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 Compan	E4C-098		ICCN NO./ PRELIM, CCN NO. N-15	PAGE	TOTAL NO. OF PAGES 50
INTERIM CALCULATION CHANGE NOTICE (ICCN)/ CALCULATION CHANGE	BASE CALC. REV.	UNIT 2 & 3	CCN CONVERSION	25	CALC. REV.
NOTICE (CCN) COVER PAGE	CALCULATION SUBJE	CALCU	WITCHGEAR PROTEC	TIVE RELAY SE	TTING
CALCULATION CFIOSS-INDEX New/Updated index included	ENGINEERING SYSTEM 1804	M NUMBER /	PRIMARY STATION SYSTE	M DESIGNATOR	O-CLASS
Existing index is complete ite Programs/Procedure Impact?	CONTROLLED PROGR DATABASE ACCORDIN SO123-XXIV-5.1		PROGRAM / DATABASE	NAME (S) VERS	SION/RELEASE NO.
O NO PYES, AR NO. 970200708	PROGRAM [DATA BASE	ALSO, LISTED E	BELOW	
Time delay relay 162S Time delay relay 162T This CCN deletes some lower/ups requirement	er limit of voltage/tim	ne delay, wh	nich are not important to	o safety, from su	rveillance
NITIATING DOCUMENT (DCP, FCN, OTH	PCN-488	3 to Units 28	3 Tech. Spec.	REV.	
OTHER AFFECTED DOCUME O YES • NO			FOR CON ONLY):	O ON ATTACHED F	ORM 26-503.
J. Kim / J. Kim / J. Z. ORIGINATOR (Print name sign/date) B. Lennartz / County	3/99 Am	m fw J. W	mslew 7/2×199	OTHER (SK	electrical gnature/date)
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. CONVERSION TO CCN DATE	7/28/99		You	Orksons	2
E 28-122-1 REV. 2 8/96 [REFERENCE: SO123-X)		-	1 "	OUE COM SO	NGS

CIJETPOFMSONEDO GENI122 1 02.MDF Ver 02.00.02.5/99: CIJETDATA19800VNT5.DAT DevID: 1.0000 Printed: 07/18/99

CALCULATION CROSS-INDEX

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Calculation No.				THEFTIME CONT.	the state of the s	
	E4C-098		8	Sheet No.	ď	CCN CONVERSION:
Cate, ray, number and responsible FLS initials and date	lations in the ed may real culati		OUTPUTS Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.	75 GP	Does the output interface calor document require revision?	Identify output interface calc/document CCN, DCN, TCN/Rev., FIDGN, or tracking number.
	Calc / Document No.	Rev. No.	Calc / Document No.	Rev. No.	YES / NO	
11 Mers for 321 / 3/99	Maintenance Orders 94071244 94071245 96030942 96031127 96050677		Tech. Spec. Unit 2 Tech. Spec. Unit 3	127	Yes	PCN-488 PCN-488
1/21/20 7/25/99	97020999 97021000 97021004 97021013 98060307		SO2-II-11.1A SO2-II-11.1B SO3-II-11.1A SO3-II-11.1B		Yes Yes Yes Yes	AR # 970200708 16
1/4 mg - Ju	CCN 20 to base calc. E4C-098					

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Project or DCP/FCN UNITS 2 & 3

Calc No. E4C-098

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet

of

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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 162\$
- Time delay relay 162T

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Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet _____ of

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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	[TLU = ±0.0	gn Limit 89 V (0.737%), rgin = 0.45 V)]	[Tol. = ±0.4	s-found) Values 45 V (0.37%), gin = 0.46 V)]		ft Values of = ±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	Тө	Existing ch. Spec. SR	,		osed Allowab otable As-Fou		-	Setting Valu		
Kesti	*****	Overall	Setting (V)		Relay S	letting (V)		Relay 3	etting (V)	
	TLU	Relay	Primary	Tol.	Relay	Primary	Tol.	Relay	Primary	
Max. relay dropout		108.47	3796.45		108.47	3796.45		106.05	3711.7	
Nominal relay dropout	±3.3 (%)	105.00	3675.00	±3.3 (%)	105.00	3675.00	±1 (%)	105.00	3675.00	
Min. relay dropout		101.56	3554.60		101.54°	3553.90*		103.95	3638.25	
Time delay (Note)	≥0.5	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.

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__Calc No. _E4C-098

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet

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te: 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

		Existing ec. SR 3.3.7.3.a		llowable Values As-Found Values)	Acceptable As-Left setting		
Relay	TLU (%)	Setting (seconds)	Tal. (%)	Setting (seconds)	Tol. (sec.)	Setting (seconds)	
162D-1,2,3.8.4	±20	110 ± 22	±16.4	110 ± 18	±2	110 ± 2	
1625-1,2,3 & 4	±4.4	4.3 ± 0.19	±3.33	4.3 ± 0.14	±0.05	4.3 ± 0.05	
162T-1,2,3.8.4	±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.

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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
	Degraded Voltage Function a 4181 V and s 4275 V	Degraded Voltage Function: i. Dropout > 4196 V (Note 1) ii. Pickup s 4281 V (Note 2)
SR 3.3.7.3. a	SDVSS (Sustained Degraded Grid Voltage): Time delay: i. 127D ≥ 1.8 seconds and s 2.2 seconds ii. 162D ≥ 88 seconds and s 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: 1. 127D ≥ 1.8 seconds and ≤ 2.2 seconds 11. 162S ≥ 4.11 seconds and ≤ 4.49 seconds 11. 162T ≥ 0.85 seconds and ≤ 1.65 seconds	DGVSS (Degraded Grid Voltage with SIAS): Time delay: 1. 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 s 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:

- 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
- 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).

