Attachment IV to IPN-93-007

LOOP ACCURACY/SETPOINT CALCULATIONS

NEW YORK POWER AUTHORITY
INDIAN POINT 3 NUCLEAR POWER PLANT
DOCKET NO. 50-286
DPR-64

CALC. NO. IP3-CALC-RPC-00298 REV. 0 IP3 [X] JAF [ ]

MOD/TASK NO.

QA CATEGORY: I PRELIMINARY: FINAL: X

PROJECT/TASK: Twenty Four (24) Month Operating Cycle Project
SYSTEM NO./NAME: Reactor Protection and Control (RPC)
TITLE: Instrument Loop Accuracy/Setpoint Calculation/RC Loop Low Flow

	NAME	SIGNATURE	DATE
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PROBLEM/OBJECTIVE/METHOD

Verify that channel trip will occur within the Analytical Limit (AL) considering additional instrument drift or uncertainties due to extension of the operating cycle from 18 months ± 25% to 24 months ± 25%.

This calculation has been prepared in accordance with ISA-RP67.04, IES-3 and DCM-2.

DESIGN BASIS/ASSUMPTIONS

The low RC flow instrumentation serves to trip the reactor on a reduction in RCS flow rate. The low flow trip protects the core from DNB following a loss of coolant flow accident. (ref. 3.2.2)

Seismic event is not considered coincident with any other postulated accident.

SUMMARY/CONCLUSIONS

The existing Trip Setpoint for RC Loop Low Flow is set higher than is required by the total channel uncertainty, therefore, it is conservative. No Setpoint change is required.

For RC Loop Low Flow trip, sufficient margin exists for the existing trip setpoint to insure that channel trip occurs within the Analytical Limit (AL) considering additional drift and uncertainties for the 24 month ±25% operating cycle.

REFERENCES

See Section 3.0

AFFECTED SYSTEMS/COMPONENTS/DOCUMENTS

FT-414, FT-415, FT-416 FC-414, FC-415, FC-416 FQ-414, FQ-415, FQ-416
FT-424, FT-425, FT-426 FC-424, FC-425, FC-426 FQ-424, FQ-425, FQ-426
FT-434, FT-435, FT-436 FC-434, FC-435, FC-436 FQ-434, FQ-435, FQ-436
FT-444, FT-445, FT-446 FC-444, FC-445, FC-446 FQ-444, FQ-445, FQ-446

[ ] VOIDED OR [ ] SUPERSEDED BY: ______ (CALC. NO.)

[ ] VOIDS OR [ ] SUPERSEDES: N/A (CALC. NO.)

New York Power
Authority

CALCULATION NO. IP3-CALC-RPC-00298 REVISION 0

Project IP3	Page 2 of 20
Title Instr. Loop Accur./Setpt. Calc.	Date 1992
Preliminary	Prepared by J. McNeil Date 8/3/92
Final X	Checked by G. Durniak Date 8/3/92

TABLE OF CONTENTS

1.0 PURPOSE

Verify that channel trip will occur within the Analytical Limit (AL), considering additional instrument drift or uncertainties due to extension of the operating cycle from 18 months ± 25% to 24 months ± 25%.

2.0 ASSUMPTIONS

2.1 Per FSAR section 16.3.3, IP3's seismic horizontal acceleration is less than or equal to 0.2g. WCAP-7817, "Seismic Testing of Electrical and Control Equipment", states that the transmitter output returned to its original pre-test condition after each seismic test (note: tests were based on a maximum seismic test acceleration of 0.7g).

Similarly, bistables were also tested at 0.7g and results indicate that tripping action of the bistable was not impaired. Therefore, seismic effect is considered negligible. (Ref. 3.1.9 & 3.2.5)

Since the issuance of WCAP-7817, various components have been replaced with similar equipment. Therefore, seismic effect is considered negligible.

In addition, seismic event is not considered coincident with any other accident.

2.2 Additional "margin" is not used in the calculation, since the methodology used is inherently conservative.

2.3 Indication portion of loop is not addressed in this calculation.

2.4 The minimum ambient temperature for instrument calibrations will be 68°F.

2.5 Instrument bus voltage variations do not exceed ± 2.0%. (Ref. 3.1.22)

2.6 No credit is taken in the Safety Analysis for operation of the Low RC Flow Instrumentation following a LOCA/HELB. Therefore, effects of the accident environment inside containment are not included in this calculation.

3.0 REFERENCES

3.1 General

3.1.1 U.S. NRC, Regulatory Guide 1.105, Rev. 2, February, 1986 "Instrument Setpoints For Safety-Related Systems".

3.1.2 ANSI/ISA-S67.04-1988 Standard "Setpoints for Nuclear Safety-Related Instrumentation", dated 2/4/88.

* 3.1.3 ISA-RP67.04, Part II, Draft 9, "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation", dated 3/22/91.

* Used as Design Input.

New York Power Authority

CALCULATION NO. IP3-CALC-RPC-00298 REVISION 0

Project IP3	Page 4 of 20
Title Instr. Loop Accur./Setpt. Calc.	Date 1992
Preliminary	Prepared by J. McNeil Date 8/3/92
Final X	Checked by G. Durniak Date 8/3/92

* 3.1.4 IES-3, Rev. 0, 1/3/91, Instrument Loop Accuracy and Setpoint Calculations.

3.1.5 DCM-2, Rev. 1, 1/18/91, Preparation and Control of Calculations and Analyses.

* 3.1.6 IP3 Master Equipment List, RP System, dated 4/11/90.

* 3.1.7 Memo from D. Luce, dated October 30, 1991; Subject: Bistables.

