Attachment 3

To

GNRO-2007/00061

GGNS Calculation JC-Q1E22-N654-1, Rev. 1

CALCULATION
COVER PAGE

☒ CALCULATION
☐ DRN

(1) DRN No. Page(s) 31
(2) Initiating Doc.: CR-GGN-2006-0863

- ☐ DRN Superseded:
- ☐ DRNs Voided:
- ☐ Calculation Superseded/Voided:
- ☒ As-Built/No ICN Required
- ☐ Pending/ICN Required (Verify current status in IDEAS.)

(3) Reason For Pending Status: (ER, T.S., Change, etc.)
N/A

(4) Calculation No: JC-Q1E22-N654-1	(5) Revision: 3

(6) Title: Instrument Loop Uncertainty and Setpoint Determination for Loops 1E22-N654C&G HPCS Pump Suction Transfer on Low CST Level (TS 3.3.5.1)

(7) System(s): E22 & P11

(8) Component/Equipment Identifier:
1E22N054C/G
1E22N654C/G
1E22F001
1E22F015
1E22K702
1P11A002

(9) Safety Code:
- ☒ Yes
- ☐ Quality
- ☐ No

(10) Calc Code: (ANO/GGNS Only)
Setpoint

(20) Study Calc
☐ YES ☒ NO

(11) 10CFR50.59 Review:
- ☐ Addressed in
- ☐ Attached
- ☒ No LBD Impact

(12) Structure:

Bldg. AUX.	Elev.
Room	Wall
Coordinates:	

(13) R-Type: J05.02

(14) Org. Code: (ANO/GGNS/RBS Only) NPE-I&C

(15) Keywords: N/A

(19) Topical Codes: (ANO Only)

REVIEWS

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(16) Name/Signature/Date	(17) Name/Signature/Date	(18) Name/Signature/Date
Responsible Engineer	☒ Design Verifier ☐ Reviewer ☐ Checker (Only As-Built DRNs included in Revision) ☐ Comments Attached	Supervisor/Approval ☐ Comments Attached

CALCULATION SHEET

ENTERGY

CALCULATION NO. JC-Q1E22-N654-1 REV. 3

CALCULATION BY TMB DATE 7/27/06 VERIFIED BY KMW DATE 07/27/06

Revision	Record of Revision
0	Initial Issue
1	CR 97/1071-00
2	DRN 05-1570 (ER-GG-1999-0217)
3	CR-GGN-2006-0863

ENTERGY

CALCULATION SHEET

CALCULATION NO. JC-Q1E22-N654-1 REV. 3

CALCULATION BY TMB DATE 7/27/06 VERIFIED BY KMW DATE 07/27/06

CALCULATION REFERENCE SHEET	*CALCULATION NO: JC-Q1E22-N654-1 Rev3*

I. **DRNs INCORPORATED:**

1.
2.
3.
4.
5.

II Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	DRN/ Tracking No.
1. see calc section 3.2			☐	☐		
2.			☐	☐		
3.			☐	☐		
4.			☐	☐		
5.			☐	☐		

III. **CROSS REFERENCES:**

1. see calc section 3.1

IV. **SOFTWARE USED:**

Title: N/A Version/Release: ____ Disk/CD No. ____

DISK/CDS INCLUDED:

Title: ____ Version/Release ____ Disk/CD No. ____

V. **OTHER CHANGES:**

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this calculation is to determine the instrument loop uncertainty and limiting allowable values and setpoints for instrument loops 1E22-N654C&G in support of ER 1999-0217. The values generated by this calculation are in accordance with Ref. 3.1.1. Instrument loops 1E51N635A&E that were originally included in this calculation are now addressed in Ref. 3.2.18.

2.0 DESIGN REQUIREMENTS

The High Pressure Core Spray (HPCS) system is an ECCS system which supplies makeup water to the reactor in the event of a loss-of-coolant accident (LOCA) or reactor isolation and failure of the Reactor Core Isolation Cooling (RCIC) system (Ref. 3.1.3 pg. 4). HPCS is automatically started on LOCA detection or may be manually started if required (Ref. 3.1.22 pg. 8).

The normal source of water for HPCS is the Condensate Storage Tank (CST) which contains reactor grade water (Ref. 3.1.4 pg.5 & 25). However, low level in CST, or high level in the suppression pool, will initiate a transfer of suction to the suppression pool (Ref. 3.1.22 pg. 10).

For the HPCS system, CST level is sensed by two level transmitters (1E22-LT-N054C&G) and two trip units (1E22-LIS-N654C&G) (Ref. 3.1.6, 3.1.7 & 3.1.8). When tank level decreases to the setpoint, the trip units send a signal to the 1E22F001 & 1E22F015 valve control logic to transfer HPCS pump suction from the CST to the suppression pool (Ref. 3.1.6, 3.1.7 & 3.1.8). Since water in the suppression pool is not of reactor quality, this transfer is done only after all condensate sources have been exhausted or the suppression pool level is too high (Ref. 3.1.22 pg. 10).

