TITLE: INSTRUMENT SCALING CALCULATION
REFUELING WATER STORAGE TANK 1-1
LEVEL CHANNEL LT-920

PREPARED BY Joe Succi DATE 03/21/98
REVIEWED BY [signature] DATE 3/27/98
APPROVED BY [signature] DATE 5-12-98

** QUALITY RELATED **

1.0 SCOPE

1.1 Revise scaling calculation to delete reference to DCM T-34, add reference and requirement of PAM calc, add requirements of J-54 and J-110, change FSAR Table 7.5-2 accuracy to ±4.5%, and delete M&TE that is no longer available.

1.1.1 Affected Test: STP I-9-L920

1.1.2 Affected Loop: 9-1

1.1.3 Affected Devices: LT-920, LQ-920, LC-920A/B, LC-920C/D, LM-920, LI-920, and ERFDS 03/08

2.0 DISCUSSION

2.1 Devices included in this loop collectively function to provide:

- One input to Residual Heat Removal (RHR) Pump trip 2 out of 3 coincidence.
- Control Room and ERFDS indication of RWST 1-1 water level.
- Control Room alarm of RWST 1-1 High, Low, and Low-Low water level.

2.2 Technical Specifications (Ref 3.13.1) does not specify any channel accuracy requirements; however, FSAR Table 7.5-2 specifies an indicated (channel) accuracy and a PAM calc exists which supports this accuracy. Failure to meet the channel accuracy essentially means that credit cannot be taken for the "Channel Calibration."

2.3 AR# A0301931 written to inform applicable departments of past calibrations not including density effects of 2300 to 2500 ppm of Boron on DP transmitter scaling.

3.0 REFERENCES

3.1 102033, Instrument Schematic

3.2 102009, Piping Schematic

3.3 109809, Functional Loop Diagram

3.4 Previous Calibration: RLOC 5254-3762

3.5 Previous Scaling Calculation: RLOC 1422-4004

3.6 "Flow Measurement Engineering Handbook," 2nd Edition, R.W. Miller

3.7 "CRC Handbook of Chemistry & Physics," 1988-1989

3.8 "Engineering Formulas," McGraw-Hill 5th Edition, Kurt Gieck

3.9 DCP M-42222, "Boric Acid Concentration reduced from 12% to 4% by weight"

3.10 Design Criteria Memorandum (DCM)

3.10.1 DCM T-24, "DCPP Plant Instrumentation and Controls"

3.10.2 DCM S-9, "Safety Injection System"

3.11 DCPP Emergency Plan, Section 7 "Emergency Facilities and Equipment"

3.12 FSAR:

3.12.1 Table 7.5-2, "Control Room Indicators/Recorders Available to the Operator (Condition IV Events)"

3.12.2 Table 7.5-6, "Summary of Compliance with Reg Guide 1.97"

3.12.3 Figure 3.2-09, "Piping Schematic Safety Injection"

3.13 Technical Specifications (TS):

3.13.1 TS 3/4.5.5, "Refueling Water Storage Tank"

3.13.2 TS 3/4.3.3.6, "Accident Monitoring Instrumentation"

3.14 663229-47, "Precautions, Limitations, and Setpoints" (PLS)

3.15 060836, Unit 1 Instrument Setpoint Requirements

3.16 Calc J-54, Nominal Setpoint Calculation

3.17 Commitment Management Database (CMD) #T30731, TS 4.3.3.6

3.18 MA2.ID2, Performance Monitoring Equipment Calibration and Usage Control

3.19 Surveillance Test Procedures

3.19.1 STP R-20, "Boric Acid Inventory"

3.19.2 STP V-15, "ECCS Flow Balance Test"

3.19.3 STP V-7B, "Test of RHR Pump Trip from RWST Level Channels"

3.20 697503-38, Barton Model 764 DP Transmitter Maintenance Manual

3.21 663100-245, Westinghouse Indicator Maintenance Manual

3.22 663230-81, Hagan Maintenance Manual

3.23 6001169-9, Hatch Signal Isolator

3.24 698796-113, "Operating Manual NUREG 0696" (ERFDS)

3.25 438038, "Requirements for Water Storage Tanks"

3.26 438039, "Requirements for Water Storage Tanks"

3.27 464831, "Vortex Suppression Cages"

3.28 663071-129, RWST Elevation and Orientation Details"

3.29 663071-132, "RWST Nozzle Details"

3.30 "Simplified Specifications For Commonly Used M&TE," SC-MTE-A1

3.31 DCP J-47928, RHR Pump Trip & Main Annunciator Alarm Isolation"

3.32 PAM-0-9-920, Post Accident RWST Level Indication Uncertainty

3.33 AR A0301936, PME range and accuracy

3.34 J-110, Various RPS and ESFAS Setpoint Allowable Values and ITDP Uncertainty Sensitivity Evaluations

4.0 REQUIREMENTS

4.1 TS 3/4.3.3.6 (Ref 3.13.2) requires RWST Water Level indication channel to be calibrated at least once per refueling interval.

4.1.1 As the FSAR specifies an indicated accuracy and PAM-0-9-920 has been written to support the FSAR value, the data for LT-920 and LI-920 will be considered TS values.

4.2 FSAR:

4.2.1 Table 7.5-2 (Ref 3.12.1) requires Control Room RWST Water Level indication range of 0 to 100%, ±4.5% of level span.

4.2.2 Table 7.5-6 (Ref 3.12.2) requires Control Room, TSC, and EOF RWST Water Level indication of 0 to 100% useable volume.

4.3 LI-920 is listed as Performance Monitoring Equipment (Ref 3.18). Previous revision specified PME requirements for STP R-20 and STP V-15, RWST Water Level indication (LI-920) of 0 to 100% ±2.1%. This is provided for information only as PME range and accuracy are no longer available in MA2.ID2.