* 3.1.8 TSP-011, Rev. 4, EQ Spare Parts Review Procedure, Attachment I, 8/30/91.

* 3.1.9 WCAP-7817, "Seismic Testing of Electrical and Control Equipment", December, 1971.

3.1.10 System Description No. 1.1, Reactor Coolant System, Rev. 1.

3.1.11 WCAP-7338, "Setpoint Study for Consolidated Edison's Nuclear Power Stations II and III, R. Reymers, September 1969.

* 3.1.12 Tech Manual FO-008, Rev. 0, Overpressurization Protection System, November 1987. (System Error Analysis)

* 3.1.13 WCAP-12128, "Westinghouse Improved Thermal Design Procedure Instrument Uncertainty Methodology For NYPA IP3," January 1989.

3.1.14 System Description No. 28, Overall Unit Protection, Rev. 0, Section 2.1.6.

* 3.1.15 NYPA Telephone Documentation Form dated 1/9/92, between J. McNeil (NYPA) and S. Nunn (Foxboro).

3.1.16 Instrument Drift Analysis for RPS Report No. IP3-RPT-RPC-00357, Preliminary Rev. 0.

3.1.17 Deleted

3.1.18 MOD 88-03-101-RCS, RCS RTD Bypass Elimination Modification (Electrical Design).

* 3.1.19 RTD Bypass Elimination Licensing report for Indian Point Unit 3, WCAP-12009 Revision 1, dated January 1989.

3.1.20 "Westinghouse Setpoint Methodology for Control and Protection systems", C.R. Tuley, IEEE Transactions on Nuclear Science, Vol 33, No.1, February.

3.1.21 "Performance Characteristics of Elbow Flowmeters", J.W. Murdock, Transactions of the ASME, September 1964, pg. 498-506.

* Used as Design Input.

* 3.1.22 Tech Manual WE-117, One Phase Instrument Power Supply, August 1979.

3.2 Final Safety Analysis Report (FSAR) Rev. 7, July 1991.

3.2.1 Chapter 4, Section 4.2.9.

* 3.2.2 Chapter 7, Section 7.2, Protective Systems.

* 3.2.3 Chapter 14, Safety Analysis, Rev. 1, dated 7/91.

* 3.2.4 Chapter 15, Technical Specification and Bases, through Amendment No. 111, dated 3/9/92.

* 3.2.5 Chapter 16 Design Criteria for Structures and Equipment.

3.3 Drawings

* 3.3.1 RPS Rack Layout Drawings:

9321-H-39903, Sht. 1, Rev. 2 9321-H-39903, Sht. 10, Rev. 2 9321-H-39903, Sht. 11, Rev. 3 9321-H-39903, Sht. 18, Rev. 2 9321-H-39903, Sht. 19, Rev. 2 9321-H-39903, Sht. 24, Rev. 1 9321-H-39903, Sht. 25, Rev. 1

* 3.3.2 Interconnection Wiring Diagrams:

9321-H-39923, Sht. 10, Rev. 2 9321-H-39923, Sht. 11, Rev. 2 9321-H-39923, Sht. 23, Rev. 2 9321-H-39923, Sht. 24, Rev. 2 9321-H-39923, Sht. 32, Rev. 2
9321-H-39923, Sht. 33, Rev. 2

* 3.3.3 Instrument Arrangement Drawings:

9321-F-70273, Rev. 14, Containment Bldg. Instrumentation
9321-F-70283, Rev. 18, Containment Bldg. Instrumentation
9321-F-70253, Rev. 8, Primary Plant Instrument Piping & Supports, Sht. 1
9321-F-70263 Rev. 11, Primary Plant Instrument Piping & Supports, Sht. 2

3.3.4 Deleted.

3.3.5 9321-H-70863 Westinghouse Suggested Routing, Reactor Coolant Flow Transmitter.

* 3.3.6 9321-F-27383, Rev. 22, Flow Diagram Reactor Coolant System Sht. 1

* Used as Design Input.

* 3.3.7 Instrument Block Diagram

IP3V-526-4.14-0075, (BD-20), Rev. 2
IP3V-526-4.14-0076, (BD-21), Rev. 2

* 3.3.8 Instrument Rack Drawing

9321-F-70513, Sht. 4, Rev. 9

3.3.9 Equipment Arrangement Control Building.

9312-F-30523, Sht. 1, Rev. 36

3.4 Calibration Procedures

3.4.1 IC-AD-2, Rev. 7, Calibration and Control of Measuring and Test Equipment.

* 3.4.2 AP-19, Rev. 10, Surveillance Test Program.

* 3.4.3 AP-17, Rev. 5, Calibration of M&TE.

* 3.4.4 3PT-M03, Rev. 15, Surveillance Test Procedure, Reactor Coolant Flow Analog Functional.

* 3.4.5 3PC-R2, Rev. 9, Reactor Coolant Loop Flow Calibration.

3.5 Foxboro Product Literature

3.5.1 Deleted

* 3.5.2 Foxboro Product Specification: PSS-2A-1C1H, E13DH Electronic Gauge Pressure Transmitters, dated 1984.

3.5.3 Deleted

* 3.5.4 Foxboro General Specification, GS-2A-5A2-A, 63U-AC Difference Alarm, August 1975.

* 3.5.5 Foxboro Instruction 18-690, Model 63U-A Single Alarm, January 1969.

