From:	WILLIAMSON, DANNY H
To:	Wang, Alan
Subject:	FW: -004/-005 calcs
Date:	Tuesday, January 31, 2012 3:28:34 PM
Attachments:	G13.18.6.2-ENS_002_0_002.pdf G13.18.6.2-ENS_004_0_001.pdf G13.18.6.2-ENS_006_0_001.pdf G13.18.6.2-ENS_007_0_001.pdf G13.18.3.1-004 Rev 0.pdf G13.18.3.1-005 Rev 0.pdf

Alan

As we understood the discussion last week, the attached is the entirety of what was requested. Please let me know if you need anything else.

Danny

☐ ANO-1 ☐ ANO-2 ☐ GGNS ☐ IP-2 ☐ IP-3 ☐ PLP
☐ JAF ☐ PNPS ☒ RBS ☐ VY ☐ W3
☐ NP-GGNS-3 ☐ NP-RBS-3

CALCULATION COVER PAGE	(1) **EC # LAR**	(2) **Page 1 of 12**
(3) Design Basis Calc. ☒ YES ☐ NO	(4) ☐ CALCULATION ☒ EC Markup	
(5) **Calculation No: G13.18.3.1-004**		(6) **Revision: 0**
(7) **Title: Degraded Voltage Relay Setpoints for ENS-SWG01A and ENS-SWG01B**		(8) **Editorial** ☐ YES ☒ NO
(9) **System(s): 302**	(10) **Review Org (Department): Electrical Design Engineering**	
(11) **Safety Class:** ☒ **Safety / Quality Related** ☐ **Augmented Quality Program** ☐ **Non-Safety Related**	(12) **Component/Equipment/Structure Type/Number:** ENS-SWG1A-62-2 ENS-SWG1A-27-1A, 1B, 1C	ENS-SWG1B-62-2 ENS-SWG1B-27-1A, 1B, 1C
(13) **Document Type: F43.02**		
(14) **Keywords (Description/Topical Codes): degraded voltage relay, setpoint, GE setpoint methodology**		

REVIEWS

(15) Name/Signature/Date	(16) Name/Signature/Date	(17) Name/Signature/Date
Charles Blackledge/See IAS	Greg Svestka/See IAS	Jason Arms/See IAS
Responsible Engineer	☒ **Design Verifier** ☒ **Reviewer** ☐ Comments Attached	**Supervisor/Approval** ☐ Comments Attached

CALCULATION REFERENCE SHEET	CALCULATION NO: G13.18.3.1-004 REVISION: 0

I. EC Markups Incorporated (N/A to NP calculations)

1. None

II. Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	Tracking No.
1. STP-302-1600	--	20	☑	☑	Y	
2. STP-302-1601	--	20	☑	☑	Y	
3. STP-302-1602	--	23	☑	☑	Y	
4. STP-302-1603	--	24	☑	☑	Y	
5. G13.18.6.2-ENS*002	0	002	☑	☐	N	EC-27437
6. G13.18.6.2-ENS*006	0	001	☑	☐	N	EC-27437
7. G13.18.3.6*016	--	002	☑	☐	N	
8. G13.18.3.1*001	--	003	☑	☑	Y	
9. RBS Technical Specifications Table 3.3.8.1-1	--		☑	☑	Y	
10. RBS Technical Requirements Manual Table 3.3.8.1-1	--		☑	☑	Y	

III. CROSS REFERENCES:

IV. SOFTWARE USED: N/A

Title:______________________ Version/Release:_____________Disk/CD No._________

V. DISK/CDS INCLUDED: N/A

Title:______________________ Version/Release______________Disk/CD No._________

VI. OTHER CHANGES:

Revision	Record of Revision
0	Initial issue.
LAR Submittal	The purpose of this calculation markup is to provide the Degraded Voltage Relay NO-LOCA time delay and Loss of Voltage Relay dropout voltage setpoints, and Technical Specification and TRM limits.

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5.0 Purpose

The purpose of this calculation markup is to provide the Degraded Voltage Relay NO-LOCA time delay and Loss of Voltage Relay dropout voltage setpoints, and Technical Specification and TRM limits.

6.0 Conclusions

The following table shows the new revised Technical Specification limits.

Specification	Existing Values	Revised Values
T.S. 3.3.8.1-1 1a	≥ 2850 V and ≤ 3090 V	≥ 3005 V and ≤ 3302 V
T.S. 3.3.8.1-1 1d	≥ 53.4 s and ≤ 66.6 s	≥ 46.59 s and ≤ 57.07 s
TRM 3.3.8.1-1 1a	≥ 2910 V and ≤ 3030 V	≥ 3105 V
TRM 3.3.8.1-1 1d	≥ 54 s and ≤ 66 s	≤ 52.55 s

7.0 Input and Design Criteria

7.1. Div 1 and 2 Degraded Voltage Relays (Voltage Function)

Relay: ENS-SWG1A-62-2
ENS-SWG1A-27-1A, 1B, 1C
ENS-SWG1B-62-2
ENS-SWG1B-27-1A, 1B, 1C

Input	ENS-SWG1A-62-2 ENS-SWG1B-62-2	ENS-SWG1A-27-1A, 1B, 1C ENS-SWG1B-27-1A, 1B, 1C	Reference Document
Loop Uncertainty (LU)	±3.22 s	0.8675 V	G13.18.6.2-ENS*006 G13.18.6.2-ENS*002
Total Loop Uncertainty (TLU)	±3.795 s	1.019 V	G13.18.6.2-ENS*006 G13.18.6.2-ENS*002
Max. Loop Setting Tol. (CT_L)	±3 s	0.87 V	G13.18.6.2-ENS*006 G13.18.6.2-ENS*002
Current Setpoint	57.8 s	49 V	G13.18.6.2-ENS*006 G13.18.6.2-ENS*002

7.2. Analytical Limits

For ENS-SWG1A-62-2 and ENS-SWG1B-62-2 Analytical Limit = 60 s (Ref: G13.18.3.6*016)
For ENS-SWG1A-27-1A, 1B, 1C and ENS-SWG1B-27-1A, 1B, 1C Analytical Limit = 2950 VAC (Ref: G13.18.3.6*016) Maximum dropout for the Loss of Voltage Relays = 3318.27 VAC

7.3. Bus to Relay Voltage Conversion

The Division 1 & 2 Degraded Voltage bus (4160 kV) to relay input voltage conversion factor is (35 * √3) (References ESK-08ENS01, ESK-08EGS09, ESK-08EGS10, G13.18.6.2-ENS*002 and G13.18.6.2-ENS*006).

7.4. Output Documents (Any Changes to the data, analyses, or conclusions of calculation G13.18.3.1-004 may impact the following RBS documents)

7.4.1. RBS Technical Specification and Technical Requirements Manual

7.4.1.1 TS 3.3.8.1, Loss of Power (LOP) Instrumentation.

7.4.1.2 TR 3.3.8.1, Loss of Power (LOP) Instrumentation.

7.4.2. Procedures

7.4.2.1 STP-302-1600, ENS-SWG1A Loss of Voltage Channel Calibration and Logic System Functional Test.

7.4.2.2 STP-302-1601, ENS-SWG1B Loss of Voltage Channel Calibration and Logic System Functional Test.

7.4.2.3 STP-302-1602, ENS-SWG1A Degraded Voltage Channel Calibration and Logic System Functional Test.

7.4.2.4 STP-302-1603, ENS-SWG1B Degraded Voltage Channel Calibration and Logic System Functional Test.

7.5. Operating Experience

CR-RBS-2011-04838:
CR-RBS-2011-04838 documented non-conservative Technical Specification for Degraded Voltage Relay NO-LOCA time delay and Loss of Voltage Relay dropout setpoints. The condition report documented that the existing limits do not protect the RBS motors against sustained degraded voltage conditions for a long period of time.

Disposition: This engineering change markup has been issued to provide revised Technical Specification and TRM setpoint limits for the Degraded Voltage Relay NO-LOCA time delay and Loss of Voltage Relay dropout setpoints. The new setpoint limits provided within this markup will ensure that the RBS motors are protected against sustained undervoltage and degraded voltage conditions.

8.0 Assumptions

8.1. The Limiting Operating Transient Variation (X_T) is assumed to be equal to the minimum voltage observed during a LOCA transient at the Lower Analytical Limit for the Degraded Voltage Relays (See calculation G13.18.3.6*016). Thus, the setpoint should be such that the Loss of Voltage relays do not dropout during a degraded grid LOCA transient.

The Limiting Operating Transient Variation (X_T) is given by the following equations (Ref: EN-IC-S-007-R):

The minimum voltage during a transient is observed for Division I bus. This voltage is 3318.27 VAC (Section 7.2). Therefore, $X_T = 3318.27 / (35 \times \sqrt{3}) = 54.73$ VAC (Ref: Section 7.3 for bus to relay voltage conversion).

8.2. The LU, TLU and reset differential, derived in calculation G13.18.6.2-ENS*002 and G13.18.6.2-ENS*006 (EC-27437), are calculated using instrument uncertainties that are based on % setting (% setpoint). Because the proposed setpoints are different from the existing, those uncertainties will increase. Therefore, this calculation will adjust the LU, TLU and reset differential values proportionally according to the increase in setpoint.

9.0 Calculation Methodology

The methodology used in this calculation is in accordance with the “Instrument Loop Uncertainty & Setpoint Calculations” (Ref: EN-IC-S-007-R) and “General Electric Instrument Setpoint Methodology” (Ref: 7224.300-000-001B).

The Allowable Values (AV) and Nominal Trip Setpoints (NTSP2) for the setpoints considered in this calculation have both upper and lower limits. The Lower Limit (AV MIN) is calculated for the Degraded Voltage Relay NO-LOCA time delay by subtracting the difference between the AV MAX and the NTSP2 from the NTSP2. Then an additional margin of 3% is applied to give the final value of AV MIN. The Upper Limit (AV MAX) is calculated for the Loss of Voltage Relay Dropout by adding the difference between the NTSP2 and AV MIN to the NTSP2. An additional margin of 3% is applied to give the final value of AV MAX. Spurious trip avoidance analysis will ensure that these relays, if found drifted in the upper/lower limit not calculated, will not trip under unanalyzed conditions.

The upper AV for the Degraded Voltage Relay NO-LOCA time delay (AV MAX) must be below the upper Analytical Limit (AL) minus the absolute value of the positive Loop Uncertainty (LU). The lower AV for the Loss of Voltage Relay Dropout (AV MIN) must be above the lower AL plus the absolute value of the negative LU.

Upper AV $\leq$ Upper AL - $|+LU|$

Lower AV $\geq$ Lower AL + $|-LU|$

The upper NTSP2 must be below the upper AL minus the absolute value of the positive Total Loop Uncertainty (TLU). The lower NTSP2 must be above the lower AL plus the absolute value of the negative TLU.

Upper NTSP2 $\leq$ Upper AL - $|+\text{TLU}|$

Lower NTSP2 $\geq$ Lower AL + $|-\text{TLU}|$

The Loop Uncertainties and Total Loop Uncertainties used as input to this calculation are developed in the Loop Uncertainty Determination calculation (Ref: G13.18.6.2-ENS*002 and G13.18.6.2-ENS*006 EC-27437) using the methodologies provided in EN-IC-S-007-R and 7224.300-000-001B.

The Maximum Loop Setting Tolerance (CT_{LV}) provides the tolerance for the desired setpoint of the relay. This tolerance is irrespective of the setpoint chosen and is, therefore, the same for the dropout and the reset values. The minimum and maximum for the Desired/TRM allowable value is calculated as follows:

Desired Max. = Desired/TRM Trip Value + CT_{LV}

Desired Min. = Desired/TRM Trip Value - CT_{LV}

10.0 <u>Calculation</u>

10.1. Degraded Voltage Relay No-LOCA time delay relay

The setpoint for the relays is calculated iteratively as the LU and TLU are proportional to the setpoint. The final Nominal setpoint (NTSP2) calculated iteratively is 52.55 s.

Following calculations below provide the calculated STP, Allowable Value and Nominal Trip Setpoints (NTSP2). A margin of 4 s is used for LER Avoidance

LU = 3.22 × New Setpoint/Current Setpoint

LU = 3.22 × 52.55/57.8 = 2.93 s

TLU = 3.795 × 52.55/57.8 = 3.450 s

AV MAX $\leq$ Upper AL - $|+\text{LU}|$ = 60 - 2.93 = 57.07 s

AV MIN $\geq$ (NTSP2 – (AV MAX - NTSP2)) × 0.97 = (52.55 – (57.07 – 52.55)) × 0.97 = 46.59 s

NTSP2 (TRM) $\leq$ Upper AL - $|+\text{TLU}|$ - LER Avoidance Margin = 60 - 3.450 - 4 = 52.55 s

STP MIN = NTSP2 - $|CT_L|$ = 52.55 - 3 = 49.55 s

STP MAX = NTSP2 + $|CT_L|$ = 52.55 + 3 = 55.55 s

10.2. Loss of Voltage Relay

The setpoint for the relays is calculated iteratively as the LU and TLU are proportional to the setpoint. The final Nominal setpoint (NTSP2) calculated iteratively is 51.23 VAC.

Following calculations below provide the calculated STP, Allowable Value and Nominal Trip Setpoints (NTSP2). A margin of 1.5 V is used for LER Avoidance.

LU = 0.8675× New Setpoint/Current Setpoint

LU = 0.8675 × 51.23/49 = 0.9067 VAC

TLU = 1.019 × 51.23/49 = 1.07 VAC

AV MIN ≥ Lower AL + │+LU│ = 2950 / (35 × √3) + 0.9067 = 48.66 + 0.9067 = 49.57 VAC (rounded up)

AV MAX ≤ (NTSP2 + (NTSP2 – AV MIN)) × 1.03 = (51.23 + (51.23 – 49.57)) × 1.03 = 54.48 VAC

NTSP2 (TRM) ≥ Lower AL + │+TLU│ + LER Avoidance Margin = 48.66 + 1.07 + 1.5 = 51.23 VAC

STP MIN = NTSP2 - $|CT_L|$ = 51.23 – 0.87 = 50.36 VAC

STP MAX = NTSP2 + $|CT_L|$ = 51.23 + 0.87 = 52.1 VAC

10.3. Margin Checks:

10.3.1. Spurious Trip Avoidance Test

The Spurious Trip Analysis is performed to demonstrate the acceptability of the calculated Nominal Trip Setpoint. The Nominal Trip Setpoint should provide at least 95% probability that a spurious trip will not occur. The value calculated for Z should be = 1.645 to achieve the 95% criteria.

Spurious Trip Equation (Ref: EN-IC-S-007-R):

$$Z_T = \frac{|NTSP2 - X_T|}{\sqrt{(\sigma_M)^2 + (\sigma_I)^2}}$$

Where:

NTSP2 = Calculated Nominal Trip Setpoint, Upper

X_T = Limiting operating transient

σ_M = standard deviation for the operating transient (equal to zero when the limiting operating transient is based on documented operating conditions).

= 0

σ_I = standard deviation of the NTSP2

$$= \left(\frac{1}{n}\right)\sqrt{(A_N)^2 + (C_L)^2 + (D_L)^2 + (P_M)^2 + (P_E)^2}$$

The Total Loop Uncertainty is defined in EN-IC-S-007-R as:

$$TLU = \pm\left(\frac{m}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (P_M)^2 + (P_E)^2}$$

A_L = Total random uncertainty that makes up the loop from device (provided in G13.18.2.3-ENS*002 and G13.18.2.3-ENS*006 EC-27437)

A_N = The loop from device uncertainty for normal conditions (i.e. A_L determined for normal conditions)

$\Rightarrow A_L \geq A_N$

Since, a higher value of σ_I reduces the spurious trip avoidance probability, therefore, it is conservative to assume that $A_N = A_L$ for the equation for standard deviation.

$$\sigma_I = \left(\frac{\pm TLU}{m}\right) = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (P_M)^2 + (P_E)^2}$$

Since, TLU as provided in G13.18.6.2-ENS*002 and G13.18.6.2-ENS*002, contains the same random component, $\left(\frac{m}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (P_M)^2 + (P_E)^2}$, for both positive and negative direction,

σ_I = +TLU / m

m = 1.645 (for Loss of Voltage relay)

= 2 (for Degraded Voltage Relay No-LOCA time delay)

σ_I = 1.07 / 1.645 V

= 0.650 V (for Loss of Voltage Relay)

= 3.45 / 2 s

= 1.725 s (for Degraded Voltage Relay No-LOCA time delay; used in Section 10.3.2.1)

10.3.1.1 Degraded Voltage Relay No-LOCA time delay relay

Spurious trip avoidance test for the time delay is bounded by the spurious trip avoidance for the Loss of Voltage relay dropout setpoint. The purpose the Loss of voltage relays is to ensure that the RBS safety related motors will not experience less than 70% terminal voltage.

The time delay ensures that, if such a condition occurs, the degraded voltage relay trips in less than 60 seconds. This condition is based on the analysis provided in calculation G13.18.3.6*016. There are no other conditions that are dependent upon the Time Delay function of the relay. However, a spurious trip avoidance test for the Loss of Voltage relays is required to ensure that the relays do not dropout during worst case LOCA transient conditions.

10.3.1.2 Loss of Voltage relay

The Spurious Trip Analysis is performed to demonstrate the acceptability of the calculated Nominal Trip Setpoint. The Nominal Trip Setpoint should provide at least 95% probability that a spurious trip will not occur. The value calculated for Z should be = 1.645 to achieve the 95% criteria.

NTSP2 = Calculated Nominal Trip Setpoint
= 51.23 (Per Section 10.2)

X_T = Limiting operating transient

= 54.73 V (Per Assumption 8.1.1)

σ_M = standard deviation for the operating transient (equal to zero when the limiting operating transient is based on documented operating conditions).

= 0

σ_I = $+TLU / m$

m = 1.645

σ_I = 1.07 / 1.645 V

= 0.650 V

Spurious Trip Calculation:

$$Z_T = \frac{|\,51.23 - 54.73\,|}{((0)^2 + (0.650)^2)^{1/2}}$$

$$= 5.38$$

The calculated value for Z_T is greater than the required 1.645. Therefore the calculated Nominal Trip Setpoint is acceptable.

10.3.2. LER Avoidance Analysis:

LER avoidance analysis is performed to determine the acceptability of the margin between the calculated Nominal Trip Setpoint and the calculated Allowable Value. The margin should provide at least a 90% probability the instrument channel's trip setpoint will not exceed the allowable value. The calculated value for Z_{LER} should be $\geq$ 1.28.

LER Avoidance Equation (Ref: EN-IC-S-007-R):

$$Z_{LER} = \frac{|AV - NTSP2|}{\sigma_I}$$

Where:

AV = Allowable Value

NTSP2 = Calculated Nominal Trip Setpoint

σ_I = standard deviation of the NTSP

10.3.2.1 Degraded Voltage Relay No-LOCA time delay relay

$$Z_{LER} = \frac{|57.07 - 52.55|}{1.725}$$

$$= 2.62$$

10.3.2.2 Loss of Voltage relay

$$Z_{LER} = \frac{|49.57 - 51.23|}{0.65}$$

$$= 2.56$$

The LER Avoidance values are equal to or above 1.28. The calculated values for Z_{LER} (upper and lower) are deemed acceptable and demonstrate sufficient probability for LER avoidance.

☐ ANO-1 ☐ ANO-2 ☐ GGNS ☐ IP-2 ☐ IP-3 ☐ PLP
☐ JAF ☐ PNPS ☒ RBS ☐ VY ☐ W3
☐ NP-GGNS-3 ☐ NP-RBS-3

CALCULATION COVER PAGE	(1) **EC # LAR**	(2) **Page 1 of 12**

(3) Design Basis Calc. ☒ YES ☐ NO

(4) ☐ CALCULATION ☒ EC Markup

(5) **Calculation No: G13.18.3.1-005**

(6) **Revision: 0**

(7) **Title: Degraded Voltage Relay Setpoints for E22-S004**

(8) **Editorial** ☐ YES ☒ NO

(9) **System(s): 302**

(10) **Review Org (Department): Electrical Design Engineering**

(11) **Safety Class:**

☒ **Safety / Quality Related**
☐ **Augmented Quality Program**
☐ **Non-Safety Related**

(12) **Component/Equipment/Structure Type/Number:**

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E22-S004-27N1	E22-S004-27N2

(13) **Document Type: F43.02**

(14) **Keywords (Description/Topical Codes): degraded voltage relay, setpoint, GE setpoint methodology**

REVIEWS

(15) Name/Signature/Date	(16) Name/Signature/Date	(17) Name/Signature/Date
Charles Blackledge/See IAS	Greg Svestka/See IAS	Jason Arms/See IAS
Responsible Engineer	☒ **Design Verifier** ☒ **Reviewer** ☐ Comments Attached	**Supervisor/Approval** ☐ Comments Attached

CALCULATION REFERENCE SHEET	CALCULATION NO: G13.18.3.1-005 REVISION: 0

I. EC Markups Incorporated (N/A to NP calculations)

1. None

II. Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	Tracking No.
1. STP-302-1604	--	21	☑	☑	Y	
2. STP-302-1605	--	25	☑	☑	Y	
3. G13.18.6.2-ENS*004	0	001	☑	☐	N	EC-27437
4. G13.18.6.2-ENS*007	0	001	☑	☐	N	EC-27437
5. G13.18.3.6*016	--	002	☑	☐	N	EC-31715
6. G13.18.3.1*002	--	003	☑	☑	Y	
7. RBS Technical Specifications Table 3.3.8.1-1	--		☑	☑	Y	
8. RBS Technical Requirements Manual Table 3.3.8.1-1	--		☑	☑	Y	

III. CROSS REFERENCES:

IV. SOFTWARE USED: N/A

Title:________________________ Version/Release:______________Disk/CD No._________

V. DISK/CDS INCLUDED: N/A

Title:________________________ Version/Release______________Disk/CD No._________

VI. OTHER CHANGES:

Revision	Record of Revision
0	Initial issue.
LAR Submittal	The purpose of this calculation markup is to provide the Degraded Voltage Relay NO-LOCA time delay and Loss of Voltage Relay dropout voltage setpoints, and Technical Specification and TRM limits.

TABLE OF CONTENTS

5.0 Purpose

The purpose of this calculation markup is to provide the Degraded Voltage Relay NO-LOCA time delay and Loss of Voltage Relay dropout voltage setpoints, and Technical Specification and TRM limits.

6.0 Conclusions

The following table shows the new revised Technical Specification limits.

Specification	Existing Values	Revised Values
T.S. 3.3.8.1-1 2a	≥ 2831 V and ≤ 3259 V	≥ 3019 V and ≤ 3325 V
T.S. 3.3.8.1-1 2d	≥ 53.4 s and ≤ 66.6 s	≥ 44.7 s and ≤ 54.83 s
TRM 3.3.8.1-1 2a	≥ 2892 V and ≤ 3198 V	≥ 3158 V
TRM 3.3.8.1-1 2d	≥ 54 s and ≤ 66 s	≤ 50.49 s

7.0 Input and Design Criteria

7.1. Div 3 Degraded Voltage Relays (Voltage Function)

Relay: E22-S004-ACB4-62S5
E22-S004-ACB4-62S6
E22-S004-27N1
E22-S004-27N2

Input	E22-S004-ACB4-62S5 E22-S004-ACB4-62S6	E22-S004-27N1 E22-S004-27N2	Reference Document
Loop Uncertainty (LU)	±5.622 s	3.678 V	G13.18.6.2-ENS*007 G13.18.6.2-ENS*004
Total Loop Uncertainty (TLU)	±5.99 s	5.31 V	G13.18.6.2-ENS*007 G13.18.6.2-ENS*004
Max. Loop Setting Tol. (CT_L)	±3 s	2.61 V	G13.18.6.2-ENS*007 G13.18.6.2-ENS*004
Current Setpoint	54.9 s	87 V	G13.18.6.2-ENS*007 G13.18.6.2-ENS*004

7.2. Analytical Limits

For E22-S004-ACB4-62S5 and E22-S004-ACB4-62S6 Analytical Limit = 60 s (Ref: G13.18.3.6*016)
For E22-S004-27N1 and E22-S004-27N2 Analytical Limit = 2935 VAC
Maximum dropout for the Loss of Voltage Relays = 3351 VAC

7.3. Bus to Relay Voltage Conversion

The Division 3 Degraded Voltage bus (4160 kV) to relay input voltage conversion factor is (35) (Ref: G13.18.6.2-ENS*004 and G13.18.6.2-ENS*007).

7.4. Output Documents (Any Changes to the data, analyses, or conclusions of calculation G13.18.3.1-005 may impact the following RBS documents)

7.4.1. RBS Technical Specification and Technical Requirements Manual

7.4.1.1 TS 3.3.8.1, Loss of Power (LOP) Instrumentation.

7.4.1.2 TR 3.3.8.1, Loss of Power (LOP) Instrumentation.

7.4.2. Procedures

7.4.2.1 STP-302-1605, HPCS DEGRADED VOLTAGE CHANNEL CALIBRATION AND LOGIC SYSTEM FUNCTIONAL TEST.

7.4.2.2 STP-302-1604, HPCS LOSS OF VOLTAGE CHANNEL CALIBRATION AND LOGICSYSTEM FUNCTIONAL TEST.

7.5. Operating Experience

CR-RBS-2011-04838:
CR-RBS-2011-04838 documented non-conservative Technical Specification for Degraded Voltage Relay NO-LOCA time delay and Loss of Voltage Relay dropout setpoints. The condition report documented that the existing limits do not protect the RBS motors against sustained degraded voltage conditions for a long period of time.

Disposition: This engineering change markup has been issued to provide revised Technical Specification and TRM setpoint limits for the Degraded Voltage Relay NO-LOCA time delay and Loss of Voltage Relay dropout setpoints. The new setpoint limits provided within this markup will ensure that the RBS motors are protected against sustained undervoltage and degraded voltage conditions.