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2.2.2 Revise Test Procedures SO2(3)-II-11. A 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		Tu	me delay	D	ropout	Pi	ckup
Relay		Nominal setting	Acceptance criteria	Nominal setting	Acceptance criteria	Nominal setting	Acceptance criteria
127D-12.3.&4 (Applicable TS	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
SR 3.3.7.3) 27N	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)	As-Left	s 1.0 sec.	0.782 sec to 0.965 sec. (Note)	105 V	103.95 V to 106.05 V	N/A	N/A
CV-2	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

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3	ASSUM	APTIONS								
	3.1	The reset time of 5 cyclelectro-mechanical G.E.	es for Westingho type IAV54E rel	use type ay.	CV-2 relay was	assumed bas	ed on the sir	nilar		
	3.2	The following instrumedelay relays (see recon			ed for calibration	of undervolt	age relays ar	nd time		
		Undervoltage relays:	Fluke 45 Mult voltage range		with a user select	ed reading r	ate of mediu	m and		
		Time delay relays:			a user selected ra	inge of secon	and millis	econd		
	3.3	The following relay vol	tage setting tolerances were assumed:							
		Relay	Setting tolerance	Refe	erence					
		127D-1,2,3,&4 (27N) 127F-1,2,3,& 4 (CV-2)	±0.1 V ±1%	Sur	veillance test data veillance test data achment 9.10 of (a (refer to pa	ra. 4.3) and			
	3.4	Since drift tolerances of which include drift tole				ing miscella	neous tolera	nces		
		127D-1,2,3,&4 (27N)	±0.36%							
		127F-1,2,3,&4 (CV-2)		±1.29%						
		As shown in paragraph tolerances.	s 4.3 & 4.4, meas	sured dr	ifts of the relays	are less than	these assum	ned		
	3.5	Time setting tolerances	of the following	relays w	vere assumed:					
			Setting					1		
		Relay	tolerance		Reference					
		162D-1,2,3,& 4	±2 seconds		Refer to par					
		162S-1,2,3,& 4	±0.05 second		Refer to par					
		162T-1,2,3,& 4	±0.05 second							
		127D-1,2,3,& 4	±0.02 second		Refer to par	3. 4.4				

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.

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Part and Association	MARKET V ST. MARKET AND AND	Type test results for 27N accuracies:	relay (Attachm	ent 9.11	of CCN 20 to E	4C-098) sho	ws the follow	ving	
		Accuracy:	Max. ±5% (1	ime tan	setting at 1)				
		Temperature effect:	±0.1% in a ra						1
		Power supply effect:	Not available		C 10 40 C				
		Based on the above data, assumed:	the following r	andom t	olerances for 271	N relay time	delay were		
		Reference tolerance:	±5%						
		Temperature effect:	±0.1%						1
		Power supply variation:							
		Miscellaneous tolerance:							
	3.7	ABB clarifies that temper	rature and conti	rol powe	er effects on the a	ccuracy are	non-random	(refer	
		to Attachment 9.16 of the	base calculation	on E4C-	098, rev. 1). Ho	wever, it was	assumed tha	at the	
		worst case effects (±0.19							
	3.8	Operating time tolerance stated in Attachment 9.10 to include temperature eff	of CCN 20 to	E4C-09	8. The operating	tolerance of	lerance of 19 ±5% is cons	% as idered	
		Voltage tap tolerance of a in Attachment 9.10 of CC include temperature effective effective temperature effective temperature effective effe	N 20 to E4C-0	98. The	voltage tap toler	ance of ±3%	ince of 1% as	stated d to	
	3.9	Temperature effect on acc However, the specification relay states 'The maximuter' -20% at -20°F, +20% at 1 1E relay.	m (Attachment m shift in the a	9.12 of average	CCN 20 to E4C-0 of three consecut	098) for serie we time dela	es 7000 non- lys from 77°F	is	
		Voltage effect on accuracy accuracy is included in the				umed that vo	oltage effect o	n	
	3.10	Since drift tolerances of s (which include drift toler the time delay relays in T	ance) for time (delay we	re assumed based				
		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	45 45 8 47	mangu	ead drifts of the r	aloue are le-	a than thaca		

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4 DESIGN INPUT

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

	Relay	4160 V bus v	oltage
	Setting(V)	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 1875516

Style No: 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)

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	4.2.2	ABB undervo	oltage rela	v (refere	nces 6 3	& 6.4)				
		, ribb undarr	ontage rera	y (refere	11003 0.5	& 0.4)				
		Device No:			0-1, 2, 3,	4				1
		Manufacture	T.	ABB						
		Type:		27N						1
		Catalog #:			5375					
		Pickup range		70-12						
		Pickup settin	g:	121.4						
		Dropout:				ckup (Note 1)				1
		Dropout dela			seconds					1
		Delay setting	:	2 sec						
		Reset time:			than 2 c					1
		Control volta	-		140 V D					1
		Temperature	range:		0 +70° C					
		Burden:			/A at 12	0 V				
		Repeatability	tolerance	(Note 2)):					
		With harmon	nic filter							
		a. @ c	onstant te	mperatur	e & con	trol voltage - ±0	1%			
						range (100-140				
			p. range		a. p		.,			
			+55° C - :	±0.75%						
			10 +40° C							
			to +70° C							1
						iseconds which	ever is great	er.		
		Notes:								
		1 Diffe	erence bet	ween pic	kup and	dropout can be	set as low as	s 0.5 %		
		2 The	three repe	eatability	tolerand	es are cumulati	ve and are ra	andom tolerano	es	
		(refe	er to para.	3.7).						
	4.2.3	GE potential tr	ansformer	r (refer to	base ca	lculation E4C-0	98)			
		Type:	JVM	-3						
		Ratio:	4200	/120 V						
		Accuracy:	0.3W	, X, Y, 1	.2Z burd	den at 120 V				
	4.2.4	Environmental	condition	data (re	ference (5.8)				
			Min.	temp.	Max	. temp.				
		Area	Norm			nal/accident				
		CR Assa DC	e com		OFFI	2/D50E				
		CB Area B5	50°F		32.1	7/95°F				1

