☐ 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:** ☒ **Safety / Quality Related** ☐ **Augmented Quality Program** ☐ **Non-Safety Related**	(12) **Component/Equipment/Structure Type/Number:**	
	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	(16) Name/Signature/Date	(17) Name/Signature/Date
Chuck Mohr (see EC 11753 for signature)	Justin Waters (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						
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°C – 55°C)	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	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, °F	**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, °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
ev
with intermediate rounding of values in the conservative direction, sufficient conservatism has been introduced.

7.1.2 _____

For conservatism, all uncertainties given in vendor data specifications are assumed to be

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

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

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

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

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

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

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

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

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 alue)

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

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

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

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)

$C_L = \pm [(MTE_L)^2 + (CT_L)^2]^{1/2}$ $\qquad CT_L$ = 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° to 50°C with no temperature coefficient given. The total timer accuracy of 0.005% is conservatively assumed or 2.89×10^{-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).

$MTE_L = \pm [(MTE_{RART})^2 + (MTE_{RIRT})^2 + (MTE_{TERT})^2 + (MTE_{CSRT})^2]^{1/2}$
$= \pm [(2.89 \times 10^{-3})^2 + (0)^2 + (2.89 \times 10^{-3})^2 + (7.23 \times 10^{-4})^2]^{1/2}$
$= \pm 4.15 \times 10^{-3}$ seconds with worse case time delay,
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
$= \pm [(4.15 \times 10^{-3})^2 + 3.0^2]^{1/2}$ 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
$= \pm [(4.15 \times 10^{-3})^2 + 0.3^2]^{1/2}$ 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
$= \pm [(4.15 \times 10^{-3})^2 + 0.3^2]^{1//2}$ 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
= $\pm (2.0/2) [(0.06)^2 + (0.2)^2]^{1/2}$
= ± 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:

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

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

$LU_T = \pm (m/n)[(A_{RT})^2 + (C_{LT})^2]^{1/2}$
$= \pm (2.0/2)[(0.089)^2 + (0.3)^2]^{1/2}$
= ± 0.313 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		**Ref**	**Values**		**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 ☐ PNPS	☐ ANO-2 ☐ VY	☐ IP-2 ☐ GGNS	☐ IP-3 ☒ RBS	☐ JAF ☐ W3	☐ PLP ☐ NP

Document No. **G13.18.6.2.ENS*006**	Revision No. **1**	Page 1 of 4

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** 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
Doc. No.:	**G13.18.6.2.ENS*006**	Rev. 1	QA Cat.: SR	☐Electrical ☒I & C
Verifier:	Justin Waters (Print)	Justin Waters (Sign)	2/26/09 (Date)	☐Mechanical
Manager authorization for supervisor performing Verification. ☐ N/A	Print	Sign	Date	☐Nuclear ☐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 ☒

Sheet 1 of 1

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	