8.0 Assumptions

8.1. The Limiting Operating Transient Variation (X_T) is assumed to be equal to the minimum voltage observed on the associated bus during a LOCA transient at the Lower Analytical Limit for the Degraded Voltage Relays (See calculation G13.18.3.6*016). Thus, the setpoint should be such that the Loss of Voltage relays do not dropout during a degraded grid LOCA transient.

The Limiting Operating Transient Variation (X_T) is given by the following equations (Ref: EN-IC-S-007-R):

The minimum voltage during a transient is observed for Division I bus. This voltage is 3351 VAC (Section 7.2). Therefore, X_T = 3351 /(35) = 95.75 VAC (Ref: Section 7.3 for bus to relay voltage conversion).

8.2. The LU, TLU and reset differential, derived in calculation G13.18.6.2-ENS*004 and G13.18.6.2-ENS*007 (EC-27437), are calculated using instrument uncertainties that are based on % setting (% setpoint). Because the proposed setpoints are different from the existing, those uncertainties will increase. Therefore, this calculation will adjust the LU, TLU and reset differential values proportionally according to the increase in setpoint.

9.0 Calculation Methodology

The methodology used in this calculation is in accordance with the “Instrument Loop Uncertainty & Setpoint Calculations” (Ref: EN-IC-S-007-R) and “General Electric Instrument Setpoint Methodology” (Ref: 7224.300-000-001B).

The Allowable Values (AV) and Nominal Trip Setpoints (NTSP2) for the setpoints considered in this calculation have both upper and lower limits. The Lower Limit (AV MIN) is calculated for the Degraded Voltage Relay NO-LOCA time delay by subtracting the difference between the AV MAX and the NTSP2 from the NTSP2. Then an additional margin of 3% is applied to give the final value of AV MIN. The Upper Limit (AV MAX) is calculated for the Loss of Voltage Relay Dropout by adding the difference between the NTSP2 and AV MIN to the NTSP2. An additional margin of 3% is applied to give the final value of AV MAX. Spurious trip avoidance analysis will ensure that these relays, if found drifted in the upper/lower limit not calculated, will not trip under unanalyzed conditions.

The upper AV for the Degraded Voltage Relay NO-LOCA time delay (AV MAX) must be below the upper Analytical Limit (AL) minus the absolute value of the positive Loop Uncertainty (LU). The lower AV for the Loss of Voltage Relay Dropout (AV MIN) must be above the lower AL plus the absolute value of the negative LU.

Upper AV $\leq$ Upper AL - $|+LU|$

Lower AV $\geq$ Lower AL + $|-LU|$

The upper NTSP2 must be below the upper AL minus the absolute value of the positive Total Loop Uncertainty (TLU). The lower NTSP2 must be above the lower AL plus the absolute value of the negative TLU.

Upper NTSP2 $\leq$ Upper AL - $|+TLU|$

Lower NTSP2 $\geq$ Lower AL + $|-TLU|$

The Loop Uncertainties and Total Loop Uncertainties used as input to this calculation are developed in the Loop Uncertainty Determination calculation (Ref: G13.18.6.2-ENS*004 and G13.18.6.2-ENS*007 EC-27437) using the methodologies provided in EN-IC-S-007-R and 7224.300-000-001B.

The Maximum Loop Setting Tolerance (CT_{LV}) provides the tolerance for the desired setpoint of the relay. This tolerance is irrespective of the setpoint chosen and is, therefore, the same for the dropout and the reset values. The minimum and maximum for the Desired/TRM allowable value is calculated as follows:

Desired Max. = Desired/TRM Trip Value + CT_{LV}

Desired Min. = Desired/TRM Trip Value - CT_{LV}

10.0 <u>Calculation</u>

10.1. Degraded Voltage Relay No-LOCA time delay relay

The setpoint for the relays is calculated iteratively as the LU and TLU are proportional to the setpoint. The final Nominal setpoint (NTSP2) calculated iteratively is 50.49 s.

The following calculations below provide the calculated STP, Allowable Value and Nominal Trip Setpoints (NTSP2). A margin of 4 s is used for LER Avoidance

LU = 5.622 × New Setpoint/Current Setpoint

LU = 5.622 × 50.49/54.9 = 5.17 s

TLU = 5.99 × 50.49/54.9 = 5.51 s

AV MAX $\leq$ Upper AL - $|+LU|$ = 60 – 5.17 = 54.83 s

AV MIN $\geq$ (NTSP2 – (AV MAX - NTSP2)) × 0.97 = (50.49 – (54.83 – 50.49)) × 0.97 = 44.7 s (rounded down)

NTSP2 (TRM) $\leq$ Upper AL - $|+TLU|$ - LER Avoidance Margin = 60 - 5.51 - 4 = 50.49 s

STP MIN = NTSP2 - $|CT_L|$ = 50.49 - 3 = 47.49 s

STP MAX = NTSP2 + $|CT_L|$ = 50.49 + 3 = 53.49 s

10.2. Loss of Voltage Relay

The setpoint for the relays is calculated iteratively as the LU and TLU are proportional to the setpoint. The final Nominal setpoint (NTSP2) calculated iteratively is 90.24 VAC.

The following calculations below provide the calculated STP, Allowable Value and Nominal Trip Setpoints (NTSP2). A margin of 0.865 V is used for LER Avoidance. For LU, Calculation

G13.18.6.2-ENS*004 shows an additional margin of 1.392. This margin is removed in this setpoint calculation.

LU = (3.678-1.392) × New Setpoint/Current Setpoint

LU = (3.678-1.392) × 90.24/87 = 2.37 VAC

TLU = 5.31 × 90.24/87 = 5.51 VAC

AV MIN ≥ Lower AL + │+LU│ = 2935 / (35) + 2.37 = 83.86 + 2.37 = 86.23 VAC (rounded up)

AV MAX ≤ (NTSP2 + (NTSP2 – AV MIN)) × 1.03 = (90.24 + (90.24 – 86.23)) × 1.03 = 97.08 VAC

97.08 VAC × 35 = 3397.8 VAC

Since AV MAX is calculated to be 3397.8 VAC, which is not within the Limiting Operating Transient Variation (assumption 8.1) for the Loss of Voltage Relays (3351 VAC), AV MAX will be chosen to be 3325 VAC to provide adequate margin to the Limiting Operating Transient Variation for the Loss of Voltage Relays.

NTSP2 (TRM) ≥ Lower AL + │+TLU│ + LER Avoidance Margin = 83.86 + 5.51 + 0.865 = 90.24 VAC (Rounded Up)

STP MIN = NTSP2 - $|CT_L|$ = 90.24 – 2.61 = 87.63 VAC

STP MAX = NTSP2 + $|CT_L|$ = 90.24 + 2.61 = 92.85 VAC

10.3. Margin Checks:

10.3.1. Spurious Trip Avoidance Test

The Spurious Trip Analysis is performed to demonstrate the acceptability of the calculated Nominal Trip Setpoint. The Nominal Trip Setpoint should provide at least 95% probability that a spurious trip will not occur. The value calculated for Z should be = 1.645 to achieve the 95% criteria.

Spurious Trip Equation (Ref: EN-IC-S-007-R):

$$Z_T = \frac{|NTSP2 - X_T|}{\sqrt{(\sigma_M)^2 + (\sigma_I)^2}}$$

Where:

NTSP2 = Calculated Nominal Trip Setpoint, Upper

X_T = Limiting operating transient

σ_M = standard deviation for the operating transient (equal to zero when the limiting operating transient is based on documented operating conditions).

= 0

σ_I = standard deviation of the NTSP2

$$= \left(\frac{1}{n}\right)\sqrt{(A_N)^2 + (C_L)^2 + (D_L)^2 + (P_M)^2 + (P_E)^2}$$

The Total Loop Uncertainty is defined in EN-IC-S-007-R as:

$$TLU = \pm\left(\frac{m}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (P_M)^2 + (P_E)^2}$$

A_L = Total random uncertainty that makes up the loop from device (provided in G13.18.2.3-ENS*002 and G13.18.2.3-ENS*006 EC-27437)

A_N = The loop from device uncertainty for normal conditions (i.e. A_L determined for normal conditions)

$\Rightarrow A_L \geq A_N$

Since a higher value of σ_I reduces the spurious trip avoidance probability, it is conservative to assume that $A_N = A_L$ for the equation for standard deviation.

$$\sigma_I = \left(\frac{\pm TLU}{m}\right) = \left(\frac{1}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (P_M)^2 + (P_E)^2}$$

Since, *TLU* as provided in G13.18.6.2-ENS*004 and G13.18.6.2-ENS*007, contains the same random component, $\left(\frac{m}{n}\right)\sqrt{(A_L)^2 + (C_L)^2 + (D_L)^2 + (P_M)^2 + (P_E)^2}$ for both positive and negative direction,

σ_I = +*TLU* / *m*

m = 1.645 (for Loss of Voltage relay)

= 2 (for Degraded Voltage Relay No-LOCA time delay)

σ_I = 5.51 / 1.645 V

= 3.35 V (for Loss of Voltage Relay)

= 5.51 / 2 s (for Degraded Voltage Relay No-LOCA time delay; used in Section 10.3.2.1)
= 2.755 s (for Degraded Voltage Relay No-LOCA time delay)

10.3.1.1 Degraded Voltage Relay No-LOCA time delay relay

Spurious trip avoidance test for the time delay is bounded by the spurious trip avoidance for the Loss of Voltage relay dropout setpoint. The purpose the Loss of voltage relays is to ensure that the RBS safety related motors will not experience less than 70% terminal voltage. The time delay ensures that, if such a condition occurs, the degraded voltage relay trips in less than 60 seconds. This condition is based on the analysis provided in calculation G13.18.3.6*016. There are no other conditions that are dependent upon the Time Delay function of the relay. However, a spurious trip avoidance test for the Loss of Voltage relays is required to ensure that the relays do not dropout during worst case LOCA transient conditions.

10.3.1.2 Loss of Voltage relay

The Spurious Trip Analysis is performed to demonstrate the acceptability of the calculated Nominal Trip Setpoint. The Nominal Trip Setpoint should provide at least 95% probability that a spurious trip will not occur. The value calculated for Z should be = 1.645 to achieve the 95% criteria.

NTSP2 = Calculated Nominal Trip Setpoint
= 90.24 V (Per Section 10.2)

X_T = Limiting operating transient

= 95.75 V (Per Assumption 8.1.1)

σ_M = standard deviation for the operating transient (equal to zero when the limiting operating transient is based on documented operating conditions).

= 0

σ_I = $+TLU$ / m

m = 1.645

σ_I = 5.51 / 1.645 V

= 3.35 V

Spurious Trip Calculation:

$$Z_T = \frac{|90.24 - 95.75|}{((0)^2 + (3.35)^2)^{1/2}}$$

$$= 1.6448$$

The calculated value for Z_T is approximately 1.645. Therefore the calculated Nominal Trip Setpoint is acceptable.

10.3.2. LER Avoidance Analysis:

LER avoidance analysis is performed to determine the acceptability of the margin between the calculated Nominal Trip Setpoint and the calculated Allowable Value. The margin should provide at least a 90% probability the instrument channel's trip setpoint will not exceed the allowable value. The calculated value for Z_{LER} should be $\geq$ 1.28.

LER Avoidance Equation (Ref: EN-IC-S-007-R):

$$Z_{LER} = \frac{|AV - NTSP2|}{\sigma_I}$$

Where:

AV = Allowable Value

NTSP2 = Calculated Nominal Trip Setpoint

σ_I = standard deviation of the NTSP

10.3.2.1 Degraded Voltage Relay No-LOCA time delay relay

$$Z_{LER} = \frac{|50.49 - 54.83|}{2.755}$$

$$= 1.575$$

10.3.2.2 Loss of Voltage relay

$$Z_{LER} = \frac{|86.23 - 90.24|}{3.35}$$

$$= 1.20$$

The LER Avoidance value for Degraded Voltage relay No-LOCA time delay is not greater than 1.28. However, the LER avoidance for Loss of Voltage relay is 1.20 which yields a probability of 88.5%. The STP limits on the relays ensure that the relays will not drift beyond the acceptable STP values.

The calculated values for Z_{LER} (upper and lower) are deemed acceptable and demonstrate sufficient probability for LER avoidance.

☐ ANO-1	☐ ANO-2	☐ GGNS	☐ IP-2	☐ IP-3	☐ PLP
☐ JAF	☐ PNPS	☒ RBS	☐ VY	☐ W3	
☐ NP-GGNS-3	☐ NP-RBS-3				

CALCULATION COVER PAGE	(1) **EC #** <u>**27437**</u>	(2) **Page 1 of** <u>**27**</u>

(3) Design Basis Calc. ☒ YES ☐ NO	(4) ☒ CALCULATION ☐ EC Markup
(5) **Calculation No: G13.18.6.2-ENS*002**	(6) **Revision: 2**
(7) **Title:** Instrument Loop Uncertainty/Setpoint Determination for the ABB Model 27H Undervoltage Relay	(8) **Editorial** ☐ YES ☒ NO
(9) **System(s): 302**	(10) **Review Org (Department): NSBE3 (I&C Design)**

(11) **Safety Class:**	(12) **Component/Equipment/Structure Type/Number:**	
☒ **Safety / Quality Related** ☐ **Augmented Quality Program** ☐ **Non-Safety Related**	**ENS-SWG1A-27-1A, 1B, 1C**	**ENS-SWG1B-27-1A, 1B, 1C**
	ENS-SWG1A-PT-BUS	**ENS-SWG1B-PT-BUS**
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REVIEWS

(15) Name/Signature/Date Chuck Mohr (see EC 11753 for signature)	(16) Name/Signature/Date Robin Smith (see EC 11753 for signature)	(17) Name/Signature/Date Paul Matzke (see EC 11753 for signature)
Responsible Engineer	☒ **Design Verifier** ☐ **Reviewer** ☒ Comments Attached	**Supervisor/Approval** ☒ Comments Attached

CALCULATION REFERENCE SHEET	CALCULATION NO: G.13.18.6.2-ENS*002 REVISION: 2

I. EC Markups Incorporated (N/A to NP calculations): None

II. Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	Tracking No.
1. EN-DC-126	--	002	☑	☐	N	
2. EN-IC-S-007-R	--	000	☑	☐	N	
3. 7224.300-000-001B	--	300	☑	☐	N	
4. 201.130-186	--	000	☑	☐	N	
5. 215.150	--	006	☑	☐	N	
6. B455-0139	--	000	☑	☐	N	
7. 3242.521-102-001A	--	300	☑	☐	N	
8. F137-0100	--	000	☑	☐	N	
9. 0242.521-102-133	--	300	☑	☐	N	
10. EE-001K	--	019	☑	☐	N	
11. EE-001L	--	015	☑	☐	N	
12. ESK-08ENS01	--	008	☑	☐	N	
13. ESK-08EGS09	001	013	☑	☐	N	
14. ESK-08EGS10	001	012	☑	☐	N	
15. ESK-08EGS13	001	011	☑	☐	N	
16. ESK-08EGS14	001	010	☑	☐	N	
17. ESK-08EGS15	001	009	☑	☐	N	
18. ESK-08EGS16	001	007	☑	☐	N	
19. STP-302-1600	--	018	☑	☐	N	
20. STP-302-1601	--	017	☑	☐	N	
21. G13.18.6.3-006	--	000	☑	☐	N	
22. LSK-24-09.05A	001	015	☑	☐	N	
23. EDP-AN-02	--	300	☑	☐	N	
24. STP-302-0102	--	016	☑	☐	N	
25. G13.18.3.1*001	--	003	☑	☐	N	

III. CROSS REFERENCES:

1. Indus Asset Suite Equipment Data Base (EDB)

2.Technical Specifications section B3.3.8.1

3. ANSI Standards C57.13 (1993)

4. Multi-Amp Instruction Book EPOCH-10

5. USAR Figures 3.11-1 through 5

IV. SOFTWARE USED: N/A

Title:______________________ Version/Release:_____________Disk/CD No._________

V. DISK/CDS INCLUDED: N/A

Title:______________________ Version/Release______________Disk/CD No._________

VI. OTHER CHANGES:

Removed the following related references:

STP-302-1602, STP-302-1603, 242.251, 0242.521-102-060, 0242.521-102-061, 0242.521-102-063, 0242.521-102-064, 0242.521-102-070, 0242.521-102-071, 0242.521-102-076, 0242.521-102-084, 0242.521-102-129, ESK-08EGS01, Sh. 001, ESK-08EGS04, Sh. 001, BE-230A, BE-230B, CSD-24-09.05

Revision	Record of Revision
0	Initial issue to support determination of undervoltage rely setpoints by Electrical Engineering.
1	Deleted Degraded Voltage Relay setpoints. With relay change per ER-RB-2001-0360-00, the degraded voltage relay setpoints are moved to G13.18.3.6.2-ENS-005 Rev. 0. Revised procedural as-left band.
2	Incorporated new drift value and extended calibration period to 30 months per EC 11753.

TABLE OF CONTENTS

1.0 Purpose and Description

1.1. Purpose

The purpose of this calculation is to determine the uncertainty associated with the existing Safety-Related 4.16 kV Loss of Voltage relays for Divisions I & II. Nominal trip Set points and Allowable values will be determined by the Electrical Engineering group in calculation G13.18.3.1*001 and documented on the applicable BE drawing.

1.2. Loop Descriptions

Each 4.16 kV emergency bus has its own independent Loss of Power (LOP) instrumentation and associated trip logic. The voltage for the Division I and II buses is monitored at two levels, which can be considered as two different undervoltage functions; loss of voltage and sustained degraded voltage.

Each 4.16 kV bus monitored by three undervoltage relays whose outputs are arranged in a two-out-of-three logic configuration (Reference 3.12). The channels include electronic equipment (e.g., trip units) that compares measured input signals with pre-established setpoints. When the setpoint is exceeded, the channel output relay actuates, which then outputs a LOP trip signal to the trip logic.

1.3. Design Bases Event

Per Technical Specification Bases B 3.3.8.1 (Reference 3.7.3), “successful operation of the required safety functions of the Emergency Core Cooling Systems (ECCS) is dependent upon the availability of adequate power sources for energizing the various components such as pump motors, motor operated valves, and the associated control components. The LOP instrumentation monitors the 4.16 kV emergency buses. Offsite power is the preferred source of power for the 4.16 kV emergency buses. If the monitors determine that insufficient power is available, the buses are disconnected from the offsite power sources and connected to the onsite diesel generator (DG) power sources.”

1.4. Degree of Accuracy/Limits of Applicability

The results of this calculation are based on the statistical methods of at least 95% probability of occurrence for a one sided probability distribution in accordance with “General Electric Instrument Setpoint Methodology,” (Reference 3.3) and EN-IC-S-007-R, “Instrument Loop Uncertainty & Setpoint Calculations” (Reference 3.2). One sided probability is used since the Loss of Voltage relay performs its safety function in the decreasing direction only.

The results of this calculation are valid under the Assumptions stated in Section 7.0 of this calculation.

The appropriate use of this calculation to support design or station activities, other than those specified in Section 1.1 of this calculation, is the responsibility of the user.

1.5. Applicability

A data analysis has been performed in order to determine which, if any, redundant instrument loops are bounded by the results of this calculation. This calculation is applicable to the Loops associated with the primary elements stated in Section 9.0. The results of this calculation are bounding for the applicable instrument loops, based on such factors as instrument manufacturer and model number, instrument location/environmental parameters, actual installation and use of the instrument in process measurements.

2.0 Results/Conclusions

2.1. Results

The Loop Uncertainty and Total Loop Uncertainty for the Loss of Voltage relays were calculated in Section 8.0. These values and other associated values such as loop drift are presented in table 2.1-1.

Table 2.1-1
Loss of Voltage Relay

System(s)	Loop Identification	Loop Uncertainty (LU) VAC	Channel Drift (D_L) VAC	Total Loop Uncertainty (TLU) VAC	M&TE Loop Accuracy Requirements VAC	Maximum Loop Setting Tol. (PALB) VAC
302	See Section 9.0	± 0.8675 ± 52.59*	± 0.392	± 1.019 ± 61.77*	± 0.155	± 0.87

* Uncertainty indexed to the primary (bus) voltage of the potential transformers.

2.2. Conclusions

The calculated Loop Uncertainty and Total Loop Uncertainty presented in table 2.1-1, are bounding for the relays and circuits listed in Section 9.0.

3.0 References

3.1 EN-DC-126, "Engineering Calculation Process"

3.2 EN-IC-S-007-R, "Instrument Loop Uncertainty & Setpoint Calculations"

3.3 7224.300-000-001B, NEDC-31336P-A, General Electric Instrument Setpoint Methodology

3.4 Indus Asset Suite Equipment Data Base (EDB)

3.5 201.130-186, "Peak Spreading of ARS Curves for the Control Building"

3.6 Environmental Design Criteria, Spec 215.150, including USAR figures 3.11-1 through 5 as outlined in EDP-AN-02 section 6.3.1

3.7 RBS Operating License

3.7.1 Not used

3.7.2 Not used

3.7.3 Bases Sections B3.3.8.1

3.7.4 Not used

3.8 RBS USAR

None

3.9 Vendor Manuals

3.9.1 B455-0139, Single-Phase Voltage Relays

3.9.2 3242.521-102-001A, Instruction Manual-STNBY 4.16 kV Switchgear

3.9.3 F137-0100, Fluke Dual Display Multimeter Users Manual

3.9.4 Multi-Amp Instruction Book for the EPOCH-10, Microprocessor-Enhanced Protective Relay Test Set, (maintained by the Standards Laboratory)

3.9.5 0242.521-102-133, Rev. 300, BOM ENS-SWG1A & 1B

3.10 Electrical Schematics

3.10.1 EE-001K, 4160V One Line Diagram Standby Bus 1ENS*SWG1A

3.10.2 EE-001L, 4160V One Line Diagram Standby Bus 1ENS*SWG1B

3.10.3 ESK-08ENS01, AC Elementary Diagram Standby Bus 1A & 1B Protection & Metering

3.10.4 ESK-08EGS09, DC Elementary Diagram Standby Bus 1ENS*SWG1A Under Voltage Protection

3.10.5 ESK-08EGS10, DC Elementary Diagram Standby Bus 1ENS*SWG1B Under Voltage Protection

3.10.6 ESK-08EGS13, DC Elementary Diagram Standby Bus 1ENS*SWG1A Under Voltage Protection

3.10.7 ESK-08EGS14, DC Elementary Diagram Standby Bus 1ENS*SWG1B Under Voltage Protection

3.10.8 ESK-08EGS15, DC Elementary Diagram Standby Bus 1ENS*SWG1A Under Voltage Protection & Load Sequence

3.10.9 ESK-08EGS16, DC Elementary Diagram Standby Bus 1ENS*SWG1B Under Voltage Protection & Load Sequence

3.11 Surveillance Test Procedures:

3.11.1 STP-302-1600, ENS-SWG1A Loss Of Voltage Channel Calibration And Logic System Functional Test

3.11.2 STP-302-1601, ENS-SWG1B Loss Of Voltage Channel Calibration And Logic System Functional Test

3.11.3 Not used

3.11.4 Not used

3.11.5 STP-302-0102, Power Distribution System Operability Check

3.12 LSK-24-09.05A, Standby Diesel Generator Load Sequence, Logic Diagram

3.13 Standards

3.13.1 ANSI Standard C57.13, Requirements for Instrument Transformers

3.13.2 Not used

3.14 G13.18.6.3-006, Rev. 0, ABB Model ITE-27H Relay Drift Analysis

4.0 Design Input

The following are the design inputs used to determine uncertainty for the DIV I and II Loss of Voltage relays.

4.1 Loop Input

4.1.1 Loop Data:

Form 1: Loop/Process Data Sheet		
Description	Data	Reference
Loop Sensor(s)	ENS-SWG1A-PT ENS-SWG1B-PT	3.10
Location	ENS-SWG1A ENS-SWG1B	3.4
Output Range	0-120 VAC	3.10
Input Range	0-4200 VAC	3.10

4.1.2 Special Considerations:

4.1.2.1 Calibration shall be performed using the following instruments:

- Multi-Amp EPOCH-10 relay tester set to Oscillator Mode (Reference 3.9.4)
- Fluke Model 45 Digital Multimeter set to Medium Resolution (Reference 3.9.3)

4.1.2.2 A minimum of 1 hour warm up time at the calibration location shall be allowed for the Fluke Model 45 Multimeter.

4.2 **Loop Instrumentation**

Form 2: Instrument Data Sheet		
Calc. Device Number 1		
Description	**Data**	**Reference**
Component Number(s	ENS-SWG1A-PT-BUS ENS-SWG1B-PT-BUS	3.4
Manufacturer	Westinghouse	3.9.5
Model(s)	VIY-60	3.9.5
Location(s)	CB 98'E1. /ENS-SWG1A CB 98'E1. /ENS-SWG1B	3.4
Service Description	Transformer	3.4
Instrument Range	0 – 4200 VAC	3.9.5
Output Range	0 – 120 VAC	3.9.5
Calibration Interval Evaluated	N/A	Note
Device Setting Tolerance	N/A	Note

Note: Potential transformers for instrument service cannot be calibrated or adjusted, therefore there is no device setting tolerance or calibration interval.