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	4.2.			er (Attachme	nt 9.8 or C	CCN 20 to base o	alc. E4C-09	8))		
		300 V	range							1
		Accura		±0.2% of rea	ading + 10	digits				
		Full sc		300 V AC						1
		Resolu	tion:	0.01 V						
		Note:				accuracy is ±(0.2				
		30 mA	range							
		Accura	acv	0.05% + 3						
		Full so	*	30 mA						1
		Resolu	100000000000000000000000000000000000000	1 μΑ						
		Note:		1 μA, the rei		sampling rate (curacy is ±(0.05)				
	4.2.	6 Timer (A			20 to bas	e calc. E4C-098)				
		Manuel	facturer:	31/2	lmar					1
		Type:	acturer.		-101					1
			tion Mode			NO or NC				1
		opera				. OFF or ON				
						OFF ON				1
		Tempe	erature ran		10 50°C					
		Range	:	Су	cles - 0-99	9999				
						- 0-99999				
					conds - 0-					1
		Accur	acy*:			±1 millisecond				1
						±1 millisecond ±1/4 cycle				1
				~~	- TOTALE	21/4 0,000				1
		* Note	es							
		(1)		ock" and "rea rall accuracy:		erance listed belo	ow must be a	added in com	puting	
			a. b.			erance - ±0.06% ±1 less significa				

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CCN CONVERSION: CCN NO. CCN -

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

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION 01 ORIGINATOR REV ORIGINATOR Joon Kim B. Lennartz 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 0.5 - 5 seconds Time delay range: 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%

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Project or DCP/FCN UNITS 2 & 3

_Calc No. _E4C-098

	t 4 KV SWITC	CHGEAR	PROTECTI	VE REL	AYSE	TTING CALC	ULATION	Sheet	of	
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	RE	I DATE I	2
	Joan Kim		B. Lennartz		I		-	A STATE OF THE PARTY OF THE PAR		CATO
										REV

4.3 CV-2 Loss of Voltage relay test data

Loss of voltage relay CV-2 (reference 6.12)

Bus/ test date	Relay	М	in. Trip Voltage	(V)	Time	Operating (sec.) to 0 V)
iosi dale		Nominal setting	As-left	As-found	Nominal setting	As-left
	127F-1			103.1		0.974
2424	127F-2		Note 2	103.9		0.965
2A04/ 2/15/97	127F-3			104.6		0.967
	127F-4	105		104.2	1.0	0.969
	127F-1			106.0	(Note 1)	0.965
2A06/ 2/15/97	127F-2		Note 2	106.5		0.964
	127F-3			103.5		0.964
	127F-4			104.1		0.967
	127F-1			104.5		0.964
3A04/	127F-2			102.9		0.986
2/15/97	127F-3		Note 2	104.5		0.976
	127F-4			104.5		0.988
	127F-1			103.5		0.962
3A06/	127F-2			103.4		0.965
2/15/97	127F-3		Note 2	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.

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CCN CONVERSION: CCN NO. CCN -

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

	t 4 KV SWITC	CHGEAR	PROTECTI	VE REL	AY SE	TTING CALC	ULATIC	N Sheet	of	
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	5 1
	Joon Kim		B. Lennartz					THE RESERVE OF THE PARTY OF THE	-	CATO
									-	REV

Loss of voltage relay CV-2 (reference 6.14)

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

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

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CON CONVERSION

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

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet of OHIGINATOR Joon Kim B. Lennartz

4.4 27N Degraded Bus Voltage relay test data

DGVSS relays 27N (reference 6.13)

Bus	Relay	As-F	ound	As-Left				
		Dropout voltage (V)	Time (sec) (120 V - 0 V)	Pickup voitage (V)	Dropout voltage (V)	Time (sec) (120 V - 0 V)		
	1270-1	120.7	2.02	121.3	120.7	2.01		
	1270-2	120.6	2.01	121.3	120.8	2.02		
3A04/ 8/15/95	1270-3	120.7	2.00	121.4	120.7	2.00		
-	127D-4	120.8	2.00	121.5	120.8	1.99		
	127D-1	120.8	2.01	121.5	120.9	2.01		
	127D-2	120.9	2.00	121.3	120.8	2.00		
37406/ 8/4/95	127D-3	120.8	2.03	121.5	120.9	2.01		
	127D-4	120.8	1.99	121.5	120.8	1.99		

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

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CON CONVERSION: CCN NO. CCN -

ubject 4 KV SWITC	PRINCIPAL PROPERTY AND ADDRESS OF THE PRINCIPAL PRINCIPA	PROTECT	IVE REL	AY SE	TTING CALC	ULATION	Sheet	of
REV ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
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								HE -

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)			
	127D-1	120.37	2.0059	121.35	120.75	1.9971			
	1270-2	120.35	2.0045	121.40	120.8	2.006			
2A04/ 12/26/96	127D-3	120.44	1.9933	121,41	120.8	1.987			
	1270-4	120.45	1.9952	121.38	120.7	1.995			
	127D-1	120.63	1.99	121.37	120.78	1.99			
2A06/	127D-2	120.59	1.99	121.31	120.71	1.99			
12/3/96	127D-3	120.60	1.99	121.31	120.73	2.00			
	127D-4	120.59	1.99	121.30	120.70	1.98			
	1270-1	120.3	1.99	121.3	120.9	2.00			
	127D-2	120.4	2.01	121.3	120.9	2.01			
3A04/ 4/14/97	127D-3	120.4	1.99	121.4	120.8	2.00			
	127D-4	120.4	2.00	121.4	120.7	2.00			
	127D-1	120.54	2.02	121.39	120.80	2.02			
0.000	127D-2	120.50	2.01	121.40	120.80	2.01			
3A06/ 5/7/97	1270-3	120.62	2.03	121,40	120.80	2.03			
	127D-4	121.14	2.0	121.4	120.8	2.04			

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CCN CONVERSION: CCN NO. CCN -

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

Subjec	t 4 KV SWITC	HGEAR	PROTECTI	VE REL	AYSE	TTING CALC	ULATION	Sheet_	of	
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DGVSS relays 27N (reference 6.14)

Bus	Relay		As-Found			As-Left				
		Pickup voltage (V)	Dropout voltage (V)	Time (sec) (120V - 0 V)	Pickup voitage (V)	Dropout voltage (V)	Time (sec) (120V - 0 V			
	127D-1	121.20	120.71	2.01	121.36	120.83	2.01			
24044	127D-2	121.32	120.70	2.01	121.32	120.70	2.01			
2A04/ 2/23/99	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			
	127D-1	121.4	120.8	2.0	121.4	120.8	2.0			
2A06/	127D-2	121.3	120.7	2.0	121.3	120.7	2.0			
2/6/99	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			

