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Westinghouse document WCAP-17696-NP, Revision 0, "Westinghouse Setpoint Calculations for the Diablo Canyon Power Plant Digital Replacement Process Protection System"

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Westinghouse Setpoint Calculations for the Diablo Canyon Power Plant Digital Replacement Process Protection System

Westinghouse

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Westinghouse Setpoint Calculations for the Diablo Canyon Power Plant Digital Replacement Process Protection System

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1.0 INTRODUCTION

This document contains the Pacific Gas and Electric Company (PGE) Diablo Canyon Power Plant (DCPP) reactor trip system (RTS) trip functions and engineered safety features actuation system (ESFAS) protection functions setpoint calculations affected by the Digital Replacement Process Protection System program. These calculations are based upon the uncertainty algorithms and setpoint methodology defined in WCAP-17706-P, "Westinghouse Setpoint Methodology as Applied to the Diablo Canyon Power Plant," (Reference 1). The uncertainty calculations for the Westinghouse Improved Thermal Design Procedure (ITDP), control system functions assumed as initial condition assumptions in the safety analyses, and control board and computer indication of plant parameters utilized by the plant operators to confirm proper operation of the control instrumentation are also included. These setpoints and control uncertainties, when supported by appropriate plant procedures and equipment qualification, are believed to result in a total instrument loop uncertainty, termed Channel Statistical Allowance (CSA), at a 95 % probability and 95 % confidence level; as stated in U.S. NRC Regulatory Guide (RG) 1.105, Revision 3, Regulatory Position, C.1 (Reference 2).

This document is divided into four sections. Section 2.1 notes the current, Westinghouse generalized algorithm (Eq. 2.1) used as the basis to determine the overall instrument uncertainty for an RTS or ESFAS function. The algorithm and its basis are described in Reference 1. All appropriate and applicable uncertainties, as defined by a review of the plant baseline design input documentation, have been included in each RTS or ESFAS function uncertainty calculation. Two variations of the protection function uncertainty algorithm are presented to describe the Westinghouse treatment of uncertainties for control functions (Eq. 2.2) and parameter indication (Eq. 2.3). Section 2.2 documents definitions of terms and associated acronyms used in the RTS/ESFAS function, control and indication uncertainty calculations. Appropriate references to industry standards have been provided where applicable.

Section 3.1 is a listing of the sources of information for the determination of each of the uncertainty terms contained in the tables of Section 3.2. Section 3.2 contains the uncertainty calculations. Included in this section are descriptions of the uncertainty terms and values for each RTS/ESFAS, control and indication function performed by Westinghouse for DCPP. Shown on each table is the function specific uncertainty algorithm which notes the appropriate combination of instrument uncertainties used to determine the CSA. Included for each protection function is a listing of the following parameters: Safety Analysis Limit (SAL), Nominal Trip Setpoint (NTS), Total Allowance (TA), Margin, and Operability criteria - As Left Tolerance (ALT) and As Found Tolerance (AFT), for both the sensor/transmitter and process racks.

2.0 SETPOINT METHODOLOGY

This section contains a brief description of the Westinghouse Setpoint Methodology as applied to DCPP. A more detailed description is contained in Reference 1. The basic algorithms for protection, control and indication used in the determination of the overall CSA are noted in Section 2.1 below. All appropriate and applicable uncertainties, as defined by a review of plant specific baseline design input documentation, are included in each protection, control or indication function CSA calculation. Section 2.2 contains the definitions of terms used in the algorithms.

2.1 Algorithms

The methodology used to combine the uncertainty components for a channel is an appropriate combination of those groups that are statistically and functionally independent. Those uncertainties considered dependent are conservatively treated by arithmetic summation and then systematically combined with the independent terms. The basic algorithm used is a square root sum of the squares (SRSS). This basic approach has been used previously for Westinghouse uncertainty calculations for DCPP, see WCAP-11082, Rev. 6 (Reference 3).

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

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

Eq. 2.1

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

a,c

Eq. 2.2

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

[ ]^{a,c}

Eq. 2.3

Where:

CSA = Channel Statistical Allowance
PMA = Process Measurement Accuracy
PEA = Primary Element Accuracy
SRA = Sensor Reference Accuracy
SMTE = Sensor Measurement and Test Equipment Accuracy
SD = Sensor Drift
SCA = Sensor Calibration Accuracy
SPE = Sensor Pressure Effects
STE = Sensor Temperature Effects
RMTE = Rack Measurement and Test Equipment Accuracy
RD = Rack Drift
RCA = Rack Calibration Accuracy
RTE = Rack Temperature Effects
EA = Environmental Allowance
BIAS = One directional, known magnitude allowance
CA = Controller Accuracy
READOUT = Readout Device Accuracy
[ ]^{a,c}

Each of the previous terms is defined in Section 2.2, Setpoint Calculation Definitions. The basis for the above equations is provided in Reference 1.

Consistent with Regulatory Guide 1.105, Rev. 3, Regulatory Position C.1 (Reference 2), the CSA value from Eq. 2.1 is believed to be determined at a 95 % probability and at a 95 % confidence level (95/95). The CSA values from Eq. 2.2 and Eq. 2.3 are believed to be determined at a 95 % probability and at a 95 % confidence level (95/95), consistent with the requirements of the Westinghouse ITDP (Reference 4).

2.2 Setpoint Calculation Definitions

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

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

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

- **Bias**

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

- **Channel**

  The sensing and process equipment, i.e., transmitter to bistable (analog process racks) or transmitter to trip output (digital process racks), for one input to the voting logic of a protection function. Westinghouse designs protection functions with voting logic made up of multiple channels, e.g., 2 out of 3 Steam Generator Level - Low-Low channels for one steam generator must have their bistables in the tripped condition for a Reactor Trip to be initiated. For control functions, a channel is the sensing and process equipment through the controller module. For indication functions, a channel is the sensing and process equipment through the indicator (control board or Plant Process Computer).

- **Channel Statistical Allowance** (CSA)

  The combination of the various channel uncertainties via SRSS, other statistical, or algebraic techniques. It includes instrument (both sensor and process rack) uncertainties and non-instrument related effects, e.g., Process Measurement Accuracy, see Eq.(s) 2.1, 2.2 and 2.3. This parameter is compared with the Total Allowance for determination of instrument channel margin, see Figure 2-1. For a protection function the uncertainties included in, and the conservatism of, the CSA algorithm results in a CSA magnitude that is believed to be determined on a two-sided 95 % probability / 95 % confidence level (95/95) basis.

- **Controller Accuracy** (CA)

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

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

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

- **Environmental Allowance** (EA)

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

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

- **Margin**

  The calculated difference (in % instrument span) between TA and CSA.

  Margin = TA – CSA

  Margin is defined to be a non-negative number i.e., Margin $\geq$ 0 % span, see Figure 2-1.

- **Nominal Trip Setpoint** (NTS)

  The trip setpoint defined in the uncertainty calculation and reflected in the plant procedures. This value is the nominal value programmed into the digital instrument process racks or the nominal value to which the bistable is set (as accurately as reasonably achievable) for analog instrument process racks. Based on the requirements of 10 CFR 50.36(c)(1)(ii)(A), Westinghouse defines the NTS as the Limiting Safety System Setting (LSSS) for the RTS and ESFAS functions listed in the DCPP Technical Specifications, i.e., Tables 3.3.1-1 and 3.3.2-1 (References 5 and 6).

- **Primary Element Accuracy** (PEA)

  Uncertainty typically due to the use of a metering device. In Westinghouse RTS/ESFAS calculations, this parameter is used for a venturi, orifice, elbow or potential transformer. This is a calculated or measured accuracy for the device.

- **Process Measurement Accuracy** (PMA)

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

- **Process Racks**

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

- **Rack Calibration Accuracy** (RCA)

  The two-sided (±) calibration tolerance of the process racks as reflected in the plant calibration procedures. The RCA is defined at multiple points across the calibration range of the channel, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span for input modules, and specifically at the NTS for the bistable or trip module (see Figure 2-1). For DCPP, the individual modules in a loop may be calibrated to a particular tolerance; however, the process loop (as a string) is verified to be calibrated to a specific tolerance (RCA). This parameter is determined utilizing DCPP supplied information and the appropriate vendor specification document listed in Section 3.1. [

  ]^{a,c}

[

]^{a,c} As applied to a process rack module or channel; the reference accuracy is the "accuracy rating" as defined in ANSI/ISA-51.1-1979 (R1993)(Reference 7, page 12), specifically as applied to Note 2 and Note 3. Inherent in this definition is the verification of the following under a set of reference conditions; conformity (Reference 7, page 16), hysteresis (Reference 7, page 36) and repeatability (Reference 7, page 49). A periodic evaluation of RCA should be performed consistent with the requirements of Reference 1.

- **Rack Drift** (RD)

  The change in input-output relationship (As Found – As Left) over a period of time at reference conditions, e.g., at constant temperature. This parameter is determined utilizing DCPP supplied information and the appropriate vendor specification document listed in Section 3.1. [

  ]^{a,c} A periodic evaluation of RD should be performed consistent with the requirements of Reference 1.

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

  The accuracy of the test equipment used to calibrate a process loop in the racks. When the magnitude of RMTE meets the requirements of ANSI/ISA-51.1-1979 (R1993) (Reference 7, p. 61) it may be considered an integral part of RCA or RD. Uncertainties due to M&TE that are 10 times more accurate than the device being calibrated are considered insignificant and may not be included in the uncertainty calculations. [

  ]^{a,c}

- **Rack Temperature Effects** (RTE)

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

  ]^{a,c} This parameter is determined utilizing DCPP supplied information and the appropriate vendor specification document listed in

Section 3.1. [

]^{a,c}

- **Range**

  The upper and lower limits of the operating region for a device, e.g., 0 to 1200 psig for a Steam Line Pressure transmitter. This is not necessarily the calibrated span of the device, although quite often the two are close. For further information see ANSI/ISA-51.1-1979 (R1993) (Reference 7).

- **Readout Device Accuracy** (READOUT)

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

- **Safety Analysis Limit** (SAL)

  The parameter value identified in the plant safety analysis or other plant operating limit at which a reactor trip or actuation function is assumed to be initiated. The SAL is defined in Chapter 15 of the DCPP Updated Final Safety Analysis Report. Actual SAL values are determined, or confirmed, by review of the plant safety analyses. The SAL is the starting point for determination of the acceptability of the CSA (see Figure 2-1).

- **Sensor Calibration Accuracy** (SCA)

  The two-sided (±) calibration tolerance for a sensor or transmitter as defined in the plant calibration procedures to be equivalent to the vendor specified reference accuracy. The SCA is defined at multiple points across the calibration range of the channel, e.g., 0 %, 25 %, 50 %, 75 % and 100 % span. This parameter is determined utilizing DCPP supplied data with the transmitter model/range code information and the appropriate vendor specification document listed in Section 3.1. [

  ]^{a,c} Westinghouse performed an evaluation of SCA consistent with the methodology identified in Reference 1. A periodic evaluation of SCA should be performed consistent with the requirements of Reference 1.

- **Sensor Drift** (SD)

  The change in input-output relationship (As Found – As Left) over a period of time at reference calibration conditions, e.g., at constant temperature. This parameter is determined utilizing DCPP supplied data with the transmitter model/range code information and the appropriate vendor specification document listed in Section 3.1. Westinghouse performed an evaluation of SD consistent with the methodology identified in Reference 1. [

]^{a,c} A periodic evaluation of SD should be performed consistent with the requirements of Reference 1.

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

  The accuracy of the test equipment (typically a high accuracy local readout gauge and Digital Multimeter (DMM)) used to calibrate a sensor or transmitter in the field or in a calibration laboratory. When the magnitude of SMTE meets the requirements of ANSI/ISA-51.1-1979 (R1993) (Reference 7, p. 61) it may be considered an integral part of SCA. Uncertainties due to M&TE that are 10 times more accurate than the device being calibrated are considered insignificant and may not be included in the uncertainty calculations. [

  ]^{a,c}

- **Sensor Pressure Effects** (SPE)

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

  This parameter is calculated utilizing the transmitter model/range code information and the appropriate vendor specification document listed in Section 3.1.

- **Sensor Reference Accuracy** (SRA)

  As applied to a sensor or transmitter; the reference accuracy is the "accuracy rating" as defined in ANSI/ISA-51.1-1979 (R1993)(Reference 7, page 12), specifically as applied to Note 2 and Note 3. The magnitude is typically defined in manufacturer's specification data sheets. Inherent in this definition is the verification of the following under a set of reference conditions; conformity (Reference 7, page 16), hysteresis (Reference 7, page 36) and repeatability (Reference 7, page 49). This parameter is determined utilizing the transmitter model/range code information and the appropriate vendor specification document listed in Section 3.1.

- **Sensor Temperature Effects** (STE)

  The change in input-output relationship due to a change in the ambient environmental conditions (temperature, humidity), and voltage and frequency from the reference calibration conditions. It has been determined that temperature is the most significant, with the other parameters being second order effects. This term is typically limited to the effect due to temperature swings that occur at less than 130 °F. This parameter is calculated utilizing the transmitter model/range code information and the appropriate vendor specification document listed in Section 3.1 [

]^{a,c}

- **Span**

  The region for which a device is calibrated and verified to be operable, e.g., for a Steam Line Pressure transmitter, 1200 psi.