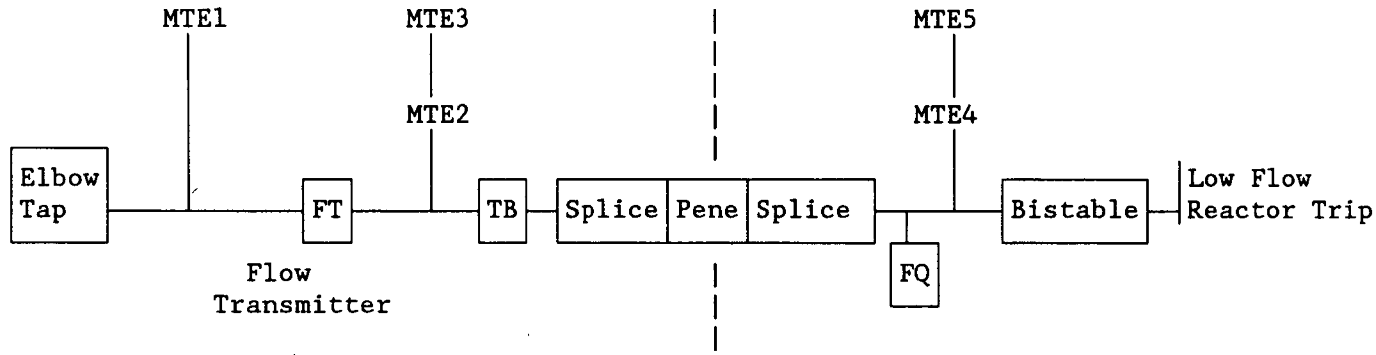
* Used as Design Input.

4.0 LOOP FUNCTION

The low flow reactor trip protects the core against DNB in the event of a loss of one or two reactor coolant pumps. (Ref. 3.2.4, page 2.3-6)

Flow transmitters are installed in the intermediate leg of each RCS loop and serve to indicate whether a reduction in the flow rate has occurred. Each transmitter supplies a flow indicator on panel SAF in the control room, a computer input (CI), and low flow comparator (bistable). At 93% of normal flow the comparator generates a low flow trip signal and an alarm on panel SAF. If two out of three flow comparators associated with a given loop trip, then the coincidence logic gate generates a loop low flow signal which may or may not cause a reactor trip depending upon the current power level and whether a low flow condition exists in any other RCS loops. (Ref. 3.1.14)

5.0 LOOP (BLOCK) DIAGRAM



The diagram above is similar for each of the twelve (12) instrument loops, as follows:

REACTOR COOLANT LOOP	FLOW TRANSMITTER	POWER SUPPLY	BISTABLE
31	FT-414 FT-415 FT-416	FQ-414 FQ-415 FQ-416	FC-414 FC-415 FC-416
32	FT-424 FT-425 FT-426	FQ-424 FQ-425 FQ-426	FC-424 FC-425 FC-426
33	FT-434 FT-435 FT-436	FQ-434 FQ-435 FQ-436	FC-434 FC-435 FC-436
34	FT-444 FT-445 FT-446	FQ-444 FQ-445 FQ-446	FC-444 FC-445 FC-446

(Ref. 3.3.3, 3.3.2, 3.3.6 & 3.3.7)

6.0 LOOP UNCERTAINTY EQUATIONS

(SEE ATTACHMENT I)

6.1 LOOP COMPONENTS (Ref. 3.1.6, 3.3.1, 3.3.2, 3.3.3, & 3.3.8)

TAG	SYSTEM	BLDG	RACK	MODEL NO.
FT-414 FT-415 FT-416	RP	VC Elev 68'	F20	E13DH-SAH1
FT-424 FT-425 FT-426	RP	VC Elev 68'	F20	E13DH-SAH1
FT-434 FT-435 FT-436	RP	VC Elev 68'	F20	E13DH-SAH1
FT-444 FT-445 FT-446	RP	VC Elev 68'	F20	E13DH-SAH1
FQ-414 FQ-415 FQ-416	RP	CB ELEV 53'	R4 R8 R11	610AC-0
FQ-424 FQ-425 FQ-426	RP	CB Elev 53'	R4 R8 R11	610AC-0
FQ-434 FQ-435 FQ-436	RP	CB Elev 53'	R4 R8 R11	610AC-0
FQ-444 FQ-445 FQ-446	RP	CB Elev 53'	R4 R8 R11	610AC-0
FC-414 FC-415 FC-416	RP	CB Elev 53'	R4 R8 R11	63U-AC-OHAAF
FC-424 FC-425 FC-426	RP	CB Elev 53'	R4 R8 R11	63U-AC-OHAAF
FC-434 FC-435 FC-436	RP	CB Elev 53'	R4 R8 R11	63U-AC-OHAAF
FC-444 FC-445 FC-446	RP	CB Elev 53'	R4 R8 R11	63U-AC-OHAAF

7.0 DETERMINE CHANNEL UNCERTAINTY (CU)

Total Channel Uncertainty (CU)

The total Channel Uncertainty is calculated as follows. The methodology is described in Attachment I:

$$CU = \pm\sqrt{PM_1^2 + PE_1^2 + IRE_1^2 + e_1^2 + e_2^2} \pm B^*$$

$$CU = \pm\sqrt{2.27^2 + 1.0^2 + 0^2 + 1.55^2 + .68^2}$$

Where, bias B = 0,

$$CU = \pm 3.0\%\ flow\ span$$

Converting "% flow span" to "% flow" given that the instrument loop span is 120% flow, (Ref. 3.4.5)

$$CU = \pm 3.0\%\ flow\ span\ X\ (120\%)$$

$$CU = \pm 3.6\%\ flow$$

The loop uncertainties are given as follows:

7.1 Process Measurement Uncertainty (PM_1)

PMA is an allowance for non-instrument related effects. Examples of the PMA terms used are the effect of the accuracy of the rod control system (Tavg) on the density of the primary coolant in the cold leg elbow where d/p transmitters are used to infer flow rate, and the accuracy of precision flow calorimetric used to normalize the cold leg elbow tap d/p transmitters. (Ref. 3.1.20)

Westinghouse provides two values (in terms of % flow span) for Process Measurement Uncertainty, PMA_1 and PMA_2. For conservatism, these values are combined algebraically as follows:

$$PM_1 = PMA_1 + PMA_2 = .25 + 2.02 = \pm 2.27\%\ flow\ span$$ (Page 19 of Ref. 3.1.19)

Values for PMA_1, PMA_2, and PE_1 were obtained from Tables 3.1-1 through 3.1-4 of Ref. 3.1.19 and reflect plant specific measurement uncertainties and operating conditions of Indian Point 3.