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

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

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	
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4.5 162D Time Delay relay test data

Time delay relays 162D (reference 6.10)

Bus	Relay		·	Operating time	(sec)	
Dus	Помау	Nominal	As-found	As-left (1)	As-left (2)	As-left (3)
	162D-1		108.6	118.4	116.3	118.6
2A04/ (2/26/96	162D-2		110.2	110.2	112.4	112.7
12/20/90	162D-3		115.4	115.4	112.7	120.4
	162D-4		116.6	116.6	111.2	112.6
	162D-1					
2A06/	162D-2		Not available	Not available	Not available	Not available
12/3/96	162D-3	110				
	162D-4					
	162D-1		111	111	111	112
3A04/	1620-2		111	111	114	114
4/14/97	162D-3		111	111	111	114
	162D-4		113	113	115	111
	162D-1		109.4	109.4	108.5	107.6
3A06/	162D-2		110.8	106.1	105.9	109.8
5/7/97	162D-3		112.8	110.5	110.6	110.2
	162D-4		112.7	104.4	108.6	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.

CALCULATION SHEET E&TS DEPARTMENT

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CCN CONVERSION: CCN NO. CCN -

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

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	E
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Time delay relays 162D (reference 6.14)

Bus	Data			Operating time	(sec)	
bus	Relay	Nominal	As-found	As-left (1)	As-left (2)	As-left (3)
	162D-1		113.32	110.8	111.93	111.92
2A04/	162D-2		110.43	109.0	108.0	108.37
2/23/99	162D-3		115.63	108.65	110.48	109.26
	162D-4		112.05	109.41	108.57	108.72
	162D-1		112.89	109.74	110.98	110.39
2A06/	162D-2		108.50	109.45	109.54	109.45
2/6/99	162D-3	110	113.43	108.79	109.4	110.81
	162D-4		110.48	109.51	110.27	110.05
	1620-1					
3A04/	162D-2		Nint multiple			
	162D-3		Not available	Not available	Not available	Not available
	162D-4					
	162D-1					
3A06/	162D-2					
	162D-3					
	162D-4					

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CON CONVERSION: CON NO. CON -

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

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Charles

DEV	ORIGINATOR	DATE	A A SA SA A A	SPECIAL DESIGNATION OF THE PARTY OF THE PART	ALSE	THING CALC	OLATION	Sneet _	01	
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4.6 162S Time Delay relay test data

Time delay relays 162S (reference 6.10)

Bus	Relay			Operating time (sec)	
535	riendy	Nominal	As-found	As-left (1)	As-left (2)	As-ieft (3)
	162S-1		4.29	4.29	4.30	4.29
2A04/ 12/26/96	1625-2		4.29	4.29	4.29	4.29
12/20/90	1625-3		4.30	4.34	4.29	4.30
	162S-4		4.30	4.29	4.29	4.29
	1625-1		4.30	4.30	4.30	4.29
2A06/ 12/3/96	162S-2		4.32	4.31	4.31	4.31
12/3/90	1625-3	4.30	4.30	4.30	4.30	4.31
	1625-4		4.30	4.30	4.30	4.30
	1625-1		4.3	4.3	4.3	4.3
3A04/ 4/14/97	162S-2		4.3	4.3	4.3	4.3
4/14/9/	1625-3		4.3	4.3	4.3	4.3
	1625-4		4.3	4.3	4.3	4.3
	1625-1		4.3	4.30	4.30	4.30
3A06/ 5/7/97	1625-2		4.31	4.31	4.31	4.31
SI I/AI	162\$-3		4.31	4.31	4.31	4.31
	1625-4		4.31	4.31	4.31	4.31

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CON CONVERSION: CCN NO. CCN -

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

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet

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Time delay relays 162S (reference 6.14)

Bus	Relay		sec)	As-left (3) 4.29 4.29 4.29 4.29 4.3		
DUS	rendy	Nominal	As-found	As-left (1)	As-left (2)	As-left (3)
	1625-1		4.29	4.29	4.29	4.29
2A04/	162S-2		4.29	4.29	4.29	4.29
2/23/99	162S-3		4.29	4.29	4.29	4.29
	1625-4		4.30	4.29	4.29	4.29
	162S-1		4.3	4.3	4.3	4.3
2A06/ 2/6/99	1625-2		4.3	4.3	4.3	4.3
2/0/99	1825-3		4.3	4.3	4.3	4.3
	1625-4		4.3	4.3	4.3	4.3

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

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CON CONVERSION: CON NO. CCN -

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

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	4
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4.7 162T Time Delay relay test data

Time delay relays 162T (reference 6.10)

Bus	Relay			Operating time (sec)	
DUS	покау	Nominal	As-lound	As-left (1)	As-left (2)	As-left (3)
	162T-1		1.35	1.32	1.33	1.32
2A04/ 12/23/96	162T-2		1.31	1.32	1.32	1.33
122340	162 T -3		1.29	1.30	1.30	1.30
	162T-4		1.32	1.32	1.32	1.33
	162T-1		1.28	1.26	1.26	1.27
2A06/ 12/3/96	162T-2		1.29	1.26	1.24	1.24
123/30	162T-3	1.25	1.33	1.45	1.38	1.36
	162T-4		1.29	1.30	1.27	1.27
	162T-1		1.27	1.27	1.27	1.29
3A04/ 4/14/97	162T-2		1.28	1.28	1.28	1.28
4/14/5/	162T-3		1.29	1.29	1.29	1.29
	162T-4		1.28	1.28	1.28	1.27
	162T-1		1.31	1.29	1.29	1.30
3A06/ 5/7/97	162T-2		1.29	1.28	1.29	1.30
Wille!	162T-3		1.27	1.28	1.29	1.28
	162T-4		1.27	1.27	1.28	1.30

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

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

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet of Joon Kim B. Lennartz

Time delay relays 162T (reference 6.14)

Bus	Relay			Operating time (sec)		
	- Tunay	Nominal	As-found	As-left (1)	As-left (2)	As-left (3)	
	162T-1		1.38	1.25	1.26	1.25	
2A04/ 2/26/99	162T-2		1.33	1.25	1.25	1.26	
220/99	162T-3		1.31	1.24	1.25	1.25	
	162T-4		1.35	1.26	1.26	1.26	
	162T-1		1.28	1.28	1.28	1.28	
2A06/ 2/6/99	162T-2		1.23	1.21	1.22	1.22	
2/0/00	162T-3	1.25	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...

