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CALC NO.: SC-BB-0522 REVISION: 3			CALCULATION COVER SHEET			Page 1	
CALC. TITLE:	Loop Tolerance Calculation for 1BBVSH-7910A1, A2, A4, B1, B2, & B4						
# SHTS (CALC):	24	# ATT / # SHTS:	2/11	# IDV/50.59 SHTS:	0/3	# TOTAL SHTS:	38

CHECK ONE:

☒ FINAL ☐ INTERIM (Proposed Plant Change) ☐ FINAL (Future Confirmation Req'd) ☐ VOID

SALEM OR HOPE CREEK: ☐ Q – LIST ☐ IMPORTANT TO SAFETY ☒ NON-SAFETY RELATED
HOPE CREEK ONLY: ☐Q ☐Qs ☐Qsh ☐F ☐R

☐ STATION PROCEDURES IMPACTED, IF SO CONTACT SYSTEM MANAGER
☒ CDs/ADs INCORPORATED (IF ANY): 80006592, 0, CD, I 00503

DESCRIPTION OF CALCULATION REVISION (IF APPL.):

Rev. 3 Revises the calculation on its entirety including the corresponding instrumentation uncertainties and sets new setpoints in accordance to information provided by the equipment vendor. Sepoints incorporated by DCPs 80045185 and 80044664. 50.59 applicability review attached.

These DCPs set the current vib. setpoints

PURPOSE:

Rev. 3 Calculate new setpoints and loop tolerances for Reactor Recirculation Pump Vibrations including all instrumentation uncertainties.

CONCLUSIONS:

Rev. 3 of the calculation provides assurance that the provided new setpoints are in accordance with pump manufacturers recommendations and that uncertainties have been considered. DCP Changes corresponding procedures and ICDs.

	Printed Name / Signature	Date
ORIGINATOR/COMPANY NAME:	Terry McCool / PSEG [signature]	01/13/03
REVIEWER/COMPANY NAME:	Ashok Bhuta / PSEG [signature]	01/13/03
VERIFIER/COMPANY NAME:	N/A	
PSEG SUPERVISOR APPROVAL:	Ken Fleischer/ PSEG [signature]	01/14/03

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ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03				
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03				

REVISION SUMMARY

Revision 3:

- SC-BB-0522 is reformatted revised per the results of this calculation (Reference DCPs 80044664 & 80045185). Inclusion of additional vibration error in SC-BB-0522 shall be used to verify acceptability of test performance. Changes in this calculation shall be used to revise SAP ICD Data for H1BB – 1BBVSH-7910A1, A2, B1 & B2 for new setpoints and increased loop uncertainties. Revision shall account for M&TE requirements. Due to the unavailability of the original calculation, this will be a complete re-write of the calculation.

Revision 2:
Revised to add setpoints for H1BB –1BBVSH-7910B1 & B2 per DCP 4HM-0345, 12/14/1988.

Revision 1:
Issued for Revision of setpoints per SDR-BB-1021 & ICD Data, 07/24/1986.

Revision 0:
Original Issue, to verify ICD Card Data, 12/16/1985.

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	CALCULATION CONTINUATION SHEET		SHEET: 6			
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REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03				

1.0 OBJECTIVES

1.1 The purpose of this calculation is to provide the loop accuracy for indication and for the alert and trip setpoints during normal and accident conditions.
1.2 This calculation provides loop calibration tolerances for Recirc Pump vibration indication loops A and B.
1.3 This calculation revision provides for reformatting and consideration of additional effects. Therefore it is a total re-write.

2.0 FUNCTIONAL DESCRIPTION/DESIGN BASIS

The design basis for the reactor recirculation pumps are to circulate the water in the reactor, vary the water flow through the reactor, and provide a method for reactivity control. The vibration levels of the pump/motor are monitored continuously using a Bentley Nevada Smart Monitor system. The alarm and required action vibration set points are an indication of a problem with the pump or motor that requires action. Though the reactor recirculation pumps are safety related components, the vibration monitoring system components are neither safety related nor have any seismic requirements. The current vibration set point values for the pumps/motors are overly conservative. This revision increases the values according to calculations performed below the forces caused by increased vibrations fall well within allowable forces.

3.0 REFERENCES

3.1 Updated Final Safety Analysis Report, Rev. 11, 11/24/00

3.1.1 Section 5.4.1 Reactor Circulation Pumps.
3.1.2 Section 13.5 Plant procedures.
3.1.3 Section 15.3.1 Reactor Circulation Pump Trip.

3.2 Technical Specifications, 2/14/01

3.2.1 Section 4.4.1 – Recirculation System.
3.2.2 Bases 4.3.4 – Recirculation Pump Trip Actuation Instrumentation.

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3.3 *Drawings*

3.3.1 M-43-1 Sheet 1, Rev. 26 – Reactor Recirculation System.
3.3.2 M-43-1 Sheet 2, Rev. 13 – Reactor Recirculation System.

3.4 *Support Documents*

3.4.1 Technical Standard DE-TS.ZZ-1001 (Q), Rev. 1 - Instrument Setpoint Calculations.
3.4.2 PN1-B31-C001-0119, Rev. 9, Reactor Recirc Pump Motors
3.4.3 PJ700-0045-000, Smart Monitor 11000 Series Vibration System Instruction Manual
3.4.4 D7.5, Rev. 17 – Environmental Design Criteria
3.4.5 S-C-ZZ-EEE-0625, Rev. 2, Engineering Evaluation of Salem Generating Station Units 1 and 2 Measuring and Test Equipment Accuracy's.
3.4.6 SC.DE-TS.ZZ-1001(Q), Rev. 0, Instrument Setpoint Calculations
3.4.7 SAP
3.4.8 ISA-RP67.04.02-2000, Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation, Approved 1 January 2000.

