0.4% SPAN	120% RTP	5.0% RTP	4
5	INTERMEDIATE RANGE, NEUTRON FLUX		—	0.4% SPAN	120% RTP	25% RTP	5
6	SOURCE RANGE, NEUTRON FLUX		—	0.4% SPAN	1.0E+06 CPS	1.0E+05 CPS	6
7	OVERTEMPERATURE ΔT (N-LOOP)	ΔT CHANNEL	— (11)	0.4% SPAN	(2)	FUNCTION(6)	7
		TAVG CHANNEL	— (11)	0.4% SPAN			
		PRESSURIZER PRESSURE CHANNEL (ROSEMOUNT 1154)	2.0% SPAN (10)	0.1% SPAN			
		f(ΔI) CHANNEL	—	0.4% SPAN			
8	OVERPOWER ΔT (N-LOOP)	ΔT CHANNEL	— (11)	0.4% SPAN	(3)	FUNCTION(7)	8
		Tavg CHANNEL	— (11)	0.4% SPAN			
9	OVERTEMPERATURE ΔT (N-1 LOOP)	ΔT CHANNEL	— (11)	0.4% SPAN	(4)	FUNCTION(6)	9
		TAVG CHANNEL	— (11)	0.4% SPAN			
		PRESSURIZER PRESSURE CHANNEL (ROSEMOUNT 1154)	2.0% SPAN (10)	0.1% SPAN			
		f(ΔI) CHANNEL	—	0.4% SPAN			
10	OVERPOWER ΔT (N-1 LOOP)	ΔT CHANNEL	— (11)	0.4% SPAN	(5)	FUNCTION(7)	10
		Tavg CHANNEL	— (11)	0.4% SPAN			
11	PRESSURIZER PRESSURE - LOW, REACTOR TRIP	(ROSEMOUNT 1154 XMITTER)	1.3% SPAN	0.2% SPAN	800 PSI	1900 PSIA	11
12	PRESSURIZER PRESSURE - HIGH, REACTOR TRIP	(ROSEMOUNT 1154 XMITTER)	1.3% SPAN	0.2% SPAN	800 PSI	2385 PSIA	12
13	PRESSURIZER WATER LEVEL - HIGH	(VERITRAK XMITTER)	1.6% SPAN	0.2% SPAN	100% SPAN	89% SPAN	13
14	PRESSURIZER WATER LEVEL - HIGH	(ROSEMOUNT XMITTER)	1.4% SPAN	0.2% SPAN	100% SPAN	89% SPAN	14

TABLE 4-1
WESTINGHOUSE PROTECTION SYSTEM STS SETPOINT INPUTS
MILLSTONE UNIT 3

	PROTECTION CHANNEL		SENSOR OPERABILITY (1,8)	RACK OPERABILITY (1,9)	INSTRUMENT SPAN	NOMINAL TRIP SETPOINT	
15	RCS LOW FLOW (N LOOP)	(ROSEMOUNT XMITTER)	0.6% SPAN	0.3% SPAN	120% DESIGN FLOW	90% DESIGN	15
16	RCS LOW FLOW (N-1 LOOP)	(ROSEMOUNT XMITTER)	0.6% SPAN	0.3% SPAN	120% DESIGN FLOW	90% DESIGN	16
17	STEAM GENERATOR WATER LEVEL - LOW-LOW	(ROSEMOUNT XMITTER)	1.2% SPAN	0.2% SPAN	100% SPAN	18.1% SPAN	17
18	REACTOR COOLANT PUMP UNDERSPEED		—	0.4% SPAN	100% SPAN	45.1% SPAN	18
19	PRESSURIZER PRESSURE LOW - SI	(ROSEMOUNT 1154 XMITTER)	1.3% SPAN	0.2% SPAN	800 PSI	1892.3 PSIA	19
20	STEAMLINE PRESSURE - LOW	(ROSEMOUNT XMITTER)	0.9% SPAN	0.2% SPAN	1300 PSI	658.6 PSIG	20
21	CONTAINMENT PRESSURE HIGH 1	(ROSEMOUNT XMITTER)	0.8% SPAN	0.2% SPAN	60 PSI	17.7 PSIA	21
22	CONTAINMENT PRESSURE HIGH 2	(ROSEMOUNT XMITTER)	0.8% SPAN	0.2% SPAN	60 PSI	17.7 PSIA	22
23	CONTAINMENT PRESSURE HIGH 3	(ROSEMOUNT XMITTER)	0.8% SPAN	0.2% SPAN	60 PSI	22.7 PSIA	23
24	NEGATIVE STEAM PRESSURE RATE - HIGH		0.9% SPAN	0.2% SPAN	1300 PSI	100 PSIG	24
25	STEAM GENERATOR WATER LEVEL - HIGH-HIGH	(ROSEMOUNT 1154 XMITTER)	1.2% SPAN	0.2% SPAN	100% SPAN	80.5% SPAN	25
26	TAVG LOW & LOW-LOW		— (11)	0.4% SPAN	100° F	564° F / 553° F	26

