ATTACHMENT G

ENGINEERING CALCULATION
E4C-098
CALCULATION CHANGE NOTICE 25
4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION

SAN ONOFRE UNITS 2 AND 3

Southern California Edison Company **INTERIM CALCULATION CHANGE NOTICE (ICCN)/ CALCULATION CHANGE NOTICE (CCN) COVER PAGE**	CALC. NO. E4C-098	ICCN NO./ PRELIM. CCN NO. N-15	PAGE 1	TOTAL NO. OF PAGES 50
	BASE CALC. REV. 1	UNIT 2 & 3	CCN CONVERSION : CCN NO. CCN- 25	CALC. REV. 1
	CALCULATION SUBJECT : 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION			
CALCULATION CROSS-INDEX ☒ New/Updated index included ☐ Existing index is complete	ENGINEERING SYSTEM NUMBER / PRIMARY STATION SYSTEM DESIGNATOR 1804 / PBA / PBB			Q-CLASS II
Site Programs/Procedure Impact? ○ NO ◉ YES, AR No. 970200708	CONTROLLED PROGRAM OR DATABASE ACCORDING TO SO123-XXIV-5.1 ☐ PROGRAM ☐ DATA BASE	PROGRAM / DATABASE NAME (S) ☐ ALSO, LISTED BELOW		VERSION/RELEASE NO.(S)

1. BRIEF DESCRIPTION OF ICCN / CCN:

This CCN evaluates the setpoints included in CCN 20 to base calculation E4C-098 for the following items to support Proposed Change Number (PCN) 488 to SR 3.3.7.3 & SR 3.3.7.4 of Units 2&3 Technical Specifications:

Loss of voltage relay 127F
Degraded bus voltage relay 127D
Time delay relay 162D
Time delay relay 162S
Time delay relay 162T

This CCN deletes some lower/upper limit of voltage/time delay, which are not important to safety, from surveillance requirement

INITIATING DOCUMENT (DCP, FCN, OTHER) PCN-488 to Units 2&3 Tech. Spec. REV. _____

2. OTHER AFFECTED DOCUMENTS (CHECK AS APPLICABLE FOR CCN ONLY):

○ YES ◉ NO OTHER AFFECTED DOCUMENTS EXIST AND ARE IDENTIFIED ON ATTACHED FORM 26-503.

3. APPROVAL :

DISCIPLINE / ESC : NEDO / Electrical

J. Kim / J. Kim 7/23/99 ORIGINATOR (Print name/sign/date)	for J. Knowles 7/23/99 FLS (Signature/date)	_____ OTHER (Signature/date)
B. Lennartz B. Lennartz 7/23/99 IRE (Print name/sign/date)	_____ OTHER (Signature/date)	_____ OTHER (Signature/date)

4. CONVERSION TO CCN DATE 7/28/99 _____
SCE CDM - SONGS

SCE 25-122-1 REV. 2 8/98 (REFERENCE: SO123-XXIV-7.15)

T:\JETFORM\FORMS\NEDO_GEN\122_1_02.MDF Ver: 02.00.02 5/99
C:\JETDATA\98CDVNTS.DAT DevID: -1.0000 Printed: 07/19/99

Site File Copy

CALCULATION CROSS-INDEX

ICCN NO./ PRELIM. CCN NO. N-15	PAGE 2 OF 50
	CCN CONVERSION: CCN NO. CCN- 25

Calculation No. E4C-098 Sheet No. ____ of ____

Calc. rev. number and responsible FLS initials and date	INPUTS: These interfacing calculations and/or documents provide input to the subject calculation and if revised may require revision of the subject calculation.		OUTPUTS: Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calc/ document require revision?	Identify output interface calc/document CCN, DCN, TCN/Rev., FIDCN, or tracking number.
	Calc / Document No.	Rev. No.	Calc / Document No.	Rev. No.	YES / NO	
1 / [illegible] 7/23/99	Maintenance Orders 94071244 94071245 96030942 96031127 96050677 96050678		Tech. Spec. Unit 2 Tech. Spec. Unit 3	127 116	Yes Yes	PCN-488 PCN-488
1 / [illegible] 7/23/99	97020999 97021000 97021004 97021013 98060307 98060308		SO2-II-11.1A SO2-II-11.1B SO3-II-11.1A SO3-II-11.1B	1 1 1 1	Yes Yes Yes Yes	AR # 970200708 – 16
1 / [illegible] 7/23/99	CCN 20 to base calc. E4C-098					

E&TS DEPARTMENT

CALCULATION SHEET

CCN NO./ PRELIM. CCN NO. N-15	PAGE 3 OF 50
CCN CONVERSION: CCN NO. CCN - 25	

Project or DCP/FCN UNITS 2 & 3 Calc No. E4C-098

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet _____ of _____

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

1 PURPOSE

This CCN evaluates the setpoints included in CCN 20 to base calculation E4C-098 for the following items to support Proposed Change Number (PCN) 488 to SR 3.3.7.3 & SR 3.3.7.4 of Units 2&3 Technical Specifications:

- Loss of voltage relay 127F
- Degraded bus voltage relay 127D
- Time delay relay 162D
- Time delay relay 162S
- Time delay relay 162T

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

2 RESULTS/CONCLUSIONS and RECOMMENDATIONS

2.1 Results

2.1.1 Setpoints for Degraded Voltage Function (127D-1,2,3,& 4 relays - ABB 27N relay)

Item	Design Limit [TLU = ±0.89 V (0.737%), Engin. Margin = 0.46 V)]		Allowable (As-found) Values [Tol. = ±0.45 V (0.37%), Engin. Margin = 0.46 V)]		As-left Values (setting tol = ±0.1 V)	
	Relay(V)	Primary (V)	Relay (V)	Primary (V)	Relay (V)	Primary (V)
Max. Relay pickup	122.75	4296.25	**122.31***	**4280.85***	121.50	4252.50
Max. Relay dropout	122.14	4274.90	**121.70***	**4259.50***	120.90	4231.50
Nominal relay pickup	121.40	4249.00	121.40	4249.00	121.40	4249.00
Nominal relay dropout	120.80	4228.00	120.80	4228.00	120.80	4228.00
Min. Relay pickup	120.05	4201.75	**120.49***	**4217.15***	121.30	4245.50
Min. Relay dropout	119.45	4180.75	**119.89***	**4196.15***	120.70	4224.50
Time delay (120 V to 0 V)	2 sec.s ± 0.2 sec.		2 sec.s ± 0.17 sec.*		2 sec.s ± 0.02 sec.	

*Revised value from the value in CCN 20 to E4C-098.

2.1.2 Setpoints for Loss of Voltage Function (127F-1,2,3,& 4 relays - Westinghouse CV-2 relay)

Item	Existing Tech. Spec. SR 3.3.7.3.b			Proposed Allowable Values (Acceptable As-Found Values)			Acceptable As-Left Setting Values		
	TLU	Overall Setting (V)		Tol.	Relay Setting (V)		Tol.	Relay Setting (V)	
		Relay	Primary		Relay	Primary		Relay	Primary
Max. relay dropout	±3.3 (%)	108.47	3796.45	±3.3 (%)	108.47	3796.45	±1 (%)	106.05	3711.75
Nominal relay dropout		105.00	3675.00		105.00	3675.00		105.00	3675.00
Min. relay dropout		101.56	3554.60		**101.54***	**3553.90***		103.95	3638.25
Time delay (Note)	≥ 0.95 sec. and ≤ 1.05 sec.			≥ 0.75 sec. and ≤ 1.0 sec.			≥ 0.782 sec. and ≤ **0.965*** sec.		

*Revised value from the value in CCN 20 to E4C-098.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

Note: Time dial of CV-2 relay should be adjusted such that the time delay of the entire LOVS channel up to an including 127F-1X3 and 127F-1X/127F-1X2 is within this time range. A LOVS channel consists of relay 127F-1 and auxiliary relays 127F-1X3 and 127F-1X1/127F-1X2 in series. This timing requirement also applies to the LOVS channels associated with relays 127F-2, 127F-3, and 127F-4. This is the time to go from nominal voltage to zero (120 V to 0 V).