7.2 Primary Element Uncertainties (PE_1) = ± .3% flow span

Primary Element Accuracy (PEA) is an allowance for use of a metering device for the measurement of flow. When an elbow is used for a protection function, the d/p transmitter used to make the measurement is normalized to a precision flow measurement to reduce the uncertainty for the flow coefficient for the elbow. The PEA term is then an allowance for the noisy signal that is characteristic of use of an elbow. (Ref. 3.1.20)

Primary Element uncertainty, due to installation of flow transmitters across an elbow in the suction of the RCP, is given by Westinghouse to be ±.3% of flow span. For added conservatism this value will be increased to ± 1.0% of flow span.

$PE_1 = PEA_1 = \pm 1.0\%$ flow span (Page 19 of Ref. 3.1.19)

Note: Ref 3.1.21 details that a calibrated elbow meter is just as accurate as any other standard primary device and has a repeatability in the order of ±0.2%. Therefore, ± 1.0% is conservative.

7.3 Insulation Resistance Effect (IRE)

The twelve (12) flow transmitters are located in the Containment Building (Ref. 3.1.6 and 3.3.3). Per Assumption 2.6, accident effects are not considered.

IRE effects are negligibly small under normal, non-accident conditions. (Ref. 3.1.3)

7.4 Transmitter Uncertainties (e_1)

$$e_1 = \pm \sqrt{RA_1^2 + DR_1^2 + TE_1^2 + RE_1^2 + SE_1^2 + HE_1^2 + SP_1^2 + MTE_1^2 + PS_1^2} \pm B_1^*$$

$$e_1 = \pm \sqrt{.5^2 + 1.80^2 + .68^2 + 0^2 + 0^2 + 0^2 + 1.5^2 + .72^2 + .1^2}$$

$e_1 = \pm$ 2.59% of ΔP Span

Please note that no bias uncertainties were identified.

Reactor Coolant flow is determined by differential pressure transmitters connected to elbow taps. The above e_1 uncertainty, is given in "% of ΔP span". In order to calculate total channel uncertainty for RC flow, the e_1 uncertainty must be converted from "% of ΔP span" to "% flow". Westinghouse provides this conversion as follows:

$$e_1\ (\%\ flow) = (\Delta P\ uncertainty)\ (1/2) \left(\frac{Transmitter\ span}{100}\right)^2$$ (pg. 19 of ref. 3.1.13)

Where RCS flow transmitter span is 120%, and nominal flow is 100%.

In order to convert e_1 above to "% flow span", divide both sides by transmitter span, and multiply by 100. Therefore,

$$e_1\ (\%\ flow\ span) = \left(\frac{\Delta P\ uncertainty}{2}\right)\left(\frac{transmitter\ span}{100}\right)$$

Solving for e_1,

$$e_1 = \left(\frac{2.59\%}{2}\right)\left(\frac{120}{100}\right)\ \%\ flow\ span$$

$$e_1 = \pm 1.55\%\ flow\ span$$

The flow transmitter uncertainties are given as follows:

7.4.1 Reference Accuracy (RA_1) = ±.5% of ΔP Span (Ref. 3.5.2).

Analysis of ref. 3.4.5 details that the pressure span is less than 500 inches of H_2O. Per Ref. 3.5.2, the corresponding Reference Accuracy is ± .5% of ΔP span.

The Calibration Procedure Tolerance for the transmitters is shown to be ±.5% of span (2mV tolerance of 400 mV span) (Ref. 3.4.5).

Therefore, either value may be used to calculate the transmitter uncertainty.

7.4.2 Drift (DR_1) = 1.2% of ΔP Span, per year (Ref. 3.1.15). Given that the drift uncertainty for a given period is a random and independent term, and that drift varies linearly with time within any one period, drift for 30 months (2 1/2 periods) may be calculated as follows:

$$DR_1 = \sqrt{1.2^2 + 1.2^2 + \left(\frac{1.2}{2}\right)^2} \qquad \text{(Paragraph 6.2.7 of Ref. 3.1.3)}$$

= ±1.80% of ΔP span, for 30 months

7.4.3 Temperature Effect (TE_1)

The Temperature Effect at the normal operating temperature can be calculated as follows:

Temp. Effect (TE_1) = ± 2.0% of ΔP span, per 100°F (Ref. 3.5.2)

The normal containment temperature is 102°F at elevation 68'

(Ref. 3.1.8)

Given that calibration is done at 68°F (Assumption 2.4), the max. temp. change ΔT = 102 - 68 = 34°F.

Given that the temperature Effect (TE) will vary linearly with temp. difference (Ref. 3.1.3),

$$\frac{2.0\%}{100°F} = \frac{TE}{34°F}$$

TE_1 (Normal) = ± .68% of ΔP Span

7.4.4 Radiation Effect (RE_1) = 0. (Assumption 2.6)

Radiation effects under normal operating conditions are considered negligible.