NOTES:

(1) ALL VALUES IN PERCENT SPAN

(2) T_{avg} - 100° F
ΔP - 800 PSI
ϕ - 120% RTP
ΔT - 90.3° F
ΔI - ±60% ΔI

(3) T_{avg} - 100° F
ΔP - 800 PSI
ϕ - 120% RTP
ΔT - 90.3° F

(4) T_{avg} - 100° F
ΔP - 800 PSI
ϕ - 120% RTP
ΔT - 87° F
ΔI - ±60% ΔI

(5) T_{avg} - 100° F
ΔP - 800 PSI
ϕ - 120% RTP
ΔT - 87° F

(6) AS NOTED IN TABLE 2.2.1, NOTE 1 OF THE PLANT TECHNICAL SPECIFICATIONS.

(7) AS NOTED IN TABLE 2.2.1, NOTE 2 OF THE PLANT TECHNICAL SPECIFICATIONS.

(8) [ ]^{a,c}

(9) [ ]^{a,c}

(10) PRESSURE SPAN - 800 PSI

(11) NARROW RANGE T_H AND T_C RTDs, 0.4° F

APPENDIX A
SAMPLE MILLSTONE UNIT 3 SETPOINT TECHNICAL SPECIFICATIONS

2.2 LIMITING SAFETY SYSTEM SETTINGS

REACTOR TRIP SYSTEM INSTRUMENTATION SETPOINTS

2.2.1 The Reactor Trip System Instrumentation Channel and Interlock Channel shall be OPERABLE and their Nominal Trip Setpoint set consistent with the Nominal Trip Setpoint values shown in Table 2.2-1.

APPLICABILITY: As shown for each channel in Table 3.3-1.

ACTION:

a. With a Reactor Trip System Instrumentation Channel or Interlock Channel Nominal Trip Setpoint inconsistent with the value shown in the Nominal Trip Setpoint column, adjust the Setpoint consistent with the Nominal Trip Setpoint value.

b. With a Reactor Trip System Instrumentation Channel or Interlock Channel found to be inoperable, declare the channel inoperable and apply the applicable ACTION statement requirement of Specification 3.3.1 until the channel is restored to OPERABLE status and its Setpoint adjusted consistent with the Nominal Trip Setpoint value.