The primary design consideration for the transfers is the maintenance of suction head on the HPCS pump (Ref. 3.1.3 pg. 3, 3.1.22 pg. 6) which will ensure an uninterrupted flow of water to the reactor. The obvious analytical limit is the level of the vortex breaker of the suction piping which is 9" above the bottom of the CST. With instrument zero at 1' 1", this equates to -0.333 ft. (Ref. 3.2.10, 3.2.11 & 3.2.8) Because the transmitters will not function below instrument zero, the analytical limit would ordinarily be set equal to 0.0 ft. In this case, however, the portion of suction piping that connects to the CST is non-safety related. Per 3.2.3, the instrumentation must be capable of detecting a suction pipe failure such that the suction swap to the suppression pool is completed before suction head is lost. For this to happen, the setpoint must be above the elevation of the top of the suction pipe. The analytical limit will therefore be set equal to 3.0 ft, the indicated level of the top of the suction pipe. (Ref. 3.2.8)

A low CST level (or a failure of the suction piping) will initiate the transfer of the HPCS suction from the CST to the suppression pool (3.1.22 pg. 10). This transfer could occur during an accident situation when HPCS is required to operate; therefore, transmitters 1E22N054C & G are required to function in accident environments.

The HPCS system is designed in accordance with seismic Category I requirements; therefore, Loops 1E22-N654C & G do have to function during and after a seismic event (Ref. 3.1.22 pg. 3).

The postulation of an SSE and a LOCA at the same time is not required (Ref. 3.1.30). It is necessary to postulate a LOCA and a subsequent SSE or a SSE and a subsequent LOCA. Therefore, both seismic and LOCA effects will be included in this calculation.

It must be noted that per the tech spec (Ref. 3.1.5) there is no upper limit on the CST low level setpoint for the HPCS pump suction swap. The friction loss errors discussed in section 7.5 will result in the low level trip occurring much earlier than desired. This will result in less usable CST volume. The 18 ft CST tech spec requirement (Ref. 3.1.31) only applies in modes 4 or 5 when suction from the suppression pool is not available. In this case the automatic swap would be disabled. Per Ref. 3.1.33, the CST is not credited for HPCS in modes 1, 2 or 3.

3.0 REFERENCES

3.1 Cross References

3.1.1 Standard No. GGNS-JS-09 Rev 1, Methodology for the Generation of Instrument Loop Uncertainty & Setpoint Calculations