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

CCN NO. CCN -

REV	ORIGINATOR	DATE	PROTECT	DATE	AY SE	ORIGINATOR	DATE	Sheet_	Of_	V
	Joon Kim		B. Lennartz				-		DATE	REV INDICATOR
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Project or DCP/FCN UNITS 2 & 3

Calc No. E4C-098

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet

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5 METHODOLOGY

5.1 Definition

Allowable values (reference 6.6) 5.1.1

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 + IPos. tolerancel + Engineering margin

Allowable value (max.) - Design limit - INeg. tolerancel - 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

Degraded Undervoltage Relay (27N) 5.2.1

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).

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Project or DCP/FCN UNIT'S 2 & 3 Calc No. E4C-098

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

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

- Total Loop Uncertainty (TLU) of metering devices 5.4
 - 5.4.1 The following uncertainties are considered per Standard JS-123-103C (reference 6.6):
 - Device tolerance
 - Reference accuracy
 - Drift allowance
 - Power supply allowance
 - Temperature allowance (normal & accident)

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		b. c. d. e.	B R M M M Setting told	I&TE accur eadability r I&TE and t I&TE temp I&TE refer	equiremente he value erature to ence stan wance, if	ent(One half of or of the least signi- equirement dards requirement applicable	ficant digit f	for digital M&	èTE)
	5.4.2	The fo a. b. c.	Drift allow Setting tole	ance		i for allowable va	dues:		
5.5	A comi	utilized ainty are	of the Straight per SCE Star combined un	der the RS	S method	Root Sum of the S (reference 6.6). fology, and any n sult as shown bel	The random	elements of	
	a.	Rando U = ±	m, independe $(W^2 + X^2 + Y$	ent element $z^2 + Z^2$) ^{1/2} & Z are ran	s are con	nbined by RSS m	ethodology:	inty and U is	the
	b.	depend are cor	dency to form	new indep	endent el	combined algebra lements. Then, a ements by RSS n	s independe	nt elements, t	hey

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		the R	SS computation	n for rando	m, indep	pendent elements				1
		11-+	$(W^2 + X^2 + Y$	271/2 4 7						1
		0-1	(" +" +1	, +2						1
		Where	e: W, X, & Y	are randor	n, indep	endent elements	of uncertain	ty, Z is non-ra	andem	1
			element of	uncertainty	, and U	is the total unce	rtainty.			
										1
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Project or DCP/FCN UNITS 2 & 3 Calc No. E4C-098

Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet ____

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6	REFER	ENCES									
	61	G £. Pr	otection	and Contro	l Products (Catalog G	EZ-7723				
	6.2	Instruct	tions We	estinghouse	I.L.41-201.	4С - Турк	CV Voltage Re	lays for Clas	ss 1E Applica	tion	
	6.3	Asea B	rown Bo	overi Inform	ation Bullet	in, IB 7.4	1.7-7 Issue D				
	6.4	Drawin	gs								
		30220-1 30299 30300	2								
	6.5	V/P SO	23-302-	2-84 & 85	B/M bus A	04 & A06	5				
	6.6	SCE St	andard.	IS-123-103(C, Instrumer	nt Setpoin	ts/Loop Accurac	cy Calculatio	n Methodolog	gy.	
	6.7	Surveil	lance Op	perating Ins	truction SO	23-3-3.23	.1 - Diesel Gene	rator Refueli	ng Interval T	ests	
	6.8	DBD-S	O23-TR	-EQ - Envir	onmental Q	ualificati	on Topical Repo	ort			
	6.9	90042 -	Nuclea	r Consolida	ted Data Ba	se					
	6.10	Mainter	nance O	rders (Histo	ry)						
		Bus	M.C). 1	Test do .e						
		2A04 2A06 3A04 3A06	96030 96031 96050 96050	127 677	12/26/96 12/3/96 4/14/97 5/7/97						
	6.11	Test Pro	ocedures cing Rel	s for Loss of ays and Cir	Voltage (Louit Test	OVS), De	graded Voltage	(SDVS, DG	VSS) and		
		SO2-II- SO3-II-	11.1B - 11.1A -	S.R. Unit 2 S.R. Unit 2 S.R. Unit 3 S.R. Unit 3	ESF Train ESF Train	B A					

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	6.12	CV-2 r	elay test data							
		Bus	_M.O.	Test date						
		2A04	97021004	2/15/97						
		2A06		2/15/97						
		3A04	97020999	2/15/97						
		3A06	97021000	2/15/97						
	6.13	Mainte	nance Orders (H	listory)						
		Bus	M.O	Test date						
		3A04	94071244	8/15/95						
		3A06	94071245	8/4/95						
		27100	74071245	6/4/23						
	6.14	Maintenance Orders (His		listory)						
		Bus	M.O	Test date						
		2A04	98060307	2/23/99						
		2A06	98060308	2/6/99						
				20,77						

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7	NOMENCLATURES											
	AR	Actio	n 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										

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Subject 4 KV SWITCHGEAR PROTECTIVE RELAY SETTING CALCULATION Sheet of

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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 $\pm (0.2\% + 10 \times 0.01 \text{V}) = \pm (0.2\% + 0.1 \text{V})$

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%.