TABLE 2.2-1

REACTOR TRIP SYSTEM INSTRUMENTATION TRIP SETPOINTS

Functional Unit	Nominal Trip Setpoint
1. Manual Reactor Trip	N.A.
2. Power Range, Neutron Flux,	
High Setpoint	
1) Four Loops Operating	109 percent of RTP*
2) Three Loops Operating	80 percent of RTP*
Low Setpoint	25 percent of RTP*
3. Power Range, Neutron Flux, High Positive Rate	5 percent of RTP* with a time constant ≥ 2 seconds
4. Power Range, Neutron Flux, High Negative Rate	5 percent of RTP* with a time constant ≥ 2 seconds
5. Intermediate Range, Neutron Flux	25 percent of RTP*
6. Source Range, Neutron Flux	10^{+5} cps
7. Overtemperature ΔT	
a. Four Loops Operating	
1) Channels I, II	See note 1
2) Channels III, IV	See note 1
b. Three Loops Operating	
1) Channels I, II	See note 1
2) Channels III, IV	See note 1
8. Overpower ΔT	See note 2
9. Pressurizer Pressure - Low	1900 psia
10. Pressurizer Pressure - High	2385 psig
11. Pressurizer Water Level - High	89 percent of instrument span
12. Reactor Coolant Flow - Low	90 percent of loop design flow**

* RTP - Rated Thermal Power

** Minimum Measured Flow Per Loop = 96,870 gpm (Four Loops Operating); 101,066 gpm (Three Loops Operating)

TABLE 2.2-1 (Continued)

REACTOR TRIP SYSTEM INSTRUMENTATION TRIP SETPOINTS

Functional Unit	Nominal Trip Setpoint
13. Steam Generator Water Level - Low-Low	18.1 percent of narrow range instrument span
14. General Warning Alarm	N.A.
15. Low Shaft Speed - Reactor Coolant Pumps	92.5% of RNS
16. Turbine Trip	
a. Low Fluid Oil Pressure	500 psig
b. Turbine Stop Valve Closure	1 percent open
17. Safety Injection Input from ESF	N.A.
18. Reactor Trip System Interlocks	
a. Intermediate Range Neutron Flux, P-6	1×10^{-10} amps
b. Low Power Reactor Trips Block, P-7	
1. P-10 input (Note 3)	11 percent of RTP*
2. P-13 input	10 percent RTP* Turbine Impulse Pressure Equivalent
c. Power Range Neutron Flux, P-8	
1) Four Loops Operating	37.5 percent of RTP*
2) Three Loops Operating	37.5 percent of RTP*
d. Power Range Neutron Flux, P-9	51 percent of RTP*
e. Power Range Neutron Flux, P-10 (Note 4)	9 percent of RTP
19. Reactor Trip Breakers	N.A.
20. Automatic Trip and Interlock Logic	N.A.
21. Three Loop Operation Bypass Circuitry	N.A.

* RTP - Rated Thermal Power

TABLE 2.2-1 (Continued)

TABLE NOTATION

NOTE 1: OVERTEMPERATURE ΔT

$$\left(\frac{1 + \tau_1 S}{1 + \tau_2 S}\right) \left(\frac{1}{1 + \tau_3 S}\right) \leq \Delta T_o \{K_1 - K_2 \left(\frac{1 + \tau_4 S}{1 + \tau_5 S}\right) [T\left(\frac{1}{1 + \tau_6 S}\right) - T'] + K_3(P - P') - f_1(\Delta I)\}$$

Where:

ΔT	=	Measured ΔT by Reactor Coolant System Instrumentation;
$\frac{1 + \tau_1 S}{1 + \tau_2 S}$	=	Lead-lag compensator on measured ΔT
τ_1, τ_2	=	Time constants utilized in the lead-lag controller for ΔT, τ_1 = 8 secs., τ_2 = 3 secs.
$\frac{1}{1 + \tau_3 S}$	=	Lag compensator on measured ΔT
τ_3	=	Time constant utilized in the lag compensator for ΔT, τ_3= 0 secs.
ΔT_o	=	Loop specific Indicated ΔT at RATED THERMAL POWER;
K_1(nominal)	=	1.20 (Four Loops Operating), 1.20 (Three Loops Operating)
K_2(nominal)	=	0.02456
$\frac{1 + \tau_4 S}{1 + \tau_5 S}$	=	The function generated by the lead-lag compensator for T_{avg} dynamic compensation;
τ_4, τ_5	=	Time constants utilized in the lead-lag compensator for T_{avg} τ_4= 20 secs., τ_5= 4 secs.
T	=	Average temperature, °F
$\frac{1}{1 + \tau_6 S}$	=	Lag compensator on measured T_{avg}
τ_6	=	Time constant utilized in the measured T_{avg} lag compensator, τ_6 = 0 secs.