2.1.3 Setpoints for time delay relays for Degraded Voltage Function

Relay	Existing Tech. Spec. SR 3.3.7.3.a		Proposed Allowable Values (Acceptable As-Found Values)		Acceptable As-Left setting	
	TLU (%)	Setting (seconds)	Tol. (%)	Setting (seconds)	Tol. (sec.)	Setting (seconds)
162D-1,2,3 & 4	±20	110 ± 22	±16.4	110 ± 18	±2	110 ± 2
162S-1,2,3 & 4	±4.4	4.3 ± 0.19	±3.33	4.3 ± 0.14	±0.05	4.3 ± 0.05
162T-1,2,3 & 4	±32	1.25 ± 0.4	±29.87	1.25 ± 0.37	±0.05	1.25 ± 0.05

No change from CCN 20 to calculation E4C-098.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

2.2 Recommendations

2.2.1 Revise Surveillance Requirements of Technical Specification section 3.3.7 as follows:

Section	Existing Allowable Values	Recommended Allowable Values
SR 3.3.7.3. a	Degraded Voltage Function ≥ 4181 V and ≤ 4275 V	Degraded Voltage Function: i. Dropout ≥ 4196 V (Note 1) ii. Pickup ≤ 4281 V (Note 2)
	SDVSS (Sustained Degraded Grid Voltage): Time delay: i. 127D ≥ 1.8 seconds and ≤ 2.2 seconds ii. 162D ≥ 88 seconds and ≤ 132 seconds	SDVSS (Sustained Degraded Grid Voltage): Time delay: i. 127D ≤ 2.17 seconds (Note 3) ii. 162D ≤ 128 seconds (Note 3)
	DGVSS (Degraded Grid Voltage with SIAS Signal): Time delay: i. 127D ≥ 1.8 seconds and ≤ 2.2 seconds ii. 162S ≥ 4.11 seconds and ≤ 4.49 seconds iii. 162T ≥ 0.85 seconds and ≤ 1.65 seconds	DGVSS (Degraded Grid Voltage with SIAS): Time delay: i. 127D ≥ 1.83 seconds and ≤ 2.17 seconds ii. 162S ≥ 4.16 seconds and ≤ 4.44 seconds iii. 162T ≥ 0.88 seconds and ≤ 1.62 seconds
SR 3.3.7.3.b	Loss of Voltage Function ≥ 3554 V and ≤ 3796 V Time delay: ≥ 0.95 seconds and ≤ 1.05 seconds at 0 V	Loss of Voltage Function ≥ 3554 V (Note 1) Time delay: ≤ 1.0 seconds at 0 V (Note 4)
SR 3.3.7.4 (Note)	Verify Response Time of required DG-LOV channel is within 1.05 seconds.	Deleted

Notes:

1. Surveillance of the lower limit of the dropout voltage is important to safety because the operation of the undervoltage relay at the setpoint ensures the protection of electrical equipment from low operating voltage.
2. Surveillance of the upper limit of the pickup voltage is required to verify that the relay will reset at the minimum bus voltage of 4297 V.
3. Surveillance of the upper limit of the time delay is required because only the upper limit of the time delay is important to safety.
4. Time dial of CV-2 relay should be adjusted such that the time delay of the entire LOVS channel up to and including 127F-1X3 and 127F-1X/127F-1X2 is within this time range. A LOVS channel consists of relay 127F-1 and auxiliary relays 127F-1X3 and 127F-1X1/127F-1X2 in series. This timing requirement also applies to the LOVS channels associated with relays 127F-2, 127F-3, and 127F-4. This is the time to go from nominal voltage to zero (120 V to 0 V).

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

2.2.2 Revise Test Procedures SO2(3)-II-11.1A and SO2(3)-II-11.1B to change acceptance criteria for as-found dropout and pickup voltages of 127D relays and as-left time delay value of 127F relays as shown below:

Undervoltage Relay

Relay		Time delay		Dropout		Pickup	
		Nominal setting	Acceptance criteria	Nominal setting	Acceptance criteria	Nominal setting	Acceptance criteria
127D-1,2,3,&4 (Applicable TS SR 3.3.7.3) 27N	AS-Left	2 Sec.	1.98 sec. to 2.02 sec.	121.40 V	120.7 V to 120.9 V	121.40 V	121.30 V to 121.5 V
	As-Found		1.83 sec to 2.17 sec.		**119.89 V to 121.70 V**		**120.49 V to 122.31 V**
127F-1,2,3,& 4 (Applicable TS SR 3.3.7.3) CV-2	As-Left	≤1.0 sec.	0.782 sec to **0.965 sec.** (Note)	105 V	103.95 V to 106.05 V	N/A	N/A
	AS-Found		0.75 sec to 1.0 sec. (Note)		101.54 V to 108.47 V		N/A

Note: Time dial of CV-2 relay should be adjusted such that the time delay of the entire LOVS channel up to and including 127F-1X3 and 127F-1X1/127F-1X2 is within this time range. A LOVS channel consists of relay 127F-1 and auxiliary relays 127F-1X3 and 127F-1X1/127F-1X2 in series. This timing requirement also applies to the LOVS channels associated with relays 127F-2, 127F-3, and 127F-4. This is the time to go from nominal voltage to zero (120 V to 0 V)

2.2.3 Instrument calibration

As recommended in CCN 20 to calculation E4C-09, the following equipment (equivalent or better accuracy) are required for instrument calibration:

Instrument	Instrument ID	Calibration equipment
Undervoltage relays	127D-1,2,3, & 4 127F-1,2,3, & 4	Fluke 45 Multimeter with a user selected reading rate of medium and voltage range of 300 V or equal.
Time delay relays	162D-1,2,3, & 4	Wilmar SC-101 with a user selected range of second or equal
	162S-1,2,3, & 4 162T-1,2,3, & 4	Wilmar SC-101 with a user selected range of millisecond or equal

E&TS DEPARTMENT

CALCULATION SHEET

ICCN NO./	
PRELIM. CCN NO. N-15	PAGE 8 OF 50
CCN CONVERSION: CCN NO. CCN - 25	

Project or DCP/FCN UNITS 2 & 3 Calc No. E4C-098

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet _____ of _____

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

INTENTIONALLY LEFT BLANK

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

3 ASSUMPTIONS

3.1 The reset time of 5 cycles for Westinghouse type CV-2 relay was assumed based on the similar electro-mechanical G.E type IAV54E relay.

3.2 The following instruments are assumed to be used for calibration of undervoltage relays and time delay relays (see recommendation 2.2.3).

Undervoltage relays: Fluke 45 Multimeter with a user selected reading rate of medium and voltage range of 300 V.

Time delay relays: Wilmar SC-101 with a user selected range of second and millisecond

3.3 The following relay voltage setting tolerances were assumed:

Relay	Setting tolerance	Reference
127D-1,2,3,&4 (27N)	±0.1 V	Surveillance test data (refer to para. 4.4)
127F-1,2,3,& 4 (CV-2)	±1%	Surveillance test data (refer to para. 4.3) and Attachment 9.10 of CCN 20 to E4C-098

3.4 Since drift tolerances of some relays are not available, the following miscellaneous tolerances which include drift tolerance for voltage tap were assumed:

127D-1,2,3,&4 (27N)	±0.36%
127F-1,2,3,&4 (CV-2)	±1.29%

As shown in paragraphs 4.3 & 4.4, measured drifts of the relays are less than these assumed tolerances.

3.5 Time setting tolerances of the following relays were assumed:

Relay	Setting tolerance	Reference
162D-1,2,3,& 4	±2 seconds	Refer to para. 4.5
162S-1,2,3,& 4	±0.05 second	Refer to para. 4.6
162T-1,2,3,& 4	±0.05 second	Refer to para. 4.7
127D-1,2,3,& 4	±0.02 second	Refer to para. 4.4
127F-1,2,3,& 4	±1%	Attachment 9.10 of CCN 20 to E4C-098

As shown in paragraphs 4.3, 4.4, 4.5, 4.6, & 4.7, measured drifts of the relays are less than these assumed tolerances.

3.6 ABB catalog for 27N relay specifies an accuracy of ±10% for time delay. However, ABB (Mr. Cliff Downs) states that the accuracy of ±10% is very conservative value that includes temperature effect, power supply effect, and miscellaneous tolerance.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennertz						

REV INDICATOR

Type test results for 27N relay (Attachment 9.11 of CCN 20 to E4C-098) shows the following accuracies:

Accuracy: Max. ±5% (time tap setting at 1)
Temperature effect: ±0.1% in a range of 0°C to 40°C
Power supply effect: Not available

Based on the above data, the following random tolerances for 27N relay time delay were assumed:
Reference tolerance: ±5%
Temperature effect: ±0.1%
Power supply variation: ±0.1%
Miscellaneous tolerance: ±8.66%

3.7 ABB clarifies that temperature and control power effects on the accuracy are non-random (refer to Attachment 9.16 of the base calculation E4C-098, rev. 1). However, it was assumed that the worst case effects (±0.1% for control power effect and ±0.4% for temperature effect) are random.

