QA Record

ORIGINAL

TVAN CALCULATION COVERSHEET

Title DEMONSTRATED ACCURACY CALCULATION 1,2-RE-90-130/131	Plant SQN	Unit 1,2	Page

Preparing Organization NE-I&C	Key Nouns (For EDM) I&C, INSTR, CALIBRATION, SETPOINT, ACCURACY		
Calculation Identifier 1,2 -RE-90-130/131	Each time these calculations are issued, preparer must ensure that the original (R0) RIMS/EDM accession number is filled in.		
	Rev	(for EDM use)	EDM Accession Number
Applicable Design Document(s) SQN-DC-V-9.0	R0		B87 000607 019
	R1		
UNID System(s) 90	R2		
	R3		

	R0	R	R	R		
					Quality Related?	Yes ☒ No ☐
DCN, EDC, NA	NA				Safety related? If yes, mark Quality Related yes	Yes ☒ No ☐
Prepared	Lm Pryby					
Checked	E. H. Turner				These calculations contain unverified assumption(s) that must be verified later?	Yes ☐ No ☒
Design Verified	E. H. Turner				These calculations contain special requirements and/or limiting conditions?	Yes ☐ No ☒
Approved	GRBell for J.H. Rinne				These calculations contain a design output attachment?	Yes ☐ No ☒
Approval Date	6/7/2000				Calculation Classification	E
SAR Affected?	Yes ☐ No ☒	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Microfiche generated	Yes ☐ No ☒
Revision applicability	Entire calc ☒	Entire calc ☐ Selected pgs ☐	Entire calc ☐ Selected pgs ☐	Entire calc ☐ Selected pgs ☐	Number	

Statement of Problem:
Determine the accuracy of the subject instrument loop(s) and demonstrate that the accuracy is adequate for the intended purpose. Primary elements are located in a Harsh environment. Subject devices are not part of PAM.

Abstract
Calculations were performed to determine the accuracy of the subject instrument loops. The determined accuracies were compared to the required accuracies, setpoints, safety limits an/or operating limits and the accuracy for the loops listed below were demonstrated to be acceptable for their intended function.

1,2-R-90-130 & 1,2-R-90-131

☒ Microfilm and return calculation to Calculation Library. Address: OPS-1

☐ Microfilm and return calculation to:

☐ Microfilm and destroy.

TVAN CALCULATION RECORD OF REVISION		
Title DEMONSTRATED ACCURACY CALCULATION 1,2-RE-90-130/131		
Revision No.	DESCRIPTION OF REVISION	Date Approved
0	Initial issue. The loops evaluated by this calculation were previously removed from the scope of calculation 0-RE-90-106A. This calculation supports resolution of SQ971511PER and defines an Allowable Value for input to proposed Tech Spec Change 98-03. Legibility Evaluated and Accepted for Issue: GRBell for J. H. Rinne Date 6/7/2006 This revision contains 115 pages.	

TVAN CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

Calculation No.	Revision
1,2-RE-90-130/131	0

Method of design verification (independent review) used:

1. Design Review ☒
2. Alternate Calculation ☐
3. Qualification Test ☐

Comments:

All comments between myself and the preparer have been resolved. This calculation revision is found to be in compliance with NEDP-2. The FSAR compliance review has been performed as denoted by incorporation of the appropriate form. Additionally, the methodology utilized in revision 0 of this calculation is commensurate with the guidelines provided in Branch Technical Instruction EEB-TI-28, R5.

Prepared: E. H. Turner Date: 6/5/00

BRANCH/PROJECT IDENTIFIER 1,2-RE-90-130/131, R0
DEMONSTRATED ACCURACY CALCULATION

FSAR COMPLIANCE REVIEW

This review has been performed to verify FSAR compliance. The following FSAR sections have been reviewed:

5.2.7.1 and 12.2.4

Tech Specs 3/4.3.1, 3/4.3.3, and 3/4.4.6

Results of review:

The SAR is not impacted by issuance of this calculation.

Note: Tech Spec Table 3.3-6 specifies a setpoint value of $\leq 8.5 \times 10^{-3}$ uCi/cc for control room isolation. This setpoint is conservative with respect to the results of this calculation. Additionally, this calculation also defines an Allowable Value. The existing setpoint of $\leq 8.5 \times 10^{-3}$ uCi/cc in Table 3.3-6 could be replaced with the Allowable Value via Tech Spec Change 98-03..

Prepared: [signature] Date: 5/30/00

Checked: E.H. Turner Date: 6/2/00

TABLE OF CONTENTS

P U R P O S E

The purpose of this calculation is a) to determine the accuracy of the instrumentation covered by this calculation, and b) to demonstrate that the instrumentation is sufficiently accurate to perform its intended function without safety or operational limits being exceeded.

A S S U M P T I O N S

✓ This calculation contains no assumptions.

______ The following assumptions were used in the performance of this calculation. These assumptions require further analysis. This calculation may require revision if the assumptions below are shown to be invalid.

R E Q U I R E M E N T S

#1 A Digital Volt Meter shall be used for calibration of the output device.

#2 M & TE accuracy shall be better than or equal to one (1) times the accuracy of the device being calibrated.

#3 The calibration cycle shall not exceed 18 months plus an allowable 25% extension (22.5 months).

S P E C I A L R E Q U I R E M E N T S

NONE

L I M I T I N G C O N D I T I O N S

NONE

SOURCE OF DESIGN INPUT INFORMATION (REFERENCES)

REF#	ATT#	REFERENCE (RIMS#)
1	-	Calculation SQNAPS3-100 (R12), "Demonstrated range for Sequoyah Nuclear Plant Radiation Monitors"
2	-	Design Criteria SQN-DC-V-21.0 (R13), "Environmental Design"
3	-	TVA Drawings: 1-45N1620-1 (R4), 2-45N2620-3 (R3), 1,2-47W605-1 (R10), 1-47W600-106 (R3), 2-47W600-106 (R0)
4	-	Calculation SQN-OSG7-0033 (R13), "Radiation Monitoring System (90) 10CFR50.49 Category and Operating Times"
5	-	General Atomic Manual, E-115-188 for RP-30.
6	-	General Atomic Manual, E-199-313 for RD-32.
7	1	Detectors: Historical Calibration Data
8	2-11	Monitoring Signal Conditioning Components: Historical Calibration data
9	12	Calculation SQNAPS3-116, R4, "Tech Spec Setpoints for Containment Monitors Rm-90-106/112 and RM-90-130/131"
10	-	Master Equipment List (MEL)
11	-	Branch Technical Instruction EEB-TI-28, R5
12	13	Statistical Analysis
13	14	Letter from Noel Seefeldt Representative for General Atomics/Sorrento 4-16-90 (B26900511900)
14	15	Calibration Report Models RD-32-05 and RD-32-08 Offline Beta Detectors
15	16	Operation and Maintenance Manual for Radiation Analyzer Readout Module RP-30
16	-	SQN TI-18, Radiation Monitoring
17	17	Letter to W. S. Raughley, TVA from Noel A. Seefeldt/Don Peat 3-16-90 (B26900330903)
18	-	General Atomic Manual, E-199-313, Seismic Test Report
19	-	Design Criteria SQN-DC-V-9.0 (R13), Radiation Monitoring
20	18	Calculation SQNEQ-EM-101, R7, "Essentially Mild (EM) Documentation for EL 690 Rooms A6 and A19"

A) DEFINITIONS & ABBREVIATIONS

Desired Value: The value of the process variable which is considered desirable for the optimum performance of the instrument loop.

As Found Value: The value of the process variable as read and recorded by the field technician when he went to the device to perform check/calibration of the device.

As Left Value: The value of the process variable read and recorded by the technician at the time when he has completed his check/calibration of the device.

As Found Deviation Percent: The percentage of deviation of the "as found value" and "the desired value".

As Left Deviation Percent: The percentage of deviation of the "as left value" and "the desired value".

As Left As Found Deviation Percent: The deviation in percent between the last calibration "as left deviation percent value" and the next calibration "as found deviation percent value".

Aa	ACCIDENT ACCURACY-ACCURACY OF A DEVICE IN A HARSH ENVIRONMENT CAUSED BY AN ACCIDENT
Aas	COMBINED ACCIDENT AND SEISMIC ACCURACY
Ab	ACCEPTANCE BAND - THE RANGE OF VALUES AROUND THE CORRECT VALUE DETERMINED TO BE ACCEPTABLE WITHOUT RECALIBRATION
AB	AUXILIARY BOILER LINE BREAK
AF	AFW PUMP TURBINE STEAM SUPPLY LINE BREAK
An	NORMAL ACCURACY - ACCURACY OF A DEVICE LOCATED IN AN ENVIRONMENT NOT AFFECTED BY AN ACCIDENT OR PRIOR TO AN ACCIDENT
Anf	CALIBRATION ACCURACY (MEASURABLE INSTRUMENT ERRORS AT TIME OF CALIBRATION)
As	POST SEISMIC ACCURACY
AV	ALLOWABLE VALUE=SAFETY LIMIT/REQUIRED ACCURACY MINUS NON-MEASUREABLES; USED FOR THE PURPOSE OF DETERMINING REPORTABILITY ONLY.
CFM	CUBIC FEET PER MINUTE