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 $(0.1/\text{degree C}) \times 8^{\circ}\text{C} \times \pm 0.283\% = \pm 0.2264\%$

- d. M&TE reference standard requirement
 25% of M&TE accuracy is 0.25 x ±0.283% = ±0.07%
- e. SRSS total = $\pm (0.283^2 + 0.0083^2 + 0.2264^2 + 0.07^2)^{1/2}\% = \pm 0.369\%$

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		8.1.1	.2 Wilmar ti	mer SC-101	toleran	ce (refer to para.	126			
						ice (refer to para.	4.2.0)			
			Dry conta	ct and DC v	oltage:					
			a. N	M&TE accus	racy requ	itement				
				The sale decid	acy requ	mement				
			'	Vilmar time	r SC-101	random accurac	cy is ± 1 mill	isecond.		
			I	f the timer	neasures	approximate 10	seconds the	n 0 001 sacon	ad in	
			c	quivalent to	0.01%.	approximate 10	seconds, the	n o.oor secon	10 15	
			b. N	4 8 TE 4	No. 11 and 1					
			D. P	M&TE reada	ionity rea	quirement				
			5	Since the lea	st signifi	cant digit is 0.00	1 second for	millisecond	range,	
			I	f the timer r	neasures	10 seconds, then	0.001 secon	id is equivale	nt to	
				.0.0176						
			c. N	A&TE temp	erature r	equirement: ±0	.06%			
			d. N	A&TF refer	anna etan	ndard requiremen				
			The second secon	5% of M&7	E accura	acy is 0.25 x ±0.0	$01\% = \pm 0.00$	25%		
			e. S	RSS total =	±(0.01*	$+0.01^2+0.06^2+$	0.00252)1/296	$6 = \pm 0.062\%$		
			AC voltag	ge:						
				4075						
			a. N	A&TE accur	racy requ	urement				
			1	Wilmar time	r SC-101	random accurac	y is ± 1/4 cy	cle		
			1	t then to see	man on the same of the same of	1 4 45	the same of the sa			

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%

- M&TE temperature requirement: ±0.06% C.
- d. M&TE reference standard requirement

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

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

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8.1	1.2	Relay voltag	ge tap toleranc	e				
	8.1.2	1 Toleran	ces to be consi	dered				
					erance (refer to p	vaes 8111\		
			Random:		169%	Mila 0.1.1.1)		
			Voltage trans					
			Random:		3% (refer to para	422		
					(refer to para. 4.			
			Random:	Pick	sup and dropout sperature and con	settings, repe stant control	atability at co voltage = ± (onstant 0.1%
					up and dropout s wable de control			
				Harritem;	cup and dropout operature range = monic Filter (HF perature will be rand 95° F (35° C) rations (reference	±0.4% for a). The ESF s maintained be during norm	relay with SWGR room etween 50° F	(10°
			Voltage settir	ng tolera	nce			
			Random accu	racy ±0.	V (refer to par	a.3.3)		
			If the relay is 0.083%.	set near	121 V, then 0.1	V is equivale	nt to about	
			Miscellaneou	s toleran	ce			
			Random toler	ance ±0.	36% (refer to pa	ra. 3.4)		
	8.1.2.	2 TLU of	27N relay circ	uit - desi	gn limit			
		a.	27N Relay pic control power	ckup and	dropout setting.	repeatability	over allowa	ble dc
		b.	27N Pelay pi	alaun and	dropout setting.	nama ata bilita		

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			c. 21	m xerature	and cons	d dropout setting, tant control volta	repeatabilit	y at constant		
				l&TE requi			6-			
			e. V	oltage setti	ng tolera	$nce = \pm 0.083\%$				
			f. P	T tolerance	= ±0.3%					
			g. M	iscellaneou	is toleran	ice = ±0.36%				
			TLU = ±($0.1^2 + 0.4$	2 + O.1 ²	+ 0.369 ² + 0.083	$^{2} + 0.3^{2} + 0.$	36 ²) ^{1/2} % = ±0).737%	
		8.1.2.	3 Tolerance	for allowab	ie values	during surveilla	nce test (rela	ay only)		
			Voltage ser	ting tolera	nce: ±0.0	83%.				
			Miscellane	ous toleran	ce: ±0.3	86%				
			Tolerance	for allowab	le value	$=\pm(0.083^2+0.36$	$(5^2)^{1/2}\% = \pm 0.$	37%		
		8.1.2.	As-Left set	ting (relay	only)					
			±0.1 V (ref	er to para.	3.3)					

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8.1.3	3 TLU	of 27N rela	y time delay s	etting				
	8.1.3.	1 Toleran	ces to be cons	idered:				
			M&TE (WI)	mar SC 1	01) tolerance (re	for to more 1	9110	
					or) toterance (re	iei to para.	0.1.1.2)	
			Random ±0.	062%				
			27N relay to	lerance (r	refer to para. 3.6)			
			Accuracy:		±5%			
			Temperature Power supply		±0.1%			
			SRSS total =	$\pm (5^2 + 0)$	$.1^2 + 0.1^2)^{1/2}\% = $	±5.002%		
			Time setting	tolerance	:			
			Random ±0.0	02 second	1 = ±(0.02 sec. / 2	2 sec.) = ±19	% (refer to pa	ara. 3.5)
			Miscellaneou					
			Random ±8.0	66% (refe	er to para. 3.6)			
	8.1.3.	2 27N rela	ay time delay	tolerance				
		8.1.3.2.1	1 TL	J for desi	gn limit			
			SRSS total =	±(0.062	+ 5.0022 + 12+ 8	$3.66^2)^{1/2}\% = $	± 10.05%	
		8.1.3.2.2						
		0.1.5.2.			r allowable value	s during sur	ventiance test	
			Time setting Miscellaneou					
			SRSS total =	±(1° + 8	$(.66^2)^{1/2}\% = \pm 8.77$	2%		
		8.1.3.2.3	3 As-	Left settin	ng			
			±0.02 second	d (refer to	para. 3.5)			