3.8 Operating time tolerance of ±5% for CV-2 relay is based on the calibration tolerance of 1% as stated in Attachment 9.10 of CCN 20 to E4C-098. The operating tolerance of ±5% is considered to include temperature effect, drift allowance, and miscellaneous allowance.

Voltage tap tolerance of ±3% for CV-2 relay is based on the calibration tolerance of 1% as stated in Attachment 9.10 of CCN 20 to E4C-098. The voltage tap tolerance of ±3% is considered to include temperature effect, drift allowance, and miscellaneous allowance.

3.9 Temperature effect on accuracy for Agastat series E7000 Class 1E relay is not available. However, the specification (Attachment 9.12 of CCN 20 to E4C-098) for series 7000 non-1E relay states "The maximum shift in the average of three consecutive time delays from 77°F is -20% at -20°F, +20% at 165F°." This temperature variation will be used for series E7000 Class 1E relay.

Voltage effect on accuracy is not available. Therefore, it was assumed that voltage effect on accuracy is included in the relay accuracy of ±10%.

3.10 Since drift tolerances of some relays are not available, the following miscellaneous tolerances (which include drift tolerance) for time delay were assumed based on the existing tolerances of the time delay relays in Tech. Spec. SR 3.3.7.3.a:

162D-1,2,3,& 4 ±16.3%
162S-1,2,3,& 4 ±3.13%
162T-1,2,3,& 4 29.3%

As shown in paragraphs 4.5, 4.6, & 4.7, measured drifts of the relays are less than these assumed tolerances.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

4 DESIGN INPUT

4.1 Undervoltage relay 127D-1,2,3,4 settings (refer to the base calculation E4C-098)

	Relay Setting(V)	4160 V bus voltage volts	P. U.
Maximum reset	122.75	4296.25	1.033
Maximum dropout	122.14	4274.90	1.028
Nominal reset	121.40	4249.00	1.021
Nominal dropout	120.80	4228.00	1.016
Minimum reset	120.05	4201.75	1.010
Minimum dropout	119.45	4180.75	1.005

4.2 Technical Data for miscellaneous devices

4.2.1 West. CV-2 undervoltage relay (references 6.2 & 6.4 and Attach. 9.10 of CCN 20 to E4C-098))

Device No:	127F1, 127F2, 127F3, and 127F4
MFR:	Westinghouse
Style No:	1875516
Tap Range:	55-140 V
Temperature range:	-20°C to 55°C
Burden:	2.4 VA w/ 0.29 power factor @105 V TAP 3.64 VA & 0.34 PF at 105 V tap (Existing) 4.66 VA & 0.35 PF at 93 V tap (Existing)
Inst. book:	I.L. 41-201K
Tap setting	105 V
Time dial:	Adjust time delay of 127F1 relay such that the time delay of the entire LOVS channel up to and including 127F1X3 and 127F1X1/127F1X2 is 1.00 ± 0.05 seconds. A LOVS channel consists of relay 127F1 and auxiliary relays 127F1X3 and 127F1X1/127F1X2 in series. This timing requirement also applies to the LOVS channels associated with relays 127F2, 127F3, and 127F4.
Accuracy:	Voltage tap - ±3% Voltage tap calibration - ±1% Time curve - ±5% Time dial calibration - ±1%

Reset time (contact opening): 5 cycles (refer to paragraph 3.1)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

4.2.2 ABB undervoltage relay (references 6.3 & 6.4)

Device No:	127D-1, 2, 3, 4
Manufacturer:	ABB
Type:	27N
Catalog #:	411T5375
Pickup range:	70-120 V
Pickup setting:	121.4 V
Dropout:	70-99% of pickup (Note 1)
Dropout delay:	2-20 seconds
Delay setting:	2 seconds
Reset time:	Less than 2 cycles
Control voltage:	100-140 V DC
Temperature range:	-30 to +70° C
Burden:	0.5 VA at 120 V

Repeatability tolerance (Note 2):

With harmonic filter

a. @ constant temperature & control voltage - ±0.1%
b. For allowable dc control power range (100-140 V) - ±0.1%
c. Temp. range
0 to +55° C - ±0.75%
+10 to +40° C - ±0.4%
-20 to +70° C - ±1.5%
d. Time delay - ±10% or ±20 milliseconds whichever is greater.

Notes:

1 Difference between pickup and dropout can be set as low as 0.5 %
2 The three repeatability tolerances are cumulative and are random tolerances (refer to para. 3.7).

4.2.3 GE potential transformer (refer to base calculation E4C-098)

Type:	JVM-3
Ratio:	4200/120 V
Accuracy:	0.3W, X, Y, 1.2Z burden at 120 V

4.2.4 Environmental condition data (reference 6.8)

Area	Min. temp. Normal	Max. temp. normal/accident
CB Area B5 (ESF SWGR room)	50°F	95°F/95°F

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

4.2.5 Fluke 45 multimeter (Attachment 9.8 of CCN 20 to base calc. E4C-098))

300 V range

Accuracy: ±0.2% of reading + 10 digits
Full scale: 300 V AC
Resolution: 0.01 V

Note: Since the resolution at medium sampling rate (refer to para. 3.2) on 300 V range is 10 mV, the reference accuracy is ±(0.2% + 10x0.01V) = ±(0.2% + 0.1 V)

30 mA range

Accuracy: 0.05% + 3
Full scale: 30 mA
Resolution: 1 µA

Note: Since the resolution at medium sampling rate (refer to para. 3.2) on 30 mA range is 1 µA, the reference accuracy is ±(0.05% + 3 x 0.000001 A) = ±(0.05% + 0.000003 A)

4.2.6 Timer (Attachment 9.9 of CCN 20 to base calc. E4C-098)

Manufacturer: Wilmar
Type: SC-101
Operation Modes: Dry contact, NO or NC
DC potential, OFF or ON
AC potential, OFF ON
Temperature range: 0°C to 50°C

Range: Cycles - 0-99999
Milliseconds - 0-99999
Seconds - 0-999.99
Accuracy*: Dry contact - ±1 millisecond
DC voltage - ±1 millisecond
AC voltage - ±1/4 cycle

* Notes

(1) The "clock" and "read-out" tolerance listed below must be added in computing the overall accuracy:

a. The internal clock tolerance - ±0.06%
b. Above accuracies are ±1 less significant digit.

(2) The AC voltage accuracy given is the worst case at low voltages and improves

with high voltage.

4.2.7 Time delay relay (Attachment 9.18 of base calc. E4C-098, rev. 1)

Device No.:	162S-1, 2, 3, & 4
Manufacturer:	ABB
Catalog No.:	417T2170
Time delay range:	0.01 - 9.99 seconds
Accuracy:	Repeatability - ±0.5% or ±15ms whichever is greater. Variation of timing with change in ambient temp. - ±2% or ±20ms whichever is greater for -20°C to +70°C Variation of timing with change in control voltage - ±2% or ±20ms whichever is greater for -20% to +10% voltage variation.

4.2.8 Time delay relay (Attachment 9.18 of base calc. E4C-098, rev. 1)

Device No.:	162T-1, 2, 3, & 4
Manufacturer:	Amerace Corp.
Catalog No.:	Agastat E7012PB
Time delay range:	0.5 - 5 seconds
Accuracy:	±10%

4.2.9 Time delay relay (Attachment 9.18 of base calc. E4C-098, rev. 1)

Device No.:	162D-1, 2, 3, & 4
Manufacturer:	Amerace Corp.
Catalog No.:	Agastat E7012PKL
Time delay range:	1-300 seconds
Accuracy:	±10%

4.3 CV-2 Loss of Voltage relay test data

Loss of voltage relay CV-2 (reference 6.12)

Bus/ test date	Relay	Min. Trip Voltage (V)			Channel Operating Time (sec.) (120 V to 0 V)	
		Nominal setting	As-left	As-found	Nominal setting	As-left
2A04/ 2/15/97	127F-1	105	Note 2	103.1	1.0 (Note 1)	0.974
	127F-2			103.9		0.965
	127F-3			104.6		0.967
	127F-4			104.2		0.969
2A06/ 2/15/97	127F-1		Note 2	106.0		0.965
	127F-2			106.5		0.964
	127F-3			103.5		0.964
	127F-4			104.1		0.967
3A04/ 2/15/97	127F-1		Note 2	104.5		0.964
	127F-2			102.9		0.986
	127F-3			104.5		0.976
	127F-4			104.5		0.988
3A06/ 2/15/97	127F-1		Note 2	103.5		0.962
	127F-2			103.4		0.965
	127F-3			103.0		0.964
	127F-4			102.7		0.962

Notes: 1. Time dial of CV-2 relay should be adjusted such that the time delay of the entire LOVS channel up to and including 127F-1X3 and 127F-1X1/127F-1X2 is within this time range. A LOVS channel consists of relay 127F-1 and auxiliary relays 127F-1X3 and 127F-1X1/127F-1X2 in series. This timing requirement also applies to the LOVS channels associated with relays 127F-2, 127F-3, and 127F-4.