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

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

- **Total Allowance** (TA)

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

  $$TA = |SAL - NTS|$$

  An example of the calculation of TA is:

  Pressurizer Pressure - Low (Safety Injection)

SAL	1680.0 psig
NTS	-1850.0 psig
TA	|-170.0 psi | = 170 psi

  The instrument span = 2500 – 1250 psig = 1250 psi, therefore,

  $$TA = \frac{(170psi) * (100\% span)}{(1250psi)} = 13.6\ \%\ span$$

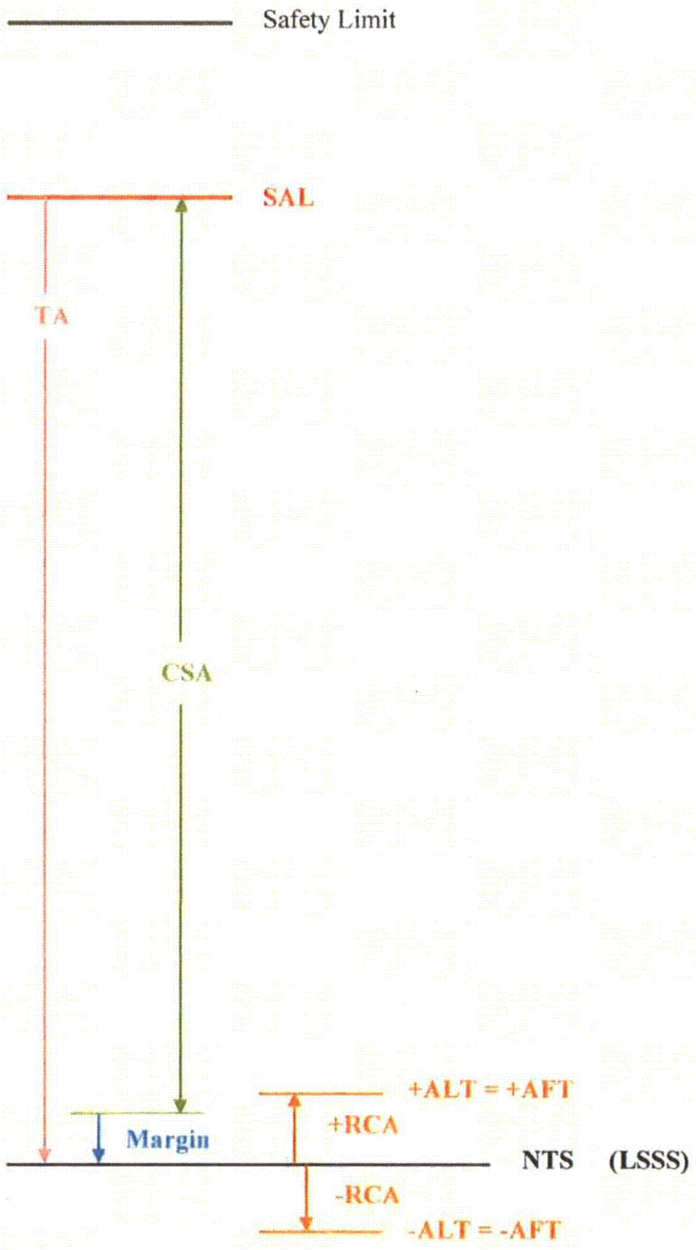

Figure 2-1 Westinghouse Setpoint Parameter Relationship Diagram (Increasing Function)

3.0 PROTECTION SYSTEM SETPOINT CALCULATIONS

This section contains the sources of information utilized in, and detailed tabulations of the uncertainty parameters for the instrument uncertainty setpoint calculations.

3.1 Uncertainty Sources

Noted below is a listing of the principal sources of information for the instrument channel uncertainty calculations performed by Westinghouse. These sources include information from the following areas:

- NRC Documents
- Westinghouse Safety Analyses
- Vendor Documents
- Scaling Procedures (listed as a typical example)
- Calibration Procedures (listed as a typical example)
- Surveillance Procedures (listed as a typical example)
- Additional DCPP Documents

Given the information noted below and design inputs from DCPP, e.g., M&TE magnitudes to be utilized, Westinghouse performed the setpoint uncertainty calculations documented in Tables 3-1 through 3-19.

a,c

a,c

3.2 Instrument Channel Uncertainty Calculations

Tables 3-1 through 3-19 document individual parameter uncertainties and instrument channel uncertainty CSA calculations for the RTS and ESFAS functions identified in Tables 3.3.1-1 and 3.3.2-1 of the DCPP Technical Specifications (References 5 and 6) that are affected by the Digital Replacement Process Protection System program. Each table includes a listing of the applicable terms for the function uncertainty and setpoint calculations:

- Model of sensor/transmitter
- Type of process rack
- Listing of each uncertainty parameter, noting –
  - Value (% span) or applicability
  - Notes applicable to the parameter, including the Source Listing number from Section 3.1
- Algorithm utilized
- Algorithm with parameter values (% span) filled in
- Source Material for SCA, SD, RCA and RD (where applicable)
- Safety Analysis Limit (engineering units), including the Source
- Nominal Trip Setpoint (engineering units), including the Source
- Instrument span, including the Source

- Total Allowance (% span)
- CSA (% span)
- Margin (% span)
- Transmitter operability criteria
  - As Left Tolerances (% span)
  - As Found Tolerances (% span)
- Process rack operability criteria
  - As Left Tolerances (% span)
  - As Found Tolerances (% span)

Westinghouse reports TA, CSA and Margin values to one decimal place using the technique of:

- Rounding down values < 0.05 % span,
- Rounding up values ≥ 0.05 % span,

as defined in Reference 1.

Parameters reported as:

- "N/A" are not applicable, i.e., have no value for that channel,
- "0" are applicable but are included in other terms, e.g., normalized parameters,
- "0.0" are applicable with a value less than 0.04 % span.

Table 3-1 Overtemperature ΔT Reactor Trip

Rosemount 1154SH9RC Transmitters, Weed N9004E RTDs, ALS and Triconex Process Racks

Parameter **Allowance***

Process Measurement Accuracy

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

Primary Element Accuracy

Sensor Calibration Accuracy (Source Listings 4 and 11)

[ ]^{a,c}

[ ]^{a,c}

Value controlled by #, consistent with SRA

Sensor Reference Accuracy (Source Listings 4 and 5)

[ ]^{a,c}

[ ]^{a,c}

Sensor Measurement & Test Equipment Accuracy (Controlled by #)

[ ]^{a,c}

[ ]^{a,c}

Sensor Pressure Effects (SPE)

Sensor Temperature Effects (STE) (Source Listing 4)

[ ]^{a,c}

Sensor Drift

[ ]^{a,c}

[ ]^{a,c}

Value controlled by #

Table 3-1 (cont.)
Overtemperature ΔT Reactor Trip
Rosemount 1154SH9RC Transmitters, Weed N9004E RTDs, ALS and Triconex Process Racks

Parameter	**Allowance***
Environmental Allowance (EA) [ ]^{a,c} [ ]^{a,c}	[ ]^{a,c}
Bias	
Rack Calibration Accuracy (Source Listings 6, 8, and 12) [ ]^{a,c} Values controlled by ##, ###, and ####	
Rack Measurement & Test Equipment Accuracy (Controlled by ##, ###, and ####) [ ]^{a,c}	
Rack Temperature Effect (Source Listings 6, and 8) [ ]^{a,c} Pressure – Included in RCA_3 term (RTE_3) NIS PPS – Included in RCA_4 term (RTE_4) [ ]^{a,c}	
Rack Drift (Source Listings 6, 8, and 12) [ ]^{a,c} Pressure – Included in RCA_3 term (RD_3) NIS PPS – Included in RCA_4 term (RD_4) [ ]^{a,c} Values controlled by ##, ###, and ####	

Table 3-1 (cont.)
Overtemperature ΔT Reactor Trip
Rosemount 1154SH9RC Transmitters, Weed N9004E RTDs, ALS and Triconex Process Racks

* In percent ΔT span (ΔT – 88.5 °F - bounding for both Units) (Source #)
See conversions on page 21
N_H = Number of hot leg RTDs = 2 (Source Listing 10)
N_C = Number of cold leg RTDs = 1 (Source Listing 10)

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l} \mathrm{PMA}_1^2 + \mathrm{PMA}_2^2 + \mathrm{PMA}_3^2 + \mathrm{PMA}_7^2 + \mathrm{PMA}_8^2 + \mathrm{PMA}_9^2 + \\ \left(\sqrt{\dfrac{(\mathrm{SCA}_1 + \mathrm{SMTE}_1)^2 + (\mathrm{SD}_1 + \mathrm{SMTE}_1)^2 + \mathrm{SRA}_1^2}{N_H} + \dfrac{(\mathrm{SCA}_1 + \mathrm{SMTE}_1)^2 + (\mathrm{SD}_1 + \mathrm{SMTE}_1)^2 + \mathrm{SRA}_1^2}{N_C}}\right)^2 + \\ (\mathrm{SMTE}_2 + \mathrm{SD}_2)^2 + \mathrm{SRA}_2^2 + \mathrm{STE}^2 + (\mathrm{SMTE}_2 + \mathrm{SCA}_2)^2 + \\ \left(\sqrt{\dfrac{(\mathrm{RCA}_1 + \mathrm{RMTE}_1)^2 + (\mathrm{RD}_1 + \mathrm{RMTE}_1)^2 + \mathrm{RTE}_1^2 + \mathrm{RCA}_6^2}{N_H} + \dfrac{(\mathrm{RCA}_1 + \mathrm{RMTE}_1)^2 + (\mathrm{RD}_1 + \mathrm{RMTE}_1)^2 + \mathrm{RTE}_1^2}{N_C}}\right)^2 + \\ (\mathrm{RMTE}_2 + \mathrm{RD}_2)^2 + (\mathrm{RMTE}_2 + \mathrm{RCA}_2)^2 + \mathrm{RTE}_2^2 + \\ (\mathrm{RMTE}_3 + \mathrm{RD}_3)^2 + (\mathrm{RMTE}_3 + \mathrm{RCA}_3)^2 + \mathrm{RTE}_3^2 + \\ 2[(\mathrm{RMTE}_4 + \mathrm{RD}_4)^2 + (\mathrm{RMTE}_4 + \mathrm{RCA}_4)^2 + \mathrm{RTE}_4^2] + \\ 2[(\mathrm{RMTE}_5 + \mathrm{RD}_5)^2 + (\mathrm{RMTE}_5 + \mathrm{RCA}_5)^2 + \mathrm{RTE}_5^2] \end{array}} \\ + \mathrm{PMA}_4 + \mathrm{PMA}_5 + \mathrm{PMA}_6 + \mathrm{EA} + \mathrm{Bias}$$

Table 3-1 (cont.)
Overtemperature ΔT Reactor Trip
Rosemount 1154SH9RC Transmitters, Weed N9004E RTDs, ALS and Triconex Process Racks

Channel Statistical Allowance =

a,c

Function specific source material for SCA, SD, RCA, RD and Instrument span

#	STP I-7-P455, "Pressurizer Pressure Channel PT-455 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).
##	STP-I-36-S1R02, "Protection Set I, Rack 2 Channels Operational Test," (Typical for this function).
###	STP-I-36-S1R01, "Protection Set I, Rack 1 Channels Operational Test," (Typical for this function).
####	STP I-37-N41.B, "Power Range N41 Channel Calibration," (Typical for this function).

Table 3-1 (cont.)
Overtemperature ΔT Reactor Trip
Rosemount 1154SH9RC Transmitters, Weed N9004E RTDs, ALS and Triconex Process Racks

Safety Analysis Limit (Source Listing 2) = [ ]^{a,c}

Nominal Trip Setpoint (Source Listing 1) = 120.0% of Rated Thermal Power

Instrument Span = Tavg = 100°F; Pressure = 1250 psi;
(Sources ##, ###, and ####) Power = 150% Rated Thermal Power;
ΔT_{span} = 88.5°F which equals 150% RTP;
ΔI = ±60% ΔI, NIS = ±60% ΔI

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

Pressurizer Pressure Input

[ ]^{a,c}

Transmitter +ALT =
Transmitter -ALT =
Transmitter +AFT =
Transmitter -AFT =

Triconex

[ ]^{a,c}

Process Racks +ALT =
Process Racks -ALT =
Process Racks +AFT =
Process Racks -AFT =

RTD Input

[ ]^{a,c}

RTD +ALT =
RTD -ALT =
RTD +AFT =
RTD -AFT =

Table 3-1 (cont.)
Overtemperature ΔT Reactor Trip
Rosemount 1154SH9RC Transmitters, Weed N9004E RTDs, ALS and Triconex Process Racks

ALS Input [a,c]

Process Racks +ALT =

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =

ALS Output [a,c]

Process Racks +ALT =

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =

Triconex Input [a,c]

Process Racks +ALT =

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =

ΔI Input

NIS Rack [a,c]

NIS +ALT =

NIS -ALT =

NIS +AFT =

NIS -AFT =

NIS PPS (Triconex) [a,c]

NIS +ALT =

NIS -ALT =

NIS +AFT =

NIS -AFT =

Table 3-1 (cont.)
Overtemperature ΔT Reactor Trip
Rosemount 1154SH9RC Transmitters, Weed N9004E RTDs, ALS and Triconex Process Racks

- The equation for Overtemperature ΔT:

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

K_1 (nominal) = 1.20 Technical Specification value
K_1 (max) = [ ]^{a,c}
K_2 = 0.0182/°F
K_3 = 0.000831/psi
Vessel ΔT = 59.0 °F
ΔI gain = 2.38 % RTP/% ΔI (positive side gain)

- Full power ΔT calculation:

ΔT span = [ ]^{a,c}
ΔT span_pwr = 150 % RTP

- Process Measurement Accuracy Calculations:

[ ]^{a,c}

[ ]^{a,c}

[ ]^{a,c}

[ ]^{a,c}

[ ]^{a,c}

Table 3-1 (cont.)
Overtemperature ΔT Reactor Trip
Rosemount 1154SH9RC Transmitters, Weed N9004E RTDs, ALS and Triconex Process Racks

- Pressure Channel Uncertainties

Gain = $[\qquad]^{a,c}$

$[\qquad]^{a,c}$
SCA =
SRA =
SMTE =
STE =
SD =

$[\qquad]^{a,c}$
RCA =
RMTE =
RTE =
RD =

- NIS Channel Uncertainties

Gain = $[\qquad]^{a,c}$

NIS Rack

$[\qquad]^{a,c}$
RCA =
RMTE =
RTE =
RD =

NIS PPS

$[\qquad]^{a,c}$
RCA =
RMTE =
RTE =
RD =

Table 3-1 (cont.)
Overtemperature ΔT Reactor Trip
Rosemount 1154SH9RC Transmitters, Weed N9004E RTDs, ALS and Triconex Process Racks

- Total Allowance

$$\begin{aligned} TA &= \left[\right.\\ &= \\ &= \left. \right]^{a,c} \end{aligned}$$

Table 3-2 Overpower ΔT Reactor Trip

Weed N9004E RTDs, ALS and Triconex Process Racks

Parameter **Allowance***

Process Measurement Accuracy

[ ] a,c [ ] a,c

Primary Element Accuracy (PEA)

Sensor Calibration Accuracy (SCA) (Source Listing 11)

[ ] a,c

Sensor Reference Accuracy (SRA) (Source Listing 5)

[ ] a,c

Sensor Measurement & Test Equipment Accuracy (SMTE) (Source Listing 11)

[ ] a,c

Sensor Pressure Effects (SPE)

Sensor Temperature Effects (STE)

Sensor Drift (SD)

[ ] a,c

Environmental Allowance (Source Listing 17)

[ ] a,c

[ ] a,c

Bias

Table 3-2 (cont.)
Overpower ΔT Reactor Trip
Weed N9004E RTDs, ALS and Triconex Process Racks

Parameter	Allowance*
Rack Calibration Accuracy (Source Listing 6, 8 and 12) [ ]^{a,c} Value controlled by #	[ ]^{a,c}
Rack Measurement & Test Equipment Accuracy (Controlled by #) [ ]^{a,c} [ ]^{a,c}	
Rack Temperature Effect (Source Listing 6 and 8) [ ]^{a,c} [ ]^{a,c}	
Rack Drift (Source Listing 6, 8 and 12) [ ]^{a,c} [ ]^{a,c} Value controlled by #	

* In percent ΔT span (ΔT – 88.5 °F - bounding for both Units) (Source #)
See conversions on page 29
N_H = Number of hot leg RTDs = 2 (Source Listing 10)
N_C = Number of cold leg RTDs = 1 (Source Listing 10)

Table 3-2 (cont.)
Overpower ΔT Reactor Trip
Weed N9004E RTDs, ALS and Triconex Process Racks

Channel Statistical Allowance =

$$\sqrt{\begin{aligned} & \mathrm{PMA}_1^2 + \mathrm{PMA}_5^2 + \mathrm{PMA}_6^2 + \mathrm{PMA}_7^2 + \\ & \left(\sqrt{\frac{(\mathrm{SCA}+\mathrm{SMTE})^2+(\mathrm{SD}+\mathrm{SMTE})^2+\mathrm{SRA}^2}{\mathrm{N_H}} + \frac{(\mathrm{SCA}+\mathrm{SMTE})^2+(\mathrm{SD}+\mathrm{SMTE})^2+\mathrm{SRA}^2}{\mathrm{N_C}}}\right)^2 + \\ & \left(\sqrt{\frac{(\mathrm{RCA}_1+\mathrm{RMTE}_1)^2+(\mathrm{RD}_1+\mathrm{RMTE}_1)^2+\mathrm{RTE}_1^2+\mathrm{RCA}_3^2+}{\mathrm{N_H}} + \frac{(\mathrm{RCA}_1+\mathrm{RMTE}_1)^2+(\mathrm{RD}_1+\mathrm{RMTE}_1)^2+\mathrm{RTE}_1^2}{\mathrm{N_C}}}\right)^2 + \\ & (\mathrm{RCA}_2+\mathrm{RMTE}_2)^2+(\mathrm{RD}_2+\mathrm{RMTE}_2)^2+\mathrm{RTE}_2^2 \end{aligned}}$$

$$+\,\mathrm{PMA}_2 + \mathrm{PMA}_3 + \mathrm{PMA}_4 + \mathrm{EA}_1 + \mathrm{EA}_2 + \mathrm{Bias}$$

Table 3-2 (cont.)
Overpower ΔT Reactor Trip
Weed N9004E RTDs, ALS and Triconex Process Racks

a,c

Function specific source material for RCA, RD and Instrument span

\# STP-I-36-S1R02, "Protection Set I, Rack 2 Channels Operational Test," (Typical for this function).

Table 3-2 (cont.)
Overpower ΔT Reactor Trip
Weed N9004E RTDs, ALS and Triconex Process Racks

Safety Analysis Limit (Source Listing 2) = [ ]^{a,c}

Nominal Trip Setpoint (Source Listing 1) = 107.20% RTP

Instrument Span (Source #) = Tavg = 100°F; Power = 150% RTP;
ΔT_{span} = 88.5°F which equals 150% RTP

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

See Overtemperature ΔT Table for ALT/AFT values.

Table 3-2 (cont.)
Overpower ΔT Reactor Trip
Weed N9004E RTDs, ALS and Triconex Process Racks

- The equation for Overpower ΔT:

$$\Delta T \frac{(1 + \tau_4 S)}{(1 + \tau_5 S)} \le \Delta T_0 \{K_4 - K_5 \frac{(\tau_3 S)}{(1 + \tau_3 S)} T - K_6 [T - T''] - f_2 (\Delta I)\}$$

K_4 (nominal) = 1.072 Technical Specification value
K_4 (max) = [ ]^{a,c}
K_5 = 0.0 for decreasing average temperature
K_5 = 0.0174 for increasing average temperature (1/°F)
K_6 = 0.00145/°F for T > T"
Vessel ΔT = 59.0 °F

- Full power ΔT calculation:

ΔT span = [ ]^{a,c}
ΔT span_pwr = 150 % RTP

- Process Measurement Accuracy Calculations:

[ ]^{a,c}

[ ]^{a,c}

[ ]^{a,c}

- Total Allowance

[ ]^{a,c}

Table 3-3 Pressurizer Pressure – Low and High Reactor Trip

Rosemount 1154SH9RC Transmitters, ALS Process Racks

Parameter	**Allowance***
Process Measurement Accuracy (PMA)	[^{a,c}
Primary Element Accuracy (PEA)	
Sensor Reference Accuracy (SRA) (Source Listing 4)	
Sensor Calibration Accuracy (SCA) (Source Listing 4) Value controlled by #, consistent with SRA	
Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #) [ ]^{a,c}	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE) (Source Listing 4)	
Sensor Drift (SD) Value controlled by #	
Environmental Allowance (EA) [ ]^{a,c} [ ]^{a,c}	
Bias	
Rack Calibration Accuracy (RCA) (Source Listing 8) Value controlled by ##	
Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##) [ ]^{a,c}	
Rack Temperature Effect (RTE) (Source Listing 8)	
Rack Drift (RD) (Source Listing 8) Value controlled by ##	]

---

* In percent span (1250 psi) (Source #)

Table 3-3 (cont.)
Pressurizer Pressure – Low and High Reactor Trip
Rosemount 1154SH9RC Transmitters, ALS Process Racks

Channel Statistical Allowance =

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

a,c

Function specific source material for SCA, SD, RCA, RD and Instrument span

\# STP I-7-P455, "Pressurizer Pressure Channel PT-455 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).

\## STP I-36-S1R01, "Protection Set I, Rack 1, Channels Operational Test," (Typical for this function).

Table 3-3 (cont.)
Pressurizer Pressure – Low and High Reactor Trip
Rosemount 1154SH9RC Transmitters, ALS Process Racks

Pressurizer Pressure Low Reactor Trip

Safety Analysis Limit (Source Listing 2) = 1845 psig
Nominal Trip Setpoint (Source Listing 1) = 1950 psig
Instrument Span (Source #) = 1250 - 2500 psig / 4 - 20 mA = 16 mA
Total Allowance = [ ]^{a,c}
CSA = [ ]^{a,c}
Margin = [ ]^{a,c}

[ ]^{a,c}
Transmitter +ALT =
Transmitter -ALT =
Transmitter +AFT =
Transmitter -AFT =

[ ]^{a,c}
Process Racks +ALT =
Process Racks -ALT =
Process Racks +AFT =
Process Racks -AFT =

Table 3-3 (cont.)
Pressurizer Pressure – Low and High Reactor Trip
Rosemount 1154SH9RC Transmitters, ALS Process Racks

Pressurizer Pressure High Reactor Trip

Safety Analysis Limit (Source Listing 2) = 2445 psig
Nominal Trip Setpoint (Source Listing 1) = 2385 psig
Instrument Span (Source #) = 1250 - 2500 psig / 4 - 20 mA = 16 mA
Total Allowance = [ ]^{a,c}
CSA = [ ]^{a,c}
Margin = [ ]^{a,c}

[ ]^{a,c}
Transmitter +ALT =
Transmitter -ALT =
Transmitter +AFT =
Transmitter -AFT =

[ ]^{a,c}
Process Racks +ALT =
Process Racks -ALT =
Process Racks +AFT =
Process Racks -AFT =

Table 3-4 Pressurizer Water Level – High Reactor Trip

Rosemount 1153HD5RA and 1153HD5RC Transmitters, Triconex Process Racks

Parameter **Allowance***

^{a,c} [ ]

Process Measurement Accuracy

[ ]^{a,c}

Primary Element Accuracy (PEA)

Sensor Reference Accuracy (SRA) (Source Listing 4)

Sensor Calibration Accuracy (SCA) (Source Listing 4)
Value controlled by #, consistent with SRA

Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #)
[ ]^{a,c}

Sensor Pressure Effects (SPE) (Source Listing 4)

[ ]^{a,c}

Sensor Temperature Effects (STE) (Source Listing 4)

Sensor Drift (SD)
Value controlled by #

Environmental Allowance (EA)
[ ]^{a,c}
[ ]^{a,c}

Bias (Source Listing 4)
[ ]^{a,c}

Rack Calibration Accuracy (RCA) (Source Listing 6)
Value controlled by ##

Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##)
[ ]^{a,c}

Table 3-4 (cont.)
Pressurizer Water Level – High Reactor Trip
Rosemount 1153HD5RA and 1153HD5RC Transmitters, Triconex Process Racks

Parameter	Allowance*
	a,c
Rack Temperature Effect (RTE) (Source Listing 6) Included in the RCA term	
Rack Drift (RD) (Source Listing 6) Included in the RCA term	

---

* In percent span (100% Level) (Source #)

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l}PEA^2 + (SMTE + SCA)^2 + SRA^2 + (SMTE + SD)^2 + SPE^2 + STE^2 + \\ (RMTE + RCA)^2 + (RMTE + RD)^2 + RTE^2\end{array}} \\ + PMA_1 + PMA_2 + PMA_3 + PMA_4 + EA + Bias$$

a,c

Function specific source material for SCA, SD, RCA, RD and instrument span.

\# STP I-7-L459, "Pressurizer Level Channel LT-459 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT.
(Typical for this function).

\## STP I-36-S1R01, "Protection Set I, Rack 1, Channels Operational Test," (Typical for this function).

Table 3-4 (cont.)
Pressurizer Water Level – High Reactor Trip
Rosemount 1153HD5RA and 1153HD5RC Transmitters, Triconex Process Racks

Safety Analysis Limit (Source Listing 2) = 100% span

Nominal Trip Setpoint (Source Listing 1) = 90% span

Instrument Span (Source #) = 0% - 100% level span / 4 - 20 mA = 16mA

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

[ ]^{a,c}

Transmitter +ALT =

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =

[ ]^{a,c}

Process Racks +ALT =

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =

Table 3-5 RCS – Loss of Flow

Rosemount 1153HD5RC Transmitters, ALS Process Racks

Parameter **Allowance***

[ ]^{a,c}

Process Measurement Accuracy

[ ]^{a,c}

Primary Element Accuracy (PEA)

[ ]^{a,c}

Sensor Reference Accuracy (SRA) (Source Listing 4)

[ ]^{a,c}

Sensor Calibration Accuracy (SCA) (Source Listing 4)

[ ]^{a,c}

Value controlled by #, consistent with SRA

Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #)

[ ]^{a,c}

Sensor Pressure Effects (SPE) (Source Listing 4)

[ ]^{a,c}

Sensor Temperature Effects (STE) (Source Listing 4)

[ ]^{a,c}

Sensor Drift (SD)

[ ]^{a,c}

Value controlled by #

Environmental Allowance (EA)

[ ]^{a,c}

[ ]^{a,c}

Bias

Rack Calibration Accuracy (RCA) (Source Listing 8)

[ ]^{a,c}

Value controlled by ##

Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##)

[ ]^{a,c}

Table 3-5 (cont.)
RCS – Loss of Flow
Rosemount 1153HD5RC Transmitters, ALS Process Racks

Parameter	Allowance*
Rack Temperature Effect (RTE) (Source Listing 8) [ ]^{a,c}	[ ]^{a,c}
Rack Drift (RD) (Source Listing 8) [ ]^{a,c} Value controlled by ##	

---

* In percent flow span (120.0 % RCS Flow) (Source #). Percent ΔP span converted to flow span via WCAP-17706-P, with F_{max} = 120.0 % and F_N = 90 %, Scaling Factor (m) = 1.3 (normalized ΔP span = ΔP actual *m) (Source Listing 13)

Channel Statistical Allowance =

$$\sqrt{\begin{aligned}&PMA_1^2 + PMA_2^2 + PEA^2 + (SMTE + SCA)^2 + SRA^2 + (SMTE + SD)^2 + SPE^2 + STE^2 + \\ &(RMTE + RCA)^2 + (RMTE + RD)^2 + RTE^2\end{aligned}}$$
$$+ EA + Bias$$

[ ]^{a,c}

Function specific source material for SCA, SD, RCA, RD, and instrument span

\# STP-I-7-F414, "Reactor Coolant System Loop 1 Flow Channel FT-414 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT.
(Typical for this function).