TABLE 2.2-1 (Continued)

TABLE NOTATION (Continued)

NOTE 1: (continued)

T'	≤	587.1°F (Nominal Loop specific Indicated T_{avg} at RATED THERMAL POWER)
K_3 (nominal)	=	0.001311/psi
P	=	Pressurizer pressure, psia
P'	=	2250 psia (Nominal RCS operating pressure)
S	=	Laplace transform operator, sec^{-1};

and $f_1(\Delta I)$ is a function of the indicated difference between top and bottom detectors of the power range neutron ion chambers; with gains to be selected based on measured instrument response during plant startup tests such that:

(1) for $q_t - q_b$ between -26 percent and +3 percent, $f_1(\Delta I) = 0$ (where q_t and q_b are percent RATED THERMAL POWER in the top and bottom halves of the core respectively, and $q_t + q_b$ is total THERMAL POWER in percent of RATED THERMAL POWER);

(2) for each percent that the magnitude of $(q_t - q_b)$ exceeds -26 percent, the ΔT trip setpoint shall be automatically reduced by 3.55 percent of its value at RATED THERMAL POWER; and

(3) for each percent that the magnitude of $(q_t - q_b)$ exceeds +3 percent, the ΔT Trip Setpoint shall be automatically reduced by 1.98 percent of its value at RATED THERMAL POWER.

TABLE 2.2-1 (Continued)

TABLE NOTATION (Continued)

NOTE 2: OVERPOWER ΔT

$$\left(\frac{1 + \tau_1 S}{1 + \tau_2 S}\right) \left(\frac{1}{1 + \tau_3 S}\right) \leq \Delta T_o \left\{K_4 - K_5 \left(\frac{\tau_7 S}{1 + \tau_7 S}\right)\left(\frac{1}{1 + \tau_6 S}\right)T - K_6\left[T\left(\frac{1}{1 + \tau_6 S}\right) - T''\right] - f_2(\Delta I)\right\}$$

Where:	ΔT	=	As defined in Note 1
	$\frac{1 + \tau_1 S}{1 + \tau_2 S}$	=	As defined in Note 1
	τ_1, τ_2	=	As defined in Note 1
	$\frac{1}{1 + \tau_3 S}$	=	As defined in Note 1
	τ_3	=	As defined in Note 1
	ΔT_o	=	As defined in Note 1
	K_4 (nominal)	=	1.09
	K_5 (nominal)	=	0.02/°F for increasing average temperature and 0 for decreasing average temperature
	$\frac{\tau_7 S}{1 + \tau_7 S}$	=	The function generated by the rate-lag compensator for T_{avg} dynamic compensation
	τ_7	=	Time constants utilized in the rate-lag compensator for T_{avg}, τ_7 = 10 secs.
	$\frac{1}{1 + \tau_6 S}$	=	As defined in Note 1
	τ_6	=	As defined in Note 1

TABLE 2.2-1 (Continued)

TABLE NOTATION (Continued)

NOTE 2: (continued)

K_6 (nominal) = 0.00180/°F for T > T" and K_6 = 0 for T ≤ T"

T = As defined in Note 1

T" ≤ 587.1°F Nominal loop specific Indicated T_{avg} at RATED THERMAL POWER

S = As defined in Note 1

$f_2(\Delta I)$ = 0 for all ΔI

NOTE 3: Setpoint is for increasing power.

NOTE 4: Setpoint is for decreasing power.