2. As-left min. trip voltages for 4.16 KV buses are not available. Since the function of the CV-2 is to generate LOVS on loss of voltage condition within a specific time, CV-2 relay with a fixed time dial will dropout at the same time on a loss of power condition regardless of voltage tap settings (existing voltage tap of 105 V is arbitrary). Therefore, As-Left min. trip voltage of CV-2 relay is not critical for this analysis.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

Loss of voltage relay CV-2 (reference 6.14)

Bus/ test date	Relay	As-found		As-left	
		Trip Voltage (V0	Channel operating Time (sec) (120V - 0 V)	Trip Voltage (V0	Channel operating Time (sec) (120V - 0 V)
2A04/ 2/23/99	127F-1	102.75	1.01	105.1	0.952
	127F-2	103.84	0.9485	105.0	0.958
	127F-3	104.25	0.9744	105.0	0.957
	127F-4	102.54	0.9138	105.1	0.953
2A06/ 2/6/99	127F-1	105.1	0.97	105.4	0.96
	127F-2	106.1	0.95	105.1	0.96
	127F-3	104.4	0.96	104.8	0.96
	127F-4	104.1	0.95	104.3	0.96

Note; Data for buses 3A04 & 3A06 are not available.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

4.4 27N Degraded Bus Voltage relay test data

DGVSS relays 27N (reference 6.13)

Bus	Relay	As-Found		As-Left		
		Dropout voltage (V)	Time (sec) (120 V - 0 V)	Pickup voltage (V)	Dropout voltage (V)	Time (sec) (120 V - 0 V)
3A04/ 8/15/95	127D-1	120.7	2.02	121.3	120.7	2.01
	127D-2	120.6	2.01	121.3	120.8	2.02
	127D-3	120.7	2.00	121.4	120.7	2.00
	127D-4	120.8	2.00	121.5	120.8	1.99
3A06/ 8/4/95	127D-1	120.8	2.01	121.5	120.9	2.01
	127D-2	120.9	2.00	121.3	120.8	2.00
	127D-3	120.8	2.03	121.5	120.9	2.01
	127D-4	120.8	1.99	121.5	120.8	1.99

Note; Data for buses 2A04 & 2A06 are not available.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

DGVSS relays 27N (reference 6.10)

Bus	Relay	As-Found		As-Left		
		Dropout voltage (V)	Time (sec) (120V - 0 V)	Pickup voltage (V)	Dropout voltage (V)	Time (sec) (120V - 0 V)
2A04/ 12/26/96	127D-1	120.37	2.0059	121.35	120.75	1.9971
	127D-2	120.35	2.0045	121.40	120.8	2.006
	127D-3	120.44	1.9933	121.41	120.8	1.987
	127D-4	120.45	1.9952	121.38	120.7	1.995
2A06/ 12/3/96	127D-1	120.63	1.99	121.37	120.78	1.99
	127D-2	120.59	1.99	121.31	120.71	1.99
	127D-3	120.60	1.99	121.31	120.73	2.00
	127D-4	120.59	1.99	121.30	120.70	1.98
3A04/ 4/14/97	127D-1	120.3	1.99	121.3	120.9	2.00
	127D-2	120.4	2.01	121.3	120.9	2.01
	127D-3	120.4	1.99	121.4	120.8	2.00
	127D-4	120.4	2.00	121.4	120.7	2.00
3A06/ 5/7/97	127D-1	120.54	2.02	121.39	120.80	2.02
	127D-2	120.50	2.01	121.40	120.80	2.01
	127D-3	120.62	2.03	121.40	120.80	2.03
	127D-4	121.14	2.0	121.4	120.8	2.04

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

DGVSS relays 27N (reference 6.14)

Bus	Relay	As-Found			As-Left		
		Pickup voltage (V)	Dropout voltage (V)	Time (sec) (120V - 0 V)	Pickup voltage (V)	Dropout voltage (V)	Time (sec) (120V - 0 V)
2A04/ 2/23/99	127D-1	121.20	120.71	2.01	121.36	120.83	2.01
	127D-2	121.32	120.70	2.01	121.32	120.70	2.01
	127D-3	121.38	120.84	2.01	121.38	120.84	2.01
	127D-4	121.24	120.66	2.0	121.40	120.85	2.00
2A06/ 2/6/99	127D-1	121.4	120.8	2.0	121.4	120.8	2.0
	127D-2	121.3	120.7	2.0	121.3	120.7	2.0
	127D-3	120.95	120.8	2.0	121.4	120.8	2.0
	127D-4	121.3	120.7	1.99	121.3	120.7	1.99

Note; Data for buses 3A04 & 3A06 are not available.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

4.5 162D Time Delay relay test data

Time delay relays 162D (reference 6.10)

Bus	Relay	Operating time (sec)				
		Nominal	As-found	As-left (1)	As-left (2)	As-left (3)
2A04/ 12/26/96	162D-1	110	108.6	118.4	116.3	118.6
	162D-2		110.2	110.2	112.4	112.7
	162D-3		115.4	115.4	112.7	120.4
	162D-4		116.6	116.6	111.2	112.8
2A06/ 12/3/96	162D-1		Not available	Not available	Not available	Not available
	162D-2					
	162D-3					
	162D-4					
3A04/ 4/14/97	162D-1		111	111	111	112
	162D-2		111	111	114	114
	162D-3		111	111	111	114
	162D-4		113	113	115	111
3A06/ 5/7/97	162D-1		109.4	109.4	108.5	107.6
	162D-2		110.8	106.1	105.9	109.8
	162D-3		112.8	110.5	110.6	110.2
	162D-4		112.7	104.4	108.8	109.0

Note: Time setting tolerance of 2 seconds for as-left time delay test is not applicable to these tests because the tests were performed before the 2 seconds tolerance was specified in CCN 20 to calculation E4C-098.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

Time delay relays 162D (reference 6.14)

Bus	Relay	Operating time (sec)				
		Nominal	As-found	As-left (1)	As-left (2)	As-left (3)
2A04/ 2/23/99	162D-1	110	113.32	110.8	111.93	111.92
	162D-2		110.43	109.0	108.0	108.37
	162D-3		115.63	108.65	110.48	109.26
	162D-4		112.05	109.41	108.57	108.72
2A06/ 2/6/99	162D-1		112.89	109.74	110.98	110.39
	162D-2		108.50	109.45	109.54	109.45
	162D-3		113.43	108.79	109.4	110.81
	162D-4		110.48	109.51	110.27	110.05
3A04/	162D-1		Not available	Not available	Not available	Not available
	162D-2					
	162D-3					
	162D-4					
3A06/	162D-1					
	162D-2					
	162D-3					
	162D-4					

4.6 162S Time Delay relay test data

Time delay relays 162S (reference 6.10)

Bus	Relay	Operating time (sec)				
		Nominal	As-found	As-left (1)	As-left (2)	As-left (3)
2A04/ 12/26/96	162S-1	4.30	4.29	4.29	4.30	4.29
	162S-2		4.29	4.29	4.29	4.29
	162S-3		4.30	4.34	4.29	4.30
	162S-4		4.30	4.29	4.29	4.29
2A06/ 12/3/96	162S-1		4.30	4.30	4.30	4.29
	162S-2		4.32	4.31	4.31	4.31
	162S-3		4.30	4.30	4.30	4.31
	162S-4		4.30	4.30	4.30	4.30
3A04/ 4/14/97	162S-1		4.3	4.3	4.3	4.3
	162S-2		4.3	4.3	4.3	4.3
	162S-3		4.3	4.3	4.3	4.3
	162S-4		4.3	4.3	4.3	4.3
3A06/ 5/7/97	162S-1		4.3	4.30	4.30	4.30
	162S-2		4.31	4.31	4.31	4.31
	162S-3		4.31	4.31	4.31	4.31
	162S-4		4.31	4.31	4.31	4.31

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

Time delay relays 162S (reference 6.14)

Bus	Relay	Operating time (sec)				
		Nominal	As-found	As-left (1)	As-left (2)	As-left (3)
2A04/ 2/23/99	162S-1		4.29	4.29	4.29	4.29
	162S-2		4.29	4.29	4.29	4.29
	162S-3		4.29	4.29	4.29	4.29
	162S-4		4.30	4.29	4.29	4.29
2A06/ 2/6/99	162S-1		4.3	4.3	4.3	4.3
	162S-2		4.3	4.3	4.3	4.3
	162S-3		4.3	4.3	4.3	4.3
	162S-4		4.3	4.3	4.3	4.3