4.4 PLS (Ref 3.14), J-54 (Ref 3.16), J-110 (Ref 3.34) and DCP J-47928 (Ref 3.31) specify the following setpoints as referenced to Nozzle N1 centerline:

4.4.1 LC-920A (Low Level RHR Pump Trip Logic) Setpoint:

- 149,200 gallons ±1% decreasing
- Control Basis Category B
- Actual Plant (Nominal) Setpoint: 2.300 VDC (J-54)
- Acceptable As Found values: 2.258 to 2.342 VDC (J-54)
- Min/Max Allowable Values: 31.43% to 33.68% (J-110)

4.4.2 LC-920B (Low-Low Level Alarm) Setpoint:

- 18,700 gallons ±1% decreasing
- Control Basis Category B
- Actual Plant (Nominal) Setpoint: 1.165 VDC
- Acceptable As Found values: 1.123 to 1.207 VDC

4.4.3 LC-920C (High Level Alarm) Setpoint:

- 441,050 gallons ±1% increasing
- Control Basis Category D

4.4.4 LC-920D (Low Level Alarm) Setpoint:

- 149,200 gallons ±1% decreasing
- Control Basis Category D

4.5 J-54 (Ref 3.16) specifies the following:

4.5.1 LT-920 Acceptable As Found value: ±0.046 VDC

4.6 PAM-0-9-920 (Ref 3.32) specifies the following:

4.6.1 LT-920 Acceptable As Found value: ±0.046 VDC

4.6.2 LI-920 Acceptable As Found Value: ±2.8% (round to ±3%)

5.0 GIVEN

5.1 Unless otherwise stated, all % specifications are % of calibrated output span (% FS).

5.2 Instrument Schematic (Ref 3.1) specifies part of this loop is Class IA which is required to initiate and maintain safe shutdown of the reactor, mitigate the consequences of an accident, or prevent exceeding 10CFR100 off-site dose limits (Ref 3.10.1).

5.3 Instrument Schematic (Ref 3.1) specifies part of this loop is Class IB which provides Post Accident Monitoring functions IAW the requirements of Regulatory Guide 1.97 (Ref 3.10.1).

5.4 Temperature Effects are the uncertainty due to changes in the ambient temperature that occur during normal plant operation above or below the temperature at which the device was last calibrated. In the case of the sensors, the uncertainty due to Temperature Effects may exceed the calibration accuracy of the device.

5.5 Conversion Factors and Equations (Ref 3.8):

- 1 ft^3 = 7.4805 liquid gallons
- 1 liquid gallon = 231 in^3

- Volume of a Cylinder (V) = $\pi r^2 h$
  where: π = 3.1416
  r = Radius of the Cylinder
  h = Height of the Cylinder

5.6 STP V-7B (Ref 3.19.3) tests the RHR Pump/RWST Low-Level logic using the test switches located at PIA, PIB, and PIC.

5.7 TS 3/4.5.5 (Ref 3.13.1) requires:

5.7.1 Boron concentration of between 2300 and 2500 ppm.

5.7.2 Minimum solution temperature of 35 °F.

5.8 Specific Gravity of RWST solution is based on (Attachment 10.2):

5.8.1 Boron Concentration of 2400 ppm (average of 2300 ppm and 2500 ppm).

5.8.2 Solution temperature of 59 °F (difference between 35 °F and 77 °F is negligible).

5.9 DCP J-47928 (Ref 3.31) provides isolation between the RHR Pump Trip on RWST low level and Main Annunciator alarm on low level. These two functions used to performed by one comparator (LC-920A). This isolation is accomplished by replacing a single alarm unit (LC-920C) with a dual alarm unit (LC-920C/D). LC-920A will now only provide an input into the RHR Pump Trip Logic on RWST low level while LC-920D will provide the input to the Main Annunciator for RWST low level. The setpoint for LC-920A and LC-920D are the same values.

6.0 CALCULATIONS

6.1 Calibration Methodology

Calibration will be performed in two parts.

6.1.1 Transmitter calibration is performed by applying pressure to the transmitter and measuring its output voltage.

6.1.2 Electronics calibration is performed by simulating transmitter output and measuring loop voltages and recording indications.

6.2 RWST Elevations and Dimensions (Ref 3.25, Ref 3.26, and Ref 3.29)

6.2.1 Top of Concrete (TOC) Elevation: 115.50'

6.2.2 Level Instrument Nozzle (N8) and Pump Suction Nozzle (N1)
- Centerline: 3.0' above TOC
  115.50' + 3.0' = 118.50'
- N8 Nominal Size: 1"
- N1 Nominal Size: 18"

6.2.3 Tank Overflow Nozzle (N7)
- Centerline: 51.25' above TOC
  115.50' + 51.25' = 166.75'
- Nominal Size: 8.0"
- Bottom of N7
  166.75' - 0.333' = 166.42'
- Top of N7
  166.75' + 0.333' = 167.08'

6.2.4 Tank Overflow Line (Line 1896)
- 8.0" Schedule 40 Pipe
- 7.981 ID
- Inverted upward
- Elevation of Overflow Line Bottom is above the top of N7.