3.1.2 SDC-E51 Rev 2 (RCIC)

3.1.3 GE Design Spec Data Sheet 22A3131AC Rev 11 (HPCS)

3.1.4 System Design Criteria SDC E22 Rev 2 High Pressure Core Spray System

3.1.5 Tech Spec Table 3.3.5.1-1, Sheet 3

3.1.6 J-1248-L-005C Rev 0 Loop Diagram

3.1.7 J-1248-L-005G Rev 0 Loop Diagram

3.1.8 J-1248-004 Rev 1 Logic Diagram

3.1.9 M-1065 Rev 40 P&ID

3.1.10 J-1506B Rev 1 Instrument Location El 119

3.1.11 A-0011 Rev 8 Plan at El 119

3.1.12 Passport EDB

3.1.13 J-0400 Rev 17 Control Room Panel Location

3.1.14 A-0120 Rev 16 Control Room Floor Plan

3.1.15 FSK-I-1065-010-B Rev 8

3.1.16 GE PPD 164C5150 Sht 1 Rev 18, Sht 2 Rev 17, Sht 3 Rev 18

3.1.17 CR 1999-0481

3.1.18 GE PPD 184C4571 Sht 1 Rev 9

3.1.19 CR 1999-0433

3.1.20 Tech Spec SR 3.3.5.1.5

3.1.21 Tech Spec SR 3.3.5.1.3

3.1.22 GE Design Spec 22A3131 Rev 5 (HPCS)

3.1.23 TRM Table TR3.3.5.1-1 Rev. 29

3.1.24 CR 97/1071-00

3.1.25 PER 91/6068 Rev 1

3.1.26 P&ID M-1086, Rev. 30

3.1.27 NEDC-31336P-A, Class 3 September 1996, General Electric Instrument Setpoint Methodology

3.1.28 CRC Handbook of Chemistry and Physics, 57th Edition (pg. F-5)

3.1.29 UFSAR 15.6.5.1

3.1.30 deleted

3.1.31 Tech Spec SR 3.5.2.2

3.1.32 Tech Spec bases SR 3.5.2.1 & 3.5.2.2 (page B 3.5-18)

3.1.33 EAR E99-018 response

3.2 Relationships

3.2.1 Standard GGNS-E-100 Rev 5, "Environmental Parameters for GGNS"

3.2.2 MC-Q1E22-00010 Rev 1

3.2.3 ER 1999-0217-00

3.2.4 865E542-002, Rev. 4 DRN 05-383

3.2.5 Rosemount Instruction Manual 4247-1 dated 7/76 Trip/Indicator 460000047

3.2.6 Vendor Manual # 460001972

3.2.7 E22 MPL# 283X237BA DRN 05-434

3.2.8 J-1660B Rev 4 Level Settings Diagram DRN 05-1560

3.2.9 Vendor manual 460000944 Tab 20

3.2.10 C143.0-N1P11A002-1.3-17 Rev 2, HPCS / RCIC CST Suction Nozzle

3.2.11 C143.0-N1P11A002-1.3-2 Rev 3, CST Vendor Drawing

3.2.12 J301.0-QS-27.0-15 Rev 0; Rosemount Low Dose Rate Radiation Test Report for 1153 Pressure Transmitters D8600063 (contained in EQ09.1-3)

3.2.13 06-IC-1E22-R-0002 Rev 104

3.2.14 06-IC-1E22-Q-0002 Rev 101

3.2.15 Bechtel Calculation M5.6.007, Rev. 1, Sht. 781

3.2.16 MP&L Spec C196.0, Rev.5

3.2.17 J1660A DRN 05-1559

3.2.18 JC-Q1E51-N635-1 Rev 1

3.2.19 SC-1E22-LT-N054 Rev 1 Scaling Calculation

3.2.20 02-S-01-33 rev 18, Turbine Building Rounds

3.2.21 DCP 83/0108, added CST temperature monitoring instrumentation

3.2.22 MS-02 rev 50

3.2.23 SFD1065 rev 6

3.2.24 386X409BA rev 6, 1H13P601-21B EDL

3.2.25 163C1392 sht 1 rev 15 item 7, 1E51R600 flow controller PPD

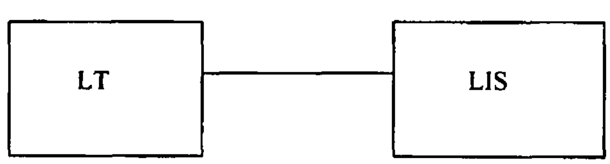
3.2.26 04-1-01-E51-1 rev 123, RCIC SOI

3.2.27 06-OP-1E51-Q-0003, rev 119, RCIC pump surveillance

4.0 GIVEN

4.1 Instrument Loop Block Diagram

Transmitter	Trip Switch	Power	P&ID	Loop Dia.
1E22-LT-N054C,G	1E22-LIS-N654C,G	1E22A-PS2	3.1.9	3.1.6, 3.1.7



4.2 Transmitter Environment

Description	Data	Reference
Tag Number	1E22-LT-N054C,G;	
Instrument Location:		
Panel	Local	3.1.6, 3.1.7
Room	1A201	3.1.10, 3.1.11
Environmental Conditions:		
Normal:Zone N-032		3.2.1
Temperature	65-104F	3.2.1
Pressure	0.25 to 0 in.wg.	3.2.1
Radiation (Gamma)	3.5E2 rads (40 yr TID)	3.2.1
Humidity	50% RH	3.2.1
DBE or Accident:	Zone A-057	3.2.1
Temperature	124F	3.2.1
Pressure	0.25 to 0 in.wg.	3.2.1
Radiation TID	1.46E5 rads	3.2.1
Radiation dose rate	0.034E6 rads/hr	3.2.15
Humidity	50% RH	3.2.1
Seismic Conditions	≤ 0.5g	Assumption 5.2
Surveillance Intervals	18 months	3.1.5, 3.1.20

4.3 Trip Unit Environment

Description	Data	Reference
Tag Number	1E22-LIS-N654C,G;	
Instrument Location:		
Panel	1H13-P625;	3.1.6, 3.1.7
Room	0C504	3.1.13, 3.1.14
Environmental Conditions:		
Normal:	Zone N-028	3.2.1
Temperature	60-90 0F	3.2.1
Pressure	0.1 to 1.0 in wg.	3.2.1
Radiation (Gamma)	1.8E2 rads (40 yr TID)	3.2.1
Humidity	50% RH	3.2.1
DBE or Accident:	Same as Normal	3.2.1
Surveillance Intervals	92 days	3.1.5, 3.1.21

4.4 Transmitter Vendor Data

Description	Data	Reference
Tag Number	1E22-LT-N054C,G;	
Manufacturer	Rosemount	3.2.3, 3.2.7
Model	1153GB5PA	3.2.3, 3.2.7
URL	62.5 ft (750 inwc)	3.2.6
Span	39.81 ft (13.19" to 490.87")	3.2.19
	39.81 ft (13.31" to 490.99")	3.2.19
Accuracy:	±0.25% span	3.2.6
Drift:	±0.25% URL per six months	3.2.6
Power Supply:	<0.005% span per volt	3.2.6
Temperature:	±(0.75% URL + 0.5% span)/100F	3.2.6
Humidity:	Sealed unit - no effects	3.2.6
Radiation:	± 0.5 % URL for 0.035 Mrad/hr	3.2.12, 5.8
Static Pres:	N/A for gage pressure transmitter	3.2.6
Seismic:	± 0.25% URL for 3 g	5.2
Overpressure:	<±0.25 URL for 2000 psi	3.2.6
Output Range	4-20 madc	3.2.6