Note; Data for buses 3A04 & 3A06 are not available.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

4.7 162T Time Delay relay test data

Time delay relays 162T (reference 6.10)

Bus	Relay	Operating time (sec)				
		Nominal	As-found	As-left (1)	As-left (2)	As-left (3)
2A04/ 12/23/96	162T-1	1.25	1.35	1.32	1.33	1.32
	162T-2		1.31	1.32	1.32	1.33
	162T-3		1.29	1.30	1.30	1.30
	162T-4		1.32	1.32	1.32	1.33
2A06/ 12/3/96	162T-1		1.28	1.26	1.26	1.27
	162T-2		1.29	1.26	1.24	1.24
	162T-3		1.33	1.45	1.38	1.36
	162T-4		1.29	1.30	1.27	1.27
3A04/ 4/14/97	162T-1		1.27	1.27	1.27	1.29
	162T-2		1.28	1.28	1.28	1.28
	162T-3		1.29	1.29	1.29	1.29
	162T-4		1.28	1.28	1.28	1.27
3A06/ 5/7/97	162T-1		1.31	1.29	1.29	1.30
	162T-2		1.29	1.28	1.29	1.30
	162T-3		1.27	1.28	1.29	1.28
	162T-4		1.27	1.27	1.28	1.30

Note: Time setting tolerance of 0.05 seconds for as-left time delay test is not applicable to these tests because the tests were performed before the 0.05 seconds tolerance was specified in CCN 20 to calculation E4C-098.

E&TS DEPARTMENT

CALCULATION SHEET

ICCN NO./
PRELIM. CCN NO. N-15

CCN CONVERSION:
CCN NO. CCN - 25

Project or DCP/FCN UNITS 2 & 3 Calc No. E4C-098

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet _____ of _____

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

Time delay relays 162T (reference 6.14)

Bus	Relay	Operating time (sec)				
		Nominal	As-found	As-left (1)	As-left (2)	As-left (3)
2A04/ 2/26/99	162T-1	1.25	1.38	1.25	1.26	1.25
	162T-2		1.33	1.25	1.25	1.26
	162T-3		1.31	1.24	1.25	1.25
	162T-4		1.35	1.26	1.26	1.26
2A06/ 2/6/99	162T-1		1.28	1.28	1.28	1.28
	162T-2		1.23	1.21	1.22	1.22
	162T-3		1.37	1.22	1.24	1.24
	162T-4		1.33	1.24	1.23	1.25

Note; Data for buses 3A04 & 3A06 are not available..

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

INTENTIONALLY LEFT BLANK

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet _____ of _____

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

5 METHODOLOGY

5.1 Definition

5.1.1 Allowable values (reference 6.6)

Allowable values of a setpoint are the design limit adjusted by the sum of the absolute value of the applicable tolerance plus the engineering margin.

Allowable value (min.) = Design limit + |Pos. tolerance| + Engineering margin

Allowable value (max.) = Design limit - |Neg. tolerance| - Engineering margin

Any operating procedures containing procedural steps having values, including surveillance acceptance values, must be more conservative than or equal to the allowable values.

5.1.2 Acceptable As-Left values

Setpoint ± Setting tolerance

5.1.3 Acceptable As-Found values

The same value as the allowable value

5.2 Setpoints of the Undervoltage Relay

5.2.1 Degraded Undervoltage Relay (27N)

Per sections 5.8 of base calculation E4C-098, revision 1, the maximum reset (pickup) voltage of the relay should be equivalent to the highest 4.16 KV ESF bus voltage determined by calculation E4C-082 (System Dynamic Voltages During Design Basis Accident) during the automatic sequencing of ESF loads immediately following a design basis accident. The minimum dropout voltage of the relay should be equal to or greater than the post accident steady state voltage of 4.16 KV ESF bus voltage determined by calculation E4C-090 (Auxiliary System Voltage Regulation).

Calculate analytical limits and allowable values for the maximum reset voltage and time delay, considering TLU of the relay circuit.

5.2.2 Loss of Voltage Relay (CV-2)

Voltage tap

Since the function of the CV-2 is to generate LOVS on loss of voltage condition within a specified time, CV-2 relay with a fixed time dial will dropout at the same time on a loss of power condition regardless of voltage tap settings (voltage tap of 105 V is arbitrary).

Therefore, TLU of the CV-2 relay voltage tap is not critical factor. However, the following should be noted:

1. As shown in section 5.8 of base calculation E4C-098, revision 1, the relay should operate at 75% of 4.16 kV bus voltage within 15 seconds to protect motors from short time voltage dips.

2. During surveillance test, the following item should be verified as specified by the relay manufacturer:

   - 1% calibration
   - Repeatability of the relay, considering tolerances of the relay & M&TE.

Time delay

Time dial of CV-2 relay was adjusted such that the time delay of the entire LOVS channel up to and including 127F-1X3 and 127F-1X1/127F-1X2 is 1.00 ± 0.05 seconds. A LOVS channel consists of relay 127F-1 and auxiliary relays 127F-1X3 and 127F-1X1/127F-1X2 in series. This timing requirement also applies to the LOVS channels associated with relays 127F-2, 127F-3, and 127F-4.

Since the upper limit of the time delay is the limiting condition, adjust CV-2 relay time dial to limit the maximum time delay if the entire LOVS channel to 1.00 second, considering TLU of the relay circuit and pickup time of the auxiliary relays 127F-1X1 and 127F-1X2 (X3).

5.3 Setpoints of time delay relays 162D-1, 2, 3, & 4, 162S-1, 2, 3, & 4, and 162T-1, 2, 3, & 4

Calculate the design limits and allowable values of the time delay, considering TLU of the relay circuit.

5.4 Total Loop Uncertainty (TLU) of metering devices

5.4.1 The following uncertainties are considered per Standard JS-123-103C (reference 6.6):

a. Device tolerance

- Reference accuracy
- Drift allowance
- Power supply allowance
- Temperature allowance (normal & accident)

b. M&TE tolerance

- M&TE accuracy requirement
- Readability requirement(One half of one minor division for analog M&TE and the value of the least significant digit for digital M&TE)
- M&TE temperature requirement
- M&TE reference standards requirement (25% of M&TE accuracy)

c. Setting tolerance allowance, if applicable

d. Readability allowance for meters

e. Miscellaneous allowance

5.4.2 The following tolerances are considered for allowable values:

a. Drift allowance

b. Setting tolerance

c. Miscellaneous allowance

5.5 Relay Circuit Tolerance

A combination of the Straight Sum and Square Root Sum of the Squares (RSS) methodologies will be utilized per SCE Standard JS-123-103C (reference 6.6). The random elements of uncertainty are combined under the RSS methodology, and any non-random uncertainties are added algebraically (straight-sum) to the RSS result as shown below:

a. Random, independent elements are combined by RSS methodology:

$$U = \pm (W^2 + X^2 + Y^2 + Z^2)^{1/2}$$

Where: W, X, Y, & Z are random, independent elements of uncertainty and U is the total uncertainty.

b. Random, dependent elements are first combined algebraically according to their dependency to form new independent elements. Then, as independent elements, they are combined with other independent elements by RSS methodology as follows:

$$U = \pm [W^2 + X^2 + (Y + Z)^2]^{1/2}$$

Where: Y & Z are random, dependent elements of uncertainty, W, X, and (Y + Z) are random, independent elements of uncertainty, and U is the total uncertainty.

c. Non-random element should be combined algebraically (straight sum) with the results of

the RSS computation for random, independent elements.

$$U = \pm (W^2 + X^2 + Y^2)^{1/2} + Z$$

Where: W, X, & Y are random, independent elements of uncertainty, Z is non-random element of uncertainty, and U is the total uncertainty.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lonnartz						

REV INDICATOR

INTENTIONALLY LEFT BLANK

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

6 REFERENCES

6.1 G.E. Protection and Control Products Catalog GEZ-7723

6.2 Instructions Westinghouse I.L.41-201.4C - Type CV Voltage Relays for Class 1E Application

6.3 Asea Brown Boveri Information Bulletin, IB 7.4.1.7-7 Issue D

6.4 Drawings

30220-2
30299
30300

6.5 V/P SO23-302-2-84 & 85 - B/M bus A04 & A06

6.6 SCE Standard JS-123-103C, Instrument Setpoints/Loop Accuracy Calculation Methodology.

6.7 Surveillance Operating Instruction SO23-3-3.23.1 - Diesel Generator Refueling Interval Tests

6.8 DBD-SO23-TR-EQ - Environmental Qualification Topical Report

6.9 90042 - Nuclear Consolidated Data Base

6.10 Maintenance Orders (History)

Bus	M.O.	Test date
2A04	96030942	12/26/96
2A06	96031127	12/3/96
3A04	96050677	4/14/97
3A06	96050678	5/7/97