A) DEFINITIONS & ABBREVIATIONS

CPM	COUNTS PER MINUTE
CV	CVCS LETDOWN LINE BREAK
De	DRIFT ACCURACY
Ebs	ERROR DUE TO BI-STABLE SET POINT VOLTAGE INACCURACY
Ebsc	ERROR DUE TO BI-STABLE CALIBRATION INACCURACY
Ect	ERROR DUE TO CURRENT TRANSMISSION
Eed	ERROR DUE TO ENERGY DEPENDENCE INACCURACY
Efa	FIELD ALIGNMENT ERROR
Efr	ERROR DUE TO FLOW RATE INACCURACY
Eip	ERROR DUE TO IMPRECISION INACCURACY
Encr	NET COUNT RATE ERROR
Epc	PRIMARY CALIBRATION ERROR
Epo	ERROR DUE TO SAMPLE LINE PLATE OUT LOSSES
Ese	SEISMIC ERROR
HELB	HIGH ENERGY LINE BREAK
IAD	INTEGRATED ACCIDENT DOSE
ICRe	INPUT TEST INSTRUMENT READING INACCURACY
ICTe	INPUT TEST INSTRUMENT CALIBRATION INACCURACY
INDRe	INDICATOR READING ERROR
IRe	INACCURACY DUE TO CABLE LEAKAGE
L	LOSS OF COOLANT ACCIDENT
M	MARGIN - THE DIFFERENCE BETWEEN THE SAFETY LIMIT/OPERATING LIMIT AND THE NORMAL/ACCIDENT ACCURACY (Mn = NORAL MARGIN Ma = ACCIDENT MARGIN
mR/Hr	MILLIREM PER HOUR

A) DEFINITIONS & ABBREVIATIONS

N/A	NOT APPLICABLE
NCR	NET COUNT RATE
OCRe	OUTPUT TEST EQUIPMENT READING INACCURACY
OCTe	OUTPUT TEST INSTRUMENT CALIBRATION INACCURACY
PRCSe	PROCESS UNCERTAINTY
PSEe	INACCURACY DUE TO POWER SUPPLY VARIATIONS
PV	PROCESS VALUE (ACTUAL)
RADe	INACCURACY TO DUE TO RADIATION EXPOSURE
Re	REPEATABILITY INACCURACY
RH	RHR LINE BREAK
RNDe	NORMAL RADIATION DOSE BETWEEN CALIBRATION
RPT	RESPONSE TIME
Se	INACCURACY FOLLOWING A SEISMIC EVENT
SECu	SPAN ERROR CORRECTION UNCERTAINTY
SL	SAFETY LIMIT
SP	SETPOINT
SPEe	ZERO ERROR DUE TO EFFECTS OF OPERATING PRESSURE
TAe	TEMPERATURE EFFECT AT ACCIDENT CONDITIONS
TID	TOTAL 40 TEARS INTEGRATED DOSE
TNe	TEMPERATURE EFFECT IN THE MAXIMUM/NINIMUM ABNORMAL TEMPERATURE RANGES
TPRe	TEST POINT RESISTOR ERROR
WLe	WATERLEG UNCERTAINTY
WLHP	WATERLEG HIGH POINT
WLLP	WATERLEG LOW POINT

D E S I G N I N P U T D A T A

B) LOOP COMPONENT LIST

LOOP ID#	COMPONENT ID#
1,2-R-90-130	0-RE-90-130
	0-RM-90-130A
	0-RM-90-130B
	0-RI-90-130
1,2-R-90-131	0-RE-90-131
	0-RM-90-131A
	0-RM-90-131B
	0-RI-90-131

DESIGN INPUT DATA

C) LOOP FUNCTION

CONTAINMENT PURGE AIR EXHAUST MONITORS (1,2-R-90-130 & 131)

These loops are used to monitor gross radioactivity of the air in the containment building purge air exhaust. When either of these redundant monitors detect a radiation level in the purge air exhaust duct in excess of the setpoint, the purge duct system will be automatically isolated to stop discharge of containment atmosphere through the shield building vent (Reference 19).

C) LOOP REQUIREMENTS AND LIMITS

RESPONSE TIME: The electronic field equipment (RE & RM) responds rapidly to Radioactivity level changes, therefore, in comparison to Operator interface the response time for this loop is negligible. This loop performs both an indicating function (RI) and a control function (purge system isolation). Therefore, the response time of the entire radiation loop is not a concern.

SAFETY LIMIT (Purge Duct System Isolation):

LWR CNTMT PURGE 1.96 X 10^6 CPM (REFERENCE 9)
UPR CNTMT PURGE 1.58 X 10^5 CPM (REFERENCE 9)

INDICATED RANGE: 10^1 to 10^7 CPM.

SETPOINT (BISTABLE):

Radiation monitoring setpoints will vary over the fuel cycle of the plant, however the error values will be given as constant and will not vary based on the setpoint. The setpoint for this loop is controlled by Chemistry but must be maintained ≤ 8.5 x 10^{-3} uCi/cc (1.380 x 10^4 cpm per reference 9) for compliance with the Tech Spec. This is conservative based on the results of this calculation.

However, this calculation defines an Allowable Value that could replace the setpoint of ≤ 8.5 x 10^{-3} uCi/cc defined in Tech Spec table 3.3-6 via Tech Spec Change 98-03.

DESIGN INPUT DATA

D) COMPONENT DATA

VALID FOR DEVICES IDENTIFIED ON SHEET(S):8

COMPONENT: 1,2-RE-90-130&131 1,2-RM-90-130B&131B CONTRACT#: 92759 REFERENCE#: 6

MANUFACTURER/MODEL: General Atomic RD-32 Detector/Pre-Amp REFERENCE#: 6

INPUT RANGE & UNITS: * NOTE#: * REFERENCE#: 1

OUTPUT RANGE & UNITS: 10^1 TO 10^7 CPM NOTE#: - REFERENCE#: 6

OVERRANGE LIMIT: N/A NOTE#: - REFERENCE#: -

CALIBRATED SPAN: 10^1 TO 10^7 CPM NOTE#: - REFERENCE#: 6

ROOM#/ PANEL#: Penetration Rm (A6,U1;A19,U2) NOTE#: - REFERENCE#: 2

ELEVATION/COORDINATE: 690/UA1(U1), UA15(U2) NOTE#: - REFERENCE#: 3

MIN/MAX ABNORMAL TEMP: 50°F / 110°F NOTE#: - REFERENCE#: 2

ACCIDENT TEMPERATURE: 111°F NOTE#: - REFERENCE#: 20

RADIATION TID (RAD): 1.6×10^4 NOTE#: - REFERENCE#: 20

RADIATION IAD (RAD): 2.85×10^3 NOTE#: - REFERENCE#: 20

INSTRUMENT TAP INFORMATION REFERENCE #: N/A

WLHP TAP ELEVATION: N/A WLHP CONDENSING POT ELEVATION: N/A

WLLP TAP ELEVATION: N/A WLLP CONDENSING POT ELEVATION: N/A

EVENT/CATEGORY/OPERATING TIME: Mild Environment NOTE#: - REFERENCE#: 4,20

L	A	5 min
RH/A	C	N/A
CV/A	C	N/A
AF	C	N/A
AB	C	N/A

* Range in µCi/cc depends on the specific isotope being monitored (See Reference 1).

DESIGN INPUT DATA

D) COMPONENT DATA

VALID FOR DEVICES IDENTIFIED ON SHEET(S):10

COMPONENT: 1,2-RM-90-130A&131A 1,2-RI-90-130&131 CONTRACT#: 92759 REFERENCE#: 5

MANUFACTURER/MODEL: General Atomic RP-30 REFERENCE#: 10

INPUT RANGE & UNITS: 10^1 to 10^7 CPM NOTE#: - REFERENCE#: 5

OUTPUT RANGE & UNITS: 10^1 to 10^7 CPM NOTE#: - REFERENCE#: 5

OVERRANGE LIMIT: N/A NOTE#: - REFERENCE#: -

CALIBRATED SPAN: 10^1 to 10^7 CPM NOTE#: - REFERENCE#: 5

ROOM#/PANEL#: Penetration Rm(A6,U1;A19,U2)/690' NOTE#: - REFERENCE#: 2

ELEVATION/COORDINATE: 690' / UA1(U1),UA15(U2) NOTE#: - REFERENCE#: 3

MIN/MAX ABNORMAL TEMP: 50°F / 110°F NOTE#: - REFERENCE#: 2

ACCIDENT TEMPERATURE: 111°F NOTE#: - REFERENCE#: 20

RADIATION TID (RAD): 1.6×10^4 NOTE#: - REFERENCE#: 20

RADIATION IAD (RAD): 2.85×10^3 NOTE#: - REFERENCE#: 20

INSTRUMENT TAP INFORMATION REFERENCE #: N/A

WLHP TAP ELEVATION: N/A WLHP CONDENSING POT ELEVATION: N/A

WLLP TAP ELEVATION: N/A WLLP CONDENSING POT ELEVATION: N/A

EVENT/CATEGORY/OPERATING TIME: Mild Environment NOTE#: - REFERENCE#: 4,20

L	A	5 min
RH/A	C	N/A
CV/A	C	N/A
AF	C	N/A
AB	C	N/A

BRANCH/PROJECT IDENTIFIER 1,2-RE-90-130/131
DEMONSTRATED ACCURACY CALCULATION

DESIGN INPUT DATA

D) COMPONENT DATA (CONTINUED)

COMPONENT: 1,2-RE/RM-90-130&131

PARAMETER	VALUE/UNITS	NOTE#	REFERENCE#
Eed	Negligible	1,3	9,17
Encr	Negligible	1	9,17
Eimp	± 20.0% of reading	1,2	15,16
Ebs	± 1.0% of reading	4	13
Ect	Not Required	5	--
Epc	± 20.0% of reading	1,6	14,17
Ese	Not Required	7	18
ICTe	± 0.1% of FS (bistable) ± 4.0% of reading (ratemeter)	8,9	8
ICRe	± 4.0% of reading	8	8
OCTe	± 0.1% of FS (ratemeter & indicator)	9	--
OCRe	Not Required	9	--
Ab	± 3.0% of span	10	15,17
Se	Not Required	7	18
RNDe	Not Required	11	20
RADe	Not Required	11	20
TNe	Included in Re	12	15,17
TAe	Not Required	12	15,17
PRCSe	+ 24.48% of reading - 13.82% of reading	13	--
$PRCSe_{BIAS}$	+16.03% of reading	13	--
INDRe	+ 1.62% of span - 1.32% of span	14	--
IRe	Not Required	15	2
TPRe	Not Required	16	--
INDMe	± 2.0% of span	17	17
Re	± 3.0% of span	12	15,17
Ebd	± 2.2% of span	18	8
Efac	± 5.1% of reading	19	17

REV 0 PREP LMB DATE 1/12/00 CHECK EHT DATE 6/2/00 SHEET 11 C/O 12 .
REV ___ PREP ___ DATE ___ CHECK ___ DATE ___ SHEET ___ C/O ___ .
REV ___ PREP ___ DATE ___ CHECK ___ DATE ___ SHEET ___ C/O ___ .