Form 2: Instrument Data Sheet		
Calc. Device Number 2		
Description	**Data**	**Reference**
Component Number(s)	See Section 9.0	3.4, 3.10
Manufacturer	Asea Brown Boveri	3.9.5, 3.9.1
Model	27H	3.9.5, 3.9.1
Location(s)	CB 98'EL/ENS-SWG1A CB 98'EL/ENS-SWG1B	3.4
Service Description	Relay	3.9.1, 3.10
Input Range	0 – 120 VAC	3.9.2
Output	Contact Action	3.10, 3.12
Calibration Interval Evaluated	30 Mo. (24 Mo. + 25%)	3.2

4.3 **Loop Device Data**

Form 3: Instrument Accuracy Sheet		
Calc. Device Number 1 Westinghouse VIY-60		
Description	**Data**	**Reference**
Reference Accuracy (RA_T)	0.3% of setting 2σ	3.9.2 7.1.2
Seismic Effects (SE_T)	N/A	7.1.4
Temperature Effects (TE_T)	N/A	7.1.12
Insulation Resistance Effects (IR_T)	N/A	7.1.10
Temperature Drift Effect (TD_T)	N/A	7.1.13
Drift (DR_T)	N/A	7.1.14

Form 3: Instrument Accuracy Sheet		
Calc. Device Number 2 Asea Brown Boveri 27H		
Description	**Data**	**Reference**
Reference Accuracy (RA_R)	±0.25% of setting 2σ	3.9.1 7.1.2 7.1.15
Seismic Effects (SE_R)	0	7.1.4
Temperature Effects (TE_R)	0.5 VAC/(68°F – 104°F) 2σ	7.1.12 7.1.2
Insulation Resistance Effects (IR_R)	N/A	7.1.10
Temperature Drift Effect (TD_R)	N/A	7.1.13
Drift (DR_R)	±0.392 VAC 2σ	3.14 7.1.2
Reset	3% of Setting ±1.5%	3.11 3.9.1 3.9.5

4.4 **Environmental Information**

Form 4: Environmental Conditions Data Sheet		
Zone: CB-98-1		
Description	**Data**	**Reference**
Location		
Building/Elevation	CB-98	3.4
Room/Area	Switchgear Room	3.4
Normal		
Temperature Range, °F	40 – 104	3.6
Humidity Range, %RH	20 – 90	3.6
Radiation 40 Year Total Integrated Dose, Rads	800	3.6
Pressure Range	Atmos	3.6
Accident (Loss of Offsite Power)		
Temperature Range, °F	Same as Normal	3.6
Humidity Range, %RH	Same as Normal	3.6
Radiation, Total Integrated Dose, Rads	Same as Normal	3.6
Pressure Range	Same as Normal	3.6
Seismic		
Accelerations, g	< 3	3.5

5.0 **Nomenclature**

The terms and abbreviations that are not defined in this section are defined in Reference 3.3, Reference 3.2 or within the text of this calculation.

6.0 Calculation Methodology

This calculation is prepared in accordance with EN-IC-S-007-R, "Instrument Loop Uncertainty & Setpoint Calculations" (Reference 3.2), EN-DC-126, "Engineering Calculation Process" (Reference 3.1) and 7224.300-000-001B, "General Electric Instrument Setpoint Methodology" (Reference 3.3).

7.0 Assumptions

7.1 Assumptions that do not require confirmation

7.1.1 Miscellaneous Allowance (ML)

A miscellaneous allowance has not been applied to uncertainty of the device evaluated by this calculation. By assuming all vendor supplied data is a 2σ value and with intermediate rounding of values in the conservative direction, sufficient conservatism has been introduced.

7.1.2 Vendor 2σ Data

For conservatism, all uncertainties given in vendor data specifications are assumed to be 2σ unless otherwise specified.

7.1.3 Zero Effect (ZE)

Not applicable

7.1.4 Seismic Effects (SE)

Reference 3.9.1 states that the undervoltage relays have been tested to 6 g ZPA "without damage or malfunction." Reference 3.5 defines the expected level of seismic activity for the 98 ft elevation of the control building as less than 3g. Therefore, seismic effects are assumed to be 0.

Seismic effects are not applicable to potential transformers.

7.1.5 Radiation Effects (RE) & Radiation Drift Effect (RD)

Radiation effects and radiation drift effects are not applicable to the relays and transformers evaluated by this calculation, as they are located in a mild environment (Reference 3.6).

7.1.6 Power Supply Effects (PS)

Per Reference 3.9.1, control voltage variations may affect the setpoint of the relay by as much as ± 0.2 volt for a 10 VDC change in the control voltage. This yields a possible variation of ± 0.02 VAC/VDC of control voltage variation. Per Reference 3.11.5, the allowable voltage range is 130 to 140 VDC. Therefore, 15 VDC will conservatively be used to calculate the PS effects for the undervoltage relays in this calculation.

Power supply effects are not applicable to transformers.

7.1.7 Process Measurement Uncertainty (PM)

Not Applicable

7.1.8 Static Pressure Effects (SP)

Not Applicable

7.1.9 Humidity Effects (HE)

The relays were specified by the switchgear manufacturer and are assumed to be designed to withstand the environmental effects in the mounting location without introduction of additional uncertainty. Per Reference 3.6, the humidity range for environmental zone CB-98 is 20 to 90% RH. Therefore, it is assumed that Humidity effects are negligible.

Humidity effects are not applicable to potential transformers.

7.1.10 Insulation Resistance Effects (IR)

(IR) effects, which may result in degradation of circuit insulation, are not applicable to the devices and circuits addressed by this calculation.

7.1.11 Voltage Drop

Voltage drop due to long wiring lengths between source and load are assumed to be negligible as the potential transformers and the undervoltage relays evaluated by this calculation are located in the same switch gear compartment.

7.1.12 Temperature Effects (TE)

Per Reference 3.9.1, the temperature effect is 0.5 VAC over a span of 68^o – 104^{o}F (20^{o}C – 40^{o}C). Reference 3.6 states that the normal temperature range for this area is 40^o – 104^{o}F and that 1% of the calendar year (30 hours) the temperature could be 5^{o}F higher. The temperature change 1% of the calendar year is considered negligible. The 0.5 VAC value will be used to determine relay temperature effects. See section 8.1.3

Temperature effects are not applicable to transformers. Temperatures above the rated value would tend to produce total failure of the transformer, rather than an error in output.

7.1.13 Temperature Drift Effects (TD)

The drift analysis performed in Reference 3.14 is assumed to encompass all components of drift and drift effects except for temperature drift effects which are assumed to be included in the Reference Accuracy of the device.

Temperature drift effects are not applicable to transformers.

7.1.14 Instrument Drift (DR)

The drift analysis can be found in Reference 3.14.

Drift is not applicable to transformers.

7.1.15 Relay Reference Accuracy (RA_R)

The accuracy rating for the ABB model 27 undervoltage relay is dependent on M&TE accuracy and calibration methodology when following the calibration instruction in Reference 3.9.1. Per Reference 3.9.3, the reference accuracy for a Fluke Model 45 digital multimeter is 0.2% of setting + 10 mV (conservatively approximated as 0.01% of setting). This yields an approximate accuracy of 0.21%. For conservatism, a value of 0.25% of setting will be used for this calculation.

7.2 Assumptions that require confirmation

None

8.0 **Calculation**

This section includes the following subsections used in performance of this calculation:

8.1) Calculation of Miscellaneous Uncertainties

8.2) Calculation of Individual Device Reference Accuracy (RA)

8.3) Calculation of Individual Device Uncertainties

8.4) Calculation of Loop Calibration Accuracy (CL)

8.5) Calculation of Insulation Resistance Effects (IR)

8.6) Calculation of Loop Uncertainty (LU)

8.7) Calculation of Loop Drift (D_L)

8.8) Calculation of Total Loop Uncertainty (TLU)

8.9) Calculation of Reset Differential

8.1 Calculation of Miscellaneous Uncertainties

8.1.1 Calculation of Transformer Burden and determination of Reference Accuracy

Per References 3.9.2 and 3.13.1, the Reference Accuracy for instrument class potential transformers is ± 0.3% W, X, and Y, and ± 1.2% Z. This relates to the burden placed upon the transformer by its connected loads. A load less than 75 VA will yield an accuracy of ± 0.3% where a load greater than 75 VA will produce a transformer accuracy of ± 1.2%.

The loads for the metering transformer are:

6 Undervoltage Relays @ 1.2 VA each	=	7.2
1 Synchronizing relay transformer @ 3 VA	=	3.0
1 Model 60 Voltage Balance Relay @ 0.7 VA each	=	0.7
2 Model 32 voltage Balance Relays @ 0.3 VA each	=	0.6
1 Volt Meter, GE 180 @ 3.0 VA burden each	=	3.0
1 Volt Transducer @ 3.0 VA burden	=	3.0
Control Relays/Meters not listed, Assumed Value	=	10.0
		30.5

Therefore Transformer Accuracy = 0.3% of setting

8.1.2 Calculation of Under Voltage Relay Power Supply Effects (PS_R)

PS_R = ± 0.2 VAC per 10 VDC control power variation
= ± 0.02 VAC x 15 VDC
= ± 0.3 VAC (2σ Value)

Assumed control power voltage variation is 15 VDC per Assumption 7.1.6.

8.1.3 Calculation of Relay Temperature Effects (TE_R)

Per Assumption 7.1.12 and Reference 3.9.1, the relay may experience a temperature effect of ± 0.5 VAC over a temperature range of 68°F – 104°F. Assuming linearity, this yields an effect of 0.014 VAC/°F. The relays are housed inside the DIV I and II switchgear which are assumed to maintain an internal temperature of 104°F to prevent condensation. However, the relay is calibrated in the electrical or relay shop which is assumed to be maintained at 70°F. Therefore:

TE_R = ± (104°F – 70°F) x 0.014 VAC/°F
= ± 0.476 VAC (2σ Value)

8.2 Calculation of Individual Device Reference Accuracy (RA)

8.2.1 Transformer Reference Accuracy (RA_T):

8.2.1.1 Transformer Reference Accuracy for Loss of Voltage (RA_{TLV})

RA_{TLV} = ± 0.3% of Setpoint
= ± 0.003 * 49.00 VAC
= ± 0.147 VAC (2σ Value)

8.2.2 Undervoltage Relay Reference Accuracy (RA_R):

8.2.2.1 Undervoltage Relay Accuracy for Loss of Voltage (RA_{RLV})

RA_{RLV} = ± 0.25% of Setting
= ± 0.0025 * 49 VAC
= ± 0.1225 VAC (2σ Value)

8.2.3 Calculation of Loop Reference Accuracy (RA_L)

8.2.3.1 Loop Reference Accuracy for Loss of Voltage (RA_{LLV})

$$RA_{LLV} = \pm [(RA_{TLV})^2 + (RA_{RLV})^2]^{1/2}$$
$$= \pm [(0.147)^2 + (0.1225)^2]^{1/2}$$
$$= \pm 0.1914 \text{ VAC} \quad (2\sigma \text{ Value})$$

Per Reference 3.11 the Loop Calibration Tolerance (CT_L) for Loss of Voltage (CT_{LV}) is ± 0.87 VAC. Per reference 3.2, if the CT_L or procedural as left band is greater than the Loop Reference accuracy (RA_L), CT_L should be used to determine the loop calibration tolerance (CT_L) and the reference accuracies of the individual loop components may be set to zero. Therefore the RA_{TLV} will be set to 0 for the following sections of this calculation.

8.3 Calculation of Individual Device Uncertainties
(Reference 3.2, Section 8.2 and Section 8.1)

8.3.1 Transformer Uncertainty (A_T)

8.3.1.1 Transformer Uncertainty Loss of Voltage (A_{TLV})

$$A_{TLV} = \pm [(RA_{TLV})^2]^{1/2}$$
$$= \pm 0 \text{ VAC} \quad (2\sigma \text{ Value})$$

8.3.2 Undervoltage Relay Device Uncertainty (A_R)

8.3.2.1 Undervoltage Relay Device Uncertainty for Loss of Voltage (A_{RLV})

$$A_{RLV} = \pm [(RA_{RLV})^2 + (PS_R)^2 + (TE_R)^2]^{1/2}$$
$$= \pm [(0.1225)^2 + (0.3)^2 + (0.476)^2]^{1/2}$$
$$= \pm 0.5758 \text{ VAC} \quad (2\sigma \text{ Value})$$

8.4 Calculation of Loop Calibration Accuracy (CL)

$$C_L \pm [(MTE_L)^2 + (CT_L)^2]^{1/2}$$

8.4.1 Calculating measuring and test equipment effects. (MTE_L)

Measurement & Test Equipment (MTE_L) effects are defined from Reference 3.2 as:

$MTE_{LV} = [(MTE_{RA})^2 + (MTE_{RI})^2 + (MTE_{TE})^2 + (MTE_{CS})^2]^{1/2}$

Where: MTE_{RA} = Reference accuracy of the Fluke Model 45 Digital Multimeter (DMM) after a one hour stabilization period at the calibration location = 0.2% of setting + 10 mV. MTE_{RALV} = 0.108 VAC.

MTE_{TE} = Effects of temperature changes on the Fluke Model 45 DMM between the calibration laboratory and the area where the M&TE is used. Assumed equal to the Reference accuracy of the M&TE used. For the Loss of Voltage, setting MTE_{TELV} = 0.108 VAC.

MTE_{RI} = Readability of the M&TE used, assumed to be 0 as all M&TE used are digital with at least 2 digital with at least 2 digits of resolution. (Reference 3.2)

MTE_{CS} = The accuracy of the calibration standard used to calibrate the M&TE, assumed equal to 1/4 the Reference accuracy of the DMM. For the Loss of Voltage, setting MTE_{CSLV} = 0.027 VAC.

8.4.1.1 Calculation of loop M&TE Effects for Loss of Voltage (MTE_{LLV})

$MTE_{LLV} = \pm [(MTE_{RALV})^2 + (MTE_{RI})^2 + (MTE_{TELV})^2 + (MTE_{CSLV})^2]^{1/2}$
$= \pm [(0.108)^2 + (0.0)^2 + (0.108)^2 + (0.027)^2 +]^{1/2}$
$= \pm 0.155$ VAC (2σ Value)

8.4.2 Calculation of Calibration Effects (CT_L)

Calibration Effects (CT_L) are defined from Reference 3.2 as:

CT_L = Square Root Sum of the Squares (SRSS) of procedural inaccuracies such as procedural as left band and calibration procedural errors.

8.4.2.1 Calculation of Calibration effects for Loss of Voltage (CT_{LLV})

$CT_{LLV} = \pm 0.87$ VAC (2σ value)

The PALB value is 0.87 from Ref. 3.11. The PALB will remain greater than RA_L.

8.4.3 Calculation of Loop Calibration Accuracy for Loss of Voltage (C_{LLV})

$C_{LLV} = \pm [(MTE_{LLV})^2 + (CT_{LLV})^2]^{1/2}$
$= \pm [(0.155)^2 + (0.87)^2]^{1/2}$
$= 0.884$ VAC (2σ Value)

8.5 Calculation of Insulation Resistance Effects (IR)

0 per Assumption 7.1.10

8.6 Calculation of Loop Uncertainty (LU)

Reference 3.2 defines loop uncertainty as:

$LU = \pm (m/n)[(A_T)^2 + (A_R)^2 + (C_L)^2]^{1/2}$

Where: m = The number of standard deviations required to encompass 95% of the area under the curve for a normal distribution either one or two sided. 1.645 corresponds to a one sided confidence while 2.00 corresponds to a two sided confidence.

n = The number of standard deviations used in specifying the individual components of uncertainty.

8.6.1 Loop Uncertainty for Loss of Voltage (LU_{LV})

$$
\begin{aligned}
LU_{LV} &= \pm (m/n)[(A_{TLV})^2 + (A_{RLV})^2 + (C_{LLV})^2]^{1/2} \\
&= \pm (1.645/2)[(0)^2 + (0.5758)^2 + (0.884)^2]^{1/2} \\
&= \pm 0.8675 \text{ VAC}
\end{aligned}
$$

When applied to the PT primary voltage (LU_{PLV})

$$
\begin{aligned}
LU_{PLV} &= \pm LU_{LV} \text{ x PT Ratio } * (3)^{1/2} \text{ (Primary voltage/Secondary voltage)} \\
&= \pm 0.8675 \text{ x } 35 \text{ x } 1.73205 \\
&= \pm 52.59 \text{ VAC}
\end{aligned}
$$

8.7 Calculation of Loop Drift (D_L)

8.7.1 Transformer Temperature Drift Effects (TD_T)

0 per Assumption 7.1.13

8.7.2 Relay Temperature Drift Effects (TD_R)

0 per assumption 7.1.13

8.7.3 Relay Drift (DR_R):

$DR_R = \pm 0.392$ VAC per Reference 3.14 (2σ Value)

As there are no other components of drift to be considered, $D_L = DR_R$

Indexed to the PT primary voltage

$$
\begin{aligned}
&= DR_R \text{ x } 35 \text{ x } (3)^{1/2} \\
&= \pm 0.392 \text{ VAC x } 35 \text{ x } (3)^{½} \\
&= \pm 23.77 \text{ VAC}
\end{aligned}
$$

8.8 Calculation of Total Loop Uncertainty (TLU)

Reference 3.2 defines loop uncertainty as:

$$TLU = \pm (m/n)[(A_T)^2 + (A_R)^2 + (C_L)^2 + (D_L)^2]^{1/2}$$

8.8.1 Total Loop Uncertainty – Loss of Voltage (TLU_{LV})

$$\begin{aligned} TLU_{LV} &= \pm (m/n)[(A_{TLV})^2 + (A_{RLV})^2 + (C_{LLV})^2 + (D_L)^2]^{1/2} \pm M \text{ (Margin)} \\ &= \pm (1.645/2)[(0)^2 + (0.5758)^2 + (0.884)^2 + (0.392)^2]^{1/2} \pm 0.093 \\ &= \pm 1.019 \text{ VAC} \end{aligned}$$

When applied to the PT primary voltage (TLU_{PLV})

$$\begin{aligned} TLU_{PLV} &= \pm TLU_{LV} \text{ x PT Ratio x } (3)^{1/2} \text{ (Primary voltage/Secondary voltage)} \\ &= \pm 1.019 \text{ x } 35 \text{ x } 1.73205 \\ &= \pm 61.77 \text{ VAC} \end{aligned}$$

8.9 Calculation of Reset Differential

8.9.1 Reset Differential for Loss of Voltage (RD_{LV})

(Reference 3.9.1 and 3.11)

$$\begin{aligned} RD_{LV} &= + \text{(3.0\% of Setting) nominal} \\ &= + 0.03 \text{ x } 49.00 \\ &= + 1.47 \text{ VAC nominal} \end{aligned}$$

Indexed to the PT primary voltage

$$\begin{aligned} &= RD_{LV} \text{ x } 35 \text{ x } (3)^{1/2} \\ &= 89.10 \text{ VAC nominal} \end{aligned}$$

$$\begin{aligned} RD_{LV} &= + \text{(3.0\% + 1.5\% of Setting) max} \\ &= + 0.045 \text{ x } 49.00 \\ &= + 2.205 \text{ VAC max} \end{aligned}$$

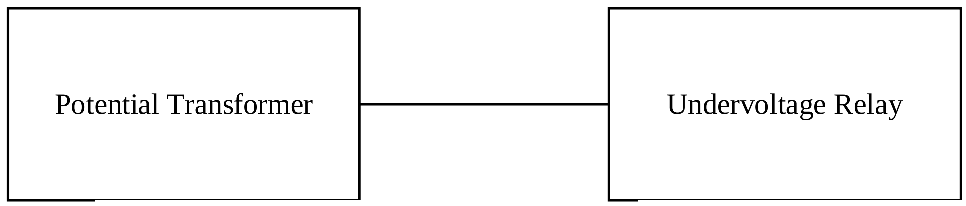
Indexed to the PT primary voltage

$$\begin{aligned} &= RD_{LV} \text{ x } 35 \text{ x } (3)^{1/2} \\ &= 133.67 \text{ VAC Max} \end{aligned}$$

Calculated uncertainties (LU and TLU) are applicable to reset.

Summary of Calculation						
Terms	**Transformer Device 1**			**Undervoltage Relay Device 2**		
	Values	**ε**	**Ref.**	**Values**	**ε**	**Ref.**
Input Range	0 – 4200	–	3.9.5	0 – 120	–	3.9.2
Process Units	VAC	–	3.9.5	VAC	–	3.9.2
Reference Accuracy (RA)	±0.3% of Setting	2	3.9.2	±0.25% of Setting	2	7.1.15
Temperature Effect (TE)	0	–	7.1.12	±0.476	2	7.1.12 8.1.3
Seismic Effects (SE)	N/A	–	7.1.4	0	–	7.1.4
Radiation Effect (RE)	N/A	–	7.1.5	N/A	–	7.1.5
Instrument Drift (DR)	N/A	–	7.1.14	±0.392	2	3.14, 7.1.14
Temperature Drift (TD)	N/A	–	7.1.13	N/A	–	7.1.13
Radiation Drift Effect (RD)	N/A	–	7.1.5	N/A	–	7.1.5
Power Supply Effect (PS)	N/A	–	7.1.6	± 0.3	2	7.1.6, 8.1.2
Static Pressure Effects (SP)	N/A	–	7.1.8	N/A	–	7.1.8
Humidity Effects (HE)	N/A	–	7.1.9	N/A	–	7.1.9
Process Measurement Effect (PM)	N/A	–	7.1.7	N/A	–	7.1.7
Insulation Resistance Effect (IR)	N/A	–	7.1.10	N/A	–	7.1.10
Zero Effect (ZE)	N/A	–	7.1.3	N/A	–	7.1.3

9.0 **Simplified Block Diagram**



Westinghouse

Model VIY-60

4200/120 VAC

ABB Model 27H

Relay Mark Numbers

Div. I	Div II	
ENS-SWG1A-27-1A	SWG1B-27-1A	Loss off Voltage
ENS-SWG1A-27-1B	SWG1B-27-1B	Loss off Voltage
ENS-SWG1A-27-1C	SWG1B-27-1C	Loss off Voltage

Transformer Mark Number

ENS-SWG1A-PT-BUS   ENS-SWG1B-PT-BUS

DESIGN VERIFICATION COVER PAGE

☐ ANO-1 ☐ ANO-2 ☐ IP-2 ☐ IP-3 ☐ JAF ☐ PLP
☐ PNPS ☐ VY ☐ GGNS ☒ RBS ☐ W3 ☐ NP

Document No. G13.18.6.2-ENS-002	Revision No. 2	Page 1 of 4

Title: Loop Uncertainty/Setpoint Determination for the ABB Model 27H Undervoltage Relay

☒ Quality Related ☐ Augmented Quality Related

DV Method: ☒ Design Review ☐ Alternate Calculation ☐ Qualification Testing

VERIFICATION REQUIRED	DISCIPLINE	VERIFICATION COMPLETE AND COMMENTS RESOLVED (DV print, sign, and date)
☐	Electrical	
☐	Mechanical	
☒	Instrument and Control	**Robin Smith** [signature] 2/20/09
☐	Civil/Structural	
☐	Nuclear	
☐		
☐		

Originator: **Charles Mohr** Charles Mohr 2/20/09
Print/Sign/Date After Comments Have Been Resolved

IDENTIFICATION:				DISCIPLINE:
Document Title: Loop Uncertainty/Setpoint Determination for the ABB Model 27H Undervoltage Relay				☐ Civil/Structural ☐ Electrical ☒ I & C ☐ Mechanical ☐ Nuclear ☐ Other
Doc. No.:	G13.18.6.2-ENS-002	Rev. 2	QA Cat.: SR	
Verifier:	Robin Smith Print	[signature] Sign	2/20/09 Date	
Manager authorization for supervisor performing Verification. ☒ N/A	Print	Sign	Date	

METHOD OF VERIFICATION:		
Design Review ☒	Alternate Calculations ☐	Qualification Test ☐

The following basic questions are addressed as applicable, during the performance of any design verification. [ANSI N45.2.11 – 1974] [NP] [QAPD, Part II, Section 3] [NQA-1-1994, Part II, BR 3, Supplement 3s-1].

NOTE The reviewer can use the "Comments/Continuation sheet" at the end for entering any comment/resolution along with the appropriate question number. Additional items with new question numbers can also be entered.

1. Design Inputs – Were the inputs correctly selected and incorporated into the design?

   (Design inputs include design bases, plant operational conditions, performance requirements, regulatory requirements and commitments, codes, standards, field data, etc. All information used as design inputs should have been reviewed and approved by the responsible design organization, as applicable.

   All inputs need to be retrievable or excerpts of documents used should be attached.

   See site specific design input procedures for guidance in identifying inputs.)