6.11 Test Procedures for Loss of Voltage (LOVS), Degraded Voltage (SDVS, DGVSS) and Sequencing Relays and Circuit Test

SO2-II-11.1A - S.R. Unit 2 ESF Train A
SO2-II-11.1B - S.R. Unit 2 ESF Train B
SO3-II-11.1A - S.R. Unit 3 ESF Train A
SO3-II-11.1B - S.R. Unit 3 ESF Train B

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

6.12 CV-2 relay test data

Bus	M.O.	Test date
2A04	97021004	2/15/97
2A06	97021013	2/15/97
3A04	97020999	2/15/97
3A06	97021000	2/15/97

6.13 Maintenance Orders (History)

Bus	M.O	Test date
3A04	94071244	8/15/95
3A06	94071245	8/4/95

6.14 Maintenance Orders (History)

Bus	M.O	Test date
2A04	98060307	2/23/99
2A06	98060308	2/6/99

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet _____ of _____

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

7 **NOMENCLATURES**

AR	Action Request
CCN	Calculation Change Notice
EDG	Emergency Diesel Generator
DGVSS	Degraded Grid Voltage Signal with SIAS
LOVS	Loss of Voltage Signal
NCR	Non Conformance Report
Para.	Paragraph
SDVS	Sustained Degraded Voltage signal
SR	Surveillance Requirement
SRSS	Square Root Sum of the Squares
Tol.	Tolerance
TLU	Total Loop Uncertainty

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

INTENTIONALLY LEFT BLANK

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

8 EVALUATION / COMPUTATIONS

8.1 TLU calculation

8.1.1 Measuring and testing equipment (M&TE) tolerance

8.1.1.1 Fluke 45 tolerance (refer to paragraph 4.2.5)

Voltage - 300 V range

a. M&TE accuracy requirement

Fluke 45 multimeter random accuracy is ± 0.2% + 10 digits

Since the resolution at medium sampling rate on the 300 V range is 10 mV, the reference accuracy is ±(0.2% +10x0.01V) = ±(0.2% + 0.1V)

If the device is set near 121 V, then 0.1 V is equivalent to about 0.083%. Therefore, the random accuracy of Fluke 45 multimeter is ±0.283%.

b. M&TE readability requirement

The resolution at medium sampling rate on the 300 V range is 10 mV. If the relay is set near 121 V, then 10 mV is equivalent to about ±0.0083%.

c. M&TE temperature requirement

Per Fluke 45 specification the temperature coefficient of Fluke 45 voltmeter is less than 0.1 times the applicable accuracy of ±0.283% per degree C for 0°C to 18°C and 28°C to 50°C (32°F to 64.4°F and 82.4°F to 122°F). The temperature range at SWGR room is 50°F to 95°F.

Temperature range to be considered:

50°F (10°C) to 64.4°F (18°C) or 82.4°F (28°C) to 90°F (32.2°C).
At 50°F (10°C) ambient temperature,

M&TE temperature effect is (0.1/degree C) x 8°C x ±0.283% = ±0.2264%

d. M&TE reference standard requirement
25% of M&TE accuracy is 0.25 x ±0.283% = ±0.07%

e. SRSS total = $\pm(0.283^2 + 0.0083^2 + 0.2264^2 + 0.07^2)^{1/2}\%$ = ±0.369%

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

8.1.1.2 Wilmar timer SC-101, tolerance (refer to para. 4.2.6)

Dry contact and DC voltage:

a. M&TE accuracy requirement

Wilmar timer SC-101 random accuracy is ± 1 millisecond.

If the timer measures approximate 10 seconds, then 0.001 second is equivalent to 0.01%.

b. M&TE readability requirement

Since the least significant digit is 0.001 second for millisecond range, If the timer measures 10 seconds, then 0.001 second is equivalent to ±0.01%

c. M&TE temperature requirement: ±0.06%

d. M&TE reference standard requirement
25% of M&TE accuracy is 0.25 x ±0.01% = ±0.0025%

e. SRSS total = $\pm(0.01^2 + 0.01^2 + 0.06^2 + 0.0025^2)^{1/2}\%$ = ±0.062%

AC voltage:

a. M&TE accuracy requirement

Wilmar timer SC-101 random accuracy is ± 1/4 cycle

If the timer measures approximate 10 seconds, then 1/4 cycle is equivalent to about 0.042%.

b. M&TE readability requirement

Since the least significant digit is 0.001 second for millisecond range, If the timer measures 10 seconds, then 0.001 second is equivalent to about ±0.01%

c. M&TE temperature requirement: ±0.06%

d. M&TE reference standard requirement

25% of M&TE accuracy is 0.25 x ±0.042% = ±0.0105%

e. SRSS total = $\pm(0.042^2 + 0.01^2 + 0.06^2 + 0.0105^2)^{1/2}\%$ ±0.075%

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

8.1.2 Relay voltage tap tolerance

8.1.2.1 Tolerances to be considered

- M&TE (Fluke 45) tolerance (refer to para. 8.1.1.1)

  Random: ±0.369%

- Voltage transformer accuracy

  Random: ± 0.3% (refer to para. 4.2.3)

- 27N Relay Tolerance (refer to para. 4.2.2)

  Random : Pickup and dropout settings, repeatability at constant temperature and constant control voltage = ± 0.1%

  Pickup and dropout settings, repeatability over allowable dc control power range = ± 0.1%

  Pickup and dropout settings, repeatability over temperature range = ±0.4% for a relay with Harmonic Filter (HF). The ESF SWGR room temperature will be maintained between 50° F (10° C) and 95° F (35° C) during normal and emergency operations (reference 4.2.4).

- Voltage setting tolerance

  Random accuracy ±0.1 V (refer to para.3.3)

  If the relay is set near 121 V, then 0.1 V is equivalent to about 0.083%.

- Miscellaneous tolerance

  Random tolerance ±0.36% (refer to para. 3.4)

8.1.2.2 TLU of 27N relay circuit - design limit

a. 27N Relay pickup and dropout setting, repeatability over allowable dc control power = ± 0.1%

b. 27N Relay pickup and dropout setting, repeatability over temperature range = ±0.2% without HF and ±0.4% with HF

c. 27N Relay pickup and dropout setting, repeatability at constant temperature and constant control voltage = ±0.1%

d. M&TE requirement = ±0.369%

e. Voltage setting tolerance = ±0.083%

f. PT tolerance = ±0.3%

g. Miscellaneous tolerance = ±0.36%

$TLU = \pm(0.1^2 + 0.4^2 + 0.1^2 + 0.369^2 + 0.083^2 + 0.3^2 + 0.36^2)^{1/2}\% = \pm 0.737\%$

8.1.2.3 Tolerance for allowable values during surveillance test (relay only)

Voltage setting tolerance: ±0.083%.

Miscellaneous tolerance: ±0.36%

Tolerance for allowable value = $\pm(0.083^2 + 0.36^2)^{1/2}\% = \pm 0.37\%$

8.1.2.4 As-Left setting (relay only)

±0.1 V (refer to para. 3.3)

8.1.3 TLU of 27N relay time delay setting

8.1.3.1 Tolerances to be considered:

- M&TE (Wilmar SC-101) tolerance (refer to para. 8.1.1.2)

  Random ±0.062%

- 27N relay tolerance (refer to para. 3.6)

  Accuracy: ±5%
  Temperature effect: ±0.1%
  Power supply: ±0.1%

  SRSS total = $\pm(5^2 + 0.1^2 + 0.1^2)^{1/2}\% = \pm 5.002\%$

- Time setting tolerance

  Random ±0.02 second = ±(0.02 sec. / 2 sec.) = ±1% (refer to para. 3.5)

- Miscellaneous tolerance

  Random ±8.66% (refer to para. 3.6)

8.1.3.2 27N relay time delay tolerance

8.1.3.2.1 TLU for design limit

SRSS total = $\pm(0.062^2 + 5.002^2 + 1^2 + 8.66^2)^{1/2}\% = \pm 10.05\%$

8.1.3.2.2 Tolerance for allowable values during surveillance test

Time setting tolerance - ±1%
Miscellaneous tolerance - ±8.66%

SRSS total = $\pm(1^2 + 8.66^2)^{1/2}\% = \pm 8.72\%$

8.1.3.2.3 As-Left setting

±0.02 second (refer to para. 3.5)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

8.1.4 TLU of CV-2 relay voltage tap

8.1.4.1 Tolerances to be considered

- M&TE, Fluke 45, tolerance - ±0.369% (refer to para. 8.1.1.1)
- Voltage transformer accuracy - ± 0.3% (refer to para. 4.2.3
- CV-2 relay accuracy - ±3% (refer to para. 4.2.1)
- Miscellaneous tolerance - ±1.29% (refer to para. 3.4)

8.1.4.2 TLU of CV-2 relay circuit

SRSS total = $\pm(0.369^2 + 0.3^2 + 3^2 + 1.29^2)^{1/2}\%$ = ±3.3%

Since the voltage setting of the CV-2 relay is a arbitrary setting, this TLU will be used to verify the operability of the CV-2 relay.