BASES

2.2.1 REACTOR TRIP SYSTEM INSTRUMENTATION SETPOINTS

The Reactor Trip Setpoint Limits specified in Table 2.2-1 are the nominal values at which the reactor trips are set for each functional unit. The Nominal Trip Setpoints are considered the Limiting Safety System Settings as identified in 10CFR50.36 and have been selected to ensure that the core and Reactor Coolant System are prevented from exceeding their safety limits during normal operation and design basis anticipated operational occurrences and to assist the Engineered Safety Features Actuation System in mitigating the consequences of accidents. The Setpoint for a Reactor Trip System or interlock function is considered to be consistent with the nominal value when the measured "as left" Setpoint is within the administratively controlled (±) band identified as the calibration tolerance.

Maintenance and Test Equipment accuracy is administratively controlled by plant procedures and is included in the plant uncertainty calculations as defined in WCAP-10991. Operability determinations are based on the use of Maintenance and Test Equipment that conforms with the accuracy used in the plant uncertainty calculation. Maintenance and Test Equipment should be consistent with the requirements of ANSI / ISA 51.1-1979 or the most accurate practicable.

The administratively controlled limit for operability of a device is determined by device drift being less than the value required for the surveillance interval. In the event the device exceeds the administratively controlled limit, operability of the device may be evaluated by other device performance characteristics, e.g., comparison to historical device drift data, calibration characteristics, response characteristics and short term drift characteristics. A device (RTD, relay, transmitter, process rack module, etc.), whose "as found" value is in excess of the calibration tolerance, but within the operability criteria (administratively controlled limit), is considered operable but must be recalibrated such that the "as left" value is within the two sided (±) calibration tolerance. Plant procedures set administrative limits ("as left" and "as found" criteria) to control the determination of operability by setting minimum standards based on the methodology in WCAP-10991 and the uncertainty values included in the determination of the Nominal Trip Setpoint, and allow the use of other device characteristics to evaluate operability. REPORTABLE EVENTS are identified when the minimum number of channels required to be operable are not met.

The methodology, as defined in WCAP-10991 to derive the Nominal Trip Setpoints, is based upon combining all of the uncertainties in the channels. Inherent in the determination of the Nominal Trip Setpoints are the magnitudes of these channel uncertainties. Sensors and other instrumentation utilized in these channels should 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 the other device performance characteristics.

2.2.1 REACTOR TRIP SYSTEM INSTRUMENTATION SETPOINTS (Continued)

Device drift in excess of the allowance that is more than occasional, may be indicative of more serious problems and would warrant further investigation.

The various reactor trip circuits automatically open the reactor trip breakers whenever a condition monitored by the Reactor Trip System reaches a preset or calculated level. In addition to redundant channels and trains, the design approach provides a Reactor Trip System functional diversity. The functional capability at the specified trip setting is required for those anticipatory or diverse reactor trips for which no direct credit was assumed in the safety analysis to enhance the overall reliability of the Reactor Trip System. The Reactor Trip System initiates a turbine trip signal whenever reactor trip is initiated. This prevents the reactivity insertion that would otherwise result from excessive Reactor Coolant System cooldown and thus avoids unnecessary actuation of the Engineered Safety Features Actuation System.

3/4.3.2 ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION

LIMITING CONDITION FOR OPERATION

3.3.2 The Engineered Safety Features Actuation System (ESFAS) instrumentation channels and interlocks shown in Table 3.3-3 shall be OPERABLE and their Nominal Trip Setpoints set consistent with the values shown in the Nominal Trip Setpoint column of Table 3.3-4.

APPLICABILITY: As shown in Table 3.3-3.

ACTION:

a. With an ESFAS Instrumentation Channel or Interlock Channel Nominal Trip Setpoint inconsistent with the value shown in the Nominal Trip Setpoint column, adjust the Setpoint consistent with the Nominal Trip Setpoint value.

b. With an ESFAS Instrumentation Channel or Interlock Channel found to be inoperable declare the channel inoperable and apply the applicable ACTION statement requirements of Table 3.3-3 until the channel is restored to OPERABLE status and its Setpoint adjusted consistent with the Nominal Trip Setpoint value.

