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2F EVAPORATOR CP CLASS INSTRUMENTATION UNCERTAINTIES EVALUATIONS

by

Edward Hwang

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

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F-Tank Farm Cognizant Engineering Manager Level 5
Bryan Hess — Date: 1/25/94

F-Tank Farm Cognizant Engineering Manager Level 4
Mark Peters — Date: 1-25-94

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INTRODUCTION

There are two instrumentation systems in the 2F Evaporator facilities (bldg. 242-16F) that are classified as the Critical Protection (CP) per technical report WSRC-TR-93-439, High Level Waste Facilities Intermediate Functional Classification.[1] They are the Evaporator Pot Temperature Instrumentations and the Steam Condensate Gamma Monitor.

The Evaporator Pot Temperature Instrumentation Loop 5042 (old loop #555) is illustrated in the loop diagram, Figure 1.[6]

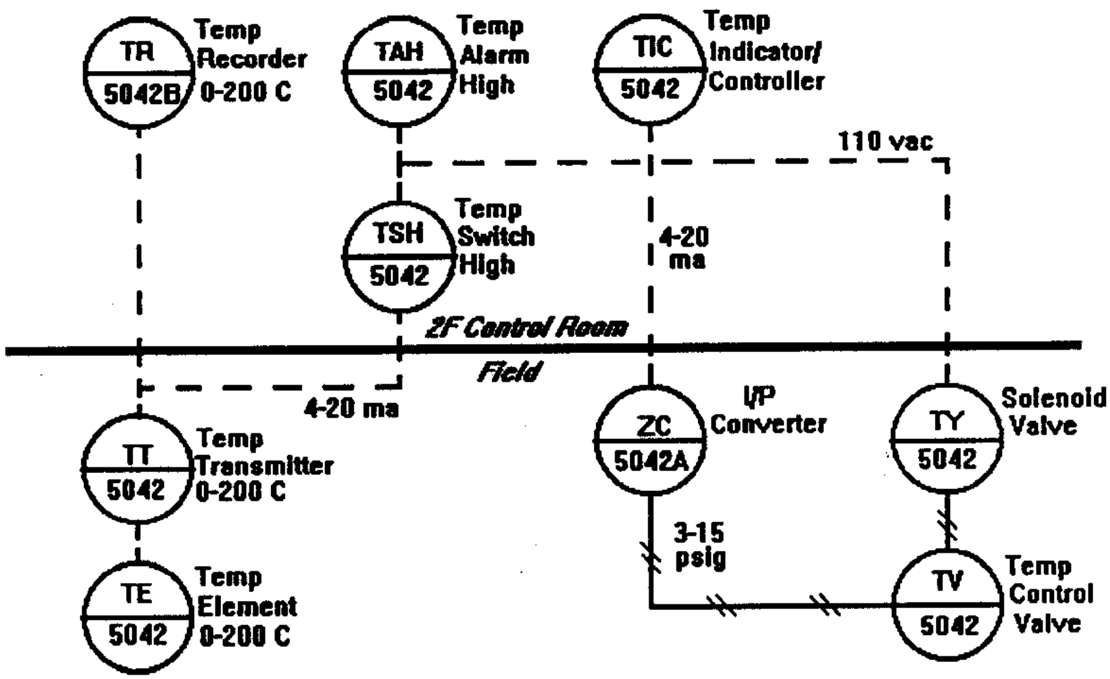

Fig. 1 2F Evaporator Pot Temperature Instrumentation Loop

The pot temperature instrumentation consists of two inter-related circuits sharing the same temperature sensor and transducer. They are:

1) Evaporator Pot Temperature High Alarm & Interlock Circuit - It provides an annunciator alarm in the control room and triggers the trip solenoid of the steam control valve to shutoff the steam supply to the tube bundle.
2) Evaporator Pot Temperature Recorder Circuit - It provides the temperature reading and the stripchart recording in the control room.

The temperature control circuit is also shown in the above loop diagram.

The Steam Condensate Gamma Monitor Instrumentation Loop 2022 (old loop #1282) is illustrated in the loop diagram, Figure 2.[7]

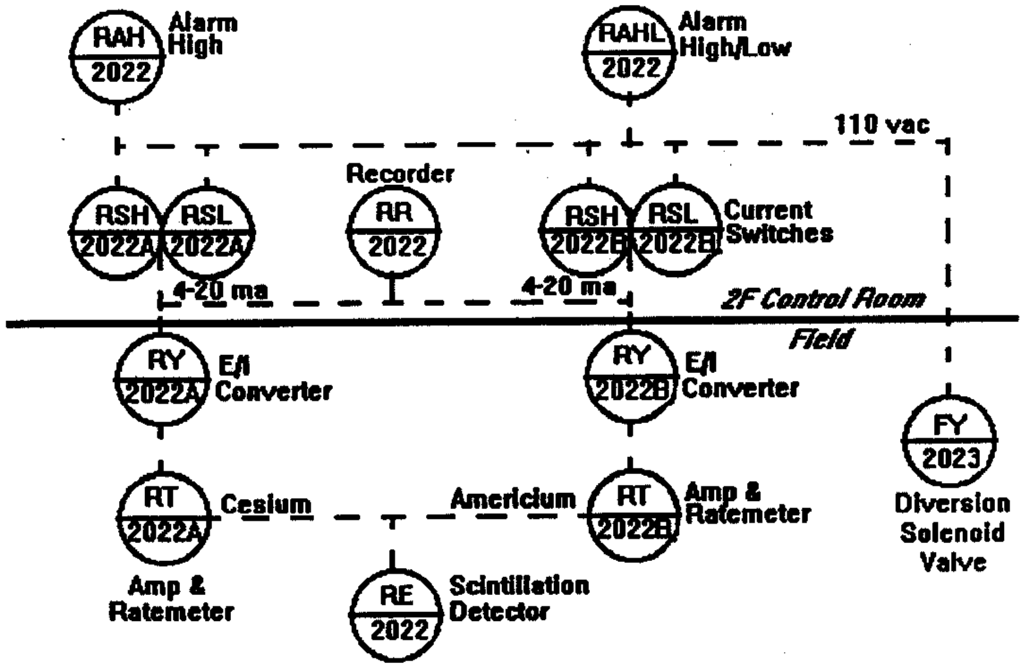

Fig. 2 2F Evaporator Condensate Gamma Monitor Instrumentation Loop

The gamma monitor instrumentation consists of four inter-related circuits sharing the same scintillation detector. They are:

1) Condensate High Gamma Alarm & Interlock Circuit - It provides an annunciator alarm in the control room and triggers the condensate diversion valve solenoid.
2) Condensate Gamma Monitor Failure Alarm & Interlock Circuit - It provides an annunciator alarm in the control room and triggers the condensate diversion valve solenoid.
3) Condensate Cesium Activity Recorder Circuit - It provides the condensate Cesium activity reading and the stripchart recording in the control room.
4) Condensate Americium Activity Recorder Circuit - It provides the condensate Americium activity reading and the stripchart recording in the control room.