7.4.5 Seismic Effect (SE_1) = 0. (Assumption 2.1)

7.4.6 Humidity Effect (HE_1) = 0. (Assumption 2.6)

7.4.7 Static Pressure Effect (SP_1) = ± 1.5% of ΔP span (Ref. 3.5.2)

7.4.8 Measurement and Test Equipment uncertainty (MTE_1)

The following three instruments are used to test the transmitters, as shown in the block diagram (Section 5.0) and Ref. 3.4.5:

MTE1:	Pressure Gage
MTE2:	Precision Resistor, 10 ohms
MTE3:	Digital Volt Meter (DVM)

The reference standards used for calibrating M&TE have an uncertainty (error) requirement of not more than 1/4 of the tolerance of the equipment being calibrated (Ref. 3.4.3).

Measuring and Test Equipment shall have an accuracy greater than or equal to that of the equipment being calibrated (Ref. 3.4.2).

Given the relative high accuracy of the M&TE, and the procedural guidelines stated above, it is conservative to assume that:

MTE1 = MTE3 = The transmitter Reference Accuracy (RA), including any M&TE reading error, and reference standard uncertainty.

The Precision Resistor (MTE2) shall have a tolerance of 9.99 to 10.01 ohms or ± .1% of span. (Ref 3.4.3, Resistor Calibration Log)

Therefore, per Ref. 3.1.3: $MTE = \sqrt{MTE\ 1^2 + MTE\ 2^2 + MTE\ 3^2}$

$$= \sqrt{.5^2 + .1^2 + .5^2}$$

$$= \pm .72\% \text{ of } \Delta P \text{ span}$$

7.4.9 Power Supply Effect (PS_1) = ±.1% of ΔP span for a ± 10% deviation in supply voltage (Ref. 3.5.2).

Per Assumption 2.5, instrument bus voltage variations will not exceed ±2.0%, therefore, it is conservative to assume,

PS_1 = ± 0.1% of ΔP span

7.4.10 Monthly Calibration Tolerance Analysis

Please note that the flow transmitter output is monitored as part of the monthly calibration procedure. Therefore, any additional drift due to extension of the Operating Cycle will be evaluated on a monthly basis.

The monthly calibration tolerance for the transmitters is ±10mV (±2.5% of ΔP span) (Ref. 3.4.4). This procedure records actual transmitter output at 100% flow. Therefore, this tolerance represents the normal combined channel uncertainty for the elbow and transmitter as seen during operation: Using values from Sec. 7.0, this tolerance should be no greater than:

given,

$PM_1 = PMA_1 = \pm\ 0.30\ \%\ \Delta P$ span (Table 3.1.4 of Ref. 3.1.19)
$PE_1 = PEA = \pm\ 0.50\ \%\ \Delta P$ span (Table 3.1.4 of Ref. 3.1.19)
$B = 0$

$$\sqrt{PM_1^2 + PE_1^2 + RA_1^2 + DR_1^2 + TE_1^2 + SP_1^2 + MTE^2 + PS_1^2}$$

$$\sqrt{.30^2 + .50^2 + .5^2 + 1.8^2 + .68^2 + 1.5^2 + .72^2 + .1^2} = \pm 2.66\%\ of\ \Delta P\ span$$

The monthly calibration tolerance is less than this value, and therefore, conservative.

7.5 Bistable Uncertainty (e_2)

As shown on the block diagram (Section 5.0), the alarm (bistable) uncertainty may be calculated as follows:

$$e_2 = \pm\sqrt{RA_2^2 + DR_2^2 + TE_2^2 + RE_2^2 + SE_2^2 + HE_2^2 + SP_2^2 + MTE_2^2 + PS_2^2} \pm B_2^*$$

$$= \pm\sqrt{.5^2 + .2^2 + .52^2 + 0^2 + 0^2 + 0^2 + 0^2 + .71^2 + .5^2} \pm 0$$

$e_2 = \pm\ 1.14\%$ of ΔP span,

Please note that no bias uncertainties were identified.

Similarly to Section 7.4, the bistable uncertainty given in "% of ΔP span" must be converted to "% flow" using the Westinghouse conversion factor. Therefore,

$$e_2\ (\%\ flow\ span) = \left(\frac{1.14}{2}\right)\left(\frac{120}{100}\right)$$

$$e_2 = \pm 0.68\%\ flow\ span$$

The bistable uncertainties are given as follows:

7.5.1 Reference Accuracy (RA_2)

Reference Accuracy for the Model 63U-AC alarm is given as ± .5%of ΔP span. (Ref 3.5.5)

The Calibration Procedure Tolerance is given as ± .2 mV, (± .5%). (Ref. 3.4.4)

Therefore, either value may be used to calculate the bistable uncertainty.

Foxboro Bistable units with cord sets have a resistor (RM1) mounted externally on a terminal block, as shown on the interconnecting wiring diagram (Ref. 3.3.2). The resistor uncertainty (±.1%) is included in the specified bistable Reference Accuracy (Ref. 3.5.5). Therefore, the uncertainty of the external resistor does not need to be addressed separately.

NOTE: The total resistance of all resistors in the loop is within the vendors recommended "output loop resistance operating area" for the transmitters. Therefore, the resistors do not introduce any additional loop uncertainty (Ref. 3.5.2).

7.5.2 Drift (DR_2) = ±.2% of ΔP span per year (Ref. 3.1.12, System Error Analysis).

The overpressurization system manual provides drift values of ± 0.2%/yr. for various 63U series bistables. The RC Flow bistables are also series 63U bistables. Therefore, by similarity it is acceptable to use this drift value for the bistable uncertainty.