DESIGN INPUT DATA

E) COMPONENT DATA NOTES (CONTINUED)

COMPONENT: 1,2-RE/RM-90-130&131

\# NOTE

1 Reference 17 identifies typical uncertainties associated with this equipment. Each uncertainty term is addressed by this calculation.

The uncertainty terms are:

A) Calibration: (Epc) This term accounts for the uncertainty of the primary calibration of the prototype detector. A known gaseous, liquid or solid source which is NBS traceable is routed through a prototype detector sample chamber or mock-up of the process stream to be monitor is used to calibrate the prototype detector assembly. The error associated with the output measurement of the prototype detector under calibration combine to yield primary calibration error. This error cannot be seen during plant calibration.

B) Factory Alignment Error: (Efac) This term accounts for the uncertainty associated with obtaining acceptable reference readings with the factory calibration source. This uncertainty is the difference between the prototype detector and the detector supplied to TVA using the factory calibration source. Mounting variation of the source is a contributor to this uncertainty. This uncertainty also accounts for the additional error in duplicating the same discriminator and gain (high voltage) levels used during the primary calibration with the prototype detector. This error cannot be seen during plant calibration.

C) Field Alignment: (Efa) After completion of factory test, monitors are delivered for installation at the site. The shipping, storage and installation process along with differences between the factory and site power, cable runs, noise, noise and general environment causes drifts in monitor response between the factory and the site. These monitors have adjustable discriminators and power supplies, and can be successfully realigned at the sites. The uncertainty associated with calibration or realignment of the monitor in the field is accomplished by calibrating to the plant calibration source. This uncertainty of calibration is accounted for via the M&TE uncertainties included in this calculation, i.e., ICTe, ICRe, OCTe, OCRe, and Ab. Thus field alignment error is not required to be included as a separate term.

D) Energy Dependence: (Eed) The difference in response of the detector to varying energy. The detector has a different sensitivity for each isotope it observes, the spread of these sensitivities is the error due to energy dependence. Normally the expected isotopes will be predominantly Xe-133. Plant procedures use the specific calibration factor analyzed by Engineering. Therefore, the energy dependence is accounted for and need not be considered as an uncertainty in this calculation.

DESIGN INPUT DATA

E) COMPONENT DATA NOTES (CONTINUED)

COMPONENT: 0-RE/RM-90-130&131

#	NOTE
1	(Continued)

E) Net Count Rate: (Encr) The Net Count Rate error is also referred to as Detector Environment error. Sorrento Electronics addresses detector environment as four types of uncertainties; Energy Dependence (discussed in D above), Temperature Effect, Response Time (Dead Time), and Sample Flow errors. Per Sorrento, changes in temperature can affect photomultiplier tubes, however on their RD-52, RD-53, AND RD-56 detectors no change in response was seen for changes in temperature from 40 to 130°F. Photomultiplier tubes are effectively linear for count rates from 10 cpm to 10^6 cpm. Above 10^6 cpm, PM tubes are affected by dead time with up to 30% foldover at count rates above 10^7 cpm. At a true count rate of 10^7 cpm, the actual reading would be about 7×10^6 cpm. The sample process error is accounted for separately inside this calculation under PRCSe. The count rate of concern is much smaller than 10^6 cpm, therefore, the Net Count Rate error is accounted for and need not be considered as an uncertainty in this calculation.

F) Electronics: (An, An of the rate meter) The uncertainty in measuring and processing the signals generated by the detector.

2 Statistical uncertainty associated with counting the nuclear events will be greatest for the lowest countrate assuming equal time for counting (same count rate). Imprecision is determined by calculating the standard deviation:

$$\sigma = \sqrt{R/T}$$

where R = countrate in cpm
T = 2RC (RC = time constant of readout module)
(RC varies with countrate)

The maximum setpoint for these monitors defined by this calculation is 4.50×10^4 CPM. The time constants used in the calculation are given in reference 15.

$$\sigma = \sqrt{\frac{4.50 \times 10^4}{2(0.00717)}}$$

$$\sigma = 1771.46$$

$$2\sigma = 3542.92$$

$$SP \pm 2\sigma = 4.50 \times 10^4 \text{ CPM} \pm 3542.92 \text{ CPM}$$

Therefore %Error $= \pm \{ \pm 3542.92 / 4.50 \times 10^4 \} \times 100$
$= \pm 7.87\%$ at setpoint at the 95% confidence level

DESIGN INPUT DATA

E) COMPONENT DATA NOTES (CONTINUED)

COMPONENT: 0-RE/RM-90-130&131

#	NOTE
2	(Continued)

	Setpoint	RC	Sigma (cpm)	2 Sigma (cpm)	% Error
	5000	0.0589	206.02	412.04	8.24
	7000	0.0589	243.77	487.54	6.96
	12000	0.00717	914.78	1829.56	15.25
	13000	0.00717	952.13	1904.26	14.65
	14000	0.00717	988.07	1976.15	14.12
	15000	0.00717	1022.75	2045.51	13.64
	16000	0.00717	1056.30	2112.59	13.20
	17000	0.00717	1088.80	2177.61	12.81
	18000	0.00717	1120.37	2240.74	12.45
	19000	0.00717	1151.07	2302.14	12.12
	20000	0.00717	1180.97	2361.95	11.81
	21000	0.00717	1210.14	2420.28	11.53
	22000	0.00717	1238.62	2477.23	11.26
	23000	0.00717	1266.45	2532.91	11.01
	24000	0.00717	1293.69	2587.38	10.78
	25000	0.00717	1320.37	2640.74	10.56
	26000	0.00717	1346.52	2693.04	10.36
	27000	0.00717	1372.17	2744.34	10.16
	28000	0.00717	1397.35	2794.70	9.98
	29000	0.00717	1422.08	2844.16	9.81
	30000	0.00717	1446.39	2892.78	9.64
	31000	0.00717	1470.30	2940.60	9.49
	32000	0.00717	1493.83	2987.65	9.34
	33000	0.00717	1516.99	3033.98	9.19
	34000	0.00717	1539.80	3079.60	9.06
	35000	0.00717	1562.28	3124.56	8.93
	36000	0.00717	1584.44	3168.89	8.80
	37000	0.00717	1606.30	3212.60	8.68
	38000	0.00717	1627.86	3255.72	8.57
	39000	0.00717	1649.14	3298.28	8.46
	40000	0.00717	1670.15	3340.30	8.35
	41000	0.00717	1690.90	3381.80	8.25
	42000	0.00717	1711.39	3422.79	8.15
	43000	0.00717	1731.65	3463.30	8.05
	44000	0.00717	1751.67	3503.34	7.96
Setpoint	**45000**	**0.00717**	**1771.46**	**3542.92**	**7.87**
	45200	0.00717	1775.39	3550.79	7.86
	46000	0.00717	1791.04	3582.07	7.79

D E S I G N   I N P U T   D A T A

E) COMPONENT DATA NOTES (CONTINUED)

COMPONENT: 0-RE/RM-90-130&131

#	NOTE

2 (Continued)

Based on the preceding tabular data, the Error varies with setpoints from 5000 to 46000 cpm with a maximum value of ±15.25% at a setpoint of 12000 cpm. Therefore, the % Error of ±15.25% for a maximum setpoint of 45000 cpm would be acceptable for Eimp. However, for conservatism, a rounded up value of ±20% of reading will be used for Eimp.

3 The detectors have a different sensitivity for each isotope they observe, the spread of these sensitivities is the error due to energy dependence. For these monitors, the isotope concentrations used for the analysis to set the safety limit which can be considered the worst-case analysis are given in reference 15. This mixture will determine the CPM output at the setpoint. Therefore, the energy dependence is accounted for and need not be considered as an uncertainty in this calculation..

4 Per reference 13, the trip circuit is highly stable and accurate with an absolute accuracy much better than 1% of reading. For conservatism, bistable error will be set equal to ±1% of reading.

5 The signal from the noble gas channel detector is coupled to the respective readout module via coaxial cable. The signal from the detector is first amplified in a preamplifier which is a part of each detector assembly. The coaxial cable is terminated in its characteristic impedance at the input of the readout module. The attenuation of the signal in the cable is "compensated" as follows:

A) A calibration source is used which has a dominant β energy low compared to that of nuclides to be detected.