The channel measurement uncertainty for each instrument circuit is evaluated in detail. The methodology used in the SRS K-Reactor Safety-Related Instrumentation Setpoint Uncertainties Evaluations, WSRC-TR-91-0167[2], is applied for this evaluation and is highlighted in the METHODOLOGY section.

The resulting uncertainties for the two loops are tabulated in the SUMMARY section.

The evaluation details for each instrument circuit are described in sections 1 and 2.

SUMMARY

The resulting uncertainties for the evaporator pot temperature instrument circuits are tabulated in the following Summary Table 1.

TABLE 1 Evaporator Pot Temperature Loop Uncertainties Summary

Circuit Name	Unit	Setpoint	Uncertainty	Span	CSA %
(1) 2F Evaporator Loop 5042 Pot Temperature High Alarm Circuit	Deg C	150	4.3	200 Deg C	2.17
(2) 2F Evaporator Loop 5042 Pot Temperature Recorder Circuit	Deg C	N/A	5.8	200 Deg C	2.89

The Pot Temperature High Alarm Circuit has an overall channel statistical allowance (CSA) of 2.17 % over the calibrated span of 200 degrees C, namely, an instrument uncertainty of 4.3 degrees C. The circuit details along with its components are described in Section 1.1; all specified/assigned measurement uncertainty terms are explained in Section 1.1.1; the overall channel statistical allowance and the instrument circuit uncertainties are calculated in Section 1.1.2; all the reference materials are listed in Section 1.1.3.

The Pot Temperature Recorder Circuit has an overall channel statistical allowance (CSA) of 2.89 % over the calibrated span of 200 degrees C, namely, an instrument uncertainty of 5.8 degrees C. The circuit details along with its components are described in Section 1.2; all specified/assigned measurement uncertainty terms are explained in Section 1.2.1; the overall channel statistical allowance and the instrument circuit uncertainties are calculated in Section 1.2.2; all the reference materials are listed in Section 1.2.3.

The resulting uncertainties for the steam condensate gamma monitor instrument circuits are tabulated in the Summary Table 2, next page.

The Condensate High Gamma Alarm Circuit has an overall channel statistical allowance (CSA) of 7.38 % over the calibrated span of 100 %, namely, an instrument uncertainty of 7.4 %. The circuit details along with its components are described in Section 2.1; all specified/assigned measurement uncertainty terms are explained in Section 2.1.1; the overall channel statistical allowance and the instrument circuit uncertainties are calculated in Section 2.1.2; all the reference materials are listed in Section 2.1.3.

TABLE 2 Condensate GAMMA Monitor Loop Uncertainties Summary

Circuit Name	Unit	Setpoint	Uncertainty	Span	CSA %
(1) 2F Evaporator Loop 2022 Condensate High Gamma Alarm Circuit	%	N/A	7.4	100 %	7.38
(2) 2F Evaporator Loop 2022 Condensate Gamma Monitor Failure Alarm Circuit	%	N/A	7.4	100 %	7.38
(3) 2F Evaporator Loop 2022 Condensate Cesium Activity Recorder Circuit	%	N/A	7.6	100 %	7.57
(4) 2F Evaporator Loop 2022 Condensate Americium Activity Recorder Circuit	%	N/A	7.6	100 %	7.57

The Condensate Gamma Monitor Failure Alarm Circuit has an overall channel statistical allowance (CSA) of 7.38 % over the calibrated span of 100 %, namely, an instrument uncertainty of 7.4 %. The circuit details along with its components are described in Section 2.2; all specified/assigned measurement uncertainty terms are explained in Section 2.2.1; the overall channel statistical allowance and the instrument circuit uncertainties are calculated in Section 2.2.2; all the reference materials are listed in Section 2.2.3.

The Condensate Cesium Activity Recorder Circuit has an overall channel statistical allowance (CSA) of 7.57 % over the calibrated span of 100 %, namely, an instrument uncertainty of 7.6 %. The circuit details along with its components are described in Section 2.3; all specified/assigned measurement uncertainty terms are explained in Section 2.3.1; the overall channel statistical allowance and the instrument circuit uncertainties are calculated in Section 2.3.2; all the reference materials are listed in Section 2.3.3.

The Condensate Americium Activity Recorder Circuit has an overall channel statistical allowance (CSA) of 7.57 % over the calibrated span of 100 %, namely, an instrument uncertainty of 7.6 %. The circuit details along with its components are described in Section 2.4; all specified/assigned measurement uncertainty terms are explained in Section 2.4.1; the overall channel statistical allowance and the instrument circuit uncertainties are calculated in Section 2.4.2; all the reference materials are listed in Section 2.4.3.

METHODOLOGY

The channel statistical allowance (CSA) for each instrument circuit is calculated using USNRC approved Westinghouse method[2] of applying the square-root-of-the-sum-of-squares (SRSS) combination of the measurement uncertainties. The SRSS method is also adopted by the Instrument Society of America Standard S67.04-1987, Setpoints for Nuclear Safety-Related Instrumentation.[3]

$$CSA = \sqrt{PMA^2 + PEA^2 + SA^2 + STE^2 + SPE^2 + RA^2 + RTE^2} + EA + BIAS$$

$$SA = \sqrt{(SCA_1+SMTE_1+SD_1)^2 + (SCA_2+SMTE_2+SD_2)^2 + (SCA_3+SMTE_3+SD_3)^2}$$

$$RA = \sqrt{RA_1^2 + RA_2^2 + RA_3^2}$$

$$RA_1 = RCA_1 + RCSA_1 + RMTE_1 + RD_1$$

$$RA_2 = RCA_2 + RCSA_2 + RMTE_2 + RD_2$$

$$RA_3 = RCA_3 + RCSA_3 + RMTE_3 + RD_3$$

Uncertainty = Span x (CSA / 100)

The measurement uncertainty terms used in the calculations are defined in the SRS Report WSRC-TR-91-0167[2] that were derived from ISA Std S67.04-1987[3], ANSI/ASME Std PTC19.1-1985[4], and SAMA Std PMC20.1-1973.[5]

- PMA - Process Measurement Accuracy
  PMA is a non-device related error that is inherent with the process measurement method.
- PEA - Primary Element Accuracy
  PEA is the error due to any use of metering device (e.g., venturi, orifice, elbow, etc.) to affect the process medium to obtain the parameter readings.
- SA - Sensor Allowance
  SA is the combined sensor error allowance for SCA, SMTE, & SD terms.
- SCA - Sensor Calibration Accuracy
  SCA is the error tolerance of the sensor that includes the combined effects of hysteresis, deadband, linearity, and repeatability.
- SMTE - Sensor Measurement & Test Equipment accuracy
  SMTE is the error tolerance of the test equipment used to calibrate the sensor in the instrument lab.
- SD - Sensor Drift
  SD is the error due to gradual change over time between calibrations in the sensor output from the original calibrated settings.
- STE - Sensor Temperature Effect
  STE is any deviation in sensor input-output relationship due to ambient temperature changes from the reference calibration conditions.