SURVEILLANCE REQUIREMENTS

4.3.2.1 Each ESFAS instrumentation channel and interlock and the automatic actuation logic and relays shall be demonstrated OPERABLE by the performance of the ESFAS Instrumentation Surveillance Requirements specified in Table 4.3-2.

4.3.2.2 The ENGINEERED SAFETY FEATURES RESPONSE TIME* of each ESFAS function shall be demonstrated to be within the limit at least once per 18 months. Each test shall include at least one train such that both trains are tested at least once per 36 months and one channel (to include input relays to both trains) per function such that all channels are tested at least once per N times 18 months where N is the total number of redundant channels in a specific ESFAS function as shown in the "Total No. of Channels" column of Table 3.3-3.

TABLE 3.3-4

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION TRIP SETPOINTS

Functional Unit	Nominal Trip Setpoint
1. Safety Injection (Reactor Trip, Feedwater Isolation, Control Building Isolation (Manual Initiation Only), Start Diesel Generators, and Service Water)	
a. Manual Initiation	N.A.
b. Automatic Actuation Logic	N.A.
c. Containment Pressure - High-1	3.0 psig
d. Pressurizer Pressure - Low	
1) Channels I and II	1877.3 psig
2) Channels III and IV	1877.3 psig
e. Steamline Pressure - Low	658.6 psig*
2. Containment Spray (CDA)	
a. Manual Initiation	N.A.
b. Automatic Actuation Logic and Actuation Relays	N.A.
c. Containment Pressure - High-3	8.0 psig
3. Containment Isolation	
a. Phase "A" Isolation	
1) Manual Initiation	N.A.
2) Automatic Actuation Logic and Actuation Relays	N.A.
3) Safety Injection	See Item 1 above for all Safety injection Trip Setpoints.
b. Phase "B" Isolation	
1) Manual Initiation	N.A.
2) Automatic Actuation Logic and Actuation Relays	N.A.
3) Containment Pressure - High-3	8.0 psig

TABLE 3.3-4 (Continued)

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION TRIP SETPOINTS

Functional Unit	Nominal Trip Setpoint
4. Steam Line Isolation	
a. Manual Initiation	N.A.
b. Automatic Actuation Logic and Actuation Relays	N.A.
c. Containment Pressure - High-2	3.0 psig
d. Steamline Pressure - Low	658.6 psig*
e. Steam Line Pressure - Negative Rate - High	100 psi**
5. Turbine Trip and Feedwater Isolation	
a. Automatic Actuation Logic Actuation Relays	N.A.
b. Steam Generator Water Level--High-High (P-14)	80.45 percent of narrow range instrument span
c. Safety Injection Actuation Logic	See Item 1 above for all Safety Injection Trip Setpoints.
d. Tavg Low Coincident with Reactor Trip (P-4)	
1) Four Loops Operating	564°F
2) Three Loops Operating	564°F
6. Auxiliary Feedwater	
a. Manual Initiation	N.A.
b. Automatic Actuation Logic and Actuation Relays	N.A.
c. Steam Generator Water Level--Low-Low	
1) Start Motor-Driven Pumps	18.1 percent of narrow range instrument span

TABLE 3.3-4 (Continued)