6.2.5 Maximum Level Elevation (MLE)

As Overflow Line is inverted upward, MLE is at the Bottom of the Overflow Line at the top of the invert. To determine Height (H) above the bottom of N7, the following geometric proofs and calculations are required (See Figure 1):

a. Δabc and Δdef are congruent right triangles based on:

Sides d & e form a Right Angle	Perpendicular Lines form a 90° Angle
Side d = 3.9905"	Given (0.5 of Pipe ID)
Angle D = 67.5°	Given (Ref 3.29)
Side e = 1.65"	(Side d)/(TANGENT Angle D)
Side c = Side f	Common to both triangles
Sides a & b form a Right Angle	Perpendicular Lines form a 90° Angle
Side a = 3.9905"	Given (0.5 of Pipe ID)
Δabc ≅ Δdef	2 Sides and 1 Angle are equal

Therefore: Side b = side e or 1.65"
Angle A = Angle D or 67.5°

b. Angle opposite of Side H = 180 - (67.5° + 67.5°) = 45°

c. Side opposite right angle = 12.375" + Side b = 14.025"

d. Side H = (COSINE 45°)(14.025) = 9.92" or 0.83'

e. Maximum Level Elevation = 166.42' + 0.83' = 167.25'

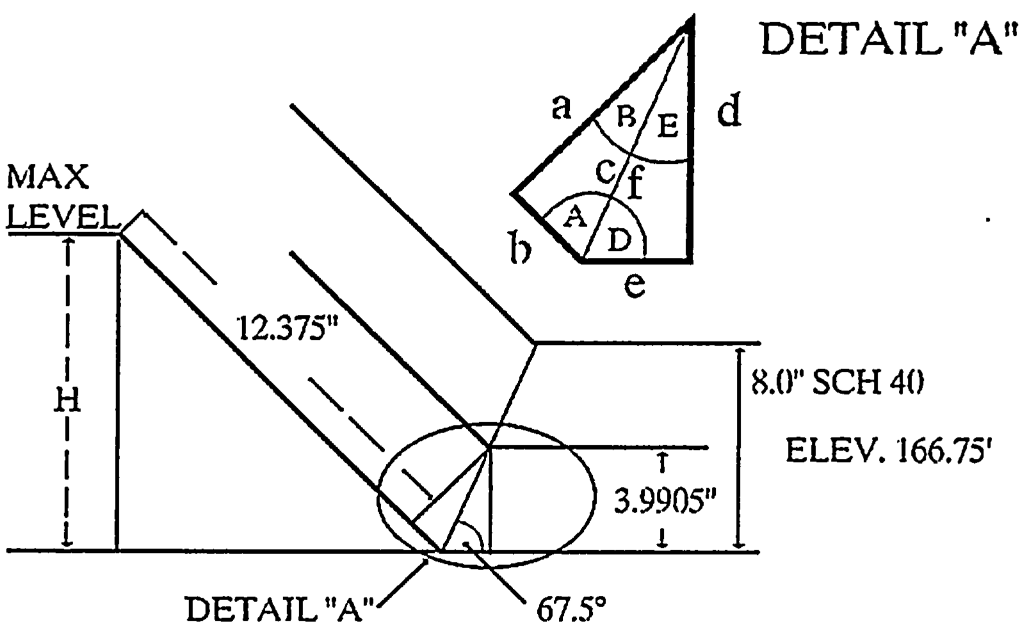

Figure 1

6.2.6 Specific Gravity (SG) Considerations

a. Density of water @ 59 °F (Ref 3.6): 62.37164 lb_m/ft^3
   - SG: 1

b. RWST Solution SG @ 59 °F (Attachment 10.2):
   1.0060 relative to water @ 59 °F

c. Test Gauge calibrated referenced to 68 °F INWC
   - Density of 68 °F water (Ref 3.6): 62.31572 lb_m/ft^3
   - SG relative to water @ 59 °F: 0.9991

d. The ratio of the specific gravities of RWST Solution @ 59 °F and water @ 68 °F will be used to determine Xmtr calibration scaling:

   SG = (1.0060)/(0.9991) = 1.0069

6.2.7 Transmitter Calibrated Range and Span

a. Xmtr Centerline Elevation (Ref 3.5): 103.5625'

b. Elevation Difference between N8 and Xmtr:
   - N8 Elev - Xmtr Elev
     118.50' - 103.5625' = 14.9375' or 179.25"

c. Elevation Difference between Maximum Level and Xmtr:
   - Maximum Level Elev - Xmtr Elev
     167.25' - 103.5625' = 63.6875' or 764.25"

d. Elevation Difference between Maximum Level and N8:
   - Maximum Level Elev - N8 Level
     764.25" - 179.25" = 585" or 48.75'

e. Pressure Difference between N8 and Xmtr
   0% Level Pressure = (0% Level Height)(SG)
   = (179.25")(1.0069)
   0% Level Pressure = 180.5 INWC @ 68 °F

f. Pressure Difference between Maximum Level and Xmtr
   100% Level Pressure = (100% Level Height)(SG)
   = (764.25")(1.0069)
   100% Level Pressure = 769.5 INWC @ 68 °F

g. Pressure Difference between Maximum Level and N8:
   - 100% Level Pressure - 0% Level Pressure
     769.5 - 180.5 = 589.0 INWC @ 68 °F

6.2.8 Measurable Volume

As the measurable volume is located within the cylindrical section of the tank:

$V = \pi r^2 h = (3.1416)(20\ ft^2)(48.75\ ft)[7.4805\ gal/ft^3]$
$V = 458{,}264$ Gallons

a. Gallons/Inch $= \pi r^2 (1\ gal/231\ in^3)$

$[(3.1416)(240\ in^2)](1\ gal/\ 231\ in^2) = 783.36$
458,264 Gallons/585 in = 783.36 gal/in

b. Gallons/Foot $= \pi r^2 (7.4805\ gal/1\ ft^3)$

$[(3.1416)(20\ ft^2)](7.4805\ gal/1\ ft^3) = 9400.3$
458,264 Gallons/48.75 ft = 9400.3 gal/ft

6.3 Transmitter (LT-920)

6.3.1 The following uncertainties will not be compensated for in determining PME Indication accuracy.

a. Stability: Calibration will be optimized.

b. Temperature Effect (Given 5.4): Area ambient temperature range is unknown and using bounding minimum and maximum temperature values would provide an unrealistically large uncertainty to PME Indication accuracy calculations (See Section 8).

c. Power Supply Effect: Insignificant

6.3.2 Manufacturer (Ref 3.20) specifies:

a. Maximum Span (MS): 40 PSI

b. Device Accuracy: ±0.5% of calibrated span including combined effects of conformance (non-linearity), deadband, hysteresis, and repeatability).

c. Static Pressure Effect (SPE): None, as RWST is not pressurized.

d. Load Effect (LE): None

Based on the calibration methodology, all loop voltages are monitored across plant installed resistors. As the only loading effect is due to the DMMs, which is negligible, Load Effect will not be included in the Transmitter accuracy.

