Calculation Cover Sheet (Cont.)

Calc. No.: ______ Unit: ______

Rev. No: 1 Verification Method: Design Review: ✓
Alternate Calculation: ____ Qualification Testing: ____

Pages Revised and/or Added: Revised pages 1 and 16. Added pages 18a and 18b.

Purpose of Revision: Added Attachment TWO which provides a set of loop error values that may be used to verify CBP bounding values for NaOH Tank level (min & max).

Initiating Documents	Resulting Document(s)	Reference Docs.
ANIN-910410-151		

Amends Calc(s): ______

Supercedes Calc(s): 91-E-0019-01 Rev. 0

Computer Software(Ver.): Symphony ver 2.2 (91E1901.WR1), Freelance 3.0 (91E1901.DRW)

By: Steve Capehart / SEC / 4-17-91 Rvw'd: ______ / ______ / ______

Chk'd: Lee R. Schwartz / LRS / 4-17-91 Apv'd: D. Wayne Cottingham / DWC / 4-18-91

(Print Name) (Initials) (Date)

Rev. No: 2 Verification Method: Design Review: ✓
Alternate Calculation: ____ Qualification Testing: ____

Pages Revised and/or Added: Revised page 1. Added pages 18c and 18d.

Purpose of Revision: Added Attachment Three which substantiates the Tank level values stated in Tech Spec submittal 1CAN099203.

Initiating Documents	Resulting Document(s)	Reference Docs.

Amends Calc(s): ______

Supercedes Calc(s): 91-E-0019-01 Rev. 1

Computer Software(Ver.): Symphony 2.2 (91E1901.WR1)

By: Steve Capehart / SEC / 9-15-92 Rvw'd: ______ / ______ / ______

Chk'd: Kurtis J. Neumeier / KJN / 9-16-92 Apv'd: D. Wayne Cottingham / DWC / 9-16-92

(Print Name) (Initials) (Date)

Check If Additional Revisions ____

CALCULATION COVER SHEET

Calc No. : 91-E-0019-01

Unit : 1 Category: Non-Q

Calc Title: Loop Error Analysis for NaOH Tank T10 Level.

System(s): CA

Topic(s): XNUN

Calc Type: IC

Component No(s): LT-1616, C47-4-8-1, LI-1616, LS-1616

Plt Area: bldg ______ Elev ______
Room ______ Wall ______
Coordinates ______

Abstract (Include Purpose/Results): To calculate the accuracy of the ANO-1 Sodium Hydroxide (NaOH) Tank T10 level measuring instrument loop. The results are given in the conclusions section of this calculation.

==

Rev No.: 0 Verification Method: Design Review: X
Alternate Calculation: ___ Qualification Testing: ___

Pages Revised and/or Added: Pages 1-18

Purpose of Revision: To provide a response to CR-1-90-0136 AI#5.

Initiating Document(s)	Resulting Document(s)	Reference Calcs
CR-1-90-0136		

Amends Calc(s): ______

Supercedes Calc(s): ______

Computer Software (Version): Symphony (2.2), Freelance (3.0) Files 91E1901.WR1 and 91E1901.DRW

By: Steve L Capehart SLC 3-22-91
(print name) (init) (date)

Rvw'd: ______
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Chk'd: GARY SULLINS GS 3-25-91
(print name) (init) (date)

Apv'd: D. Wayne Cottingham / DWC 3-26-91
(print name) (init) (date)

Check if Additional Revisions: ___

TABLE OF CONTENTS

PURPOSE

The intent of this calculation is to determine the accuracy of the ANO-1 Sodium Hydroxide (NaOH) tank level instrument loops.

SCOPE

This calculation is applicable to the following instrument loop:

UNIT	INSTRUMENT LOOP	SERVICE
1	LT-1616	NaOH Tank T10 Level

Instrument loop errors are calculated for the Reference condition and Abnormal condition.

The loop output error is calculated for the following outputs:

UNIT	INSTRUMENT/DEVICE
1	LI-1616
1	LS-1616

INTRODUCTION

The statistical method of the Square Root of the Sum of the Squares (SRSS) is used to determine the random error on a component level and for the loop. Non-random errors are combined algebraically with the random error term to establish total error.

This calculation is done in accordance with the guidelines set forth in the Instrument Loop Error analysis and Setpoint Methodology Manual (Reference 13).

All percentages are expressed in terms of span unless otherwise noted.

All terms are considered random error terms unless noted by a lower case "b" suffix to indicate a bias error term. A lower case "t" is added to denote a combination of bias and random errors.