3.5 *Procedures*

3.5.1 HC.IC-DC.ZZ-0161, Rev. 8 – Bentley Nevada Probe and Proximeter 3000 and 70000 Series
3.5.2 HC.IC-DC.ZZ-0162, Rev. 3 – Dev/Equip Cal Bentley Nevada Smart Monitor Series 11000
3.5.3 HC.IC-DC.ZZ-0208, Rev. 5 - Dev/Equip Cal Bentley Nevada Velocity Seismoprobe Series 700.
3.5.4 HC.OP-SO.BB-0002(Q), Rev. 40 – Reactor Recirculation System Operation
3.5.5 HC.OP-AR.ZZ-0008(Q), Rev. 21 – Overhead Annunciator Window Box C1

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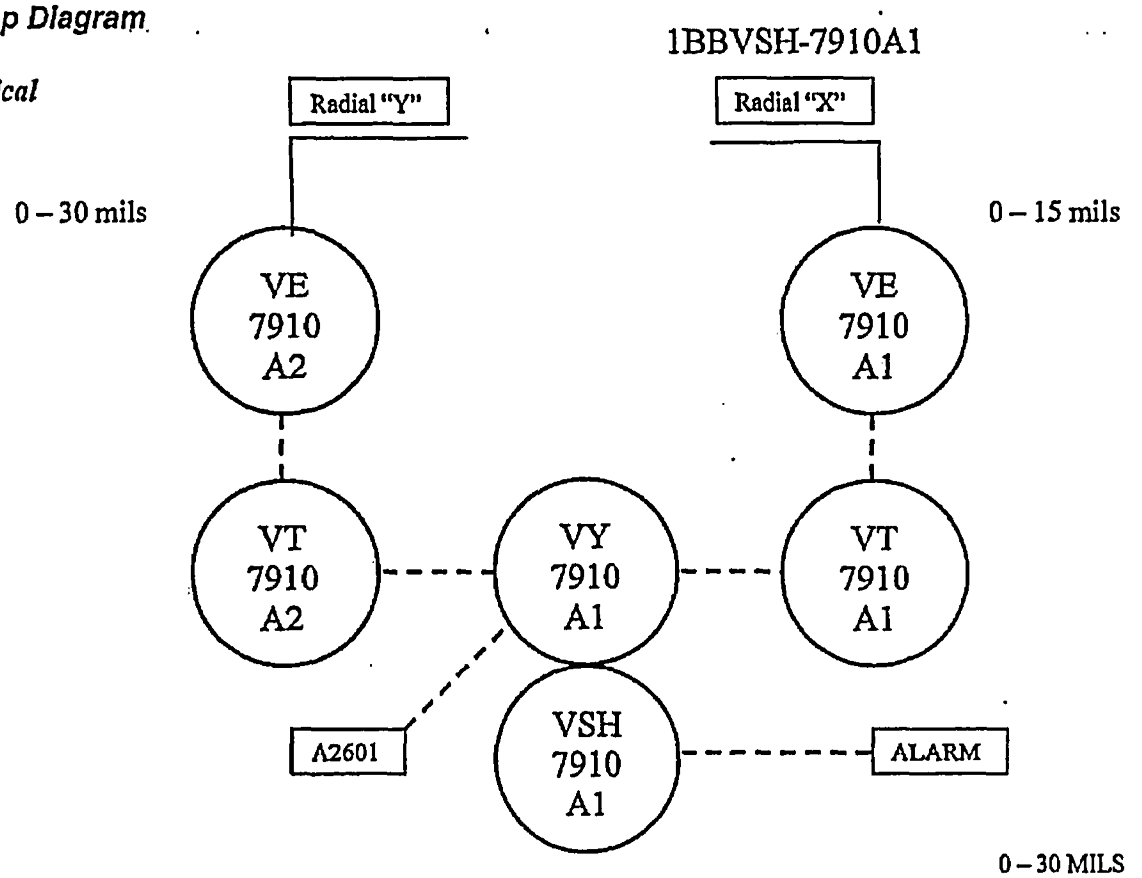
Loop Diagram

Typical



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5.0 DESIGN INPUTS

5.1 General Design Inputs

5.1.1 Equipment Locations (Ref. 3.4.7)

Device	Description	Location
1BBVE-7910A1	Sensor	Rx. Bldg. 77 Elev.
1BBVT-7910A1	Transducer	Rx Bldg. 77 Elev.
1BBVY-7910A1	Monitor	Aux. Bldg. 124 Elev.
1BBVSH-7910A1	Switch	Aux. Bldg. 124 Elev.
1BBVE-7910A2	Sensor	Rx Bldg. 77 Elev.
1BBVT-7910A2	Transducer	Rx Bldg. 77 Elev.
1BBVSH-7910A2	Switch	Aux. Bldg. 124 Elev.
1BBVE-7910A3	Sensor	Rx. Bldg. 77 Elev.
1BBVT-7910A3	Transducer	Rx Bldg. 77 Elev.
1BBVY-7910A3	Monitor	Aux. Bldg. 124 Elev.
1BBVE-7910A4	Sensor	Rx Bldg. 100 Elev.
1BBVT-7910A4	Transducer	Rx Bldg. 100 Elev.
1BBVSH-7910A4	Switch	Aux. Bldg. 124 Elev.
1BBVE-7910B1	Sensor	Rx Bldg. 77 Elev.
1BBVT-7910B1	Transducer	Rx Bldg. 77 Elev.
1BBVY-7910B1	Monitor	Aux. Bldg. 124 Elev.
1BBVSH-7910B1	Switch	Aux. Bldg. 124 Elev.
1BBVE-7910B2	Sensor	Rx Bldg. 77 Elev.
1BBVT-7910B2	Transducer	Rx Bldg. 77 Elev.
1BBVE-7910B3	Sensor	Rx. Bldg. 77 Elev.
1BBVT-7910B3	Transducer	Rx Bldg. 77 Elev.
1BBVY-7910B3	Monitor	Aux. Bldg. 124 Elev.
1BBVE-7910B4	Sensor	Rx Bldg. 100 Elev.
1BBVT-7910B4	Transducer	Rx Bldg. 100 Elev.
1BBVSH-7910B4	Switch	Aux. Bldg. 124 Elev.

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5.1.2 Environmental Parameters (Ref. 3.4.4)

AREA ENVIRONMENTAL PARAMETERS			
AREA	NORMAL TEMPERATURE	ACCIDENT TEMPERATURE	RADIATION
Aux. Bldg. 124 Level Room 3449	40-104°F	N/A	Norm-8.8E2 TID (40 yrs) Rads gamma
Reactor Bldg. 77 Level Room 4220	40-150°F	177°F	Norm-2.1E6 TID (40 yrs) Rads gamma Acc-2.3E7 Rads gamma

5.2 Component Design Inputs

5.2.1 Probe/Sensor (Ref. 3.4.2, 3.4.3, and 3.4.7)

Component I.D.: 1BBVE-7910A1, A2, A3, A4, B1, B2, B3, B4 Device Type: Vibration Probe

Manufacturer/Model No.: Bentley Nevada
Quality Classification: N Accident Service: N/A
Seismic Category: 1 Excitation: N/A
Tech Spec Requirement: No Section: N/A
Range Limits: 0-30 Mils
Calibrated Range: Input: 0-30 Process: Mils
Span: Process: 30 Mils
Output Signal: digital To: 1BBVT-7910A1, A2, A3, A4, B1, B2, B3, B4
Setpoint: N/A
Baseline Accuracy (VA): ± 2.0% Reading

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5.2.2 Transducer (Reference 3.4.2, 3.4.3, 3.4.4 & 3.4.7)