- SPE - Sensor Pressure Effect
  SPE is any deviation in sensor input-output relationship due to static head pressure changes from the reference calibration conditions.
- RA - Rack Allowance
  RA is the combined rack error allowance for RCA, RCSA, RMTE, & RD terms.
- RCA - Rack Calibration Accuracy
  RCA is the error tolerance of the process rack circuit that includes the combined effects of hysteresis, deadband, linearity, and repeatability.
- RCSA - Rack Comparator Setting Accuracy
  RCSA is the calibration error tolerance of the bistable module in the process rack.
- RMTE - Rack Measurement & Test Equipment accuracy
  RMTE is the error tolerance of the test equipment used to calibrate the process rack in the field.
- RD - Rack Drift
  RD is the error due to gradual change over time between calibrations in the process rack output from the original calibrated settings.
- RTE - Rack Temperature Effect
  RTE is any deviation in input-output relationship for the process rack module string due to changes in ambient temperature from the reference calibration conditions.
- EA - harsh Environmental Allowance
  EA is any deviation in process measurement output (sensor and process rack) due to adverse environmental conditions from a limiting accident, such as:
  - radiation effect on sensor,
  - seismic effects on sensor and process rack, and
  - high temperature effects on signal cable insulation.
- BIAS
  BIAS is any known existing unidirectional effect to the measured process parameter.

REFERENCE

[1] SRS Report WSRC-TR-93-439 Rev 0, High Level Waste Facilities Intermediate Functional Classification.
[2] SRS Report WSRC-TR-91-0167 Rev 0, SRS K-Reactor Instrumentation Setpoint Uncertainties Evaluation.
[3] Instrument Society of America (ISA) Std S67.04-1987, Setpoint for Nuclear Safety-Related Instrumentation.
[4] American National Standard Institute (ANSI/ASME) Std PTC19.1-1985, Measurement Uncertainty.
[5] Scientific Apparatus Makers of America (SAMA) Std PMC20.1-1973, Process Measurement & Control Terminology.
[6] SRS Drawing M-M6-F-3025 Rev. 0, Evaporator Instrumentation Piping Diagram.
[7] SRS Design Change Package J-DCP-F-93047 Rev. 0, Repair 2F Evaporator Steam Condensate Gamma Monitor.

1. EVAPORATOR POT TEMPERATURE INSTRUMENTATION LOOP

1.1 Temperature High Alarm & Interlock Circuit

The high temperature alarm circuit in the evaporator control room is to alert the operator when the pot temperature reaches 150 degrees C that is the operating limit for the evaporator. The alarm circuit, referring to Fig. 1 loop diagram, consists of the temperature element TE-5042, the temperature transmitter TT-5042, the current switch TSH-5042 connecting to an interposing relay that is wired to the annunciator window TAH-5042 and the solenoid valve actuator TY-5042.[5] Except for the sensor, the remainder of the circuit constitutes the process rack in the uncertainty evaluations.

- Temperature Element: Type J Thermocouple for 0-200 degrees C.
- Temperature Transmitter: HY-CAL Model CT-865-C Millivolts/Current Transmitter - calibrated to 4-20 ma for 0-200 deg C.[3]
- Current Switch: LEEDS & NORTHRUP Model 453 Alarm Unit - calibrated to activate the switch at 4 vdc (16 ma across a 250 ohms resister) increasing electrical signal corresponding to 150 degrees C evaporator pot temperature.[4]
- Interposing Relay & Panel Annunciator "EVAPORATOR POT TEMP HIGH".[4]

The high alarm circuit is calibrated for 0 to 200 degrees C pot temperature span. The temperature transmitter, in a NEMA-4 enclosure by the evaporator building 242-16F, receives a thermocouple input from the thermowell tap on the evaporator cover. The current signal output from the transmitter is routed to the current switch located at the rear of the control panel in the control room bldg. 241-18F.[6,7] The energizing contact signal from the interposing relay is connected to the annunciator window on the control panel and to the trip solenoid of the inlet steam control valve for the evaporator tube bundle.

1.1.1 Measurement Uncertainties - in % of calibrated span

Process Measurement Accuracy (PMA = 1.0 %)
A 2 degree C is assigned for the process measurement error to take into account the hot spot uncertainties influenced by uneven temperature gradiations or stratifications in the evaporator pot.

Primary Element Accuracy (PEA = 0.25 %)
The effect of thermowell to the thermocouple is assigned to be 0.5 degree C.

Sensor Calibration Accuracy (SCA = 0.5 %)
The error tolerance for the thermocouple is 0.5 % per vender device performance specifications.

Sensor Measurement & Test Equipment (SMTE = 0.5 %)
The standards lab M&TE to the field M&TE accuracy ratio will meet the IEEE Std 498-1980[1] requirements of 4:1[2]. Therefore, the accuracy of the standards lab M&TE can be ignored and the uncertainty for the field M&TE can be set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Sensor Drift (SD = 0.3 %)
The sensor stability is 0.3 % per year per vender device performance specifications.

Sensor Temperature Effect (STE = 0 %)
The ambient temperature effect is negligible.

Sensor Pressure Effect (SPE = 0 %)
The ambient static pressure has negligible effect on the sensor.

Rack Calibration Accuracy (RCA = 0.35 %)
The error tolerance for the HY-CAL transmitter is 0.35% per vendor device performance specifications.[8]

Rack Comparator Setting Accuracy (RCSA = 0.1 %)
The error tolerance for L&N current switch is 0.1 % per vendor device performance specifications.[9]

Rack Measurement & Test Equipment ($RMTE_1$ = 0.35 %, $RMTE_2$=0.1%)
The uncertainty for the field M&TE is set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy. Thus, $RMTE_1$ for HY-CAL transmitter is 0.35% and $RMTE_2$ for L & N current switch is 0.1%.

Rack Drift (RD_1= 0.3 %, RD_2=0.3%)
RD_1 for HY-CAL transmitter is 0.3% and RD_2 for L & N current switch is 0.3% per vendor device performance specifications.

Rack Temperature Effect (RTE_1 = 0.66 %, RTE_2=0.5%)
RTE_1 for HY-CAL transmitter is 0.66% and RTE_2 for L & N current switch is 0.5% per vendor device performance specifications.

harsh Environmental Allowance (EA = 0 %)
The circuit is not subject to harsh environment.

BIAS - 0 %
No known bias exists.