4.5 Trip Unit Vendor Data

Description	Data	Reference
Tag Number	1E22-LIS-N654C,G;	
Manufacturer	Rosemount	3.2.4, 3.1.16
Model	510DU or 710DU	Assumption 5.6
Repeatability:	±0.2% span	3.2.5, Note 1
Drift:	±0.2% span per 6 months	3.2.5
Input Range	4-20 madc	3.2.5

Note 1: Table 5 of Ref. 3.2.5 defines environmental conditions at the Trip Switch in terms of "operating condition" and "environment." Conditions in Zone N-028 are bounded by line 2 defined as "adverse operating conditions" and "normal environment" The corresponding line on Table 6 specifies repeatability under the defined conditions as ±0.2%. This repeatability is valid for 6 months operation. An allowance for power supply effects, temperature effects, humidity effects and radiation effects are included in the repeatability.

4.6 Power Supplies

Power Supply Tag No.	1E22A-PS2 (1E22K702)	3.1.6, 3.1.7
Power Supply Nominal	24.0 volts	3.2.4, 3.1.18
Power Supply Variations	23 - 28 vdc	3.2.4, 3.1.18

4.7 Instrument Tubing

The CST outlet piping runs to the RCIC and HPCS pumps. One side of the transmitter is tapped into this line; the other is vented to atmosphere.

Description	Data	Reference
Room	1A201	3.1.10, 3.1.11
Normal Temp	65-104F	3.2.1
DBE Temp	124F	3.2.1
Vertical Rise	2.763 ft. ±2 in.	3.1.15

4.8 Condensate Storage Tank

Per 3.2.23, the normal temperature of the CST water is 130F. Per 3.2.22, this is also the maximum expected temperature (based on associated line HCD-9). During normal plant operation the minimum CST water temperature will not drop below 75F. During extended cold weather plant outages the temperature could fall below the 65F limit for the feedwater injection piping for RCIC. As a result, CST temperature monitoring instrumentation was installed. (reference 3.2.21) Procedural controls were put in place to maintain the temperature above 70F (3.2.20).

5.0 ASSUMPTIONS

5.1 Per reference 3.1.1, the M&TE error is normally assumed to be equal to the reference accuracy of the pressure transmitter. Per 3.2.13, a Fluke 45 (±0.040 ma) and a pressure gage (±1.194" or ±0.0995 ft) are used to calibrate 1E22N054C & G. The total M&TE error for this device is the SRSS of the two. Converting the ma error to ft; (0.040 ma)(40 ft / 16 ma) = 0.10 ft. The SRSS of 0.1 and 0.0995 is 0.141 ft. Since this is larger than the ±0.25% (40 ft) =±0.1 ft reference accuracy of the transmitter, the ±0.141ft value will be assumed for the M&TE error.

5.2 The published 0.5% URL seismic effect for the 1153 series B transmitters is for a 4 g peak ZPA (Ref. 3.2.6). Per reference 3.2.16, the worst ZPA experienced at Aux Building elevation 119' is 0.361g. At the 122' mounting location of the transmitters it will be conservative to assume a ZPA of 0.5g. The ±0.25% URL published seismic effect for 1152 transmitters (with 3 g peak ZPA per Ref. 3.2.9) will instead be assumed because of the similarity of the sensing modules. See also reference 3.1.27 page 2-12.

5.3 Vendor documents list equipment performance data without stating the statistical basis for the numbers. Although some vendor data is "worst case", it will be assumed that all such data is a 2 sigma value.

5.4 Per reference 3.2.13 & 3.2.14, a Rosemount readout assembly is used to calibrate the Rosemount trip units. Per reference 3.2.5, the accuracy of the readout assembly is ±0.01 ma which is equal to (0.01 ma)(40 ft/16 ma) = ±0.025 ft and the accuracy of the trip unit is ±0.2% span = 0.2% (40 ft) = ±0.08 ft. However, since Ref. 3.2.13 & 3.2.14 specify a setpoint tolerance of ±0.04 ma = (0.04)(40/16) = 0.1 ft, the larger ±0.1 ft value will be assumed for the M&TE error.

5.5 Assume the IR effects are negligible since the cables are not located in line break areas.

5.6 Based on data in reference 3.1.12, the trip units are currently Rosemount 510DU's. Since this model is obsolete, they may be replaced with 710DU's in the future (Ref. 3.1.25). The performance spec for the 710DU is equal or better than the 510DU.

5.7 Assume that the standby gas treatment system maintains a 2.0 in. DP between the Aux. Building and the atmosphere outside the plant (based on PDS data for T42N031A/B). This will be a bias term when determining LU.