Component I.D. 1BBVT-7910A1, A2, A3, A4, B1, B2, B3, B4 Device Type: Vibration Transducer
Manufacturer/Model No.: Bentley Nevada
Quality Classification: N Accident Service: N/A
Seismic Category: II/I Excitation: N/A
Tech Spec Requirement: No Section: N/A
Range Limits: 0-30 Mils
Calibrated Range: Input: 0-30 Process: Mils Vibration
Span: N/A. Process: 0-30 Mils
Output Signal: -4.5 - -7.5vdc To: 1BBVY-7910A1, A4, B1, B4
Setpoint: N/A Calibration Period: 550 days
Baseline Accuracy (VA): ± 2.0% Span
Deadband (DB): N/A Drift (VD): ± 0.25% For: 6 months
Temperature Affect (ATE): ± (0.6% of reading)/100°F
Humidity Effect (HE): 0% (0-100%RH)
Power Supply Effect (PSE): ± 0.005% per volt charge
RFI/EMI Effect (REE): No Data Available
Radiation Effect (RE): ± 4.2% of reading TID <3.4 x 10^7 Rads
± 2.4% of reading TID <5 x 10^6 Rads (Ref. 3.4.3)

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5.2.3 Monitor/Switch (Reference 3.4.2, 3.4.3, 3.4.4 & 3.4.7)

Component I.D. 1BBVY-7910A1, A4, B1, B4/1BBVSH-7910A1, A4, B1, B4
Device Type: Vibration Monitor/Switch
Manufacturer/Model No.: Bentley Nevada
Quality Classification: N Accident Service: N/A
Seismic Category: II/I Excitation: N/A
Tech Spec Requirement: No Table: N/A
Range Limits: 0 – 30 Mils
Calibrated Range: Input: 0 - 30 Process: Mils
Span: N/A. Process: 0 – 30 Mils
Output Signal: Digital To: Alarm A2601-2604
Trip Setpoint: 21 Mils Calibration Period: 550 days
Baseline Accuracy (VA): ± 2.0% Span
Deadband N/A DB : N/A Drift (VD): ± 3.0% For: 6 months
Temperature Affect (ATE): ± (0.43% reading)/100°F
Humidity Effect (HE): 0% (0-100%RH)
Power Supply Effect (PSE): ± 0.005% per volt
RFI/EMI Effect (REE): No Data Available
Radiation Effect (RE): ± 1.4% URL TID <5 x 10^6 Rads

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5.3 Miscellaneous Design Inputs

5.3.1 M&TE

The M&TE for the calibration of the loops will be specified as Fluke 45 DMM with the following accuracies (Ref. 3.4.5):

Fluke 8600A DMM (0-20Vdc range): Transducers in React. Bldg.

Accuracy = (0.02%*20VDC+0.005VDC)/20VDC
= 0.022 % span

6.0 ASSUMPTIONS

6.1 Normal Radiation Exposure

Per Ref 3.4.4, the probes and transducers are located in an area with a normal radiation exposure of 2.1E6 Rads TID over 40 years. This correlates to 1.05E5 Rads over a 24-month period (2.1E6/40 yr. x 2 yr.) which more than bounds the calibration period. This value is greater than a Total Integrated Dose of 1E3 Rads, which is considered a harsh environment per Ref. 3.4.1.

7.0 UNCERTAINTIES

Accuracies for non-qualified equipment are expressed in terms of 2 Sigma.

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7.1 Process Measurement Accuracy (PMA)

N/A

7.2 Primary Element Accuracy (PEA) 1BBVE-7910A1, A2, A3, A4, B1, B2, B3, B4

(Section 5.2.1)

Primary Element Accuracy for the Vibration Probe, 1BBVE-7910A1, is 2% at normal operating temperature. No additional uncertainty is considered.

PEA = 2.0%

7.3 Calculation of Transducer Uncertainty and Calibration/Recalibration Tolerances

7.3.1 Transducer Uncertainty (1BBVT-7910A1, A2, A3, A4, B1, B2, B3, B4)

(Section 5.2.2)

7.3.1.1 Monitor Accuracy (VA)

$VA_T = \pm 2.0\%$

7.3.1.2 Temperature Effect (ATE)

Per Environmental Parameters (Section 5.1.2), the normal temperature variation inside this area of the building will range from 40°F to 110°F.

a) Normal/Abnormal Condition

$ATE_T = \pm$ (0.6% of reading) $\Delta T/100$
$ATE_T = \pm$ (0.6% of reading) (110-40)/100
$ATE_T = \pm$ (0.42% of reading)

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7.3.1.3 Humidity Effect (HE)

No effect between 0-100% RH is expected with materials used.

$HE_T = 0$

7.3.1.4 Power Supply Effect (PSE)

PSE is specified as 0.005% per volt change over a very short (3.0Vdc) range, therefore, the error due to power supply variation is assumed to be negligible.

$PSE_T = 0$

7.3.1.5 RFI/EMI Effects (REE)

The RFI/EMI effects are considered to be negligible based upon the area being zoned, operational limitations and cabling design of HCGS.

$REE_T = 0$

7.3.1.6 Radiation Effects (RE)

Per Section 6.1, the probes and transducers are located in an area with a normal radiation exposure 2.1E6 Rads over a bounding 24 month calibration period. This is considered a harsh environment per Ref. 3.4.1; therefore, the manufacturer test data for exposure will be used to determine errors introduced between calibration periods. Drift due to radiation effects can be corrected during calibrations.

RE_T = 4.2% of Reading

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7.3.1.7 Transducer Calibration Tolerance (CAL)

$VA_T < 2\ \%$

2% x 30 mils = 0.6 mils

7.3.1.8 Transmitter Recalibration Tolerance

$CAL_T = \pm (2)^{½} VA_T$

$CAL_T = \pm (2)^{½}\ (2.0) = \pm 0.28\ \%$

In Signal Units ± 0.28 % x 3.0 vdc = ± 0.084 vdc ≈ 0.08 vdc or 0.8 mils (100 mVdc/mil)

$CAL_T = \pm 0.28\%$ span

7.3.1.9 Transducer M&TE Accuracy (MTE)

Per Section 5.3.3, the transducer is calibrated using a Fluke 6800A DMM. Total device M&TE uncertainty is:

$MTE_T = \pm 0.022\%$ span

7.3.1.10 Transducer Drift (VD)

As drift is considered independent for each period.

$VD_T = \pm 0.25\ \%$ of reading for 180 Days

Calibration period P = 675 Days

$VD_T = \pm[\ 0.25^2\ (675/180)]^{1/2}$
$VD_T = \pm 0.484\ \%$ of reading

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7.3.1.11 Total Device Accuracy (A)

a) Normal conditions:

CAL, MTE, and VD are considered a random variables, statistically independent of the others. They can be combined using SRSS. ATE and RE are considered Biases.