B) In the calibration procedure, using the source described in A. above, the discriminator levels in the readout module are adjusted to give a countrate within a specified band which agrees with the activity of the source.

C) The signal pulses from the expected nuclides in the expected spectra of nuclides will then be larger than those which were used to set the discriminator levels, and will be counted.

Therefore it is not necessary to consider errors due to current transmission.

D E S I G N   I N P U T   D A T A

E) COMPONENT DATA NOTES (CONTINUED)

COMPONENT: 1,2-RE/RM-90-130&131

#	NOTE

6 Primary calibration is a procedure in which an NBS traceable source is routed through a sample chamber and the response is noted. The error associated with this calibration is ± 20% of reading, reference 14 & 17.

7 Per reference 18, GA Seismic report, a seismic event will have no effect on the system. Therefore, Ese and Se are not required.

8 The calibration of the readout module uses a pulse generator, counter and timer. Instrument maintenance records (reference 8) have shown that a 4% variance in the desired pulse rate is achievable. A 45 variance in pulse rate can be equated to a 4% variance in reading Therefore, ICTe & ICRe = ± 4% of reading.

9 As a requirement of this calculation, a digital voltmeter shall be used to read the output of the calibrated device. Therefore, OCRe is not required. Instrument maintenance has used a Keithley 197 DVM which has a stated accuracy of 0.018% input + 0.00024 V over a range of 0-20 V dc. It is reasonable that any new DVMs will have an accuracy at least equal to the current DVMs. Therefore to be conservative an error of ±0.1% full scale will be used for OCTe for the ratemeter and indicator, and ICTe for the bistable.

10 Per reference 15 and 17, the ratemeter reference accuracy is ±3% of equivalent linear full scale. All of the ratemeter errors are encompassed by this 3% error (Reference 15). This includes calibration inaccuracies, temperature effect, environmental effects and inherent equipment inaccuracies. Reference 15 states that temperature effect is ±0.1% of equivalent linear full scale / °C. The ratemeter is located in the Aux Building EL 690 Penetration Room, where the maximum temperature excursion is 10°C to 43.9°C (reference 20). This would yield a temperature effect of:

$$\text{Temp. Effect} = \pm(43.9 - 10C) \times 0.1\% \times 10V$$
$$= \pm 0.34\ V$$

This indicates the temperature effect is larger than the ±3.0% reference accuracy. However, per reference 8, the monitors have been able to meet the ±3.0% accuracy. Therefore, to minimize impact to existing plant procedures, Ab for the ratemeter and ratemeter/detector will be set equal to ±3.0% of equivalent full scale, while the Ab for the bistable and the indicator will also be set equal to ±3.0% of equivalent full scale.

D E S I G N   I N P U T   D A T A

E) COMPONENT DATA NOTES (CONTINUED)

COMPONENT: 1,2-RE/RM-90-130/131

#	NOTE
11	The detector, preamplifier and readout module are located in an essentially mild environment where the Accident dose radiation is 2.85×10^3 RADs and the 40 year dose is 1.6×10^4 RADs (reference 20).
12	Per reference 15 and 17, the vendor stated accuracy is ± 3% of equivalent linear full scale. This ± 3% includes calibration inaccuracies, temperature effect, environmental effects and inherent equipment accuracies.
13	Process uncertainty is applicable to the gas monitors. Process uncertainty is discussed in Computation/Analyses Section A.
14	The indicator reading error is 1/2 the largest division on the scale. The indicator scale is logarithmic which means that the reading error will vary depending on which part of the decade the reading is taken. To obtain the reading in percentage of span. The maximum reading error in the positive direction = Log(1.5) - Log(1.0) = 0.176 decades, while the maximum reading error in the negative direction = Log(2.0) - Log(1.5) = 0.124 decades. These rate meters have a scale of 6 decades, therefore, % span error equals:

$$INDRe(+) = \frac{0.176 \frac{decades}{error}}{6 \ decades}$$

$$\begin{aligned} INDRe(+) &= 0.0293 \text{ error} \\ &= 2.93\% \text{ of span} \end{aligned}$$

$$INDRe(-) = \frac{0.124 \frac{decades}{error}}{6 \ decades}$$

$$\begin{aligned} INDRe(-) &= -\ 0.0206 \text{ error} \\ &= -\ 2.06\% \text{ of span} \end{aligned}$$

D E S I G N   I N P U T   D A T A
E) COMPONENT DATA NOTES (CONTINUED)

COMPONENT: 1,2-RE/RM-90-130&131

#	NOTE

14 (Continued)

However, as shown by this table the positive and negative reading errors will vary throughout the readings on the decade.

Reading on Decade	% Span Error
2.0 - 3.0	+1.62% -1.32%
5.0 - 6.0	+0.69% -0.63%
7.0 - 8.0	+0.50% -0.47%
8.0 - 9.0	+0.44% -0.41%

The readability between the 1 and 2 divisions is approximately 10 times better than between 9 and 10 due to the physical size of the scale markings. Therefore, the operator is less likely to make a 1/2 division reading error on the larger scale divisions. Using this reasoning the reading error for the first scale division (between 1.0 and 2.0) will be taken as 1/4 divisions. Therefore positive reading will = Log(1.25) - Log(1.0) = 0.0969 decades, and the negative reading error = Log(1.25) - Log(1.5) = -0.0792 decades. Therefore % span reading error equals:

$$INDRe(+) = \frac{0.0969 \frac{decades}{error}}{6 \ decades}$$

$$INDRe(+) = 0.0162 \ error$$
$$= 1.62\% \ of \ span$$

$$INDRe(-) = \frac{0.0792 \frac{decades}{error}}{6 \ decades}$$

$$INDRe(-) = -\ 0.0132 \ error$$

$$= -\ 1.32\% \ of \ span$$

It should be noted that these values for 1/4 division reading error between the 1 and 2 scale divisions are still more conservative than 1/2 division reading errors for the remainder of the decade scale division.

D E S I G N   I N P U T   D A T A

E) COMPONENT DATA NOTES (CONTINUED)

COMPONENT: 1,2-RE/RM-90-130/131

#	NOTE
15	Per reference 2, the detector, preamplifier and readout module are in a mild environment, therefore insulation resistance effects will be negligible.
16	The test point resistor used for the calibration of this equipment is internal to the readout module and is accounted for in the accuracy of the module. Therefore, no additional error is needed for TPRe.
17	Per reference 17, the movement error of the indicator is ±2%. Therefore INDMe = ±2% of equivalent full scale. The front panel indicator is not used for calibration of the bistable or ICS point, a DVM is used for these devices, therefore INDMe is not required for these devices.
18	Using the calibration data from these devices, a statistical analysis shows the bistable and the drift associated with it was determined to be 2.2% of full scale (See reference 12 statistical analysis).
19	Per reference 17 the error associated with factory alignment of the detectors, as given by the vendor, is 5.1% of reading.

COMPUTATIONS/ANALYSES

A) PROCESS UNCERTAINTY DISCUSSION/CALCULATION

_____ NO PROCESS UNCERTAINTY EXISTS FOR THIS CALCULATION BECAUSE:

_____ THE MEASURED PARAMETER IS THE PARAMETER OF CONCERN; THEREFORE, PROCESS VARIATIONS ARE ACCOUNTED FOR IN THE DETERMINATION OF SAFETY AND/OR OPERATIONAL LIMITS.

_____ OTHER: SEE DISCUSSION BELOW.

__X__ PROCESS UNCERTAINTY DOES EXIST AND IS DETAILED IN THE FOLLOWING DISCUSSION/CALCULATION.

A.1 Radiation Monitor 1,2-R-90-130 and 131 Density Correction

A.1.1 Temperature

A difference in temperature between the process and the detector infers a difference in density between the process and the detector. A change in density will bias the concentration per unit volume measurement.

Due to a high velocity transit through the sample line, approximately 30 fps based on 10 CFM through a 1" O.D. sample line, the measurement will be considered isothermal. At 30 fps it will only take a few seconds for the sample to reach the detector location. Any slight cooling will result in higher densities at the detector which will produce slightly higher count rates than at the process.

A.1.2 Pressure

The radiation detector sample pumps are low volumetric flow pumps set to 10 SCFM based on the flow correction curves supplied in the technical manuals. A representative sample from the process line is set up using the flow pump, manual ball valves, the monitor flow indicator, pressure indicator, and M&TE flow instrumentation. Considering this setup procedure and that the gas detector is located on the suction side of the pump, the pressure at the detector location will be less than at the process.

A difference in pressure between the process and the detector infers a difference in density between the process and the detector. A difference in density will bias the concentration per unit volume measurement. If the density at the detector is lower than process density then the detector will undercount the activity, which is not conservative with respect to containment concentration. Thus pressure difference must be accounted for between the process and the detector.

COMPUTATIONS/ANALYSES

A) PROCESS UNCERTAINTY DISCUSSION/CALCULATION

A.1 Radiation Monitor Density Correction (Continued)

A.1.2 Pressure (Continued)

The optimum means with which to compensate for this phenomena is to quantify the difference in pressure between the detector and the process and to then establish the setpoint/indication allowing for the difference. Thus a pressure compensation factor must be calculated. The compensation factor is to be used in conjunction with the sensitivity curve supplied with the detectors to account for the difference between the measured pressure at the detector location and the process. The compensation factor can also be used to compensate indicated activity readings used in determining containment concentration.

Since the plant chemistry group will establish these setpoints, a correction factor formula based on observed detector pressure will be developed for inclusion in the Design Engineering Setpoint Scaling Document (the output document for this calculation). Uncertainty in the pressure measurement associated with the correction factor will be included in this calculation.