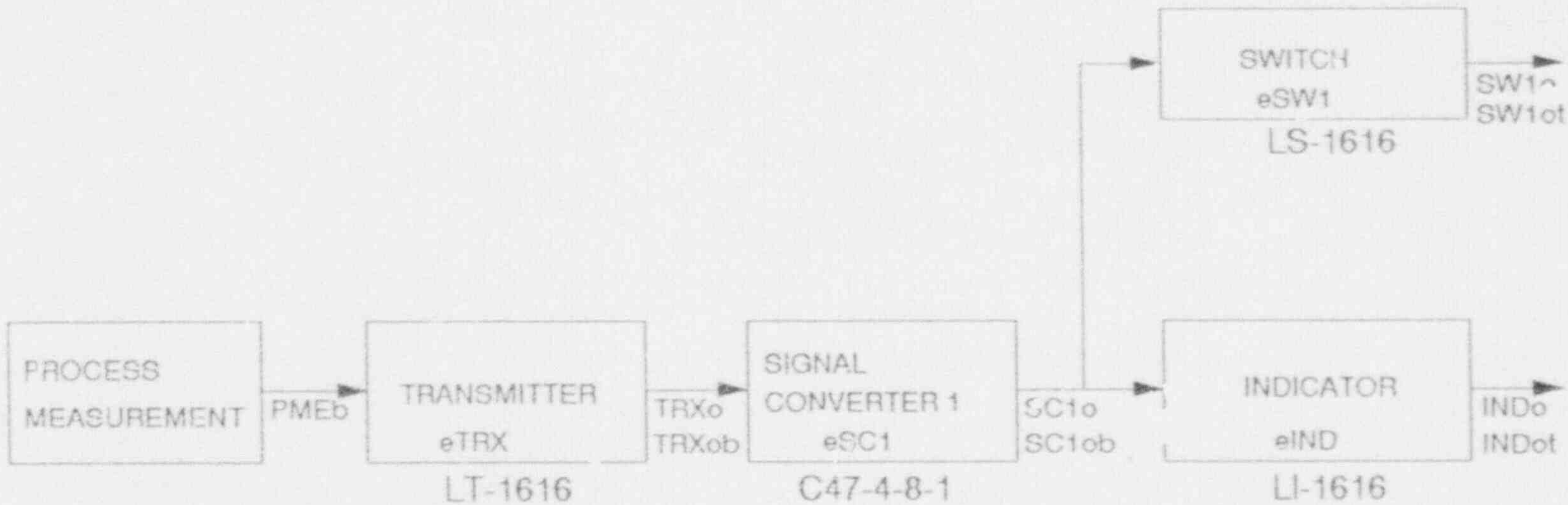

FIGURE 1
NAOH TANK T10 LEVEL

ASSUMPTIONS AND GIVEN CONDITIONS

1. Since no specific data is available, line voltage variance is assumed to be +/- 10%.

2. Due to the unavailability of drift values from the vendors, the drift value for each device is assumed to be no greater than the Reference Accuracy for that device.

3. The calibration error for the buffer and signal monitor is based on using two digital voltmeters, each having a reference accuracy of one-half that of the respective instrument.

4. The calibration error for the indicator is based on using an input calibration device having a reference accuracy of one-half that of that device and using the indicator as the output.

5. The calibration error for the transmitter is based on using a Dead Weight Tester and a digital voltmeter each having a reference accuracy of one-half that of the respective instrument.

6. The transmitter is located outside the Auxiliary and Reactor buildings. The transmitter will be exposed to the radiation field caused by the BWST contents. However, the normal BWST radiation field is minor and is considered to have a negligible effect on the transmitter.

7. The Bailey Voltage Buffer module (C47-4-8-1) and Signal Monitor module (LS-1616) internal circuitry voltages are regulated by zener diodes. The zener diodes provide a voltage reference that is extremely accurate. Therefore, any module supply voltage variation that occurs will not appreciably affect the overall accuracy of the module. The inaccuracy caused by supply voltage variance will be considered negligible based on engineering judgement.

8. The calibration temperature for the transmitter is assumed to be 60 degrees F. This is a conservative temperature to envelope the expected ambient temperature at the time of calibration.

9. The Temperature Effect specifications for the Bailey Voltage Buffer module (C47-4-8-1) and Signal Monitor (LS-1616) is +/- 0.25% of span over an ambient temperature range of 40 - 140 deg F. Since the ambient internal cabinet temperature, 105 deg F, falls within the specified temperature range, a Temperature Effect value of +/- 0.25% of span will be used.

10. According to Ref.19, the output voltage of the power supply will vary 12% with a 10% supply voltage variance. Therefore, the power supply variance for the transmitter will be +/- 12%.

11. The resolution is based on the formula RES=0.5*smallest scale demarcation. Per field inspection the scale for LI-1616 is 0-35 ft in 1 ft increments. Therefore, the RES=0.5 ft. The RES expressed in % span is as follows: 0.5/35*100% = 1.428%.

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PROCESS MEASUREMENT

The process measurement error will be based on the density changes caused by tank contents temperature and concentration. The tank temperature is controlled by temperature switch TS-1618. The temperature switch setpoints are set to maintain the temperature between 73 and 80 degrees F. A review of Operations Log 1015.003A-9 (Ref. 17) indicates the nominal tank temperature is 75 deg F during the Fall, Winter and Spring seasons. During the Summer season, the tank temperature will increase to above the upper setpoint temperature due to higher ambient temperatures. A review of Ref. 17 indicates the tank temperature will rise to approximately 90 deg F. NOTE:The tank temperature will fluctuate very little (i.e. 1 degree) during a 24 hour period. This delta T is considered insignificant for the purposes of this calculation.

The temperature of the tank contents is assumed to be uniform due to convectional mixing (Ref. 16). The temperature of the fluid in the measuring leg is considered to be the same as the tank contents. This consideration is substantiated by the following facts :

1. The transmitter is flange mounted onto an extension from the tank. This configuration is relatively short in length.
2. The measuring leg piping and associated isolation valve are heat traced up to the transmitter.
3. The measuring leg piping and associated isolation valve are insulated up to the transmitter.

NOTE: There is no reference leg on this instrument installation.