\## STP I-36-S1R01, "Protection Set I, Rack 1, Channels Operational Test,"
(Typical for this function).

Table 3-5 (cont.)
RCS – Loss of Flow
Rosemount 1153HD5RC Transmitters, ALS Process Racks

Safety Analysis Limit (Source Listing 2) = 85% flow

Nominal Trip Setpoint (Source Listing 1) = 90% flow

Instrument Span (Source #) = 0 to 120% flow / 4 – 20 mA = 16 mA

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

^{a,c}

Transmitter +ALT = [

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =]

^{a,c}

Process Racks +ALT = [

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =]

Table 3-6 Steam Generator Narrow Range Water Level – Low-Low

Rosemount 1154DH5RC Transmitters, Triconex Process Racks

Parameter **Allowance***

Process Measurement Accuracy (PMA) a,c

a,c

[ ]

Primary Element Accuracy (PEA)

Sensor Calibration Accuracy (SCA) (Source Listing 4)
Value controlled by #, consistent with SRA

Sensor Reference Accuracy (SRA) (Source Listing 4)

Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #)
[ ] a,c

Sensor Pressure Effects (SPE) (Source Listing 4)
[ ] a,c
[ ] a,c

Sensor Temperature Effects (STE) (Source Listing 4)

Sensor Drift (SD)
Value controlled by #

Environmental Allowance (EA)
[ ] a,c (Source Listing 4)
[ ] a,c
[ ] a,c
[ ] a,c (Source Listing 17)

Bias (Bias$_3$_L1) (Source Listing 4)
[ ] a,c

Table 3-6 (cont.)
Steam Generator Narrow Range Water Level – Low-Low
Rosemount 1154DH5RC Transmitters, Triconex Process Racks

Parameter	Allowance*
Rack Calibration Accuracy (RCA) (Source Listing 5) Value controlled by ##	[^{a,c}
Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##) [ ]^{a,c}	
Rack Temperature Effect (RTE) (Source Listing 5) Included in the RCA term	
Rack Drift (RD) (Source Listing 5) Included in the RCA term	]

---

* In percent span (100 % level) (Source #)

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l}\mathrm{PEA}^2 + (\mathrm{SMTE} + \mathrm{SCA})^2 + \mathrm{SRA}^2 + (\mathrm{SMTE} + \mathrm{SD})^2 + \mathrm{SPE}^2 + \mathrm{STE}^2 + \\ (\mathrm{RMTE} + \mathrm{RCA})^2 + (\mathrm{RMTE} + \mathrm{RD})^2 + \mathrm{RTE}^2\end{array}}$$
$$+ \mathrm{BIAS}_3\_\mathrm{L1} + \mathrm{EA}_1 + \mathrm{EA}_2 + \mathrm{EA}_3 + \mathrm{EA}_4$$
$$+ \mathrm{PMA}_{PP} + \mathrm{PMA}_{RL} + \mathrm{PMA}_{FV} + \mathrm{PMA}_{SC} + \mathrm{PMA}_{MD} + \mathrm{PMA}_{ID} + \mathrm{PMA}_{FR} + \mathrm{PMA}_{DL}$$

[ ]^{a,c}

Function specific source material for SCA, SD, RCA, RD, and instrument span

#	STP I-4-L517, "Steam Generator Narrow Range Level Channel LT-517 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).
##	STP I-36-S1R01, "Protection Set I, Rack 1, Channels Operational Test," (Typical for this function).

Table 3-6 (cont.)
Steam Generator Narrow Range Water Level – Low-Low
Rosemount 1154DH5RC Transmitters, Triconex Process Racks

Safety Analysis Limit (Source Listing 2) = 0% span

Nominal Trip Setpoint (Source Listing 1) = 15% span

Instrument Span (Source #) = 0 - 100% level span / 4-20 mA = 16 mA

Total Allowance = [$]^{a,c}$

CSA = [$]^{a,c}$

Margin = [$]^{a,c}$

a,c

Transmitter +ALT = [

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =]

a,c

Process Racks +ALT = [

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =]

Table 3-7 Containment Pressure – High and High-High

Rosemount 1154DP6RC Transmitters, ALS Process Racks

Parameter	**Allowance**[*]
	^{a,c}
Process Measurement Accuracy (PMA)	
Primary Element Accuracy (PEA)	
Sensor Reference Accuracy (SRA) (Source Listing 4)	
Sensor Calibration Accuracy (SCA) (Source Listing 4) Value controlled by #, consistent with SRA	
Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #) [ ]^{a,c}	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE) (Source Listing 4)	
Sensor Drift (SD) Value controlled by #	
Environmental Allowance (EA) [ ]^{a,c} [ ]^{a,c}	
Bias	
Rack Calibration Accuracy (RCA) (Source Listing 8) Value controlled by ##	
Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##) [ ]^{a,c}	
Rack Temperature Effects (RTE) (Source Listing 8)	
Rack Drift (RD) (Source Listing 8) Value controlled by ##	

---

[*] In percent span (60 psi) (Source #)

Table 3-7 (cont.)
Containment Pressure – High and High-High
Rosemount 1154DP6RC Transmitters, ALS Process Racks

Channel Statistical Allowance =

$$\sqrt{\begin{aligned}&\mathrm{PMA}^2 + \mathrm{PEA}^2 + (\mathrm{SMTE} + \mathrm{SCA})^2 + \mathrm{SRA}^2 + (\mathrm{SMTE} + \mathrm{SD})^2 + \mathrm{SPE}^2 + \mathrm{STE}^2 + \\ &(\mathrm{RMTE} + \mathrm{RCA})^2 + (\mathrm{RMTE} + \mathrm{RD})^2 + \mathrm{RTE}^2\end{aligned}}$$
$$+ \mathrm{EA} + \mathrm{Bias}$$

a,c

Function specific source material for SCA, SD, RCA, RD and instrument span

\# STP I-12-P934, "Containment Pressure Channel PT-934 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT.
(Typical for this function).

\## STP I-36-S1R04, "Protection Set I, Rack 4, Channels Operational Test," (Typical for this function).

Table 3-7 (cont.)
Containment Pressure – High and High-High
Rosemount 1154DP6RC Transmitters, ALS Process Racks

Containment Pressure – High

Safety Analysis Limit (Source Listing 2) = 5.00 psig

Nominal Trip Setpoint (Source Listing 1) = 3.00 psig

Instrument Span (Source #) = -5 psid – 55 psid / 4-20 mA =16 mA

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

a,c

Transmitter +ALT =

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =

a,c

Process Racks +ALT =

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =

Table 3-7 (cont.)
Containment Pressure – High and High-High
Rosemount 1154DP6RC Transmitters, ALS Process Racks

<u>Containment Pressure – High-High</u>

Safety Analysis Limit (Source Listing 2) = 24.70 psig

Nominal Trip Setpoint (Source Listing 1) = 22.00 psig

Instrument Span (Source #) = -5 psid – 55 psid / 4-20 mA =16 mA

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

a,c

Transmitter +ALT = [

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =]

a,c

Process Racks +ALT = [

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =]

Table 3-8 Pressurizer Pressure – Low Safety Injection

Rosemount 1154SH9RC Transmitters, ALS Process Racks

Parameter	Allowance*
	[ ] ^{a,c}
Process Measurement Accuracy (PMA)	
Primary Element Accuracy (PEA)	
Sensor Reference Accuracy (SRA) (Source Listing 4)	
Sensor Calibration Accuracy (SCA) (Source Listing 4) Value controlled by #, consistent with SRA	
Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #) [ ] ^{a,c}	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE) (Source Listing 4)	
Sensor Drift (SD) Value controlled by #	
Environmental Allowance [ ] ^{a,c} (Source Listing 4) [ ] ^{a,c} (Source Listing 4) [ ] ^{a,c} (Source Listing 17) [ ] ^{a,c}	
Bias	
Rack Calibration Accuracy (RCA) (Source Listing 8) Value controlled by ##	
Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##) [ ] ^{a,c}	
Rack Temperature Effect (RTE) (Source Listing 8)	
Rack Drift (RD) (Source Listing 8) Value controlled by ##	

---

[*] In percent span (1250 psi) (Source #)

Table 3-8 (cont.)
Pressurizer Pressure – Low Safety Injection
Rosemount 1154SH9RC Transmitters, ALS Process Racks

Channel Statistical Allowance (with EA Terms) =

$$\sqrt{\begin{array}{l}\mathrm{PMA}^2+\mathrm{PEA}^2+(\mathrm{SMTE}+\mathrm{SCA})^2+\mathrm{SRA}^2+(\mathrm{SMTE}+\mathrm{SD})^2+\mathrm{SPE}^2+\mathrm{STE}^2+\\(\mathrm{RMTE}+\mathrm{RCA})^2+(\mathrm{RMTE}+\mathrm{RD})^2+\mathrm{RTE}^2\end{array}}$$
$$+\mathrm{Bias}+\mathrm{EA}_1+\mathrm{EA}_2+\mathrm{EA}_3+\mathrm{EA}_4$$

a,c

[ ]

Channel Statistical Allowance (without EA Terms) =

a,c

[ ]

Function specific source material for SCA, SD, RCA, RD, and Instrument span

#	STP I-7-P455, "Pressurizer Pressure Channel PT-455 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).
##	STP I-36-S1R01, "Protection Set I, Rack 1, Channels Operational Test," (Typical for this function).

Table 3-8 (cont.)
Pressurizer Pressure – Low Safety Injection
Rosemount 1154SH9RC Transmitters, ALS Process Racks

Pressurizer Pressure Low Safety Injection (with EA Terms)

Safety Analysis Limit (Source Listing 2) = 1680 psig
Nominal Trip Setpoint (Source Listing 1) = 1850 psig
Instrument Span (Source #) = 1250 - 2500 psig / 4 - 20 mA = 16 mA
Total Allowance = [ ]^{a,c}
CSA = [ ]^{a,c}
Margin = [ ]^{a,c}

Pressurizer Pressure Low Safety Injection (without EA Terms)

Safety Analysis Limit (Source Listing 2) = 1800 psig
Nominal Trip Setpoint (Source Listing 1) = 1850 psig
Instrument Span (Source #) = 1250 - 2500 psig / 4 - 20 mA = 16 mA
Total Allowance = [ ]^{a,c}
CSA = [ ]^{a,c}
Margin = [ ]^{a,c}

a,c

Transmitter +ALT = [
Transmitter -ALT =
Transmitter +AFT =
Transmitter -AFT =]

a,c

Process Racks +ALT = [
Process Racks -ALT =
Process Racks +AFT =
Process Racks -AFT =]

Table 3-9 Steam Line Pressure – Low Safety Injection (Rosemount Transmitters)

Rosemount 1154SH9RC Transmitters, Triconex Process Racks

^{a,c}

Parameter	Allowance*
Process Measurement Accuracy (PMA)	
Primary Element Accuracy (PEA)	
Sensor Reference Accuracy (SRA) (Source Listing 4)	
Sensor Calibration Accuracy (SCA) (Source Listing 4) Value controlled by #, consistent with SRA	
Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #) [ ]^{a,c}	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE) (Source Listing 4)	
Sensor Drift (SD) Value controlled by #	
Environmental Allowance [ ]^{a,c} (Source Listings 4 and 15) [ ]^{a,c} (Source Listings 15 and 17) [ ]^{a,c}	
Bias	
Rack Calibration Accuracy (RCA) (Source Listing 6) Value controlled by ##	
Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##) [ ]^{a,c}	
Rack Temperature Effects (RTE) (Source Listing 6) Included in the RCA term	
Rack Drift (RD) (Source Listing 6) Included in the RCA term	

---

* In percent span (1200 psi) (Source #)

Table 3-9 (cont.)
Steam Line Pressure – Low Safety Injection
Rosemount 1154SH9RC Transmitters, Triconex Process Racks

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l}\mathrm{PMA}^2 + \mathrm{PEA}^2 + (\mathrm{SMTE} + \mathrm{SCA})^2 + \mathrm{SRA}^2 + (\mathrm{SMTE} + \mathrm{SD})^2 + \mathrm{SPE}^2 + \mathrm{STE}^2 + \\ (\mathrm{RMTE} + \mathrm{RCA})^2 + (\mathrm{RMTE} + \mathrm{RD})^2 + \mathrm{RTE}^2\end{array}}$$

$$+ \mathrm{EA}_1 + \mathrm{EA}_2 + \mathrm{EA}_3 + \mathrm{Bias}$$

a,c

Function specific source material for SCA, SD, RCA, RD and instrument span

\# STP I-4-P514, "Steam Generator 1 Steam Line Pressure Channel PT-514 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT.
(Typical for this function).