1.1.2 Channel Statistical Allowance

The channel statistical allowance and the measurement uncertainties for the evaporator pot high temperature alarm circuit are:

$$CSA = \sqrt{1^2 + .25^2 + (.5+.5+.3)^2 + 0 + 0 + (.35+0+.35+.3)^2 + (0+.1+.1+.3)^2 + .66^2 + .5^2} + 0 + 0$$
$$= 2.165\ \%$$

Uncertainty = 200 x (2.165 / 100) = 4.33 degrees C

The resulting CSA is 2.165 % of the calibrated span of 200 degrees C, namely, the instrument uncertainty for the high temperature alarm circuit is 4.33 degrees C.

1.1.3 Reference Document

[1] IEEE Std 498-1980, Calibration and Control of Measuring & Test Equipment Used in Nuclear Power Generation Stations.
[2] SRS Quality Assurance Manual 1Q Procedure QAP 12-1 4/1/90, Control of Measuring and Test Equipment.

SRS HLWM Procedures:
[3] #14347 Rev. 1, Verification/Calibration of HY-CAL Temperature Transmitter.
[4] #14353 Rev. 1, Verification/Calibration of L & N 453 Alarm Unit.
[5] #17028 Rev. 2, Loop Verification for 2F Evaporator Pot Temperature Loop 5042TT.

SRS Drawings:
[6] M-M6-F-3025 Rev. 0, Evaporator Instrumentation Piping Diagram.
[7] W-701091 Rev. 87, Bldg. 242-16F Evaporator Piping Diagram.

Vendor Literature:
[8] HY-CAL Engineering Manual, Thermocouple/Current Transmitter Model CT-865-C.
[9] LEEDS & NORTHRUP Manual, CENTRY 453 Alarm Unit.

1.2 Temperature Recorder Circuit

The pot temperature recorder circuit in the evaporator control room is to provide the temperature readings and stripchart recordings for the operator. The recorder circuit, referring to Fig. 1 loop diagram, consists of the temperature element TE-5042, the temperature transmitter TT-5042, and the stripchart recorder TR-5042B.[5] Except for the sensor, the remainder of the circuit constitutes the process rack in the uncertainty evaluations.

- Temperature Element: Type J Thermocouple for 0-200 degrees C.
- Temperature Transmitter: HY-CAL Model CT-865-C Millivolts/Current Transmitter - calibrated to 4-20 ma for 0-200 deg C.[3]
- Temperature Recorder: LEEDS & NORTHRUP Speedomax 430 Series - calibrated to 0-200 deg. C for 4-20 ma.[4]

The recorder circuit is calibrated for 0 to 200 degrees C pot temperature span. The temperature transmitter, in a NEMA-4 enclosure by the evaporator building 242-16F, receives a thermocouple input from the thermowell tap on the evaporator cover. The current signal output from the transmitter is routed to the stripchart recorder located on the control panel in the control room bldg. 241-18F.[6,7]

1.2.1 Measurement Uncertainties - in % of calibrated span

Process Measurement Accuracy (PMA = 1.0 %)
A 2 degree C is assigned for the process measurement error to take into account the hot spot uncertainties influenced by uneven temperature gradiations or stratifications in the evaporator pot.

Primary Element Accuracy (PEA = 0.25 %)
The effect of thermowell to the thermocouple is assigned to be 0.5 degrees C.

Sensor Calibration Accuracy (SCA = 0.5 %)
The error tolerance for the thermocouple is 0.5 % per vender device performance specifications.

Sensor Measurement & Test Equipment (SMTE = 0.5 %)
The standards lab M&TE to the field M&TE accuracy ratio will meet the IEEE Std 498-1980[1] requirements of 4:1[2]. Therefore, the accuracy of the standards lab M&TE can be ignored and the uncertainty for the field M&TE can be set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Sensor Drift (SD = 0.3 %)
The sensor stability is 0.3 % per year per vender device performance specifications.

Sensor Temperature Effect (STE = 0 %)
The ambient temperature effect is negligible.

Sensor Pressure Effect (SPE = 0 %)
The ambient static pressure has negligible effect on the sensor.

Rack Calibration Accuracy (RCA_1 = 0.35 %, RCA_2=0.7%, RCA_3=1.0%)
RCA_1 for the HY-CAL transmitter is 0.35% and RCA_2 for L & N recorder is 0.7% per vendor equipment specifications.[8,9] In addition, a 2 degree C is assigned to the chart reading error allowance RCA_3 (one half of the smallest chart scale).

Rack Comparator Setting Accuracy (RCSA = 0 %)
There is no bistable element in the recorder circuit.

Rack Measurement & Test Equipment ($RMTE_1$ = 0.35 %, $RMTE_2$=0.7%)
The uncertainty for the field M&TE is set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy. Thus, $RMTE_1$ for HY-CAL transmitter is 0.35% and $RMTE_2$ for L & N recorder is 0.7%.

Rack Drift (RD_1 = 0.3 %, RD_2=0.3%)
RD_1 for HY-CAL transmitter is 0.3% and RD_2 for L & N recorder is 0.3% per vendor device performance specifications.

Rack Temperature Effect (RTE_1 = 0.66 %, RTE_2=0.5%)
RTE_1 for HY-CAL transmitter is 0.66% and RTE_2 for L & N recorder is 0.5% per vendor device performance specifications.

harsh Environmental Allowance (EA = 0 %)
The circuit is not subject to harsh environment.

BIAS - 0 %
No known bias exists.

1.2.2 Channel Statistical Allowance

The channel statistical allowance and the measurement uncertainties for the evaporator pot temperature recorder circuit are:

$$CSA = \sqrt{1^2 + .25^2 + (.5+.5+.3)^2 + 0 + 0 + (.35+0+.35+.3)^2 + (.7+0+.7+.3)^2 + (1+0+0+0)^2 + .66^2 + .5^2} + 0 + 0$$
$$= 2.886\ \%$$

Uncertainty = 200 x (2.886 / 100) = 5.77 degrees C

The resulting CSA is 2.886 % of the calibrated span of 200 degrees C, namely, the instrument uncertainty for the temperature recorder circuit is 5.77 degrees C.

1.2.3 Reference Document

[1] IEEE Std 498-1980, Calibration and Control of Measuring & Test Equipment Used in Nuclear Power Generation Stations.
[2] SRS Quality Assurance Manual 1Q Procedure QAP 12-1 4/1/90, Control of Measuring and Test Equipment.

SRS HLWM Procedures:
[3] #14347 Rev. 1, Verification/Calibration of HY-CAL Temperature Transmitter.
[4] #14361 Rev. 1, Verification/Calibration of L & N 430 Recorder.
[5] #17028 Rev. 2, Loop Verification for 2F Evaporator Pot Temperature Loop 5042TT.

SRS Drawings:
[6] M-M6-F-3025 Rev. 0, Evaporator Instrumentation Piping Diagram.
[7] W-701091 Rev. 87, Bldg. 242-16F Evaporator Piping Diagram.

Vendor Literature:
[8] HY-CAL Engineering Manual, Thermocouple/Current Transmitter Model CT-865-C.
[9] LEEDS & NORTHRUP Manual, Model 430 Recorder.