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 THE HISTORY PLANTAGE AND ADDRESS OF THE STREET		*************			**************************************		ACCOUNTS OF THE PARTY OF THE PA	
8.1.4	TLU of	CV-2 rel	ay voltage tap)				
	8.1.4.1	Toleran	ces to be cons	idered				
			M&TE, Fluk	te 45, tol	erance - ±0.369%	(refer to pa	ra. 8.1.1.1)	
		•			accuracy - ± 0.3%		ra. 4.2.3	
		•			±3% (refer to pa			
		•			nce - ±1.29% (ref	er to para. 3	.4)	
	8.1.4.2		CV-2 relay ci					
					$3^2 + 1.29^2)^{1/2}\%$			
		be used	to verify the o	ing of the	e CV-2 relay is a y of the CV-2 rel	arbitrary set ay.	ting, this TLU	will
	8.1.4.3	As-Left	setting					
		±1% (re	efer to para. 3.	3)				
8.1.5	TLU of E4C-09	CV-2 rel 98)	ay time delay	setting(r	refer to para. 3.8 a	& Attach. 9.	10 of CCN 20	to
	8.1.5.1	Toleran	ces to be cons	idered:				
		•	M&TE, Will	mar SC-	101, tolerance (re	fer to para. I	3.1.1.2)	
			±0.062%					
			CV-2 relay to	olerance				
			±5%					
	8.1.5.2		elay time delay					
			xal = ±(0.062	$(2 + 5^2)^{1/2}$	% = ±5%			
	8.1.5.3	As-Left						
		±1% (re	efer to para. 3.	3)				

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

Tolerance for allowable values during surveillance test 8.1.6.2.2

> 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)

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	ORIGINATOR	DATE	IRE	DATE	REV	TTING CALC	DATE	IRE	DATE
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-							-		
-		Material designation of the last of the la	CANADA SANA TANA SANATSANINA S						
	8.1.7	Tolera	nce of time	delay relays	160T 1	2261			
	0.177					2,3,824			
		8.1.7.	Tolerano	es to be cons	idered:				
				M&TE (Wil	mar SC-	101) tolerance (r	efer to para.	8.1.1.2)	
				±0.062%					
				Relay accura	cy - ±10	%			
				Temperature	effect or	n accuracy (refer	to para. 3.9))	
				delays from	77°F is -2	shift in the avera	1+20% at 16	55°F.	ne
				At the SWG	R room to	5%/°F and (+20° emperature of 50°	°F, -0.206%	x 27°F = -5.5	562%
						emperature of 95	F, +0.22/%	x 18"r = +4.	.1%
				±5.562% wil	I be used	1.			
				Time setting	tolerano	e			
				±0.05 second	(refer to	para. 3.5)			
				±(0.05 sec. /	1.25 sec.	.) = ±4%			
				Miscellaneou	is tolerar	nce - ±29.3% (re	fer to para. 3	.10)	
		8.1.7.2	2 Tolerance	e of time del	ay relays	162T-1,2,3,&4			
			8.1.7.2.1	TLI	J for desi	ign limit			
				SRSS total =	±(0.062	$^2 + 10^2 + 5.562^2$	+ 42 +29.32)	12% = ±32%	
			8.1.7.2.2	Tole	erance fo	r allowable valu	es during sur	rveillance test	
				Time setting	tolerano	e - ±4%			
			1	Miscellaneou	us tolera	- ±29.3%			
				SRSS total =	±(42 + 2	$(9.3^2)^{1/2}\% = \pm 29.$	87%		
			8.1.7.2.3	As-	Left setti	ng			
				±0.05 second	l (refer to	o para. 3.5)			

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Subjec	et 4 KV SWITC	CHGEAR	PROTECTI	VE RELA	AYSE	TTING CALC	ULATIO	N Sheet	of	
REV	ORIGINATOR	DATE	IRE	DATE				IRE	T DATE T	21
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					-		-			> 00

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) $\pm (2 \sec. / 110 \sec.) = \pm 1.8\%$

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)

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Joan I	Gen		B. Lennartz				4.4	THE REAL PROPERTY OF THE PARTY	REV
8.2	27N R	elay Volt	age Setpoints						-
	8.2.1	Given	data for 27N relay setting						
		+	27N relay reset voltage a	at 4.16 KV:					
			4201.75 V (base calc. E4	4C-098, rev.	1)				
			27N relay dropout voltag	ge:					
			99.5% of relay reset (pic	kup) voltage	(refer to p	ara. 4.2.2)			
		٠	Relay circuit tolerance:						
			TLU for design limit - ± Tolerance for allowable	0.737% (refe value - ±0.37	r to para.	8.1.2.2) o para. 8.1.2	.3)		
		+	PT ratio: 4200 V/120 V	- 35 (refer to	para. 4.2	.3)			
	8.2.2	27N re	lay setting - design limit						
		PT sec	ondary voltage at 27N rela	y reset value	= 4201.7	5 V / 35 = 12	20.05 V		
		Minim Minim	um relay dropout voltage « um relay dropout primary	120.05 V x voltage = 11	0.995 (99. 9.45 V x 3	.5% of picku 5 = 4180.75	p) = 119.45 V V	/	
		TLU	= ±0.737% (refer to para = 121 V x 0.00737 = 0.8						
		Consid 121.40	er an engineering margin V,	of 0.46 V to	agree with	the existing	nominal setti	ng of	
		Nomin	al relay reset (pickup) volt			+ TLU + En + 0.89 V +	gineering ma 0.46 V	rgin	
		Nomin	al relay reset (pickup) prin	nary voltage	= 121.40 N	/ x 35 = 424	9.00 V		
			al relay dropout voltage al relay dropout primary v				7		
		Maxim	num relay reset (pickup) vo			TLU + Eng + 0.89 V + 0	ineering mars	gin	