$A_T = \pm (CAL^2 + MTE^2 + VD^2)^{½} + ATE + RE$
$A_T = \pm (0.28^2 + 0.022^2 + 0.484^2)^{½} + 0.42 + 4.2$

$A_T = \pm 5.179$ % of Reading

7.3.2 Recalibration Tolerance

$Recal_T = \pm (Cal^2 + A_T^2)^{½}$

$Recal_T = \pm \{(2\%)^2 + (5.179\%)^2\}^{½}$

$Recal_T = \pm 5.552$ % of reading

In Signal Units ± 5.552 % x 3.0 vdc max= ± 0.166 vdc ≈ 0.17 vdc = 1.7 mils

7.4 Calculation of Monitor/Switch Uncertainty and Calibration/Recalibration Tolerances

7.4.1 Monitor/Switch Uncertainty (1BBVY-7910A1, A4, B1, B4) (Section 5.2.3)

7.4.1.1 Monitor Accuracy (VA)

$VA_T = \pm 2\%$

7.4.1.2 Temperature Effect (ATE)

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Per Environmental Parameters (Section 5.1.2), the normal temperature variation inside this area of the building will range from 40°F to 110°F and the highest expected accident temperature is 148°F.

$ATE_T = \pm 3\%$ over temperature range

7.4.1.3 Humidity Effect (HE)

No effect between 0-100% RH is expected with existing enclosure and location.
$HE_T = 0$

7.3.1.4 Power Supply Effect (PSE)

PSE is specified as 0.005% per volt change over a very short (3.0Vdc) range, therefore, the error due to power supply variation is assumed to be negligible.

$PSE_T = 0$

7.4.1.5 RFI/EMI Effects (REE)

The RFI/EMI effects are considered to be negligible based upon the area being zoned, operational limitations and cabling design of HCGS.

$REE_T = 0$

7.4.1.6 Radiation Effects (RE)

a) Normal condition:

Per Section 6.1, the probes and transducers are located in an area with a normal radiation exposure 2.1E6 Rads over a bounding 24 month calibration period. This is considered a harsh environment per Ref. 3.4.1; therefore, the manufacturer test data for exposure will be used to determine errors introduced between calibration periods. Drift due to radiation effects can be corrected during calibrations.

$RE_T = 1.4\%$ of Upper Range Limit

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7.4.1.7 Monitor Calibration Tolerance (CAL)

$VA_T < 0.6$ % of reading

$CAL_T = \pm (2)^{½} VA_T$

$CAL_T = \pm (2)^{½} (0.6) = \pm 2.01$ %

7.4.1.8 Monitor M&TE Accuracy (MTE)

Per Section 5.3.3, the transducer is calibrated using a Fluke 6800A DMM. Total device M&TE uncertainty is:

$MTE_T = \pm 0.022\%$ span

7.4.1.9 Monitor Drift (VD)

As drift is considered independent for each period.

$VD_T = \pm 3.0\%$ of reading for 180 Days (PD)

Calibration period P = 675 Days

$VD_T = \pm [3.0^2 (675/180)]^{½}$
$VD_T = \pm 5.81$ % of reading

7.4.1.10 Total Device Accuracy (A)

CAL, MTE, and VD are considered a random variables, statistically independent of the others. They can be combined using SRSS. ATE and RE are considered Biases.

$A_T = \pm (CAL^2 + MTE^2 + VD^2)^{½} + ATE + RE$
$A_T = \pm (2.01^2 + 0.022^2 + 5.81^2)^{½} + 3 + 4.2$
$A_T = \pm 13.35\%$ of reading

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7.4.2 **Recalibration Tolerance**

$Recal_T = \pm (Cal^2 + A_T^2)^{½}$

$Recal_T = \pm \{(2\%)^2 + (13.35\%)^2\}^{½}$

$Recal_T = \pm$ 13.50% Span

In Signal Units ± 13.50% x 3.0 vdc Span = ± 0.405 vdc = 4.05 mils

7.5 Propagation of Error

7.5.1 Loop Calibration Accuracy (LCA)

$LCA = \pm [(A_E^2 + A_{VT}^2 + A_{MON}^2)^{½}]$
$LCA = \pm [(2.01)^2 + (5.179)^2 + (13.35)^2]^{½}$
$LCA = \pm 14.46\%$
LCA = ± 0.434 vdc =4.34 mils

(rounded to 4 for setpoint, assuming vendor recommendations are conservative)

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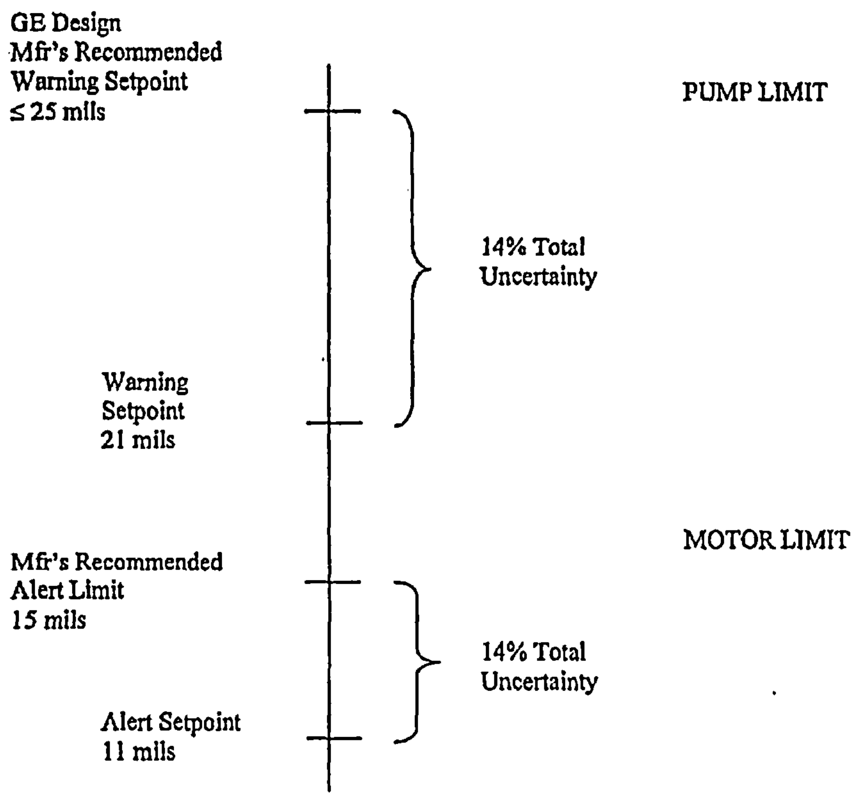
ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03				
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03				

7.6 Evaluation of Setpoints

7.6.1 Radial Vibration Setpoints

High Vibration Setpoint

The current Vibration Setpoints are established from the manufacturer data and calculated in Attachment 9.1. This calculation must verify that the setpoint is established sufficiently away from the allowable value to include instrument, process and installation uncertainties.