8.1.4.3 As-Left setting

±1% (refer to para. 3.3)

8.1.5 TLU of CV-2 relay time delay setting(refer to para. 3.8 & Attach. 9.10 of CCN 20 to E4C-098)

8.1.5.1 Tolerances to be considered:

- M&TE, Wilmar SC-101, tolerance (refer to para. 8.1.1.2)

  ±0.062%

- CV-2 relay tolerance

  ±5%

8.1.5.2 CV-2 relay time delay tolerance

SRSS total = $\pm(0.062^2 + 5^2)^{1/2}\%$ = ±5%

8.1.5.3 As-Left setting

±1% (refer to para. 3.3)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV INDICATOR
	Joon Kim		B. Lennartz							

8.1.6 Tolerance of time delay relays 162S-1,2,3,&4

8.1.6.1 Tolerances to be considered:

- M&TE (Wilmar SC-101) tolerance (refer to para. 8.1.1.2)

  Random ±0.062%

- Relay tolerance

  Repeatability - ±0.5% or 15ms whichever is greater.
  [15ms is 0.35% (0.015 sec. / 4.3 sec. = 0.35%)]
  Ambient temp. effect - ±2%
  Voltage variation effect - ±2%

  SRSS total = $\pm(0.5^2 + 2^2 + 2^2)^{1/2}\% = \pm 2.87\%$

- Time setting tolerance

  ±0.05 sec. / 4.3 sec. = ±1.163% (refer to para. 3.5)

- Miscellaneous tolerance

  Random ±3.13% (refer to para. 3.10)

8.1.6.2 Tolerance of time delay relays 162S-1,2,3,&4

8.1.6.2.1 TLU for design limit

SRSS total = $\pm(0.062^2 + 2.87^2 + 1.163^2 + 3.13^2)^{1/2}\% = \pm 4.4\%$

8.1.6.2.2 Tolerance for allowable values during surveillance test

Time setting tolerance - ±1.16%
Miscellaneous tolerance - ±3.13%

SRSS total = $\pm(1.16^2 + 3.13^2)^{1/2}\% = \pm 3.34\%$

8.1.6.2.3 As-Left setting

±0.05 second (refer to para. 3.5)

8.1.7 Tolerance of time delay relays 162T-1,2,3,&4

8.1.7.1 Tolerances to be considered:

- M&TE (Wilmar SC-101) tolerance (refer to para. 8.1.1.2)

  ±0.062%

- Relay accuracy - ±10%

- Temperature effect on accuracy (refer to para. 3.9)

  Since the maximum shift in the average of three consecutive time delays from 77°F is -20% at -20°F and +20% at 165°F,
  (-20% / 97°F) = 0.206%/°F and (+20% / 88°F) = +0.227%/°F

  At the SWGR room temperature of 50°F, -0.206% x 27°F = -5.562%
  At the SWGR room temperature of 95°F, +0.227% x 18°F = +4.1%

  ±5.562% will be used.

- Time setting tolerance

  ±0.05 second (refer to para. 3.5)
  ±(0.05 sec. / 1.25 sec.) = ±4%

- Miscellaneous tolerance - ±29.3% (refer to para. 3.10)

8.1.7.2 Tolerance of time delay relays 162T-1,2,3,&4

8.1.7.2.1 TLU for design limit

SRSS total = $\pm(0.062^2 + 10^2 + 5.562^2 + 4^2 + 29.3^2)^{1/2}\% = \pm 32\%$

8.1.7.2.2 Tolerance for allowable values during surveillance test

Time setting tolerance - ±4%
Miscellaneous tolera... - ±29.3%

SRSS total = $\pm(4^2 + 29.3^2)^{1/2}\% = \pm 29.87\%$

8.1.7.2.3 As-Left setting

±0.05 second (refer to para. 3.5)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

8.1.8 Tolerance of time delay relays 162D-1,2,3,&4

8.1.8.1 Tolerances to be considered:

- M&TE (Wilmar SC-101) tolerance (refer to para. 8.1.1.2)

  ±0.062%

- Relay accuracy - ±10%

- Temperature effect on accuracy (refer to para. 3.9)

  Since the maximum shift in the average of three consecutive time delays from 77°F is -20% at -20°F and +20% at 165°F,
  (-20% / 97°F) = 0.206%/°F and (+20% / 88°F) = +0.227%/°F

  At the SWGR room temperature of 50°F, -0.206% x 27°F = -5.562%
  At the SWGR room temperature of 95°F, +0.227% x 18°F = +4.1%

  ±5.562% will be used.

- Time setting tolerance

  ±2 seconds (refer to para. 3.5)
  ±(2 sec. / 110 sec.) = ±1.8%

- Miscellaneous tolerance - ±16.3% (refer to para. 3.10)

8.1.8.2 Tolerance of time delay relays 162D-1,2,3,&4

8.1.8.2.1 TLU for design limit

SRSS total = $\pm(0.062^2 + 10^2 + 5.562^2 + 1.8^2 + 16.3^2)^{1/2}\% = \pm 20\%$

8.1.8.2.2 Tolerance for allowable values during surveillance test

Time setting tolerance - ±1.8%
Miscellaneous tolerance - ±16.3%

SRSS total = $\pm(1.8^2 + 16.3^2)^{1/2}\% = \pm 16.4\%$

8.1.8.2.3 As-Left setting

±2 seconds (refer to para. 3.5)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

8.2 27N Relay Voltage Setpoints

8.2.1 Given data for 27N relay setting

- 27N relay reset voltage at 4.16 KV :

  4201.75 V (base calc. E4C-098, rev. 1)

- 27N relay dropout voltage:

  99.5% of relay reset (pickup) voltage (refer to para. 4.2.2)

- Relay circuit tolerance:

  TLU for design limit - ±0.737% (refer to para. 8.1.2.2)
  Tolerance for allowable value - ±0.37% (refer to para. 8.1.2.3)

- PT ratio: 4200 V/120 V= 35 (refer to para. 4.2.3)

8.2.2 27N relay setting - design limit

PT secondary voltage at 27N relay reset value = 4201.75 V / 35 = 120.05 V

Minimum relay dropout voltage = 120.05 V x 0.995 (99.5% of pickup) = 119.45 V
Minimum relay dropout primary voltage = 119.45 V x 35 = 4180.75 V

TLU = ±0.737% (refer to para. 8.1.2.2)
= 121 V x 0.00737 = 0.89 V

Consider an engineering margin of 0.46 V to agree with the existing nominal setting of 121.40 V,

Nominal relay reset (pickup) voltage = 120.05 V + TLU + Engineering margin
= 120.05 V + 0.89 V + 0.46 V
= 121.40 V

Nominal relay reset (pickup) primary voltage = 121.40 V x 35 = 4249.00 V

Nominal relay dropout voltage = 121.40 V x 0.995 = 120.80 V
Nominal relay dropout primary voltage = 120.80 V x 35 = 4228.00 V

Maximum relay reset (pickup) voltage = 121.4 V + TLU + Engineering margin
= 121.4 V + 0.89 V + 0.46 V
= 122.75 V

Maximum relay reset (pickup) primary voltage = 122.75 V x 35 = 4296.25 V

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

Maximum relay dropout voltage = 122.75 V x 0.995 = 122.14 V
Maximum relay dropout primary voltage = 122.14 V x 35 =4274.90 V

The min. relay dropout voltage at 4.16 KV bus is 119.45 V x 35 = 4180.75 V or 1.005 p.u. which exceeds the post accident steady state voltages of 4.16 KV Class 1E buses shown in paragraph 8.4.2 of CCN 20 to E4C-098.