6.3.3 Calibrated Accuracy (CA)

Transmitter will be calibrated to the manufacturer's specified device accuracy of ±0.5% which is consistent with standard practice and previous calibration.

(0.5%)(589 INWC) = ±2.95 INWC

6.3.4 Transmitter Accuracy (TA)

Transmitter Accuracy is the total of error sources affecting transmitter output at the time it is calibrated. As M&TE does not meet 4:1, the uncertainty of the test gauge (TG) will be included in the Transmitter Accuracy (See Section 7.1.5.a). As this loop is used for non ASME Section XI testing:

$TA = [(CA)^2 + (TG)^2]^{0.5}$
$TA = [(2.95)^2\ (0.85)^2]^{0.5}$
TA = ±3.1 INWC or ±0.53% of span

6.3.5 Scaling

a. DP = [(Vo - 1 VDC)/4 VDC](589 INWC) + 180.5 INWC

b. Vo = [(DP - 180.5 INWC)/589 INWC](4 VDC) + 1 VDC

6.3.6 Transmitter Calibration Summary

INPUT INWC	OUTPUT VDC
180.5	1.000 ± 0.020
327.8	2.000 ± 0.020
475.0	3.000 ± 0.020
622.3	4.000 ± 0.020
769.5	5.000 ± 0.020

6.4 Power Supply (LQ-920)

6.4.1 Manufacturer (Ref 3.22) specifies:

a. Device Output and Accuracy: 46.0 VDC ±5% or ±2.3 VDC

b. ≤0.100 VAC_{pp} or 0.035 VAC_{rms} at 20 mADC, which will be relaxed to the standard practice value of ≤0.070 VAC_{rms}.

c. This is consistent with previous calibrations.

6.5 Signal Isolator (LM-920)

6.5.1 Manufacturer (Ref 3.23) specifies:

a. Provides input current/output current isolation (I/I).

b. Input: 4 to 20 mADC

c. Output: 4 to 20 mADC

d. Device Accuracy: ±0.1% of span (includes linearity, hysteresis, and repeatability)

6.5.2 Calibrated Accuracy

Relaxed to standard practice of ±0.5% of span or ±20 mVDC.

6.5.3 Scaling: VDC Out = VDC In

6.6 Comparators (LC-920A/B and LC-920C/D)

6.6.1 Manufacturer (Ref 3.22) specifies:

a. Can be configured to compare either one or two input signals to an internal setpoint voltage or compare the two input signals to each other.

b. Signal Input: Two 1-5 VDC inputs

c. Alarm Output: 0 or 120 VAC

d. Deadband: 0.020 to 1.000 VDC above/below alarm setpoint

e. Terminal Panel Connections:
- Input #1: Terminals 1(+) & 2(-)
- Input #2: Terminals 3(+) & 4(-)
- Output #1: Terminals 13 & 14
- Output #2: Terminals 11 & 12

f. For a single signal input to be compared with the internal setpoint voltage:
- For signal input on #1: jumper out Input #2
- For signal input on #2: jumper out Input #1

g. Make necessary internal jumper connections IAW Table 1 for desired alarm requirements.

6.6.2 Configuration

a. FLD (Ref 3.3) specifies for LC-920A/B (Dual Comparator):

Single signal input on #2: Input #1 jumpered out (0 VDC)

1. Output #1 (LC-920A)

a) Trip Condition:
- Light On (Energized)
- Decreasing input signal difference
  (Input #2 - Input #1) < Setpoint #1

b) Non-Trip Condition:
- Light Off (De-energized)
- Increasing input signal difference
- (Input #2 - Input #1) > Setpoint #1

2. Output #2 (LC-920B)

a) Trip Condition:
- Light Off (De-energized)
- Decreasing input signal difference
  (Input #2 - Input #1) < Setpoint #2

b) Non-Trip Condition:
- Light On (Energized)
- Increasing input signal difference
- (Input #2 - Input #1) > Setpoint #2

b. FLD (Ref 3.31) and DCP J-47928 (Ref 3.31) specify for LC-920C/D (Dual Comparator):

Single signal input on #1: Input #2 jumpered out (0 VDC)

1. Output #1 (LC-920C)

a) Trip Condition:
- Light Off (De-energized)
- Increasing input signal difference
  (Input #1 - Input #2) > Setpoint #1

b) Non-Trip Condition:
- Light On (Energized)
- Decreasing input signal difference
- (Input #1 - Input #2) < Setpoint #1

2. Output #2 (LC-920D)

   a) Trip Condition:
      - Light On (Energized)
      - Decreasing input signal difference (Input #1 - Input #2) < Setpoint #2

   b) Non-Trip Condition:
      - Light Off (De-energized)
      - Increasing input signal difference
      - (Input #1 - Input #2) > Setpoint #2

6.6.3 Setpoint and Reset (Req 4.4)

a. Accuracy tightened from PLS specified ±1% of span to standard practice of ±0.5% of span or ±0.020 VDC. This is consistent with previous calibration.

b. IAW standard practice, Reset will be 1% from Setpoint.

c. LC-920A (Low-Level RHR Pump Trip Logic) and LC-920D (Low Level Alarm):

   1. Process Setpoint: 149,200 gallons decreasing

   2. VDC Setpoint:

      (149,200 gallons)/(458,264 gallons) = 32.56%

      (32.56%)(4 VDC) + 1 VDC = 2.300 ±0.020 VDC

   3. Reset: 2.340 ±0.020 VDC increasing

d. Allowable Values

   (31.43%)(4 VDC) + 1 VDC = 2.257 VDC

   (33.68%)(4 VDC) + 1 VDC = 2.347 VDC

e. LC-920B (Low-Low Level Alarm)