   Yes ☒ No ☐ N/A ☐

2. Assumptions – Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are assumptions identified for subsequent re-verification when the detailed activities are completed? *Are the latest applicable revisions of design documents utilized?*

   Yes ☒ No ☐ N/A ☐

3. Quality Assurance – Are the appropriate quality and quality assurance requirements specified?

   Yes ☒ No ☐ N/A ☐

4. Codes, Standards and Regulatory Requirements – Are the applicable codes, standards and regulatory requirements, including issue and addenda properly identified and are their requirements for design met?
Yes ☒ No ☐ N/A ☐

5. Construction and Operating Experience – Have applicable construction and operating experience been considered?
Yes ☐ No ☐ N/A ☒

6. Interfaces – Have the design interface requirements been satisfied and documented?
Yes ☐ No ☐ N/A ☒

7. Methods – Was an appropriate design or analytical (for calculations) method used?
Yes ☒ No ☐ N/A ☐

8. Design Outputs – Is the output reasonable compared to the inputs?
Yes ☒ No ☐ N/A ☐

9. Parts, Equipment and Processes – Are the specified parts, equipment, and processes suitable for the required application?
Yes ☐ No ☐ N/A ☒

10. Materials Compatibility – Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
Yes ☐ No ☐ N/A ☒

11. Maintenance requirements – Have adequate maintenance features and requirements been specified?
Yes ☐ No ☐ N/A ☒

12. Accessibility for Maintenance – Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
Yes ☐ No ☐ N/A ☒

13. Accessibility for In-service Inspection – Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
Yes ☐ No ☐ N/A ☒

14. Radiation Exposure – Has the design properly considered radiation exposure to the public and plant personnel?
Yes ☐ No ☐ N/A ☒

15. Acceptance Criteria – Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
Yes ☒ No ☐ N/A ☐

16. Test Requirements – Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
Yes ☐ No ☐ N/A ☒

17. Handling, Storage, Cleaning and Shipping – Are adequate handling, storage, cleaning and shipping requirements specified?
Yes ☐ No ☐ N/A ☒

18. Identification Requirements – Are adequate identification requirements specified?
Yes ☐ No ☐ N/A ☒

19. Records and Documentation – Are requirements for record preparation, review, approval, retention, etc., adequately specified? Are all documents prepared in a clear legible manner suitable for microfilming and/or other documentation storage method? Have all impacted documents been identified for update as necessary?
Yes ☒ No ☐ N/A ☐

20. Software Quality Assurance- ENN sites: For a calculation that utilized software applications (e.g., GOTHIC, SYMCORD), was it properly verified and validated in accordance with EN- IT-104 or previous site SQA Program?
ENS sites: This is an EN-IT-104 task. However, per ENS-DC-126, for exempt software, was it verified in the calculation?
Yes ☐ No ☐ N/A ☒

21. Has adverse impact on peripheral components and systems, outside the boundary of the document being verified, been considered?
Yes ☐ No ☐ N/A ☒

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	Comments provided by markup for calculation G.13.18.6.2-ENS*002.	Comments resolved to the satisfaction of the reviewer.	CS 2/20/09

Calculation G13.18.6.2-ENS*002, Rev. 002 (EOI Review Comments)

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	Fix formatting in Section 7 and 8. Assumption and Subsection headers are indented to the right.	Fixed formatting and indentation problem.	
2	Move Assumption 7.1.15 title to top of next page to stay with text response.	Moved assumption 7.1.15	
3	In equation 8.8.1 change (.64) to (0.64).	Revised equation to read 0.5758 for LU change back to original value. See #4 below.	
4	TLU error went down and LU error went up. Since this calc affects G13.18.3.1*001 and potentially the TS, you may consider revising this calc to keep the TLU and LU values the same. The LU only changed due to the revised normal max temp of 109°F. However, you could have left it as 104°F by stating in the assumptions that although the normal maximum design temperature of the zone will be exceeded by 5°F approximately 1 percent of the calendar year (30 hours), this change is negligible and 104°F will be used in the calculation. TLU can be increased by adding margin. Keep this in mind when you review G13.18.3.1*001 for revision.	Corrected LU revising the assumption for temperature effect. Revised TLU adding margin to make result match existing number.	

Calculation G13.18.6.2-ENS*002, Rev. 002 (EOI Review Comments, Second Round)

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	Assumption 7.1.12 states in the last sentence that "this value will be used…" Clarify that the 0.5 VAC is the value that will be used.	Now reads: "The 0.5 VAC value will be used to determine relay temperature effects."	

☐ ANO-1	☐ ANO-2	☐ GGNS	☐ IP-2	☐ IP-3	☐ PLP
☐ JAF	☐ PNPS	☒ RBS	☐ VY	☐ W3	
☐ NP-GGNS-3	☐ NP-RBS-3				

CALCULATION COVER PAGE	(1) **EC #** 27437	(2) **Page 1 of** 22

(3) Design Basis Calc. ☒ YES ☐ NO	(4) ☒ CALCULATION ☐ EC Markup
(5) **Calculation No: G13.18.6.2-ENS*004**	(6) **Revision: 1**
(7) **Title:** Loop Uncertainty Determination for DIV III Loss of Voltage Relays – GE Model NGV Undervoltage Relay	(8) **Editorial** ☐ YES ☒ NO
(9) **System(s): 302**	(10) **Review Org (Department):** NSBE3 (I&C Design)

(11) **Safety Class:**	(12) **Component/Equipment/Structure Type/Number:**	
☒ **Safety / Quality Related** ☐ **Augmented Quality Program** ☐ **Non-Safety Related**	E22-S004-27N1	E22-S004-27N2
(13) **Document Type:** F43.02		
(14) **Keywords (Description/Topical Codes):** uncertainty, calculation		

REVIEWS

(15) Name/Signature/Date Chuck Mohr (see EC 11753 for signature)	(16) Name/Signature/Date Justin Waters (see EC 11753 for signature)	(17) Name/Signature/Date Paul Matzke (see EC 11753 for signature)
Responsible Engineer	☒ **Design Verifier** ☐ **Reviewer** ☒ Comments Attached	**Supervisor/Approval** ☒ Comments Attached

CALCULATION REFERENCE SHEET	CALCULATION NO: G.13.18.6.2-ENS*004 REVISION: 1

I. EC Markups Incorporated (N/A to NP calculations) None

II. Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	Tracking No.
1. EN-DC-126	--	002	☑	☐	N	
2. EN-IC-S-007-R	--	000	☑	☐	N	
3. 7224.300-000-001B	--	300	☑	☐	N	
4. 201.130-186	--	000	☑	☐	N	
5. 215.150	--	006	☑	☐	N	
6. G080-1344	--	000	☑	☐	N	
7. 6221.418-000-001A	--	300	☑	☐	N	
8. F137-0100	--	000	☑	☐	N	
9. 0221.418-000-008	--	300	☑	☐	N	
10. EE-001M	--	009	☑	☐	N	
11. GE-828E537AA	003	028	☑	☐	N	
12. GE-828E537AA	007	030	☑	☐	N	
13. GE-828E537AA	008	028	☑	☐	N	
14. GE-828E537AA	011	029	☑	☐	N	
15. STP-302-1604	--	018	☑	☐	N	
16. GE-152D8167	005	004	☑	☐	N	
17. G13.18.6.3-012	--	000	☑	☐	N	
18. EDP-AN-02	--	300	☑	☐	N	
19. G13.18.3.1*002	--	004	☐	☑	Y	EC11753
20. GE-152D8167	003	006	☑	☐	N	
21. GE-152D8167	003A	006	☑	☐	N	
22. GE-152D8167	004	007	☑	☐	N	
23. BE-230D	--	010	☑	☐	N	
24. 0221.418-000-049	--	300	☑	☐	N	

III. CROSS REFERENCES:

1. Indus Asset Suite Equipment Data Base (EDB)
2. Technical Specifications section B3.3.8.1
3. ANSI Standards C57.13 (1993), C37.90 (1989)
4. Multi-Amp Instruction Book EPOCH-10
5. USAR Figures 3.11-1 through 5

IV. SOFTWARE USED: N/A

Title:______________________ Version/Release:_____________Disk/CD No.________

V. DISK/CDS INCLUDED: N/A

Title:______________________ Version/Release_____________Disk/CD No.________

VI. OTHER CHANGES: The following related references have been removed:

3221.418-000-003U, 0221.415-000-122, GE-828E537AA #006, GE-DL828E537AA, STP-302-0102

Revision	Record of Revision
0	Initial issue to support determination of loss of voltage relay setpoints by Electrical Engineering
1	Incorporated new drift value and extended calibration period to 30 months per EC 11753.

TABLE OF CONTENTS

1.0 Purpose and Description

1.1. Purpose

The purpose of this calculation is to determine the uncertainty associated with the existing Division III, Safety-Related, 4.16 kV Loss of Voltage relays E22-27N1 and 27N2. Nominal trip Setpoints and Allowable values will be determined by the Electrical Engineering group in calculation G13.18.3.1*002 and documented on the applicable BE drawing.

1.2. Loop Descriptions

The DIV. III incoming Normal Supply power is monitored by two undervoltage relays (27N1 and 27N2) whose outputs are arranged in a one-out-of-two logic configuration (Reference 3.10.3). The channels include electronic equipment (e.g., trip units) that compare measured input signals with pre-established setpoints. When the setpoint is exceeded, the channel output relay actuates, opens the DIV III Normal Supply source breaker.

The Division III 4.16 kV emergency bus has its own independent Loss of Voltage instrumentation and associated trip logic. The DIV III emergency bus is monitored by undervoltage relays 27S1 through 27S4) whose outputs are arranged in a one-out-of-two, twice logic configuration (Reference 3.10.3).

1.3. Design Bases/Design Bases Event

Per Bases B 3.3.8.1, Reference 3.7.3, "successful operation of the required safety functions of the Emergency Core Cooling Systems (ECCS) is dependent upon the availability of adequate power sources for energizing the various components such as pump motors, motor operated valves, and the associated control components. The LOP instrumentation monitors the 4.16 kV emergency buses. Offsite power is the preferred source of power for the 4.16 kV emergency buses. If the monitors determine that insufficient power is available, the buses are disconnected from the offsite power sources and connected to the onsite diesel generator (DG) power sources."

1.4. Degree of Accuracy/Limits of Applicability

The results of this calculation are based on the statistical methods of at least 95% probability of occurrence for a one sided probability of distribution in accordance with "General Electric Instrument Setpoint Methodology," (Reference 3.3) and EN-IC-S-007-R, "Instrument Loop Uncertainty & Setpoint Calculations", (Reference 3.2).

The results of this calculation are valid under the Assumptions stated in Section 7.0 of this calculation. The appropriate use of this calculation to support design or station activities, other than those specified in Section 1.1 of this calculation, is the responsibility of the user.

1.5. Applicability

A data analysis has been performed in order to determine which, if any, redundant instrument loops are bounded by the results of this calculation. This calculation is applicable to the Loops associated with the primary elements stated in Section 2.1. The results of this calculation are bounding for the applicable instrument loops, based on such factors as instrument manufacturer and model number, instrument location/environmental parameters, actual installation and use of the instrument in process measurements.

2.0 Results/Conclusion

2.1. Results

The Loop Uncertainty and Total Loop Uncertainty for the Loss of Voltage and Loss of Voltage relays were calculated in Section 8.0. These values and other associated values such as loop drift are presented in table 2.1-1.

Table 2.1-1
Model NGV Loss of Voltage Relay – Voltage Trip

System(s)	Loop Identification	Loop Uncertainty (LU) VAC	Channel Drift (D_L) VAC	Total Loop Uncertainty (TLU) VAC	M&TE Loop Accuracy Requirements (MTE_L) VAC	Maximum Loop Setting Tol. (PALB) VAC
302	E22-S004-27N1 E22-S004-27N2	± 3.678 *± 128.73	± 5.823	± 5.31 *± 185.85	± 0.375	± 2.61

*** Value adjusted to reflect uncertainty applied to the primary of the potential transformer.**

2.2. Conclusions

The calculated Loop Uncertainty and Total Loop Uncertainty presented in table 2.1-1 are bounding for the relays and circuits listed in Section 2.1.

3.0 **References**

3.1. EN-DC-126, "Engineering Calculation Process"

3.2. EN-IC-S-007-R, "Instrument Loop Uncertainty & Setpoint Calculations"

3.3. 7224.300-000-001B, NEDC-31336P-A, General Electric Instrument Setpoint Methodology

3.4. Indus Asset Suite Equipment Data Base (EDB)

3.5. 201.130-186, "Peak Spreading of ARS Curves for the Control Building"

3.6. Environmental Design Criteria, Spec 215.150, including USAR figures 3.11-1 through 5 as outlined in EDP-AN-02 section 6.3.1

3.7. RBS Operating License

3.7.1. Not used

3.7.2. Not used

3.7.3. Bases Sections B3.3.8.1

3.8. RBS USAR

None

3.9. Vendor Manuals/Documents

3.9.1. G080-1344, General Electric Instructions Undervoltage Relays

3.9.2. F137-0100, Fluke 45 Dual Display Multimeter Users Manual

3.9.3. Multi-Amp Instructions for the EPOCH-10, Microprocessor-Enhanced Protective Relay Test Set, (maintained by the Standards Laboratory)

3.9.4. 6221.418-000-001A, High Pressure Core Spray System Power Supply Unit, NEDO-10905

3.9.5. 0221.418-000-008, Purchase Specification Data Sheet 21A9300AU, High Pressure Core Spray System

3.10. Electrical Schematics

3.10.1. EE-001M, 4160V One Line Diagram Standby Bus E22-S004

3.10.2. GE-828E537AA#003, Elementary Diagram HPCS Power Supply System

3.10.3. GE-828E537AA#007, Elementary Diagram HPCS Power Supply System

3.10.4. GE-828E537AA#008, Elementary Diagram HPCS Power Supply System

3.10.5. GE-828E537AA#011, Elementary Diagram HPCS Power Supply System

3.11. Surveillance Test Procedures:

3.11.1. STP-302-1604, HPCS Loss of Voltage Channel Calibration And Logic System Functional Test

3.11.2. Not used

3.12. Logic Diagrams

3.12.1. GE-152D8167#003, Functional Control Diagram, High Pressure Core Spray Power Supply

3.12.2. GE-152D8167#003A, Functional Control Diagram, High Pressure Core Spray Power Supply

3.12.3. GE-152D8167#004, Functional Control Diagram, High Pressure Core Spray Power Supply

3.12.4. GE-152D8167#005, Functional Control Diagram, High Pressure Core Spray Power Supply

3.13. Standards

3.13.1. ANSI Standard C57.13, Requirements for Instrument Transformers

3.13.2. ANSI Standard C37.90, Relays and Relay Systems Associated with Electric Power Apparatus

3.14. E-mail message from General Electric Power Management to George Boles, Attachment 1

3.15. G13.18.6.3-012, Rev.0, General Electric Model NGV13B Relay Drift Analysis

3.16. BE-230D, 4.16kV Bus 1E22-S004 Relay Settings

3.17. 0221.418-000-049, 1E22-S004 Equipment Summary

4.0 Design Input

4.1. Loop Input

4.1.1. Loop Data:

Form 1: Loop/Process Data Sheet		
Description	**Data**	**Reference**
Loop Sensor(s)	E22-S004 PT-Line	3.10.4
Location	E22-S004	3.10.4
Output Range	0 – 120 VAC	3.10.4
Input Range	0 – 4200 VAC	3.10.4

4.1.2. Special Considerations:

4.1.2.1. Calibration shall be performed using the following instruments:

- Multi-Amp EPOCH-10 relay tester set to Oscillator mode (Reference 3.9.3)
- Fluke Model 45 Digital Multimeter set to medium resolution (Reference 3.9.2)

4.1.2.2. A minimum of 1 hour warm up time at the location where the M&TE will be used shall be allowed for the Fluke Model 45 Multimeter.

4.2. Loop Instrumentation

Form 2: Instrument Data Sheet Calc. Device Number 1		
Description	**Data**	**Reference**
Component Number(s)	E22-S004-PT-Bus	3.4
Manufacturer	GE	3.17
Model(s)	JVM	3.17
Location(s)	CB. 116'EL/E22-S004	3.4
Service Description	Transformer	3.4
Instrument Range	0 – 4200 VAC	3.10.4
Instrument Span	120 VAC	3.10.4
Output Range	0 – 120 VAC	3.10.4
Calibration Interval Evaluated	N/A	Note
Device Setting Tolerance	N/A	Note

Note: Potential transformers for instrument service cannot be calibrated or adjusted. Therefore there is no device setting tolerance or calibration interval.

Form 2: Instrument Data Sheet Calc. Device Number 2		
Description	**Data**	**Reference**
Component Number(s)	E22-S004-27N1 E22-S004-27N2	3.4
Manufacturer	General Electric	3.16
Model	12NGV	3.16
Location(s)	CB. 116'EL/E22-S004	3.4
Service Description	Relay	3.4
Input Range	0 – 120 VAC	3.9.1
Output	Contact Action	3.10, 3.12
Calibration Interval Evaluated	30 Mo. (24 Mo. + 25%)	3.2

4.3. **Loop Device Data**

Form 3: Instrument Accuracy Data Sheet Calc. Device Number 1 General Electric JVM		
Description	**Data**	**Reference**
Reference Accuracy (RA_T)	0.3% of setting 2σ	3.9.4, 8.2.1 7.1.2
Seismic Effects (SE_T)	N/A	7.1.4
Temperature Effects (TE_T)	N/A	7.1.12
Insulation Resistance Effects (IR_T)	N/A	7.1.10
Temperature Drift Effect (TD_T)	N/A	7.1.13
Drift (DR_T)	N/A	7.1.14

Form 3: Instrument Accuracy Data Sheet **Calc. Device Number 2** **General Electric NGV**		
Description	**Data**	**Reference**
Reference Accuracy (RA_R)	± 1% of setting 2σ	3.14, Attachment 1 7.1.2
Seismic Effects (SE_R)	0	7.1.4
Temperature Effects (TE_R)	2% of setting (68°F – 104°F)	7.1.12
Insulation Resistance Effects (IR_R)	N/A	7.1.10
Temperature Drift Effect (TD_R)	N/A	7.1.13
Drift (DR_R)	± 5.823 VAC 2σ	3.15
Power Supply Effect (PS_R)	N/A	7.1.6
Reset Differential	10% of Setting 2σ	3.9.1 3.11.1, 7.1.2

4.4. **Environmental Information**

Form 4: Environmental Conditions Data Sheet		
Zone: CB-116-2		
Description	**Data**	**Reference**
Location		
Building/Elevation	CB-116	3.4
Room/Area	Switchgear Room	3.4
Normal		
Temperature Range, °F	40 - 104	3.6, 7.1.12
Humidity Range, %RH	20 - 90	3.6, 7.1.9
Radiation 40 Year Total Integrated Dose, Rads	800	3.6
Pressure Range	Atmos	3.6
Accident (Loss of Offsite Power)		
Temperature Range, °F	Same as Normal	3.6
Humidity Range, %RH	Same as Normal	3.6
Radiation, Total Integrated Dose, Rads	Same as Normal	3.6
Pressure Range	Same as Normal	3.6
Seismic		
Accelerations, g	< 3	3.5

5.0 Nomenclature

The terms and abbreviations that are not defined in this section are defined in Reference 3.3, Reference 3.2 or within the text of this calculation.

6.0 Calculation Methodology

This calculation is prepared in accordance with the EN-IC-S-007-R, “Instrument Loop Uncertainty & Setpoint Calculations” (Reference 3.2), EN-DC-126, “Engineering Calculation Process” (Reference 3.1) and 7224.300-000-001B, “General Electric Instrument Setpoint Methodology” (Reference 3.3).

7.0 Assumptions

7.1. Assumptions that do not require confirmation

7.1.1. Miscellaneous Allowance (ML)

A miscellaneous allowance has not been applied to the uncertainty of the devices evaluated by this calculation. By assuming all vendor supplied data is a 2σ value and with intermediate rounding of values, sufficient conservatism has been introduced.

7.1.2. Vendor 2σ Data

For conservatism, all uncertainties given in vendor data specifications are assumed to be 2σ unless otherwise specified.

7.1.3. Zero Effect

Not applicable

7.1.4. Seismic Effects (SE)

Seismic effects are assumed to be negligible for the NGV relay, per Reference 3.9.5. Seismic effects are not applicable to potential transformers.

7.1.5. Radiation Effects (RE) & Radiation Drift Effect (RD)

Are not applicable to the relays and transformers evaluated by this calculation, as they are located in a mild environment (Reference 3.6).

7.1.6. Power Supply Effects (PS)

Power supply effects are not applicable to type NGV relays as the relay does not utilize a control power source separate from the sensed voltage.

Power supply effects are not applicable to transformers.

7.1.7. Process Measurement Uncertainty (PM)

Not Applicable

7.1.8. Static Pressure Effects (SP)

Not Applicable

7.1.9. Humidity Effects (HE)

The relays were specified by the HPCS manufacturer and are assumed to be designed to with stand the environmental effects in the mounting location. The HPCS Design Specification, Section 4.6.1 (reference 3.9.5) states that the design conditions for the switchgear and its sub-components are 20-90% Relative Humidity. Per Reference 3.6, the humidity range for environmental zone CB-116-2 is 20 to 90% RH. Reference 3.6 also identifies that 1% of the calendar year (30 hours) the humidity could be 5 % higher. This is considered negligible.Therefore, it is assumed that Humidity Effects are negligible.

7.1.10. Insulation Resistance Effects (IR)

(IR) effects, which may result in degradation of circuit insulation, are not applicable to the devices and circuits addressed by this calculation.

7.1.11. Voltage Drop

Voltage drop due to long wiring lengths between source and load are assumed to be negligible as the potential transformers and the under-voltage relays evaluated by this calculation are located in the same switch gear compartment.

7.1.12. Temperature Effects (TE)

There is no temperature effect data available from the manufacturer for the Type NGV relay. Therefore for conservatism, temperature effects are assumed to be equal to the repeatability value (± 2% of setting) given in Attachment 1. Reference 3.6 also identifies that 1% of the calendar year (30 hours) the temperature could be 5°F higher. This is considered negligible.

Temperature effects are not applicable to transformers. Temperatures above the rated value would tend to produce total failure of the transformer, rather than an error in output.

7.1.13. Temperature Drift Effects (TD)

The drift analysis performed in Reference 3.15 is assumed to encompass all components of drift and drift effects except for temperature drift effects which are assumed to be included in the Reference Accuracy of the device.

Temperature drift effects are not applicable to transformers.

7.1.14. Instrument Drift

The drift analysis can be found in Reference 3.15.

Drift is not applicable to transformers.

7.2. Assumptions that require confirmation

None

8.0 **Calculation**

This section includes the following subsections used in performance of this calculation:

8.1) Calculation of Miscellaneous Uncertainties

8.2) Calculation of Individual Device Reference Accuracy (RA) and Determination of Appropriate Device Uncertainty

8.3) Calculation of Individual Device Uncertainties

8.4) Calculation of Loop Calibration Accuracy (C_L)

8.5) Calculation of Insulation Resistance Effects (IR)

8.6) Calculation of Loop Uncertainty (LU)

8.7) Calculation of the Loop Drift (D_L)

8.8) Calculation of Total Loop Uncertainty (TLU)

8.9) Calculation of Reset Differential (RD)

8.1. Calculation of Miscellaneous Uncertainties

8.1.1. Calculation of Transformer Burden and Determination of Reference Accuracy

Per Reference 3.9.4, page 5-10, section 5.3, the Type JVM potential transformer has a 1.2% ratio error for a combined relaying and metering burden of greater than 75 VA. However, a burden below 75VA yields a transformer accuracy of ± 0.3% of setting. As shown below, the devices fed by the PT Line transformer do not meet the 75 VA burden threshold.

2 Model NGV Undervoltage Relays @ 4.2 VA each	=	8.4
2 Model 27N Undervoltage Relays @ 0.5 VA each	=	1.0
1 Synchronizing Relay @ 2.0 VA	=	2.0
2 Volt Meter, GE AB40 @ 0.32 VA each	=	0.64
1 Synchronizing Scope @ 5.2 VA	=	5.2
Control Relays/Meters not listed, Assumed Value	=	10.0
		25.24 VA

Therefore, PT Reference Accuracy shall be 0.3% of setting (87 VAC per Ref. 3.11.1) or 0.261 VAC for this calculation.

8.1.2. Calculation of Relay Temperature Effects (TE_R) (Assumption 7.1.12)

TE_R = ± 1% Setting
= ± 0.01 x 87 VAC
= ± 0.87 VAC

8.2. **Calculation of Individual Device Reference Accuracy (RA) & Determination of Appropriate Device Uncertainty**

8.2.1. Transformer Reference Accuracy (RA_T)

RA_T = ± 0.3% of Setting
= ± 0.003 * 87 VAC
= ± 0.261 VAC (2σ Value)

8.2.2. Undervoltage Relay Reference Accuracy for Voltage Setting (RA_R)

RA_R = ± 1% of Setting
= ± 0.01 * 87 VAC
= ± 0.87 VAC (2σ Value)

8.2.3. Loop Reference Accuracy (RA_L)
(Reference 3.2)

$RA_L = \pm [(RA_T)^2 + (RA_R)^2]^{1/2}$
$= \pm [(0.261)^2 * (0.87)^2]^{1/2}$
= ± 0.908 VAC (2σ Value)

Per Reference 3.11.1 the Loop Calibration Tolerance (CT_L – Procedural As Left Band) for Loss of Voltage is ± 2.61 VAC. As the CT_L value is greater than the associated Loop Reference Accuracy, the individual device Reference Accuracies are set to zero for the remainder of this calculation (Reference 3.2).

8.3. **Calculation of Individual Device Uncertainties** (Reference 3.2)

8.3.1. Device Uncertainty Transformer (A_T) (Sections 4.3 and 8.2.1)

$A_T = \pm [(RA_T)^2]^{1/2}$
$= \pm [(0)^2]1/2$
= + 0 VAC (2σ Value)

8.3.2. Device Uncertainty Relay Voltage Setting (A_R)

$A_R = \pm [(RA_R)^2 + (PS_R)^2 + (TE_R)^2]^{1/2}$
$= \pm [(0)^2 + (0)^2 + (0.87)^2]^{1/2}$
= ± 0.87 VAC (2σ Value)

8.4. **Calculation of Loop Calibration Accuracy (C_L)**
Per reference 3.2 and 3.3 Loop Calibration uncertainty (C_L) is defined as:

$C_L = \pm [(MTE_L)^2 + (CT_L)^2]^{1/2}$
$= \pm [0.375^2 + 2.61^2]^{1/2}$ VAC
= ± 2.64 VAC (2σ Value)

8.4.1. Measuring and Test Equipment Effects – Relay (MTE_L)

Measurement & Test Equipment (MTE_L) effects are defined from Reference 3.2 as:

$MTE_L = \pm [(MTE_{RAT})^2 + (MTE_{RIT})^2 + (MTE_{TET})^2 + (MTE_{CST})^2]^{1/2}$

Where:

MTE_{RAT} = Reference accuracy of the M&TE used for calibration. Assumed equal to the Reference Accuracy of the primary element in the loop, 0.261 VAC (Reference 3.2).