2. CONDENSATE GAMMA MONITOR INSTRUMENTATION LOOP

2.1 High Gamma Alarm & Interlock Circuit

The high gamma alarm circuit is to alert the operator that the gamma activity in the evaporator condensate exceeds the limit setting. It also automatically triggers the diversion valve to transfer the condensate to a waste storage tank for reprocessing. The alarm circuit, referring to Fig. 2 loop diagram, consists of the scintillation detector RE-2022, the cesium discriminating amplifier & ratemeter RT-2022A along with its associated E/I converter RY-2022A, the current switch RSH-2022A, and the annunciator high alarm plate RAH-2022.[3] Except for the scintillation detector, the remainder of the circuit constitutes the process rack in the uncertainty evaluations.

- Scintillation Detector: HARSHAW/FILTROL MPF assembly with 2"x6" crystal - calibrated to 0-100 % from pre-set known solution.[7]
- Discriminating Amp & Ratemeter: HARSHAW/FILTROL NA-23, NC-22, and NR-25 - calibrated to 0-10 mv for 0-100 %.[7,15]
- Millivolt/current Transmitter: ACROMAG Model 160T - calibrated to 4-20 ma for 0-10 mv.[6]
- Current Switch: MOORE Model DCA - calibrated to 0-100 % for 4-20 ma.[5]
- Annunciator High Alarm Plate "CONDENSATE GAMMA ACTIVITY HIGH".

The alarm circuit is calibrated for 0 to 100 % of gamma activity span. The discriminating amplifier & ratemeter, in a NEMA 4 enclosure by the evaporator building 242-16F, receives the scintillation detector input from a monitor container housing on the condensate transfer pipings. The E/I converter in the same enclosure converts the ratemeter 0-10 mv output signal to 4-20 ma electric signal and is wired to the high/low current switches located in the rear of the 550B1 control panel in the control room bldg. 241-18F. The energizing contact from the interposing relay is connected to the annunciator high alarm plate on the control panel and to the diversion solenoid valve on the condensate transfer pipings.[3,8,9,15]

2.1.1 Measurement Uncertainties - in % of calibrated span

Process Measurement Accuracy (PMA = 5 %)
A 5 % error tolerance is allowed in the SRS instrumentation practice.[4]

Primary Element Accuracy (PEA = 3 %)
A 3 % error allowance is assigned for the flow disturbance effect of the detector pot arrangement to the detector readings.

Sensor Calibration Accuracy (SCA = 0.5 %)
The error tolerance is 0.5 % per vendor device performance specifications.[10,11]

Sensor Measurement & Test Equipment (SMTE = 0.5 %)
The standards lab M&TE to the field M&TE accuracy ratio will meet the IEEE Std 498-1980[1] requirements of 4:1[2]. Therefore, the accuracy of the standards lab M&TE can be ignored and the uncertainty for the field M&TE can be set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Sensor Drift (SD = 0.5 %)
The sensor stability is 0.5 % error per year per vendor device performance specifications.

Sensor Temperature Effect (STE = 0 %)
The ambient temperature has negligible effect on the sensor.

Sensor Pressure Effect (SPE = 0 %)
The static pressure has negligible effect on the sensor.

Rack Calibration Accuracy (RCA_1 = 1.6 %; RCA_2 = 0.1 %)
RCA_1 for the amp & ratemeter is 1.6 % and RCA_2 for the E/I converter is 0.1 % per vendor device performance specifications.[12,13,14,16]

Rack Comparator Setting Accuracy (RCSA = 0.1 %)
The error tolerance for the current switch is 0.1 % per vendor device performance specifications.[17]

Rack M&TE ($RMTE_1$=1.6%; $RMTE_2$=0.1%, $RMTE_3$=0.1%)
The uncertainty for the field M&TE is set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Rack Drift (RD_1=1.0 %, RD_2 = 0.1 %, RD_3=0.1%)
RD_1 for the amp & ratemeter is 1.0 %, RD_2 for the E/I converter is 0.1%, and RD_3 for the current switch is 0.1 % per vendor device performance specifications.

Rack Temperature Effect (RTE_1 = 0.5 %, RTE_2=0.3%)
RTE_1 for the ratemeter is 0.5 %, and RTE_2 for the E/I converter is 0.3 % per vendor device performance specifications.

harsh Environmental Allowance (EA = 0 %)
The circuit is not subject to harsh environment.

BIAS - 0 %
No known bias exists.

2.1.2 Channel Statistical Allowance

The channel statistical allowance and the measurement uncertainties for the condensate high gamma alarm circuit are:

$$CSA = \sqrt{5^2 + 3^2 + (.5+.5+.5)^2 + 0 + 0 + (1.6+0+1.6+1)^2 + (.1+0+.1+.1)^2 + (0+.1+.1+.1)^2 + .5^2 + .3^2 + 0 + 0}$$
$$= 7.376\ \%$$

Uncertainty = 100 x (7.376 / 100) = 7.38 %

The resulting CSA is 7.376 % of the calibrated span of 100 %, namely, the instrument uncertainty for the high gamma alarm circuit is 7.38 %.

2.1.3 Reference Document

[1] IEEE Std 498-1980, Calibration and Control of Measuring & Test Equipment Used in Nuclear Power Generation Stations.
[2] SRS Quality Assurance Manual 1Q Procedure QAP 12-1 4/1/90, Control of Measuring and Test Equipment.
[3] SRS Design Change Package J-DCP-F-93047 Rev. 0, Repair 2F Evaporator Steam Condensate Gamma Monitor.
[4] SRS Technical Report WSRC-TR-93-535 Rev.0, Evaluation of 242-H Evaporator Instrument Loop Setpoint Basis and Calibration Accuracy.

SRS HLWM Procedures:

[5] #14368 Rev 1, Verification/Calibration of MOORE Industries DCA Current Alarm.
[6] #14401 Rev 1, Calibration of the ACROMAG Series 160T Transmitter.
[7] #14487 Rev 1, Verification/Calibration of HARSHAW Scintillation Detector.

SRS Drawings:

[8] W-830425 Rev. 1, Bldg. 242-16F Radiation Monitors Loop Diagrams.
[9] M-M6-F-2929 Rev. 0, 2F Evaporator Steam System Piping Diagram.

Vendor Literature:

[10] HARSHAW/FILTROL Manual, Scintillation Detector Operations.
[11] HARSHAW/FILTROL Manual, NV-25A High Voltage Power Supply.
[12] HARSHAW/FILTROL Manual, Model NA-23 Stabilized AMP/SCA.
[13] HARSHAW/FILTROL Manual, NC-22 Single Channel Pulse Height Analyzer.
[14] HARSHAW/FILTROL Manual, NR-25 Logarithmic-Linear Ratemeter.
[15] HARSHAW Dwg 62534 Rev 0, Project S-4171 SRP Block Diagram.
[16] ACROMAG Manual, Model 160T Millivolt/Current Transmitter.
[17] MOORE Industries Manual, Direct Current Alarm Unit Operations #192-701 F.