5.8 For conservatism it appears that Rosemount has specified the radiation effect error in terms of % URL instead of % span. The "true" radiation effect error for the 1153 transmitter at 0.035 Mrads/hr will likely be less than ±0.25% span based on a review of Ref. 3.2.12 test data. However, a ±0.5% URL effect will be assumed to maintain Rosemount conservatism.

5.9 The radiation drift effect (RD) of the transmitters will assumed to be zero since it is calibrated every 18 months.

5.10 A flow of 9000 gpm is assumed for the flow induced errors in sections 7.5, 7.7 & 7.8. This assumes a RCIC flow of 825 gpm and that HPCS is at 8175 gpm runout flow per Ref. 3.1.4. Although the RCIC design flow is 800 gpm (3.1.2), the actual RCIC flow is adjustable from 0 to 1000 gpm via controller 1E51R600 (3.2.24 & 3.2.25). References 3.2.26 & 3.2.27 specify the nominal setting for the flow controller is 800 gpm. Reference 3.2.27 specifies a flow rate acceptance criteria of 800 ±10 gpm using a DVM. The assumed RCIC flow of 825 gpm (810 gpm + 15 gpm instrument uncertainty allowance) is therefore conservative.

6.0 METHODOLOGY

6.1 Device Uncertainties

For each module, the uncertainty terms applicable to this application will be specified and combined into the following module errors:

RA	-	reference accuracy
L	-	positive bias uncertainty
M	-	negative bias uncertainty
MTE	-	measurement and test equipment inaccuracies
D	-	drift

6.2 Loop Uncertainties

The random and bias components of:

PE - errors associated with the Primary Element
PM - errors in Process Measurement, and
IR - errors due to degradation in Insulation Resistance

will be quantified, the loop error equation given, and the device and loop uncertainties combined to produce:

A_L - SRSS of all device random uncertainties except drift
L_L - The sum of all positive bias uncertainties
M_L - The sum of all negative bias uncertainties
C_L - SRSS of all measurement and test equipment inaccuracies used for calibration.
D_L - SRSS of all drifts
LU - SRSS(A_L, C_L, PE, PM) $\pm$ IR + L_L - M_L

6.3 Total Loop Uncertainty

The total loop uncertainty will be calculated using the Ref. 3.1.1 equation:

$$TLU = LU + D_L$$

6.4 Allowable Value

The allowable value for the loop will be calculated using the Ref. 3.1.1 equation:

$$AV = AL \pm LU$$

6.5 Nominal Trip Setpoint

The nominal trip setpoint will be calculated using the Ref. 3.1.1equation:

$$NTSP = AL \pm TLU$$

6.6 Spurious Trip Avoidance

The probability of a spurious trip during normal plant operation using the Tech Spec setpoint will be evaluated using the methodology of Ref. 3.1.1and calculated loop errors. Per Ref. 3.1.1, a 95% probability of no spurious trip is acceptable.

6.7 LER Avoidance

The probability of exceeding the Tech Spec allowable value without a trip at the tech spec setpoint will be evaluated using the methodology of Ref. 3.1.1 and calculated loop errors. Per Ref. 3.1.1, a 90% probability of avoiding LERs is acceptable.

Note: When considering the probability of a spurious trip, any late actuation will be conservative. Similarly, when considering the probability of an LER, any early actuation will be conservative. This means that single sided distributions are appropriate for this evaluation.

Per Ref. 3.1.1, a Z of 1.645 corresponds to a probability of 95%. Similarly, a Z of 1.28 corresponds to a probability of 90%.

6.8 Nomenclature

The nomenclature of Ref. 3.1.1, Section 1.6, will be used. Errors associated with the transmitter will be subscripted with a "1", errors associated with the trip unit will be subscripted with a "2", while loop errors will be subscripted with an "L". For example, D_1 would be the transmitter drift, D_2 would be the trip unit drift, and D_L would be the loop drift.

6.9 Worst Case Loop

The equipment and environments for each loop are identical; therefore, no worst case calculation is required.

7.0 CALCULATION

7.1 Transmitter Uncertainties

Using the vendor data from Section 4.4:

URL = 62.5 ft
SPAN = 39.81 ≈ 40 ft

RA_1 = ± 0.25% span
= (0.0025)*(40)
= ± 0.100 ft

Temp Effect = ± (0.75 % URL + 0.5% span) / 100F
= ±{(0.75%)(62.5) + (0.5%)(40)}/100F
= ± 0.669 ft /100F

Temperature effect will be broken into TD (65-90F per Ref. 3.1.1), TEN (90-104F, the balance of the normal range from Sec 4.2) and TEA (the additional accident range from Sec 4.2).

Therefore:

TD_1 = (0.669)*(25/100)
= ± 0.167 ft

TEN_1 = (0.669)*(14/100)
= ± 0.0937 ft

TEA_1 = (0.669)*(20/100)
= ± 0.134 ft

Per Ref. 3.2.6, humidity has no effect on the sealed transmitter.