The transmitter is calibrated using a Specific Gravity (S.G.) of 1.201 (Ref.5). PER-1-84-12 (Ref. 14) provided the S.G. values to used in the calibration of the NaOH level loop per OP-1304.019 (Ref.5). The S.G. values were based on 68 deg F. The corresponding NaOH concentration is 18.16 % wt.The calibration conditions are substantiated by a review of Chemistry log 1042.001CC (Ref.18). The average value for the NaOH concentration for the time period from 10/6/88 to 7/12/90 is 18.17 %.

The process measurement error will be calculated at the following temperatures:

1. Normal Winter (75 degF)
2. Normal Summer (90 degF)
3. SAR Low Temp (40 degF)
4. SAR High Temp (120 degF)

The process measurement error will be calculated at the following NaOH concentrations for each of the aforementioned temperatures:

1. Tech Spec Low Conc. (15.00% wt)
2. Tech Spec High Conc. (20.80% wt)
3. Normal Average Conc. (18.16% wt)
4. Intermediate Conc. (17.00% wt)
5. Intermediate Conc. (20.00% wt)

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PROCESS MEASUREMENT

The process measurement error (PMEb) for the various conditions is given as follows:

PMEb = (HL(SG@Tank Temp - SG@68 F)/HLmax*SG@68 F)*100% (Ref. 13)

The maximum error will occur when HL equals Hmax (Ref.13). Therefore, the equation simplifies to :

PMEb = ((SG@Tank Temp - SG@68 F)/SG@68 F)*100%

The value that will be used for the SG@68F will be determined from the concentration conditions established for calibration purposes. This concentration is 18.16% wt. The SG value is 1.19886 @ 68 deg F. The derivation of this value will be explained in Attachment One.

The PMEb for Temperature vs NaOH Concentration is presented below:

	PMEb % Tank Temperature			
NaOH % wt	40 degF	75 degF	90 degF	120 degF
15.00	-2.28	-3.07	-3.43	-4.19
17.00	-0.42	-1.24	-1.61	-2.39
18.16	0.66	-0.18	-0.56	-1.34
20.00	2.37	1.51	1.12	0.31
20.80	3.11	2.24	1.84	1.03

NOTE:The numerical values for the PMEb term will not be included in the analysis portion of this calculation. The conclusions portion of the calculation will include the PMEb values as part of the total value. The derivation of the specific gravity values used in calculating the PMEb is shown in Attachment One.

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ANALYSIS
NaOH TANK LEVEL

LEVEL TRANSMITTER

COMPONENT ID

TAG NUMBER	:	LT-1616	[Ref. 1]
MANUFACTURER	:	FOXBORO	[Ref. 2]
MODEL NUMBER	:	E17DM-HSH31A	[Ref. 3]
CAPSULE CODE	:	H	[Ref. 4]
RANGE	:	0-35 FT	[Ref. 5]
SPAN	:	35 FT	

PROCESS/ENVIRONMENTAL CONDITIONS

AMB CAL TEMP	:		60 F		(A&GC 9)
AMB ABN TEMP LOW	:		32 F	DT_1=28	[Ref. 12]
AMB ABN TEMP HIGH	:		90 F	DT2=30	[Ref. 12]
PWR SPLY VOLTAGE	:		84 VDC		[Ref. 2]
PS VOLT VAR (DV)	:	+/-	12 %		(A&GC 10)

ERROR SUMMARY

REF ACCURACY (RA)	:	+/-	0.50 %	[Ref. 4]
DRIFT (DR)	:	+/-	0.50 %	(A&GC 2)
CALIBRATION (CAL)	:	+/-	((RA/2)^2+(RA/2)^2)^0.5	(A&GC 5)
	:	+/-	0.35 %	
ABN TEMP EFFECT	:	+/-	((ZERO EFF)^2 + (SPAN EFF)^2)^0.5	(Ref. 13)
ZERO EFF	:	+/-	2.0 % SPAN/100 F * DT2	(Ref. 21)
ZERO EFF	:	+/-	0.60 %	
SPAN EFF	:	+/-	2.0 % SPAN/100 F * DT2	(Ref. 21)
SPAN EFF	:	+/-	0.60 %	
ABN TEMP E. (TE)	:	+/-	0.85 %	
RADIATION EFFECT	:		Negligible	(A&GC 6)
PWR SPLY EFFECT	:	+/-	.1 % per 10 % volt change * DV	[Ref. 4]
PWR SPLY e (PS)	:	+/-	0.12 %	

The transmitter error (eTRX) is given as follows:

REF eTRX	= +/-	(RA+CAL)
REF eTRX	= +/-	0.85
ABN eTRX	= +/-	((RA+CAL)^2 + PS^2 + TE^2 + DR^2)^0.5
ABN eTRX	= +/-	1.31

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The output RANDOM error terms for the transmitter (TRXo) are:

REF TRXo = +/- eTRX
REF TRXo = +/- 0.85

ABN TRXo = +/- eTRX
ABN TRXo = +/- 1.31

The output BIAS error terms for the transmitter (TRXob) are:

REF TRXob = PMEb

ABN TRXob = PMEb

INSULATION RESISTANCE

Insulation Resistance (IR) error is introduced during accident conditions when temperature, pressure and humidity conditions increase, causing a degradation of electrical insulation in electrical signal components. The IR error is not applicable to this loop error calculation for the following reasons:

1. The instrumentation is in place to ensure Non-Accident compliance with Tech Spec values.
2. The instrumentation is not utilized to take any actions during an accident that requires use of the NaOH (i.e. Containment Spray).