2.2 Gamma Monitor Failure Alarm & Interlock Circuit

The gamma monitor failure alarm circuit is to alert the operator that the gamma monitor has failed and to trigger the diversion valve to transfer the condensate to a waste storage tank for reprocessing. The alarm circuit, referring to Fig. 2 loop diagram, consists of the scintillation detector RE-2022, the americium discriminating amplifier & ratemeter RT-2022B along with its associated E/I converter RY-2022B, the current switch RSH/L-2022B, and the annunciator hi/lo alarm plate RAHL-2022.[3] Except for the scintillation detector, the remainder of the circuit constitutes the process rack in the uncertainty evaluations.

- Scintillation Detector: HARSHAW/FILTROL MPF with 2"x6" crystal - calibrated to 0-100 % from pre-set known solution.[7]
- Discriminating Amp & Ratemeter: HARSHAW/FILTROL NA-23, and NR-25 - calibrated to 0-10 mv for 0-100 %.[7,15]
- Millivolt/current Transmitter: ACROMAG Model 160T - calibrated to 4-20 ma for 0-10 mv.[6]
- Current Switch: MOORE Model DCA - calibrated to 0-100 % for 4-20 ma.[5]
- Annunciator Alarm Plate "CONDENSATE GAMMA MONITOR TROUBLE".

The alarm circuit is calibrated for 0 to 100 % of gamma activity span. The discriminating amplifier & ratemeter, in a NEMA 4 enclosure by the evaporator building 242-16F, receives the scintillation detector input from a monitor container housing on the condensate transfer pipings. The E/I converter in the same enclosure converts the ratemeter 0-10 mv output signal to 4-20 ma electric signal and is wired to the high/low current switches located in the rear of the 550B1 control panel in the control room bldg. 241-18F. The energizing contact from the interposing relay is connected to the annunciator hi/lo alarm plate on the control panel and to the diversion solenoid valve on the condensate transfer pipings.[3,8,9,15]

2.2.1 Measurement Uncertainties - in % of calibrated span

Process Measurement Accuracy (PMA = 5 %)
A 5 % error tolerance is allowed in the SRS instrumentation practice.[4]

Primary Element Accuracy (PEA = 3 %)
A 3 % error allowance is assigned for the flow disturbance effect of the detector pot arrangement to the detector readings.

Sensor Calibration Accuracy (SCA = 0.5 %)
The error tolerance is 0.5 % per vendor device performance specifications.[10,11]

Sensor Measurement & Test Equipment (SMTE = 0.5 %)
The standards lab M&TE to the field M&TE accuracy ratio will meet the IEEE Std 498-1980[1] requirements of 4:1[2]. Therefore, the accuracy of the standards lab M&TE can be ignored and the uncertainty for the field M&TE can be set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Sensor Drift (SD = 0.5 %)
The sensor stability is 0.5 % error per year per vendor device performance specifications.

Sensor Temperature Effect (STE = 0 %)
The ambient temperature has negligible effect on the sensor.

Sensor Pressure Effect (SPE = 0 %)
The static pressure has negligible effect on the sensor.

Rack Calibration Accuracy (RCA_1 = 1.6 %; RCA_2 = 0.1 %)
RCA_1 for the amp & ratemeter is 1.6 % and RCA_2 for the E/I converter is 0.1 % per vendor device performance specifications.[12,13,14,16]

Rack Comparator Setting Accuracy (RCSA = 0.1 %)
The error tolerance for the current switch is 0.1 % per vendor device performance specifications.[17]

Rack M&TE ($RMTE_1$=1.6%; $RMTE_2$=0.1%, $RMTE_3$=0.1%)
The uncertainty for the field M&TE is set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Rack Drift (RD_1=1.0 %, RD_2 = 0.1 %, RD_3=0.1%)
RD_1 for the amp & ratemeter is 1.0 %, RD_2 for the E/I converter is 0.1%, and RD_3 for the current switch is 0.1 % per vendor device performance specifications.

Rack Temperature Effect (RTE_1 = 0.5 %, RTE_2=0.3%)
RTE_1 for the ratemeter is 0.5 %, and RTE_2 for the E/I converter is 0.3 % per vendor device performance specifications.

harsh Environmental Allowance (EA = 0 %)
The circuit is not subject to harsh environment.

BIAS - 0 %
No known bias exists.

2.2.2 Channel Statistical Allowance

The channel statistical allowance and the measurement uncertainties for the condensate gamma monitor failure alarm circuit are:

$$CSA = \sqrt{.5^2 + .3^2 + (.5+.5+.5)^2 + 0 + 0 + (1.6+0+1.6+1)^2 + (.1+0+.1+.1)^2 + (0+.1+.1+.1)^2 + .5^2 + .3^2} + 0 + 0$$
$$= 7.376\ \%$$

Uncertainty = 100 x (7.376 / 100) = 7.38 %

The resulting CSA is 7.376 % of the calibrated span of 100 %, namely, the instrument uncertainty for the gamma monitor failure alarm circuit is 7.38 %.

2.2.3 Reference Document

[1] IEEE Std 498-1980, Calibration and Control of Measuring & Test Equipment Used in Nuclear Power Generation Stations.
[2] SRS Quality Assurance Manual 1Q Procedure QAP 12-1 4/1/90, Control of Measuring and Test Equipment.
[3] SRS Design Change Package J-DCP-F-93047 Rev. 0, Repair 2F Evaporator Steam Condensate Gamma Monitor.
[4] SRS Technical Report WSRC-TR-93-535 Rev.0, Evaluation of 242-H Evaporator Instrument Loop Setpoint Basis and Calibration Accuracy.

SRS HLWM Procedures:
[5] #14368 Rev 1, Verification/Calibration of MOORE Industries DCA Current Alarm.
[6] #14401 Rev 1, Calibration of the ACROMAG Series 160T Transmitter.
[7] #14487 Rev 1, Verification/Calibration of HARSHAW Scintillation Detector.

SRS Drawings:
[8] W-830425 Rev. 1, Bldg. 242-16F Radiation Monitors Loop Diagrams.
[9] M-M6-F-2929 Rev. 0, 2F Evaporator Steam System Piping Diagram.

Vendor Literature:
[10] HARSHAW/FILTROL Manual, Scintillation Detector Operations.
[11] HARSHAW/FILTROL Manual, NV-25A High Voltage Power Supply.
[12] HARSHAW/FILTROL Manual, Model NA-23 Stabilized AMP/SCA.
[13] HARSHAW/FILTROL Manual, Model NM-4 Monitor.
[14] HARSHAW/FILTROL Manual, NR-25 Logarithmic-Linear Ratemeter.
[15] HARSHAW Dwg 62534 Rev 0, Project S-4171 SRP Block Diagram.
[16] ACROMAG Manual, Model 160T Millivolt/Current Transmitter.
[17] MOORE Industries Manual, Direct Current Alarm Unit Operations #192-701 F.