HE_1 = ± 0.00 inwc

Radiation Drift (normal)

RD_1 = ± 0.00 inwc Sec. 5.9

Accident dose = 1.35E5 rads Sec 4.2
Accident dose rate = 0.034E6 rads/hr

Radiation effect (Accident)

REA_1 = ± 0.5% URL
= ± (0.5%)*(62.5)
= ± 0.313 ft

Per Sec 4.6, the worst power supply variations are –1.0 volts, +4.0 volts. For simplicity, this will be conservatively taken as ± 4.0 volts.

PS_1 = ± 0.005% span / volt variation
= ± (0.00005)*(40 ft)*(4 volts)
= ± 0.008 ft

Seismic Effects

SE_1 = ± 0.25% URL
= ± 0.25% (62.5 ft)
= ± 0.156 ft

Overpressure is a differential pressure above the upper range limit, in this case 62.5 ft. Per Ref. 3.2.11 & 3.2.8, the CST is 31 ft high, therefore, these transmitters will not experience the overpressure effect.

OVP_1 = 0.000 ft

The static pressure effect is not applicable for gage pressure transmitters.

SPE_1 = ± 0.00 inwc

Drift is specified for six months. The actual worst case calibration period is 22.5 months (Ref. 3.1.1). Per Ref. 3.1.27page 2-8 the drift for each time interval can be combined using the SRSS methodology. Therefore:

DR_1 = ±{SQRT (22.5/6)}* (0.25% URL) for 22.5 months
= ±{SQRT (3.75)}*(0.25%)*(62.5)
= ±0.303 ft

Summarizing for the transmitter:

A_1 = ± SRSS(RA_1, (TEN_1+TEA_1), REA_1, PS_1, SE_1)
= ± SRSS{0.100, (0.0937+0.134), 0.313, 0.008, 0.156}
= ± 0.429 ft

L_1 = + 0.0 inwc
M_1 = - 0.0 inwc

C_1 = ± 0.141 ft Assumption 5.1

D_1 = ± SRSS(DR_1, TD_1)
= ± SRSS(0.303, 0.167)
= ± 0.346 ft

7.2 Trip Unit Uncertainties

Using the vendor values from Sec 4.5:

SPAN = 40 ft

A_2 = ± 0.20% span
= ± (0.002)*(40)
= ± 0.080 ft

L_2 = + 0.00 inwc
M_2 = - 0.00 inwc

C_2 = ±0.10 ft Assumption 5.4

Six months of drift allowance is included in the reference accuracy of the trip units. Since these trip units are calibrated every six months, the six month drift is equal to zero.

$D_2 = \pm 0.0$ ft

7.3 Primary Element Accuracy

PE = ± 0.00 inwc (This loop does not employ a primary element)

7.4 Process Measurement Accuracy

Changes in water density caused by changes in reference leg water temperature will affect the loop accuracy by causing the transmitter to sense a level that is either lower or higher than the actual level in the CST. The PM effect associated with the density changes is determined by using the following equation extracted from reference 3.1.1 Appendix B.

$$PM = HV((SV1/SV2) - 1)$$

The temperature in the reference leg of the transmitters will be assumed to be between 65°F to 124°F (Ref. 3.2.1) and the calibration temperature will be 90°F (Ref. 3.2.1).

HV = reference leg water height = 2.763 ft Section 4.7

SV1 = specific volume at T1 (90°F) = 0.016099 ft^3/lbm Ref. 3.1.28

**Calculate PM for the lower temperature range value:

SV2 = specific volume at T2 (65°F) = 0.016041 ft^3/lbm Ref. 3.1.28

PM tubing = (2.763)((0.016099/0.016041)-1)) = +0.001 ft

**Now calculate for the upper temperature range value:

SV2 = specific volume at T2 (124°F) = 0.016221 ft^3/lbm Ref. 3.1.28

PM tubing = (2.763)((0.016099/0.016221)-1)) = -0.021 ft

PM tubing = + 0.001 ft, -0.021 ft

Changes in the CST water temperature will result in level changes that are not detected by the level transmitters. The PM effect associated with the density changes is again determined by using the following equation extracted from reference 3.1.1 Appendix B.

PM = HV ((SV1/SV2) – 1)

The worst case PM error would be at the 30.167 ft high alarm setpoint (3.2.17). However, for this calculation it is only necessary to consider the error at the 6.083 ft low level setpoint (3.2.8).