SIGNAL CONVERTER 1

COMPONENT ID

TAG NUMBER :	C47-4-8-1 ckt 3	[Ref. 6]
MANUFACTURER :	BAILEY	[Ref. 2]
MODEL NUMBER :	6624610-1121	[Ref. 5]

ENVIRONMENTAL CONDITIONS

AMB CAB TEMP	:	105 F	[Ref. 9]
PS VOLT VAR (DV)	: +/-	10 %	(A&GC 1)

ERROR SUMMARY

REF ACCURACY (RA)	: +/-	0.10 %	[Ref. 8]
DRIFT (DR)	: +/-	0.10 %	(A&GC 2)
CALIBRATION (CAL)	: +/-	((RA/2)^2+(RA/2)^2)^0.5	(A&GC 3)
	: +/-	0.07 %	
TEMPERATURE EFFECT:	+/-	0.25 % From 40 deg F to 140 deg F	[Ref. 8]
TEMP e (TE)	: +/-	0.25 %	(A&GC 9)
POWER SPLY EFFECT :		Negligible	(A&GC 7)

The signal converter error (eSC1) is given as follows:

REF eSC1 = +/- (RA+CAL)
REF eSC1 = +/- 0.17

ABN eSC1 = +/- ((RA+CAL)^2 + TE^2 + DR^2)^0.5
ABN eSC1 = +/- 0.32

The output RANDOM error terms for the signal converter (SC1o) are:

REF SC1o = +/- (TRXo^2 + eSC1^2)^0.5
REF SC1o = +/- 0.87

ABN SC1o = +/- (TRXo^2 + eSC1^2)^0.5
ABN SC1o = +/- 1.35

The output BIAS error terms for the signal converter (SC1ob) are:

REF SC1ob = REF TRXob

ABN SC1ob = ABN TRXob

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INDICATOR

COMPONENT ID

TAG NUMBER	:	LI-1616	[Ref. 1]
MANUFACTURER	:	BAILEY	[Ref. 2]
MODEL NUMBER	:	RY1000-BJO-1	[Ref. 7]
SPAN	:	35 FT	[Ref. 5]

ENVIRONMENTAL CONDITIONS

AMB TEMP VAR	(DT)	: +/-	9 F	[Ref. 13]
LINE VOLT VAR	(DV)	: +/-	12 VAC	(A&GC 1)

ERROR SUMMARY

REF ACCURACY	(RA)	: +/-	1.00 %	[Ref. 10]
DRIFT	(DR)	: +/-	1.00 %	(A&GC 2)
RESOLUTION	(RES)	: +/-	1.43 %	(A&GC 11)
CALIBRATION	(CAL)	: +/-	((RA/2)^2 + (RES)^2)^0.5	(A&GC 4)
		: +/-	1.51 %	
TEMPERATURE EFFECT		: +/-	0.01 % span per deg F * DT	[Ref. 10]
TEMP e	(TE)	: +/-	0.09 %	
LINE VOLTAGE EFFECT		: +/-	0.02 % span per VAC * DV	[Ref. 10]
LINE VOLT e	(LV)	: +/-	0.24 %	

The indicator error (eIND) is given as follows:

REF eIND = +/- ((RA+CAL)^2 + RES^2)^0.5
REF eIND = +/- 2.89 %

ABN eIND = +/- ((RA+CAL)^2 + RES^2 + TE^2 + LV^2 + DR^2)^0.5
ABN eIND = +/- 3.07 %

The output RANDOM error terms for the indicator (INDo) are:

REF INDo = +/- (SC1o^2 + eIND^2)^0.5
REF INDo = +/- 3.02

ABN INDo = +/- (SC1o^2 + eIND^2)^0.5
ABN INDo = +/- 3.35

The total loop error terms for the indicator (INDot) are:

REF INDot = +/- REF INDo + REF SC1ob

ABN INDot = +/- ABN INDo + ABN SC1ob

NOTE: The numerical values will be presented in the Conclusion portion of the calculation.

Prepared by: SLC Date: 3-22-91 Checked by: [signature] Date: 3-25-91

SWITCH

COMPONENT ID

TAG NUMBER	:	LS-1616	[Ref. 1]
MANUFACTURER	:	BAILEY	[Ref. 2]
MODEL NUMBER	:	6623819A1	[Ref. 5]

ENVIRONMENTAL CONDITIONS

AMB CAB TEMP	:	105 F	[Ref. 9]
PS VOLT VAR (DV)	: +/-	10 %	(A&GC 1)

ERROR SUMMARY

REF ACCURACY (RA)	: +/-	0.25 %	[Ref. 11]
DRIFT (DR)	: +/-	0.25 %	(A&GC 2)
CALIBRATION (CAL)	: +/-	((RA/2)^2 + (RA/2)^2)^0.5	(A&GC 3)
	: +/-	0.18 %	
TEMPERATURE EFFECT:	+/-	0.25 % From 40 deg F to 140 deg F	[Ref. 11]
TEMP e (TE)	: +/-	0.25 %	(A&GC 9)
POWER SPLY EFFECT :		Negligible	(A&GC 7)

The switch error (eSW1) is given as follows:

REF eSW1 = +/- (RA+CAL)
REF eSW1 = +/- 0.43

ABN eSW1 = +/- ((RA+CAL)^2 + TE^2 + DR^2)^0.5
ABN eSW1 = +/- 0.55

The output RANDOM error terms for the signal converter (SW1o) are:

REF SW1o = +/- (SC1o^2 + eSW1^2)^0.5
REF SW1o = +/- 0.97

ABN SW1o = +/- (SC1o^2 + eSW1^2)^0.5
ABN SW1o = +/- 1.46

The total loop error terms for the indicator (SW1ot) are:

REF SW1ot = +/- REF SW1o + REF SC1ob

ABN SW1ot = +/- ABN SW1o + ABN SC1ob

NOTE: The numerical values will be presented in the Conclusion portion of the calculation.