2.3 Cesium Activity Recorder Circuit

The condensate cesium activity recorder circuit is to provide the cesium activity readings and stripchart recording in the control room bldg. 241-18F. The recorder circuit, referring to Fig. 2 loop diagram, consists of the scintillation detector RE-2022, the cesium discriminating amplifier & ratemeter RT-2022A along with its associated E/I converter RY-2022A, and the stripchart recorder RR-2022.[3] Except for the scintillation detector, the remainder of the circuit constitutes the process rack in the uncertainty evaluations.

- Scintillation Detector: HARSHAW/FILTROL MPF with 2"x6" crystal - calibrated to 0-100 % from pre-set known solution.[7]
- Discriminating Amp & Ratemeter: HARSHAW/FILTROL NA-23, NC-22, and NR-25 - calibrated to 0-10 mv for 0-100 %.[7,15]
- Millivolt/current Transmitter: ACROMAG Model 160T - calibrated to 4-20 ma for 0-10 mv.[6]
- Stripchart Recorder: L & N Speedomax 1000 - calibrated to 0-100 % for 4-20 ma.[5]

The recorder circuit is calibrated for 0 to 100 % of gamma activity span. The discriminating amplifier & ratemeter, in a NEMA 4 enclosure by the evaporator building 242-16F, receives the scintillation detector input from a monitor container housing on the condensate transfer pipings. The E/I converter in the same enclosure converts the ratemeter 0-10 mv output signal to 4-20 ma electric signal and is wired to the stripchart recorder located on the 550B1 control panel in the control room bldg. 241-18F.[3,8,9,15]

2.3.1 Measurement Uncertainties - in % of calibrated span

Process Measurement Accuracy (PMA = 5 %)
A 5 % error tolerance is allowed in the SRS instrumentation practice.[4]

Primary Element Accuracy (PEA = 3 %)
A 3 % error allowance is assigned for the flow disturbance effect of the detector pot arrangement to the detector readings.

Sensor Calibration Accuracy (SCA = 0.5 %)
The error tolerance is 0.5 % per vendor device performance specifications.[10,11]

Sensor Measurement & Test Equipment (SMTE = 0.5 %)
The standards lab M&TE to the field M&TE accuracy ratio will meet the IEEE Std 498-1980[1] requirements of 4:1[2]. Therefore, the accuracy of the standards lab M&TE can be ignored and the uncertainty for the field M&TE can be set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Sensor Drift (SD = 0.5 %)
The sensor stability is 0.5 % error per year per vendor device performance specifications.

Sensor Temperature Effect (STE = 0 %)
The ambient temperature has negligible effect on the sensor.

Sensor Pressure Effect (SPE = 0 %)
The static pressure has negligible effect on the sensor.

Rack Calibration Accuracy (RCA_1 = 1.6 %; RCA_2 = 0.1 %, RCA_3=0.5 %)
RCA_1 for the amp & ratemeter is 1.6 %, RCA_2 for the E/I converter is 0.1 %, and RCA_3 for the recorder is 0.5 % per vendor device performance specifications.[12,13,14,16] In addition, a 1 % chart reading error allowance is assigned to the recorder (one half of the smallest chart scale).

Rack Comparator Setting Accuracy (RCSA = 0 %)
There is no bistable element in the recorder circuit.

Rack M&TE ($RMTE_1$=1.6%; $RMTE_2$=0.1%, $RMTE_3$=0.5%)
The uncertainty for the field M&TE is set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Rack Drift (RD_1=1.0 %, RD_2 = 0.1 %, RD_3=0.3%)
RD_1 for the amp & ratemeter is 1.0 %, RD_2 for the E/I converter is 0.1%, and RD_3 for the recorder is 0.3 % per vendor device performance specifications.

Rack Temperature Effect (RTE_1 = 0.5 %, RTE_2=0.3%, RTE_3=0.5%)
RTE_1 for the ratemeter is 0.5 %, RTE_2 for the E/I converter is 0.3 %, and RTE_3 is 0.5 % per vendor device performance specifications.

harsh Environmental Allowance (EA = 0 %)
The circuit is not subject to harsh environment.

BIAS - 0 %
No known bias exists.

2.3.2 Channel Statistical Allowance

The channel statistical allowance and the measurement uncertainties for the condensate cesium activity recorder circuit are:

$$CSA = \sqrt{5^2 + 3^2 + (5+5+5)^2 + 0 + 0 + (1.6+0+1.6+1)^2 + (1+0+1+1)^2 + (5+0+5+3)^2 + 1^2 + 5^2 + 3^2 + 5^2 + 0 + 0}$$
$$= 7.567\ \%$$

Uncertainty = 100 x (7.567 / 100) = 7.57 %

The resulting CSA is 7.567 % of the calibrated span of 100 %, namely, the instrument uncertainty for the cesium activity recorder circuit is 7.57 %.

2.3.3 Reference Document

[1] IEEE Std 498-1980, Calibration and Control of Measuring & Test Equipment Used in Nuclear Power Generation Stations.
[2] SRS Quality Assurance Manual 1Q Procedure QAP 12-1 4/1/90, Control of Measuring and Test Equipment.
[3] SRS Design Change Package J-DCP-F-93047 Rev. 0, Repair 2F Evaporator Steam Condensate Gamma Monitor.
[4] SRS Technical Report WSRC-TR-93-535 Rev.0, Evaluation of 242-H Evaporator Instrument Loop Setpoint Basis and Calibration Accuracy.

SRS HLWM Procedures:
[5] #14401 Rev 1, Calibration of the ACROMAG Series 160T Transmitter.
[6] #14466 Rev 0, Verification/Calibration of Speedomax 1000 Series Recorder.
[7] #14487 Rev 1, Verification/Calibration of HARSHAW Scintillation Detector.

SRS Drawings:
[8] W-830425 Rev. 1, Bldg. 242-16F Radiation Monitors Loop Diagrams.
[9] M-M6-F-2929 Rev. 0, 2F Evaporator Steam System Piping Diagram.

Vendor Literature:
[10] HARSHAW/FILTROL Manual (BPF 216611), Scintillation Detector Operations.
[11] HARSHAW/FILTROL Manual, NV-25A High Voltage Power Supply.
[12] HARSHAW/FILTROL Manual, Model NA-23 Stabilized AMP/SCA.
[13] HARSHAW/FILTROL Manual, NC-22 Single Channel Pulse Height Analyzer.
[14] HARSHAW/FILTROL Manual, NR-25 Logarithmic-Linear Ratemeter.
[15] HARSHAW Dwg 62534 Rev 0, Project S-4171 SRP Block Diagram.
[16] ACROMAG Manual, Model 160T Millivolt/Current Transmitter.
[17] LEEDS & NORTHRUP Manual 277871, SPEEDOMAX 1000 Recorders.