\## STP I-36-S1R03 "Protection Set I, Rack 3 Channels Operational Test,"
(Typical for this function).

Table 3-9 (cont.)
Steam Line Pressure – Low Safety Injection
Rosemount 1154SH9RC Transmitters, Triconex Process Racks

Safety Analysis Limit (Source Listing 2) = 444.3 psig

Nominal Trip Setpoint (Source Listing 1) = 600.0 psig

Instrument Span (Source #) = 0 – 1200 psig / 4-20 mA = 16mA

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

a,c

Transmitter +ALT = [

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =]

a,c

Process Racks +ALT = [

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =]

Table 3-10 Steam Line Pressure – Low Safety Injection (Barton Transmitters)

Barton 763 Transmitters, Triconex Process Racks

Parameter **Allowance***

^{a,c}

Process Measurement Accuracy (PMA)

Primary Element Accuracy (PEA)

Sensor Reference Accuracy (SRA) (Source Listing 3)

Sensor Calibration Accuracy (SCA) (Source Listing 3)
Value controlled by #, consistent with SRA

Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #)
[ ]^{a,c}

Sensor Pressure Effects (SPE)

Sensor Temperature Effects (STE) (Source Listing 3)

Sensor Drift (SD)
Value controlled by #

Environmental Allowance
[ ]^{a,c} (Source Listings 9 and 15)
[ ]^{a,c} (Source Listings 15 and 17)
[ ]^{a,c}

Bias

Rack Calibration Accuracy (RCA) (Source Listing 6)
Value controlled by ##

Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##)
[ ]^{a,c}

Rack Temperature Effects (RTE) (Source Listing 6)
Included in the RCA term

Rack Drift (RD) (Source Listing 6)
Included in the RCA term

---

[*] In percent span (1200 psi) (Source #)

Table 3-10 (cont.)
Steam Line Pressure – Low Safety Injection
Barton 763 Transmitters, Triconex Process Racks

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l}PMA^2 + PEA^2 + (SMTE + SCA)^2 + SRA^2 + (SMTE + SD)^2 + SPE^2 + STE^2 + \\ (RMTE + RCA)^2 + (RMTE + RD)^2 + RTE^2\end{array}}$$
$$+ EA_1 + EA_2 + EA_3 + Bias$$

[ ]^{a,c}

Function specific source material for SCA, SD, RCA, RD and instrument span

STP I-4-P514, "Steam Generator 1 Steam Line Pressure Channel PT-514 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).

STP I-36-S1R03 "Protection Set I, Rack 3 Channels Operational Test," (Typical for this function).

Table 3-10 (cont.)
Steam Line Pressure – Low Safety Injection
Barton 763 Transmitters, Triconex Process Racks

Safety Analysis Limit (Source Listing 2) = 444.3 psig

Nominal Trip Setpoint (Source Listing 1) = 600.0 psig

Instrument Span (Source #) = 0 – 1200 psig / 4-20 mA = 16mA

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

a,c

Transmitter +ALT =

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =

a,c

Process Racks +ALT =

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =

Table 3-11 RCS Loop ΔT Equivalent to Power

Weed N9004E RTDs, ALS and Triconex Process Racks

Parameter	Allowance*
Process Measurement Accuracy [ ]^{a,c}	[ ]^{a,c}
Primary Element Accuracy (PEA)	
Sensor Calibration Accuracy (SCA) (Source Listing 11) [ ]^{a,c}	
Sensor Reference Accuracy (SRA) (Source Listing 5) [ ]^{a,c}	
Sensor Measurement & Test Equipment Accuracy (SMTE) (Source Listing 11) [ ]^{a,c}	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE)	
Sensor Drift (SD) [ ]^{a,c}	
Environmental Allowance (EA) (Source Listing 17) [ ]^{a,c}	
Bias	

Table 3-11 (cont.)
RCS Loop ΔT Equivalent to Power
Weed N9004E RTDs, ALS and Triconex Process Racks

Parameter **Allowance***

^{a,c}

Rack Calibration Accuracy (Source Listings 6, 8 and 12)

[ ]^{a,c}

[

]^{a,c}

Value controlled by #

Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by #)

[ ]^{a,c}

Rack Temperature Effect (RTE) (Source Listings 6 and 8)

[ ]^{a,c}

Rack Drift (RD) (Source Listings 6, 8 and 12)

[ ]^{a,c}

Value controlled by #

[ ]

* In percent ΔT span (ΔT – 88.5 °F - bounding for both Units) (Source #)
See conversions on page 29
N_H = Number of hot leg RTDs = 2 (Source Listing 10)
N_C = Number of cold leg RTDs = 1 (Source Listing 10)

Table 3-11 (cont.)
RCS Loop ΔT Equivalent to Power
Weed N9004E RTDs, ALS and Triconex Process Racks

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l} PMA_1^2 + PMA_3^2 + PMA_4^2 + PMA_5^2 + \\ \left(\sqrt{\dfrac{(SCA + SMTE)^2 + (SD + SMTE)^2 + SRA^2}{N_H} + \dfrac{(SCA + SMTE)^2 + (SD + SMTE)^2 + SRA^2}{N_C}}\right)^2 + \\ \left(\sqrt{\dfrac{(RCA_1 + RMTE)^2 + (RD + RMTE)^2 + RTE^2 + RCA_2^2}{N_H} + \dfrac{(RCA_1 + RMTE)^2 + (RD + RMTE)^2 + RTE^2}{N_C}}\right)^2 \end{array}}$$

$$+ PMA_2 + EA + Bias$$

Table 3-11 (cont.)
RCS Loop ΔT Equivalent to Power
Weed N9004E RTDs, ALS and Triconex Process Racks

a,c

Function specific source material for RCA, RD and Instrument span

STP-I-36-S1R02, "Protection Set I, Rack 2 Channels Operational Test," (Typical for this function).

Table 3-11 (cont.)
RCS Loop ΔT Equivalent to Power
Weed N9004E RTDs, ALS and Triconex Process Racks

Safety Analysis Limit (Source Listing 2) = [ ]^{a,c}

Nominal Trip Setpoint (Source Listing 1) = 50.0% RTP

Instrument Span (Source #) = ΔT_{span} = 88.5°F which equals 150% RTP

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

See Overtemperature ΔT Table for ALT/AFT values.

Table 3-12 Steam Line Pressure – Negative Rate

Rosemount 1154SH9RC or Barton 763 Transmitters, Triconex Process Racks

Parameter **Allowance**[*]

a,c

Process Measurement Accuracy (PMA)

Primary Element Accuracy (PEA)

Sensor Reference Accuracy (SRA)
[ ]^{a,c}

Sensor Calibration Accuracy (SCA)
[ ]^{a,c}

Sensor Measurement & Test Equipment Accuracy (SMTE)
[ ]^{a,c}

Sensor Pressure Effects (SPE)

Sensor Temperature Effects (STE)
[ ]^{a,c}

Sensor Drift (SD)
[ ]^{a,c}

Environmental Allowance (EA)
[ ]^{a,c}

Bias
[ ]^{a,c}

Rack Calibration Accuracy (RCA) (Source Listing 6)
Value controlled by ##

Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##)
[ ]^{a,c}

Rack Temperature Effects (RTE) (Source Listing 6)
Included in the RCA term

Rack Drift (RD) (Source Listing 6)
Included in the RCA term

---

[*] In percent span (1200 psi) (Source #)

Table 3-12 (cont.)
Steam Line Pressure – Negative Rate
Rosemount 1154SH9RC or Barton 763 Transmitters, Triconex Process Racks

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l}\mathrm{PMA}^2 + \mathrm{PEA}^2 + (\mathrm{SMTE} + \mathrm{SCA})^2 + \mathrm{SRA}^2 + (\mathrm{SMTE} + \mathrm{SD})^2 + \mathrm{SPE}^2 + \mathrm{STE}^2 + \\ (\mathrm{RMTE} + \mathrm{RCA})^2 + (\mathrm{RMTE} + \mathrm{RD})^2 + \mathrm{RTE}^2\end{array}}$$

$$+ \mathrm{EA} + \mathrm{Bias}$$

a,c

Function specific source material for RCA, RD and instrument span

\# STP I-4-P514, “Steam Generator 1 Steam Line Pressure Channel PT-514 Calibration,” procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT.
(Typical for this function).

\## STP I-36-S1R03 “Protection Set I, Rack 3 Channels Operational Test,”
(Typical for this function).

Table 3-12 (cont.)
Steam Line Pressure – Negative Rate
Rosemount 1154SH9RC or Barton 763 Transmitters, Triconex Process Racks

Safety Analysis Limit (Source Listing 2) = N/A

Nominal Trip setpoint (Source Listing 1) = 100 psi /sec

Instrument Span (Source #) = 0 – 1200 psig / 4-20 mA = 16mA

Total Allowance = N/A

CSA = [ ]^{a,c}

Margin = N/A

a,c

Transmitter +ALT =

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =

a,c

Process Racks +ALT =

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =

Table 3-13 Steam Generator Narrow Range Water Level – High-High

Rosemount 1154DH5RC Transmitters, Triconex Process Racks

Parameter **Allowance***

Process Measurement Accuracy (PMA)

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

Primary Element Accuracy (PEA)

Sensor Calibration Accuracy (SCA) (Source Listing 4)
Value controlled by #, consistent with SRA

Sensor Reference Accuracy (SRA) (Source Listing 4)

Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #)
[ ]^{a,c}

Sensor Pressure Effects (SPE) (Source Listing 4)
[ ]^{a,c}
[ ]^{a,c}

Sensor Temperature Effects (STE) (Source Listing 4)

Sensor Drift (SD)
Value controlled by #

Environmental Allowance (EA)
[ ]^{a,c}
[ ]^{a,c}

Bias (Bias$_3$_H) (Source Listing 4)
[ ]^{a,c}

Table 3-13 (cont.)
Steam Generator Narrow Range Water Level – High-High
Rosemount 1154DH5RC Transmitters, Triconex Process Racks

Parameter	Allowance*
Rack Calibration Accuracy (RCA) (Source Listing 5) Value controlled by ##	[
Rack Measurement & Test Equipment Accuracy (RMTE) (Controlled by ##) [ ]^{a,c}	
Rack Temperature Effect (RTE) (Source Listing 5) Included in the RCA term	
Rack Drift (RD) (Source Listing 5) Included in the RCA term	]^{a,c}

---

* In percent span (100 % level) (Source #)

Channel Statistical Allowance =
“ – ” Indicates direction only

$$
-\sqrt{\begin{array}{l}\mathrm{PEA}^2 + (\mathrm{SMTE} + \mathrm{SCA})^2 + \mathrm{SRA}^2 + (\mathrm{SMTE} + \mathrm{SD})^2 + \mathrm{SPE}^2 + \mathrm{STE}^2 + \\ (\mathrm{RMTE} + \mathrm{RCA})^2 + (\mathrm{RMTE} + \mathrm{RD})^2 + \mathrm{RTE}^2\end{array}}
$$
$$
+ \mathrm{BIAS}_3\_\mathrm{H} + \mathrm{EA}
$$
$$
+ \mathrm{PMA}_{PP} + \mathrm{PMA}_{RL} + \mathrm{PMA}_{FV} + \mathrm{PMA}_{SC} + \mathrm{PMA}_{MD} + \mathrm{PMA}_{ID} + \mathrm{PMA}_{FR} + \mathrm{PMA}_{DL}
$$

[ ]^{a,c}

Function specific source material for SCA, SD, RCA, RD, and instrument span

\# STP I-4-L517, “Steam Generator Narrow Range Level Channel LT-517 Calibration,” procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT.
(Typical for this function).

\## STP I-36-S1R01, “Protection Set I, Rack 1, Channel Operational Test,”
(Typical for this function).

Table 3-13 (cont.)
Steam Generator Narrow Range Water Level – High-High
Rosemount 1154DH5RC Transmitters, Triconex Process Racks

Safety Analysis Limit (Source Listing 2) = 98.8% span

Nominal Trip Setpoint (Source Listing 1) = 90% span

Instrument Span (Source #) = 0 - 100% level span / 4 - 20 mA = 16 mA

Total Allowance = [$]^{a,c}$

CSA = [$]^{a,c}$

Margin = [$]^{a,c}$

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

Transmitter +ALT =

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =

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

Process Racks +ALT =

Process Racks -ALT =

Process Racks +AFT =

Process Racks -AFT =

Table 3-14 Pressurizer Pressure – Control

Rosemount 1154SH9RC Transmitters, Westinghouse Isolator, VX-252 Meter

Parameter	**Allowance***
Process Measurement Accuracy (PMA) [ ]^{a,c}	[ ]^{a,c}
Primary Element Accuracy (PEA)	
Sensor Reference Accuracy (SRA) (Source Listing 4)	
Sensor Calibration Accuracy (SCA) (Source Listing 4) Value controlled by #, consistent with SRA	
Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #) [ ]^{a,c}	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE) (Source Listing 4)	
Sensor Drift (SD) Value controlled by #	
Environmental Allowance (EA) [ ]^{a,c}	
Bias (Source Listing 12) [ ]^{a,c}	
Indicator Calibration Accuracy (RCA_{IND}) (Source Listing 11) Value controlled by #	
Indicator Measurement & Test Equipment Accuracy ($RMTE_{IND}$) (Controlled by #) [ ]^{a,c}	
Indicator Temperature Effect (RTE_{IND}) (Source Listing 9)	
Indicator Drift (RD_{IND}) Value controlled by #	
Indicator (READOUT) (Source Listing 10) Control Board meter readability	
Controller Accuracy (CA)	

---

* In percent span (1250 psi) (Source #)

Table 3-14 (cont.)
Pressurizer Pressure – Control
Rosemount 1154SH9RC Transmitters, Westinghouse Isolator, VX 252 Meter

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

a,c

[ ]

a,c

[ ]

Function specific source material for SCA, SD, RCA, RD, and Instrument span.