Prepared by: SLC Date: 3-22-91 Checked by: [signature] Date: 3-25-91

CONCLUSIONS

The Reference loop errors at output device LI-1616 (INDot) are:

REFERENCE CONDITIONS

NaOH %wt		40 degF % SPAN	40 degF FEET		71 degF % SPAN	71 degF FEET
15.00	+	3.02	1.06	+	3.02	1.06
	-	5.30	1.86	-	6.09	2.13
17.00	+	3.02	1.06	+	3.02	1.06
	-	3.44	1.20	-	4.26	1.49
18.16	+	3.68	1.29	+	3.02	1.06
	-	3.02	1.06	-	3.20	1.12
20.00	+	5.39	1.89	+	4.53	1.59
	-	3.02	1.06	-	3.02	1.06
20.80	+	6.13	2.15	+	5.26	1.84
	-	3.02	1.06	-	3.02	1.06

NaOH %wt		90 degF % SPAN	90 degF FEET		120 degF % SPAN	120 degF FEET
15.00	+	3.02	1.06	+	3.02	1.06
	-	6.45	2.26	-	7.21	2.52
17.00	+	3.02	1.06	+	3.02	1.06
	-	4.63	1.62	-	5.41	1.89
18.16	+	3.02	1.06	+	3.02	1.06
	-	3.58	1.25	-	4.36	1.53
20.00	+	4.14	1.45	+	3.33	1.17
	-	3.02	1.06	-	3.02	1.06
20.80	+	4.86	1.70	+	4.05	1.42
	-	3.02	1.06	-	3.02	1.06

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The Abnormal loop errors at output device LI-1616 (INDot) are:

ABNORMAL CONDITIONS

NaOH %wt		40 degF % SPAN	40 degF FEET		75 degF % SPAN	75 degF FEET
15.00	+	3.35	1.17	+	3.35	1.17
	-	5.63	1.97	-	6.42	2.25
17.00	+	3.35	1.17	+	3.35	1.17
	-	3.77	1.32	-	4.59	1.61
18.16	+	4.01	1.40	+	3.35	1.17
	-	3.35	1.17	-	3.53	1.24
20.00	+	5.72	2.00	+	4.86	1.70
	-	3.35	1.17	-	3.35	1.17
20.80	+	6.46	2.26	+	5.59	1.96
	-	3.35	1.17	-	3.35	1.17

NaOH %wt		90 degF % SPAN	90 degF FEET		120 degF % SPAN	120 degF FEET
15.00	+	3.35	1.17	+	3.35	1.17
	-	6.78	2.37	-	7.54	2.64
17.00	+	3.35	1.17	+	3.35	1.17
	-	4.96	1.74	-	5.74	2.01
18.16	+	3.35	1.17	+	3.35	1.17
	-	3.91	1.37	-	4.69	1.64
20.00	+	4.47	1.57	+	3.66	1.28
	-	3.35	1.17	-	3.35	1.17
20.80	+	5.19	1.82	+	4.38	1.53
	-	3.35	1.17	-	3.35	1.17

The Reference loop errors at output device LS-1616 (SWlot) are:

REFERENCE CONDITIONS

NaOH %wt		40 degF % SPAN	40 degF FEET		75 degF % SPAN	75 degF FEET
15.00	+	0.97	0.34	+	0.97	0.34
	-	3.25	1.14	-	4.04	1.41
17.00	+	0.97	0.34	+	0.97	0.34
	-	1.39	0.49	-	2.21	0.77
18.16	+	1.63	0.57	+	0.97	0.34
	-	0.97	0.34	-	1.15	0.40
20.00	+	3.34	1.17	+	2.48	0.87
	-	0.97	0.34	-	0.97	0.34
20.80	+	4.08	1.43	+	3.21	1.12
	-	0.97	0.34	-	0.97	0.34

NaOH %wt		90 degF % SPAN	90 degF FEET		120 degF % SPAN	120 degF FEET
15.00	+	0.97	0.34	+	0.97	0.34
	-	4.40	1.54	-	5.16	1.81
17.00	+	0.97	0.34	+	0.97	0.34
	-	2.58	0.90	-	3.36	1.18
18.16	+	0.97	0.34	+	0.97	0.34
	-	1.53	0.54	-	2.31	0.81
20.00	+	2.09	0.73	+	1.28	0.45
	-	0.97	0.34	-	0.97	0.34
20.80	+	2.81	0.98	+	2.00	0.70
	-	0.97	0.34	-	0.97	0.34

The Abnormal loop errors at output device LS-1616 (SWlot) are:

ABNORMAL CONDITIONS

NaOH %wt		40 degF % SPAN	40 degF FEET		75 degF % SPAN	75 degF FEET
15.00	+	1.46	0.51	+	1.46	0.51
	-	3.74	1.31	-	4.53	1.58
17.00	+	1.46	0.51	+	1.46	0.51
	-	1.88	0.66	-	2.70	0.94
18.16	+	2.12	0.74	+	1.46	0.51
	-	1.46	0.51	-	1.64	0.57
20.00	+	3.83	1.34	+	2.97	1.04
	-	1.46	0.51	-	1.46	0.51
20.80	+	4.57	1.60	+	3.70	1.29
	-	1.46	0.51	-	1.46	0.51