The vendor has developed an empirical formula to be used for pressure compensation. (Reference 19 "GA Manual E-115-647", Rev. 6). This equation will be used to calculate a correction factor to be used in calculating setpoints and to compensate for errors in indications used to calculate offsite releases.

The equation is

$$\text{Correction Factor (CF)} = \frac{P_P}{(P_P - P_n)*(1+P_n*A_n)}$$

Where: P_P = Process pressure In. Hg. Absolute

P_n = Detector pressure In. Hg. Vac.

A_n = Self absorption factor

A_n = .013 for Xe-133

A_n = .004 for Kr-85

A_{nxe} = .013 will be used to calculate the correction factor. The dominant isotope is Xe-133 and yields a worst case error. Table A.2 gives the correction factors for detector pressures from 0 - 12 Inches of Hg. Vacuum.

COMPUTATIONS/ANALYSES

A) PROCESS UNCERTAINTY DISCUSSION/CALCULATION

TABLE A.2
DETECTOR PRESSURE CORRECTION FACTOR

PRESSURE CORRECTION FACTORS		
PROCESS PRESSURE	DETECTOR PRESSURE	CORRECTION FACTOR
29.92 In. Hg. Ab.	12.00 In. Hg. Vac.	1.4443
29.92 In. Hg. Ab.	11.50 In. Hg. Vac.	1.4131
29.92 In. Hg. Ab.	11.00 In. Hg. Vac.	1.3835
29.92 In. Hg. Ab.	10.50 In. Hg. Vac.	1.3556
29.92 In. Hg. Ab.	10.00 In. Hg. Vac.	1.3292
29.92 In. Hg. Ab.	9.50 In. Hg. Vac.	1.3042
29.92 In. Hg. Ab.	9.00 In. Hg. Vac.	1.2804
29.92 In. Hg. Ab.	8.50 In. Hg. Vac.	1.2578
29.92 In. Hg. Ab.	8.00 In. Hg. Vac.	1.2364
29.92 In. Hg. Ab.	7.50 In. Hg. Vac.	1.2160
29.92 In. Hg. Ab.	7.00 In. Hg. Vac.	1.1965
29.92 In. Hg. Ab.	6.50 In. Hg. Vac.	1.1780
29.92 In. Hg. Ab.	6.00 In. Hg. Vac.	1.1603
29.92 In. Hg. Ab.	5.50 In. Hg. Vac.	1.1435
29.92 In. Hg. Ab.	5.00 In. Hg. Vac.	1.1274
29.92 In. Hg. Ab.	4.50 In. Hg. Vac.	1.1120
29.92 In. Hg. Ab.	4.00 In. Hg. Vac.	1.0973
29.92 In. Hg. Ab.	3.50 In. Hg. Vac.	1.0832
29.92 In. Hg. Ab.	3.00 In. Hg. Vac.	1.0697
29.92 In. Hg. Ab.	2.50 In. Hg. Vac.	1.0568
29.92 In. Hg. Ab.	2.00 In. Hg. Vac.	1.0445
29.92 In. Hg. Ab.	1.50 In. Hg. Vac.	1.0326
29.92 In. Hg. Ab.	1.00 In. Hg. Vac.	1.0213
29.92 In. Hg. Ab.	0.50 In. Hg. Vac.	1.0104
29.92 In. Hg. Ab.	0.00 In. Hg. Vac.	1.0000

COMPUTATIONS/ANALYSES

A) PROCESS UNCERTAINTY DISCUSSION/CALCULATION

A.1 Radiation Monitor Density Correction (Continued)

A.1.2 Pressure (Continued)

Normal vacuum is between 5 and 7 In. Hg. A maximum detector baseline pressure of 6 In. Hg. Vacuum will be used to calculate a pressure correction factor to define PRCSe. Additionally, a bias error ($PRCSe_{BIAS}$) will also be defined for this baseline pressure of 6 In. Hg. Vacuum. The correction factor does not need to be used for TI-30 "Radiological Gaseous Effluent" calculations because these monitors are not used to calculate offsite releases. Since a bias term is being considered for the maximum detector baseline pressure of 6 In. Hg. Vacuum, this correction factor does not need to be input to the ICS for compensating setpoints or ICS indications.

From Table A.2 CF = 1.1603 for 6 In. of Hg. Vacuum

Table A.2 can be used to determine a correction factor for the indicator and recorder based on actual detector pressure reading by the plant if a situation arises that requires specific data.

As stated above, the uncertainties in the correction factor included in this calculation will be based on 6 In. Hg. Vacuum, ± 6 In. Hg. Vacuum. The ± 6 In. Hg. Vacuum accounts for a span of 0 to 12 In. Hg. Vacuum range. The only way for the 0 In. Hg. Vacuum to occur would be for the vacuum pump to stop. If the vacuum pump stops the flow would also stop, resulting in a malfunction alarm due to a flow rate of less than 4 scfm flow. The +6 In. Hg. Vacuum uncertainty in the correction factor will give a +12 In. Hg. Which will cause the vacuum switch to initiate a malfunction alarm. Therefore, a , ± 6 In. Hg. Vacuum uncertainties in the correction factor will be conservative. The uncertainties are calculated as follows:

$$+CF = (CF_{12} - CF_6)/CF_6 * 100 = ((1.4443 - 1.1603)/ 1.1603) * 100$$
$$+CF = +24.48\% \text{ of reading}$$

$$-CF = (CF_0 - CF_6)/CF_6 * 100 = ((1.0000 - 1.1603)/ 1.1603) * 100$$
$$-CF = -13.82\% \text{ of reading}$$

Therefore, **PRCSe = +24.48 / -13.82% of reading**

An additional bias term $PRCSe_{BIAS}$ will be considered based on utilizing the 6 In. Hg. Vacuum defined in the above discussion. From Table A.2, the error is 16.03%. The sign convention for this error term is positive. As previously stated, if the density (i.e., pressure) at the detector is lower than process density the detector will undercount the activity. Therefore, decreasing pressure (i.e.,increasing vacuum) will result in an indicating value that is lower than the true value. From reference 11 (EEB Branch Instruction TI-28), Error = True Value - Indicated Value.

Therefore, **$PRCSe_{BIAS}$ = +16.03% of reading**

COMPUTATIONS/ANALYSES

B) WATERLEG UNCERTAINTY DISCUSSION/CALCULATION

__X__ APPLICABLE TO ALL LOOPS LISTED ON SHEET 8

_____ APPLICABLE ONLY TO LOOPS:

__X__ WATERLEG UNCERTAINTY IS NOT CONSIDERED FOR THE CALCULATION BECAUSE:

__X__ NO WATERLEG EXISTS FOR THIS CALCULATION.

_____ THE EFFECTS OF WATERLEG CHANGES ARE INSIGNIFICANT. SEE DISCUSSION/CALCULATION BELOW.

_____ OTHER. SEE DISCUSSION/CALCULATION BELOW.

_____ A WATERLEG UNCERTAINTY DOES EXIST FOR THIS LOOP. SEE CALCULATION/DISCUSSION BELOW.

_____ SEE SENSING LINE DIAGRAM ON SHEET ____ OF THIS CALCULATION.

COMPUTATIONS/ANALYSES

C) ACCURACY DISCUSSION

__X__ The accuracy of this instrument for normal, post seismic and accident conditions will be determined by considering the parameters tabulated in the design input section of this calculation.

The accuracy calculation for seismic (As) is bounding for all seismic events.

__X__ The square root of the sum of the squares method shall be used in this calculation for the calculating accuracy since the factors affecting accuracy are independent variables.

__X__ Bi-directional errors and uni-directional errors will be combined in a manner such that the sum of the positive uni-directional errors will be added to the positive portion of the bi-directional error (obtained from the square root of the sum of the squares method), and the sum of the negative portion of the bi-directional error.

This method is conservative. Therefore, it will be used in this calculation.

Example:	(+/-)10	= bi-directional error
	+ 5	= first uni-directional error
	- 2	= second uni-directional error
Total Error		= (+10 +5) to (-10 -2) = +15 to -12

_____ Other:

For the purposes of this calculation, accuracy is defined as the range of actual process values that may exist for a given indicated or bistable trip value, e.g. an accuracy of +15 psig to -12 psig means that for a indicated or bistable trip value of 100 psig, the actual process pressure may be anywhere between 88 and 115 psig.

All system analysis based on or using accuracy values from this calculation should take into account the fact that operator action and/or automatic initiations may occur at a process value differing from the indicated or setpoint values by the amount of the calculated inaccuracies.