   1. Process Setpoint: 18,700 gallons decreasing

   2. VDC Setpoint:

      (18,700 gallons)/(458,264 gallons) = 4.081%

      (4.081%)(4 VDC) + 1 VDC = 1.165 VDC ±0.020 VDC

   3. Reset: 1.205 ±0.020 VDC increasing

f. LC-920C (High Level Alarm)

1. Process Setpoint: 441,050 gallons increasing

2. VDC Setpoint:

(441,050 gallons)/(458,264 gallons) = 96.24%

(96.24%)(4 VDC) + 1 VDC = 4.850 VDC ±0.020 VDC

3. Reset: 4.810 ±0.020 VDC decreasing

6.7 Analog Indicator (LI-920)

6.7.1 Manufacturer (Ref 3.21) specifies analog indicator device accuracy of ±1.5% of indicated span.

6.7.2 Range: 0 to 100% for an input of 4 to 20 mADC

6.7.3 Minor Divisions: 2%

6.7.4 Device Accuracy: ±1.5%

6.7.5 Calibrated Accuracy

As the indicator is calibrated with the I/I, its calibrated accuracy is its device accuracy plus the I/I calibrated accuracy.

0.5% + 1.5% = ±2.0%

6.7.6 Scaling

For a specific VDC input (Vi):

Indication = [(Vi - 1 VDC)/4 VDC](100%)

6.8 ERFDS (Mux 03, Slot 08)

6.8.1 Operating Manual NUREG 0696, Tab B (Ref 3.24) specifies:

a. Output Card Voltage Range: -9.0 to +9.0 VDC

b. String Accuracy: ±0.25% of span, relaxed to standard ERFDS accuracy of ±0.5% of span or ±0.090 VDC.

6.8.2 Calibrated Accuracy

a. Calibrated to standard ERFDS accuracy of ±0.5% as there is no accuracy requirements specified for ERFDS.

b. As ERFDS is calibrated with the I/I, its calibrated accuracy is its device accuracy plus the I/I calibrated accuracy.

0.5% + 0.5% = ±1.0% or ±180 mVDC

6.8.3 Scaling

For a specific ERFDS VDC input (Vi):

ERFDS Vo = [(Vi - 1 VDC)/4 VDC](18 VDC) + (-9 VDC)

6.9 Analog Calibration Summary

LM INPUT VDC	LM OUTPUT VDC	LI INDICATION %	ERFDS INPUT CARD OUTPUT VDC
1.000	1.000 ±0.020	0 ±2	-9.000 ±0.180
2.000	2.000 ±0.020	25 ±2	-4.500 ±0.180
3.000	3.000 ±0.020	50 ±2	0.000 ±0.180
4.000	4.000 ±0.020	75 ±2	4.500 ±0.180
5.000	5.000 ±0.020	100 ±2	9.000 ±0.180

7.0 M&TE SELECTION

7.1 Transmitter (LT-920)

Based on the calibration methodology the measurement system consists of a test gauge and a DMM. Output VDC measured across plant installed resistor at LC-920A/B input.

7.1.1 Available M&TE and Accuracy (Ref 3.30)
- Digital Heise 0-850 INWC Acc'y: ±0.1% FS or ±0.85 INWC
- Fluke 45 & 8842A Acc'y (@ 5 VDC): ±2 mVDC

7.1.2 mVDC/INWC Conversion Factor for Digital Heise:

$$\left[\frac{\text{Cal Span in mVDC}}{\text{Cal Span in INWC}}\right] = \left[\frac{4000\text{ mVDC}}{589\text{ INWC}}\right] = 6.79\text{ mVDC/INWC}$$

7.1.3 Total M&TE Accuracy can be calculated using the "Square Root of the Sum of the Squares" (SRSS) Methodology:

$$\pm[(\text{Heise Gauge})^2 + (\text{DMM})^2]^{0.5}$$

$$\pm\left[[(0.85\text{ INWC})(6.79\text{ mVDC/INWC})]^2 + (2\text{ mVDC})^2\right]^{0.5}$$

$$= \pm 6.1\text{ mVDC}$$

7.1.4 LT Acc'y (Calc 6.3.3): ±20 mVDC

7.1.5 LT Acc'y/M&TE Acc'y = 20 mVDC/6.1 mVDC = 3.3:1

a. M&TE:Device Accuracy Ratio cannot meet 4:1 due to the calibration methodology, therefore the accuracy of the Test Gauge (±0.85 INWC) will be included in the Transmitter Accuracy (See Calculation 6.3.4).

7.2 Power Supply (LQ-920)

Based on the calibration methodology the measurement system consists of a DMM.

7.2.1 Available M&TE and Acc'y (Ref 3.30)
- Fluke 45 & 8842A (@ 46 VDC): ±17.5 VDC

7.2.2 LQ Acc'y (Calc 6.4.1.a): ±2.3 VDC

7.2.3 LQ Acc'y/M&TE Acc'y: 2.3 VDC/0.0175 VDC = 131:1

a. M&TE 4:1 Accuracy Ratio to instrument is met.

7.2.4 As the standard practice of checking power supply output VAC ripple is to verify the measured value is ≤0.070 VAC_{rms} and not to a specified value and accuracy, M&TE:Device Analysis for VAC_{rms} ripple will not be provided.

7.3 Signal Isolator (LM-920)

Based on the calibration methodology the measurement system consists of two DMMs. Input VDC measured across plant installed resistor at LC-920A/B input and output VDC measured across plant installed resistor at ERFDS input.