HV = CST water level = 6.083 ft

SV1 = specific volume at T1 (130°F) = 0.01625 ft^3/lbm Ref. 3.1.28

SV2 = specific volume at T2 (70°F) = 0.01605 ft^3/lbm Ref. 3.1.28

PM CST = (6.083)((0.01625/0.01605)-1)) = +0.076 ft

PM total = SRSS (PM tubing, PM CST)

= +SRSS(0.001, 0.076), -SRSS(0.021, 0.00)

= +0.076, -0.021

Assume PM = $\pm$0.080 ft

7.5 Friction Loss Bias

For an ideal CST level measurement, the transmitter would have a dedicated sensing line with a tap near the bottom of the tank like the non-safety related CST level transmitter 1P11N003. This transmitter is located inside the CST dike area near the CST. Bechtel chose to locate the safety related CST level transmitters inside the aux building so that they would not have to design a means of protecting them from seismic and tornado missile hazards. Instead of providing a dedicated sensing line to the transmitters in the aux building, Bechtel chose to utilize a tap off of the 20 " HCB-9 HPCS / RCIC suction line. With zero flow, the level readings of the safety related level transmitters will be correct. With flow, the measured pressure will be less than the CST pressure due to frictional pressure drops in the pipe. This will result in a lower level being indicated (Ref. 3.1.19). Per Ref. 3.2.2 Att. 5 page 3 & 4, the friction loss error is 2.738 ft at 7115 gpm and 4.337 ft at 9000 gpm.

FL = -4.337 ft Assumption 5.10

7.6 Ventilation System Bias

NRC information notice IEN 97-0033 was issued to advise addressees of the potential adverse affects ventilation systems can have on level instrumentation (Ref. 3.1.24). The level transmitters of this calculation have low pressure ports opened to the ambient pressure of area 1A201 of the Aux. Building. The fuel pool area ventilation system maintains the Aux. Building at a negative pressure. This causes the level transmitters to indicate the CST level 0.7 inwc higher than it actually is based on PDS data for T42N037A/B. When the Standby Gas Treatment system is operating, the indication of the CST level by the transmitters could be 2.0 inwc (0.167 ft) higher than it actually is based on the PDS data for T42N037A/B.

VNT= +0.167 ft (Ref. 4.9)

7.7 Response Time (Drawdown) Bias

The suction swap to the suppression pool will be delayed because of instrument response times and valve stroke times. As a result, the level of the CST will drop below the low level trip setpoint. Per Ref. 3.2.2 Att. 5 page 3 & 4, the maximum "drawdown" effect is 0.893 ft at 7115 gpm and 1.096 ft at 9000 gpm. The minimum effect is 0.881 ft at 7115 gpm and 1.081 ft at 9000 gpm.

RTmax = +1.096 ft Assumption 5.10

7.8 Vortexing

Per Ref. 3.2.2 Att 5 page 3 & 4, vortexing could occur at 2.504 ft indicated level at a flow rate of 7115 gpm and 4.207 ft indicated level at 9000 gpm. Since vortexing is not desirable, the vortex height will be conservatively treated as a positive bias although the formation of a full vortex would likely result in a lower indicated pressure that would be interpreted as a level decrease (a negative bias).

VTX = +4.207 ft Assumption 5.10

7.9 Effective Flow Induced Error

The total Effective Flow Induced Error (FIE) is the sum of the Friction loss, Response Time and Vortexing errors.

$$FIE = FL + RTmax + VTX$$
$$= -4.337 + 1.096 + 4.207$$
$$= +0.966 \text{ ft}$$

For comparison the total Effective Flow Induced Error (FIE') without the Vortexing error will also be calculated.

$$FIE'min = FL + RTmax \quad \text{at 7115 gpm}$$
$$= -2.738 + 0.893$$
$$= -1.845 \text{ ft}$$

$$FIE'max = FL + RTmin \quad \text{at 9000 gpm}$$
$$= -4.337 + 1.081$$
$$= -3.256 \text{ ft}$$

7.10 Insulation Resistance Bias

IR = +0.0 Assumption 5.5

7.11 Loop Uncertainties

Using the equations from Ref. 3.1.1 and the values from above:

$$A_L = \pm SRSS(A_1, A_2)$$
$$= \pm SRSS(0.429, 0.080)$$
$$= \pm 0.436 \text{ ft}$$

$$L_L = +L_1 + L_2 = 0.0 \text{ inwc}$$
$$M_L = -M_1 - M_2 = 0.0 \text{ inwc}$$

$$C_L = \pm SRSS(C_1, C_2)$$
$$= \pm SRSS(0.141, 0.10)$$
$$= \pm 0.173 \text{ ft}$$

$$D_L = \pm SRSS(D_1, D_2)$$
$$= \pm SRSS(0.346, 0.0)$$
$$= \pm 0.346 \text{ ft}$$

LU_+ = + SRSS(A_L, C_L, PM, PE) + IR + VNT + FIE
= + SRSS(0.436, 0.173, 0.080, 0.0) + 0.0 + 0.167 +0.966
= + 0.476 + 1.133
= +1.609 ft

LU_- = - SRSS(A_L, C_L, PM, PE)
= - SRSS(0.436, 0.173, 0.080, 0.0)
= -0.476 ft

For comparison, the loop uncertainties LU'_+: LU'_- without the FIE error will be calculated.