COMPUTATIONS / ANALYSES

D) ACCURACY CALCULATION INDEX

COMPUTATIONS / ANALYSES

D) ACCURACY CALCULATIONS

1.1 READOUT MODULE ERROR (RM)

1.1.1 Reference Accuracy (Re)

Re = ±3.0% of FS
= ±0.03 * 10 V
= ±0.3 V
= ±0.3 V

1.1.2 Output Calibration Test Error (OCTe)

OCTe = ±0.1% of FS
= ±0.001 * 10 V
= ±0.01 V

1.1.3 Acceptance Band (Ab)

Ab = ±3.0% of FS
= ±0.03 * 10 V
= ±0.3 V

1.1.4 Input Calibration Test Error (ICTe) & Reading Error (ICRe)

ICTe = ICRe = ±4.0% of reading

Per Reference 14, the transfer function to equate a reading error into an equivalent linear full scale error is:

% Reading Error = $-[1 - 10^{\pm B(A)}] * 100$

Where B = No. of decades/span
A = Eq. linear full scale error in volts

Therefore, by arranging terms the reading error can be expressed in volts by the following equation:

Volts(+) = [Log(1 + (% Reading/100))] / (No. Decades/Span)

Volts(-) = [Log(1 - (% Reading/100))] / (No. Decades/Span)

Therefore, ICTe expressed in volts is calculated as follows:

+ICTe = [Log(1 + (4.0%/100))] / (6/10)
= (Log(1.04)) / 0.6
= +0.028 V

-ICTe = [Log(1 - (4.0%/100))] / (6/10)
= (Log(0.96)) / 0.6
= -0.029 V

And;

+ICRe = +0.028 V

-ICRe = -0.029 V

C O M P U T A T I O N S / A N A L Y S E S

D) ACCURACY CALCULATIONS

1.1.5 Normal Measurable/Normal Accuracy Anf_{RM}/An_{RM}

$\pm Anf_{RM} = \pm\sqrt{(Re^2+OCTe^2+Ab^2+ICTe^2+ICRe^2)}$

$+Anf_{RM} = +\sqrt{(0.3^2+0.01^2+0.3^2+0.028^2+0.028^2)}$
$= +0.426$ V

$-Anf_{RM} = -\sqrt{(0.3^2+0.01^2+0.3^2+0.029^2+0.029^2)}$
$= -0.426$ V

From the equation above, these values may be converted to % of reading as follows:

$+Anf_{RM} = -[1 - 10^{(0.426)(0.6)}] * 100$
$= -[1 - 10^{(0.256)}] * 100$
$= +80.30\%$ of reading

$-Anf_{RM} = -[1 - 10^{(-0.426)(0.6)}] * 100$
$= -[1 - 10^{(-0.256)}] * 100$
$= -44.53\%$ of reading

Since all parameters are measurable, the Normal Accuracy is equal the normal measurable accuracy.

$\pm An_{RM} = \pm Anf_{RM} = \pm 0.426$ V

1.2 READOUT MODULE - DETECTOR ERROR (RM/RD)

1.2.1 Primary Calibration Accuracy (Epc)

$\pm Epc = \pm 20\%$ of reading
$+Epc = +0.132$ V
$-Epc = -0.162$ V

1.2.2 Factory Alignment Error (Efac)

$\pm Efac = \pm 5.1\%$ of reading
$+Efac = +0.036$ V
$-Efac = -0.038$ V

1.2.3 Imprecision Error (Eimp)

$\pm Eimp = \pm 20\%$ of reading
$+Eimp = +0.132$ V
$-Eimp = -0.162$ V

1.2.4 Process Uncertainty Error (PRCSe)

$\pm PRCSe = +24.48\% / -13.82\%$ of reading
$+PRCSe = +0.158$ V
$-PRCSe = -0.108$ V

$PRCSe_{BIAS} = +16.03\%$ of reading
$PRCSe_{BIAS} = +0.108$ V

COMPUTATIONS / ANALYSES

D) ACCURACY CALCULATIONS

1.2.5 Normal Measurable Accuracy ($Anf_{RM/RD}$)

$$\pm Anf_{RM/RD} = \pm\sqrt{(Anf_{RM}^2+Eimp^2)}$$

$$+Anf_{RM/RD} = +\sqrt{(0.426^2+0.132^2)}$$
$$= +0.446 \text{ V}$$

$$-Anf_{RM/RD} = -\sqrt{(0.426^2+0.162^2)}$$
$$= -0.456 \text{ V}$$

1.2.6 Normal Loop Accuracy ($An_{RM/RD}$)

$$\pm An_{RM/RD} = \pm\sqrt{(Anf_{RM}^2+Epc^2+Efac^2+Eimp^2+PRCSe^2)} + PRCSe_{BIAS}$$

$$+An_{RM/RD} = +\sqrt{(0.426^2+0.132^2+0.036^2+0.132^2+0.158^2)} + 0.108$$
$$= +0.493 + 0.108 \text{ V}$$
$$= +0.601 \text{ V}$$

$$-An_{RM/RD} = -\sqrt{(0.426^2+0.162^2+0.038^2+0.162^2+0.108^2)}$$
$$= -0.497 \text{ V}$$

1.3 BISTABLE ACCURACY (BS)

1.3.1 Bistable Error (Ebs)

±Ebs = ±1.0% of reading

+Ebs = +0.007 V
-Ebs = -0.007 V

1.3.2 Input Calibration Test Error (ICTe)

±OCTe = ±0.1% of FS
= ±0.001 * 10 V
= ±0.01 V

1.3.3 Acceptance Band (Ab)

±Ab = ±3.0% of FS
= ±0.03 * 10 V
= ±0.3 V

1.3.4 Bistable Drift (Ebd)

±Ebd = ±2.2% of FS
= ±0.022 * 10 V
= ±0.22 V

COMPUTATIONS / ANALYSES

D) ACCURACY CALCULATIONS

1.3.5 Normal Measurable Accuracy (Anf_{BS})

$$\pm Anf_{BS} = \pm\sqrt{(Ebs^2+ICTe^2+Ab^2+Ebd^2)}$$

$$\pm Anf_{BS} = \pm\sqrt{(0.007^2+0.01^2+0.3^2+0.22^2)} = \pm 0.372 \text{ V}$$

1.3.6 Normal Measurable Loop Accuracy ($LAnf_{BS}$)

$$\pm LAnf_{BS} = \pm\sqrt{(Anf_{RM/RD}{}^2+Anf_{BS}{}^2)}$$

$$+LAnf_{BS} = +\sqrt{(0.446^2+0.372^2)} = +0.581 \text{ V} \quad (+123.2\% \text{ of reading})$$

$$-LAnf_{BS} = -\sqrt{(0.456^2+0.372^2)} = -0.588 \text{ V} \quad (-55.6\% \text{ of reading})$$

1.3.7 Normal Loop Accuracy (LAn_{BS})

$$\pm LAn_{BS} = \pm\sqrt{(Anf_{BS}{}^2+ An_{RM/RD}{}^2)} + PRCSe_{BIAS}$$

$$+LAn_{BS} = +\sqrt{(0.372^2+0.493^2)} + 0.108 = +0.726\text{V} \quad (+172.6\% \text{ of reading})$$

$$-LAn_{BS} = -\sqrt{(0.372^2+0.497^2)} = -0.621 \text{ V} \quad (-57.6\% \text{ of reading})$$

1.3.8 Accident Loop Accuracy (LAa_{BS})

There are no additional inaccuracies during an accident. Therefore, $LAa_{BS} = LAn_{BS}$

$+LAa_{BS}$ = +0.726 V (+172.6% of reading)

$-LAa_{BS}$ = -0.621 V (-57.6% of reading)

COMPUTATIONS / ANALYSES
D) ACCURACY CALCULATIONS

1.3.9 Allowable Value (AV)

The safety limit for these monitors is:

Safety Limit(LWR Containment Purge) = 1.96×10^6 cpm
Safety Limit(UPR Containment Purge) = 1.58×10^5 cpm

The smaller of the safety limits (1.58×10^5 cpm) for the bistable will be analyzed for conservatism. The loop bistable errors defined in sections 1.3.6 and 1.3.7 are:

$+LAnf_{BS}$ = +0.581 V (+123.2% of reading)

$+LAn_{BS}$ = +0.726 V (+172.6% of reading)

+AV is defined as follows:

+AV = Safety Limit - (Adbe - $LAnf_{BS}$ + Margin)

Where Adbe = $+LAn_{BS}$, and Margin is defined as 0.182 V or 25% of $+LAn_{BS}$ for conservatism.

Converting the Safety Limit to volts:

$$\text{Safety Limit(volts)} = \frac{Log[Input(cpm)] - 1}{\left[\frac{\#of\ Decades}{Voltage\ Span}\right]}$$

$$\text{Safety Limit(volts)} = \frac{Log[1.58 x 10^5] - 1}{\left[\frac{6}{10}\right]}$$

Safety Limit(volts) = 6.998 volts

Therefore;

+AV(volts) = 6.998 - (0.726 - 0.581 + 0.182)
+AV(volts) = 6.671 V

Converting to cpm;

$$+AV(cpm) = 10^{\left[\frac{Output(volts)\ X\ \#of\ Decades}{Voltage\ Span}+1\right]}$$

$$+AV(cpm) = 10^{\left[\frac{6.671\ X\ 6}{10}+1\right]}$$

+AV(cpm) = 1.00×10^5 cpm (rounded down for conservatism)

COMPUTATIONS / ANALYSES

D) ACCURACY CALCULATIONS

1.3.10 Setpoint Determination

A maximum setpoint value will be determined based on the value defined for +AV in the previous section:

$$Setpoint_{MAX}(volts) = +AV - (+LAnf_{BS})$$
$$Setpoint_{MAX}(volts) = 6.671 - 0.581$$
$$Setpoint_{MAX}(volts) = 6.090\ V$$

Converting to cpm;

$$Setpoint_{MAX}(cpm) = 10^{\left[\frac{Output(volts)\ X\ \#of\ Decades}{Voltage\ Span}+1\right]}$$

$$Setpoint_{MAX}(cpm) = 10^{\left[\frac{6.090\ X\ 6}{10}+1\right]}$$
$$Setpoint_{MAX}(cpm) = 4.50 \times 10^{4}$$ (rounded down for conservatism)

Note: $Setpoint_{MAX} + LAn_{BS} = 6.090 + 0.726 = 6.816$ volts or 1.23×10^{5} cpm and $Setpoint_{MAX} - LAn_{BS} = 6.090 - 0.621 = 5.469$ volts or 1.91×10^{4} cpm.