NaOH %wt		90 degF % SPAN	90 degF FEET		120 degF % SPAN	120 degF FEET
15.00	+	1.46	0.51	+	1.46	0.51
	-	4.89	1.71	-	5.65	1.98
17.00	+	1.46	0.51	+	1.46	0.51
	-	3.07	1.07	-	3.85	1.35
18.16	+	1.46	0.51	+	1.46	0.51
	-	2.02	0.71	-	2.80	0.98
20.00	+	2.58	0.90	+	1.77	0.62
	-	1.46	0.51	-	1.46	0.51
20.80	+	3.30	1.15	+	2.49	0.87
	-	1.46	0.51	-	1.46	0.51

Prepared by: SLC Date: 3-22-91 Checked by: [illegible] Date: 3-25-91

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2. SIMS Database
3. BQR-89-0005
4. FOXBORO specification sheet for E17 Electronics Liquid Level d/p Cell Transmitters. FOXBORO document number PSS 2A-1D1 A.
5. Periodic Test Procedure OP-1304.019 Rev. 5.
6. B&W Vendor drawing 6600-M1R-185 Rev. 6.
7. Bailey Data Sheet DH-24.
8. Vendor Manual TD B045.0990 Rev. 0, Product Instruction - Buffer Module Part No. 6624610P.
9. Conversation Memorandum ANIN-910226-081.
10. Vendor Manual TD B045.2580 Rev. 1, Product Instruction for Bailey Edgewise Indicator.
11. Vendor Manual TD B045.0870 Rev. 1, Product Instruction Signal Monitor Part No. 6623819-1.
12. Unit 1 SAR Section 2.3.3.1.
13. Design Guide IDG-001-0; Instrument Loop Error Analysis and Setpoint Methodology Manual.
14. Performance Evaluation Request PER No. 1-84-12.
15. DCP-83-1160
16. Calculation 83-D-1160-02
17. Operations Log Form 1015.003A-9
18. Chemistry Log Form 1042.001CC
19. FOXBORO General Specifications for 610AT and 610AC Series Single Power Supply. FOXBORO document number GS 2A-12B2 C.
20. Chemical Engineers' Handbook, Fourth Edition, John Perry-Editor
21. Facsimile from Rose Miller (FOXBORO) to Steve Capehart dated 3/5/91. ANO document # VNEO-910305-081.
22. Conversation Memorandum ANIN-910410-151.

Prepared by: S.C. Date: 4-17-91 Checked by: [signature] Date: 4-17-91

ATTACHMENT ONE

Specific Gravity Derivation

This attachment will explain the derivation of the Specific Gravity values utilized in this calculation. The percent weight (% wt) of NaOH that is used for calculational purposes is 18.16 @ 68 deg F. The origin of this value is discussed in the Process Measurement error section of this calculation. The values for Specific Gravity vs. Temperature were obtained from Reference 20. The Specific Gravity values for 12, 16, 20, and 24% wt NaOH were plotted against temperature in Figure 2 in order to determine any linear relationships. As can be seen from the plot, the Specific Gravity vs Temperature relationship is linear for the concentrations of NaOH. The values for 15, 17, 18.16, 20 and 20.8 % wt NaOH can therefore be determined using interpolation formulas.

The values used for calibration purposes were obtained from CRC Handbook of Chemistry ,52 Edition. The values from this handbook vary slightly from the values used in Reference 20. This explains the difference in value of the SG used for calibration (1.201 @ 68degF) and the SG used for PMEb determination (1.19886 @ 68degF). The use of SG ratios in determining PMEb values eliminates any error caused by difference in values due to different references.