7.3.1 Available M&TE and Accuracy (Ref 3.30)
- Fluke 45 & 8842A Acc'y (@ 5 VDC): ±2 mVDC

7.3.2 Total M&TE Accuracy calculated using the "SRSS" Methodology:

$$\pm[(\text{Input DMM})^2 + (\text{Output DMM})^2]^{0.5}$$

$$\pm[(2\ \text{mVDC})^2 + (2\ \text{mVDC})^2]^{0.5} = \pm 2.8\ \text{mVDC}$$

7.3.3 LM Acc'y (Calc 6.5.2): ±20 mVDC

7.3.4 LM Acc'y/M&TE Acc'y = 20 mVDC/2.8 mVDC = 7:1

a. M&TE 4:1 Accuracy Ratio to instrument is met.

7.4 Comparators (LC-920A/B and LC-920C/D)

Based on the calibration methodology the measurement system consists of a DMM. Input VDC monitored across plant installed resistor at LC-920A/B input.

7.4.1 Available M&TE and Accuracy (Ref 3.30)
- Fluke 45 & 8842A Acc'y (@ 5 VDC): ±2 mVDC

7.4.2 LC Acc'y (Calc 6.6.3.a): ±20 mVDC

7.4.3 LC Acc'y/M&TE Acc'y = 20 mVDC/2 mVDC = 10:1

a. M&TE 4:1 Accuracy Ratio to instrument is met.

7.5 Analog Indicator (LI-920)

Based on the calibration methodology the measurement system consists of a DMM. Input VDC measured across plant installed resistor at LC-920A/B input.

7.5.1 Available M&TE and Accuracy (Ref 3.30)
- Fluke 45 & 8842A Acc'y (@ 5 VDC): ±2 mVDC

7.5.2 LI Acc'y (Calc 6.7.5): ±2% or ±80 mVDC

7.5.3 LI Acc'y/M&TE Acc'y = 80 mVDC/2 mVDC = 40:1

a. M&TE 4:1 Accuracy Ratio to instrument is met.

7.6 ERFDS (Mux 03, Slot 08)

Based on the calibration methodology the measurement system consists of two DMMs. Input VDC measured across plant installed resistor at LC-920A/B input and output VDC measured at ERFDS input card's output.

7.6.1 Available M&TE and Accuracy (Ref 3.30)
- Fluke 45 & 8842A Acc'y (@ 5 VDC): ±2 mVDC
- Fluke 45 & 8842A Acc'y (@ 9 VDC): ±3 mVDC

7.6.2 Total M&TE Accuracy calculated using the "SRSS" Methodology:

$$\pm[(\text{Input DMM})^2 + (\text{Output DMM})^2]^{0.5}$$
$$\pm[(2\ \text{mVDC})^2 + (3\ \text{mVDC})^2]^{0.5} = \pm 3.6\ \text{mVDC}$$

7.6.3 ERFDS Acc'y (Calc 6.8.2): ±180 mVDC

7.6.4 ERFDS Acc'y/M&TE Acc'y = 180 mVDC/3.6 mVDC = 50:1

a. M&TE 4:1 Accuracy Ratio to instrument is met.

8.0 CHANNEL ACCURACY

8.1 For PME indication, the end user is responsible for determining uncertainties to be included and the methodology used to combine them IAW MA2.ID2 (Ref 3.18).

9.0 CONCLUSION

9.1 Channel Check Philosophy

STP I-48 (previous STP for RWST level channels) specified a CHANNEL CHECK of 4% between redundant channels.
As the transmitter is calibrated to 0.5% and the indicator is calibrated to 2.0%, using SRSS methodology results in an accuracy of ±2.1%. Therefore, differences between channels would not be expected to differ by (2.1% + 2.1%) 4.2%. As calibration optimization is specified for both the transmitter and indicator calibrations, this will be tightened to ±4% which is consistent with previous calibrations.
Therefore to return this channel to service a CHANNEL CHECK between redundant channels should be within 4% of each other.

9.2 Technical Specifications

LT-920 and LI-920 will be considered as TS. As Found data exceeding TS OOT will be reported. As Left data shall be within desired.

9.3 Regulatory Guide 1.97

The calibration methodology and specified M&TE supports values used in PAM-0-9-920. As Found data exceeding that specified in Step 4.6 will be reported. LT-920 and LI-920 As Left data shall be within desired.

9.4 PME Indication

Standard practice is to set PME OOT = Desired Accuracy as end user is responsible for determining PME indication uncertainties. As Found data exceeding Desired Accuracy will be reported. LT-920 and LI-920 As Left data shall be within desired.

9.5 FSAR Table 7.5-2

Based on calibration methodology of calibration transmitter and indication separately and using specified M&TE, FSAR Table 7.5-2 channel accuracy of ±4.5% is met.

9.6 The effect of the vortex cage (located in the first 3.2% of measured level) on measured tank volume will not be addressed in this scaling calculation as the bases for Tech Spec 3/4.5.5 specifies "The contained water volume limit includes an allowance for water not useable because of tank discharge line location or other physical characteristics."

9.7 PLS, J-54, and J-110 Specified Field Settings

The calibration methodology and specified M&TE supports values used in J-54 for Cat. B setpoints (LC-920A and LC-920B). As Found data exceeding that specified in Step 4.4 will be reported. LT-920, LC-920A and LC-920B As Left data shall be within desired.

For LC-920A, J-110 provides Allowable Values and J-54 provides AAF. Per DCM T24, the terms Allowable Value and AAF are analogous for a Cat. B setpoint. The difference between these calcs is documented in AR A0456549. The values in J-54 are conservative to those in J-110, therefore the values in J-54 will be used for reportability.

9.8 Administrative Requirements

LC-920C and LC-920D are Cat. D setpoints and As Left data shall be within desired.