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION TRIP SETPOINTS

Functional Unit	Nominal Trip Setpoint
6. Auxiliary Feedwater (continued)	
2) Start Turbine-Driven Pumps	18.1 percent of narrow range instrument span
d. Safety Injection	See Item 1 above for all Safety Injection Trip Setpoints.
e. Loss of Offsite Power Start Motor-Driven Pumps	2800V
f. Containment Depressurization Actuation (CDA) Start Motor-Driven Pumps	See Item 2 above for all CDA Trip Setpoints.
7. Control Building Isolation	
a. Manual Actuation	N.A.
b. Manual Safety Injection Actuation	N.A.
c. Automatic Actuation Logic and Actuation Relays	N.A.
d. Containment Pressure -- High-1	3.0 psig
e. Control Building Inlet Ventilation Radiation	$1.5 \times 10^{-5} \mu ci/cc$
8. Loss of Power	
a. 4 kV Bus Undervoltage (Loss of Voltage)	***
b. 4 kV Bus Undervoltage (Grid Degraded Voltage)	***
9. Engineered Safety Features Actuation System Interlocks	
a. Pressurizer Pressure, P-11	1985 psig
b. Low-Low Tavg, P-12	553°F
c. Reactor Trip, P-4	N.A.
10. Emergency Generator Load Sequencer	N.A.

TABLE 3.3-4 (Continued)

TABLE NOTATIONS

* Time constants utilized in the lead-lag controller for Steam Line Pressure-Low are $\tau_1 \geq 50$ seconds and $\tau_2 \leq 5$ seconds. CHANNEL CALIBRATION shall ensure that these time constants are adjusted to these values.

** The time constant utilized in the rate-lag controller for Steam Line Pressure - Negative Rate - High is less than or equal to 50 seconds. CHANNEL CALIBRATION shall ensure that this time constant is adjusted to this value.

*** To be provided by plant.

3.4.3 INSTRUMENTATION

BASES

3/4.3.1 and 3/4.3.2 REACTOR TRIP SYSTEM INSTRUMENTATION AND ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION

The OPERABILITY of the Reactor Trip System and the Engineered Safety Features Actuation System 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, (3) sufficient redundancy is maintained to permit a channel to be out of service for testing or maintenance, and (4) sufficient system functional capability is available from diverse parameters.

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.

The Engineered Safety Features Actuation System Nominal Trip Setpoints specified in Table 3.3-4 are the nominal values at which the bistables are set for each functional unit. The Nominal Trip Setpoints are considered the Limiting Safety System Settings as identified in 10CFR50.36 and have been selected to mitigate the consequences of accidents. A Setpoint is considered to be consistent with the nominal value when the measured "as left" Setpoint is within the administratively controlled (±) band identified as the calibration tolerance.

Maintenance and Test Equipment accuracy is administratively controlled by plant procedures and is included in the plant uncertainty calculations as defined in WCAP-10991. Operability determinations are based on the use of Maintenance and Test Equipment that conforms with the accuracy used in the plant uncertainty calculation. Maintenance and Test Equipment should be consistent with the requirements of ANSI / ISA 51.1-1979 or the most accurate practicable.

The administratively controlled limit for operability of a device is determined by device drift being less than the value required for the surveillance interval. In the event the device exceeds the administratively controlled limit, operability of the device may be evaluated by other device performance characteristics, e.g., comparison to historical device drift data, calibration characteristics, response characteristics and short term drift characteristics. A device (RTD, relay, transmitter, process rack module, etc.), whose "as found" value is in excess of the calibration tolerance, but within the operability criteria (administratively controlled limit), is considered operable but must be recalibrated such that the "as left" value is

3/4.3.1 and 3/4.3.2 REACTOR TRIP SYSTEM INSTRUMENTATION AND ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION (continued)

within the two sided (±) calibration tolerance. Plant procedures set administrative limits ("as left" and "as found" criteria) to control the determination of operability by setting minimum standards based on the methodology in WCAP-10991 and the uncertainty values included in the determination of the Nominal Trip Setpoint, and allow the use of other device characteristics to evaluate operability. REPORTABLE EVENTS are identified when the minimum number of channels required to be operable are not met.

The methodology, as defined in WCAP-10991 to derive the Nominal Trip Setpoints, is based upon combining all of the uncertainties in the channels. Inherent in the determination of the Nominal Trip Setpoints are the magnitudes of these channel uncertainties. Sensors and other instrumentation utilized in these channels should 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 the other device performance characteristics. Device drift in excess of the allowance that is more than occasional, may be indicative of more serious problems and would warrant further investigation.