1.4 INDICATOR ACCURACY (I)

1.4.1 Output Calibration Test Error (OCTe)

$\pm OCTe = \pm 0.1\%$ of FS
$= \pm 0.001 * 10\ V$
$= \pm 0.01\ V$

1.4.2 Acceptance Band (Ab)

$\pm Ab = \pm 3.0\%$ of FS
$= \pm 0.03 * 10\ V$
$= \pm 0.3\ V$

1.4.3 Indicator Movement Error (INDMe)

$\pm INDMe = \pm 2.0\%$ of FS
$= \pm 0.02 * 10\ V$
$= \pm 0.2\ V$

1.4.4 Indicator Reading Error (INDRe)

$+INDRe = +1.61\%$ of span
$= +0.0161 * 10\ V$
$= +0.161\ V$

$-INDRe = -1.32\%$ of span
$= -0.0132 * 10\ V$
$= -0.132\ V$

COMPUTATIONS / ANALYSES

D) ACCURACY CALCULATIONS

1.4.5 Normal Measurable Accuracy (Anf_I)

$\pm Anf_I = \pm\sqrt{(OCTe^2+Ab^2INDMe^2)}$

$\pm Anf_I = \pm\sqrt{(0.01^2+0.3^2+0.2^2)}$
$= \pm 0.361$ V

1.4.6 Normal Measurable Loop Accuracy ($LAnf_I$)

$\pm LAnf_I = \pm\sqrt{(Anf_{RM/RD}{}^2+Anf_I{}^2)}$

$+LAnf_I = +\sqrt{(0.446^2+0.361^2)}$
$= +0.574$ V (+121.0% of reading)

$-LAnf_I = -\sqrt{(0.456^2+0.361^2)}$
$= -0.582$ V (-55.2% of reading)

1.4.7 Normal Loop Accuracy (LAn_I)

$\pm LAn_I = \pm\sqrt{(Anf_I{}^2+INDRe^2+An_{RM/RD}{}^2)} + PRCSe_{BIAS}$

$+LAn_I = +\sqrt{(0.361^2+0.161^2+0.493^2)} + 0.108$
$= +0.740$ V (+178.0% of reading)

$-LAn_I = -\sqrt{(0.361^2+0.132^2+0.497^2)}$
$= -0.628$ V (-58.0% of reading)

1.4.8 Accident Loop Accuracy (LAa_I)

There are no additional inaccuracies during an accident. Therefore, $LAa_I = LAn_I$

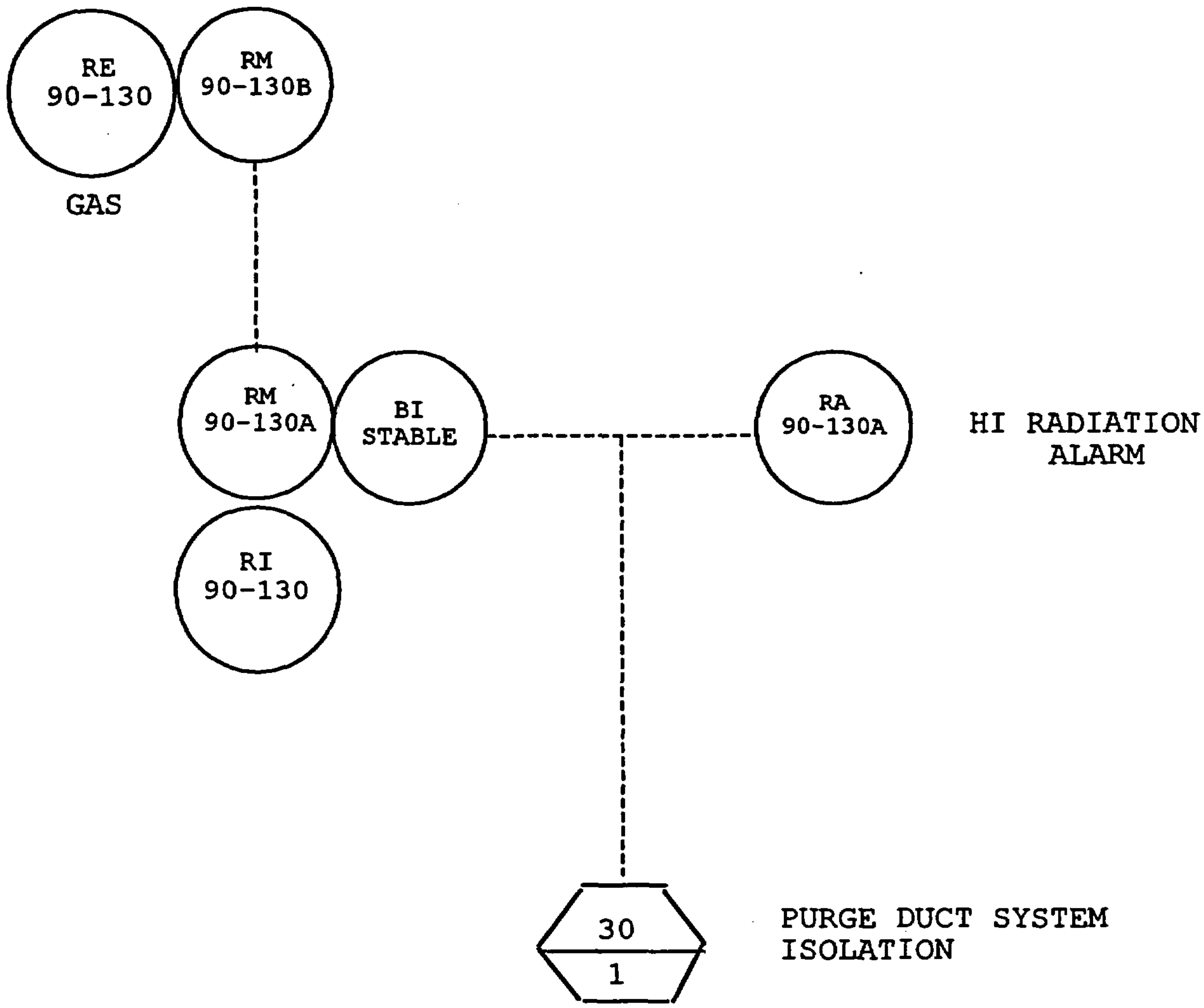
$+LAa_I = +0.740$ V (+178.0% of reading)

$-LAa_I = -0.628$ V (-58.0% of reading)

Per reference 9, there is no required accuracy for the indicator.

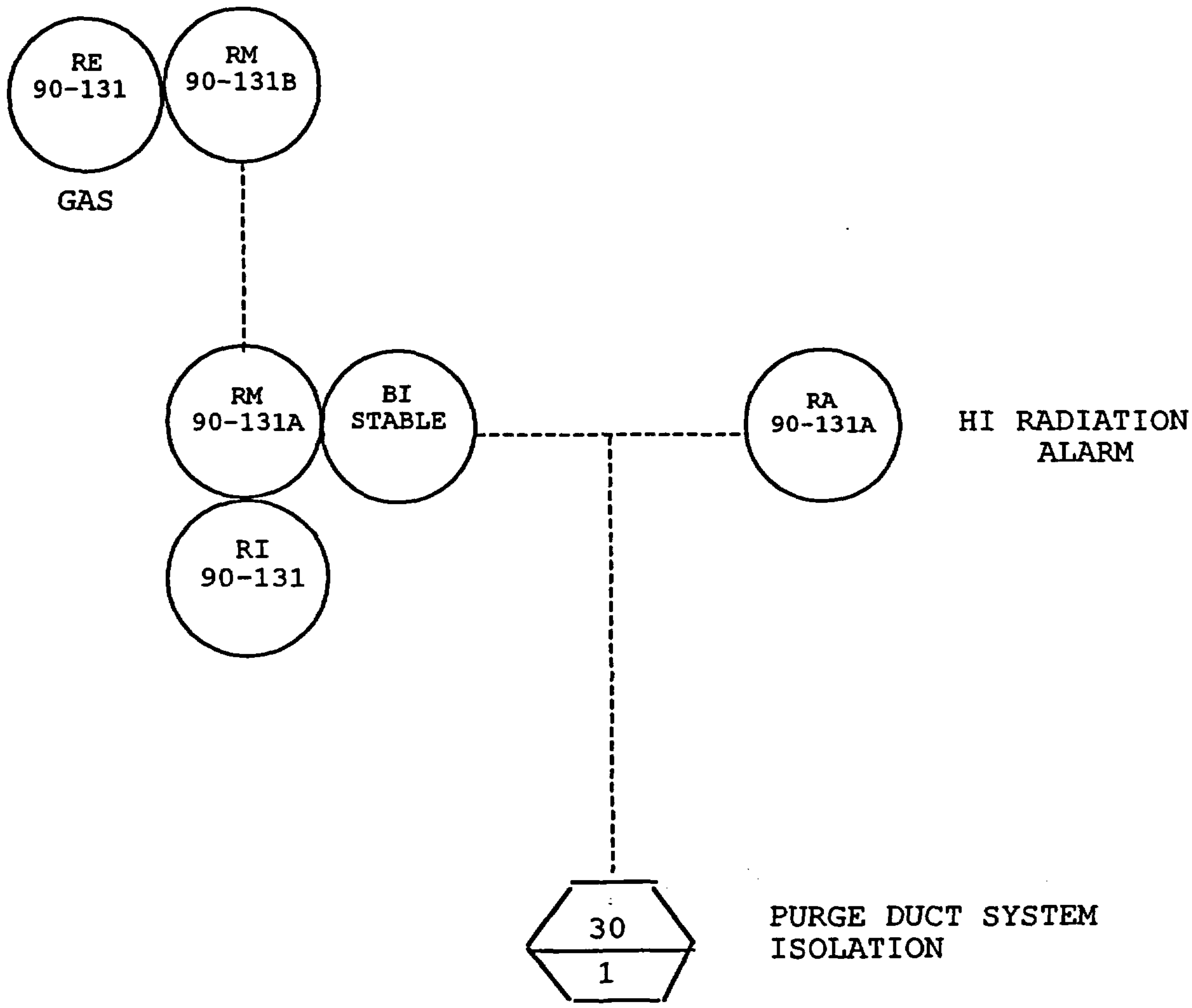
A) LOOP DIAGRAM

APPLICABLE ONLY TO LOOPS: 1,2-R-90-130



A) LOOP DIAGRAM

APPLICABLE ONLY TO LOOPS: 1,2-R-90-131



SUMMARY OF RESULTS (BISTABLE)