MTE_{RIT} = Readability of the M&TE used, assumed to be 0 as all M&TE used are digital with at least 2 digits of resolution. (Reference 3.2)

MTE_{TET} = Effects of temperature changes on the M&TE between the calibration laboratory and the area where the M&TE is used, Assumed equal to the Reference accuracy of the primary element in the loop, 0.261 VAC (Reference 3.2).

MTE_{CST} = The accuracy of the calibration standard used to calibrate the M&TE, assumed equal to 1/4 the Reference accuracy of the primary element in the loop, 0.065 VAC (Reference 3.2).

$$\begin{aligned} MTE_L &= \pm [(MTE_{RAT})^2 + (MTE_{RIT})^2 + (MTE_{TET})^2 + (MTE_{CST})^2]^{1/2} \\ &= \pm [(0.261)^2 + (0)^2 + (0.261)^2 + (0.065)^2]^{1/2} \\ &= \pm 0.375 \text{ VAC} \qquad (2\sigma \text{ Value}) \end{aligned}$$

8.4.2. Calculation of Calibration Effects (CT)

Calibration Effects (CT_L) are defined from Reference 3.2 as:

CT_L = Square Root Sum of the Squares (SRSS) of the calibration effects which are uncertainties due to "as Left" loop accuracy.

$CT_L = \pm 2.61$ VAC (2σ value)

8.5. Calculation of Insulation Resistance Effects (IR)

0 per Assumption 7.1.10

8.6. Calculation of Loop Uncertainty (LU)

$$\begin{aligned} LU &= \pm (m/n)[(A_T)^2 + (A_R)^2 + (C_L)^2]^{1/2} \pm M \text{ (margin)} \\ &= \pm (1.645/2)[(0)^2 + (0.87)^2 + (2.64)^2]^{1/2} \pm 1.392 \\ &= \pm 3.678 \text{ VAC} \end{aligned}$$

Adjusted to reflect primary voltage to the PT

= ± 3.678 x PT Ratio (Primary Voltage/Secondary Voltage)

= ± 3.678 x 35 VAC

= ± 128.73 VAC

8.7. Calculation of Loop Drift (D_L)

8.7.1. Transformer Temperature Drift Effects (TD_T)

0 for per Assumption 7.1.13

8.7.2. Relay Temperature Drift Effects (TDR)

0 per assumption 7.1.13

8.7.3. Relay Drift (DR_R):

Assumption 7.1.14

$DR_R = \pm$ 5.823 VAC (2σ Value)

As the only component of loop drift is the relay drift determined in reference 3.15, Loop Drift (DR_L) is equal to Relay Drift (DR_R).

$D_L = \pm$ 5.823 VAC (2σ Value)

8.8. Calculation of Total Loop Uncertainty (TLU) Calculation:

$$TLU = \pm (m/n)[(A_T)^2 + (A_R)^2 + (C_L)^2 + (DR_L)^2]^{1/2}$$
$$= \pm (1.645/2)[(0)^2 + (0.87)^2 + (2.64) + (5.823)^2]^{1/2}$$
$$= \pm 5.31 \text{ VAC}$$

Adjusted to reflect primary voltage to the PT:

= ± 5.31 x PT Ratio (Primary Voltage/Secondary Voltage)
= ± 5.31 x 35 VAC
= ± 185.85 VAC

8.9. Calculation of Reset Differential

The reset differential is applied to the voltage setting and is specified to be ± 10% of setting per References 3.9.1 and 3.11.1. This value will be used in the calculation.

RR = ± 0.1 * setting VAC
= ± 0.1*87
= ± 8.70 VAC

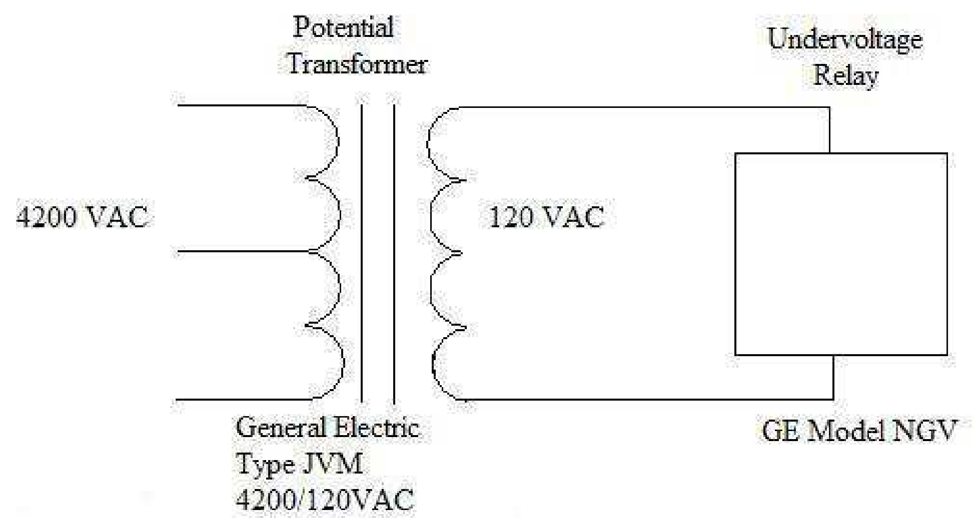
Adjusted to reflected primary (bus) voltage at the PT:

= RR x PT Ratio (primary voltage/secondary voltage)
= ± 8.7 x 35 VAC
= ± 304.5 VAC

Calculated uncertainties are applicable to reset.

Summary of Calculation Data						
	Transformer Device 1			**Undervoltage Relay Device 2**		
	Values	**σ**	**Ref**	**Values**	**σ**	**Ref**
Input Range	0 – 42 kV	–	3.13	0 – 120	–	3.13
Process Units	**VAC**	–	3.13	**VAC**	–	3.13
Reference Accuracy (RA)	0.3% of Setting	2	8.2.1	1% of Setting	2	8.2.2
Temperature Effect (TE)	N/A	–	7.1.12	± 0.87	2	7.1.12
Seismic Effects (SE)	N/A	–	7.1.4	N/A	–	7.1.4
Radiation Effect (RE)	N/A	–	7.1.5	N/A	–	7.1.5
Instrument Drift (DR)	N/A	–	7.1.14	± 5.823	2	3.15
Temperature Drift Effect (TD)	N/A	–	7.1.13	N/A	–	7.1.13
Radiation Drift Effect (RD)	N/A	–	7.1.5	N/A	–	7.1.5
Power Supply Effect (PS)	N/A	–	7.1.6	N/A	–	7.1.6
Humidity Effects (HE)	N/A	–	7.1.9	N/A	–	7.1.9
Static Pressure Effect (SP)	N/A	–	7.1.8	N/A	–	7.1.8
Process Measurement Effect (PM)	N/A	–	7.1.7	N/A	–	7.1.7
Insulation Resistance Effect (IR)	N/A	–	7.1.10	N/A	–	7.1.10
Zero Effect (ZE)	N/A	–	7.1.3	N/A	–	7.1.3

9.0 <u>Simplified Block Diagram</u>



From: "EmailClerk (IndSys,IM)" <emailclerk@indsys.ge.com>
To: <georgeboles@dpengineering.com>
Subject: Email out for Case C01-39202
Date: Thursday, April 19, 2001 7:14 AM

Please use Reply to respond to this e-mail.
Any changes made to the Original Message content will not be transferred.
Please do not modify the subject line or processing of this e-mail may be delayed.

Case C01-39202
Subject NGV Dropout Range

George,

The dropout range for the NGV11 relay is "Once the voltage dropout level has been adjusted to a value within the range of Dropout Adjustment as in Table C of the Instruction Book then on any dropout operation, the voltage range from the beginning of the action to its completion is about one percent of rated voltage"

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DESIGN VERIFICATION COVER PAGE

☐ ANO-1 ☐ ANO-2 ☐ IP-2 ☐ IP-3 ☐ JAF ☐ PLP
☐ PNPS ☐ VY ☐ GGNS ☒ RBS ☐ W3 ☐ NP

Document No. **G13.18.6.2.ENS*004**	Revision No. **1**	Page 1 of 4

Title: **Loop Uncertainty Determination for Div III Loss of Voltage Relays – GE Model NGV Undervoltage Relay**

☒ Quality Related ☐ Augmented Quality Related

DV Method: ☒ Design Review ☐ Alternate Calculation ☐ Qualification Testing

VERIFICATION REQUIRED	DISCIPLINE	VERIFICATION COMPLETE AND COMMENTS RESOLVED (DV print, sign, and date)
☐	Electrical	
☐	Mechanical	
☒	Instrument and Control	**Justin Waters** Justin Waters 2/24/09
☐	Civil/Structural	
☐	Nuclear	
☐		
☐		

Originator: **Charles Mohr** Charles Mohr 2/24/09
Print/Sign/Date After Comments Have Been Resolved

IDENTIFICATION:				DISCIPLINE:
Document Title: **Loop Uncertainty Determination for Div III Loss of Voltage Relays – GE Model NGV Undervoltage Relay**				☐ Civil/Structural ☐ Electrical
Doc. No.:	**G13.18.6.2.ENS*004**	Rev. **1**	QA Cat.: SR	☒ I & C
Verifier:	Justin Waters Print	Justin Waters Sign	2/24/09 Date	☐ Mechanical ☐ Nuclear
Manager authorization for supervisor performing Verification. ☐ N/A	Print	Sign	Date	☐ Other
METHOD OF VERIFICATION: Design Review ☒	Alternate Calculations ☐		Qualification Test ☐	

The following basic questions are addressed as applicable, during the performance of any design verification. [ANSI N45.2.11 – 1974] [NP] [QAPD, Part II, Section 3] [NQA-1-1994, Part II, BR 3, Supplement 3s-1].

NOTE The reviewer can use the "Comments/Continuation sheet" at the end for entering any comment/resolution along with the appropriate question number. Additional items with new question numbers can also be entered.

1. Design Inputs – Were the inputs correctly selected and incorporated into the design?

   (Design inputs include design bases, plant operational conditions, performance requirements, regulatory requirements and commitments, codes, standards, field data, etc. All information used as design inputs should have been reviewed and approved by the responsible design organization, as applicable.

   All inputs need to be retrievable or excerpts of documents used should be attached.

   See site specific design input procedures for guidance in identifying inputs.)

   Yes ☒ No ☐ N/A ☐

2. Assumptions – Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are assumptions identified for subsequent re-verification when the detailed activities are completed? *Are the latest applicable revisions of design documents utilized?*

   Yes ☒ No ☐ N/A ☐

3. Quality Assurance – Are the appropriate quality and quality assurance requirements specified?

   Yes ☒ No ☐ N/A ☐

4. Codes, Standards and Regulatory Requirements – Are the applicable codes, standards and regulatory requirements, including issue and addenda properly identified and are their requirements for design met?
Yes ☒ No ☐ N/A ☐

5. Construction and Operating Experience – Have applicable construction and operating experience been considered?
Yes ☐ No ☐ N/A ☒

6. Interfaces – Have the design interface requirements been satisfied and documented?
Yes ☐ No ☐ N/A ☒

7. Methods – Was an appropriate design or analytical (for calculations) method used?
Yes ☒ No ☐ N/A ☐

8. Design Outputs – Is the output reasonable compared to the inputs?
Yes ☒ No ☐ N/A ☐

9. Parts, Equipment and Processes – Are the specified parts, equipment, and processes suitable for the required application?
Yes ☐ No ☐ N/A ☒

10. Materials Compatibility – Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
Yes ☐ No ☐ N/A ☒

11. Maintenance requirements – Have adequate maintenance features and requirements been specified?
Yes ☐ No ☐ N/A ☒

12. Accessibility for Maintenance – Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
Yes ☐ No ☐ N/A ☒

13. Accessibility for In-service Inspection – Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
Yes ☐ No ☐ N/A ☒

14. Radiation Exposure – Has the design properly considered radiation exposure to the public and plant personnel?
Yes ☐ No ☐ N/A ☒

15. Acceptance Criteria – Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
Yes ☒ No ☐ N/A ☐

16. Test Requirements – Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
Yes ☐ No ☐ N/A ☒

17. Handling, Storage, Cleaning and Shipping – Are adequate handling, storage, cleaning and shipping requirements specified?
Yes ☐ No ☐ N/A ☒

18. Identification Requirements – Are adequate identification requirements specified?
Yes ☐ No ☐ N/A ☒

19. Records and Documentation – Are requirements for record preparation, review, approval, retention, etc., adequately specified? Are all documents prepared in a clear legible manner suitable for microfilming and/or other documentation storage method? Have all impacted documents been identified for update as necessary?
Yes ☒ No ☐ N/A ☐

20. Software Quality Assurance- ENN sites: For a calculation that utilized software applications (e.g., GOTHIC, SYMCORD), was it properly verified and validated in accordance with EN- IT-104 or previous site SQA Program?
ENS sites: This is an EN-IT-104 task. However, per ENS-DC-126, for exempt software, was it verified in the calculation?
Yes ☐ No ☐ N/A ☒

21. Has adverse impact on peripheral components and systems, outside the boundary of the document being verified, been considered?
Yes ☐ No ☐ N/A ☒

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	Comments provided by markup for calculation G.13.18.6.2-ENS*004.	Comments resolved to the satisfaction of the reviewer.	JW 2/24/09

Calculation G13.18.6.2-ENS*004, Rev. 001 (EOI Review Comments)

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	Calc number should be G13.18.6.2-ENS*004	Corrected	
2	Calc ref sheet does list the following references from the original calc. Should they be listed in Section VI of the form as being removed? 0221.415-000-122 3221.418-000-003U STP-302-0102	Agreed, those are not used.	
3	Should a reference be added to show where the Setting value of 87 VAC is derived in Section 8.1.1?	I think that's a good idea – the setting doesn't appear to be referenced anywhere. Added reference to STP in Section 8.1.1	
4	Use Ref. 3.11.1 for the STP in Section 8.9 instead of directly referring to it like was done in Section 8.2.3.	Agreed, although this paragraph will be removed per comment below.	
5	Your change in the first paragraph to Section 8.9 now references the STP As-Left reset tolerance. However, the original paragraph pertained to the reset differential value itself, not its tolerance. The current STP revision shows the Reset Differential as 95.70 VAC or 10% of setting. This is stated in the second paragraph of Section 8.9. Based on this I don't believe the first paragraph is required anymore since the rest is now the same whether the relay is calibrated or not calibrated during performance of the STP.	Agreed – first paragraph serves no purpose. Removed. (changes page count)	
		Note: Per discussion, margin was added to the LU to bring it up to previous value. No margin added to TLU. See Section 8.6 and 2.1.	

☐ ANO-1	☐ ANO-2	☐ GGNS	☐ IP-2	☐ IP-3	☐ PLP
☐ JAF	☐ PNPS	☒ RBS	☐ VY	☐ W3	
☐ NP-GGNS-3	☐ NP-RBS-3				

CALCULATION COVER PAGE	(1) **EC # 27437**	(2) **Page 1 of 30**
(3) Design Basis Calc. ☒ YES ☐ NO	(4) ☒ CALCULATION ☐ EC Markup	
(5) **Calculation No: G13.18.6.2-ENS*006**		(6) **Revision: 1**
(7) **Title: Loop Uncertainty Determination for Div I and II Under Voltage Time Delay Relays – ABB Model 62K and 62L Time Delay Relays**		(8) **Editorial** ☐ YES ☒ NO
(9) **System(s): 302**	(10) **Review Org (Department): NSBE3 (I&C Design)**	

(11) **Safety Class:**	(12) **Component/Equipment/Structure Type/Number:**	
☒ **Safety / Quality Related** ☐ **Augmented Quality Program** ☐ **Non-Safety Related**	**ENS-SWG1A-62-1**	**ENS-SWG1B-62-1**
	ENS-SWG1A-62-2	**ENS-SWG1B-62-2**
	ENS-SWG1A-62-5	**ENS-SWG1B-62-5**
(13) **Document Type: F43.02**	**ENS-SWG1A-62-6**	**ENS-SWG1B-62-6**
(14) **Keywords (Description/Topical Codes):** **Uncertainty, time delay**		

REVIEWS

(15) Name/Signature/Date Chuck Mohr (see EC 11753 for signature)	(16) Name/Signature/Date Justin Waters (see EC 11753 for signature)	(17) Name/Signature/Date Paul Matzke (see EC 11753 for signature)
Responsible Engineer	☒ **Design Verifier** ☐ **Reviewer** ☒ Comments Attached	**Supervisor/Approval** ☒ Comments Attached

CALCULATION REFERENCE SHEET

I. EC Markups Incorporated (N/A to NP calculations):

II. Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	Tracking No.
1. EN-DC-126	--	002	☑	☐	N	
2. EN-IC-S-007-R	--	000	☑	☐	N	
3. 7224.300-000-001B	--	300	☑	☐	N	
4. 201.130-186	--	000	☑	☐	N	
5. 215.150	--	006	☑	☐	N	
6. B455-0147	--	000	☑	☐	N	
7. 3242.521-102-001A	--	300	☑	☐	N	
8. 0242.521-102-133	--	300	☑	☐	N	
9. B455-0157	--	300	☑	☐	N	
10. EE-001K	--	019	☑	☐	N	
11. EE-001L	--	015	☑	☐	N	
12. ESK-08ENS01	001	008	☑	☐	N	
13. ESK-08EGS09	001	013	☑	☐	N	
14. ESK-08EGS10	001	012	☑	☐	N	
15. ESK-08EGS13	001	011	☑	☐	N	
16. ESK-08EGS14	001	010	☑	☐	N	
17. ESK-08EGS15	001	009	☑	☐	N	
18. ESK-08EGS16	001	007	☑	☐	N	
19. STP-302-1600	--	018	☑	☐	N	
20. STP-302-1601	--	017	☑	☐	N	
21. G13.18.6.3-009	--	000	☑	☐	N	
22. LSK-24-09.05A	001	015	☑	☐	N	
23. EDP-AN-02	--	300	☑	☐	N	
24. 0242.521-102-129	--	300	☑	☐	N	
25. G13.18.3.1*001	--	003	☐	☑	Y	EC11753

CALCULATION REFERENCE SHEET

26. STP-302-1602	--	020	☑	☐	N	
27. STP-302-1603	--	020	☑	☐	N	
28. BE-230A	--	008	☑	☐	N	
29. BE-230B	--	010	☑	☐	N	
30. G13.18.6.2-ENS*005	--	000	☑	☐	N	
31. G13.18.3.1*002	--	004	☑	☐	N	
32. EE-420G	--	011	☑	☐	N	
33. EE-420H	--	008	☑	☐	N	
34. STP-302-0102	--	016	☑	☐	N	

III. CROSS REFERENCES:

1. Indus Asset Suite Equipment Data Base (EDB)
2. Technical Specifications section B3.3.8.1
3. Multi-Amp Instruction Book EPOCH-40
4. USAR Figures 3.11-1 through 5.
5. EQTAP

IV. SOFTWARE USED:

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

V. DISK/CDS INCLUDED:

Title: N/A Version/Release______ Disk/CD No.______

VI. OTHER CHANGES: The following references are no longer used:

0242.521-102-060, 0242.521-102-061, 0242.521-102-063, 0242.521-102-064, 0242.521-102-070, 0242.521-102-071, 0242.521-102-076, 242.521, CSD-24-09.05, 0242.521-102-084, ESK-08EGS01 #001, ESK-08EGS04 #001, EDP-AA-20, EDG-EE-003, F137-0100

Revision	Record of Revision
0	Initial issue to support determination of degraded voltage relay setpoints and LAR by ER-RB-2001-0360-000.
1	Incorporated new drift value for 62K and 62L relay per EC 11753.

TABLE OF CONTENTS

1.0 PURPOSE AND DESCRIPTION

1.1 Purpose

The purpose of this calculation is to determine the uncertainty associated with the Division I & II, Safety-Related, 4.16 kV undervoltage time delay relays. Nominal trip Set points and Allowable values will be determined by the Electrical Engineering group in calculation G13.18.3.1*001 and documented on the applicable BE drawing.

1.2 Loop Descriptions

Each 4.16 kV emergency bus has its own independent Loss Of Power (LOP) instrumentation and associated trip logic. The voltage for the Division I and II buses is monitored at two levels, which can be considered as two different undervoltage functions; loss of voltage and sustained degraded voltage.

Each 4.16 kV bus is monitored by three degraded voltage relays whose outputs are arranged in a two-out-of-three logic configuration (Reference 3.12). The channels include electronic equipment (e.g., trip units) that compares measured input signals with pre-established setpoints. When the setpoint is exceeded, the channel output relay actuates a time delay relay, which then outputs a LOP trip signal to the trip logic. Two different time delays are applied depending on whether a LOCA signal is present at the time of the degraded voltage. The LOCA and Non-LOCA time delay is provided by the combination of the 27N relay and the 62K relays.

1.3 Design Bases/Design Bases Event

Per Bases B 3.3.8.1, Reference 3.7.3, “successful operation of the required safety functions of the Emergency Core Cooling Systems (ECCS) is dependent upon the availability of adequate power sources for energizing the various components such as pump motors, motor operated valves, and the associated control components. The LOP instrumentation monitors the 4.16 kV emergency buses. Offsite power is the preferred source of power for the 4.16 kV emergency buses. If the monitors determine that insufficient power is available, the buses are disconnected from the offsite power sources and connected to the onsite diesel generator (DG) power sources.”

1.4 Degree of Accuracy/Limits of Applicability

The results of this calculation are based on the statistical methods of at least 95% probability of occurrence for a two sided probability distribution in accordance with 7224.300-100-001B, "General Electric Instrument Setpoint Methodology," (Reference 3.3) and EN-IC-S-007-R, "Instrument Loop Uncertainty & Setpoint Calculations," (Reference 3.2). One-sided probability could be used since the time delay relay performs its safety function in the decreasing direction only. However a two sided probability is used for added conservatism.

The results of this calculation are valid under the Assumptions stated in Section 7.0 of this calculation. The appropriate use of this calculation to support design or station activities, other than those specified in Section 1.1 of this calculation, is the responsibility of the user.

1.5 Applicability

A data analysis has been performed in order to determine which, if any, redundant instrument loops are bounded by the results of this calculation. This calculation is applicable to the Loops associated with the primary elements stated in Section 2.1. The results of this calculation are bounding for the applicable instrument loops, based on such factors as instrument manufacturer and model number, instrument location/environmental parameters, actual installation and use of the instrument in process measurements.

2.0 RESULTS/CONCLUSION

2.1 Results

The Loop Uncertainty and Total Loop Uncertainty for the Time Delay Voltage relays were calculated in Section 8.0. These values and other associated values such as loop drift are presented in table 2.1-1.

Table 2.1-1
Model 62K and 62L Relay – Time Delay Function

System	Loop Identification	Model	Loop Uncertainty (LU) Seconds	Channel Drift (D_L) Seconds	Total Loop Uncertainty (TLU) Seconds	M&TE Loop Accuracy Requirements (MTE_L) Seconds	Maximum Loop Setting Tol. (CT_L) Seconds
302	ENS-SWG1A-62-1 ENS-SWG1B-62-1	62K	±0.209	±0.07	±0.221	$\pm 4.15 \times 10^{-3}$	± 0.2
302	ENS-SWG1A-62-2 ENS-SWG1B-62-2	62K	±3.22	±1.20	±3.795	$\pm 4.15 \times 10^{-3}$	± 3.0
302	ENS-SWG1A-62-5 ENS-SWG1B-62-5	62K	±0.306	±0.07	±0.314	$\pm 4.15 \times 10^{-3}$	± 0.3
302	ENS-SWG1A-62-6 ENS-SWG1B-62-6	62L	±0.313	±0.07	±0.321	$\pm 4.15 \times 10^{-3}$	± 0.3

2.2 Conclusions

The calculated Loop Uncertainty and Total Loop Uncertainty presented in table 2.1-1. These values are bounding for the relays and circuits listed in Section 2.1.