10.0 ATTACHMENTS

10.1 "Tank Elevations and Indicated Volume," 04/11/94

10.2 "RWST Solution Specific Gravity," 04/05/93

DIABLO CANYON POWER PLANT

SC-I-9-L920
ATTACHMENT 10.1

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TITLE: TANK ELEVATIONS AND INDICATED VOLUME

	DESCRIPTION	ELEV.	HEIGHT	MEASURED GALLONS	% IND.
RWST	TOP OF TANK	168.00'	52.50'		
	MAX LEVEL	167.25'	51.75'	458,264	100.0%
	N7 TOP	167.08'	51.58'	456,666	99.7%
	N7 CL	166.75'	51.25'	453,564	99.0%
	N7 BOTTOM	166.42'	50.92'	450,462	98.3%
	HI LEVEL (C)	165.42'	49.92'	441,050	96.2%
	LO LEVEL (A & D)	134.37'	18.87'	149,200	32.6%
	LO-LO LEVEL (B)	120.49'	4.99'	18,700	4.1%
	VC GRATING TOP	120.08'	4.58'	14,852	3.2%
	VORTEX CAGE TOP	120.00'	4.50'	14,100	3.1%
	N1 TOP	119.25'	3.75'	7,050	1.5%
	N1 & N8 CL	118.50'	3.00'	0	0 %
	N1 BOT	117.75'	2.25'		
	TANK BOTTOM	115.52'	0.02'		
	TOP OF CONCRETE	115.50'	0		
	LT-920 CENTERLINE	103.56'			

DIABLO CANYON POWER PLANT

SC-I-9-L920
ATTACHMENT 10.2

1

TITLE: RWST SOLUTION SPECIFIC GRAVITY

Boron (B) Atomic Weight	10.811	Ref 3.7, Page B-10
Hydrogen (H) Atomic Weight	1.00794	Ref 3.7, Page B-20
Oxygen (O) Atomic Weight	15.9994	Ref 3.7, Page B-27
Boric Acid (H_3BO_3) Formula Weight = 3(1.00794) + 10.811 + 3(15.9994)	61.833	Ref 3.7, Page B-77
RWST Temperature	59 °F	Ref 5.8.2
SG of water @ 59 °F / 59 °F	1	
SG of H_3BO_3 / 59 °F	1.435	Ref 3.7, Page B-77
Boric Acid (H_3BO_3) Concentration	4% by Weight	Ref 3.9
Water Concentration	96% by Weight	100% - 4%

4% Boric Acid Specific Gravity at 59 °F (Relative to water @ 59 °F):

$$= \frac{(40{,}000\ ppm)\ (1.435) + (960{,}000\ ppm)\ (1)}{(1{,}000{,}000\ ppm)\ (1)} = 1.0174$$

ppm of Element
= (% Concentration) (Element Atomic Wt. / Formula Wt.) (10,000 ppm / 1%)

ppm of Element of 4% Boric Acid
B = (4%) (10.811 / 61.833) (10,000 ppm / 1%) = 6,994 ppm
H = (4%) [(3) 1.00794 / 61.833] (10,000 ppm / 1%) = 1,956 ppm
O = (4%) [(3) 15.9994 / 61.833] (10,000 ppm / 1%) = 31,050 ppm
Total PPM = 40,000 ppm or 4%

For 2,400 ppm of Boron
% Boric Acid = (2,400 ppm) (1% / 10,000 ppm) (61.833 / 10.811) = 1.37%

SG of 2,400 ppm Boron Solution @ 59 °F Relative to water @ 59 °F:

$$= \frac{(13{,}700\ ppm)\ (1.435) + (986{,}300\ ppm)\ (1)}{(1{,}000{,}000\ ppm)\ (1)} = 1.0060$$

SG of 2,400 ppm Boron Solution @ 35 °F Relative to water @ 59 °F:

$$= \frac{(13{,}700\ ppm)\ (1.435) + (986{,}300\ ppm)\ (1.0008)}{(1{,}000{,}000\ ppm)\ (1)} = 1.0068$$

SG of 2,400 ppm Boron Solution @ 77 °F Relative to water @ 59 °F:

$$= \frac{(13{,}700\ ppm)\ (1.435) + (986{,}300\ ppm)\ (0.9979)}{(1{,}000{,}000\ ppm)\ (1)} = 1.0039$$

As RWST solution specific gravity change is negligible from 35 °F to 77 °F and that tank temperature is generally between these temperatures, the specific gravity of RWST solution at 59 °F will be used.

NOTE: Per 4/29/92 Telecon with Joe Kormuth of Westinghouse (412)374-5697, although W has done little research on the subject, his belief is that "the change in density of H_3BO_3 due to change in temperature, over the temperature range of 50 to 200°F, is insignificant."

PACIFIC GAS AND ELECTRIC COMPANY

DIABLO CANYON UNITS NO. 1 AND 2

PRECAUTIONS, LIMITATIONS AND SET POINTS FOR NUCLEAR STEAM SUPPLY SYSTEMS

REVISION 9

MAY 1981

WESTINGHOUSE ELECTRIC CORPORATION
Nuclear Energy Systems
P. O. Box 355
Pittsburgh, Pennsylvania 15230

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35 M/M NEG

6. SAFETY INJECTION SYSTEM

A. PRECAUTIONS AND LIMITATIONS

The following recommendations are intended for use during normal operation. The Emergency Instructions include the precautions and limitations to be observed during accident conditions.

1. The Technical Specification sets the minimum Safety Injection System requirements that must be met during reactor operation.
2. The requirements for periodic tests of the system are set by the Technical Specification.
3. Prior to operating the pumps verify that the miniflow lines are open.
4. Following any test or procedure in which gas can enter a safety injection line, the line must be completely filled and vented.
5. Prior to plant startup the recirculation sump and screen should be verified to be clean and free of debris.
6. During plant startup:
   a. Unlock the safety injection pumps after the pressurizer steam bubble is formed and the residual heat removal loop is isolated.
   b. Unlock and open the accumulator isolation valves when the reactor coolant pressure exceeds 1000 psig. Prior to opening the isolation valves the check valves should be leak tested.
   c. Verify that the safety injection actuation block is automatically removed at the set point.
7. During plant cooldown and depressurization:
   a. Block the automatic safety injection circuit when the reactor coolant pressure is reduced below the automatic unblocking set point. The operator must be prepared to manually actuate the system is required. NOTE: Do not block the safety injection circuit unless the reactor coolant has been borated by at least 300 ppm.
   b. Close the accumulator isolation valves and lock out the valve controllers when the reactor coolant pressure is less than 1000 psig and the temperature is below 425°F.

c. When the reactor coolant pressure is less than 1000 psig lock out the safety injection pumps.