\# STP I-7-P455, "Pressurizer Pressure Channel PT-455 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).

Table 3-14 (cont.)
Pressurizer Pressure – Control
Rosemount 1154SH9RC Transmitters, Westinghouse Isolator, VX-252 Meter

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

a,c

a,c

Function specific source material for SCA, SD, RCA, RD, and Instrument span.

\# STP I-7-P455, "Pressurizer Pressure Channel PT-455 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).

Table 3-14 (cont.)
Pressurizer Pressure – Control
Rosemount 1154SH9RC Transmitters, Westinghouse Isolator, VX-252 Meter

Nominal Control Setpoint (NCS) (Source Listing 2) = [ ]^{a,c}

Instrument Span (Source #) = 1250 to 2500 psig / 4 - 20 mA = 16mA

Safety Analysis Initial Condition
(indicated higher than actual) (Source Listing 2) = [ ]^{a,c}

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

CSA (indicated higher than actual) = [ ]^{a,c}

Margin (indicated higher than actual) = [ ]^{a,c}

Safety Analysis Initial Condition
(indicated lower than actual) (Source Listing 2) = [ ]^{a,c}

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

CSA (indicated lower than actual) = [ ]^{a,c}

Margin (indicated lower than actual) = [ ]^{a,c}

a,c

Transmitter +ALT =
Transmitter -ALT =
Transmitter +AFT =
Transmitter -AFT =

a,c

Process Racks (controller) +ALT =
Process Racks (controller) -ALT =
Process Racks (controller) +AFT =
Process Racks (controller) -AFT =

a,c

Process Racks (Indicator) +ALT =
Process Racks (Indicator) -ALT =
Process Racks (Indicator) +AFT =
Process Racks (Indicator) -AFT =

Table 3-15 Tavg – Control

Tavg Input - Weed N9004E RTD, ALS/Triconex Process Racks, VX-252 Meter

Parameter	**Allowance***
Process Measurement Accuracy (PMA) [ ]^{a,c}	[ ]^{a,c}
Primary Element Accuracy (PEA_{RTD})	
Sensor Reference Accuracy (SRA_{RTD}) (Source Listing 5)	
Sensor Calibration Accuracy (SCA_{RTD}) (Source Listing 11) Value controlled by #	
Sensor Measurement & Test Equipment Accuracy ($SMTE_{RTD}$)	
Sensor Pressure Effects (SPE_{RTD})	
Sensor Temperature Effects (STE_{RTD})	
Sensor Drift (SD_{RTD}) (Source Listing 5 and 11) Value controlled by #	
Environmental Allowance (EA)	
ALS RTD A/D – Rack Calibration Accuracy ($RCA_{RTDInput}$) (Source Listing 8) Value controlled by ##	
ALS RTD A/D – Rack Measurement & Test Equipment Accuracy ($RMTE_{RTDInput}$) [ ]^{a,c} Controlled by ##	
ALS RTD A/D – Rack Temperature Effects ($RTE_{RTDInput}$) (Source Listings 8 & 13)	
ALS RTD A/D – Rack Drift ($RD_{RTDInput}$) (Source Listing 8) Value controlled by ##	

Table 3-15 (cont.)
Tavg – Control
Tavg Input - Weed N9004E RTD, ALS/Triconex Process Racks, VX-252 Meter

Parameter **Allowance***

a,c

ALS RTD D/A – Rack Calibration Accuracy ($RCA_{ALS\ D/A}$) (Source Listing 8)
Value controlled by ##

ALS RTD D/A – Rack Measurement & Test Equipment Accuracy ($RMTE_{ALS\ D/A}$)
[ ] a,c
Controlled by ##

ALS RTD D/A – Rack Temperature Effects ($RTE_{ALS\ D/A}$) (Source Listings 8 & 13)

ALS RTD D/A – Rack Drift ($RD_{ALS\ D/A}$) (Source Listing 8)
Value controlled by ##

Triconex RTD A/D Protection – Rack Calibration Accuracy ($RCA_{TRI\ A/D}$) (Source Listings 6 & 7)
Value controlled by ##

Triconex RTD A/D Protection – Rack Measurement & Test Equipment Accuracy ($RMTE_{TRI\ A/D}$)
[ ] a,c
Controlled by ##

Triconex RTD A/D Protection – Rack Temperature Effects ($RTE_{TRI\ A/D}$)
Included in the $RCA_{TRI\ A/D}$ term (Source Listings 6 & 7)

Triconex RTD A/D Protection – Rack Drift ($RD_{TRI\ A/D}$)
Included in the $RCA_{TRI\ A/D}$ term (Source Listings 6 & 7)
Value controlled by ##

Triconex Tavg D/A Protection – Rack Calibration Accuracy ($RCA_{TRI\ D/A}$) (Source Listing 6)
Value controlled by ##

Triconex Tavg D/A Protection – Rack Measurement & Test Equipment Accuracy ($RMTE_{TRI\ D/A}$)
[ ] a,c
Controlled by ##

Triconex Tavg D/A Protection – Rack Temperature Effects ($RTE_{TRI\ D/A}$)
Included in the $RCA_{TRI\ D/A}$ term (Source Listing 6)

Triconex Tavg D/A Protection – Rack Drift ($RD_{TRI\ D/A}$)
Included in the $RCA_{TRI\ D/A}$ term (Source Listing 6)
Value controlled by ##

Table 3-15 (cont.)
Tavg Control
Tavg Input - Weed N9004E RTD, ALS/Triconex Process Racks, VX-252 Meter

Parameter	**Allowance**[*]
Triconex A/D Tavg Control Tavg Input – Rack Calibration Accuracy ($RCA_{PCS\_TRI\ A/D}$) (Source Listings 6 & 7) Value controlled by ##	[ ]^{a,c}
Triconex A/D Tavg Control Tavg Input– Rack Measurement & Test Equipment Accuracy ($RMTE_{PCS\_TRI\ A/D}$) [ ]^{a,c} Controlled by ##	
Triconex A/D Tavg Control Tavg Input – Rack Temperature Effects ($RTE_{PCS\_TRI\ A/D}$) Included in the $RCA_{PCS\_TRI\ A/D}$ term (Source Listings 6 & 7)	
Triconex A/D Tavg Control Tavg Input – Rack Drift ($RD_{PCS\_TRI\ A/D}$) Included in the $RCA_{PCS\_TRI\ A/D}$ term (Source Listings 6 & 7) Value controlled by ##	
Indicator Calibration Accuracy (RCA_{IND}) (Source Listing 11) Value controlled by ##	
Indicator Measurement & Test Equipment Accuracy ($RMTE_{IND}$) Controlled by ## [ ]^{a,c}	
Indicator Temperature Effect (RTE_{IND}) (Source Listing 9)	
Indicator Drift (RD_{IND}) Value controlled by ##	
Indicator ($READOUT_{IND}$) (Source Listing 10) Control Board Meter Readability	
Controller Accuracy (CA)	

---

[*] In Tavg span (100 °F) (Source ##)

Table 3-15 (cont.)
Tavg – Control
Turbine Pressure Input - Rosemount 1153DD8RC Transmitter, ALS/Triconex Process Racks

Parameter	**Allowance****
	a,c
Process Measurement Accuracy (PMA_{TP})	
Primary Element Accuracy (PEA_{TP})	
Sensor Reference Accuracy (SRA_{TP}) (Source Listing 4)	
Sensor Calibration Accuracy (SCA_{TP}) (Source Listing 4) Value controlled by ###, consistent with SRA	
Sensor Measurement & Test Equipment Accuracy ($SMTE_{TP}$) (Controlled by ###) [ ]^{a,c}	
Sensor Pressure Effects (SPE_{TP})	
Sensor Temperature Effects (STE_{TP}) (Source Listings 4, 15 & 16)	
Sensor Drift (SD_{TP}) Value controlled by ###	
Environmental Allowance (EA) [ ]^{a,c}	
Bias	
Turbine Pressure Sensitivity (TP_Sen)	
Triconex A/D Turbine Pressure Rack Calibration Accuracy ($RCA_{TP\_TRI\ A/D}$) (Source Listings 6 & 7) Value controlled by ###	
Triconex A/D Turbine Pressure Rack Measurement & Test Equipment Accuracy ($RMTE_{TP\_TRI\ A/D}$) [ ]^{a,c} Controlled by ###	
Triconex A/D Turbine Pressure Rack Temperature Effects ($RTE_{TP\_TRI\ A/D}$) Included in the $RCA_{TP\_TRI\ A/D}$ term (Source Listings 6 & 7)	
Triconex A/D Turbine Pressure Rack Drift ($RD_{TP\_TRI\ A/D}$) Included in the $RCA_{TP\_TRI\ A/D}$ term (Source Listings 6 & 7) Value controlled by ###	

Table 3-15 (cont.)
Tavg – Control
Turbine Pressure Input - Rosemount 1153DD8RC Transmitter, ALS/Triconex Process Racks

Parameter	Allowance[**]
Triconex D/A Turbine Pressure Rack Calibration Accuracy ($RCA_{TP\_TRI\ D/A}$) (Source Listing 6) Value controlled by ###	[
Triconex D/A Turbine Pressure Rack Measurement & Test Equipment Accuracy ($RMTE_{TP\_TRI\ D/A}$) [ ] ^{a,c} Controlled by ###	
Triconex D/A Turbine Pressure Rack Temperature Effects ($RTE_{TP\_TRI\ D/A}$) Included in the $RCA_{TP\_TRI\ D/A}$ term (Source Listing 6)	
Triconex D/A Turbine Pressure Rack Drift ($RD_{TP\_TRI\ D/A}$) Included in the $RCA_{TP\_TRI\ D/A}$ term (Source Listing 6) Value controlled by ###	
Triconex A/D Tavg Control Pressure Input– Rack Calibration Accuracy ($RCA_{PCS\_TP\_TRI\ A/D}$) (Source Listings 6 & 7) Value controlled by ###	
Triconex A/D Tavg Control Pressure Input Rack Measurement & Test Equipment Accuracy ($RMTE_{PCS\_TP\_TRI\ A/D}$) [ ] ^{a,c} Controlled by ###	
Triconex A/D Tavg Control Pressure Input– Rack Temperature Effects ($RTE_{PCS\_TP\_TRI\ A/D}$) Included in the $RCA_{PCS\_TP\_TRI\ A/D}$ term (Source Listings 6 & 7)	
Triconex A/D Tavg Control Pressure Input– Rack Drift ($RD_{PCS\_TP\_TRI\ A/D}$) Included in the $RCA_{PCS\_TP\_TRI\ A/D}$ term (Source Listings 6 & 7) Value controlled by ###	] ^{a,c}

[**] In Turbine Pressure span (650 psi) (Source ###)

[***] [ ] ^{a,c}

Table 3-15 (cont.)
Tavg – Control

a,c

Table 3-15 (cont.)
Tavg – Control

a,c

However, this does not include the controller deadband of ± 1.5 °F. The controller uncertainty is the combination of the electronics uncertainty and the deadband. The probability distribution for the deadband has been determined to be [ ].^{a,c} The variance for the deadband uncertainty is then:

$$(s_2)^2 = [\qquad]^{a,c}.$$

Combining the variance for the electronics and the variance for the deadband results in a controller variance of:

$$(s_C)^2 = (s_1)^2 + (s_2)^2 = [\qquad]^{a,c}$$

The controller standard deviation s_C = [ ]^{a,c} results in a total random uncertainty for a 30 month surveillance interval of [ ]^{a,c} and a cold leg streaming bias of [ ]^{a,c}.

Function specific source material for SCA, SD, RCA, RD and instrument span

#	STP R-27, "Diablo Canyon Power Plant Surveillance Test Procedure Unit 1 and 2 Incore Thermocouples and RCS RTD Cross Calibration," (Typical for this function).
##	STP I-7-T411, "Diablo Canyon Power Plant Surveillance Test Procedure RCS Loop 2 Delta-T/Tavg Channel T-411/412 Calibration," (Typical for this function).
###	MP I-4-P505A, "Diablo Canyon Power Plant I&C Maintenance Procedure Unit 2 Main Turbine First Stage Pressure Channel PT-505A Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).