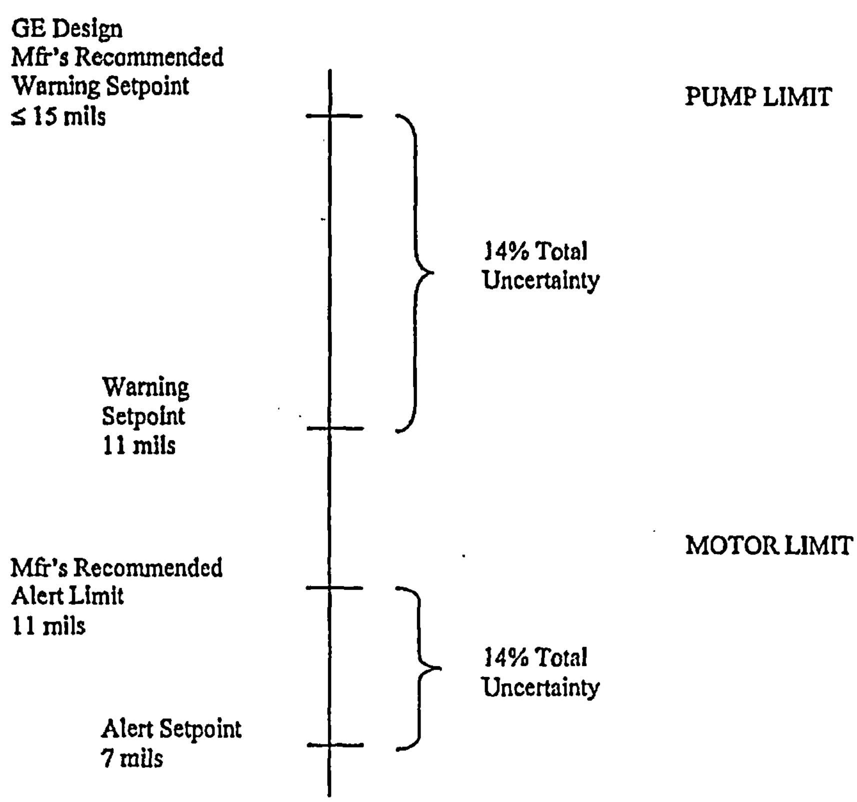
	CALCULATION CONTINUATION SHEET	SHEET: 22			
CALC. NO.: SC-BB-0522		REFERENCE: NUCPs 80044664 & 80045185			
ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03			
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03			

7.6 Evaluation of Setpoints

7.6.1 Axial Vibration Setpoints

High Vibration Setpoint

The current Vibration Setpoints are established from the manufacturer data and calculated in Attachment 9.1. This calculation must verify that the setpoint is established sufficiently away from the allowable value to include instrument, process and installation uncertainties.



	CALCULATION CONTINUATION SHEET			SHEET: 23		
CALC. NO.: SC-BB-0522			REFERENCE: NUCPs 80044664 & 80045185			
ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03				
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03				

8.0 *DISCUSSION and SUMMARY OF RESULTS*

8.1 Summary Of Results

The TLA for the vibration system (for validation):

Per the Vendor Performance specifications, (Ref. 3.4.3), are maximum range of 100 ±10.2 mV/mil over the calibrated range.

Bench Calibration: 100 ±6mV/mil over the calibrated range.

Calibrated Span = 40-70 mils = 30 mils = 3.0 vdc
System Accuracy = 10mV/50mV (range)
In terms of Span:

System Accuracy = 4% span (random effects)
Bench calibration Tolerance = 6 mV/mil over the range (random)
In terms of Span:

Calibration Tolerance = 2.4% span (random)
Radiation Tolerance = 10.1 mV/mil
In terms of Span:

Rad = 4.04% span (bias)
TE = 4% span (bias)

$\therefore$ TLA = (Monitor Accuracy^2 + System Accuracy^2 + Calib. Tol.^{2})$^{1/2}$ +Rad + TE
TLA = $(2^2 + 4^2 + 2.4^2)^{1/2} + 4.04 + 4.00$

The TLA = 13.12% = .394 vdc = 3.94 mils (rounded to 4 for setpoint, assuming vendor recommendations are conservative)

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REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03					

8.2 Conclusions

8.2.1 Procedures HC.OP-AR.ZZ-0008 and HC.OP-SO.BB-0002 require revision to:

- Revise setpoint values per Section 7.6, reference the DCPs and this calculation.

8.2.2 ICDs need to be revised to establish setpoint values per Section 7.6, reference the DCPs and this calculation.

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ATTACHMENT 9.1

SETPOINT DETERMINATION

Axial Vibration Set Points

Following references/ numbers are from VTD # PN1-B31-C001-0119:(Ref. 3.4.2)

Maximum pump up-thrust (page 18) = 42,200 lbs.

Weight of motor and pump moving parts (page 18) = 13,530 lbs.

Therefore net up thrust is (42,200 – 13,530) = 28,670 lbs.

Max. allowable up-thrust (page 11) = 38,700 lbs.

This leaves a force margin of (38,700 – 28670) = 10,030 lbs.

Using The Hydraulics Institute Standard's guideline of 10% = 42,000x0.10 = 4,200 lbs.

Considering a safety factor of 1.5, force (4,200x1.5) = 6,300 lbs.

This leaves a net up-thrust margin of (10,030 – 6,300) = 3,730 lbs

The table below shows bearing forces in the motor thrust bearing:

Vibration mils	Speed rpm	Acceleration R/ω^2 ft/sec^2	Rotor Mass lb	Constant g lbm/lbf	Vibrational Bearing Force F=MA lbf
3	1680	3.880	13365	32.2	1610.2
5	1680	6.466	13365	32.2	2683.7
7	1680	9.052	13365	32.2	3757.2
9	1680	11.639	13365	32.2	4830.7
11	1680	14.225	13365	32.2	5904.2
13	1680	16.811	13365	32.2	6977.7

Based on the above information, calculations and references, the axial vibration for the Hope Creek Reactor Recirculating pump "A" a shutdown set point of 11 mils and an alarm setpoint of 7 mils are within limits.