3.0 **REFERENCES**

3.1 EN-DC-126, "Engineering Calculation Process"

3.2 EN-IC-S-007-R, "Instrument Loop Uncertainty & Setpoint Calculation"

3.3 7224.300-000-001B, NEDC-31336P-A, General Electric Instrument Setpoint Methodology

3.4 Indus Asset Suite Equipment Data Base (EDB)

3.5 201.130-186, "Peak Spreading of ARS Curves for the Control Building"

3.6 Environmental Design Criteria, Spec 215.150, including USAR figures 3.11-1 through 5 as outlined in EDP-AN-02 section 6.3.1

3.7 RBS Operating License

3.7.1 Not Used

3.7.2 Not Used

3.7.3 Bases Sections B3.3.8.1

3.7.4 Not Used

3.8 RBS USAR

None

3.9 Vendor Manuals

3.9.1 B455-0147, ITE Solid-State Timing Relay Relays (62K)

3.9.2 B455-0157. ITE Solid-State Time Delay Relay ITE-62L

3.9.3 3242.521-102-001A, Instruction Manual-Stdby 4.16 kV Switchgear

3.9.4 Not Used

3.9.5 Multi-Amp Instruction Book for the EPOCH-40, Microprocessor-Enhanced Protective Relay Test Set, (maintained by the Standards Laboratory)

3.10 Electrical Schematics

3.10.1 EE-001K, 4160V One Line Diagram Standby Bus 1ENS*SWG1A

3.10.2 EE-001L, 4160V One Line Diagram Standby Bus 1ENS*SWG1B

3.10.3 ESK-08ENS01, AC Elementary Diagram Standby Bus 1A & 1B Protection & Metering

3.10.4 ESK-08EGS09, DC Elementary Diagram Standby Bus 1ENS * SWG1A Under Voltage Protection

3.10.5 ESK-08EGS10, DC Elementary Diagram Standby Bus 1ENS * SWG1B Under Voltage Protection

3.10.6 ESK-08EGS13, DC Elementary Diagram Standby Bus 1ENS * SWG1A Under Voltage Protection

3.10.7 ESK-08EGS14, DC Elementary Diagram Standby Bus 1ENS * SWG1B Under Voltage Protection

3.10.8 ESK-08EGS15,DC Elementary Diagram Standby Bus 1ENS * SWG1A Under Voltage Protection & Load Sequence

3.10.9 ESK-08EGS16, DC Elementary Diagram Standby Bus 1ENS * SWG1B Under Voltage Protection & Load Sequence

3.11 Surveillance Test Procedures:

3.11.1 STP-302-1600, ENS-SWG1A Loss Of Voltage Channel Calibration And Logic System Functional Test

3.11.2 STP-302-1601, ENS-SWG1B Loss Of Voltage Channel Calibration And Logic System Functional Test

3.11.3 STP-302-1602, ENS-SWG1A Degraded Voltage Channel Calibration And Logic System Functional Test

3.11.4 STP-302-1603, ENS-SWG1B Degraded Voltage Channel Calibration And Logic System Functional Test

3.11.5 STP-302-0102, Power Distribution System Operability Check

3.12 LSK-24-09.05A, Standby Diesel Generator Load Sequence, Logic Diagram

3.13 Standards

None

3.14 Calculations:

3.14.1 G13.18.6.2-ENS*005, Loop Uncertainty Determination for DIV I and DIV II Degraded Voltage Relays – ABB Model 27N Undervoltage Relay

3.14.2 G13.18.3.1*002, Sustained and Degraded Voltage Relay Setpoints for E22-S004

3.14.3 G13.18.6.3-009, ABB Model ITE-62 Relay Drift Analysis

3.15 Equipment Qualification Trending and Thermal Aging Program (EQTAP)

3.16 Relay Setting Drawings

3.16.1 BE-230A, 4kV Bus 1ENS*SWB1A Relay Settings

3.16.2 BE-230B, 4kV Bus 1ENS*SWB1B Relay Settings

3.17 0242.521-102-133, Rev. 300, BOM ENS-SWG1A & 1B

3.18 0242.521-102-129, Rev. 300, BOM ENS-SWG1A & 1B

3.19 EE-420G, Seismic Conduit Installation Plan EL 98’

3.20 EE-420H, Seismic Conduit Installation Plan EL 98’

4.0 DESIGN INPUT

The following are the design inputs used to determine the uncertainty for the Division I and Division II degraded voltage timing relays.

4.1 Loop Input

4.1.1 Loop Data:

Form 1: Loop/Process Data Sheet		
Description	**Data**	**Reference**
Loop Sensor(s)	Relay contacts	3.10.4-9
Location	ENS-SWG1A ENS-SWG1B	3.4
Output	Contact Closure	3.10.4-9

4.1.2 Special Considerations:

4.1.2.1 Calibration shall be performed using the following instruments:

- Multi-Amp EPOCH-40 DC/Timer Test set (Reference 3.9.5)

4.2 Loop Instrumentation

Form 2: Instrument Data Sheet
Calc. Device Number 1& 2

Description	Data Device 1	Reference	Data Device 2	Reference
Component Number(s)	ENS-SWG1A 62-1, 62-2, 62-5 ENS-SWG1B 62-1, 62-2, 62-5	3.4 3.10	ENS-SWG1A 62-6 ENS-SWG1B 62-6	3.4 3.10
Type(s)	Relay	3.4	Relay	3.4
Manufacturer	Asea Brown Boveri	3.17, 3.18	Asea Brown Boveri	3.18
Model	62K	3.17, 3.18	62L	3.18
Location(s)	CB. 98	3.19, 3.20	CB. 98	3.19, 3.20
Service Description	Relay	3.4	Relay	3.4
Quality Class	Safety Related	3.4	Safety Related	3.4
Environmental Qualification	N	3.4	N	3.4
Input Range	0.2-4 sec 0-100 sec	3.10	1-30 sec.	3.10
Output	Contact Action	3.10	Contact Action	3.10
Calibration Interval Evaluated	30.0 Mo. (24 Mo. + 25%)	3.2	30.0 Mo. (24 Mo. + 25%)	3.2

4.3 Loop Device Data

Form 3: Instrument Accuracy Data Sheet
Calc. Device Number 1 ITE 62K

Description	Data	References
	Time Delay	
Reference Accuracy (RA_R)	±1% of Setting	3.9.1
Seismic Effects (SE_R)	0	7.1.4
Temperature Effects (TE_R)	±6% of setting or ±30 ms, which ever is greater ($-15^oC – 55^oC$) 2σ	3.9.1 3.14 7.1.12
Insulation Resistance Effects (IR_R)	N/A	7.1.10
Temperature Drift Effect (TD_R)	N/A	7.1.13
Drift (DR_R)	±2.072% Setpoint	3.14.3
Power Supply Effect (PS_R)	±1% of setting or ±5 ms, which ever is greater 2σ	3.9.1 7.1.2

Form 3: Instrument Accuracy Data Sheet Calc. Device Number 2 ITE 62L		
Description	**Data**	**References**
	Time Delay	
Reference Accuracy (RA_R)	±2% of Setting or ±5 ms, whichever is greater	3.9.2
Seismic Effects (SE_R)	0	7.1.4
Temperature Effects (TE_R)	±4% of setting (-20°C – 55°C)	3.9.2 3.14 7.1.12
Insulation Resistance Effects (IR_R)	N/A	7.1.10
Temperature Drift Effect (TD_R)	N/A	7.1.13
Drift (DR_R)	±2.072% Setpoint	3.14.3
Power Supply Effect (PS_R)	±2% of Setting or ±5 ms, whichever is greater	3.9.2

4.4 Environmental Information

Form 4: Environmental Conditions Data Sheet		
Zone: CB-98-1		
Description	Data	Reference
Location		
Building/Elevation	**CB-98**	**3.4**
Room/Area	**Switchgear Room**	**3.4**
Normal		
Temperature Range, ºF	**40 – 109** **(68-96 act.)**	**3.6** **3.15**
Humidity Range, %RH	**20-90**	**3.6**
Radiation 40 Year Total Integrated Dose, Rads	**800**	**3.6**
Pressure Range	**Atmos**	**3.6**
Accident (Loss of Offsite Power)		
Temperature Range, ºF	**Same as Normal**	**3.6**
Humidity Range, % RH	**Same as Normal**	**3.6**
Radiation, Total Integrated Dose, Rads	**Same as Normal**	**3.6**
Pressure Range	**Same as Normal**	**3.6**
Seismic		
Accelerations, g	**< 3**	**3.5**

5.0 NOMENCLATURE

The terms and abbreviations that are not defined in this section are defined in Reference 3.3, Reference 3.2 or within the text of this calculation.

6.0 CALCULATION METHODOLOGY

This calculation is prepared in accordance with the EN-IC-S-007-R, "Instrument Loop Uncertainty & Setpoint Calculations" (Reference 3.2), EN-DC-126, "Engineering Calculation Process" (Reference 3.1) and 7224.300-000-001B, "General Electric Instrument Setpoint Methodology" (Reference 3.3).

7.0 ASSUMPTIONS

7.1 Assumptions that do not require confirmation

7.1.1 Miscellaneous Allowance (ML)

A miscellaneous allowance has not been applied to the uncertainty of the devices evaluated by this calculation. By assuming all vendor supplied data is a 2σ value and with intermediate rounding of values in the conservative direction, sufficient conservatism has been introduced.

7.1.2 Vendor 2σ Data

For conservatism, all uncertainties given in vendor data specifications are assumed to be 2σ unless otherwise specified.

7.1.3 Zero Effect (ZE)

Not applicable

7.1.4 Seismic Effects (SE)

Reference 3.9.2 states that the undervoltage relays have been tested to 6 g ZPA “without damage, malfunction or failure.” Reference 3.5 defines the expected level of seismic activity for the 98 ft elevation of the control building as less than 3g. Therefore, seismic effects are assumed to be 0.

7.1.5 Radiation Effects (RE) & Radiation Drift Effect (RD)

Are not applicable to the relays and transformers evaluated by this calculation as they are located in a mild environment (Reference 3.6).

7.1.6 Power Supply Effects (PS)

Per Reference 3.9.1, the model 62K relay has a power supply effect of ± 1% over the allowable DC control power range of 100 to 137.5 VDC (-20,+10% variation). Per Reference 3.9.2, the model 62L1 relay has a power supply effect of ± 2% over the allowable DC control power range of 100 to 137.5 VDC (-20,+10% variation). Per Reference 3.11.5, the allowable voltage range is 130 to 140 VDC (104 to 112%). Since the relay will only see an 8% voltage variation, ±1% and ±2% deviations will be used to calculate the PS effects for the respective time delay relays in this calculation.

7.1.7 Process Measurement Uncertainty (PM)

Not applicable

7.1.8 Static Pressure Effects (SP)

Not applicable

7.1.9 Humidity Effects (HE)

The relays were specified by the switchgear manufacturer and are assumed to be designed to withstand the environmental effects in the mounting location without effect. Per Reference 3.6, the humidity range for environmental zone CB-98 is 20 to 90% RH. Therefore, it is assumed that Humidity effects are negligible.

7.1.10 Insulation Resistance Effects (IR)

(IR) effects, which may result in degradation of circuit insulation, are not applicable to the devices and circuits addressed by this calculation. The timers evaluated are not low-current DC devices affected by current leakage due to insulation resistance degradation.

7.1.11 Voltage Drop

Voltage drop due to long wiring lengths between source and load are not applicable because the timing relays evaluated are located in the same switchgear as their power source.

7.1.12 Temperature Effects (TE)

Per ABB Descriptive Bulletin IB 18.7.7-1G, Ref. 3.9.1, the temperature effect for an ITE 62K relay is 6% of setting over a span of 5° - 131°F (-15°C - +55°C) or 0.0476% per °F. This value will be used to determine relay temperature effects.

Per ABB Descriptive Bulletin IB 18.7.7-4B, Ref. 3.9.2, the temperature effect for an ITE 62L relay is 4% of setting over a span of -4° – 131°F (-20°C - +55°C) or 0.0296% per °F. This value will be used to determine relay temperature effects.

7.1.13 Temperature Drift Effects (TD)

The drift analysis performed in Reference 3.14.3 is assumed to encompass all components of drift and drift effects, including drift due to temperature variations. The drift analysis performed in Reference 3.14.3 is assumed to encompass all components of drift and drift effects except for temperature drift effects which are assumed to be included in the Reference Accuracy of the device.

7.1.14 Instrument Drift

None

7.2 Assumptions that require confirmation

None

8.0 CALCULATION

This section includes the following subsections used in performance of this calculation:

8.1) Calculation of Miscellaneous Uncertainties

8.2) Calculation of Individual Device Reference Accuracy (RA) and Determination of Appropriate Device Uncertainty to Use

8.3) Calculation of Individual Device Uncertainties

8.4) Calculation of Loop Calibration Accuracy (CL)

8.5) Calculation of Insulation Resistance Effects (IR)

8.6) Calculation of Loop Uncertainty (LU)

8.7) Calculation of Loop Drift (D_L)

8.8) Calculation of Total Loop Uncertainty (TLU)

8.9) Calculation of Reset Differential

8.1 Calculation of Miscellaneous Uncertainties

8.1.1 Calculation of Power Supply Effects on 62-1 Time delay setting (PS_{RT})
(Reference 3.9.1, Assumption 7.1.6)

PS_{RT} = ± 1% of Time Delay setting or ± 5 ms
= ± (0.010 * 3.0) seconds (Reference 3.16.1, 3.16.2)
= ± 0.03 seconds (2σ Value)

8.1.2 Calculation of Power Supply Effects on 62-2 Time delay setting (PS_{RT})
(Reference 3.9.1, Assumption 7.1.6)

PS_{RT} = ± 1% of Time Delay setting or ± 5 ms
= ± (0.010 * 57.8) seconds (setting per Reference 3.11.3, 3.11.4)
= ± 0.578 seconds (2σ Value)

8.1.3 Calculation of Power Supply Effects on 62-5 Time delay setting (PS_{RT})
(Reference 3.9.2, Assumption 7.1.6)

PS_{RT} = ± 1% of Time Delay setting or ± 5 ms
= ± (0.010 * 3) seconds (Reference 3.16.1, 3.16.2)
= ± 0.03 seconds (2σ Value)

8.1.4 Calculation of Power Supply Effects on 62-6 Time delay setting (PS_{RT})
(Reference 3.9.2, Assumption 7.1.6)

PS_{RT} = ± 2% of Time Delay setting or ± 5 ms
= ± (0.020 * 3) seconds (Reference 3.16.1, 3.16.2)
= ± 0.06 seconds (2σ Value)

8.1.5 Calculation of Relay 62-1 Temperature Effects (TE_R)

Per Assumption 7.1.12 and Reference 3.9.1, the relay may experience a temperature effect of ±6% (or ±30 ms which ever is greater) over a temperature range of -15°C – 55°C (5°F – 131°F). Assuming linearity, this yields an effect of 0.0476 VAC/°F. The relays are housed inside the DIV I and II switchgear which are assumed to maintain an internal temperature of 104°F to prevent condensation. Reference 3.6 also states that for 1% of the calendar year (30 hours), the temperature could be 5°F higher. This is considered negligible. However, the relay is calibrated in the electrical or relay shop which is assumed to be maintained at 73°F. Therefore:

TE_R = ± (104°F – 73°F)/ x 0.0476% /°F * 3.0 seconds
= ± 1.48% * 3.0 sec.
= ± 0.0444 sec

8.1.6 Calculation of Relay 62-2 Temperature Effects (TE_R)

TE_R = ± (31°F) x 0.0476%/°F * 57.8 seconds
= ± 1.48% * 57.8 sec.
= ± 0.855 sec

8.1.7 Calculation of Relay 62-5 Temperature Effects (TE_R)

TE_R = ± (31°F) x 0.0303%/°F * 3.0 seconds
= ± 1.48% * 3.0 sec.
= ± 0.0444 sec

8.1.8 Calculation of Relay 62-6 Temperature Effects (TE_R)

Per Assumption 7.1.12 and Reference 3.9.2, the relay may experience a temperature effect of ±4% over a temperature range of -20°C – 55°C (-4°F – 131°F). Assuming linearity, this yields an effect of 0.0296%/°F. The relays are housed inside the DIV I and II switchgear which are assumed to maintain an internal temperature of 104°F to prevent condensation. Reference 3.6 also states that for 1% of the calendar year (30 hours), the temperature could be 5°F higher. This is considered negligible. However, the relay is calibrated in the electrical or relay shop which is assumed to be maintained at 73°F. Therefore:

TE_R = ± (31°F) x 0.0296% /°F * 3.0 seconds
= ± 0.919% * 3.0 sec.
= ± 0.02757 sec

8.2 Calculation of Individual Device Reference Accuracy (RA) & Determination of Appropriate Device Uncertainty

8.2.1 Time Delay Relay 62-1 Reference Accuracy for Time Delay Setting (RA_{RT})

RA_{RT} = ± 1% of Time Delay setting
= ± 0.01 * 3.0 seconds
= ± 0.03 seconds (2σ Value)

8.2.2 Time Delay Relay 62-2 Reference Accuracy for Time Delay Setting (RA_{RT})

RA_{RT} = ± 1% of Time Delay setting
= ± 0.01 * 57.8 seconds
= ± 0.578 seconds (2σ Value)

8.2.3 Time Delay Relay 62-5 Reference Accuracy for Time Delay Setting (RA_{RT})

RA_{RT} = ± 1% of Time Delay setting
= ± 0.01 * 3.0 seconds
= ± 0.030 seconds (2σ Value)

8.2.4 Time Delay Relay 62-6 Reference Accuracy for Time Delay Setting (RA_{RT})

RA_{RT} = ± 2% of Time Delay setting
= ± 0.02 * 3.0 seconds
= ± 0.06 seconds (2σ Value)

8.3 Calculation of Individual Device Uncertainties (Reference 3.2)

8.3.1 Device Uncertainty Relay 62-1 Time Delay Setting (A_{RT})
(Sections 8.2.3, 8.1.3, 8.1.5)

$A_{RT} = \pm [(RA_{RT})^2 + (PS_{RT})^2 + (TE_{RT})^2]^{1/2}$
$= \pm [(0.03)^2 + (0.03)^2 + (0.0444)^2]^{1/2}$ seconds
= ± 0.0614 seconds (2σ value)

8.3.2 Device Uncertainty Relay 62-2 Time Delay Setting (A_{RT})
(Sections 8.2.3, 8.1.3, 8.1.5)

A_{RT} = $\pm [(RA_{RT})^2 + (PS_{RT})^2 + (TE_{RT})^2]^{1/2}$
= $\pm [(0.578)^2 + (0.578)^2 + (0.855)^2]^{1/2}$ seconds
= $\pm$ 1.183 seconds (2σ value)

8.3.3 Device Uncertainty Relay 62-5 Time Delay Setting (A_{RT})
(Sections 8.2.3, 8.1.3, 8.1.5)

A_{RT} = $\pm [(RA_{RT})^2 + (PS_{RT})^2 + (TE_{RT})^2]^{1/2}$
= $\pm [(0.03)^2 + (0.03)^2 + (0.00444)^2]^{1/2}$ seconds
= $\pm$ 0.0614 seconds (2σ value)

8.3.4 Device Uncertainty Relay 62-6 Time Delay Setting (A_{RT})
(Sections 8.2.3, 8.1.3, 8.1.5)

A_{RT} = $\pm [(RA_{RT})^2 + (PS_{RT})^2 + (TE_{RT})^2]^{1/2}$
= $\pm [(0.06)^2 + (0.06)^2 + (0.02757)^2]^{1/2}$ seconds
= $\pm$ 0.0892 seconds (2σ value)

8.4 Calculation of Loop Calibration Accuracy (C_L)

Per references 3.2 and 3.3, loop calibration effects are defined as:

$C_L = \pm [(MTE_L)^2 + (CT_L)^2]^{1/2}$

The CT_L is set to the procedural as-left band (PALB).

8.4.1 Calculation of Loop Calibration Effects for the 62-1 Time Setting (C_L)
(Sections 3.9.2, 3.9.3, 8.4.1.1, 8.4.1.2, 3.11.1, 3.11.2)

C_L = $\pm [(MTE_L)^2 + (CT_L)^2]^{1/2}$ CT_L = PALB selected = 0.2
= $\pm [(4.15 \times 10^{-3})^2 + 0.2^2]^{1/2}$ VAC
= $\pm$ 0.2 seconds

8.4.1.1 Measuring and Test Equipment Effects – Relay Time Setting (MTE_L)

Measurement & Test Equipment (MTE_L) effects are defined from Reference 3.2 as:

$MTE_{LV} = \pm [(MTE_{RAT})^2 + (MTE_{RIT})^2 + (MTE_{TET})^2 + (MTE_{CST})^2]^{1/2}$

Where:
MTE_{RAT} = The reference accuracy of the M&TE being utilized. Epoch 40 Aux. Timer and DC voltage/current unit has a timer accuracy of 0.005% or one digit on the min. 99.9999 range. Using 57.8 x 0.00005 =2.89×10^{-3} seconds.

MTE_{TET} = Temperature effect on the M&TE being utilized. The Epoch 40 operating range is 0^o to 50^oC with no temperature coefficient given. The total timer accuracy of 0.005% is conservatively assumed or $2.89x10^{-3}$ seconds (Reference 3.2).

MTE_{RIT} = Assumed to be 0 as all M&TE used are digital with at least 2 digits of resolution. (Reference 3.2)

MTE_{CST} = Assumed equal to 1/4 the Reference Accuracy of the time delay function of the relay time delay function = 0.005%/4 seconds (per Reference 3.2).

$MTE_L = \pm [(MTE_{RART})^2 + (MTE_{RIRT})^2 + (MTE_{TERT})^2 + (MTE_{CSRT})^2]^{1/2}$

$= \pm [(2.89x10^{-3})^2 + (0)^2 + (2.89x10^{-3})^2 + (7.23\ x10^{-4})^2]^{1/2}$

$= \pm 4.15\ x\ 10^{-3}$ seconds with worse case time delay, (2σ Value)

This value will be conservatively used for all the relays.

8.4.2 Calculation of Loop Calibration Effects for the 62-2 Time Delay Setting (C_{LT})

$C_{LT} = \pm [(MTE_{LT})^2 + (CT_{LT})^2]^{1/2}$ CT_L = PALB = 3.0

$= \pm [(4.15\ x\ 10^{-3})^2 + 3.0^2]^{1/2}$ seconds

$= \pm 3.0$ seconds

8.4.3 Calculation of Loop Calibration Effects for the 62-5 Time Delay Setting (C_{LT})

$C_{LT} = \pm [(MTE_{LT})^2 + (CT_{LT})^2]^{1/2}$ CT_L = PALB = 0.3

$= \pm [(4.15\ x\ 10^{-3})^2 + 0.3^2]^{1/2}$ seconds

$= \pm 0.3$ seconds

8.4.4 Calculation of Loop Calibration Effects for the 62-6 Time Delay Setting (C_{LT})

$CL_{LT} = \pm [(MTE_{LT})^2 + (CT_{LT})^2]^{1/2\ 2}$ CT_L = PALB = 0.3

$= \pm [(4.15\ x\ 10^{-3})^2 + 0.3^2]^{1//2}$ seconds

$= \pm 0.3$ seconds

8.5 Calculation of insulation Resistance Effects (IR)

0 per Assumption 7.1.10

8.6 Calculation of Loop Uncertainty (LU)

8.6.1 Loop Uncertainty for Time Delay 62-1 Setting (LU_T)

Per references 3.2 and 3.3 Loop Uncertainty is defined as:

$LU_T = \pm (m/n)[(A_{RT})^2 + (C_{LT})^2]^{1/2}$

Where: m = The number of standard deviations required to encompass 95% of the area under the curve for a normal distribution either one or two sided. 1.645 corresponds to a one sided confidence while 2.00 corresponds two a two sided confidence.

n = The number of standard deviations used in specifying the individual components of uncertainty

$= \pm (2.0/2)\ [(0.06)^2 + (0.2)^2]^{1/2}$

$= \pm$ 0.209 seconds

While a one sided distribution may be used, a two sided is used in this calculation for added conservatism.

8.6.2 Loop Uncertainty for Time Delay 62-2 Setting (LU_T)

Per references 3.2 and 3.3 Loop Uncertainty is defined as:

$$LU_T = \pm (m/n)[(A_{RT})^2 + (C_{LT})^2]^{1/2}$$
$$= \pm (2.0/2)[(1.183)^2 + (3.0)^2]^{1/2}$$
$$= \pm 3.22 \text{ seconds}$$

Note: The transformer uncertainty is not applicable to the time delay function of the relay.

8.6.3 Loop Uncertainty for Time Delay 62-5 Setting (LU_T)

Per references 3.2 and 3.3 Loop Uncertainty is defined as:

$$LU_T = \pm (m/n)[(A_{RT})^2 + (C_{LT})^2]^{1/2}$$
$$= \pm (2.0/2)[(0.06)^2 + (0.3)^2]^{1/2}$$
$$= \pm 0.306 \text{ seconds}$$

8.6.4 Loop Uncertainty for Time Delay 62-6 Setting (LU_T)

Per references 3.2 and 3.3 Loop Uncertainty is defined as:

$$LU_T = \pm (m/n)[(A_{RT})^2 + (C_{LT})^2]^{1/2}$$
$$= \pm (2.0/2)[(0.089)^2 + (0.3)^2]^{1/2}$$
$$= \pm 0.313 \text{ seconds}$$

8.7 Calculation of Loop Drift (DL)

8.7.1 Transformer Temperature Drift Effects (TD_T)

0 for the time delay function.

8.7.2 Relay Temperature Drift Effects (TD_R)

0 for the time delay function.

8.7.3 Relay Drift (DR_{RV})

8.7.3.1 Relay 62-1 Drift for Time Delay Setting (DR_{RT}) (Assumption 7.1.14).

DR_{RT} = ±2.072% Setpoint
= ±2.072% (3.0 sec.)
= ±0.07 seconds

As there are no other components of drift to be considered for the relay time delay setting, Loop drift for the time delay setting (DR_{LT}) = DR_{RT}

8.7.3.2 Relay 62-2 Drift for Time Delay Setting (DR_{RT}) (Assumption 7.1.14).

DR_{RT} = ±2.072% Setpoint
= ±2.072% (57.8 sec.)
= ±1.20 seconds

As there are no other components of drift to be considered for the relay time delay setting, Loop drift for the time delay setting (DR_{LT}) = DR_{RT}

8.7.3.3 Relay 62-5 Drift for Time Delay Setting (DR_{RT}) (Assumption 7.1.14).

DR_{RT} = ±2.072% Setpoint
= ±2.072% (3.0 sec.)
= ±0.07 seconds

As there are no other components of drift to be considered for the relay time delay setting, Loop drift for the time delay setting (DR_{LT}) = DR_{RT}

8.7.3.4 Relay 62-6 Drift for Time Delay Setting (DR_{RT}) (Assumption 7.1.14).

DR_{RT} = ±2.072% Setpoint
= ±2.072% (3.0 sec.)
= ±0.07 seconds

As there are no other components of drift to be considered for the relay time delay setting, Loop drift for the time delay setting (DR_{LT}) = DR_{RT}

8.8 Calculation of Total Loop Uncertainty (TLU)

8.8.1 Total Loop Uncertainty – 62-1 Time Delay Setting (TLU_T)

Per references 3.2 and 3.3 Total Loop Uncertainty is defined as:

$$TLU_T = \pm (m/n) [(A_{RT})^2 + (C_{LT})^2 + (DR_{LT})^2]^{1/2}$$
$$= \pm (2.0/2) [(0.06)^2 + (0.2)^2 + (0.07)^2]^{1/2}$$
$$= \pm 0.221 \text{ seconds}$$

8.8.2 Total Loop Uncertainty – 62-2 Time Delay Setting (TLU_T)

Per references 3.2 and 3.3 Total Loop Uncertainty is defined as:

$$TLU_T = \pm (m/n) [(A_{RT})^2 + (C_{LT})^2 + (DR_{LT})^2]^{1/2} + M \text{ (Margin)}$$
$$= \pm (2.0/2) [(1.183)^2 + (3.0)^2 + (1.20)^2]^{1/2} + 0.354$$
$$= \pm 3.795 \text{ seconds}$$

8.8.3 Total Loop Uncertainty – 62-5 Time Delay Setting (TLU_T)

Per references 3.2 and 3.3 Total Loop Uncertainty is defined as:

$$TLU_T = \pm (m/n) [(A_{RT})^2 + (C_{LT})^2 + (DR_{LT})^2]^{1/2}$$
$$= \pm (2.0/2) [(0.06)^2 + (0.3)^2 + (0.07)^2]^{1/2}$$
$$= \pm 0.314 \text{ seconds}$$

8.8.4 Total Loop Uncertainty – 62-6 Time Delay Setting (TLU_T)

Per references 3.2 and 3.3 Total Loop Uncertainty is defined as:

$$TLU_T = \pm (m/n) [(A_{RT})^2 + (C_{LT})^2 + (DR_{LT})^2]^{1/2}$$
$$= \pm (2.0/2) [(0.089)^2 + (0.3)^2 + (0.07)^2]^{1/2}$$
$$= \pm 0.321 \text{ seconds}$$

Note: The transformer uncertainty is not applicable to the time delay function of the undervoltage relay.