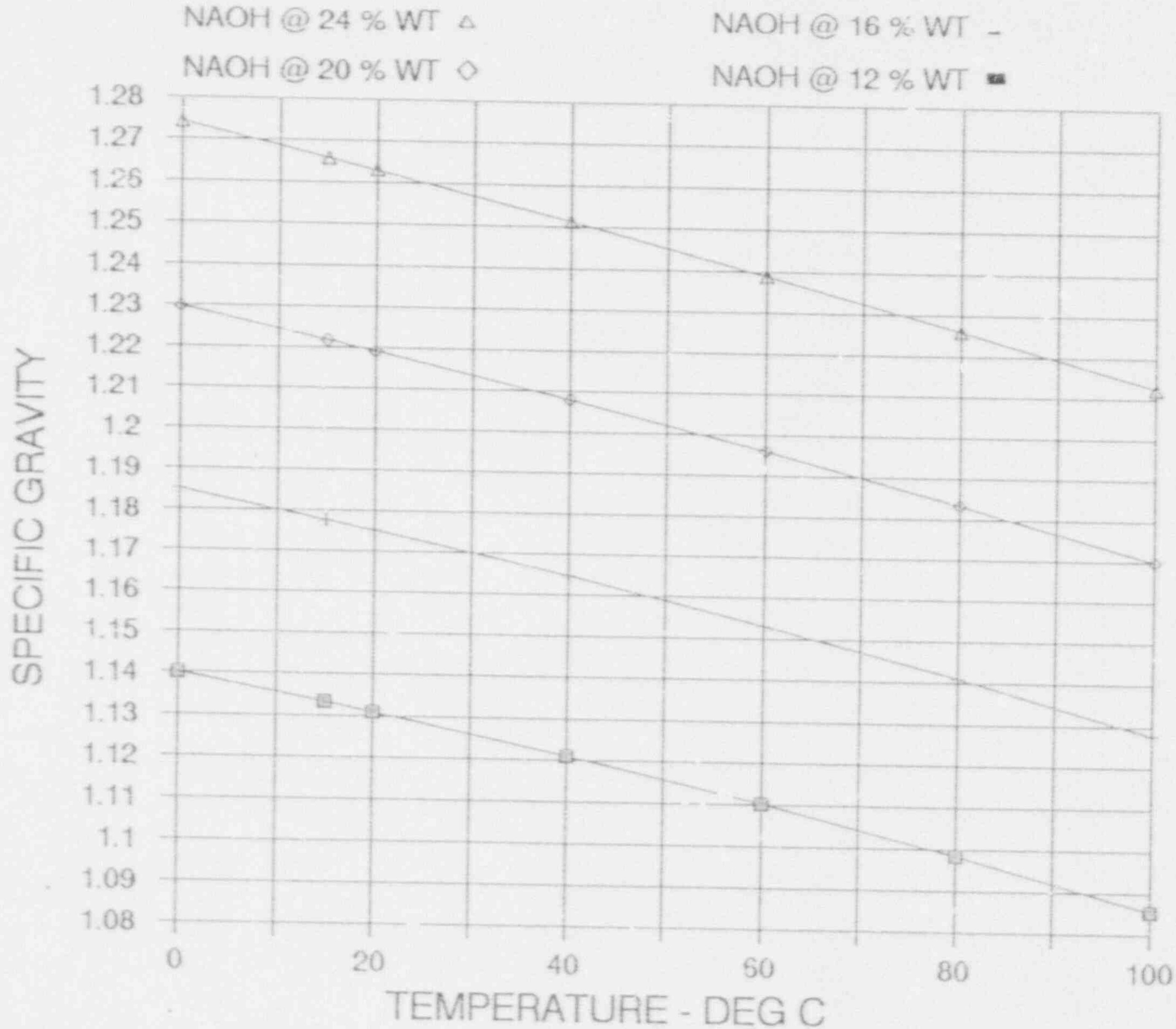
The values from Reference 20 are as follows:

TEMP degC	SG@12%	SG@16%	SG@20%	SG@24%
0	1.1399	1.1849	1.2296	1.2741
15	1.1333	1.1776	1.2218	1.2658
20	1.1309	1.1751	1.2191	1.2629
40	1.1210	1.1645	1.2079	1.2512
60	1.1101	1.1531	1.1960	1.2388
80	1.0983	1.1408	1.1833	1.2259
100	1.0855	1.1277	1.1700	1.2124

The interpolated values are as follows:

TEMP degC	SG@15%	SG@17%	SG@18.16%	SG@20%	SG@20.8%
0	1.1737	1.1961	1.2090	1.2296	1.2385
15	1.1665	1.1887	1.2015	1.2218	1.2306
20	1.1641	1.1861	1.1989	1.2191	1.2279
40	1.1536	1.1754	1.1879	1.2079	1.2166
60	1.1424	1.1638	1.1763	1.1960	1.2046
80	1.1302	1.1514	1.1638	1.1833	1.1918
100	1.1172	1.1383	1.1505	1.1700	1.1785

FIGURE 2


NAOH @ 24 % WT △
NAOH @ 20 % WT ◇
NAOH @ 16 % WT -
NAOH @ 12 % WT ■
SPECIFIC GRAVITY
1.28
1.27
1.26
1.25
1.24
1.23
1.22
1.21
1.2
1.19
1.18
1.17
1.16
1.15
1.14
1.13
1.12
1.11
1.1
1.09
1.08
0
20
40
60
80
100
TEMPERATURE - DEG C

ATTACHMENT TWO

The purpose of this attachment is to provide loop error values that may be used to verify Licensing Basis Documents bounding values for actual Sodium Hydroxide Tank levels. The following tables provide values for worst case scenarios (Ref. 22). The scenarios are :

Case One: Low Tank Temperature, Low NaOH Concentration & Low Level
Case Two: High Tank Temperature, High NaOH Concentration & High Level

The values for the NaOH concentration extremes were obtained from Tech Spec 3.3.4. The values for the Temperature extremes were obtained from SAR section 6.2.2.4.6.

LI-1616

ABNORMAL CONDITION @ 40 degF

NaOH % wt	Level Feet	Bias % Span	Error (INDo + PMEb) % Span	Error (INDo + PMEb) Feet	* Note 1
15	30.84	-2.01	+ 1.34 - 5.36	+ 0.47 - 1.88	* Note 2

ABNORMAL CONDITION @ 120 degF

NaOH % wt	Level Feet	Bias % Span	Error (INDo + PMEb) % Span	Error (INDo + PMEb) Feet	* Note 1
20.8	35.87	+1.06	+ 4.41 - 2.29	+ 1.54 - 0.80	* Note 2

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ABNORMAL CONDITION @ 40 degF

NaOH % wt	Level Feet	Bias % Span	Error (SW1o + PMEb) % Span	Error (SW1o + PMEb) Feet	* Note 1
15	30.84	-2.01	+ 0.00 - 3.47	+ 0.00 - 1.21	* Note 2

ABNORMAL CONDITION @ 120 degF

NaOH % wt	Level Feet	Bias % Span	Error (SW1o + PMEb) % Span	Error (SW1o + PMEb) Feet	* Note 1
20.8	35.87	+1.06	+ 2.52 - 0.40	+ 0.88 - 0.14	* Note 2

*For notes see page 18b

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ATTACHMENT TWO

SUMMARY

The acceptability criteria for the lower Tech Spec Indicated Value is as follows:

Indicated Value - Positive Error ≥ Lower Analysis Limit * Note 3

The calculated value is 33.2 - .47 = 32.73 ≥ 30.84.