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REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03				

Radial Vibration Set Points

Vendor specified vibration limit is 25 mils

25 mils – 4 mils uncertainty = 21 mils

H.I.S. recommends the alarm be set at two thirds of limit
25 mils * 2/3 = 17 mils
17 mils – 4 mils uncertainty = 13 mils

To verify this H.I.S. recommends that for the style motor used on the Hope Creek Recirculation pumps, the vibration spikes be limited to 0.7 g (force of gravity)

$0.7 \text{ g} * 32.3 \text{ ft} / \text{sec}^2 = 22.54 \text{ ft} / \text{sec}^2$

Angular Acceleration = $\frac{1}{2} * r * \theta^2$ <u>or</u> $r = 2 * \text{Acceleration} / \theta^2$

$r = 2 * 22.54 \text{ ft/sec}^2 / (176 \text{ rad/sec})^2 * 12 \text{ inches} / 1 \text{ foot} = 0.017 \text{ inches} = 17 \text{ mils.}$
17 mils – 4 mils uncertainty = 13 mils

This is higher than alarm set point of 11 mils and therefore, acceptable.

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CALCULATION CONTINUATION SHEET

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ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03				
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03				

Vendor Input Information

Here is the e-mail from Lovejoy to Pete Koppel for axial vibration.

Ashok Bhuta
Phone: 856-339-5332
Fax: 856-339-5076
Beeper: 877-451-3712

-----Original Message-----
From: Bhardwaj, Suresh C.
Sent: Wednesday, July 17, 2002 11:22 AM
To: Bhuta, Ashok V.
Subject: FW: Axial Vibration RR Pump

-----Original Message-----
From: Bhuta, Ashok V.
Sent: Tuesday, April 16, 2002 2:01 PM
To: Bhardwaj, Suresh C.; Ayers, Patrick
Cc: Stith, Gary M.
Subject: FW: Axial Vibration RR Pump

Pat/Suresh,

Here is another e-mail.

Thanks,

Ashok

-----Original Message-----
From: Koppel, Peter J.
Sent: Monday, January 21, 2002 11:19 AM
To: Bhuta, Ashok V.
Cc: Stith, Gary M.; Kaminski, Richard M.
Subject: FW: Axial Vibration RR Pump

Ashok,

Attached is a file containing the background information for new setpoint changes to the Hope Creek Recirculation Pumps. This file only contains the information for the axial limit. I do not yet have the information for the radial limit. Unfortunately, I will not have the radial information until late February at the earliest. The

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CALCULATION CONTINUATION SHEET

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ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03		
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03		

revision of the setpoints will permit the removal of a T-Mod which we would like to have done prior to 2R12. I am sending you this now so you can look at it when you get a chance. I am afraid that when the radial setpoint information is available, it will all turn into another rush DCP, and I am trying to alleviate that rush as much as possible.

Peter Koppel
877-652-4439

-----Original Message-----
From: Dechant, Thomas
Sent: Friday, January 18, 2002 5:17 PM
To: Koppel, Peter J.
Subject: Axial Vibration RR Pump

HC RR Pump.doc

FORM 2
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CALCULATION CONTINUATION SHEET

	CALCULATION CONTINUATION SHEET			SHEET: 29	
CALC. NO.: SC-BB-0522, Attachment 9.2			REFERENCE: NUCPs 80044664 & 80045185		
ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03			
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03			

To: Peter J. Koppel

Subject: Hope Creek Reactor Recirculating Pump Axial Vibration Limits

Status: The Hope Creek Reactor Recirculating Water Pumps have their vibration limits set at an alarm limit of 4.5 mils and a shutdown limit of XX mils. The current operating mode has temporary modifications are in place to raise the limits to allow the operation of the pump above the alarm limits.

Investigation: The vendors' manuals for both the Flowserve Pump and the General Electric motor reveal that axial vibration forces are transmitted to the motor thrust bearing. Their instructions do not provide any operating limits for this vibration. An independent review of the axial forces indicates that the thrust bearing maximum up thrust is 38,700 lbs. The maximum pump up thrust is 42,200 lbs. The motor rotor / pump shaft/impeller mass is 13,530 lbs. Therefore the net up thrust is 28,670 lbs.

This produces a force margin of 9,930 lbs. The Hydraulics Institute Standard is 5% margin or 2,110 lbs. A safety factor of 3 times or 15% margin is 6330 lbs. This allows 3600 lbs for axial vibration. The table below shows a calculation of the bearing forces in the motor thrust bearing.

Vibration mils	Speed rpm	Acceleration R/ω^2 ft/sec^2	Rotor Mass lb	Constant g lbm/lbf	Vibrational Bearing Force F=MA lbf
3	1680	3.880	13365	32.2	1610.2
5	1680	6.466	13365	32.2	2683.7
7	1680	9.052	13365	32.2	3757.2
9	1680	11.639	13365	32.2	4830.7
11	1680	14.225	13365	32.2	5904.2
13	1680	16.811	13365	32.2	6977.7

Recommendations: Based on the above information, calculations and references, the vibration limits for the Hope Creek Reactor Recirculating Water Pumps need revision. The allowable forces should set the limits. Therefore, an alarm limit of 7 mils and a shutdown limit of 11mils are recommended for the axial limits.

Thomas De Chant
Lovejoy Controls Corporation

	CALCULATION CONTINUATION SHEET		SHEET: 30			
CALC. NO.: SC-BB-0522, Attachment 9.2			REFERENCE: NUCPs 80044664 & 80045185			
ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03				
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03				

Hope Creek Reactor Recirculation Pump Motor

Vibration Setpoints

1) Problem Statement:

The Hope Creek Reactor Recirculation Pump Motor vibration setpoints are set at several different values. The 'A' Recirculation pump has a history of satisfactory vibrations while the 'B' Recirculation pump has a history of higher than desired vibration levels. Recent maintenance activities have corrected the pump's alignment, coupling stack-up, and proven that there are not balance concern. No additional maintenance activities are required or planned at this time.

The 'B' Recirculation pump currently has axial vibration levels of 4-5 mils and has a T-Mod 01-020 installed to raise its alarm setpoint to 5.5 mils to prevent nuisance alarms.

The current vibration setpoints are as listed below:

	Alarm 'A'	Alarm 'B'	Shutdown 'A'	Shutdown 'B'
Axial Direction	4 mils	5.5 mils	13 mils	20 mils
Radial Direction	4 mils	6 mils	14.5 mils	22 mils

2) Design Basis:

The design basis for the recirculation pumps are to circulate the water in the reactor, vary the water flow through the reactor, and provide a method of reactivity control. The vibration levels of the motor are recorded continuously using the SMART monitor system. The alarm and required action vibration setpoints are an indication to the operators that there is a problem with the pump or motor that requires action.

3) Recommended least cost solution:

Revise the vibration setpoints for both 'A' & 'B' pump to the values listed below:

	Alarm	Shutdown
Axial Direction	7 mils	11 mils
Radial Direction	15 mils	22 mils

The technical information behind these values is given in attachment 1.