Summary of Calculation Data

Terms	Time Delay Device 1			Time Delay Device 2		
	Values	**σ**	**Ref**	**Values**	**σ**	**Ref**
Model	ITE 62K		N/A	ITE 62L		N/A
Input Range	0.2 to 4.0 sec 0 to 100 sec		3.10.6 3.10.7 3.10.8 3.10.9	1 to 30 sec	–	3.10.8 3.10.9
Process Units	Seconds	–	N/A	Seconds		N/A
Voltage Input Range	-20% to +10%	–	3.9.1	-20% to +10%	–	3.9.2
Input Range	N/A	–	N/A	N/A	–	N/A
Process Units	Seconds	–	3.9.1	Seconds	–	3.9.2
Reference Accuracy (RA)	±1% of Setting.	–	3.9.1	± 2% of Setting.	2	3.9.2
Temperature Effect (TE)	Greater of ± 6% of Setting or +/- 30ms.	2	3.9.1	Greater of ± 4% of Setting	2	3.9.2
Seismic Effects (SE)	N/A	2	7.1.4	N/A	–	7.1.4
Radiation Effect (RE)	N/A	–	7.1.5	N/A	–	7.1.5
Timing Relay Drift (DR)	±0.07 ±1.20	–	8.7.3.1 8.7.3.2	±0.07	2	8.7.3.4
Temperature Drift Effect (TD)	N/A	2	7.1.13	N/A	–	7.1.13
Radiation Drift Effect (RD)	N/A	–	7.1.5	N/A	–	7.1.5
Power Supply Effect (PS)	+/ Greater of ±1% of Setting or +/- 5ms.	–	3.9.1	+/ Greater of ±2% of Setting or +/- 5ms.	2	3.9.2
Humidity Effects (HE)	N/A	2	7.1.9	N/A	–	7.1.9
Static Pressure Effect (SP)	N/A	–	7.1.8	N/A	–	7.1.8
Process Measurement Effect (PM)	N/A	–	7.1.7	N/A	–	7.1.7
Insulation Resistance Effect (IR)	N/A	–	7.1.10	N/A	–	7.1.10
Zero Effect (ZE)	N/A	–	7.1.3	N/A	–	7.1.3

9.0 APPLICABLE MARK NUMBERS

Model	Relay Mark Numbers Div. I	Div. II	
ITE 62K	ENS-SWG1A-62-1	ENS-SWG1B-62-1	Sustained Undervoltage Short Time Delay
ITE 62K	ENS-SWG1A-62-2	ENS-SWG1B-62-2	Degraded Voltage Long Time Delay
ITE 62K	ENS-SWG1A-62-5	ENS-SWG1B-62-5	LOCA 3 second Time Retention
ITE 62L	ENS-SWG1A-62-6	ENS-SWG1B-62-6	Degraded Undervoltage Short Time Delay

DESIGN VERIFICATION COVER PAGE

☐ ANO-1	☐ ANO-2	☐ IP-2	☐ IP-3	☐ JAF	☐ PLP
☐ PNPS	☐ VY	☐ GGNS	☒ RBS	☐ W3	☐ NP

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Title: **Loop Uncertainty Determination for Div I and II Under Voltage Time Delay Relays – ABB Model 62K and 62L Time Delay Relays**

☒ Quality Related ☐ Augmented Quality Related

DV Method: ☒ Design Review ☐ Alternate Calculation ☐ Qualification Testing

VERIFICATION REQUIRED	DISCIPLINE	VERIFICATION COMPLETE AND COMMENTS RESOLVED (DV print, sign, and date)
☐	Electrical	
☐	Mechanical	
☒	Instrument and Control	**Justin Waters** Justin Waters 2/26/09
☐	Civil/Structural	
☐	Nuclear	
☐		
☐		

Originator: **Chuck Mohr** Chuck Mohr 2/26/09
Print/Sign/Date After Comments Have Been Resolved

IDENTIFICATION:				DISCIPLINE:
Document Title: **Loop Uncertainty Determination for Div I and II Under Voltage Time Delay Relays – ABB Model 62K and 62L Time Delay**				☐Civil/Structural ☐Electrical ☒I & C ☐Mechanical ☐Nuclear ☐Other
Doc. No.:	**G13.18.6.2.ENS*006**	Rev. **1**	QA Cat.: SR	
Verifier:	Justin Waters Print	Justin Waters Sign	2/26/09 Date	
Manager authorization for supervisor performing Verification. ☐ N/A	Print	Sign	Date	
METHOD OF VERIFICATION: Design Review ☒	Alternate Calculations ☐	Qualification Test ☐		

The following basic questions are addressed as applicable, during the performance of any design verification. [ANSI N45.2.11 – 1974] [NP] [QAPD, Part II, Section 3] [NQA-1-1994, Part II, BR 3, Supplement 3s-1].

NOTE The reviewer can use the "Comments/Continuation sheet" at the end for entering any comment/resolution along with the appropriate question number. Additional items with new question numbers can also be entered.

1. Design Inputs – Were the inputs correctly selected and incorporated into the design?

(Design inputs include design bases, plant operational conditions, performance requirements, regulatory requirements and commitments, codes, standards, field data, etc. All information used as design inputs should have been reviewed and approved by the responsible design organization, as applicable.

All inputs need to be retrievable or excerpts of documents used should be attached.

See site specific design input procedures for guidance in identifying inputs.)

Yes ☒ No ☐ N/A ☐

2. Assumptions – Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are assumptions identified for subsequent re-verification when the detailed activities are completed? *Are the latest applicable revisions of design documents utilized?*

Yes ☒ No ☐ N/A ☐

3. Quality Assurance – Are the appropriate quality and quality assurance requirements specified?

Yes ☒ No ☐ N/A ☐

4. Codes, Standards and Regulatory Requirements – Are the applicable codes, standards and regulatory requirements, including issue and addenda properly identified and are their requirements for design met?
Yes ☒ No ☐ N/A ☐

5. Construction and Operating Experience – Have applicable construction and operating experience been considered?
Yes ☐ No ☐ N/A ☒

6. Interfaces – Have the design interface requirements been satisfied and documented?
Yes ☐ No ☐ N/A ☒

7. Methods – Was an appropriate design or analytical (for calculations) method used?
Yes ☒ No ☐ N/A ☐

8. Design Outputs – Is the output reasonable compared to the inputs?
Yes ☒ No ☐ N/A ☐

9. Parts, Equipment and Processes – Are the specified parts, equipment, and processes suitable for the required application?
Yes ☐ No ☐ N/A ☒

10. Materials Compatibility – Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
Yes ☐ No ☐ N/A ☒

11. Maintenance requirements – Have adequate maintenance features and requirements been specified?
Yes ☐ No ☐ N/A ☒

12. Accessibility for Maintenance – Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
Yes ☐ No ☐ N/A ☒

13. Accessibility for In-service Inspection – Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
Yes ☐ No ☐ N/A ☒

14. Radiation Exposure – Has the design properly considered radiation exposure to the public and plant personnel?
Yes ☐ No ☐ N/A ☒

15. Acceptance Criteria – Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
Yes ☒ No ☐ N/A ☐

16. Test Requirements – Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
Yes ☐ No ☐ N/A ☒

17. Handling, Storage, Cleaning and Shipping – Are adequate handling, storage, cleaning and shipping requirements specified?
Yes ☐ No ☐ N/A ☒

18. Identification Requirements – Are adequate identification requirements specified?
Yes ☐ No ☐ N/A ☒

19. Records and Documentation – Are requirements for record preparation, review, approval, retention, etc., adequately specified? Are all documents prepared in a clear legible manner suitable for microfilming and/or other documentation storage method? Have all impacted documents been identified for update as necessary?
Yes ☒ No ☐ N/A ☐

20. Software Quality Assurance- ENN sites: For a calculation that utilized software applications (e.g., GOTHIC, SYMCORD), was it properly verified and validated in accordance with EN- IT-104 or previous site SQA Program?
ENS sites: This is an EN-IT-104 task. However, per ENS-DC-126, for exempt software, was it verified in the calculation?
Yes ☐ No ☐ N/A ☒

21. Has adverse impact on peripheral components and systems, outside the boundary of the document being verified, been considered?
Yes ☐ No ☐ N/A ☒

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	References from the "Reference Documentation" of revision 0 which are not included in Section 3 should be added to removed references or referenced in the calculation.	Resolved mismatch in Reference documentation and Section 3.	JW 2/26/09
2	Section 3 references 3.9.4, 3.11.1, 3.11.2, 3.11.5 are not referenced in the calculation.	Deleted references not used in calculation.	JW 2/26/09
3	Section 3: Reference 3.15 should be added to the "Calculation Reference Sheet" under Section III	Added reference 3.15 to Calc. Ref. Sheet	JW 2/26/09
4	Section 4.2: IAS does not list a location for relays A62-5, A62-6, B62-5, B62-6.	Found new ref (3.19 and 3.20) for these relays.	JW 2/26/09
5	Section 4.3: The temperature effects for both devices list reference 3.1.4 however this reference is not listed in Section 3.	Reference was actually 3.14,corrected.	JW 2/26/09
6	Assumption 7.1.13 refers to the old drift analysis reference (Attachment C) in revision 0 and should reflect the new drift guide.	Revised assumption.	JW 2/26/09
7	Section 8.1.5: The temperature effect uses 104°F instead of the revised temperature, 109°F. This section also uses 73°F as the lower limit. Should 40°F be used since this is the lower limit? This would make the temperature range 40-109°F which would change subsequent sections after this one.	Temp will remain at 104°F instead of 109°F, assumption revised to say this (5°F change) is negligible for the 1% of the time. Revising TE to use 40-109°F instead of the existing 73-104°F would be a change to the existing calc. which is outside the scope of the project.	JW 2/26/09

Calculation G13.18.6.2-ENS*006, Rev. 001 (EOI Review Comments)

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	Calc G13.18.6.3-009 is referenced for device 1 drift in Section 4.3, but relays ENS-SWG1A-62-5 and ENS-SWG1B-62-5 are not listed in that calc. Did Excel miss them? If so, instruct them to add them to the calc.	No change to this calc. The drift calculation states that it is applicable to similar instruments, and is therefore a valid input for this calculation.	
2	Rev. 1 listed ESK-08EGS04, Sh. 001, and F137-0100, but they are not listed in Section VI of the Calc Ref Sheet in Rev. 1.	Both added to Section VI	
3	STP-302-0102 is listed as Ref. 3.11.5, but is not on the Calc Ref Sheet.	Added to Ref Sheet	

☐ ANO-1	☐ ANO-2	☐ GGNS	☐ IP-2	☐ IP-3	☐ PLP
☐ JAF	☐ PNPS	☒ RBS	☐ VY	☐ W3	
☐ NP-GGNS-3	☐ NP-RBS-3				

CALCULATION COVER PAGE	(1) **EC #** <u>27437</u>	(2) **Page 1 of** <u>22</u>

(3) Design Basis Calc. ☒ YES ☐ NO

(4) ☒ CALCULATION ☐ EC Markup

(5) **Calculation No: G13.18.6.2-ENS*007**

(6) **Revision: 1**

(7) **Title:** **Loop Uncertainty Detemination for DIV III Undervoltage Time Delays - Agastat ETR14 Time Delay Relay**

(8) **Editorial** ☐ YES ☒ NO

(9) **System(s): 203/302**

(10) **Review Org (Department):** **NSBE3 (I&C Design)**

(11) **Safety Class:**

☒ **Safety / Quality Related**
☐ **Augmented Quality Program**
☐ **Non-Safety Related**

(12) **Component/Equipment/Structure Type/Number:**

E22-S004-ACB4-62S3	E22-S004-ACB1-62S4
E22-S004-ACB4-62S5	E22-S004-ACB1-62S6

(13) **Document Type:** F43.02

(14) **Keywords (Description/Topical Codes):**

uncertainty, calculation, relay, time delay

REVIEWS

(15) Name/Signature/Date	(16) Name/Signature/Date	(17) Name/Signature/Date
Chuck Mohr (see EC 11753 for signature)	Robin Smith (see EC 11753 for signature)	Paul Matzke (see EC 11753 for signature)
Responsible Engineer	☒ **Design Verifier** ☐ **Reviewer** ☒ Comments Attached	**Supervisor/Approval** ☒ Comments Attached

CALCULATION REFERENCE SHEET	CALCULATION NO: G.13.18.6.2-ENS*007 REVISION: 1

I. EC Markups Incorporated (N/A to NP calculations) None

II. Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	Tracking No.
1. EN-DC-126	--	002	☑	☐	N	
2. EN-IC-S-007-R	--	000	☑	☐	N	
3. 7224.300-000-001B	--	300	☑	☐	N	
4. 201.130-186	--	000	☑	☐	N	
5. 215.150	--	006	☑	☐	N	
6. A348-0116	--	000	☑	☐	N	
7. 6221.418-000-001A	--	300	☑	☐	N	
8. GE-DL828E537AA	--	018	☑	☐	N	
9. 0221.418-000-008	--	300	☑	☐	N	
10. EE-001M	--	009	☑	☐	N	
11. A348-0111	--	000	☑	☐	N	
12. GE-828E537AA	003	028	☑	☐	N	
13. GE-828E537AA	007	030	☑	☐	N	
14. GE-828E537AA	008	028	☑	☐	N	
15. GE-828E537AA	011	029	☑	☐	N	
16. STP-302-1604	--	018	☑	☐	N	
17. BE-230D	--	010	☑	☐	N	
18. G13.18.6.3-014	--	000	☑	☐	N	
19. EDP-AN-02	--	300	☑	☐	N	
20. G13.18.3.1*002	--	004	☐	☑	Y	EC11753
21. STP-302-1605	--	021	☑	☐	N	

III. CROSS REFERENCES:

1. Indus Asset Suite Equipment Data Base (EDB)
2. Technical Specifications section B3.3.8.1
3. USAR Figures 3.11-1 through 5
4. EQTAP

IV. SOFTWARE USED: N/A

Title:______________________ Version/Release:_____________Disk/CD No.________

V. DISK/CDS INCLUDED: N/A

Title:______________________ Version/Release_____________Disk/CD No.________

VI. OTHER CHANGES: Related references not longer used:

1. STP-302-0102
2. 0221.415-000-122
3. 3221.418-000-003U
4. B455-0139
5. VTD-F137-0100
6. GE-152D8167, # 003, #003A, #004, #005
7. Multi-Amp Instruction Book EPOCH-10
8. 242.521

Revision	Record of Revision
0	Initial issue to support determination of degraded voltage relay setpoints by Electrical Engineering
1	Incorporated new drift value and extended calibration period to 30 months per EC 11753.

TABLE OF CONTENTS

1.0 Purpose and Description

1.1. Purpose

The purpose of this calculation is to determine the uncertainty associated with the existing Division III, Safety-Related, 4.16 kV undervoltage time delay relays. Nominal trip Set point and Allowable values will be determined by the Electrical Engineering group in calculation G13.18.3.1*002 and documented on the applicable BE drawing.

1.2. Loop Descriptions

The Division III 4.16 kV emergency bus has its own independent sustained Degraded Voltage instrumentation and associated trip logic. The Division III bus is monitored by two undervoltage relays whose outputs are arranged in a two-out-of-two logic configuration (Reference 3.10.3). The channels include electronic equipment (e.g., trip units) that compare measured input signals with pre-established setpoints. When the setpoint is exceeded, the channel output relay actuates, which starts the time delay relays to open the DIV III Normal Supply source breaker and illuminates a Main Control Room annunciator alarm. Two different time delays are applied depending on whether a LOCA signal is present at the time of the degraded voltage. The LOCA time delay is provided by the 27N relay. The Non-LOCA time delay is provided by the combination of the 27N relay and the ETR14 relays.

1.3. Design Bases/Design Bases Event

Per Bases B 3.3.8.1, Reference 3.7.3, "successful operation of the required safety functions of the Emergency Core Cooling Systems (ECCS) is dependent upon the availability of adequate power sources for energizing the various components such as pump motors, motor operated valves, and the associated control components. The LOP instrumentation monitors the 4.16 kV emergency buses. Offsite power is the preferred source of power for the 4.16 kV emergency buses. If the monitors determine that insufficient power is available, the buses are disconnected from the offsite power sources and connected to the onsite diesel generator (DG) power sources. The Time Delay Allowable Values are long enough to provide time for the offsite power supply to recover to normal voltages, but short enough to ensure that power is available to the required equipment."

1.4. Degree of Accuracy/Limits of Applicability

The results of this calculation are based on the statistical methods of at least 95% probability of occurrence for a one sided probability distribution in accordance with 7224.300-100-001B, "General Electric Instrument Setpoint Methodology," (Reference 3.3) and EN-IC-S-007-R, "Instrument Loop Uncertainty & Setpoint Calculations", (Reference 3.2). One-sided probability is used since the time delay relay performs its safety function in the decreasing direction only.

The results of this calculation are valid under the Assumptions stated in Section 7.0 of this calculation. The appropriate use of this calculation to support design or station activities, other than those specified in Section 1.1 of this calculation, is the responsibility of the user.

1.5. **Applicability**

A data analysis has been performed in order to determine which, if any, redundant instrument loops are bounded by the results of this calculation. This calculation is applicable to the Loops associated with the devices stated in Section 2.1. The results of this calculation are bounding for the applicable instrument loops, based on such factors as instrument manufacturer and model number, instrument location/environmental parameters, actual installation and use of the instrument in process measurements.

2.0 Results/Conclusions

2.1. Results

The Loop Uncertainty and Total Loop Uncertainty for the Agastat time delay relays were calculated in Section 8.0. These values and other associated values such as loop drift are presented in table 2.1-1.

Table 2.1-1
Model ETR14 Time Delay Relay

Systems	Loop Identification	Loop Uncertainty (LU) Seconds	Channel Drift (D_L) Seconds	Total Loop Uncertainty (TLU) Seconds	M&TE Loop Accuracy Requirements (MTE_L) Seconds	Maximum Loop Setting Tol. (CT_L) Seconds
203/302	E22-S004-ACB4-62S3 E22-S004-ACB1-62S4	±0.316	± 0.112	±0.322	$\pm 1.55 \times 10^{-4}$	±0.18
203/302	E22-S004-ACB4-62S5 E22-S004-ACB1-62S6	+5.622	± 2.05	±5.99	$\pm 2.83 \times 10^{-3}$	±3.0

2.2. Conclusions

The calculated Loop Uncertainty and Total Loop Uncertainty presented in table 2.1-1. These values apply to the relays and circuits listed in Section 2.1.

3.0 **References**

3.1. EN-DC-126, “ Engineering Calculation Process”

3.2. EN-IC-S-007-R, “Instrument Loop Uncertainty & Setpoint Calculations.”

3.3. 7224.300-000-001B, NEDC-31336P-A, General Electric Instrument Setpoint Methodology

3.4. Indus Asset Suite Equipment Data Base (EDB)

3.5. 201.130-186, “Peak Spreading of ARS Curves for the Control Building”

3.6. Environmental Design Criteria, Spec 215.150, including USAR figures 3.11-1 through 5 as outlined in EDP-AN-02 section 6.3.1

3.7. RBS Operating License

3.7.1. Not used

3.7.2. Not used

3.7.3. Bases Sections B3.3.8.1

3.8. RBS USAR

None

3.9. Vendor Manuals/Documents

3.9.1. A348-0116, Amerace – Agastat Nuclear Qualified Control Relays

3.9.2. Not used

3.9.3. Not used

3.9.4. 6221.418-000-001A, High Pressure Core Spray System Power Supply Unit, NEDO10905

3.9.5. 0221.418-000-008, Purchase Specification Data Sheet 21A9300AU, High Pressure Core Spray System

3.9.6. A348-0111, Amerace Electronic Components Catalog, Agastat Electromechanical Relays.

3.10. Electrical Schematics

3.10.1. EE-001M, 4160V One Line Diagram Standby Bus E22-S004

3.10.2. GE-828E537AA#003, Elementary Diagram HPCS Power Supply System

3.10.3. GE-828E537AA#007, Elementary Diagram HPCS Power Supply System

3.10.4. GE-828E537AA#008, Elementary Diagram HPCS Power Supply System

3.10.5. GE-828E537AA#011, Elementary Diagram HPCS Power Supply System

3.11. Surveillance Test Procedures:

3.11.1. STP-302-1605, HPCS Degraded Voltage Channel Calibration and Logic System Functional Test

3.11.2. STP-302-1604, HPCS Loss of Voltage Channel Calibration and Logic System Functional Test

3.11.3. Not used

3.12. Logic Diagrams

None

3.13. Standards

None

3.14. Equipment Qualification Trending and Thermal Aging Program (EQTAP)

3.15. 4.16 Kv Bus E22-S004 Relay Settings, Drawings BE-230D

3.16. Calculations

3.16.1. Not used

3.16.2. G13.18.3.1*002, Sustained and Degraded Voltage Relay Setpoint for E22-S004

3.16.3. G13.18.6.3-014, Drift Study for Agastat ETR Series Time Delay Relays

3.17 GE-DL828E537AA , Elementary Diagram-Device List

4.0 **Design Input**

The following are the design inputs used to determine the uncertainty for the Division III Agastat time delay relays.

4.1. **Loop Input**

4.1.1. Loop Data:

Form 1: Loop/Process Data Sheet		
Description	**Data**	**Reference**
Loop Sensor(s)	Auxiliary Relays	3.10.4
Location	E22-S004	3.10.4
Output	Contact closure	3.10.4

4.1.2. Special Considerations:

4.1.2.1 Calibration shall be performed using the following instruments:

- Multi-Amp EPOCH-40 DC/Timer Test set.

4.2. **Loop Instrumentation**

Form 2: Instrument Data Sheet Calc. Device Number 1		
Description	**Data**	**Reference**
Component Number(s)	E22-S004-ACB4-62S3 E22-S004-ACB1-62S4 E22-S004-ACB4-62S5 E22-S004-ACB1-62S6	3.4 3.10
Manufacturer	Amerace/Agastat	3.17
Model	ETR14	3.17
Location(s)	CB.116/E33-S004	3.4
Service Description	Relay	3.4
Quality Class	Safety Related	3.4
Environmental Qualification	N	3.4
Input Range	0-125 VDC	3.10
Output	Contact Action	3.10
Calibration Interval Evaluated	30 Mo (24 Mo. + 25%).	3.2

4.3. **Loop Device Data**

Form 3: Instrument Accuracy Data Sheet Calc. Device Number 1 Agastat ETR14		
Description	**Data**	**References**
	Time Delay	
Reference Accuracy (RA_R)	10% of Setting (2σ) 5% of Setting (TR) (2σ)	3.9.1 3.9.6
Seismic Effects (SE_R)	0	7.1.4
Temperature Effects (TE_R)	5% of setting (40^oF – 122^oF) 2σ	3.9.6 3.14 7.1.12
Insulation Resistance Effects (IR_R)	N/A	7.1.10
Temperature Drift Effect (TD_R)	N/A	7.1.13
Drift (DR_R)	3.725% Setpoint 2σ	3.16.3
Power Supply Effect (PS_R)	5% of setting (includes TE_R) 2σ	3.9.6 3.14

4.4. **Environmental Information**

Form 4: Environmental Conditions Data Sheet		
Zone: CB-116-2		
Description	Data	Reference
Location		
Building/Elevation	CB-116	3.4
Room/Area	Switchgear Room	3.4
Normal		
Temperature Range, ^oF	40 – 109 (68^oF to 83^oF act.)	3.6 3.14
Humidity Range, %RH	20-95	3.6
Radiation 40 Year Total Integrated Dose, Rads	800	3.6
Pressure Range	Atmos	3.6
Accident (Loss of Offsite Power)		
Temperature Range, ^oF	Same as Normal	3.6
Humidity Range, %RH	Same as Normal	3.6
Radiation, Total Integrated Dose, Rads	Same as Normal	3.6
Pressure Range	Same as Normal	3.6
Seismic		
Accelerations, g	< 3	3.5

5.0 **Nomenclature**

The terms and abbreviations that are not defined in this section are defined in Reference 3.3, Reference 3.2 or within the text of this calculation.

6.0 Calculation Methodology

This calculation is prepared in accordance with the EN-IC-S-007-R, "Instrument Loop Uncertainty & Setpoint Calculations" (Reference 3.2), EN-DC-126, "Engineering Calculation Process" (Reference 3.1) and 7224.300-000-001B, "General Electric Instrument Setpoint Methodology" (Reference 3.3).