LU'_+ = + SRSS(A_L, C_L, PM, PE) + IR + VNT
= + SRSS(0.436, 0.173, 0.080, 0.0) + 0.0 + 0.167
= + 0.476 + 0.167
= +0.643 ft

LU'_- = - SRSS(A_L, C_L, PM, PE)
= - SRSS(0.436, 0.173, 0.080, 0.0)
= -0.476 ft

7.12 Total Loop Uncertainty

TLU_+ = LU_+ + D_L
= + 1.609 + 0.346
= + 1.955 ft

TLU_- = LU_- - D_L
= - 0.476 - 0.346
= - 0.822 ft

Without FIE error;

TLU'_+ = + SRSS(A_L, C_L, D_L, PM) + VNT
= + SRSS(0.436, 0.173, 0.346, 0.080) + 0.167
= + 0.588 + 0.167
= +0.755 ft

TLU'_- = - SRSS(A_L, C_L, D_L, PM)
= - SRSS(0.436, 0.173, 0.346, 0.080)
= - 0.588

7.13 Allowable Value

AV = AL + LU_+
= 3.0 + 1.609
= 4.609 ft

The specified allowable value will be 4.7 ft.

7.14 Nominal Trip Setpoint

NTSP = AL + TLU_+
= 3.0 + 1.955
= 4.955

The specified setpoint will be 5.0 ft.

The minimum CST level after the HPCS suction swap Lmin = NTSP – TLU'_+ - FIE' min = 5 – 0.755 – (-1.845) = 6.090 ft at 7115 gpm. The maximum CST level after the HPCS suction swap, Lmax = NTSP - TLU'_- - FIE max = 5 – (-0.588) – (-3.256) = 8.844 ft at 9000 gpm.

7.15 Spurious Trip Avoidance

$Sigma_i$ = (1/n) * SRSS(LU_+, D_L) Ref. 3.1.1
n = 2 Sec 5.3
$Sigma_i$ = (1/2) * SRSS(1.609, 0.346)
= 0.823

It is assumed that the minimum normal operating value of the CST would be equivalent to the CST low level alarm (1P11K603) of 23'-1" actual or 22'-0" indicated (Ref. 3.2.17).

X_T = 22.0 ft

$Sigma_N$ is the standard deviation associated with X_T. In this application, X_T is assigned as an enveloping value and $Sigma_N$ should be set to zero.

$Sigma_N$ = 0.00

Z = ABS(Tech Spec SP - X_T) / SRSS($Sigma_N$, $Sigma_i$) Ref. 3.1.1

= ABS(5.0 – 22.0) / SRSS(0.00, 0.823)

= 20.656

This is above the Sec 6.6 minimum acceptable Z value of 1.645 for 95%.

7.16 LER Avoidance

$Sigma_l$ = (1/n) * SRSS (A_L, C_L, D_L)

n = 2

$Sigma_l$ = (1/2) * SRSS (0.436, 0.173, 0.346)

= 0.291

Z = ABS(Tech Spec AV - Tech Spec SP) / $Sigma_l$ Ref. 3.1.1

= ABS(4.7 - 5.0) / 0.291

= 1.031

This is slightly below the Sec 6.7 minimum acceptable Z value of 1.28 for 90%. However, the LER avoidance evaluation does not require the inclusion of accident or seismic effects. A new sigma' without these uncertainties will be derived and the associated Z' will be calculated.

A'_1 = ± SRSS(RA_1, TEN_1, PS_1)

= ± SRSS{0.100, 0.0937, 0.008}

= ± 0.137 ft

A'_2 = A_2 = = ± 0.080 ft

A'_L = ± SRSS(A'_1, A'_2)

= ± SRSS(0.137, 0.080)

= ± 0.159 ft

$Sigma'_l$ = (1/2) * SRSS (A'_L, C_L, D_L)

= (1/2) * SRSS(0.159, 0.173, 0.346)

= 0.209

Z' = ABS(Tech Spec AV - Tech Spec SP) / $Sigma'_l$

= ABS(4.7 - 5.0) / 0.209

= 1.435

This is above the Sec 6.7 minimum acceptable Z value of 1.28 for 90%.

8.0 CONCLUSION

The Tech Spec setpoints and allowable values support the safety function (are conservative with respect to the calculated values) and give adequate margin from spurious trips and LERs. Therefore, they are acceptable. The minimum CST level after the HPCS suction swap is 6.090 ft at 7115 gpm. The maximum CST level after the HPCS suction swap is 8.844 ft at 9000 gpm.

SUMMARY OF RESULTS		
SYSTEM		E22
LOOP NUMBERS		N654C&G
TOTAL LOOP UNCERTAINTY		+ 1.955, - 0.822 ft
LOOP UNCERTAINTY		+ 1.609, - 0.476 ft
DRIFT ALLOWANCE		± 0.346 ft
M&TE		± 0.173 ft
	SPECIFIED (ft)	CALCULATED (ft)
Analytical Limit	3.0	--------------
Allowable Value	4.7 (TS)	4.609
Nominal Trip Setpoint	5.0 (TRM)	4.955