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Page 2 of 2 (Page 1 contains the instructions)
CALCULATION CONTINUATION SHEET

	CALCULATION CONTINUATION SHEET			SHEET: 31		
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ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03				
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03				

4) <u>Alternatives Considered</u>:

a) Do nothing. This option would incur no additional engineering costs. T-Mod 01-020 would remain in place on 'B' Recirculation pump.

Activity	Est. Hourly Cost	Estimated Hours	Totals	Comments
Materials			0	
Installation			0	
Engineering			0	
Miscellaneous			0	
Total			0	

b) Adjust the vibration setpoints as specified above.

Activity	Est. Hourly Cost	Estimated Hours	Totals	Comments
Materials				
Installation	[redacted]			Assume 2 Technicians
Engineering				Assume 1 Engineer
Miscellaneous				
Total			[redacted]	

5) <u>Cost/Benefit explanation</u>:

The benefit of the new vibration setpoints is that they will remove a T-Mod in the plant an provide vibration setpoints with a engineering basis which do not cause nuisance alarms or require T-Mod to change the setpoints whenever the pump or motor have a change in vibration levels.

6) <u>Engineering Change Request</u>:

Form 1 is attached.

7) <u>Station Department requesting</u> the modification, and which supervisor or Manager from that department who will present the modification to the Engineering Review Board.
Component Engineer: Rich Kaminski
Engineering Supervisor: Peter Koppel.

	CALCULATION CONTINUATION SHEET		SHEET: 32			
CALC. NO.: SC-BB-0522, Attachment 9.2			REFERENCE: NUCPs 80044664 & 80045185			
ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03				
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03				

ATTACHMENT 1
Technical Information

This attachment contains the following three letters:

1) Lovejoy Controls Corporation Letter, dated February 28, 2002
2) Byron Jackson Technical Service Bulletin, N. 9309-08-022
3) Nuclear Electric Insurance Limited (NEIL) – Loss Control Standards, Section 8-2D

Lovejoy Controls engineers evaluated the Hope Creek Recirculation pumps and motors and prepared this letter of documentation of the logic behind the proposed vibration setpoints. This letter and the associated logic has been review by Component Engineering and found to be accurate.

The Byron Jackson bulletin lists the two most likely causes of high vibrations. Those are alignment and runout of coupling pieces. During RF09, the alignment on 'B' Recirculation pump was corrected and current vibration data show that the alignment is very accurate. During RF10, the coupling on 'B' Recirculation pump was measured and re-machined to remove runout from all the coupling components; therefore, that concern has also been resolved. The bulletin also advises against installing balance weights. During cycle 10 balance weights were added to 'B' Recirculation pump with no positive affect, and they have been removed.

Byron Jackson also reports that normal radial vibration levels should be < 15 mils. The alarm should be 7 mils above normal and the shutdown should be ≤ 25 mils. Current Recirculation pump radial vibrations are 6-8 mils. The proposed alarm setpoint is approximately 7 mils above this level, and the proposed shutdown level is below the required 25 mils. Therefore, the proposed setpoints are in alignment with the Vendor guidance.

The NEIL standards give guidance that various vibration levels. At the proposed radial vibration alarm setpoint of 15 mils, the NEIL standards required the station to evaluate and determine the cause of the elevated vibration, contact the vendor for addition information and several other items. All of these requirements are standard procedure for engineering when a component reaches the alarm condition. At the proposed radial vibration shutdown setpoint of 22 mils, the NEIL standards also require the component to be shutdown. Therefore, the proposed setpoints are in alignment with the NEIL standards.

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CALC. NO.: SC-BB-0522, Attachment 9.2			REFERENCE: NUCPs 80044664 & 80045185		
ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03			
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03			

ATTACHMENT 2
Setpoint Calculations

Axial Vibration Setpoint:

42,200 Maximum up thrust from pump (Upward Force)
- 13,530 Weight of pump and motor (Downward Force)
28,670 lb_m Resulting force from pump onto bearings in axial direction

38,700 Maximum force allowable on bearings
- 28,670 Force from pump
9,930 lb_m Margin remaining on bearings

Hydraulics Institute Standard (H.I.S.) recommends a 10% margin

42,200 * 0.10 = 4,220 lbs

Add a 50% safety factor
4,220 * 1.5 = 6,330 lbs

9,930 Margin on bearings
- 6,330 Safety margin
3,600 lb_m Force remaining, which axial vibrations can take up

The axial force from vibration is determined using F = MA

M = Mass of pump and motor = 13,365 lbs
A = Angular acceleration over the distance of the vibration

Angular acceleration = ½ * r * θ^2

r = radius (displacement of vibration) (for this example 3 mils or 0.003 inches)

r = 0.003 inches * 1 foot / 12 inches = 0.00025 ft

θ = Angular displacement

FORM 2
Page 2 of 2 (Page 1 contains the instructions)
CALCULATION CONTINUATION SHEET

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CALC. NO.: SC-BB-0522, Attachment 9.2		REFERENCE: NUCPs 80044664 & 80045185		
ORIGINATOR,DATE	REV: 3	T. McCool 1/13/03		
REVIEWER/VERIFIER,DATE		Ashok Bhuta 1/13/03		

1680 rev/min * 1 min / 60 seconds * 2 π rad / 1 rev = 176 rad/sec

½ * 0.00025 ft * (176 rad/sec) ^{2} = 3.88 ft/sec^2

F = 13,530 lb_m * 1 lb_f sec^2 / 32.2 lb_m ft * 3.88 ft/sec^2 = 1630 lb_f

FORM-1
REGULATORY CHANGE PROCESS DETERMINATION

Document I.D.: SC-BB-0522 Revision: 3

Title: Loop Tolerance Calculation for 1BBVSH-7910A1, A2, B1, B2

Activity Description:
SC-BB-0522, Rev. 3, was performed to implement new High Vibration Alarm setpoints for H1BB –1BBVSH-7910B1 & B2 via DCPs 80044664 & 80045185). The new setpoints are set within the required range limits for the equipment. A 50.59 was performed under the corresponding DCPS.

Note that more than one process may apply. If unsure of any answer, contact the cognizant department for guidance.