7.0 Assumptions

7.1. Assumptions that do not require confirmation

7.1.1. Miscellaneous Allowance (ML)

A miscellaneous allowance has not been applied to the uncertainty of the devices evaluated by this calculation. By assuming all vendor supplied data is a 2σ value and with intermediate rounding of values in the conservative direction, sufficient conservatism has been introduced.

7.1.2. Vendor 2σ Data

For conservatism, all uncertainties given in vendor data specifications are assumed to be 2σ unless otherwise specified.

7.1.3. Zero Effect (ZE)

Not applicable

7.1.4. Seismic Effects (SE)

Reference 3.9.1 states that the timing delays have been tested to 6 g ZPA "without damage, malfunction or failure." Reference 3.5 defines the expected level of seismic activity for the 116 ft elevation of the control building as less than 3g. Therefore, seismic effects are assumed to be 0.

7.1.5. Radiation Effects (RE) & Radiation Drift Effect (RD)

Are not applicable to the relays evaluated by this calculation as they are located in a mild environment (Reference 3.6).

7.1.6. Power Supply Effects (PS)

Per reference 3.9.6, Power Supply Effects for the model TR time delay function is assumed to be well under 5% of setting under all control voltage conditions. Therefore, for conservatism the power supply effects on the time delay function will be assumed to equal ±5% of setting.

7.1.7. Process Measurement Uncertainty (PM)

Not Applicable

7.1.8. Static Pressure Effects (SP)

Not Applicable

7.1.9. Humidity Effects (HE)

The relays were specified by the HPCS manufacturer and are assumed to be designed to withstand the environmental effects in the mounting location. The HPCS Design Specification, Section 4.6.1 (reference 3.9.5) states that the design conditions for the switchgear and its sub-components are 20 to 90% relative Humidity. Per Reference 3.6, the humidity range for environmental zone CB-116-2 is 20 to 90% RH. Reference 3.6 also identifies that 1% of the days/calendar year (30 hours) the humidity could be 5 % higher. This is considered negligible. Therefore, it is assumed that Humidity effects are negligible.

7.1.10. Insulation Resistance Effects (IR)

(IR) effects, which may result from degradation of circuit insulation, are not applicable to the devices and circuits addressed by this calculation. The timers evaluated are not low-current DC devices affected by current leakage due to insulation resistance degradation.

7.1.11. Voltage Drop

Voltage drop due to long wiring lengths between source and load are assumed to be negligible as the timing relays evaluated by this calculation are located in the same switchgear compartment. The voltage effects are included in the temperature effects per Ref. 3.9.1 and 3.9.6.

7.1.12. Temperature Effects (TE)

Per Reference 3.9.1, the temperature effect for the ETR relay is 10% of setting over a span of $40^{o} – 156^{o}$F. Per Reference 3.9.6, the temperature effect for the TR relay is 5% of setting over a span of $32^{o} – 122^{o}$F (the non-safety version of the same relay). Since the historical temperature in the area only varies 14^{o}F the 5% value is assumed. The non-safety relay is built to the same specifications but substitute material may be used. This value will be used to determine relay temperature effect. The 5% tolerance is combined with voltage effects in Ref. 3.9.6 but will be conservatively used as an independent effect.

7.1.13. Temperature Drift Effects (TD)

The drift analysis performed in Reference 3.16.3 is assumed to encompass all components of drift and drift effects except for temperature drift effects which are assumed to be included in the Reference Accuracy of the device .

Temperature drift effects are not applicable to transformers.

7.1.14. Instrument Drift

Deleted

7.2. Assumptions that require confirmation

None

8.0 **Calculation**

This section includes the following subsections used in performance of this calculation:

8.1) Calculation of Miscellaneous Uncertainties

8.2) Calculation of Individual Device Reference Accuracy (RA) and Determination of Appropriate Device Uncertainty to Use

8.3) Calculation of Individual Device Uncertainties

8.4) Calculation of Loop Calibration Accuracy (CL)

8.5) Calculation of Insulation Resistance Effects (IR)

8.6) Calculation of Loop Uncertainty (LU)

8.7) Calculation of Loop Drift (D_L)

8.8) Calculation of Total Loop Uncertainty (TLU)

8.9) Calculation of Reset Differential

8.1. **Calculation of Miscellaneous Uncertainties**

8.1.1. Calculation of Power Supply Effects on 62S3 and 62S4 Time delay setting (PS_{RT})
(Reference 3.9.1, Assumption 7.1.6)

PS_{RT1} = ± 5% of Time Delay setting, Setting is 3.0 seconds from Ref. 3.15
= ± (0.050*3.0) seconds
= ± 0.15 seconds (2σ value)

8.1.2. Calculation of Power Supply Effects on 62S5 and 62S6 Time delay setting (PS_{RT})
(Reference 3.9.1, Assumption 7.1.6) Setting is 54.9 seconds per Ref. 3.16.2

PS_{RT2} = ± 5% of Time delay setting Setting
= ± (0.050 * 54.9) seconds
= ± 2.745 seconds (2σ value)

8.1.3. Calculation of Temperature Effects on 62S3 and 62S4 Relay Time Delay Settings (TE_{RT})
(Reference 3.9.1, Assumption 7.1.12)

TE_{RT1} = ± 5% of Time Delay setting under Adverse Conditions
= ± (0.05 x 3) seconds
= ± 0.15 seconds (2σ value)

8.1.4. Calculation of Temperature Effects on 62S5 and 62S6 Relay Time Delay Settings (TE_{RT})
(Reference 3.9.1, Assumption 7.1.12)

TE_{RT2} = ± 5% of Time Delay setting under Adverse Conditions
= ± (0.05 x 54.9) seconds
= 2.745 seconds (2σ value)

8.2. **Calculation of Individual Device Reference Accuracy (RA) & Determination of Appropriate Device Uncertainty**

8.2.1. Undervoltage Relay Reference Accuracy for Time Delay Setting (RA_{RT})

RA_{RT1} = ± 5% of Setting   Setting is 3.0 seconds per Ref. 3.15
= ± 0.05 * 3.0 seconds
= ± 0.15 seconds (2σ value)

8.2.2. Undervoltage Relay Reference Accuracy for Time Delay Setting (RA_{RT})

RA_{RT2} = ± 0.5% of Setting
= ± 0.05 * 54.9 seconds
= 2.745 seconds (2σ Value)

8.3. **Calculation of Individual Device Uncertainties** (Reference 3.2)

8.3.1. Device Uncertainty Relay Time Delay Setting (A_{RT})
(Sections 8.2.3, 8.1.3, 8.1.5)

A_{RT1} $= \pm [(RA_{RT})^2 + (PS_{RT})^2 + (TE_{RT})^2]^{1/2}$
$= \pm [(0.15)^2 + (0.15)^2 + (0.15)^2]^{1/2}$ seconds
= ± 0.2598 seconds (2σ value)

This is conservative because the impacts of RA_{RT}, PS_{RT} and TE_{RT} are all combined in the manufacturers specified RA_{RT}.

8.3.2. Device Uncertainty Relay Time Delay Setting (A_{RT})
(Sections 8.2.3, 8.1.3, 8.1.5)

A_{RT2} $= \pm [(RA_{RT})^2 + (PS_{RT})^2 + (TE_{RT})^2]^{1/2}$
$= \pm [(2.745)^2 + (2.745)^2 + (2.745)^2]^{1/2}$ seconds
= ± 4.754 seconds

8.4. **Calculation of Loop Calibration Accuracy (C_L)**

Per references 3.2 and 3.3, loop calibration effects are defined as:

$CL_T = \pm [(MTE_L)^2 + (CT_{LT})^2]^{1/2}$

The CT_L is set to the procedural as-left band (PALB) since the PALB is greater than the A_{RT} per Ref. 3.2. New PALB's of 0.18 and 3.0 (Ref. 3.11) are selected by iteration of this calculation results into Ref. 3.16.2 and used for CT_{LT}.

8.4.1. Calculation of Loop Calibration Effects for the Time Delay Setting (C_{LT})

$$
\begin{aligned}
CL_{T1} &= \pm [(MTE_{LT1})^2 + (CT_{LT})^2]^{1/2} \\
&= \pm [(1.55 \text{ x } 10^{-4})^2 + (0.18)^2]^{1/2} \text{ seconds} \\
&= \pm 0.18 \text{ seconds}
\end{aligned}
$$

$$
\begin{aligned}
CL_{T2} &= \pm [(MTE_{LT2})^2 + (CT_{LT})^2]^{1/2} \\
&= \pm [(2.83 \text{ x } 10^{-3})^2 + (3.0)^2]^{1/2} \text{ seconds} \\
&= \pm 3.00 \text{ seconds}
\end{aligned}
$$

8.4.2.1 Measurement & Test Equipment (MTE_L) effects are defined from Reference 3.2 as:

$$MTE_{LV} = \pm [(MTE_{RAT})^2 + (MTE_{RIT})^2 + (MTE_{TET})^2 + (MTE_{CST})^2]^{1/2}$$

Where:

MTE_{RAT} = The reference accuracy of the M&TE being utilized. Epoch 40 Aux. Timer and DC voltage/current unit has a timer accuracy of 0.005% or one digit on the min. 99.9999 range. Using 3.0 x 0.00005 = 1.5 x 10^{-4} seconds or using 54.9 x 0.00005 = 2.745 x 10^{-3} seconds.

MTE_{TET} = Temperature effect on the M&TE being utilized. Zero is assumed since the Epoch 40 operating range is 0^o to 50^oC with no temperature coefficient given. (Reference 3.9.4).

MTE_{RIT} = Assumed to be 0 as all M&TE used are digital with at least 2 digits of resolution. (Reference 3.2)

MTE_{CST} = Assumed equal to 1/4 the Reference Accuracy of the time delay function of the relay time delay function = 0.005%/4 seconds (per Reference 3.2).

$$
\begin{aligned}
MTE_{L1} &= \pm [(MTE_{RART1})^2 + (MTE_{RIRT1})^2 + (MTE_{TERT1})^2 + (MTE_{CSRT1})^2]^{1/2} \\
&= \pm [(1.5 \text{ X } 10^{-4})^2 + (0)^2 + (0)^2 + (3.75 \text{ X } 10^{-5})^2]^{1/2} \\
&= \pm 1.55 \text{ X } 10^{-4} \text{ seconds.} \qquad (2\sigma \text{ Value})
\end{aligned}
$$

$$
\begin{aligned}
MTE_{L2} &= \pm [(MTE_{RART2})^2 + (MTE_{RIRT2})^2 + (MTE_{TERT2})^2 + (MTE_{CSRT2})^2]^{1/2} \\
&= \pm [(2.745\text{x}10^{-3})^2 + (0)^2 + (0)^2 + (6.86 \text{ x } 10^{-4})^2]^{1/2} \\
&= \pm 2.83 \text{ x}10^{-3} \text{ seconds.} \qquad (2\sigma \text{ Value})
\end{aligned}
$$

8.5. **Calculation of Insulation Resistance Effects (IR)**

0 per Assumption 7.1.10

8.6. **Calculation of Loop Uncertainty (LU)**

8.6.1. Loop Uncertainty for Time Delay Setting (LU_T)

Per references 3.2 and 3.3 Loop Uncertainty is defined as:

$$LU_{T1} = \pm (m/n)[(A_{RT1})^2 + (C_{LT1})^2]^{1/2}$$

Where: m = The number of standard deviations required to encompass 95% of the area under the curve for a normal distribution either one or two sided. 1.645 corresponds to a one sided confidence while 2.00 corresponds two a two sided confidence.

N = The number of standard deviations used in specifying the individual components of uncertainty

$= \pm (2.0/2)[(0.2598)^2 + (0.18)^2]^{1/2}$

$= \pm 0.316$ seconds

One or two sided distributions may be used in this calculation. Where appropriate, two sided distributions will be used for extra conservatism.

8.6.2. Loop Uncertainty for Time Delay Setting (LU_T)
Per references 3.2 and 3.3 Loop Uncertainty is defined as:

$LU_{T2} = \pm (m/n)[(A_{RT2})^2 + (CL_{T2})^2]^{1/2}$
$= \pm (2.0/2)[(4.7544)^2 + (3.0)^2]^{1/2}$
$= 5.622$ seconds

8.7. Calculation of Loop Drift (D_L)

8.7.1. Transformer Temperature Drift Effects (TD_T)

N/A for both the voltage and time delay function per Assumption 7.1.13

8.7.2. Relay Temperature Drift Effects (TD_R)

N/A for both the voltage and time delay function per assumption 7.1.13

8.7.3. Relay Drift (DR_{RV})

8.7.3.1 Relay Drift for Time Delay Setting (DR_{RT}) (Assumption 7.1.14)

$DR_{RT1} = \pm 3.725\%$ Setpoint
$= \pm (0.03725 \times 3)$ seconds
$= \pm 0.112$ seconds (2σ Value)

As there are no other components of drift to be considered for the relay time delay setting, Loop drift for the time delay setting (DR_{LT}) = DR_{RT}

8.7.3.2 Relay Drift for Time Delay Setting (DR_{RT}) (Assumption 7.1.14)

$DR_{RT2} = \pm 3.725\%$ Setpoint
$= \pm (0.03725 \times 54.9)$ seconds
$= \pm 2.05$ seconds (2σ Value)

As there are no other components of drift to be considered for the relay time delay setting, Loop drift for the time delay setting (DR_{LT}) = DR_{RT}

8.8. **Calculation of Total Loop Uncertainty (TLU)**

8.8.1. Total Loop Uncertainty – Time Delay Setting (TLU_T)

Per references 3.2 and 3.3 Total Loop Uncertainty is defined as:

TLU_{T1} $= \pm (m/n) [(A_{RT1})^2 + (C_{LT1})^2 + (DR_{LT1})^2]^{1/2} \pm M$ (margin)
$= \pm (1.645/2)[[(0.2598)^2 + (0.18)^2 + (0.112)^2]^{1/2} \pm 0.042$
$= \pm 0.322$ seconds

Per ref. 3.9.1 the repeat accuracy under adverse conditions is 10%. Adverse conditions include high/low temperature, high/low humidity, and low voltage which envelope the requirements for TLU.

TLU_T $= \pm (10.0\%) (3.0)$
$= \pm 0.300$ seconds

Tech Spec limits are 3.33 to 2.67 sec. = ± 0.33 sec.

8.8.2. Total Loop Uncertainty – Time Delay Setting (TLU_T)

Per references 3.2 and 3.3 Total Loop Uncertainty is defined as:

TLU_{T2} $= \pm (m/n) [(A_{RT2})^2 + (C_{LT2})^2 + (DR_{TL2})^2]^{1/2}$
$= \pm (2.0/2)[[4.754)^2 + (3.0)^2 + (2.05)^2]^{1/2}$
$= \pm 5.99$ seconds.

Per ref. 3.9.1 the repeat accuracy under adverse conditions is 10%. Adverse conditions include high/low temperature, high/low humidity, and low voltage which envelope the requirements for TLU.

TLU_{T2} $= \pm (10.0\%) (54.9)$
$= \pm 5.49$ seconds therefore selected method is more conservative..

Tech spec limits are 53.4 to 66.6 sec. = ± 6.6 sec

Summary of Calculation Data						
	Time Delay Relay Device 1					
	Time Delay Normal Conditions (TR data)			Time Delay Adverse Conditions (ETR data)		
Terms	**Values**	**σ**	**Ref**	**Values**	**σ**	**Ref**
Input Range 62S3, 62S4 62S5, 62S6	.55 to 15 4 to 120	–	3.9.6	.55 to 15 4 to 120	–	3.9.1
Process Units	Seconds	–	3.9.6	Seconds	–	3.9.1
Voltage Range	85-110%V		3.9.6	80% Min V.		3.9.1
Humidity	40-60%		3.9.6	10-95%		3.9.1
Temperature Range ^{o}F	70-104	–	3.9.6	40-145	–	3.9.1
Reference Accuracy (RA)	5% of Setting	2	3.9.6	± 10% of Setting	2	3.9.1
Temperature Effect (TE)	Included in RA	2	7.1.12 8.1.4	Included in RA	2	7.1.12 8.1.3 8.1.4
Seismic Effects (SE)	Included in RA	–	7.1.4	Included in RA	–	7.1.4
Radiation Effect (RE)	Included in RA	–	7.1.5	Included in RA	–	7.1.5
Instrument Drift (DR)	± 0.112 sec. ± 2.05 sec.	2 2	7.1.14 8.7.3	± 0.112 sec. ± 2.05 sec.	2 2	7.1.14 8.7.3
Temperature Drift Effect (TD)	N/A	–	7.1.13	N/A	–	7.1.13
Radiation Drift Effect (RD)	N/A	–	7.1.5	N/A	–	7.1.5
Power Supply Effect (PS)	Included in RA	2	7.1.6 8.1.1	Included in RA	2	7.1.6 8.1.2
Humidity Effects (HE)	Included in RA	–	7.1.9	Included in RA	–	7.1.9
Static Pressure Effect (SP)	N/A	–	7.1.8	N/A	–	7.1.8
Process Measurement Effect (PM)	N/A	–	7.1.7	N/A	–	7.1.7
Insulation Resistance Effect (IR)	N/A	–	7.1.10	N/A	–	7.1.10
Zero Effect (ZE)	N/A	–	7.1.3	N/A	–	7.1.3

DESIGN VERIFICATION COVER PAGE

☐ ANO-1	☐ ANO-2	☐ IP-2	☐ IP-3	☐ JAF	☐ PLP
☐ PNPS	☐ VY	☐ GGNS	☒ RBS	☐ W3	☐ NP

Document No. G13.18.6.2-ENS-007	Revision No. 1	Page 1 of 4

Title: Loop Uncertainty Determination for DIV III Undervoltage Time Delays – Agastat ETR14 Time Delay Relay

☒ Quality Related ☐ Augmented Quality Related

DV Method: ☒ Design Review ☐ Alternate Calculation ☐ Qualification Testing

VERIFICATION REQUIRED	DISCIPLINE	VERIFICATION COMPLETE AND COMMENTS RESOLVED (DV print, sign, and date)
☐	Electrical	
☐	Mechanical	
☒	Instrument and Control	**Robin Smith** [signature] 1/22/09
☐	Civil/Structural	
☐	Nuclear	
☐		
☐		

Originator:	**Charles Mohr** Charles Mohr 1/22/09 Print/Sign/Date After Comments Have Been Resolved

IDENTIFICATION:				DISCIPLINE:
Document Title: Loop Uncertainty Determination for DIV III Undervoltage Time Delays – Agastat ETR14 Time Delay Relay				☐Civil/Structural ☐Electrical ☒I & C ☐Mechanical ☐Nuclear ☐Other
Doc. No.:	G13.18.6.2-ENS-007	Rev. 1	QA Cat.: SR	
Verifier:	Robin Smith Print	[signature] Sign	1/22/09 Date	
Manager authorization for supervisor performing Verification. ☒ N/A	Print	Sign	Date	

METHOD OF VERIFICATION:		
Design Review ☒	Alternate Calculations ☐	Qualification Test ☐

The following basic questions are addressed as applicable, during the performance of any design verification. [ANSI N45.2.11 – 1974] [NP] [QAPD, Part II, Section 3] [NQA-1-1994, Part II, BR 3, Supplement 3s-1].

NOTE The reviewer can use the "Comments/Continuation sheet" at the end for entering any comment/resolution along with the appropriate question number. Additional items with new question numbers can also be entered.

1. Design Inputs – Were the inputs correctly selected and incorporated into the design?

   (Design inputs include design bases, plant operational conditions, performance requirements, regulatory requirements and commitments, codes, standards, field data, etc. All information used as design inputs should have been reviewed and approved by the responsible design organization, as applicable.

   All inputs need to be retrievable or excerpts of documents used should be attached.

   See site specific design input procedures for guidance in identifying inputs.)

   Yes ☒ No ☐ N/A ☐

2. Assumptions – Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are assumptions identified for subsequent re-verification when the detailed activities are completed? *Are the latest applicable revisions of design documents utilized?*

   Yes ☒ No ☐ N/A ☐

3. Quality Assurance – Are the appropriate quality and quality assurance requirements specified?

   Yes ☒ No ☐ N/A ☐

4. Codes, Standards and Regulatory Requirements – Are the applicable codes, standards and regulatory requirements, including issue and addenda properly identified and are their requirements for design met?
Yes ☒ No ☐ N/A ☐

5. Construction and Operating Experience – Have applicable construction and operating experience been considered?
Yes ☐ No ☐ N/A ☒

6. Interfaces – Have the design interface requirements been satisfied and documented?
Yes ☐ No ☐ N/A ☒

7. Methods – Was an appropriate design or analytical (for calculations) method used?
Yes ☒ No ☐ N/A ☐

8. Design Outputs – Is the output reasonable compared to the inputs?
Yes ☒ No ☐ N/A ☐

9. Parts, Equipment and Processes – Are the specified parts, equipment, and processes suitable for the required application?
Yes ☐ No ☐ N/A ☒

10. Materials Compatibility – Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
Yes ☐ No ☐ N/A ☒

11. Maintenance requirements – Have adequate maintenance features and requirements been specified?
Yes ☐ No ☐ N/A ☒

12. Accessibility for Maintenance – Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
Yes ☐ No ☐ N/A ☒

13. Accessibility for In-service Inspection – Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
Yes ☐ No ☐ N/A ☒

14. Radiation Exposure – Has the design properly considered radiation exposure to the public and plant personnel?
Yes ☐ No ☐ N/A ☒

15. Acceptance Criteria – Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
Yes ☒ No ☐ N/A ☐

16. Test Requirements – Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
Yes ☐ No ☐ N/A ☒

17. Handling, Storage, Cleaning and Shipping – Are adequate handling, storage, cleaning and shipping requirements specified?
Yes ☐ No ☐ N/A ☒

18. Identification Requirements – Are adequate identification requirements specified?
Yes ☐ No ☐ N/A ☒

19. Records and Documentation – Are requirements for record preparation, review, approval, retention, etc., adequately specified? Are all documents prepared in a clear legible manner suitable for microfilming and/or other documentation storage method? Have all impacted documents been identified for update as necessary?
Yes ☒ No ☐ N/A ☐

20. Software Quality Assurance- ENN sites: For a calculation that utilized software applications (e.g., GOTHIC, SYMCORD), was it properly verified and validated in accordance with EN- IT-104 or previous site SQA Program?
ENS sites: This is an EN-IT-104 task. However, per ENS-DC-126, for exempt software, was it verified in the calculation?
Yes ☐ No ☐ N/A ☒

21. Has adverse impact on peripheral components and systems, outside the boundary of the document being verified, been considered?
Yes ☐ No ☐ N/A ☒

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	Comments provided by markup for calculation G.13.18.6.2-ENS*007.	Comments resolved to the satisfaction of the reviewer.	CS 5/15/09

Calculation G13.18.6.2.-ENS*007, Rev. 001 (EOI Review Comments)

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	See generic comments in 2/10/09 memo to Jim Schott.	Resolved as agreed. - Ref Form & Section 3 match - Revision formatting changed - DV comment form attached	
2	Calc # is should be G13.18.6.2-ENS*007.	Corrected calc # on front page.	
3	Calc ref sheet does list the following references from the original calc. Should they be listed in Section VI of the form? 0221.415-000-122 242.521 3221.418-000-003U B445-0139 Also, GE-DL828E537AA and BE-230D are not listed but are referenced in the calc and shown in Section 3.0.	Added 0221.415-000-122, 242.521, 3221.418-000-003U, B445-0139 to section VI (removed). Also added references VTD-F137-0100, and Multi-Amp Instruction Book EPOCH-10 to section VI (removed). Added GE-DL828E537AA and BE-230D to the calc. Reference sheet.	
4	Section 2.2: typo; change “fort” to “for”.	Revised paragraph, typo eliminated.	
5	On the Calc Ref Sheet and Ref. 3.4 change “Passport EDB” to “Indus Asset Suite Equipment Data Base (EDB)”. Passport was replaced by Indus awhile back.	corrected	
6	Make sure the final approval of calc’s G13.18.6.3*014 still supports the new drift value on Page 13 of the calc for a 30 month calibration frequency. Also, why does this Excel calc have an “*” in it and others don’t?	Okay. Corrected error in the Excel calc number format.	
7	Component numbers in Section 4.2 do not match component numbers in section 2.1 and cover page.	Corrected component number mis-match.	
8	Move 8.4.1 on page 19 to top of next page.	Moved as suggested.	
9	Shouldn’t assumption 7.1.14 be deleted since there’s no assumption being made?	Assumption 7.1.14 changed to read “deleted”.	
10	Is reference 9.3.2 used in the calc? It’s on the Calc Ref Sheet.	Reference is actually 3.9.2 and it was removed from calc., Ref. form and added to Sec. VI.	
11	Calc G13.18.3.1*002 is shown as being impacted. What is the impact?	These TLU’s are an input to that calc.	
12	Where do the revised Channel Drift values in table 2.1-1 come from?	Drift comes from section 8.7.3 , values were corrected on Table 2.1-1.	
13 (new)	Use of word “bounding” in section 2.2 need clarifying.	Per phone discussion revised section 2.2 “Conclusions” as to what components and circuits the calculated values apply to.	

Calculation G13.18.6.2-ENS*007, Rev. 002 (EOI Review Comments, Second Round)

Comments / Continuation Sheet

Question #	Comments	Resolution	Initial/Date
1	Remove space in drift value in Form 4 on Page 12. Should be "3.725%"	Removed space.	
2	Sections 8.8.1 and 8.8.2 reference Tech Spec limits. Verify that these values don't change in G13.18.3.1*002.	Those TS limits are not changed by the pending revision to G13.18.3.1*002.	