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			- Commence of the Commence of	PART - STOREGO WALLES			Con and Million and	A DESCRIPTION OF THE PARTY OF T		H.
		Maxis	mum relay dro mum relay dro	pout voltag	ge = 122. ry voltag	75 V x 0.995 = 1 96 = 122.14 V x 3	22.14 V 35 =4274.90	V		
		р.ц. ч	nin. relay drop which exceeds in in paragraph	the post acc	rident ste	KV bus is 119.45 ady state voltage E4C-098.	5 V x 35 = 4 es of 4.16 KV	180.75 V or Class 1E b	1.005 uses	
	8.2.3	27N r	elay setting -	Allowable v	alues (A	s-Found) during	surveillance	test		
		Nomi Nomi	nal relay reset nal relay reset	(pickup) vo (pickup) p	oltage =	121.40 V oltage = 121.40 V	V x 35 = 424	9.00		
		Nomi Nomi	nal relay drop nal relay drop	out voltage out primary	= 121.40 voltage	0 V x 0.995 = 12 = 120.80 V x 35	6.30 V = 4228.00 V	V		
		Toler	ance for allow	able value	= ±0 = 13	0.37% (refer to p 21 V x 0.0037 ==	ara. 8.1.2.3) 0.45 V			
		Consi	der an engine	ering margi	in of 0.46	6 V (refer to para	. 5.1 & 8.2.2	2).		
		'Minir	num relay reso	et (pickup)	voltage		TLU - Engi 0.45 V - 0.4		gin	
		Minir	num relay rese	et (pickup)	primary	voltage = 120.49	V x 35 = 42	17.15 V		
		Minir Minir	num relay dro num relay dro	pout voltag	e = 120.4 ry voltag	49 V x 0.995 = 1 e = 119.89 V x 3	19.89V 5 = 4196.15	v		
		Maxii	mum relay res	et (pickup)	voltage		+ TLU + En		argin	
		Maxii	mum relay res	et (pickup)	primary	voltage = 122.31	V x 35 = 42	280.85 V		
		Maxie	mum relay dro	pout voltag	ge = 122.	31 V x 0.995 = 1	21.70 V			
		Maxi	mum relay dro	pout prima	ry voltag	ge = 121.70 V x	35 =4259.5 \	1		
	8.2.4	27N r	elay setting -	As-Left sett	ing duri	ng surveillance te	est (refer to p	para. 8.1.2)		
			nal relay reset nal relay reset			121.40 V oltage = 121.40 '	V x 35 = 424	9.00 (1.021	p.u.)	
		Nomi Nomi	nal relay drop nal relay drop	out voltage	= 121.40 voltage	0 V x 0.995 = 12 = 120.80 V x 35	0.8 V = 4228.00 Y	V (1.016 p.u.	.)	

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			Selection Control to the Selection Control				AND THE PROPERTY OF THE PROPER	-		-
		Minir Minir Minir Minir Maxir	num relay dro num relay dro num relay dro mum relay res	et (pickup) et (pickup) pout voltag pout prima et (pickup)	voltage = primary e = 121.: ry voltage	a. 3.3) = 121.40 V - 0.1 voltage = 121.30 30 V x 0.995 = 1 e = 120.7 V x 35 = 121.40 V + 0.1 voltage = 121.5	$V \times 35 = 42$ 20.7 V = 4224.5 V V = 121.5 V	(1.016 p.u.)		
		Maxii Maxii	mum relay dro mum relay dro	pout voltag	ge = 121. ry voltag	5 V x 0.995 = 12 ge = 120.9 V x 35	0.9 V 5 =4231.5 V	(1.01 7 p.u.)		
8.3	27N r	elay time	delay setpoin	t (refer to p	para.s 3.5	& 8.1.3)				
	8.3.1	27N r	elay time dela	y - design l	imit					
		Setpo	int - 2 seconds	5						
		Desig	m limit - 2 sec	onds ± 10%	b = 2 sec	onds ± 0.2 second	d			
,	8.3.2	27N :	relay time dela	y - Allowat	de value	(As-Found setting	ig) during su	rveillance te	est	
		Setpo	int - 2 seconds							
		Allow	vable value - 2	seconds ±	8.72% -	2 seconds ± 0.17	44 second			
	8.3.3	27N r	relay time dela	y As-Left s	etting					
		2 seco	onds ± 0.02 sec	cond						

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CCN CONVERSION CCN NO. CCN -

Sut	ject	4 KV SWIT	CHGEAR	PROTECTI	VE REL	AY SE	TTING CALC	ULATION	Sheet	of	
RE	V	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	-
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- CV-2 Relay Voltage Setpoint (refer to para.s 3.3, 5.2.2, & 8.1.4) 8.4
 - 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:

$$V_{mlay} = (0.75 \text{ x rated motor voltage}) / PT ratio$$

= (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:

$$V_{\text{misy mis.}} = 89.1 \text{ V x } 0.967 = 86.16 \text{ V}$$

 $V_{\text{misy max.}} = 89.1 \text{ V x } 1.033 = 92.04 \text{ V}$

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.

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Subjec	ORIGINATOR	HGEAR	PROTECTI	VE REL	AY SE	TTING CALC	ULATION	Sheet	4
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								***************************************	- SG

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) \le 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 s Allowable limit s 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

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OF	RIGINATOR		DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	Of	T
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		Mar water was not to	MANAGED IN ANY OR PO					ANY ANY PROPERTY AND PARTY AND ANY			HE HE
	8.6	Time c	ielay rela	ay 162D-1,2,3	& 4 setpoi	int (refer	to para. 8.1.8)				
		8.6.1	Setpoint	for design lin	Tuit						
			Setpoi	nt - 110 secon	nds						
			110 se	econds ± 20%	= 110 seco	onds ± 22	seconds				
		8.6.2	Setpoin	for allowable	value						
			110 se	econds ± 16.49	% = 110 se	conds ±	18 seconds				
		8.6.3	As-Left	setting							
			110 se	econds ± 2 sec	conds						
	8.7	Time o	lelay rela	ay 162S-1,2,3	& 4 setpoi	nt (refer	to para. 8.1.6)				
		8.7.1	Setpoin	t for design lin	mit						
			Setpoi	int - 4.3 secon	ids						
			4.3 se	conds ± 4.4%	= 4.3 seco	nds ± 0.1	9 second				
		8.7.2	Setpoin	t for allowable	e value						
			4.3 se	conds ± 3.349	$% = 4.3 \sec \theta$	onds ± 0	.14 second				
		8.7.3	As-Left	setting							
			4.3 se	conds ± 0.05	seconds						
	8.8 Time delay relay 162T-1,2,3,& 4 setpoint (refer to para. 8.1.7)										
		8.8.1	Setpoin	t for design lin	mit						
			Setpo	int - 1.25 seco	onds						
			1.25 s	seconds ± 32%	= 1.25 se	conds ± (0.4 second				
		8.8.2	Setpoin	t for allowable	e value						
			1.25 8	seconds ± 29.8	87% = 1.25	seconds	± 0.37 second				
		8.8.3	As-Left	setting							
			1.25	seconds ± 0.05	seconds						1