8.2.3 27N relay setting - Allowable values (As-Found) during surveillance test

Nominal relay reset (pickup) voltage = 121.40 V
Nominal relay reset (pickup) primary voltage = 121.40 V x 35 = 4249.00

Nominal relay dropout voltage = 121.40 V x 0.995 = 120.80 V
Nominal relay dropout primary voltage = 120.80 V x 35 = 4228.00 V

Tolerance for allowable value = ±0.37% (refer to para. 8.1.2.3)
= 121 V x 0.0037 = 0.45 V

Consider an engineering margin of 0.46 V (refer to para. 5.1 & 8.2.2).

Minimum relay reset (pickup) voltage = 121.4 V - TLU - Engineering margin
= 121.4 V - 0.45 V - 0.46 V
= 120.49 V

Minimum relay reset (pickup) primary voltage = 120.49 V x 35 = 4217.15 V

Minimum relay dropout voltage = 120.49 V x 0.995 = 119.89V
Minimum relay dropout primary voltage = 119.89 V x 35 = 4196.15 V

Maximum relay reset (pickup) voltage = 121.40 V + TLU + Engineering margin
= 121.4 V + 0.45 V + 0.46 V
= 122.31 V

Maximum relay reset (pickup) primary voltage = 122.31 V x 35 = 4280.85 V

Maximum relay dropout voltage = 122.31 V x 0.995 = 121.70 V

Maximum relay dropout primary voltage = 121.70 V x 35 =4259.5 V

8.2.4 27N relay setting - As-Left setting during surveillance test (refer to para. 8.1.2)

Nominal relay reset (pickup) voltage = 121.40 V
Nominal relay reset (pickup) primary voltage = 121.40 V x 35 = 4249.00 (1.021 p.u.)

Nominal relay dropout voltage = 121.40 V x 0.995 = 120.8 V
Nominal relay dropout primary voltage = 120.80 V x 35 = 4228.00 V (1.016 p.u.)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

Setting tolerance = ±0.1 V (refer to para. 3.3)

Minimum relay reset (pickup) voltage = 121.40 V - 0.1 V = 121.30 V
Minimum relay reset (pickup) primary voltage = 121.30 V x 35 = 4245.5 V (1.021 p.u.)

Minimum relay dropout voltage = 121.30 V x 0.995 = 120.7 V
Minimum relay dropout primary voltage = 120.7 V x 35 = 4224.5 V (1.016 p.u.)

Maximum relay reset (pickup) voltage = 121.40 V + 0.1 V = 121.5 V
Maximum relay reset (pickup) primary voltage = 121.5 V x 35 = 4252.5 V (1.022 p.u.)

Maximum relay dropout voltage = 121.5 V x 0.995 = 120.9 V
Maximum relay dropout primary voltage = 120.9 V x 35 =4231.5 V (1.017 p.u.)

8.3 27N relay time delay setpoint (refer to para.s 3.5 & 8.1.3)

8.3.1 27N relay time delay - design limit

Setpoint - 2 seconds

Design limit - 2 seconds ± 10% = 2 seconds ± 0.2 second

8.3.2 27N relay time delay - Allowable value (As-Found setting) during surveillance test

Setpoint - 2 seconds

Allowable value - 2 seconds ± 8.72% = 2 seconds ± 0.1744 second

8.3.3 27N relay time delay As-Left setting

2 seconds ± 0.02 second

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

8.4 CV-2 Relay Voltage Setpoint (refer to para.s 3.3, 5.2.2, & 8.1.4)

8.4.1 Operating range of CV-2 relay

Relay setpoint: 105 V

TLU of CV-2 relay: ±3.3%

Since the function of the CV-2 is to generate LOVS on loss of voltage condition within a specific time, CV-2 relay with a fixed time dial will dropout at the same time on a loss of power condition regardless of voltage tap settings (existing voltage tap of 105 V is arbitrary). Therefore, TLU of ±3.3% for the CV-2 relay voltage tap will be utilized for Tech. Spec. and surveillance procedure.

Relay operating voltage, considering relay circuit inaccuracy:

Min. operating voltage at relay = 105 V x 0.967 = 101.54 V
Min. operating voltage at bus = 101.54 V x 35 = 3553.9 V

Max. operating voltage at relay = 105 V x 1.033 = 108.47 V
Max. operating voltage at bus = 108.47 V x 35 = 3796.45 V

8.4.2 CV-2 relay voltage tap As-Left setting

105 V ± 1% = 105 V ± 1.05 V

8.4.3 In order to protect the 4.16 kV motors during a short time voltage dip, the CV-2 relay should operate within 15 seconds at 75% of rated motor voltage.

The voltage at the CV-2 relay corresponding to 75% of rated motor voltage:

V_{relay} = (0.75 x rated motor voltage) / PT ratio

= (0.75 x 4160 V) / 35

= 89.1 V

The voltage drop between 4.16 KV bus and a motor is considered negligible.

Considering relay circuit inaccuracy:

$V_{relay\ min.}$ = 89.1 V x 0.967 = 86.16 V
$V_{relay\ max.}$ = 89.1 V x 1.033 = 92.04 V

These voltages correspond to 82.1% and 87.7% of the existing relay tap setting (105 V), respectively. The existing relay (with 105 V tap and time dial #1) will operate within 5 seconds at these voltages.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

8.5 CV-2 relay time delay setpoint (refer to para.s 3.5, 3.8, 5.2.2, & 8.1.5)

8.5.1 Existing setting

Time dial of CV-2 relay was adjusted such that the time delay of the entire LOVS channel up to and including 127F-1X3 and 127F-1X1/127F1-X2 is 1.00 ± 0.05 seconds. A LOVS channel consists of relay 127F1 and auxiliary relays 127F-1X3 and 127F-1X1/127F-1X2 in series. This timing requirement also applies to the LOVS channels associated with relays 127F-2, 127F-3, and 127F-4.

8.5.2 Allowable values

Since the upper limit of the time delay is the limiting condition, adjust CV-2 relay time dial to limit the maximum time delay if the entire LOVS channel to 1.00 second, considering TLU of the relay circuit and pickup time of the auxiliary relays 127F-1X3 and 127F-1X1/X2.

Time delay of the entire LOVS channel should be

X second + 5% of X second + 10 cycles (2-HFA relays operating time) ≤ 1.0 second (Refer to CCN 20 to E4C-098 for HFA relay operating tome)

Where X is operating time of CV-2 relay on loss of voltage.

1.05X second + 10 cycles ≤ 1.0 second

1.05X ≤ 0.83 second, X ≤ 0.79 second

Adjust time dial to operate in 0.79 second on loss of voltage

Upper limit = 0.79 sec. x 1.05 + 10 cycles = 0.9962 second < 1.0 second

Since the minimum operating time of the GE HFA relay is not available, only the CV-2 relay tolerance of 5% is conservatively considered.

Lower limit = 0.79 x 0.95 = 0.7505 second

0.75 second ≤ Allowable limit ≤ 1.0 second

M&TE tolerance of 0.062% (refer to para. 8.1.1.2) is considered negligible for less than 1 second time range.

8.5.3 As-Left setting

Upper limit: 0.79 sec. + 1% (setting tolerance) + 10 cycles = 0.965 second

Lower limit: 0.79 sec. - 1% (setting tolerance) = 0.782 second

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	Joon Kim		B. Lennartz						

REV INDICATOR

8.6 Time delay relay 162D-1,2,3,& 4 setpoint (refer to para. 8.1.8)

8.6.1 Setpoint for design limit

Setpoint - 110 seconds

110 seconds ± 20% = 110 seconds ± 22 seconds

8.6.2 Setpoint for allowable value

110 seconds ± 16.4% = 110 seconds ± 18 seconds

8.6.3 As-Left setting

110 seconds ± 2 seconds

8.7 Time delay relay 162S-1,2,3,& 4 setpoint (refer to para. 8.1.6)

8.7.1 Setpoint for design limit

Setpoint - 4.3 seconds

4.3 seconds ± 4.4% = 4.3 seconds ± 0.19 second

8.7.2 Setpoint for allowable value

4.3 seconds ± 3.34% = 4.3 seconds ± 0.14 second

8.7.3 As-Left setting

4.3 seconds ± 0.05 seconds

8.8 Time delay relay 162T-1,2,3,& 4 setpoint (refer to para. 8.1.7)

8.8.1 Setpoint for design limit

Setpoint - 1.25 seconds

1.25 seconds ± 32% = 1.25 seconds ± 0.4 second

8.8.2 Setpoint for allowable value

1.25 seconds ± 29.87% = 1.25 seconds ± 0.37 second

8.8.3 As-Left setting

1.25 seconds ± 0.05 seconds