2.4 Americium Activity Recorder Circuit

The condensate americium activity recorder circuit is to provide the americium activity readings and stripchart recording in the control room bldg. 241-18F. The recorder circuit, referring to Fig. 2 loop diagram, consists of the scintillation detector RE-2022, the americium discriminating amplifier & ratemeter RT-2022B along with its associated E/I converter RY-2022B, and the stripchart recorder RR-2022.[3] Except for the scintillation detector, the remainder of the circuit constitutes the process rack in the uncertainty evaluations.

- Scintillation Detector: HARSHAW/FILTROL MPF with 2"x6" crystal - calibrated to 0-100 % from pre-set known solution.[7]
- Discriminating Amp & Ratemeter: HARSHAW/FILTROL NA-23 and NR-25 - calibrated to 0-10 mv for 0-100 %.[7,15]
- Millivolt/current Transmitter: ACROMAG Model 160T - calibrated to 4-20 ma for 0-10 mv.[6]
- Stripchart Recorder: L & N Speedomax 1000 - calibrated to 0-100 % for 4-20 ma.[5]

The recorder circuit is calibrated for 0 to 100 % of gamma activity span. The discriminating amplifier & ratemeter, in a NEMA 4 enclosure by the evaporator building 242-16F, receives the scintillation detector input from a monitor container housing on the condensate transfer pipings. The E/I converter in the same enclosure converts the ratemeter 0-10 mv output signal to 4-20 ma electric signal and is wired to the stripchart recorder located on the 550B1 control panel in the control room bldg. 241-18F.[3,8,9,15]

2.4.1 Measurement Uncertainties - in % of calibrated span

Process Measurement Accuracy (PMA = 5 %)
A 5 % error tolerance is allowed in the SRS instrumentation practice.[4]

Primary Element Accuracy (PEA = 3 %)
A 3 % error allowance is assigned for the flow disturbance effect of the detector pot arrangement to the detector readings.

Sensor Calibration Accuracy (SCA = 0.5 %)
The error tolerance is 0.5 % per vendor device performance specifications.[10,11]

Sensor Measurement & Test Equipment (SMTE = 0.5 %)
The standards lab M&TE to the field M&TE accuracy ratio will meet the IEEE Std 498-1980[1] requirements of 4:1[2]. Therefore, the accuracy of the standards lab M&TE can be ignored and the uncertainty for the field M&TE can be set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Sensor Drift (SD = 0.5 %)
The sensor stability is 0.5 % error per year per vendor device performance specifications.

Sensor Temperature Effect (STE = 0 %)
The ambient temperature has negligible effect on the sensor.

Sensor Pressure Effect (SPE = 0 %)
The static pressure has negligible effect on the sensor.

Rack Calibration Accuracy (RCA_1 = 1.6 %; RCA_2 = 0.1 %, RCA_3=0.5 %)
RCA_1 for the amp & ratemeter is 1.6 %, RCA_2 for the E/I converter is 0.1 %, and RCA_3 for the recorder is 0.5 % per vendor device performance specifications.[12,13,14,16] In addition, a 1 % chart reading error allowance is assigned to the recorder (one half of the smallest chart scale).

Rack Comparator Setting Accuracy (RCSA = 0 %)
There is no bistable element in the recorder circuit.

Rack M&TE ($RMTE_1$=1.6%; $RMTE_2$=0.1%, $RMTE_3$=0.5%)
The uncertainty for the field M&TE is set based on the 1:1 ratio of the field M&TE to process instrument calibration accuracy.

Rack Drift (RD_1=1.0 %, RD_2 = 0.1 %, RD_3=0.3%)
RD_1 for the amp & ratemeter is 1.0 %, RD_2 for the E/I converter is 0.1%, and RD_3 for the recorder is 0.3 % per vendor device performance specifications.

Rack Temperature Effect (RTE_1 = 0.5 %, RTE_2=0.3%, RTE_3=0.5%)
RTE_1 for the ratemeter is 0.5 %, RTE_2 for the E/I converter is 0.3 %, and RTE_3 is 0.5 % per vendor device performance specifications.

harsh Environmental Allowance (EA = 0 %)
The circuit is not subject to harsh environment.

BIAS - 0 %
No known bias exists.

2.4.2 Channel Statistical Allowance

The channel statistical allowance and the measurement uncertainties for the condensate americium activity recorder circuit are:

$$CSA = \sqrt{5^2 + 3^2 + (.5+.5+.5)^2 + 0 + 0 + (1.6+0+1.6+1)^2 + (.1+0+.1+.1)^2 + (.5+0+.5+.3)^2 + 1^2 + .5^2 + .3^2 + .5^2 + 0 + 0}$$
$$= 7.567\ \%$$

Uncertainty = 100 x (7.567 / 100) = 7.57 %

The resulting CSA is 7.567 % of the calibrated span of 100 %, namely, the instrument uncertainty for the americium activity recorder circuit is 7.57 %.

2.4.3 Reference Document

[1] IEEE Std 498-1980, Calibration and Control of Measuring & Test Equipment Used in Nuclear Power Generation Stations.
[2] SRS Quality Assurance Manual 1Q Procedure QAP 12-1 4/1/90, Control of Measuring and Test Equipment.
[3] SRS Design Change Package J-DCP-F-93047 Rev. 0, Repair 2F Evaporator Steam Condensate Gamma Monitor.
[4] SRS Technical Report WSRC-TR-93-535 Rev.0, Evaluation of 242-H Evaporator Instrument Loop Setpoint Basis and Calibration Accuracy.

SRS HLWM Procedures:
[5] #14401 Rev 1, Calibration of the ACROMAG Series 160T Transmitter.
[6] #14466 Rev 0, Verification/Calibration of Speedomax 1000 Series Recorder.
[7] #14487 Rev 1, Verification/Calibration of HARSHAW Scintillation Detector.

SRS Drawings:
[8] W-830425 Rev. 1, Bldg. 242-16F Radiation Monitors Loop Diagrams.
[9] M-M6-F-2929 Rev. 0, 2F Evaporator Steam System Piping Diagram.

Vendor Literature:
[10] HARSHAW/FILTROL Manual (BPF 216611), Scintillation Detector Operations.
[11] HARSHAW/FILTROL Manual, NV-25A High Voltage Power Supply.
[12] HARSHAW/FILTROL Manual, Model NA-23 Stabilized AMP/SCA.
[13] HARSHAW/FILTROL Manual, Model NM-4 Monitor.
[14] HARSHAW/FILTROL Manual, NR-25 Logarithmic-Linear Ratemeter.
[15] HARSHAW Dwg 62534 Rev 0, Project S-4171 SRP Block Diagram.
[16] ACROMAG Manual, Model 160T Millivolt/Current Transmitter.
[17] LEEDS & NORTHRUP Manual 277871, SPEEDOMAX 1000 Recorders.