Activities Affected	No	Yes	Action
1. Does the proposed activity involve a change to the Technical Specifications or the Operating License?	☒	☐	If Yes, contact Licensing; process in accordance with NC.NA-AP.ZZ-0035(Q) LCR No. ________
2. Does the proposed activity involve a change to the Quality Assurance Plan? Examples: • Changes to Chapter 17.2 of UFSAR	☒	☐	If Yes, contact Quality Assessment; process in accordance with ND.QN-AP.ZZ-0003(Q)
3. Does the proposed activity involve a change to the Security Plan? Examples: • Change program in NC.NA-AP.ZZ-0033(Q) • Change indoor/outdoor security lighting • Placement of component or structure (permanent or temporary) within 20 feet of perimeter fence • Obstruct field of view from any manned post • Interfere with security monitoring device capability • Change access to any protected or vital area •	☒	☐	If Yes, contact Security Department; process in accordance with NC.NA-AP.ZZ-0033(Q)
4. Does the proposed activity involve a change to the Emergency Plan? Examples: • Change ODCM/accident source term • Change liquid or gaseous effluent release path • Affect radiation monitoring instrumentation or EOP/AOP setpoints used in classifying accident severity • Affect emergency response facilities or personnel, including control rm • Affect communications, computers, information systems or Met tower	☒	☐	If Yes, contact Emergency Preparedness
5. Does the proposed activity involve a change to the ISI Program Plan? Examples: • Affect Nuclear Class 1, 2, or 3 Piping, Vessels, or Supports (Guidance in NC.DE-AP.ZZ-0007(Q) Form-11)	☒	☐	If Yes, contact Reliability Programs ISI/IST; process in accordance with NC.NA-AP.ZZ-0027(Q)
6. Does the proposed activity involve a change to the IST Program Plan? Examples: • Affect the design or operating parameters of a Nuclear Class 1, 2, or 3 Pump or Valve (Guidance in NC.DE-AP.ZZ-0007(Q) Form-15)	☒	☐	If Yes, contact Reliability Programs ISI/IST; process in accordance with NC.NA-AP.ZZ-0070(Q)

FORM-1
REGULATORY CHANGE PROCESS DETERMINATION

Document I.D.: SC-BB-0522 Revision: 3

Title: Loop Tolerance Calculation for 1BBVSH-7910A1, A2, B1, B2

Activities Affected	No	Yes	Action
7. Does the proposed activity involve a change to the Fire Protection Program? Examples: • Change program in NC.DE-PS.ZZ-0001(Q) • Change combustible loading of safety related space • Change or affect fire detection system • Change or affect fire suppression system/component • Change fire doors, dampers, penetration seal or barriers • See NC.DE-AP.ZZ-0007, Forms 3, 4 and 14 for details	☒	☐	If Yes, contact Design Engineering; process in accordance with NC.DE-PS.ZZ-0001(Q)
8. Does the proposed activity involve Maintenance which restores SSCs to their original design and configuration? Examples: • CM or PM activity • Implements an approved Design Change? • Troubleshooting (which does not require 50.59 screen per SH.MD-AP.ZZ-0002)	☒	☐	If Yes, process in accordance with NC.WM-AP.ZZ-0001(Q)
9. Is the proposed activity a temporary change (T-Mod) which *meets all the following conditions*? • Directly supports maintenance and is NOT a compensatory measure to ensure SSC operability. • Will be in effect at power operation less than 90 days. • Plant will be restored to design configuration upon completion. • SSCs will NOT be operated in a manner that could impact the function or operability of a safety related or Important-to-Safety system.	☒	☐	If Yes, contact Engineering; process in accordance with NC.DE-AP.ZZ-0030(Q)
10. Does the proposed activity consist of changes to maintenance procedures which do NOT affect SSC design, performance, operation or control? Note: Procedure information affecting SSC design, performance, operation or control, including Tech Spec required surveillance and inspection, ***require 50.59 screening***. Examples include acceptance criteria for valve stroke times or other SSC function, torque values, and types of materials (e.g., gaskets, elastomers, lubricants, etc.)	☒	☐	If Yes, process in accordance with NC.NA-AP.ZZ-0001(Q)
11. Does the proposed activity involve a *minor* UFSAR change (including documents incorporated by reference)? Examples: • Reformatting, simplification or clarifications that do not change the meaning or substance of information • Removes obsolete or redundant information or excessive detail • Corrects inconsistencies within the UFSAR • Minor correction of drawings (such as mislabeled ID)	☒	☐	If Yes, process in accordance with NC.NA-AP.ZZ-0035(Q)
12. Does the proposed activity involve a change to an Administrative Procedure (NAP, SAP or DAP) governing the conduct of station operations? Examples: • Organization changes/position titles • Work control/ modification processes	☒	☐	If Yes, process in accordance with NC.NA-AP.ZZ-0001(Q) and NC.DM-AP.ZZ-0001(Q)

FORM-1
REGULATORY CHANGE PROCESS DETERMINATION

Document I.D.: SC-BB-0522 Revision: 3

Title: Loop Tolerance Calculation for 1BBVSH-7910A1, A2, B1, B2

Activities Affected	No	Yes	Action
13. Does the proposed activity involve a change to a regulatory commitment?	☒	☐	If Yes, contact Licensing and process in accordance with NC.NA-AP.ZZ-0030(Q)
14. Does the activity impact other programs controlled by regulations, operating license or Tech Spec? Examples: • Chemical Controls Program • NJ "Right-to-know" regulations • OSHA regulations • NJPDES Permit conditions • State and/or local building, electrical, plumbing, storm water management or "other" codes and standards • 10CFR20 occupational exposure	☒	☐	If Yes, process in accordance with applicable procedures such as: NC.NA-AP.ZZ-0038(Q) NC.LR-AP.ZZ-0037(Q)
15. Has the activity already received a 10CFR50.59 Screen or Evaluation under another process? Examples: • Calculation • Design Change Package or OWD change • Procedure for a Test or Experiment • DR/Nonconformance • Incorporation of previously approved UFSAR change	☐	☒	Take credit for 10CFR50.59 Screen or Evaluation already performed. ID: DCPs 80045185, 80044664

If any other program or regulation *may be* affected by the proposed activity, contact the department indicated for further review in accordance with the governing procedure. If responsible department determines program is not affected, attach written explanation.

If ALL of the answers on the previous pages are "No," then check A below:

A. [ ] None of the activity is controlled by any of the processes above, therefore a 10CFR50.59 review **IS** required. Complete a 10CFR50.59 screen.

If one or more of the answers on the previous pages are "Yes," then check either B or C below as appropriate and explain the regulatory processes which govern the change:

B. [X] All aspects of the activity are controlled by one or more of the processes above, therefore a 10CFR50.59 review **IS NOT** required.

C. [ ] Only part of the activity is controlled by the processes above, therefore a 10CFR50.59 review **IS** required. Complete a 50.59 screen.

Explanation: ____________________

Preparer: Luis Gonzalez (Printed Name) — [signature] (Signature) — 1/13/03 (Date)

Reviewer: Terry McCool (Printed Name) — [signature] (Signature) — 1-13-03 (Date)