APPLICABLE ONLY TO LOOPS: 1,2-R-90-130
1,2-R-90-131

SAFETY LIMIT	1.58×10^5 cpm	Margin	3.5×10^4 cpm
PV = Accident	1.23×10^5 cpm		
PV = Seismic	1.23×10^5 cpm		
PV = Normal	1.23×10^5 cpm		
Max Setpoint	4.50×10^4 cpm		
PV = Normal	1.91×10^4 cpm		
PV = Seismic	1.91×10^4 cpm		
PV = Accident	1.91×10^4 cpm		

All values shown are in cpm

(Refer to accuracy discussion, sheets 29-32 for clarification of above)

+Av = 1.00×10^5 cpm   **+Aas =** N/A

-Av = N/A   **-Aas =** N/A

SUMMARY OF RESULTS (INDICATION)

APPLICABLE ONLY TO LOOPS: 1,2-R-90-130
1,2-R-90-131

SAFETY LIMIT	N/A	Margin	N/A
PV = Accident	+178.0		
PV = Seismic	+178.0		
PV = Normal	+178.0		
Indication			
PV = Normal	-58.0		
PV = Seismic	-58.0		
PV = Accident	-58.0		

All values shown are in % of reading

(Refer to accuracy discussion, sheets 32-33 for clarification of above)

+Av = N/A   +Aas = N/A

-Av = N/A   -Aas = N/A

C O N C L U S I O N S

X APPLICABLE TO ALL LOOPS LISTED ON SHEETS 8

____ APPLICABLE ONLY TO LOOPS: ________

In conclusion, the demonstrated accuracy of +0.726 volts (+LAn_{BS}) and -0.621 volts (-LAn_{BS}) for bistable loops 1,2-R-90-130 and 131 will not result in challenging the upper safety limit of 1.58 x 10^5 cpm based on maintaining a bistable setpoint of ≤ 4.50 x 10^4 cpm. However, the current setpoint for this loop is controlled by Chemistry and must be maintained ≤ 8.5 x 10^{-3} uCi/cc (1.380 x 10^4 cpm per reference 9) for compliance with the value listed in Tech Spec table 3.3-6.

This calculation defines an Allowable Value of ≤ 1.00 x 10^5 cpm that could replace the setpoint of ≤ 8.5 x 10^{-3} uCi/cc (1.380 x 10^4 cpm per reference 9) defined in Tech Spec table 3.3-6 via Tech Spec Change 98-03. Loop Indication for 1,2-R-90-130 and 131 does not have a required accuracy and is therefore determined to be acceptable.

ORIGINAL

QA Record

TVAN CALCULATION COVERSHEET

Title	Technical Specification Setpoints For Containment Monitors RM-90-106/112 and RM-90-130/131	Plant SQN	Page 1
		Unit 1/2	

Preparing Organization	Key Nouns (For EDM)
Mechanical Design	Rad Monitor, STP, FENCDOSE, COROD, Setpoint

Calculation Identifier	Each time these calculations are issued, preparer must ensure that the original (R0) RIMS/EDM accession number is filled in.		
SQNAPS3-116	Rev	(for EDM use)	EDM Accession Number
Applicable Design Document(s)	R0	930419G0001	B87 930416 002
	R4		B87 000203 004
UNID System(s)	R5		
	R6		

	R0	R4	R5	R6			
					Quality Related?	Yes ■	No ☐
DCN, EDC, NA	NA	NA			Safety related? If yes, mark Quality Related yes	Yes ■	No ☐
Prepared	Regis M. Nicoll	[signature]					
Checked	Marc C. Berg	Marc C. Berg			These calculations contain unverified assumption(s) that must be verified later?	Yes ☐	No ■
Design Verified	Marc C. Berg	Marc C. Berg SAB			These calculations contain special requirements and/or limiting conditions?	Yes ☐	No ■
Approved	W.A.Eberly	[signature]			These calculations contain a design output attachment?	Yes ☐	No ■
Approval Date	4/16/93	1-27-00			Calculation Classification	Essential	
SAR Affected?	Yes ☐ No ■	Yes ☐ No ■	Yes ☐ No ☐	Yes ☐ No ☐	Microfiche generated	Yes ■	No ■
Revision applicability	Entire calc ☐	Entire calc ■ Selected pgs ☐	Entire calc ☐ Selected pgs ☐	Entire calc ☐ Selected pgs ☐	Number TVA-F-G-103968		

Statement of Problem:
Determine the adequacy of existing Tech Spec setpoints, exclusive of instrument and sampling inaccuracies for RM-90-106/112 and RM-90-130/131 for limiting doses to 10CFR100 and GDC 19 during a small LCA with containment purge. Establish safety limits for the subject monitors.

Abstract

This calculation determines the adequacy of the SQN Tech Spec setpoints for Containment (CTM) monitors RM-90-106/112 and Purge Monitors RM-90-130/131, exclusive of instrument and sampling inaccuracies. This was done as part of the corrective action to the radiation monitoring incident investigation reported in II-S-92-80. Revision 1 was performed to establish safety limits for the subject monitors. The safety objective is specifically applicable to a small break LOCA event concurrent with CTM purging.

Source terms for the small LOCA consisted of a release of 100% of the RCS activity with a factor of 10 iodine spike. Total release to the environment consisted of CTM leakage (0.25%/day for the first 24 hours, 0.125%/day thereafter) and CTM purge (14000 cfm of lower CTM, case 1 and 14000 cfm of upper CTM, case2). STP was used to calculate the radioactive purge concentrations. These concentrations were compared to those in Table 3.3.6 of the SQN TSs. FENCDOSE and COROD were used to calculate the offsite and control room doses due to the event to determine compliance with 10CFR100 and GDC 19.

The results of this calculation are found in the body of this calculation.

■ Microfilm and return calculation to Calculation Library. Address:OPS-1B SQN

☐ Microfilm and return calculation to:

☐ Microfilm and destroy.

Attachment No. 12 Sheet 1 of 2
Identifier 1,2-RE-90-130/131

Discussion

It is clear from the results presented in the previous section that the SQN TS setpoints (8.5E-3 uCi/cc, NG and 1.5E-5 uCi/cc, Particulate) for the RM-90-130, -131 monitors are sufficiently adequate to initiate a timely CVI during a small LOCA with concurrent LCTM purging (Case 1). This event resulted in doses that are small fractions of the 10CFR100 and GDC 19 dose criteria as indicated in the previous section.

Thus, the TS setpoints have substantial margin to limit offsite and control room doses to within the dose criteria of 10CFR100 and GDC 19 for this event.

It is also clear from the preceding section that under the conditions of a small LOCA during UCTM purge (Case 2), the SQN TS setpoints for a CVI will not be exceeded for the noble gas channel of the RM-90-130, -131 monitors. The maximum NG concentration attained during this event is 5.88E-3 uCi/cc vs. the 8 5E-3 uCi/cc TS setpoint, or a factor of 0.69 below the TS setpoint. However, the doses due to this event are small fractions of the 10CFR100 and GDC 19 dose criteria as indicated in the previous section.

Thus, although the SQN TS noble gas setpoint is not exceeded for this event, the setpoint is sufficiently low to provide a substantial margin in maintaining offsite and control room operator doses to well within the dose criteria of 10CFR100 and GDC 19.

The monitors RM-90-106 and -112 do not provide a control function. They are to provide trending and also to provide an alarm function for RCS leakage. Therefore, as long as the setpoint is below the safety limit established in this calculation, the setpoint will be acceptable. It is suggested that the setpoint be as low as possible without causing spurious alarms (such as 2 to 4 times background), however it is up to the site to establish the actual value, which is to be less than the safety limit (not including monitor inaccuracies).

Lastly, the following setpoints are established for the subject monitors:

Monitor RM-90-	Safety Limit [uCi/cc]	Safety Limit [cpm]		Safety Limit [uCi/cc	Safety Limit [cpm]
LCTM Purge			UCTM Purge		
106 NG	1.20E+00	4.92E+07	106 NG	9.71E-02	3.91E+06
106 Part	1.21E-02	1.21E+09	106 Part	1.18E-03	1.18E+08
112 NG	1.20E+00	4.38E+07	112 NG	9.71E-02	3.48E+06
112 Part	1.21E-02	1.21E+09	112 Part	1.18E-03	1.18E+08
130/131	1.20E+00	1.96E+06	130/131	9.71E-02	1.58E+05

For additional information, the 1,2-RM-90-130/131 concentration provided in TECH SPEC Table 3.3-6, 8.5E-3 uCi/cc was converted to 1.380E+4 cpm in the Table 7 of this calculation for the small break LOCA at T = 0.0 seconds.