8. The temperature of the accumulators must be kept above 70°F, the minimum temperature for pressurization whenever the accumulators are pressurized.

B. INSTRUMENT SET POINTS

TABLE 6.1

SAFETY INJECTION SYSTEM PRESSURES

INSTRUMENT NUMBER	DESCRIPTION	PGE INST. TAG NO.	SET POINT FUNCTION	SET POINT (psig)	SETTING TOLERANCE (psig)
1-PIA-960	Accumulator #1	[PC-960A] [PC-960B]	HI alarm * LO alarm *	647.5 595.5	±3.5 ±3.5
1-PIA-961	Accumulator #1	[PC-961A] [PC-961B]	HI alarm * LO alarm *	647.5 595.5	±3.5 ±3.5
1-PIA-962	Accumulator #2	[PC-962A] [PC-962B]	HI alarm * LO alarm *	647.5 595.5	±3.5 ±3.5
1-PIA-963	Accumulator #2	[PC-963A] [PC-963B]	HI alarm * LO alarm *	647.5 595.5	±3.5 ±3.5
1-PIA-964	Accumulator #3	[PC-964A] [PC-964B]	HI alarm * LO alarm *	647.5 595.5	±3.5 ±3.5
1-PIA-965	Accumulator #3	[PC-965A] [PC-965B]	HI alarm * LO alarm *	647.5 595.5	±3.5 ±3.5
1-PIA-966	Accumulator #4	[PC-966A] [PC-966B]	HI alarm * LO alarm *	647.5 595.5	±3.5 ±3.5
1-PIA-967	Accumulator #4	[PC-967A] [PC-967B]	HI alarm * LO alarm *	647.5 595.5	±3.5 ±3.5
~~**PIA-947~~	~~Boron injection tank~~		~~HI alarm~~	~~2460~~	~~±30~~
1-PCV-199	Accumulators nitrogen pressure regulator		Maintains pressure downstream	621.5	±26.0

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* The pressure alarms are set at the Tech. Spec. limits.
~~** This applies to Unit 2 only. The Unit 1 Boron Injection Tank Hi Alarm was deleted due to BIT elimination.~~

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DC 663229-7-52 PG. 89

TABLE 6.2

SAFETY INJECTION SYSTEM - FLOWS

INSTRUMENT NUMBER	DESCRIPTION	SET POINT FUNCTION	SET POINT (gpm)	SETTING TOLERANCE (gpm)
~~* FIA-940~~	~~BIT tank recirculation flow~~	~~LO alarm~~	~~90% of normal flow~~	~~±0.5~~

~~* THIS APPLIES TO UNIT 2 ONLY. THE UNIT 1 BORON INJECTION TANK RECIRCULATION FLOW LO ALARM WAS DELETED DUE TO BIT ELIMINATION.~~

TABLE 6.3
(Continued)

INSTRUMENT NUMBER	DESCRIPTION	PGE INST. TAG NO.	SET POINT FUNCTION	SET POINT (psig)	SETTING TOLERANCE (psig)
1-LIA-920	Refueling water storage tank	[LC-920C]	HI alarm	441,050 gal.**	±1%
		[LC-920D]	LO alarm	149,200 gal.**	±1%
		[LC-920B]	LO-LO alarm	18,700 gal.**	±1%
		[LC-920A]	pump stop & alarm	149,200 gal.**	±1%
1-LIA-921	Refueling water storage tank	[LC-921A]	HI alarm	441,050 gal.**	±1%
		[LC-921B]	LO alarm	149,200 gal.**	±1%
		[LS-921]	pump stop & alarm	149,200 gal.**	±1%
1-LIA-922	Refueling water storage tank	[LS-922]	pump stop & alarm	149,200 gal.**	±1%
1-LIA-950	Accumulators	[LC-950A/B]	(A) HI alarm*	57.08 inches	±0.15 in.
1-LIA-951		[LC-951A/B]	(B) LO alarm*	53.54 inches	±0.15 in.
1-LIA-952		[LC-952A/B]			
1-LIA-953		[LC-953A/B]			
1-LIA-954		[LC-954A/B]			
1-LIA-955		[LC-955A/B]			
1-LIA-956		[LC-956A/B]			
1-LIA-957		[LC-957A/B]			
1-LIA-931	Spray Additive Tank	[LC-931]	LO alarm	60	±1%
1-LIA-932		[LC-932]			

* All level readings are given in inches above centerline of lower level tap (0 inches). ~~and are based on the requirement that the midpoint (50% level) of the level instrument is 55.31 inches above the centerline of the lower level tap.~~ The water level at the bottom of the range (0%) is 35.31 inches and at the top of the range (100%) is 65.31 inches above the lower level tap. The water volumes at the high and low alarms are 864 ft^3 and 836 ft^3 respectively.

** Volume above centerline of nozzle N1, as requested by PGE in letter 2098.

NRC Question 2:

Provide a copy of the surveillance test procedures (STPs) that are performed for the refueling water storage tank (RWST) level channels.

PG&E Response:

The STPs performed for the RWST level channels are attached.

1. STP I-9-L920, "Refueling Water Storage Tank 1-1 Level Channel LT-920 Calibration."

2. STP V-7B, "Test of Engineered Safeguards, Valve Interlocks and RHR Pump Trip From RWST Level Channels."