The bistables are checked and calibrated monthly, therefore this drift value is conservative.

7.5.3 Temperature Effect (TE_2) = ±.5% of ΔP span, for a 50°F change in ambient temperature. (ref. 3.5.4)

Control Room equipment is designed for a maximum temperature of 120°F. (page 7.2-7 of ref 3.2.2)

Given that calibration may be performed at 68°F (assumption 2.4), the temperature effect over a temperature change of 52°F (120°F-68°F) is assumed to vary linearly as follows:

$$TE_2 = \pm 0.5\% \left(\frac{52}{50}\right)$$
$$TE_2 = \pm 0.52\% \text{ of } \Delta P \text{ span}$$

The above temperature effect is conservative.

7.5.4 Radiation effect (RE_2) = 0

The bistable is located in a mild environment.

7.5.5 Seismic Effect (SE_2) = 0 (Assumption 2.1)

7.5.6 Humidity Effect (HE_2) = 0

The rack is located in a mild environment.

7.5.7 Static Pressure Effect (SP_2) = 0

Pressure Effects are not applicable for electronic components.

7.5.8 Measuring and Test Equipment (MTE_2)

Two instruments are involved in calibrating the bistables, as shown in the block diagram (section 5.0) and Ref. 3.4.4:

MTE4: Test Point resistor (Part of the Foxboro Rack)
MTE5: Digital Volt Meter

As described in Section 7.4.8:

MTE4 = MTE5 = Bistable Reference Accuracy (RA_2)

Therefore:

$$MTE2 = \sqrt{MTE4^2 + MTE5^2}$$

$$= \sqrt{.5^2 + .5^2}$$

$$= \pm .71\% \text{ of } \Delta P \text{ span}$$

$$MTE_2 = \pm .71\% \text{ of } \Delta P \text{ span}$$

7.5.9 Power Supply Effect (PS_2) = ±.5% of ΔP span, due to a ± 10% change in line voltage. (Ref. 3.1.12, System Error Analysis)

This value is typical for a 63U series bistable. Also, per assumption 2.5, instrument bus voltage variations will not exceed ± 2.0%, therefore, it is conservative.

8.0 OBTAIN ANALYTICAL LIMIT (AL)

8.1 The Analytical Limit used in the safety analysis for low flow reactor trip is 87% of loop flow. (page 14.1-4 of Ref 3.2.3)

9.0 DETERMINE SETPOINT (TS)

9.1 Calculated trip setpoint

The trip setpoint can be calculated from the following equation:

TS = AL ± (CU + Margin) (Section 7.2 of Ref. 3.1.3)
given, Margin = 0 (Assumption 2.2)
CU = ± 3.60% flow (Section 7.0)

CU is then combined with the Analytical Limit (AL) in an appropriate direction, in order to determine the Trip Setpoint, as shown below.

TS = 87% + 3.60%
TS = 90.6% flow

9.2 Determination of existing setpoint

The existing setpoint for each bistable can be found from procedure 3PT-M03, Rev. 15 (Ref. 3.4.4). The following is provided for information only, to show the existing Trip Setpoint in % flow. Please note that these values may change at each refueling.

LOOP	BISTABLE TAG NO.	EXPECTED TRANSMITTER OUTPUT (mV DC)	TRIP SETPOINT (mV DC)
31	FC-414	377	339.58
	FC-415	388	349.09
	FC-416	380	342.17
32	FC-424	365	329.20
	FC-425	380	342.17
	FC-426	376	338.71
33	FC-434	384	345.63
	FC-435	387	348.23
	FC-436	382	343.90
34	FC-444	365	329.20
	FC-445	384	345.63
	FC-446	378	340.44

The expected "as found" flow transmitter output is given in the monthly calibration procedure (Ref. 3.4.4), and is based upon previous transmitter operating behavior. The relationship of the calibration procedure Trip Setpoint and the expected transmitter output is given as follows:

$$X = \sqrt{\frac{TS - 100}{\Delta P - 100}}(100)\ \%\ flow$$

Where,

X = Trip Setpoint in % flow

TS = Trip Setpoint in mV DC

ΔP = Transmitter Output (mV) at 100% Nominal Flow

Solving for X, given the above values for bistable FC-414,

$$X = \sqrt{\frac{339.58 - 100}{377 - 100}}\ (100)\ \%\ flow$$

$$X = 93\%\ flow$$

10.0 DETERMINE ALLOWABLE VALUE (AV)

The Allowable Value (AV) can be calculated from the following equation (method 3 of ref. 3.1.3).

AV = TS $\pm$ CU_{CAL}

Where, TS = Trip Setpoint

CU_{CAL} = Channel Uncertainty (CU) as seen during calibration. Therefore, uncertainties due to a harsh environment, process measurement, or primary element are not considered. For conservatism, only RA, DR, and MTE uncertainties are considered.