Therefore, the Tech Spec value is acceptable.

The acceptability criteria for the higher Tech Spec Indicated Value is as follows:

Indicated Value + |Negative Error| ≤ Upper Analysis Limit * Note 3

The calculated value is 35 + .80 = 35.80 ≤ 35.87.

Therefore, the Tech Spec value is acceptable.

NOTES

Note 1:The method of error combination above deviates from IDG-001 in that the PME bias error is combined algebraically with the resulting random portion of the loop error including the random portion which is of the opposite sign of the bias. This is normally not done because certain bias effects may not always occur simultaneously with random errors or the models for the bias may not be precisely predictable. Using biases of opposite sign to cancel or reduce the random error magnitude could lead to nonconservative results when these conditions are true. However, in this calculation the PME error is both certain and precisely predictable for the conditions analyzed. Therefore, it is acceptable and correct to combine the errors as shown above. The error combination is expressed as "INDo + PMEb" for the indicator and "SW1o + PMEb" for the switch.

Note 2:The Height of Liquid that is included in the formula for determining the PME for the indicator is equal to the Safety Analysis limits of 30.84 feet for 15% wt NaOH and 35.87 feet for 20.80% wt NaOH. These values are used to ensure the Safety Analysis values are bounded by the Tech Spec values plus instrument error (for the indicator). The Safety Analysis limits of 30.84 ft (15% wt) and 35.87 ft (20.8% wt) were obtained from the response to AI#4 of CR-1-90-0136. This response states the level variations are assessed at 34.0 +1.87/-3.16 feet. ANO Engineering Report 89R-1006-02 Rev. 1 is referenced as the source for this data.

Note 3:The "Indicated Values" extremes were obtained from Tech Spec 3.3.4. The Tech Spec states the NaOH tank level shall contain an indicated 34.0 +1.0/-0.8 feet of NaOH solution. This range equates to 33.2 to 35 feet.

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ATTACHMENT THREE

This attachment will discuss the NaOH Tank Level values stated in letter 1CAN099203, Technical Specification Change Request Concerning Sodium Hydroxide Tank Required Level. The proposed Technical Specification (TS) change will revise the NaOH tank level requirements from 34.0 +1,-0.8 feet to 33.2 ±1.8 feet. The Discussion of Change section of the TS letter provides a discussion of the tank level indication instrumentation errors as related to TS maximum/minimum and Safety Analysis maximum/minimum values.

The TS letter states "The potential instrument error for the NaOH tank level indication instrumentation is bounded by values or 0.80 ft and 0.47 ft for the maximum and minimum NaOH tank levels, respectively."

The error values of 0.80 ft and 0.47 ft are derived in Attachment Two of this calculation. The error values were originally calculated to verify the acceptability of the TS indicated limits of 34.0 +1,-0.8 ft. Since the error values were calculated based on the extreme level values used in the Safety Analysis, i.e. 35.87 ft maximum level and 30.84 ft minimum level, the error values may be used to determine acceptability of the proposed TS indicated limits of 33.2 ±1.8 ft. The acceptability equations are presented below:

MINIMUM LEVEL LIMIT

TS Minimum Indicated Level = Nominal TS Indicated Level - Lower TS Boundary Tolerance

TS Minimum Indicated Level = 33.2 - 1.8 = 31.4 ft

In order to determine if the minimum indicated level is acceptable, it is necessary to prove the possible ACTUAL level (i.e. minimum indicated level minus the appropriate positive instrument loop error) is greater than or equal to the minimum Safety Analysis Level Limit. The acceptability equation is as follows:

Indicated Value - Positive Error ≥ Minimum Safety Analysis Limit

31.4 - 0.47 = 30.93 which is ≥ 30.84

Therefore, the TS minimum indicated level is acceptable.

MAXIMUM LEVEL LIMIT

TS Maximum Indicated Level = Nominal TS Indicated Level + Upper TS Boundary Tolerance

TS Maximum Indicated Level = 33.2 + 1.8 = 35.0 ft

In order to determine if the maximum indicated level is acceptable, it is necessary to prove the possible ACTUAL level (i.e. maximum indicated level plus the appropriate negative instrument loop error) is less than or equal to the maximum Safety Analysis Level Limit.

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ATTACHMENT THREE

The acceptability equation is as follows:

Indicated Value + |Negative Error| ≤ Maximum Safety Analysis Limit

35.0 + 0.80 = 35.80 which is ≤ 35.87

Therefore, the TS maximum indicated level is acceptable.

The various NaOH Tank Levels and descriptions are summarized below:

NaOH Tank Level	Description
35.87 ft	Maximum level analyzed in the Safety Analysis
35.80 ft	Maximum actual level at TS maximum indicated level with instrument loop error
35.0 ft	TS maximum indicated level
33.2 ft	TS nominal indicated level
31.4 ft	TS minimum indicated level
30.93 ft	Minimum actual level at TS minimum indicated level with instrument loop error
30.84 ft	Minimum level analyzed in the Safety Analysis

SUMMARY

The possible minimum and maximum actual tank levels calculated by combining TS indicated minimum and maximum levels with the appropriate instrument loop errors are bounded by the Safety Analysis level limits.

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