Table 3-15 (cont.)
Tavg – Control
Rosemount 1153DD8RC Transmitter, ALS/Triconex Process Racks, VX-252 Meter

Nominal Full Power Control Setpoint (NCS) (Source Listing 2) = [ ]^{a,c}

Instrument Span (Tavg) (Source ##) = 530 to 630 °F / 4 – 20 mA = 16 mA

Instrument Span (Turbine Pressure)(Source ###) = 21.5 to 671.5 psig / 4 – 20 mA = 16 mA

Safety Analysis Initial Condition (indicated lower than actual) = [ ]^{a,c}

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

CSA (indicated lower than actual) = [ ]^{a,c}

Margin (indicated lower than actual) = [ ]^{a,c}

Safety Analysis Initial Condition (indicated higher than actual) = [ ]^{a,c}

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

CSA (indicated higher than actual) = [ ]^{a,c}

Margin (indicated higher than actual) = [ ]^{a,c}

Turbine Pressure [ ]^{a,c}

Transmitter +ALT =

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =

Triconex [ ]^{a,c}

Analog Input Process Racks (controller) +ALT =

Analog Input Process Racks (controller) -ALT =

Analog Input Process Racks (controller) +AFT =

Analog Input Process Racks (controller) -AFT =

[ ]^{a,c}

Analog Output Process Racks (controller) +ALT =

Analog Output Process Racks (controller) -ALT =

Analog Output Process Racks (controller) +AFT =

Analog Output Process Racks (controller) -AFT =

Table 3-15 (cont.)
Tavg – Control
Rosemount 1153DD8RC Transmitter, ALS/Triconex Process Racks, VX-252 Meter

T_H, T_C (ALS) a,c

Analog Input Process Racks (controller) +ALT =

Analog Input Process Racks (controller) -ALT =

Analog Input Process Racks (controller) +AFT =

Analog Input Process Racks (controller) -AFT =

a,c

Analog Output Process Racks (controller) +ALT =

Analog Output Process Racks (controller) -ALT =

Analog Output Process Racks (controller) +AFT =

Analog Output Process Racks (controller) -AFT =

T_H, T_C (Triconex) a,c

Analog Input Process Racks (controller) +ALT =

Analog Input Process Racks (controller) -ALT =

Analog Input Process Racks (controller) +AFT =

Analog Input Process Racks (controller) -AFT =

Tavg a,c

Analog Output Process Racks (controller) +ALT =

Analog Output Process Racks (controller) -ALT =

Analog Output Process Racks (controller) +AFT =

Analog Output Process Racks (controller) -AFT =

Tavg a,c

Indicator +ALT =

Indicator -ALT =

Indicator +AFT =

Indicator -AFT =

Table 3-16 Secondary Side Power Calorimetric Measurement Feedwater Temperature

Burns 100Ω RTD, Rosemount 3144P Temperature Transmitter/ Plant Process Computer (PPC)

Parameter	**Allowance***
Process Measurement Accuracy (PMA)	a,c
Primary Element Accuracy (PEA)	
Sensor Calibration Accuracy (SCA) [ ]^{a,c}	
Sensor Reference Accuracy (SRA) [ ]^{a,c}	
Sensor Measurement & Test Equipment Accuracy (SMTE) [ ]^{a,c}	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE)	
Sensor Drift (SD) [ ]^{a,c}	
Environmental Allowance (EA) [ ]^{a,c}	
Bias	
Rack Calibration Accuracy (RCA_{COMP}) [ ]^{a,c} (Source Listings 11, 12) Value controlled by ##	
Rack Measurement & Test Equipment Accuracy ($RMTE_{COMP}$) [ ]^{a,c} (Controlled by ##) [ ]^{a,c}	
Rack Temperature Effect (RTE_{COMP}) [ ]^{a,c} [ ]^{a,c}	
Rack Drift (RD_{COMP}) [ ]^{a,c} Value controlled by ##	
RTD (RTD_{LII}) [ ]^{a,c}	

---

* In percent span (400°F) (Source #)

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Feedwater Temperature
Burns 100Ω RTD, Rosemount 3144P Temperature Transmitter/PPC

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l}\mathrm{PMA}^2 + \mathrm{PEA}^2 + (\mathrm{SMTE} + \mathrm{SCA})^2 + \mathrm{SRA}^2 + (\mathrm{SMTE} + \mathrm{SD})^2 + \mathrm{SPE}^2 + \mathrm{STE}^2 + \\ (\mathrm{RMTE}_{\mathrm{COMP}} + \mathrm{RCA}_{\mathrm{COMP}})^2 + (\mathrm{RMTE}_{\mathrm{COMP}} + \mathrm{RD}_{\mathrm{COMP}})^2 + \mathrm{RTE}_{\mathrm{COMP}}{}^2 + \mathrm{RTD}_{\mathrm{LII}}^2\end{array}}$$
$$+ \mathrm{EA} + \mathrm{BIAS}$$

[ ]^{a,c}

Number of RTDs used: 1 per loop

Function specific source material for RCA, RD, and instrument span

\# MP-I-3-T1189.B, "Steam Generator 3 Feedwater Inlet Temperature Channel 1189 Calibration Unit 1" (Typical for this function).

\## MP-I-3-T1189.A, "Steam Generator 3 Feedwater Inlet Temperature Channel 1189 Channel Check Unit 1" (Typical for this function).

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Feedwater Flow
Rosemount 1153HD5RC, Triconex Digital Feedwater Control System (DFWCS)/Plant Process Computer (PPC)

Parameter **Allowance***

[ ]^{a,c}

Process Measurement Accuracy (PMA)
[
]^{a,c}

Primary Element Accuracy (PEA)
[
]^{a,c}

Sensor Calibration Accuracy (SCA) (Source Listing 4)
Value controlled by #, consistent with SRA

Sensor Reference Accuracy (SRA) (Source Listing 4)

Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #)
[ ]^{a,c}

Sensor Pressure Effects (SPE) (Source Listing 4)

[ ]^{a,c}

Sensor Temperature Effects (STE) (Source Listing 4)

Sensor Drift (SD)
Value controlled by #

Environmental Allowance (EA)
[ ]^{a,c}

Bias (Source Listing 4)
[ ]^{a,c}

Rack Calibration Accuracy (RCA$_{COMP}$) (Source Listing 11)
Value controlled by #

Rack Measurement & Test Equipment Accuracy (RMTE$_{COMP}$) (Controlled by #)
[ ]^{a,c}

Rack Temperature Effect (RTE$_{COMP}$)

Rack Drift (RD$_{COMP}$)
Value controlled by #

---

* In percent dp span (Source #)

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Feedwater Flow
Rosemount 1153HD5RC, Triconex DFWCS/PPC

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l}\mathrm{PMA}^2 + \mathrm{PEA}^2 + (\mathrm{SMTE} + \mathrm{SCA})^2 + \mathrm{SRA}^2 + (\mathrm{SMTE} + \mathrm{SD})^2 + \mathrm{SPE}^2 + \mathrm{STE}^2 + \\ (\mathrm{RMTE}_{\mathrm{COMP}} + \mathrm{RCA}_{\mathrm{COMP}})^2 + (\mathrm{RMTE}_{\mathrm{COMP}} + \mathrm{RD}_{\mathrm{COMP}})^2 + \mathrm{RTE}_{\mathrm{COMP}}{}^2\end{array}}$$
$$+ \mathrm{EA} + \mathrm{BIAS}_1$$

a,c

[ ]

To convert from % dp span to % nominal flow via WCAP-17706-P; F_{max} = 123.0% and F_N = 100%, the conversion factor from % dp span to % nominal flow is $(123.0/100)^2 / 2 = 0.76$.

Number of Feedwater Flow Channels used: 1 per loop

Function specific source material for SCA, SD, RCA, RD, and instrument span

\# MP-I-36-F510, "Steam Generator 1 Feedwater Flow and Steam Flow Channel F-510/512 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Steam Pressure
Rosemount 1154SH9RC, Westinghouse Isolator, Triconex DFWCS/PPC

Parameter	**Allowance***
Process Measurement Accuracy (PMA)	[ ]^{a,c}
Primary Element Accuracy (PEA)	
Sensor Calibration Accuracy (SCA) (Source Listing 4) Value controlled by #, consistent with SRA	
Sensor Reference Accuracy (SRA) (Source Listing 4)	
Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #) [ ]^{a,c}	
Sensor Pressure Effects (SPE)	
Sensor Temperature Effects (STE) (Source Listing 4)	
Sensor Drift (SD) Value controlled by #	
Environmental Allowance (EA) [ ]^{a,c}	
Bias	
Rack Calibration Accuracy (RCA_{COMP}) (Source Listing 11) Value controlled by #	
Rack Measurement & Test Equipment Accuracy ($RMTE_{COMP}$) (Controlled by #) [ ]^{a,c}	
Rack Temperature Effect (RTE_{COMP})	
Rack Drift (RD_{COMP}) Value controlled by #	

---

* In percent span (1200 psi) (Source #)

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Steam Pressure
Rosemount 1154SH9RC, Westinghouse Isolator, Triconex DFWCS/PPC

Channel Statistical Allowance =

$$\sqrt{\begin{array}{l}\mathrm{PMA}^2 + \mathrm{PEA}^2 + (\mathrm{SMTE} + \mathrm{SCA})^2 + \mathrm{SRA}^2 + (\mathrm{SMTE} + \mathrm{SD})^2 + \mathrm{SPE}^2 + \mathrm{STE}^2 + \\ (\mathrm{RMTE}_{\mathrm{COMP}} + \mathrm{RCA}_{\mathrm{COMP}})^2 + (\mathrm{RMTE}_{\mathrm{COMP}} + \mathrm{RD}_{\mathrm{COMP}})^2 + \mathrm{RTE}_{\mathrm{COMP}}{}^2\end{array}} \\ + \mathrm{EA} + \mathrm{BIAS}$$

[ ]^{a,c}

Number of Steam Pressure Channels used: 1 per loop

Function specific source material for SCA, SD, RCA, RD, and instrument span

\# STP-I-4-P514, "Steam Generator 1 Steam Line Pressure Channel PT-514 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Power Calorimetric Sensitivities
(Using Feedwater Venturis)

a,c

FEEDWATER FLOW
F_a
TEMPERATURE =
MATERIAL =
DENSITY
TEMPERATURE =
PRESSURE =

FEEDWATER ENTHALPY
TEMPERATURE =
PRESSURE =
h_s =
h_f =
Δh (SG) =

STEAM ENTHALPY
PRESSURE =
MOISTURE =

SG BLOWDOWN
DENSITY
PRESSURE =
ENTHALPY
PRESSURE =

LOOP UNCERTAINTY =

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Power Calorimetric Measurement Uncertainty
(Using Feedwater Venturis)

a,c

COMPONENT	INSTRUMENT UNCERTAINTY	POWER UNCERTAINTY % RTP
FEEDWATER FLOW		
VENTURI (FW_v) (Source Listing 13)		
THERMAL EXPANSION COEFFICIENT		
TEMPERATURE ($FWFa_t$)		
MATERIAL ($FWFa_m$)		
DENSITY		
TEMPERATURE ($FW\rho_t$)		
PRESSURE ($FW\rho_p$)		
ΔP ($FW_{\Delta P}$)		
FEEDWATER ENTHALPY		
TEMPERATURE (FWh_t)		
PRESSURE (FWh_p)		
STEAM ENTHALPY		
PRESSURE (h_{sp})		
MOISTURE ($h_{s\,moist}$)		
NET PUMP HEAT ADDITION (NPHA) (Source Listing 13)		
SG BLOWDOWN FLOW (SGBD)		
DENSITY ($SGBD\rho_p$)		
ENTHALPY ($SGBDh_p$)		
BIASES		
BIAS(FF_{SPE})		
BIAS(FF_{FWv}) (Source Listing 13)		

*, **, Indicates sets of dependent parameters.

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Power Calorimetric Measurement Uncertainty
(Using Feedwater Venturis)

Using the power uncertainty values, the 4 loop uncertainty equation is as follows:

Power = Channel Statistical Allowance

a,c

a,c

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Power Calorimetric Measurement Uncertainty
(Using Feedwater Venturis)

Safety Analysis Uncertainty (Source Listing 2) = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

Feedwater Flow

Rosemount 1153HD5RC, DFWCS/PPC
Instrument Span (Source #) = 0 to 123% Flow/4 – 20 mA = 16 mA

a,c

Transmitter +ALT =
Transmitter -ALT =
Transmitter +AFT =
Transmitter -AFT =

a,c

Process Racks (DFWCS/PPC) +ALT =
Process Racks (DFWCS/PPC) -ALT =
Process Racks (DFWCS/PPC) +AFT =
Process Racks (DFWCS/PPC) -AFT =

Feedwater Temperature

Burns 100Ω RTD, Rosemount 3144P Temperature Transmitter, PPC
Instrument Span = 400°F (Source #)

a,c

Process Racks (Rosemount 3144P/PPC) +ALT =
Process Racks (Rosemount 3144P/PPC) -ALT =
Process Racks (Rosemount 3144P/PPC) +AFT =
Process Racks (Rosemount 3144P/PPC) -AFT =

Feedwater Pressure

Feedwater Pressure is not a measured parameter.

Table 3-16 (cont.)
Secondary Side Power Calorimetric Measurement
Power Calorimetric Measurement Uncertainty
(Using Feedwater Venturis)

Steam Pressure

Rosemount 1154SH9, Isolator, DFWCS, PPC
Instrument Span (Source #) = 0 to 1200 psig

Process Racks (Isolator/DFWCS/PPC) +ALT = [
Process Racks (Isolator/DFWCS/PPC) -ALT =
Process Racks (Isolator/DFWCS/PPC) +AFT =
Process Racks (Isolator/DFWCS/PPC) -AFT =]^{a,c}

See Table 3-9 for Steam Pressure functions transmitter information.