The AV will be calculated using the Square-Root-Sum-of-the-Squares (SRSS) method which is consistent with the method used for the determination of the trip setpoint. Therefore, a check calculation is not required. (ref. 3.1.3)

10.1 Determine e_{CAL}

From Section 7.4,

$$e_1 = \pm\sqrt{RA_1^2 + DR_1^2 + TE_1^2 + RE_1^2 + SE_1^2 + HE_1^2 + SP_1^2 + PS_1^2 + MTE_1^2} \pm B_1$$

As defined above, CU_{CAL} only considers the normal uncertainties as seen during calibration, therefore the module uncertainty equation e_1 reduces to:

$$e_{1CAL} = \pm\sqrt{RA_1^2 + DR_1^2 + MTE_1^2}$$

The e_1 effects for RA, DR, and MTE from section 7.4 are substituted in the above equation:

Therefore,

$$e_{1CAL} = \pm\sqrt{.5^2 + 1.8^2 + .72^2}$$

$$e_{1CAL} = \pm 2.0\% \textit{ of } \Delta P \textit{ span}$$

Similarly for e_2 and using values from section 7.5, the uncertainty associated with e_2 calibration is:

$$e_{2CAL} = \pm\sqrt{.5^2 + .2^2 + .71^2}$$

$$e_{2CAL} = \pm .89\% \textit{ of } \Delta P \textit{ span}$$

10.2 Determine CU_{CAL}

Given the above CU_{CAL} definition, the channel uncertainty equation from Section 7.0 reduces to:

$$CU_{CAL} = \pm\sqrt{e_{1CAL}^2 + e_{2CAL}^2}$$

Therefore,

$$CU_{CAL} = \pm\sqrt{2.0^2 + .89^2}$$

$$CU_{CAL} = \pm 2.19\% \textit{ of } \Delta P \textit{ span}$$

converting "% of ΔP span" to "% flow span" given the conversion factor of Section 7.4,

$$CU_{CAL} = \pm\left(\frac{2.19\%}{2}\right)\left(\frac{120}{100}\right) \% \textit{ flow span}$$

$$CU_{CAL} = \pm 1.31\% \textit{ flow span}$$

Multiplying by 120%,

$$CU_{CAL} = \pm (1.31\%)(120\%)$$

$$CU_{CAL} = \pm 1.57\% \textit{ flow}$$

10.3 Allowable Value (AV) Calculation

Calculating for RC low flow allowable value,

given, TS = 90.6% flow (Sec. 9.1)

CU_{CAL} = ± 1.57% flow

The magnitude of CU_{CAL} is combined with the trip setpoint in an appropriate direction to determine AV for a decreasing signal. Therefore,

$AV = TS - CU_{CAL}$

$AV = 90.6 - 1.57$

AV = 89.0% flow

11.0 SUMMARY

	CALCULATED	EXISTING
Trip Setpoint (TS)	90.6% flow (Sec. 9.1)	93% flow (Ref. 3.4.4)
Limiting Safety System Setting		90% flow (Sec. 2.3 of Ref. 3.2.4)
Allowable Value (AV)	89.0% flow (Sec. 10.3)	
Analytical Limit (AL)	87% flow (Sec. 8.1)	87% flow (Sec. 8.1)

NOTES:

1. The calculated Allowable Value (AV) represents the limiting "as-found" condition for the instrument loop.

2. Normal operating RC flow is 100%.

11.1 CONCLUSION:

The existing Trip Setpoint for Reactor Coolant Loop Low Flow is set higher than is required by the total channel uncertainty, therefore it is conservative. No Setpoint change is required.

For RC Loop Low Flow trip, sufficient margin exists for the existing trip setpoint to insure that channel trip occurs within the Analytical Limit (AL) considering additional drift and uncertainties for the 24 month ± 25% operating cycle.

12.0 ATTACHMENTS

I. Channel Uncertainty Equations

CALC NO. IP3-CALC-RPC-00298	REV. 0	PROJECT IP3
REFERENCE IES-3, Rev. 0, Instrument Loop Accuracy and Setpoint Calculations		

1.0 Total Channel Uncertainty (CU)

The calculation of an instrument channel uncertainty can be performed with a single loop equation containing all potential uncertainty values, or by a series of related term equations. A specific channel calculation coincides with a channel's layout from process measurement to final output module or modules.

The typical linear channel uncertainty calculation has the following form:

$$CU^{+} = +\sqrt{PM^2 + PE^2 + IRE^2 + (Module_1)^2 + (Module_2)^2 + \ldots (Module_n)^2} + B^{+}$$

$$CU^{-} = -\sqrt{PM^2 + PE^2 + IRE^2 + (Module_1)^2 + (Module_2)^2 + \ldots (Module_n)^2} - B^{-}$$

Where:

CU = Channel Uncertainty (CU) at a specific point in the channel: the CU can be calculated for any point in a channel from Module 1 to Module n, as needed.

PM = Random uncertainties that exist in the channel's basic Process Measurement (PM).

PE = Random uncertainties that exist in a channel's Primary Element (PE), if it has one, such as the accuracy of a flowmeter table.

IRE = Insulation resistance effect, leakage allowance in % of span.

MODULE 1, 2, n = Total random uncertainty of each module that makes up the loop from Module 1 through Module n.

B^{+} = The total of all positive biases associated with a channel; this would include any uncertainties from PM, PE, or the Modules that could not be combined as a random term (biases, arbitrarily - distributed uncertainties, and random bias).

B^{-} = The total of all negative biases associated with a channel.

CALC NO. IP3-CALC-RPC-00298	REV. 0	PROJECT IP3
REFERENCE IES-3, Rev. 0, Instrument Loop Accuracy and Setpoint Calculations		

2.0 Module (e_n) Uncertainties

The individual module random uncertainties are in themselves a statistical combination of uncertainties. Depending on the type of module, its location, and the specific factors that can affect its accuracy, the determination of the module uncertainty will vary. For example, the module uncertainty for a module may be calculated as:

$$e^{+} = +\sqrt{RA^2 + DR^2 + TE^2 + RE^2 + SE^2 + HE^2 + SP^2 + PS^2 + MTE^2} + B^{+}$$

$$e^{-} = -\sqrt{RA^2 + DR^2 + TE^2 + RE^2 + SE^2 + HE^2 + SP^2 + PS^2 + MTE^2} - B^{-}$$

Where:

e = Uncertainty of module,

RA = Module Reference Accuracy specified by the manufacturer,

DR = Drift of the module over a specific period,

TE = Temperature Effect for the module; the effect of ambient temperature variations on module accuracy; the TE may be a normal operating TE, or an accident TE, as required,

RE = Radiation Effect for the module; the effect of radiation exposure on module accuracy; the RE may be a normal operating RE, an accident RE, or time of trip RE as required,

SE = Seismic Effect or vibration effect for the module; the effect of seismic or operational vibration on the module accuracy,

HE = Humidity Effect for the module; the effect of changes in ambient humidity on module accuracy, if any,

SP = Static Pressure effects for the module; the effect of changes in process static pressure on module accuracy,

MTE = Measuring and Test Equipment effect for the module; this accounts for the uncertainties in the equipment utilized for calibration of the module,

PS = Power Supply effect,

B = Biases associated with the module, if any.

IP3 [X]

JAF [ ]

INDEPENDENT DESIGN VERIFICATION
CONTROL SHEET

VERIFICATION OF: IP3-CALC-RPC-00298/Setpoint Calculation for RC Loop Low Flow
Document Title/Number

SUBJECT: 24 Month Operating Cycle - Reactor Scram Setting

MOD/TASK NUMBER (If Applicable): ______

QA CATEGORY: Cat I

DISCIPLINE REVIEW:	ELEC	MECH	C/S	I&C	OTHER (SPECIFY) O & M
Check as required	[ ]	[ ]	[ ]	[ ]	[X]

METHOD USED *:	DR					
VERIFIER'S NAME:	W. Wittich					
VERIFIER'S INITIALS/DATE:	WW 8/3/92					

APPROVED BY: A Petrenko Nett Date: 8/18/92

REMARKS/SCOPE OF VERIFICATION:

Verification completed in accordance with Attachment 4.3 of DCM 4, Rev. 7.

Calculation is clear and technically understandable. The assumptions, approach, and technique are in accordance with industry practice. The results are valid and reasonable.

In addition to an overall evaluation of the calculation, independent verification compared the results of this calculation to results from similar plants. The total calculated channel uncertainty of 3.0% of flow span is consistent with the total

* Methods of verification: Design Review (DR), Alternate Calculations (AC), Qualification Test (QT)

IP3 [X]

JAF [ ]

INDEPENDENT DESIGN VERIFICATION
CONTROL SHEET

allowance used elsewhere. Both the Turkey Point Tech Specs and the W Standard Technical Specification document a total channel uncertainty with margin of 2.5% - 4.6% of span.

DESIGN VERIFICATION CHECKLIST
DESIGN REVIEW METHOD

VERIFICATION OF: RC Loop Low Flow/IP3-CALC-RPC-00298
Document/Title/Number

SUBJECT: Setpoint Calculations for 24 Month Cycle

MOD/TASK NO.: (If Applicable) N/A

DISCIPLINE REVIEW

	ELEC	MECH	C/S	I&C	OTHER (SPECIFY) O&M
Check as Required	☐	☐	☐	☐	X

		Yes/No/Not Applicable
1.	Were the inputs correctly selected and incorporated into the design?	Yes/No/NA
2.	Are assumptions necessary to perform the design activity adequately described and reasonable: Where necessary, are the assumptions identified for subsequent reverifications when the detailed design activities are completed?	Yes/No/NA
3.	Are the appropriate quality and quality assurance requirements specified? e.g., safety classification.	Yes/No/NA
4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?	Yes/No/NA
5.	Have applicable construction and operating experience been considered?	Yes/No/NA
6.	Have the design interface requirements been satisfied?	Yes/No/NA
7.	Was an appropriate design method used?	Yes/No/NA
8.	Is the output reasonable compared to inputs?	Yes/No/NA
9.	Are the specified parts, equipment and processes suitable for the required application?	Yes/No/NA

DESIGN VERIFICATION CHECKLIST
DESIGN REVIEW METHOD

		Yes/No/Not Applicable
10.	Are the specified materials compatible with each other and the design environmental conditions to which the materials will be exposed?	Yes/No/NA
11.	Have adequate maintenance features and requirements been satisfied?	Yes/No/NA
12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?	Yes/No/NA
13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?	Yes/No/NA
14.	Has the design properly considered radiation exposure to the public and plant personnel? (ALARA/cobalt reduction)	Yes/No/NA
15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	Yes/No/NA
16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?	Yes/No/NA
17.	Are adequate handling, storage, cleaning and shipping requirements specified?	Yes/No/NA
18.	Are adequate identification requirements specified?	Yes/No/NA
19.	Are the conclusions drawn in the Safety Evaluation fully supported by adequate discussion in the test or Safety Evaluation itself?	Yes/No/NA
20.	Are necessary procedural changes specified and are responsibilities for such changes clearly delineated?	Yes/No/NA
21.	Are requirements for record preparation, review, approval, retention, etc., adequately specified?	Yes/No/NA
22.	Have supplemental reviews by other engineering disciplines (seismic, electrical, etc.) been performed on the integrated design package?	Yes/No/NA

DESIGN VERIFICATION CHECKLIST
DESIGN REVIEW METHOD

Yes/No/Not Applicable

23. Have the drawings, sketches, calculations etc., included in the integrated design package been reviewed? Yes/No/NA

24. References used as part of the design review which are not listed as part of the design calculation/analysis.

NONE

DESIGN VERIFIER: ______________________
Signature/Date

Supervisor – NOSG
Title

Ebasco Services Inc.