Table 3-17 RCS Flow – Cold Leg Elbow Tap Indication

Rosemount 1153HD5RC Transmitters, ALS Process Racks, VX-252 Meter

Parameter **Allowance***

^{a,c} [ ]

Process Measurement Accuracy

[ ]^{a,c}

Primary Element Accuracy (PEA)

[ ]^{a,c}

Sensor Reference Accuracy (SRA) (Source Listing 4)

[ ]^{a,c}

Sensor Calibration Accuracy (SCA) (Source Listing 4)

[ ]^{a,c}
Value controlled by #, consistent with SRA

Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #)

[ ]^{a,c}

Sensor Pressure Effects (SPE) (Source Listing 4)

[ ]^{a,c}

Sensor Temperature Effects (STE) (Source Listing 4)

[ ]^{a,c}

Sensor Drift (SD)

[ ]^{a,c}
Value controlled by #

Environmental Allowance (EA)

[ ]^{a,c}

Bias

Rack Calibration Accuracy (RCA) Input Card (Source Listing 8)

[ ]^{a,c}
Value controlled by #

Rack Measurement & Test Equipment Accuracy (RMTE) Input Card (Controlled by #)

[ ]^{a,c}

Table 3-17 (cont.)
RCS Flow – Cold Leg Elbow Tap Indication
Rosemount 1153HD5RC Transmitters, ALS Process Racks, VX-252 Meter

Parameter **Allowance**[*]

a,c

Rack Temperature Effect (RTE) Input Card (Source Listing 8)
[ ]^{a,c}

Rack Drift (RD) Input Card (Source Listing 8)
[ ]^{a,c}
Value controlled by #

Rack Calibration Accuracy (RCA) Output Card (Source Listing 8)
[ ]^{a,c}
Value controlled by #

Rack Measurement & Test Equipment Accuracy (RMTE) Output Card (Controlled by #)
[ ]^{a,c}
[ ]^{a,c}

Rack Temperature Effect (RTE) Output Card (Source Listing 8)
[ ]^{a,c}

Rack Drift (RD) Output Card (Source Listing 8)
[ ]^{a,c}
Value controlled by #

Indicator Calibration Accuracy (RCA_{IND}) (Source Listing 11)
Value controlled by #

Indicator Measurement & Test Equipment Accuracy (RMTE) (Controlled by #)
[ ]^{a,c}

Indicator Temperature Effect (RTE) (Source Listing 9)

Indicator Drift (RD_{IND})
(Value controlled by #)

Indicator (READOUT) (Source Listing 10)
Control Board meter readability

---

[*] In % flow: Percent ΔP span converted to % flow via WCAP-17706-P, with F_{max} = 120.0 % and F_N = 100 %, Scaling Factor (m) = 1.3 (normalized ΔP span = ΔP actual *m) (Source Listing 13)

Table 3-17 (cont.)
RCS Flow – Cold Leg Elbow Tap Indication
Rosemount 1153HD5RC Transmitters, ALS Process Racks, VX-252 Meter

Channel Statistical Allowance =

a,c

[

]

Channel Statistical Allowance for [ ] ^{a,c}

a,c

[

]

Function specific source material for SCA, SD, RCA, RD, and instrument span

\# STP-I-7-F414, "Reactor Coolant System Loop 1 Flow Channel FT-414 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT.
(Typical for this function).

Table 3-17 (cont.)
RCS Flow – Cold Leg Elbow Tap Indication
Rosemount 1153HD5RC Transmitters, ALS Process Racks, VX-252 Meter

Instrument Span (Source #) = 0 to 120% flow / 4 – 20 mA = 16 mA

Safety Analysis Uncertainty (Source Listing 2) = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

^{a,c}

Transmitter +ALT =

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =

^{a,c}

Process Racks (input) +ALT =

Process Racks (input) -ALT =

Process Racks (input) +AFT =

Process Racks (input) -AFT =

^{a,c}

Process Racks (output) +ALT =

Process Racks (output) -ALT =

Process Racks (output) +AFT =

Process Racks (output) -AFT =

^{a,c}

Process Racks (control board meter) +ALT =

Process Racks (control board meter) -ALT =

Process Racks (control board meter) +AFT =

Process Racks (control board meter) -AFT =

Table 3-18 Pressurizer Water Level – Control

Rosemount 1153HD5RA and 1153HD5RC Transmitters, Westinghouse Isolator, VX-252 Meter (indicated lower than actual)

Parameter	Allowance*
Process Measurement Accuracy [ ]^{a,c}	[ ]^{a,c}
Primary Element Accuracy (PEA)	
Sensor Reference Accuracy (SRA) (Source Listing 4)	
Sensor Calibration Accuracy (SCA) (Source Listing 4) Value controlled by #, consistent with SRA	
Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #) [ ]^{a,c}	
Sensor Pressure Effects (SPE) (Source Listing 4) [ ]^{a,c}	
Sensor Temperature Effects (STE) (Source Listing 4)	
Sensor Drift (SD) Value controlled by #	
Environmental Allowance (EA) [ ]^{a,c}	
Bias (Source Listing 4) [ ]^{a,c}	
Indicator Calibration Accuracy (RCA_{IND}) (Source Listing 11) Value controlled by #	
Indicator Measurement & Test Equipment Accuracy ($RMTE_{IND}$) (Controlled by #) [ ]^{a,c}	
Indicator Temperature Effect (RTE_{IND}) (Source Listing 9)	
Indicator Drift (RD_{IND}) Value controlled by #	

Table 3-18 (cont.)
Pressurizer Water Level – Control (indicated lower than actual)
Rosemount 1153HD5RA and 1153HD5RC Transmitters, Westinghouse Isolator, VX-252 Meter

Parameter	Allowance*
Controller Accuracy (CA)	[ ]^{a,c}
Indicator (READOUT) (Source Listing 10) Control Board meter readability	

---

* In percent span (100% Level) (Source #)

Channel Statistical Allowance [ ]^{a,c} =

[ ]^{a,c}

[ ]^{a,c}

Function specific source material for SCA, SD, RCA, RD and instrument span.

\# STP I-7-L459, "Pressurizer Level Channel LT-459 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).

Table 3-18 (cont.)
Pressurizer Water Level – Control (indicated lower than actual)
Rosemount 1153HD5RA and 1153HD5RC Transmitters, Westinghouse Isolator, VX-252 Meter

Nominal (Full Power) Control Setpoint (NCS) (Source Listing 2) = [ ]^{a,c}

Instrument Span (Source #) = 0% - 100% level span / 4 - 20 mA = 16 mA

Safety Analysis Initial Condition (Source Listing 2) = [ ]^{a,c}

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

Transmitter +ALT = [

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =]^{a,c}

Process Racks (controller) +ALT = [

Process Racks (controller) -ALT =

Process Racks (controller) +AFT =

Process Racks (controller) -AFT =]^{a,c}

Process Racks (control board meter) +ALT = [

Process Racks (control board meter) -ALT =

Process Racks (control board meter) +AFT =

Process Racks (control board meter) -AFT =]^{a,c}

Table 3-19 Steam Generator Narrow Range Water Level – Control

Rosemount 1154DH5RC Transmitters, Westinghouse Isolator, VX-252 Meter
(indicated higher than actual)

Parameter **Allowance***

Process Measurement Accuracy (PMA) a,c a,c

[ ]

Primary Element Accuracy (PEA)

Sensor Calibration Accuracy (SCA) (Source Listing 4)
Value controlled by #, consistent with SRA

Sensor Reference Accuracy (SRA) (Source Listing 4)

Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #)
[ ]^{a,c}

Sensor Pressure Effects (SPE) (Source Listing 4)
[ ]^{a,c}
[ ]^{a,c}

Sensor Temperature Effects (STE) (Source Listing 4)

Sensor Drift (SD)
Value controlled by #

Environmental Allowance (EA)
[ ]^{a,c}

Bias (Bias$_3$_pos) (Source Listing 4)
[ ]^{a,c}

Table 3-19 (cont.)
Steam Generator Narrow Range Water Level – Control (indicated higher than actual)
Rosemount 1154DH5RC Transmitters, Westinghouse Isolator, VX-252 Meter

Parameter	**Allowance***
	^{a,c}
Indicator Calibration Accuracy (RCA_{IND}) (Source Listing 11) Value controlled by #	[
Indicator Measurement & Test Equipment Accuracy ($RMTE_{IND}$) (Controlled by #) [ ]^{a,c}	
Indicator Temperature Effect (RTE_{IND}) (Source Listing 9)	
Indicator Drift (RD_{IND}) Value controlled by #	
Controller Accuracy (CA)	
Indicator (READOUT) (Source Listing 10) Control Board meter readability	]

---

* In percent span (100 % level) (Source #)

Channel Statistical Allowance [ ]^{a,c} =

[ ]^{a,c}

[ ]^{a,c}

Function specific source material for SCA, SD, RCA, RD, and instrument span

\# STP I-4-L517, "Steam Generator Narrow Range Level Channel LT-517 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT. (Typical for this function).

Table 3-19 (cont.)
Steam Generator Narrow Range Water Level – Control (indicated higher than actual)
Rosemount 1154DH5RC Transmitters, Westinghouse Isolator, VX-252 Meter

Nominal (Full Power) Control Setpoint (NCS) (Source Listing 2) = [ ]^{a,c}
Instrument Span (Source #) = 0 - 100% level span / 4 – 20 mA = 16 mA

Safety Analysis Initial Condition (Source Listing 2) = [ ]^{a,c}
Total Allowance = [ ]^{a,c}
CSA = [ ]^{a,c}
Margin = [ ]^{a,c}

a,c

Transmitter +ALT = [
Transmitter -ALT =
Transmitter +AFT =
Transmitter -AFT =]

a,c

Process Racks (controller) +ALT = [
Process Racks (controller) -ALT =
Process Racks (controller) +AFT =
Process Racks (controller) -AFT =]

a,c

Process Racks (control board meter) +ALT = [
Process Racks (control board meter) -ALT =
Process Racks (control board meter) +AFT =
Process Racks (control board meter) -AFT =]

Table 3-19 (cont.)
Steam Generator Narrow Range Water Level – Control (indicated lower than actual)
Rosemount 1154DH5RC Transmitters, Westinghouse Isolator, VX-252 Meter

Parameter **Allowance***

Process Measurement Accuracy (PMA) a,c a,c

Primary Element Accuracy (PEA)

Sensor Calibration Accuracy (SCA) (Source Listing 4)
Value controlled by #, consistent with SRA

Sensor Reference Accuracy (SRA) (Source Listing 4)

Sensor Measurement & Test Equipment Accuracy (SMTE) (Controlled by #)
[ ] a,c

Sensor Pressure Effects (SPE) (Source Listing 4)
[ ] a,c
[ ] a,c

Sensor Temperature Effects (STE) (Source Listing 4)

Sensor Drift (SD)
Value controlled by #

Environmental Allowance (EA)
[ ] a,c

Bias (Bias$_3$_neg) (Source Listing 4)
[ ] a,c

Table 3-19 (cont.)
Steam Generator Narrow Range Water Level – Control (indicated lower than actual)
Rosemount 1154DH5RC Transmitters, Westinghouse Isolator, VX-252 Meter

Parameter	Allowance*
Indicator Calibration Accuracy (RCA_{IND}) (Source Listing 11) Value controlled by #	
Indicator Measurement & Test Equipment Accuracy ($RMTE_{IND}$) (Controlled by #) [ ]a,c	
Indicator Temperature Effect (RTE_{IND}) (Source Listing 9)	
Indicator Drift (RD_{IND}) Value controlled by #	
Controller Accuracy (CA)	
Indicator (READOUT) (Source Listing 10) Control Board meter readability	

a,c

---

* In percent span (100 % level) (Source #)

Channel Statistical Allowance [ ]a,c =
"–" Indicates direction only

a,c

a,c

Function specific source material for SCA, SD, RCA, RD, and instrument span

\# STP I-4-L517, "Steam Generator Narrow Range Level Channel LT-517 Calibration," procedure controls transmitter drift magnitude determined from drift data evaluation process, see transmitter AFT.

(Typical for this function).

Table 3-19 (cont.)
Steam Generator Narrow Range Water Level – Control (indicated lower than actual)
Rosemount 1154DH5RC Transmitters, Westinghouse Isolator, VX-252 Meter

Nominal (Full Power) Control Setpoint (NCS) (Source Listing 2) = [ ]^{a,c}

Instrument Span (Source #) = 0 - 100% level span / 4 – 20 mA = 16 mA

Safety Analysis Initial Condition (Source Listing 2) = [ ]^{a,c}

Total Allowance = [ ]^{a,c}

CSA = [ ]^{a,c}

Margin = [ ]^{a,c}

a,c

Transmitter +ALT =

Transmitter -ALT =

Transmitter +AFT =

Transmitter -AFT =

a,c

Process Racks (controller) +ALT =

Process Racks (controller) -ALT =

Process Racks (controller) +AFT =

Process Racks (controller) -AFT =

a,c

Process Racks (control board meter) +ALT =

Process Racks (control board meter) -ALT =

Process Racks (control board meter) +AFT =

Process Racks (control board meter) -AFT =

4.0 REFERENCES

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4. WCAP-11594, Rev. 2, "Westinghouse Improved Thermal Design Procedure Instrument Uncertainty Methodology – Diablo Canyon Units 1 & 2, 24 Month Fuel Cycle Evaluation," Westinghouse Electric Company LLC, January 1997.
5. Pacific Gas and Electric Company Diablo Canyon Nuclear Power Plant, Unit 1 Facility Operating License, Appendix A, Technical Specifications, Amendment Number 211.
6. Pacific Gas and Electric Company Diablo Canyon Nuclear Power Plant, Unit 2 Facility Operating License, Appendix A, Technical Specifications, Amendment Number 213.
7. ANSI/ISA-51.1-1979 (R1993), "Process Instrumentation Terminology," International Society of Automation, Reaffirmed May 1995.